1991-1996 CHEVROLET CAPRICE FACTORY SERVICE MANUAL



EMISSION CONTROL ABBREVIATIONS

Gasoline & Diesel

"A"

A/C

Air Conditioning

A/C-ISUS

A/C Idle Speed-Up Solenoid

A/F

Air/Fuel

AAI

Air Assist Injector

ACL

Air Cleaner (Thermostatic Air Cleaner)

ACL-BMS

ACL Bimetallic Sensor

ACL-CKV

ACL Check Valve

ACL-DV

ACL Delay Valve

ACL-PVS

ACL Ported Vacuum Switch

ACL-RDV

ACL Reverse Delay Valve

ACL-RDVS

ACL Reverse Delay Valve (Single)

ACL-TCV

ACL Thermal Control Valve

ACL-TS

ACL Temperature Sensor

ACL-TSOV

ACL Temperature Sensor Override Valve

ACL-TVS

ACL Thermal Vacuum Switch

ACL-TVV

ACL Thermal Vacuum Valve

ACL-VCDV

ACL Vacuum Control Delay Valve

ACL-VCV

ACL Vacuum Control Valve

ACL-VM

ACL Vacuum Motor

ACL-WP

ACL Wax Pellet Type Motor

ADS

Anti-Dieseling Solenoid

AFR

Air/Fuel Ratio Sensor

AFS

Air/Fuel Ratio Sensor

AIH

Air Intake Heaters

AIH-TS

AIH Temperature Sensor

AIR

Air Injection System

AIS

Air Injection System

AIS-ACV

AIS Air Control Valve

AIS-AMV

AIS Air Management Valve

AIS-ASV

AIS Air Switching Valve

AIS-BPV

AIS By-Pass Valve

AIS-CC

AIS Computer Controlled

AIS-CKV

AIS Check Valve

AIS-CSV

AIS Control Solenoid Valve

AIS-CV

AIS Combination Valve

AIS-DV

AIS Diverter Valve

AIS-IMCV

AIS Intake Manifold Change-Over Valve

AIS-MCV

AIS Manifold Change-Over Valve

AIS-PAF

AIS Pulse Air Feeder

AIS-PM

AIS Pump Motor

AIS-PV

AIS Pneumatic Valve

AIS-RV

AIS Relief Valve

AIS-SAV

AIS Secondary Air Valve

AIS-SOL

AIS Solenoid

AIS-SV

AIS Solenoid Valve

AIS-VCV

AIS Vacuum Control Valve

AIS-VSV

AIS Vacuum Switching Valve

AIS-VT

AIS Vacuum Tank

AIS-VCV

AIS Vacuum Control Valve

AIS-VSV

AIS Vacuum Switching Valve

AIV

Air Injection Valve

AIV-SOL

Air Injection Valve Solenoid

ALVW

Adjusted Loaded Vehicle Weight

AMV

Air Management Valve

AP

Air Pump Injection System

AP-ACV

AP Air Control Valve

AP-AMV

AP Air Management Valve

AP-ASRV

AP Air Switching Relief Valve

AP-ASS

AP Air Switching Solenoid

AP-ASV

AP Air Switching Valve

AP-BPV

AP By-Pass Valve

AP-CKV

AP Check Valve

AP-CS

AP Control Solenoid

AP-DCTO

AP Dual Coolant Temperature Override

AP-DLY

AP Delay Valve

AP-DV

AP Diverter Valve

AP-EADV

AP Electric Air Control Diverter Valve

AP-EAMR

AP Electric Air Management Relay

AP-EAMS

AP Electric Air Management Solenoid

AP-EAP

AP Electric Air Pump

AP-EC

AP Electromagnetic Clutch

AP-ERLY

AP Electric Air Pump Relay

AP-RDV

AP Reed Valve

AP-RV

AP Relief Valve

AP-SOL

AP Solenoid

AP-SOV

AP Shut-Off Valve

AP-SV

AP Solenoid Valve

AP-SWV

AP Switchover Valve

AP-TV

AP Transmitting Valve

AP-VCS

AP Vacuum Control Solenoid

AP-VCSV

AP Vacuum Controlled Air Shut-Off Valve

AP-VCV

AP Vacuum Control Valve

AP-VSV

AP Vacuum Switching Valve

A/T

Automatic Transmission

ATCV

Air Temperature Control Valve

"B"

BP/EGR

Backpressure EGR System

BP/EGR-BPS

BP/EGR Backpressure Sensor

BP/EGR-BPT

BP/EGR Backpressure Transducer

BP/EGR-BPV

BP/EGR Backpressure Valve

BP/EGR-BS

BP/EGR Bleed Solenoid

BP/EGR-BVSV

BP/EGR Bimetallic Vacuum Switching Valve

BP/EGR-C

BP/EGR Controller

BP/EGR-CLR

BP/EGR Cooler

BP/EGR-CS

BP/EGR Control Solenoid

BP/EGR-CTO

BP/EGR Coolant Temperature Override

BP/EGR-CV

BP/EGR Control Valve

BP/EGR-DCTO

BP/EGR Dual Coolant Temperature Override

BP/EGR-DS

BP/EGR Diagnostic Solenoid

BP/EGR-DSOL

BP/EGR Duty Solenoid

BP/EGR-DTVSW

BP/EGR Distributor Thermal Vacuum Switch

BP/EGR-DV

BP/EGR Delay Valve

BP/EGR-EET

BP/EGR Electric Transducer

BP/EGR-EPV

BP/EGR External Pressure Valve

BP/EGR-FDV

BP/EGR Forward Delay Valve

BP/EGR-LC

BP/EGR Load Control Valve

BP/EGR-PS

BP/EGR Position Sensor

BP/EGR-PT

BP/EGR Pressure Tranducer

BP/EGR-PVS

BP/EGR Ported Vacuum Switch

BP/EGR-RES

BP/EGR Reservoir

BP/EGR-RST

BP/EGR Restrictor

BP/EGR-SOL

BP/EGR Solenoid

BP/EGR-TCTVS

BP/EGR Torque Converter Thermal Vacuum Switch

BP/EGR-TCV

BP/EGR Thermal Control Valve

BP/EGR-TCVLV

BP/EGR Temperature Control Valve

BP/EGR-TS

BP/EGR Temperature Sensor

BP/EGR-TVS

BP/EGR Thermal Vacuum Switch

BP/EGR-TVV

BP/EGR Thermal Vacuum Valve

BP/EGR-VCV

BP/EGR Vacuum Control Valve

BP/EGR-VM

BP/EGR Vacuum Modulator

BP/EGR-VRV

BP/EGR Vacuum Regulator Valve

BP/EGR-VS

BP/EGR Vacuum Switch

BP/EGR-VSOL

BP/EGR Vent Solenoid

BP/EGR-VSV

BP/EGR Vacuum Switching Valve

"C"

C-4

Computer Controlled Catalytic Converter

CAC

Charge Air Cooler

CAS

Clean Air System

CB

Crankcase Breather

CB-VC

Crankcase Breather-Vapor Canister

CBPS

Coasting By-Pass System

CBVC

Crankcase Breather Vapor Canister

CCIEV

Coolant Controlled Idle Enrichment Valve

CCS

Controlled Combustion System

CCV

Closed Crankcase Ventilation

CD-REGVLV

Crankcase Depression Regulator Valve

CDRV

Crankcase Depression Relief Valve

CEAB

Cold Engine Air Bleed

CEAB-TVS

CEAB Thermal Vacuum Switch

CEAB-TVV

CEAB Thermal Vacuum Valve

CEC

Computerized Engine Controls

CESS

Cold Engine Sensor Switch

CETS

Cold Engine Temperature Switch

CFI

Continuous Fuel Injection

CMH

Cold Mixture Heater

CNG

Compressed Natural Gas

CO

Carbon Monoxide

CO2

Carbon Dioxide

CPI

Central Port Injection

CRV

Coasting Richer Valve

CSI

Central Sequential Injection

CTAVS

Cold Temperature Activated Vacuum System

CTOX

Continous Trap Oxidizer

"D"

DCLV

Deceleration Valve

DCS

Deceleration Control System

DDI

Direct Diesel Injection

DFI

Direct Diesel Injection

DI

Direct Injection

DKV

Deceleration Kick Valve

DMCV

Deceleration Mixture Control Valve

DMS

Dual Manifold System

DOC

Diesel Oxidation Catalyst

DOHC

Dual Overhead Cam

DPF

Diesel Particulate Filter

DPFE

Differential Pressure Feedback EGR Valve

DPFEGR

Differential Pressure Feedback EGR Valve

DTM

Deceleration Throttle Modulator

"E"

EAIR

Electric Air Injection System

EAIR-DV

EAIR Diverter Valve

ECM

Electronic Control Module

ECU

Electronic Control Unit

EDC

Electronic Diesel Control

EDS

Electronic Diesel System

EEC

Electronic Engine Control

EFE

Early Fuel Evaporation

EFE-CKV

EFE Check Valve

EFE-CV

EFE Control Valve

EFE-DTVS

EFE Delay Thermal Vacuum Switch

EFE-HTR

EFE Heater

EFE-HCV

EFE Heat Control Valve

EFE-OTS

EFE Oil Temperature Switch

EFE-PTC

EFE Positive Temperature Coefficient (Intake Heater Grid)

EFE-PVS

EFE Ported Vacuum Switch

EFE-SOL

EFE Solenoid

EFE-TVS

EFE Thermal Vacuum Switch

EFE-TVV

EFE Thermal Vacuum Valve

EFE-VSV

EFE Vacuum Switching Valve

EFI

Electronic Fuel Injection

EFI-MA

EFI Mass Airflow Sensor

EFI-MAF

EFI Mass Airflow Sensor

EGR

Exhaust Gas Recirculation System

EGR-BCS

EGR Boost Check Solenoid

EGR-BPBV

EGR By-Pass Backpressure Valve

EGR-BPT

EGR Backpressure Transducer

EGR-BPV

EGR By-Pass Valve

EGR-BS

EGR Bleed Solenoid

EGR-BSSV

EGR Boost Sensor Solenoid Valve

EGR-BVSV

EGR Bimetallic Vacuum Switching Valve

EGR-C

EGR Controller

EGR-CC

EGR Coolant Controlled

EGR-CLR

EGR Cooler

EGR-VSOL

EGR Vacuum Solenoid

EGR-CKV

EGR Check Valve

EGR-CS

EGR Control Solenoid

EGR-CSOL

EGR Cut-Off Solenoid

EGR-CSV

EGR Control Solenoid

EGR-CTO

EGR Coolant Temperature Override

EGR-CTS

EGR Charge Temperature Sensor

EGR-CTSW

EGR Charge Temperature Switch

EGR-CTTS

EGR Coolant Temperature Thermoswitch

EGR-CV

EGR Control Valve

EGR-CVCV

EGR Constant Vacuum Control Valve

EGR-CVS

EGR Control Vent Solenoid

EGR-DC

EGR Digital Control

EGR-DCTO

EGR Dual Coolant Temperature Override

EGR-DPFE

Differential Pressure Feedback EGR Sensor

EGR-DPFS

EGR Differential Pressure Feedback Sensor

EGR-DS

EGR Diagnostic Solenoid

EGR-DSOL

EGR Duty Solenoid

EGR-DTVS

EGR Delay Thermal Vacuum Switch

EGR-DTVSW

EGR Distributor Thermal Vacuum Switch

EGR-DV

EGR Delay Valve

EGR-EPRS

EGR Exhaust Pressure Regulator Solenoid

EGR-EPRV

EGR Exhaust Pressure Regulator Valve

EGR-EPV

EGR External Pressure Valve

EGR/EVAP-CSV

EGR/EVAP Control Solenoid Valve

EGR-EVR

EGR Vacuum Regulator

EGR-EVRV

EGR Electronic Vacuum Regulator Valve

EGR-FDV

EGR Forward Delay Valve

EGR-FJS

EGR Floor Jet System

EGR-FPS

EGR Feedback Pressure Sensor

EGR-LCV

EGR Load Control Valve

EGR-MAP

EGR Manifold Absolute Pressure Sensor

EGR-PFE

EGR-PFE Sensor

EGR-PS

EGR Position Sensor

EGR-PSW

EGR Pulse Switch

EGR-PVS

EGR Ported Vacuum Switch

EGR-REG

EGR Regulator

EGR-RES

EGR Reservoir

EGR-RST

EGR Restrictor

EGR-SC

EGR Signal Converter

EGR-SEC

EGR, Secondary

EGR-SEN

EGR Sensor

EGR-SOL

EGR Solenoid

EGR-SU

EGR Switchover Valve

EGR-SUB

Sub-EGR Valve

EGR-SVV

EGR Solenoid Vacuum Valve

EGR-T

EGR Temperature Sensor

EGR-TC

EGR Transmission Controlled

EGR-TCTVS

EGR Torque Converter Thermal Vacuum Switch

EGR-TCV

EGR Thermal Control Valve

EGR-TCVLV

EGR Temperature Control Valve

EGR-TRANS

EGR Transducer

EGR-TS

EGR Temperature Sensor

EGR-TSW

EGR Temperature Switch

EGR-TVD

EGR Throttle Valve Diaphragm

EGR-TVS

EGR Thermal Vacuum Switch

EGR-TVSOL

EGR Throttle Valve Solenoid

EGR-TVV

EGR Thermal Vacuum Valve

EGR-VA

EGR Vacuum Amplifier

EGR-VCV

EGR Vacuum Control Valve

EGR-VM

EGR Vacuum Modulator

EGR-VR

EGR Vacuum Regulator

EGR-VRS

EGR Vacuum Regulator Solenoid

EGR-VRSV

EGR Vacuum Regulator Solenoid Valve

EGR-VRV

EGR Vacuum Regulator Valve

EGR-VS

EGR Vacuum Switch

EGR-VSDV

EGR Vacuum Switch Dump Valve

EGR-VSEN

EGR Vacuum Sensor

EGR-VSOL

EGR Vent Solenoid

EGR-VSS

EGR Vacuum Switching Solenoid

EGR-VST

EGR Vacuum Surge Tank

EGR-VSV

EGR Vacuum Switching Valve

EGR-VVCS

EGR Venturi Vacuum Control System

EGRB

EGR Boost Sensor

EGRC

EGR Control Solenoid

EGRC-BPT

EGR Control Backpressure Transducer

EGRC-SV

EGR Control Solenoid Valve

EHOC

Electronically Heated Oxidation Catalyst

EHTWC

Electronically Heated Three-Way Catalyst

EI

Electronic Ignition System

EIS

Electronic Ignition System

ELB

Electronic Lean Burn

EPR

Exhaust Pressure Regulator

EPR-SOL

EPR Solenoid

ESA

Electronic Spark Advance

EVAP

Fuel Evaporative System

EVAP-AAC

EVAP Auxiliary Air Control

EVAP-BPSV

EVAP By-Pass Solenoid Valve

EVAP-BVSV

EVAP Bimetallic Vacuum Switching Valve

EVAP-CAV

EVAP Canister Air Valve

EVAP-CCV

EVAP Control Canister Close Valve

EVAP-CCVSV

EVAP Control Canister Vent Shut Valve

EVAP-CCVVSV

EVAP Closed Canister Valve Vacuum Switching Valve

EVAP-CDCV

EVAP Canister Drain Cut Valve

EVAP-CKV

EVAP Check Valve

EVAP-CPCS

EVAP Canister Purge Control Solenoid

EVAP-CPCSV

EVAP Canister Purge Control Solenoid Valve

EVAP-CPCV

EVAP Canister Purge Control Valve

EVAP-CPRV

EVAP Canister Purge Regulator Valve

EVAP-CPSV

EVAP Canister Vent Shut Valve

EVAP-CPT

EVAP Canister Purge Timer

EVAP-CPTVS

EVAP Canister Purge Thermal Vacuum Switch

EVAP-CPV

EVAP Canister Vent Valve

EVAP-CPVCSV

EVAP Canister Purge Volume Control

EVAP-CPVCV

EVAP Canister Purge Volume Control Valve

EVAP-CPVDV

EVAP Canister Purge Vacuum Delay Valve

EVAP-CPVR

EVAP Canister Purge Valve Resonator

EVAP-CS

EVAP Control Solenoid

EVAP-CSPS

EVAP Control System Pressure Sensor

EVAP-CST

EVAP Canister Surge Tank

EVAP-CT

EVAP Catch Tank

EVAP-CVCS

EVAP Canister Vent Control Solenoid

EVAP-CVCV

EVAP Canister Vent Control Valve

EVAP-CVS

EVAP Canister Vent Solenoid

EVAP-CVSV

EVAP Carburetor Vent Switching Valve

EVAP-CVV

EVAP Canister Vent Valve

EVAP-DCTO

EVAP Dual Coolant Temperature Override

EVAP-DF

EVAP Drain Filter

EVAP-DPS

EVAP Differential Pressure Sensor

EVAP-DV

EVAP-Drain Valve

EVAP-EV

EVAP Emission Valve

EVAP-FBVV

EVAP Fuel Bowl Vent Valve

EVAP-FBVS

EVAP Fuel Bowl Vent Solenoid

EVAP-FCV

EVAP Fuel Cut Valve

EVAP-FLS

EVAP Fuel Level Sensor

EVAP-FOLV

EVAP Fuel Overflow Limiter Valve

EVAP-FS

EVAP Flow Switch

EVAP-FSV

EVAP Flow Switchover Valve<

EVAP-FTEV

EVAP Fuel Tank EVAP Valve

EVAP-FTPCSV

EVAP Fuel Tank Pressure Control Solenoid Valve

EVAP-FTPS

EVAP Fuel Tank Pressure Sensor

EVAP-FTS

EVAP Fuel Temperature Sensor

EVAP-FVCV

EVAP Fuel Vapor Control Valve

EVAP-FVS

EVAP Fuel Vapor Separator

EVAP-FVTS

EVAP Fuel Vapor Temperature Sensor

EVAP-FVV

EVAP Fuel Vent Valve

EVAP-FVVV

EVAP Fuel Vapor Vent Valve

EVAP-IVS

EVAP Inner Vent Solenoid

EVAP-LDP

EVAP Leak Detection Pump

EVAP-LDPAF

EVAP Leak Detection Pump Air Filter

EVAP-LDPF

EVAP Leak Detection Pump Filter

EVAP-LDPVV

EVAP Leak Detection Pump Vent Valve

EVAP-LSEP

EVAP Liquid Separator

EVAP-NVLD

EVAP Natural Vacuum Leak Detection

EVAP-ORVR

Evaporative On-Board Refueling Vapor Recovery System

EVAP-ORVRCV

Evaporative On-Board Refueling Vapor Recovery Check Valve

EVAP-ORVRFTVRV

EVAP-ORVR Fuel Tank Vapor Recirculation

EVAP-OVCV

EVAP Outer Vent Control Valve

EVAP-OWV

EVAP One-Way Valve

EVAP-PCDV

EVAP Purge Control Diaphram Valve

EVAP-PCSV

EVAP Purge Cut-Off Solenoid Valve

EVAP-PFS

EVAP Purge Flow Sensor

EVAP-PFSVVSV

EVAP Purge Flow Switching Valve Vacuum Switching Valve

EVAP-PRRV

EVAP Pressure Relief Rollover Valve

EVAP-PSVVSV

EVAP Pressure Switching Valve Vacuum Switching Valve

EVAP-PSOL

EVAP Purge Solenoid

EVAP-PSSV

EVAP Pressure Switching Solenoid

EVAP-PSVVSV

EVAP Pressure Switching Valve Vacuum Switching Valve

EVAP-PV

EVAP Purge (Frequency) Valve

EVAP-PVS

EVAP Ported Vacuum Switch

EVAP-RV

EVAP Rollover Valve

EVAP-RV/FTPS

EVAP Rollover Valve/Fuel Tank

EVAP-RVSV

EVAP Rollover Vapor Separator Valve

EVAP-SNR

EVAP Canister Sensor

EVAP-SOL

EVAP Solenoid

EVAP-SOV

EVAP Shutoff Valve

EVAP-SSV

EVAP Shut-Off Solenoid Valve

EVAP-SV

EVAP Solenoid Valve

EVAP-TC

EVAP Trap Canister

EVAP-TS

EVAP Temperature Switch

EVAP-TPBPV

EVAP Tank Pressure By-Pass Valve

EVAP-TPCS

EVAP Tank Pressure Control Solenoid

EVAP-TPCV

EVAP Tank Pressure Control Valve

EVAP-TRWV

EVAP Tree-Way Valve

EVAP-TV

EVAP Thermal Valve

EVAP-TVS

EVAP Thermal Vacuum Switch

EVAP-TVV

EVAP Thermal Vacuum Valve

EVAP-TWV

EVAP Two-Way Valve

EVAP-VC

EVAP Vapor Canister

EVAP-VCAT

EVAP Vapor Canister Air Tank

EVAP-VCF

EVAP Vapor Canister Filter

EVAP-VCSV

EVAP Vapor Canister Shut-off Valve

EVAP-VCTV

EVAP Vacuum Control Valve

EVAP-VCV

EVAP Vacuum Canister Valve

EVAP-VCVS

EVAP Vapor Canister Vent Solenoid

EVAP-VM

EVAP Vacuum Motor

EVAP-VPS

EVAP Vapor Pressure Sensor

EVAP-VPSVSV

EVAP Vapor Pressure Sensor Vacuum Switching Valve

EVAP-VS

EVAP Vacuum Sensor

EVAP-VSOL

EVAP Ventilation Solenoid

EVAP-VSOL/LDP

EVAP Ventilation Solenoid/Leak Detection Pump

EVAP-VST

EVAP Vacuum Surge Tank

EVAP-VSV

EVAP Vacuum Switching Valve

EVAP-VV

EVAP Ventilation Valve

EVRS

EGR Vacuum Regulator Solenoid

"F"

FBC

Feedback Carburetor

FCOV

Fuel Change Over Valve

FF

Flex Fuel

FF-CKV

Fuel Fill Check Valve

FF-FCV

Fuel Tank Fuel Cut-Off Valve

FF-FLVV

Fuel Tank Fill Limit Vent Valve

FGOV

Fuel Gravity/Overflow Valve

FGVV

Fuel Gravity Vent Valve

FI

Fuel Injected

FICD

Fast Idle Control Device

FISR

Fast Idle Solenoid Relay

FLV

Fill Limit Valve

FLVV

Fill Limiting Vent Valve

FP-CKV

Fill Pipe Check Valve

FP-RV

Fill Pipe Rollover Valve

FR

Fill Pipe Restrictor

FT-FLVV

Fuel Tank Fill Limit Vent Valve

FT-GVV

Fuel Tank Grade Vent Valve

FT-OPRV

Fuel Tank Over Pressure Vent Valve

FT-PCV

Fuel Tank Pressure Control Valve

FT-VCV

Fuel Tank Vapor Control Valve

FT-VRV

Fuel Tank Vapor Recirculation Valve

FTCV

Fuel Tank Check Valve

FTDPS

Fuel Tank Differential Pressure Sensor

FTEV

Fuel Tank EVAP Valve

FTPS

Fuel Tank Pressure Sensor

FTT

Fuel Tank Temperature Sensor

FTTS

Fuel Tank Temperature Sensor

FTV/LSV

Fuel Tank Vapor/Liquid Seperation Valve

FTVCV

Fuel Tank Vapor Control Valve

FTVPRV

Fuel Tank Ventilation Pressure Retention Valve

FVPS

Fuel Vapor Pressure Sensor

FTVV

Fuel Tank Vent Valve

FVV

Fuel Vapor Valve

"G"

GVWR

Gross Vehicle Weight Rating

"H"

HAC

High Altitude Compensator

HAFS

Heated Air Fuel Ratio Sensor

HAI

Hot Air Intake

HAS

High Altitude System

HC

Hydrocarbons

HCAC-VSV

Hydrocarbon Absorber Catalyst Vacuum Switching Valve

HDC

Heavy Duty Cooling

HDC-CTO

HDC Coolant Temperature Override

HFM-SFI

Hot Film Engine Management SFI

HIC

Hot Idle Compensator

HIM

Heated Intake Manifold

HO

High Output

HO2S

Heated Oxygen Sensor

HP

High Performance

HP

Horsepower

HPCA

Housing Pressure Cold Advance

HSC

High Swirl Combustion

"I"

IAC

Idle Air Control Valve

IACV-SW

IACV Switch

ICOM

Idle Compensator

IDI

Indirect Diesel Injection

IES

Idle Enrichment System

IMCO

Improved Combustion System

"K"

KS

Knock Sensor

"L"

LH-SFI

Hot Wire Sequential Multiport Fuel Injection

LVFD

Liquid/Vapor Fuel Discriminator

LVW

Loaded Vehicle Weight

"M"

MD-TICS

Timing & Injection rate Control System

MDP

Manifold Differential Pressure sensor

ME-SFI

Motor Electronics Sequential Fuel Injection

MFI

Multiport Fuel Injection

MFI-MAF

MFI Mass Airflow Sensor

MFLS

Main Fuel Level Sensor

MI

Mechanical Fuel Injection

MIL

Malfunction Indicator Light

M/T

Manual Transmission

"N"

NAC

Nitrogen Oxides (NOx) Adsorbing Catalyst

NLV

Non-Linear Valve

NOS

NOx Sensor

NOx

NOx Emission Control

NOxC

Nitrogen Oxide Catalyst

NOxS

Nitrogen Oxide Sensor

NOxTWC

NOx adsorptive TWC

NSC

Nitrogen Oxides (NOx) Storage Catalyst

"O"

OBD

On-Board Diagnostic System

PBD (F)/(P)

Full/Partial On-Board Diagnostic

OC

Oxidation Catalytic Converter

OHC

Overhead Cam

ORVR

On-Board Refueling Vapor Recovery

ORVR-COV

ORVR Cut-Off Valve

ORVR-CV

ORVR Control Valve

ORVR-FMV

ORVR Flow Management Valve

ORVR-FTVCV

ORVR Fuel Tank Vapor Control Valve

ORVR-FTVRV

ORVR Fuel Tank Vapor Recirculation Valve

ORVR-LV

ORVR Leveling Valve

ORVR-OCKV

ORVR Overfill Check Valve

ORVR-RCV

ORVR Refueling Control Valve

ORVR-VCV

ORVR Vapor Cut Valve

ORVR-VRV

ORVR Vapor Recirculating Valve

ORVR-VSV

ORVR Vent Shut Valve

ORVR-VV

ORVR Vent Valve

OVCV

Outer Vent Control Valve

O2S

Oxygen Sensor

"P"

PAIR

Pulsed Secondary Air Injection

PAIR-ABV

PAIR Anti-Backfire Valve

PAIR-ACOV

PAIR Air Cut-Off Valve

PAIR-ACS

PAIR Air Control Solenoid

PAIR-ACV

PAIR Air Control Valve

PAIR-AIV

PAIR Air Injection Valve

PAIR-ASCS

PAIR Air Suction Control Solenoid

PAIR-ASOV

PAIR Air Shutoff Valve

PAIR-ASS

PAIR Air Switching Solenoid

PAIR-ASV

PAIR Air Switching Valve

PAIR-ASVL

PAIR Air Suction Valve

PAIR-AVCS

PAIR Air Valve Control Solenoid

PAIR-CSV

PAIR Control Solenoid Valve

PAIR-CKV

PAIR Check Valve

PAIR-DV

PAIR Diverter Valve

PAIR-PAF

PAIR Pulse Air Feeder

PAIR-PAV

PAIR Pulse Air Valve

PAIR-RES

PAIR Resonator

PAIR-RV

PAIR Reed Valve

PAIR-SCSV

PAIR Swirl Control Solenoid Valve

PAIR-SCV

PAIR Swirl Control Valve

PAIR-SOL

PAIR Solenoid

PAIR-VSV

PAIR Vacuum Switching Valve

PCM

Powertrain Control Module

PCV

Positive Crankcase Ventilation

PCV-DOV

PCV Dual Orifice Valve

PCV-HCB

PCV Heated Crankcase Breather

PCV-HE

PCV Heating Element

PCV-PRV

PCV Pressure Regulator Valve

PCV-SOL

PCV Solenoid

PEVR

Power Enrichment Vacuum Regulator

PPM

Parts Per Million

PTOX

Periodic Trap Oxidizer

PURCV

Purge Crankcase Ventilation

PVCS

Ported Valve Control System

PVCS-A

PVCS Actuator

PVCS-CS

PVCS Control Solenoid

PVLCS

Power Valve Control System

"R"

ROV

Rollover Valve

"S"

SAI-SV

Secondary Air Injection Shutoff Valve

SAIR-CV

Secondary Air Injection Control Valve

SC

Supercharged or Super Charger

SC MFI

Supercharged Multiport Fuel Injection

SCR

Selective Catalytic Reduction

SCSV

Swirl Control Solenoid Valve

SCV

Swirl Control Valve

SCV-A

SCV Actuator

SFI

Sequential Multiport Fuel Injection

SFI-MAF

SFI Mass Airflow Sensor

SFLS

Sub-Fuel Level Sensor

SOHC

Single Overhead Cam

SPK

Spark Controls

SPK-AVM

SPK Advance Vacuum Modulator

SPK-BVSV

SPK Bimetal Vacuum Switching Valve

SPK-CC

SPK Computer Controlled

SPK-CKV

SPK Check Valve

SPK-CSSA

SPK Cold Start Spark Advance System

SPK-CSSH

SPK Cold Start Spark Hold System

SPK-CTO

SPK Coolant Temperature Override

SPK-DAVS

SPK Distributor Vacuum Advance Solenoid

SPK-DCKV

SPK Distributor Check Valve

SPK-DCTO

SPK Dual Coolant Temperature Override

SPK-DDD

SPK Dual Diaphragm Distributor

SPK-DMV

SPK Distributor Modulator Valve

SPK-DPD

SPK Dual Point Distributor

SPK-DPVS

SPK Distributor Ported Vacuum Switch

SPK-DRCV

SPK Distributor Retard Control Valve

SPK-DRS

SPK Distributor Retard Solenoid

SPK-DSVMV

SPK Distributor Spark Vacuum Modulator Valve

SPK-DTVS

SPK Distributor Thermal Vacuum Switch

SPK-DTVV

SPK Distributor Thermal Vacuum Valve

SPK-DV

SPK Delay Valve

SPK-DVA

SPK Distributor Vacuum Advance

SPK-DVAS

SPK Distributor Vacuum Advance Solenoid

SPK-DVCS

SPK Distributor Vacuum Control Solenoid

SPK-DVCSW

SPK Distributor Vacuum Controlled Switch

SPK-DVCV

SPK Distributor Vacuum Control Valve

SPK-DVDV

SPK Distributor Vacuum Delay Valve

SPK-DVRS

SPK Distributor Vacuum Retard Switch

SPK-DVRV

SPK Distributor Vacuum Regulating Valve

SPK-DVVV

SPK Distributor Vacuum Vent Valve

SPK-EAVS

SPK Electronically Actuated Vacuum Switch

SPK-EDM

SPK Electronic Distributor Modulator

SPK-EI

SPK Electronic Ignition

SPK-ESA

SPK Electronic Spark Advance

SPK-ESC

SPK Electronic Spark Control (Retard)

SPK-ESS

SPK Electronic Spark Selection

SPK-EST

SPK Electronic Spark Timing

SPK-FDV

SPK Forward Delay Valve

SPK-HPCA

SPK Housing Pressure Cold Advance

SPK-ITCS

SPK Ignition Timing Control System

SPK-ITVS

SPK Ignition Timing Vacuum Switch

SPK-NLVR

SPK Non-Linear Vacuum Regulator

SPK-OSAC

SPK Orifice Spark Advance Control

SPK-PVA

SPK Ported Vacuum Advance

SPK-PVS

SPK Ported Vacuum Switch

SPK-RDO

SPK Retard Delay Orifice

SPK-RDV

SPK Reverse Delay Valve

SPK-RDVD

SPK Reverse Delay Valve (Dual)

SPK-RDVLV

SPK Retard Delay Valve

SPK-RDVS

SPK Reverse Delay Valve (Single)

SPK-RETS

SPK Retard Switch

SPK-SC

SPK Speed Controlled

SPK-SOL

SPK Solenoid

SPK-SRRV

SPK Spark Relay Regulator Valve

SPK-TAVIA

SPK Temperature Activated Vacuum Ignition Advance

SPK-TCS

SPK Transmission Controlled Spark

SPK-TCSYS

SPK Timing Control System

SPK-TIDC

SPK Thermostatic Ignition Distributor Control

SPK-TV

SPK Thermal Valve

SPK-TVS

SPK Thermal Vacuum Switch

SPK-VACTO

SPK Vacuum Advance Coolant Temperature Override

SPK-VAS

SPK Vacuum Advance Solenoid

SPK-VAV

SPK Vacuum Advance Valve

SPK-VR

SPK Vacuum Retard

SPK-VRSW

SPK Vacuum Retard Switch

SPK-VSV

SPK Vacuum Switching Valve

SPK-VTCS

SPK Vacuum Timing Control System

SPL

Smoke Puff Limiter

SRI

Service Reminder Indicator

SSCA

Stepped Speed Control Actuator

SSCS

Stepped Speed Control Solenoid

STS

Service Throttle Soon Light

STVS

Secondary Throttle Valve System

SUB-HO2S

Sub-Heated Oxygen Sensor (after CAT)

SUB-O2S

Sub-Oxygen Sensor

SUB-TWC

Sub Three-Way Catalytic Converter

"T"

TAA

Turbo Air-To-Air

TAA

Throttle Actuator Assembly

TAB

Thermactor Air By-Pass

TAD

Thermactor Air Diverter

TAC

Thermostatic Air Cleaner

TBI

Throttle Body Injection

TBPCS

Throttle By-Pass Control System

TC

Turbo Charger

TCC

Torque Converter Clutch

TCCL

Torque Converter Control

TCD

Throttle Closing Dashpot

TC-DV

TC Delay Valve

TC-TVC

TC Thermal Vacuum Switch

TC-VS

TC Vacuum Switch

TD

Thermactor Diverter

TFT

Tank Fuel Temperature Sensor

THOS2

Third Heated Oxygen Sensor

TICV

Thermal Ignition Control Valve

TIV

Thermal Idle Valve

TK

Throttle Kicker

TLUC

Transmission Lock-Up Converter

TLUC-TVS

TLUC Thermal Vacuum Switch

TLUC-VS

TLUC Vacuum Switch

TM

Throttle Modulator

TOS

Throttle Opener System

TP

Throttle Positioner

TPI

Tuned Port Fuel Injection

TPV

Throttle Poppet Valve

TR

Thermal Reactor

TRC

Throttle Return Control

TRCS

Throttle Return Control Solenoid

TRCTL

Throttle Return Control Throttle Lever Actuator

TRSCV

Throttle Return Solenoid Control Valve

TRTVV

Temperature Regulator Thermal Vacuum Valve

TRVV

Transmission Vacuum Valve

TSOL

Throttle Solenoid

TVISD

Throttle Vacuum Idle Speed Diaphragm

TVM

Transmission Vacuum Modulator

TWC

Three-Way Catalytic Converter

TWC+OC

Three-Way + Oxidation Catalytic Converter

"V"

VA

Vacuum Advance Unit

VAC-AMP

Vacuum Amplifier

VA-CTO

VA Coolant Temperature Override

VCV

Vacuum Cut Valve

VCV-BV

VCV By-Pass Valve

VLFR

Vent Line Flow Restrictor/Anti-Trickle Fill Valve

"W"

WU

Warm-Up Catalyst

WU-OC

Warm-Up Oxidation Converter

WU-TWC

Warm-Up Three-Way Catalytic Converter

GENERAL INFORMATION

Commonly Used Abbreviations

* PLEASE READ THIS FIRST *

NOTE: **This article is intended for general information purposes only. This information may not apply to all makes and models. Not all abbreviations are covered as manufacturers add new ones every day.**

"A"

A

Amperes

ABS

Anti-Lock Brakes

ABRS

Air Bag Restraint System

AC

Alternating Current

A/C

Air Conditioning

ACCS

A/C Cycling Switch

ACCUM

Accumulator

ACCY

Accessory

ACT

Air Charge Temperature Sensor

ADJ

Adjust or Adjustable

ADV

Advance

AFS

Airflow Sensor

AI

Air Injection

AIR or A.I.R.

Air Injection Reactor

AIS

Air Injection System

Alt.

Alternator or Altitude

Amp./amp/amps

Ampere

ASCS

Air Suction Control Solenoid

ASD

Auto Shutdown

ASDM

Air Bag System Diagnostic Module

ASV

Air Suction Valve

A/T

Automatic Transmission/Transaxle

ATC

Automatic Temperature Control

ATDC

After Top Dead Center

ATF

Automatic Transmission Fluid

ATS

Air Temperature Sensor

Aux.

Auxiliary

Avg.

Average

AXOD

Automatic Transaxle Overdrive (Ford Models Only)

"B"

BAC

By-Pass Air Control

BAP

Barometric Absolute Pressure Sensor

BARO

Barometric

Batt.

Battery

Bbl.

Barrel (Example: 4-Bbl.)

BCM

Body Control Module

BHP

Brake Horsepower

BMAP

Barometric and Manifold Absolute Pressure Sensor

BOO

Brake On-Off Switch

B/P

Backpressure

BPS

Barometric Pressure Sensor

BPT

Backpressure Transducer

BTDC

Before Top Dead Center

BTSI

Brake Transmission Shift Interlock

BTU

British Thermal Unit

BVSV

Bimetallic Vacuum Switching Valve

"C"

° C

Celsius (Degrees)

Calif.

California

CANP

Canister Purge

CARB

California Air Resources Board

CAT

Catalytic Converter

CB

Circuit Breaker

CBD

Closed Bowl Distributor

cc

cubic centimeter

CCC

Close Coupled Catalyst

CCC

Computer Command Control

CCD

Computer Controlled Dwell

CCOT

Cycling Clutch Orifice Tube

CCW

Counterclockwise

CDI

Capacitor Discharge Ignition

CEC

Computerized Engine Control

CID

Cubic Inch Displacement

cm

Centimeter

CMP

Camshaft Position Sensor

CO

Carbon Monoxide

CO_2

Carbon Dioxide

Cont.

Continued

CONV

Convertible

CP

Canister Purge

CKP

Crankshaft Position Sensor

CTS

Coolant Temperature Sensor

Cu. In.

Cubic Inch

CVC

Constant Vacuum Control

CV

Check Valve or Constant Velocity

CW

Clockwise

CYL or Cyl.

Cylinder

C^3 I

Computer Controlled Coil Ignition

C^4

Computer Controlled Catalytic Converter

"D"

"D"

Drive

DC

Direct Current Or Discharge

DDD

Dual Diaphragm Distributor

Def.

Defrost

Defog.

Defogger

DERM

Diagnostic Energy Reserve Module

DFI

Digital Fuel Injection

Diag.

Diagnostic

DTC

Diagnostic Trouble Code

DIC

Driver Information Center

DIS

Distributorless Ignition System

DIST

Distribution

DLC

Data Link Connector

DOC

Diesel Oxidation Catalyst

DOHC

Double Overhead Cam

DOT

Department of Transportation

DPF

Diesel Particulate Filter

DRB-II

Diagnostic Readout Box

DVOM

Digital Volt-Ohmmeter

"E"

EACV

Electric Air Control Valve

EATX

Electronic Automatic Transaxle

EBCM

Electronic Brake Control Module

EBL

Electronic Back Light

ECM

Engine Control Module

ECT

Engine Coolant Temperature Sensor

EDIS

Electronic Distributorless Ignition System

EEC

Electronic Engine Control

EECS

Evaporative Emission Control System

EEPROM

Electronically Erasable PROM

EFE

Early Fuel Evaporation

EGO

Exhaust Gas Oxygen Sensor

EGR

Exhaust Gas Recirculation

EOT

Engine Oil Temperature

ESA

Electronic Spark Advance

ESC

Electronic Spark Control

EST

Electronic Spark Timing

EVAP

Fuel Evaporative System

EVIC

Electronic Vehicle Information Center

EVP

EGR Valve Position Sensor

EWMA

Exponentially Weighted Moving Average (MODE 6)

Exc.

Except

"F"

° F

Fahrenheit (Degrees)

F/B

Fuse Block

Fed.

Federal

FI

Fuel Injection

FICU

Fuel Injection Control Unit

FIPL

Fuel Injector Pump Lever

FLI

Fuel Level Indicator

FPR-VSV

Fuel Pressure Regulator Vacuum Switching Valve

Ft. Lbs.

Foot Pounds

FWD

Front Wheel Drive

"G"

g

grams

Gals.

gallons

GND or GRND

Ground

"H"

HAC

High Altitude Compensation

HC

Hydrocarbons

H/D

Heavy Duty

HO2S

Heated Exhaust Gas Oxygen Sensor

Hg

Mercury

Hgt.

Height

HLDT

Headlight

HO

High Output

HO2S

Heated Oxygen Sensor

HP

High Performance

HSC

High Swirl Combustion

HSO

High Specific Output

HTR

Heater

Hz

Hertz (Cycles Per Second)

"I"

IAC

Idle Air Control

IACV

Idle Air Control Valve

IAT

Intake Air Temperature

IC

Integrated Circuit

ID

Identification

I.D.

Inside Diameter

IFS

Independant Front Suspension

IFS

Inertia Fuel Shutoff (Ford)

Ign.

Ignition

IMRC

Intake Manifold Runner Control

In.

Inches

INCH Lbs.

Inch Pounds

in. Hg

Inches of Mercury

Inj.

Injector

IP

Instrument Panel

IRS

Independant Rear Suspension

ISC

Idle Speed Control

IVD

Interactive Vehicle Dynamics (Ford)

IVSV

Idle Vacuum Switching Valve

"J"

J/B

Junction Block

"K"

KAPWR

Keep Alive Power

k/ohms

kilo-ohms (1000 ohms)

kg

Kilograms (weight)

kg/cm^2

Kilograms Per Square Centimeter

KM/H

Kilometers Per Hour

KOEO

Key On, Engine Off

KOER

Key On, Engine Running

KS

Knock Sensor

kW

Kilowatt

kV

Kilovolt

"L"

L

Liter

lbs. (Lbs. when used in table)

Pounds

LCD

Liquid Crystal Display

L/D

Light Duty

LDP

Leak Detection Pump (Part of EVAP system.)

LED

Light Emitting Diode

LH

Left Hand

"M"

mA

Milliamps

MA or MAF

Mass Airflow

MAFS

Mass Airflow Sensor

MAP

Manifold Absolute Pressure

MAT

Manifold Air Temperature

Mem.

Memory

MEM-CAL

Memory Calibration Chip

mfd.

Microfarads

MFI

Multiport Fuel Injection

MICU

Multiplex Integrated Control Unit (Acura/Honda)

MIL

Malfunction Indicator Light

MPI

Multi-Point (Fuel) Injection

mm

Millimeters

MPH

Miles Per Hour

mV

Millivolts

"N"

NA

Not Available

NAC

NOx Adsorber Catalyst

NCA

No Color Available (Wiring Diagrams)

NGS

New Generation Star

N.m

Newton Meter

No.

Number

Nos.

Numbers

NOx

Oxides of Nitrogen

"O"

O_2

Oxygen

OBD

On-Board Diagnostics

OC

Oxidation Catalyst

OD

Overdrive

O.D.

Outside Diameter

OHC

Overhead Camshaft

OSS

Output Speed Sensor

O/S

Oversize

oz.

Ounce

ozs.

Ounces

"P"

"P"

Park

P/C

Printed Circuit

PCM

Powertrain Control Module

PCS

Purge Control Solenoid

PC-SOL

Purge Control Solenoid

PCV

Positive Crankcase Ventilation

PFI

Port Fuel Injection

PGM-FI

Programmed Fuel Injection

PID

Parameter Identification

PIP

Profile Ignition Pick-up

PNP

Park Neutral Position Switch

P/N

Park/Neutral

PRNDL

Park Reverse Neutral Drive Low

PROM

Programmable Read-Only Memory

psi

Pounds Per Square Inch

P/S

Power Steering

PSPS

Power Steering Pressure Switch

PTC

Positive Temperature Coefficient

PTO

Power Take-Off

Pts.

Pints

Pwr.

Power

"Q"

Qts.

Quarts

"R"

RABS

Rear Anti-Lock Brake System

RECIRC

Recirculation

RH

Right Hand

RPM

Revolutions Per Minute

RWAL

Rear Wheel Anti-Lock Brake

RWD

Rear Wheel Drive

"S"

SAS

Steering Angle Sensor

SBC

Single Bed Converter

SBEC

Single Board Engine Controller

SDARS

Satellite Digital Audio Radio Service

SES

Service Engine Soon

SFI

Sequential (Port) Fuel Injection

SIL

Shift Indicator Light

SIR

Supplemental Inflatable Restraint

SOHC

Single Overhead Cam

SOL or Sol.

Solenoid

SPFI

Sequential Port Fuel Injection

SPK

Spark Control

SPOUT

Spark Output

SRI

Service Reminder Indicator

SRS

Supplemental Restraint System (Air Bag)

STAR

Self-Test Automatic Readout

STO

Self-Test Output

SUB-O_2

Sub Oxygen Sensor

Sw.

Switch

Sys.

System

"T"

TAB

Thermactor Air By-Pass

TAC

Throttle Actuator Module

TAD

Thermactor Air Diverter

TBC

Body Control Module (General Motors)

TBI

Throttle Body Injection

TCC

Torque Converter Clutch

TDC

Top Dead Center

Temp.

Temperature

TFI

Thick Film Ignition

THERMAC

Thermostatic Air Cleaner

TPM

Tire Pressure Monitor

TPMS

Tire Pressure Monitor System

TPS

Throttle Position Sensor/Switch

TS

Temperature Sensor

TV

Thermovalve

TWC

Three-Way Catalyst

"V"

V

Valve

Vac.

Vacuum

VAF

Vane Airflow

VAPS

Variable Assist Power Steering

VCC

Viscous Converter Clutch

VCRM

Variable Control Relay Module

VIN

Vehicle Identification Number

VM

Vacuum Modulator

Volt.

Voltage

VOM

Volt-Ohmmeter (Analog)

VRV

Vacuum Regulator Valve

VSS

Vehicle Speed Sensor

VSV

Vacuum Switching Valve

"W"

W/

With

W/O

Without

WAC

Wide Open Throttle A/C Switch

WOT

Wide Open Throttle

ANTI-LOCK BRAKE SYSTEM

BRAKES Anti-Lock - Bosch 2U - "B" Body

DESCRIPTION

The Bosch 2U Anti-Lock Brake System (ABS) is designed to prevent wheel lock-up during heavy braking. This provides improved driver control and reduces the distance required to stop vehicle.

Major system components include the Electronic Brake Control Module (EBCM), speed sensors mounted at each front wheel, one rear speed sensor mounted in rear axle differential case, 2 instrument cluster warning indicators and Brake Pressure Modulator (BPM) valve assembly. Brake pressure modulator assembly houses electric pump motor and solenoid valves.

NOTE: For more information on brake system, see BRAKE SYSTEM article.

OPERATION

During normal driving and braking operations, ABS acts like a conventional braking system. Each wheel sensor constantly sends an AC voltage signal to Electronic Brake Control Module (EBCM). This information is translated to wheel rotation speed. When the EBCM detects wheel lock-up is about to occur, it activates the appropriate solenoid to pulse on and off rapidly, regulating hydraulic pressure to each wheel. A slight pulsation should be felt through brake pedal, indicating ABS is working.

BRAKE warning indicator will come on when ignition switch is turned to START position and should go off when ignition switch is turned to ON position. ANTI-LOCK indicator comes on when ignition is turned on and goes out after approximately 2 seconds. If either indicator stays on more than 30 seconds after vehicle is started, system malfunction is indicated. See DIAGNOSIS & TESTING.

Red BRAKE warning indicator will activate if parking brake is applied or brake fluid is low. Amber ANTI-LOCK indicator is controlled by EBCM and comes on if problem is detected with ABS. When indicator is on, ABS is disabled and braking is accomplished by conventional brake system. If both warning indicators are on, check conventional brake system for hydraulic system failure.

CAUTION: See ANTI-LOCK BRAKE SAFETY PRECAUTIONS article in GENERAL INFORMATION before servicing anti-lock brake system.

BLEEDING BRAKE SYSTEM

NOTE: Brake system can be bled by either manual or pressure method. Use DOT 3 brake fluid only.

MANUAL BLEEDING PROCEDURE

1. Deplete vacuum reserve from power brake booster by depressing brake pedal several times with engine

off. Fill master cylinder and keep at least half full during bleeding procedure. If master cylinder is not known or suspected to have air in bore, go to step 4). If master cylinder is known or suspected to have air in bore, go to next step.

2. Disconnect forward brakeline fitting at master cylinder. Allow fluid to flow from fitting. Tighten fitting to specification. See TORQUE SPECIFICATIONS. Have an assistant slowly depress and hold brake pedal. Loosen forward fitting. Tighten fitting while pedal is still at floor. Release brake pedal slowly. Wait 15 seconds.
3. Repeat step 2) until fluid is clear and free of air bubbles. Repeat procedure at other (rearmost) brakeline fitting on master cylinder. Master cylinder is now bled. If wheel cylinders/calipers are not suspected to have air in them, it is not necessary to bleed them.
4. If wheel cylinders/calipers are known or suspected to have air in them, raise and support vehicle. Remove bleeder valve cap from right rear wheel, place proper size box end wrench over bleeder valve. Attach one end of clear tube over valve and submerge other end in container partially filled with clean brake fluid.
5. Have an assistant slowly depress and hold brake pedal. Loosen bleeder valve to purge air from cylinder. Tighten bleeder valve and slowly release brake pedal. Wait 15 seconds. Repeat sequence until all air is removed.
6. Remove tube and wrench. Proceed to left rear, right front and left front wheels in this order. Fill master cylinder reservoir, and install cover.

PRESSURE BLEEDING PROCEDURE

1. Install Bleeder Adapter (J-29567) to brake master cylinder. Pressurize bleeder to 20-25 psi (1.41-1.76 kg/cm^2). Connect bleeder hose to adapter, and bleed air from adapter.
2. Raise and support vehicle. For rear drum brakes, manual override is required to permit fluid flow to front wheels when pressure bleeding. Use Proportioning Valve Depressor (J-39177) to hold valve stem of combination valve open during pressure bleeding.
3. Starting at right rear wheel, place proper size box end wrench over bleeder valve. Attach one end of clear tube over valve and submerge other end in container partially filled with clean brake fluid.
4. Loosen bleeder valve to purge air from cylinder. Tighten bleeder valve when air is no longer present in tube. Repeat sequence until all air is removed.
5. Remove tube and wrench. Proceed to left rear, then right front and finish at left front wheel. Remove bleeder adapter, fill master cylinder and replace cover.

DIAGNOSIS

NOTE: When using Tech 1 for diagnostics, ABS system is disabled by EBCM. ANTI - LOCK indicator will come on indicating only normal power assisted braking is available. After diagnostics have been completed using Tech 1, disconnect Tech 1 from DLC connector and turn ignition off for a least 10 seconds before road testing vehicle. This procedure is done to reset EBCM.

PRE-DIAGNOSTIC INSPECTION

When checking potential ABS system faults, check following before using DIAGNOSTIC TROUBLE CODE (DTC) CHARTS:

1. Check fuses No. 5, 11 and 37 in main fuse block.
2. Check fusible link to brake pressure modulator.
3. Ensure Electronic Brake Control Module (EBCM) connector is fully seated and tight.
4. Ensure parking brake switch is functioning properly.
5. Check ABS ground circuit for clean tight connections. Ground is located on front of left cylinder head.
6. Always perform ABS system functional check before using DIAGNOSTIC TROUBLE CODE CHARTS. See **Fig. 1**.

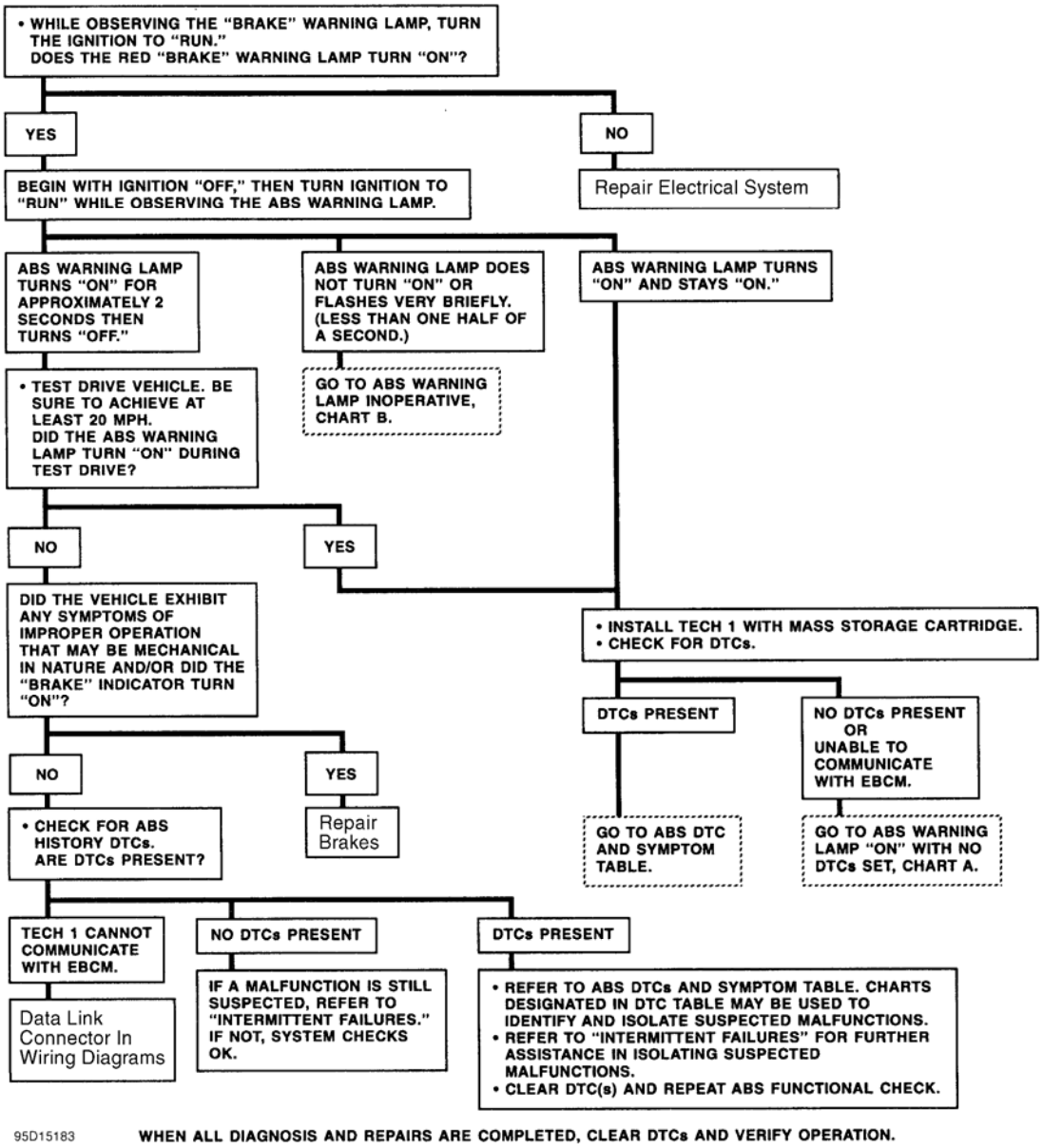


Fig. 1: Anti-Lock Brake System Functional Check
Courtesy of GENERAL MOTORS CORP.

USING TECH 1

NOTE: Tech 1 Scan Tester (94-00101-A) with Bosch ABS DLC Adapter, Pinout Boxes (J-35592 and J-41247) and High-Impedance Digital Multimeter (J-39200) will be needed to test ABS system.

1988-95 Mass Storage Cartridge (MSC) must be inserted in Tech 1 to perform diagnostic procedures on anti-lock brake system. Plug Tech 1 into DLC connector before turning ignition on. A Bosch ABS adapter is required when testing Bosch 2U anti-lock brake system.

Selecting Vehicle

Using Tech 1 function keys, select model year. After selecting model year, enter type of vehicle being tested. Press NO until "B" is flashing. Pressing EXIT will return Tech 1 to previous screen.

Selecting Test Mode

Five test modes are available for diagnosing anti-lock brake system. Test modes are:

Mode F0 (Data List)

Mode displays actual reading which each wheel speed sensor is sending to EBCM. In this mode, vehicle can be driven and wheel speed information can be observed to determine if readings are comparable to actual vehicle speed. By pressing brake pedal, status of brakelight switch can be observed.

Mode F1 (Code History)

Mode displays DTCs and description. EBCM keeps track of ignition cycles since DTC occurred. Ignition cycle information is useful in determining reason vehicle is in for service. If display indicates zero ignition cycles since DTC was set, fault is currently present. Vehicle speed information can be used to duplicate fault if an intermittent fault condition caused DTC to set. History information on up to 3 DTCs can be stored.

Mode F2 (Diagnostic Trouble Codes)

Mode displays ABS trouble codes. Tech 1 will display any DTCs and brief description of DTC displayed. If no DTC is stored, Tech 1 will display NO ABS CODES. Go to SYMPTOM DIAGNOSIS. Tech 1 will respond to a clear DTCs command by indicating ABS CODES CLEARED or CODE CLEAR FAIL.

Mode F3 (ABS Snapshot)

Mode helps isolate intermittent problems by capturing data before and after fault condition.

If MANUAL TRIGGER mode is selected, Tech 1 will wait for ENTER to be pressed before storing speed sensor information. All stored information can be displayed and examined for conditions which might indicate a problem.

If AUTOMATIC TRIGGER mode is selected, Tech 1 will capture data which deviates from normal conditions but may not set a DTC, such as driving over bumpy roads or railroad tracks. Condition may be caused by loose

connections or intermittent wiring problems. While Tech 1 is waiting for a trigger, ENTER or F9 key may be used to force a trigger.

Mode F4 (Misc Test)

This mode is used to perform following tests.

- SOLENOID VALVE PRESSURE HOLD TEST
- SOLENOID VALVE PRESSURE RELEASE TEST
- AUTOMATIC TESTS

By selecting appropriate test and observing results, error conditions and faults can be further identified.

CLEARING DIAGNOSTIC TROUBLE CODES

NOTE: Following 2 methods can be used to clear codes.

Tech 1 CLEAR CODES Selection

1. Connect Tech 1 scan tester. See USING TECH 1. Before clearing DTCs, check and note history DTC data. Select appropriate menu and CLEAR CODES function.
2. Verify DTCs are cleared. DTC 12 should be only DTC displayed. If other DTCs are displayed, either DTCs were not cleared or ABS fault still exists. Correct fault, and repeat procedure.

Ignition Cycle Default

If vehicle power is cycled 100 times without any particular fault reappearing, DTC will be erased from EBCM memory. Ignition cycle counter inside EBCM will reset to zero.

SYMPTOM DIAGNOSIS

If no DTCs are stored, use appropriate SYMPTOM DIAGNOSTIC CHARTS at end of article if necessary. See SYMPTOM DIAGNOSTIC CHART INDEX table.

SYMPTOM DIAGNOSTIC CHART INDEX

Symptom	(1) Chart
Anti-Lock Light On, No DTCs Set	"A"
Anti-Lock Light Inoperative Or Light Flashes Briefly At Ignition On	"B"
(1) See appropriate chart under SYMPTOM DIAGNOSTIC CHARTS.	

INTERMITTENTS & POOR CONNECTIONS

Failures in anti-lock brake system may be difficult to diagnose accurately. If an ABS failure or fault occurs, ANTI-LOCK indicator will glow. If fault is an intermittent problem which has corrected itself (ANTI-LOCK indicator off), history DTC will be stored.

Stored history DTC will display history data of fault at time fault occurred. Tech 1 must be used to read ABS history data. ABS self-diagnostic system can be used to help find suspect circuit. To do so:

- Record current DTCs and DTC history information. Record any descriptive driving circumstances during failure occurrence.
- Use Tech 1, mode F3 (ABS snapshot), while test driving vehicle. See USING TECH 1. Try to duplicate fault condition.
- If no DTC is stored, use SYMPTOM DIAGNOSTIC CHARTS if necessary.

Most intermittent problems are caused by faulty electrical connectors or wiring. When an intermittent failure is encountered, inspect suspect circuits as follows:

- Check for poor mating of connector halves or terminals not fully seated in connector body (backed out).
- Check for improperly formed or damaged terminals. Carefully reform all connector terminals of problem circuit to increase contact tension.
- Check for poor terminal-to-wire connection. This requires removing terminal from connector body to inspect.

Electro-Magnetic Interference (EMI) Test

Due to sensitivity of ABS components to Electro-Magnetic Interference (EMI), the following checks should be made if an intermittent fault is suspected:

- Ensure proper installation of wiring harnesses from add-on options (police packages, etc.).
- Visually inspect wheel speed sensor and tooth ring for looseness, damage, accumulation of foreign material and proper mounting.
- Ensure proper routing of front wheel speed sensor wiring harness near spark plug wires.
- Measure resistance of spark plug wires. If resistance is more than 30,000 ohms, replace spark plug wires.
- While test driving vehicle, use Tech 1 to monitor wheel speeds. If any wheel speed drops or displays an erratic speed, refer to appropriate wheel speed DTC.

SYMPTOM DIAGNOSTIC CHARTS

CHART A - ANTI-LOCK LIGHT ON, NO DTCS SET

ANTI-LOCK indicator is located on right side of instrument cluster. Battery voltage is supplied through fuse No. 11 and circuit No. 39. ANTI-LOCK indicator is grounded through circuit No. 852. Indicator is controlled by EBCM at pin No. 40.

EBCM supplies ground to indicator for approximately 2 seconds when ignition is first turned on. During first 2 seconds, EBCM will energize solenoid valve relay if no faults are detected. When relay is energized, ground circuit No. 852 through relay is open, allowing indicator to go off when EBCM indicator control line at pin No. 40 is opened.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Confirms that a fault condition exists.
2. Determines whether fault is due to a DTC setting condition, an indicator low side circuit fault, or an EBCM supply power fault.
3. Checks for an open power feed fuse.
4. Checks for an open power feed circuit.
5. Checks for an open ground circuit to the EBCM.
6. Checks for proper connection of EBCM ground circuit.
7. Checks whether open fuse is due to a short to ground.
8. Determines whether short to ground is in circuit No. 539 or the EBCM.
9. Checks for proper retention of EBCM connector.
10. Checks for damaged EBCM harness connector.
11. Checks for damaged connector (broken lift finger) on EBCM, or short to ground in circuit No. 852.

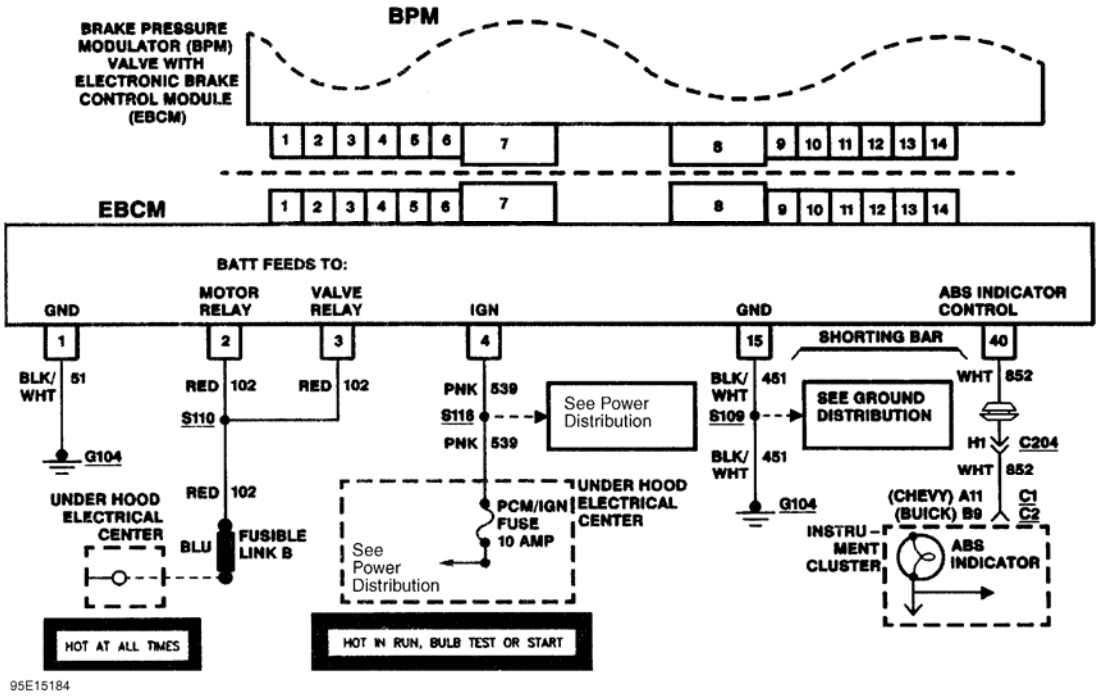


Fig. 2: Chart A Schematic
Courtesy of GENERAL MOTORS CORP.

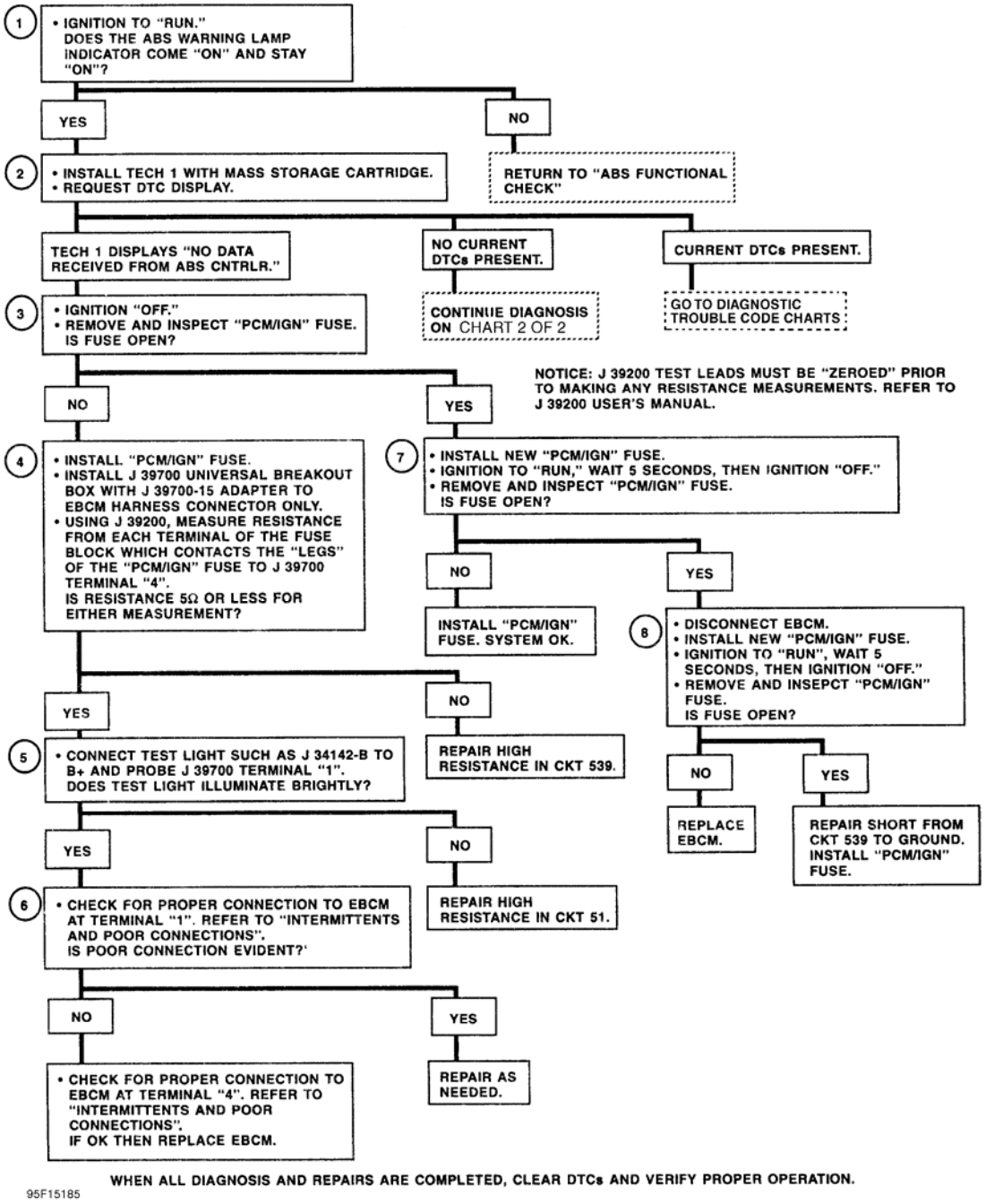


Fig. 3: Chart A Flow Chart (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

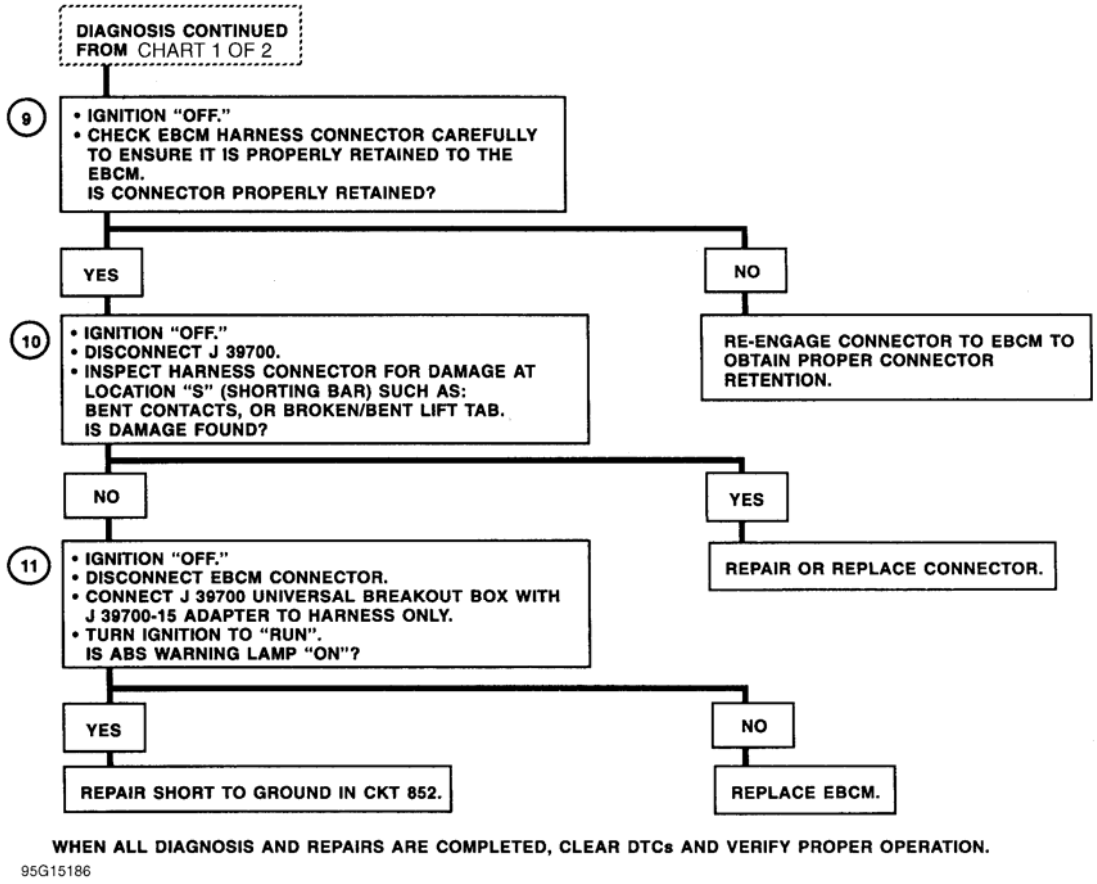


Fig. 4: Chart A Flow Chart (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

CHART B - ANTI-LOCK LIGHT INOPERATIVE OR LIGHT FLASHES BRIEFLY AT IGNITION ON

ANTI-LOCK indicator is located on right side of instrument cluster. Battery voltage is supplied through fuse No. 11 and circuit No. 39. ANTI-LOCK indicator is grounded through circuit No. 852. Indicator is controlled by EBCM at pin No. 40.

EBCM supplies ground to indicator for approximately 2 seconds when ignition is first turned on. During first 2 seconds, EBCM will energize solenoid valve relay if no faults are detected. When relay is energized, ground circuit No. 852 through relay is open, allowing indicator to go off when EBCM indicator control line at pin No. 40 is opened.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Confirms that a fault condition exists.
2. Checks to see if indicator can be turned on manually.
3. Checks for bad indicator bulb.

4. Checks for indicator low side circuit open.
5. Checks for indicator low side circuit short to voltage.

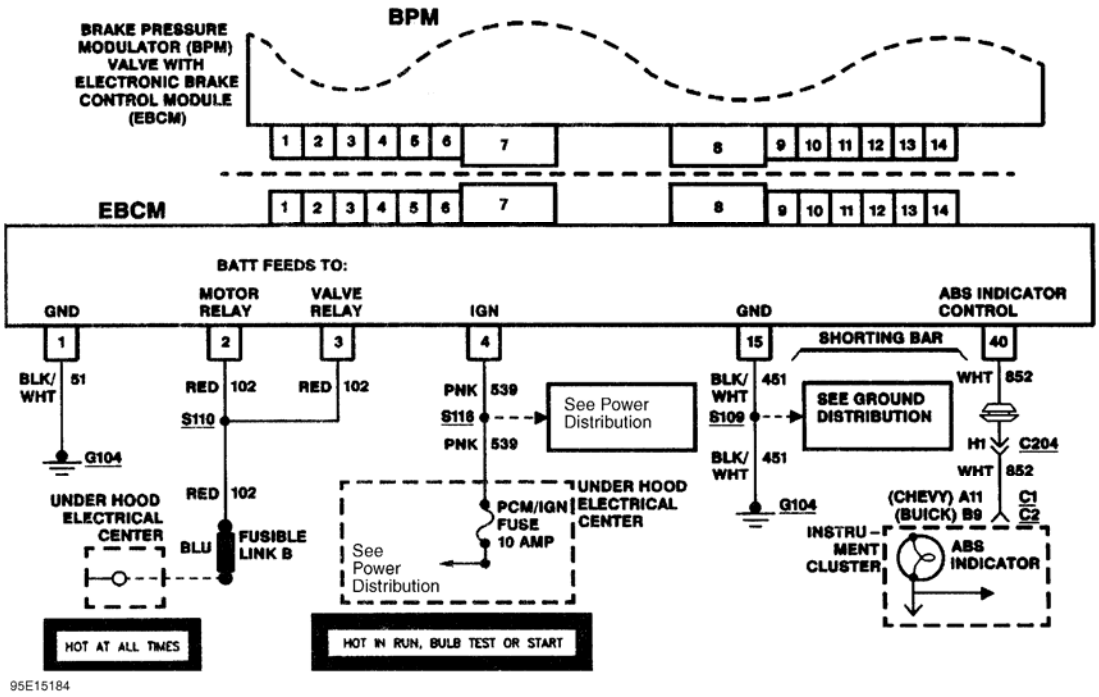


Fig. 5: Chart B Schematic
Courtesy of GENERAL MOTORS CORP.

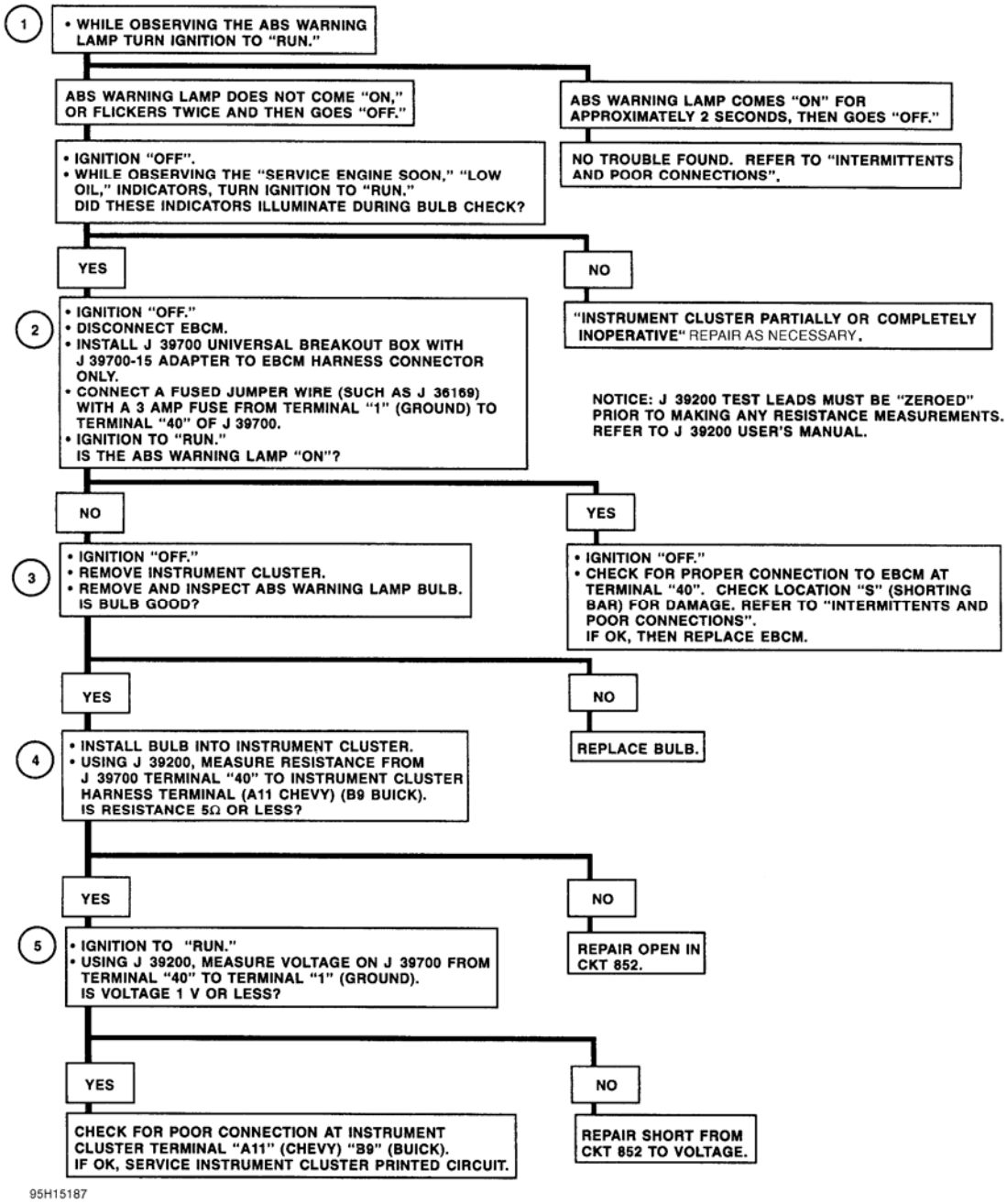


Fig. 6: Chart B Flow Chart
Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC TROUBLE CODE CHARTS

DTC 21 & 25 - FRONT WHEEL SPEED SENSOR CIRCUIT FAULT

Toothed wheel generates a voltage pulse as it moves past sensor. EBCM uses these pulses to determine wheel speed. Amount of voltage generated in each pulse depends on wheel speed and air gap between sensor and

toothed wheel.

EBCM uses wheel speed sensor signal to calculate vehicle reference speeds and individual speed, acceleration and slip values for each wheel. These values are used to determine when anti-lock control is needed.

DTC 21 or 25 will set if short to battery voltage or ground exists in circuit No. 833 or 872 (RF) or circuit No. 830 or 873 (LF). Faulty wheel speed sensor will also set DTC 21 or 25. Testing occurs when vehicle is moving. Fault will not set with ignition on and vehicle at rest.

If a fault is detected which causes a speed sensor DTC to set, anti-lock braking is disabled and EBCM turns on ANTI-LOCK indicator for remainder of ignition cycle. If failure is intermittent, EBCM will enable system at next ignition cycle and a history DTC will be present.

NOTE: To prevent electro-magnetic interference, wheel speed sensor wires are twisted together 9 times per foot of wire. If repairs are necessary, ensure wires are properly twisted, routed and secured.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for proper resistance of sensor.
2. Checks for short to voltage in either of the speed sensor circuit wires.
3. Checks for short between wheel speed sensor circuit wires.
4. Checks for short to ground in speed sensor input circuit wires. A short with a resistance less than 2 megohms, though not a hard short, can still cause DTCs to set.
5. Checks if DTC resets during road test.
6. Checks wiring and connectors for intermittents.
7. Replace wheel bearing/speed sensor assembly. If DTC resets, EBCM is concluding fault is present when no fault is present.
8. Ensures DTC is not due to electro-magnetic interference.

Diagnostic Aids

Intermittent setting of wheel speed sensor DTCs may be caused by improperly mounted sensor or improper wire routing. Improper wire routing may also cause DTC 35 to be set. Ensure sensor is mounted correctly and sensor face does not contain an accumulation of metallic particles, dirt or grease.

To aid in trouble shooting intermittent conditions, use Tech 1 while road testing vehicle. During usage of Tech 1, ABS will be disabled. If intermittent is still not identified, wet speed sensor harness on underside of vehicle and road test while monitoring wheel speeds.

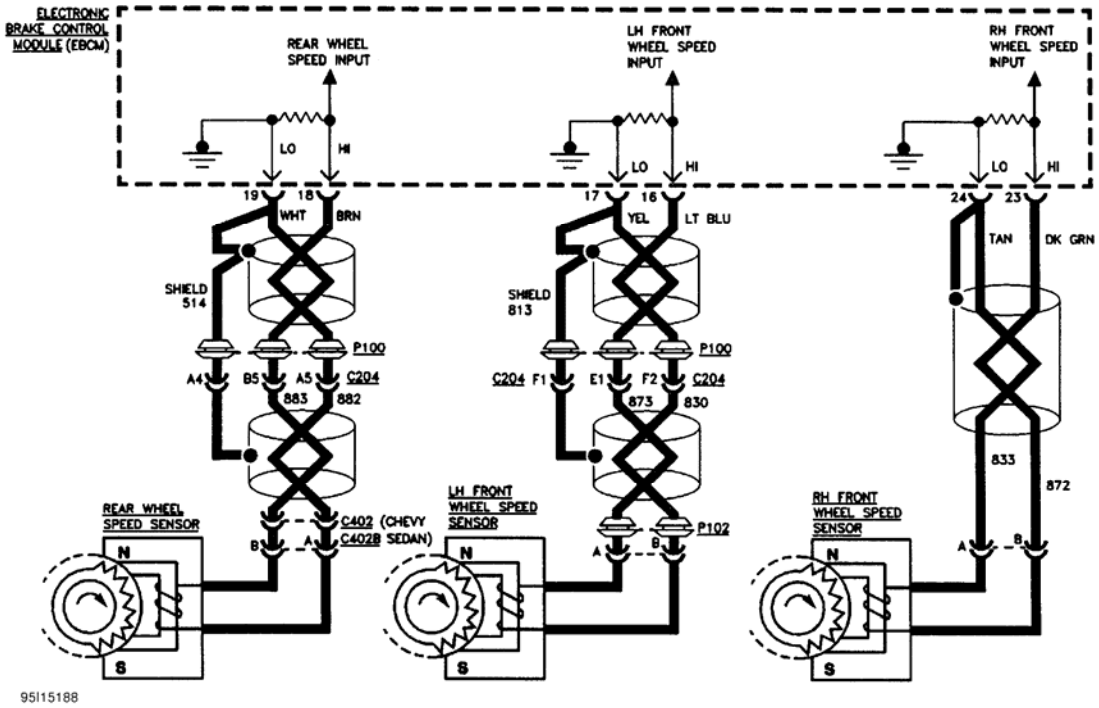


Fig. 7: DTC 21 & 25 Schematic
Courtesy of GENERAL MOTORS CORP.

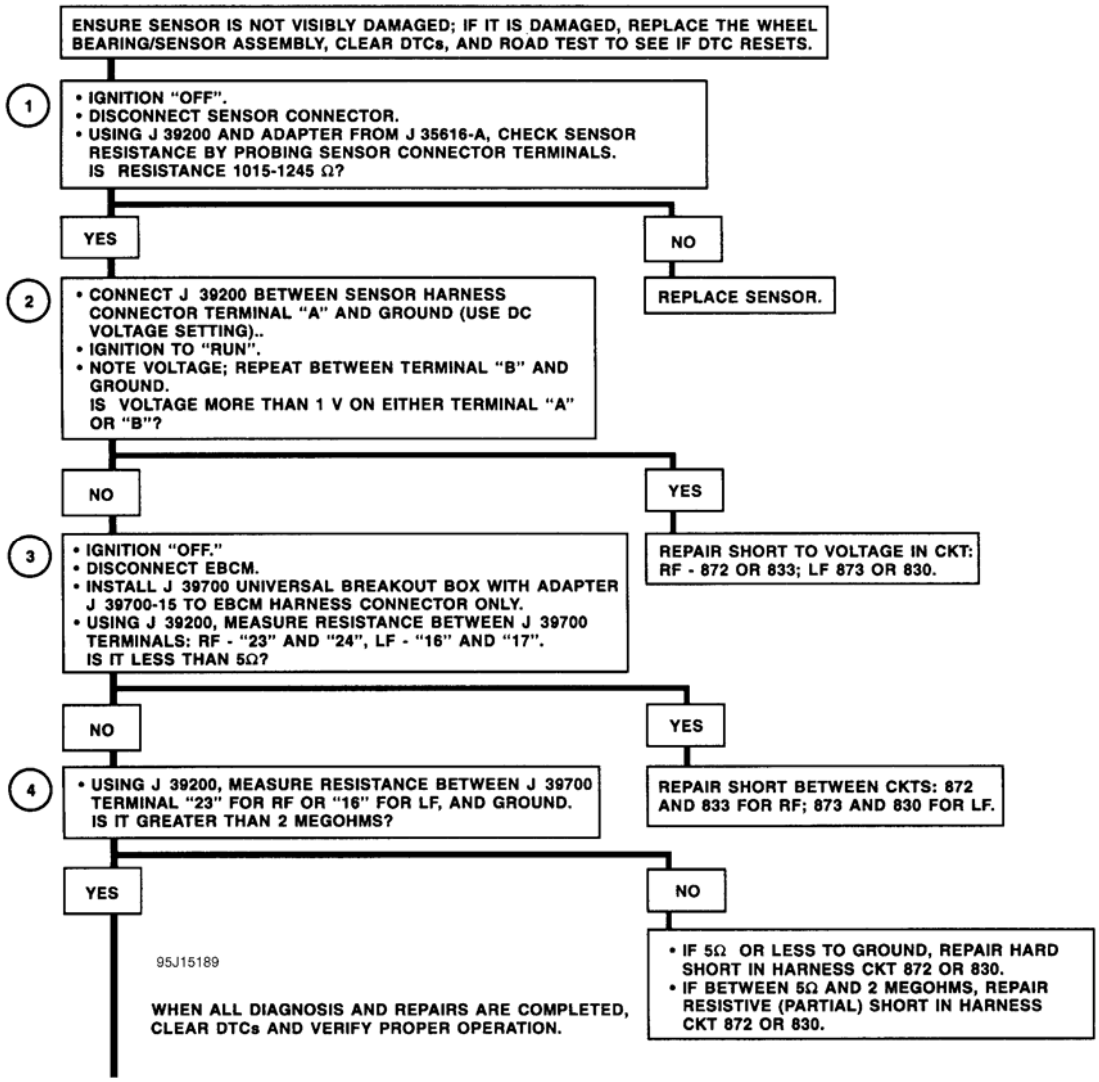


Fig. 8: DTC 21 & 25 Flow Chart (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

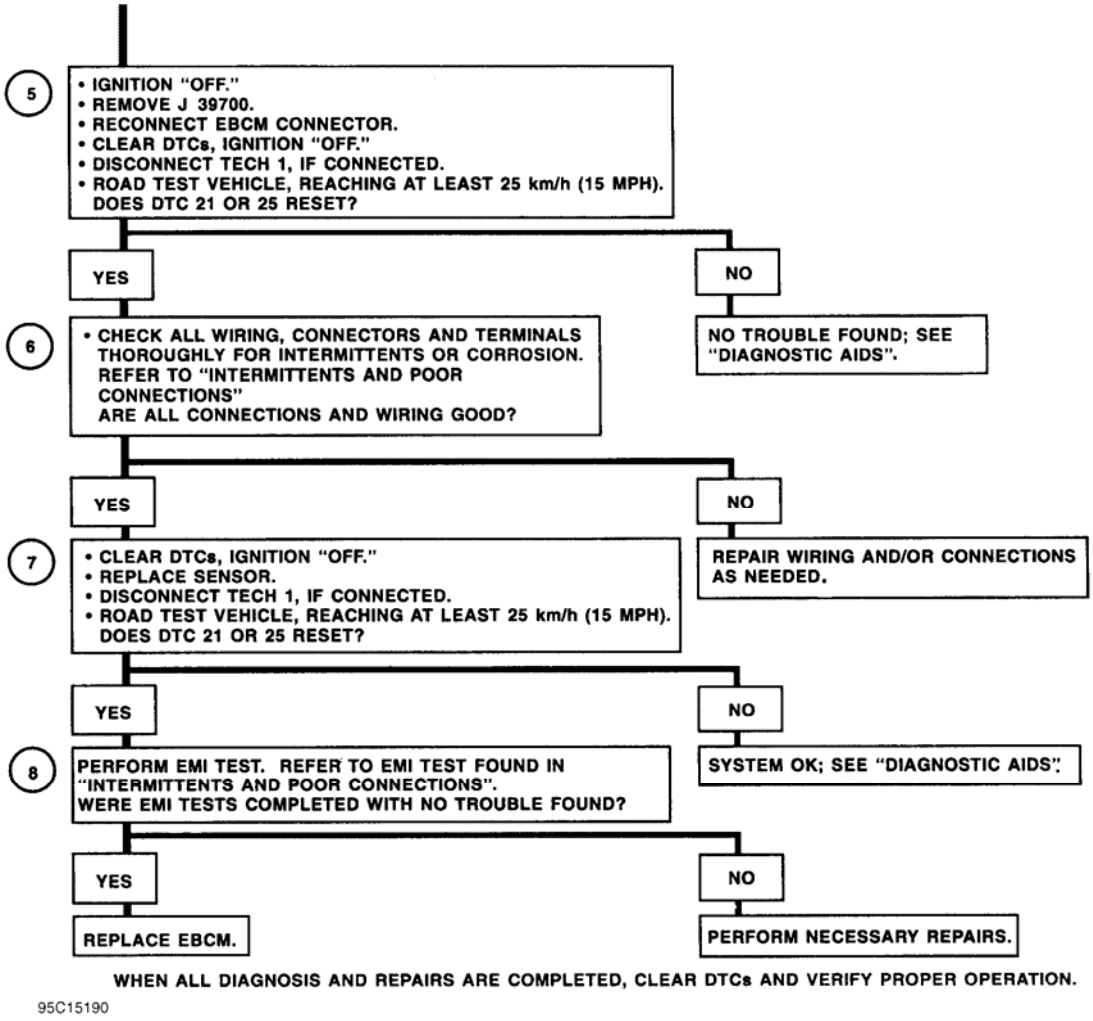


Fig. 9: DTC 21 & 25 Flow Chart (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

DTC 23, 27, & 37 - WHEEL SPEED SENSOR CONTINUITY FAULT

Toothed wheel generates a voltage pulse as it moves past sensor. EBCM uses the frequency of these pulses to determine wheel speed. Amount of voltage generated in each pulse depends on wheel speed and air gap between sensor and toothed wheel.

DTC will set when there is a short to battery voltage or open in the affected circuit, or if wheel speed sensor is malfunctioning. Testing occurs with ignition on and vehicle at rest.

If a fault is detected which causes a speed sensor DTC to set, anti-lock braking is disabled and EBCM turns on ANTI-LOCK indicator for remainder of ignition cycle. If failure is intermittent, EBCM will enable system at next ignition cycle and a history DTC will be present.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for proper resistance of sensor.
2. Checks for short to battery voltage in either of the speed sensor circuit wires.
3. Checks for open in both speed sensor circuit wires.
4. Checks wiring and connectors for intermittents.
5. Checks if DTC resets during key-up. If DTC resets, wheel bearing/speed sensor assembly may be causing DTC.
6. Checks if DTC 21, 25, or 35 sets during road test.
7. DTC 21, 25, or 35 will set with vehicle in motion. DTC 23, 27, or 37 will set with vehicle at rest. If DTC 21, 25, or 35 sets, go to appropriate chart.
8. Replace wheel bearing/speed sensor assembly. If DTC resets, EBCM is concluding fault is present when no fault is present.

Diagnostic Aids

To help prevent false signals due to electrical noise being picked up by circuit wiring, ensure wiring is properly routed and retained. To prevent misdiagnosis, conduct thorough inspection of wiring and connectors.

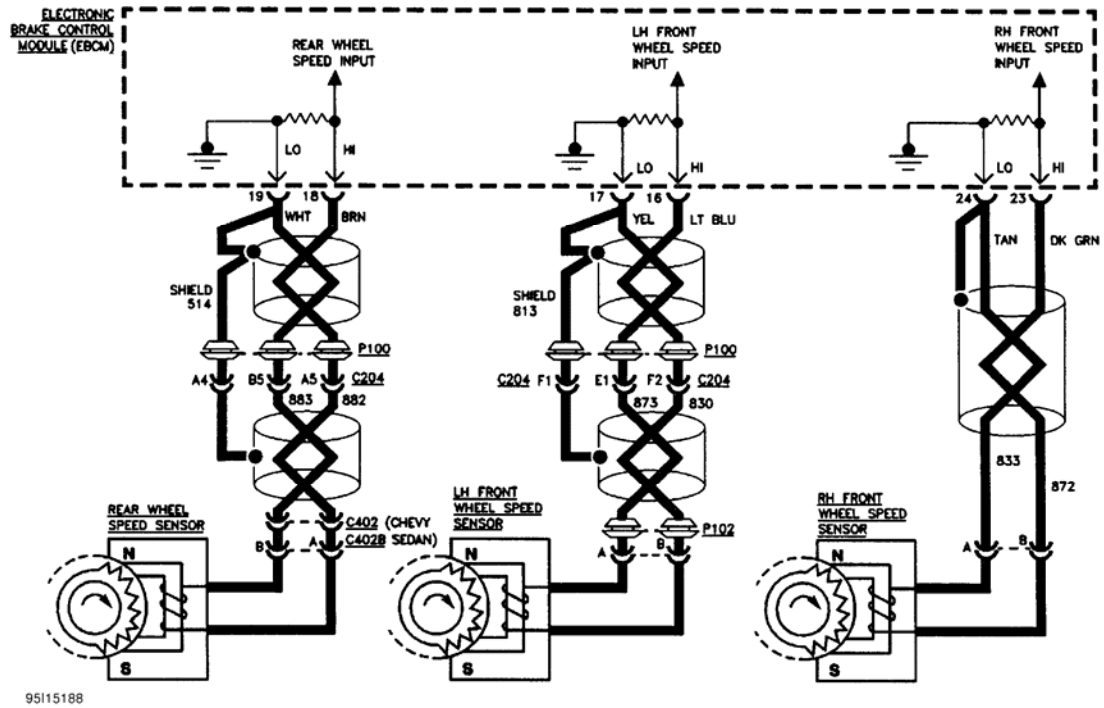


Fig. 10: DTC 23, 27, & 37 Schematic
Courtesy of GENERAL MOTORS CORP.

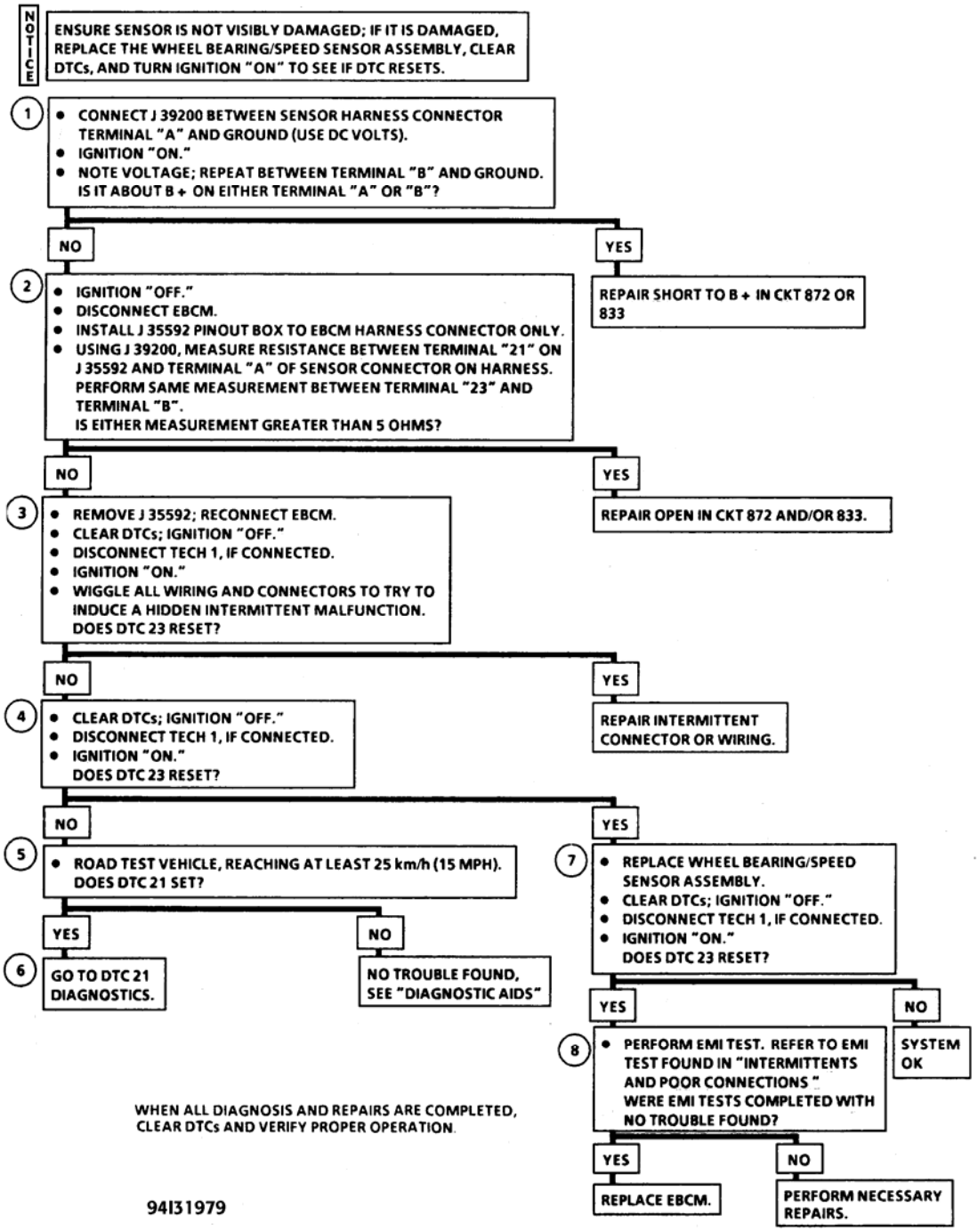


Fig. 11: DTC 23, 27, & 37 Flow Chart
Courtesy of GENERAL MOTORS CORP.

DTC 28 - WHEEL SPEED SENSOR FREQUENCY ERROR

Toothed wheel generates a voltage pulse as it moves past sensor. EBCM uses the frequency of these pulses to determine wheel speed. Amount of voltage generated in each pulse depends on wheel speed and air gap

between sensor and toothed wheel.

DTC 28 will set if EBCM cannot specifically identify which wheel speed sensor is causing frequency error. If EBCM can identify specific wheel speed sensor causing trouble, DTC for that sensor (DTC 21, 25, or 35) will be set instead of DTC 28.

If DTC 28 is set, anti-lock braking is disabled and EBCM turns on ANTI-LOCK indicator for remainder of ignition cycle. If failure is intermittent, EBCM will enable system at next ignition cycle and a history DTC 28 will be present.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks wiring and connectors. Performing this step is critical as wiring or connector malfunction is most likely cause for this DTC to set.
2. Monitors electrical system for noise picked up by wheel speed sensor circuits.
3. Monitors wheel speed sensors while vehicle is operating. If Tech 1 auto-trigger snapshot mode triggers, wheel speed sensor or wiring and/or connectors are going intermittent during road test.
4. Checks resistance of wheel speed sensor.
5. Replaces wheel speed sensor as most likely cause of intermittent.
6. Ensures DTC does not reset due to faulty EBCM.
7. Checks for short to ground in speed sensor input circuit wires. A short with a resistance of less than 2 megohms, though not a direct short, may set DTC 28.
8. Ensures DTC is not due to electro-magnetic interference.

Diagnostic Aids

Check for build-up of foreign material in gaps between teeth on toothed sensor ring. Check toothed sensor ring for large grooves, gouges and marks which may influence sensor ring signal. Excessive play in hub/bearing assembly may cause DTC to set.

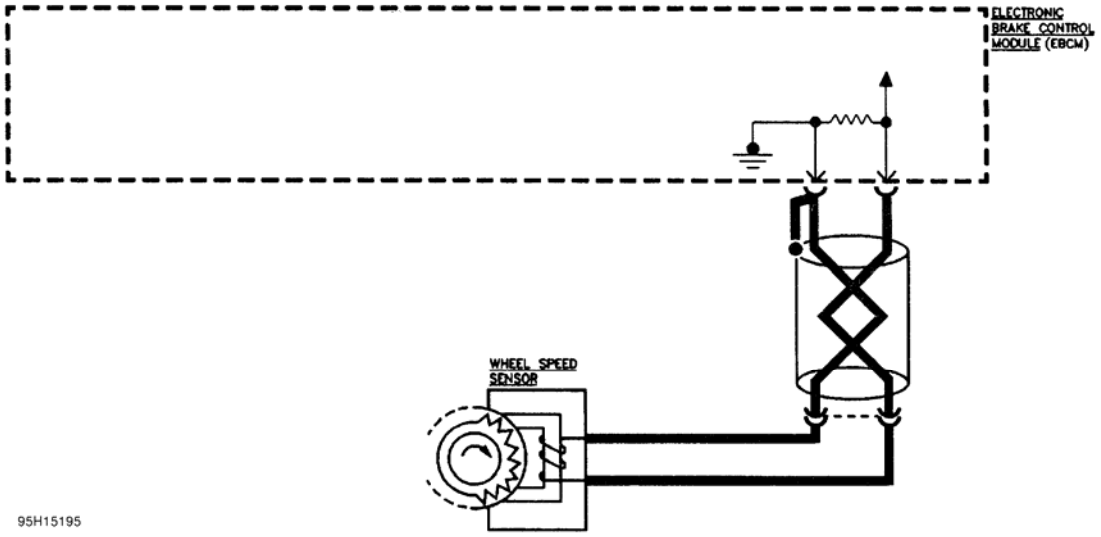


Fig. 12: DTC 28 Schematic
Courtesy of GENERAL MOTORS CORP.

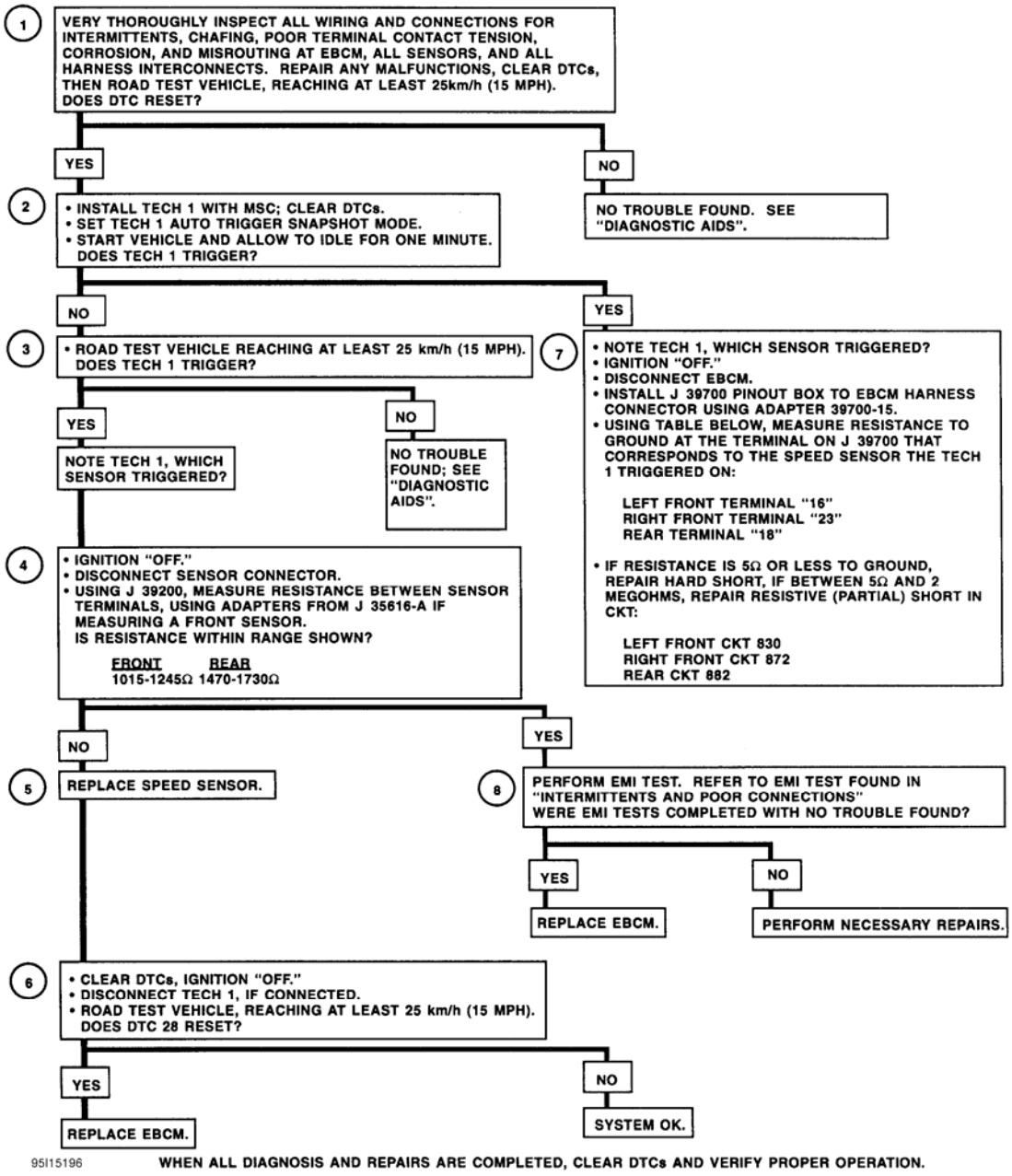


Fig. 13: DTC 28 Flow Chart
Courtesy of GENERAL MOTORS CORP.

DTC 35 - REAR WHEEL SPEED SENSOR CIRCUIT FAULT

As differential pinion gear turns, toothed wheel (mounted on differential pinion gear) generates a voltage pulse as it moves past sensor. Frequency and voltage generated is proportional to rear axle speed.

EBCM uses rear axle (wheel) speed sensor signal to calculate vehicle reference speeds and individual speed, acceleration and slip values for rear wheels. These values are used to determine when anti-lock control is

needed.

DTC 35 will set if short to battery voltage or ground exists in circuit No. 1810 or No. 1811. Faulty speed sensor will also set DTC 35. Testing occurs when vehicle is moving. DTC will not set with ignition on and vehicle at rest.

If DTC 35 is set, anti-lock braking is disabled and EBCM turns on ANTI-LOCK indicator for remainder of ignition cycle. If failure is intermittent, EBCM will enable system at next ignition cycle and a history DTC 35 will be present.

NOTE: To prevent electro-magnetic interference, wheel speed sensor wires are twisted together 9 times per foot of wire. If repairs are necessary, ensure wires are properly twisted, routed and secured.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for proper resistance of sensor.
2. Checks for short to battery voltage in either of the speed sensor circuit wires.
3. Checks for short between speed sensor circuit wires.
4. Checks for short to ground in speed sensor input circuit wires. A short with resistance of less than 2 megohms, though not a direct short, may set DTC 35.
5. Checks if DTC resets during road test.
6. Checks wiring and connectors for intermittents.
7. Checks wheel speed sensor mounting, toothed wheel and rear wheel bearing for cause of malfunction. Checks for build-up of foreign material in gaps between teeth on toothed sensor ring. Checks toothed sensor ring for large grooves, gouges and marks which may influence sensor ring signal. Inspects rear axle (wheel) speed sensor for damage and contamination.
8. Replace wheel speed sensor as likely cause of DTC reset.

Diagnostic Aids

Check for build-up of foreign material in gaps between teeth on toothed sensor ring. Check toothed sensor ring for large grooves, gouges and marks which may influence sensor ring signal. If rear axle service was performed, and toothed ring was removed, toothed ring must be replaced. Ensure sensor wires are properly twisted, routed and secured. Improper wire routing may cause DTC 21 and/or 25 to set.

To aid in trouble shooting intermittent conditions, use Tech 1 while road testing vehicle. During usage of Tech 1, ABS will be disabled. If intermittent is still not identified, wet speed sensor harness on underside of vehicle and road test while monitoring wheel speeds.

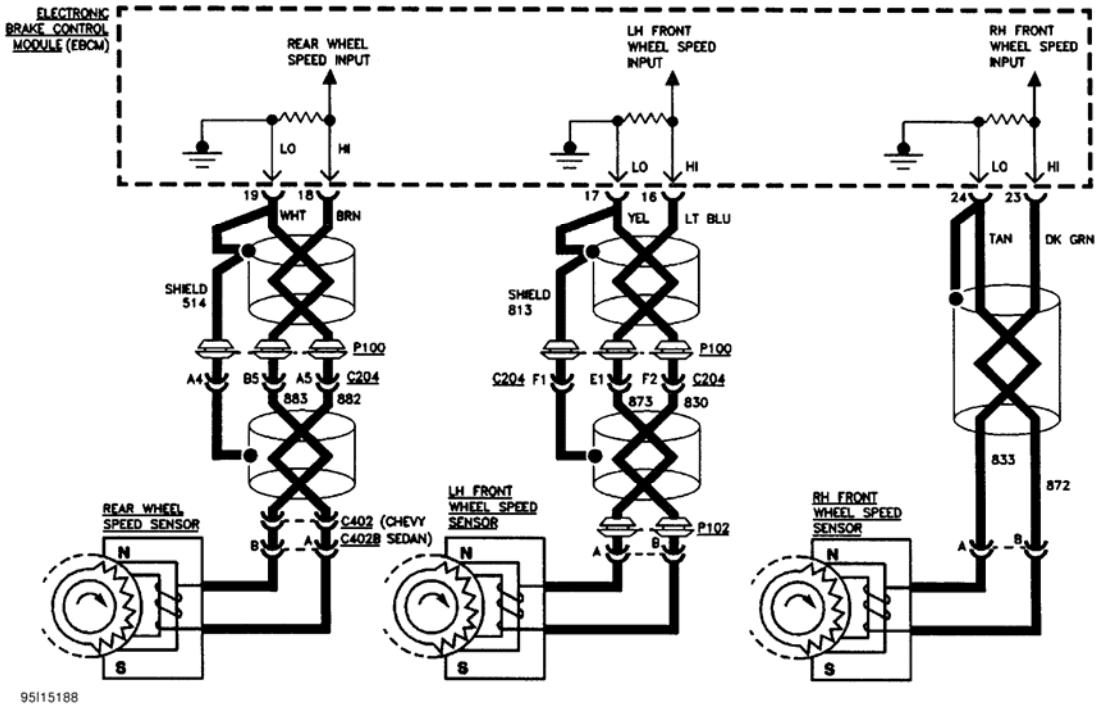


Fig. 14: DTC 35 Schematic
Courtesy of GENERAL MOTORS CORP.

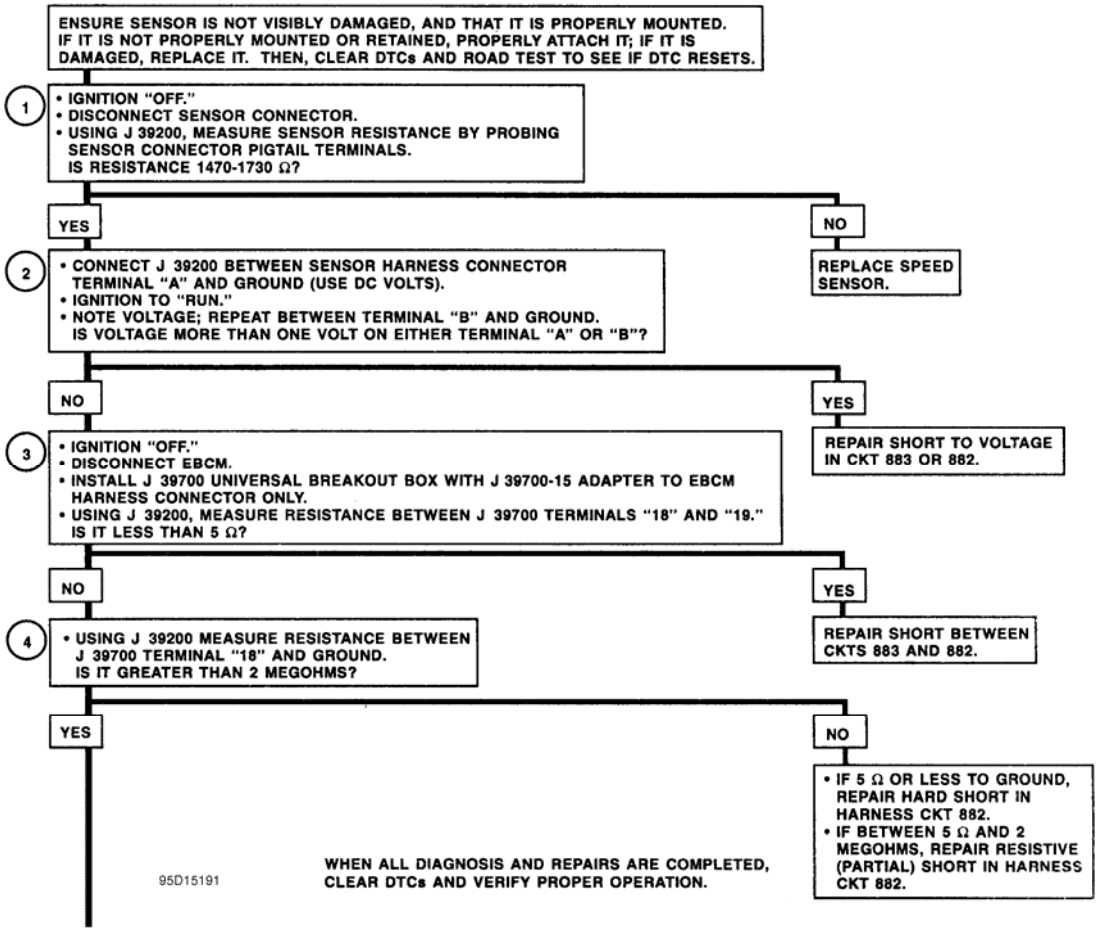


Fig. 15: DTC 35 Flow Chart (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

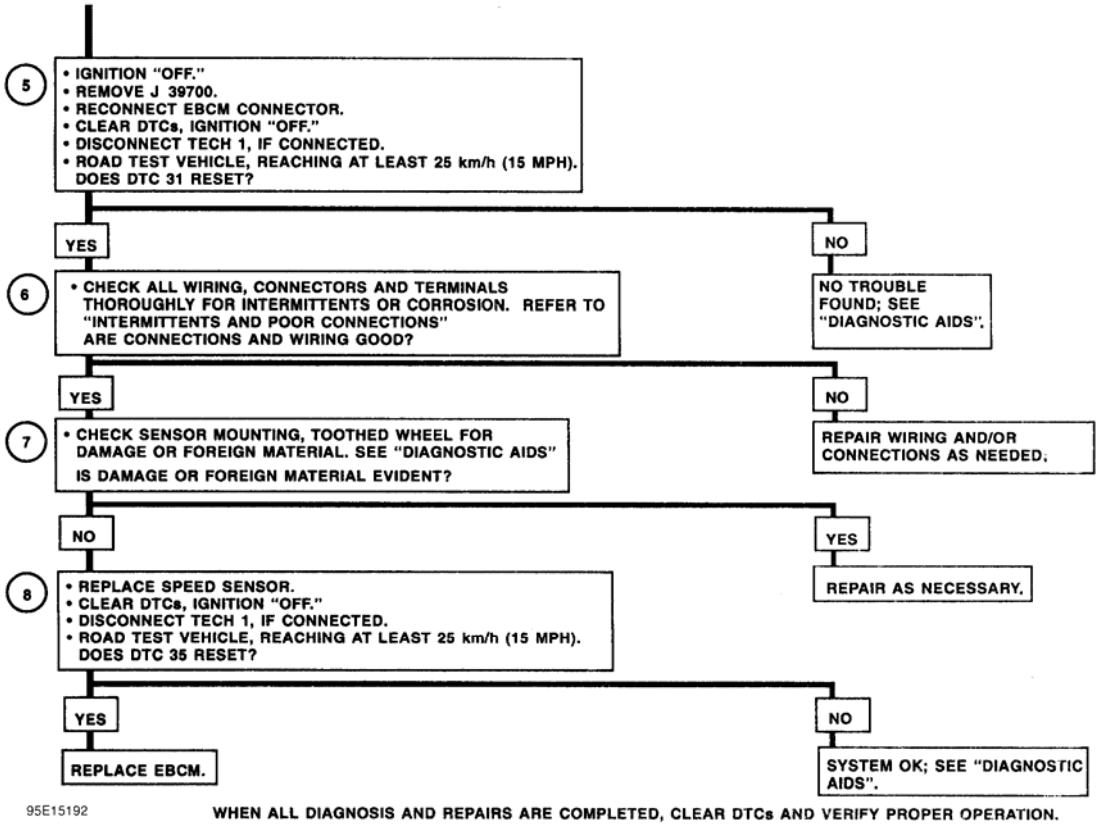


Fig. 16: DTC 35 Flow Chart (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

DTC 41, 45, & 55 - RIGHT FRONT, LEFT FRONT & REAR INLET VALVE SOLENOID FAULT

With ignition switch in RUN, BULB CHECK or START position, EBCM applies battery voltage to valve relay. EBCM will complete an internal self-check before providing ground to relay. When valve relay is energized, battery power is supplied to solenoid valves.

DTC will set when there is damage to the solenoid, open or short to ground or battery voltage in the circuit.

If a fault is detected which causes a valve DTC to set, anti-lock braking is disabled and EBCM turns on ANTI-LOCK indicator for remainder of ignition cycle. If failure is intermittent, EBCM will enable system at next ignition cycle and a history DTC will be present.

NOTE: Auto test is performed once during each ignition cycle when vehicle reaches approximately 4 MPH. Test can be heard and felt and should be considered normal. Test may also be performed using Tech 1 in MISC TESTS mode F4.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks operation of affected valve and solenoid, using Tech 1.

2. Checks condition of EBCM-to-BPM connector.
3. Checks integrity of affected valve solenoid circuitry internal to the BPM valve, and valve solenoid coil.
4. Determines whether DTC is set by an intermittent condition or an EBCM fault.
5. Checks if DTC 71 was set concurrently with valve DTC.

Diagnostic Aids

To prevent misdiagnosis, conduct thorough inspection of wiring and connectors.

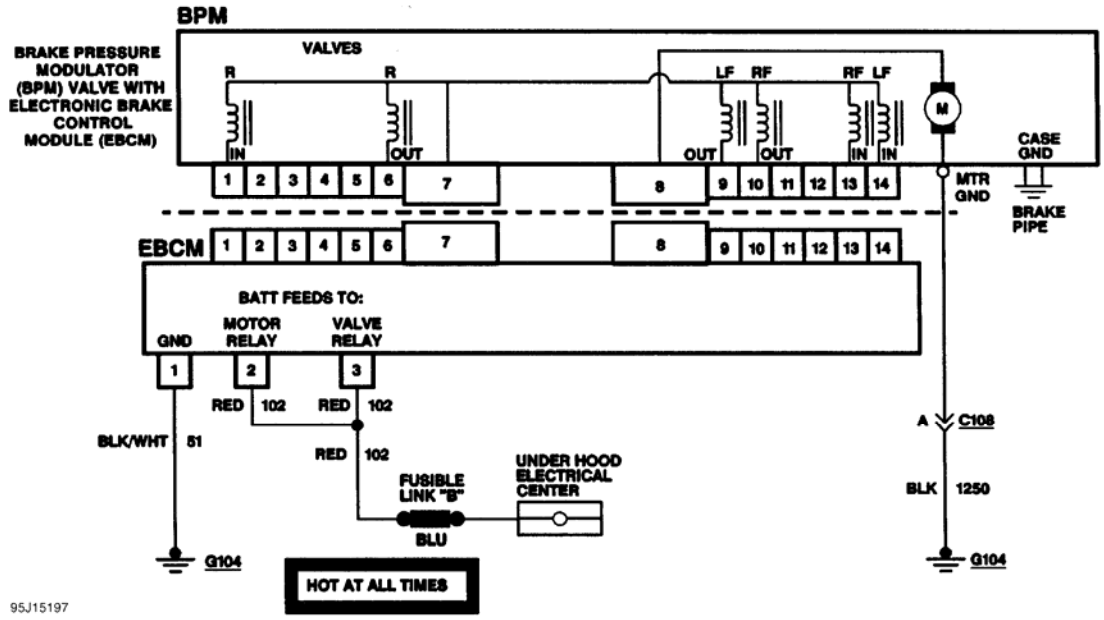


Fig. 17: DTC 41, 45, & 55 Schematic
Courtesy of GENERAL MOTORS CORP.

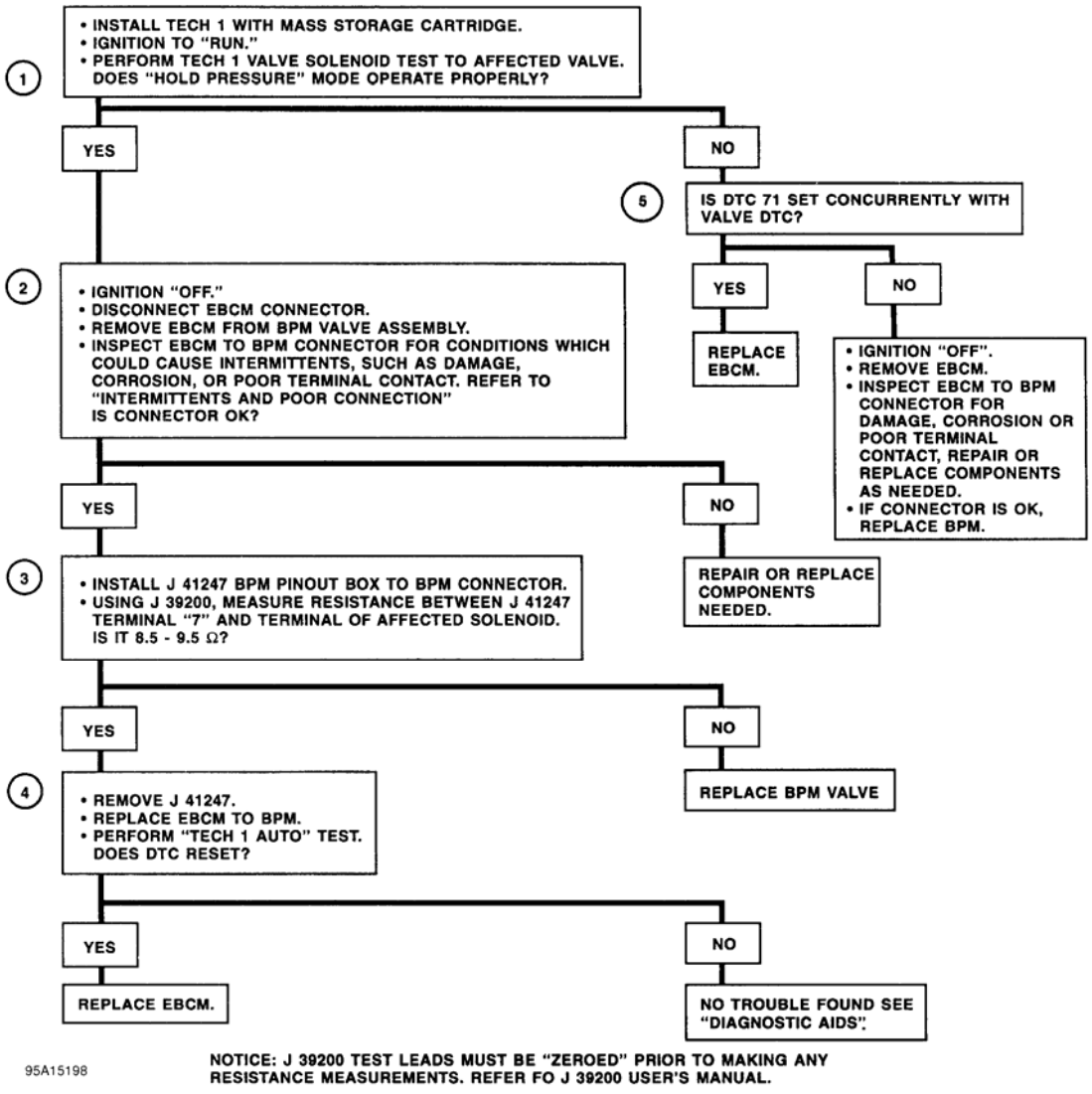


Fig. 18: DTC 41, 45, & 55 Flow Chart
Courtesy of GENERAL MOTORS CORP.

DTC 42, 46, & 56 - RIGHT FRONT, LEFT FRONT & REAR OUTLET VALVE SOLENOID FAULT

With ignition switch in RUN, BULB CHECK or START position, EBCM applies battery voltage to valve relay. EBCM will complete an internal self-check before providing ground to relay. When valve relay is energized, battery power is supplied to solenoid valves.

DTC will set when there is damage to the solenoid, open or short to ground or battery voltage in the circuit.

If a fault is detected which causes a valve DTC to set, anti-lock braking is disabled and EBCM turns on ANTI-LOCK indicator for remainder of ignition cycle. If failure is intermittent, EBCM will enable system at next ignition cycle and a history DTC will be present.

NOTE: Auto test is performed once during each ignition cycle when vehicle reaches approximately 4 MPH. Test can be heard and felt and should be considered normal. Test may also be performed using Tech 1 in MISC TESTS mode F4.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks operation of affected valve and solenoid, using Tech 1.
2. Checks condition of EBCM-to-BPM connector.
3. Checks integrity of affected valve solenoid circuitry internal to the BPM valve, and valve solenoid coil.
4. Determines whether DTC is set by an intermittent condition or an EBCM fault.
5. Checks if DTC 71 was set concurrently with valve DTC.

Diagnostic Aids

To prevent misdiagnosis, conduct thorough inspection of wiring and connectors.

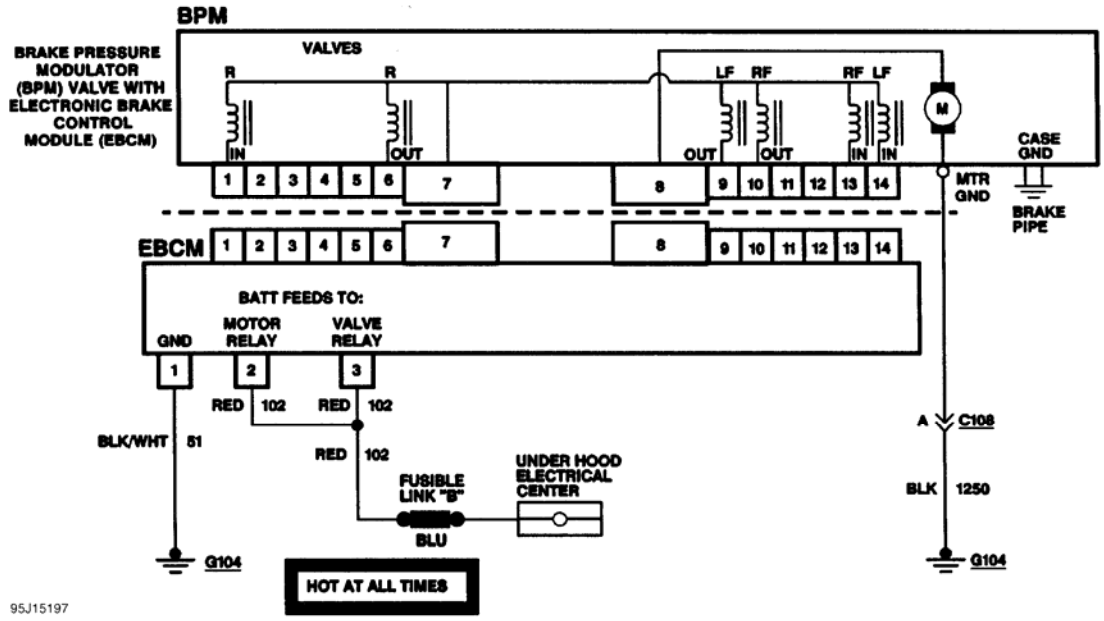


Fig. 19: DTC 42, 46, & 56 Schematic
Courtesy of GENERAL MOTORS CORP.

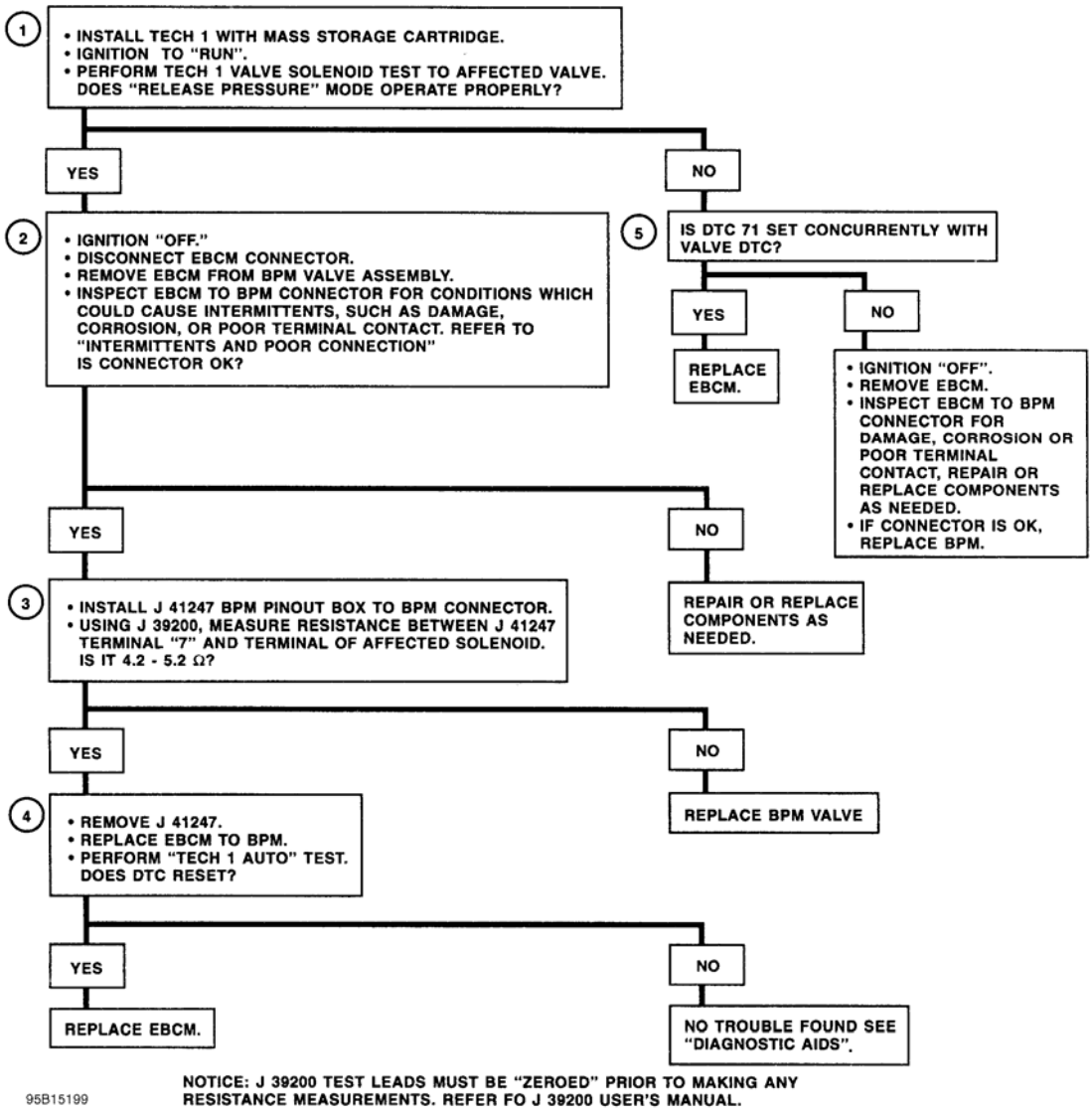


Fig. 20: DTC 42, 46, & 56 Flow Chart
Courtesy of GENERAL MOTORS CORP.

DTC 61 - BPM VALVE PUMP MOTOR FAULT

Pump motor returns brake fluid to master cylinder brake circuit at brake pressure modulator during anti-lock braking. During normal braking, pump does not operate. When vehicle begins to move after start-up, EBCM will turn on pump motor and perform a self-check of pump motor and pump motor circuit. This check may be felt and heard by the driver when vehicle begins to move and is considered part of normal operation. Pump motor is an integral part of brake pressure modulator and cannot be serviced separately.

Pump motor relay provides power to pump motor. Pump motor relay is located in EBCM assembly and cannot be replaced.

DTC 61 will set if battery voltage is present at pump motor without pump motor being requested to activate or if battery voltage is not present at pump motor within 60 milliseconds after pump motor has been requested to activate.

If DTC 61 is set, anti-lock braking is disabled and EBCM turns on ANTI-LOCK indicator for remainder of ignition cycle. If failure is intermittent, EBCM will enable system at next ignition cycle and a history DTC 61 will be present.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks that fusible link "B" feeding EBCM motor relay circuit is good.
2. Checks for open in pump motor ground circuit No. 1250.
3. Checks for voltage from EBCM motor relay circuit, using the EBCM ground to complete the circuit.
4. Checks EBCM connector terminals for good contact.
5. Checks EBCM connector for good retention to EBCM when installed.
6. Checks condition of connector.
7. Checks integrity of pump motor and pump motor circuitry internal to the BPM valve.
8. Checks operation of pump motor and circuitry, using Tech 1.

Diagnostic Aids

All tests which require a connection to pinout box pin No. 1 are using this pin as ground. This assumes integrity of ground circuit No. 51 has been maintained. To prevent misdiagnosis, conduct thorough inspection of wiring and connectors.

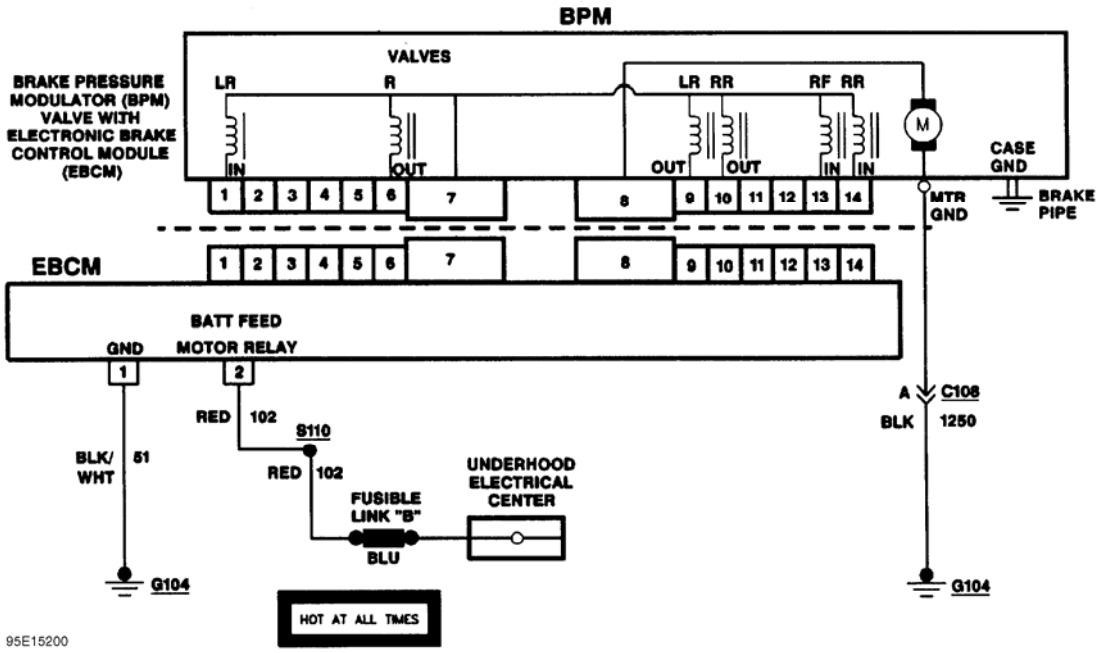


Fig. 21: DTC 61 Schematic
Courtesy of GENERAL MOTORS CORP.

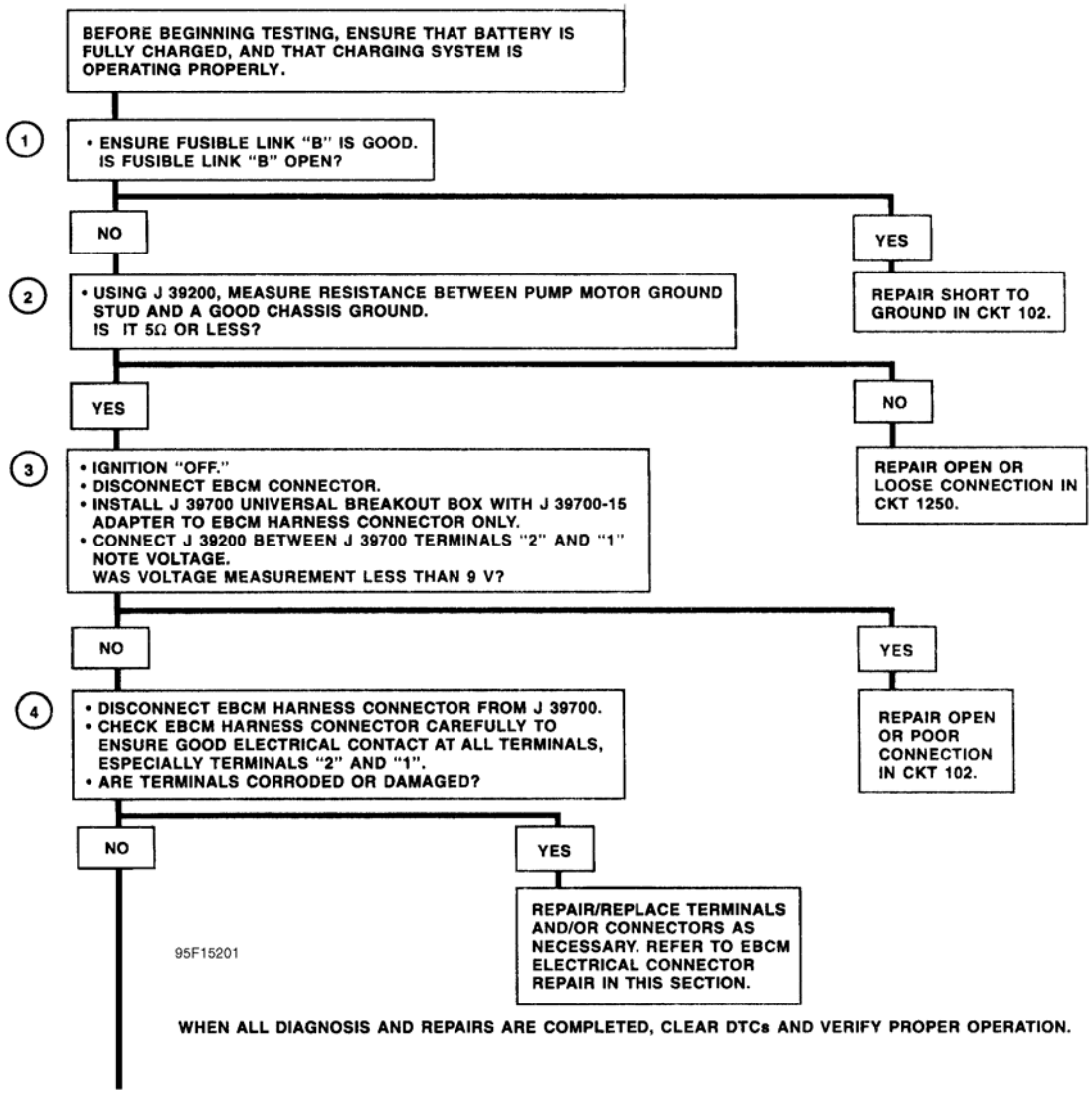


Fig. 22: DTC 61 Flow Chart (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

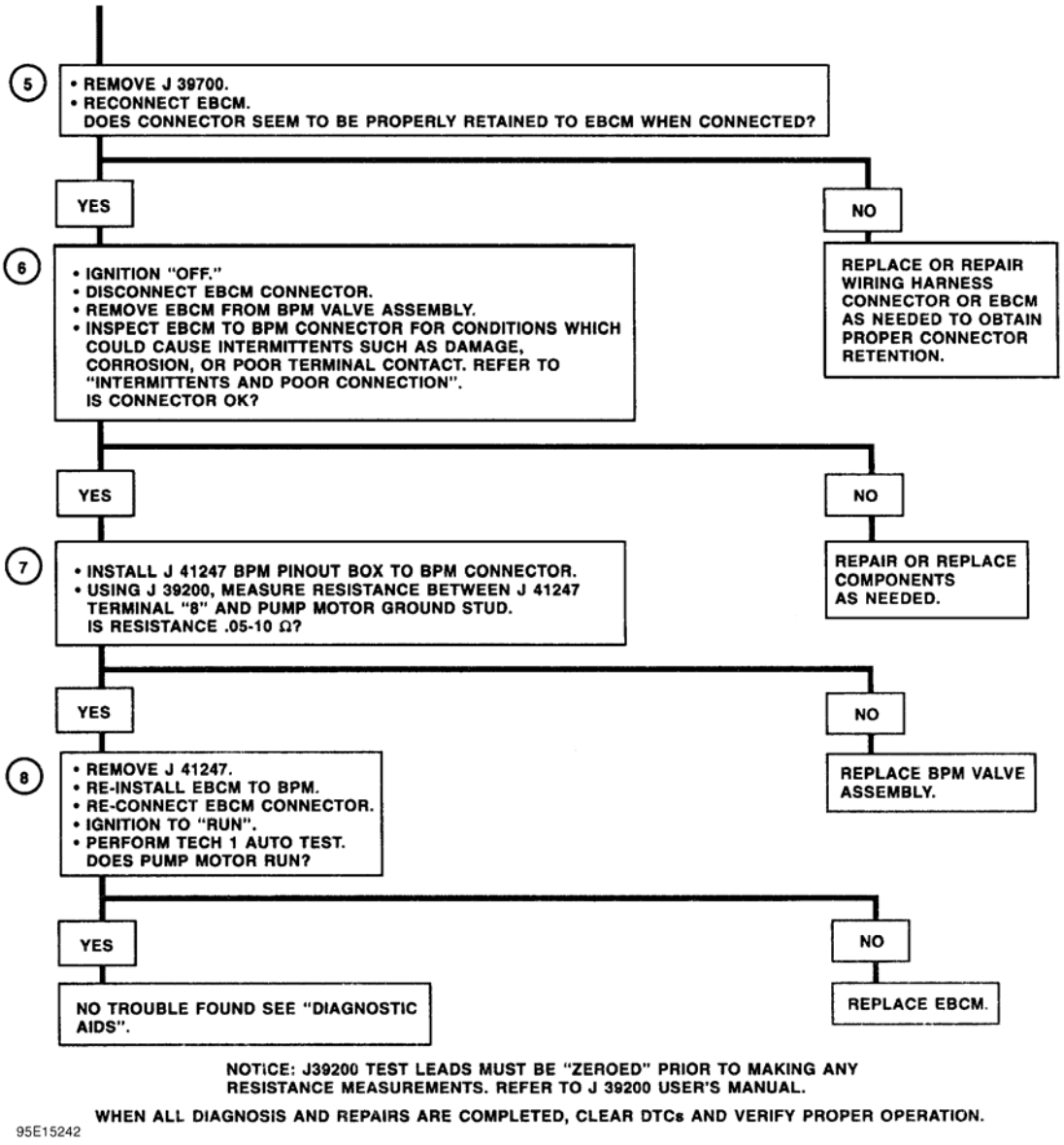


Fig. 23: DTC 61 Flow Chart (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

DTC 63 - VALVE POWER SUPPLY FAULT

Valves require a certain minimum voltage to operate properly. EBCM monitors the valve feed circuit to determine if voltage falls below a minimum level. DTC 63 will set when voltage falls below 5 volts.

If DTC 63 is set, anti-lock braking is disabled and EBCM turns on ANTI-LOCK indicator for remainder of ignition cycle. If failure is intermittent, EBCM will enable system at next ignition cycle and a history DTC 63 will be present.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks that fusible link "B" feeding valve relay circuit is good.
2. Checks for voltage from valve circuit supply voltage.
3. Checks EBCM connector terminals for good contact.
4. Checks condition of EBCM-to-BPM connector.
5. Checks EBCM connector for good retention to EBCM when installed.
6. Checks for DTC reset after other portions of system have tested okay.

Diagnostic Aids

All tests which require a connection to pinout box pin No. 1 are using this pin as ground. This assumes integrity of ground circuit No. 51 has been maintained. To prevent misdiagnosis, conduct thorough inspection of wiring and connectors.

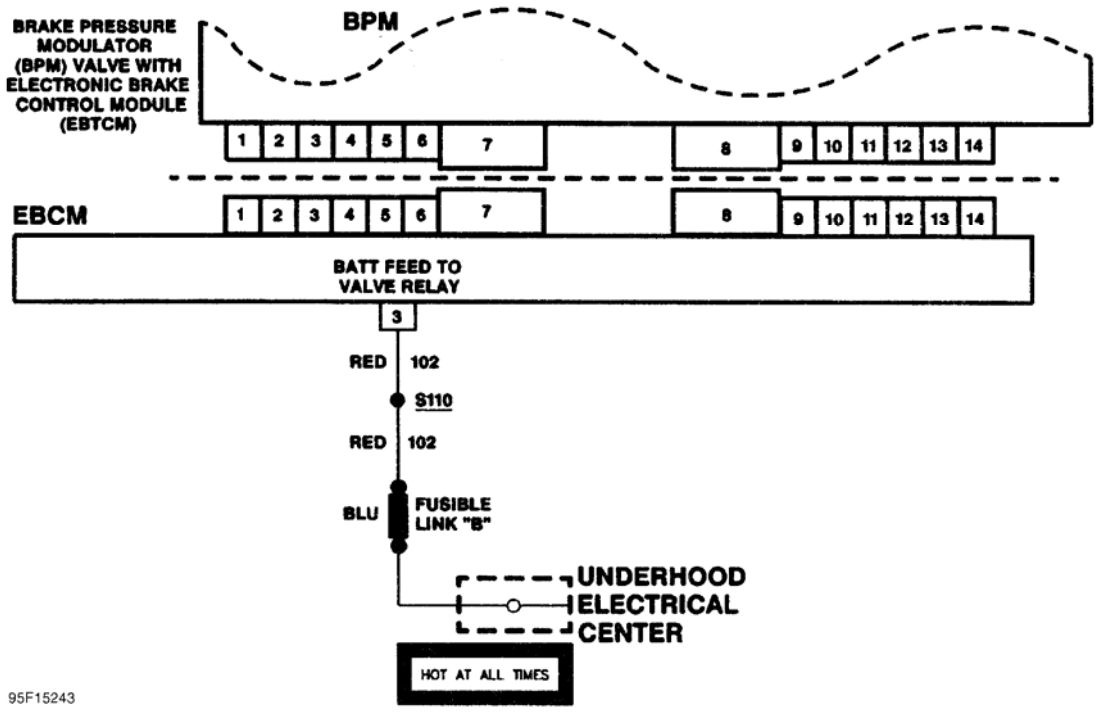


Fig. 24: DTC 63 Schematic
Courtesy of GENERAL MOTORS CORP.

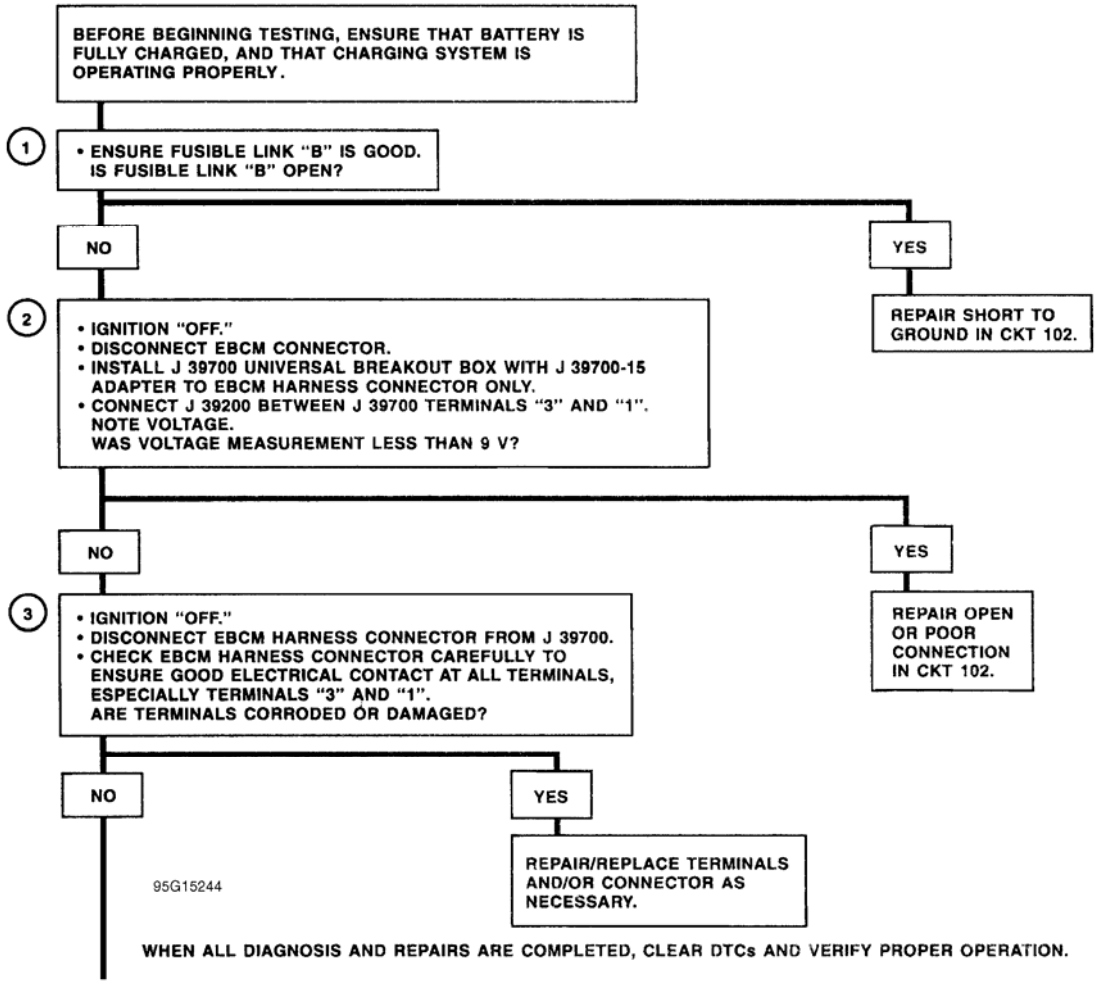


Fig. 25: DTC 63 Flow Chart (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

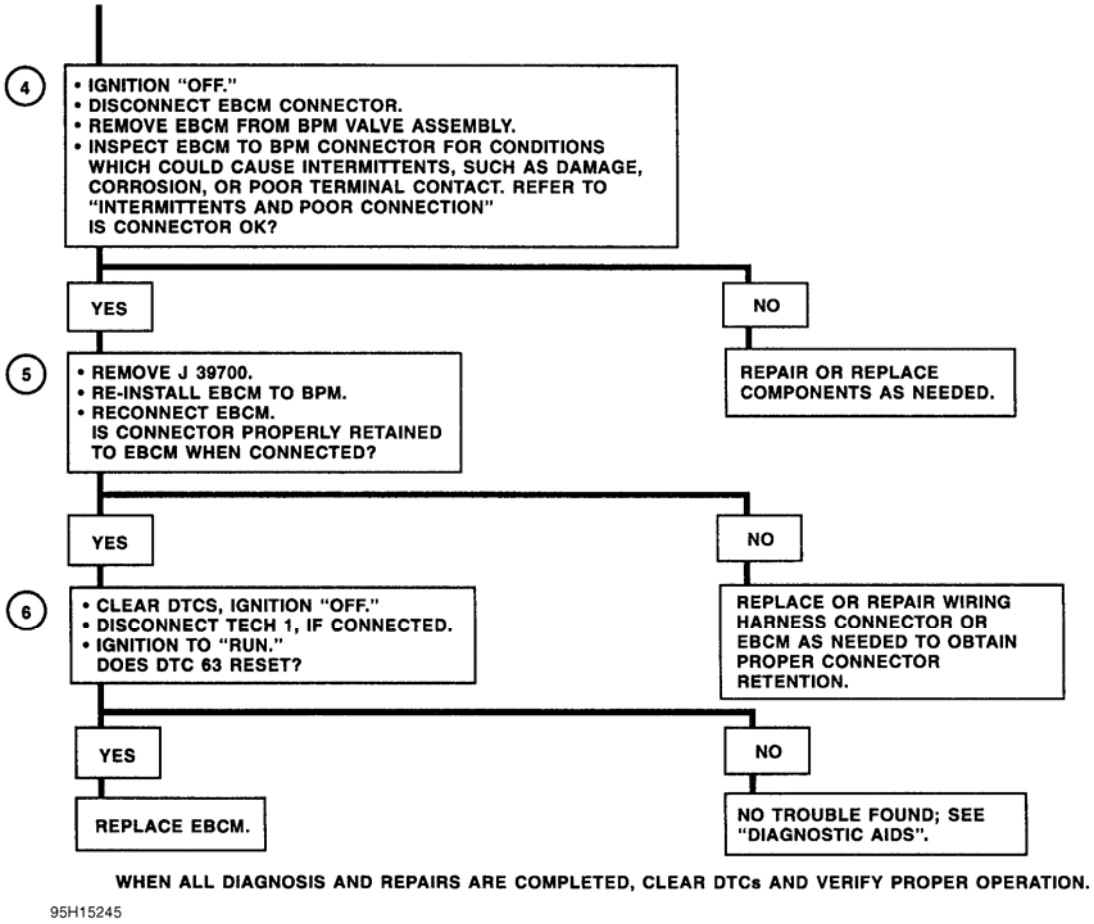


Fig. 26: DTC 63 Flow Chart (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

DTC 71 - EBCM FAULT

EBCM has self-diagnostics which can detect internal failure within module. EBCM also monitors supply voltage and integrity of EBCM harness connection.

DTC 71 will set when EBCM detects an internal fault or the pump motor supply circuit is open or shorted to ground (open fuse).

If a failure is detected and sets a DTC 71, anti-lock brake system is disabled and EBCM turns on ANTI-LOCK indicator for remainder of ignition cycle.

If failure is intermittent, EBCM will enable system at next ignition cycle and a history DTC 71 will be present.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks that fusible link "B" feeding pump motor relay is good.

2. Checks for voltage from pump motor supply circuit using EBCM ground to complete circuit.
3. Checks for good connections from the harness to the EBCM.
4. Checks to see if fault was false. If DTC 71 resets, replace EBCM.

Diagnostic Aids

An open pump motor supply circuit (open fuse) will cause DTC 71 to set. Check that fusible link "B" feeding pump motor relay is good. To prevent misdiagnosis, conduct thorough inspection of wiring and connectors.

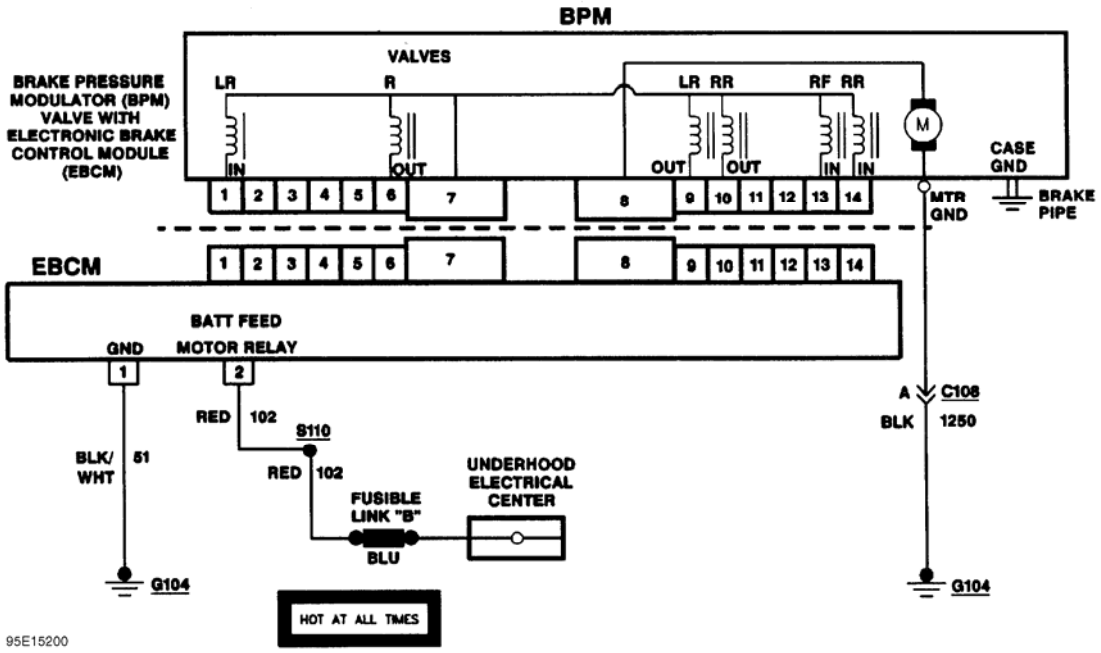


Fig. 27: DTC 71 Schematic
Courtesy of GENERAL MOTORS CORP.

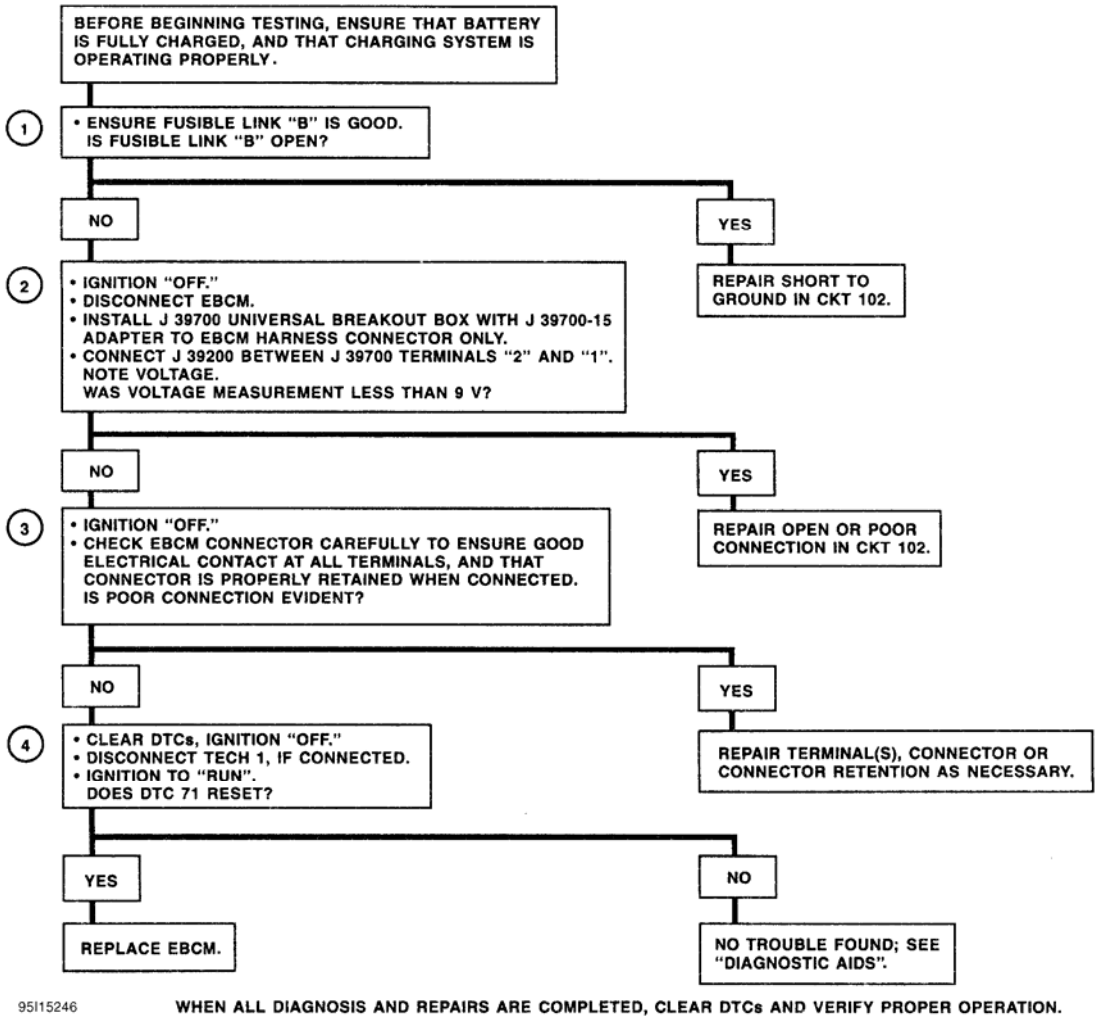


Fig. 28: DTC 71 Flow Chart
Courtesy of GENERAL MOTORS CORP.

DTC 85 - LOW VOLTAGE

EBCM requires a certain minimum voltage to operate properly. EBCM monitors the ignition feed circuit to determine if voltage falls below a minimum level.

DTC 85 will set when EBCM operating voltage falls below 9.4 volts out of ABS control, 8.8 volts during ABS control and low voltage is detected for more than 500 milliseconds with vehicle speed above 3.6 MPH.

When low voltage is detected, the ABS valves are switched to passive, which prevents possible pump start-up and the ANTI-LOCK indicator will be on.

If failure is intermittent, EBCM will enable system at next ignition cycle and a history DTC 85 will be present.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks that PCM/IGN fuse feeding EBCM ignition circuit is good.
2. Checks for voltage from EBCM ignition circuit.
3. Checks EBCM connector terminals for good contact.
4. Checks EBCM connector for good retention when connected to EBCM.
5. Checks for DTC 85 reset after other portions of system tested okay.
6. Checks if fault found in step 2) is due to open or poor connection in EBCM ignition feed circuit No. 539, or poor ground in circuit No. 51.

Diagnostic Aids

To prevent misdiagnosis, conduct thorough inspection of wiring and connectors.

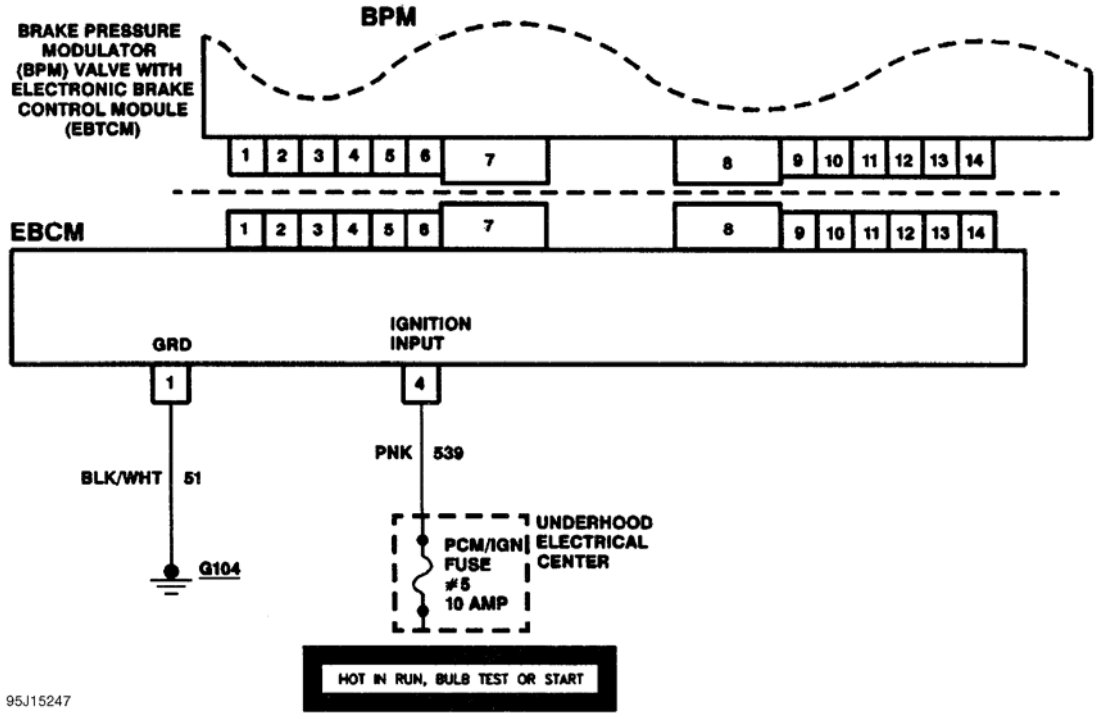


Fig. 29: DTC 85 Schematic
Courtesy of GENERAL MOTORS CORP.

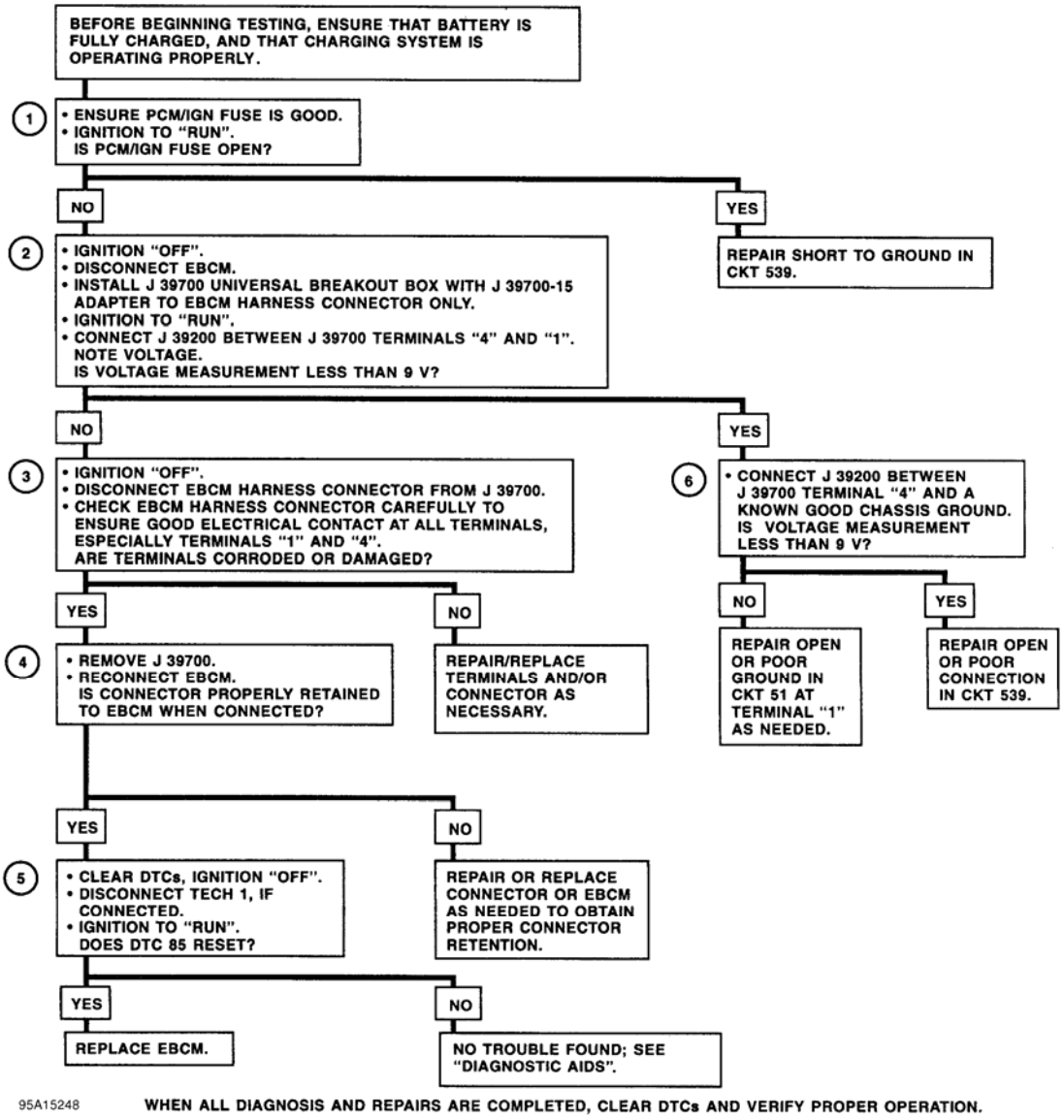


Fig. 30: DTC 85 Flow Chart
Courtesy of GENERAL MOTORS CORP.

TESTING

SOLENOID VALVE PRESSURE HOLD TEST

1. Raise vehicle on frame contact hoist so wheels to be tested are off ground. Turn ignition on. Using Tech 1, select F4: MISC TESTS and then F0: SOLENOID TESTS. Select solenoid to be tested. Select PRESSURE HOLD mode.
2. Have assistant apply brakes. Try to spin wheel being tested. While in PRESSURE HOLD mode, wheel should spin even with brakes applied. Repeat test if necessary to verify proper operation. Perform SOLENOID VALVE PRESSURE RELEASE TEST.

SOLENOID VALVE PRESSURE RELEASE TEST

1. Raise vehicle on frame contact hoist so wheels to be tested are off ground. Have assistant apply brakes. Turn ignition on. Using Tech 1, select F4: MISC TESTS and then F0: SOLENOID TESTS. Select solenoid to be tested. Select PRESSURE RELEASE mode.
2. Try to spin wheel being tested. Wheel should spin freely. Repeat test if necessary to verify proper operation. Perform SOLENOID VALVE PRESSURE HOLD TEST if test has not yet been performed.

AUTOMATIC TESTS

Turn ignition on. Using Tech 1, select F4: MISC TESTS and then F1: AUTO TEST. Press ENTER when ready. Valves can be heard and felt cycling from hydraulic control unit. Have assistant verify pump motor is turned on. See DIAGNOSTIC TROUBLE CODE (DTC) table if DTCs are set. See DIAGNOSTIC TROUBLE CODE CHARTS. After all diagnosis and repairs are completed, clear DTCs and verify operation. AUTO test is performed automatically by EBCM once during each ignition cycle when vehicle reaches approximately 4 MPH.

DIAGNOSTIC TROUBLE CODE (DTC)

DTC	(1)Definition
12	Diagnostic System Operational
21	Right Front Wheel Speed Sensor Circuit
23	Right Front Wheel Speed Sensor Continuity
25	Left Front Wheel Speed Sensor Circuit
27	Left Front Wheel Speed Sensor Continuity
28	Wheel Speed Sensor Frequency Error
35	Rear Axle (Wheel) Speed Sensor Circuit
37	Rear Axle (Wheel) Speed Sensor Continuity
41	Right Front Inlet Solenoid Valve Fault
42	Right Front Outlet Solenoid Valve Fault
45	Left Front Inlet Solenoid Valve Fault
46	Left Front Outlet Solenoid Valve Fault
55	Rear Inlet Solenoid Valve Fault
56	Rear Outlet Solenoid Valve Fault
61	Pump Motor Or Relay Fault
63	Solenoid Valve Relay Fault
71	EBCM Fault
85	Low Voltage

(1) Always perform ABS system functional check before using DIAGNOSTIC TROUBLE CODE CHARTS. See **Fig. 1**.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems

may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

BRAKE PRESSURE MODULATOR

Removal

1. Remove Electronic Brake Control Module (EBCM). See ELECTRONIC BRAKE CONTROL MODULE (EBCM). Remove BPM mounting insulators. See **Fig. 31**. Remove ground wire from pump motor.
2. Note location of brakelines, and remove lines. Plug brakelines to prevent loss and contamination of fluid. Remove brake pressure modulator from bracket.

NOTE: When removing brake pressure modulator valve, protect vehicle exterior from possible brake fluid spillage.

Installation

1. To install, reverse removal procedure. Ensure brakelines are installed in original locations. See **Fig. 31**. Tighten brake pressure modulator mounting bolts, nuts and brakelines to specification. See TORQUE SPECIFICATIONS.
2. Refill brake master cylinder, bleed brakes and check for leaks. See BLEEDING BRAKE SYSTEM. Perform ABS functional check. See **Fig. 1**.

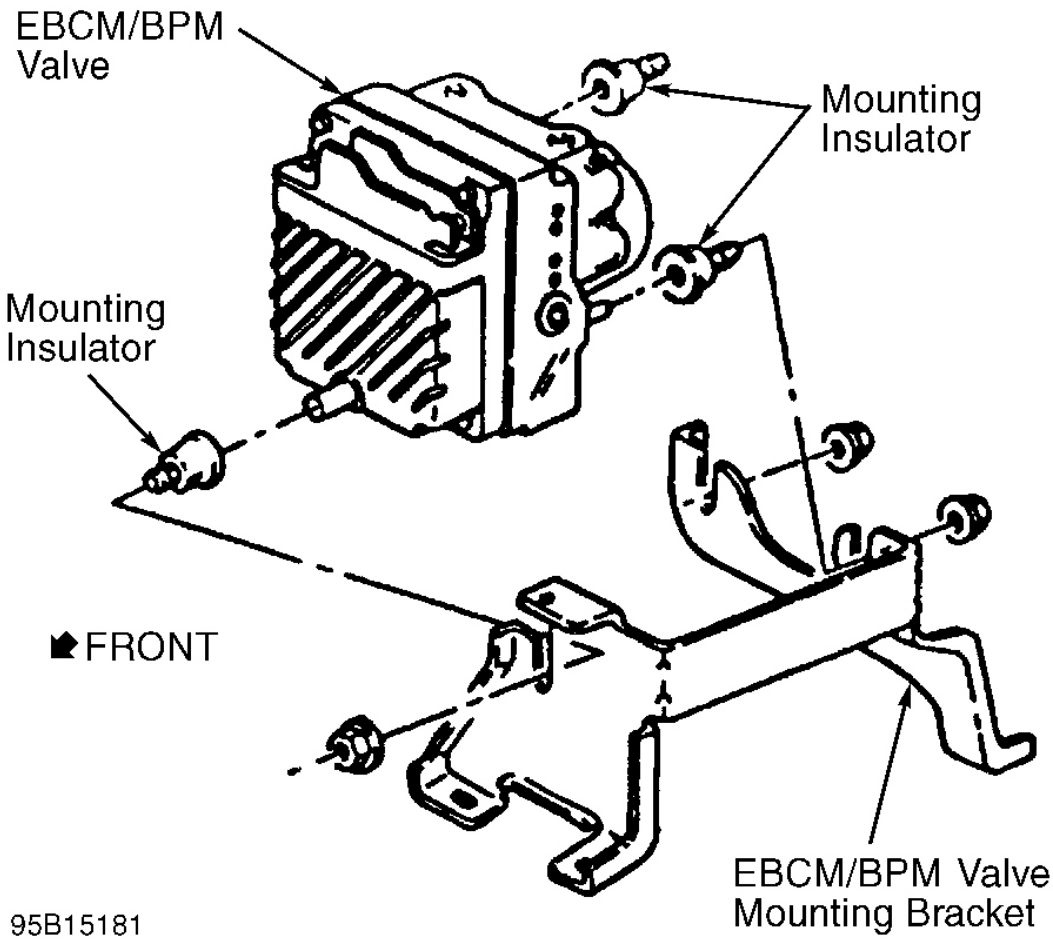


Fig. 31: Removing Brake Pressure Modulator
Courtesy of GENERAL MOTORS CORP.

ELECTRONIC BRAKE CONTROL MODULE

CAUTION: To prevent EBCM damage, never disconnect EBCM wiring harness connector with ignition on.

Removal & Installation

1. EBCM is mounted to Brake Pressure Modulator (BPM) located on left side of engine compartment, left of alternator. Disconnect negative battery cable. Remove air intake duct and resonator.
2. Unlock tab and disconnect EBCM connector. Disconnect EBCM ground wire. Remove EBCM/BPM assembly-to-bracket nuts. Remove brakeline clip bolt, downstream of EBCM/BPM valve. Raise and support EBCM/BPM valve with wood block.
3. Remove EBCM-to-BPM bolts. Remove EBCM front mounting insulator bolt. Carefully separate EBCM

from BPM valve. DO NOT pry EBCM from BPM, if seal is damaged EBCM must be replaced.

4. To install, reverse removal procedure. Tighten bolts and nuts to specification. See TORQUE SPECIFICATIONS. Ensure EBCM connector is fully seated and tab is locked. Perform ABS functional check. See **Fig. 1**.

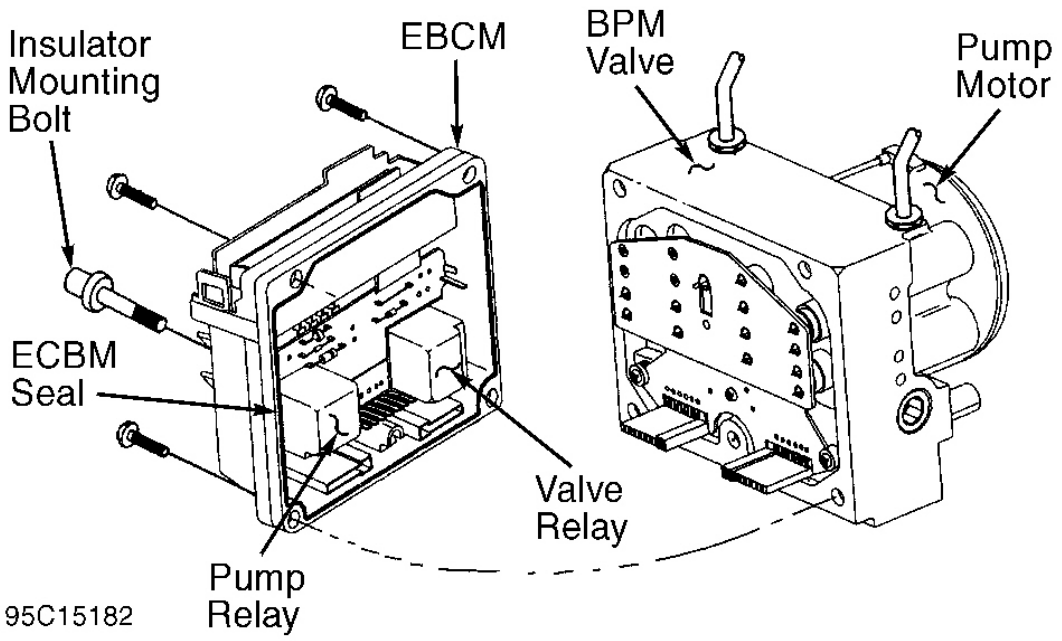


Fig. 32: Removing Electronic Brake Control Module
Courtesy of GENERAL MOTORS CORP.

WHEEL SPEED SENSOR

Removal (Front)

Front wheel speed sensor is mounted in steering knuckle. Disconnect wheel speed sensor electrical connector at strut tower. Raise and support vehicle. Remove tire and wheel assembly. Note wiring harness routing for installation reference. Remove sensor wiring harness with grommets from brackets. Remove sensor mounting bolt, and remove sensor from steering knuckle.

NOTE: Wheel speed sensors fit tightly into steering knuckle and are installed by hand. DO NOT hammer sensors into position.

Installation

1. To install, reverse removal procedure. Coat steering knuckle and speed sensor with Anti-Corrosion Compound (12345489) before installing. DO NOT use grease. Tighten sensor mounting bolt to specification. See TORQUE SPECIFICATIONS.

2. Ensure wiring harness is routed in original location and properly installed in retainers. Sensor air gap is not adjustable.

Removal (Rear)

1. Rear axle (wheel) speed sensor is mounted in rear axle differential. Raise and support vehicle. Disconnect sensor wiring harness connector.
2. Note wiring harness routing for installation reference. Remove sensor wiring harness with grommets from brackets. Remove sensor mounting bolt and remove sensor from rear axle housing.

Installation

1. To install, reverse removal procedure. Sensor fits tightly into rear axle housing. DO NOT use force to install sensor. Use hand pressure only.
2. Tighten sensor mounting bolt to specification. See TORQUE SPECIFICATIONS. Ensure wiring harness is routed in original location and properly installed in retainers. Sensor air gap is not adjustable.

TOOTHED SENSOR RING

Removal (Front)

1. Front toothed sensor ring is an integral part of front brake rotor. If sensor ring requires replacement, brake rotor must be replaced.
2. Raise and support vehicle. Remove tire and wheel assembly. Using a "C" clamp, bottom piston into caliper bore. Remove caliper mounting bolts and sleeves. Remove brake caliper, and wire aside. Remove brake rotor.

Installation

To install, reverse removal procedure. Tighten bolts to specification. See TORQUE SPECIFICATIONS.

Removal & Installation (Rear)

1. Rear toothed sensor ring is an integral part of rear axle differential pinion gear. To inspect sensor ring, remove rear axle (wheel) speed sensor. See WHEEL SPEED SENSOR.
2. Using a flashlight and mirror, inspect sensor ring through sensor mounting hole. Check for missing or damaged teeth. If sensor ring needs replacement, differential pinion gear must be removed. See appropriate article in DRIVE AXLES.

ADJUSTMENTS

PARKING/EMERGENCY BRAKE

Depress parking brake lever 6 ratchet clicks. Raise and support vehicle. Tighten adjusting nut at parking brake equalizer rod until right rear wheel can be turned rearward but not forward. Release parking brake. Both rear wheels should turn freely. If both wheels do not turn freely, repeat procedure. Lower vehicle.

BRAKELIGHT SWITCH

Hold brake pedal in depressed position. Insert brakelight switch into retainer until switch body seats on retainer. Pull brake pedal upward against internal pedal stop. Switch will be moved in retainer by brake pedal to provide proper adjustment.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Brake Caliper Bolts	38 (51)
Brakeline-To-Brake Pressure Modulator Valve	12 (16)
EBCM Insulator Bolt	11 (15)
Wheel Lug Nuts	103 (140)
	INCH Lbs. (N.m)
Brake Pressure Modulator	
Valve Ground Wire Nut	25 (2.8)
EBCM/BPM Assembly-To-Bracket Nut	89 (10)
EBCM-To-BPM Bolt	18 (2)
Front Wheel Speed Sensor Bolt	71 (8)
Front Wheel Speed Sensor Wiring Bracket Bolt	89 (10)
Rear Axle (Wheel) Speed Sensor Bolt	71 (8)
Rear Axle (Wheel) Speed Sensor	
Wiring Bracket Bolt	71 (8)

WIRING DIAGRAM

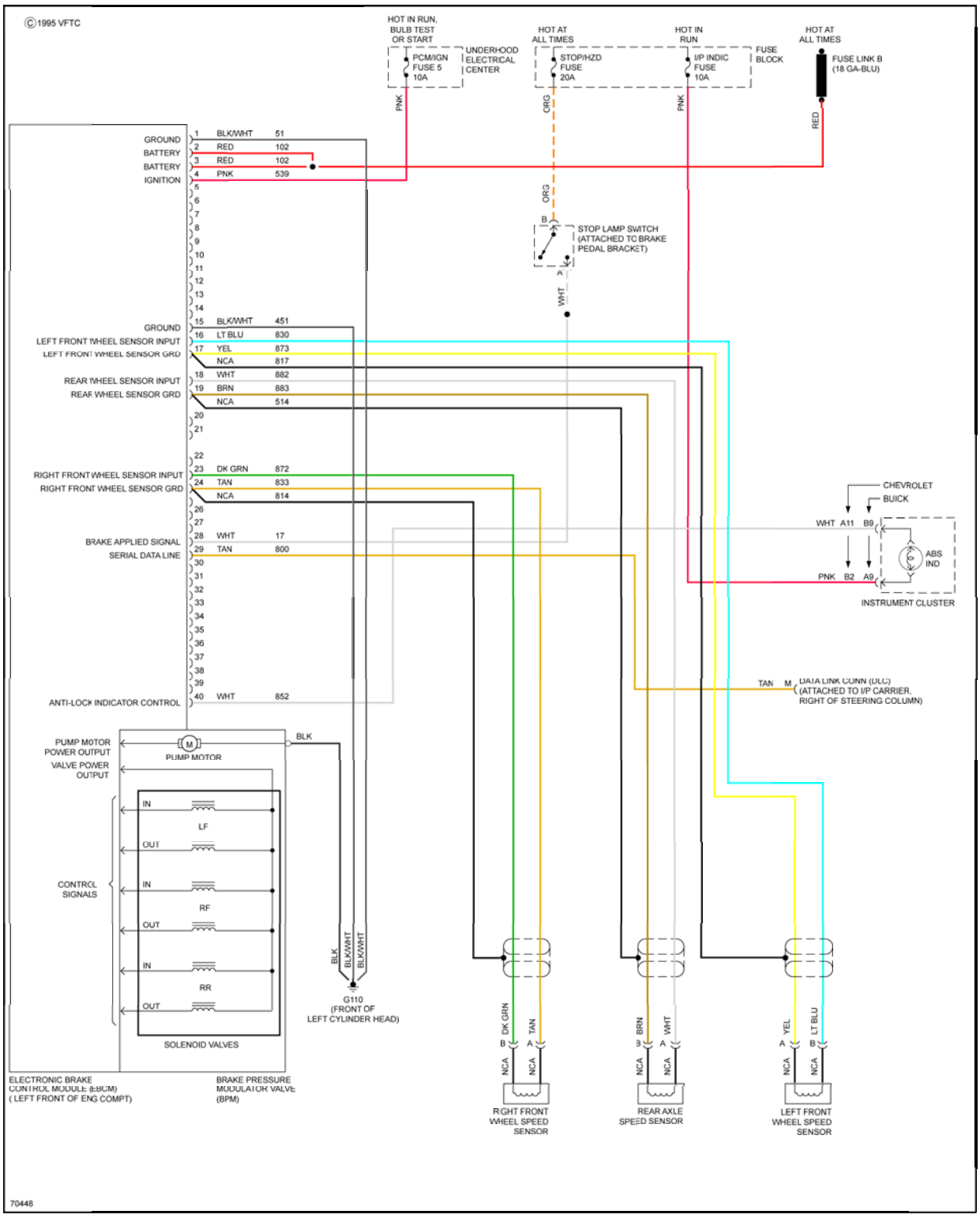


Fig. 33: Anti-Lock Brake System Wiring Diagram

A/C COMPRESSOR CLUTCH CONTROLS

A/C COMPRESSOR CLUTCH CONTROLS General Motors Corp.

MODEL IDENTIFICATION

BODY CODE DESIGNATIONS

Body Designation (1)	Model
"B" Body	Caprice, Impala SS & Roadmaster
(1) Body codes determined by fourth character of VIN code.	

DESCRIPTION & OPERATION

To improve idle quality and Wide Open Throttle (WOT) performance, and for system protection, the A/C compressor clutch is controlled by the Powertrain Control Module (PCM).

A refrigerant pressure sensor is used to indicate high and low side refrigerant pressure to the PCM for controlling cooling fan, A/C compressor clutch and Idle Air Control (IAC) valve. If a fault is detected in refrigerant pressure circuit, A/C compressor clutch will be disabled.

The A/C compressor clutch relay is controlled by the PCM. This allows the PCM to raise idle speed before engaging compressor clutch, and disable compressor clutch during WOT, high engine RPM, high power steering loads and hot engine restarts. PCM also disables compressor clutch if coolant temperature becomes excessive.

TROUBLE SHOOTING

NOTE: This article contains test charts which are part of General Motors Computerized Engine Controls. Only those charts required to test A/C compressor clutch control are included. Other diagnostic information may be referenced while performing A/C compressor clutch control diagnosis. For complete information on General Motors Computerized Engine Control systems, see the appropriate G-TESTS W/CODES article in the ENGINE PERFORMANCE section.

TESTS W/CODES - 4.3L

TESTS W/CODES - 5.7L

Trouble shoot A/C compressor clutch control using appropriate schematic and diagnostic charts. See A/C COMPRESSOR CLUTCH RELAY LOCATION table for A/C compressor clutch relay location.

RELAY LOCATION

A/C COMPRESSOR CLUTCH RELAY LOCATION

Application	Location

"B" Body	In Fuse/Relay Block, On Right Rear Of Engine Compartment

SCAN TESTER

A variety of information is transmitted through Data Link Connector (DLC) terminal "E" or "M", depending on engine. This data is transmitted at a high frequency which requires a Tech 1 scan tester for interpretation. Several scan testers are available for diagnostic work. Scan testers other than Tech 1 scan tester will function and provide information for diagnostic work; however, some charts will specify a Tech 1 scan tester. Failure to use a Tech 1 scan tester when specified may result in incorrect diagnosis of a system.

TROUBLE SHOOTING CHARTS

CHART C-10 - A/C COMPRESSOR CLUTCH CIRCUIT DIAGNOSIS 4.3L - VIN W - 5.7L - VIN P

Powertrain Control Module (PCM) delays A/C compressor clutch engagement momentarily after A/C is turned on. This delay allows PCM time to adjust engine RPM before A/C compressor clutch engages.

PCM will temporarily disengage A/C compressor clutch for a precalibrated time during one or more of the following conditions: Wide Open Throttle (WOT), high engine RPM, high engine coolant temperature, or A/C refrigerant pressure too high or too low.

An A/C refrigerant pressure sensor is used to monitor A/C system pressure. If A/C refrigerant pressure is greater than 429 psi (30.2 kg/cm^2) or less than zero, A/C compressor clutch will not engage. If A/C refrigerant pressure sensor signal wire becomes open, shorted to ground or shorted to voltage, Diagnostic Trouble Code (DTC) 66 will set.

If A/C compressor clutch engages and no refrigerant pressure change is detected, DTC 67 will set. When A/C request is detected by PCM, cooling fan(s) will be turned on unless vehicle speed is too fast.

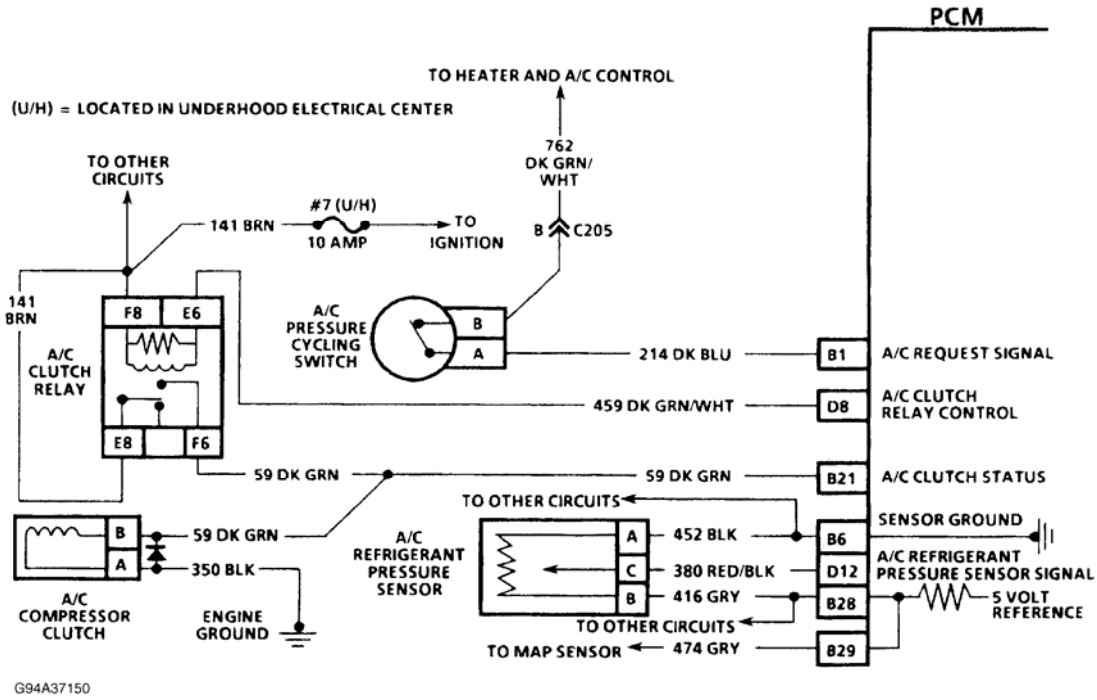


Fig. 1: A/C Compressor Clutch Circuit Diag. (4.3L VIN W/5.7L VIN P)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to numbers on diagnostic chart. See Fig. 2 and Fig. 3 .

1) Checks PCM's ability to control A/C compressor clutch relay.

2) Before replacing A/C system control components, refer to the appropriate A/C-HEATER SYSTEM article in the AIR CONDITIONING & HEAT section. See **A/C-HEATER SYSTEM** - Caprice, Impala SS or **A/C-HEATER SYSTEM - MANUAL** - Roadmaster.

3) Checks for a grounded circuit No. 459 to PCM.

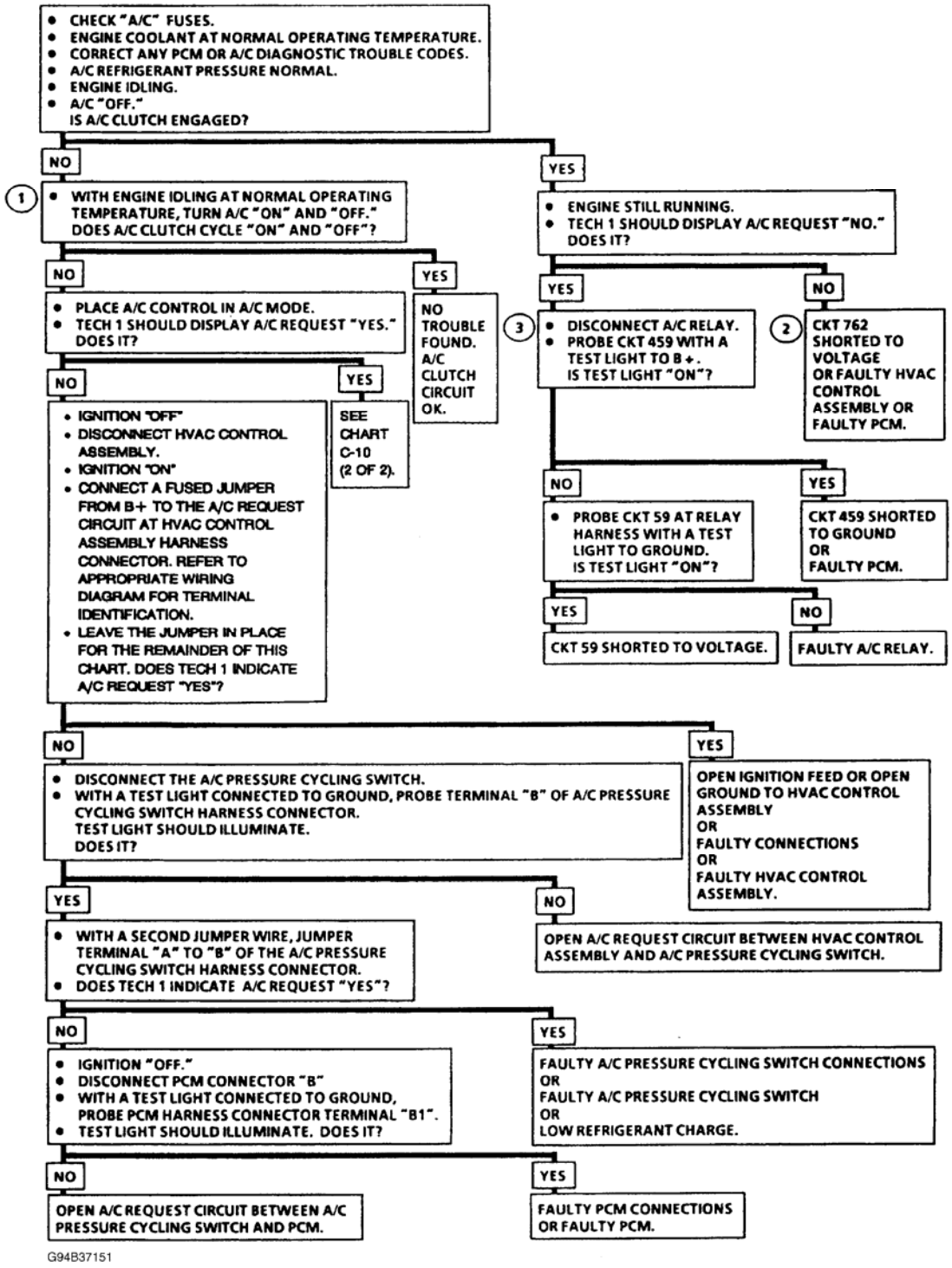


Fig. 2: A/C Compressor Clutch System Diagnosis, Flow Chart (1 Of 2) (4.3L VIN W - 5.7L VIN P)
Courtesy of GENERAL MOTORS CORP.

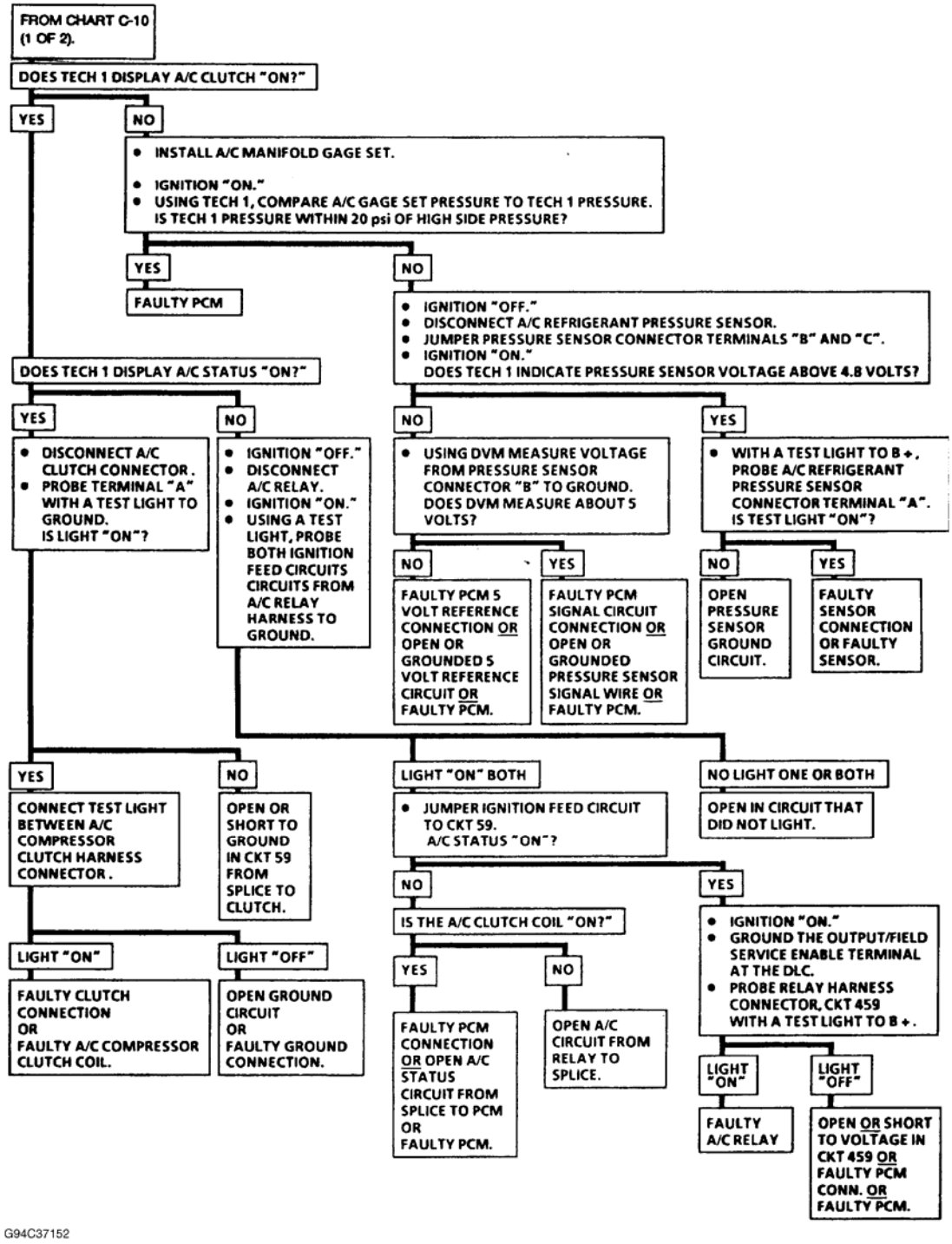


Fig. 3: A/C Compressor Clutch System Diagnosis, Flow Chart (2 Of 2) (4.3L VIN W - 5.7L VIN P) Courtesy of GENERAL MOTORS CORP.

Diagnostic Aids

Before diagnosing vehicle using C-10 chart, ensure no DTCs are stored. PCM will not activate A/C compressor

clutch if any DTC is stored.

A/C SYSTEM SPECIFICATIONS

A/C SYSTEM SPECIFICATIONS

Application	Specification
Compressor Type	Harrison HD6/HR6-HE 6-Cyl.
Compressor Belt Tension	(1)
System Oil Capacity (2)	8 ozs.
Refrigerant (R-134a) Capacity	28 ozs.
System Operating Pressures (3)	
High Side	315 psi (22.1 kg/cm^2)
Low Side	36 psi (2.5 kg/cm^2)

(1) Equipped with automatic belt tensioner. If indicator marks on tensioner is not within range, replace serpentine belt.

(2) Use PAG Refrigerant Oil (Part No. 12345923).

(3) With ambient temperature at 80°F (27°C) and relative humidity at 60 percent.

AIR BAG RESTRAINT SYSTEM

ACCESSORIES/SAFETY EQUIPMENT General Motors Air Bag Restraint System

IDENTIFICATION

All models equipped with a Supplemental Inflatable Restraint (SIR) system have a number "2" (driver and passenger-side air bags) or "3" (driver-side air bag only) in the seventh position of the Vehicle Identification Number (VIN). Some vehicles have the words Supplemental Inflatable Restraint or SIR on the inflator module. Steering wheel hub is slightly larger in order to accommodate the driver-side air bag.

DESCRIPTION & OPERATION

SUPPLEMENTAL INFLATABLE RESTRAINT (SIR) SYSTEM

The Supplemental Inflatable Restraint (SIR) system is designed to protect the driver and passenger (if equipped) in a frontal collision. The air bag(s) will deploy only upon frontal or near frontal impact of no more than 30 degrees off the center line of vehicle. System is not designed to deploy in rear impacts, side impacts, or rollovers. A frontal impact of sufficient severity (comparable to a collision into a solid wall at approximately 14 MPH or more) will cause sensors in vehicle to detect this sudden deceleration. These sensors, in turn, trigger the inflator module(s).

NOTE: Following SIR components are not necessarily installed on all vehicles.

SENSING & DIAGNOSTIC MODULE (SDM)

Vehicles not equipped with a DERM are equipped with a Sensing and Diagnostic Module (SDM).

SDM contains a sensing device which converts vehicle velocity changes to an electrical signal. The electrical signal generated is processed by SDM and compared to a value stored in memory. When generated signal exceeds stored value, additional signal processing is performed, and generated signals are compared to value stored in memory. When 2 generated signals exceed stored values, or when one generated signal exceeds stored value and forward discriminating sensor closes, SDM will close circuit, providing voltage to inflator module.

SDM is designed to provide following functions in SIR system:

Energy Reserve

SDM maintains a 36-Volt Loop Reserve (36VLR) energy supply for 2 minutes to provide deployment energy when ignition voltage is lost in a frontal crash.

Frontal Crash Detection

SDM monitors vehicle velocity changes to detect frontal crashes which are severe enough to cause deployment.

Air Bag Deployment

When a frontal crash of sufficient force is detected, SDM will close circuit, deploying air bags.

Frontal Crash Recording

SDM records information regarding SIR system status during a frontal crash.

Malfunction Detection

SDM performs diagnostic monitoring of SIR system electrical components and sets a diagnostic trouble code when malfunction is detected.

Malfunction Diagnosis

SDM displays SIR diagnostic trouble codes and system status information via a scan tool.

Driver Notification

SDM warns driver of SIR system malfunction by controlling AIR BAG warning light.

SDM is connected to SIR wiring harness by a 20-pin connector. Harness connector utilizes a shorting bar across certain terminals in contact area. Shorting bar connects AIR BAG warning light to ground when SDM harness connector is disconnected. This causes AIR BAG warning light to come on steady whenever ignition is on.

AIR BAG RESTRAINT WARNING LIGHT

NOTE: Some vehicles have an INFLATABLE RESTRAINT warning light as opposed to an AIR BAG warning light.

When ignition switch is in RUN, BULB TEST, or START positions, battery voltage is applied to AIR BAG warning light. DERM/SDM illuminates this light by providing a ground to a lamp driver. Some vehicles are equipped with a Serial Data Controlled Warning Lamp (SDCWL). An SDCWL equipped vehicle utilizes a smart cluster which communicates via the serial data line, so in this case, DERM/SDM transmits a request to turn on AIR BAG warning light. When ignition is first turned on, AIR BAG warning light verifies light and DERM/SDM operation by flashing 7-9 times. Light is also used to warn driver of SIR electrical system faults which could potentially affect SIR system operation. AIR BAG warning light is the key to driver notification of SIR system faults.

In addition, the light provides diagnostic information by flashing Diagnostic Trouble Codes (DTCs) when the flash code diagnostic mode is entered on models without on-board diagnosis. INFLATABLE RESTRAINT indicator light notifies driver of SIR system faults.

ARMING SENSOR/DUAL POLE ARMING SENSOR

Arming sensor/dual pole arming sensor is a protective switch located in power feed side (positive side) of deployment loop. It is calibrated to close at low-level velocity changes (lower than discriminating sensors). This assures that each inflator module is connected directly to 36VLR output of DERM or ignition voltage when either of the discriminating sensors close.

Arming sensor/dual pole arming sensor consists of a sensing element, normally open switch contacts, a diagnostic resistor, and 2 diodes. Sensing element closes switch contacts when velocity of vehicle changes at a rate indicating potential need for deployment. A diagnostic resistor is connected in parallel with normally open switch contacts and allows for a small amount of current flow through deployment loop during normal undeployed conditions. This small current flow results in voltage drops across each component within loop.

DERM monitors these voltage drops to detect circuit or component faults. The 2 diodes provide isolation between 36VLR output of DERM and ignition voltage. In some vehicles, arming sensor is combined with passenger compartment discriminating sensor.

DISCRIMINATING SENSORS

Most SIR systems have 2 discriminating sensors. Some vehicles have 2 forward discriminating sensors, while other vehicles have one forward discriminating sensor and a passenger compartment discriminating sensor, or 2 mid-rail discriminating sensors. Forward discriminating sensor is located on radiator support brace or tie bar. Passenger compartment discriminating sensor is located under center of instrument panel/console area or under front passenger seat. Mid-rail discriminating sensors are located on side mid-rails in engine compartment.

In some vehicles, the passenger compartment discriminating sensor is combined with arming sensor. Discriminating sensors are wired in parallel on the ground side of deployment loop. These sensors are calibrated to close when deceleration velocity changes are severe enough to warrant deployment.

Sensors consist of a sensing element, normally open switch contacts, and a diagnostic resistor. Sensing element closes the normally open switch contacts when vehicle velocity changes are severe enough to warrant deployment.

A diagnostic resistor is connected in parallel with the normally open switch contacts within each of the sensors. These parallel resistors supply the ground path for current passing through the deployment loop during normal undeployed conditions. This small current flow results in a voltage drop across each component within loop. DERM monitors these voltage drops to detect circuit or component faults.

SIR COIL ASSEMBLY

SIR coil assembly consists of 2 current-carrying coils. It is installed in steering column and allows rotation of steering wheel while maintaining continuous (directly wired) contact of deployment loop through steering wheel inflator module. Slip rings are not used in SIR system to transmit current from column to steering wheel.

Gold-plated terminals and a shorting bar are used on coil assembly lower steering column Yellow connector. Shorting bar shorts the circuits to main coil and steering wheel inflator module when lower steering column connector is disconnected. This shorts the circuit to the inflator module(s), preventing unwanted deployment of the air bag(s) when servicing the steering column or other SIR components.

INFLATOR MODULE

When the vehicle is in an accident of sufficient force to simultaneously close the arming sensor and at least one discriminating sensor, nitrogen gas inflates the cloth bag packed inside the steering wheel hub and in passenger-side instrument panel, (if equipped). The bag(s) inflate in less than 1/20 of a second. As air bag is contacted by driver or passenger, the gas is vented through openings in the bag, which deflates almost as soon as it is

completely deployed.

RESISTOR MODULE

Resistor module is located in SIR harness between inflator module and DERM. Resistor module allows DERM to monitor deployment loop for faults and to detect when a deployment has occurred.

Resistors in resistor module are balanced with resistors on arming and discriminating sensors to allow DERM to monitor voltage drops across the components of the deployment loop. Faults are detected during normal undeployed conditions by monitoring these voltages. On some vehicles, resistor module is mounted on DERM.

SYSTEM OPERATION CHECK

If system is functioning normally, air bag warning light flashes 7-9 times when ignition switch is turned to ON position and goes out.

Four possible warning light conditions can indicate a system failure:

- Light does not illuminate at all.
- Light comes on while vehicle is driven.
- Light flashes 7-9 times, and remains on.
- Light does not flash but remains lit when ignition is turned on.

SIR system faults are usually due to a disconnected/loose electrical connector caused by previous service on vehicle. Always check Yellow SIR connector at base of steering column for loose or damaged wiring.

POST-COLLISION INSPECTION

When a vehicle has been involved in a collision, certain components of the passive restraint system must be inspected or replaced. See **PASSIVE RESTRAINT SYSTEM INSPECTION** article in the GENERAL INFORMATION section for post-collision inspection information.

All SIR components, including harness and brackets, must be inspected after an accident. Replace any damaged or bent components, even if a deployment did not occur. Check steering column, knee bolster, instrument panel steering column reinforcement plate, right side instrument panel supports, and all braces for damage. DO NOT service forward discriminating sensor, passenger compartment discriminating sensor, arming sensor, DERM/SDM, coil assembly, or inflator module(s). These components require replacement. System wiring harness can only be serviced with splice sleeves in Wire Repair Kit (J-38125-A). If wiring pigtail of sensor runs through area of accident damage but sensor case/bracket is not damaged, sensor should still be replaced.

CAUTION: Correct operation of sensors and SIR system requires any repairs to vehicle structure return it to its original production configuration. Deployment requires, at a minimum, replacement of inflator module(s) and sensors in area of accident damage.

INTERMITTENTS & POOR CONNECTIONS

Most intermittents are caused by faulty electrical connections or wiring, or a sticking relay or solenoid. Items to check are:

- Poor mating or connector halves, or terminals not fully seated in connector
- Dirt or corrosion on terminals. Terminals must be clean and free of any foreign material which could impede proper terminal contact.
- Damaged connector, exposing the terminals to dirt and moisture, as well as not maintaining proper terminal orientation with the component or mating connector.
- Improperly formed or damaged terminals. All connector terminals in problem circuit(s) should be checked carefully to ensure good contact.
- Connector Test Adapter Kit (J-35616-A) must be used whenever a diagnostic procedure requests checking or probing a terminal. Using adapter will ensure that no damage to terminals will occur, as well as giving an idea whether contact is sufficient.
- Poor terminal-to-wire connections. some conditions which fall under this description are poor crimps, poor solder joints, crimping over wire insulation rather than the wire itself, or corrosion in the wire-to-terminal contact area.
- Wire Insulation which is rubbed through, causing an intermittent short as the bare area touches other wiring or parts of vehicle.
- Broken wires inside insulation. Perform continuity check while flexing wiring harness to find location of broken wires.

SERVICE PRECAUTIONS

SYSTEM REPAIR

Before any repairs are performed, disconnect and shield battery ground. Because system has ability to retain voltage, remove SIR or AIRBAG fuse, and disconnect Yellow SIR connector at base of steering column, and, on vehicles with passenger-side air bags, disconnect Yellow SIR connector at base of right instrument panel (behind knee bolster).

Wait 2 minutes before working on vehicle. All connectors used on SIR system use Connector Position Assurance (CPA) clips to ensure connector retention. Even if system is disconnected, always use caution when working near inflator modules.

SENSOR HANDLING

Use special care when handling a sensor. DO NOT strike or jar a sensor, as air bag deployment, personal injury or improper operation of SIR system could result. A sensor must be replaced if dropped 3 feet or more. Sensors and mounting bracket bolts must be carefully torqued to ensure correct operation. Never power up SIR system when any sensor is not rigidly attached to vehicle, since sensor is easily activated and could cause air bag deployment.

LIVE INFLATOR MODULE HANDLING

WARNING: Special care is necessary when handling and storing a live (undeployed)

inflator module. Rapid gas generation, produced during deployment of air bag, could throw inflator module, or any object in front of inflator module, through air, possibly causing serious injury.

When carrying a live inflator module, ensure bag and trim cover are pointed away from body. If an accidental deployment occurs, bag will then deploy with reduced chance of injury. When placing a live inflator module on a bench or other surface, always face bag and trim cover up and away from surface so space is provided to allow air bag to expand in case of deployment. In addition, never carry any SIR component by wires or connector.

SPECIAL TOOLS

To avoid deployment when working on SIR system, DO NOT use electrical test equipment such as test lights, battery or A/C-powered volt/ohmmeter, or any type of electrical equipment other than those specified by manufacturer. See SIR RECOMMENDED TOOLS table.

SIR RECOMMENDED TOOLS

Tool Name	Tool Number
Connector Test Adapter Kit	J-35616-A
Digital Volt/Ohmmeter	J-39200
Inflator Module & Steering Column Replacement Load	J-37808 Or J-38715
Wire Repair Kit	J-38125-A

DISABLING & ACTIVATING AIR BAG SYSTEM

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. Record customer radio stations, as memory will be lost. Code equipped radios may also lock. Obtain code from customer. See COMPUTER RELEARN PROCEDURES in GENERAL INFORMATION before disconnecting battery.

DISABLING SYSTEM

1. Turn steering wheel to place vehicle wheels in straight-ahead position. Turn ignition switch to LOCK position.
2. Remove SIR or AIRBAG fuse. Remove CPA clip and disconnect Yellow SIR connector at base of steering column (it may be necessary to remove left sound insulator). If equipped with passenger-side air bag, disconnect Yellow SIR connector under right instrument panel or behind glove box door assembly. Some models have access to connector through a trap door in glove box.
3. Wait 2 minutes before beginning service. All connectors in SIR system use CPA clips to ensure connector retention. Even if system is disconnected, use caution when working near air bags.

ACTIVATING SYSTEM

Connect Yellow SIR connector at base of steering column, and under right side instrument panel, if equipped. Install CPA clips and fuse. Turn ignition switch to RUN position and ensure AIR BAG warning light flashes 7-9 times and then goes out.

ADJUSTMENTS

CENTERING COIL ASSEMBLY

1. If coil assembly has been removed from steering column and is being reinstalled, go to next step. New coil assemblies are provided pre-centered and include a Blue plastic tab that is snapped off once coil is installed. See **Fig. 1** .

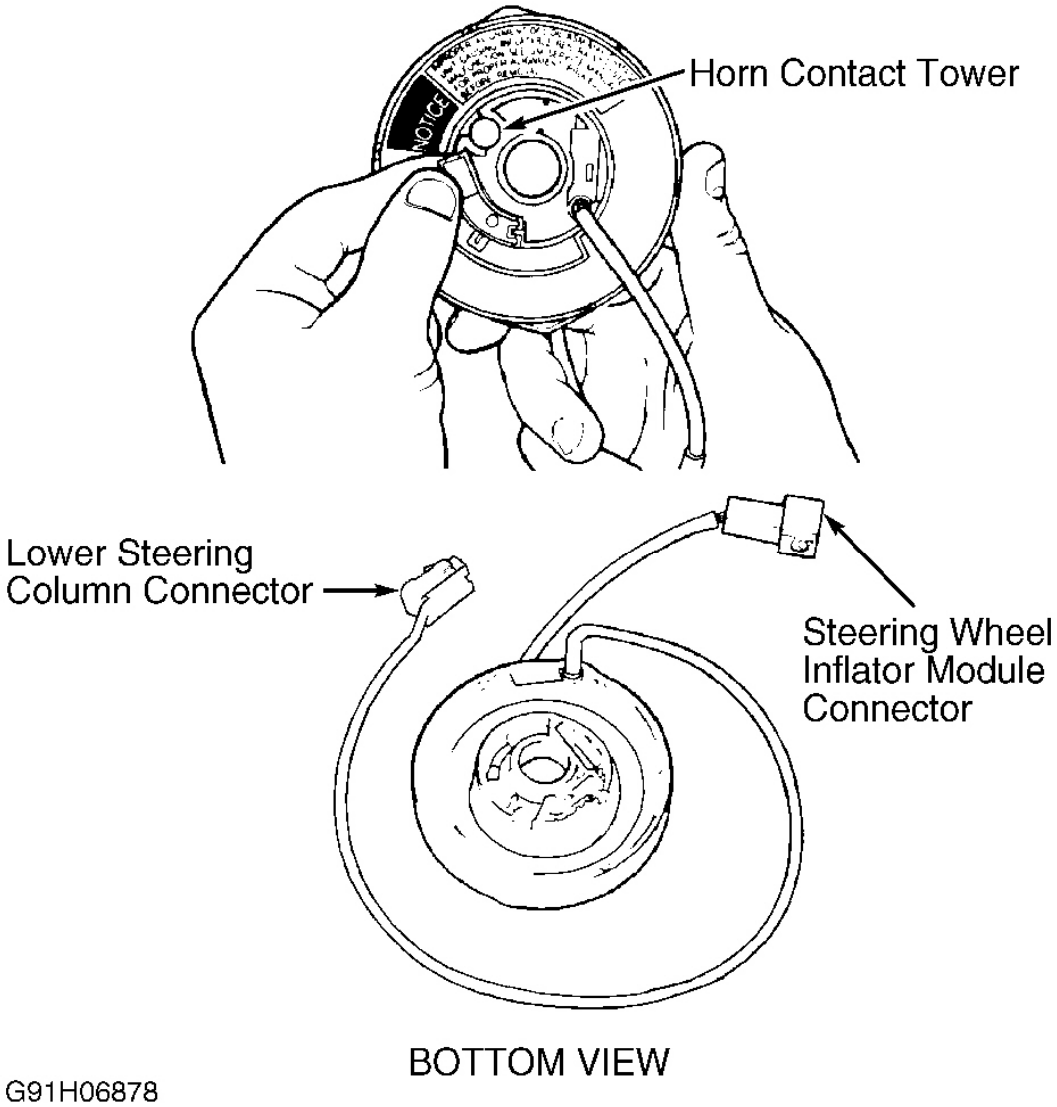


Fig. 1: Installing SIR Coil Assembly
Courtesy of GENERAL MOTORS CORP.

2. Ensure front wheels face straight ahead when installing or removing a coil assembly. If coil is removed without wheels in straight-ahead position and steering wheel has not been moved, same coil can be reinstalled if coil hub has not been rotated.
3. Hold coil assembly with clear bottom upward to see coil ribbon. Note there are 2 different styles of coil assemblies: one rotates clockwise and other counterclockwise.
4. While holding coil assembly housing, depress spring lock and rotate hub in direction of arrow until it stops. Coil assembly should now be wound up snug against center hub. Rotate coil assembly hub in opposite direction approximately 2 1/2 turns. Release spring lock between locking tabs in front of arrow.

DISPOSAL PROCEDURES

CAUTION: If SIR inflator is disposed of improperly, air bag deployment may result and cause personal injury. Undeployed inflator modules must not be disposed of at normal refuse locations. Undeployed inflator modules contain substances which can cause severe illness or personal injury if sealed container is damaged during disposal. Disposal of module in any manner inconsistent with proper procedures may be a violation of federal, state, and/or local laws.

DEPLOYED AIR BAG

Once an inflator module has been deployed, surface of air bag may contain a small amount of sodium hydroxide dust, combined with a White packing powder. Sodium hydroxide dust can be irritating to skin if left on for an extended period of time. Always wear gloves and safety glasses when handling a deployed inflator module. Wash hands with mild soap and water afterward. Deployed air bag modules can be disposed of as would any other part. Handle air bag module with gloves, and wear safety glasses.

UNDEPLOYED AIR BAG

Undeployed air bag modules must not be disposed of at normal refuse locations. Undeployed air bag modules contain substances which can cause illness or injury if handled improperly. Disposal of air bag module in any manner inconsistent with proper procedures may be a violation of federal, state and/or local laws. If possible, deploy air bag module in vehicle. See SCRAPPED VEHICLE.

Transportation of undeployed inflator modules is regulated by hazardous materials regulations of U.S. Government Department of Transportation and most state governments. Special shipping procedures must be followed. Check with hazardous material section of state government for applicable shipping requirements.

SCRAPPED VEHICLE

Some vehicles which have to be scrapped may have undeployed SIR systems. When scrapping a vehicle with an undeployed module:

1. Turn ignition switch to OFF position. Remove SIR fuse. Disconnect Yellow 2-pin connector at base of steering column. Cut harness side of SIR wiring approximately 3-6" from Yellow 2-pin connector.
2. Splice 2 wires at least 20 feet long to wiring cut from SIR harness. Connect Yellow 2-pin connector.
3. Ensure inflator module is secured to steering wheel. Remove all loose objects from front seat, and ensure no one is in vehicle. Stretch wires away from car as far as possible.
4. Connect wires to a 12-volt battery. Air bag should deploy. DO NOT touch inflator module area for 20 minutes due to heat generated during deployment. Wear gloves and safety glasses before handling deployed air bag. Wash hands with mild soap and water afterward.
5. On vehicles with passenger-side air bags, repeat deployment procedure for passenger-side. Access Yellow 2-pin connector at base of right instrument panel (behind knee bolster) or behind glove box door assembly.

REMOVAL & INSTALLATION

WARNING: Failure to follow air bag service precautions may result in air bag deployment and personal injury. See SERVICE PRECAUTIONS. After component replacement, perform a system operational check to ensure proper system operation. See SYSTEM OPERATION CHECK.

SENSING & DIAGNOSTIC MODULE (SDM)

Removal

1. Before proceeding, follow air bag service precautions. See SERVICE PRECAUTIONS. Disable air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM.
2. SDM is located under left side of instrument panel, on right side of steering column brace. Remove accelerator pedal assembly. Remove CPA clip and disconnect SDM electrical connector. Remove SDM mounting bolts. Remove SDM. See **Fig. 2** .

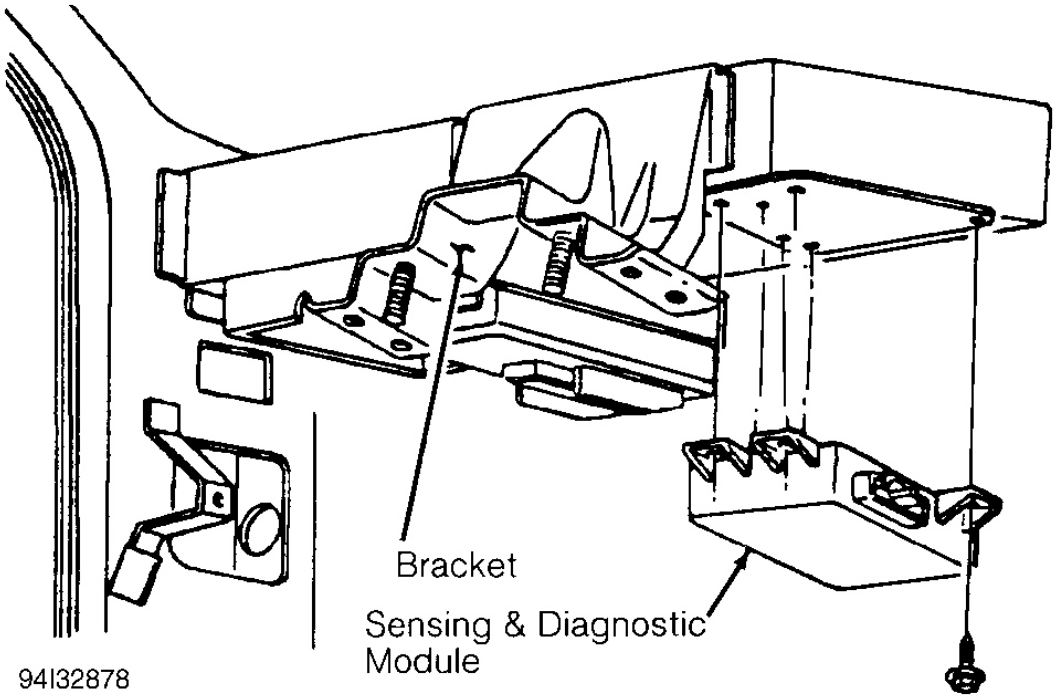


Fig. 2: Removing SDM
Courtesy of GENERAL MOTORS CORP.

Installation

To install, reverse removal procedure. Transfer retainers to new DERM if replacing. Reactivate air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM. Check AIR BAG warning light to ensure system is functioning properly. See SYSTEM OPERATION CHECK.

FORWARD DISCRIMINATING SENSORS

Removal

1. Before proceeding, follow service precautions. See SERVICE PRECAUTIONS. Disable air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM.
2. Forward discriminating sensor is on radiator brace. Remove CPA clip. Disconnect electrical connector from radiator support. Remove screws and discriminating sensor. Note position and routing of pigtail wiring for installation. See **Fig. 3** .

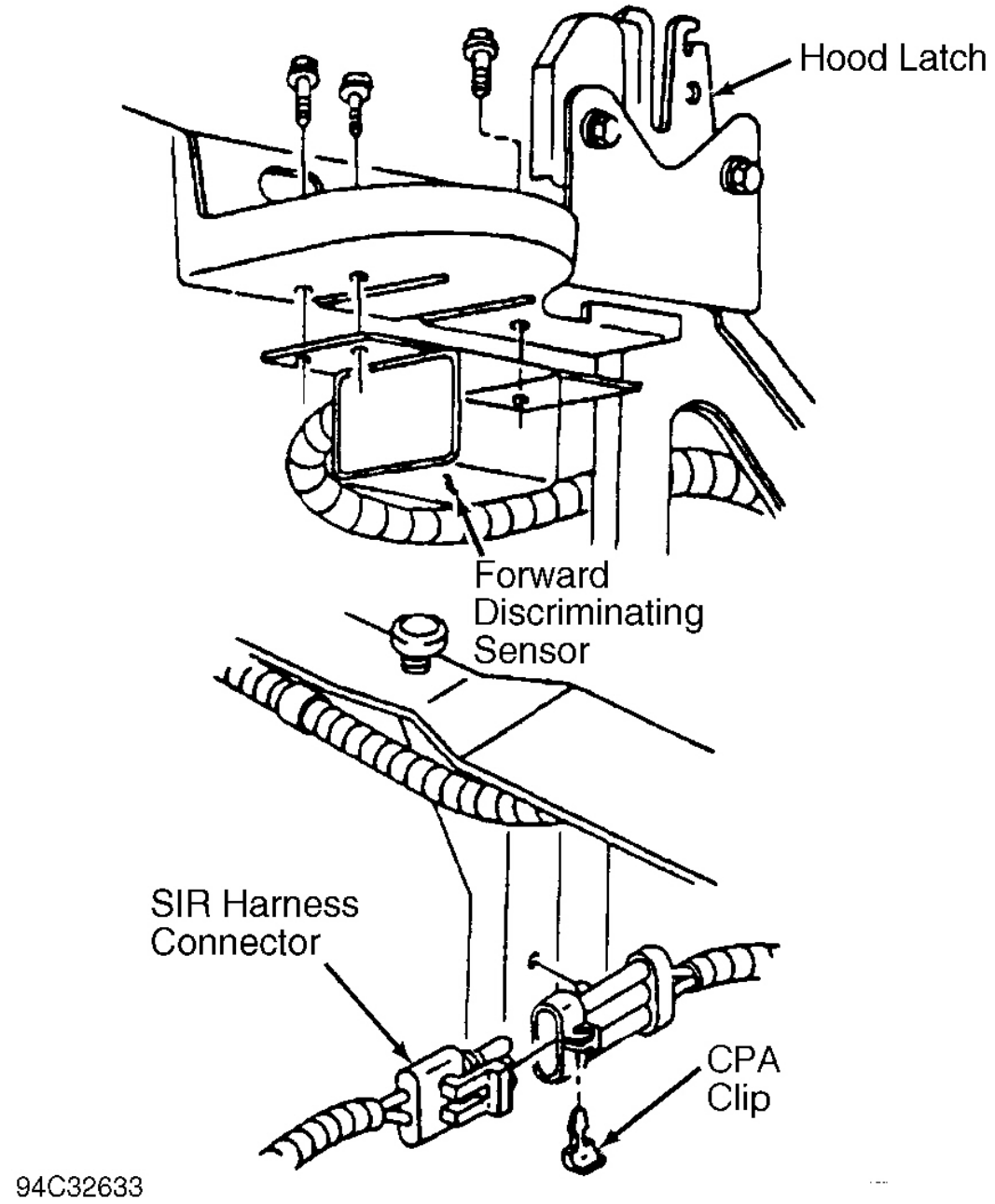


Fig. 3: Removing Forward Discriminating Sensor
Courtesy of GENERAL MOTORS CORP.

Installation

1. Install forward discriminating sensor so arrow points to vehicle front. Install and torque sensor attaching screws to 27 INCH Lbs. (3 N.m). To complete, reverse removal procedure.

2. Reactivate air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM. Check AIR BAG warning light to ensure system is functioning properly. See SYSTEM OPERATION CHECK.

STEERING WHEEL

Removal & Installation

1. Before proceeding, follow air bag service precautions. See SERVICE PRECAUTIONS. Disable air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM.
2. Remove inflator module. See INFLATOR MODULE under REMOVAL & INSTALLATION. Remove horn contact wire from steering column. Remove steering wheel hexagonal locking nut. Using appropriate puller, remove steering wheel. See STEERING WHEEL PULLER SPECIFICATIONS table.

STEERING WHEEL PULLER SPECIFICATIONS

Application	Tool (Part No.)
Caprice, Impala SS, Roadmaster	Puller (J-1859-A)

SIR COIL ASSEMBLY

NOTE: Front wheels of vehicle must be turned to straight-ahead position before beginning service. Failure to do so can result in coil assembly being removed without being centered. Reinstalling coil assembly under such circumstances causes ribbon in coil assembly to break when steering wheel is turned fully in one direction. Ensure key is always in LOCK position to prevent wheel from turning and uncentering coil assembly. To re-center coil assembly, see CENTERING COIL ASSEMBLY under ADJUSTMENTS.

Removal

1. Before proceeding, follow air bag service precautions. See SERVICE PRECAUTIONS. Disable air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM.
2. Remove inflator module. See INFLATOR MODULE under REMOVAL & INSTALLATION. Remove horn contact wire from steering column. Remove steering wheel. See STEERING WHEEL under REMOVAL & INSTALLATION. DO NOT install puller bolts too far, as damage to coil assembly can result.
3. Remove coil assembly retaining ring from steering shaft. Grasp clear plastic wire protector shield on underside of steering column, and slide downward. Partially remove coil assembly from end of steering wheel shaft and allow coil to hang freely. Note orientation to steering column housing before removal.
4. Remove wave washer from steering shaft. Using Lock Plate Compressor (J-23653-C), depress shaft lock and remove shaft lock retaining ring. Remove shaft lock plate and upper bearing spring. Remove turn signal canceling cam.
5. Remove hazard knob and attaching screw. Remove turn signal switch arm. Remove 3 turn signal switch screws and partially withdraw switch. Disconnect any remaining electrical connectors. Attach mechanics wire to coil assembly lower connector at base of steering column and carefully pull wire through gear shift lever bowl, column housing and lock housing cover.

Installation

1. Carefully feed coil assembly wire and lower connector through lock housing cover, column housing, and gear shift lever bowl. Allow coil assembly to hang freely.

NOTE: Use care not to pinch wires when installing components. After wire is fed through, attach CAUTION tag to wire near connector at base of steering column. Tag is included in coil assembly repair kit.

2. Install turn signal switch and torque screws to 30 INCH Lbs. (3.4 N.m). Install turn signal switch arm and torque attaching screw to 20 INCH Lbs. (2.3 N.m).
3. Install hazard knob and attaching screw. Install turn signal canceling cam and shaft lock plate. Install shaft lock retaining ring. Using lock plate compressor, align block tooth on shaft, and depress shaft lock plate. Install wave washer.
4. Ensure coil assembly hub and steering shaft are centered. Coil assembly will become uncentered if column is separated from steering gear and is allowed to rotate, or if centering spring is depressed, allowing hub to rotate while coil assembly is removed from column.
5. Install coil assembly, using horn tower on canceling cam to align hole on inner ring of coil and projections on steering column housing with projections on outer ring of coil. To complete installation, reverse removal procedure.
6. Reactivate air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM. Check AIR BAG warning light to ensure system is functioning properly. See SYSTEM OPERATION CHECK.

INFLATOR MODULE

Removal (Driver-Side)

1. Before proceeding, follow air bag service precautions. See SERVICE PRECAUTIONS. Disable air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM.
2. Remove screws and nuts from underside of steering wheel. Partially remove inflator module and disconnect steering wheel inflator module connector, and CPA clip. Disconnect horn contact from inflator. Remove radio control switch connector, if equipped. Remove inflator module.

Installation (Driver-Side)

1. Install horn contact, steering wheel inflator module connector, and CPA clip. Install inflator module to steering wheel. Tighten inflator module screws to proper specification. See TORQUE SPECIFICATIONS.
2. To complete installation, reverse removal procedure. Reactivate air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM. Check AIR BAG warning light to ensure system is functioning properly. See SYSTEM OPERATION CHECK.

Removal (Passenger-Side)

1. Before proceeding, follow air bag service precautions. See SERVICE PRECAUTIONS. Disable air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM.

2. Remove instrument panel upper trim pad. Remove CPA clip and disconnect electrical connector from inflator module. Remove fasteners from module and remove module.

Installation (Passenger-Side)

To install, reverse removal procedure. Tighten module fasteners to 89 INCH Lbs. (10 N.m). Reactivate air bag system. See DISABLING & ACTIVATING AIR BAG SYSTEM. Check AIR BAG warning light to ensure system is functioning properly. See SYSTEM OPERATION CHECK.

DIAGNOSIS & TESTING

WARNING: Failure to follow air bag service precautions may result in air bag deployment and personal injury. See SERVICE PRECAUTIONS. After component replacement, ensure proper system operation. See SYSTEM OPERATION CHECK.

SELF-DIAGNOSIS

Diagnostic Trouble Codes (DTCs)

Diagnostic Energy Reserve Module (DERM) provides a record of DTCs stored according to type. Current DTCs are faults presently being detected. Current DTCs are stored in Random Access Memory (RAM) and are erased when fault is corrected. Current DTCs can be read using a scan tester such as Tech 1, or on-board diagnostics on Cadillac vehicles.

Scan Tester Diagnostics

A scan tester will read and clear current codes and history codes. Ensure scan tester contains correct cartridge for SIR diagnostics. To use scan tester, connect it to DLC connector, plug in power source and turn ignition switch to ON position. Follow scan tester manufacturer instructions for communication with SIR system. Scan tester reads serial data from DERM data link output to DLC connector.

On-Board Diagnostics

On-board diagnostics can only be used on Cadillac models which have an on-board diagnostics panel. Enter diagnostics by depressing WARMER and OFF buttons on diagnostics panel. Service mode and codes will appear in display area. Current Code 51 (accident detected) cannot be cleared using on-board diagnostics; a scan tester is necessary to clear current Code 51. Current Code 34 will remain current after fault is repaired unless ignition is off long enough to allow 36-Volt Loop Reserve (36VLR) to fully discharge.

NOTE: Failure to follow diagnostic procedures may result in extended diagnostic time and incorrect diagnosis and parts replacement.

Diagnostic Procedure

1. SIR SYSTEM DIAGNOSTIC CHECK should always be starting point of SIR diagnostics. See appropriate SIR DIAGNOSTIC SYSTEM CHECK under DIAGNOSTIC CHARTS. SIR DIAGNOSTIC

SYSTEM CHECK checks for proper INFLATABLE RESTRAINT indicator light operation and SIR trouble codes using flash code and scan tester methods.

2. SIR DIAGNOSTIC SYSTEM CHECK will lead to correct diagnostic chart to diagnose SIR problems. Always perform SIR DIAGNOSTIC SYSTEM CHECK after repair or diagnostic procedures to ensure repair is correct and no other problems are present.

DIAGNOSTIC CHARTS

SIR DIAGNOSTIC SYSTEM CHECK

Description

Diagnostic procedures used in this section are designed to find and repair SIR problems. For best results, utilize diagnostic charts and follow sequence listed below:

A. Perform SIR DIAGNOSTIC SYSTEM CHECK. SIR DIAGNOSTIC SYSTEM CHECK should be start of any SIR diagnosis. SIR DIAGNOSTIC SYSTEM CHECK checks for proper AIR BAG/INFLATABLE RESTRAINT indicator operation and SIR trouble codes.

B. Refer to diagnostic chart as directed by SIR DIAGNOSTIC SYSTEM CHECK. SIR DIAGNOSTIC SYSTEM CHECK will lead to correct chart to diagnose any SIR problems. By-passing these procedures may result in extended diagnostic time, incorrect diagnosis, and incorrect parts replacement.

C. Repeat SIR DIAGNOSTIC SYSTEM CHECK after any repair or diagnostic procedures are performed. Repeating SIR DIAGNOSTIC SYSTEM CHECK will ensure repair was made correctly and no other conditions exist. When ignition is first turned on, system voltage is applied through AIR BAG fuse to Sensing and Diagnostic Module (SDM) at IGNITION 1 input terminal B9 and from I/P INDC fuse to SDM at REDUNDANT INDICATOR IGNITION 1 input terminal A4. SDM responds by flashing AIR BAG/INFLATABLE RESTRAINT indicator 7 times.

When engine is cranked, system voltage is applied from CRANK fuse to SDM at CRANK input terminal B1. SDM grounds light circuit until system voltage is removed from CRANK input. This results in a steady AIR BAG/INFLATABLE RESTRAINT indicator during cranking. After engine is cranked, SDM will flash AIR BAG/INFLATABLE RESTRAINT indicator 6 times.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. AIR BAG/INFLATABLE RESTRAINT indicator should flash 7 times after ignition is first turned on.
2. AIR BAG/INFLATABLE RESTRAINT indicator should remain on steady during cranking.
3. After cranking, AIR BAG/INFLATABLE RESTRAINT indicator should flash 6 times and then go off.
4. Test checks for proper operation of SERIAL DATA circuit. This test will also determine which history codes, if any, are stored.
5. When AIR BAG/INFLATABLE RESTRAINT warning light flashes 4 times during BULB CHECK, this indicates a malfunction in redundant light driver circuitry. These malfunctions are diagnosed by DTC 62 chart.
6. Improper operation of AIR BAG/INFLATABLE RESTRAINT warning light is indicated. Test

differentiates a warning light stays on condition from a warning light does not come on condition.

7. Test checks for proper operation of SERIAL DATA circuit. Test will also identify stored DTCs and whether they are current or history.

Diagnostic Aids

Order in which DTCs are diagnosed is very important. Failure to diagnose DTCs in order specified may result in extended diagnostic time, incorrect diagnosis and incorrect parts replacement.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

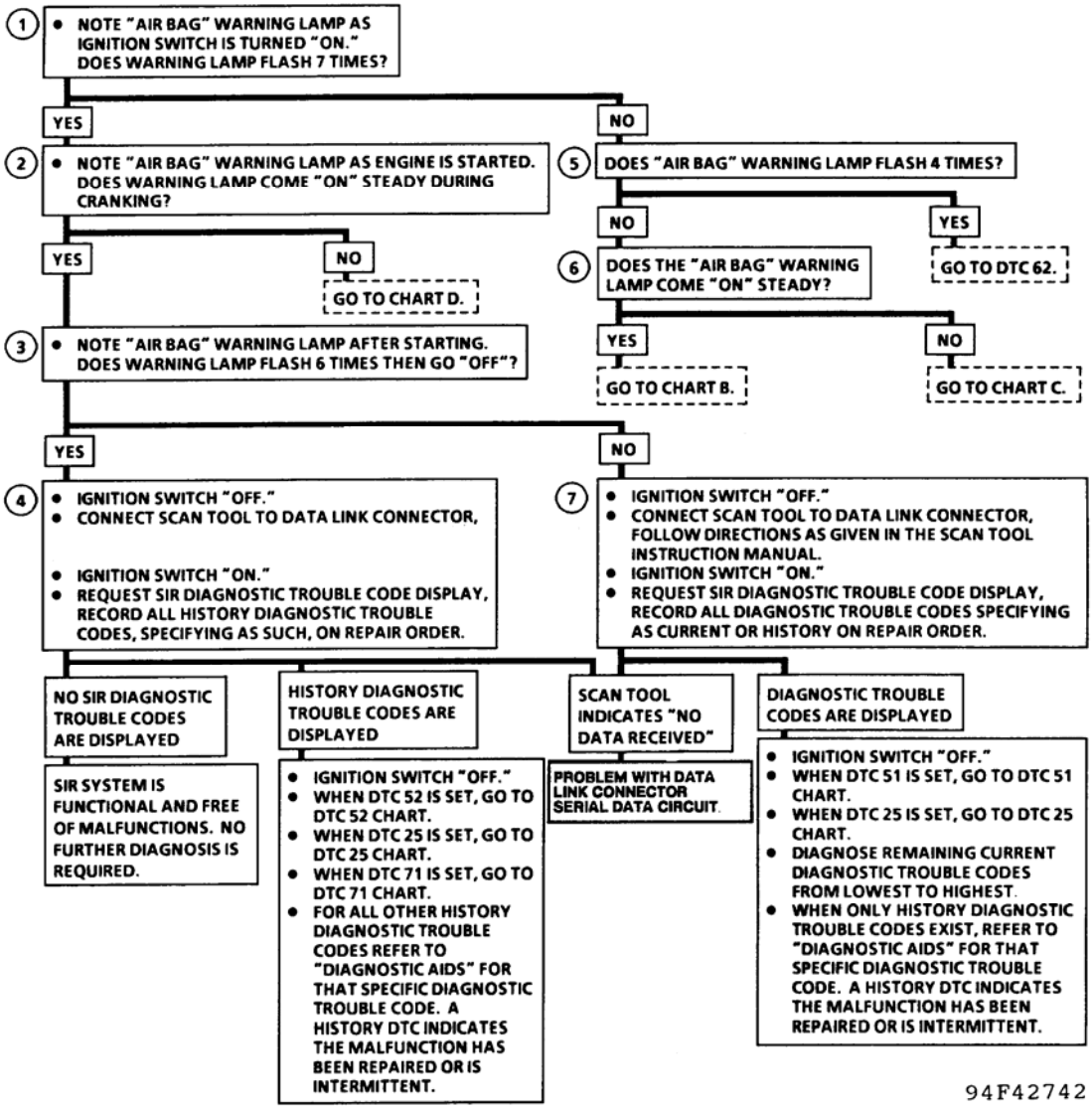


Fig. 4: SIR Diagnostic System Check
Courtesy of GENERAL MOTORS CORP.

CHART A - SDM INTEGRITY CHECK

Description

When SDM recognizes IGNITION 1 voltage (applied to terminal B9) is greater than 6.4 volts, the AIR BAG/INFLATABLE RESTRAINT warning light is flashed 7 times to verify operation. At this time, SDM performs TURN-ON tests followed by CURRENT SOURCE DIAGNOSTICS and CONTINUOUS MONITORING tests. When a malfunction is detected, SDM sets a current DTC and illuminates AIR BAG/INFLATABLE RESTRAINT warning light. SDM will clear current DTCs and move them to a history file when malfunction is no longer detected and/or ignition switch is cycled, except for DTCs 51, 52, and 71. DTC 51 can only be cleared using a scan tool CLEAR CODES command. DTCs 52 and 71 may not clear after a CLEAR CODES command is issued.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Test confirms a current malfunction. If no current malfunction is occurring (history DTC set), DIAGNOSTIC AIDS for appropriate DTC should be referenced. SDM should not be replaced for a history DTC.
2. Checks for a malfunction introduced into SIR system during diagnostic process. It is unlikely that a malfunctioning SDM would cause a new malfunction to occur during diagnostic process.
3. When all circuitry outside SDM has been found to operate correctly, as indicated by appropriate diagnostic chart, then and only then should SDM be replaced.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

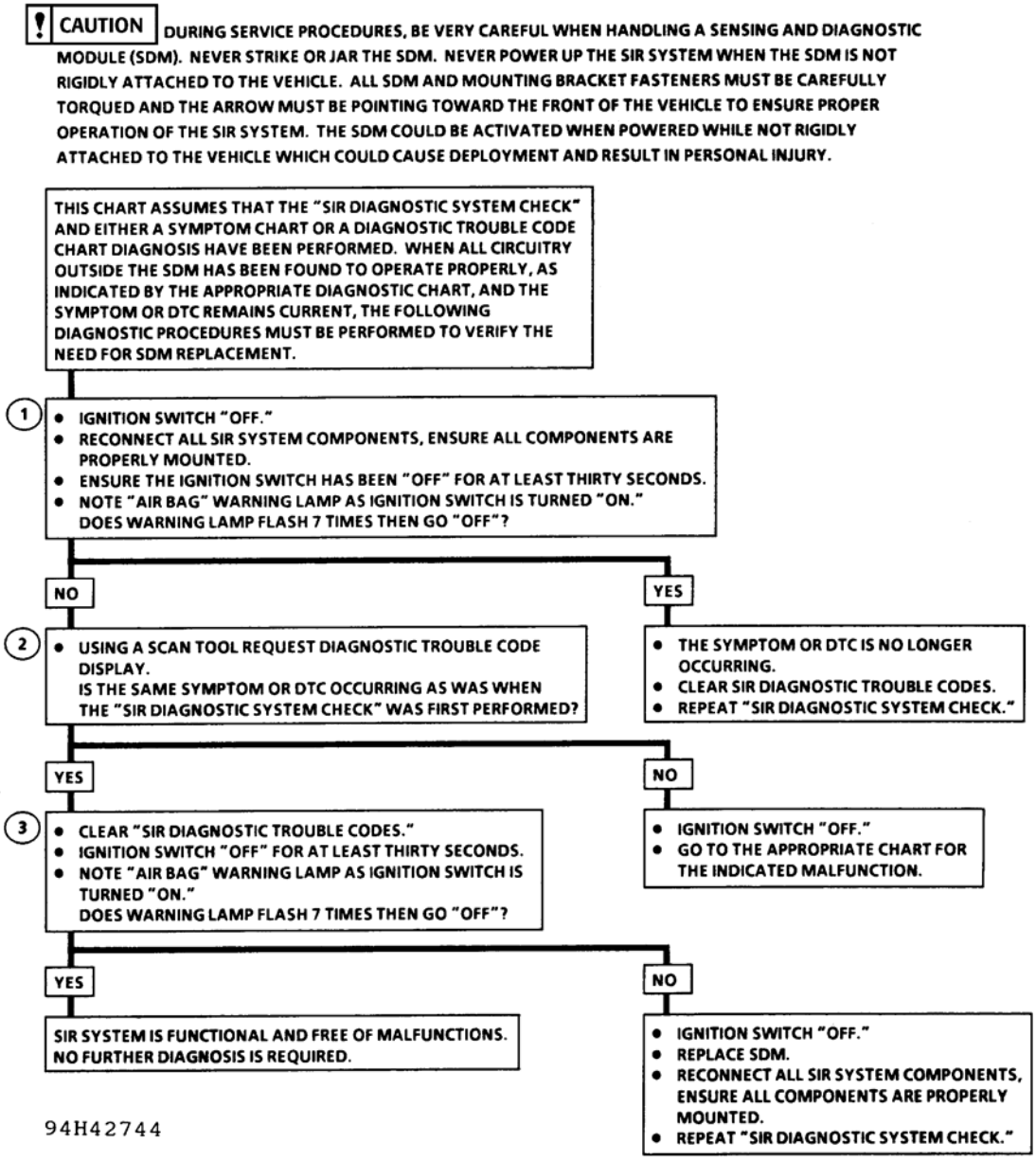


Fig. 5: Chart A - SDM Integrity Check
Courtesy of GENERAL MOTORS CORP.

CHART B - AIR BAG/INFLATABLE RESTRAINT INDICATOR COMES ON STEADY

Description

When ignition is first turned on, system voltage is applied from I/P INDC fuse to REDUNDANT INDICATOR IGNITION 1, terminal A4, and to AIR BAG/INFLATABLE RESTRAINT indicator light, which is connected to SIR INDICATOR, terminal A9. AIR BAG fuse applies system voltage to IGNITION 1 input, terminal B9. SDM responds by flashing AIR BAG/INFLATABLE RESTRAINT warning light 7 times. If IGNITION 1 is

outside of normal operating voltage range, AIR BAG/INFLATABLE RESTRAINT warning light will come on with no DTCs set. When engine is being cranked, IGNITION 1 voltage is applied from CRANK fuse to SDM at CRANK input. SDM responds by grounding SIR INDICATOR output until IGNITION 1 voltage is removed from CRANK input. This results in AIR BAG/INFLATABLE RESTRAINT warning light being on during cranking. After engine is cranked, SDM will flash AIR BAG/INFLATABLE RESTRAINT indicator 6 times.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. An open fuse would cause AIR BAG/INFLATABLE RESTRAINT light to come on steady.
2. Disconnected SDM harness connector will cause warning light to come on steady via shorting bar from terminal A9 to terminal A10 (ground).
3. Checks for an open in ground circuit to SDM.
4. Checks for an open in IGNITION 1 circuit to SDM.
5. Checks for a short from CRANK input circuit to voltage.
6. Checks for a short from SIR INDICATOR circuit to ground.
7. Checks whether a short to ground caused fuse to open.
8. Determines whether short to ground is due to a short in wiring.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

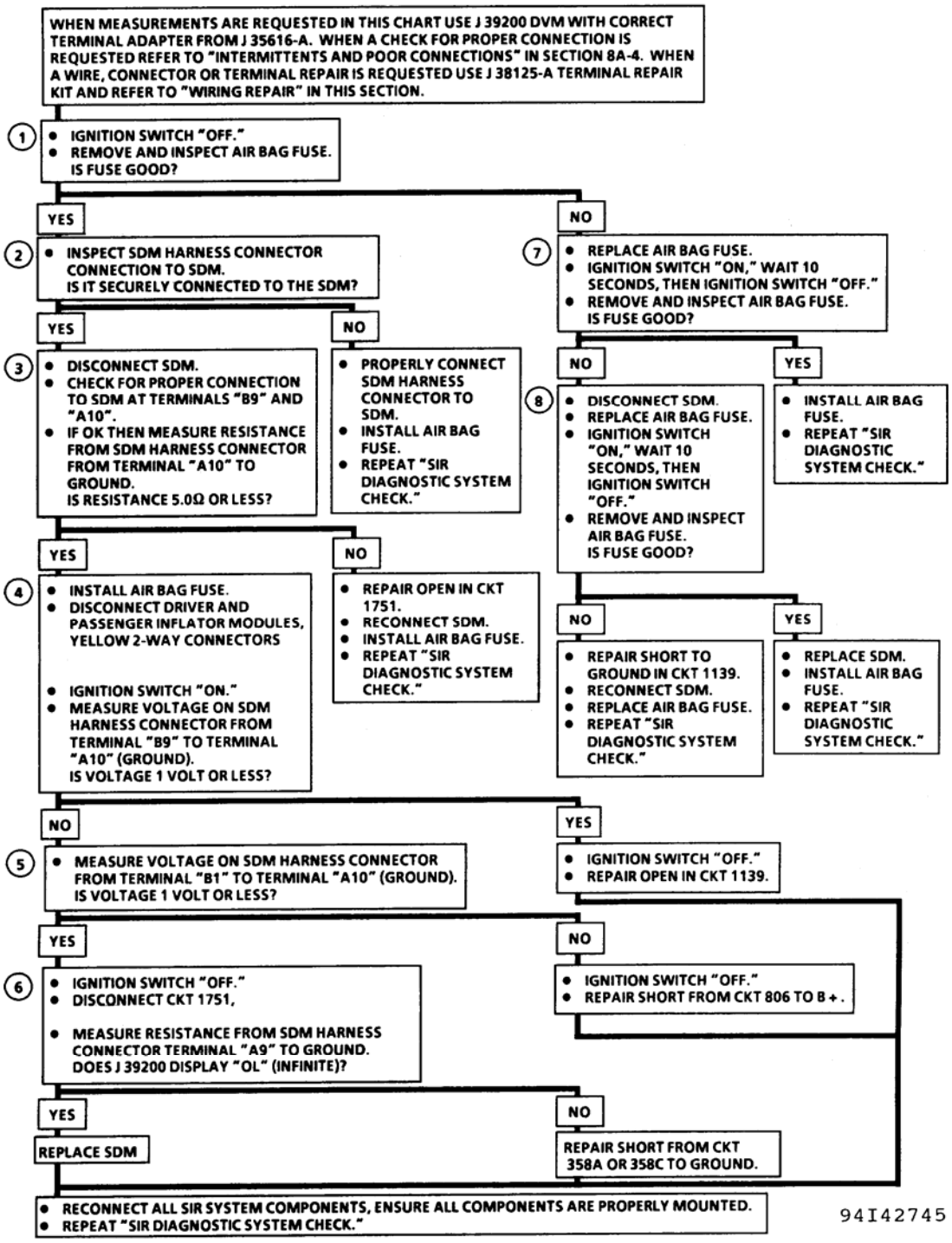


Fig. 6: Chart B - Air Bag/Inflatable Restraint Indicator Comes On Steady
Courtesy of GENERAL MOTORS CORP.

CHART C - AIR BAG/INFLATABLE RESTRAINT INDICATOR DOES NOT COME ON

Description

When ignition is first turned on, system voltage is applied from I/P INDC fuse to REDUNDANT INDICATOR IGNITION 1, terminal A4, and to AIR BAG/INFLATABLE RESTRAINT indicator light, which is connected to SIR INDICATOR, terminal A9. AIR BAG fuse applies system voltage to IGNITION 1 input, terminal B9. SDM responds by flashing AIR BAG/INFLATABLE RESTRAINT warning light 7 times. If IGNITION 1 is outside of normal operating voltage range, AIR BAG/INFLATABLE RESTRAINT warning light will come on with no DTCs set. When engine is being cranked, IGNITION 1 voltage is applied from CRANK fuse to SDM at CRANK input. SDM responds by grounding SIR INDICATOR output until IGNITION 1 voltage is removed from CRANK input. This results in AIR BAG/INFLATABLE RESTRAINT warning light being on during cranking. After engine is cranked, SDM will flash AIR BAG/INFLATABLE RESTRAINT indicator 6 times.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Checks whether malfunction is in AIR BAG/INFLATABLE RESTRAINT warning light circuitry or in instrument cluster power feed circuitry.
2. Checks for an open in SIR INDICATOR circuit, instrument cluster circuit, and AIR BAG/INFLATABLE RESTRAINT warning bulb.
3. Checks whether open is caused by a bad bulb.
4. Checks whether malfunction is an open in SIR INDICATOR circuit or an open in instrument cluster.
5. Checks whether malfunction is due to a short from SIR INDICATOR circuit to voltage.

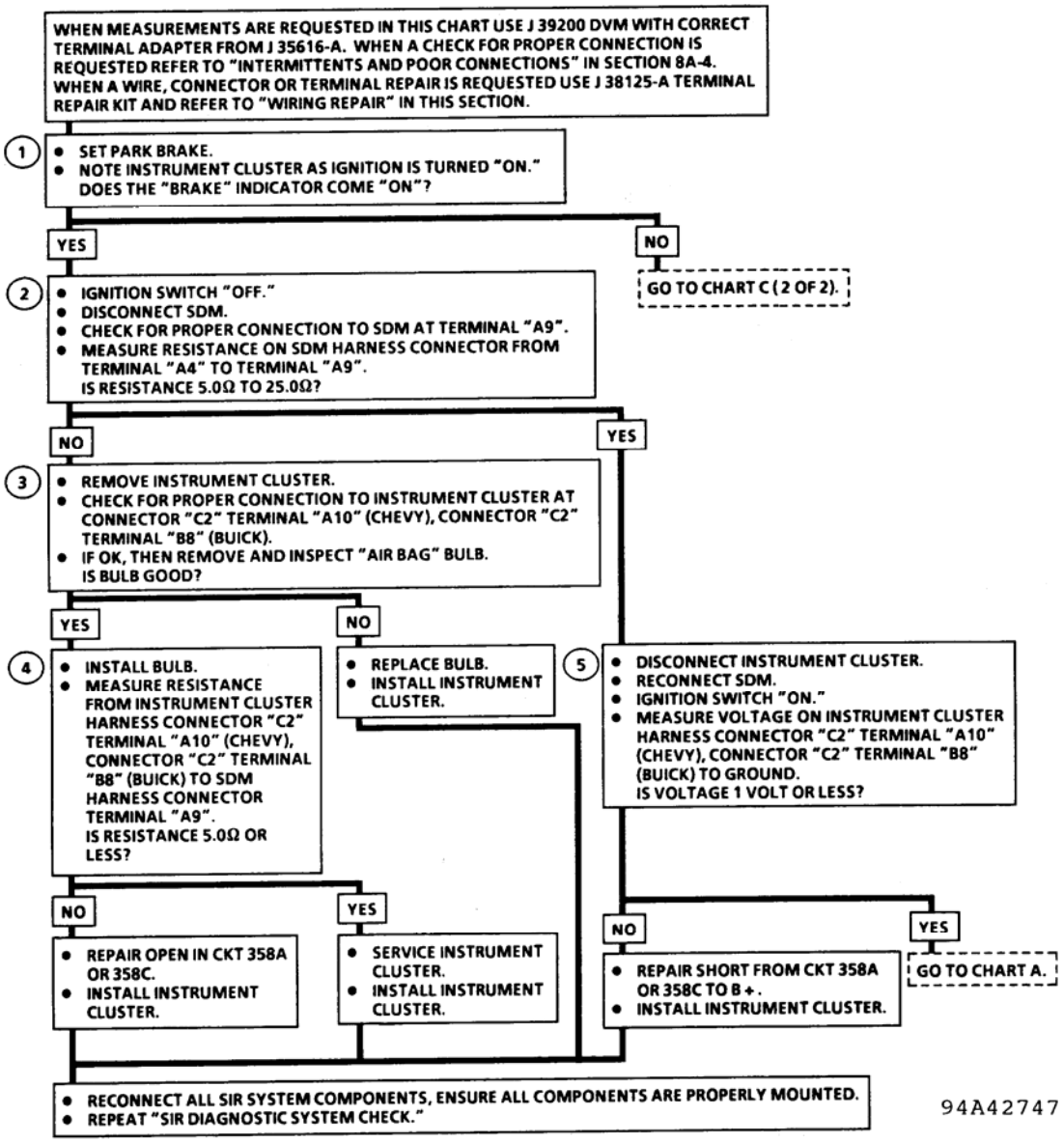


Fig. 7: Chart C - Air Bag/Inflatable Restraint Indicator Does Not Come On (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

6. Checks whether power is available to instrument cluster power feed circuit.
7. Checks for a short from instrument cluster power feed circuit to ground.
8. Checks whether short to ground is due to a short in wiring.
9. Checks whether malfunction is due to an open power feed circuit from I/P INDC fuse to connector C200 terminal B4.
10. Determines whether malfunction is due to an open power feed circuit from connector C200 terminal B4 to instrument cluster or an open in power feed to I/P INDC fuse.

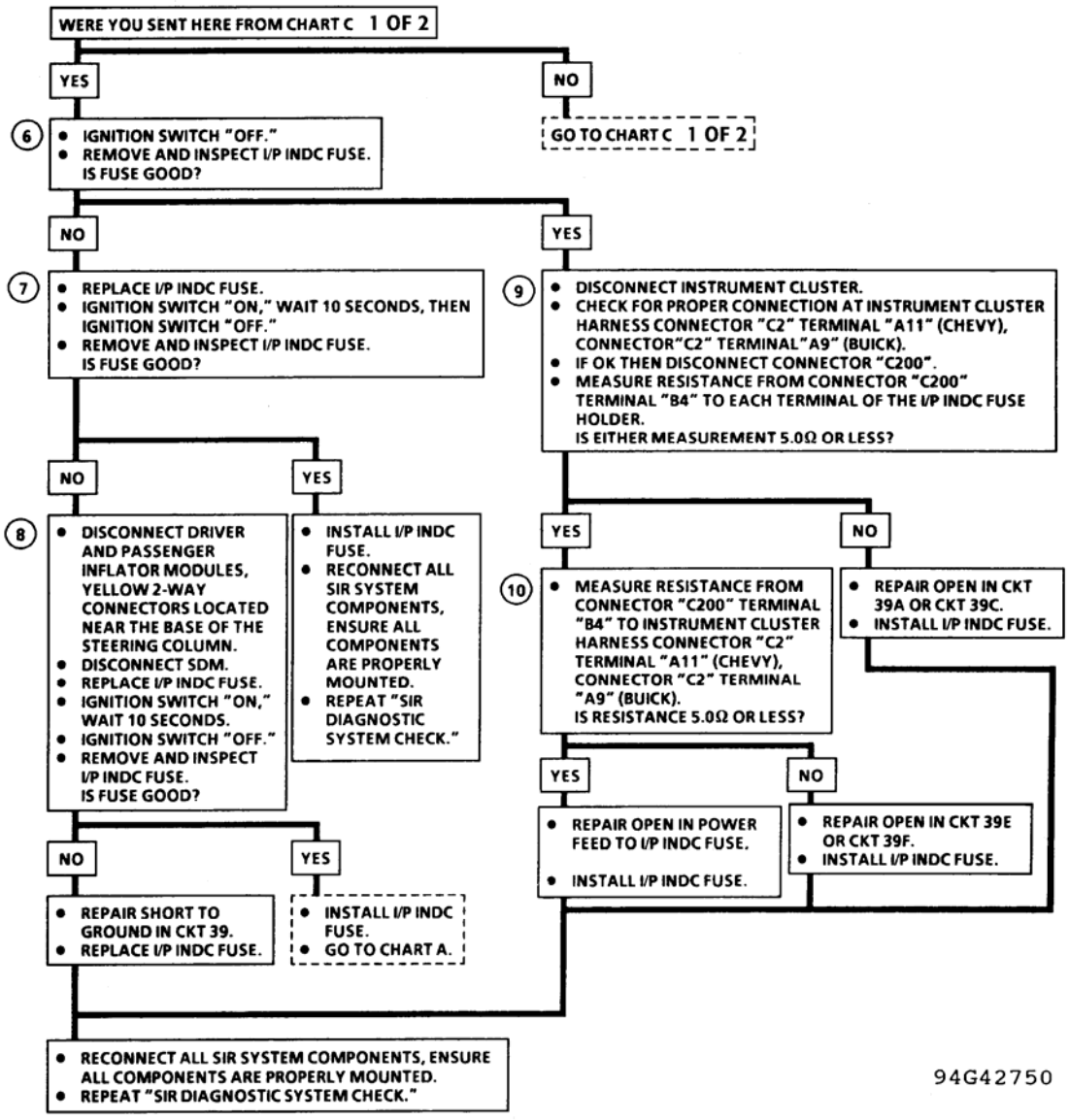


Fig. 8: Chart C - Air Bag/Inflatable Restraint Indicator Does Not Come On (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

CHART D - AIR BAG/INFLATABLE RESTRAINT INDICATOR DOES NOT COME ON STEADY DURING CRANK

Description

When ignition is first turned on, system voltage is applied from I/P INDC fuse to REDUNDANT INDICATOR IGNITION 1, terminal A4, and to AIR BAG/INFLATABLE RESTRAINT indicator light, which is connected to SIR INDICATOR, terminal A9. AIR BAG fuse applies system voltage to IGNITION 1 input, terminal B9. SDM responds by flashing AIR BAG/INFLATABLE RESTRAINT warning light 7 times. If IGNITION 1 is outside of normal operating voltage range, AIR BAG/INFLATABLE RESTRAINT warning light will come on

with no DTCs set. When engine is being cranked, IGNITION 1 voltage is applied from CRANK fuse to SDM at CRANK input. SDM responds by grounding SIR INDICATOR output until IGNITION 1 voltage is removed from CRANK input. This results in AIR BAG/INFLATABLE RESTRAINT warning light illumination during cranking. After engine is cranked, SDM will flash AIR BAG/INFLATABLE RESTRAINT indicator 6 times.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Checks whether fault is due to an open CRANK fuse.
2. Checks for a proper signal to CRANK input during cranking.
3. Determines whether lack of proper crank signal is due to an open CRANK input circuit or an open power feed to CRANK fuse .
4. Checks whether CRANK fuse is open due to a short to ground in CRANK input circuit.
5. Checks whether short to ground is in wiring harness.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

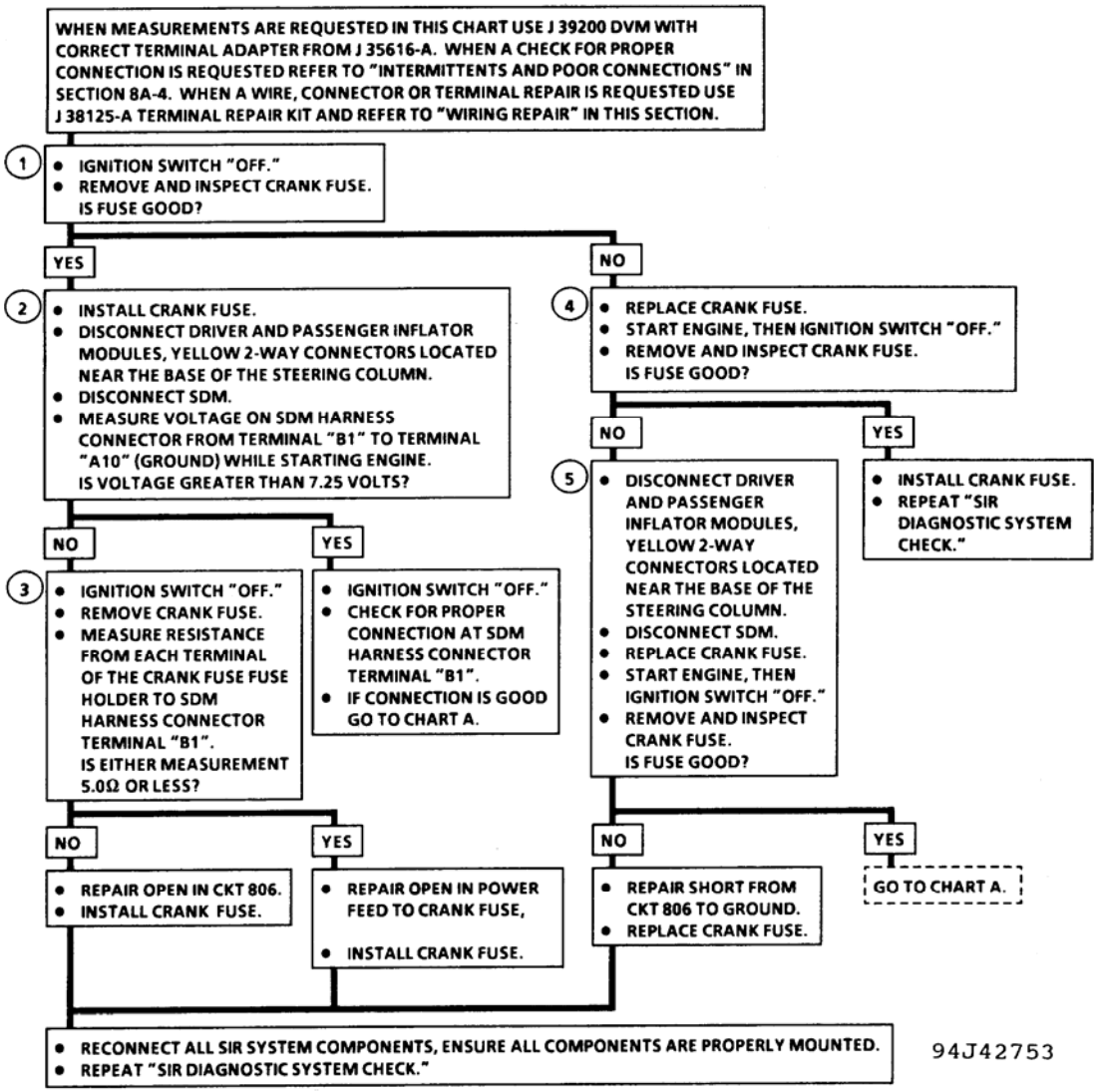


Fig. 9: Chart D - Air Bag/Inflatable Restraint Indicator Does Not Come On During Steady Crank
Courtesy of GENERAL MOTORS CORP.

DTC 15 - PASSENGER INITIATOR CIRCUIT RESISTANCE HIGH

Description

When ignition switch is turned on, SDM will perform tests to diagnose critical malfunctions within itself. Upon passing these tests, IGNITION 1, 36VLR, and deployment loop voltages are measured to ensure they are within their respective normal voltages ranges. SDM then proceeds with CURRENT SOURCE DIAGNOSTICS. PASSENGER-SIDE LOW terminal A5 is grounded through a resistor and passenger current source connected to PASSENGER-SIDE HIGH terminal A6 allows a known amount of current to flow. By monitoring voltage difference between PASSENGER-SIDE HIGH and PASSENGER-SIDE LOW, the SDM calculates combined resistance of passenger inflator module, harness wiring at circuits No. 1403 and 1404, and connector terminal

contact.

Failure Conditions

DTC will set when combined resistance of passenger inflator module, harness wiring at circuits No. 1403 and 1404, and connector terminal contact is greater than a specified value.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT warning light and sets DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Determines whether malfunction is in passenger inflator module circuitry or in SDM wiring harness circuitry.
2. Checks whether malfunction is caused by high resistance in circuit No. 1403.
3. Checks whether malfunction is caused by high resistance in circuit No. 1404.
4. Checks whether malfunction is due to passenger inflator module or passenger inflator module jumper.

Diagnostic Aids

An intermittent condition is likely to be caused by a poor connection at passenger inflator module harness connector terminals "A" and "B", SDM terminals A5 and A6, or a poor connection in circuit No. 1403 or 1404. Test for this DTC is only run while AIR BAG/INFLATABLE RESTRAINT warning light is performing Bulb check, unless DTC 17 or 26 is detected. When a scan tool CLEAR CODES command is issued and malfunction is still present, DTC will not reappear until next ignition cycle.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

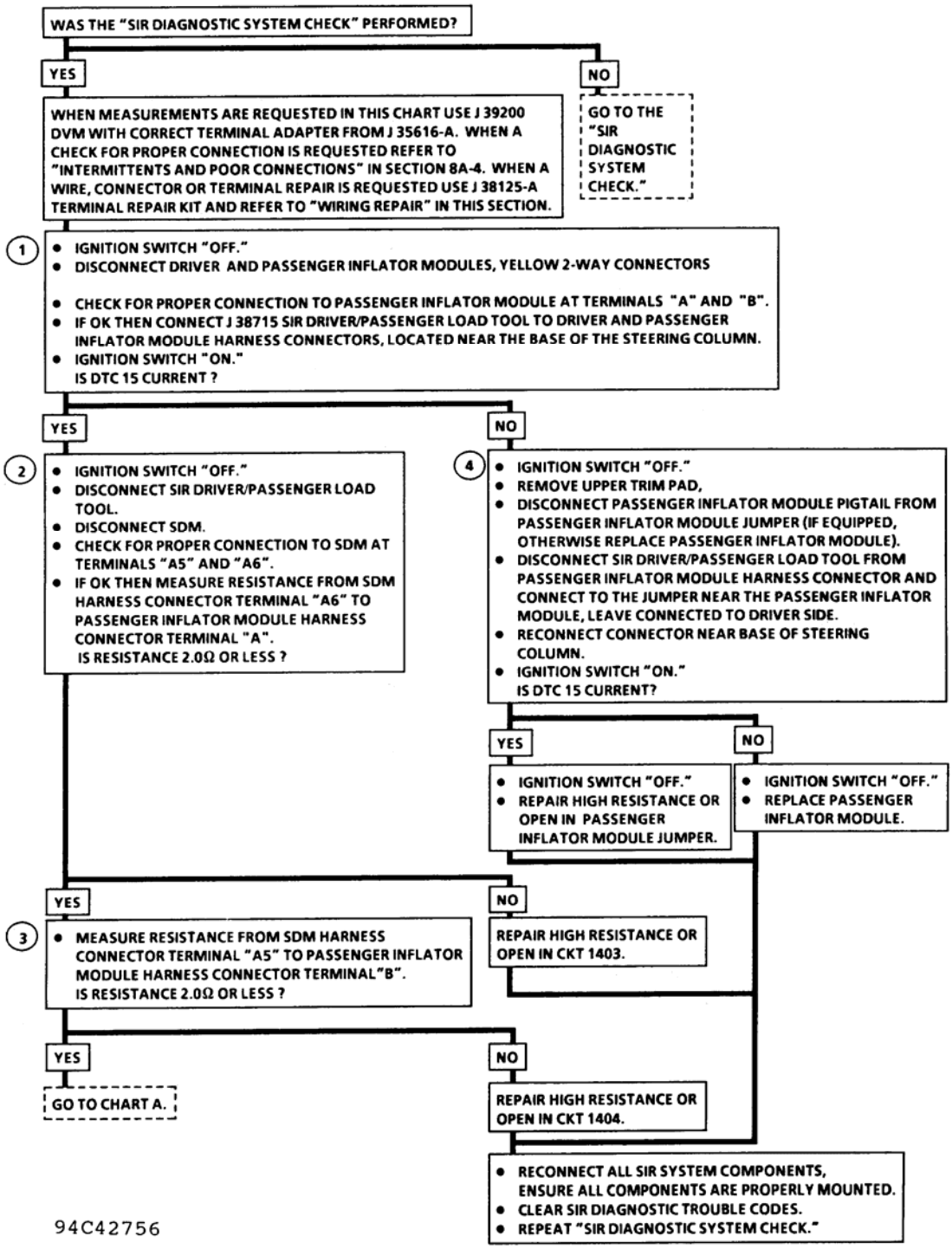


Fig. 10: DTC 15 - Passenger Initiator Circuit Resistance High
Courtesy of GENERAL MOTORS CORP.

DTC 16 - PASSENGER INITIATOR CIRCUIT RESISTANCE LOW

Description

When ignition switch is turned on, SDM will perform tests to diagnose critical malfunctions within itself. Upon passing these tests, IGNITION 1, 36VLR, and deployment loop voltages are measured to ensure they are within their respective normal voltages ranges. SDM then proceeds with CURRENT SOURCE DIAGNOSTICS. PASSENGER-SIDE LOW terminal A5 is grounded through a resistor and passenger current source connected to PASSENGER-SIDE HIGH terminal A6 allows a known amount of current to flow. By monitoring voltage difference between PASSENGER-SIDE HIGH and PASSENGER-SIDE LOW the SDM calculates combined resistance of passenger inflator module, harness wiring at circuits No. 1403 and 1404, and connector terminal contact.

Failure Conditions

DTC will set when combined resistance of passenger inflator module, harness wiring at circuits No. 1403 and 1404, and connector terminal contact is less than a specified value.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT warning light and sets DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Codes set simultaneously when DRIVER-SIDE HIGH circuit is shorted to PASSENGER-SIDE HIGH circuit due to parallel current paths.
2. Determines whether malfunction is in passenger inflator module circuitry or in SDM wiring harness circuitry.
3. Checks for a short from PASSENGER-SIDE HIGH circuit to PASSENGER-SIDE LOW circuit.
4. Checks for a short from PASSENGER-SIDE HIGH circuit to DRIVER-SIDE LOW circuit.

Diagnostic Aids

An intermittent condition is likely to be caused by a short between circuit No. 1403 and circuit No. 347, 348, or 1404, or a malfunctioning shorting bar on passenger inflator module which would require replacement of module. Test for this DTC is only run while AIR BAG/INFLATABLE RESTRAINT warning light is performing Bulb check, unless DTC 17 or 26 is detected. When a scan tool CLEAR CODES command is issued and malfunction is still present, DTC will not reappear until next ignition cycle.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

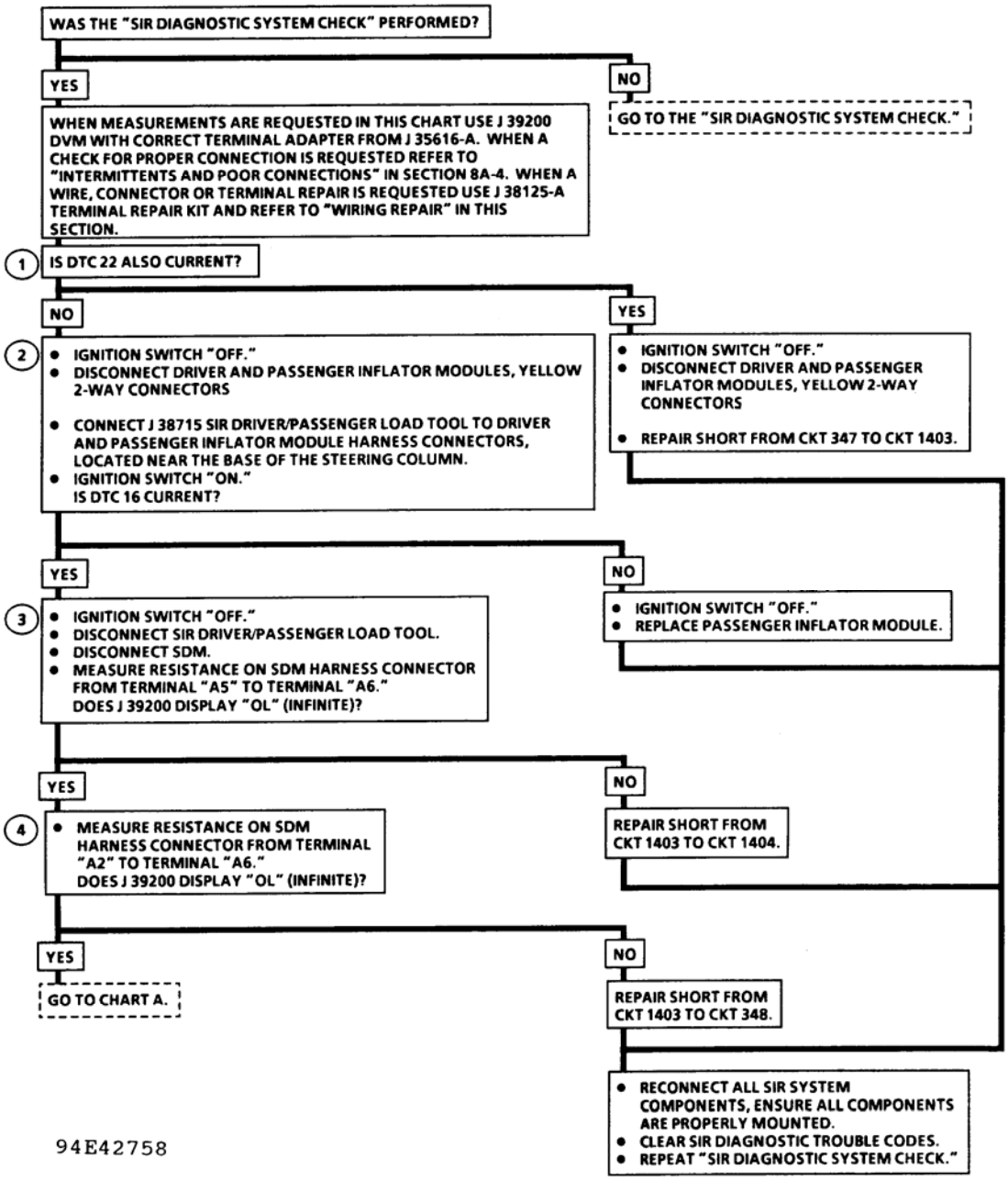


Fig. 11: DTC 16 - Passenger Initiator Circuit Resistance Low
Courtesy of GENERAL MOTORS CORP.

DTC 17 - PASSENGER INITIATOR CIRCUIT OPEN

Description

When ignition switch is turned on, SDM will perform tests to diagnose critical malfunctions within itself. Upon passing these tests, IGNITION 1, 36VLR, and deployment loop voltages are measured to ensure they are within their respective normal voltage ranges. SDM then proceeds with CURRENT SOURCE DIAGNOSTICS.

PASSENGER-SIDE LOW terminal A5 is grounded through a resistor and passenger current source connected to PASSENGER-SIDE HIGH terminal A6 allows a known amount of current to flow. After CURRENT SOURCE DIAGNOSTICS are completed SDM removes low resistance ground from PASSENGER-SIDE LOW and switches passenger current source at PASSENGER-SIDE HIGH. SDM then measures voltage at PASSENGER-SIDE HIGH and PASSENGER-SIDE LOW during CONTINUOUS MONITORING. By monitoring voltage difference between PASSENGER-SIDE HIGH and PASSENGER-SIDE LOW, SDM calculates combined resistance of passenger inflator module, wiring in circuits No. 1403 and 1404, and connector terminal contact.

Failure Conditions

Code sets if voltage difference between PASSENGER-SIDE HIGH terminal A6 and PASSENGER-SIDE LOW terminal A5 is above or equal to a specified value for 500 milliseconds during CURRENT SOURCE DIAGNOSIS or CONTINUOUS MONITORING.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT indicator light and sets a DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Determines whether malfunction is in passenger inflator module circuitry or SDM wiring harness circuitry.
2. Checks whether malfunction is caused by high resistance in circuit No. 1403.
3. Checks whether malfunction is due to high resistance in circuit No. 1404.
4. Checks whether malfunction is caused by passenger inflator module or passenger inflator module jumper.

Diagnostic Aids

An intermittent condition is likely to be caused by a poor connection at passenger inflator module harness connector terminals "A" and "B", SDM terminals "A5" and "A6", or an open in circuit No. 1403 or 1404.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

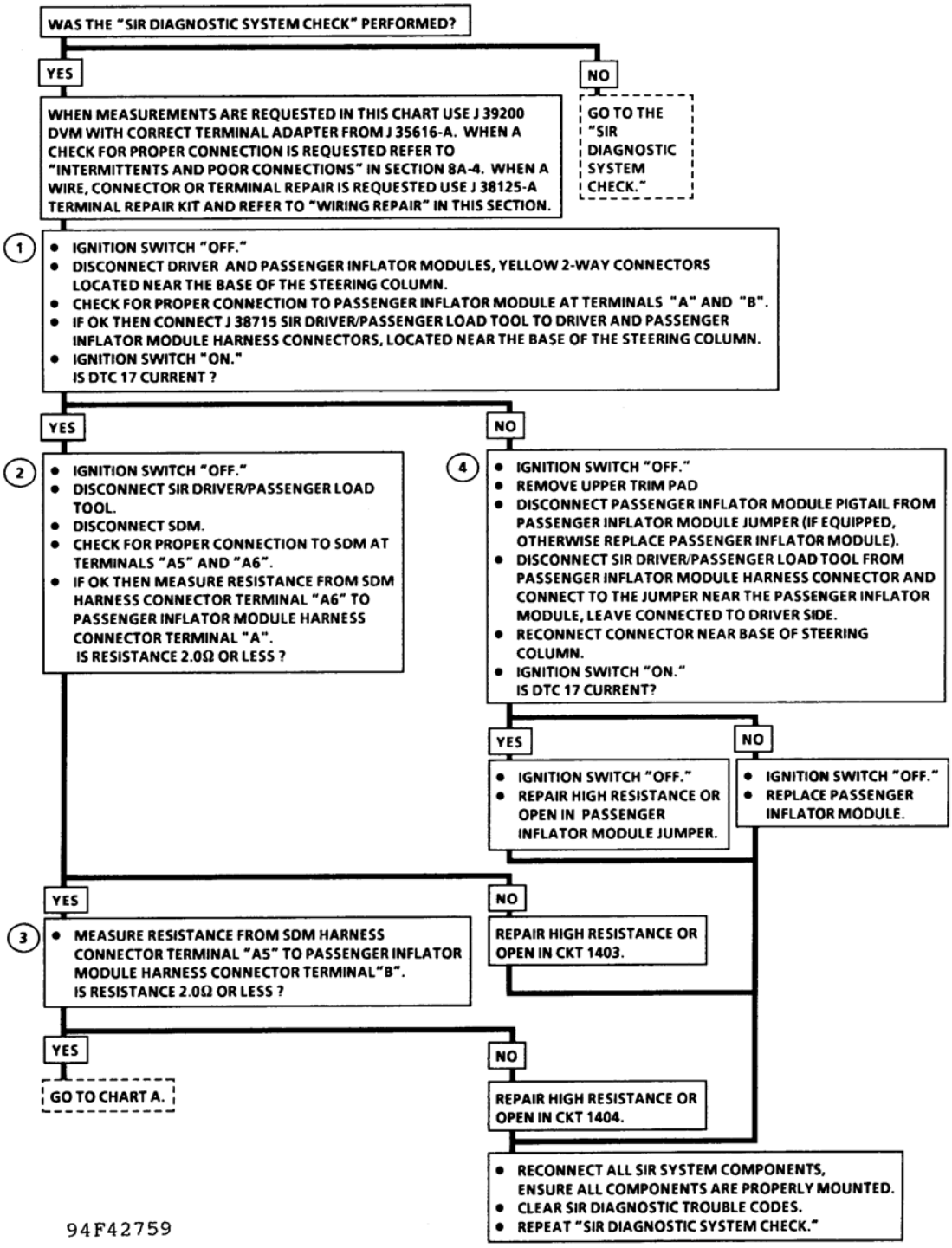


Fig. 12: DTC 17 - Passenger Initiator Circuit Open
Courtesy of GENERAL MOTORS CORP.

DTC 21 - DRIVER INITIATOR CIRCUIT RESISTANCE HIGH

Description

When ignition switch is turned on, SDM will perform tests to diagnose critical malfunctions within itself. Upon passing these tests, IGNITION 1, 36VLR, and deployment loop voltages are measured to ensure they are within their respective normal voltage ranges. SDM then proceeds with CURRENT SOURCE DIAGNOSTICS. DRIVER-SIDE LOW terminal A2 is grounded through a resistor and driver current source connected to DRIVER-SIDE HIGH terminal A1 allows a known amount of current to flow. By monitoring voltage difference between DRIVER-SIDE HIGH and DRIVER-SIDE LOW, SDM calculates combined resistance of driver inflator module, SIR coil assembly, wiring in circuits No. 347 and 348, and connector terminal contact.

Failure Conditions

Code sets if combined resistance of driver inflator module, SIR coil assembly, harness wiring at circuits No. 347 and 348, and connector terminal contact is greater than a specified value.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT indicator light and sets a DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Determines whether malfunction is in driver inflator module circuitry or in SDM wiring harness circuitry.
2. Checks whether malfunction is caused by high resistance in circuit No. 347.
3. Checks whether malfunction is caused by high resistance in circuit No. 348.
4. Checks whether malfunction is in driver inflator module or SIR coil assembly.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

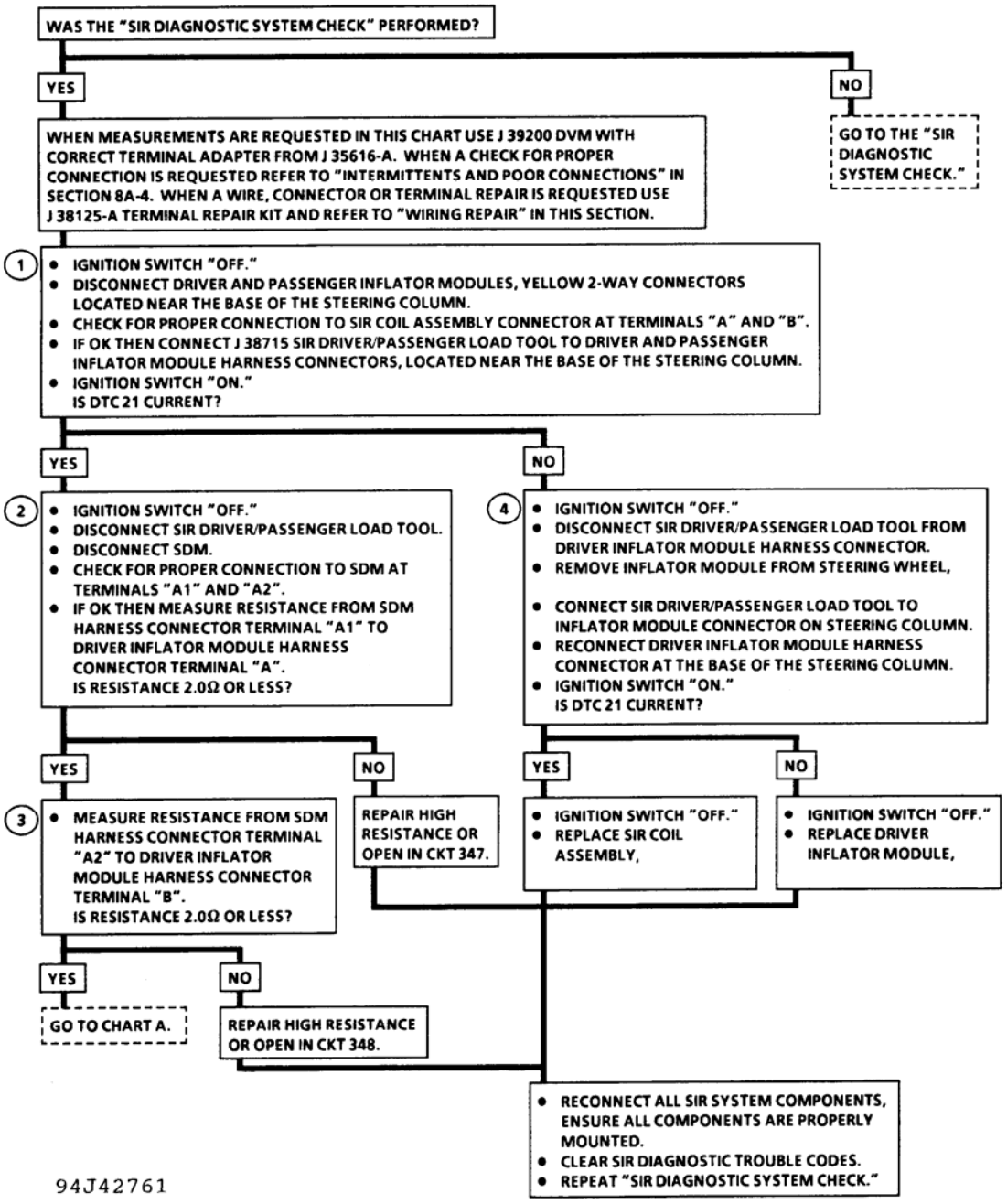


Fig. 13: DTC 21 - Driver Initiator Circuit Resistance High
Courtesy of GENERAL MOTORS CORP.

DTC 22 - DRIVER INITIATOR CIRCUIT RESISTANCE LOW

Description

When ignition switch is turned on, SDM will perform tests to diagnose critical malfunctions within itself. Upon passing these tests, IGNITION 1, 36VLR, and deployment loop voltages are measured to ensure they are within

their respective normal voltage ranges. SDM then proceeds with CURRENT SOURCE DIAGNOSTICS. DRIVER-SIDE LOW terminal A2 is grounded through a resistor and driver current source connected to DRIVER-SIDE HIGH terminal A1 allows a known amount of current to flow. By monitoring voltage difference between DRIVER-SIDE HIGH and DRIVER-SIDE LOW, SDM calculates combined resistance of driver inflator module, SIR coil assembly, wiring in circuits No. 347 and 348, and connector terminal contact.

Failure Conditions

Code sets if combined resistance of driver inflator module, SIR coil assembly, harness wiring at circuits No. 347 and 348, and connector terminal contact is greater than a specified value.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT indicator light and sets a DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Codes will simultaneously when DRIVER-SIDE HIGH circuit is shorted to PASSENGER-SIDE HIGH circuit due to parallel current paths.
2. Checks whether malfunction is in driver inflator module circuitry or in SDM wiring harness circuitry.
3. Checks for a short from DRIVER-SIDE HIGH circuit to DRIVER-SIDE LOW circuit.
4. Checks for a short from DRIVER-SIDE HIGH circuit to PASSENGER-SIDE LOW circuit.
5. Checks whether malfunction is in driver inflator module or SIR coil assembly.

Diagnostic Aids

An intermittent condition is likely to be caused by a short between circuit No. 347 and circuits No. 348, 1403, or 1404, or a malfunctioning shorting bar on driver inflator module or SIR coil assembly which would require replacement of component. Test for this DTC is only run while AIR BAG/INFLATABLE RESTRAINT warning light is performing Bulb check, unless DTC 17 or DTC 26 is detected. When a scan tool CLEAR CODES command is issued and malfunction is still present, DTC will not reappear until next ignition cycle.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

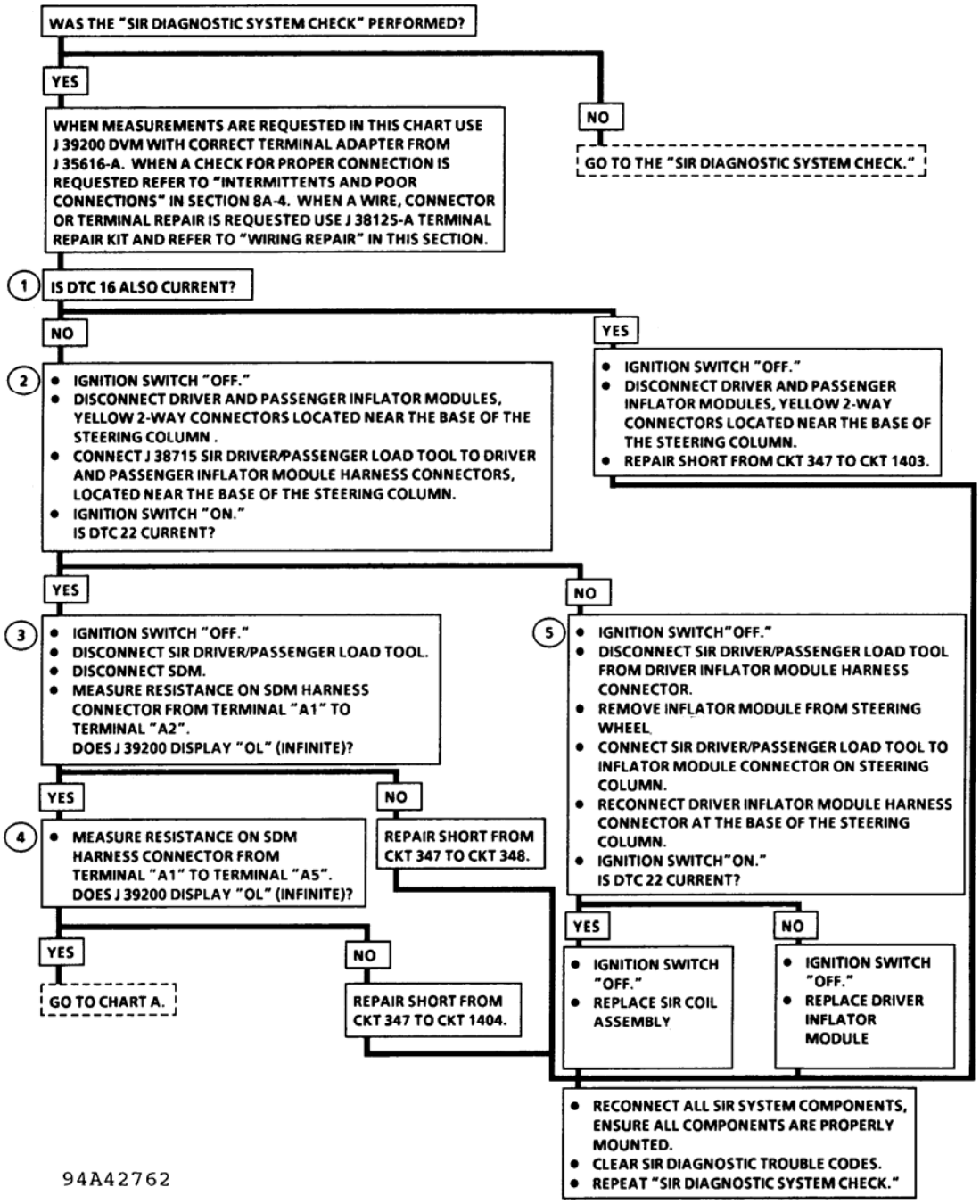


Fig. 14: DTC 22 - Driver Initiator Circuit Resistance Low
Courtesy of GENERAL MOTORS CORP.

DTC 24 - INITIATOR CIRCUIT VOLTAGE LOW

Description

When ignition switch is turned on, SDM will perform tests to diagnose critical malfunctions within itself. Upon

passing these tests, IGNITION 1, 36VLR, and deployment loop voltages are measured to ensure they are within their respective normal voltage ranges. SDM then monitors voltages at DRIVER-SIDE LOW terminal A2 and PASSENGER-SIDE LOW terminal A5 to detect shorts to ground in inflator module circuits.

Failure Conditions

Code sets if 36VLR power supply in SDM is in normal operating range and at least one of 2 inflator modules is not open.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT indicator light and sets a DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Checks whether malfunction is occurring in driver inflator module circuitry.
2. Checks whether malfunction is occurring in passenger inflator module circuitry.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

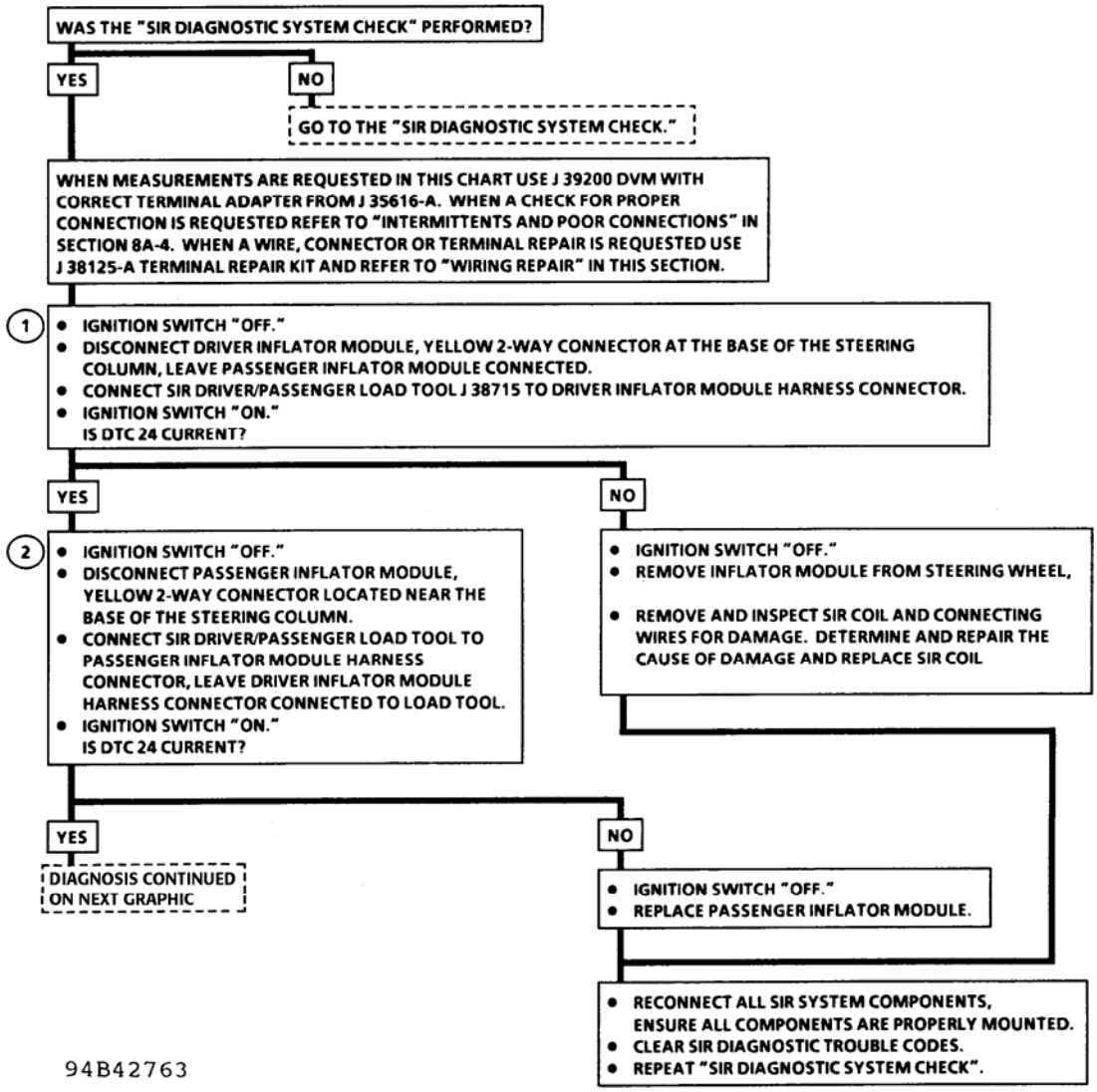


Fig. 15: DTC 24 - Initiator Circuit Voltage Low (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

3. Checks for a short from DRIVER-SIDE HIGH to ground.
4. Checks for a short from DRIVER-SIDE LOW to ground.
5. Checks for a short from PASSENGER-SIDE LOW to ground.
6. Checks for a short from PASSENGER-SIDE HIGH to ground.

Diagnostic Aids

An intermittent condition is likely to be caused by a short to ground in inflator module circuits. Check circuits No. 347, 348, 1403 and 1404 carefully. If wiring pigtail of SIR coil assembly, driver inflator module, or passenger inflator module is damaged, component must be replaced.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

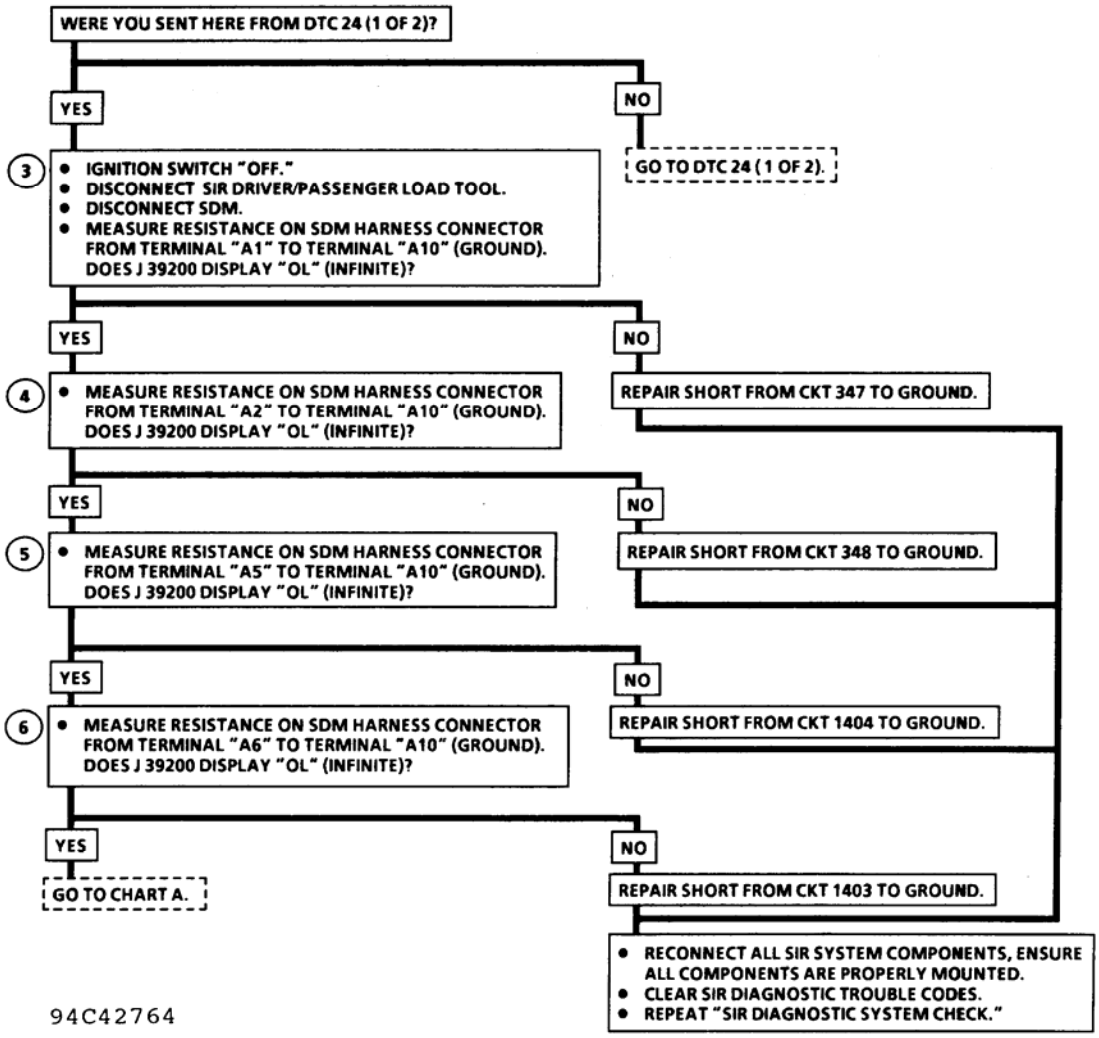


Fig. 16: DTC 24 - Initiator Circuit Voltage Low (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

DTC 25 - INITIATOR CIRCUIT SHORT TO IGNITION

NOTE: When DTC 25 has been set it is necessary to replace SDM. Setting DTC 25 will also cause DTC 71 to set. When a scan tool CLEAR CODES command is issued and malfunction is still present, DTC 25 and 71 will remain current. When a scan tool CLEAR CODES command is issued and malfunction is no longer present, DTC 25 will clear but DTC 71 will remain current. Ensure short to voltage condition is repaired before installing a replacement SDM to avoid damaging

SDM.

Description

When ignition switch is turned on, SDM will perform tests to diagnose critical malfunctions within itself. Upon passing these tests, IGNITION 1, 36VLR, and deployment loop voltages are measured to ensure they are within their respective normal voltage ranges. SDM then monitors voltages at DRIVER-SIDE LOW terminal A2 and PASSENGER-SIDE LOW terminal A5 to detect shorts to voltage in inflator module circuits.

Failure Conditions

Code sets if 36VLR power supply in SDM is in normal operating voltage range and neither of 2 inflator modules is open.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT indicator light and sets a DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Checks whether malfunction is occurring in driver inflator module circuitry.
2. Checks whether malfunction is occurring in passenger inflator module circuitry.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

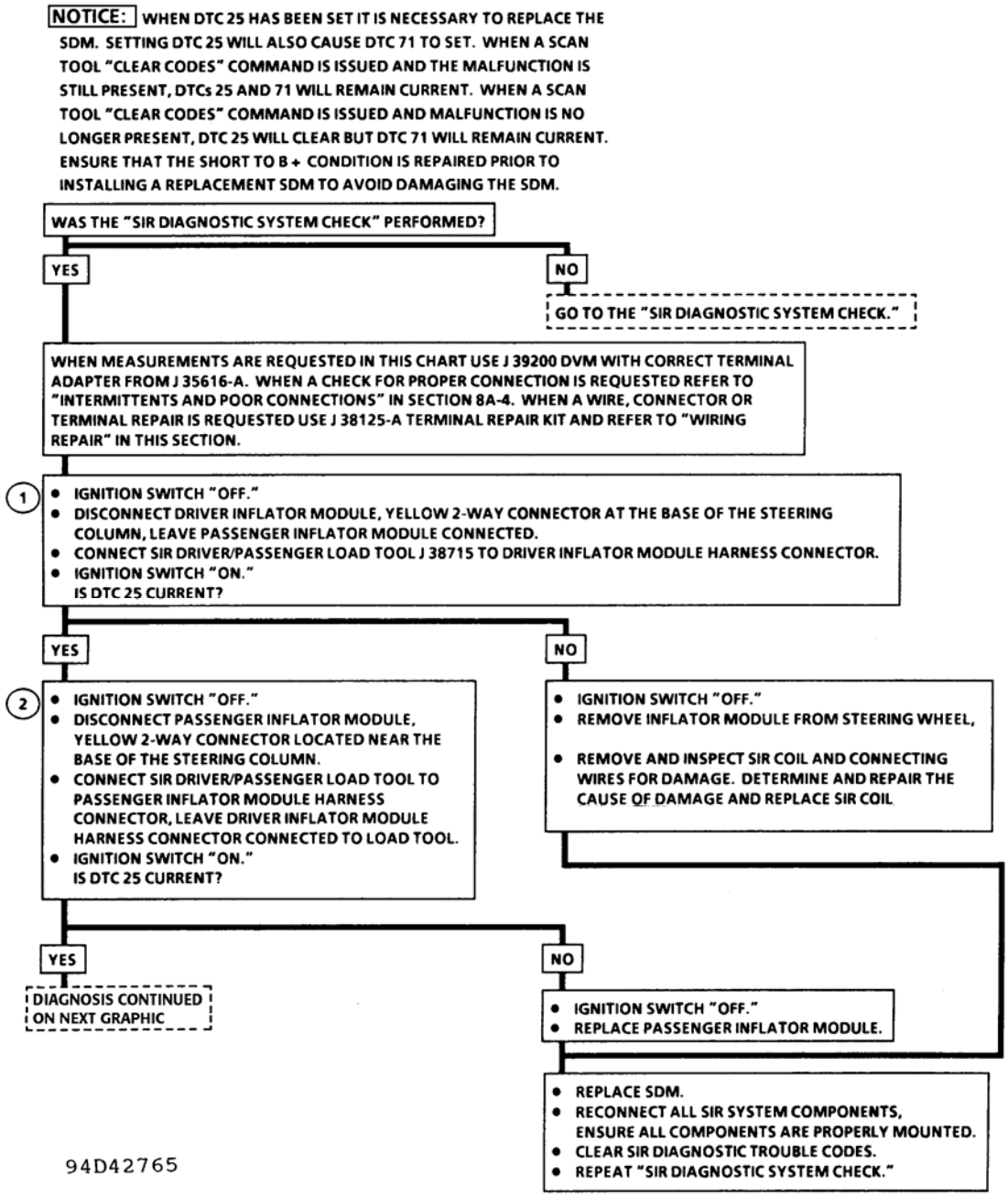


Fig. 17: DTC 25 - Initiator Circuit Short To Ignition (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

3. Checks for a short from DRIVER-SIDE HIGH to voltage.
4. Checks for a short from DRIVER-SIDE LOW to voltage.
5. Checks for a short from PASSENGER-SIDE HIGH to voltage.
6. Checks for a short from PASSENGER-SIDE LOW to voltage.

Diagnostic Aids

An intermittent condition is likely to be caused by a short to voltage in inflator module circuits. DTC 25 history would be accompanied by DTC 71 current. A careful inspection of circuits and components indicated on DTC 25 charts is essential to ensure that replacement SDM will not be damaged.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

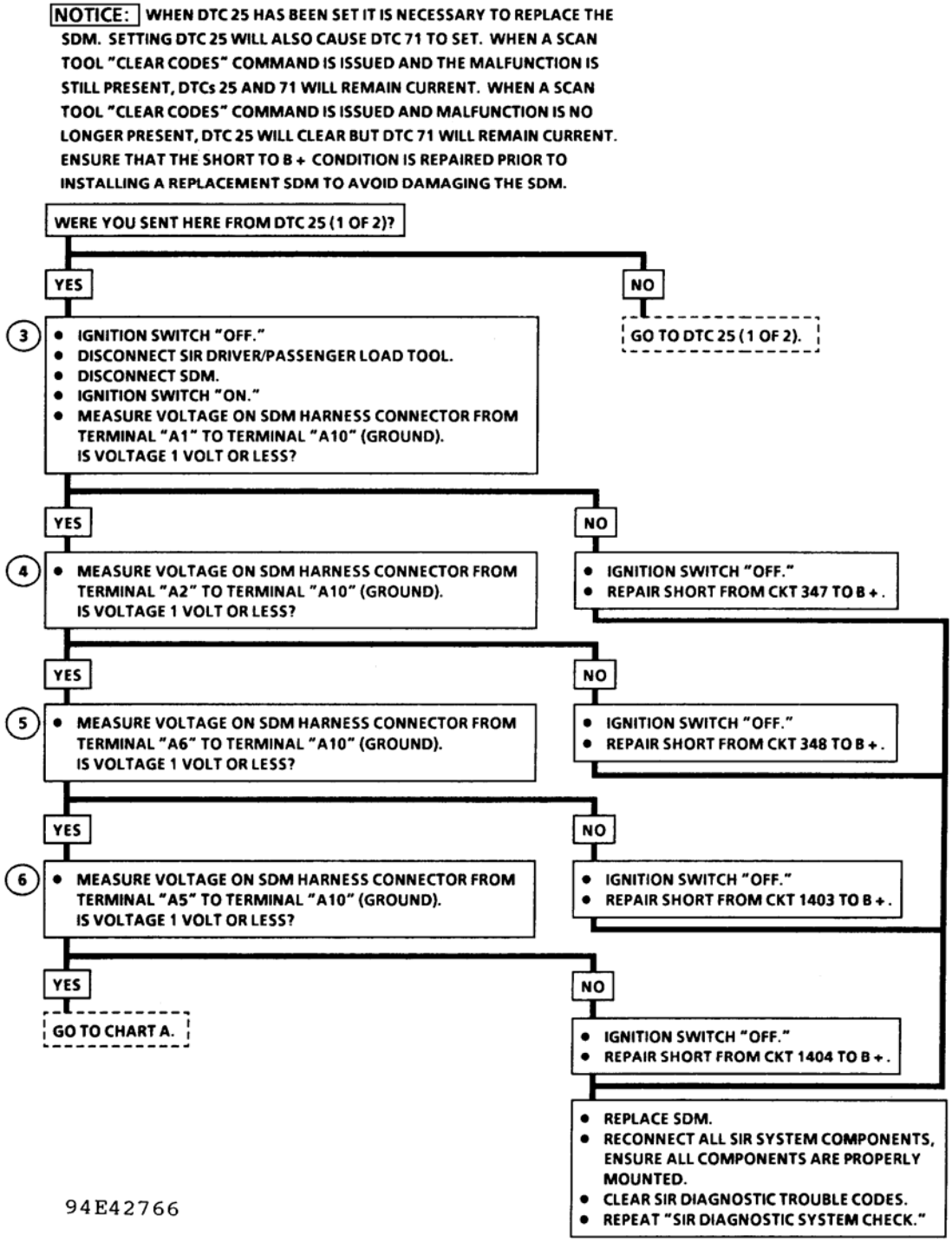


Fig. 18: DTC 25 - Initiator Circuit Short To Ignition (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

DTC 26 - DRIVER INITIATOR CIRCUIT OPEN

Description

When ignition switch is turned on, SDM will perform tests to diagnose critical malfunctions within itself. Upon passing these tests, IGNITION 1, 36VLR, and deployment loop voltages are measured to ensure they are within their respective normal voltage ranges. SDM then proceeds with CURRENT SOURCE DIAGNOSIS. DRIVER-SIDE LOW terminal A2 is grounded through a resistor and driver current source connected to DRIVER-SIDE HIGH terminal A1 allows a known amount of current to flow. After CURRENT SOURCE DIAGNOSTICS are completed, SDM removes low resistance ground from DRIVER-SIDE LOW and switches driver current source at DRIVER-SIDE HIGH. SDM then monitors voltages at DRIVER-SIDE HIGH and DRIVER-SIDE LOW during CONTINUOUS MONITORING.

Failure Conditions

Code sets if voltage difference between DRIVER-SIDE HIGH terminal A1 and DRIVER-SIDE LOW terminal A2 is greater than or equal to a specified value for 500 milliseconds during CURRENT SOURCE DIAGNOSIS or CONTINUOUS MONITORING.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT indicator light and sets a DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Determines whether malfunction is in driver inflator module circuitry or in SDM wiring harness circuitry.
2. Checks whether malfunction is due to high resistance in circuit No. 347.
3. Checks whether malfunction is due to high resistance in circuit No. 348.
4. Checks whether malfunction is in driver inflator module or SIR coil assembly.

Diagnostic Aids

An intermittent condition is likely to be caused by a poor connection at driver inflator module terminals "A" and "B", SIR coil assembly terminals "A" and "B", SDM terminals A1 and A2, or an open in circuits No. 347 and 348.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

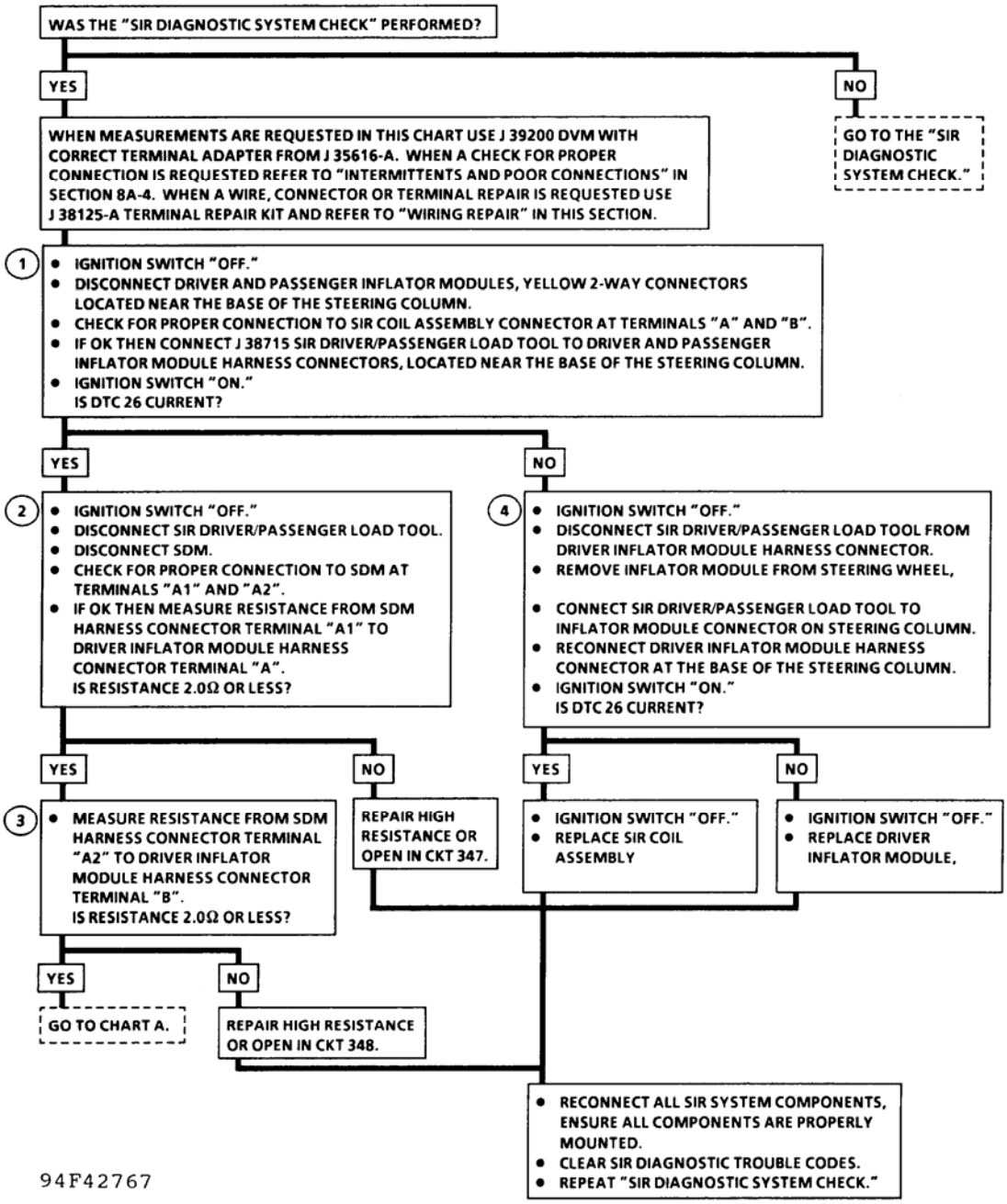


Fig. 19: DTC 26 - Driver Initiator Circuit Open
Courtesy of GENERAL MOTORS CORP.

DTC 35 - DISCRIMINATING SENSOR OPEN OR SHORT TO GROUND

Description

When ignition switch is turned on, SDM will perform tests to diagnose critical malfunctions within itself. Upon passing these tests, IGNITION 1, 36VLR, and deployment loop voltages are measured to ensure they are within

their respective normal voltage ranges. SDM then proceeds with CURRENT SOURCE DIAGNOSTICS, followed by CONTINUOUS MONITORING. SDM supplies REFERENCE VOLTAGE at terminal B6 and measures voltage at SENSOR SIGNAL terminal B5. During normal operation voltage measured at SENSOR SIGNAL will be about one-half REFERENCE VOLTAGE.

Failure Conditions

Code sets when voltage measured at SENSOR SIGNAL terminal B5 is less than a specified value for 500 milliseconds during CONTINUOUS MONITORING.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT warning light and sets a DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Checks proper resistance of forward discriminating sensor.
2. Checks for an open in REFERENCE VOLTAGE circuit.
3. Checks for an open in SENSOR SIGNAL circuit.
4. Checks for a short from REFERENCE VOLTAGE to ground.
5. Checks for a short from SENSOR SIGNAL to ground.

Diagnostic Aids

An intermittent condition is likely to be caused by a poor connection to forward discriminating sensor at terminals "A" or "B", poor connection to SDM at terminals B5 or B6, a short to ground in circuits No. 349 or 354, or an open in circuits No. 349 or 354.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

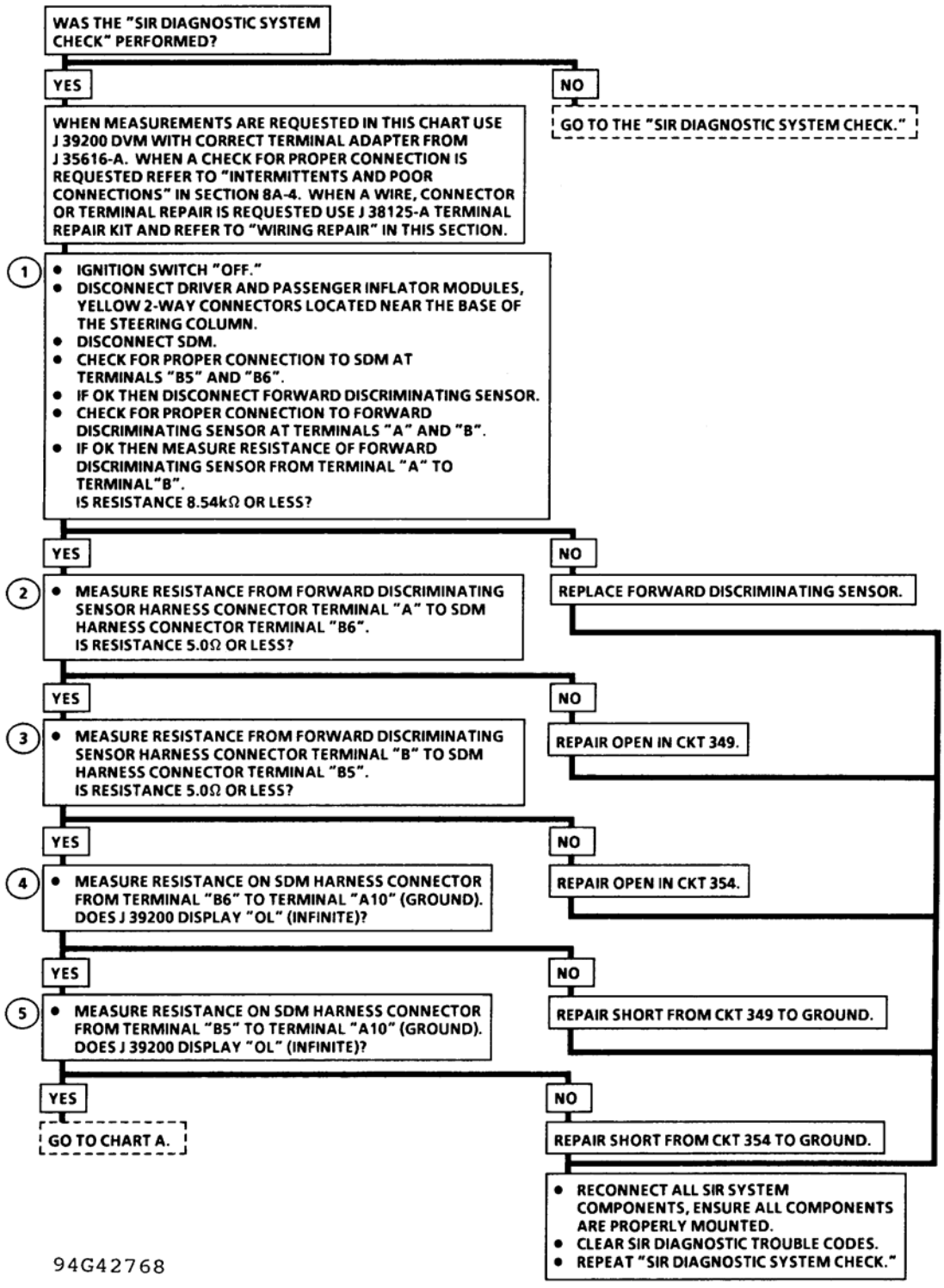


Fig. 20: DTC 35 - Discriminating Sensor Open Or Short To Ground
Courtesy of GENERAL MOTORS CORP.

DTC 36 - DISCRIMINATING SENSOR CLOSED OR SHORT TO IGNITION

Description

When ignition switch is turned on, SDM will perform tests to diagnose critical malfunctions within itself. Upon passing these tests, IGNITION 1, 36VLR, and deployment loop voltages are measured to ensure they are within their respective normal voltage ranges. SDM then proceeds with CURRENT SOURCE DIAGNOSTICS, followed by CONTINUOUS MONITORING. SDM supplies REFERENCE VOLTAGE at terminal B6 and measures voltage at SENSOR SIGNAL terminal B5. During normal operation voltage measured at SENSOR SIGNAL will be about one-half REFERENCE VOLTAGE.

Failure Conditions

Code sets when voltage measured at SENSOR SIGNAL terminal B5 is greater than a specified value for 500 milliseconds during CONTINUOUS MONITORING.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT warning light and sets a DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Checks proper resistance of forward discriminating sensor.
2. Checks for a short in REFERENCE VOLTAGE circuit to SENSOR SIGNAL circuit.
3. Checks for a short from REFERENCE VOLTAGE to voltage.
4. Checks for a short from SENSOR SIGNAL to voltage.

Diagnostic Aids

An intermittent condition is likely to be caused by a short from circuit No. 349 to 354, a short from circuit No. 349 to voltage, or a short from circuit No. 354 to voltage.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

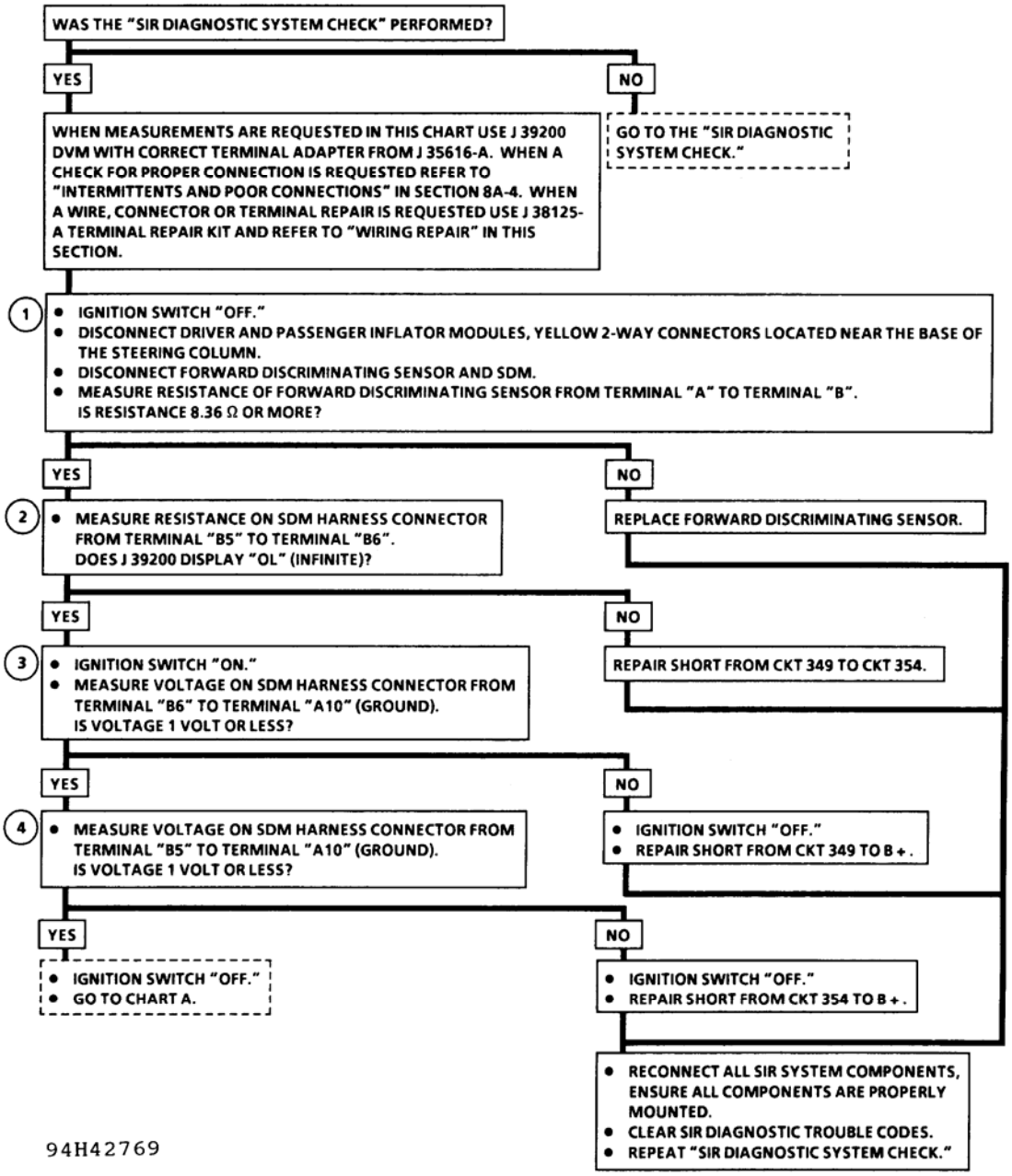


Fig. 21: DTC 36 - Discriminating Sensor Closed Or Short To Ignition
Courtesy of GENERAL MOTORS CORP.

DTC 51 - FRONTAL CRASH DETECTED

Description

SDM contains a sensing device which converts vehicle velocity changes to an electrical signal. Electrical signal generated is processed by SDM and then compared to a value stored in memory. When generated signal exceeds stored value, additional signal processing is performed and generated signals are compared to signals

stored in memory. When 2 generated signals exceed stored values or when one generated signal exceeds stored value and forward discriminating sensor closes, SDM will cause current to flow thorough inflator modules deploying air bags and causing DTC 51 to set.

Failure Conditions

Code sets when SDM sets a frontal crash, up to 30 degrees off centerline of vehicle, of sufficient force to warrant deployment of air bags.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT warning light, records crash data, and sets a DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. If inflator module(s) has not deployed, DTC 51 may have set falsely.
2. If DTC 51 has set with no signs of frontal impact, DTC has set falsely.
3. Checks for an SDM malfunction setting DTC.
4. Determines whether DTC was set inadvertently during diagnosis.
5. When a frontal crash has occurred, perform indicated procedures to ensure SIR system is fully functional. See POST-COLLISION INSPECTION.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

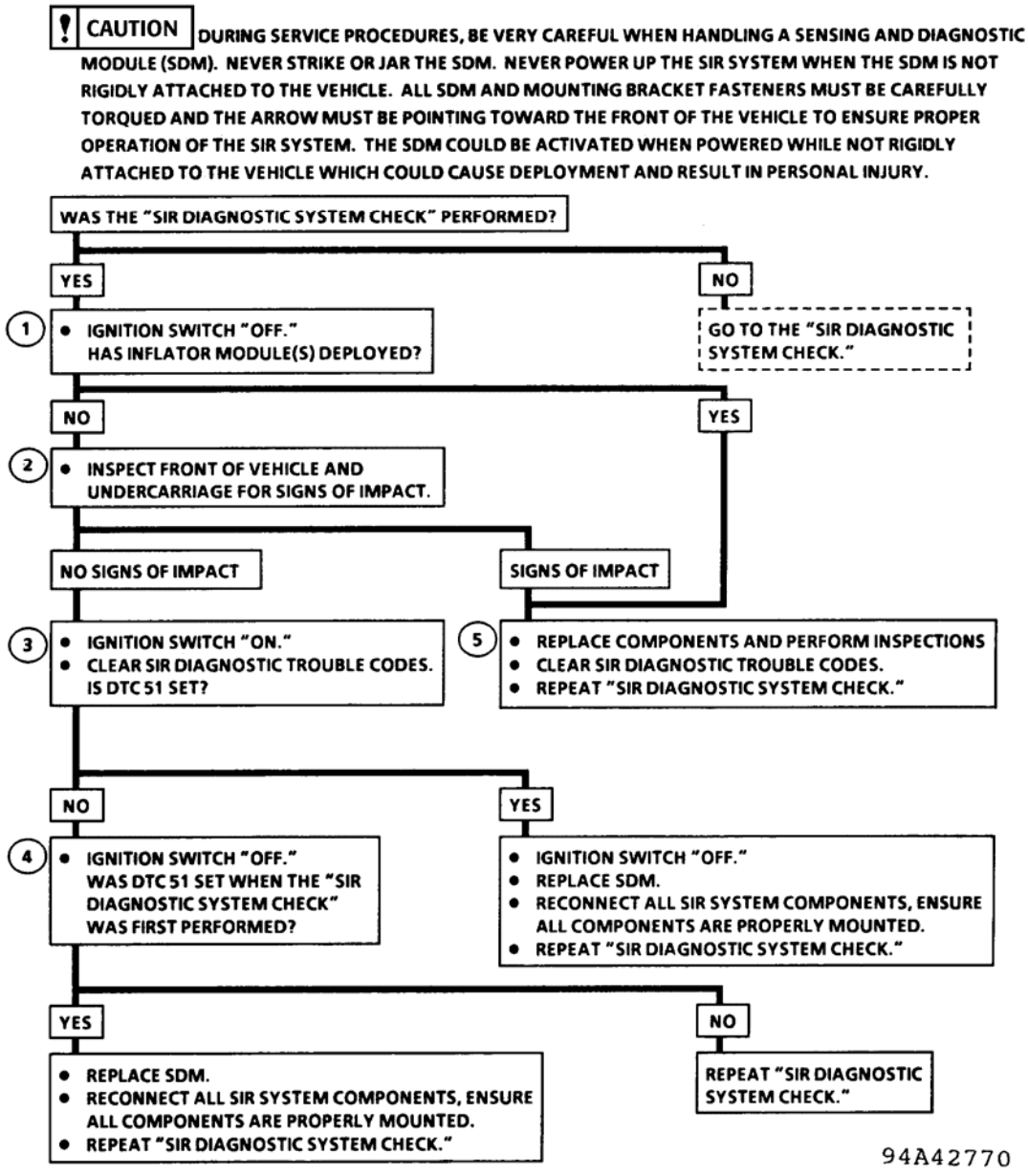


Fig. 22: DTC 51 - Frontal Crash Detected
Courtesy of GENERAL MOTORS CORP.

DTC 52 - DATA AREA FULL

Description

When there is a frontal crash of sufficient force, up to 30 degrees off centerline of vehicle, SDM will cause enough current to flow to deploy air bags and will set DTC 51. At this time SDM will record information regarding SIR system status and vehicle status in EEPROM. DTC 52 will set when SDM has stored information regarding 2 frontal crash events.

Failure Conditions

SDM attempts to store frontal crash information and finds EEPROM data area full. Test is run each time SDM stores or attempts to store information regarding a frontal crash event and also during TURN-ON tests.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT warning light and sets a DTC.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

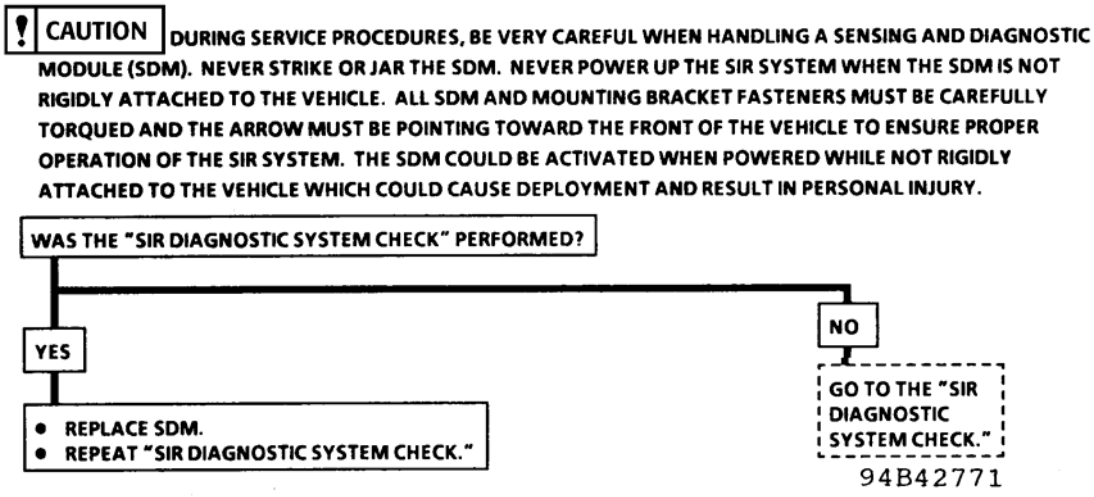


Fig. 23: DTC 52 - Data Area Full
Courtesy of GENERAL MOTORS CORP.

DTC 61 - CIRCUIT INDICATOR CIRCUIT FAILURE

Description

When ignition switch is first turned on, battery voltage is applied to AIR BAG/INFLATABLE RESTRAINT warning light and to IGNITION 1 input terminal B9. SDM responds by flashing AIR BAG/INFLATABLE RESTRAINT warning light 7 times alternating between primary and redundant lamp drivers. SDM monitors primary lamp driver output by comparing output state at SIR INDICATOR terminal A9 to microprocessor commanded state. When IGNITION 1 is greater than a specified value and output state does not match commanded state of primary lamp driver for 400 milliseconds DTC 61 is set.

Failure Conditions

DTC will set when IGNITION 1 voltage is greater than a specified value and output state at SIR INDICATOR

terminal A9 does not match commanded state of primary lamp driver for 400 milliseconds. This test is run every 100 milliseconds during CONTINUOUS MONITORING.

Action Taken

SDM attempts to turn on AIR BAG/INFLATABLE RESTRAINT warning light using redundant lamp driver and sets a DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. When SDM is configured for a serial data controlled warning light, DTC 61 will set. Clearing SIR diagnostic trouble codes will reset SDM allowing SDM to control AIR BAG/INFLATABLE RESTRAINT warning light.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

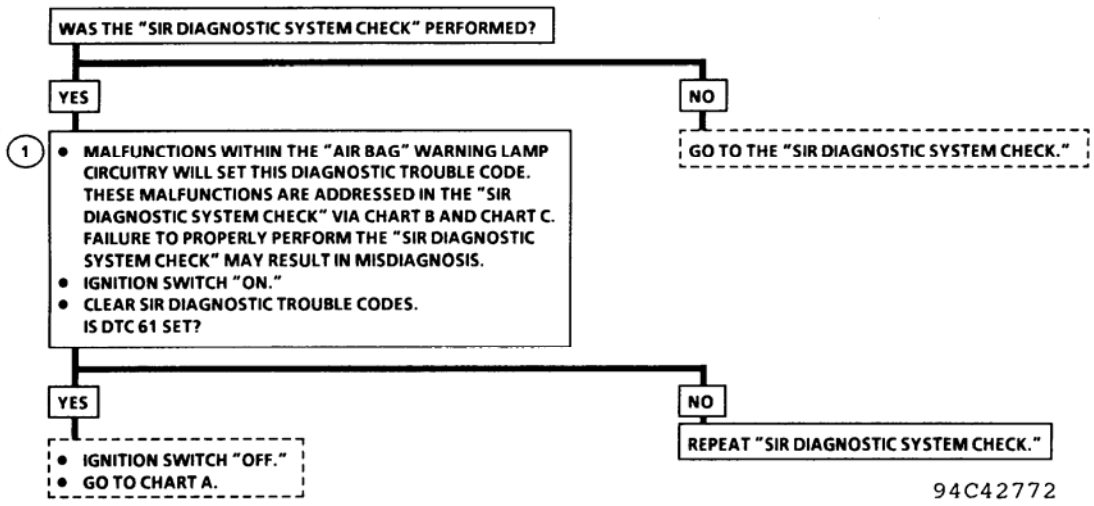


Fig. 24: DTC 61 - Circuit Indicator Circuit Failure
Courtesy of GENERAL MOTORS CORP.

DTC 62 - REDUNDANT SIR INDICATOR CIRCUIT FAILURE

Description

When ignition switch is first turned on, battery voltage is applied to AIR BAG/INFLATABLE RESTRAINT warning light and to IGNITION 1 input terminal B9. SDM responds by flashing AIR BAG/INFLATABLE RESTRAINT warning light 7 times alternating between primary and redundant lamp drivers. SDM monitors primary lamp driver output by comparing output state at SIR INDICATOR terminal A9 to microprocessor

commanded state. When IGNITION 1 is greater than a specified value and output state does not match commanded state of primary lamp driver for 400 milliseconds, DTC 62 is set.

Failure Conditions

DTC will set when IGNITION 1 voltage is greater than a specified value and output state at SIR INDICATOR terminal A9 does not match commanded state of redundant lamp driver for 400 milliseconds. This test is run every 100 milliseconds during CONTINUOUS MONITORING.

Action Taken

SDM attempts to turn on AIR BAG/INFLATABLE RESTRAINT warning light using primary lamp driver and sets a DTC.

NOTE: Test numbers refer to test numbers on diagnostic chart. For circuit number identification, see WIRING DIAGRAMS.

1. Determines whether malfunction is due to an open in REDUNDANT INDICATOR IGNITION 1 circuit.

Diagnostic Aids

An intermittent condition is likely to be caused by a poor connection to SDM at terminal A4 or an open in circuit No. 39B. A poor REDUNDANT INDICATOR GROUND connection to SDM would set DTC 62. It is important that SDM mounting surface be free of any dirt or foreign material and that fasteners are properly torqued to ensure a good REDUNDANT INDICATOR GROUND.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

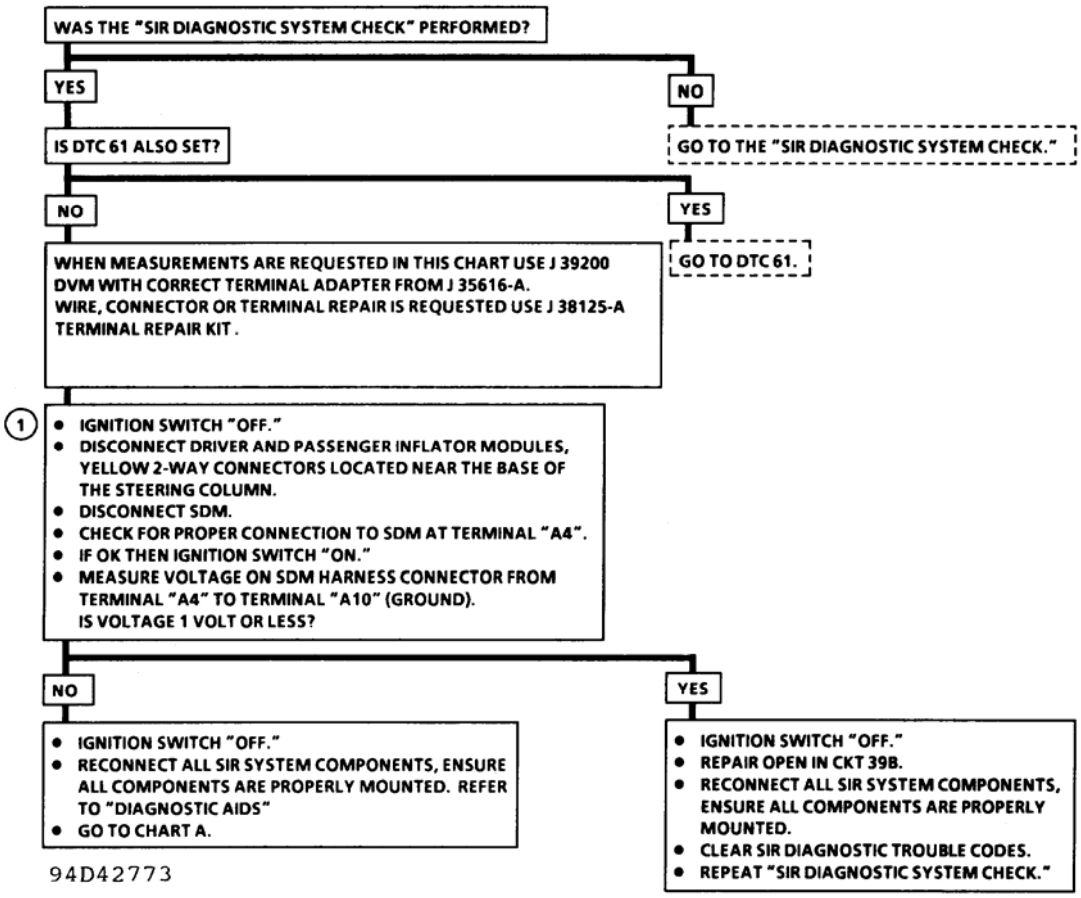


Fig. 25: DTC 62 - Redundant SIR Indicator Circuit Failure
Courtesy of GENERAL MOTORS CORP.

DTC 71 - INTERNAL SDM FAULT

NOTE: When DTC 25 has been set, it is necessary to replace SDM. Setting DTC 25 will also cause DTC 71 to set. When a scan tool CLEAR CODES command is issued and malfunction is still present, DTCs 25 and 71 will remain current. When a scan tool CLEAR CODES command is issued and malfunction is no longer present, DTC 25 will clear but DTC 71 will remain current. Ensure that short to voltage condition is repaired prior to installing a replacement SDM to avoid damaging SDM.

Description

DTC 71 is an indication of a potential internal SDM malfunction and will set if 36VLR voltage is out of normal operating range, crash data recording reserve voltage discharge time failure for 3 consecutive ignition cycles, calculated check sum for internal memory does not match stored value, voltage measured at DRIVER-SIDE LOW and/or PASSENGER-SIDE LOW is too high, sensing device inside SDM which converts vehicle velocity changes to an electrical signal is malfunctioning, driver current source and/or passenger current source is

malfunctioning, temporary memory storage area is malfunctioning, SDM is unable to read from or write to EEPROM, arming sensor inside SDM is not closed during a deployment event, or DTC 25 has been set.

Failure Conditions

DTC 71 will set when malfunctions in TURN-ON, CONTINUOUS MONITORING and/or CURRENT SOURCE DIAGNOSTICS are detected by SDM.

Action Taken

SDM turns on AIR BAG/INFLATABLE RESTRAINT warning light and sets a DTC.

WARNING: To avoid air bag deployment and injury when trouble shooting system, only use test equipment specified in diagnostic charts. Under no circumstances should battery powered test equipment or test light be used. Carefully follow all instructions.

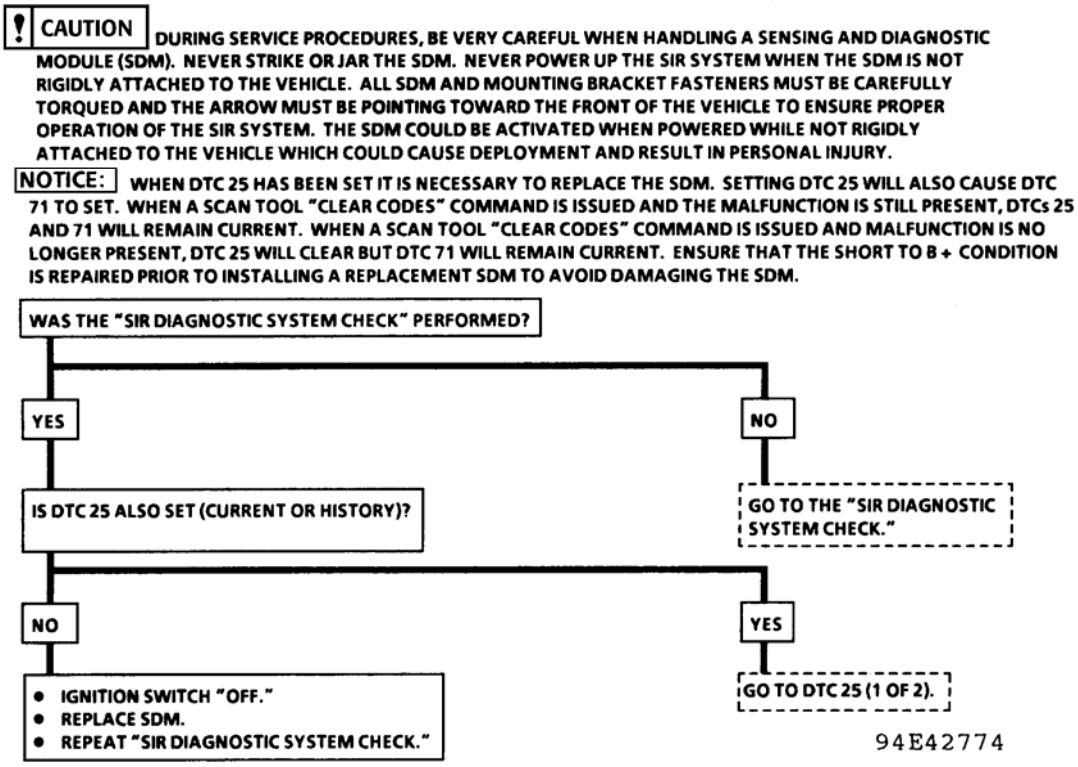


Fig. 26: DTC 71 - Internal SDM Fault
Courtesy of GENERAL MOTORS CORP.

WIRE REPAIR

Because of sensitive nature of circuitry, manufacturer has developed special wiring repair procedures. Wire

Repair Kit (J-38125-A) contains special sealed splices for use in repairing SIR wiring. Sealed splices are a heat shrink sleeve with sealing adhesive to produce a sealed splice and a cross-hatched core crimp to produce a positive contact for low energy circuits.

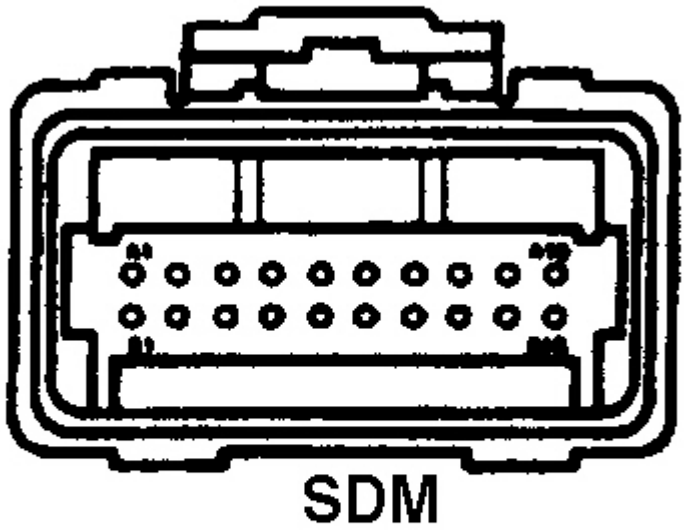
If any terminal or connector in SIR wire harness (except pigtails) is damaged, component can be repaired using one of connector repair assembly packs. Terminals in SIR system are manufactured from a special metal to provide necessary contact for low energy circuits. These terminals are only available in wiring kit, and no other terminal should be substituted.

If an SIR wire pigtail is damaged, entire component (including pigtail) should be replaced. Under no circumstances should wire, connector or terminal repair be attempted on arming sensor, passenger compartment discriminating sensor, forward discriminating sensor, inflator module, or SIR coil assembly.

If any wire except a pigtail is damaged, wire can be repaired by splicing in a new section of wire of same gauge. Sealed splices and crimping tool must be used for these splices. To open wiring harness, remove tape as necessary. To avoid wire insulation damage, manufacturer recommends use of a sewing seam ripper. Refer to instructions in kit for wire repair procedure.

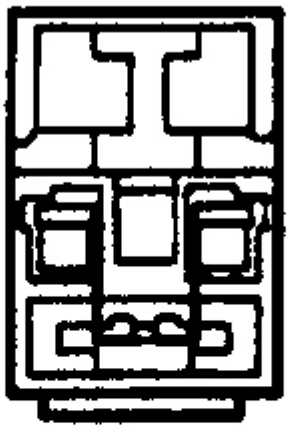
CONNECTOR IDENTIFICATION

NOTE: To identify SIR wiring connector terminals, see Fig. 27 -8.



94B43035

Fig. 27: SDM Connector
Courtesy of GENERAL MOTORS CORP.



Passenger Jumper Harness
& Inflator Connectors (Female)

50H03771

Fig. 28: Passenger Jumper Harness & Inflator Connectors (Female)
Courtesy of GENERAL MOTORS CORP.



Fig. 29: Passenger Jumper Harness & Inflator Connectors (Male)
Courtesy of GENERAL MOTORS CORP.



Forward Discriminating
Sensor Connector

50B03773

Fig. 30: Forward Discriminating Sensor Connector (Except Impala)
Courtesy of GENERAL MOTORS CORP.



Fig. 31: Steering Column Harness Connector
Courtesy of GENERAL MOTORS CORP.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Steering Wheel Hexagonal Lock Nut	30 (41)
	INCH Lbs. (N.m)
DERM Bracket Mounting Bolt	71 (8)
DERM Mounting Nut/Screw	17 (2)
DERM Bracket Nut	17 (2)
Forward Discriminating Sensor Bolt/Nut	27 (3)
Inflator Module Nut/Screw	27 (3)
Passenger-Side	89 (10)
Sensing & Diagnostic Module Bolt	80 (9)
SIR Coil Mounting Screw	30 (3.4)
Turn Signal Switch Screw	30 (3.4)
Turn Signal Switch Arm Screw	20 (2.3)

WIRING DIAGRAMS

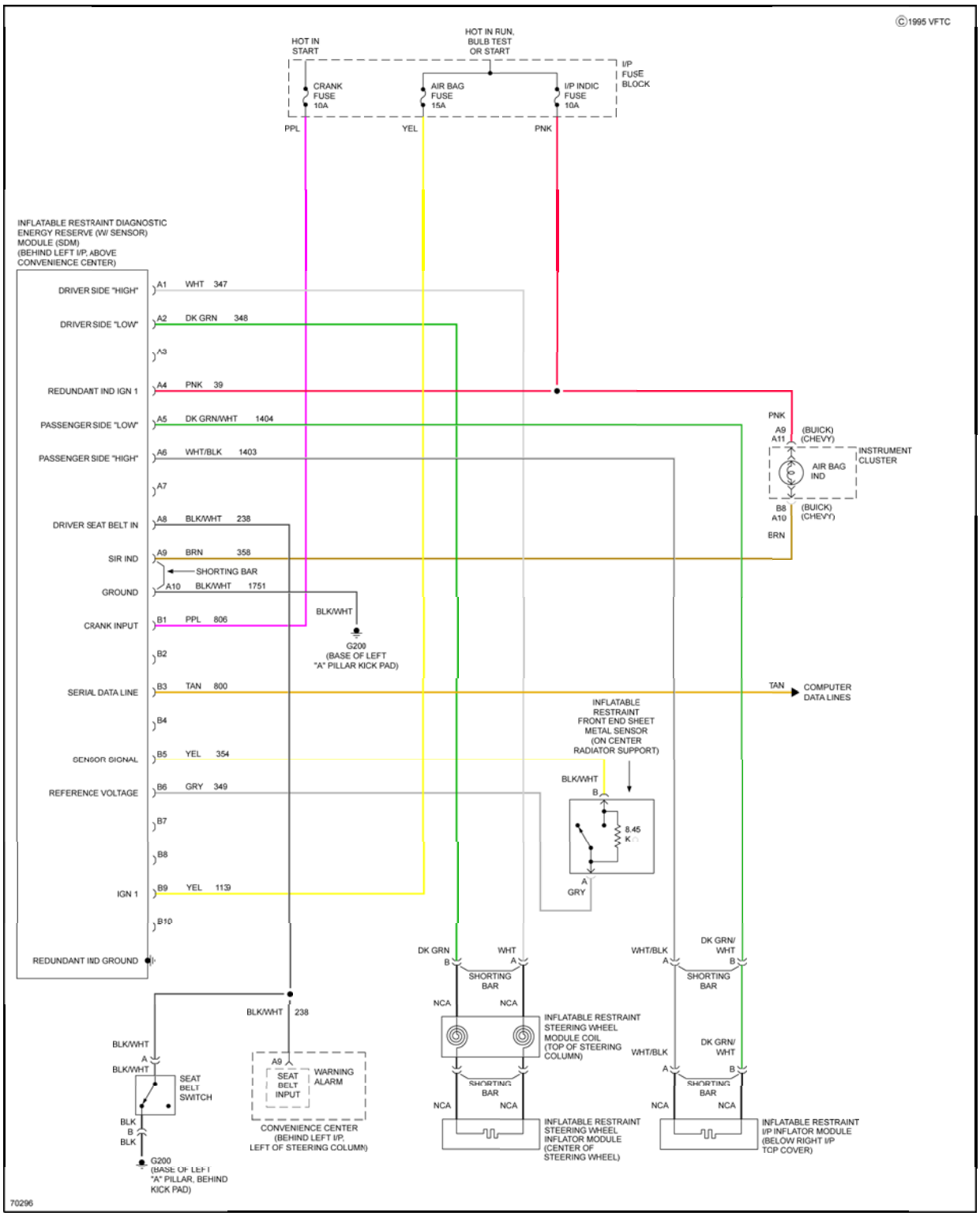


Fig. 32: SIR System Wiring Diagram (Caprice & Roadmaster)

Courtesy of GENERAL MOTORS CORP.

ALTERNATOR & REGULATOR

STARTING & CHARGING SYSTEMS General Motors Corp. - Alternators & Regulators

DESCRIPTION

Charging System (CS) series generators include a delta stator, rectifier bridge, and rotor with slip rings and brushes. A built-in regulator incorporates fault detection circuitry. A conventional pulley and external fan are used to cool slip ring end frame, rectifier bridge and regulator.

Most CS series generators operate with 2 wire connections and a ground path through the mounting bracket. The first wire connection is the BAT (output) terminal. This terminal must be connected to the battery during operation. The second wire connection is through the charge indicator light or an external resistor to terminal "L" of the regulator. This connection provides initial excitation at start-up.

Three other regulator terminals, "P", "F/I" and "S", are provided for optional use. Terminal "P" is connected to the stator and may be connected to a tachometer. Terminal "F/I" provides an alternative method for turning on the generator without going through the charge indicator light or external resistor. Terminal "S" may be used to sense electrical system voltage at a remote point on the vehicle. If terminal "S" is not used, the regulator senses internal generator voltage.

Some CS144 models have 3 auxiliary phase terminals which supply current to operate heated windshields if equipped.

No periodic maintenance is necessary. CS144 generators, except for those with 3 auxiliary phase terminals, can be disassembled and repaired. CS130, and CS144 generators with 3 auxiliary phase terminals, are serviced by replacement only.

Regulated voltage varies with temperature. System limits voltage by controlling rotor field current while field current is on. Regulator switches rotor field current on and off at a fixed frequency of 400 cycles per second to help control radio noise. By varying overall on/off time, correct average field current for proper system voltage control is obtained. At high speeds, with lower electrical loads, on-time may be 10 percent of off-time. At low speeds, with higher electrical loads, on-time may be 90 percent of off-time. See the **GENERATOR USAGE/AMP OUTPUT RATING** table.

ADJUSTMENTS

NOTE: No adjustment or maintenance is required on generator assembly. Regulator voltage is preset and no adjustment is possible. Drive belt tension is controlled by a belt tensioner.

TROUBLE SHOOTING

NOTE: See the TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL INFORMATION section.

ON-VEHICLE TESTING

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

NOTE: Only CS144 generators without auxiliary phase terminals are repairable. CS130 and CS144 generators with auxiliary phase terminals are serviced as a complete assembly only.

CHARGE INDICATOR LIGHT

NOTE: Perform this test only if charge indicator light does not illuminate when ignition is turned on, or does not go out after engine is started.

CAUTION: DO NOT run engine with generator output terminal disconnected from battery.

1. Ensure battery is fully charged. Visually check generator belt and wiring. Turn ignition switch to ON position (engine not running). Charge indicator light should illuminate. If charge indicator light does not illuminate, go to next step. If charge indicator light illuminates, go to step 4).
2. Turn ignition off. Disconnect generator harness connector. Using a fused (5-amp) jumper wire, connect terminal "L" of generator harness connector to ground. Turn ignition on (engine not running). If charge indicator light illuminates, replace or repair generator.
3. If charge indicator light still does not illuminate, check for open in circuit between generator terminal "L" and ignition switch. Also check charge indicator light bulb. See WIRING DIAGRAM.
4. Start engine and run at 1500 RPM. Charge indicator light should go off. If charge indicator light remains illuminated, turn ignition off. Disconnect generator harness connector. If charge indicator light goes out, replace or repair generator. If charge indicator light remains illuminated, check for short to ground in generator terminal "L" circuit wiring harness.

UNDERCHARGED OR OVERCHARGED BATTERY

NOTE: Ensure battery is fully charged and in good condition before performing the following steps. If battery is not at (or near) a fully charged condition, or if condition is questionable, substitute a known good battery before proceeding.

1. Ensure battery is fully charged. Turn ignition and all accessories off. Using a voltmeter, measure and record battery voltage for use instep 4). Disconnect generator harness connector. Turn ignition switch to ON position (engine not running).
2. Connect negative lead of a voltmeter to a good engine ground. Connect positive voltmeter lead to terminal "L" of generator harness connector. On models with gauges, also connect positive voltmeter lead

to terminal F/I of generator harness connector. Refer to **WIRING DIAGRAM**.

3. On all models, near battery voltage should be present at terminal "L" or F/I (gauges only). If battery voltage is not present, repair open circuit between generator connector terminal and battery. If battery voltage is present, reconnect generator harness connector and go to next step.
4. Start engine and slowly increase speed to approximately 1500 RPM. Using a voltmeter, measure voltage between battery terminals. If voltage is greater than 16 volts, or less than voltage as measured in step 1), replace or repair generator. If voltage is less than 16 volts, or greater than voltage as measured in step 1), go to next step.

CAUTION: To prevent injury and/or damage to vehicle, disconnect negative battery cable before connecting or disconnecting a series type ammeter to generator.

CAUTION: Carbon pile testing is part of this procedure. To avoid battery explosion, turn carbon pile OFF before connecting to or disconnecting from vehicle battery.

5. Disconnect negative battery cable. Install ammeter to voltmeter. Connect voltmeter to generator output (BAT) terminal. Connect negative battery cable. With load off, connect carbon pile load tester across battery terminals. Run engine at approximately 1500 RPM, turn accessories on and load battery with carbon pile load until maximum generator output is reached. Adjust carbon pile to maintain 13 volts or more. Measure amp output.
6. If amp output is within 15 amps of rated output, generator is okay. If amp output is not within 15 amps of rated output, repair or replace generator. See GENERATOR USAGE/AMP OUTPUT RATING table.

BENCH TESTING

NOTE: After repairs, use bench testing to verify operation of CS144 generator without auxiliary phase terminals.

GENERATOR OUTPUT TEST

CAUTION: Carbon pile testing is part of this procedure. To avoid battery explosion, turn carbon pile OFF before connecting to or disconnecting from test stand battery.

CS144 (Without Auxiliary Phase Terminals)

1. Mount generator on test stand. Set test stand controls to turn generator clockwise. Ensure ground polarity of generator and battery are the same. Ensure battery is fully charged. Connect voltmeter, ammeter and carbon pile (in OFF position). Connect 30-500 ohm resistor between battery and terminal "L" of the generator. See **Fig. 1**.
2. Slowly increase generator speed while observing voltmeter. If output is uncontrolled and increases to greater than 16 volts, rotor field coil is shorted and/or regulator is defective. A shorted rotor field coil can cause regulator failure. Replace or repair generator.

3. If voltage is less than 16 volts, increase speed and adjust carbon pile to obtain maximum generator output. Maintain voltage greater than 13 volts. If amperage output is within 15 amps of rated output, generator is okay. If amperage output is not within 15 amps of rated output, replace or repair generator. Refer to the **GENERATOR USAGE/AMP OUTPUT RATING** table.

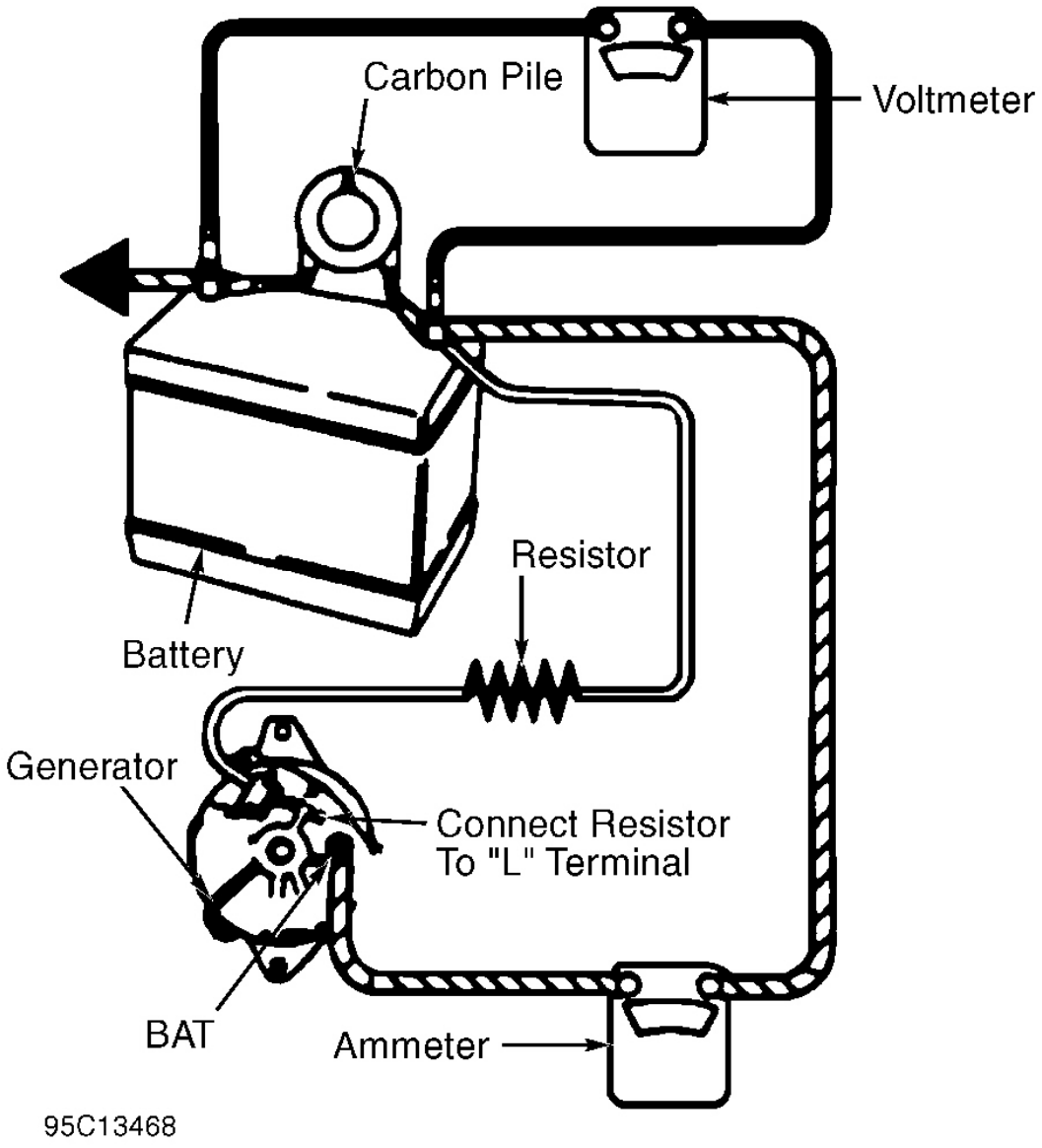


Fig. 1: Bench Testing Generator (CS144)
Courtesy of GENERAL MOTORS CORP.

ROTOR TEST

NOTE: Install NEW bearing at slip ring end whenever generator is reassembled. When disassembling generator, carefully note locations of insulated and uninsulated screws.

CS144 (Without Auxiliary Phase Terminals)

1. Scribe end frames to facilitate reassembly. Remove through-bolts and separate end frames.
2. With ohmmeter set to its lowest range, measure coil resistance between slip rings. See **Fig. 2**. Replace rotor if coil resistance is not 1.7-2.1 ohms at 70°F (21°C).
3. With ohmmeter set to its highest range, check for grounds between either slip ring and rotor pole piece. See **Fig. 2**. If reading is not close to infinite, replace rotor.
4. To reassemble generator, reverse disassembly procedure. Retain brushes with brush retaining pin during reassembly. See **Fig. 3**. Remove retaining pin after tightening through-bolts.

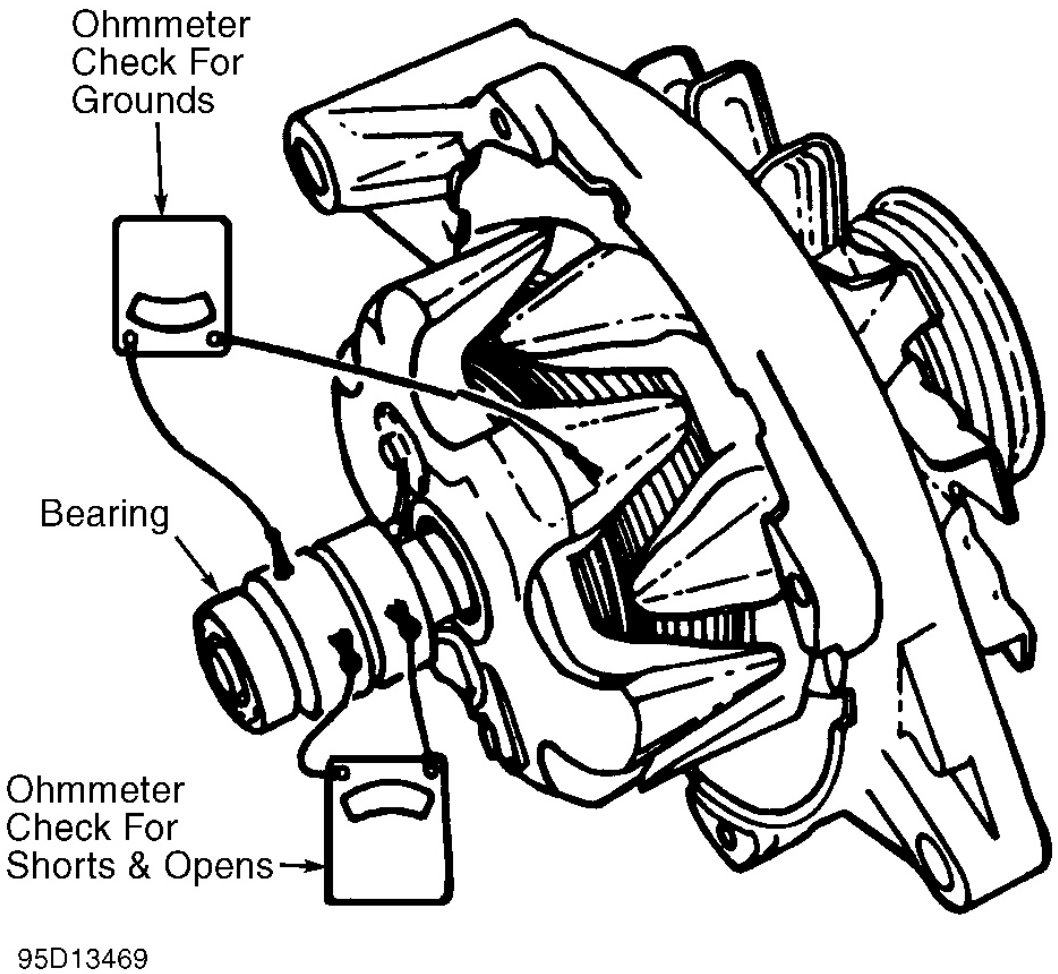


Fig. 2: Testing Generator Rotor (CS144)

Courtesy of GENERAL MOTORS CORP.

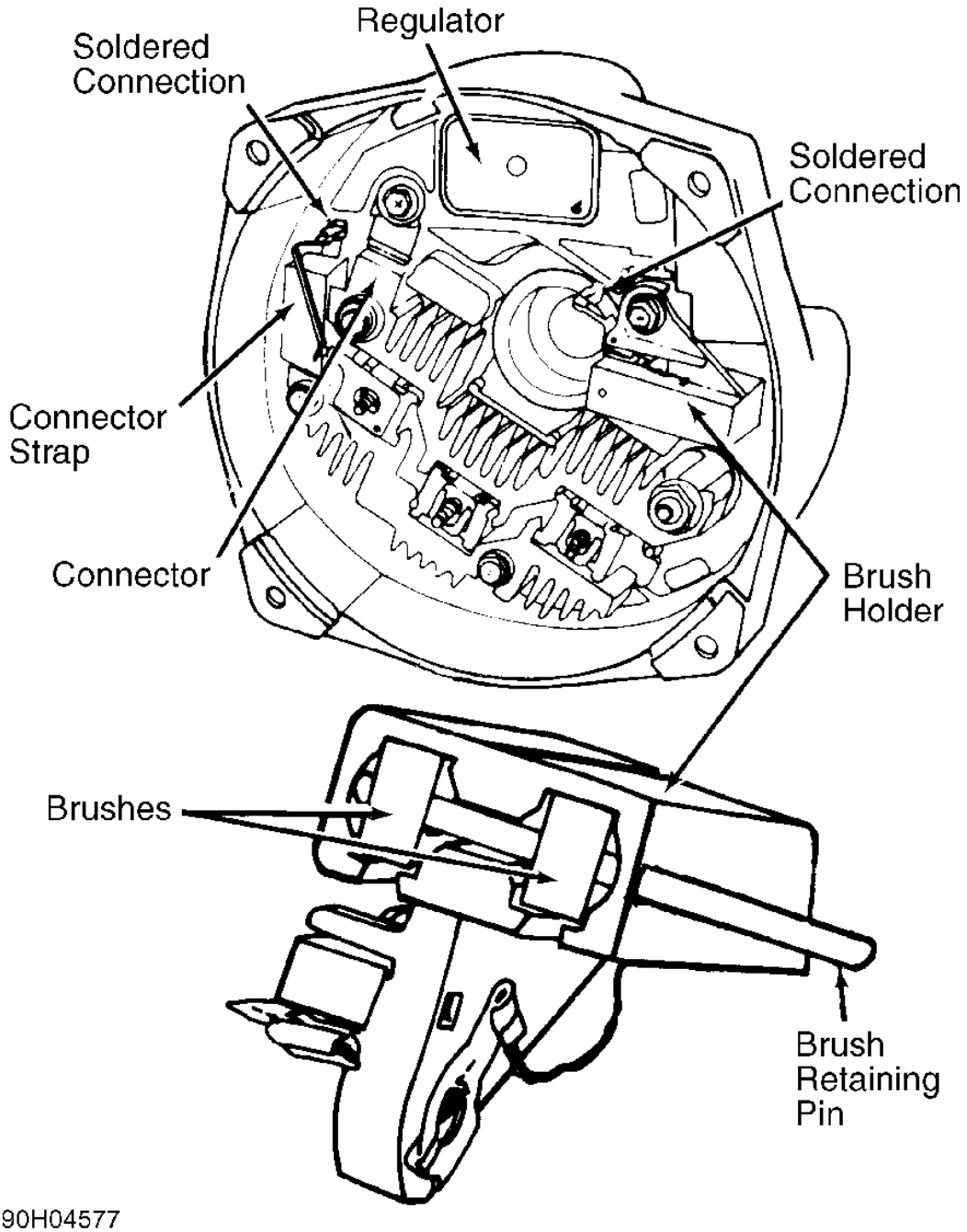


Fig. 3: Removing Brushes (CS144)
Courtesy of GENERAL MOTORS CORP.

STATOR TEST

NOTE: Install NEW bearing at slip ring end whenever generator is reassembled.

CS144 (Without Auxiliary Phase Terminals)

1. Scribe end frames to facilitate reassembly. Remove through-bolts and separate end frames. Remove stator lead attaching nuts and remove stator.
2. With ohmmeter set to its highest range, ensure coil is not grounded to stator core. See **Fig. 4**. Ohmmeter should indicate infinite resistance. If ohmmeter does not indicate infinity, replace stator. Stator cannot be checked for opens or shorts with ohmmeter.
3. To reassemble generator, reverse disassembly procedure. Retain brushes with brush retaining pin during reassembly. See **Fig. 3**. Remove retaining pin after tightening through-bolts.

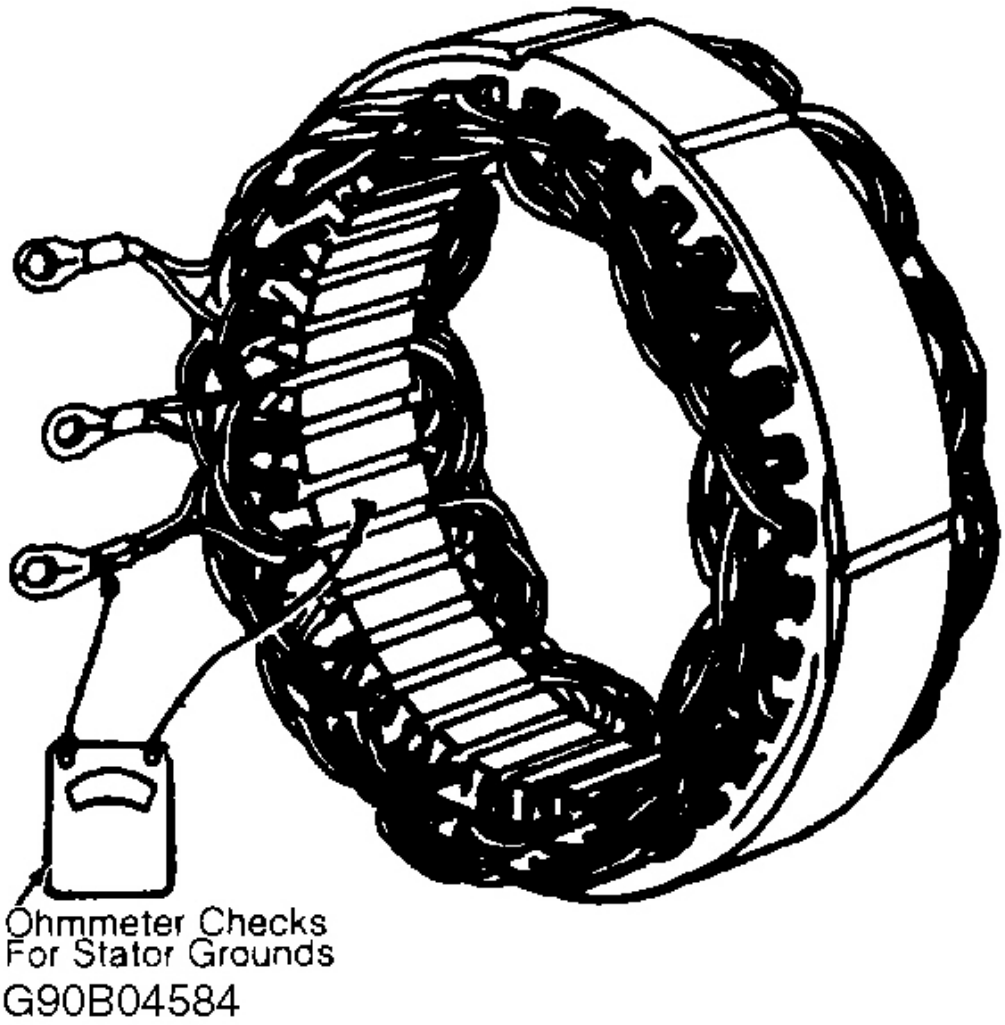


Fig. 4: Testing Generator Stator (CS144)
Courtesy of GENERAL MOTORS CORP.

RECTIFIER BRIDGE TEST

NOTE: Install NEW bearing at slip ring end whenever generator is reassembled.

CS144 (Without Auxiliary Phase Terminals)

1. Scribe end frames to facilitate reassembly. Remove through-bolts and separate end frames. Remove stator. Connect ohmmeter between grounded heat sink and any of 3 grounded flat metal rectifier bridge terminal connectors and note reading. See **Fig. 5**.

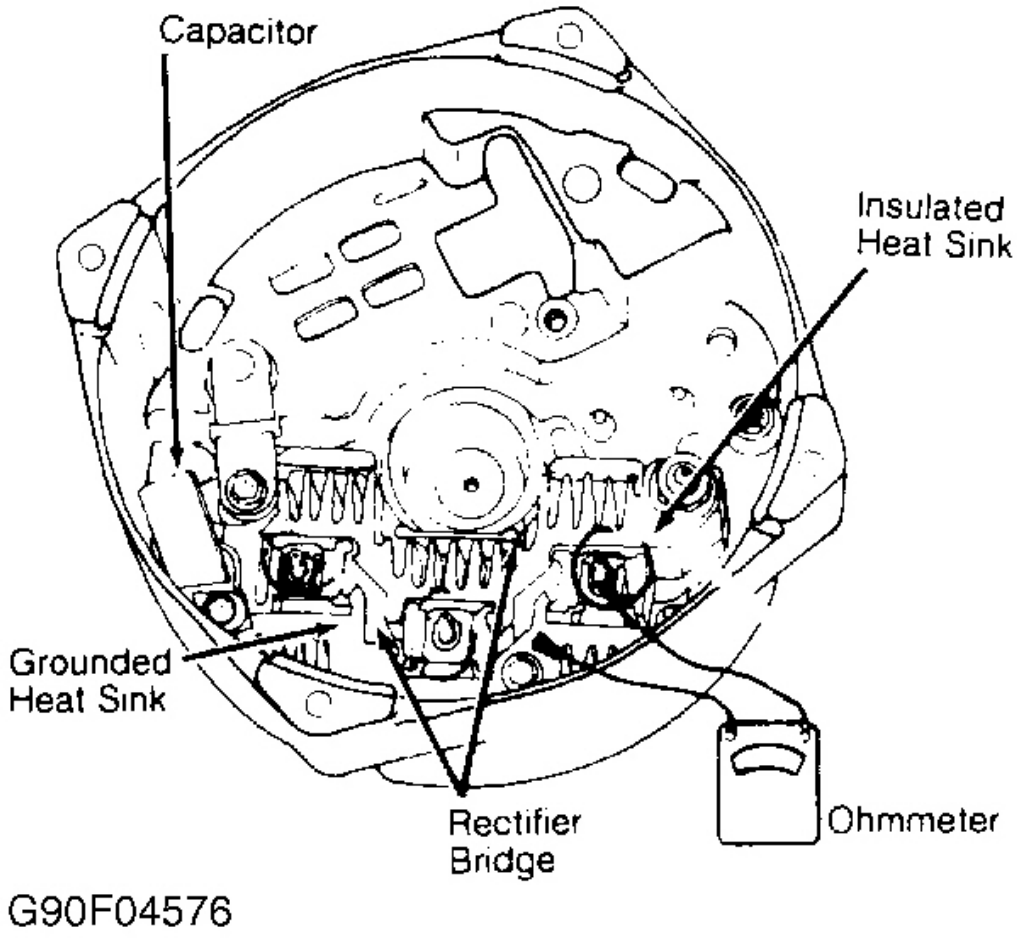


Fig. 5: Testing Generator Rectifier Bridge (CS144)
Courtesy of GENERAL MOTORS CORP.

2. Reverse meter leads. If both readings are the same, replace rectifier bridge. Repeat test between grounded heat sink and other 2 flat metal terminal connectors. If readings are the same when leads are reversed at either connection, replace rectifier bridge.
3. Repeat test between insulated heat sink and its 3 flat rectifier bridge metal connectors. Replace rectifier bridge if test readings are the same when leads are reversed at any test connection.
4. To reassemble generator, reverse disassembly procedure. Retain brushes with brush retaining pin during reassembly. See **Fig. 3**. Remove retaining pin after tightening through-bolts.

OVERHAUL

NOTE: Replacement parts are not available for CS130 and CS144 generators with

auxiliary phase terminals. If generator is defective, install a NEW unit. CS144 generators without auxiliary terminals may be disassembled for repair.

BRUSHES & REGULATOR

NOTE: Install new bearing at slip ring end whenever generator is reassembled.

CS144 (Without Auxiliary Phase Terminals)

1. Scribe end frames to facilitate reassembly. Remove through-bolts and separate end frames. Unsolder brush connections. Remove attaching screws and connectors. Remove regulator and brush holder. Clean NEW brushes with soft dry cloth.
2. Put brushes in holder and hold with brush retaining pin. See **Fig. 3**. Install brush holder into generator by reversing removal procedure. To reassemble generator, reverse disassembly procedure. Remove brush retainer pin after tightening through-bolts.

DRIVE-END BEARING

NOTE: Install NEW bearing at slip ring end whenever generator is reassembled.

CS144 (Without Auxiliary Phase Terminals)

1. Scribe end frames to facilitate reassembly. Remove through-bolts and separate end frames. Remove shaft nut while holding rotor with hex wrench inserted into shaft end. Push rotor from housing. Remove retainer plate and press bearing out. On some generators, drive end bearing cannot be replaced.
2. To install NEW bearing, press against outer race until bearing seats. Bearing is sealed; no added lubricant is required. Assemble retainer and press rotor into end frame. Tighten shaft nut to 75 ft. lbs. (102 N.m).
3. To reassemble generator, reverse disassembly procedure. Retain brushes with brush retaining pin during reassembly. See **Fig. 3**. Remove retaining pin after tightening through-bolts.

GENERATOR SPECIFICATIONS

GENERATOR USAGE/AMP OUTPUT RATING

Application	Generator	RPO Code	Rated Output
4.3L & 5.7L	CS130	K68	105
4.3L & 5.7L	CS144	KG9	140

TORQUE SPECIFICATIONS

Component	Specification
Battery Negative Cable Bolt/Screw	13 Ft. lbs. (17 N.m)
Drive Belt Tensioner Bolt/Screw	18 Ft. lbs. (25 N.m)
Generator & Power Steering Pump Bracket Bolt/Screw *	30 Ft. lbs. (41 N.m)

Generator Battery Terminal Nut (CS 144)	106 In. lbs. (12 N.m)
Generator Battery Terminal Nut (CS 130)	71 In. lbs. (8 N.m)
Generator Bolt/Screw	37 Ft. lbs. (50 N.m)
Generator Front Brace Stud Nut	25 Ft. lbs. (34 N.m)
Generator Rear Brace Bolt/Screw (CS 144)	37 Ft. lbs. (50 N.m)
Generator Rear Brace Bolt/Screw (CS 130)	18 Ft. lbs. (25 N.m)
Generator Rear Brace Nut	30 Ft. lbs. (41 N.m)
Generator Rear Bracket Nut	37 Ft. lbs. (50 N.m)
Generator Rotor Shaft Drive End Nut	75 Ft. lbs. (100 N.m)

WIRING DIAGRAM

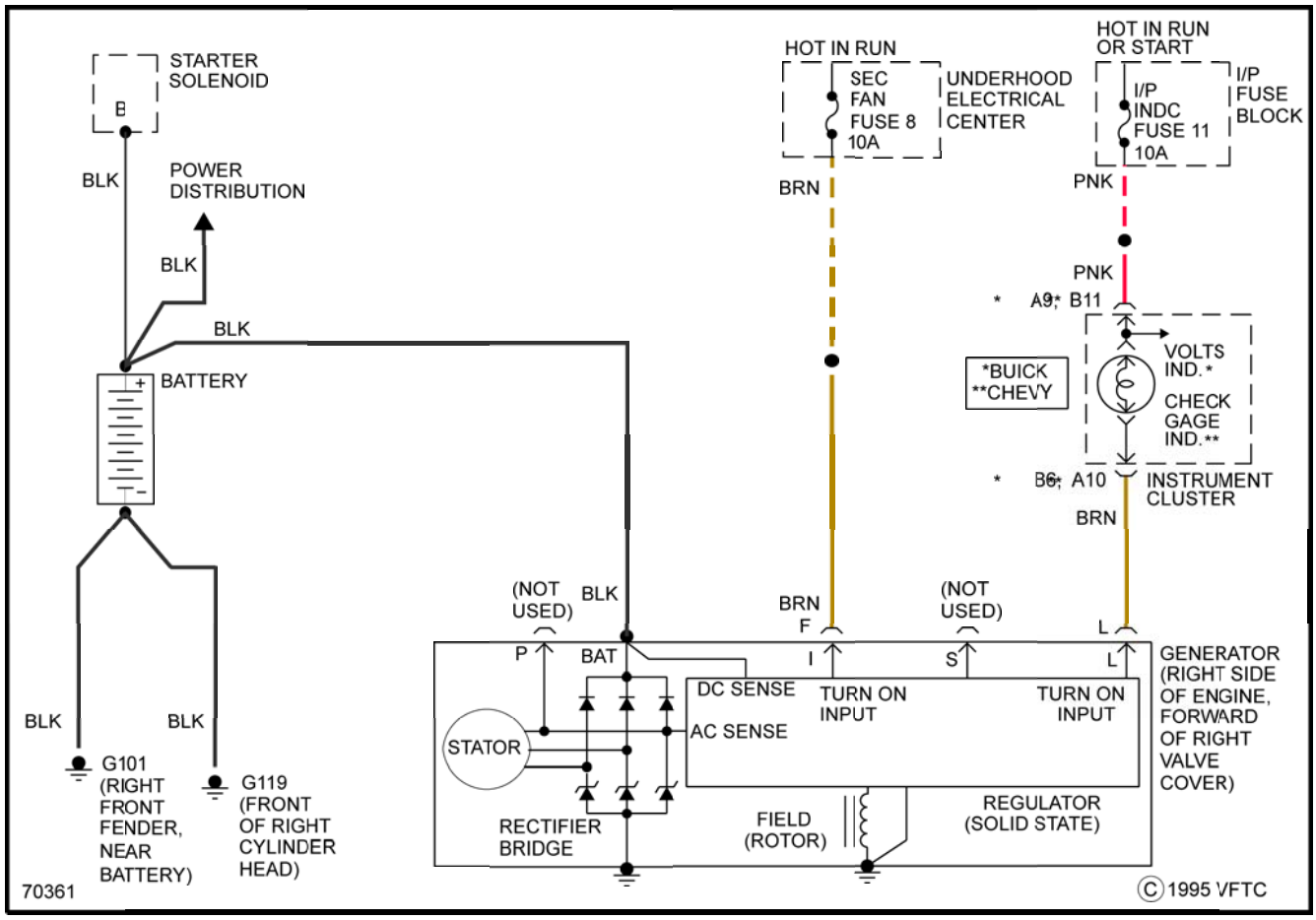


Fig. 6: Charging System Wiring Diagram

ANTI-THEFT SYSTEM

General Motors Corp. Anti-Theft System

DESCRIPTION & OPERATION

Personal Automotive Security System (PASS-Key II(R)) is designed to prevent vehicle theft by disabling engine unless an ignition key assembly with a specific electrical resistance is used in ignition cylinder assembly. System components include ignition key assembly, ignition cylinder assembly, theft deterrent module assembly, theft deterrent relay assembly, and Powertrain Control Module (PCM).

COMPONENT LOCATION

THEFT DETERRENT SYSTEM COMPONENT LOCATION

Component	Location
Powertrain Control Module	Engine Compartment, Front Of Left Wheelhouse, Under Air Cleaner
Theft Deterrent Module	Behind Left Instrument Panel, Left Of Brake Pedal Bracket
Theft Deterrent Relay	Next To Theft Deterrent Module
Starter Solenoid	Above Starter Motor

TESTING

NOTE: To prevent misdiagnosis, check for diagnostic trouble codes. See the appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section.

TESTS W/CODES - 4.3L

TESTS W/CODES - 5.7L

Engine Does Not Crank, PASSKEY Indicator Illuminates For

About 5 Seconds, Then Goes Out

1. If no codes are present, disconnect theft deterrent relay. Attach a test light between theft deterrent relay connector terminal A1 (Yellow/Black wire) and voltage. Observe test light and turn ignition switch to START position.
2. If test light does not light, check for poor connection, open, or short circuit to voltage in Yellow/Black wire. If wire is okay, replace theft deterrent module. If test light lights, connect test light between theft deterrent relay connector C2 (Purple wire) and ground. Observe test light and turn ignition switch to START position.
3. If test light does not light, check for an open or short circuit to ground in Purple wire. If wire is okay, check for an open circuit in Yellow wire or open circuit in power feed through and including ignition switch. If test light lights, connect test light between theft deterrent relay connector terminal C1 (Yellow wire) and ground. Observe test light and turn ignition switch to START position.
4. If test light does not light, check for open circuit in Yellow wire between theft deterrent relay connector

terminal C1 and splice. If test light lights, connect 30-amp fused jumper wire between theft deterrent relay connector terminals C1 (Yellow wire) and A2 (Yellow wire). Turn ignition switch to START position.

5. If engine does not crank, diagnose problem with starting or charging system. See the **ALTERNATOR & REGULATOR** article or the **STARTER** article in the ELECTRICAL section. If engine cranks, check for poor connection to theft deterrent relay. If relay connection is okay, replace theft deterrent relay. In addition, check Yellow wire to starter solenoid for a short circuit.

Engine Cranks But Will Not Start, PASSKEY Indicator

Illuminates For About 5 Seconds, Then Goes Out

1. Disconnect theft deterrent module. Turn ignition switch to RUN position. Measure voltage between theft deterrent module connector terminal A3 (Dark Blue wire) and ground. If about 5 volts is present, go to step 3). If about 5 volts is not present, go to next step.
2. Check Dark Blue wire for an open or short circuit between theft deterrent module connector terminal A3 (Dark Blue wire) and Powertrain Control Module (PCM). Check for poor connections to modules.
3. Turn ignition off. Reconnect theft deterrent module. Turn ignition switch to RUN position. Measure voltage theft deterrent module connector terminal A3 (Dark Blue wire) and ground. If about 2.5 volts is not present, check for poor connection. If connector is okay, replace theft deterrent module. If about 2.5 volts is present, diagnose starting system. See the **ALTERNATOR & REGULATOR** article or the **STARTER** article in the ELECTRICAL section.

PASSKEY Indicator On Steady, Engine Starts

1. Disconnect theft deterrent module. Turn ignition switch to RUN position. If PASSKEY indicator lights, check for short to ground in Gray wire. If Gray wire is okay, check instrument panel printed circuit for shorts and replace as necessary.
2. Perform lock cylinder and harness test. Go to LOCK CYLINDER & HARNESS TEST. If keys, lock cylinder, and lock cylinder harness are okay, replace theft deterrent module.

PASSKEY Indicator Never Illuminates, Engine Starts

1. Disconnect theft deterrent module. Attach a 10-amp fused jumper wire between theft deterrent module connector terminal A5 (Gray wire) and ground. Turn ignition switch to RUN position.
2. If PASSKEY indicator lights, check for poor connection at theft deterrent module. If connection is okay, replace theft deterrent module. If PASSKEY indicator does not light, check for poor connection or open circuit in Gray wire between theft deterrent module connector terminal A5 and instrument cluster connector terminal B8 (Chevrolet) or terminal A6 (Buick). In addition, check for open or short to ground in Orange wire between instrument cluster and fuse. Check instrument cluster printed circuit and replace as necessary.

Lock Cylinder & Harness Test

1. Insert ignition key into PASS-Key II(R) Interrogator (J 35628-A). Turn interrogator on. Move steering wheel from side to side. Read key code shown on interrogator display. If display is 1 through 15, go to next step. If display is "E", clean and retest key. If key code is incorrect, replace key.

2. Record displayed key code. Turn interrogator off. Connect interrogator to 2-pin ignition switch lock cylinder harness connector at base of steering column. Insert ignition key into ignition switch lock cylinder. Turn interrogator on. While checking display on interrogator, turn ignition switch slowly to START position. Check if displayed key code matches value recorded earlier.
3. If displayed code does not match value recorded earlier, check for poor connection. If connection is okay, replace ignition switch lock cylinder and harness.
4. If displayed code does match value recorded earlier, connect test light between terminal "B" (Purple/White wire) of 2-pin connector at base of steering column and voltage. If test light lights, check Purple/White wire for an open, short to voltage, or short to ground. If wire is okay, replace theft deterrent module.
5. If test light does not light, disconnect theft deterrent module. Connect test light between theft deterrent module connector terminal B5 (Black/White wire) and voltage. If test light does not light, repair open circuit in Black/White wire. If test light lights, check for poor connection at module connector terminals B5 (White/Black wire) or B7 (Purple/White wire). If connection is okay, replace theft deterrent module.

TROUBLE SHOOTING

PASS-KEY II(R)

1. Check ignition key for cracked, dirty, or coated resistor pellet. Ensure ignition key is free from excess plastic around resistor pellet contacts. Check ignition key using Interrogator (J 35628-A). If key code window shows "E", replace key. Check key pellet sensing contacts in ignition lock cylinder by looking into key opening. If contacts are damaged or not Silver, replace lock cylinder.
2. Check PASS-Key II(R) fuses No. 14 and 34. If theft deterrent relay must be replaced, check Yellow wire to starter solenoid for a short to ground.
3. To check contacts to key and wires in steering column, disconnect connector near base of steering column. Measure resistance back to key at this connector while turning and adjusting steering wheel. If there is a change or intermittent reading, replace lock cylinder and attached steering column wires. See **Fig. 1** .

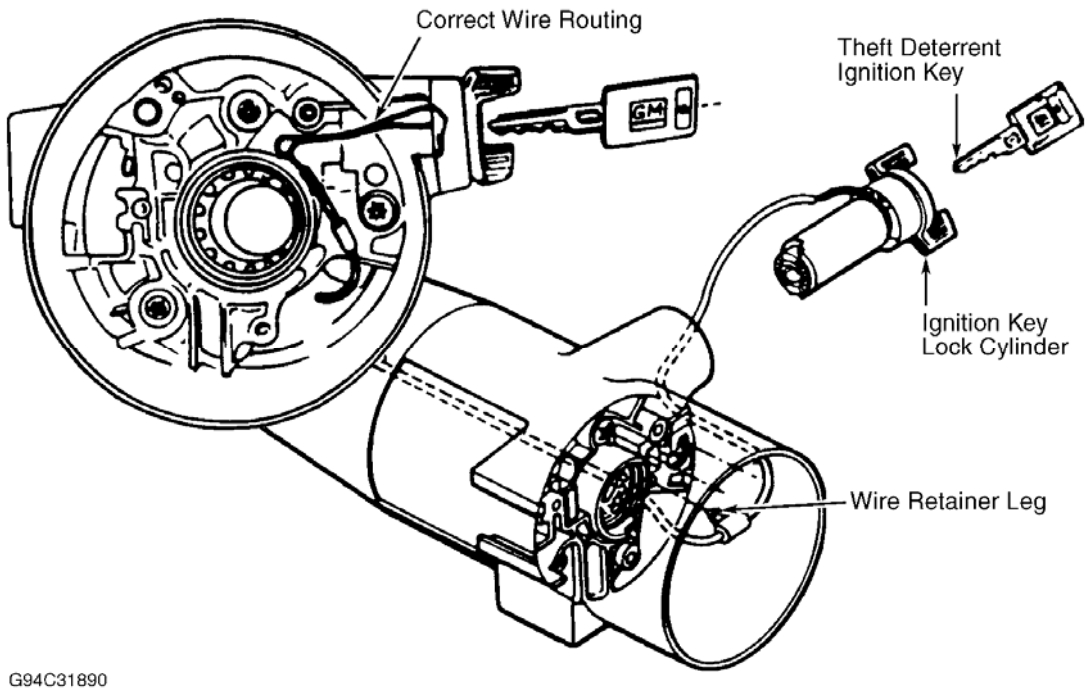


Fig. 1: Removing Steering Column Lock & Cylinder Assembly
Courtesy of GENERAL MOTORS CORP.

Pass Key Resistance Values

Key Resistance Number	Ohms Value
1	402
2	523
3	681
4	887
5	1130
6	1407
7	1870
8	2370
9	3010
10	3740
11	4750
12	6040
13	7500
14	9530
15	11800

WIRING DIAGRAMS

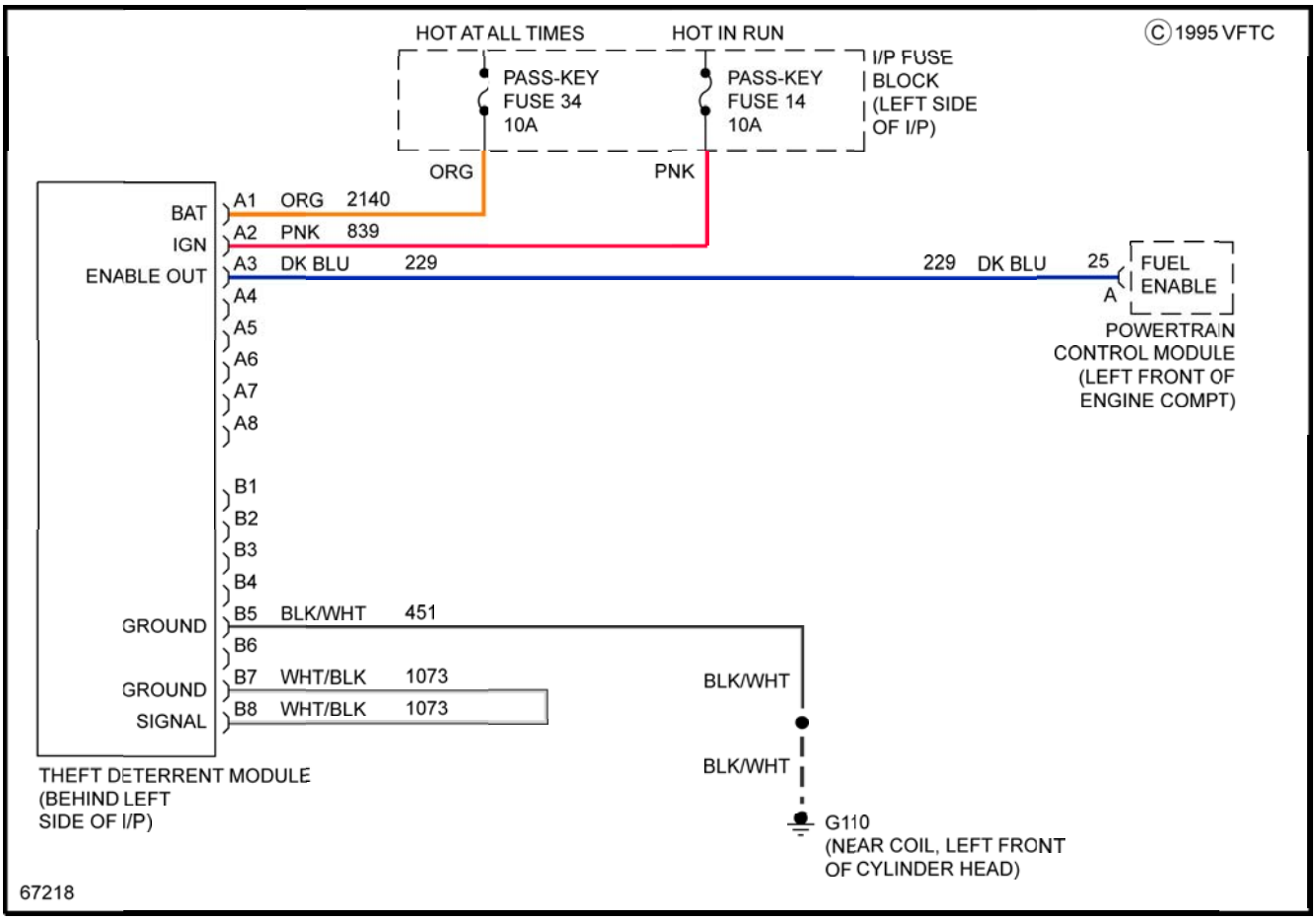


Fig. 2: Anti-Theft System (PASS-Key (R)) Wiring Diagram (W/SEO)

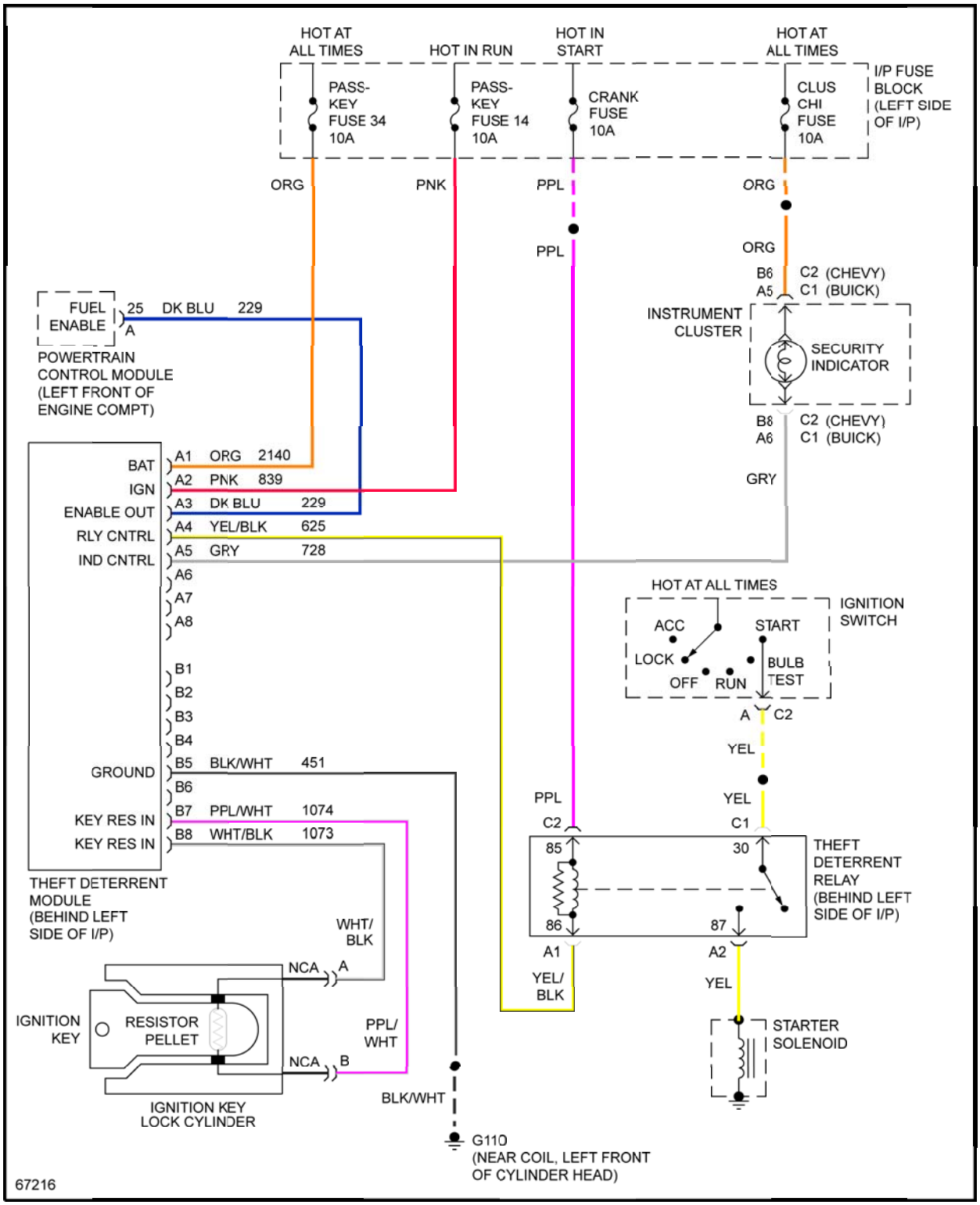


Fig. 3: Anti-Theft System (PASS-Key (R)) Wiring Diagram (W/O SEO)

APPLICATION

THM 3T40 APPLICATION

THM 3T40 APPLICATION

Application (Body Code)	Engine
Buick	
Century (A)	2.5L & 3.3L
Skylark (N)	2.3L, (1) 2.5L & 3.3L
Chevrolet	
Beretta (L)	2.2L, 2.3L & 3.1L
Cavalier (J)	2.2L & 3.1L
Corsica (L)	2.2L, 2.3L & 3.1L
Lumina (W)	2.5L & 3.1L
Lumina APV	3.1L
Oldsmobile	
Achieva (N) (2)	2.3L & 3.3L
Cutlass Calais (N) (1)	2.3L, 2.5L & 3.3L
Cutlass Ciera (A) & Cutlass Cruiser (A)	2.5L & 3.3L
Cutlass Supreme (W)	(1) 2.3L & (2) 3.1L
Silhouette	3.1L
Pontiac	
Grand Am (N)	2.3L, (1) 2.5L & (2) 3.3L
Grand Prix (W)	(1) 2.3L & (2) 3.1L
LeMans (T)	1.6 & 2.0L
Sunbird (J)	2.0L & 3.1L
Trans Sport	3.1L
6000 (A) (1)	2.5L & 3.1L
(1) Applies to 1991 models.	
(2) Applies to 1992 models.	

THM 4L60/700-R4 APPLICATION (1991-92)

THM 4L60/700-R4 APPLICATION (1991-92)

Application (Body Code)	Engine
Buick	
Roadmaster (B)	5.0L, 5.7L
Cadillac	

Brougham (D)	5.0L, 5.7L
Chevrolet	
Astro	4.3L
Blazer	2.5L, 4.3L, 5.7L, 6.2L
Camaro (F)	3.1L, 5.0L, 5.7L
Caprice (B)	5.0L, 5.7L
Corvette (Y)	5.7L
Cutaway Van	5.7L, 6.2L, 7.4L
Hi-Cube Van	5.7L, 6.2L, 7.4L
Passenger Van	4.3L, 5.0L, 5.7L, 6.2L, 7.4L
Sport Van	4.3L, 5.0L, 5.7L, 6.2L, 7.4L
Suburban	5.7L, 6.2L, 7.4L
Pickup	2.5L, 4.3L, 5.0L, 5.7L, 6.2L, 6.5L, 7.4L
GMC	
Cutaway Van	4.3L, 5.7L
Jimmy	5.7L, 6.2L
Magnavan	5.7L, 6.2L, 7.4L
Passenger Van	4.3L
Rally Van	4.3L, 5.0L, 5.7L, 6.2L
Safari	4.3L
School Bus	4.3L, 5.7L
Sierra	4.3L, 5.7L, 6.2L, 7.4L
Pickup	2.5L, 4.3L, 5.7L, 6.2L
Vandura	4.3L, 5.0L, 5.7L, 6.2L
Yukon	5.7L
Oldsmobile	
Bravada	4.3L
Custom Cruiser (B)	5.0L, 5.7L
Pontiac	
Firebird (F)	3.1L, 5.0L, 5.7L

THM 4T60 & 4T60-E APPLICATION (1991-92)

THM 4T60 & 4T60-E APPLICATION (1991-92)

Application (Body Code)	Engine
Buick	
Century (A)	3.3L
LeSabre (H), Park Avenue (C), Riviera (E) & 1991 Reatta (E)	(1) 3.8L
Regal (W)	3.1L & 3.8L
Chevrolet	
Lumina (W)	3.1L & (1) 3.4L
Lumina APV	(1) 3.8L
Oldsmobile	
Cutlass Ciera (A) & Cutlass Cruiser (A)	3.3L
Cutlass Supreme (W)	3.1L & (1) 3.4L
Eighty Eight (Royale) (H), Ninety-Eight (C), Silhouette, Toronado (E) & Trofeo (E)	(1) 3.8L
Pontiac	
Bonneville (H) & Trans Sport	(1) 3.8L
Grand Prix (W)	3.1L & (1) 3.4L
1991 6000 (A)	3.1L
(1) These 1992 models, including 1991 Reatta, use THM 4T60-E transaxles.	

THM 4L80-E APPLICATION

THM 4L80-E APPLICATION

Application (1)	Engine
Chevrolet	
"C", "G", "K", "P", "R" & "V" Series	4.3L, 5.7L, 6.2L & 7.4L
GMC	
"C", "G", "K", "R" & "V" Series	4.3L, 5.7L, 6.2L & 7.4L
(1) See **THM 4L80-E SERIES CODE DESIGNATION** table.	

THM 4L80-E SERIES CODE DESIGNATION

THM 4L80-E SERIES CODE DESIGNATION

Model	Designation
1991	
Blazer & Jimmy	"V" Series

Parcel Van	"P" Series
Pickup	
2WD	"C" & "R" Series
4WD	"K" & "V" Series
Suburban	
2WD	"R" Series
4WD	"V" Series
Van	"G" Series
1992	
Blazer	"K" Series
Parcel Van	"P" Series
Pickup	
2WD	"C" Series
4WD	"K" Series
Sierra & Suburban	
2WD	"C" Series
4WD	"K" Series
Van	"G" Series
Yukon	"K" Series

MP6 & MP7 APPLICATIONS (1991-92)

MP6 & MP7 APPLICATIONS

Manufacturer	Engine
Saturn	1.9L

DIAGNOSTIC FLOW

TCC diagnosis should be performed in the following order:

- See **TROUBLE SHOOTING**.
- See **RETRIEVING TROUBLE CODES** or DISPLAYING TROUBLE CODES under appropriate TESTING & DIAGNOSIS.
- Verify TCC system fault.
- See **TORQUE CONVERTER CLUTCH CHARTS (TRUCKS)**.
- See **DIAGNOSTIC FLOW CHARTS (CARS)** or **DIAGNOSTIC CODE CHARTS (TRUCKS)**.

NOTE: This article contains test charts that are part of General Motors Computerized Engine Controls. Only those charts required to test Torque Converter Clutch (TCC) system and related circuits are included. Other diagnostic codes may

appear while performing TCC electrical diagnosis. See appropriate article in the ENGINE PERFORMANCE section for complete information on General Motors Computerized Engine Control systems.

DESCRIPTION

NOTE: ECM is often referred to as PCM in diagnostic charts.

The Torque Converter Clutch (TCC) assembly consists of a 3-element torque converter with the addition of a converter clutch. The converter clutch is an internal mechanism with friction material attached to front face. It is splined to the turbine assembly in converter.

The purpose of the torque converter clutch feature is to eliminate power loss due to slippage when vehicle is cruising. This allows the convenience of an automatic transmission and the fuel economy of a manual transmission.

When the TCC solenoid ground circuit is completed by the Electronic Control Module (ECM), the torque converter clutch is applied, resulting in a direct mechanical coupling between engine and transmission. When TCC solenoid is deactivated, the torque converter clutch is released, allowing torque converter to operate in a conventional manner.

TCC CONTROL COMPONENTS

The following components are used in TCC system. Not all components will be present on all vehicles.

Brake Switch

Power from ignition switch passes through brake switch to TCC solenoid. When brake pedal is depressed with TCC engaged, power to TCC solenoid is interrupted, releasing converter clutch and preventing engine from stalling.

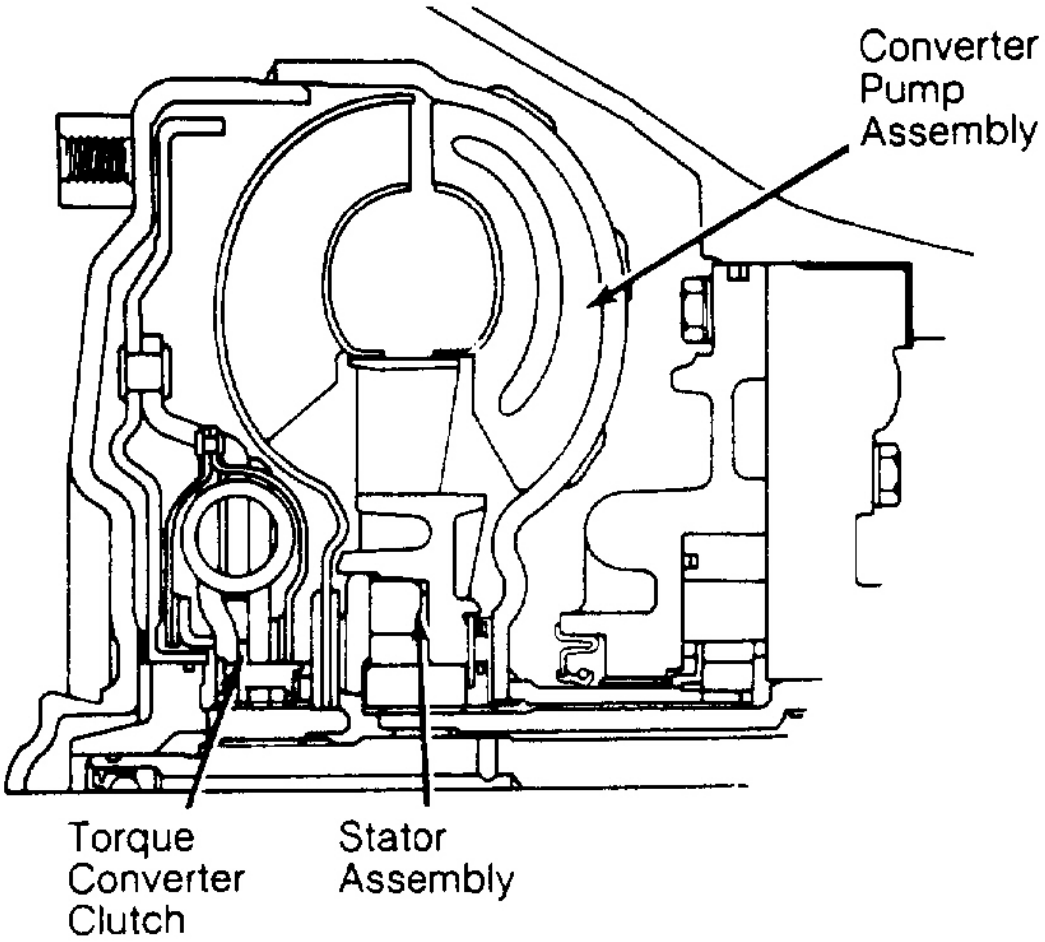


Fig. 1: Torque Converter Assembly with TCC
Courtesy of GENERAL MOTORS CORP.

Coolant Temperature Sensor

This sensor provides ECM with engine coolant temperature information. ECM will not allow TCC operation until signal from this sensor indicates coolant temperature greater than 130-150°F (55-65°C).

Electronic Control Module (ECM)

To determine application of torque converter clutch, ECM receives and processes information from various input devices. These devices may include the vehicle speed sensor, coolant temperature sensor, throttle position sensor, 3rd and 4th gear switches and brake switch. The ECM controls application of torque converter clutch by providing a ground circuit for the TCC solenoid circuit.

TCC Solenoid Assembly

Solenoid is energized by ECM to redirect transmission fluid to the converter clutch apply valve in the auxiliary control valve assembly.

Throttle Position Sensor (TPS)

Provides ECM with throttle position information. TCC operation is prevented when throttle position signal is less than a specified value.

Vacuum Sensor

Sends engine vacuum (load) information to ECM.

Vehicle Speed Sensor (VSS)

This sensor sends vehicle speed information to ECM. Vehicle speed must be greater than a certain value before TCC can be applied. Two types of speed sensor are used. A light emitting diode type is used in the instrument cluster on some models. Other models use a Permanent Magnet (PM) generator mounted in the transmission.

3rd & 4th Gear Switches

When open, 3rd and 4th gear switches prevent TCC operation. Switch status may be monitored by ECM, or switch may be an integral portion (series circuit) of TCC solenoid power supply.

TROUBLE SHOOTING

NOTE: Every diagnosis of automatic transmission problems should begin with a check of the transmission fluid and linkage. Most of the conditions listed in TROUBLE SHOOTING can be caused by one or more of the following factors:

- Incorrect fluid level
- Contaminated fluid
- Improperly adjusted linkage
- Damaged or worn linkage

When diagnosing converter clutch problems, ensure engine and vacuum systems are operating properly.

NO CONVERTER CLUTCH APPLICATION

Problem In Electronic Control Module

- Verify Electronic Control Module (ECM) operation. See appropriate CHART C-8.

Electrical Problems

- Voltage not reaching transmission. Ensure 12 volts reaches transmission to engage solenoid.
- Ground inside transmission. Ensure solenoid is not grounded inside transmission case.
- Defective connector, wiring harness, or solenoid. Check and repair or replace if necessary. Defective pressure switch (if equipped). Check and replace pressure switch if necessary.
- 3rd and 4th gear switches inoperative. Check and replace switches if necessary.

Valve Body Assembly

- Sticking converter clutch shift and/or apply valve. Clean and/or replace valve body if necessary.
- Solenoid "O" ring leaking or solenoid screen blocked. Check and repair or replace if necessary.
- Inspect valve body and service as necessary.

Oil Pump Assembly

- Orifice cup plug restricted or damaged. Clean and inspect orifice for blockage.
- Solenoid "O" ring damaged or missing. Check and replace "O" ring if necessary.
- Oil pump wear plate or gasket mispositioned or damaged. Check and replace wear plate or gasket.
- Improper torque on oil pump-to-converter housing bolts. Tighten bolts to specifications.
- Turbine shaft seals damaged. Check and replace seals.
- Converter clutch valve stuck or assembled backwards or retaining ring mispositioned. Check and repair as necessary.

CONVERTER CLUTCH APPLY SLIPS, ROUGH OR SHUDDERS

- Torque converter assembly has internal damage. Replace as necessary.
- Damaged or missing check ball in end of turbine shaft. Check and replace turbine shaft if necessary.
- Converter clutch valve stuck or restricted oil passage. Clean and/or repair if necessary.
- Crack in oil filter body, restricted filter neck or "O" ring seal cut or damaged. Check and repair or replace if necessary.

CONVERTER CLUTCH DOES NOT RELEASE

- External ground or clogged exhaust orifice. Check and repair if necessary.
- ECM has external ground. Verify ECM operation. See appropriate CHART C-8.
- Converter clutch apply valve stuck. Clean and/or replace if necessary.
- Check for damaged torque converter. Replace torque converter if necessary.

TESTING & DIAGNOSIS (EXC. REATTA, RIVIERA, TORONADO & TROFEO)

DIAGNOSTIC TOOLS

NOTE: On all models, diagnosis of the TCC system may be performed by following the appropriate CHART C-8 for the transmission/engine application in question.

When utilizing C-8 charts, specific tools which may be required are a tachometer, test light, digital volt/ohmmeter (DVOM) with 10-megohm input impedance (minimum), and jumper wires. A test light, rather than a voltmeter, must be used when indicated by diagnostic chart.

NOTE: In the diagnostic and trouble code charts, special scan testers are referred to (and recommended) by the manufacturer to read data parameters and check voltages in the system.

RETRIEVING TROUBLE CODES

The ECM stores component failure information under a related trouble code, which can be recalled later for diagnosis and repair. When recalled, these codes can be displayed on a scan tester, or by entering diagnostic mode and observing flashes of the SERVICE ENGINE SOON light. It is NOT necessary to enter diagnostic mode to use TCC test charts; however, it will be necessary to enter ECM diagnostic mode to verify the presence of any codes.

NOTE: Even when using a scan tester, it is recommended that the diagnostic mode be accessed in advance to verify the computer's ability to self-diagnose.

ENTERING DIAGNOSTIC MODE

1. To enter diagnostic mode, turn ignition switch on, but do not start engine. SERVICE ENGINE SOON light should glow. Locate Assembly Line Diagnostic Link (ALDL) connector attached to ECM wiring harness under instrument panel. Insert jumper wire across diagnostic mode "test" terminal "B" and ground terminal "A". See **Fig. 2**.

CAUTION: Inserting jumper wire in terminals of ALDL connector completes test circuit. DO NOT ground ALDL connector until after ignition switch is on. Inserting jumper wire in terminals of ALDL connector with engine running will cause fuel injected vehicles to enter field service mode. Flashes of the SERVICE ENGINE SOON light will not indicate codes if this is done.

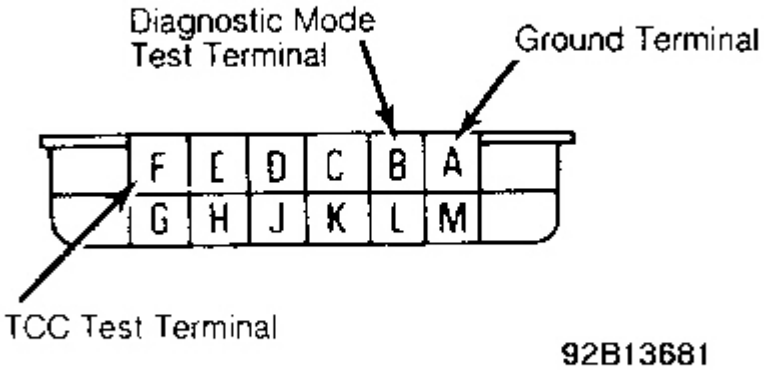


Fig. 2: Identifying ALDL Diagnostic Terminal Locations
Courtesy of GENERAL MOTORS CORP.

2. SERVICE ENGINE SOON light should flash Code 12 (FLASH, pause, FLASH, FLASH) followed by a longer pause. Trouble Code 12 will be repeated 3 more times, then if any trouble codes are stored in the ECM memory, they will be displayed in the same manner.
3. Trouble codes will be displayed from lowest to highest numbered codes (3 times each) and be repeated as long as the test terminal of the ALDL connector is grounded.
4. To exit diagnostic mode, remove jumper wire from ALDL connector and turn ignition switch off.

NOTE: If Code 12 is not flashed when the ALDL diagnostic test terminal is grounded, information received by a scan tester on the serial data line may not be accurate. For complete testing of the ECM diagnostic circuit, refer to appropriate article in the ENGINE PERFORMANCE section.

CLEARING TROUBLE CODES (EXCEPT SATURN)

Trouble codes are cleared by removing battery voltage from ECM for at least 30 seconds. Ensure test terminal is not grounded. Turn ignition switch off and remove ECM fuse from fuse block for 30 seconds, and then reinsert fuse. Another way of removing battery voltage is to disconnect the battery positive cable (or pigtail) from the battery for 30 seconds, and then reconnect it. In either case, ensure the ignition switch is in the OFF position before removing battery voltage. Otherwise, a voltage spike could occur and damage the ECM. When power to ECM is removed, degraded driveability may be exhibited until control module relearns optimum operational parameters. See **COMPUTER RELEARN PROCEDURES** article in the GENERAL INFORMATION section. See menu below.

CLEARING TROUBLE CODES (SATURN)

To clear general information codes, turn ignition switch on and jumper diagnostic test terminal "B" to ground terminal "A" at ALDL connector 3 times within 5 seconds. See **Fig. 2**. General information codes will also clear automatically if code does not reoccur within 50 ignition "ON" cycles. Malfunction history codes and information flags can only be cleared using a scan tester.

TESTING & DIAGNOSIS (REATTA, RIVIERA, TORONADO & TROFEO)

ENTERING SELF-DIAGNOSTICS

NOTE: It will be necessary to enter service mode to use Reatta, Riviera, Toronado and Trofeo TCC test charts. Enter appropriate test condition (i.e., ECM INPUTS, BCM CODE, etc.) as indicated in charts.

1. On Reatta and Riviera, turn ignition switch on. Simultaneously depress OFF and TEMP buttons on the Electronic Climate Control Panel (ECCP). See **Fig. 3**. Continue to depress OFF and TEMP buttons until all segments and bulbs of the Instrument Panel Cluster (IPC), the Driver Information Center (DIC) and ECCP illuminate. When all segments are lit, system has entered self-diagnostic mode. Release OFF and TEMP buttons. Go to step 4).
2. On Toronado and Trofeo, turn ignition switch on. On models without Cathode Ray Tube (CRT), simultaneously depress OFF and WARM buttons on the Electronic Climate Control Panel (ECCP). On CRT equipped vehicles, simultaneously push OFF button and touch WARM key on CRT monitor control panel. See **Fig. 4**.
3. On both non-CRT and CRT monitor equipped vehicles, continue to depress OFF and WARM button/key until all segments and bulbs of the IPC, the Driver Information Center (DIC) and ECCP illuminate. See **Fig. 5**. When all segments are lit, system has entered self-diagnostic mode. Release OFF and WARM button/key.
4. On all models, illuminating the segments of the IPC, DIC and ECCP ensures all display segments are working properly. If all segments illuminate, proceed to **DISPLAYING TROUBLE CODES**. Failure of any segment to illuminate may result in inaccurate test results. All inoperative segments of the display must be made to operate before proceeding with self-diagnostic procedures.
5. Partial segment check is possible by depressing TEST button on IPC when vehicle is in Park or Neutral. Holding button depressed will light all vacuum fluorescent displays and all telltales on IPC in order to check for faulty bulbs or panels.

CAUTION: Accessing self-diagnostics for 30 minutes or longer without running engine will cause battery to discharge, resulting in a possible no-start condition and faulty diagnostic readings. To ensure proper operation, attach battery charger to battery.

EXITING SELF-DIAGNOSTICS

During self-diagnostics procedure, it is possible to exit service mode without erasing trouble codes. On non-CRT equipped vehicles, depress BI-LEV button on ECCP or turn ignition switch to OFF position. On CRT monitor equipped panel vehicles, touch RTN key on CRT monitor panel or turn ignition switch to OFF position.

DISPLAYING TROUBLE CODES

After diagnostic service mode is entered, any trouble codes stored in the computer memory will be displayed. Codes will also be followed by a "C" or "H". Letter "H" stands for history and indicates that the failure was not present when last tested. Letter "C" stands for current and indicates the fault still exists. ECM codes will be displayed first. If no ECM codes are stored, a NO E CODE message is displayed.

After ECM codes have been displayed, the Body Control Module (BCM) codes will be displayed. BCM codes mainly deal with body control functions, with climate control being one of its main features. If no BCM codes are present, a NO B CODE message will be displayed. Trouble codes for both the ECM and BCM will be displayed in numerical succession of lowest to highest numbered code. Trouble code display can be bypassed at any time by depressing FAN DOWN button on ECCP or touching RTN key on CRT monitor control panel.

ECM & BCM TROUBLE CODES

Application	Circuit Affected
ECM Code	
E024	Vehicle Speed Sensor (VSS)
E031	Park/Neutral Switch
E038	Brake Switch
BCM Code	
B127	PRNDD21 Sensor

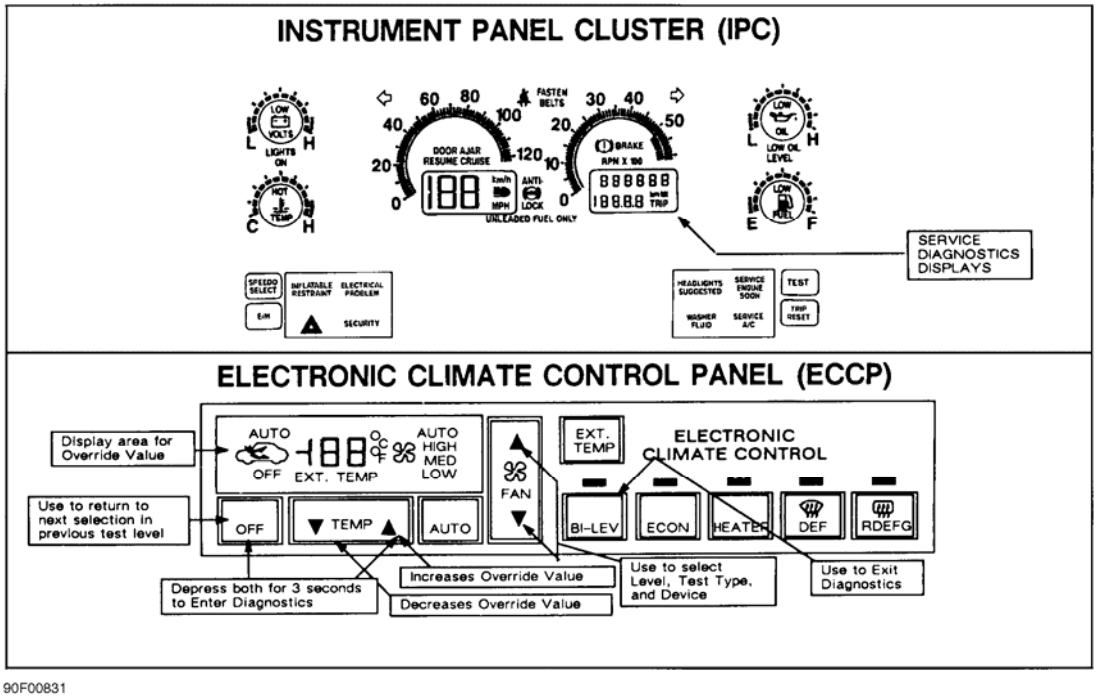


Fig. 3: Analog Instrument Cluster & Climate Control Panel (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

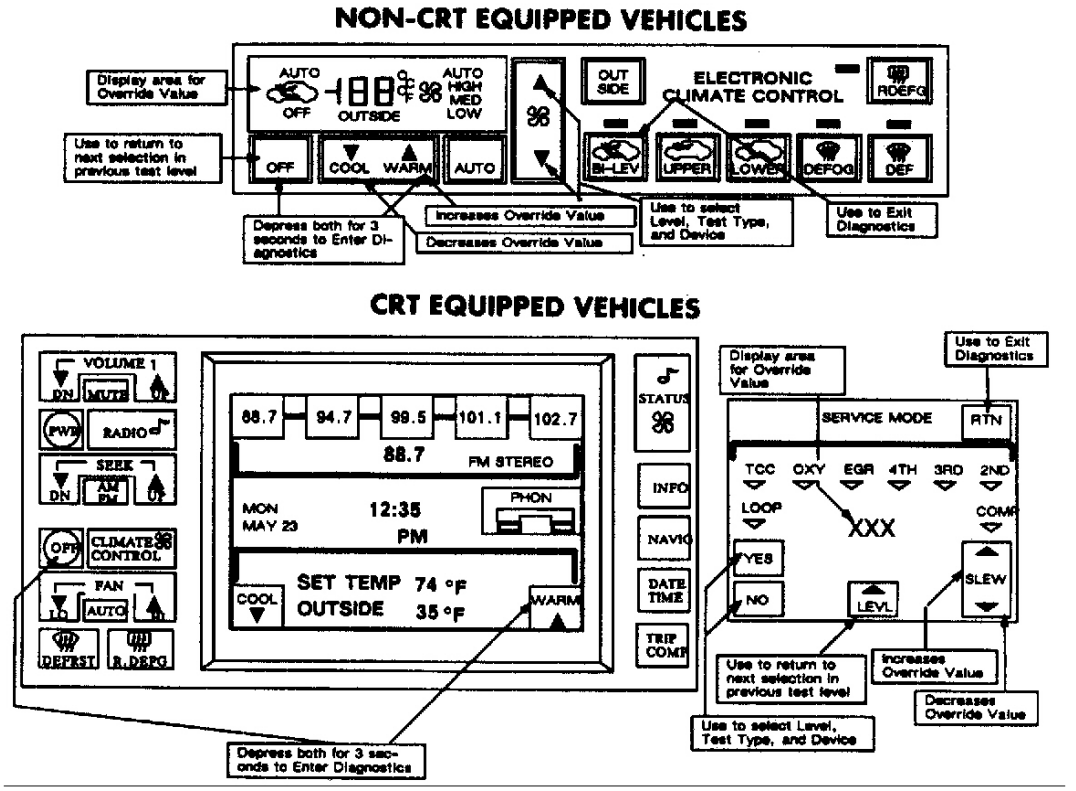


Fig. 4: Climate Control Panel & (CRT) Monitor Control Panel (Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

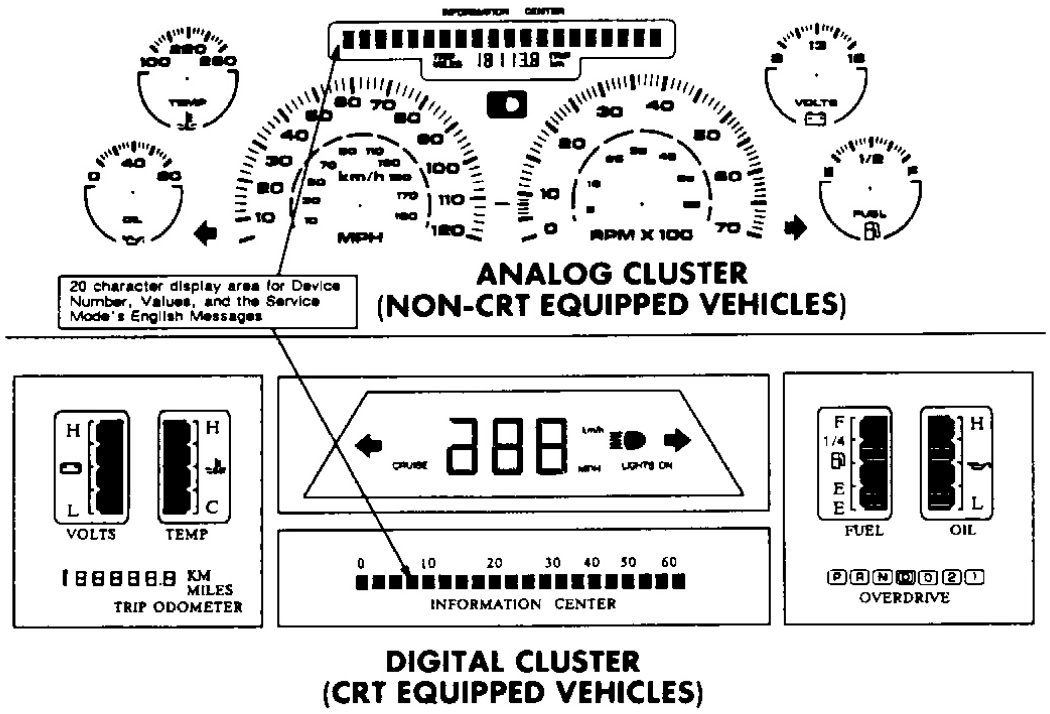


Fig. 5: Driver Information Center (DIC) (Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CLEARING TROUBLE CODES

See CLEAR CODES under **TEST TYPE SELECTION**.

SYSTEM SELECTION

1. After all trouble codes have been displayed, the SERVICE MODE system can be directed to perform specific system diagnostic tests. See **DISPLAYING TROUBLE CODES**. Following the trouble code display, the first system available for testing will automatically be displayed. For example, ECM? may now be present on the display.
2. To select the desired system, (ECM or BCM), advance and stop the DIC display as follows: On non-CRT equipped vehicles, depressing the FAN DOWN button on the ECCP will cycle the system selection list. When the desired diagnostic system is displayed, depress FAN UP button on ECCP and the displayed system will be selected for testing.
3. On CRT equipped vehicles, touching NO key on CRT monitor panel will cycle system selection list. When desired diagnostic system is displayed on DIC display panel, touch YES key on CRT monitor panel and displayed system will be selected for testing. See **Fig. 4**.
4. On non-CRT vehicles, depressing BI-LEVEL button on ECCP will exit diagnostics and return to normal IPC and ECCP operation.

NOTE: **To cancel a system selection and repeat the system selection process, depress the OFF button on the ECCP for non-CRT equipped vehicles or touch LEVL key on CRT monitor panel for CRT equipped vehicles.**

TEST TYPE SELECTION

1. After the diagnostic system has been selected, 6 test types are now made available for selection. The menu choices are: CLEAR CODES?, DATA?, INPUTS?, OUTPUTS?, OVERRIDE? and SNAPSHOT?. The Season Odometer/DIC display may be showing any one of these 6 test type choices. The Trip Odometer or DIC will display selected value as seen by computer. See **Fig. 6**-**Fig. 13** .
2. To advance the display, depress FAN DOWN button on the ECCP. When the desired test type is displayed, depress the FAN UP button on the ECCP.

NOTE: **To cancel a system selection and repeat the system selection process, depress the OFF button on the ECCP for non-CRT equipped vehicles or touch LEVL key on CRT monitor panel for CRT equipped vehicles. To exit diagnostics without clearing codes, depress the BI-LEV button on ECCP or touch RTN key on CRT monitor panel.**

The 6 test types are as follows:

CLEAR CODES

Selection of CLEAR CODES? will result in the message CODES CLEAR or CODES NOT CLEAR being displayed, indicating whether the codes were successfully cleared. This message appears for 3 seconds, indicating all stored trouble codes have been erased from that system's memory. After 3 seconds, the display will automatically return to the next test type available for testing. See **Fig. 6**-**Fig. 13** .

NOTE: **After trouble code has been cleared, test drive vehicle and recheck to ensure code did not reset.**

DATA

Data test displays component/system present specifications, which can be compared with specifications of a properly functioning system. Trip Odometer/DIC displays data value.

INPUTS

1. Input test displays the voltage level of the circuit being tested as HI of LO. Input test display is shown on Trip Odometer/DIC panel.
2. HI or LO refers to input terminal voltage for the particular circuit. The display also indicates if an input reading has changed since the test was selected. This feature permits technician to activate or deactivate any list device/circuit and then return to the display to see if voltage reading has changed.
3. If a voltage reading change occurs, an X will appear next to the HI/LO indicator; otherwise, a "O" will remain displayed indicating no change occurred. The X will only appear once per selected input. The HI/LO indicator will continue to change as the input changes.

OUTPUTS

Output test displays the voltage level of selected device/circuit as HI or LO. After 3 seconds, this level will cycle between HI and LO voltage. Output test display is shown in Trip Odometer/DIC panel.

OVERRIDE

Override test is represented as a percentage of the tested functions full range during its current operation. This percentage value will be displayed in the ECCP temperature display area. The display will alternate between the override percentage and ("-") and the normal operation value. This alternating display is a reminder that the tested function IS NOT currently being overridden.

Pressing the TEMP UP and TEMP DOWN buttons simultaneously on the ECCP begins the override function. Alternating display will stop, and show override value.

Pressing the TEMP UP button increases the value while pressing the TEMP DOWN button decreases the value. Normal program control can be resumed in 1 of following 3 ways:

1. Selection of another override will cancel current override.
2. Selection of another system (i.e. ECM, BCM) will cancel current override.
3. Overriding the value beyond either extreme (O or 99) will display"--" momentarily before resuming value. If the button is released while "--" is being displayed, normal program control will resume and the display will again alternate. The override test type is unique in that any other test type within the selected system may be active at the same time. After selecting an override test, pressing the OFF button will allow selection of another test type. The ECCP will continue to display the selected override. By pressing OFF and TEMP UP or TEMP DOWN buttons at the same time, it is possible to monitor effect of override on different parameter. Pressing the BI-LEV button will exit diagnostics without clearing codes.

SNAPSHOT

Snapshot is a test type that will record all BCM or ECM data and inputs at one instant for review at a later time. Snapshot also permits a technician-triggered recording of specific current BCM/ECM data and input parameters for review at a later time. BCM and ECM have slightly different types of snapshot.

NOTE: Proceed to SNAPSHOT after selecting snapshot test type.

EXPLANATION OF SPECIFIC TEST SELECTION

Following test type selection, first of many specific tests will be made available for selection; 4 characters of this display represent a test code. First 2 characters of test code are letters which identify system and test type selected. Study the following examples;

- If BCM system and DATA test type were selected, BD will be the first characters of display. BD stands for BCM DATA. The last 2 characters numerically identify specific test selection. For example: BD51 designates BCM DATA, test 51.
- If ECM system and Data test type were selected, ED will be the first 2 characters of display. ED stands for ECM DATA. The numerals following these 2 characters will represent the particular specific test

selection.

- When BI appears as the first 2 characters of test code, this signifies BCM system and INPUT test type were selected. The last 2 characters numerically identify the specific test selection. For example: BI51 designates BCM INPUT, test 51.

SPECIFIC TEST SELECTION

1. On non-CRT equipped vehicles, scrolling to a lower specific test number is done by depressing the FAN DOWN button. Scrolling to a higher specific test number is done by depressing the FAN UP button. The system will automatically display the values for whatever specific test number is displayed.
2. On CRT monitor equipped vehicles, scrolling to a lower specific test number is done by touching NO key on CRT monitor control panel. Scrolling to a higher specific test number is done by touching YES key. The system will automatically display the values for whatever specific test number is displayed.

NOTE: To cancel a system selection and repeat the system selection process, depress the OFF button on the ECCP for non-CRT equipped vehicles or touch LEVL key on CRT monitor panel for CRT equipped vehicles.

SNAPSHOT

NOTE: If directed here from TEST TYPE SELECTION, go to step 2) of either BCM SNAPSHOT or ECM SNAPSHOT.

BCM Snapshot

1. SNAPSHOT allows recall of system operating specifications present at exact time a BCM malfunction code was set. Up to 3 snapshots may be recalled. In addition, one snapshot may be triggered on demand by depressing FAN UP button (ECCP equipped) or touching YES key (CRT equipped) when TAKE BCM SNAPSHOT? is displayed. To enter snapshot:
   - Enter self-diagnostics. See **ENTERING SELF-DIAGNOSTICS**.
   - Display trouble codes stored in memory. See **DISPLAYING TROUBLE CODES**.
   - Select BCM system for testing. See **SYSTEM SELECTION**.
   - Select SNAPSHOT test type. See **TEST TYPE SELECTION**.

   NOTE: To cancel a system selection and repeat the system selection process, depress the OFF button on the ECCP for non-CRT equipped vehicles or touch LEVL key on CRT monitor panel for CRT equipped vehicles.

2. Immediately following selection of SNAPSHOT, system will display BXXX SNAPSHOT. B stands for BCM. XXX represents 3-digit trouble code stored in BCM snapshot. See **Fig. 8**, **Fig. 9**, **Fig. 12** and **Fig. 13** .
3. With BXXX displayed, depress FAN DOWN button (ECCP equipped) or touch NO key (CRT equipped) to scroll through list of BCM diagnostic codes for which BCM has stored a snapshot. See **DISPLAYING TROUBLE CODES** for list of BCM trouble codes which may be present in snapshot.

NOTE: **A trouble code displayed during trouble code display cycle may not be present as a snapshot trouble code. In this case, exit SNAPSHOT by depressing OFF button (ECCP equipped) or touching LEVL key (CRT equipped). This will return display to next available system selection.**

4. After display of last BCM trouble code for which a snapshot exists, pressing FAN DOWN button (ECCP equipped) or touching NO key (CRT equipped) will result in TAKE BCM SNAPSHOT? display. Responding to this display by depressing FAN DOWN button (ECCP equipped) or touching NO key (CRT equipped) will return display to first BXXX SNAP? display.
5. Responding to TAKE BCM SNAPSHOT? display by depressing FAN UP button (ECCP equipped) or touching YES key (CRT equipped) with SNAP DATA? or SNAP INPUTS? displayed will select that test type for display.
6. Display is now controlled as it would be for non-snapshot data and inputs display; however, all values and status information represents memorized vehicle conditions. See **SPECIFIC TEST SELECTION**.
7. Depressing FAN UP key (ECCP equipped) or touching YES key (CRT equipped) again with TAKE BCM SNAPSHOT? displayed will change DIC to display SNAP TAKEN message to indicate new information has been stored in memory.

ECM Snapshot

1. ECM snapshot is slightly different from BCM snapshot because snapshot must be manually taken and then data and inputs can be reviewed. No previously stored information is recalled as in BCM snapshot. To enter ECM snapshot:
   - Enter self-diagnostics. See **ENTERING SELF-DIAGNOSTICS**.
   - Display trouble codes stored in memory. See **DISPLAYING TROUBLE CODES**.
   - Select ECM system for testing. See **SYSTEM SELECTION**.
   - Select SNAPSHOT test type. See **TEST TYPE SELECTION**.

   NOTE: **To cancel a system selection and repeat the system selection process, depress the OFF button on the ECCP for non-CRT equipped vehicles or touch LEVL key on CRT monitor panel for CRT equipped vehicles.**

2. Immediately following selection of SNAPSHOT, system will display message SNAPSHOT TAKEN. See **Fig. 7** and **Fig. 11** . Message appears for 3 seconds to indicate all ECM data and inputs have been stored in memory. Following this 3-second information storage verification period, display will automatically proceed to first available snapshot test type (i.e., E SNAP DATA or E SNAP INPUTS).
3. At this point, depressing FAN DOWN button (ECCP equipped) or touching NO key (CRT equipped) will display next available snapshot test type. Display may be toggled between E SNAP DATA and E SNAP INPUTS.
4. Depressing FAN UP button (ECCP equipped) or touching YES key (CRT equipped) with E SNAP DATA or E SNAP INPUTS displayed will select that particular test type. Display is now controlled as it would be for non-snapshot data and inputs displays; however, all values and status information represents memorized vehicle conditions. See **SPECIFIC TEST SELECTION**.
5. Depressing FAN UP button (ECCP equipped) or touching YES key (CRT equipped) with ECM

SNAPSHOT? displayed will again display SNAPSHOT TAKEN message to indicate new information has been stored in memory. This information can be accessed as previously described.

STATUS LIGHT INDICATORS

During self-diagnostics, the status light display on ECCP is used to indicate switchable parameter status. Each different mode of operation is indicated by its status light being turned on or off. Status light indicators are relative to system level being tested (ECM or BCM). See **Fig. 7** and **Fig. 9** .

ECM

The following are brief summaries of ECM status light indicators. See **Fig. 7**.

HIGH

Indicator light will be on when ECM is in closed loop fuel control. Light comes on only after coolant and O2 sensors reach operating temperature.

MED

Indicator light only indicates whether Torque Converter Clutch (TCC) is enabled (on) or disabled (off) by ECM. Actual TCC engagement depends on TCC system being in working order.

LOW

Indicator light stays on when oxygen sensor signals rich exhaust condition to ECM. Light will flash on and off during warm engine, steady throttle, and proper fuel mix condition.

OFF or VENT

Indicator light will be on when ECM commands 4th gear. Light should only be on in 4th gear.

Left-Side AUTO

Indicator light will be on when ECM commands 3rd gear. Light should only be on in 3rd or 4th gear.

°C

Indicator light will be on when ECM commands 2nd gear. Light should only be on in 2nd, 3rd or 4th gear.

Upper Arrow (Icon)

A/C compressor command upper arrow indicator light will be on only when ECM allows A/C clutch engagement through A/C relay. Light will also be on if BCM requests ECM to turn clutch on during test sequence. Light should be off if ECM commands disengagement. See **Fig. 7**.

BCM

The following are brief summaries of BCM system status light indicators. See **Fig. 9**.

Lower Arrow (Icon)

Indicator light will be on if BCM senses low refrigerant pressure switch is open. Light will remain off if A/C system is fully charged and operational; however, light will come on when outside vehicle ambient temperature is less than -5°F (-21°C). This is due to the temperature-pressure relationship of R-12 refrigerant. See **Fig. 9**.

OFF or VENT

Indicator light will be on when BCM commands air recirculation.

MED

Indicator light will be on when BCM commands airflow out the A/C vents. Light should also be on in A/C and BI-LEV modes.

LOW

Indicator light will be on when BCM commands airflow out defroster outlets or when in defrost and A/C modes.

HIGH

Indicator light will be on when BCM commands airflow out floor outlets. Light should be on in heater mode.

Left-Side AUTO

Indicator light will be on when BCM requests ECM to engage A/C compressor clutch.

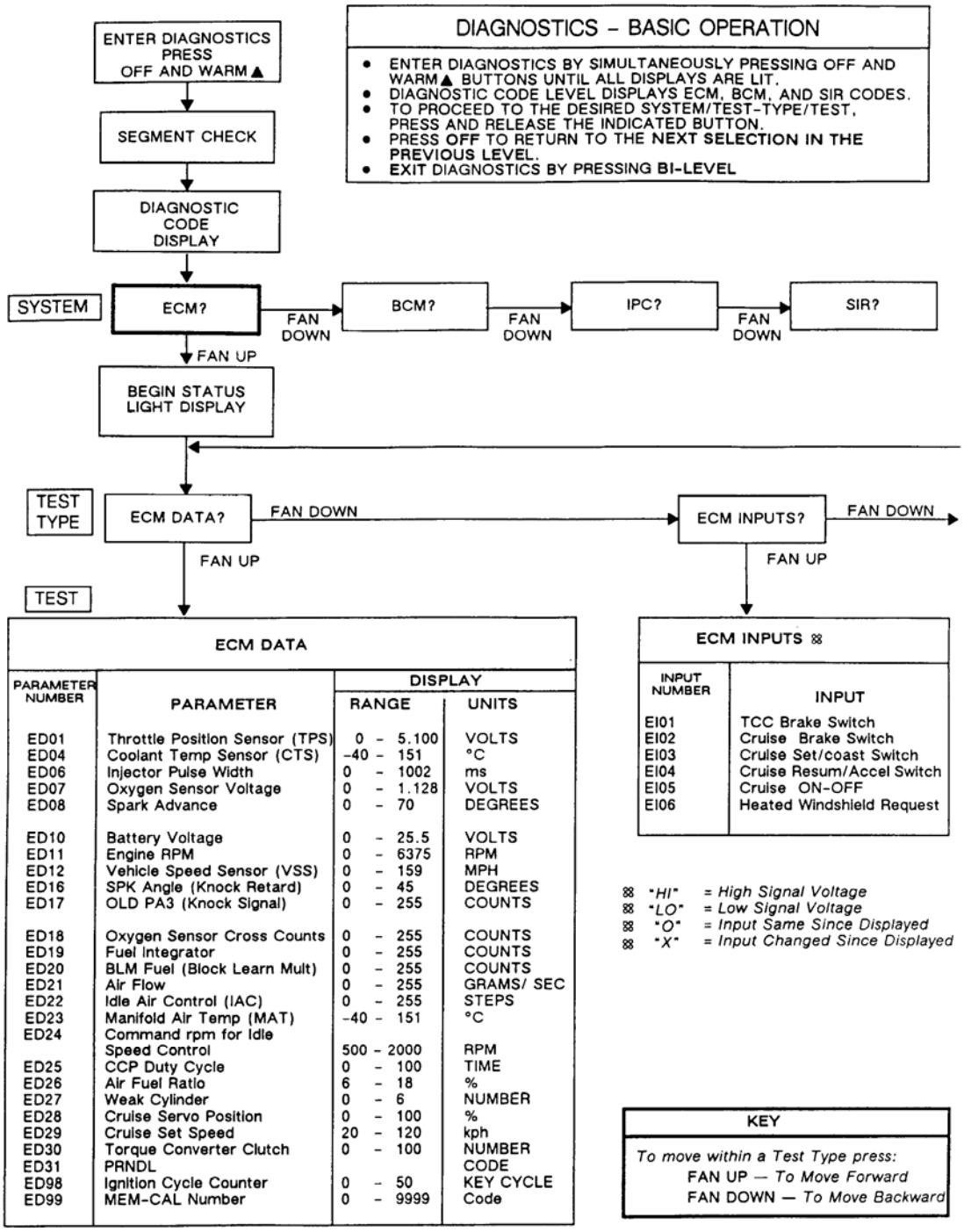


Fig. 6: ECM (PCM) System Diag. Flow Chart (All W/O CRT) (1 of 2)
Courtesy of GENERAL MOTORS CORP.

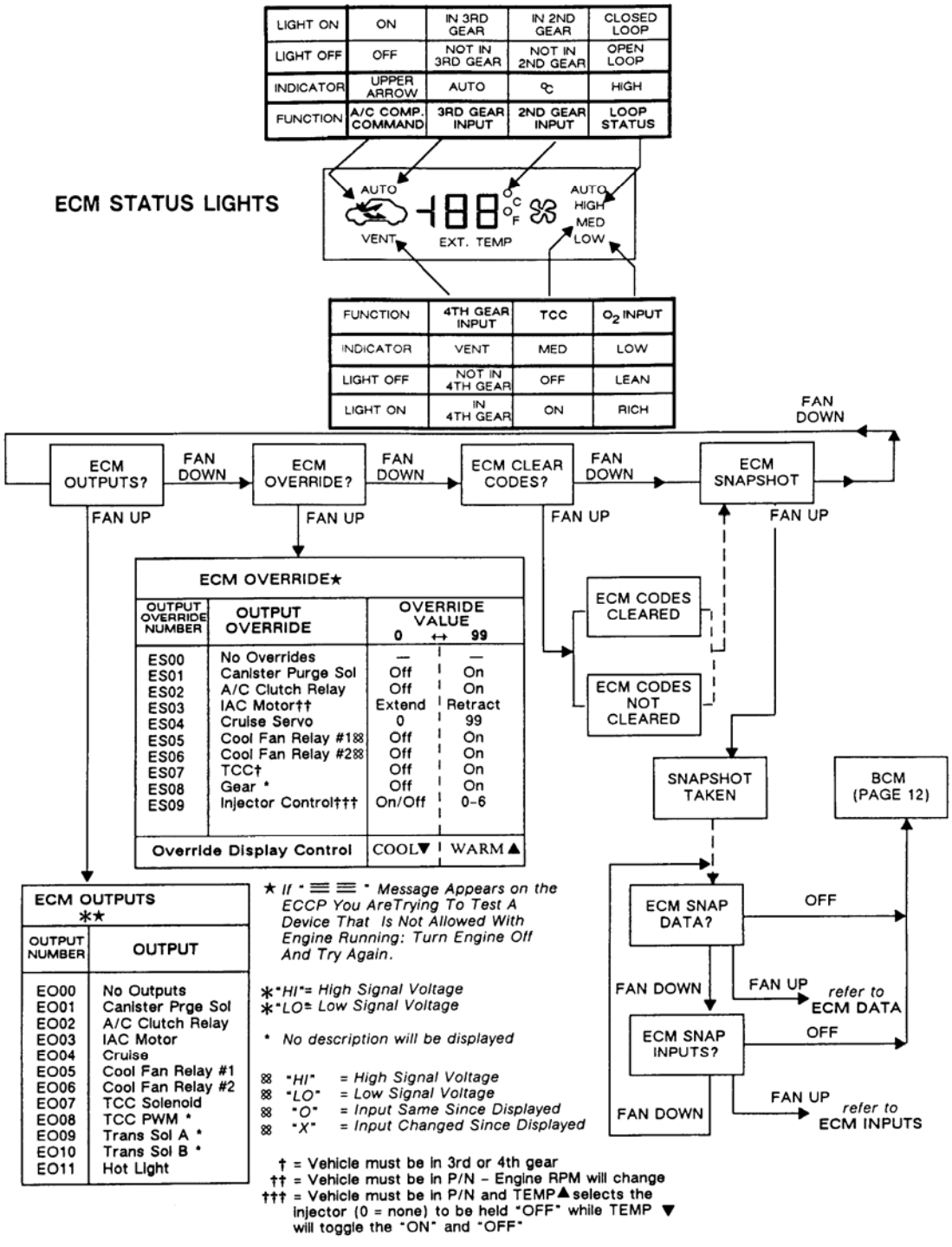


Fig. 7: ECM (PCM) System Diag. Flow Chart (All W/O CRT) (2 of 2)
Courtesy of GENERAL MOTORS CORP.

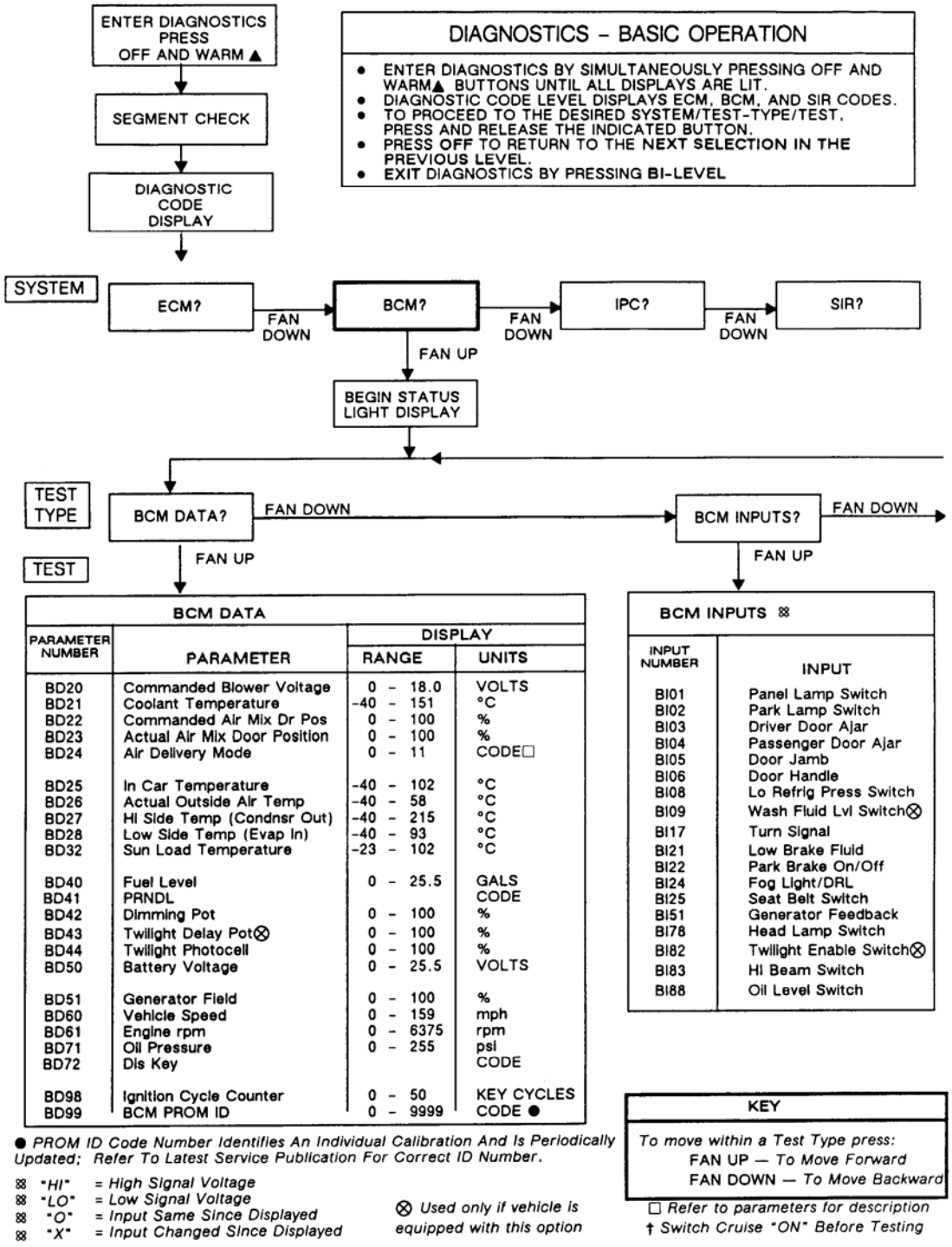


Fig. 8: BCM System Diag. Flow Chart (All W/O CRT) (1 of 2)
Courtesy of GENERAL MOTORS CORP.

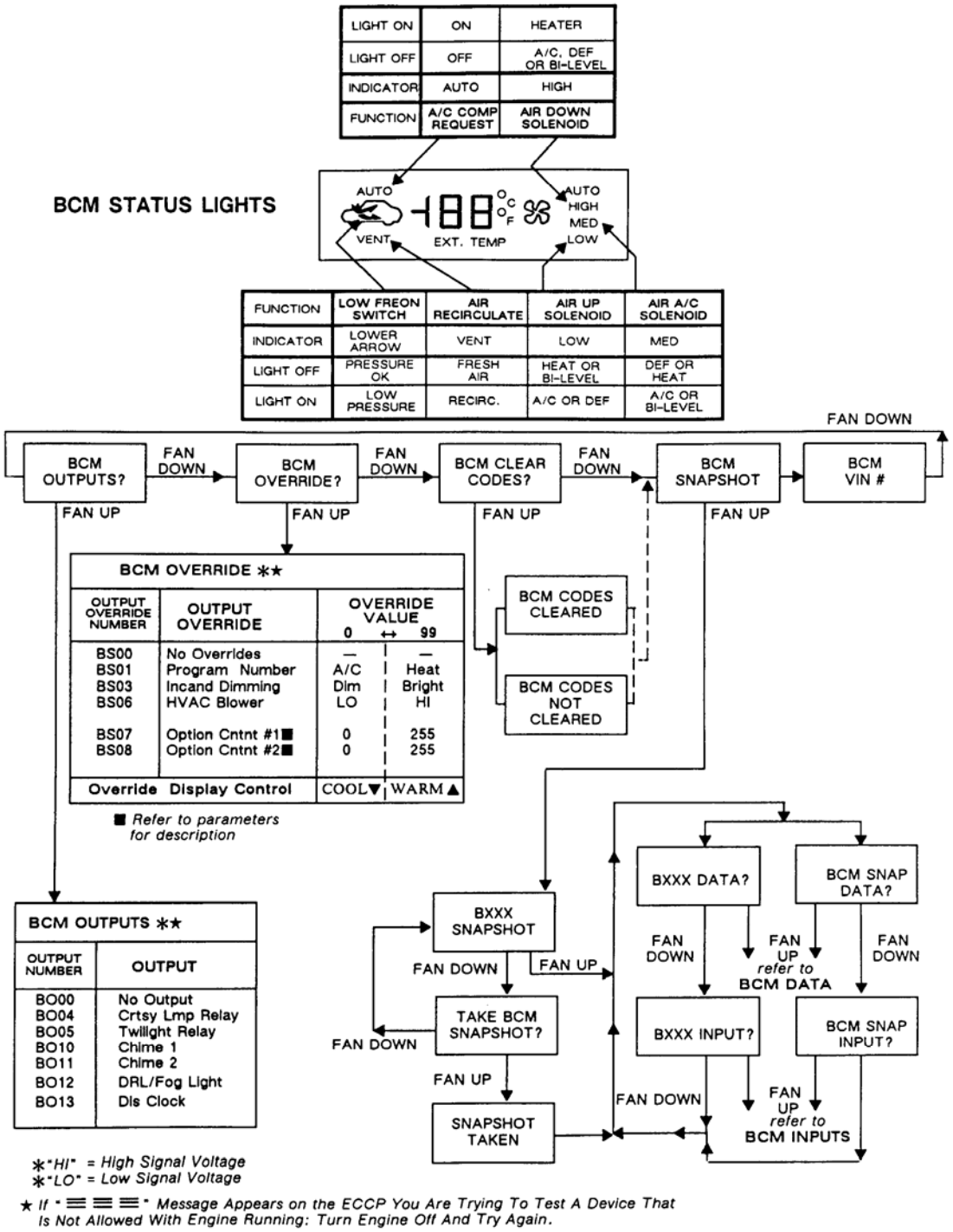


Fig. 9: BCM System Diag. Flow Chart (All W/O CRT) (2 of 2)
Courtesy of GENERAL MOTORS CORP.

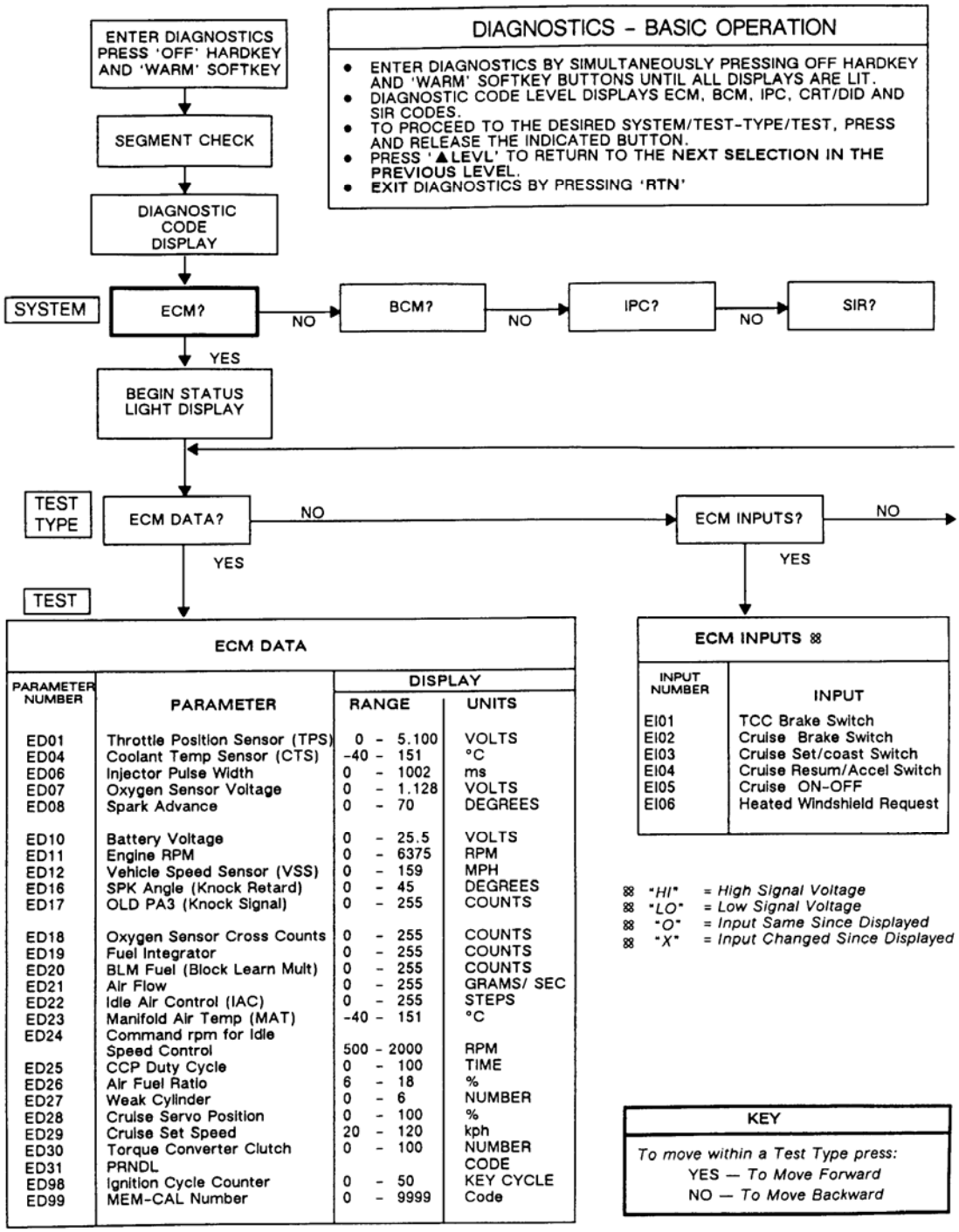


Fig. 10: ECM (PCM) System Diag. Flow Chart (All W/CRT) (1 of 2)
Courtesy of GENERAL MOTORS CORP.

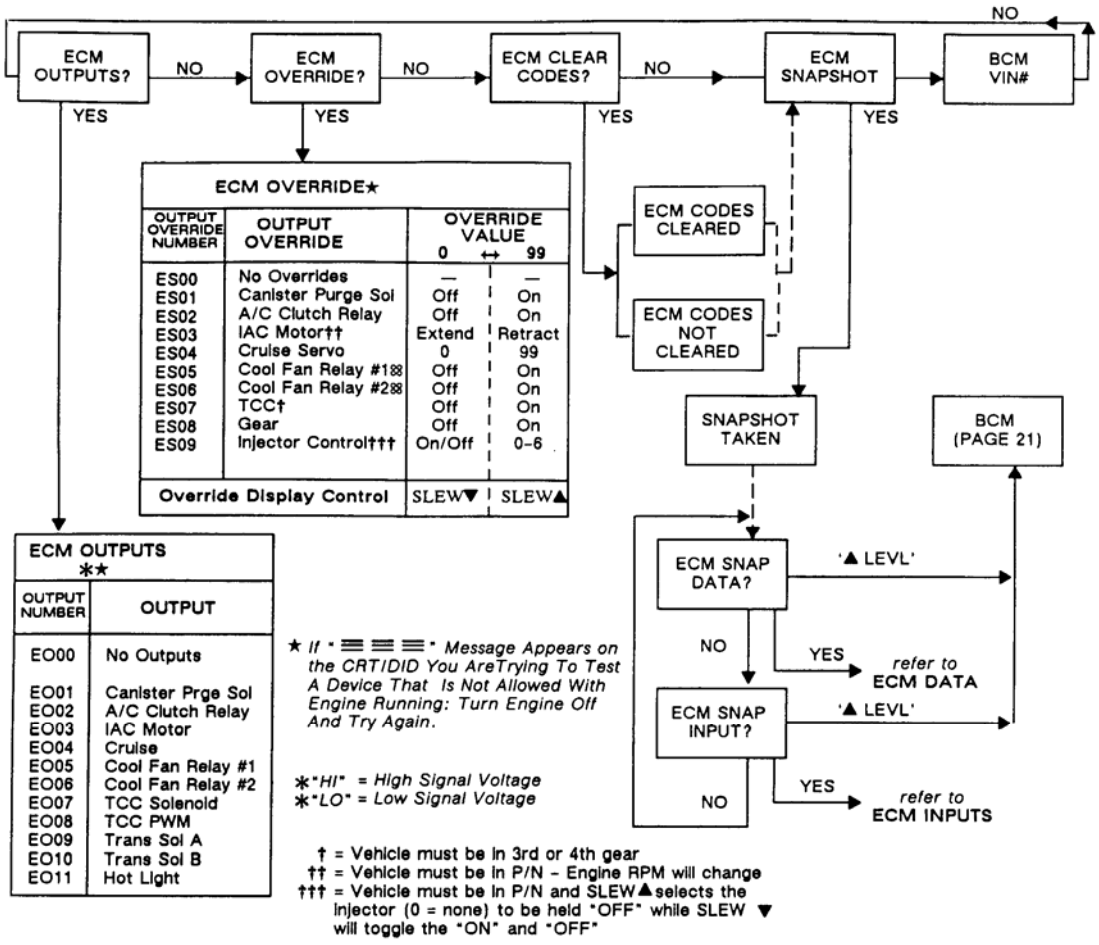


Fig. 11: ECM (PCM) System Diag. Flow Chart (All W/CRT) (2 of 2)
Courtesy of GENERAL MOTORS CORP.

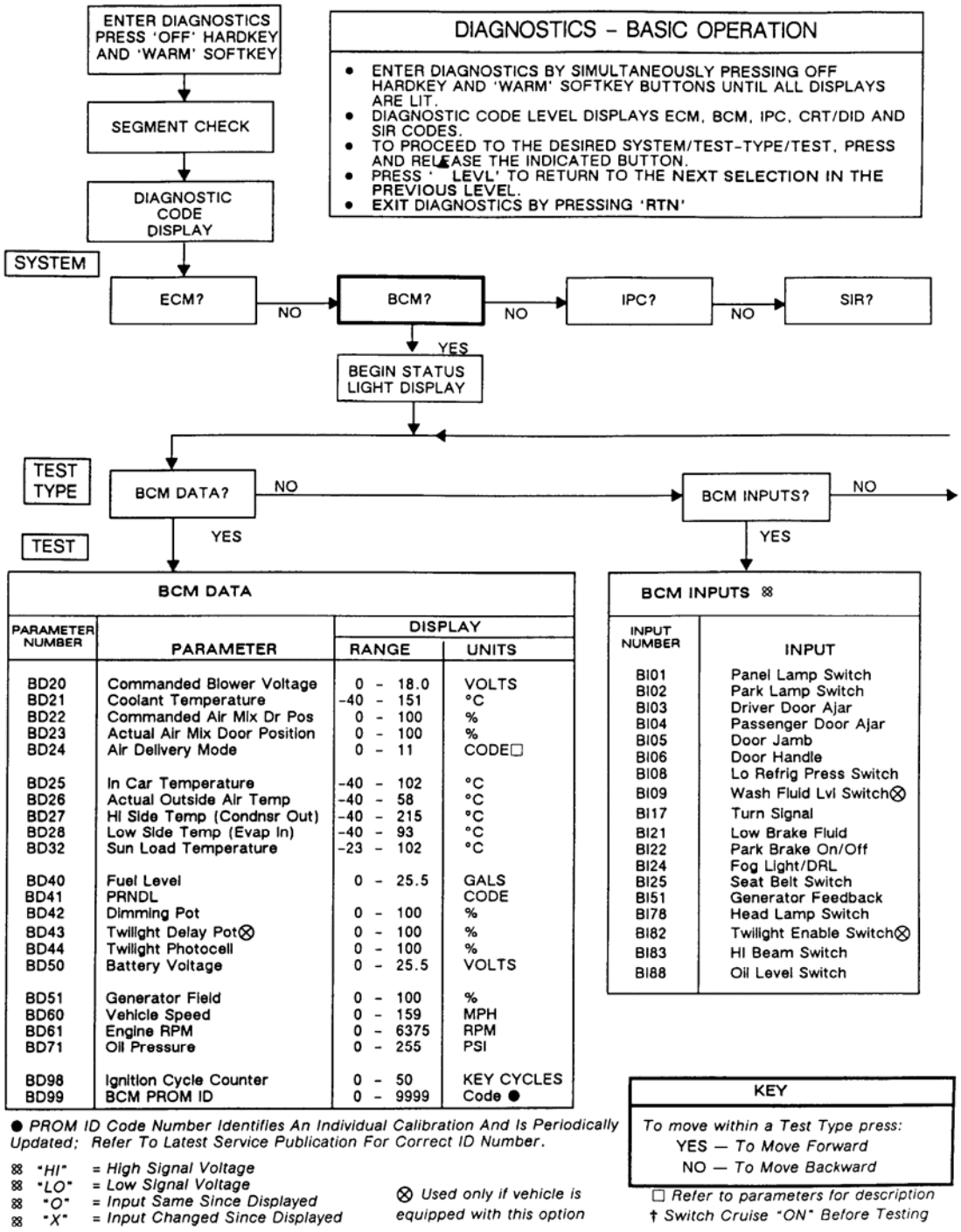


Fig. 12: BCM System Diag. Flow Chart (All W/CRT) (1 of 2)
Courtesy of GENERAL MOTORS CORP.

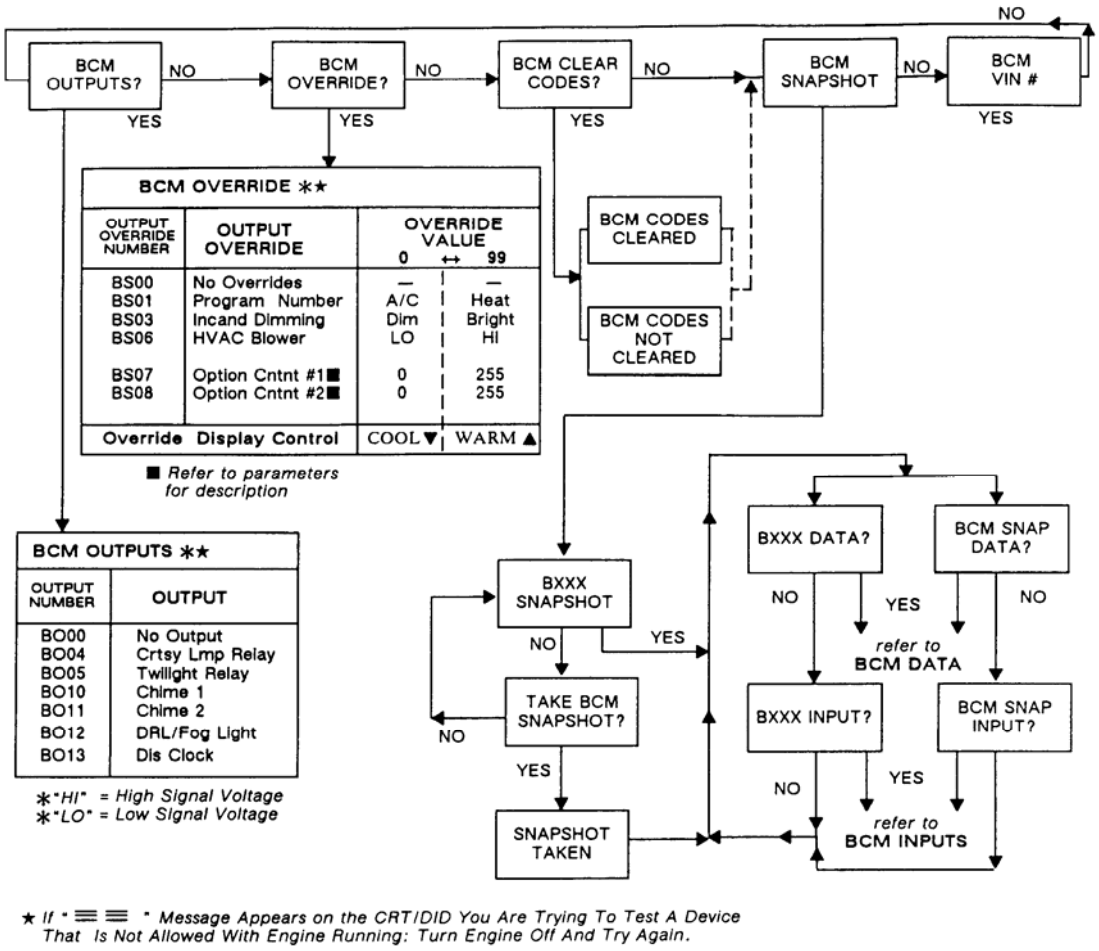


Fig. 13: BCM System Diag. Flow Chart (All W/CRT) (2 of 2)
Courtesy of GENERAL MOTORS CORP.

SERVICE BULLETINS

TCC LOCK-UP PROBLEMS

NOTE: The following test procedures (part of ATRA TSB 046) apply to all GM lock-up transmissions. Tests address the problems of no lock-up and no lock-up release.

NO LOCK-UP CONDITION

1. Does TCC release with brake switch? If yes, go to step 3). If no, check brake switch. See **BRAKE SWITCH TEST**. If brake switch is okay, check TCC apply solenoid. See **TCC APPLY SOLENOID TEST**. If solenoid is okay, check for stuck lock-up apply valve or lock-up apply valve installed backward. Repair as necessary and retest.
2. If apply valve is okay, block lock-up apply valve in unlocked position. If TCC still does not release,

problem is located in torque converter or oil pump. If lock-up does not occur, check appropriate signal oil circuit.

3. If TCC released in step 1), check for short to ground at terminal "D" wire of ALDL connector. See **Fig. 2**. If short is found, check apply solenoid. See **TCC APPLY SOLENOID TEST**. If short is not found, check for computer system problem. See CHECKING SELF-DIAGNOSTIC SYSTEM.

BRAKE SWITCH TEST

1. Ensure fuse marked "gauges" is okay (most models). Check for 12 volts at both sides of brake switch(es). Some GM vehicles have 2 electric switches at brake pedal. One switch will have 4 wires and the other switch will have 2 wires and a vacuum hose.

NOTE: Either of these switches can be used for lock-up. To avoid misdiagnosis, check both switches. If upper switch with vacuum hose is used, check 2 wires at that switch. On 4-wire lower switch, check 2 wires farthest from plunger.

2. Ground test light. **DO NOT** depress brake pedal. Turn ignition on. Check wires for voltage. Voltage should be present at both wires. Depress brake pedal and retest. Only one wire should have voltage.
3. If brake switch did not pass previous test, remove brake switch and repeat step 2), pushing and releasing brake switch plunger. If brake switch fails test, replace switch. If brake switch is okay, adjust switch as necessary.

CHECKING SELF-DIAGNOSTIC SYSTEM

Checking self-diagnostic system for trouble codes can help in diagnosing lock-up and/or no lock-up conditions. For testing procedures, see appropriate TESTING & DIAGNOSIS section.

TCC APPLY SOLENOID TEST

1. An analog ohmmeter and a 12 volt source will be needed to perform this test. Connect black lead of ohmmeter to Red wire on solenoid. Connect Red lead of ohmmeter to Black wire on solenoid. If solenoid is a one-wire solenoid, connect Red lead of ohmmeter to solenoid body.
2. With ohmmeter set at ohms times one, reading should be greater than 20 ohms but not infinite. Connect Red lead of ohmmeter to Red wire of solenoid, and Black lead to black wire or body of solenoid. Ohmmeter reading should be less than previous reading.
3. Connect a 12 volt source to solenoid. With very low pressure, try to blow through solenoid. Solenoid should be sealed. Disconnect 12 volt source. You should now be able to blow through solenoid. If solenoid does not test as described, replace solenoid.

NO TCC RELEASE CONDITION

1. Check for 12 volts to terminal "A" at transmission. See CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION. If voltage is present, go to step 3). If voltage is not present, ensure fuse marked "gauges" is okay (most models). If fuse is okay, go to next step. If only one side of fuse has voltage, replace fuse and check for shorts. If voltage is not found at fuse, check wire from fuse to ignition switch.

Repair as necessary and retest.

2. If fuse was okay in previous step, check brake switch. See **BRAKE SWITCH TEST**. If brake switch is okay, check for open circuit in wire from terminal "A" to brake switch.
3. If voltage was present to terminal "A" of transmission, check for ground at terminal "D" at transmission. See CHECKING FOR GROUND AT TERMINAL "D" AT TRANSMISSION. Ground terminal "D" at transmission. See **GROUNDING "D" WIRE AT TRANSMISSION USING ALDL**. If lock-up occurs, computer system problem exists. See CHECKING SELF-DIAGNOSTIC SYSTEM. If lock-up does not occur, check cooler line pressure. See **COOLER LINE PRESSURE TEST**.
4. If cooler line pressure is okay, internal problem exists in transmission. If cooler line pressure is not okay, check apply solenoid and electrical switches. See **TCC APPLY SOLENOID TEST** and **ELECTRICAL SWITCHES TEST**. Repair as necessary. Check for stuck lock-up apply valve or apply valve installed backward. If all components are okay, check appropriate signal oil circuit and repair as necessary. Retest for lock-up.

CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION USING ALDL

Connect one end of test light to terminal "A" at ALDL. See **Fig. 2**. Connect other end to terminal "F" at ALDL. Turn ignition on. Test light should light. Some transmissions must be in 3rd gear before test light will light. If test light does not light, see CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION. If test light lights, 12 volts are present at terminal "A" at transmission. See CHECKING FOR GROUND AT TERMINAL "D" AT TRANSMISSION USING ALDL.

CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION

1. Check for 12 volts to terminal "A" at transmission. See **WIRING DIAGRAMS**. Raise and support vehicle. Ground test light. Unplug connector at transmission case and install tip of test light into terminal "A". **DO NOT** depress brake pedal. On computer-controlled vehicles, turn ignition on. Test light should light.
2. On all other vehicles, start engine and run to normal operating temperature. Raise engine speed to 1500 RPM. Test light should light. If test light lights, see CHECKING FOR GROUND AT TERMINAL "D" AT TRANSMISSION. If test light does not light, ensure fuse marked "gauges" is okay (most models).

CHECKING FOR GROUND AT TERMINAL "D" AT TRANS. USING ALDL

1. Before performing this test, CHECKING VOLTAGE TO TERMINAL "A" OF TRANSMISSION USING ALDL test must pass. Otherwise, see CHECKING FOR GROUND AT TERMINAL "D" AT TRANSMISSION. Test light should be connected between terminals "A" and "F" at ALDL connector. See **Fig. 2** With engine at normal operating temperature, road test vehicle. When road test is started, test light should light.
2. If brake pedal is applied, test light will not light. Watch test light to see if test light goes out during road test. If test light goes out, terminal "D" is grounded at transmission. See **GROUNDING "D" WIRE AT TRANSMISSION USING ALDL**. If test light does not go out, a computer system problem exists. See CHECKING SELF-DIAGNOSTIC SYSTEM.

CHECKING FOR GROUND AT TERMINAL "D" AT TRANSMISSION

1. Check for ground at terminal "D" at transmission. See **WIRING DIAGRAMS**. On non-computer controlled vehicles, see COOLER LINE PRESSURE TEST. On all other vehicles, raise and support vehicle (if necessary). Disconnect transmission electrical connector and connect test light ground wire to terminal "A" of transmission connector. Install tip of test light into terminal "D" of transmission connector.
2. Start engine and run to normal operating temperature. Place gear selector in Drive (O.D. on 4 speed transmissions). Accelerate slowly to 60 MPH. Test light should light. If test light does not light, computer system problem exists. Shave insulation off of wire "D", or pierce wire near transmission connector.
3. Connect one end of jumper wire to wire "D" at shaved or pierced area. Ground other end of jumper wire. With vehicle on lift, road test for lock-up. If unsure lock-up occurred, hold steady speed of 60 MPH and slightly touch and release brake pedal. Disengagement and re-engagement should be felt. Seal bare wire connection with silicon after test is complete (if necessary).

COOLER LINE PRESSURE TEST

Check cooler line pressure or surge. Disconnect a transmission cooler line from radiator. Attach a hose to disconnected line. Insert other end of hose in fill tube of transmission. With drive wheels off ground, start engine. Grip hose firmly. Have a helper place gear selector in Drive and slowly accelerate to 60 MPH. When lock-up valve moves, hose should jump slightly.

ELECTRICAL SWITCHES TEST

NOTE: If CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION USING ALDL test passed, electrical switches are not causing a no lock-up condition. Check lock-up apply valve.

Single Terminal Switch (8642473) & 2 Terminal Switch

(8643710) - (Normally Open)

On single-terminal switch, connect one ohmmeter lead to switch terminal and other lead to body of switch. On 2-terminal switch, connect one lead to one terminal and other lead to other terminal. Ohmmeter should read infinite. Apply 60 psi of air to switch. Ohmmeter should read zero.

Single Terminal Switch (8642569 & 8634475) & 2 Terminal

Switch (8642346) (Normally Closed)

On single-terminal switch, connect one ohmmeter lead to switch terminal and other lead to body of switch. On 2 terminal switch, connect one lead to one terminal and other lead to other terminal. Ohmmeter should read zero. Apply 60 psi of air to switch. Ohmmeter should read infinite.

GROUNDING "D" WIRE AT TRANSMISSION USING ALDL

Before performing this test, CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION USING ALDL test must pass. Connect one end of test light or jumper wire to terminal "A" at ALDL connector. See **Fig. 2**. Road test vehicle. Vehicle can be tested on lift. At approximately 35 MPH, connect other end of test light or

jumper wire to terminal "F" at ALDL connector. Torque converter should lock up. Proceed to **COOLER LINE PRESSURE TEST**.

SERVICE BULLETINS

TCC LOCK-UP PROBLEMS

NOTE: The following test procedures (part of ATRA TSB 046) apply to all GM lock-up transmissions. Tests address the problems of no lock-up and no lock-up release.

NO LOCK-UP CONDITION

1. Does TCC release with brake switch? If yes, go to step 3). If no, check brake switch. See **BRAKE SWITCH TEST**. If brake switch is okay, check TCC apply solenoid. See **TCC APPLY SOLENOID TEST**. If solenoid is okay, check for stuck lock-up apply valve or lock-up apply valve installed backward. Repair as necessary and retest.
2. If apply valve is okay, block lock-up apply valve in unlocked position. If TCC still does not release, problem is located in torque converter or oil pump. If lock-up does not occur, check appropriate signal oil circuit.
3. If TCC released in step 1), check for short to ground at terminal "D" wire of ALDL connector. See **Fig. 2**. If short is found, check apply solenoid. See **TCC APPLY SOLENOID TEST**. If short is not found, check for computer system problem. See CHECKING SELF-DIAGNOSTIC SYSTEM.

BRAKE SWITCH TEST

1. Ensure fuse marked "gauges" is okay (most models). Check for 12 volts at both sides of brake switch(es). Some GM vehicles have 2 electric switches at brake pedal. One switch will have 4 wires and the other switch will have 2 wires and a vacuum hose.

NOTE: Either of these switches can be used for lock-up. To avoid misdiagnosis, check both switches. If upper switch with vacuum hose is used, check 2 wires at that switch. On 4-wire lower switch, check 2 wires farthest from plunger.

2. Ground test light. **DO NOT** depress brake pedal. Turn ignition on. Check wires for voltage. Voltage should be present at both wires. Depress brake pedal and retest. Only one wire should have voltage.
3. If brake switch did not pass previous test, remove brake switch and repeat step 2), pushing and releasing brake switch plunger. If brake switch fails test, replace switch. If brake switch is okay, adjust switch as necessary.

CHECKING SELF-DIAGNOSTIC SYSTEM

Checking self-diagnostic system for trouble codes can help in diagnosing lock-up and/or no lock-up conditions. For testing procedures, see appropriate TESTING & DIAGNOSIS section.

TCC APPLY SOLENOID TEST

1. An analog ohmmeter and a 12 volt source will be needed to perform this test. Connect black lead of

ohmmeter to Red wire on solenoid. Connect Red lead of ohmmeter to Black wire on solenoid. If solenoid is a one-wire solenoid, connect Red lead of ohmmeter to solenoid body.

2. With ohmmeter set at ohms times one, reading should be greater than 20 ohms but not infinite. Connect Red lead of ohmmeter to Red wire of solenoid, and Black lead to black wire or body of solenoid. Ohmmeter reading should be less than previous reading.
3. Connect a 12 volt source to solenoid. With very low pressure, try to blow through solenoid. Solenoid should be sealed. Disconnect 12 volt source. You should now be able to blow through solenoid. If solenoid does not test as described, replace solenoid.

NO TCC RELEASE CONDITION

1. Check for 12 volts to terminal "A" at transmission. See CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION. If voltage is present, go to step 3). If voltage is not present, ensure fuse marked "gauges" is okay (most models). If fuse is okay, go to next step. If only one side of fuse has voltage, replace fuse and check for shorts. If voltage is not found at fuse, check wire from fuse to ignition switch. Repair as necessary and retest.
2. If fuse was okay in previous step, check brake switch. See **BRAKE SWITCH TEST**. If brake switch is okay, check for open circuit in wire from terminal "A" to brake switch.
3. If voltage was present to terminal "A" of transmission, check for ground at terminal "D" at transmission. See CHECKING FOR GROUND AT TERMINAL "D" AT TRANSMISSION. Ground terminal "D" at transmission. See **GROUNDING "D" WIRE AT TRANSMISSION USING ALDL**. If lock-up occurs, computer system problem exists. See CHECKING SELF-DIAGNOSTIC SYSTEM. If lock-up does not occur, check cooler line pressure. See **COOLER LINE PRESSURE TEST**.
4. If cooler line pressure is okay, internal problem exists in transmission. If cooler line pressure is not okay, check apply solenoid and electrical switches. See **TCC APPLY SOLENOID TEST** and **ELECTRICAL SWITCHES TEST**. Repair as necessary. Check for stuck lock-up apply valve or apply valve installed backward. If all components are okay, check appropriate signal oil circuit and repair as necessary. Retest for lock-up.

CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION USING ALDL

Connect one end of test light to terminal "A" at ALDL. See **Fig. 2**. Connect other end to terminal "F" at ALDL. Turn ignition on. Test light should light. Some transmissions must be in 3rd gear before test light will light. If test light does not light, see CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION. If test light lights, 12 volts are present at terminal "A" at transmission. See CHECKING FOR GROUND AT TERMINAL "D" AT TRANSMISSION USING ALDL.

CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION

1. Check for 12 volts to terminal "A" at transmission. See **WIRING DIAGRAMS**. Raise and support vehicle. Ground test light. Unplug connector at transmission case and install tip of test light into terminal "A". **DO NOT** depress brake pedal. On computer-controlled vehicles, turn ignition on. Test light should light.
2. On all other vehicles, start engine and run to normal operating temperature. Raise engine speed to 1500 RPM. Test light should light. If test light lights, see CHECKING FOR GROUND AT TERMINAL "D" AT TRANSMISSION. If test light does not light, ensure fuse marked "gauges" is okay (most models).

CHECKING FOR GROUND AT TERMINAL "D" AT TRANS. USING ALDL

1. Before performing this test, CHECKING VOLTAGE TO TERMINAL "A" OF TRANSMISSION USING ALDL test must pass. Otherwise, see CHECKING FOR GROUND AT TERMINAL "D" AT TRANSMISSION. Test light should be connected between terminals "A" and "F" at ALDL connector. See **Fig. 2** With engine at normal operating temperature, road test vehicle. When road test is started, test light should light.
2. If brake pedal is applied, test light will not light. Watch test light to see if test light goes out during road test. If test light goes out, terminal "D" is grounded at transmission. See **GROUNDING "D" WIRE AT TRANSMISSION USING ALDL**. If test light does not go out, a computer system problem exists. See CHECKING SELF-DIAGNOSTIC SYSTEM.

CHECKING FOR GROUND AT TERMINAL "D" AT TRANSMISSION

1. Check for ground at terminal "D" at transmission. See **WIRING DIAGRAMS**. On non-computer controlled vehicles, see COOLER LINE PRESSURE TEST. On all other vehicles, raise and support vehicle (if necessary). Disconnect transmission electrical connector and connect test light ground wire to terminal "A" of transmission connector. Install tip of test light into terminal "D" of transmission connector.
2. Start engine and run to normal operating temperature. Place gear selector in Drive (O.D. on 4 speed transmissions). Accelerate slowly to 60 MPH. Test light should light. If test light does not light, computer system problem exists. Shave insulation off of wire "D", or pierce wire near transmission connector.
3. Connect one end of jumper wire to wire "D" at shaved or pierced area. Ground other end of jumper wire. With vehicle on lift, road test for lock-up. If unsure lock-up occurred, hold steady speed of 60 MPH and slightly touch and release brake pedal. Disengagement and re-engagement should be felt. Seal bare wire connection with silicon after test is complete (if necessary).

COOLER LINE PRESSURE TEST

Check cooler line pressure or surge. Disconnect a transmission cooler line from radiator. Attach a hose to disconnected line. Insert other end of hose in fill tube of transmission. With drive wheels off ground, start engine. Grip hose firmly. Have a helper place gear selector in Drive and slowly accelerate to 60 MPH. When lock-up valve moves, hose should jump slightly.

ELECTRICAL SWITCHES TEST

NOTE: If CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION USING ALDL test passed, electrical switches are not causing a no lock-up condition. Check lock-up apply valve.

Single Terminal Switch (8642473) & 2 Terminal Switch

(8643710) - (Normally Open)

On single-terminal switch, connect one ohmmeter lead to switch terminal and other lead to body of switch. On 2-terminal switch, connect one lead to one terminal and other lead to other terminal. Ohmmeter should read infinite. Apply 60 psi of air to switch. Ohmmeter should read zero.

Single Terminal Switch (8642569 & 8634475) & 2 Terminal

Switch (8642346) (Normally Closed)

On single-terminal switch, connect one ohmmeter lead to switch terminal and other lead to body of switch. On 2 terminal switch, connect one lead to one terminal and other lead to other terminal. Ohmmeter should read zero. Apply 60 psi of air to switch. Ohmmeter should read infinite.

GROUNDING "D" WIRE AT TRANSMISSION USING ALDL

Before performing this test, CHECKING VOLTAGE TO TERMINAL "A" AT TRANSMISSION USING ALDL test must pass. Connect one end of test light or jumper wire to terminal "A" at ALDL connector. See **Fig. 2**. Road test vehicle. Vehicle can be tested on lift. At approximately 35 MPH, connect other end of test light or jumper wire to terminal "F" at ALDL connector. Torque converter should lock up. Proceed to **COOLER LINE PRESSURE TEST**.

DIAGNOSTIC FLOW CHARTS (CARS)

SELF-DIAGNOSTIC SYSTEM CHECK REATTA & RIVIERA

The self-diagnostic system check is an organized approach for identifying a problem caused by on-vehicle computer controlled electronics. Understanding this chart and using it correctly will reduce diagnostic time, prevent unnecessary replacement of parts, and reduce comebacks. To review the basic information on how to use the computer self-diagnostics, go to beginning of this article.

Always Start Electrical Or Electronic Diagnosis Here

1. SERVICE ENGINE SOON telltale light at key ON confirms battery, ignition, and ground integrity to ECM and also verifies Ignition 1 power feed to IPC.
2. IPC odometer is primary display device for diagnosis and must be functional in order to use self-diagnostic system.
3. ECCP serves as access for onboard diagnosis and must be functional in order to use self-diagnostic system. A display other than standard temperature indicates fault that must be corrected before diagnostics can be entered.
4. After entering diagnostics, record all displayed trouble codes and note if they display as CURRENT or HISTORY. Codes displayed as current may be diagnosed using the procedures outlined in this article, but those codes displayed as HISTORY are not presently falling and may require visual inspection of circuitry to isolate.
5. Failure of SERVICE ENGINE SOON light to go out in the expected time period indicates ECM problem.
6. If no fault is found and driveability problems exist, see appropriate TESTS W/O CODES article in the ENGINE PERFORMANCE section for diagnosis by symptom.

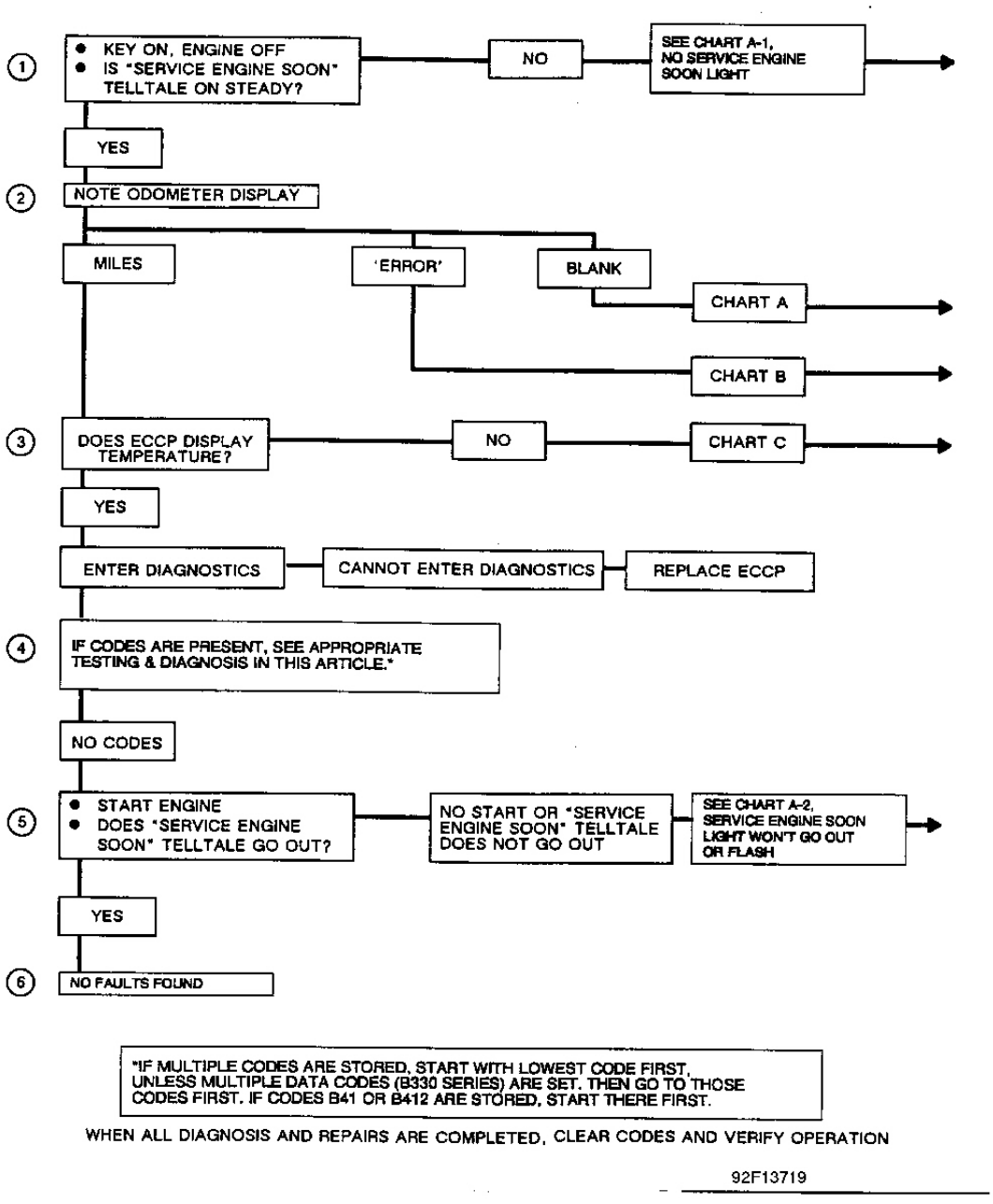


Fig. 14: Self-Diagnostic System Troubleshooting Chart (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

CHART A-1, NO SERVICE ENGINE SOON LIGHT - REATTA & RIVIERA

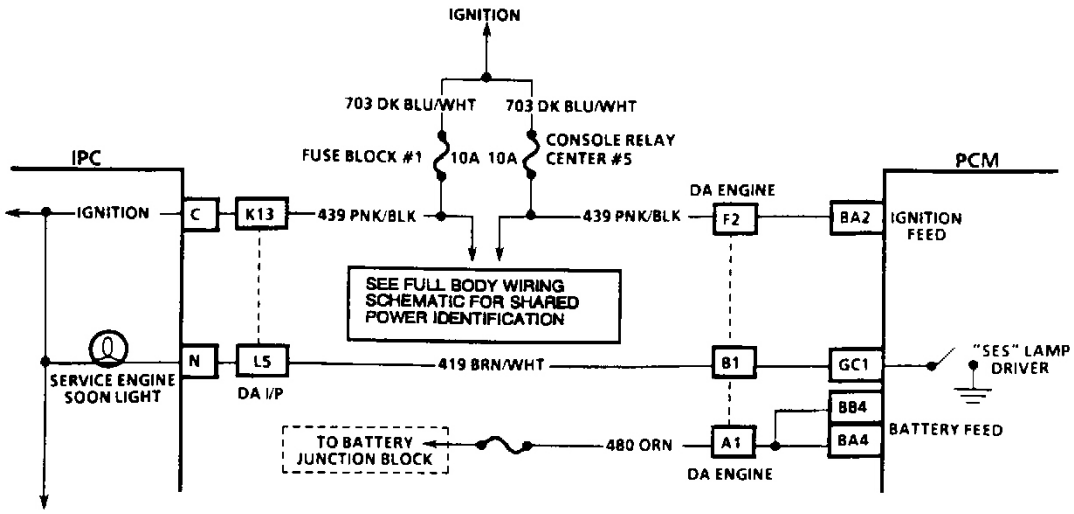


Fig. 15: Chart A-1 Wiring Schematic (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

The SERVICE ENGINE SOON light is attached to the IPC. It is powered by CPS circuit No. 439. PCM completes the ground to turn the light on. The light will be on while engine is not running. With the engine running, a steady light indicates a PCM code is set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. SERVICE ENGINE SOON light should be on.
2. Using a test light connected to battery voltage, probe each of the system ground circuits to be sure a good ground is present.

Diagnostic Aids

If engine runs okay, check:

- Faulty light bulb
- PCM drive circuit open
- 10-amp ignition fuse open

If engine cranks, but will not run:

- Continuous battery-fusible link open
- Ignition feed to PCM open
- Open fuse No. 5 in console relay center
- Poor connection to PCM

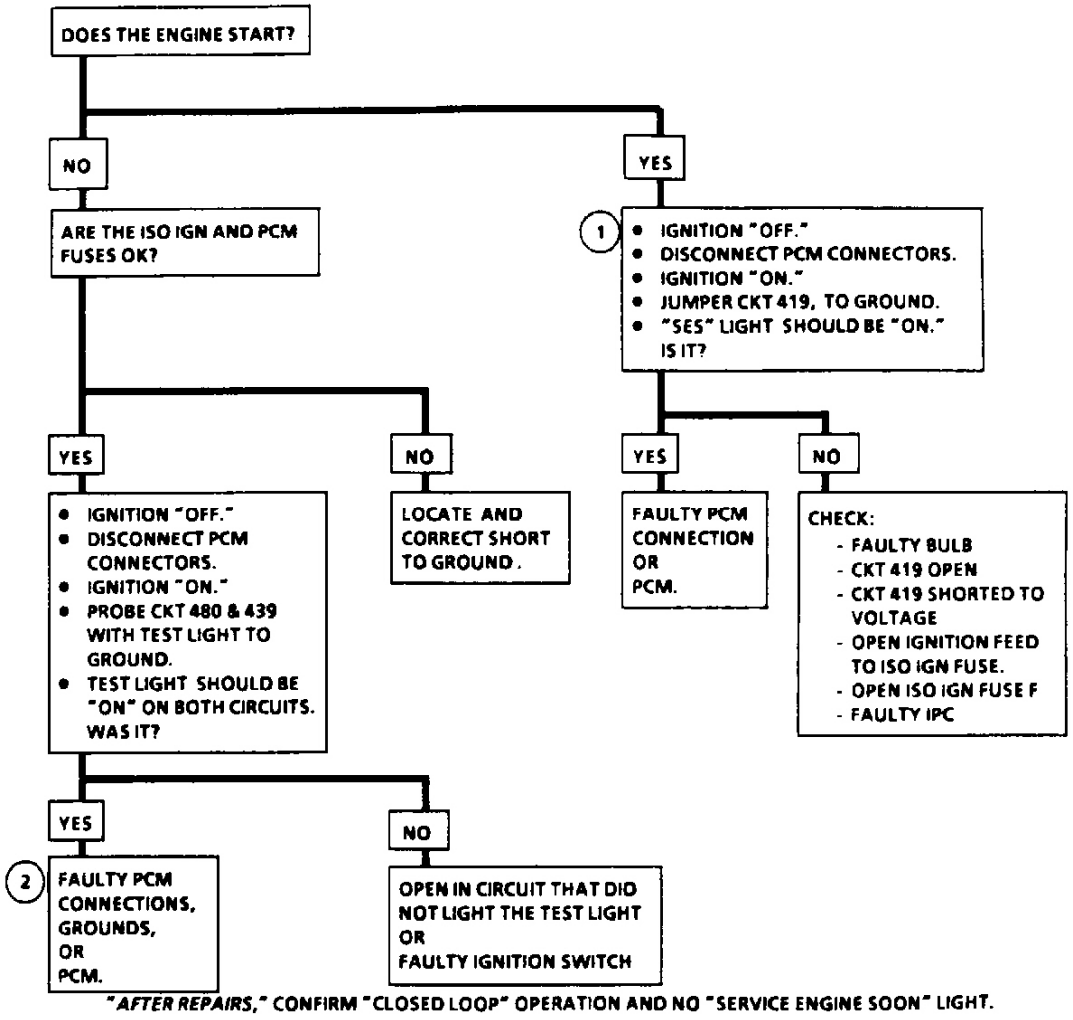


Fig. 16: Chart A-1 Troubleshooting Flowchart (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

CHART A-2, SERVICE ENGINE SOON LIGHT WON'T GO OUT OR FLASH (REATTA & RIVIERA)

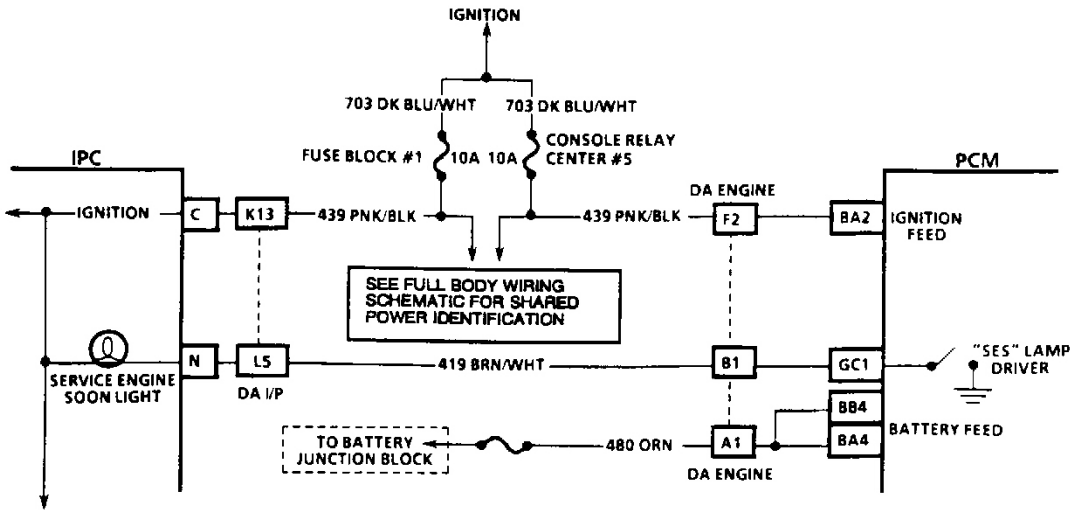


Fig. 17: Chart A-2 Wiring Schematic (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

The SERVICE ENGINE SOON light is attached to the IPC. It is powered by CPS circuit No. 439. PCM completes the ground to turn the light on. The light will be on while engine is not running. With the engine running, a steady light indicates a PCM code is set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If the light goes off when PCM connector is unplugged, PCM drive circuit is not shorted to ground.
2. If there is a problem with PCM that causes a "Scan" tester to not read serial data, PCM should not flash Code 12. IF Code 12 does flash, be sure that the tester is working properly by trying it on another vehicle. If tester is working properly and circuit No. 800 is okay, MEM-CAL or PCM or another component which uses the serial data line may be at fault for the NO ALDL problem.
3. This step will check for an open diagnostic circuit No. 451 (terminal "B" of ALDL).
4. At this point, SERVICE ENGINE SOON light wiring is okay. The problem is a faulty PCM or MEM-CAL. If Code 12 does not flash. PCM should be replaced using original MEM-CAL. Replace MEM-CAL only after trying a PCM, as a defective MEM-CAL is an unlikely cause of the problem.

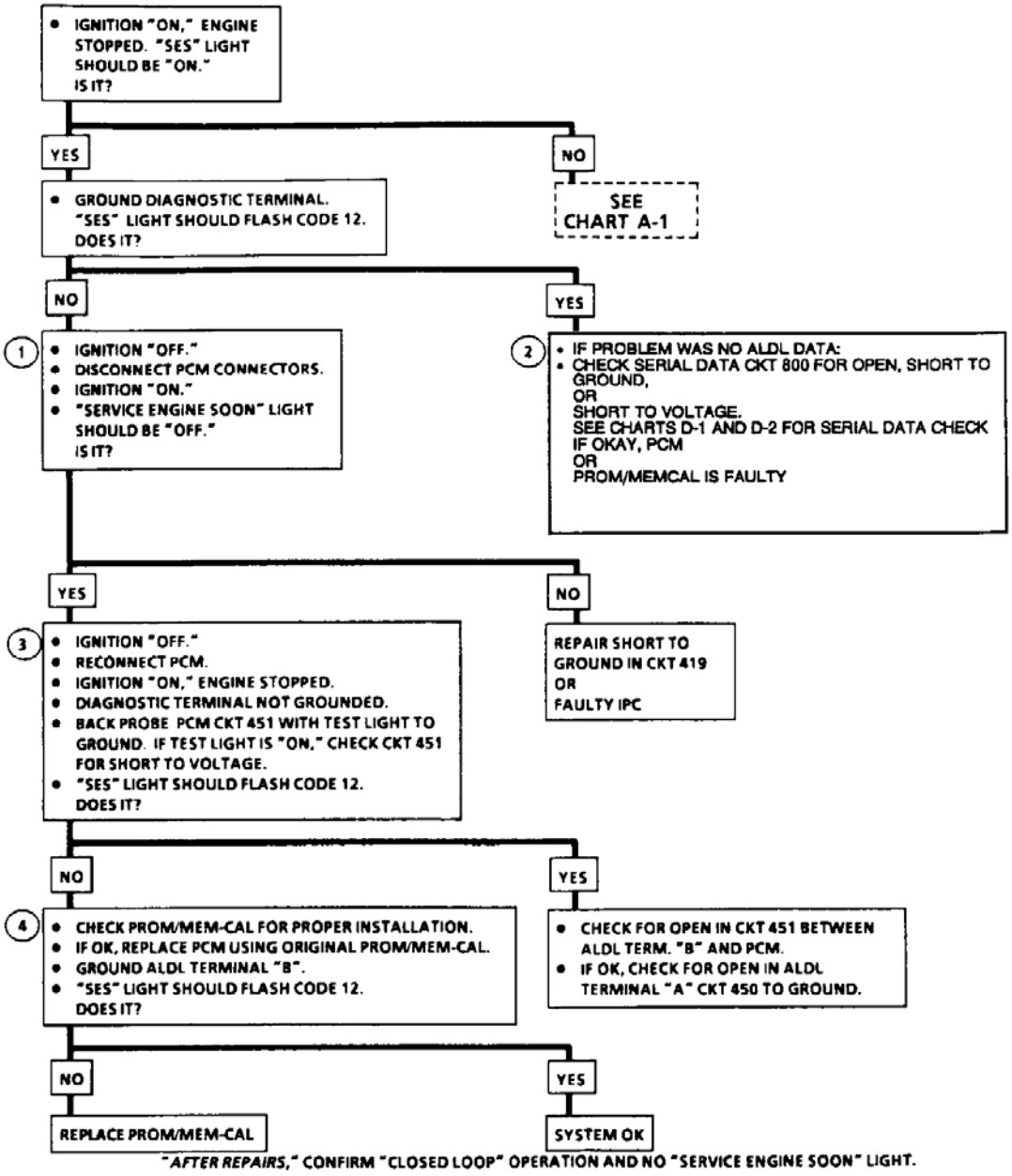


Fig. 18: Chart A-2 Troubleshooting Diagram (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

CHART A, BLANK ODOMETER DISPLAY - REATTA & RIVIERA

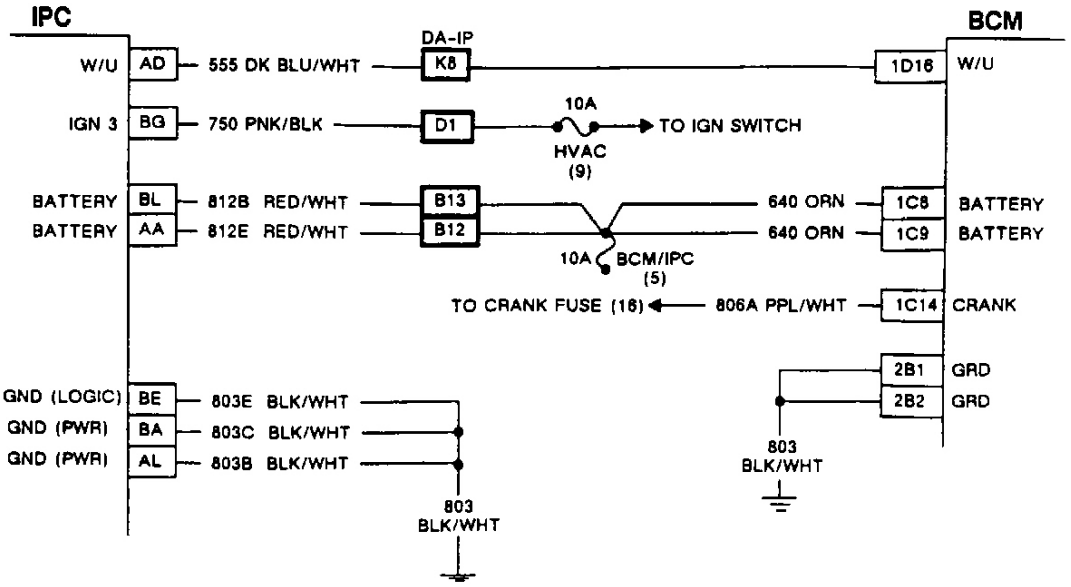


Fig. 19: Chart A - Wiring Schematic (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

Loss of IPC display and messages can result from the following:

- Loss of 12 volt power to IPC (circuit No. 812)
- Loss of ground to IPC (circuit No. 803)
- Internal fault in CPS or IPC.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks the IPC power and grounds.
2. Power, Ignition 3 and ground circuits to IPC are functioning properly; therefore, fault is either in terminal contacts or internal to the IPC.
3. The 12-volt feed to the IPC is not functioning. Check for open in circuit No. 640.

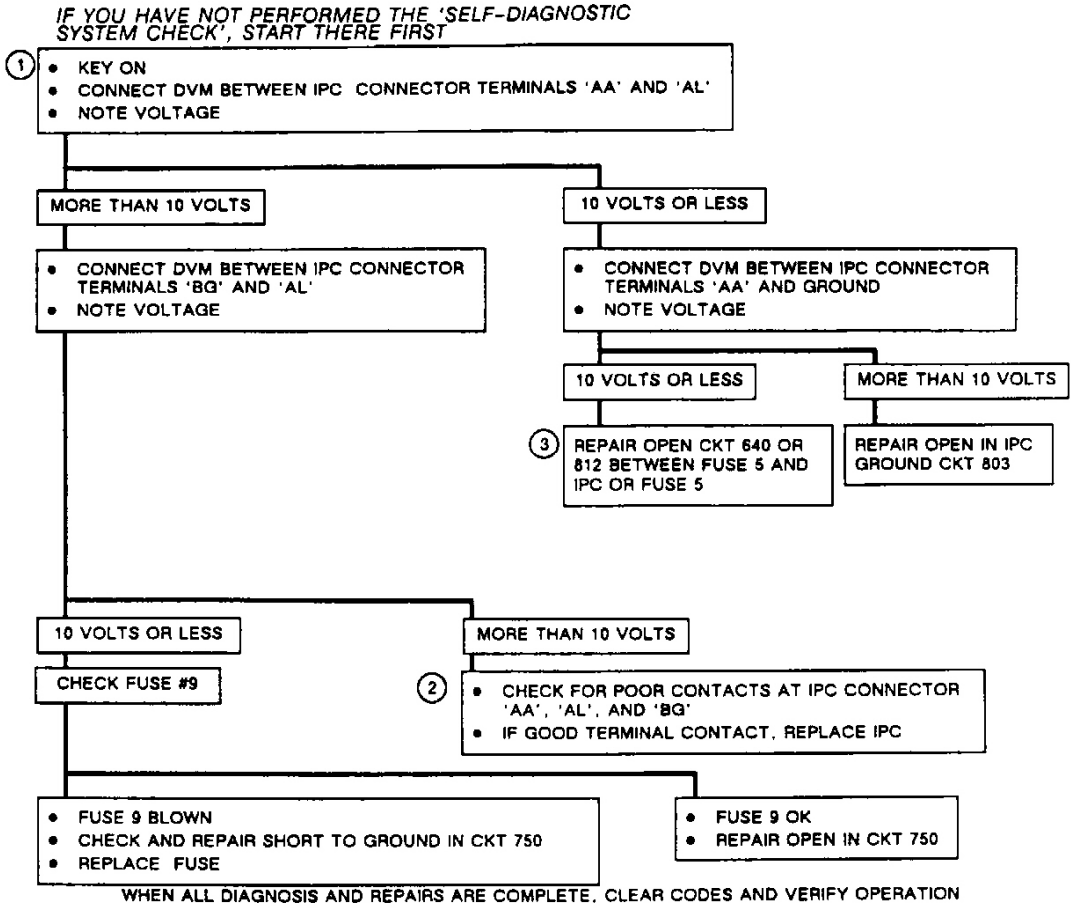


Fig. 20: Chart A - Troubleshooting Diagram (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

CHART B, ODOMETER DISPLAYS ERROR (LOS OF SERIAL DATA) (REATTA & RIVIERA)

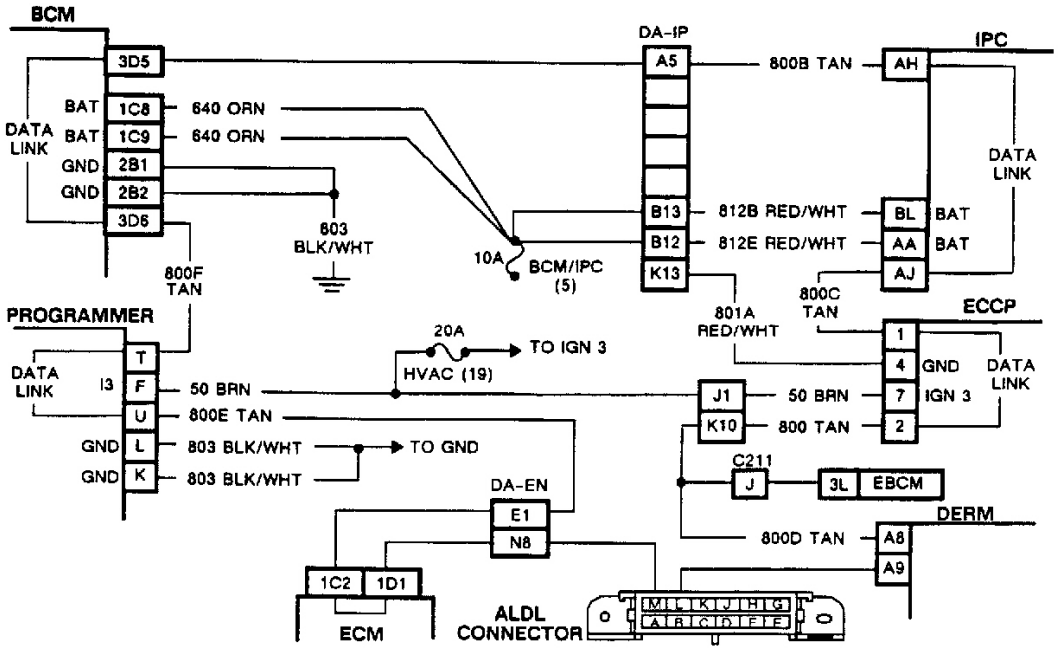


Fig. 21: Chart B - Wiring Schematic (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

IPC indicates loss of serial data communication by displaying ERROR in odometer and illuminating ELECTRICAL PROBLEM telltale light. Loss of serial data communications can occur for the following reasons:

- Short to ground somewhere in circuit No. 800
- Short to voltage somewhere in circuit No. 800
- Two opens in circuit No. 800
- Internal fault in BCM or IPC
- Open in ECCP ground circuit

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This steps checks if BCM is awake and functioning. If it is not, use chart B-1 to isolate fault.
2. This step checks if ECC head has lost data communication along with IPC.
3. Code B556 indicates IPC EEPROM error. Odometer will display ERROR, but diagnostics will be accessible.
4. Since IPC lost data communications, creating an open in data line at ALDL connector should remove data communications from ECCP as well. If not, IPC is receiving data but is unable to communicate due to poor connection or internal problem.
5. This test indicates data line shorted to ground.

6. This test indicates data line functioning properly, but with multiple opens isolating IPC and ECCP from BCM.
7. This test indicates data line shorted to voltage.

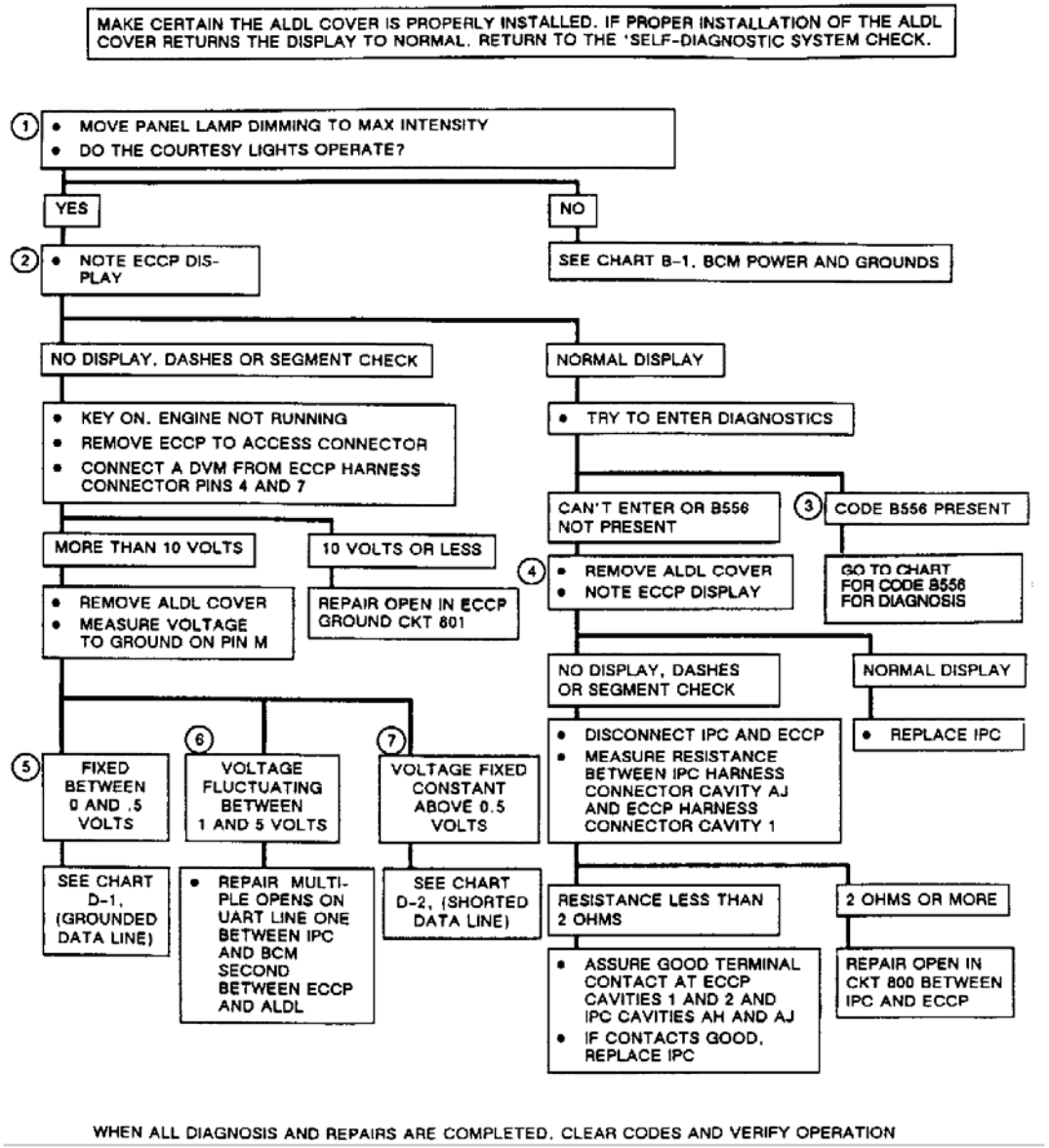


Fig. 22: Chart B - Troubleshooting Diagram (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

CHART B-1, BCM POWER & GROUNDS - REATTA & RIVIERA

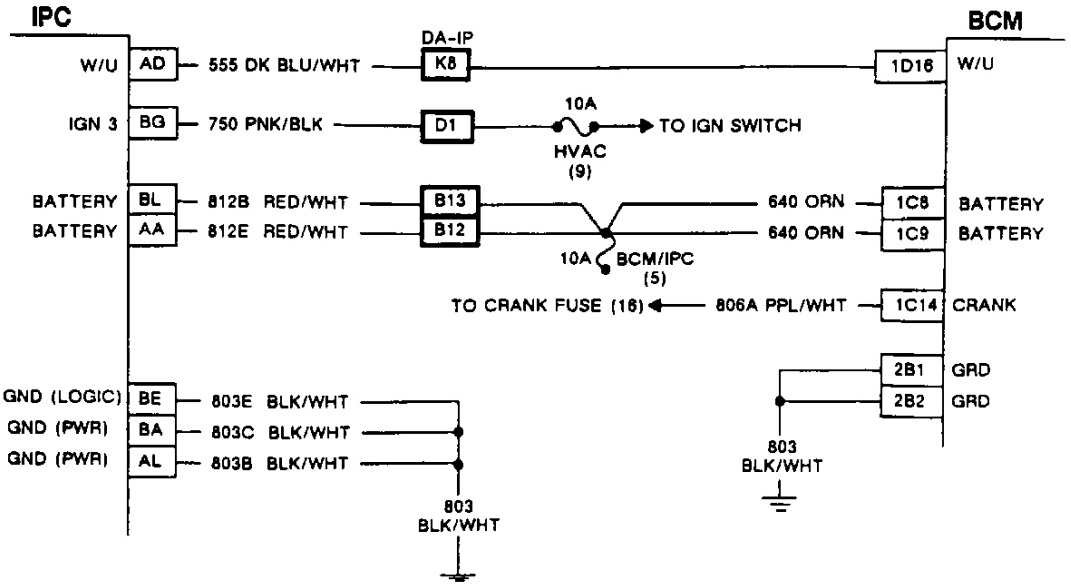


Fig. 23: Chart B-1 - Wiring Schematic (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

The loss of BCM functions can result from the following:

- Loss of 12-volt power on circuit No. 640 to BCM
- Loss of ground on circuit No. 803 to BCM
- Internal BCM fault

NOTE: Test numbers refer to numbers on diagnostic chart.

1. BCM is not receiving 12-volt input. Check power and ground supply to BCM.
2. This step checks for short to ground in any part of circuit No. 640.
3. Checks to see if the short to ground is inside a component or in the circuit itself.

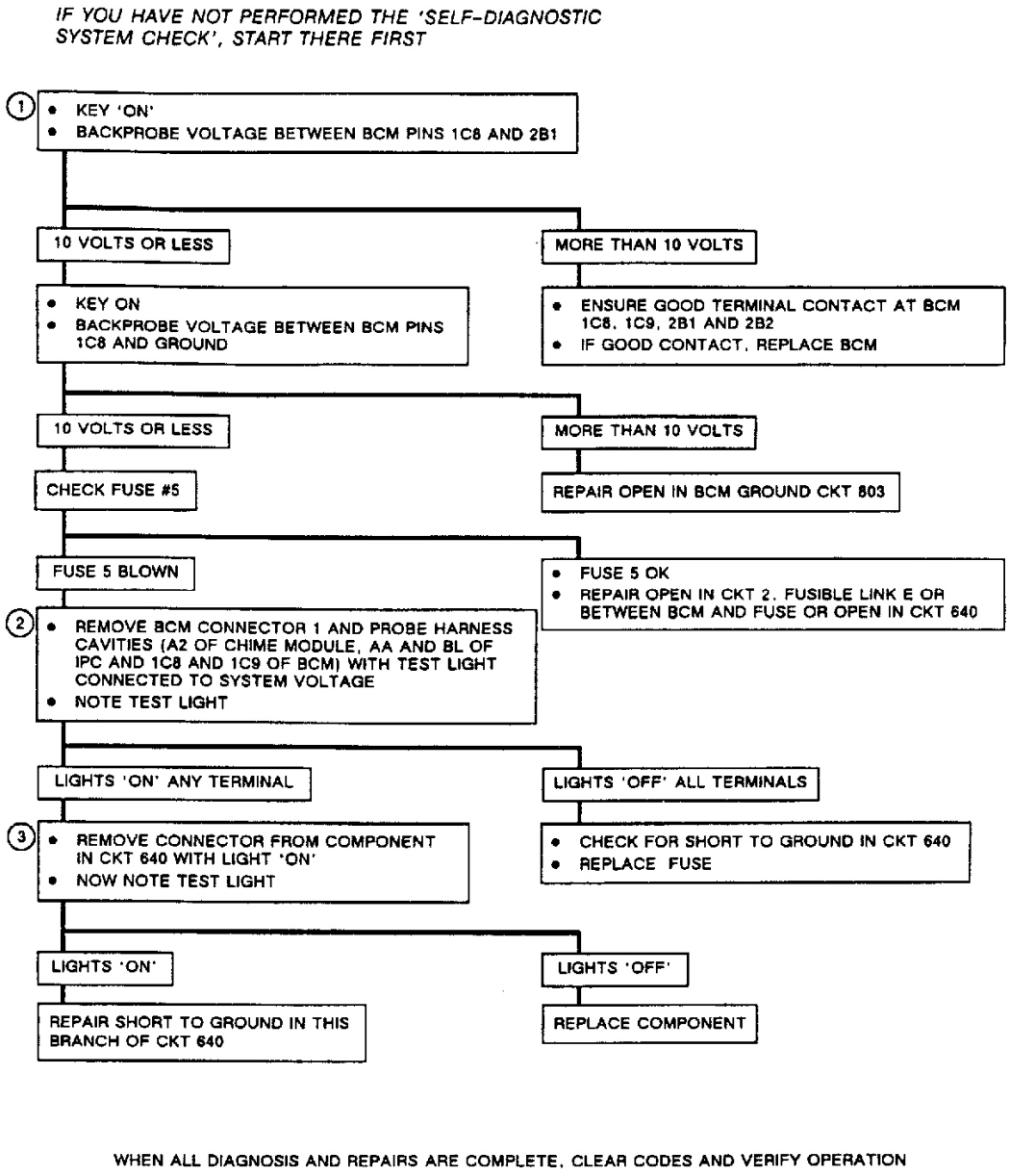


Fig. 24: Chart B-1 - Troubleshooting Diagram (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

CHART C, ECCP DISPLAY PROBLEMS (LOSS OF ECCP COMMUNICATIONS) (REATTA & RIVIERA)

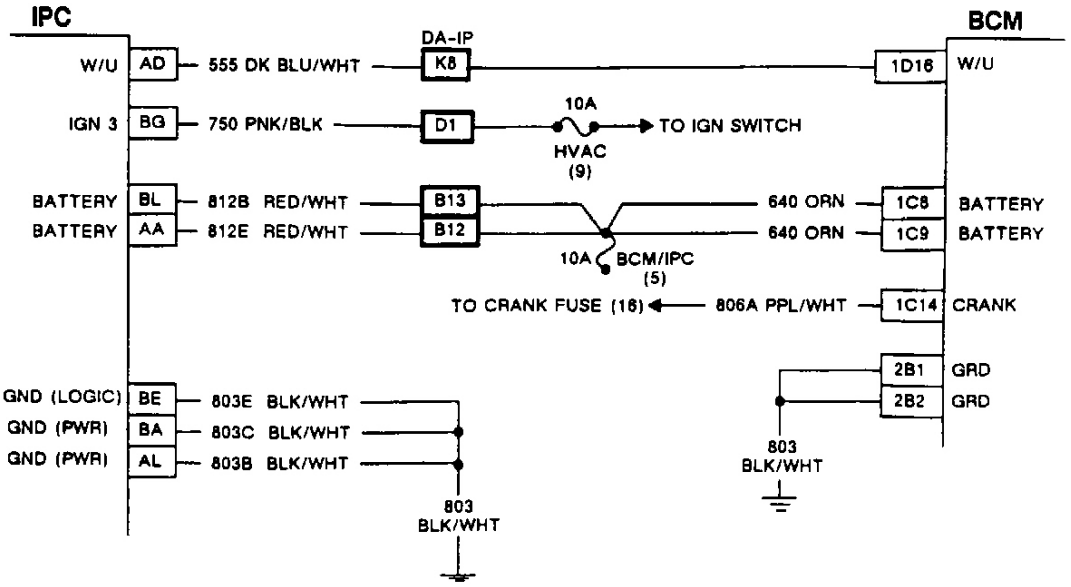


Fig. 25: Chart C - Wiring Schematic (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

When ECC communications are lost, service diagnostics usually cannot be entered, but a quick scan of panel will usually help isolate source of fault. Loss of serial data will result in 3 dashes being shown on the panel VF display. This indicates power and ground are okay. If panel displays normal exterior or interior set temperature, power, ground and serial data communications are being received and panel replacement is indicated.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This step checks for power and ground to panel. Voltage should be HI for both power to ground checks.
2. This step checks for serial data voltage. Normal voltage should be more than one volt and varying. Steady voltage indicates second open exists, or ALDL cover is off.

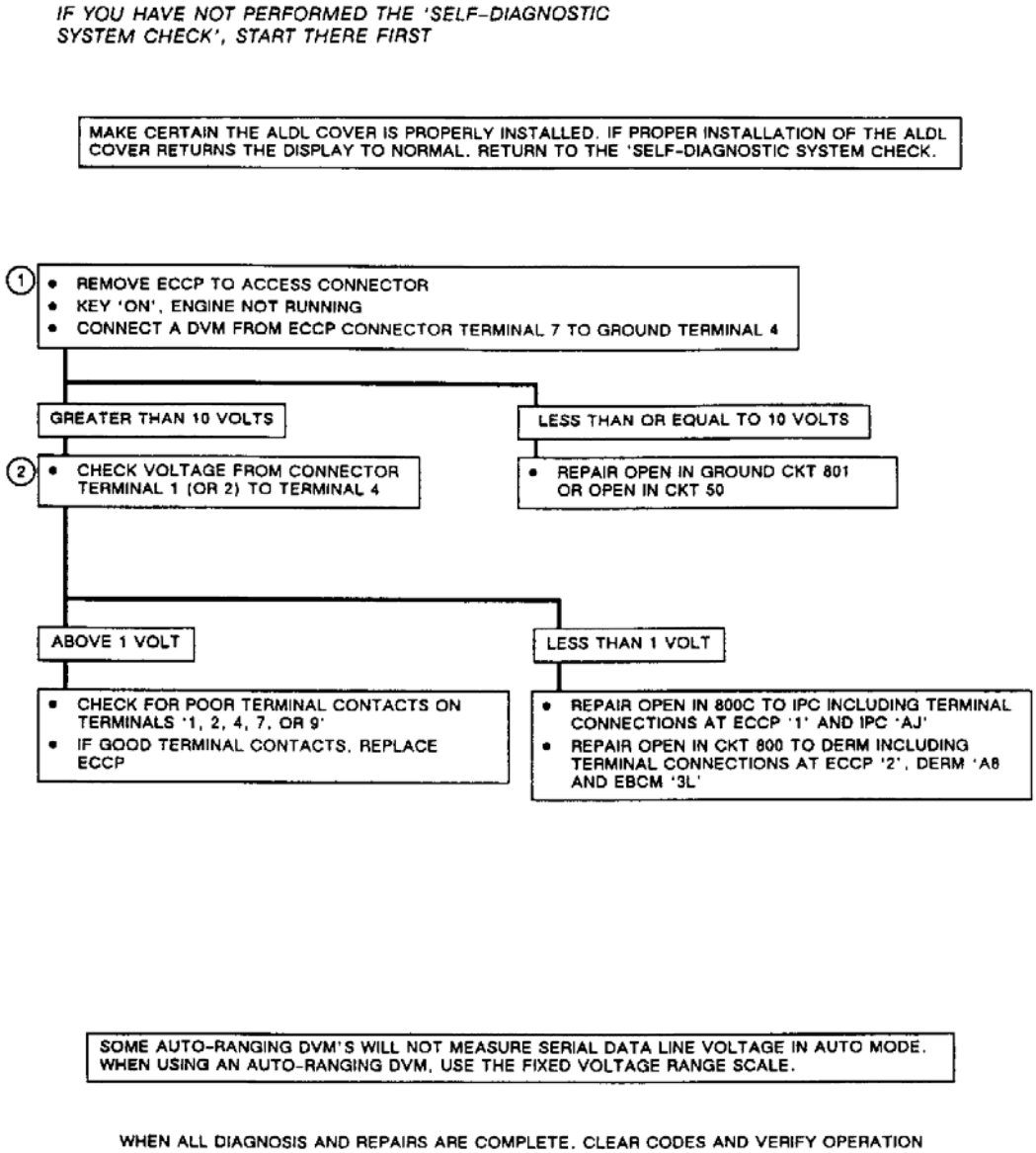


Fig. 26: Chart C - Troubleshooting Diagram (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

CHART D-1, GROUNDED SERIAL DATA CIRCUIT - REATTA & RIVIERA

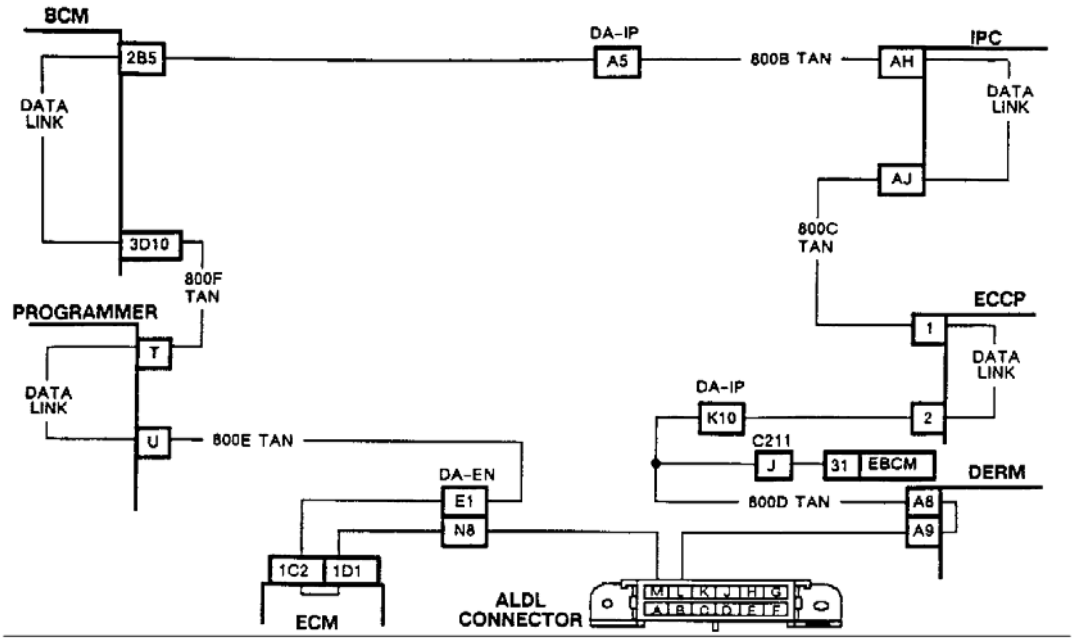


Fig. 27: Chart D-1 & D-2 - Wiring Schematic (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

With grounded serial data circuit, BCM will not be able to communicate with any other devices in system. Voltage measured anywhere in circuit will zero. IPC will display ELECTRICAL PROBLEM; ECCP will display dashes ("---").

NOTE: Test numbers refers to test number on diagnostic chart.

1. This step splits the system in half to help isolate source of grounded serial data line. If taking IPC out of the system allows both halves of serial data line to rise more than one volt, source of short has been located. The remaining steps follow same pattern in that components are removed from serial data line until normal voltage range is again measured. When section of circuit is isolated, a simple check of wire for short to ground will differentiate between grounded wire or ground in a device remote.

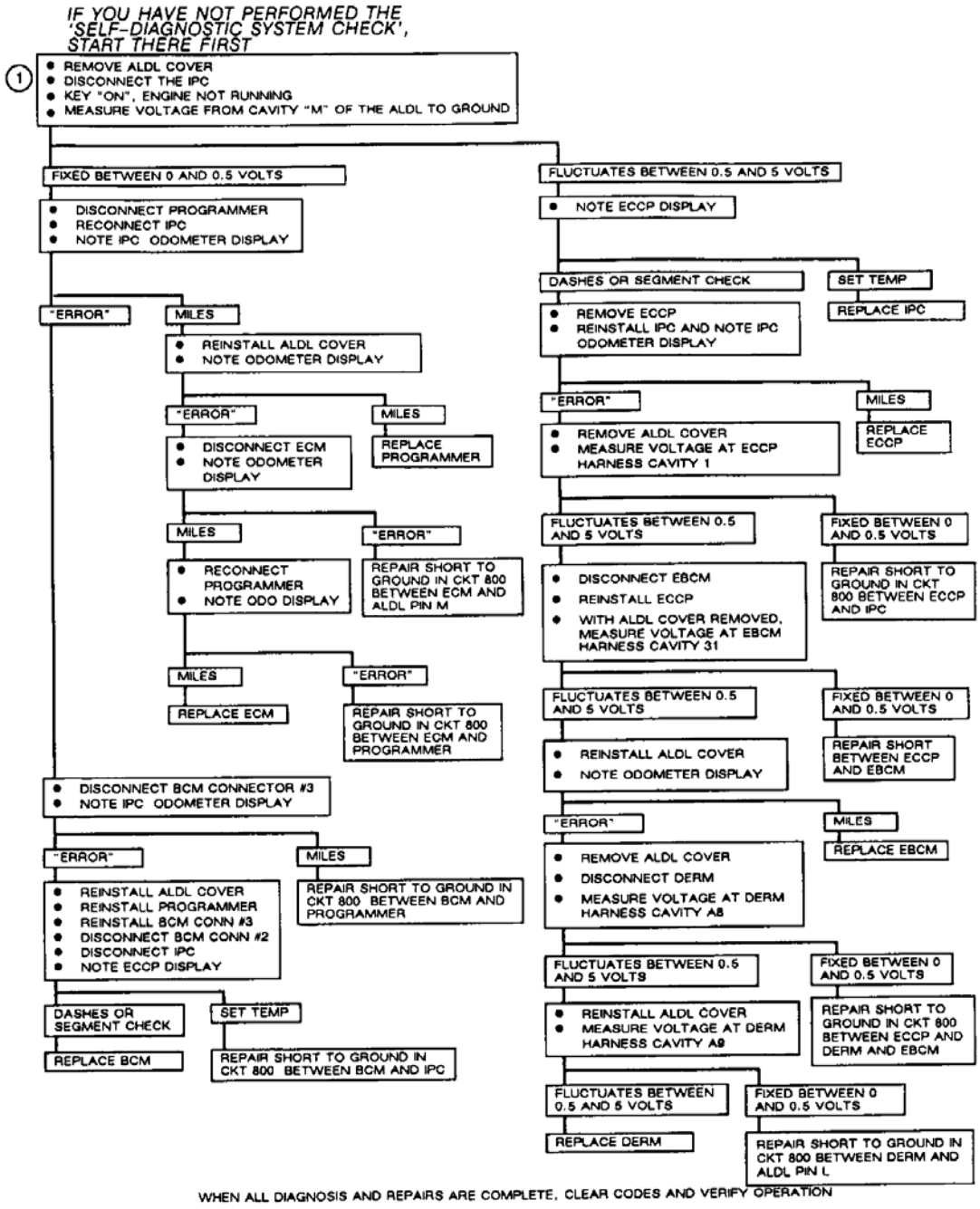


Fig. 28: Chart D-1 - Troubleshooting Diagram (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

CHART D-2, SERIAL DATA CIRCUIT SHORTED TO VOLTAGE - REATTA & RIVIERA

With a shorted serial data circuit, BCM will not be able to communicate with other devices in system. Voltage measured any where in circuit will be more than 5 volts. IPC display showing only ELECTRICAL PROBLEM.

See **Fig. 27**.

NOTE: Test number refers to test number on diagnostic chart.

1. This step splits system in half to help isolate the source of short in the serial data line. If taking ECM out of system allows both halves of serial data line to fall below 5 volts, source of short was in IPC. The remaining steps follow the same pattern in that components are removed from serial data line until normal voltage range is again measured.

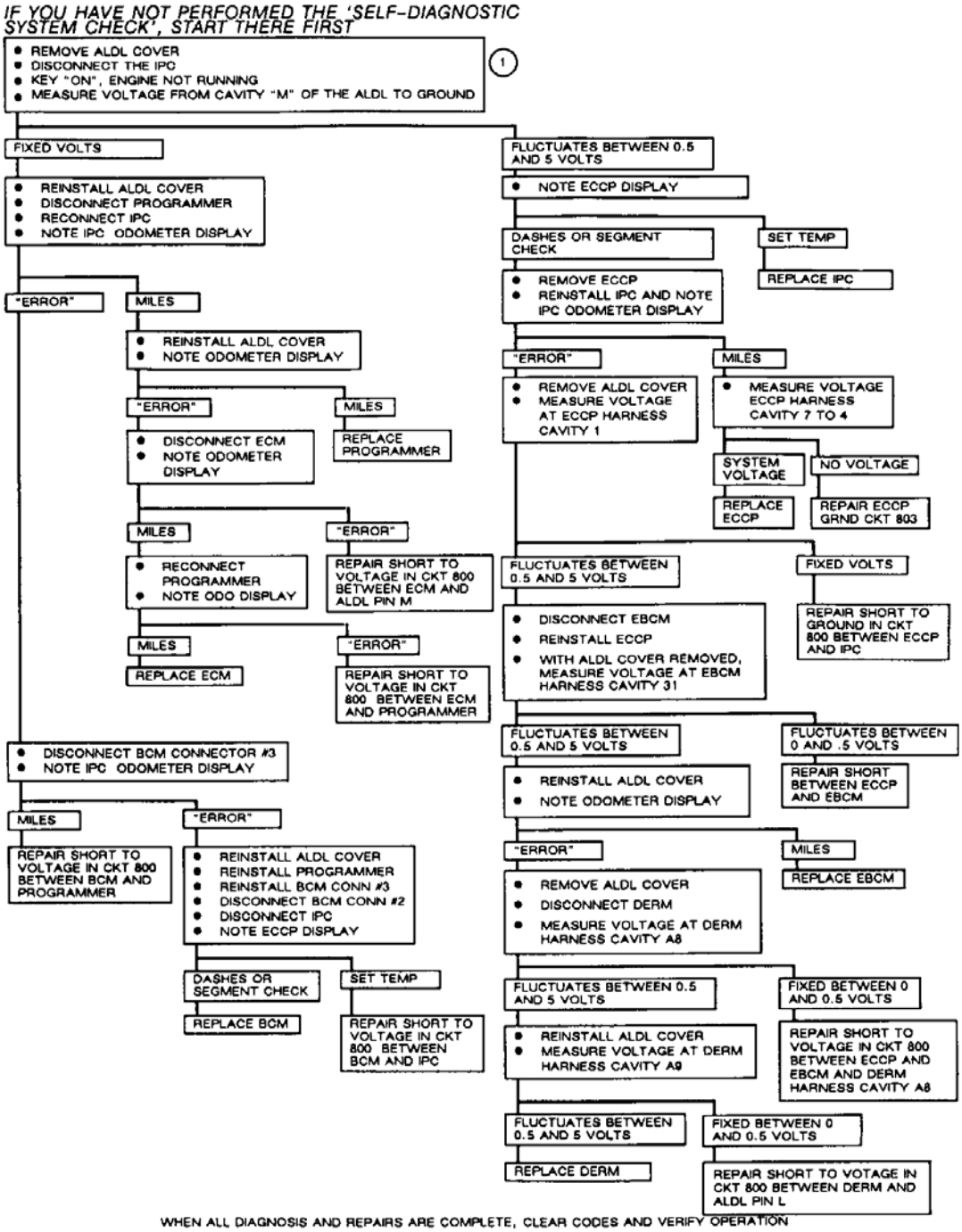


Fig. 29: Chart D-2 - Troubleshooting Diagram (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

CODE B556, ODOMETER (EE) PROM ERROR - REATTA & RIVIERA

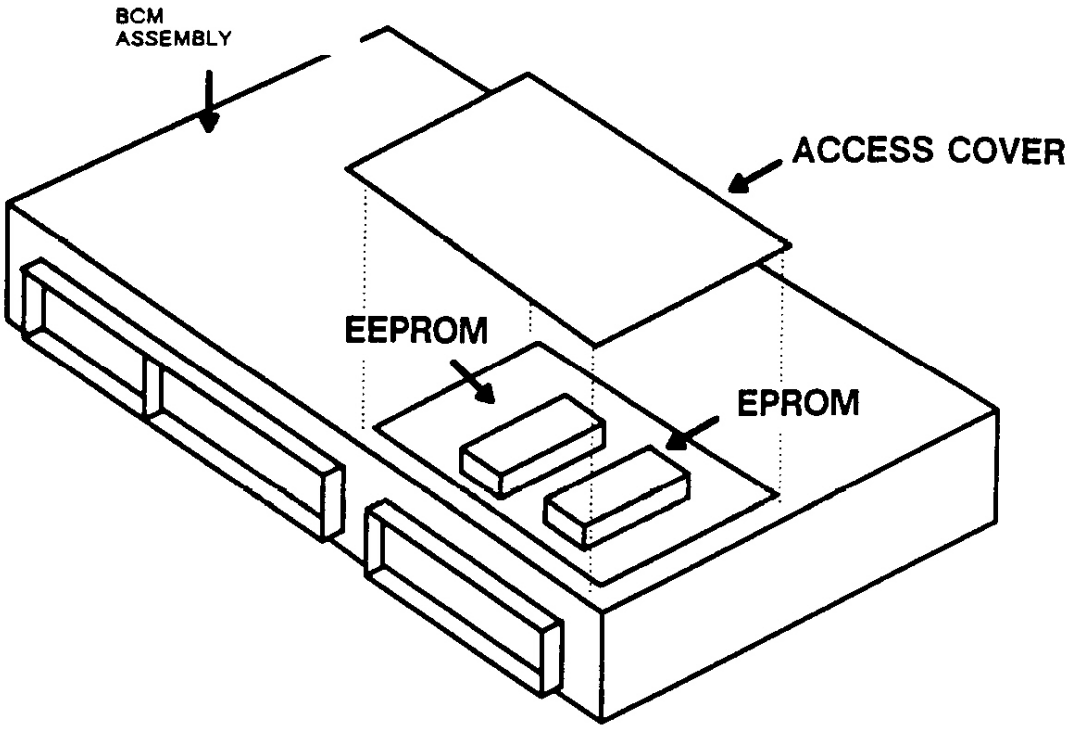


Fig. 30: BCM Assembly - (Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

Code B556 indicates that EEPROM, which records elapsed odometer mileage, is not being read by BCM. Usually along with Code 556, ERROR will be displayed in the odometer display. The EEPROM contains specific vehicle information such as vehicle ID number, season odometer mileage and certain vehicle options. Since this information is programmed for the specific vehicle in which it is installed, and EEPROM cannot be transferred from one vehicle in which it is installed, an EEPROM cannot be transferred from one vehicle to another. Check for proper EEPROM installation. If the EEPROM is properly installed (no bent pins) but Code B556 persists, replace EEPROM. Obtain replacement EEPROMs through an authorized Delco Service Center.

CHART A-1, NO SERVICE ENGINE SOON LIGHT - TORONADO & TROFEO

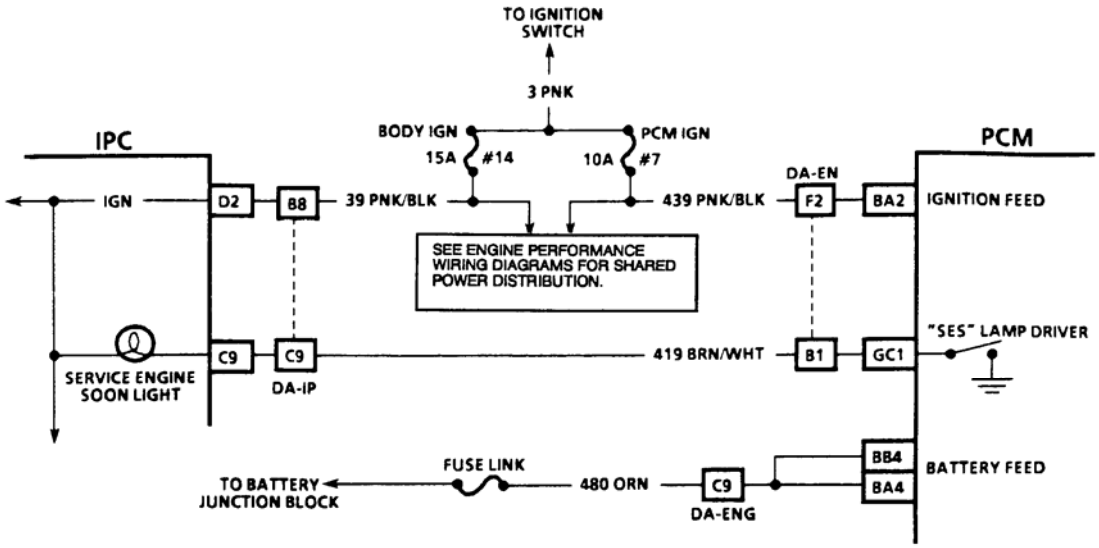


Fig. 31: Chart A-1 & A-2, Wiring Schematic (Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

The SERVICE ENGINE SOON light is located in IPC. Light is powered by Ignition 1, circuit No. 39 and PCM completes system ground to turn light on. With ignition on and engine not running, light should be on. If with engine running, light is on steady, this indicates a fault code is set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. SERVICE ENGINE SOON light should be on.
2. Using a test light connected to battery voltage, probe each of the system ground circuits to be sure a good ground is present.

Diagnostic Aids

If engine runs okay, check:

- Faulty light bulb
- PCM drive circuit open
- 15-amp BODY IGN fuse open.

If engine cranks, but will not run:

- Continuous battery-fusible link open
- Ignition feed to PCM open
- Open fuse No. 7 bad
- Poor connection to PCM

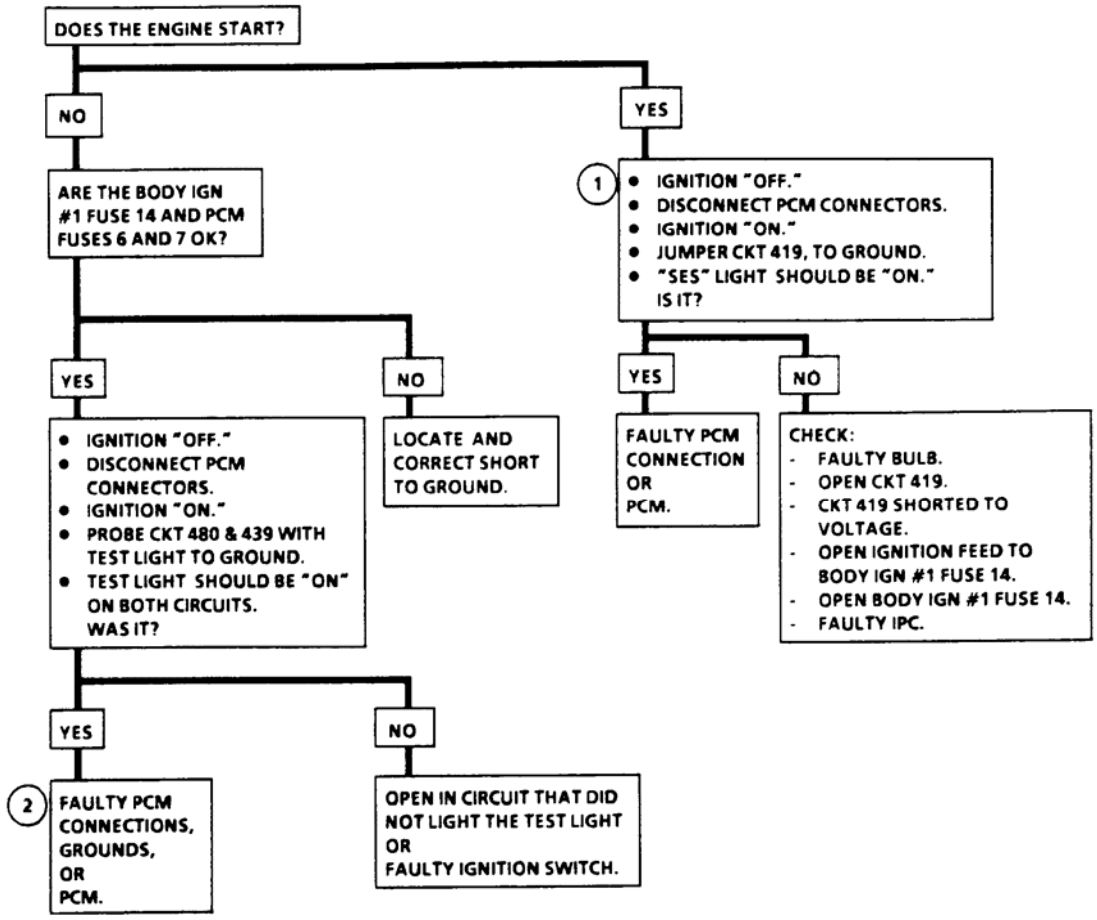


Fig. 32: Chart A-1 - Troubleshooting Diagram (Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART A-2, SERVICE ENGINE SOON LIGHT WILL NOT GO OUT OR FLASH - TORONADO & TROFEO

The SERVICE ENGINE SOON light is attached to the IPC. It is powered by circuit No. 39. PCM completes the ground to turn the light on. The light will be on while engine is not running. With the engine running, a steady light indicates a fault code is set. See **Fig. 31**.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If the light goes off when PCM connector is unplugged, PCM drive circuit is not shorted to ground.
2. If there is a problem with PCM that causes a "Scan" tester to not read serial data, PCM should not flash Code 12. If Code 12 does flash, be sure that the tester is working properly by trying it on another vehicle. If tester is working properly and circuit No. 800 is okay, MEM-CAL or PCM or another component which uses the serial data line may be at fault for the NO ALDL problem.
3. This step will check for an open diagnostic circuit No. 451 (terminal "B" of ALDL).
4. At this point, SERVICE ENGINE SOON light wiring is okay. The problem is a faulty PCM or MEM-CAL. If Code 12 does not flash, PCM should be replaced using original MEM-CAL. Replace MEM-CAL only after trying a PCM, as a defective MEM-CAL is an unlikely cause of the problem.

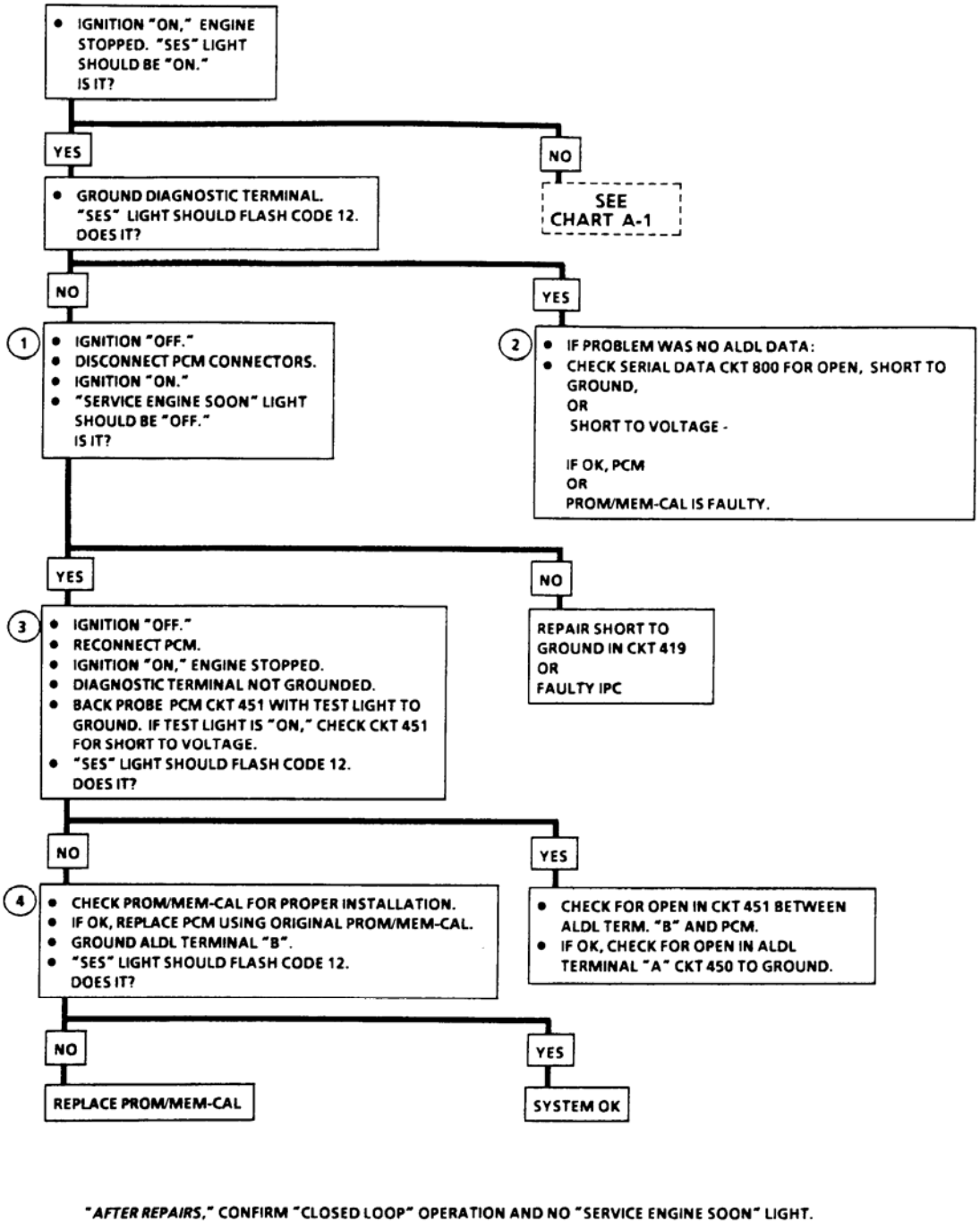


Fig. 33: Chart A-2 - Troubleshooting Diagram (Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

SELF-DIAGNOSTIC SYSTEM CHECK (NON-CRT TORONADO & TROFEO)

The Self-Diagnostic System Check is an organized approach for identifying problems caused by on-vehicle computer controlled electronics. Understanding this chart and using it correctly will reduce diagnostic time and

prevent unnecessary replacement of components. If you have not reviewed the basic information on how to use computer self-diagnostics, go to beginning of this article.

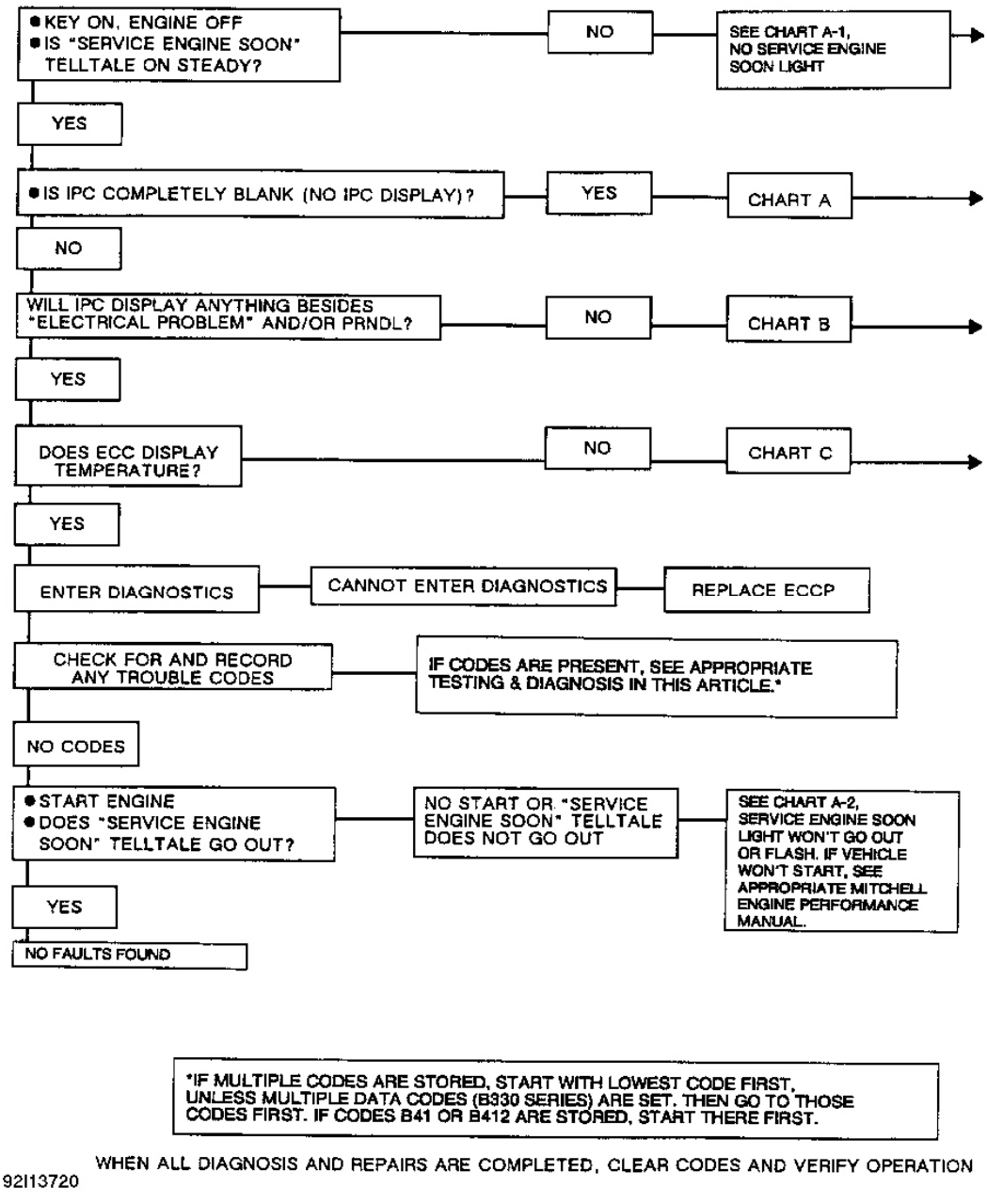


Fig. 34: Self-Diagnostic Troubleshooting Diagram (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART A, LOSS OF IPC DISPLAY (NON-CRT EQUIPPED) TORONADO & TROFEO

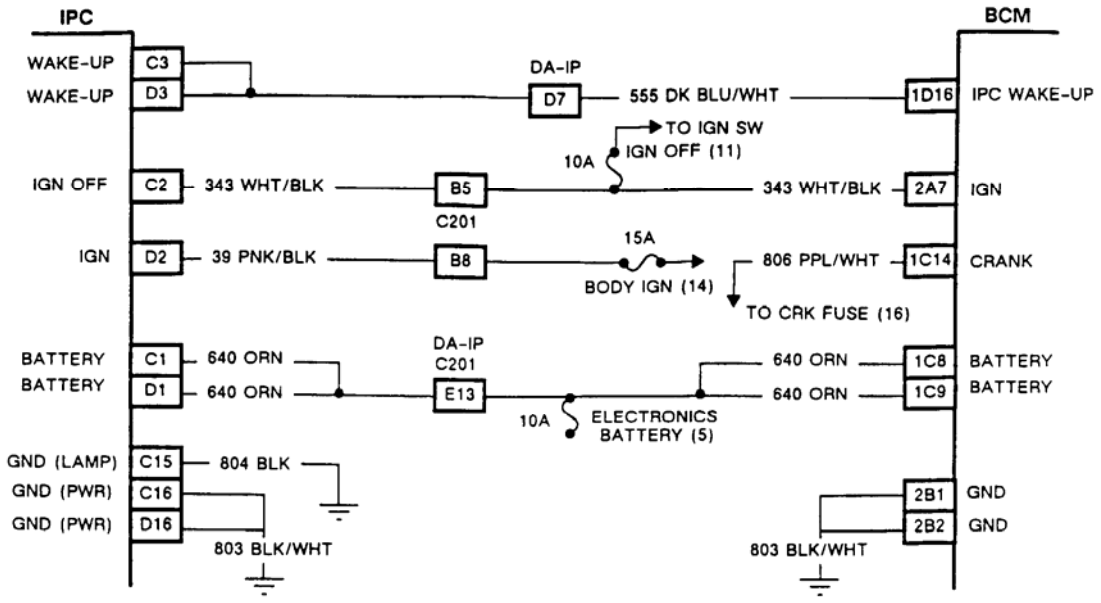


Fig. 35: Chart A - Wiring Schematic (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

Loss of IPC display and messages can result from following:

- Loss of 12 volts to IPC
- Loss of ground to IPC
- Loss of wake-up signal to BCM
- Internal fault in BCM or IPC

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This step checks to see if BCM is awake. If BCM is not awake, cause of blank display is power and/or ground related.
2. This step checks BCM power and ground sources.
3. This step checks to see if IPC has lost power or ground. Normally with ignition on, battery voltage should be present at listed terminals.
4. This step checks for short to ground in any of the 640 circuits.
5. This step checks if short to ground is inside component or in circuit.
6. This step checks if IPC is receiving 7 volts from BCM.

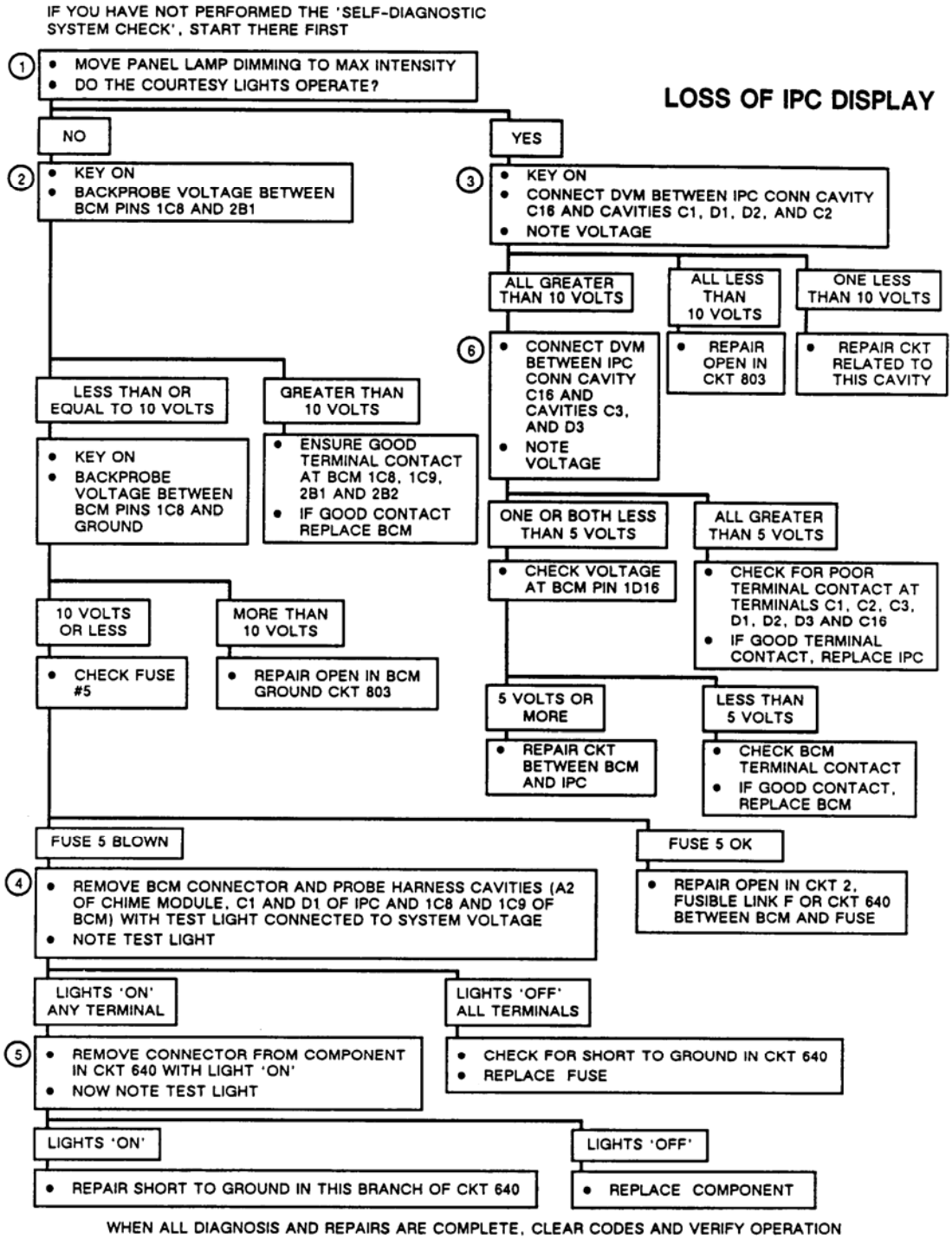


Fig. 36: Chart A - Troubleshooting Diagram (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART B, LOSS OF SERIAL DATA (NON-CRT EQUIPPED TORONADO & TROFEO)

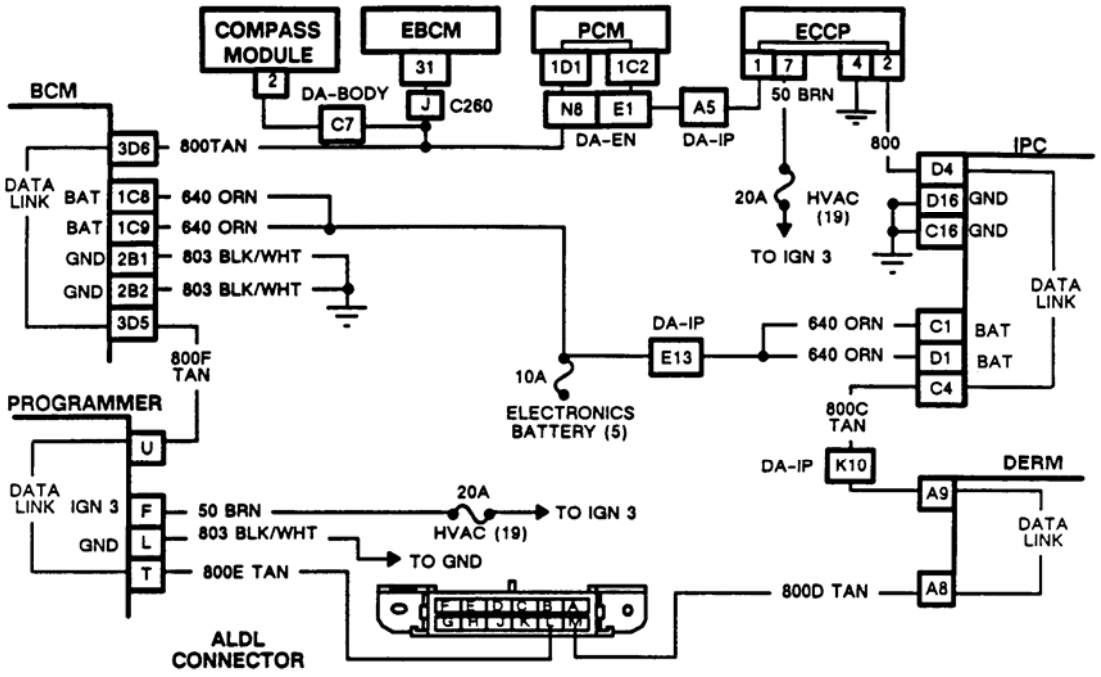


Fig. 37: Chart B - Wiring Schematic (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

IPC indicates loss of serial data communication by displaying the message ELECTRICAL PROBLEM. All other segments are blank. If display is fully illuminated and ELECTRICAL PROBLEM message is displayed, enter diagnostics and proceed to appropriate code chart. **DO NOT** use CHART A. Loss of serial data communications can occur for the following reasons:

- Short to ground anywhere in circuit No. 800
- Short to voltage anywhere in circuit No. 800
- Two opens in circuit No. 800
- Internal BCM or IPC fault
- Open in ECCP ground circuit or IGN 3 circuit

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This step checks to see if ECCP has lost data communication along with IPC.
2. Since IPC has lost data communications, shorting terminal "M" at ALDL connector should NOT remove data communications from ECCP. If this does happen, IPC is receiving data but is unable to communicate due to poor connection or an internal problem.

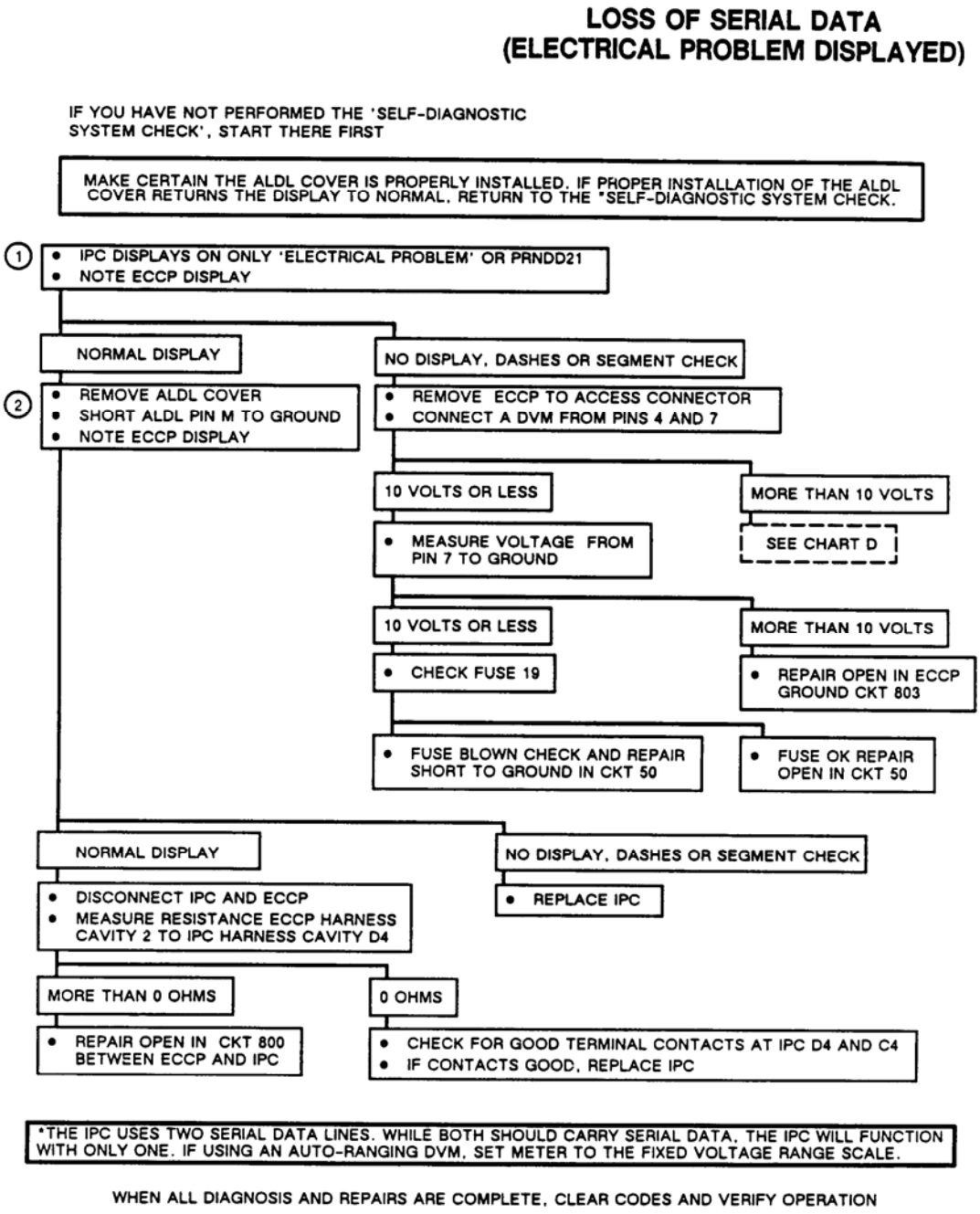


Fig. 38: Chart B - Troubleshooting Diagram (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART C, LOSS OF ECCP COMMUNICATIONS (NON-CRT EQUIPPED TORONADO & TROFEO)

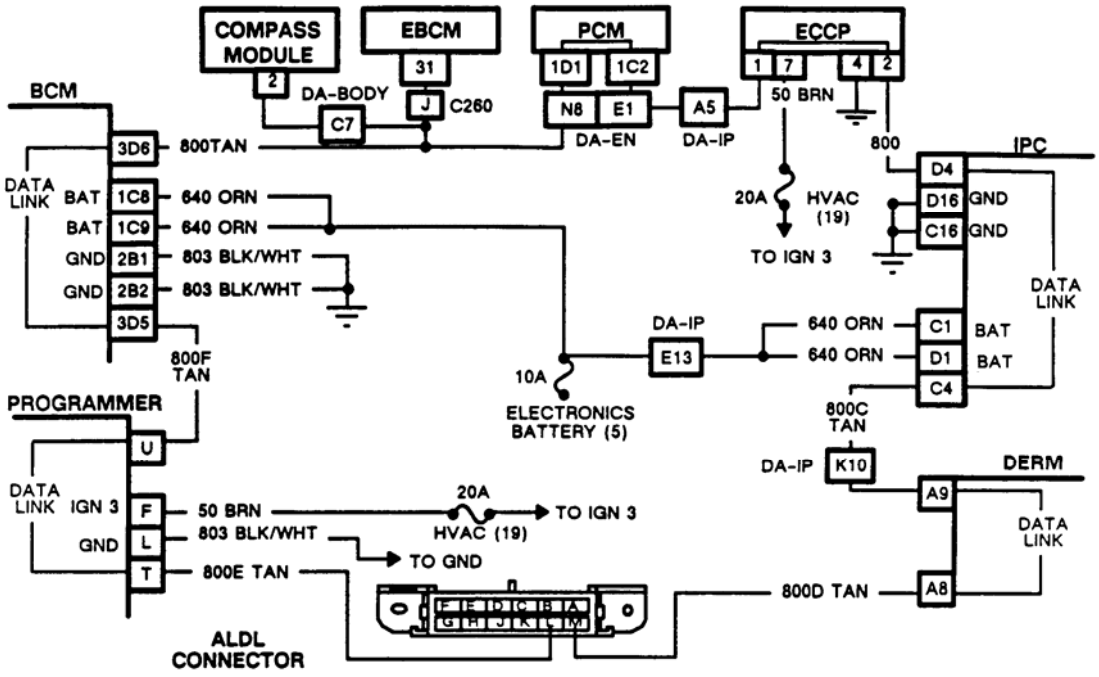


Fig. 39: Chart C - Wiring Schematic (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

When ECCP communications are lost, service diagnostics usually cannot be entered, but a quick scan of panel will usually help isolate source of fault. ECCP is powered by ignition. If power source is lost, IPC will usually display ELECTRICAL PROBLEM. Loss of serial data will result in 3 dashes being shown on panel VF display. This indicates power and ground are okay. If the panel displays normal outside or interior set temperature, power, ground and serial communications are being received, indicating need to replace panel.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This step checks for power and ground to panel. Test light should be on for both power to ground checks.
2. This step checks for serial data voltage. Normal voltage should be above one volt and varying.

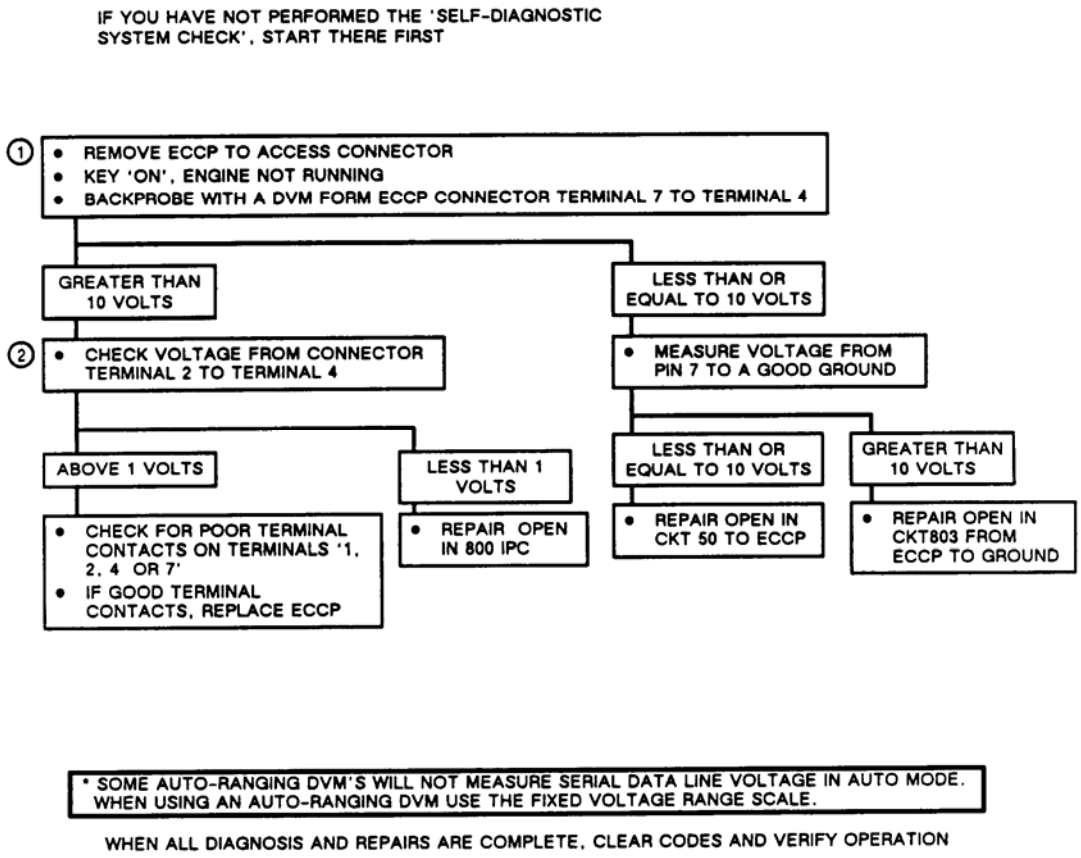


Fig. 40: Chart C - Troubleshooting Diagram (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART D, LOSS OF COMMUNICATIONS (NON-CRT EQUIPPED TORONADO & TROFEO)

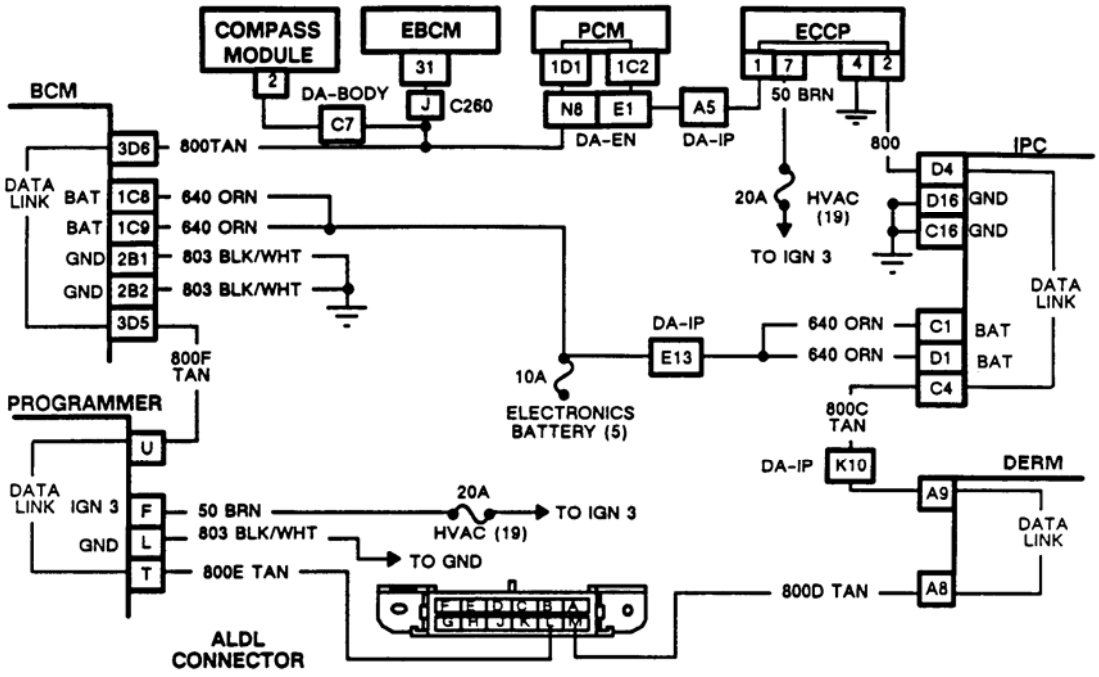


Fig. 41: Chart D - Wiring Schematic (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Zero volts indicate an open or grounded data line.
2. This step checks for short to ground on data line
3. Since ECCP displays were lost, an open must exist between BCM and ECCP. This step determines which side of PCM open is on.

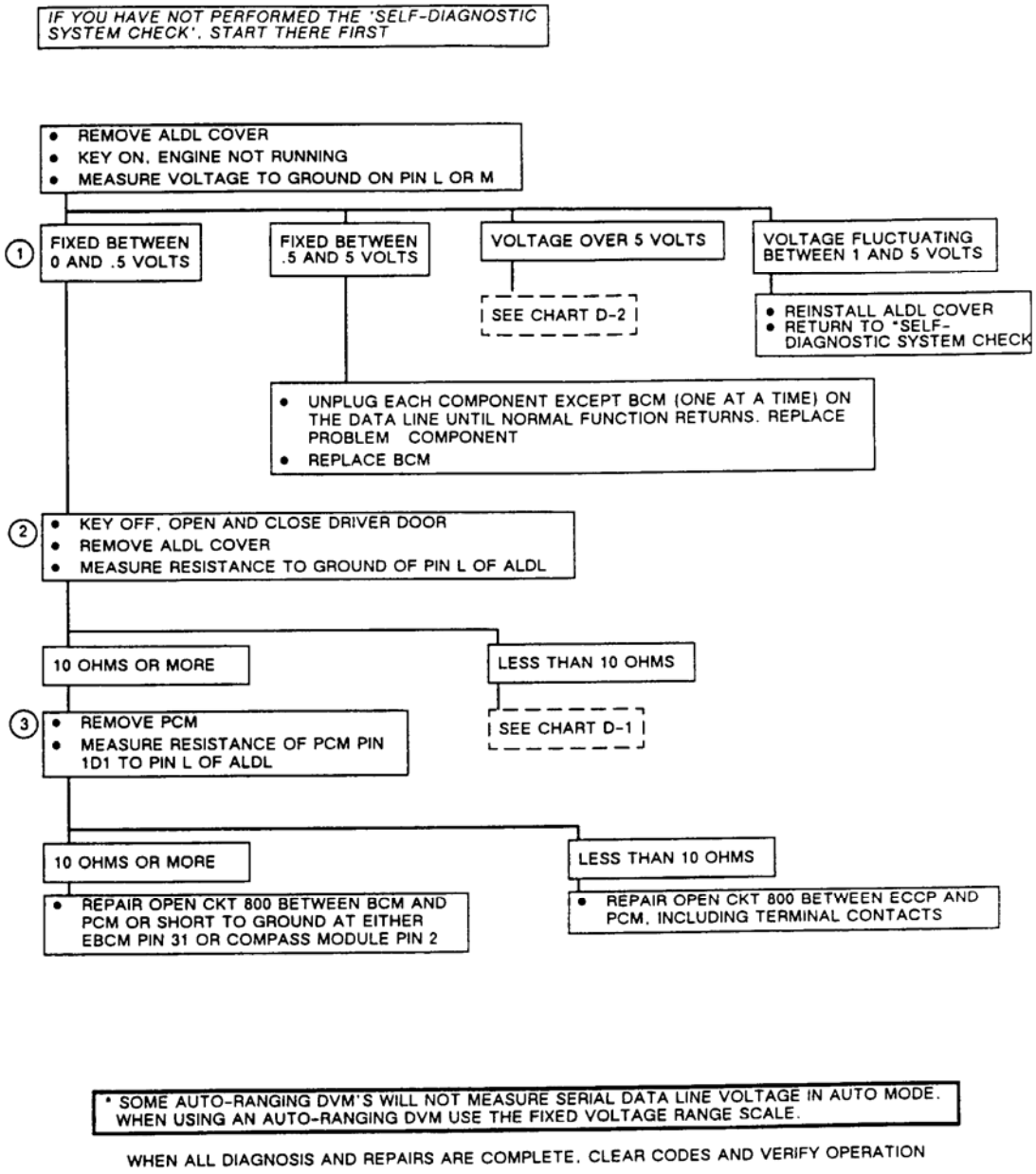


Fig. 42: Chart D - Troubleshooting Diagram (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART D-1, GROUNDED SERIAL DATA CIRCUIT (NON-CRT EQUIPPED TORONADO & TROFEO)

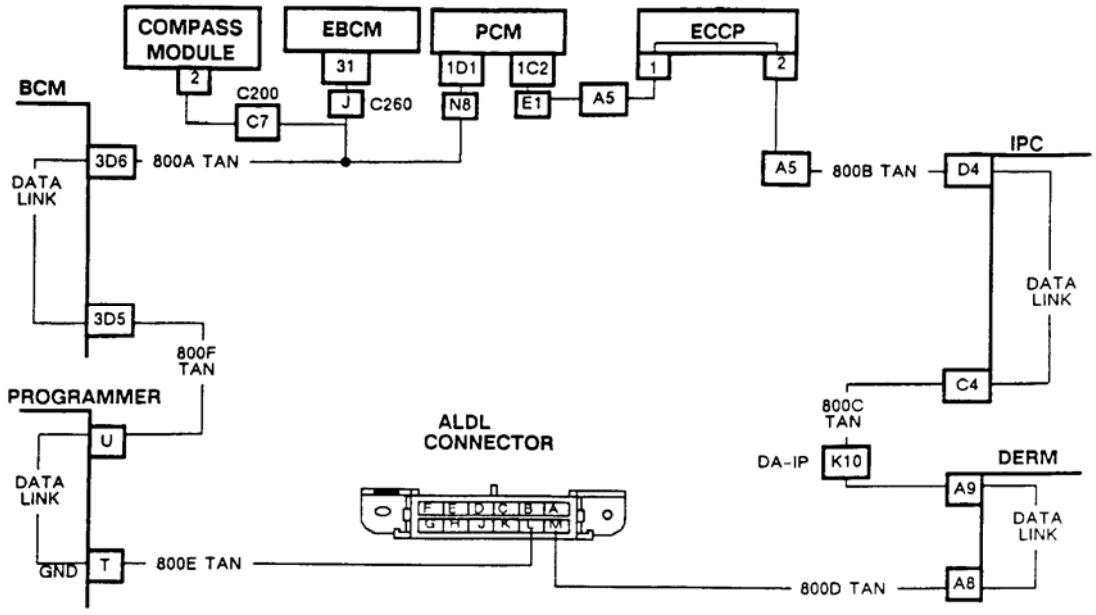


Fig. 43: Chart D-1 - Wiring Schematic (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

With grounded serial data circuit, BCM will not be able to communicate with any other devices in system. Voltage measured anywhere along circuit will be zero. Display on IPC will be ELECTRICAL PROBLEM and ECCP will display dashes "---".

NOTE: Test number refers to test number no diagnostic chart.

1. This step splits system in half to help isolate the source of grounded serial data line. If taking PCM out of system allows both halves of serial data line to rise above one volt, the source of short has been located. The remaining steps of chart follow same pattern in that the components are removed from serial data line until normal voltage range is again measured. When section of circuit is isolated, a simple check of wire for short to ground differentiates between a grounded wire or a ground in the device.

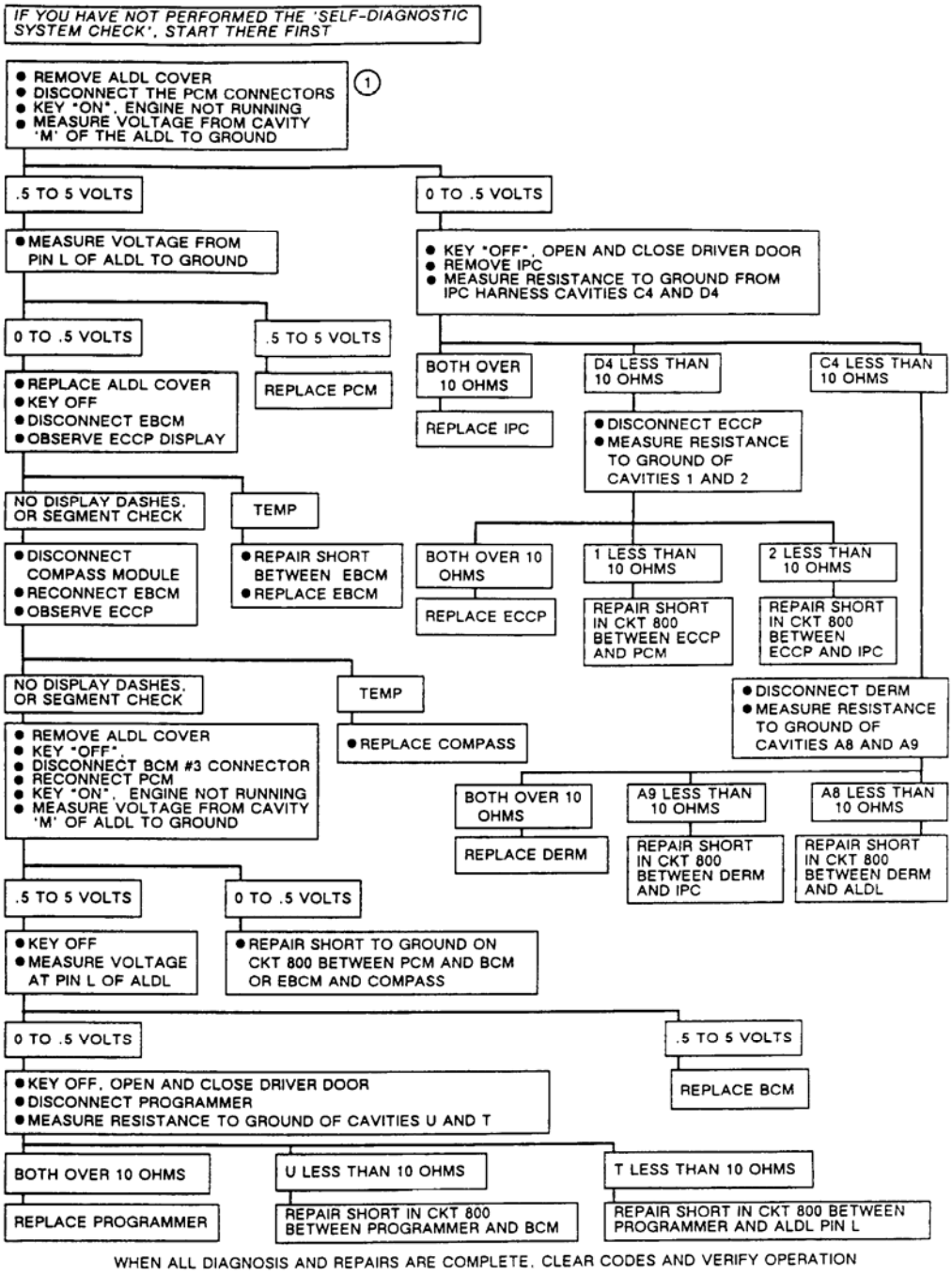


Fig. 44: Chart D-1 - Troubleshooting Diagram (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART D-2, SERIAL DATA CIRCUIT SHORTED TO VOLTAGE (NON-CRT EQUIPPED TORONADO & TROFEO)

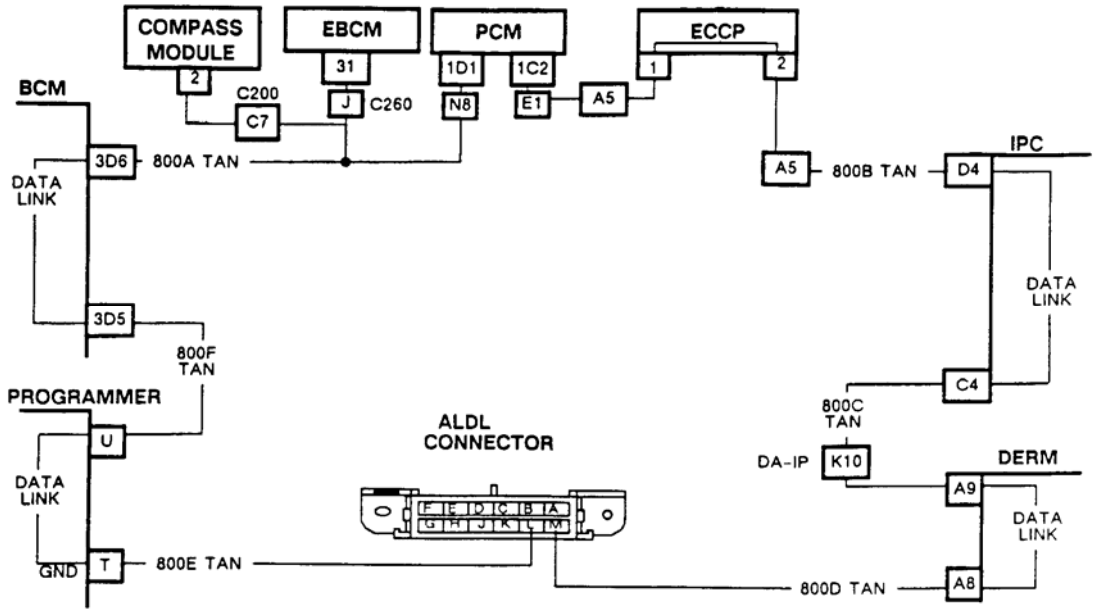


Fig. 45: Chart D-1 - Wiring Schematic (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

With shorted serial data circuit BCM will not be able to communicate with other devices in system. Voltage measured anywhere along circuit will be above 5 volts. IPC will display ELECTRICAL PROBLEM.

NOTE: Test numbers refers to test number on diagnostic chart.

1. This step splits system in half to help isolate source of short in serial data line. If taking PCM out of system allows both halves of serial data line to fall below 5 volts, source of short was in PCM. The remaining steps follow the same pattern in that components are removed from serial data line until normal voltage range is again measured.

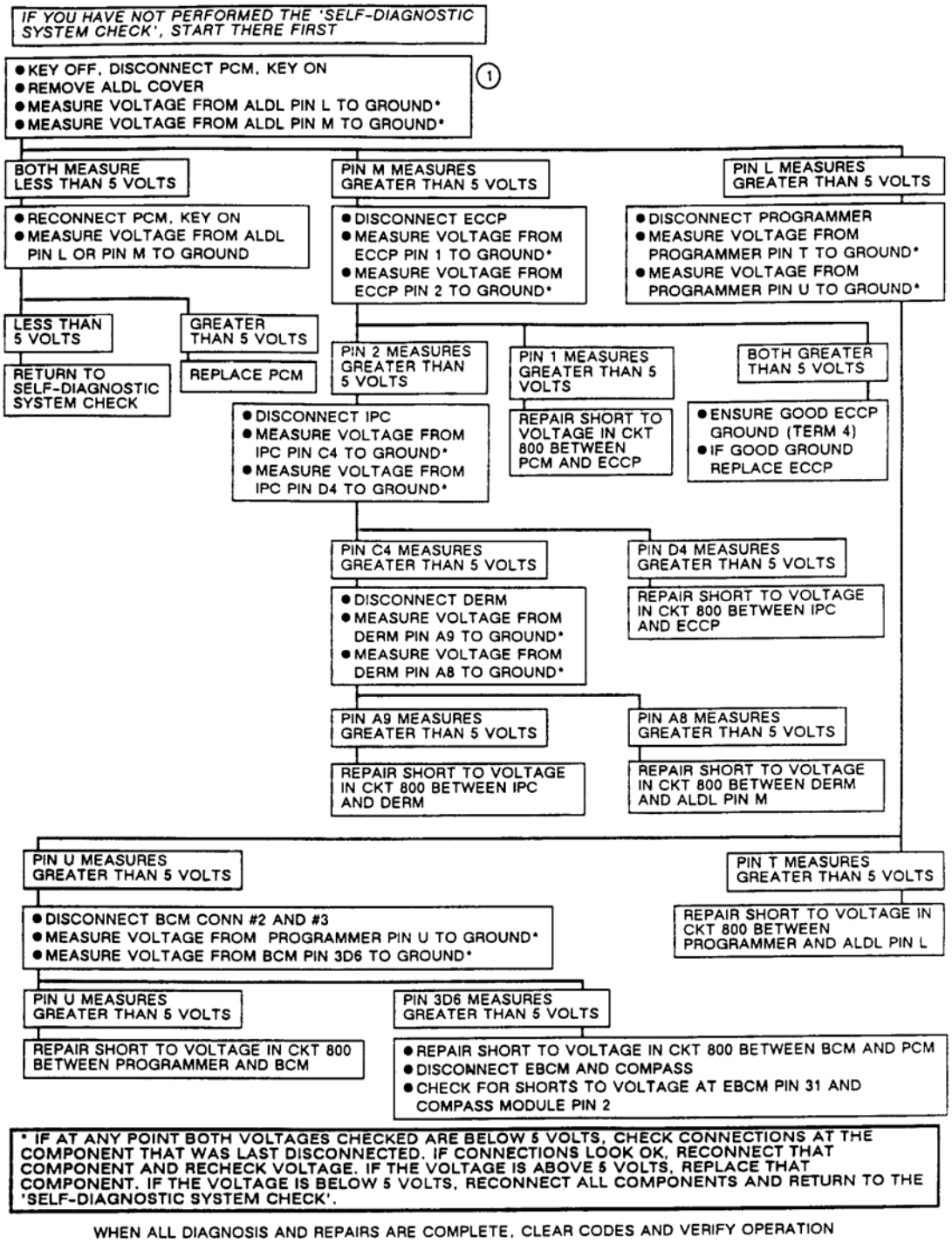


Fig. 46: Chart D-2 - Troubleshooting Diagram (Non-CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

SELF-DIAGNOSTIC SYSTEM CHECK (CRT EQUIPPED TORONADO & TROFEO)

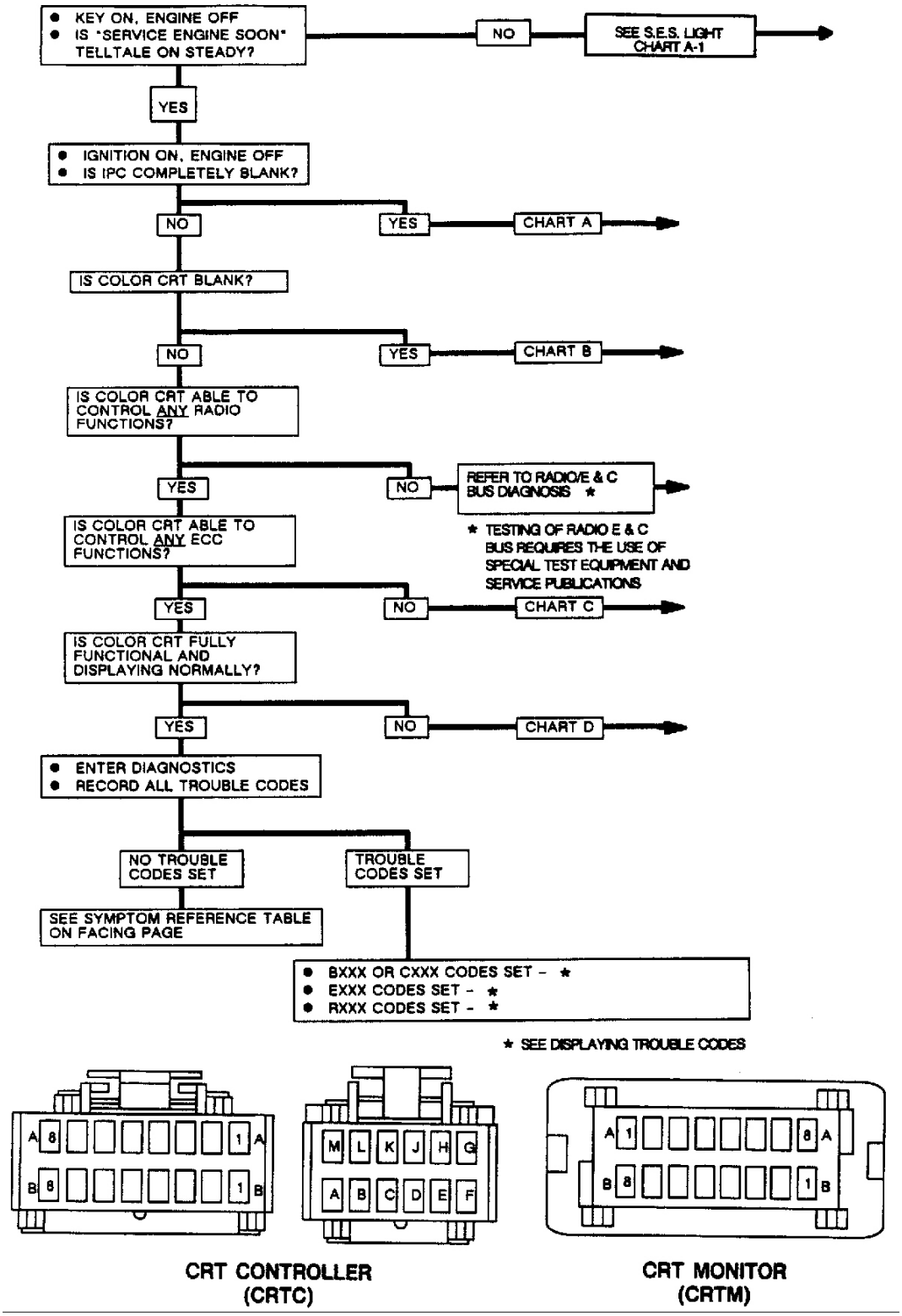


Fig. 47: CRT/DID Connectors (Cavity Views)

Courtesy of GENERAL MOTORS CORP.

The Self-Diagnostic System Check is organized approach for identifying problems caused by on-vehicle computer controlled electronics. Understanding this chart and using it correctly will reduce diagnostic time and prevent unnecessary replacement of components. If you have not reviewed the basic information on how to use computer self-diagnostics, go to beginning of this article.

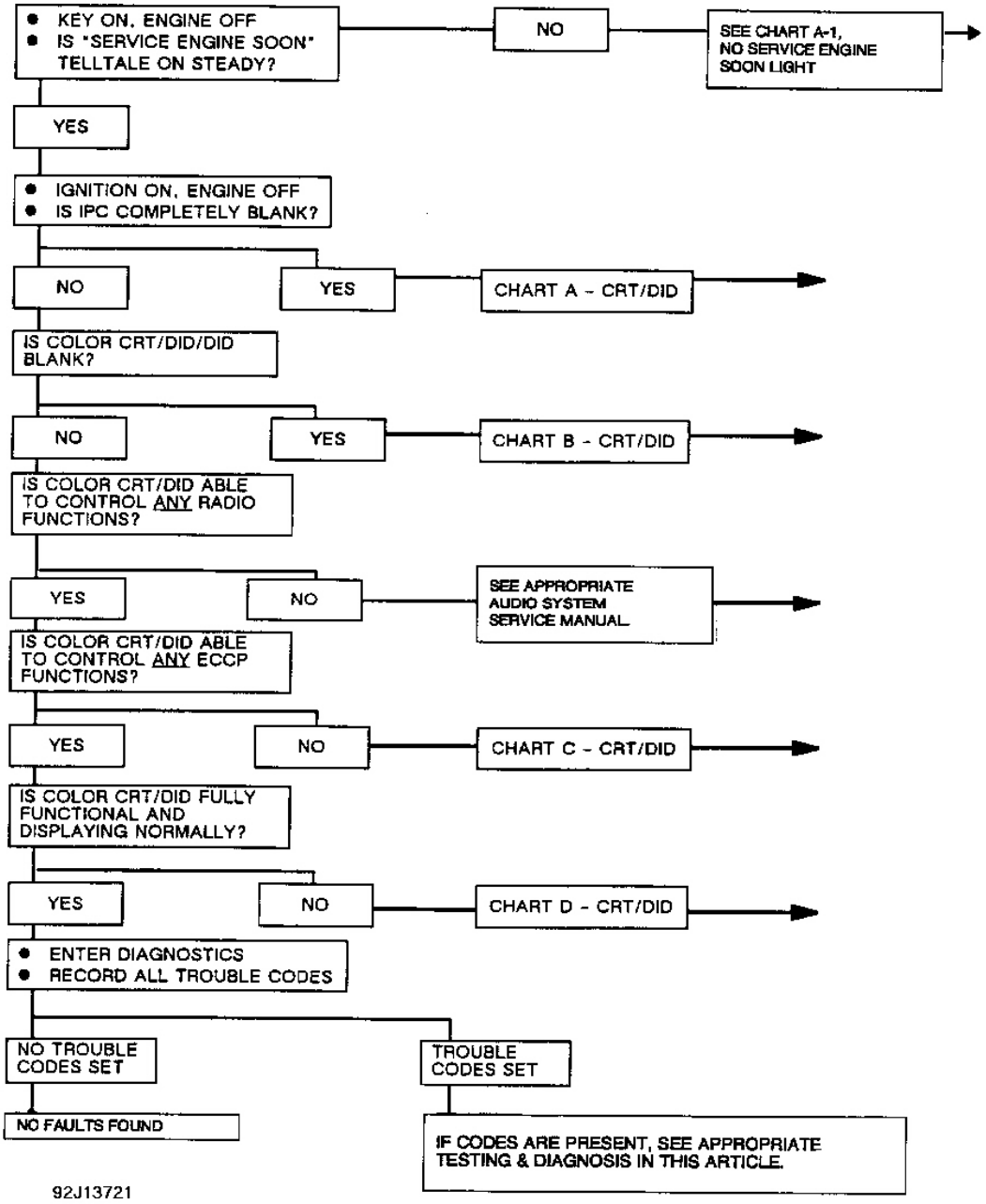


Fig. 48: Self-Diagnostic - Troubleshooting Diagram (CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART A, LOSS OF IPC DISPLAY (CRT EQUIPPED TORONADO & TROFEO)

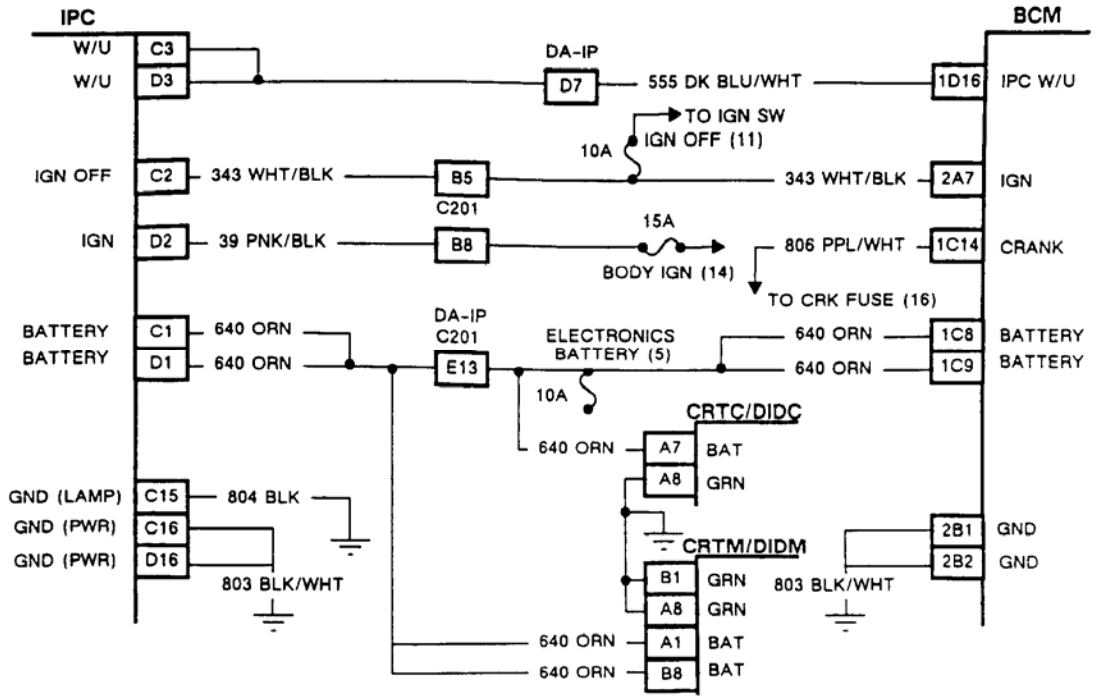


Fig. 49: Chart A - Wiring Schematic (CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

Loss of IPC display and messages can result from the following:

- Loss of 12 volts to IPC
- Loss of ground to IPC
- Loss of wake-up signal from BCM
- Internal BCM or IPC fault

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This step checks to see if BCM is awake. If not awake, the cause of blank display is power and ground related.
2. This step checks BCM power and ground sources.
3. This step checks to see which BCM has lost, power or ground.
4. This step checks for ignition source, BCM power and ground to IPC. With ignition on, battery voltage should be present at listed terminals.

5. Checks for short to ground in any of the 640 circuits.
6. This step checks to see if short to ground is inside a component or in circuit itself.
7. This step checks to see if IPC is receiving 7 volts from BCM.

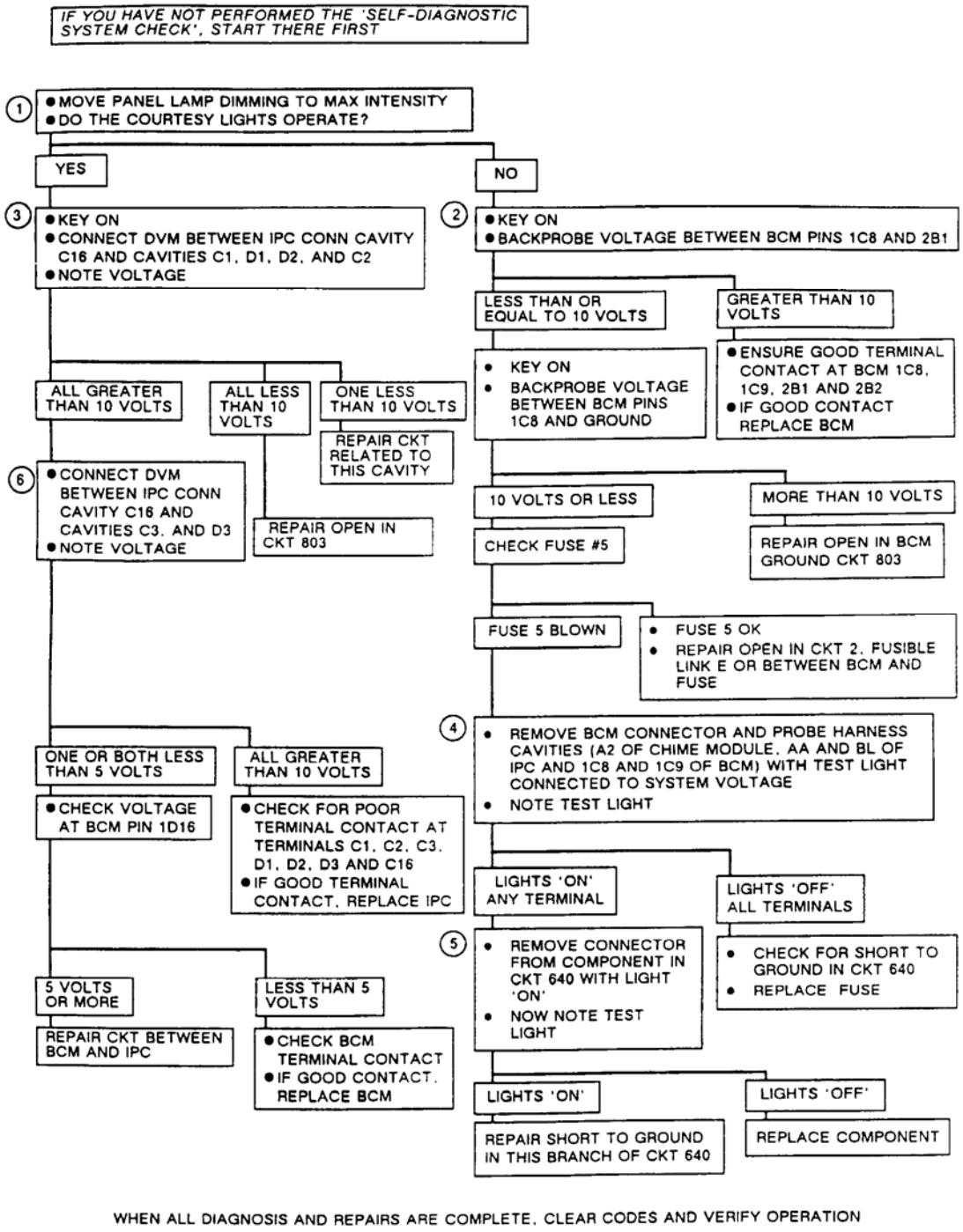


Fig. 50: Chart A - Troubleshooting Diagram (CRT Toronado & Trofeo)

Courtesy of GENERAL MOTORS CORP.

CHART B, COLOR CRT BLANK WITH IGNITION ON (CRT EQUIPPED TORONADO & TROFEO)

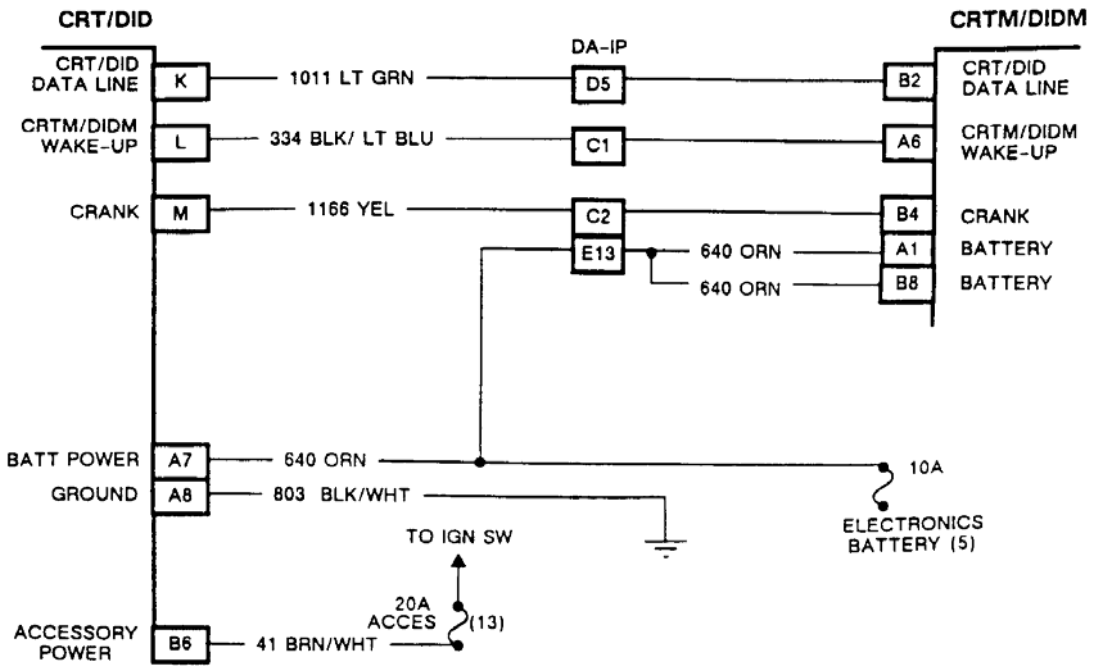


Fig. 51: Wiring Schematic (CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This step checks power supplies to CRT and CRT controller.
2. This step determines if CRT system is awake and operating.
3. This step checks voltage on data line from CRT to CRT controller.
4. This step checks if CRT or CRT controller is causing the low voltage reading on data line.

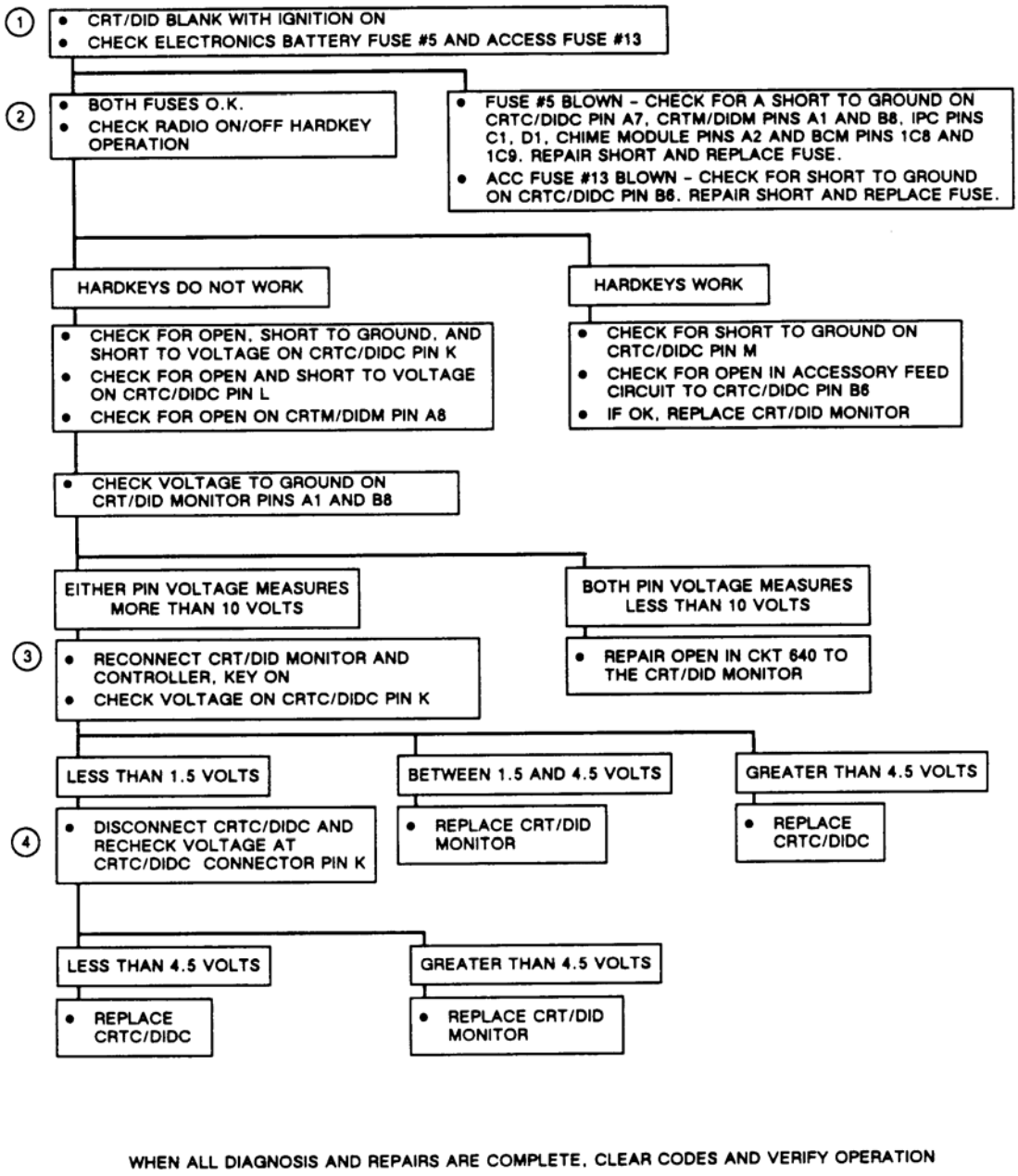


Fig. 52: Chart B - Troubleshooting Diagram (CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART C, COLOR CRT UNABLE TO CONTROL ECCP (CRT EQUIPPED TORONADO & TROFEO)

IPC indicates loss of serial data communication by displaying the message ELECTRICAL PROBLEM. All other segments are blank. If display is fully illuminated and ELECTRICAL PROBLEM message is displayed, enter diagnostics and proceed to appropriate code chart. **DO NOT** use CHART A. See **Fig. 51**.

Loss of serial data communications can occur for the following reasons:

- Short to ground anywhere in circuit No. 800
- Short to voltage anywhere in circuit No. 800
- Two opens in circuit No. 800
- Internal BCM or IPC fault

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If climate control page is accessible, CRTC is receiving ignition power and should be capable of communicating with BCM.
2. This step checks to see if CRTC has lost communications with BCM.
3. This step checks to see if IPC has lost communication with BCM also.
4. This step checks continuity of the data line (circuit No. 800). Since data line is a loop, resistance around it should be close to zero ohms.
5. This step checks for short to ground on data line.
6. This step checks voltage on data line under normal operating conditions. Normal data line voltage is a continual fluctuating between 1.0 and 5.0 volts. Voltage above 5.0 volts or non-fluctuating voltage indicates a problem in data line causing entire communications network to be inoperative.

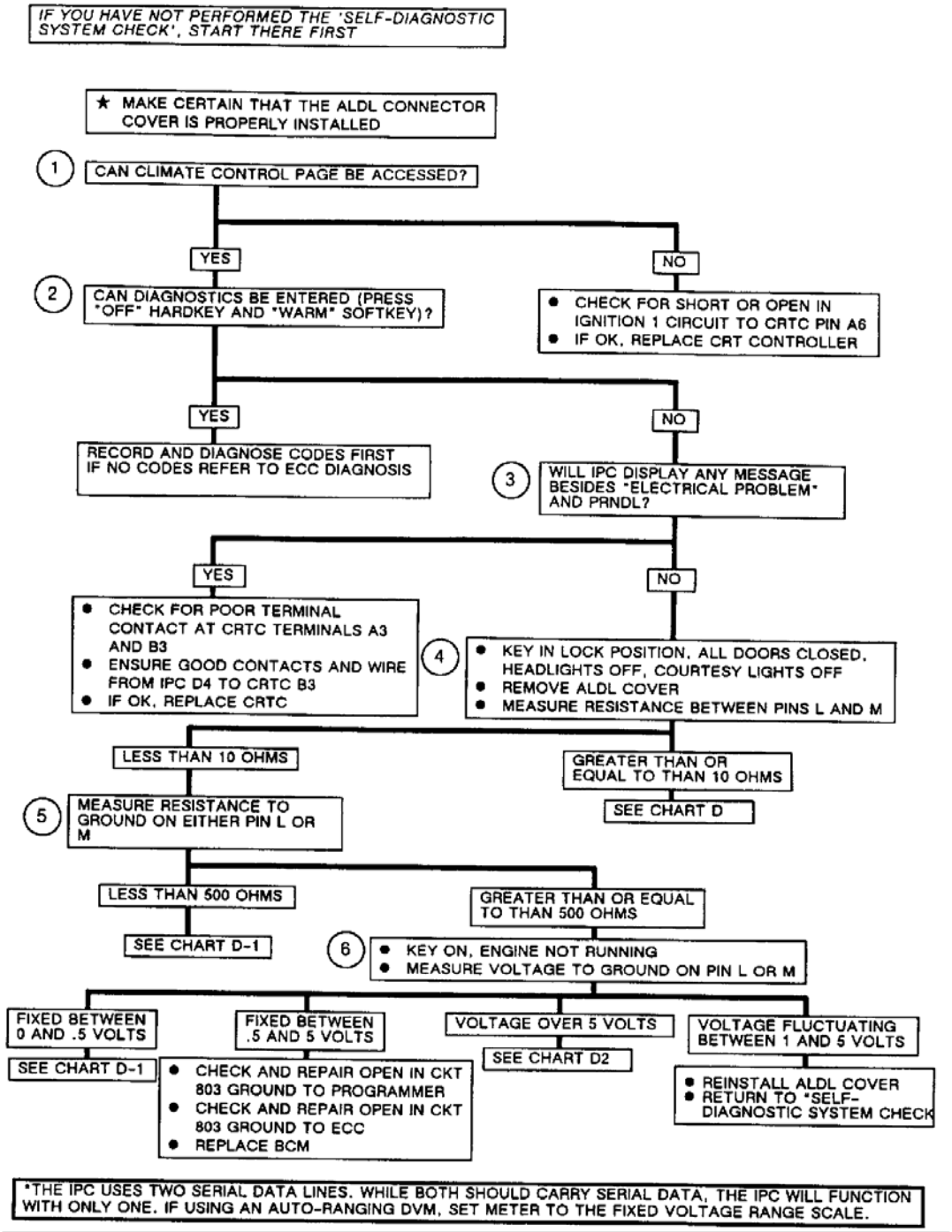


Fig. 53: Chart C - Troubleshooting Diagram (CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART D, SERIAL DATA CIRCUIT OPEN (CRT EQUIPPED TORONADO & TROFEO)

Serial data line is redundant at most of the devices it communicates with. Only one line need be connected to each device for that system to function. When making repairs, both lines should be made operational. If when ALDL cover is removed the system shuts down, a single open existed before. Now a second open in circuit is being created by removing ALDL cover. See **Fig. 51**.

NOTE: Test number refers to test number on diagnostic chart.

1. This test and all subsequent tests are designed to subdivide data line. This is necessary to pinpoint location of open in data line. This is not the only way to pinpoint an open, but in this case, will most quickly lead to the open.

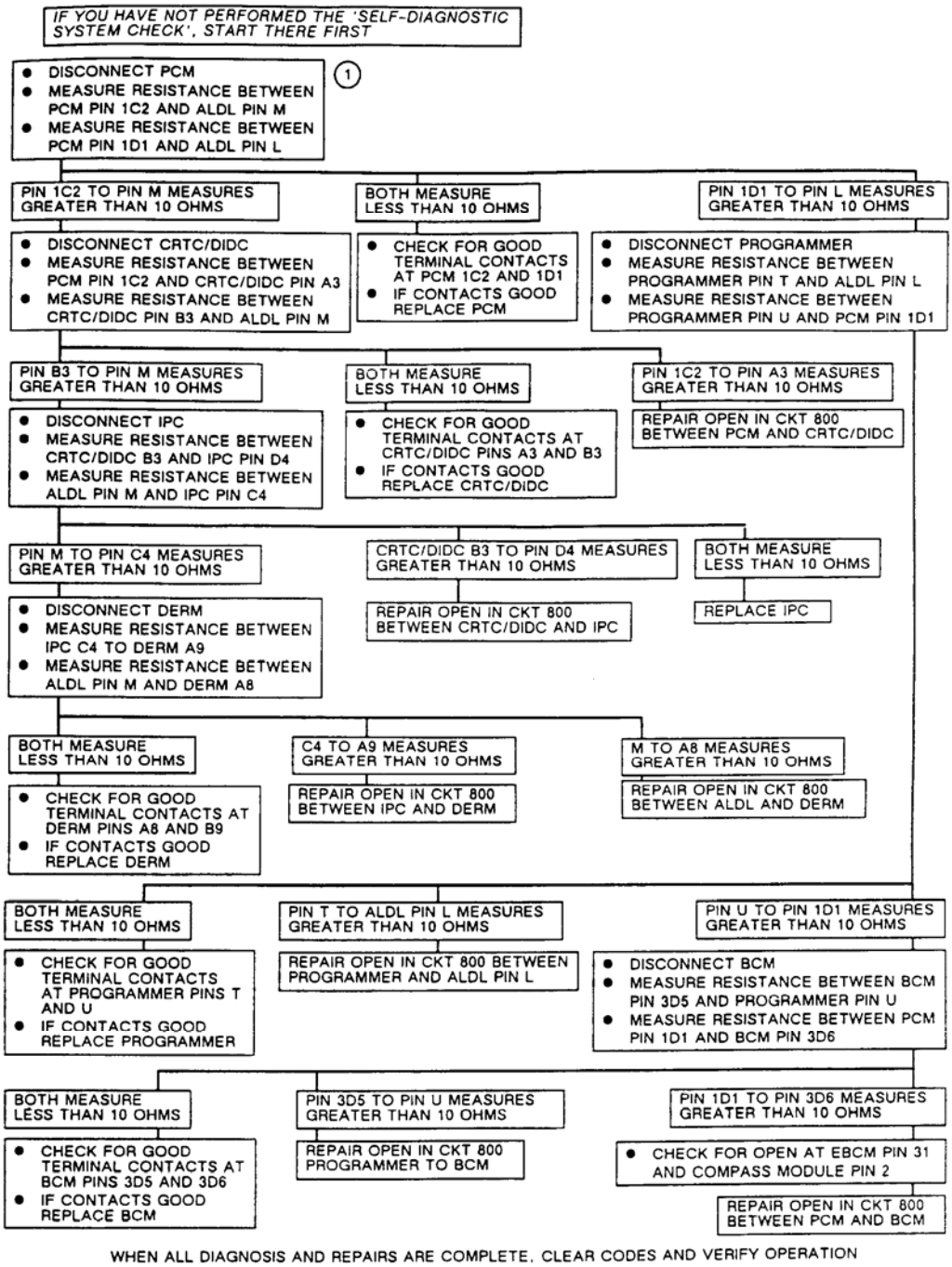


Fig. 54: Chart D - Troubleshooting Diagram (CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART D-1, GROUNDED SERIAL DATA CIRCUIT (CRT EQUIPPED TORONADO & TROFEO)

With grounded serial data circuit, BCM will not be able to communicate with any other devices in system. Voltage measured anywhere in circuit will be zero. IPC display will show ELECTRICAL PROBLEM, CRT

will display normally and HVAC controls will not function. See **Fig. 51**.

NOTE: Test number refers to test number on diagnostic chart.

1. This step splits the system in half to help isolate source of grounded serial data line. If taking PCM out of the system allows both halves of serial data line to rise above one volt, source of short has been located. The remaining steps follow same pattern in that components are removed from serial data line until normal voltage range is again measured. When section of circuit is isolated, a simple check of wire for short to ground will differentiate between grounded wire or ground in a device remote.

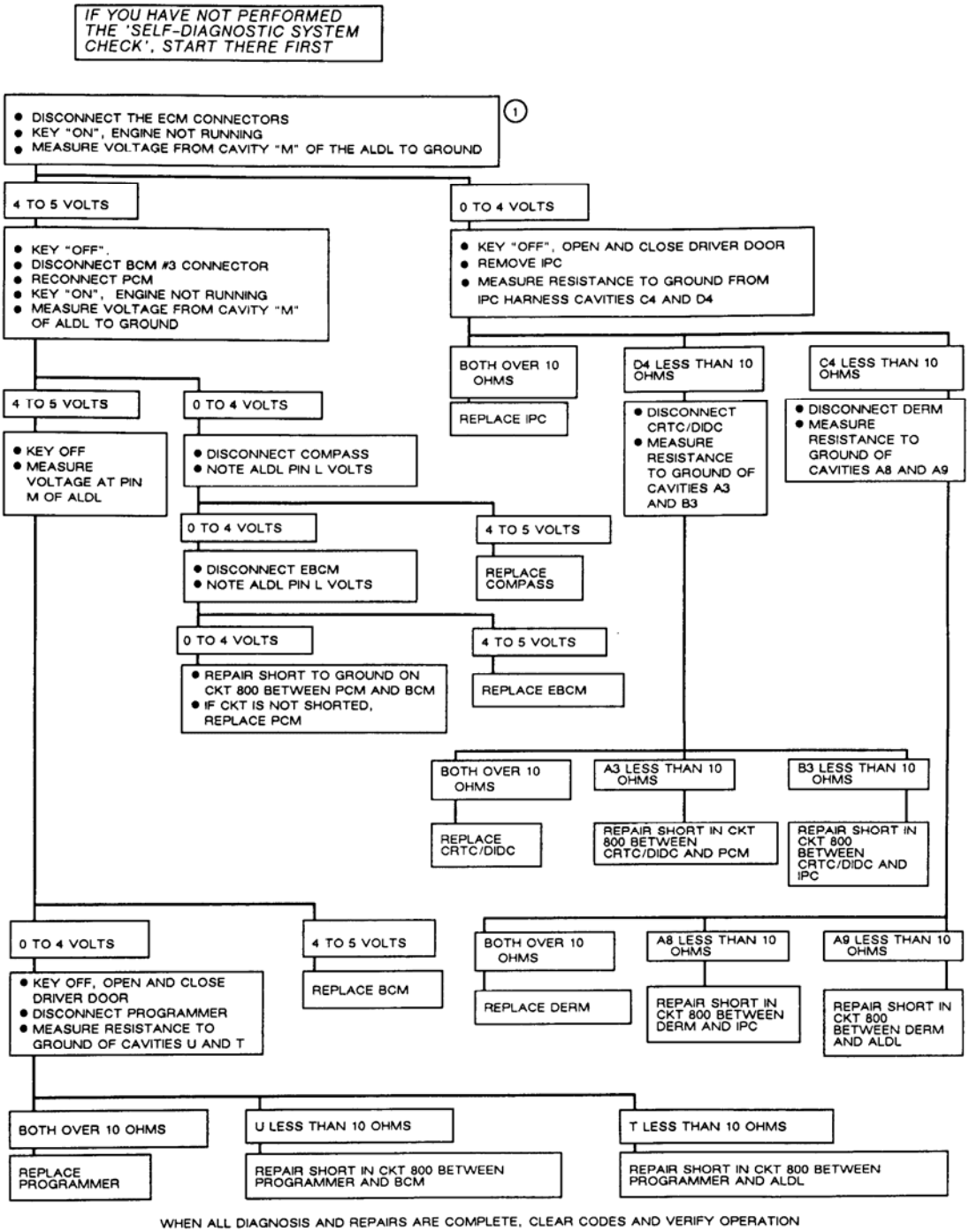


Fig. 55: Chart D-1 - Troubleshooting Diagram (CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART D-2, SERIAL DATA CIRCUIT SHORTED TO VOLTAGE (CRT EQUIPPED TORONADO & TROFEO)

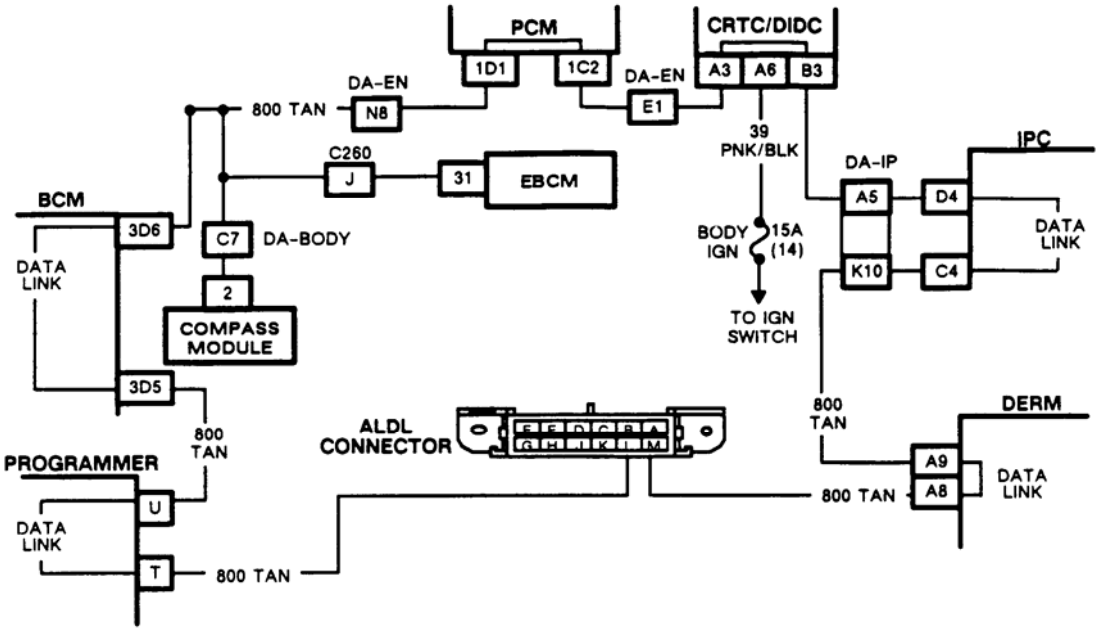


Fig. 56: Chart D-2 - Wiring Schematic (CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

With a shorted serial data circuit, BCM will not be able to communicate with other devices in system. Voltage measured anywhere in circuit will be above 5 volts. IPC display showing only ELECTRICAL PROBLEM.

NOTE: Test number refers to test number on diagnostic chart.

1. This step splits system in half to help isolate the source of short in the serial data line. If taking PCM out of system allows both halves of serial data line to fall below 5 volts, source of short was in PCM.

The remaining steps follow the same pattern in that components are removed from serial data line until normal voltage range is again measured.

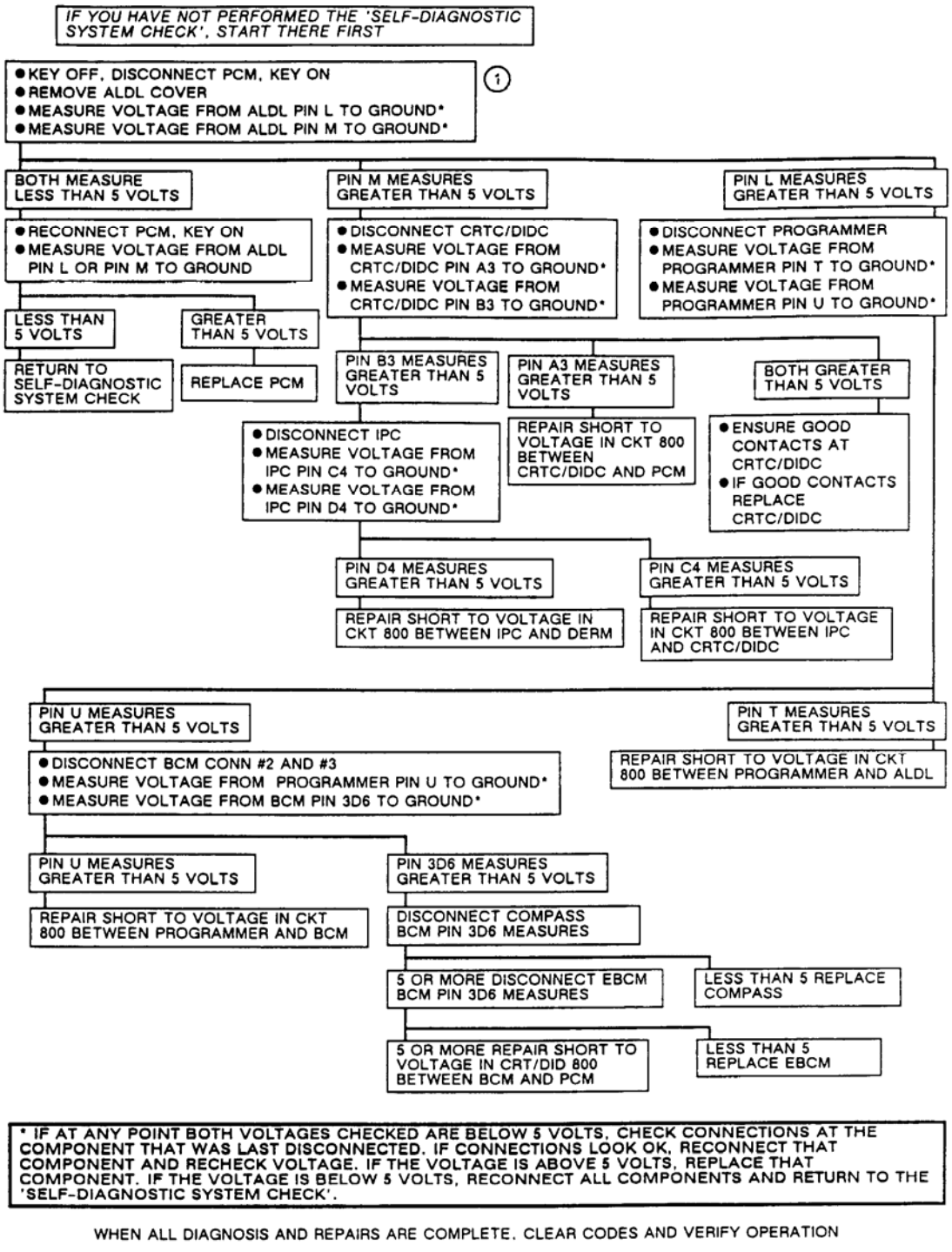


Fig. 57: Chart D-2 - Troubleshooting Diagram (CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CHART E, COLOR CRT ABNORMALITIES (CRT EQUIPPED TORONADO & TROFEO)

NOTE: **If you have not performed the SELF-DIAGNOSTIC SYSTEM CHECK, start there first.**

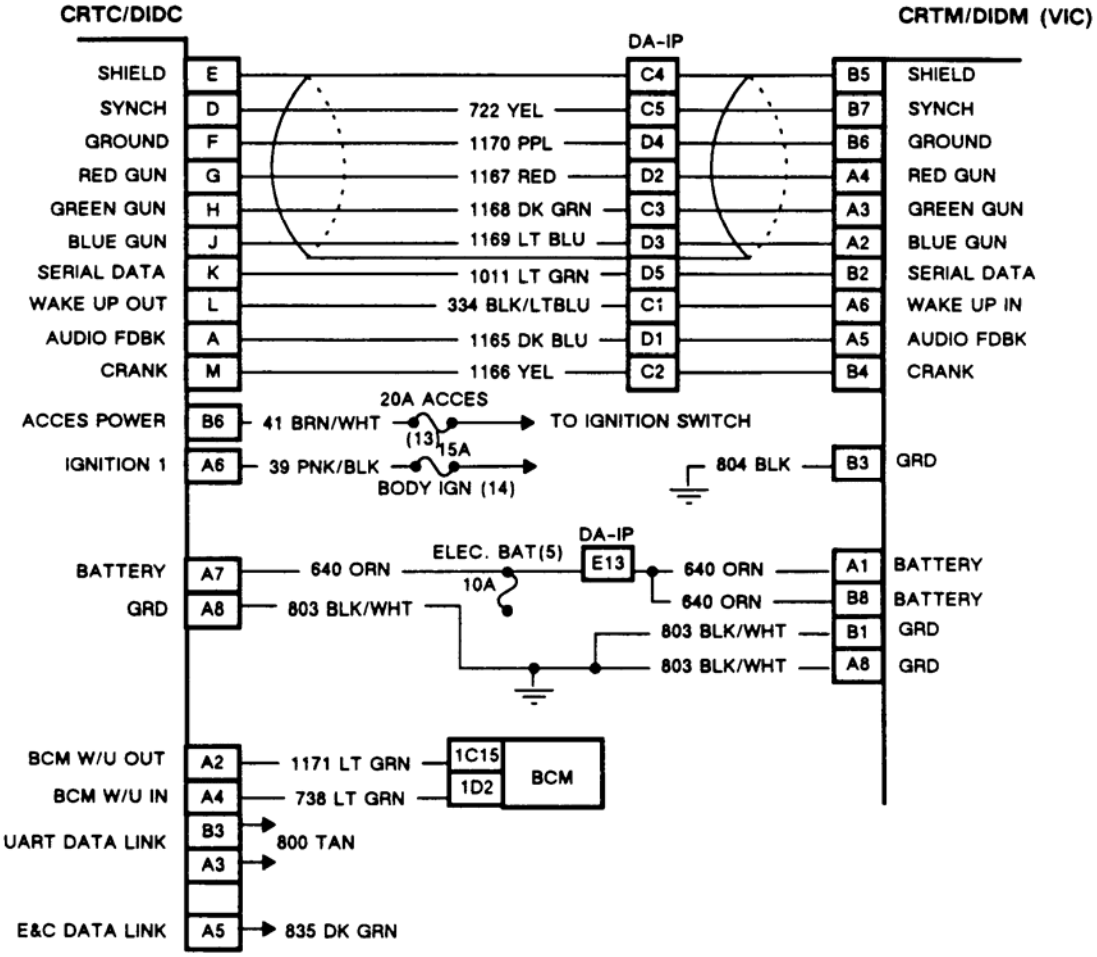
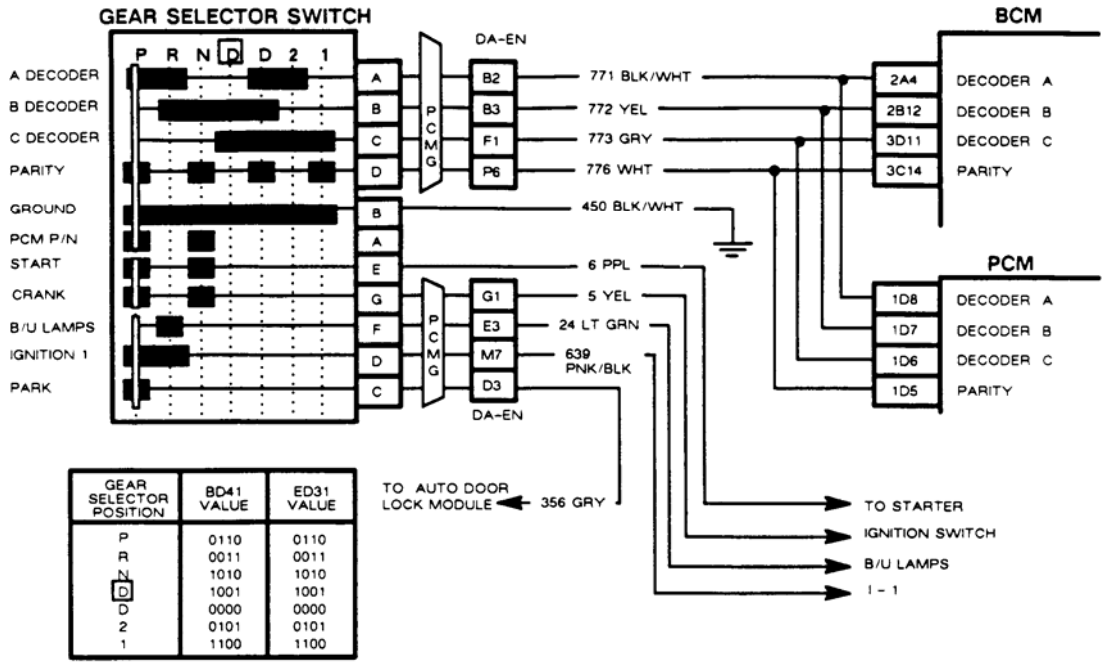


Fig. 58: Chart E - Wiring Schematic (CRT Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CODE B127, GEAR SELECTOR SWITCH CIRCUIT



GEAR SELECTOR POSITION	BD41 VALUE	ED31 VALUE
P	0110	0110
R	0011	0011
N	1010	1010
D	1001	1001
D	0000	0000
2	0101	0101
1	1100	1100

Fig. 59: Code B127 - Wiring Schematic (Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

The gear selector switch (or PRN**D** D21) is mounted on transaxle assembly. It is a multi-signal switch sending information relative to gear selector position to BCM and PCM. The PRN**D** D21 switch assembly also contains the neutral safety switch. The PRN**D** D21 switch uses 4 discrete circuits to pull 4 BCM voltages low in various combinations to indicate each gear range. The voltage level of each of circuits is represented in BD41 display as "0" equals grounded and "1" equals not grounded. The 4 digits displayed represent decoder "A", "B", "C" and parity inputs in sequence.

Switch status can be seen by monitoring BD41 or ED31 data parameter, where switch status is displayed as a 4-digit binary number. Code B127 will set if following conditions:

- BCM PRN**D** D21 switch data input indicates park/neutral, but PCM input does not
- BCM PRN**D** D21 switch data input does not indicate park/neutral, but PCM input does
- Decoder and parity data inputs do not agree with possible combinations per BD41 display values found in DATA DISPLAY in introduction portion of this article.

If Code B127 is set, Driver Information Center (DIC) will display warning message GEAR SELECT FAULT and IPC PRN**D** D21 display will flash.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks BCM data inputs when only decoder "A" and parity circuit are pulled low.
2. Checks BCM data inputs when only decoder "B" and "C" inputs are pulled low. This will complete HI/LO check of all 4 BCM inputs.

3. This step is to check gear selector switch problem in other gear ranges.
4. Checks to see if code is due to discrepancy between PCM and BCM inputs.

Note On Intermittents

Manipulate related PCM and BCM wiring in each gear range while looking for a change in ED31 or BD41 display values to check for intermittent open or short to ground. Also check terminals for good contact at PCM, BCM and PRN**D** D21 switch. If good contact exists and Code B127 continues to set, replace PRN**D** D21 switch.

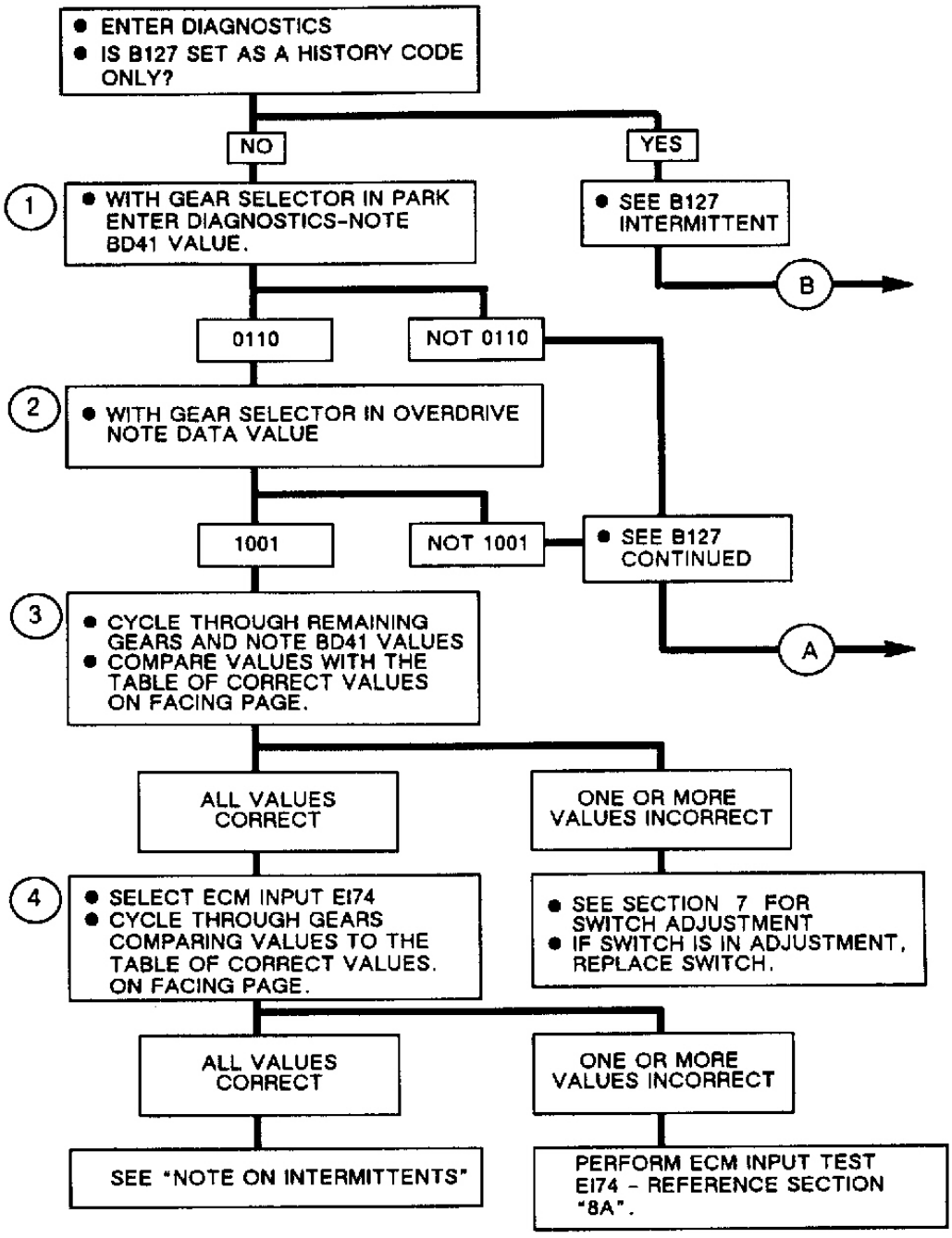


Fig. 60: Code B127 - Troubleshooting Diagram 1 of 3 (Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for short to ground in gear selector switch to BCM circuits.

2. Checks for open in circuits to BCM.
3. Circuit shorted to ground will result in a "0" for that circuit.
4. Checks for open PRN**D** D21 sensor ground.
5. Circuit with open will result in a "1" for that circuit.

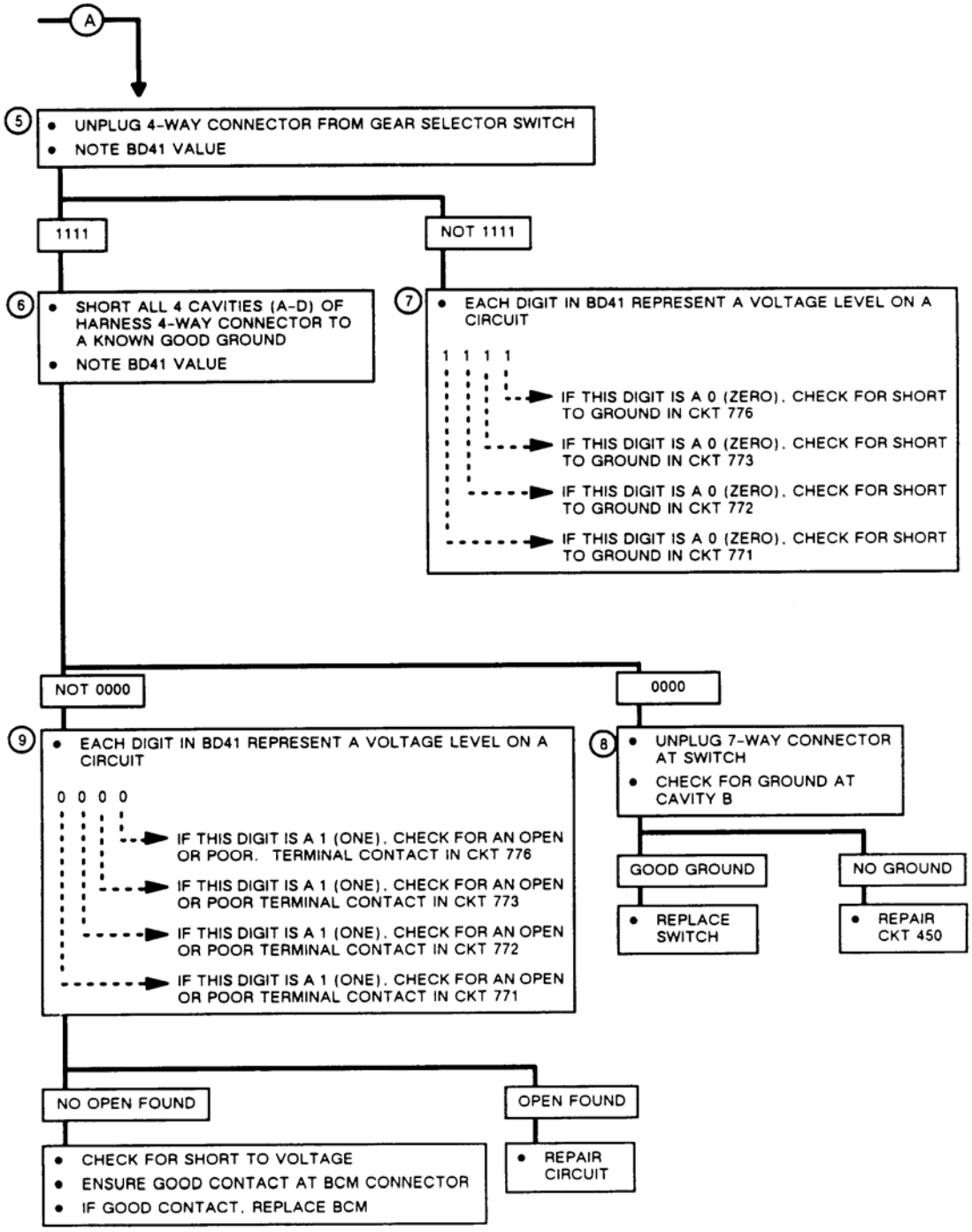


Fig. 61: Code B127 - Troubleshooting Diagram 2 of 3 (Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

6. The snap data value of DB41 display will be the value that BCM recognized when code was set. This is used to determine whether this value is valid. If it is a valid, PCM park/neutral input must be incorrect to set code.

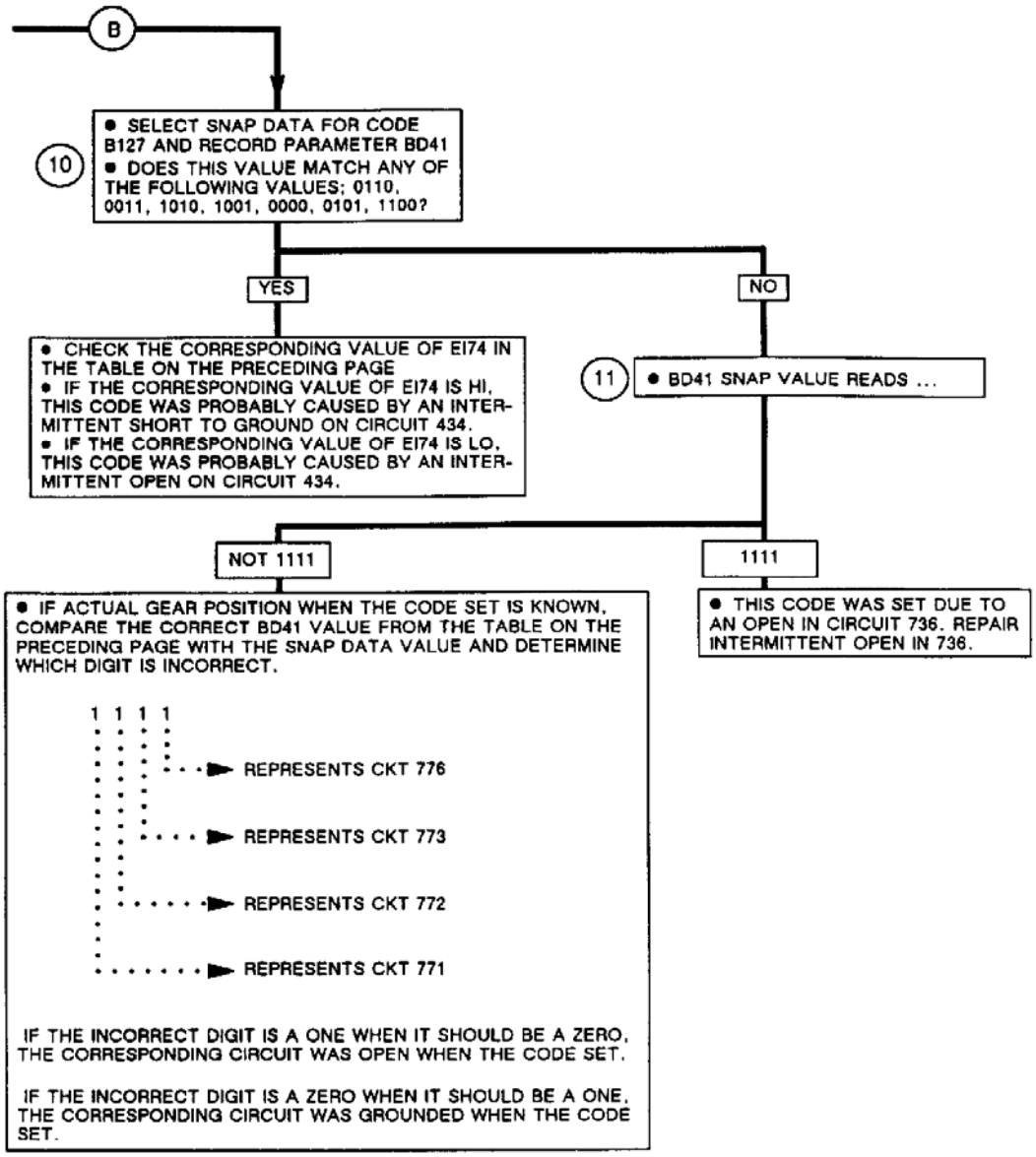


Fig. 62: Code B127 - Troubleshooting Diagram 3 of 3 (Toronado & Trofeo)
Courtesy of GENERAL MOTORS CORP.

CODE 23, MAT SENSOR SIGNAL VOLTAGE HIGH

CODE 23 ECM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM Terminal	Wire Color
2.0L, 2.2L J Body & 2.5L A & N Bodies		
MAT Signal	B5	Tan
MAT Ground	W14	Black/Orange
2.2L L Body		
MAT Signal	B5	Black/Pink
MAT Ground	W14	Black
2.3L L Body		
MAT Signal	GF16	Black/Pink
MAT Ground	BB5	Black
2.3L W Body, 2.5L W Body & 3.1L W Body & 3.4L W Body		
MAT Signal	C4	Tan
MAT Ground	C5	Black
3.1L A, F & J Bodies & 5.0L & 5.7L PFI F Body		
MAT Signal	GF16	Tan
MAT Ground	BB5	Black
3.1L L Body		
MAT Signal	GF16	Pink/Black
MAT Ground	BB5	Black
3.8L C & E Bodies		
MAT Signal	BB7	Tan
MAT Ground	BA7	Black
3.8L H Body		
MAT Signal	YD11	Tan
MAT Ground	YD5	Black
3.8L W Body		
MAT Signal	R12	Tan
MAT Ground	R2	Black/White
5.0L & 5.7L TBI		
MAT Signal	C12	Tan
MAT Ground	A11	Black
5.7L Y Body		
MAT Signal	C4	Tan
MAT Ground	C5	Black/Pink

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This checks if code is the result of a hard failure or an intermittent condition. Code 23 will set if engine has been running for a precalibrated period of time, has reached operating temperature and signal voltage indicates a MAT temperature less than -22°F (-30°C).
2. This simulates conditions for a Code 25. If the "Scan" tester displays a high temperature, the control

module and wiring are not at fault.

3. This checks for continuity of sensor signal and ground circuits. If ground circuit is shared by other sensors and ground circuit is open, accompanying codes related to those sensors may be present.

Diagnostic Aids

If the engine is allowed to cool overnight, the coolant and MAT sensors should read close to each other, when measured with a "Scan" tester. A Code 23 will result if signal and ground circuits become open. Check sensor for shifted calibration by using sensor **TEMPERATURE-TO-RESISTANCE VALUES** table.

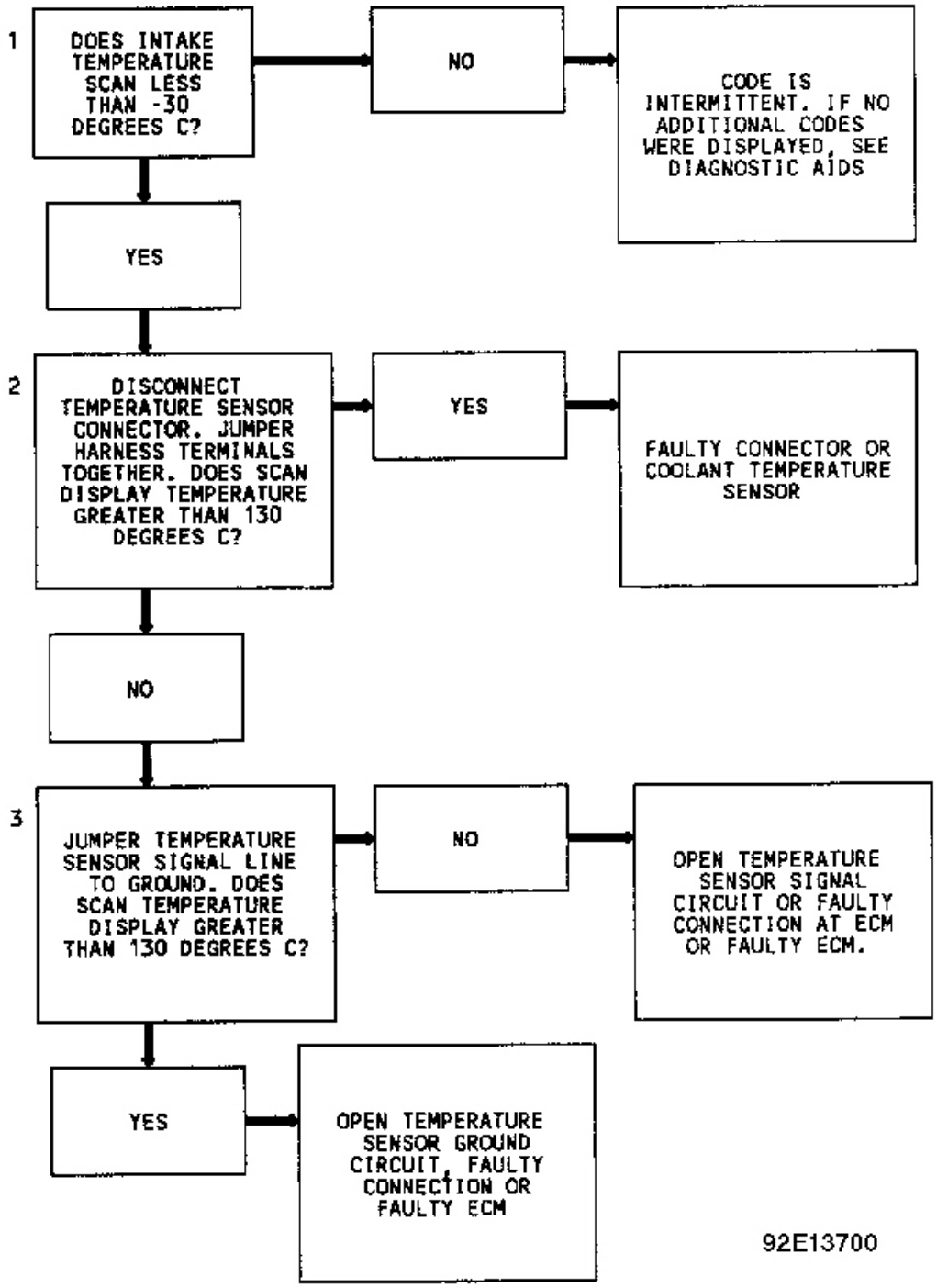


Fig. 63: Code 23 Troubleshooting Diagram
Courtesy of GENERAL MOTORS CORP.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	Ohms
210 (100)	185
160 (70)	450
100 (38)	1800
70 (20)	3400
20 (-7)	13,500
0 (-18)	25,000
-40 (-40)	100,700
NOTE:	Measure resistance across sensor terminals.

CODE 24, VEHICLE SPEED SENSOR (A, F, J, L, N, W & Y BODIES)

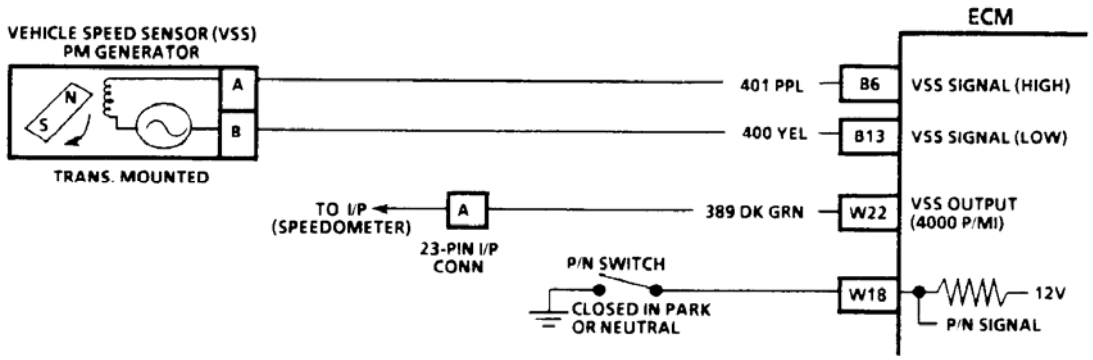


Fig. 64: Code 24, VSS Circuit Diagram 1 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

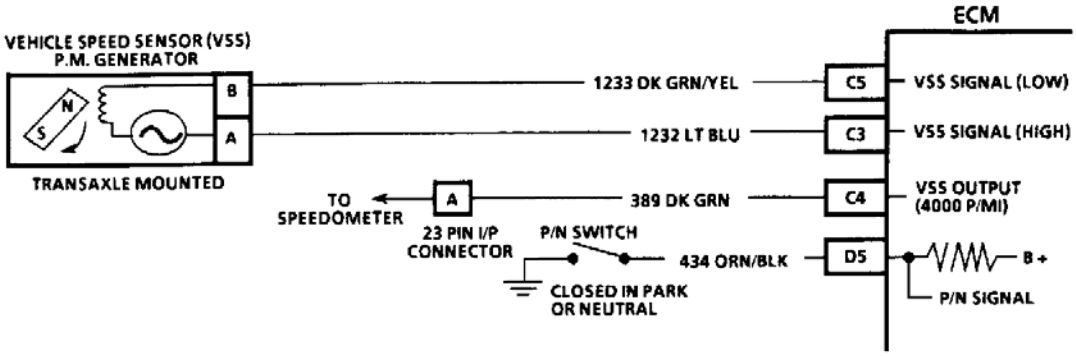


Fig. 65: Code 24, VSS Circuit Diagram 2 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

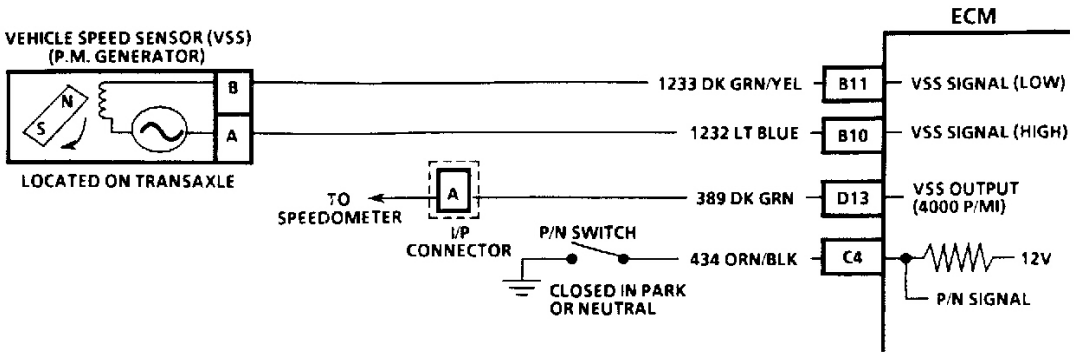


Fig. 66: Code 24, VSS Circuit Diagram 3 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

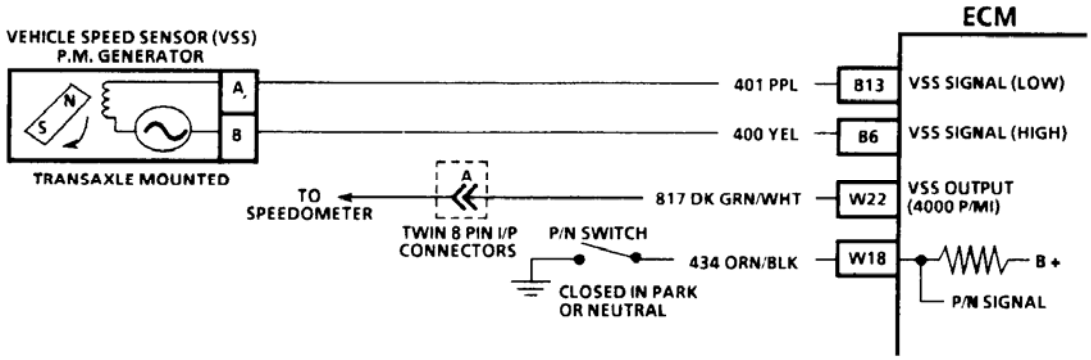


Fig. 67: Code 24, VSS Circuit Diagram 4 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

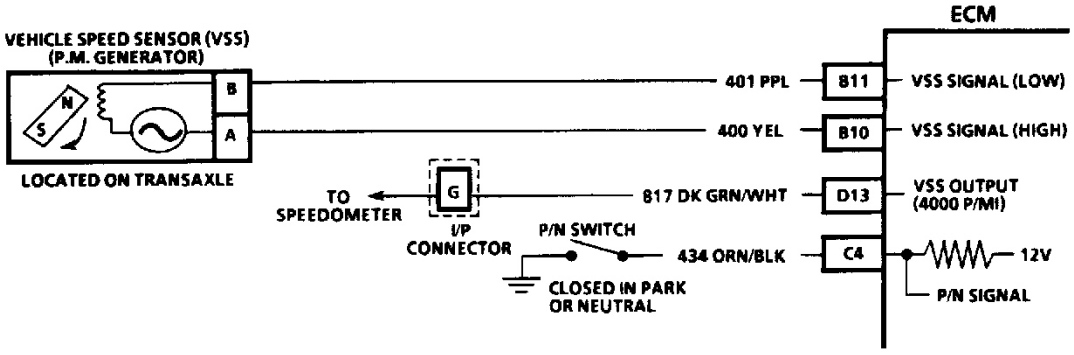


Fig. 68: Code 24, VSS Circuit Diagram 5 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

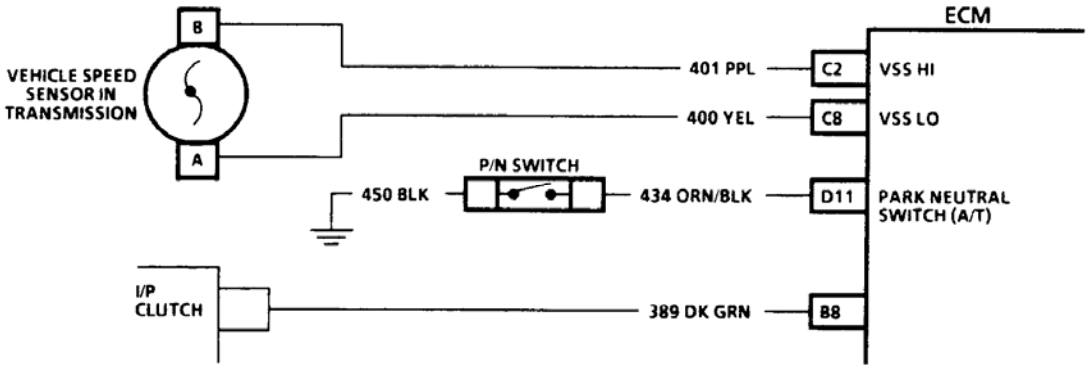


Fig. 69: Code 24, VSS Circuit Diagram 6 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

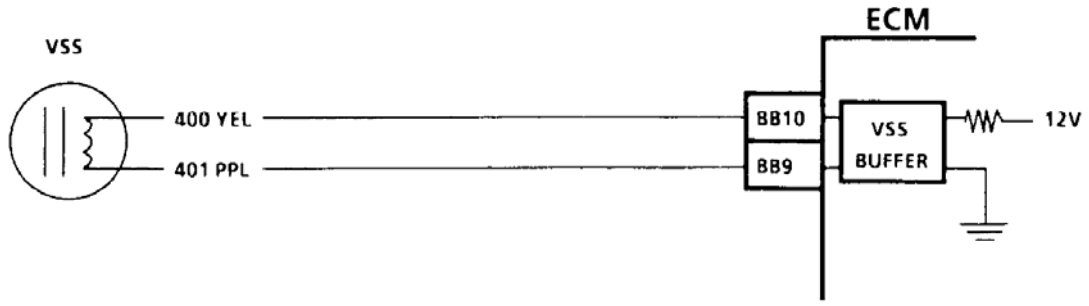


Fig. 70: Code 24, VSS Circuit Diagram 7 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

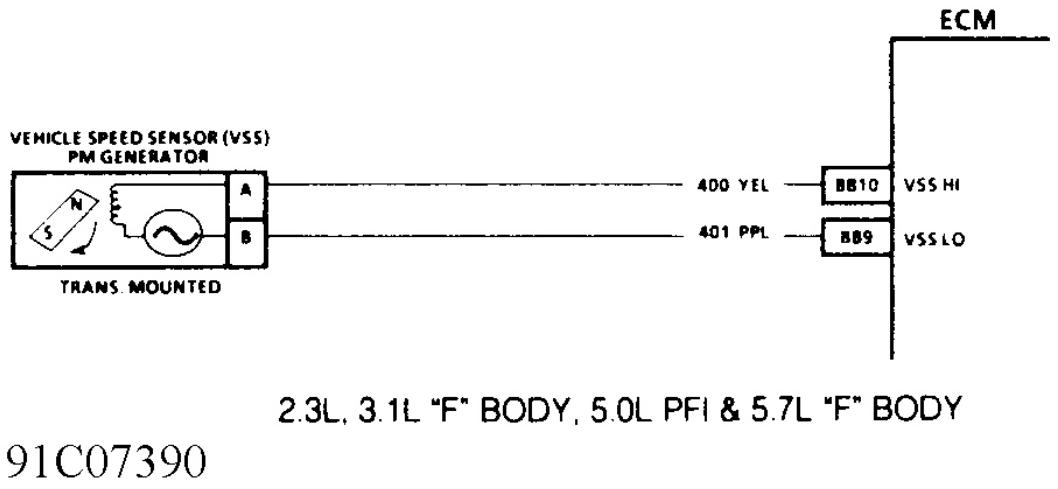


Fig. 71: Code 24, VSS Circuit Diagram 8 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

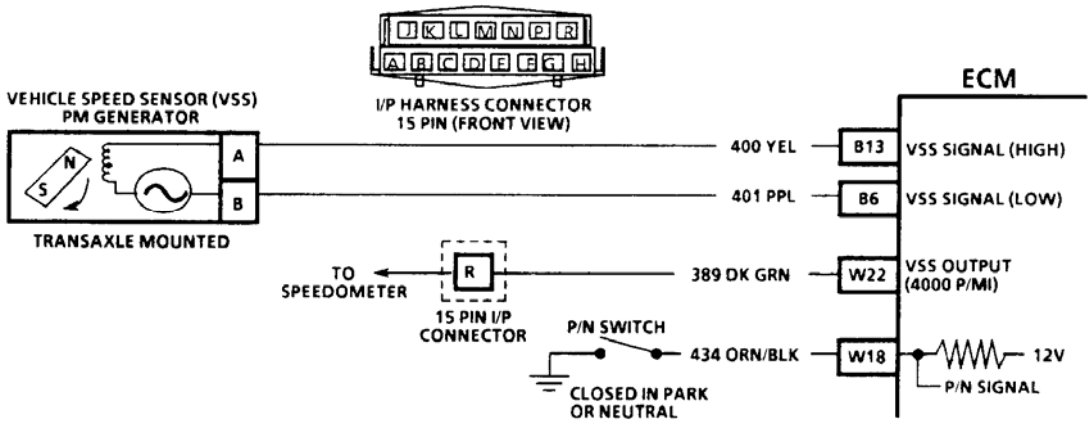


Fig. 72: Code 24, VSS Circuit Diagram 9 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

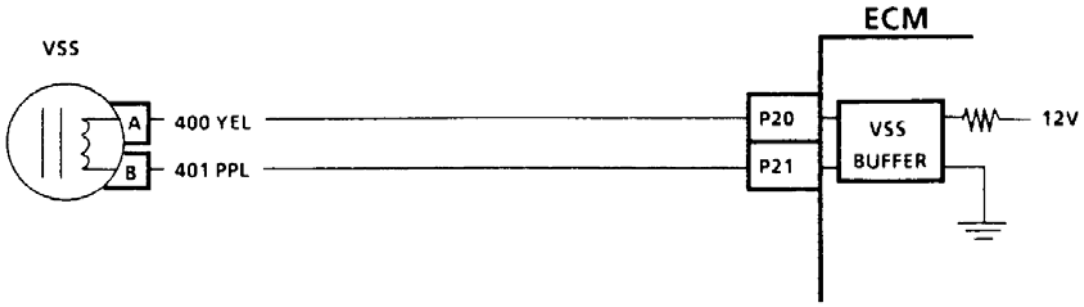


Fig. 73: Code 24, VSS Circuit Diagram 10 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

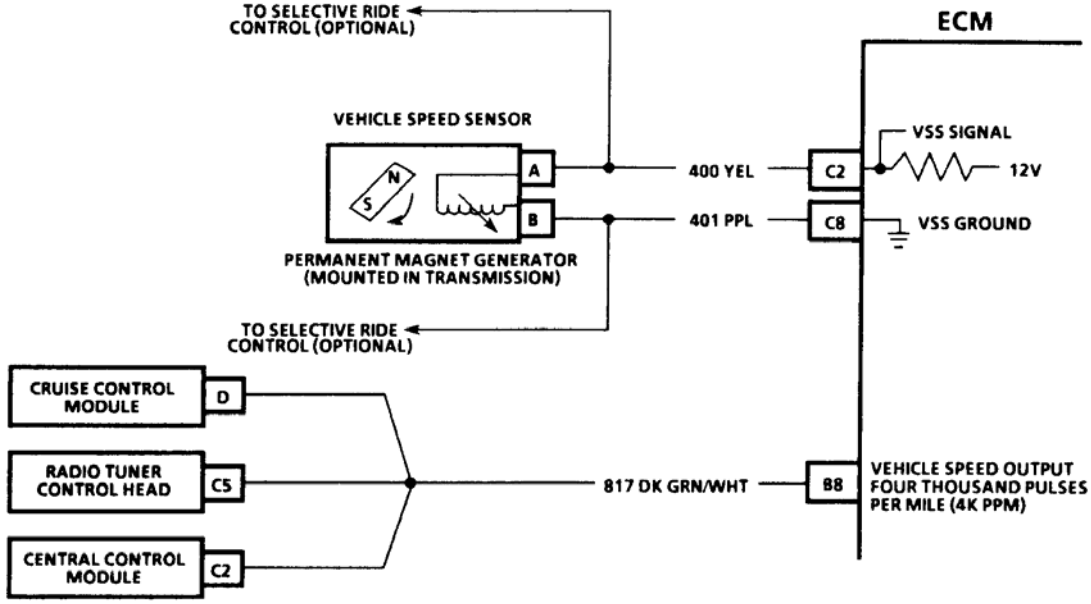


Fig. 74: Code 24, VSS Circuit Diagram 11 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

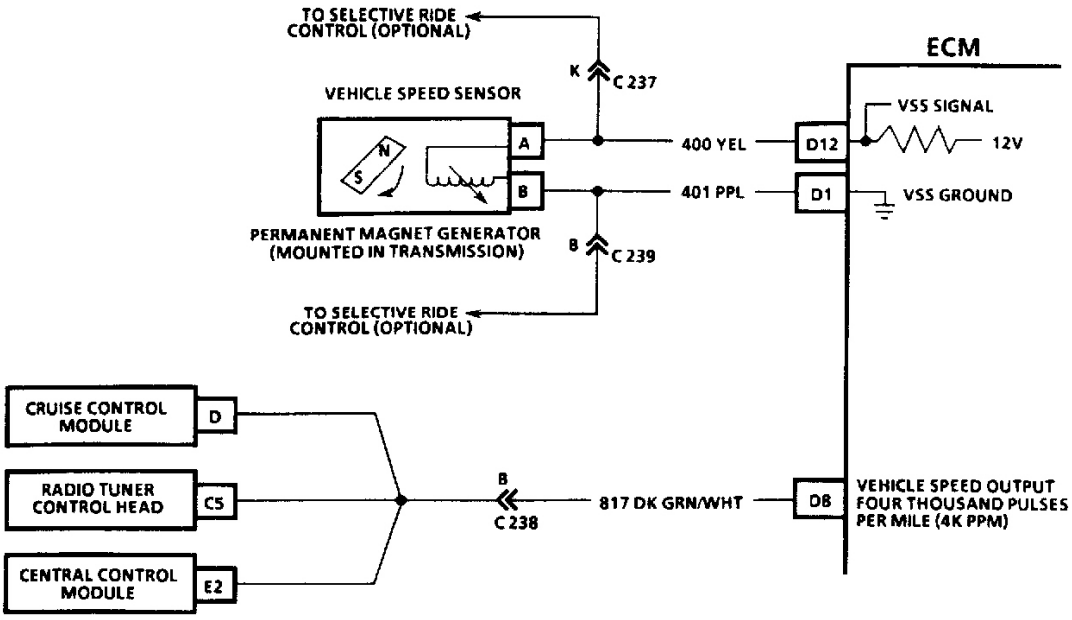


Fig. 75: Code 24, VSS Circuit Diagram 12 Of 12 (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

The speed sensor, which is a Permanent Magnet (PM) generator, provides the control module with vehicle speed information. The PM generator, mounted on the transmission, produces a pulsing voltage signal whenever the vehicle speed is more than 3 MPH. The voltage level and pulses increase with vehicle speed. The control module converts the pulsing voltage to MPH, which is used by the control module in calculations to determine vehicle adjustments.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. A Code 24 will set when MPH reads zero, transmission is not in Park or Neutral, engine speed indicates vehicle is in a cruise mode (1200-4400) RPM, TPS indicates closed throttle and high manifold vacuum is sensed by the MAP sensor. All of these conditions must be met for 2-5 seconds. The PM generator only produces a voltage signal if drive wheels are turning greater than 3 MPH.
2. Before replacing the control module, PROM/MEM-CAL should be checked for correct application.

Diagnostic Aids

A faulty or misadjusted park/neutral switch may set a false Code 24. Use "Scan" tester and check for proper signal in Drive, while wiggling shifter. Code 24 may set if vehicle is power braked (brakes applied and throttle depressed) for more than 10 seconds.

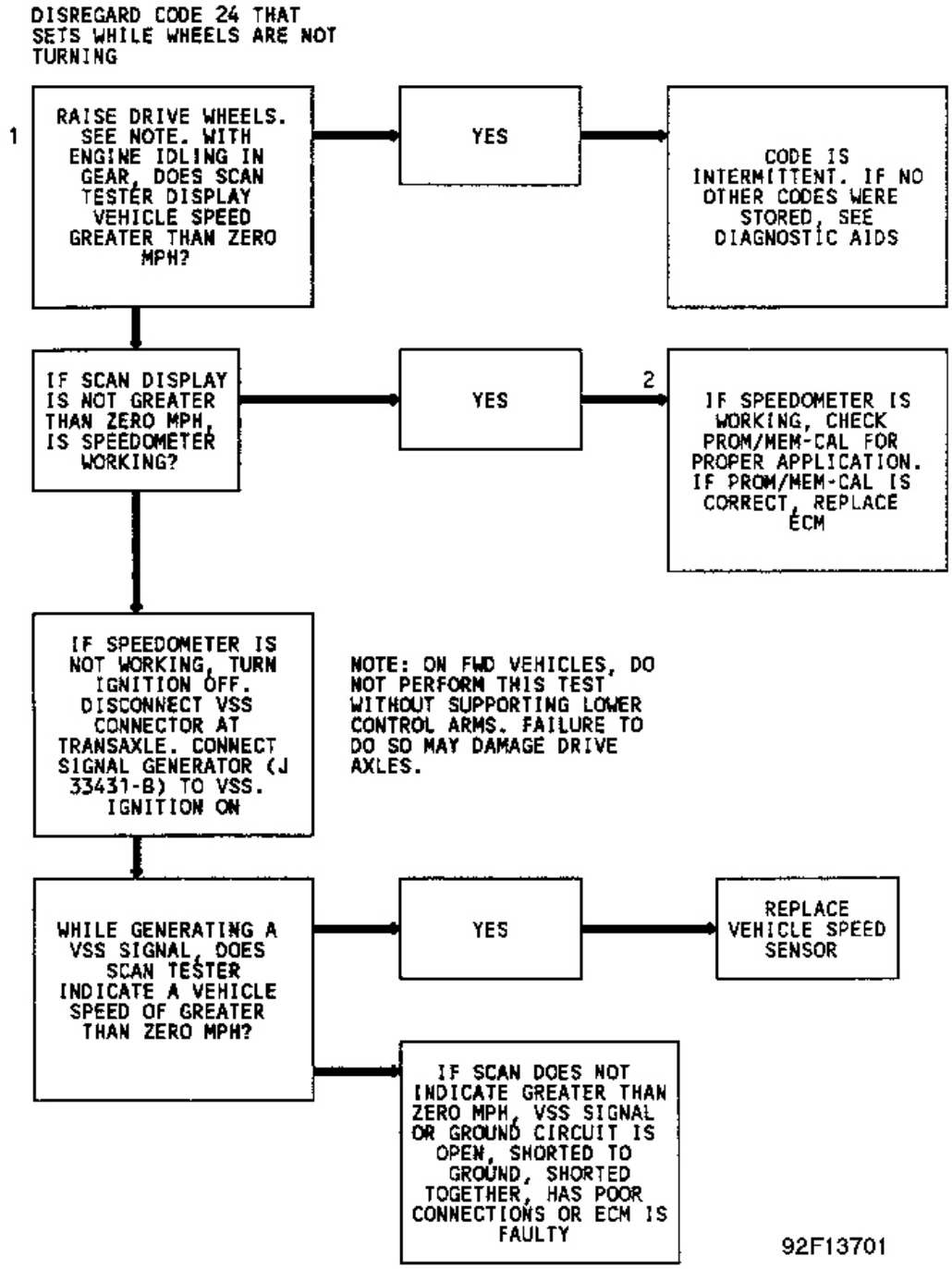


Fig. 76: Code 24 Troubleshooting Diagram (A, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR (VSS) 2.2L J BODY (1991)

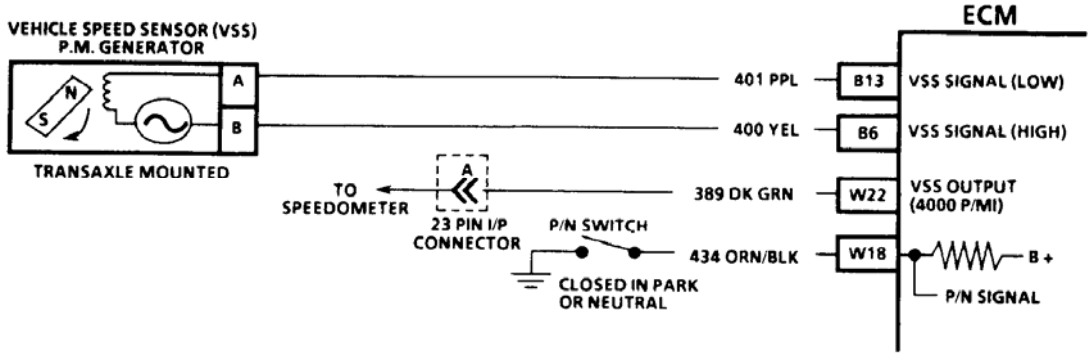


Fig. 77: Code 24, VSS Circuit Diagram (2.2L J Body - 1991)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test number refers to test number on diagnostic chart.

1. Code 24 will set if vehicle is less than 2 MPH with engine speed at 1125-4400 RPM, transmission is not in Park or Neutral, MAP indicates a road load deceleration condition and these conditions have been met for 5 seconds.

Diagnostic Aids

A faulty or misadjusted park/neutral switch may set a false Code 24. Use "Scan" tester and check for proper signal in Drive, while wiggling shifter.

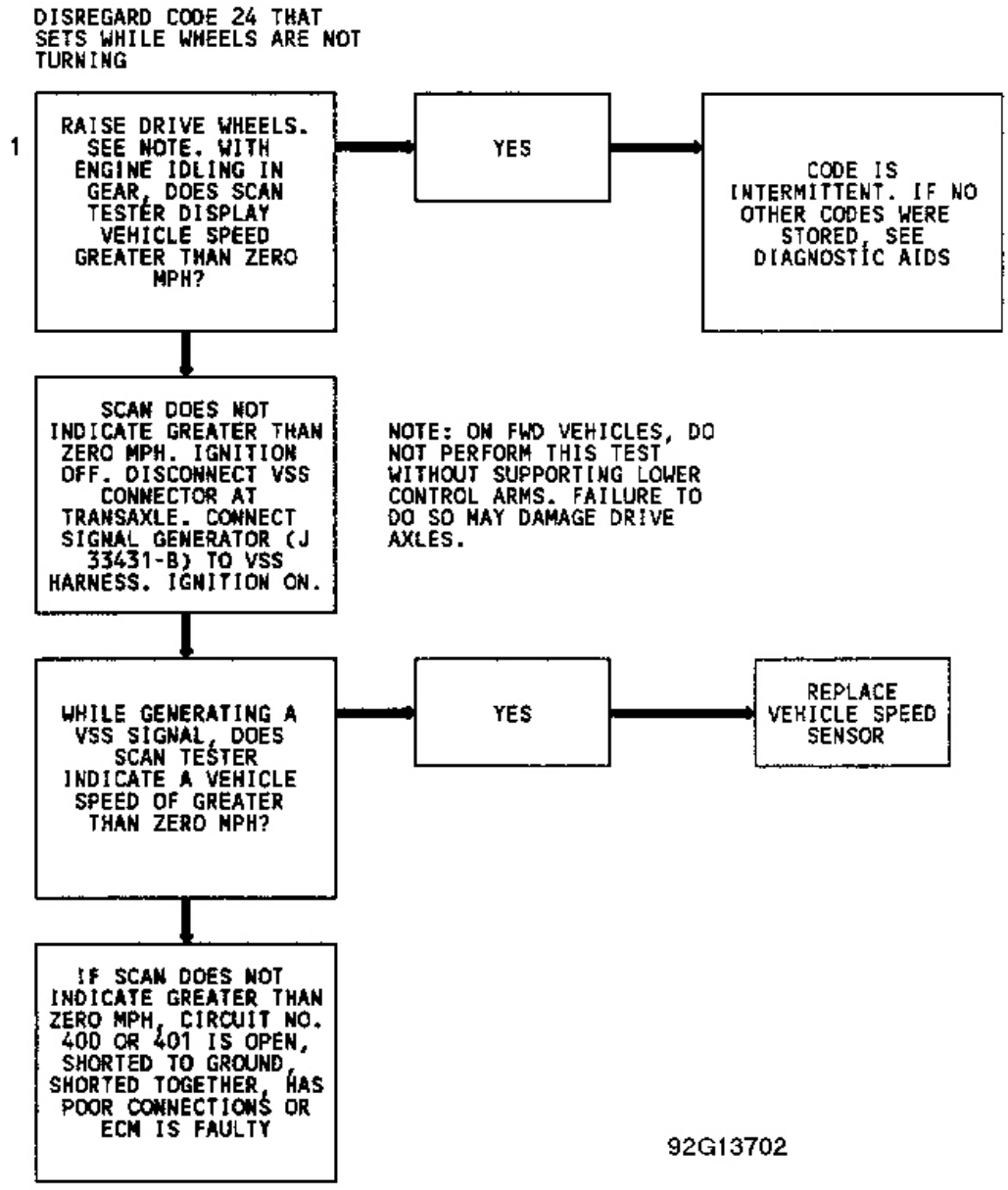


Fig. 78: Code 24 Troubleshooting Diagram (2.2L J Body - 1991)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR (VSS) 5.0L & 5.7L TBI B, D & F BODIES

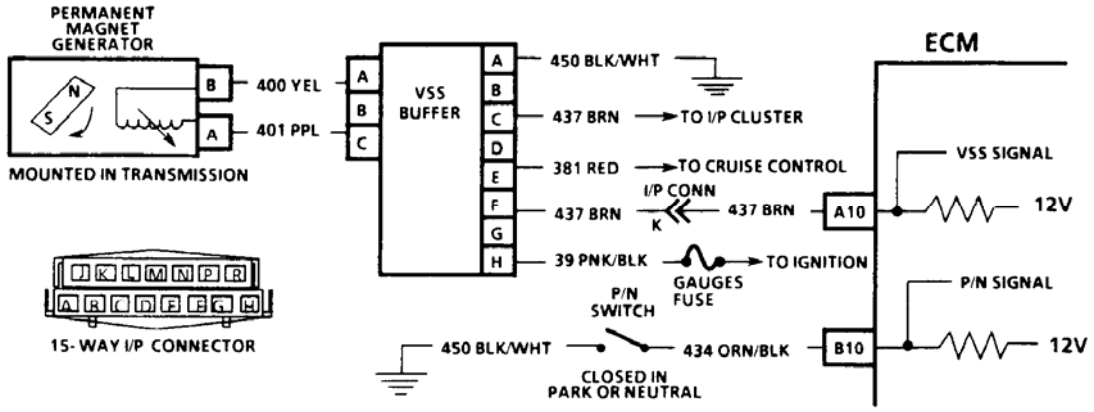


Fig. 79: Code 24, VSS Circuit Diagram 1 Of 4 (5.0L & 5.7L TBI B, D & F Bodies)
Courtesy of GENERAL MOTORS CORP.

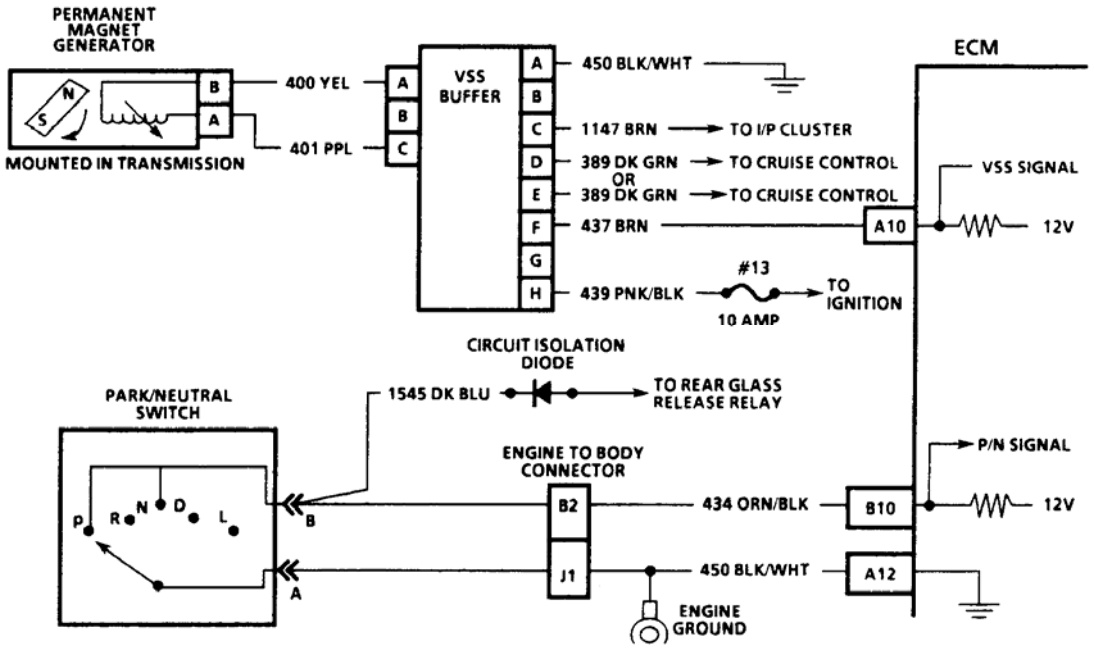


Fig. 80: Code 24, VSS Circuit Diagram 2 Of 4 (5.0L & 5.7L TBI B, D & F Bodies)
Courtesy of GENERAL MOTORS CORP.

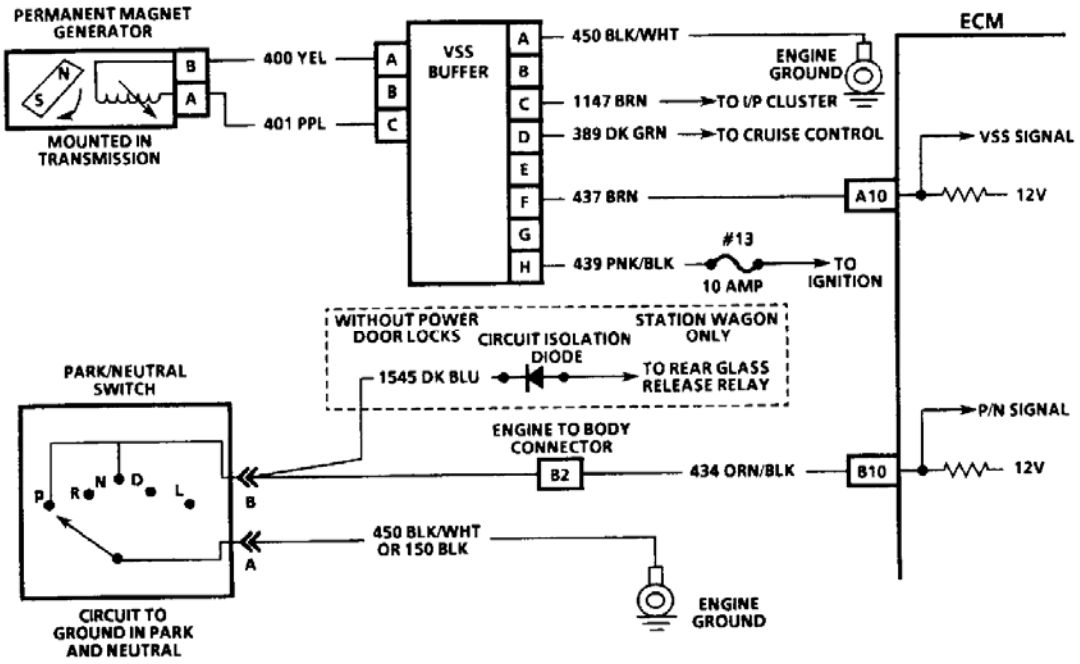


Fig. 81: Code 24, VSS Circuit Diagram 3 Of 4 (5.0L & 5.7L TBI B, D & F Bodies)
Courtesy of GENERAL MOTORS CORP.

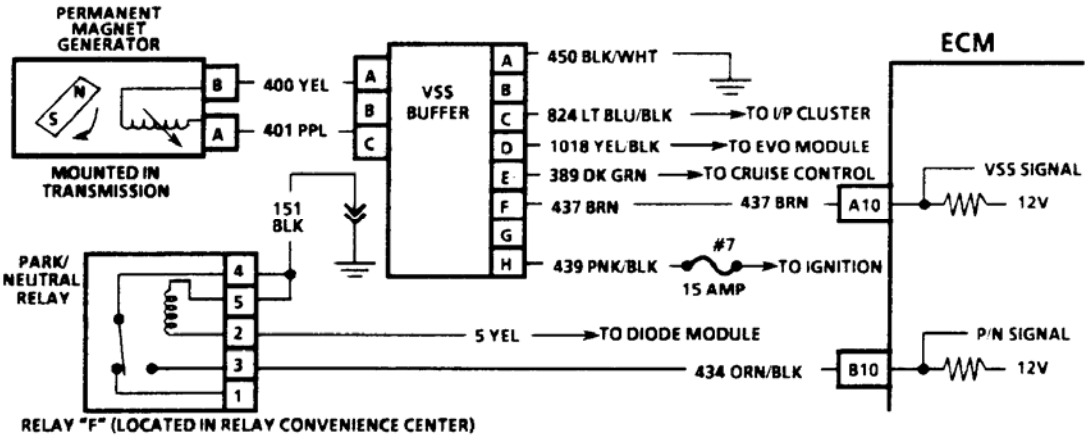


Fig. 82: Code 24, VSS Circuit Diagram 4 Of 4 (5.0L & 5.7L TBI B, D & F Bodies)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Code 24 will set if VSS signal circuit voltage is constant, engine speed is 1200-4400 RPM. TPS indicates throttle is near idle position, transmission is not in Park or Neutral and all conditions have been met for at least 4 seconds.

2. A voltage of less than one volt at the instrument panel connector indicates that VSS signal circuit wire may be shorted to ground. Disconnect signal wire at the VSS buffer. If voltage remains less than 10 volts, circuit is shorted to ground or open. If circuit is not open or shorted to ground, check for poor control module connection or faulty control module.

Diagnostic Aids

A faulty or misadjusted park/neutral switch may set a false Code 24. Use "Scan" tester and check for proper signal in Drive, while wiggling shifter.

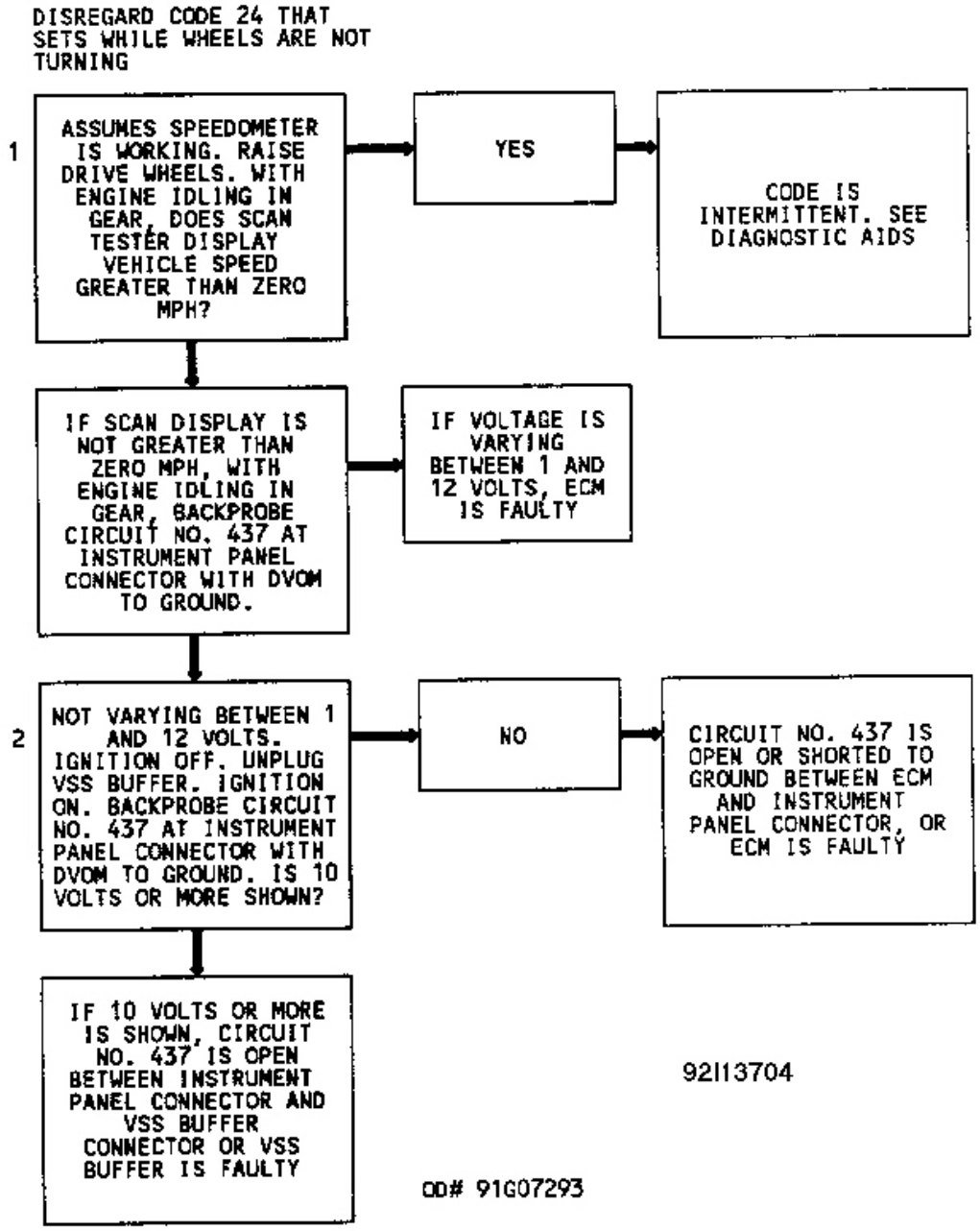


Fig. 83: Code 24 Troubleshooting Diagram (5.0L & 5.7L TBI B, D & F Bodies)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR (VSS) SATURN (1991-92)

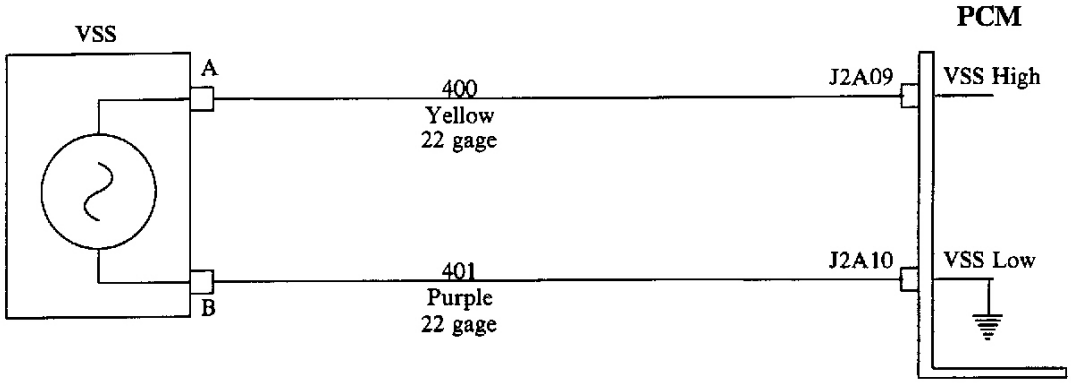


Fig. 84: Code 24, VSS Circuit Diagram (Saturn 1991-92)
Courtesy of GENERAL MOTORS CORP.

Vehicle speed values are provided by vehicle speed sensor (VSS). Sensor is a permanent magnet (PM) generator mounted on differential areas of transmission converter housing. PM generator produces a pulsing voltage whenever vehicle speed above 3 MPH. These pulses occur 16 times per each revolution of differential housing and are translated to provide vehicle speed in miles per hour.

Code 24 will set if VSS indication is less than 1 MPH, engine speed is above idle, MAP indication is less tan .5 volts or vehicle is not in park or neutral.

Diagnostic Aids

When attempting to diagnose an intermittent problem, use a Scan tester to review diagnostic information. Check connectors for poor connections. Speedometer will not work if VSS subsystem has hailed. If VSS reading is accurate and speedometer is incorrect, problem may exist in instrument cluster.

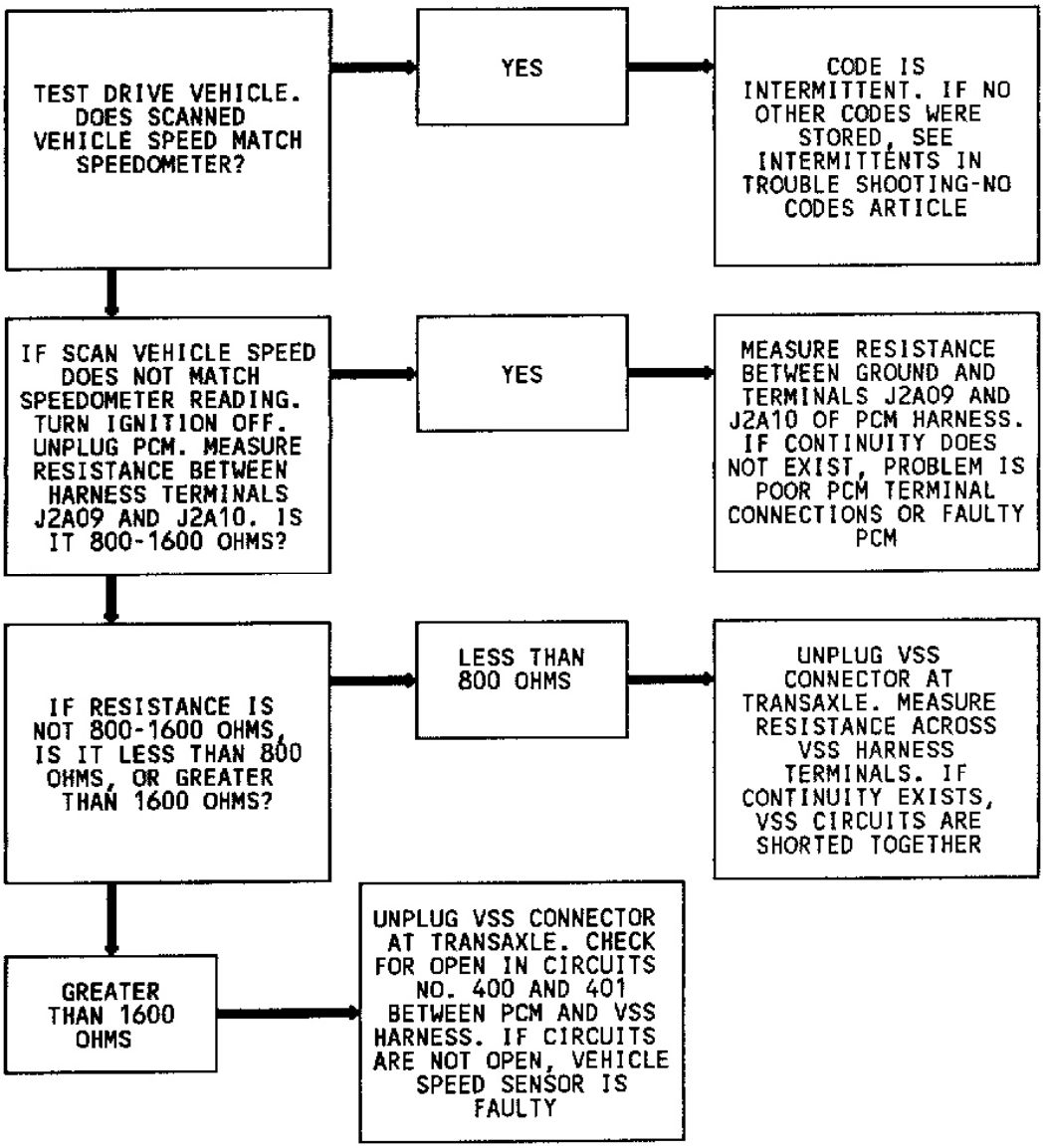


Fig. 85: Code 24 Troubleshooting Diagram (Saturn 1991-92)
Courtesy of GENERAL MOTORS CORP.

CODE 25, MAT SENSOR SIGNAL VOLTAGE LOW

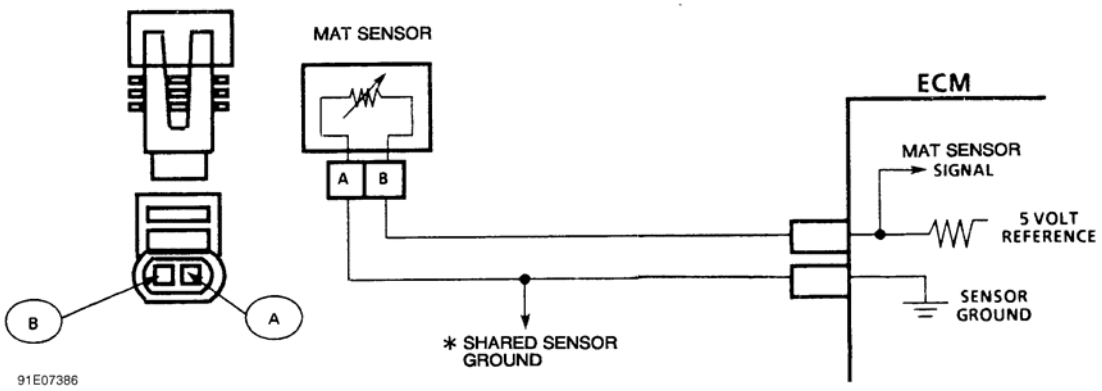


Fig. 86: Code 25, MAT Sensor Circuit Diagram
Courtesy of GENERAL MOTORS CORP.

CODE 25 ECM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM Terminal	Wire Color
2.0L, 2.2L J Body & 2.5L A & N Bodies		
MAT Signal	B5	Tan
MAT Ground	W14	Black/Orange
2.2L L Body		
MAT Signal	B5	Black/Pink
MAT Ground	W14	Black
2.3L L Body		
MAT Signal	GF16	Black/Pink
MAT Ground	BB5	Black
2.3L W Body, 2.5L W Body & 3.1L W Body & 3.4L W Body		
MAT Signal	C4	Tan
MAT Ground	C5	Black
3.1L A, F & J Bodies & 5.0L & 5.7L PFI F Body		
MAT Signal	GF16	Tan
MAT Ground	BB5	Black
3.1L L Body		
MAT Signal	GF16	Pink/Black
MAT Ground	BB5	Black
3.8L C & E Bodies		
MAT Signal	BB7	Tan
MAT Ground	BA7	Black
3.8L H Body		
MAT Signal	YD11	Tan
MAT Ground	YD5	Black
3.8L W Body		

MAT Signal	R12	Tan
MAT Ground	R2	Black/White
5.0L & 5.7L TBI		
MAT Signal	C12	Tan
MAT Ground	A11	Black
5.7L Y Body		
MAT Signal	C4	Tan
MAT Ground	C5	Black/Pink

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This checks if the code is a hard failure or an intermittent condition. Code 25 will set if a MAT temperature greater than 266°F (130°C) is sensed for more than a precalibrated period.
2. This simulates condition for Code 23, if control module recognizes the open circuit and "Scan" tester displays a temperature of less than -30°C, control module and wiring are okay.

Diagnostic Aids

If the engine is allowed to cool overnight, the coolant temperature sensor and MAT sensor should read close to each other, when measured with a "Scan" tester. A Code 25 will result if sensor signal circuit is shorted to ground. Check sensor for shifted calibration by using sensor **TEMPERATURE-TO-RESISTANCE VALUES** table.

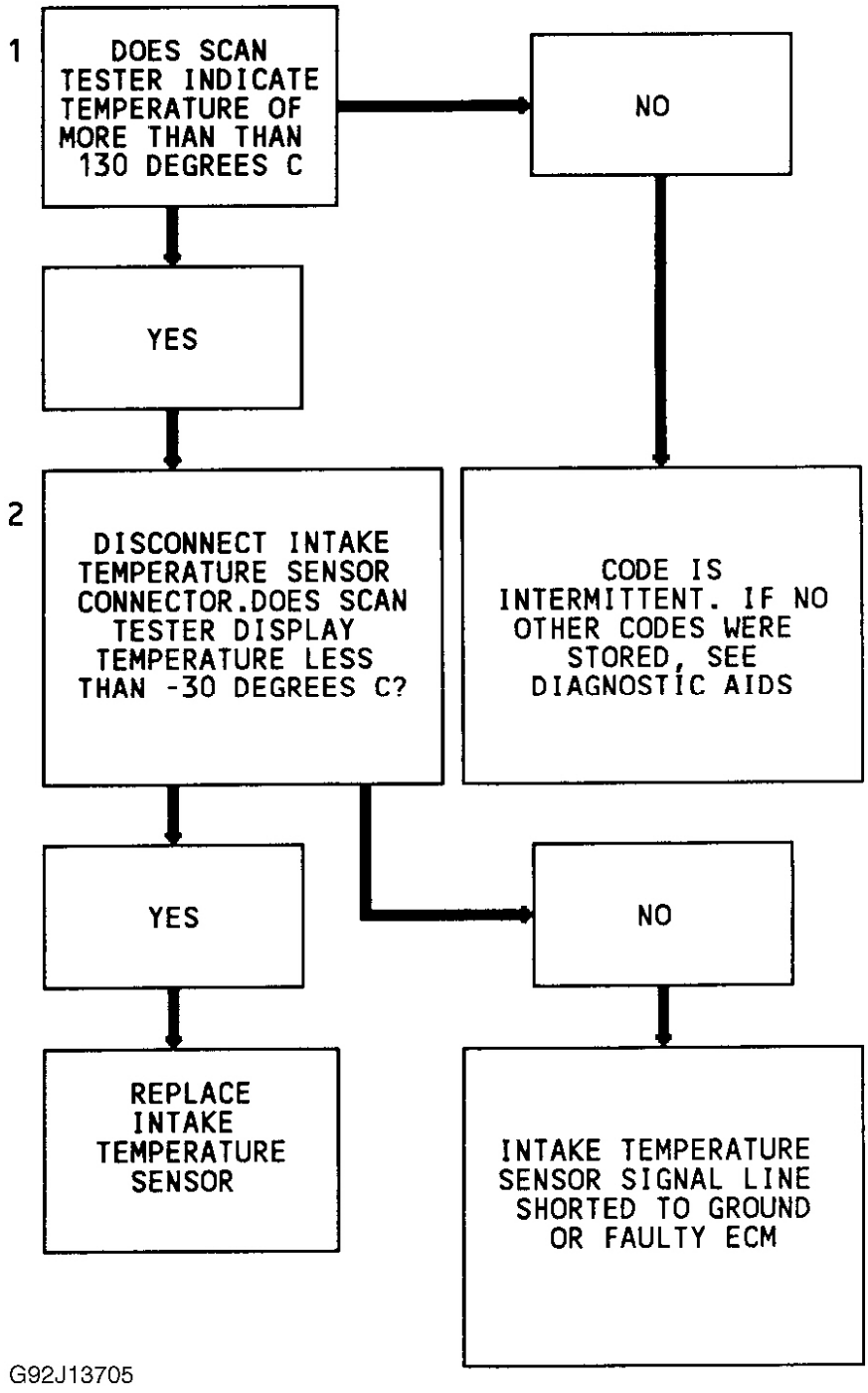


Fig. 87: Code 25 Troubleshooting Diagram
Courtesy of GENERAL MOTORS CORP.

CODE 26, DIAGNOSTIC CIRCUIT CHECK

The Diagnostic Circuit Check determines:

- If SERVICE ENGINE SOON light works
- If ECM is operating and can recognize a fault
- If any codes are stored
    1. Check operation of SERVICE ENGINE SOON light. Turn ignition on with engine off. SERVICE ENGINE SOON light should be on steady. If light illuminates and stays on steady, go to next step. If light does not illuminate, go to SERVICE ENGINE SOON LIGHT INOPERATIVE. If light flashes, go to step 3.
    2. Grounding ALDL "test" terminal "B" at this time should cause SERVICE ENGINE SOON light to flash a Code 12, followed by any codes stored in ECM memory. If light foes from bright to dim, this is not considered a code. If light dims or remains on, and does not flash Code, go to SERVICE ENGINE SOON LIGHT WON'T GO OUT OR FLASH CODE 12.
    3. If light begins to flash as soon as ignition is turned on, check for a short to ground on the diagnostic test terminal wire between ALDL terminal "B" and ECM terminal No. 5. If circuit is okay, replace ECM.

SERVICE ENGINE SOON LIGHT INOPERATIVE

1. If SERVICE ENGINE SOON light does not illuminate with ignition on and engine off, attempt to start engine. If engine starts, go to step 3. If engine does not start, check fusible links at battery and ECM fuse. If fusible links or ECM fuse are blown, repair short to ground.
2. If fusible links and ECM fuse are okay, turn ignition on and check power circuits to ECM, including keep alive memory and ignition feed. If power is not available to power terminals of ECM, check for opens in power circuits. If power is available to ECM power terminals, check for poor ECM ground circuits, or replace faulty ECM.
3. If engine starts and SERVICE ENGINE SOON light does not illuminate, turn ignition off. Disconnect ECM connectors. Turn ignition on and jumper ECM SERVICE ENGINE SOON light driver terminal to ground using a test light.
4. If light is now on, repair light driver terminal connections at ECM or replace faulty ECM. If light stays off when test light is used to ground light driver terminal, check for blown instrument panel fuse, faulty bulb, open in light driver circuit between ECM and bulb, driver circuit shorted to voltage, or an open in the ignition feed to the SERVICE ENGINE SOON light.

SERVICE ENGINE SOON LIGHT WON'T GO OUT OR FLASH CODE 12

1. Turn ignition off. Disconnect ECM connectors. Turn ignition on. If SERVICE ENGINE SOON light is on, check for short to ground in light driver circuit between light and ECM driver terminal.
2. If light is off with ECM connectors disconnected, turn ignition off. Reconnect ECM connectors. Turn ignition on with engine off. Using a DVOM, check voltage at ALDL "test" terminal "B". If voltage is greater than 9 volts, check for a short to voltage on ALDL terminal "B" wire between ECM and ALDL connector. If voltage is 5-6 volts, proceed to next step. If voltage is less than 5 volts, backprobe appropriate ECM terminal with DVOM. If 5-6 volts is now present, repair open or short in wire between ECM and ALDL terminal "B".
3. If voltage at terminal "B" of ALDL connector is 5-6 volts, jumper that wire terminal at ECM to ground. If

SERVICE ENGINE SOON light flashes a Code 12, and terminal "A" of ALDL was used when grounding terminal "B" the first time, check for open between ALDL connector terminal "A" and ground. If SERVICE ENGINE SOON light does not flash when ECM end of terminal "B" wire is jumpered to ground, check PROM/MEM-CAL for proper installation. If installed correctly, replace ECM, using original PROM/MEM-CAL. Repeat diagnostic circuit check. If Code 12 still does not flash, replace PROM/MEM-CAL. Replace PROM/MEM-CAL only after replacing ECM, as PROM/MEM-CAL is not likely to be faulty.

CODE 26, QUAD-DRIVER CIRCUIT 3.8L W BODY

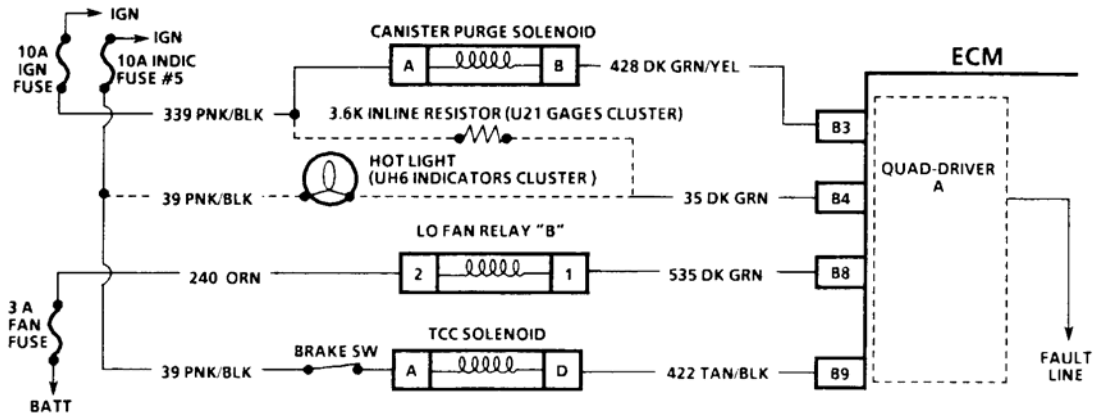


Fig. 88: Code 26 Quad-Driver Circuit Diagram (3.8L W Body)
Courtesy of GENERAL MOTORS CORP.

Each ECM Quad Driver has a fault line which is monitored by the ECM. The ECM compares voltage values of the fault line with acceptable values in ECM memory. If the ECM senses other than accepted values, a Code 26 will set.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. The ECM does not know which controlled circuit set the Code 26 so this chart will go through each circuit to determine which is at fault. On vehicles equipped with an ECM controlled hot light, this test check hot light driver and hot light circuit.
2. QDM SYMPTOMS
    - TCC inoperative, Code 39
    - Hot light on all the time, off during bulb check
    - Cooling fans on low speed all of the time or will not come on at all
    - Poor driveability due to 100 percent canister purge

Diagnostic Aids

The coolant temperature sensor, in rare cases, may fail to indicate the correct coolant temperature without setting a malfunction code (Code 14 or 15). This could result in turning on the hot light without having an

overheating condition. It could also result in engine overheating without turning on the hot light. Check coolant sensor temperature-to-resistance values.

Hot Light Diagnosis

NOTE: These checks assume vehicle is not overheating. Verify proper operation of cooling system prior to diagnosing hot light.

Hot light is powered by the 10-amp INDIC fuse. Light will turn on when ECM provides a ground for the circuit. If circuit grounds between light and ECM, light will illuminate any time the ignition is turned on.

1. Turn ignition on with engine off (bulb test position). If hot light illuminates, go to step 3. If hot light does not illuminate, check the following:
    - 10-amp INDIC fuse
    - Faulty instrument cluster bulb
    - Open circuit between fuse and hot light
2. Backprobe terminal B4 at ECM with a test light to battery voltage. Turn ignition on. If test light does not illuminate. ECM terminal connection is bad or ECM is faulty. If test light illuminates, turn ignition off. Disconnect ECM connectors. Jumper terminal B4 to ground. turn ignition on. If hot light does not illuminate, check for open circuit between hot light and ECM. If light does not illuminate and all circuits are intact and power is available to light, instrument cluster must be replaced.
3. Start engine. If test light goes off, no problem is evident. See DIAGNOSTIC AIDS. If test light is on, turn ignition off. Disconnect ECM connector. Probe ECM harness terminal B4 with a test light to battery voltage. If light is off, replace ECM. IF light is on, repair short to ground in circuit No. 35. If no short is present, replace instrument cluster.

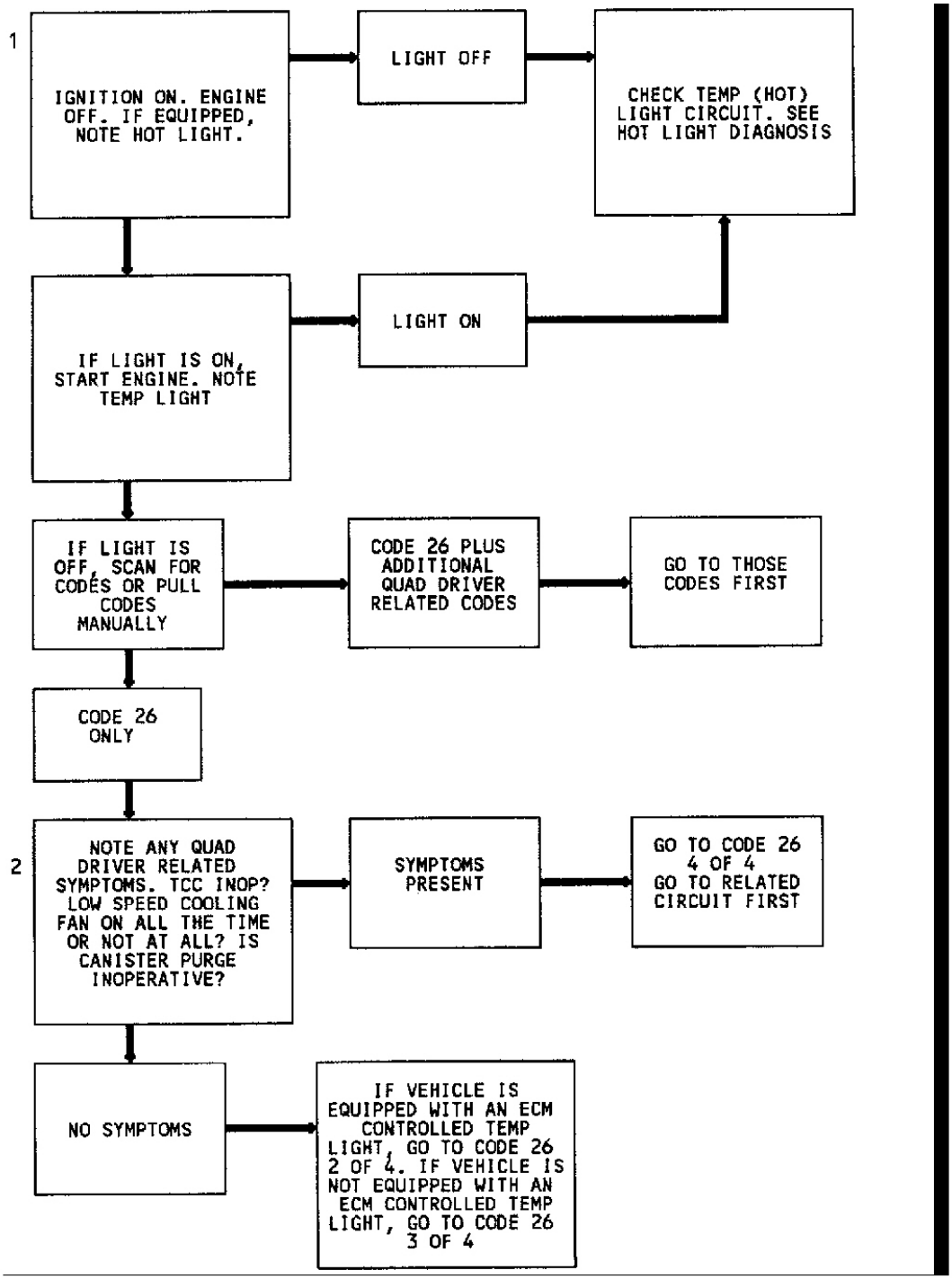


Fig. 89: Code 26 Troubleshooting Flowchart 1 Of 2 (3.8L W Body)
Courtesy of GENERAL MOTORS CORP.

A) (3.8L W Body With ECM-Controlled Temp Light) This determines which circuit is out of specification.

Diagnostic Aids

Monitor the voltage of each terminal while moving related harness connectors, including ECM harness. If the fault is induced, the voltage will change. This may help locate intermittent problems. If code reappears with no apparent problems, replace ECM.

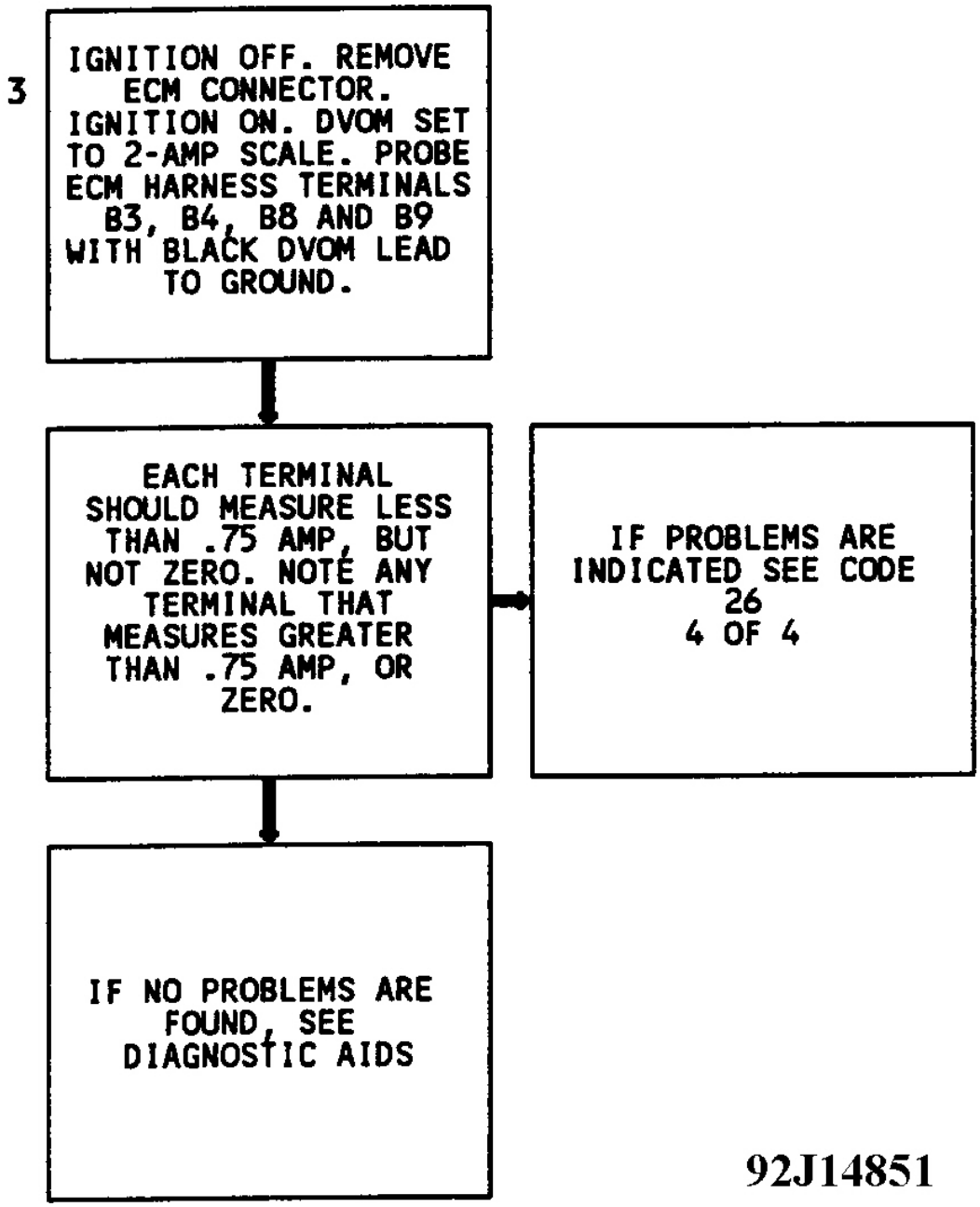


Fig. 90: Code 26 Troubleshooting Flowchart (3.8L W Body W/ECM)

Courtesy of GENERAL MOTORS CORP.

B) (3.8L W Body Without ECM-Controlled Temp Light) This determines which circuit is out of specification. If all circuits check out okay, the in-line resistor (used in place of the hot light) and related wiring should be checked. In-line resistor is taped into engine harness between right power center and ECM pigtail, about 2 inches from ECM pigtail junction.

Diagnostic Aids

Monitor the voltage of each terminal while moving related harness connectors, including ECM harness. If the fault is induced, the voltage will change. This may help locate intermittent problems. If code reappears with no apparent problems, replace ECM.

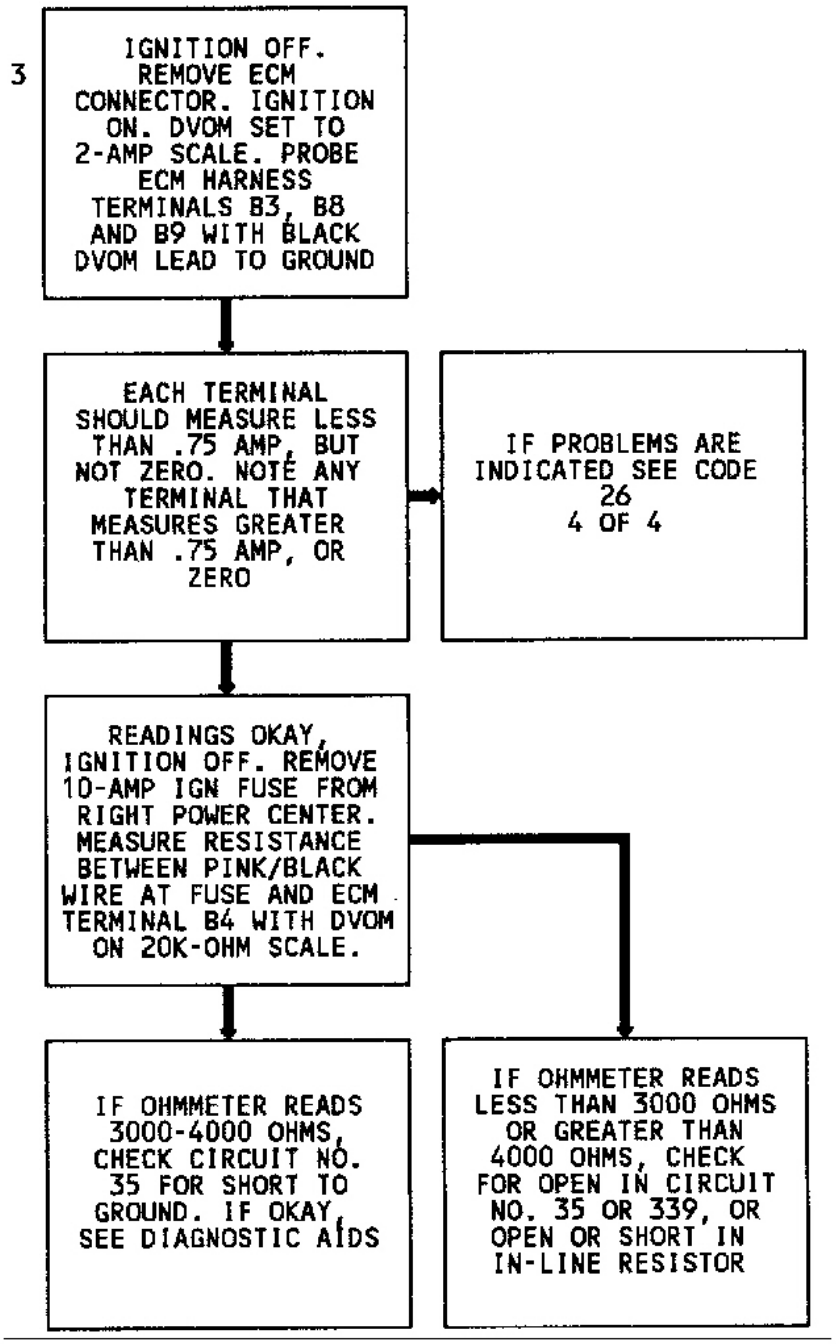


Fig. 91: Code 26 Troubleshooting Flowchart (3.8L W Body W/O ECM)
Courtesy of GENERAL MOTORS CORP.

1. This determines if the problem is the circuit or the component. Factory-installed ECM has an internal fuse and it's unlikely ECM needs replacing.

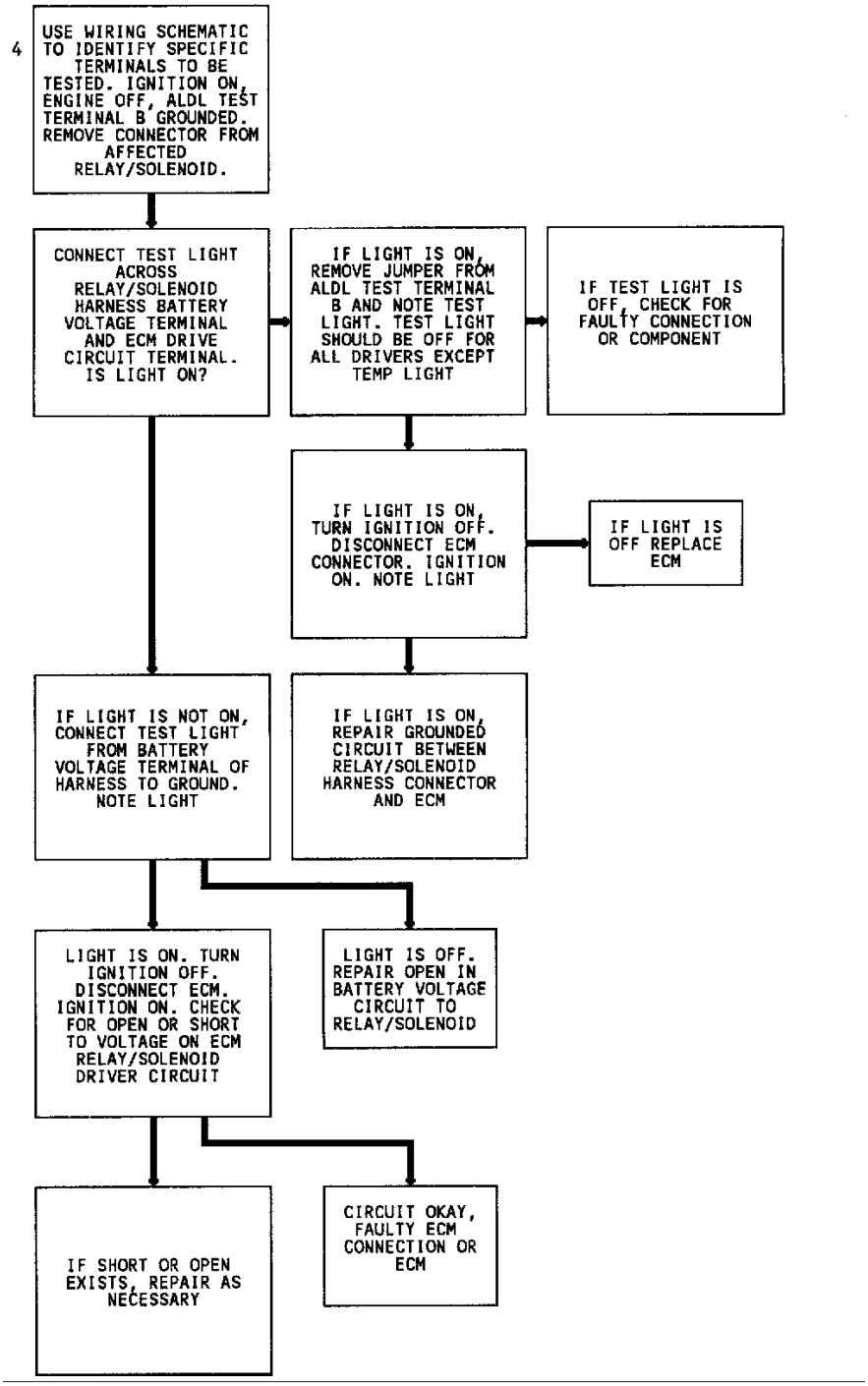


Fig. 92: Code 26 Troubleshooting Flowchart 2 Of 2 (3.8L W Body)
Courtesy of GENERAL MOTORS CORP.

CODE 26, QUAD-DRIVER CIRCUIT - 3.8L H BODY

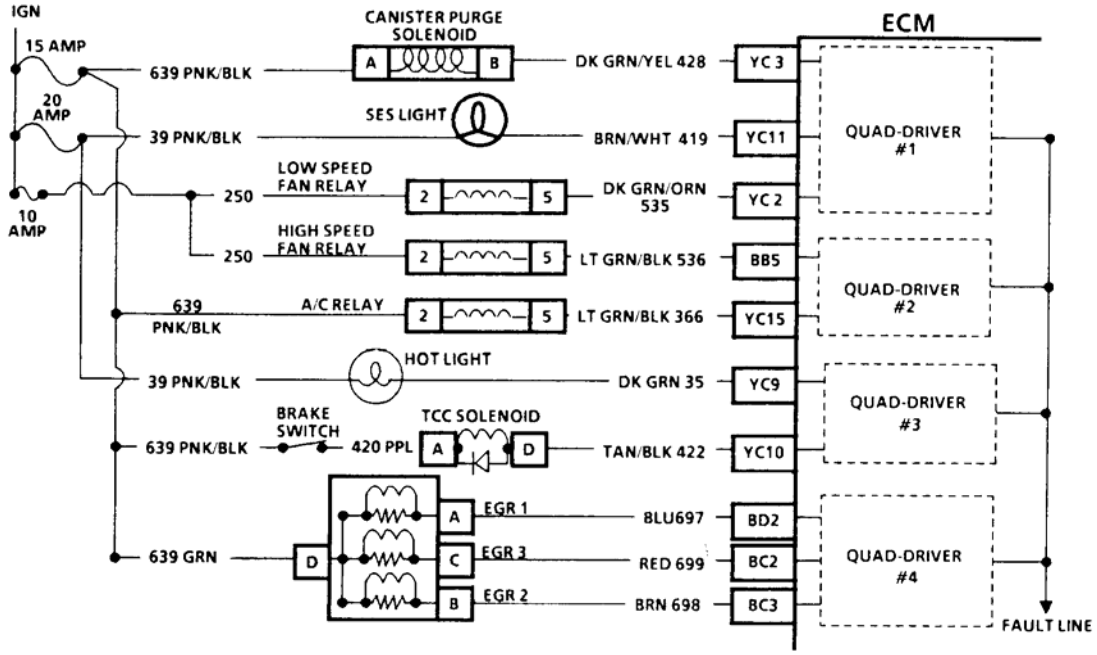


Fig. 93: Code 26 Quad-Driver Circuit Diagram (3.8L H Body)
Courtesy of GENERAL MOTORS CORP.

Each ECM Quad-Driver has a fault line which is monitored by the ECM. The ECM compares voltage values of the fault line with acceptable values in ECM memory. If the ECM senses other than accepted values, a Code 26 will set.

Some QDM circuits will normally cycle between high and low, such as depressing the brake pedal, cooling fans cycling on and off. QDM 2 will not set a Code 26. Some "Scan" testers may set a false Code 26 if engine is running, tester is installed and brake pedal is depressed for more than 30 seconds.

NOTE: Test numbers refer to test numbers on diagnostic charts.

1. The ECM does not know which controlled circuit set Code 26 so this chart will go through each circuit to determine which is at fault. On vehicles equipped with an ECM controlled hot light, this test checks hot light driver and hot light circuit.
2. QDM SYMPTOMS:
    - TCC inoperative, Code 39
    - EGR inoperative, Codes 63, 64 and 65
    - Hot light on all the time, off during bulb check
    - Cooling fan on low speed all of the time or will not come on at all
    - Poor driveability due to 100 percent canister purge

Diagnostic Aids

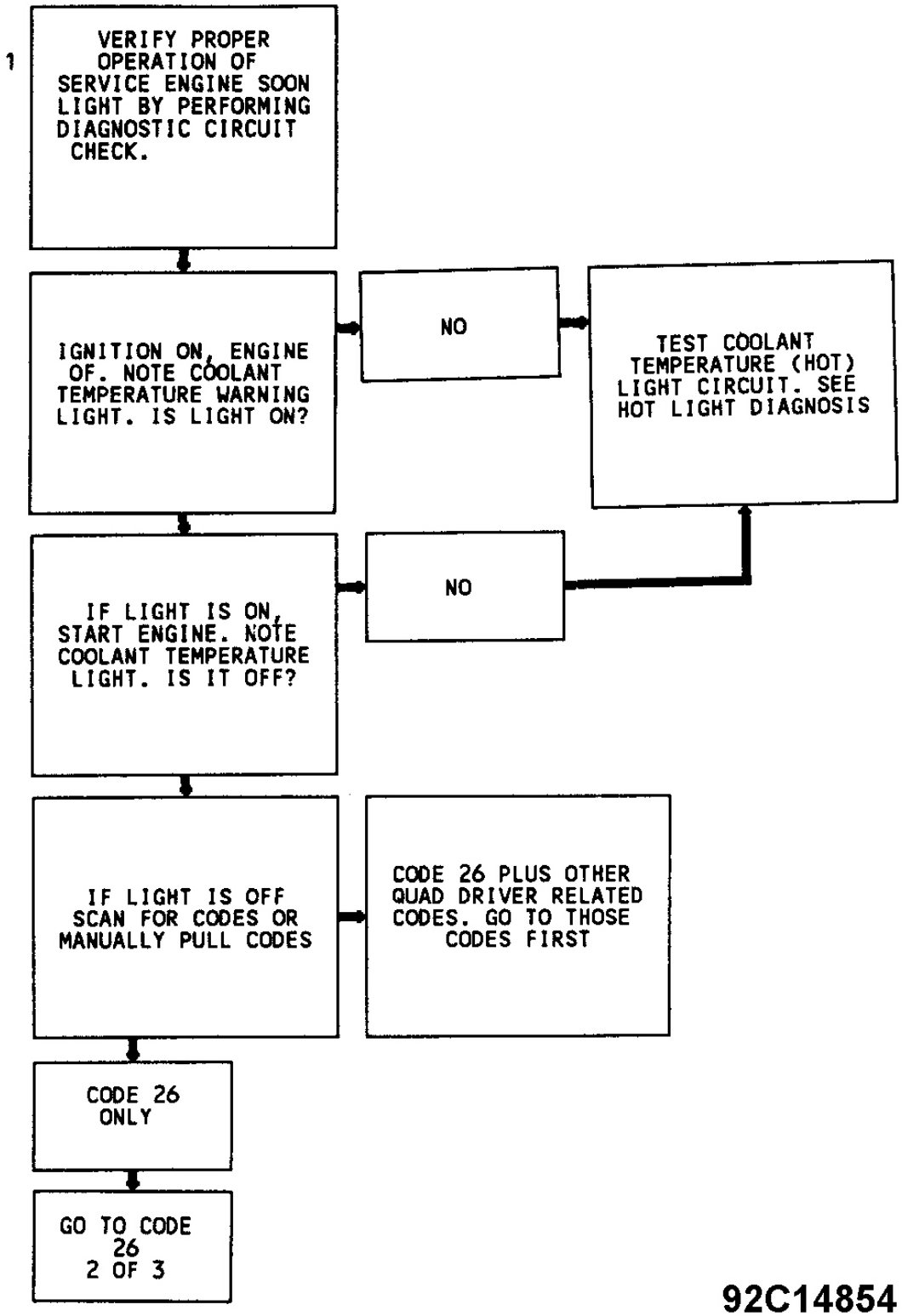
The coolant temperature sensor, in rare cases, may fail to indicate the correct coolant temperature without setting a malfunction code (Code 14 or 15). This could result in turning on the hot light without having an overheating condition. It could also result in engine overheating without turning on the hot light. Check coolant sensor temperature-to-resistance values in SENSOR RANGE CHARTS article.

Hot Light Diagnosis

NOTE: These checks assume vehicle is not actually overheating. Verify proper operation of cooling system prior to diagnosing hot light.

Hot light is powered by the 10-amp INDIC fuse. Light will turn on when ECM provides a ground for the circuit. If circuit grounds between light and ECM, light will illuminate any time the ignition is turned on.

1. Turn ignition on with engine off (bulb test position). If hot light illuminates, go to step 3. If hot light toes not illuminate, check the following:
    - 10-amp INDIC fuse
    - Faulty instrument cluster bulb
    - Open circuit between fuse and hot light
2. Backprobe terminal YC9 at ECM with a test light to battery voltage. Turn ignition on. If test light does not illuminate, ECM terminal connection is bad or ECM is faulty. If test light illuminates, turn ignition off. Disconnect ECM connectors. Jumper terminal YC9 to ground. Turn ignition on. If hot light does not illuminate, check for open circuit between hot light and ECM. If light does not illuminate and all circuits are intact and power is available to light, instrument cluster must be replaced.
3. Start engine. If test light goes off, no problem is evident. See DIAGNOSTIC AIDS. If test light is on, turn ignition off. Disconnect ECM connector. Probe ECM harness terminal TC9 with a test light to battery voltage. If light is off, replace ECM. If light is on, repair short to ground in circuit No. 35. If no short is present, replace instrument cluster.


1
VERIFY PROPER OPERATION OF SERVICE ENGINE SOON LIGHT BY PERFORMING DIAGNOSTIC CIRCUIT CHECK.
IGNITION ON, ENGINE OF. NOTE COOLANT TEMPERATURE WARNING LIGHT. IS LIGHT ON?
NO
TEST COOLANT TEMPERATURE (HOT) LIGHT CIRCUIT. SEE HOT LIGHT DIAGNOSIS
IF LIGHT IS ON, START ENGINE. NOTE COOLANT TEMPERATURE LIGHT. IS IT OFF?
NO
IF LIGHT IS OFF SCAN FOR CODES OR MANUALLY PULL CODES
CODE 26 PLUS OTHER QUAD DRIVER RELATED CODES. GO TO THOSE CODES FIRST
CODE 26 ONLY
GO TO CODE 26 2 OF 3

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Fig. 94: Code 26 Troubleshooting Flowchart 1 Of 3 (3.8L H Body)
Courtesy of GENERAL MOTORS CORP.

This determines which circuit is out of specification. All circuits except SERVICE ENGINE SOON light and hot light should have battery voltage with engine running and ALDL test terminal "B" not grounded.

Diagnostic Aids

Monitor the voltage of each terminal while moving related harness connectors, including control module harness. If the fault is induced, the voltage will change. This may help locate intermittent problems. If code reappears with no apparent problems, replace control module.

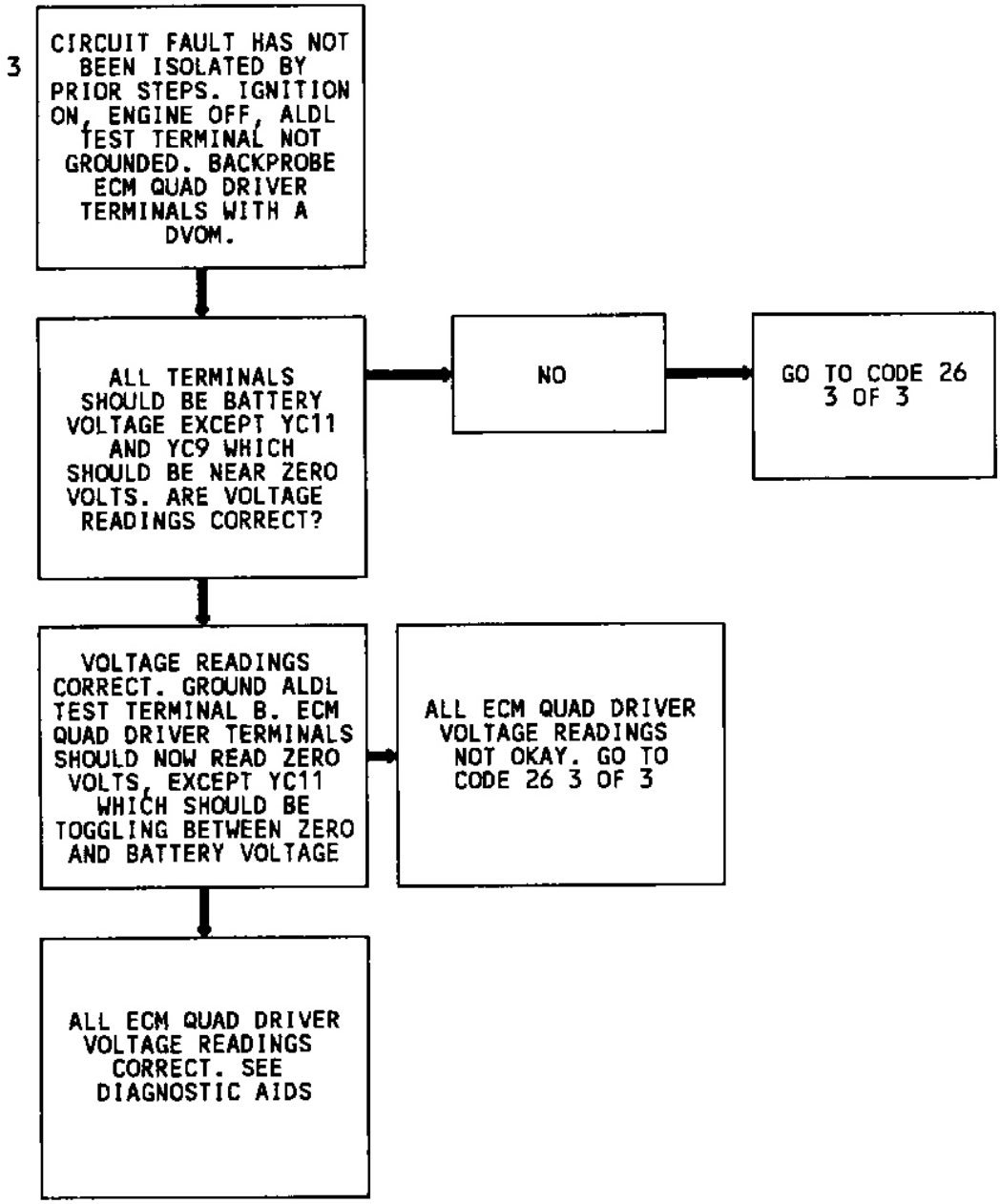


Fig. 95: Code 26 Troubleshooting Flowchart 2 Of 3 (3.8L H Body)
Courtesy of GENERAL MOTORS CORP.

1. This determines if the problem is the circuit or the component. Factory-installing ECM has an internal fuse and it's unlikely ECM needs replacing.

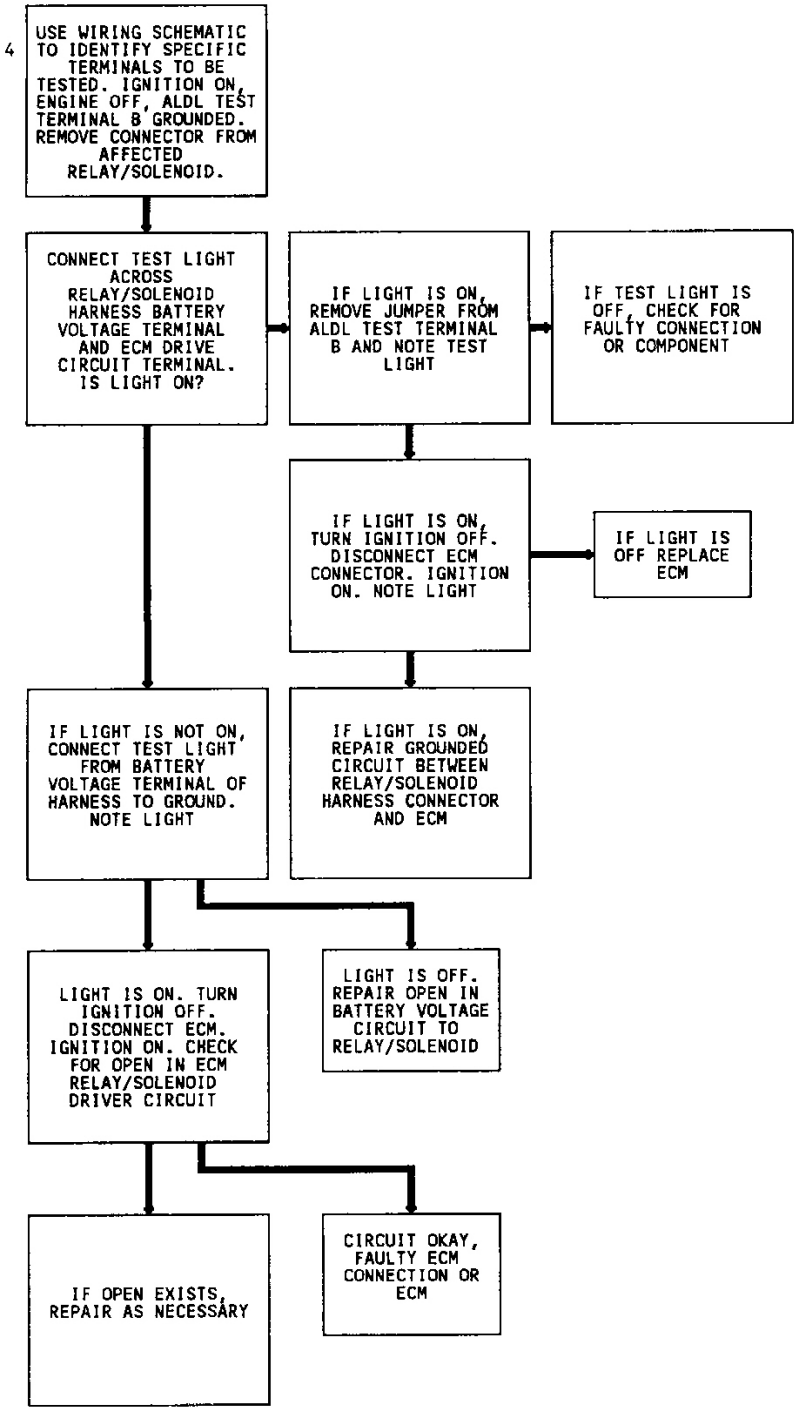


Fig. 96: Code 26 Troubleshooting Flowchart 3 Of 3 (3.8L H Body)
Courtesy of GENERAL MOTORS CORP.

CODE 26, QUAD-DRIVER CIRCUIT - 3.3L A & N BODIES

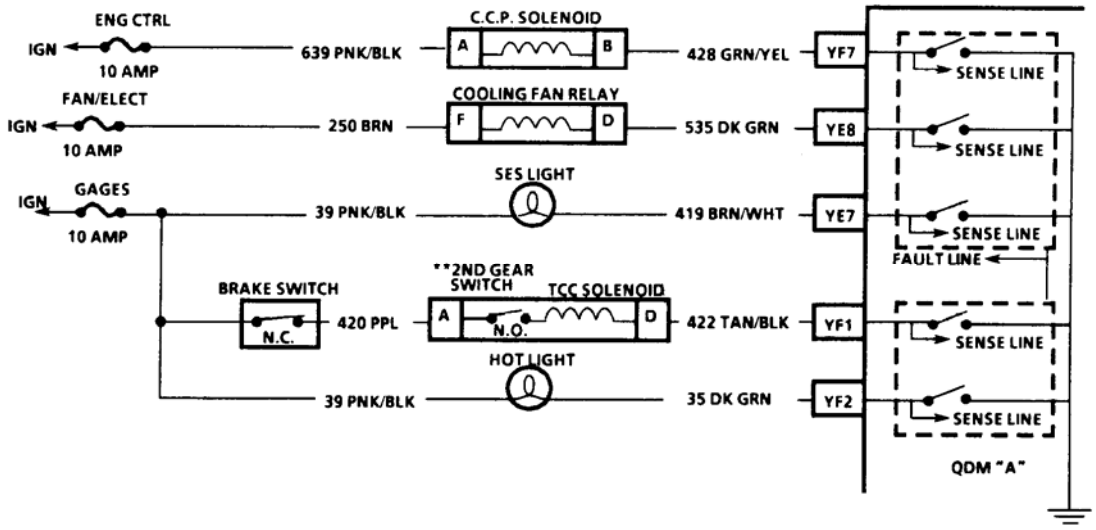


Fig. 97: Code 26 Quad-Driver Circuit Diagram (3.3L A Body)
Courtesy of GENERAL MOTORS CORP.

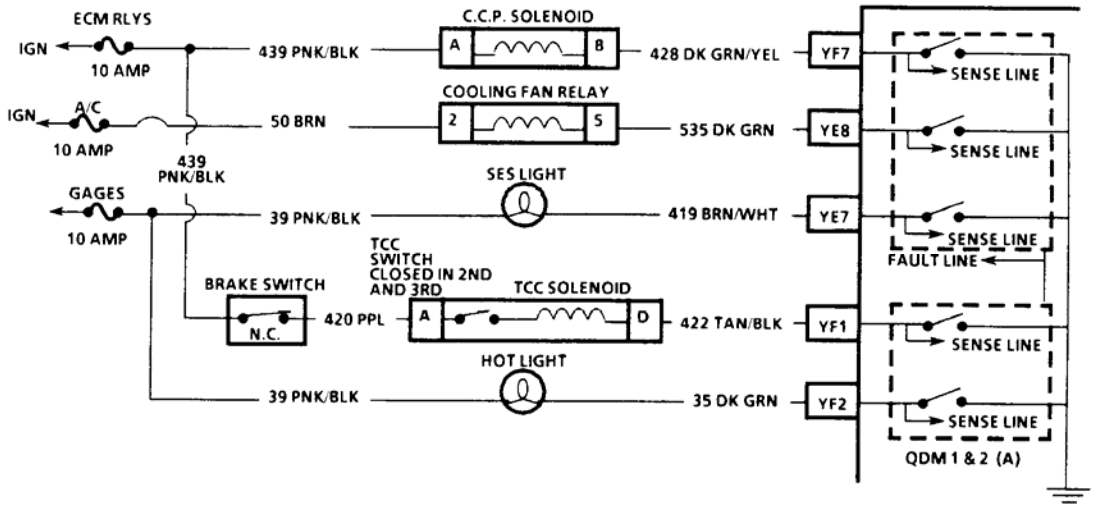


Fig. 98: Code 26 Quad-Driver Circuit Diagram (3.3L N Body)
Courtesy of GENERAL MOTORS CORP.

Each ECM Quad-Driver has a fault line which is monitored by the ECM. The ECM compares voltage values of the fault line with acceptable values in ECM memory. If the ECM senses other than accepted values, a Code 26 will set. QDM B will not set a Code 26.

NOTE: Test numbers refer to test numbers on diagnostic charts.

1. The ECM does not know which controlled circuit set the Code 26. This tests SERVICE ENGINE SOON

light driver and circuit.

2. QDM SYMPTOMS
    - TCC inoperative
    - Hot light on all the time, off during bulb check
    - Cooling fan on all the time or will not come on at all
    - Poor driveability due to 100 percent canister purge

Diagnostic Aids

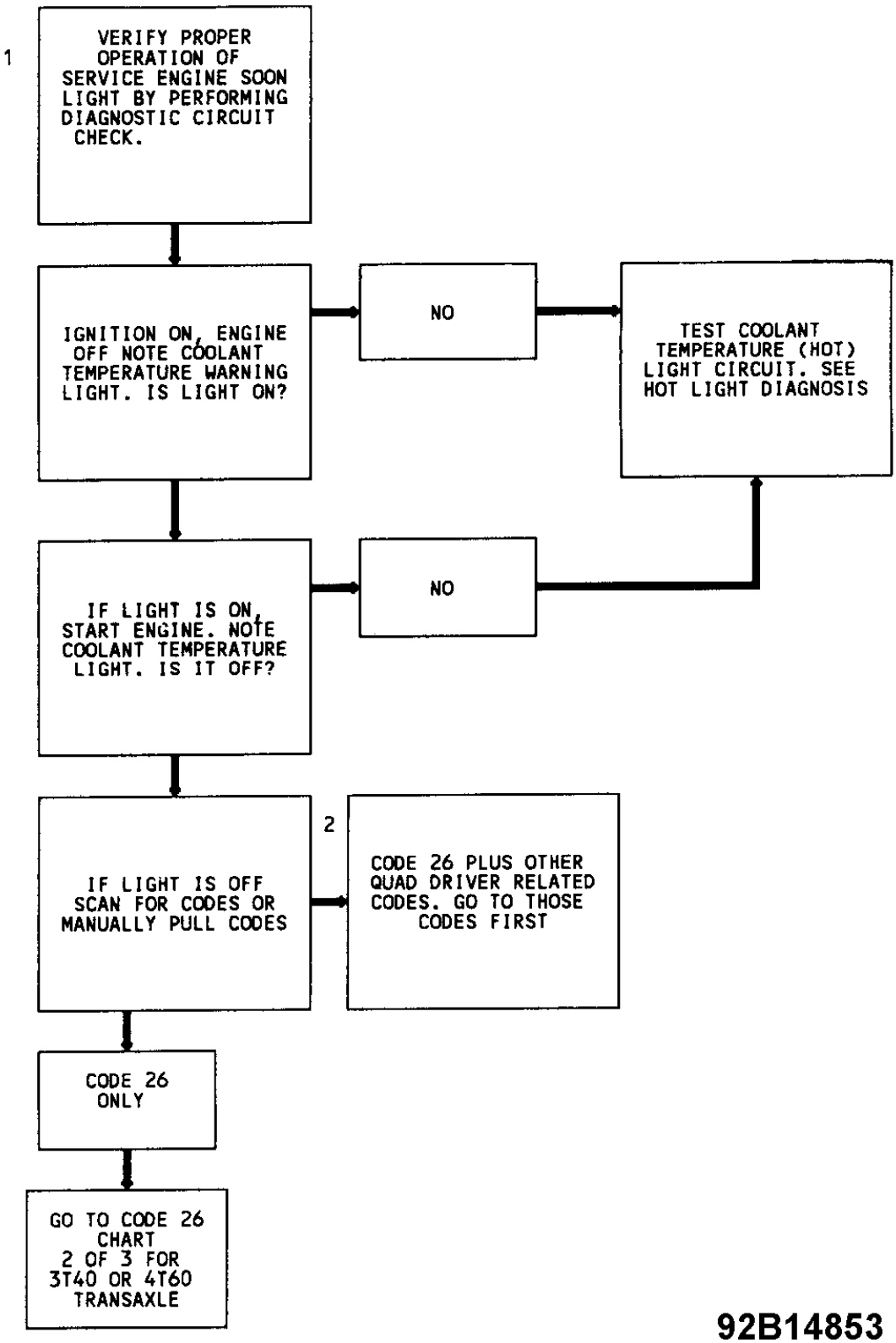
The coolant temperature sensor, in rare cases, may fail to indicate the correct coolant temperature without setting a malfunction code (Code 14 or 15). This could result in turning on the hot light without having an overheating condition. It could also result in engine overheating without turning on the hot light.

Hot Light Diagnosis

NOTE: These checks assume vehicle is not overheating. Verify proper operation of cooling system prior to diagnosing hot light.

Hot light is powered by the 10-amp GAGES fuse. Light will turn on when ECM provides a ground for the circuit. If circuit grounds between light and ECM, light will illuminate any time the ignition is turned on.

1. Turn ignition on with engine off (bulb test position). If hot light illuminates, go to step 3. If hot light toes not illuminate, check the following:
    - 10-amp GAGES fuse
    - Faulty instrument cluster bulb
    - Open circuit between fuse and hot light
2. Backprobe terminal YE2 (A body) or YF2 (N body) at ECM with a test light to battery voltage. Turn ignition on. If test light does not illuminate, ECM terminal connection is bad or ECM is faulty. If test light illuminates, turn ignition off. Disconnect ECM connectors. Jumper terminal YE2 (A body) or YF2 (N body) to ground. Turn ignition on. If hot light does not illuminate, check for open circuit between hot light and ECM. If light does not illuminate and all circuits are intact and power is available to light, instrument cluster must be replaced.
3. Start engine. If test light goes off, no problem is evident. See DIAGNOSTIC AIDS. If test light is on, turn ignition off. Disconnect ECM connector. Probe ECM harness terminal YE2 (A body) or YF2 (N body) with a test light to battery voltage. If light is off, replace ECM. If light is on, repair short to ground in circuit No. 35. If no short is present, replace instrument cluster.


1
VERIFY PROPER OPERATION OF SERVICE ENGINE SOON LIGHT BY PERFORMING DIAGNOSTIC CIRCUIT CHECK.
IGNITION ON, ENGINE OFF NOTE COOLANT TEMPERATURE WARNING LIGHT. IS LIGHT ON?
NO
TEST COOLANT TEMPERATURE (HOT) LIGHT CIRCUIT. SEE HOT LIGHT DIAGNOSIS
IF LIGHT IS ON, START ENGINE. NOTE COOLANT TEMPERATURE LIGHT. IS IT OFF?
NO
2
IF LIGHT IS OFF SCAN FOR CODES OR MANUALLY PULL CODES
CODE 26 PLUS OTHER QUAD DRIVER RELATED CODES. GO TO THOSE CODES FIRST
CODE 26 ONLY
GO TO CODE 26 CHART 2 OF 3 FOR 3T40 OR 4T60 TRANSAXLE

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Fig. 99: Code 26 Troubleshooting Flowchart 1 Of 2 (3.3L A & N Body)
Courtesy of GENERAL MOTORS CORP.

On vehicle with a 3T40 transmission, QDM A fault status on "Scan" tester should read HIGH until 2nd gear switch is closed or brake is applied. To simulate driving in 2nd gear and change status to LOW, disconnect TCC connector and connect test light between harness terminals A and D.

NOTE: Test number refers to test number on diagnostic chart.

1. This step determines which circuit is out of specification.

Diagnostic Aids

Monitor the voltage of each terminal while moving related harness connectors, including control module harness. If the fault is induced, the voltage will change. This may help locate intermittent problems. If code reappears with no apparent problems, replace control module.

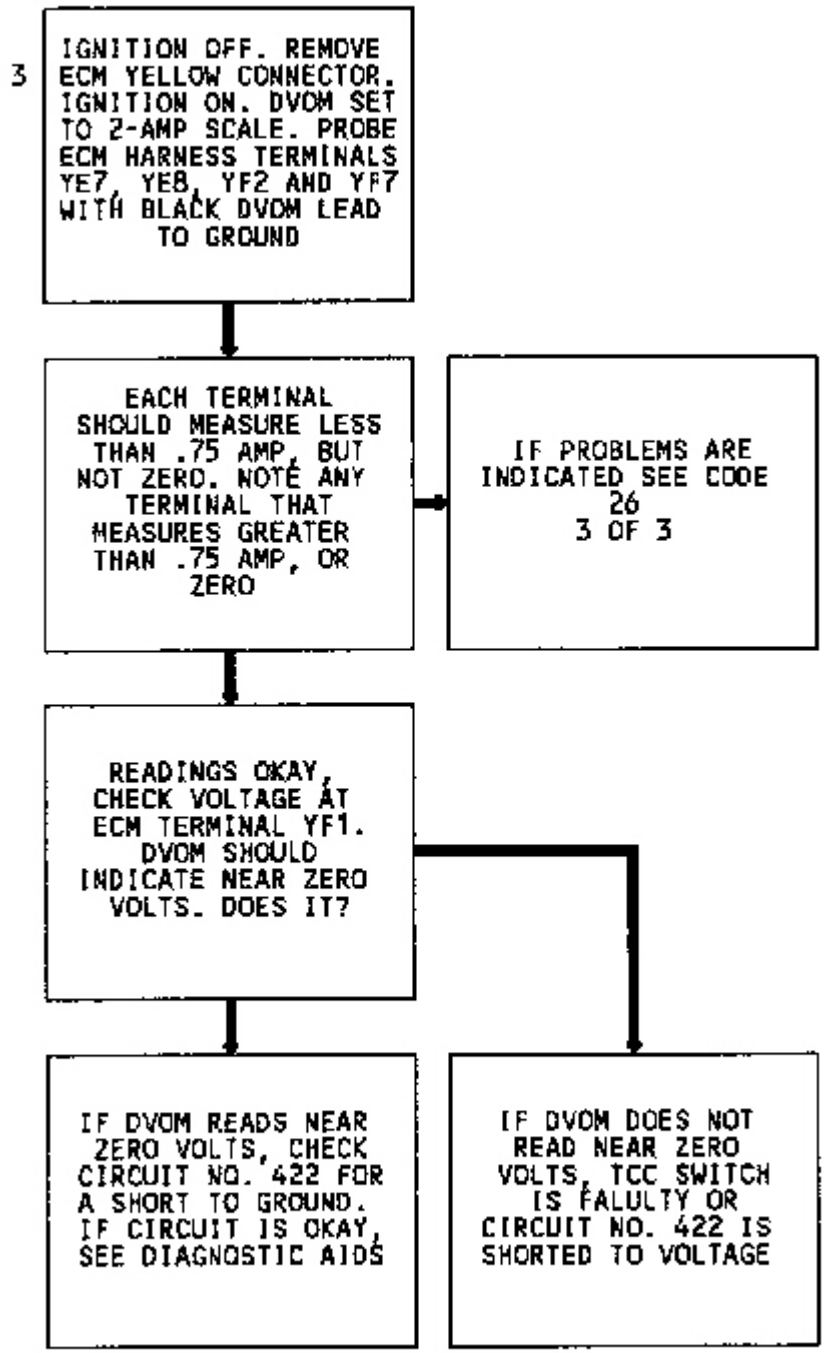


Fig. 100: Code 26 Troubleshooting Flowchart (3.3L A & N Body W/3T40)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test number refers to test number on diagnostic chart.

1. This step determines which circuit is out of specification.

Diagnostic Aids

Monitor the voltage of each terminal while moving related harness connectors, including control module harness. If the fault is induced, the voltage will change. This may help locate intermittent problems. If code reappears with no apparent problems, replace control module.

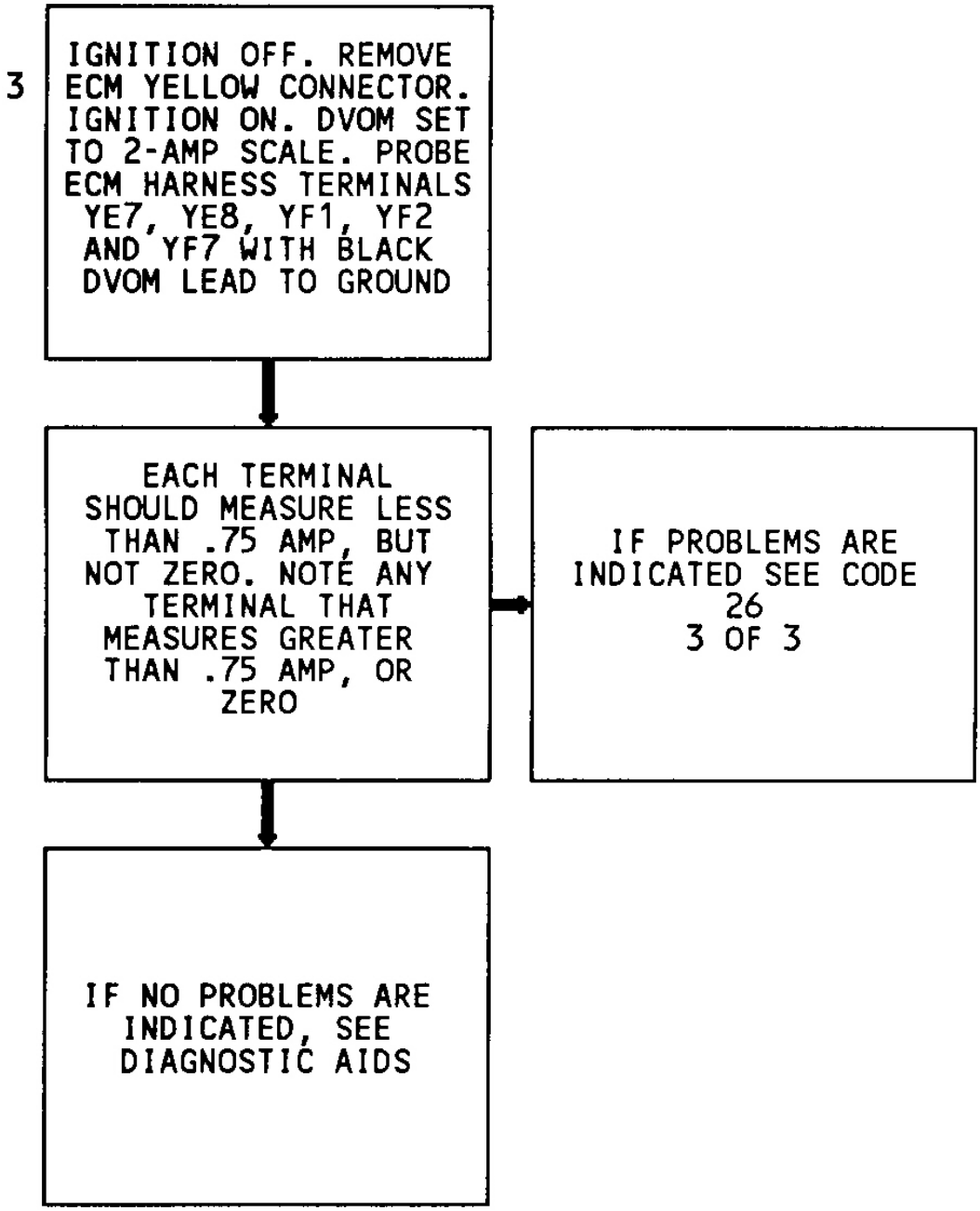


Fig. 101: Code 26 Troubleshooting Flowchart (3.3L A & N Body W/4T60)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This step determines if the problem is the circuit or the component. Factory-installed ECM has an internal

fuse and it's unlikely ECM needs replacing.

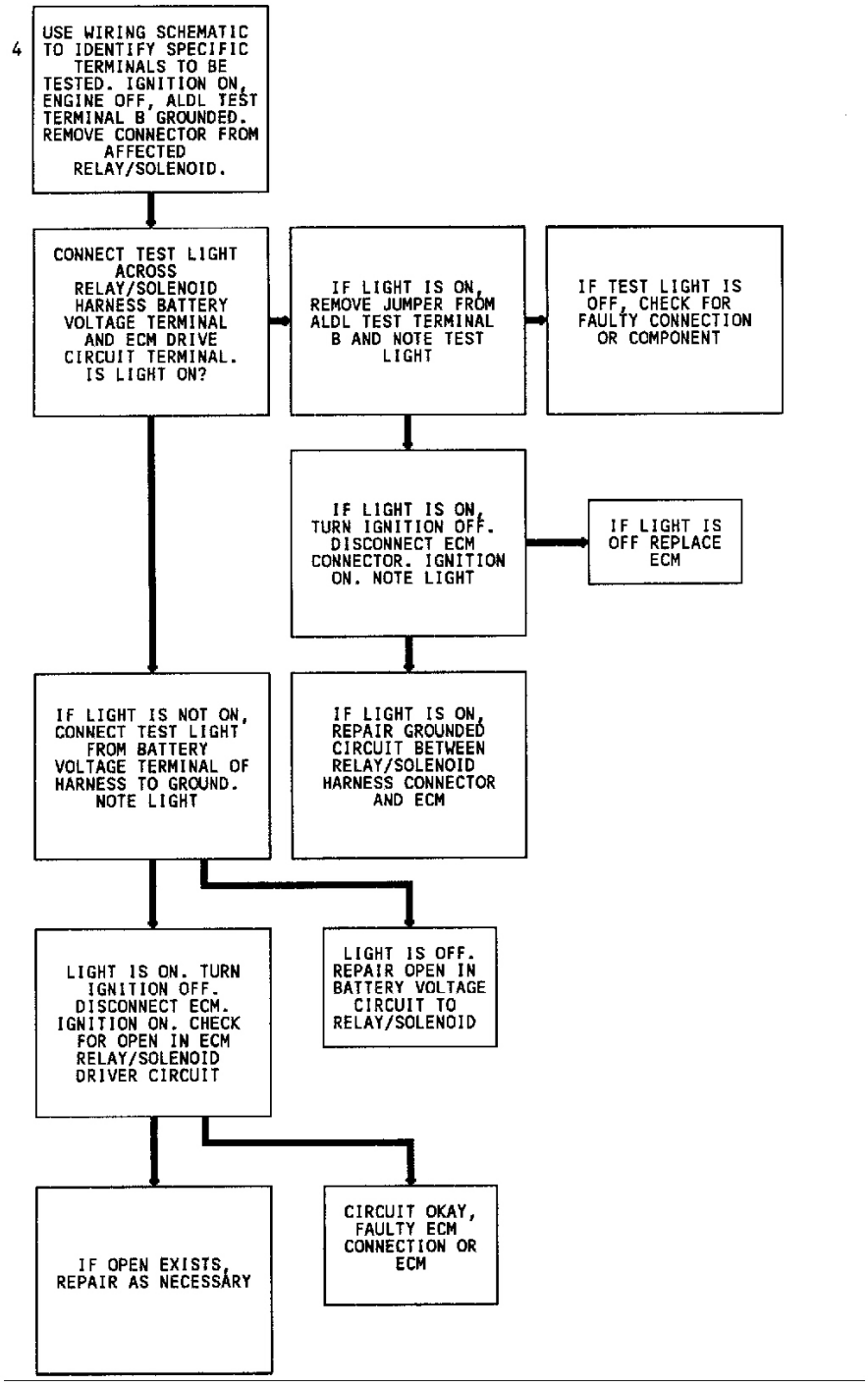


Fig. 102: Code 26 Troubleshooting Flowchart 2 Of 2 (3.3L A & N Body)
Courtesy of GENERAL MOTORS CORP.

CODE 26, QUAD-DRIVER CIRCUIT 3.8L C & E BODIES

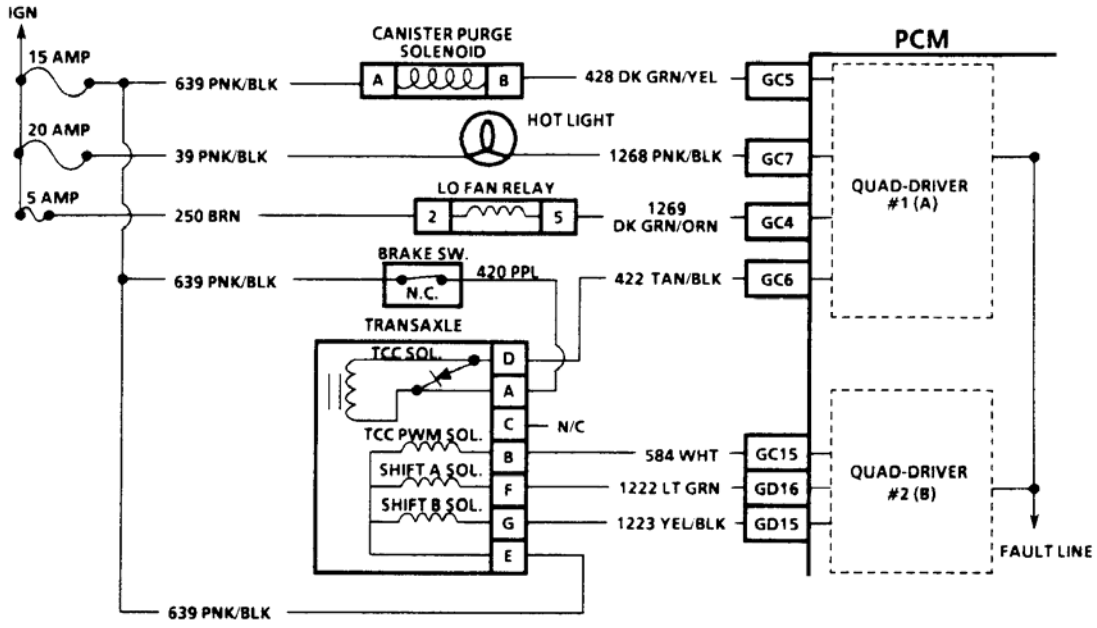


Fig. 103: Code 26 Quad-Driver Circuit Diagram (3.8L C Body)
Courtesy of GENERAL MOTORS CORP.

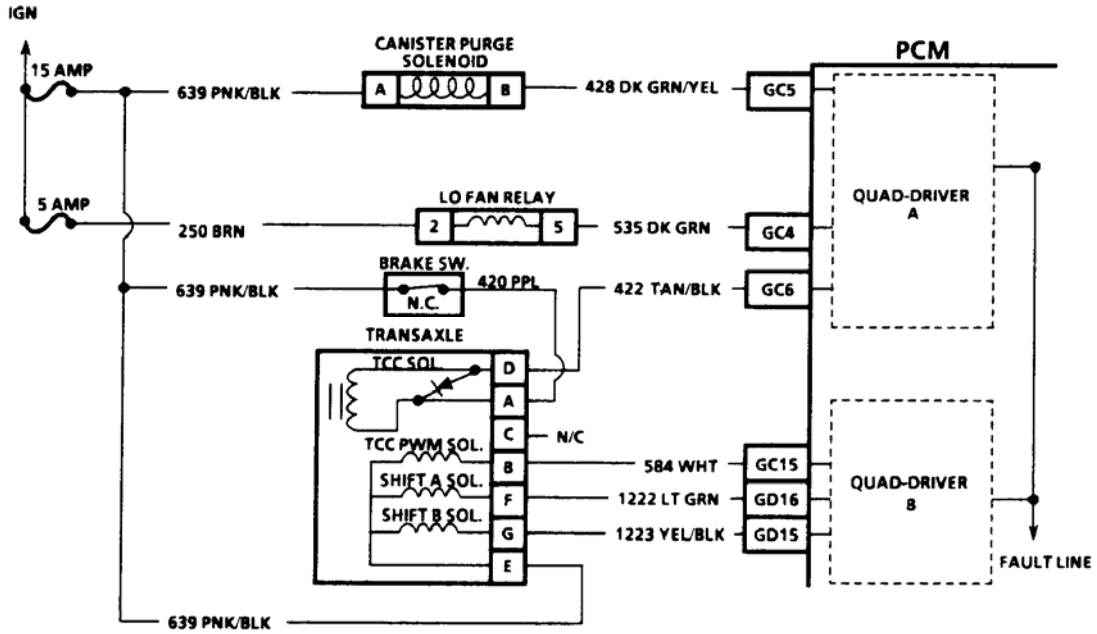


Fig. 104: Code 26 Quad-Driver Circuit Diagram (3.8L E Body - Reatta & Riviera)
Courtesy of GENERAL MOTORS CORP.

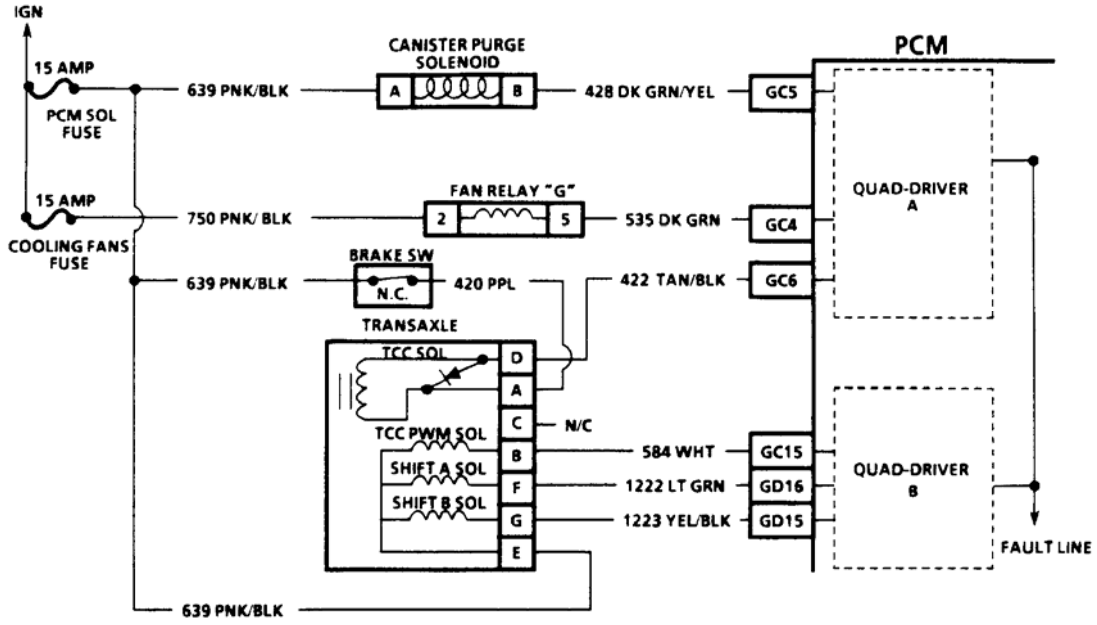


Fig. 105: Code 26 Quad-Driver Circuit Diagram (3.8L E Body - Trofeo & Toronado)
Courtesy of GENERAL MOTORS CORP.

Each PCM Quad-Driver has a fault line which is monitored by the PCM. The PCM compares voltage values of the fault line with acceptable values in PCM memory. If the PCM senses other than accepted values, a Code 26 will set.

Some QDM circuits will normally cycle between high and low, such as depressing the brake pedal. Some "Scan" testers may set a false Code 26 if engine is running, tester is installed and brake pedal is depressed for more than 30 seconds.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. The PCM does not know which controlled circuit set the Code 26 so this chart will go through each of the circuits to determine which is at fault. This step tests SERVICE ENGINE SOON light driver and circuit.

QDM CIRCUITS

- Hot light (C body) on all the time, off during bulb check
- Cooling fan on low speed all of the time or will not come on at all
- Poor driveability due to 100 percent canister purge

Diagnostic Aids

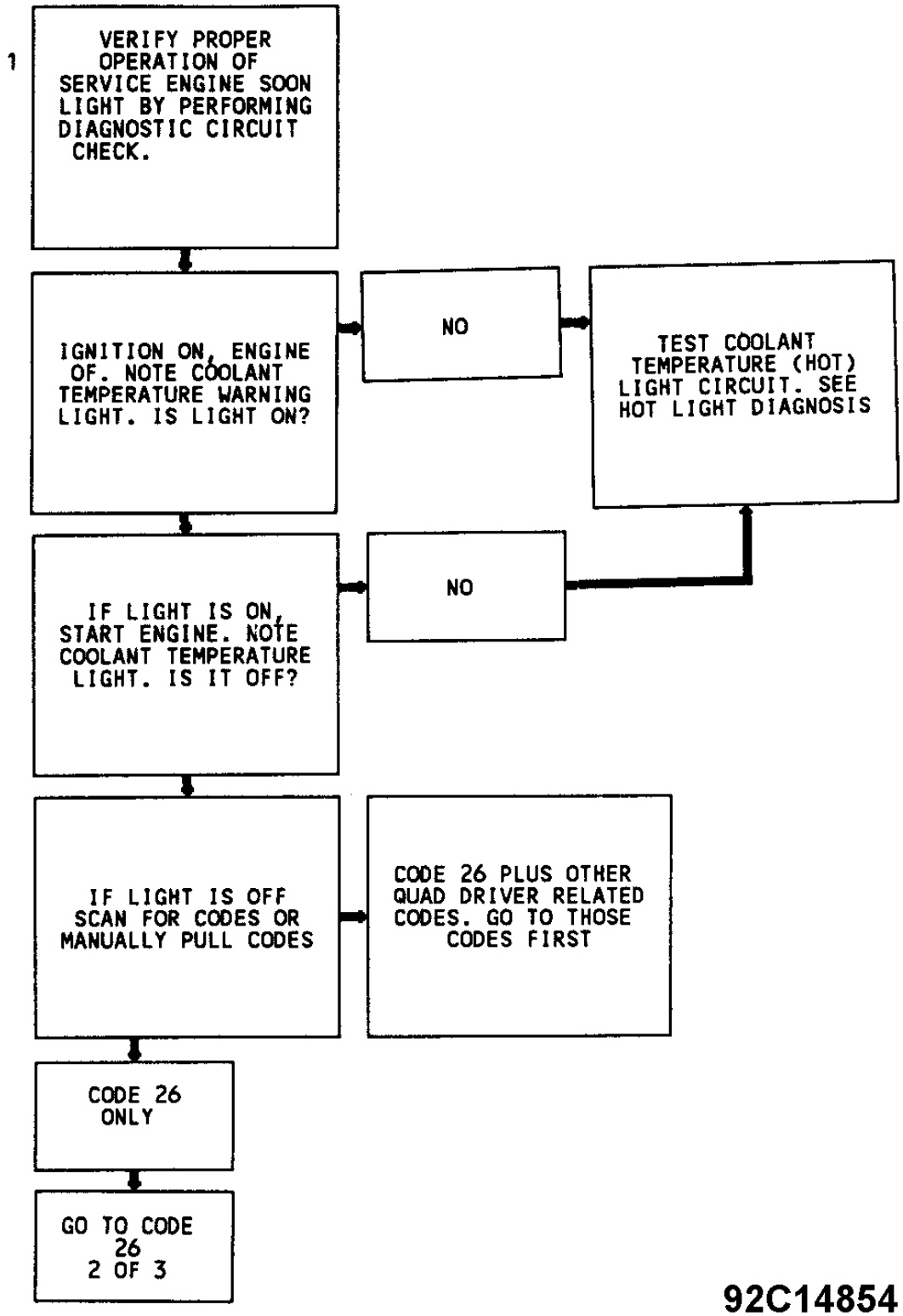
The Coolant temperature sensor, in rare cases, may fail to indicate the correct coolant temperature without setting a malfunction code (Code 14 or 15). This could result in turning on the hot light without having an overheating condition. It could also result in engine overheating without turning on the hot light.

Hot Light Diagnosis (C Body)

NOTE: These checks assume vehicle is not overheating. Verify proper operation of cooling system prior to diagnosing hot light.

Hot light is powered by a 15 or 20-amp fuse No. 6 (depending upon instrument cluster option). Light will turn on when PCM provides a ground for the circuit. If circuit grounds between light and PCM, light will illuminate any time the ignition is turned on.

1. Turn ignition on with engine off (bulb test position). If hot light illuminates, go to step 3. If hot light does not illuminate, check the following:
    - 15 or 20-amp fuse No. 6 in I.P. fuse panel
    - Faulty instrument cluster bulb
    - Open circuit between fuse and hot light
2. Backprobe terminal GC7 at PCM with a test light to battery voltage. Turn ignition on. If test light does not illuminate, PCM terminal connection is bad or PCM is faulty. If test light illuminates, turn ignition off. Disconnect ECM connectors. Jumper terminal GC7 to ground. Turn ignition on. If hot light does not illuminate, check for open circuit between hot light and PCM. If light does not illuminate and all circuits are intact and power is available to light, instrument cluster must be replaced.
3. Start engine. If test light goes off, no problem is evident. See DIAGNOSTIC AIDS. If test light is on, turn ignition off. Disconnect PCM connector. Probe ECM harness terminal GC7 with a test light to battery voltage. If light is off, replace PCM. If light is on, repair short to ground in circuit No. 1268. If no short is present, replace instrument cluster.


1
VERIFY PROPER OPERATION OF SERVICE ENGINE SOON LIGHT BY PERFORMING DIAGNOSTIC CIRCUIT CHECK.
IGNITION ON, ENGINE OF. NOTE COOLANT TEMPERATURE WARNING LIGHT. IS LIGHT ON?
NO
TEST COOLANT TEMPERATURE (HOT) LIGHT CIRCUIT. SEE HOT LIGHT DIAGNOSIS
IF LIGHT IS ON, START ENGINE. NOTE COOLANT TEMPERATURE LIGHT. IS IT OFF?
NO
IF LIGHT IS OFF SCAN FOR CODES OR MANUALLY PULL CODES
CODE 26 PLUS OTHER QUAD DRIVER RELATED CODES. GO TO THOSE CODES FIRST
CODE 26 ONLY
GO TO CODE 26 2 OF 3

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Fig. 106: Code 26 Troubleshooting Flowchart 1 Of 3 (3.8L C & E Body)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to test numbers on diagnostic chart.

4. This determines which circuit is out of specification. All circuits except GD16 and GD15 should have battery voltage with ignition on, engine not running and ALDL test terminal not grounded.

Diagnostic Aids

Monitor the voltage of each terminal while moving related harness connectors, including PCM harness. If the fault is induced, the voltage will change. This may help locate intermittent problems. If code reappears with no apparent problems, replace PCM.

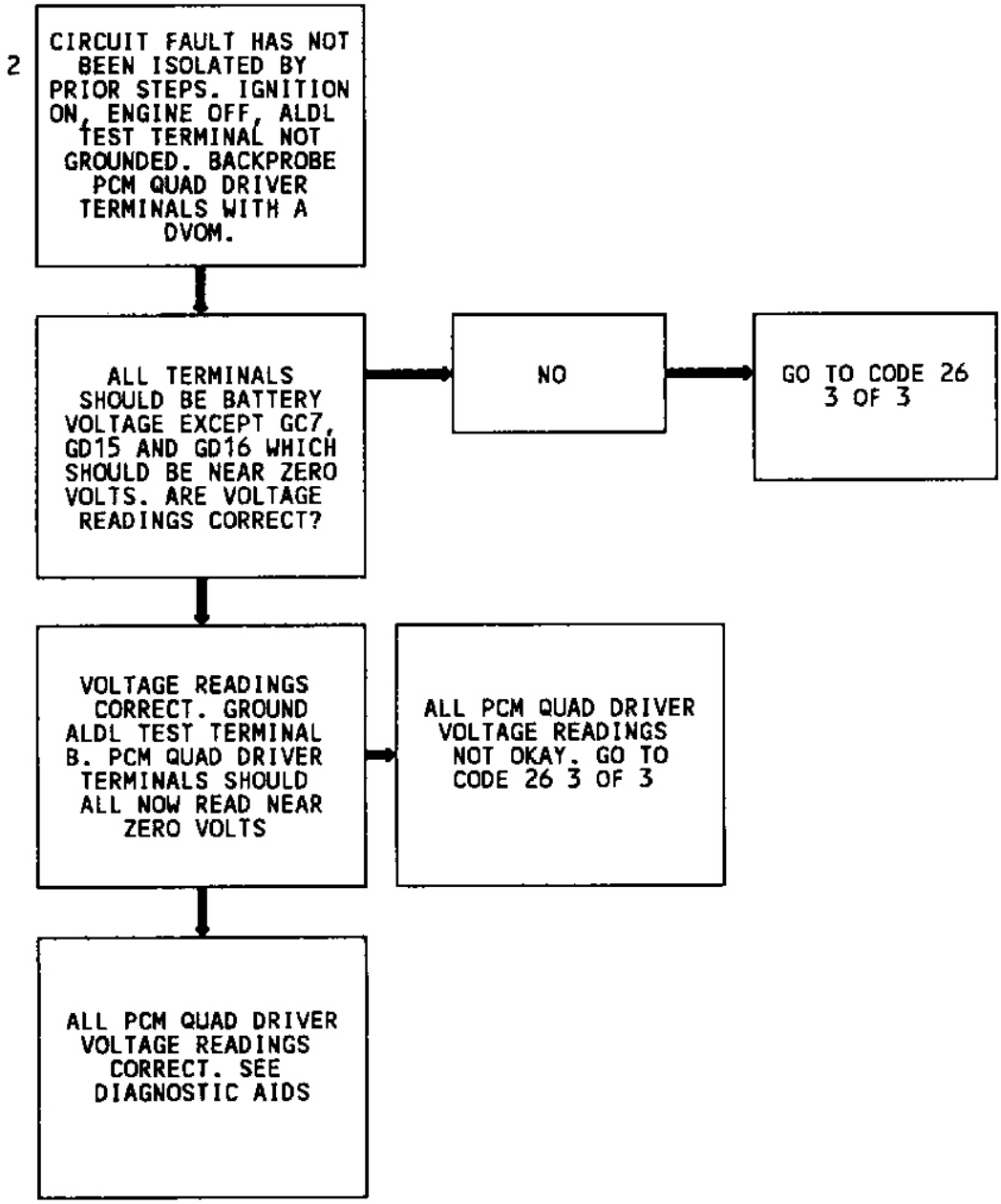


Fig. 107: Code 26 Troubleshooting Flowchart 2 Of 3 (3.8L C & E Body)
Courtesy of GENERAL MOTORS CORP.

1. This determines if the problem is the circuit or the component. Factory-installed PCM has an internal fuse and it's unlikely PCM needs replacing.

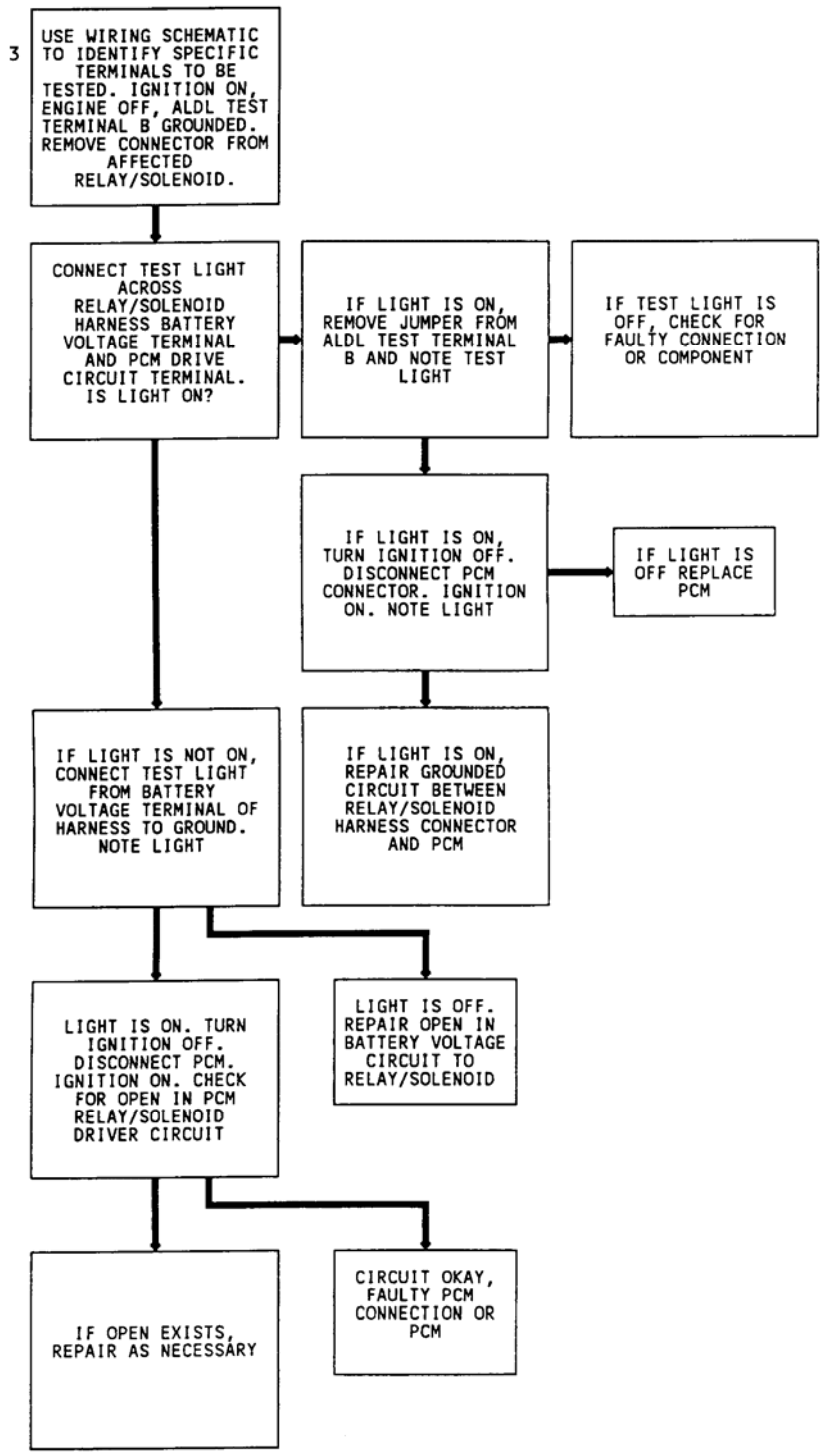


Fig. 108: Code 26 Troubleshooting Flowchart 3 Of 3 (3.8L C & E Body)
Courtesy of GENERAL MOTORS CORP.

CODE 27 OR 28, GEAR SWITCH CIRCUITS - 3.3L WITH 3T40 TRANSAXLE

The gear switches are located inside the transaxle. Switches are normally closed. As road speed increases, hydraulic pressure applies the specific gear clutches and the gear switch opens. The ECM uses the gear switches to control fuel delivery and TCC operation. See **Fig. 126** and **Fig. 150** .

Code 27 will set if circuit No. 108 indicates ground or closed switch for 12 seconds when the vehicle is in 3rd gear or if circuit No. 108 indicates an open when engine is first stared.

Code 28 will set if circuit No. 581 indicates ground or closed switch for 10 seconds when the vehicle is in 3rd gear or if circuit No. 581 indicates an open when engine is first started.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. A digital volt-ohmmeter must be used in this test. A test light will not work due to the low voltage supplied by the ECM.
2. Checks if the circuit is grounded through the switch.
3. Checks for a good, properly operating switch and checks circuit within transaxle for an improper ground.

Diagnostic Aids

Check for poor connections at ECM pins. Inspect harness for incorrect routing (too close to high voltage wiring) or chafing. Monitor the voltage of each terminal while moving related harness connectors. If the failure is induced, the voltage reading will change.

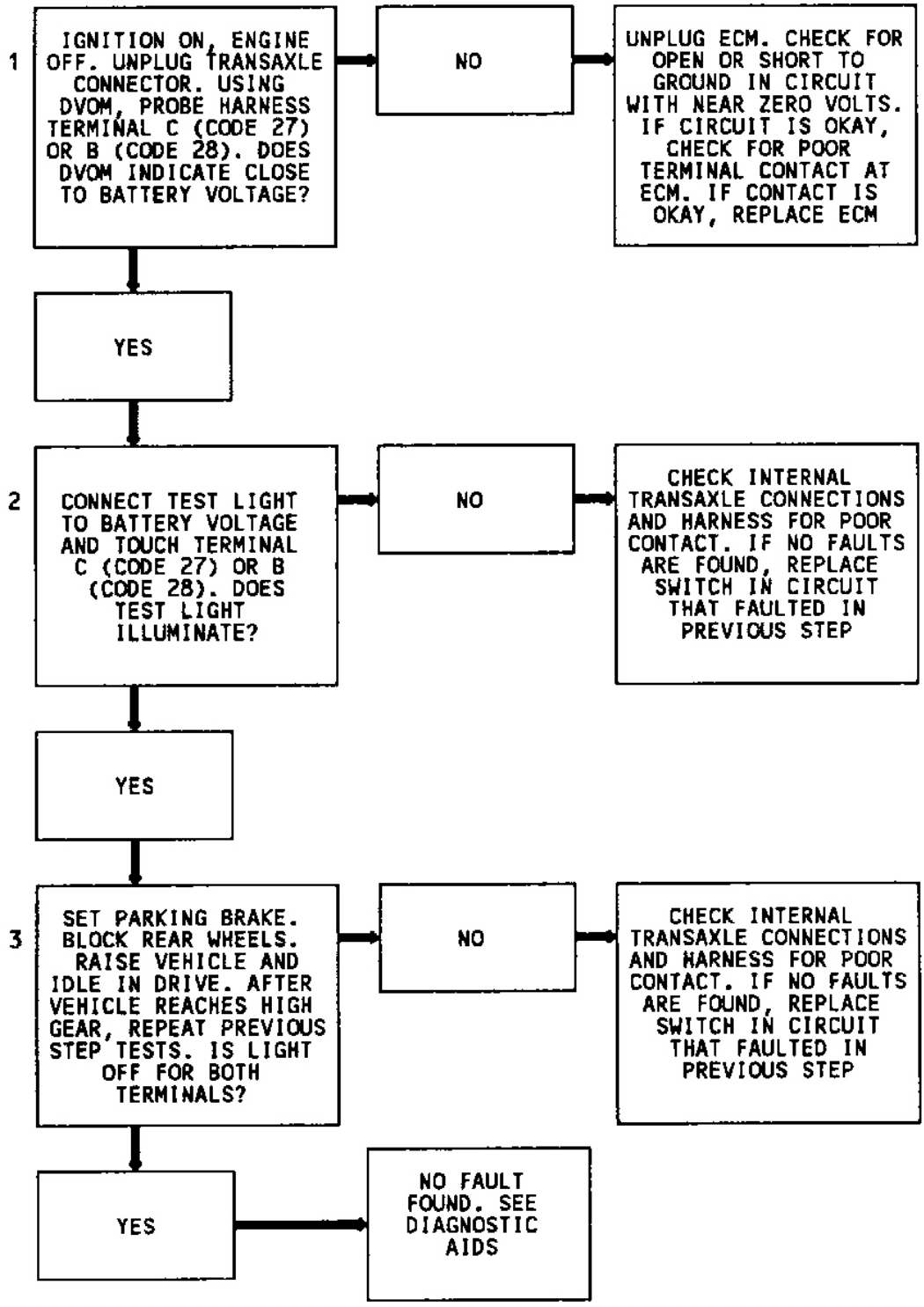


Fig. 109: Code 27 Or 28 Troubleshooting Flowchart (3.3L A & N Body)

Courtesy of GENERAL MOTORS CORP.

CODE 28 OR 29, GEAR SWITCH CIRCUITS - 3.3L A BODY WITH 4T60

TRANSAXLE

The gear switches are located inside the transaxle. Switches are normally closed. As road speed increases, hydraulic pressure applies the specific gear clutches and the gear switch opens. The ECM uses the gear switches to help determine control of fuel delivery and TCC operation. Code 28 will set if circuit No. 108 indicates ground or closed switch for 12 seconds when the vehicle is in 4th gear or if circuit No. 108 indicates an open when engine is first started. See **Fig. 127**.

Code 29 will set if circuit No. 446 indicates ground or closed switch for 10 seconds when the vehicle is in 4th gear or if circuit No. 446 indicates an open when engine is first started.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. A digital volt-ohmmeter must be used in this test. A test light will not work due to the low voltage supplied by the ECM
2. Checks if the circuit is grounded through the switch
3. Checks for a good, properly operating switch and checks circuit within transaxle for an improper ground.

Diagnostic Aids

Check for poor connections at ECM pins. Inspect harness for incorrect routing (too close to high voltage wiring) or chafing. Monitor the voltage of each terminal while moving related harness connectors. If the failure is induced, the voltage reading will change.

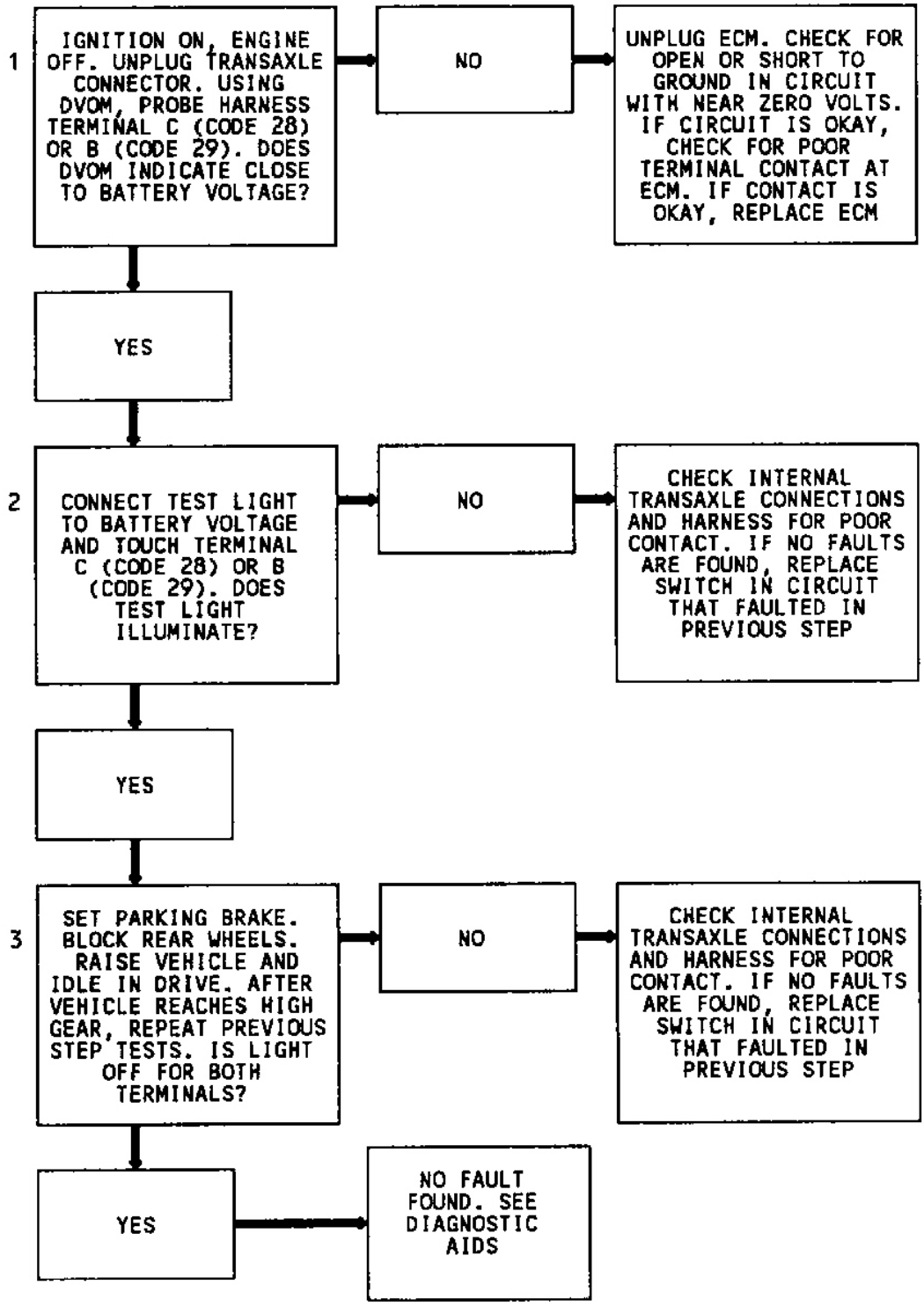


Fig. 110: Code 28 Or 29 Troubleshooting Diagram (3.3L A Body W/4T60)

Courtesy of GENERAL MOTORS CORP.

CODE 27, 28 OR 29 GEAR SWITCH CIRCUITS - 3.8L

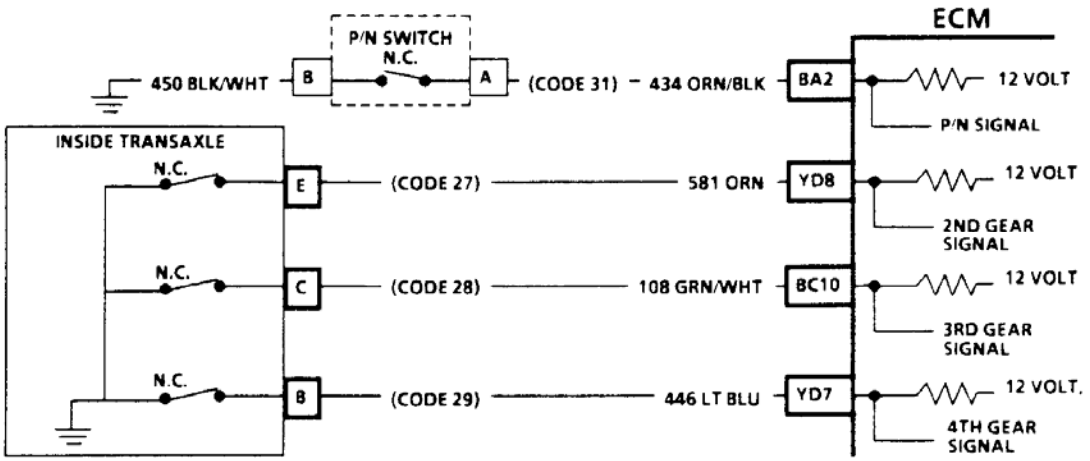


Fig. 111: Code 27, 28 Or 29 Gear Switch Circuit Diagram (3.8L H Body)
Courtesy of GENERAL MOTORS CORP.

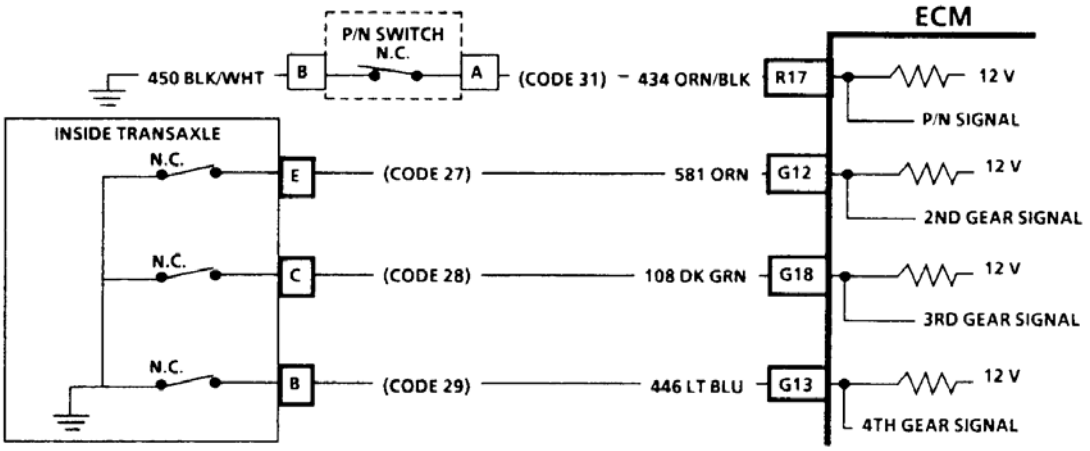


Fig. 112: Code 27, 28 Or 29 Gear Switch Circuit Diagram (3.8L W Body)
Courtesy of GENERAL MOTORS CORP.

The gear switches are located inside the transaxle. Switches are normally closed. As road speed increases, hydraulic pressure applies the specific gear clutches and gear switch opens. The ECM uses the gear switches to help determine control of fuel delivery and TCC operation.

Code 27 will set if no Code 29 is present, circuit No. 581 indicates ground or closed switch for 10 seconds when vehicle is in 4th gear, or circuits No. 581 or No. 446 indicate an open when the engine is first started.

Code 28 will set if circuit No. 108 indicates ground or closed switch for indicate an open when engine is first started.

Code 29 will set if circuit No. 446 indicates ground or closed switch for 10 seconds when the vehicle is in 4th gear (TCC locked and brake not applied) or if circuit No. 446 indicates an open when engine is first started.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. A digital volt-ohmmeter must be used in this test. A test light will not work due to the low voltage supplied by the ECM.
2. Checks if the circuit is grounded through the switch.
3. Checks for a good, properly operating switch and checks circuit within transaxle for an improper ground.

Diagnostic Aids

Check for poor connections at ECM pins. Inspect harness for incorrect routing (too close to high voltage wiring) or chafing. Monitor the voltage of each terminal while moving related harness connectors. If the failure is induced, the voltage reading will change.

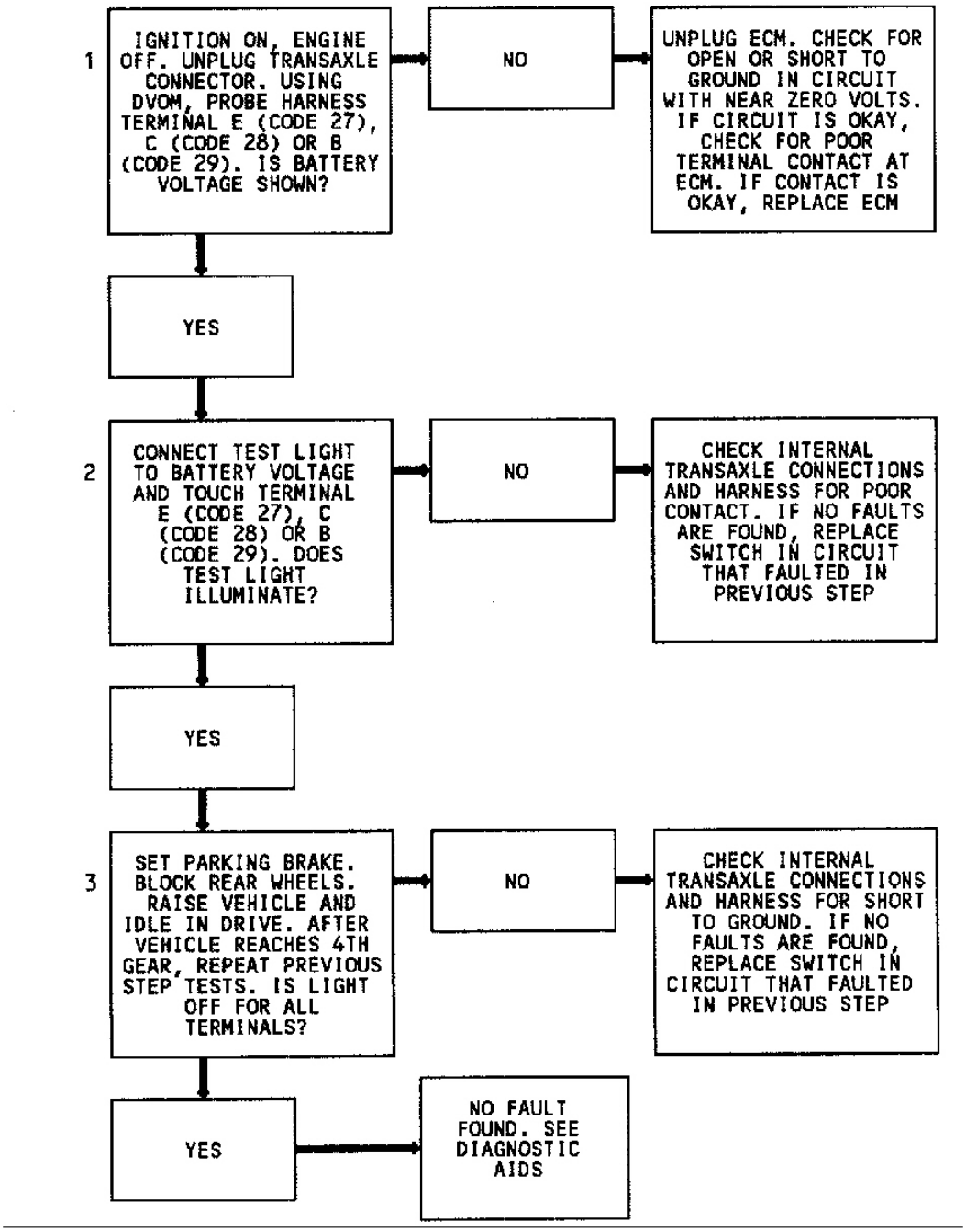


Fig. 113: Code 27, 28 Or 29 Troubleshooting Diagram
Courtesy of GENERAL MOTORS CORP.

CODE 31, PARK/NEUTRAL SWITCH CIRCUIT - 3.3L & 3.8L

NOTE: **Complete diagnosis of Code 31 for 3.8L (VIN L) C and E body vehicles requires the use of a GM Tech 1 "Scan" tester which is capable of indicating status of all 4 park/neutral switch positions. This chart does not apply to 3.8L (VIN L) C and E body vehicles.**

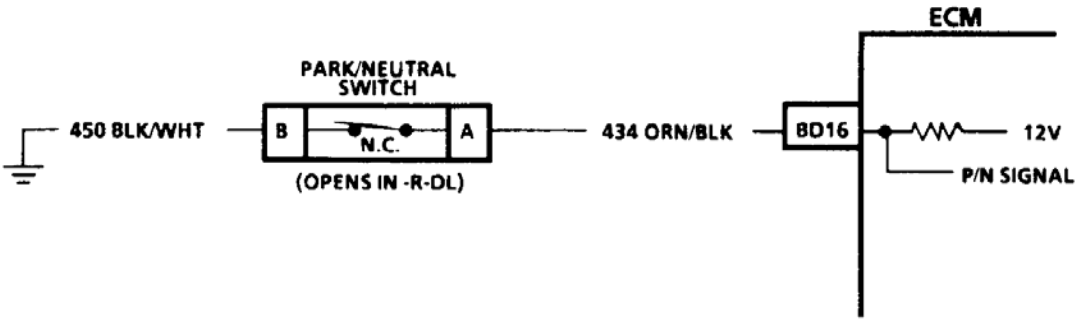


Fig. 114: Code 31 Park/Neutral Switch Circuit Diagram (3.3L A & N Bodies)
Courtesy of GENERAL MOTORS CORP.

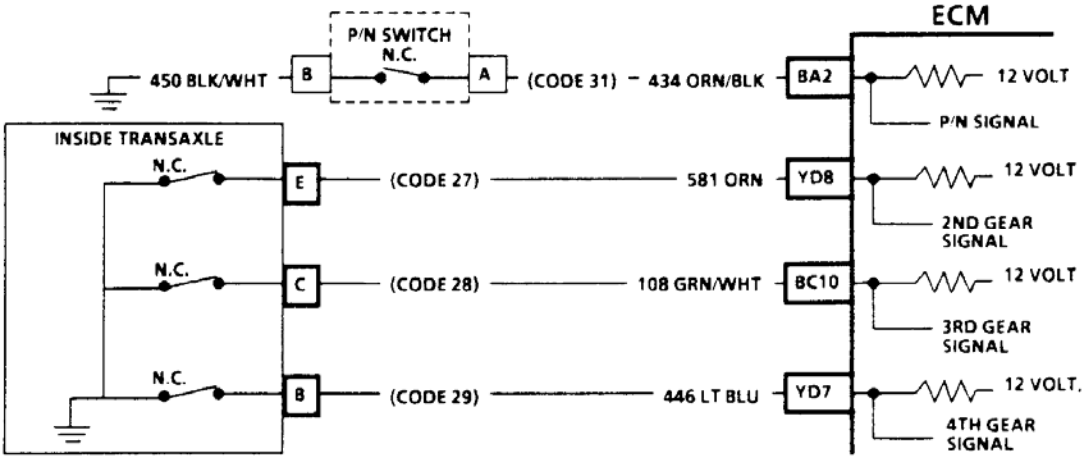


Fig. 115: Code 31 Park/Neutral Switch Circuit Diagram (3.8L H Bodies)
Courtesy of GENERAL MOTORS CORP.

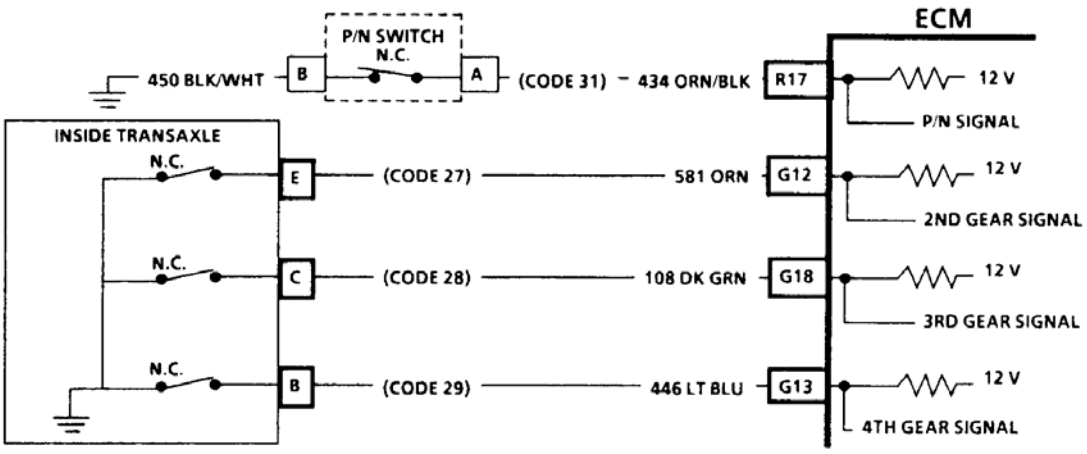


Fig. 116: Code 31 Park/Neutral Switch Circuit Diagram (3.8L W Bodies)
Courtesy of GENERAL MOTORS CORP.

The park/neutral switch contacts are part of the neutral start switch. The contacts close to ground in Park or Neutral and open in Drive. Code 31 will set if park/neutral signal circuit indicates an open for 3-4 consecutive starts or if conditions occur as follows:

- No Code 38 (3.3L) or 29 (3.8L) exists
- Circuit No. 434 indicates ground
- Transmission is in high gear
- TCC is locked on 4T60 trans. only
- Vehicle speed is greater than 45 MPH and TPS is less than 15 percent (.94 volt) on 3T40 trans. only
- All above conditions have been met for at least 12 seconds

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This tests for a closed switch to ground in Park.
2. This test for an open switch in Drive.
3. Be sure "Scan" tester indicates Drive, even when wiggling shifter.

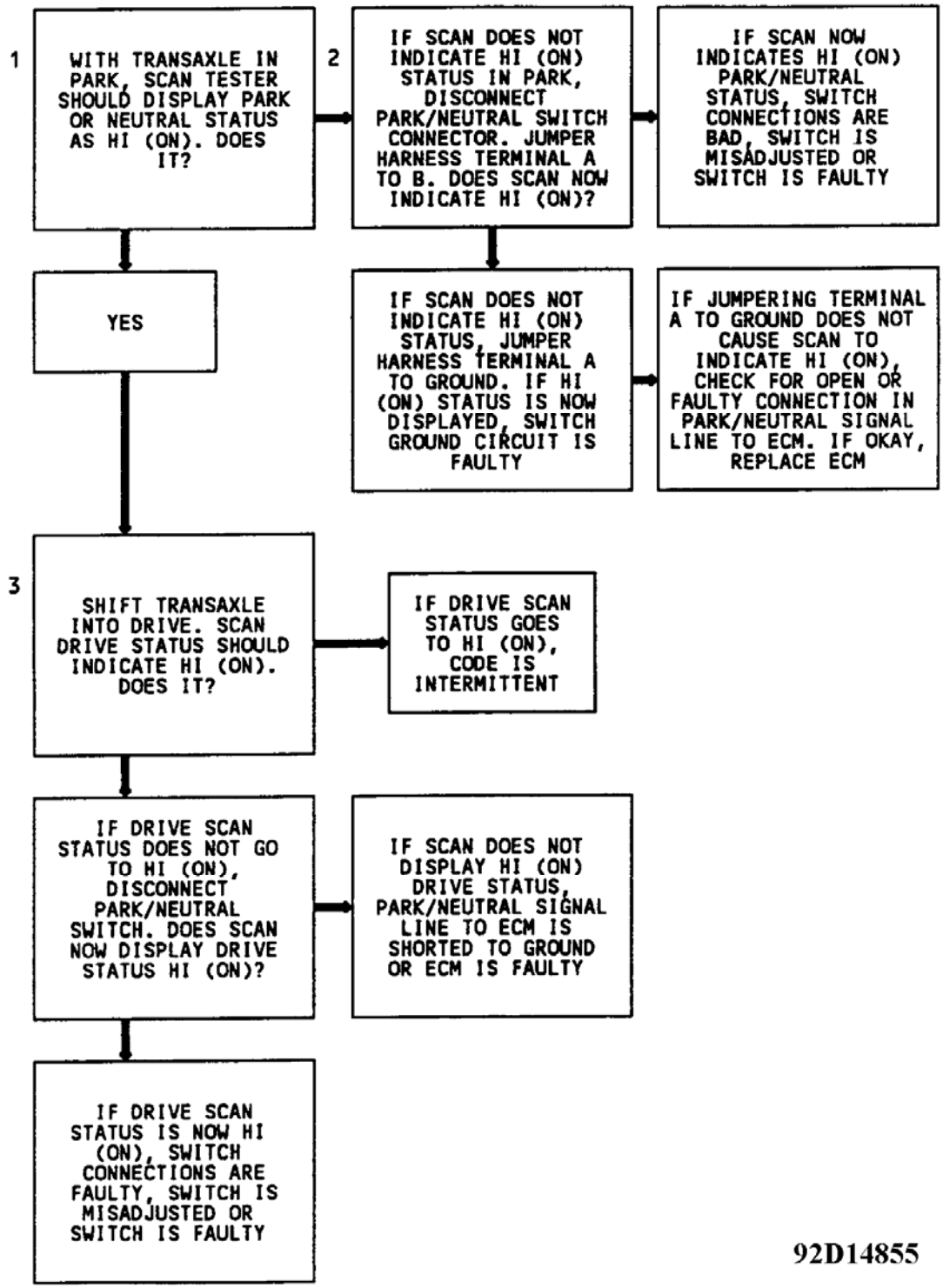


Fig. 117: Code 31 Troubleshooting Diagram (3.3L & 3.8L)
Courtesy of GENERAL MOTORS CORP.

CODE 31, PARK/NEUTRAL SWITCH CIRCUIT - 3.8L PFI (VIN L)

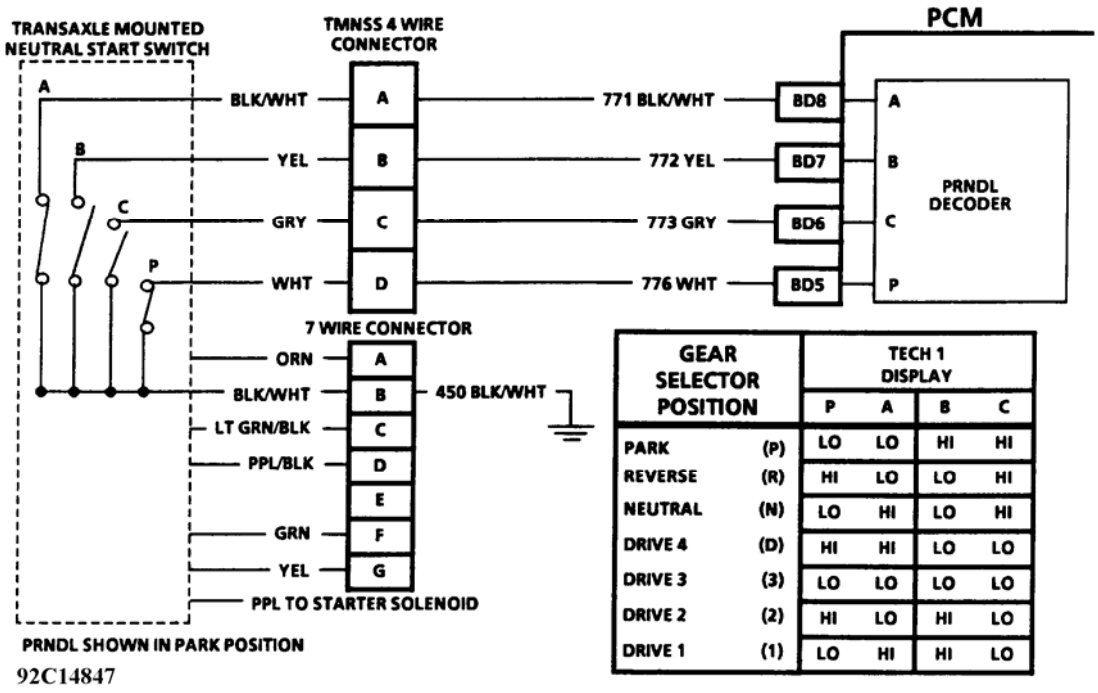


Fig. 118: Code 31, Park/Neutral Switch Circuit Diagram (3.8L PFI - VIN L)
Courtesy of GENERAL MOTORS CORP.

PRNDL switch is mounted on transaxle assembly. Switch sends information relative to gear selector position to PCM. PRNDL assembly also contains neutral safety switch. PRNDL switch uses 4 discrete circuits to pull 4 PCCM voltages low in various combinations to indicate each gear range. Voltage level of each of the circuits is represented as LO being grounded and HI being open. The 4 digits displayed represent Code 31 sets under the following conditions:

- Ignition is on and engine is off
- Vehicle speed is 0 MPH
- PRNDL indicates a gear other than Park or Neutral
- All conditions met for 13 seconds for 3 consecutive starts.
- PRNDL status indicators (A, B, C and P) indicate an incorrect combination of LO and HI for more than 10 seconds.
- When a Code 31 is present, PCM assumes the D4 position until a correct combination is received by PCM. Some gear select positions may not be possible until fault is repaired.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks for proper operation of PRNDL.
2. This test checks for proper operation of PRNDL.

3. This test checks for open or grounded circuit.

Diagnostic Aids

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broaden inside the insulation. check for the following:

Poor Connection or Damaged Harness

Inspect PCM harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.

Intermittent Test

Monitor a scan tool while moving related connectors and wiring harness. If failure is induced, scan data will change from LO to HI or HI to LO. Moving gear selector slowly through each gear position while monitoring PRNDL switch with scan tool may locate a faulty switch. This procedure may help isolate location of malfunction.

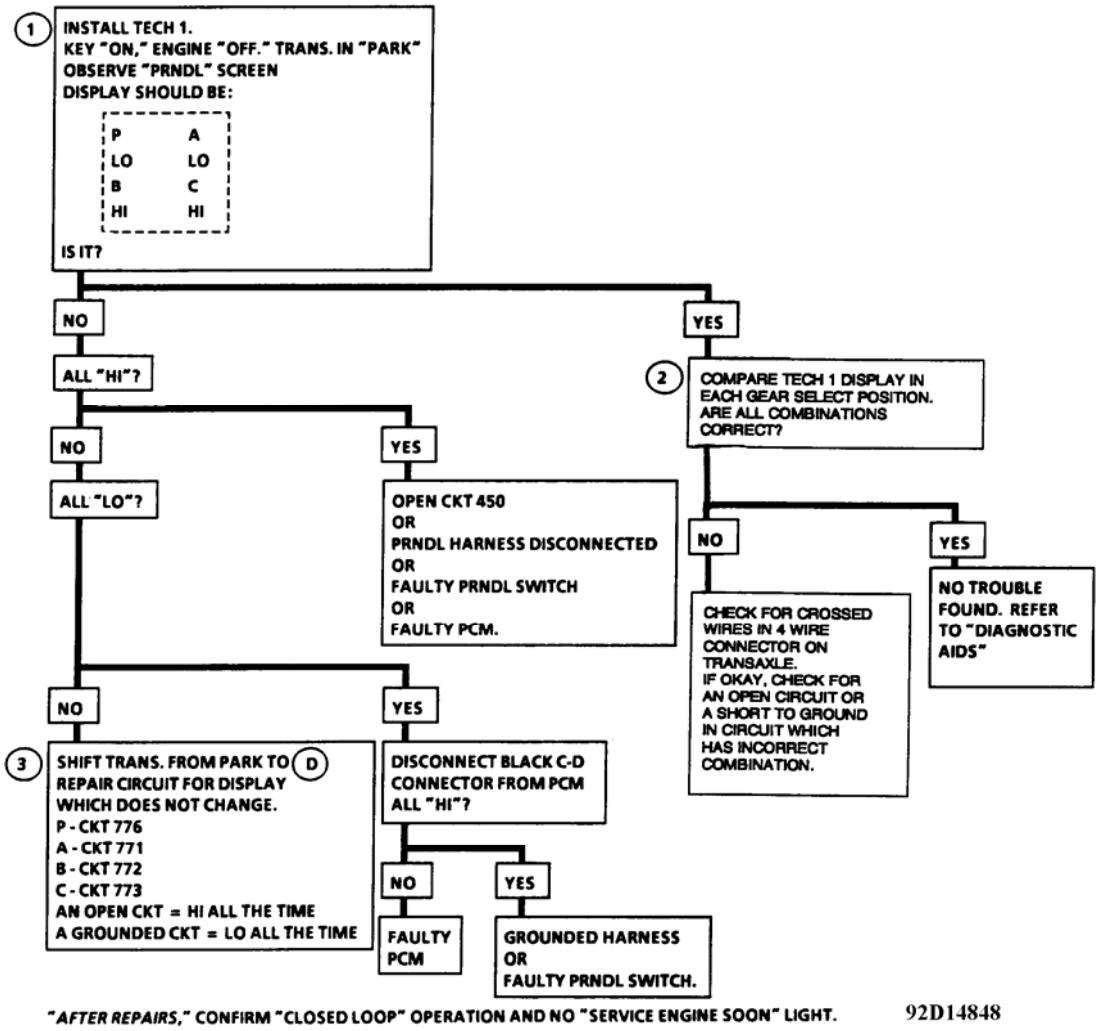


Fig. 119: Code 31, Troubleshooting Diagram (3.8L PFI - VIN L)
Courtesy of GENERAL MOTORS CORP.

CODE 31, PARK/NEUTRAL SWITCH CIRCUIT - 3.3L PFI (VIN N)

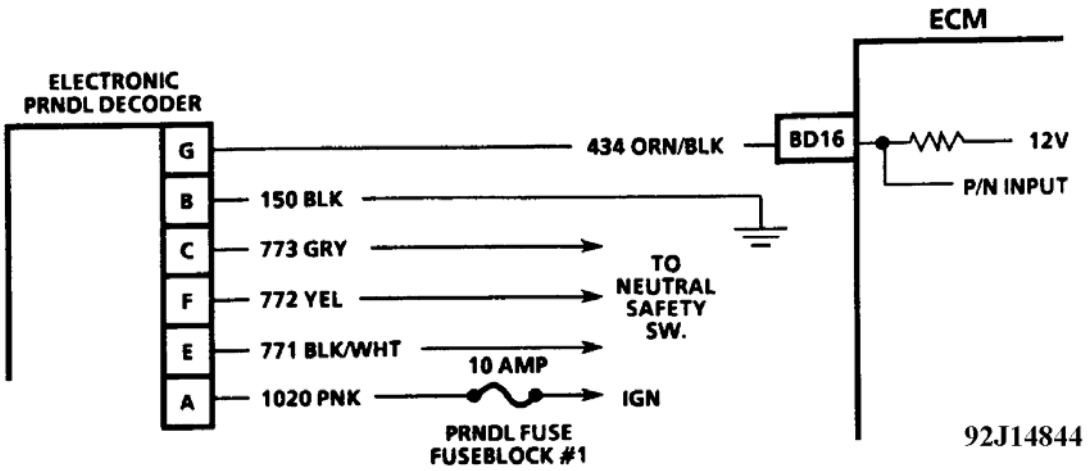


Fig. 120: Code 31, Park/Neutral Switch Circuit Diagram (Achieva)
Courtesy of GENERAL MOTORS CORP.

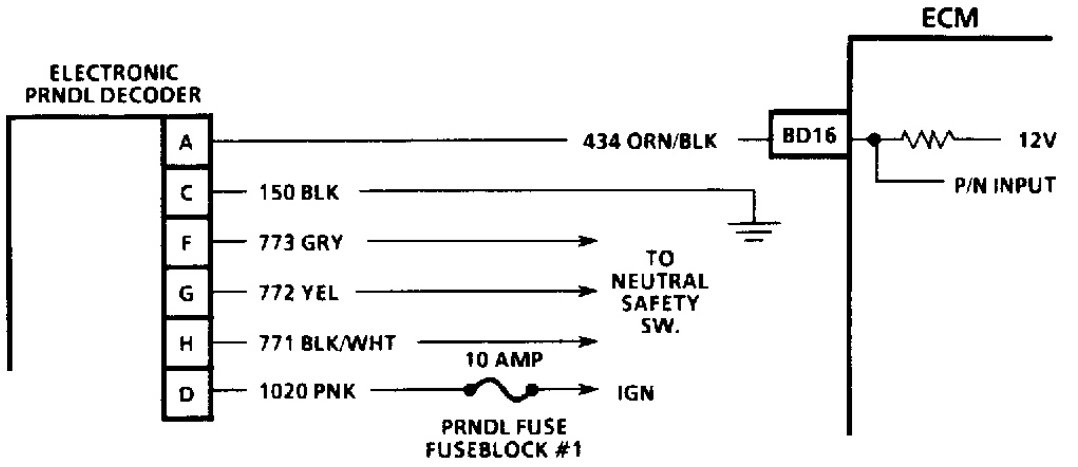


Fig. 121: Code 31, Park/Neutral Switch Circuit Diagram (Skylark)
Courtesy of GENERAL MOTORS CORP.

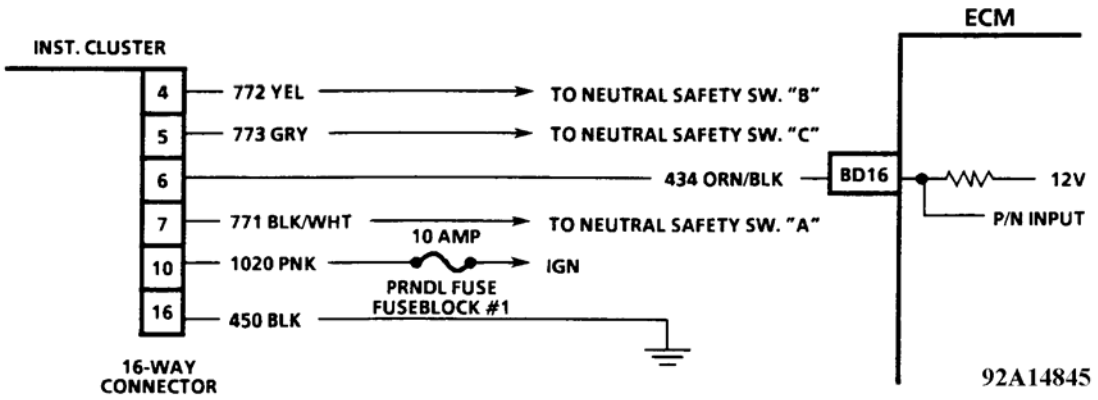


Fig. 122: Code 31, Park/Neutral Switch Circuit Diagram (Grand Am)
Courtesy of GENERAL MOTORS CORP.

ECM supplies ignition voltage through a current limiting resistor to circuit No. 434 and senses a closed switch when voltage on circuit No. 434 drops to less than one volt. ECM uses Park/Neutral signal as one of the inputs to control Idle Speed Control (IAC), spark timing and Vehicle Speed Sensor (VSS). Code 31 will set under the following conditions:

- Circuit No. 434 indicates ground.
- No Code 38.
- Transmission is in high gear
- VSS greater than 45 MPH and TPS is less than .94 volt.
- Above conditions are met for 12 seconds.

Code 31 does not illuminate "Service Engine Soon" light.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks for a closed switch to ground in park position.
2. This test checks for a faulty ECM.
3. This test checks for an ungrounded Park/Neutral input in drive range. Ensure scan tool indicates drive, even while wiggling shifter. If scan tool does not indicate as previously described, check for a misadjusted neutral safety switch or and intermittent problem.

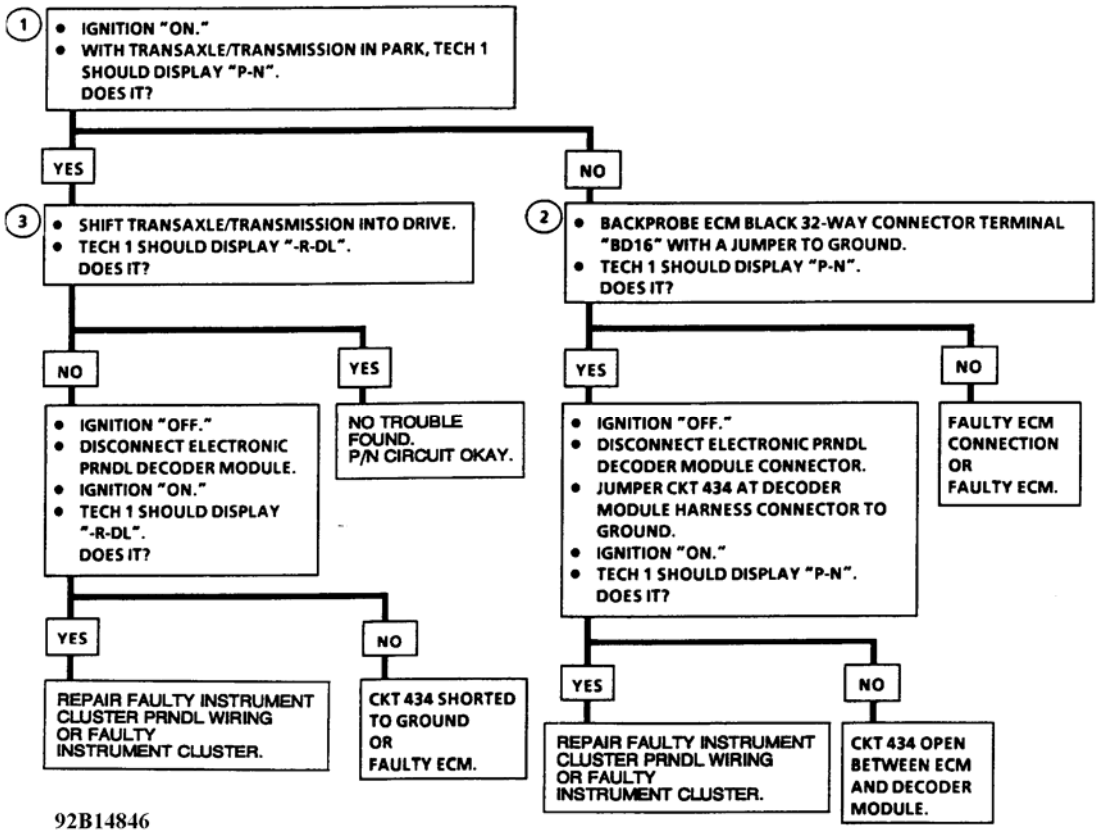


Fig. 123: Code 31, Troubleshooting Diagram (3.3L PFI - VIN N)
Courtesy of GENERAL MOTORS CORP.

CODE 36, SHIFT CONTROL PROBLEM - 3.8L C & E BODIES W/4T60E TRANSAXLE

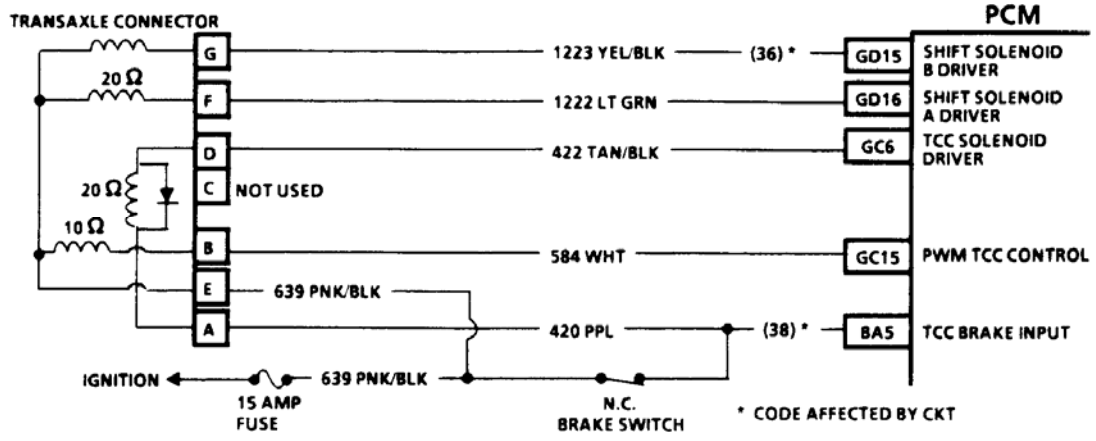


Fig. 124: Code 36, Shift Control Circuit Diagram (3.8L C & E Bodies W/4T60E Transaxle)
Courtesy of GENERAL MOTORS CORP.

The 4T60E transaxle is electronically shifted. Within transaxle are 4 solenoids. Solenoid A is used for 1st and 4th gear operation only. Solenoid B is used for 1st and 2nd gear operation. The remaining 2 solenoids are for TCC operation only. All PRNDL indications are ignored as far as transaxle shifting is concerned except manual low. Code 36 will set if solenoid B failed in the off position, which will cause the transaxle to be in 3rd gear and desired gear is 1st. TPS is greater than 5 percent, VSS is greater than 5 MPG and no code 21, 22 or 24 is present. Code will also set if solenoid B failed in the on position, which will cause transaxle to be in 1st gear and desired gear is 4th, PRNDL is in 3rd or 4th, TPS is greater than 10 percent and no Code 31, 21 or 22 is present.

Diagnostic Aids

When Code 36 is set, transaxle will be forced into 3rd gear. If code sets due to a grounded circuit No. 1223, 1st and 2nd gear operation will be available only. If circuit No. 1223 is open, 3rd and 4th gear operation will be available only. If fault goes away, normal operation will be resumed for the duration of the key cycle.

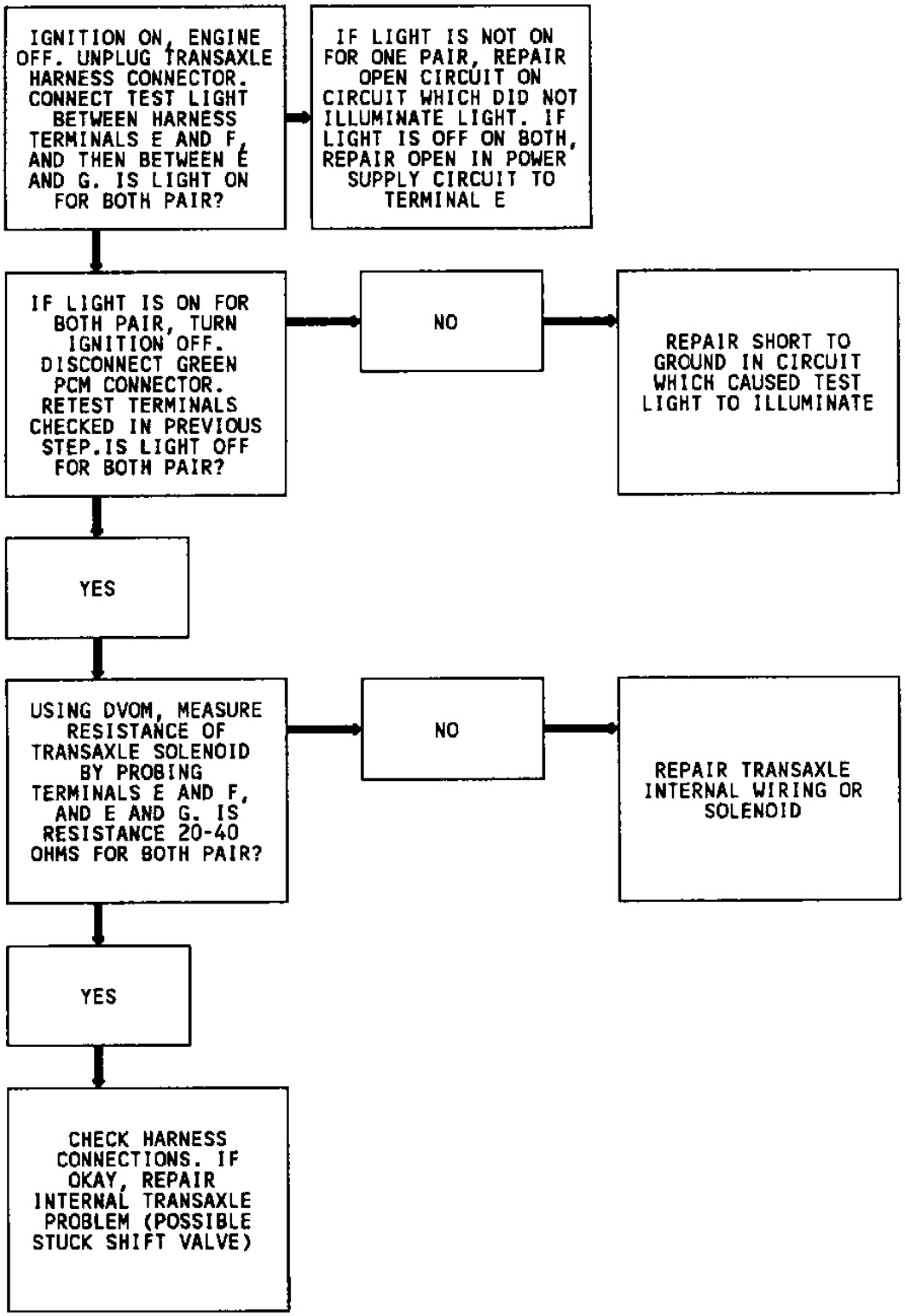

IGNITION ON, ENGINE OFF. UNPLUG TRANSAXLE HARNESS CONNECTOR. CONNECT TEST LIGHT BETWEEN HARNESS TERMINALS E AND F, AND THEN BETWEEN E AND G. IS LIGHT ON FOR BOTH PAIR?
IF LIGHT IS NOT ON FOR ONE PAIR, REPAIR OPEN CIRCUIT ON CIRCUIT WHICH DID NOT ILLUMINATE LIGHT. IF LIGHT IS OFF ON BOTH, REPAIR OPEN IN POWER SUPPLY CIRCUIT TO TERMINAL E
IF LIGHT IS ON FOR BOTH PAIR, TURN IGNITION OFF. DISCONNECT GREEN PCM CONNECTOR. RETEST TERMINALS CHECKED IN PREVIOUS STEP.IS LIGHT OFF FOR BOTH PAIR?
NO
REPAIR SHORT TO GROUND IN CIRCUIT WHICH CAUSED TEST LIGHT TO ILLUMINATE
YES
USING DVOM, MEASURE RESISTANCE OF TRANSAXLE SOLENOID BY PROBING TERMINALS E AND F, AND E AND G. IS RESISTANCE 20-40 OHMS FOR BOTH PAIR?
NO
REPAIR TRANSAXLE INTERNAL WIRING OR SOLENOID
YES
CHECK HARNESS CONNECTIONS. IF OKAY, REPAIR INTERNAL TRANSAXLE PROBLEM (POSSIBLE STUCK SHIFT VALVE)

Fig. 125: Code 36, Troubleshooting Diagram (3.8L C & E Bodies W/4T60E Transaxle)
Courtesy of GENERAL MOTORS CORP.

CODE 38, BRAKE SWITCH CIRCUIT - 3.3L & 3.8L

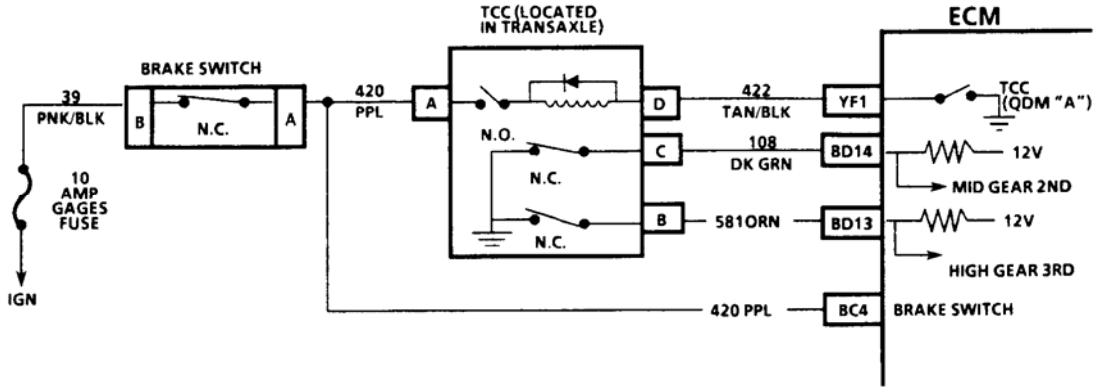


Fig. 126: Code 38, Brake Switch Circuit Diagram (3.3L A Body W/3T40)
Courtesy of GENERAL MOTORS CORP.

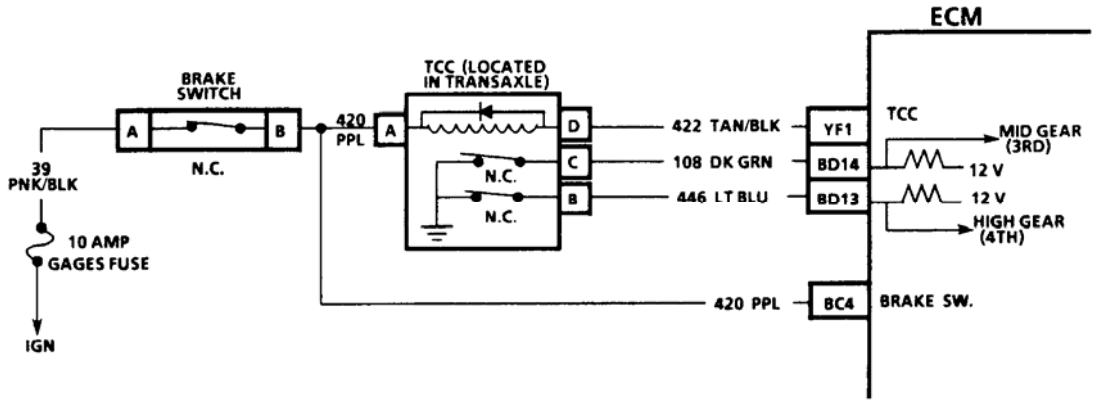


Fig. 127: Code 38, Brake Switch Circuit Diagram (3.3L A Body W/4T60)
Courtesy of GENERAL MOTORS CORP.

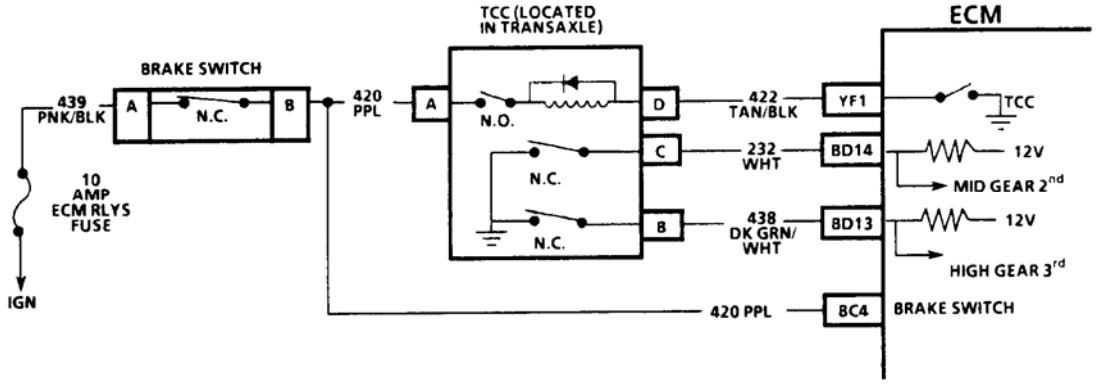


Fig. 128: Code 38, Brake Switch Circuit Diagram (3.3L N Body)
Courtesy of GENERAL MOTORS CORP.

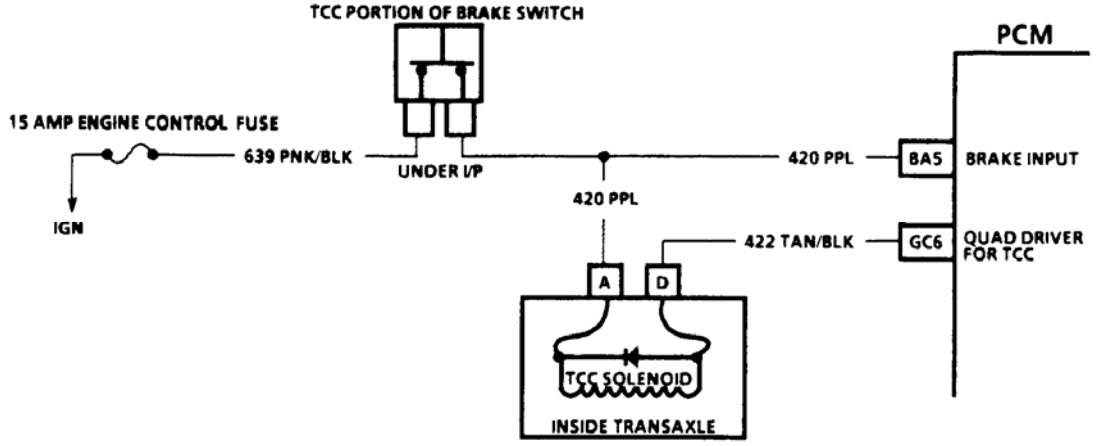


Fig. 129: Code 38, Brake Switch Circuit Diagram (3.8L C & E Bodies)
Courtesy of GENERAL MOTORS CORP.

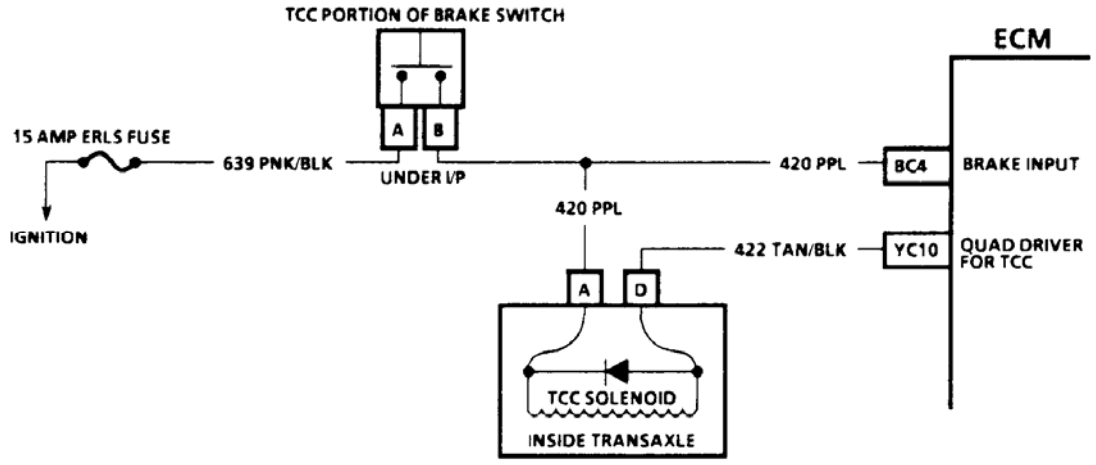


Fig. 130: Code 38, Brake Switch Circuit Diagram (3.8L H Body)
Courtesy of GENERAL MOTORS CORP.

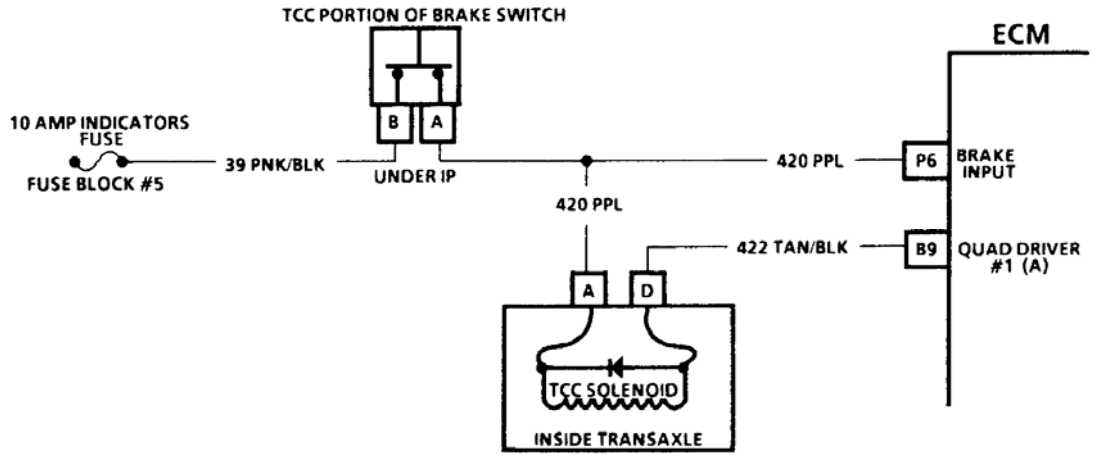


Fig. 131: Code 38, Brake Switch Circuit Diagram (3.8L W Body)
Courtesy of GENERAL MOTORS CORP.

Code 38 will set if no Code 24 is present, status at brake input terminal of control module has not changed from high to low and vehicle speed has been greater than 35 MPH and back to zero MPH a precalibrated number of times.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Jumpering the brake switch determines if the ECM and wiring for the brake switch are okay.
2. Determines if brake switch is out of adjustment or is faulty.
3. Verifies the voltage to the brake switch.

Diagnostic Aids

A Code 38 in conjunction with a Code 39 or 26 would mean a problem with one or more of the following components.

- Fuse or power supply circuit, brake switch or wire before the splice.
- Code 38 shown is the result of a wire or circuit problem between the splice and the control module, poor connection to the control module, or possibly the control module, itself.

If brake switch has failed in an open state, TCC will not engage. Code 38 does not turn on SERVICE ENGINE SOON light on all models.

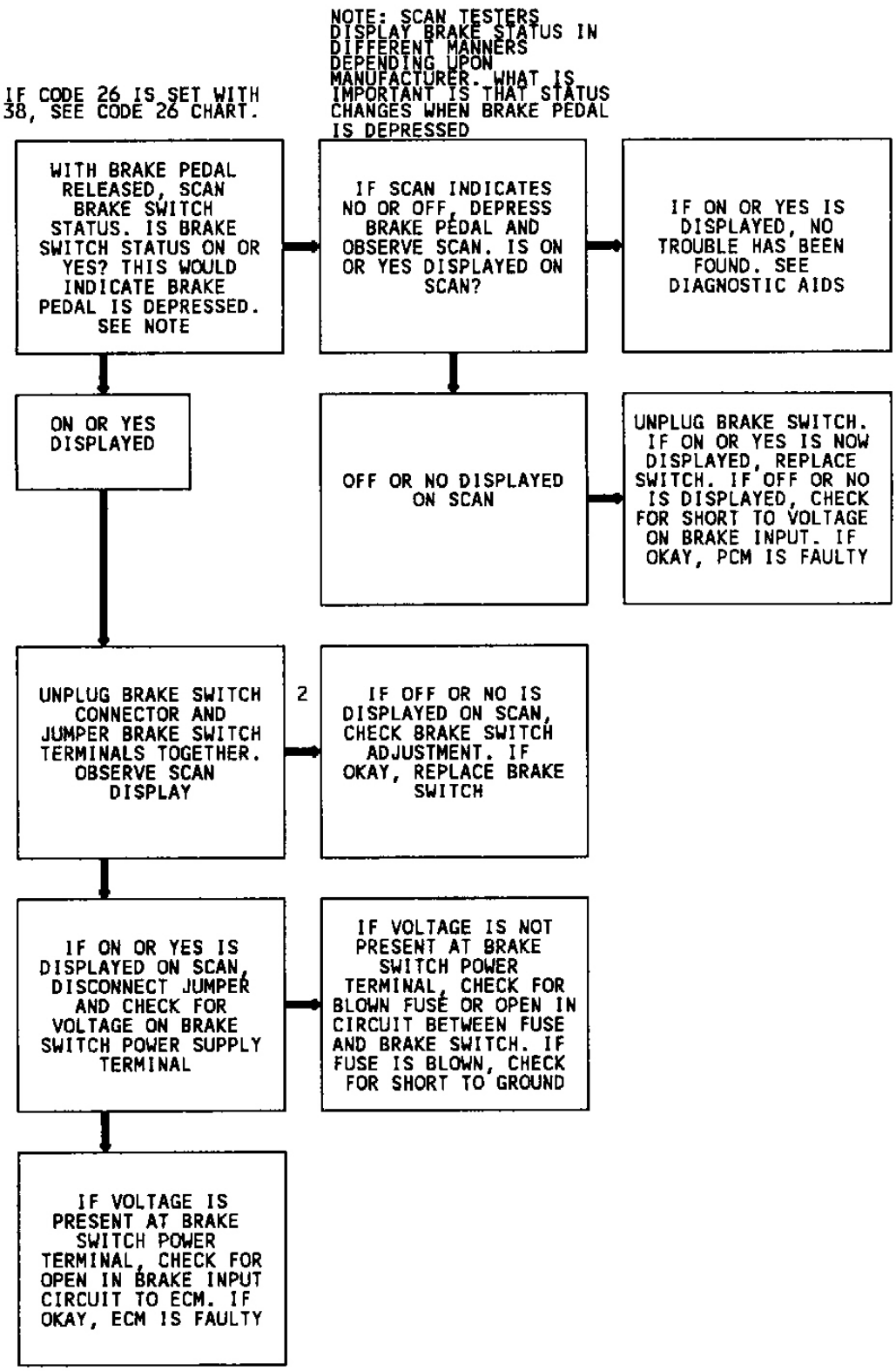

IF CODE 26 IS SET WITH 38, SEE CODE 26 CHART.
NOTE: SCAN TESTERS DISPLAY BRAKE STATUS IN DIFFERENT MANNERS DEPENDING UPON MANUFACTURER. WHAT IS IMPORTANT IS THAT STATUS CHANGES WHEN BRAKE PEDAL IS DEPRESSED
WITH BRAKE PEDAL RELEASED, SCAN BRAKE SWITCH STATUS. IS BRAKE SWITCH STATUS ON OR YES? THIS WOULD INDICATE BRAKE PEDAL IS DEPRESSED. SEE NOTE
IF SCAN INDICATES NO OR OFF, DEPRESS BRAKE PEDAL AND OBSERVE SCAN. IS ON OR YES DISPLAYED ON SCAN?
IF ON OR YES IS DISPLAYED, NO TROUBLE HAS BEEN FOUND. SEE DIAGNOSTIC AIDS
ON OR YES DISPLAYED
OFF OR NO DISPLAYED ON SCAN
UNPLUG BRAKE SWITCH. IF ON OR YES IS NOW DISPLAYED, REPLACE SWITCH. IF OFF OR NO IS DISPLAYED, CHECK FOR SHORT TO VOLTAGE ON BRAKE INPUT. IF OKAY, PCM IS FAULTY
1
UNPLUG BRAKE SWITCH CONNECTOR AND JUMPER BRAKE SWITCH TERMINALS TOGETHER. OBSERVE SCAN DISPLAY
2
IF OFF OR NO IS DISPLAYED ON SCAN, CHECK BRAKE SWITCH ADJUSTMENT. IF OKAY, REPLACE BRAKE SWITCH
3
IF ON OR YES IS DISPLAYED ON SCAN, DISCONNECT JUMPER AND CHECK FOR VOLTAGE ON BRAKE SWITCH POWER SUPPLY TERMINAL
IF VOLTAGE IS NOT PRESENT AT BRAKE SWITCH POWER TERMINAL, CHECK FOR BLOWN FUSE OR OPEN IN CIRCUIT BETWEEN FUSE AND BRAKE SWITCH. IF FUSE IS BLOWN, CHECK FOR SHORT TO GROUND
IF VOLTAGE IS PRESENT AT BRAKE SWITCH POWER TERMINAL, CHECK FOR OPEN IN BRAKE INPUT CIRCUIT TO ECM. IF OKAY, ECM IS FAULTY

Fig. 132: Code 38, Troubleshooting Diagram (3.3L & 3.8L)
Courtesy of GENERAL MOTORS CORP.

CODE 39, TCC CIRCUIT 3.3L WITH 3T40 TRANSAXLE

Code 39 will set when no Code 28 is set, brake is not applied, TCC is commanded by ECM, transmission is in high gear and engine speed-to-vehicle speed ration does not indicate TCC has engaged. All these conditions must have been met for more than 15 seconds. See **Fig. 126** and **Fig. 223** .

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Tests TCC power supply (GAGES fuse) and brake switch.
2. Test ECM for proper operation.
3. Tests internal transaxle switches.

Diagnostic Aids

A poor connection can cause an intermittent Code 39. Using a digital volt-ohmmeter connected to the circuit, move the related wiring and connectors. An intermittent condition would cause a voltage reading change.

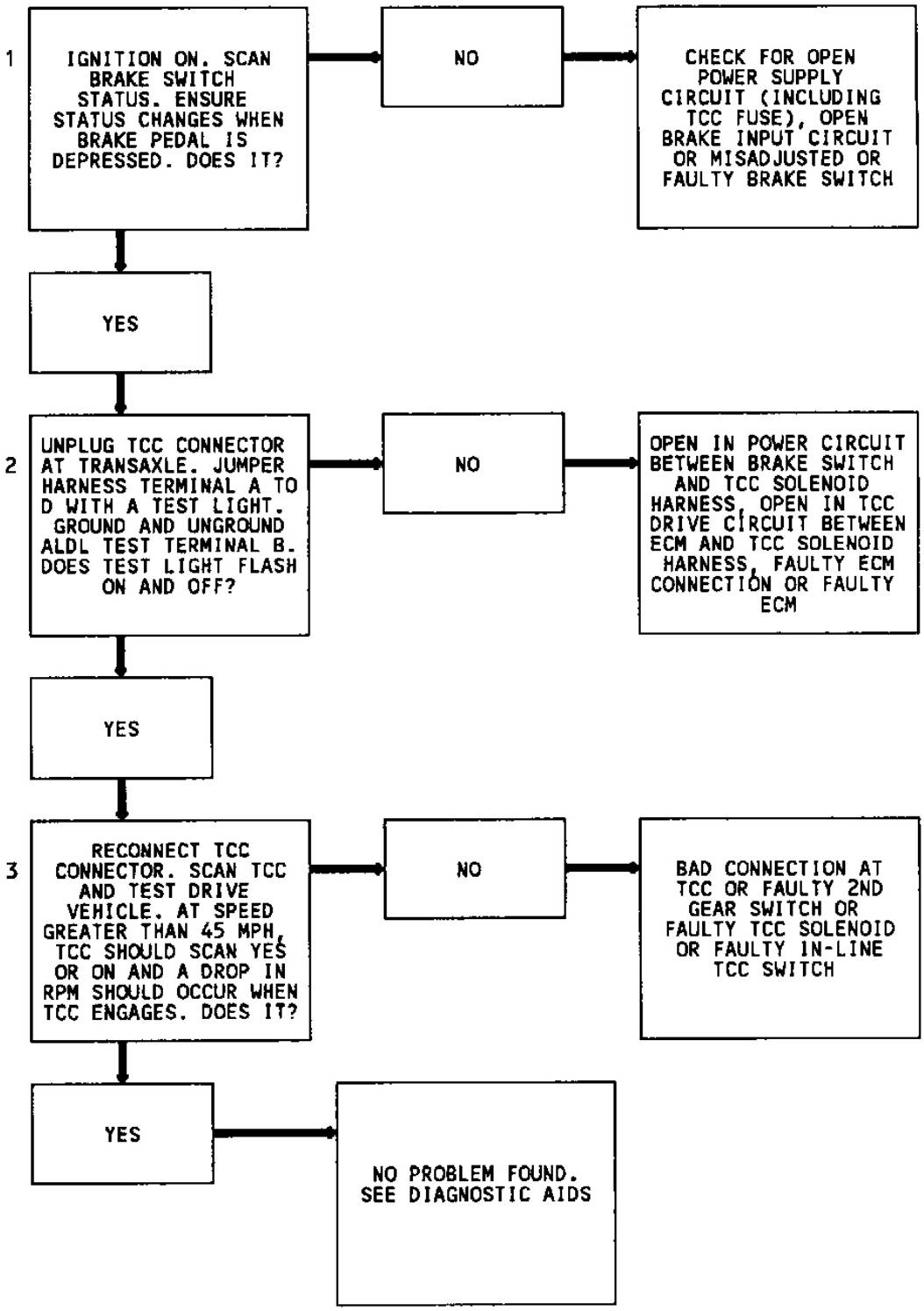


Fig. 133: Code 39, TCC Circuit Diagram (3.3L W/3T40 Transaxle)

Courtesy of GENERAL MOTORS CORP.

CODE 39, TCC CIRCUIT 3.3L & 3.8L WITH 4T60 (440-T4) TRANSAXLE

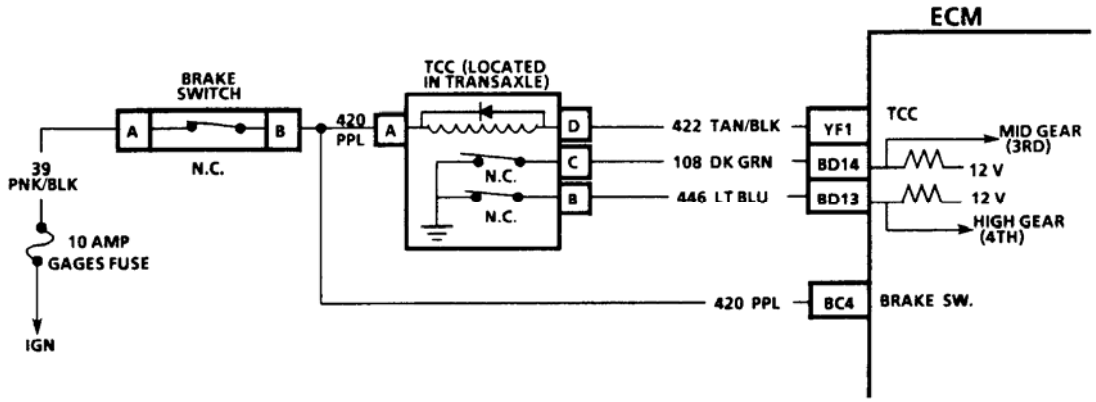


Fig. 134: Code 39, TCC Circuit Diagram (3.3L A Body W/4T60 Transaxle)
Courtesy of GENERAL MOTORS CORP.

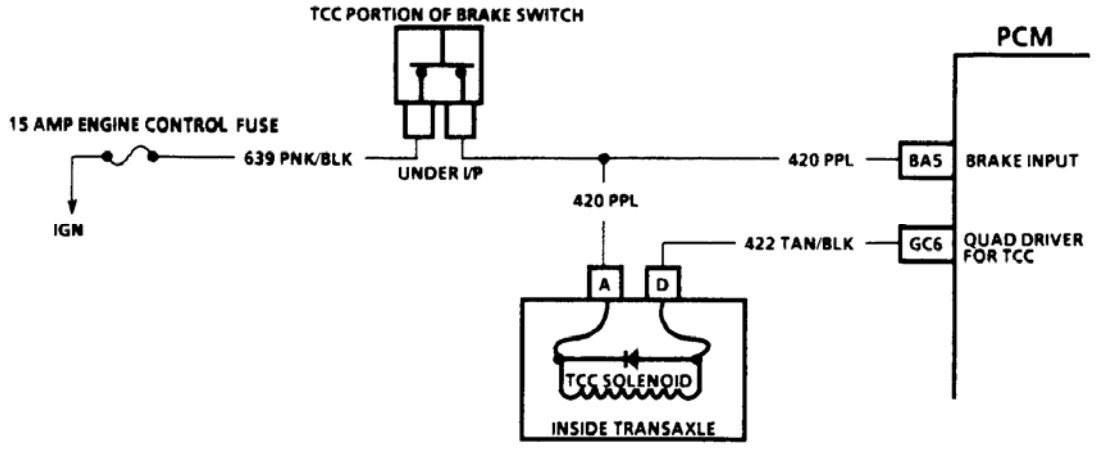


Fig. 135: Code 39, TCC Circuit Diagram (3.8L C & E Bodies W/4T60 Transaxle)
Courtesy of GENERAL MOTORS CORP.

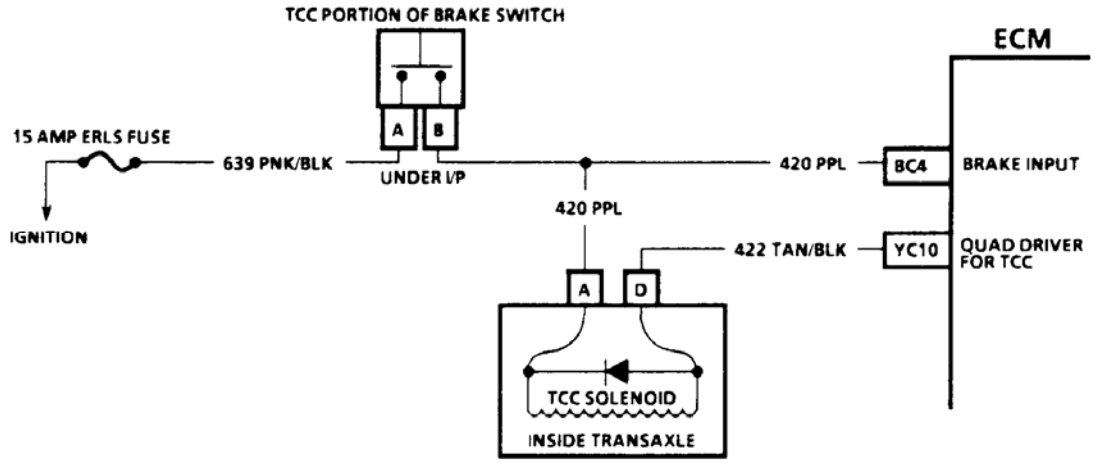


Fig. 136: Code 39, TCC Circuit Diagram (3.8L H Body W/4T60 Transaxle)
Courtesy of GENERAL MOTORS CORP.

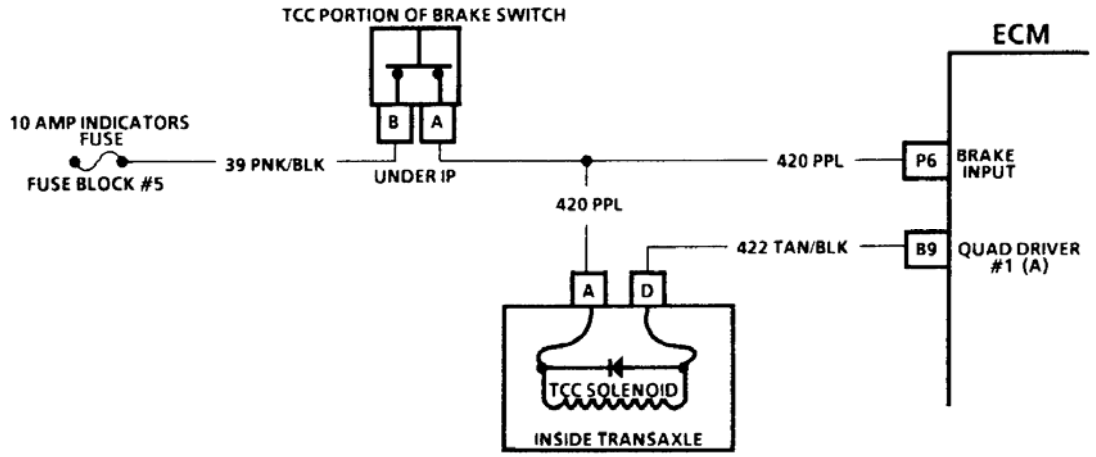


Fig. 137: Code 39, TCC Circuit Diagram (3.8L W Body W/4T60 Transaxle)
Courtesy of GENERAL MOTORS CORP.

Code 39 will set when no Code 28 or 29 is set, brake is not applied, TCC is commanded by ECM, transmission is in high gear and engine speed-to-vehicle speed ratio does not indicate TCC has engaged. All these conditions must have been bet for more than 15 seconds.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Tests fuse, brake switch and battery power circuit to the TCC solenoid.
2. Tests for ECM driver operation at TCC harness connector.
3. Tests for ECM driver operation at ECM terminal.

Diagnostic Aids

A Code 39 in conjunction with a Code 38 would mean a problem with one or more of the following components.

- Fuse or power circuit, brake switch or wire before the splice.

Code 39 alone indicates a problem at:

- Circuit No. 420 between splice and TCC solenoid.
- Circuit No. 422 between TCC solenoid and ECM.
- Poor connection to the ECM or ECM, itself.

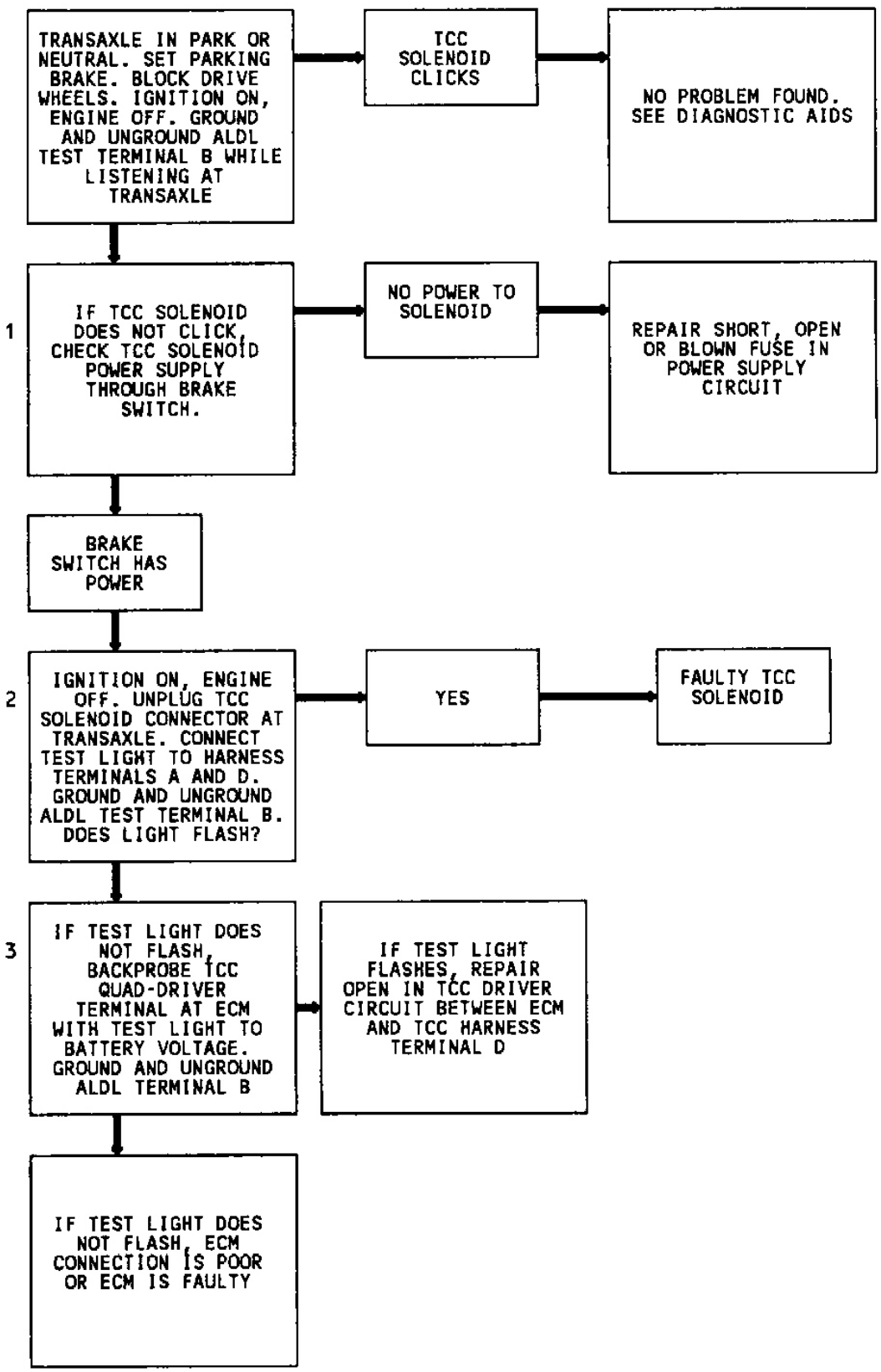

TRANSAXLE IN PARK OR NEUTRAL. SET PARKING BRAKE. BLOCK DRIVE WHEELS. IGNITION ON, ENGINE OFF. GROUND AND UNGROUND ALDL TEST TERMINAL B WHILE LISTENING AT TRANSAXLE
TCC SOLENOID CLICKS
NO PROBLEM FOUND. SEE DIAGNOSTIC AIDS
1
IF TCC SOLENOID DOES NOT CLICK, CHECK TCC SOLENOID POWER SUPPLY THROUGH BRAKE SWITCH.
NO POWER TO SOLENOID
REPAIR SHORT, OPEN OR BLOWN FUSE IN POWER SUPPLY CIRCUIT
BRAKE SWITCH HAS POWER
2
IGNITION ON, ENGINE OFF. UNPLUG TCC SOLENOID CONNECTOR AT TRANSAXLE. CONNECT TEST LIGHT TO HARNESS TERMINALS A AND D. GROUND AND UNGROUND ALDL TEST TERMINAL B. DOES LIGHT FLASH?
YES
FAULTY TCC SOLENOID
3
IF TEST LIGHT DOES NOT FLASH, BACKPROBE TCC QUAD-DRIVER TERMINAL AT ECM WITH TEST LIGHT TO BATTERY VOLTAGE. GROUND AND UNGROUND ALDL TERMINAL B
IF TEST LIGHT FLASHES, REPAIR OPEN IN TCC DRIVER CIRCUIT BETWEEN ECM AND TCC HARNESS TERMINAL D
IF TEST LIGHT DOES NOT FLASH, ECM CONNECTION IS POOR OR ECM IS FAULTY

Fig. 138: Code 39, TCC Circuit Diagram (3.3L & 3.8L W/4T60 Transaxle)
Courtesy of GENERAL MOTORS CORP.

CODE 38, BRAKE SWITCH CIRCUIT - 3.3L PFI N BODY

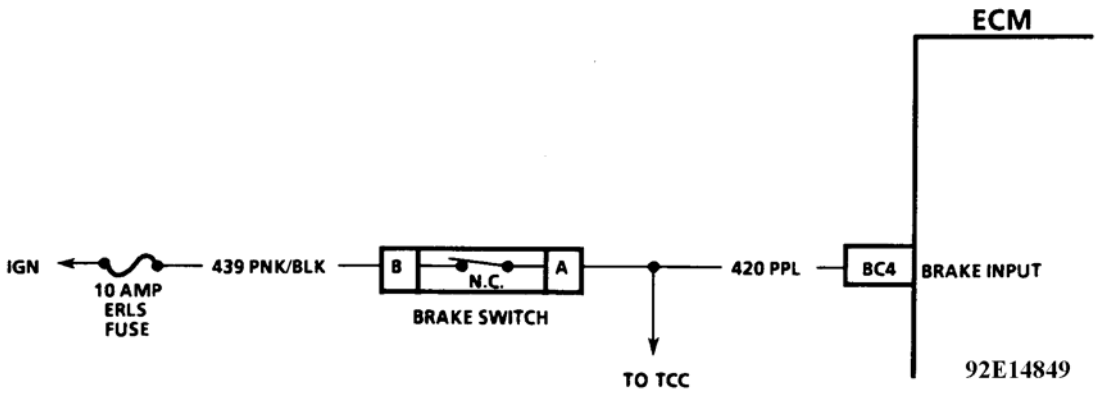


Fig. 139: Code 38, Brake Switch Circuit Diagram (3.3L PFI N Body)
Courtesy of GENERAL MOTORS CORP.

ECM monitors status of brake switch circuits through ECM terminal BC4. Code 38 will set under the following conditions:

- No. Code 24 is present.
- Vehicle speed has been above 35 MPH and back to 0 MPH 23 times.
- Status of circuit No. 420 has not changed state.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Jumpering brake switch will determine if ECM and wiring for brake circuit are okay.
2. This test verifies supply voltage to brake switch.

Diagnostic Aids

A Code 38 in combination with a Code 39 would mean a problem with one or more of the following components. Fuse, circuit No. 439, brake switch or wire before splice. A singe Code 38 is the result of wire or circuit No. 420 problem between splice and ECM, poor connection to ECM connector or possibly the ECM.

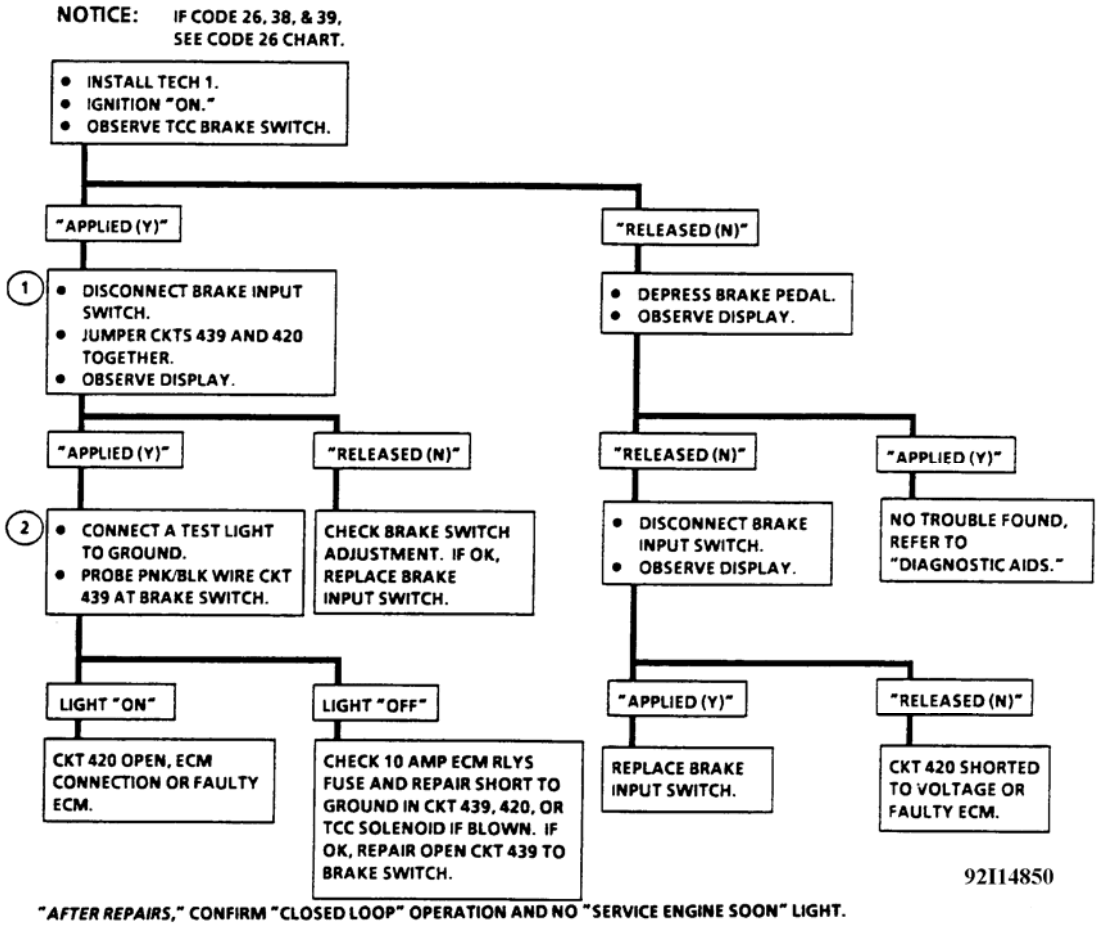


Fig. 140: Code 38, Troubleshooting Diagram (3.3L PFI N Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-1A, PARK/NEUTRAL SWITCH 1.6L TBI T BODY

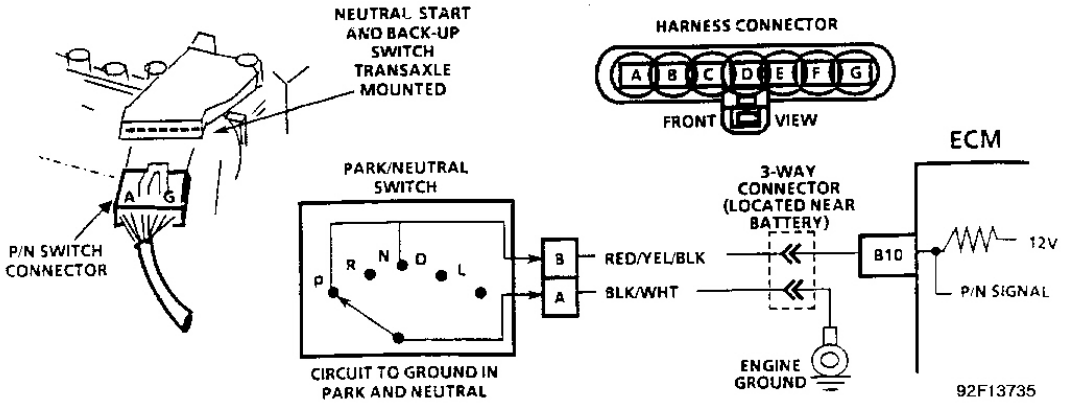


Fig. 141: Chart C-1A, Park/Neutral Switch Diagram (1.6L TBI T Body)
Courtesy of GENERAL MOTORS CORP.

Park/Neutral switch contacts are a part of neutral safety switch and are closed to ground in park or neutral, and open in drive ranges. ECM supplies ignition voltage through a current limiting resistor to signal wire and senses a closed switch when voltage on signal wire drops to less than one volt. ECM uses P/N signal as one of the inputs to control idle air and spark timing.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks for a closed switch to ground in park position. Different scan tools will read P/N differently. Check tester operators manual for type of display used.
2. This test checks for an open switch in drive range.
3. Ensure scan tool indicates drive, even while wiggling shifter to test for an intermittent or misadjusted switch in drive range.

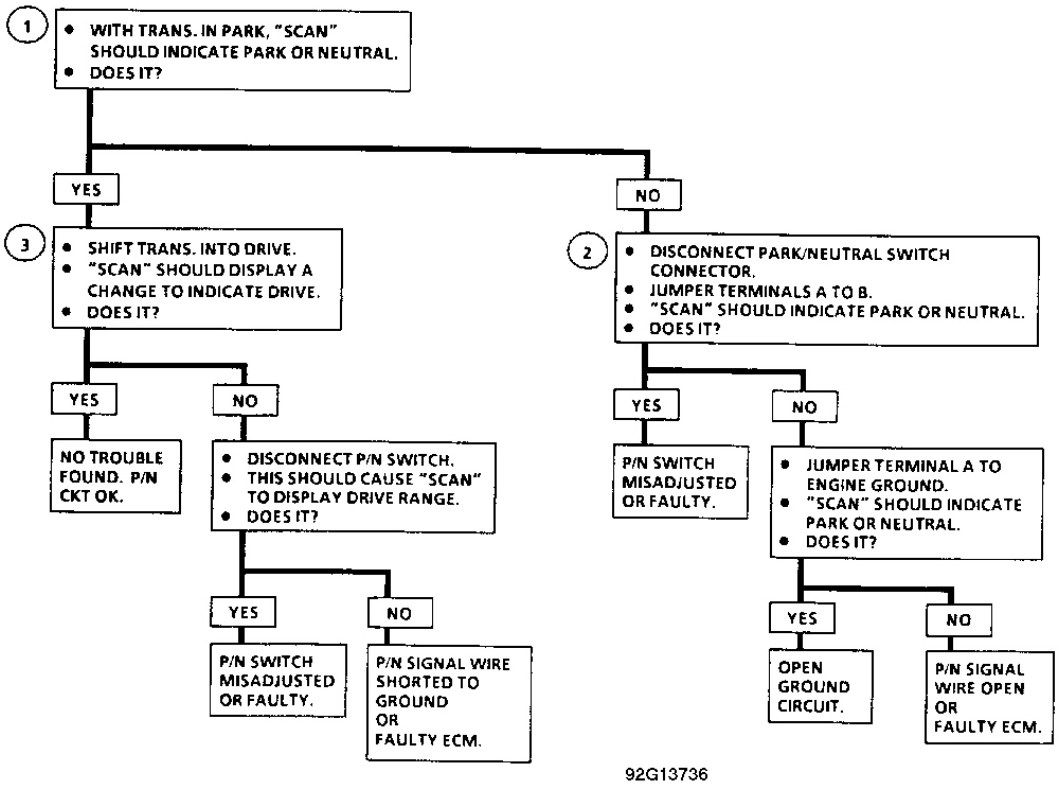


Fig. 142: Chart C-1A, Troubleshooting Diagram (1.6L TBI T Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-1A, PARK/NEUTRAL SWITCH - 2.0L & 2.5L TBI & PFI A, J & N BODIES

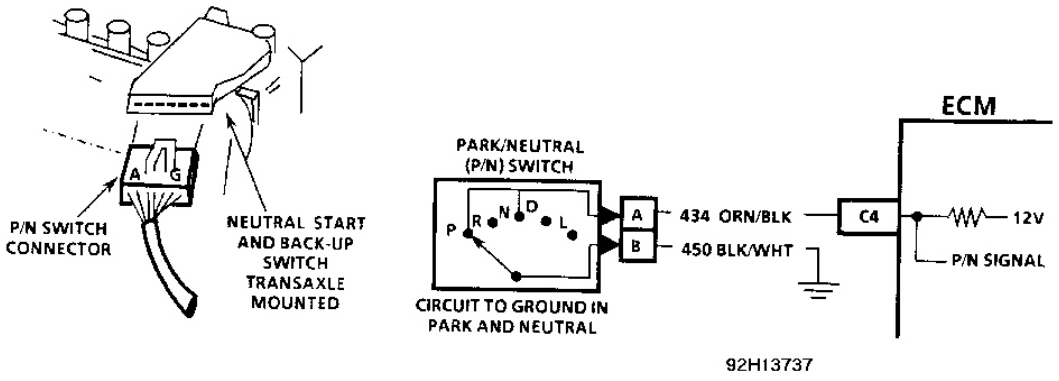


Fig. 143: Chart C-1A, Park/Neutral Switch Diagram (2.0L PFI)

Courtesy of GENERAL MOTORS CORP.

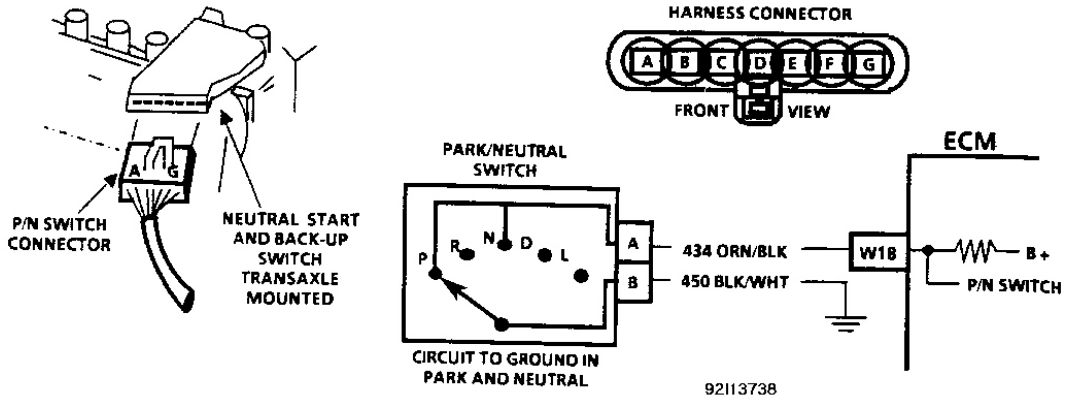


Fig. 144: Chart C-1A, Park/Neutral Switch Diagram (2.0L & 2.5L TBI)
Courtesy of GENERAL MOTORS CORP.

Park/Neutral switch contacts are a part of neutral safety switch and are closed to ground in park or neutral, and open in drive ranges. ECM supplies ignition voltage through a current limiting resistor to signal wire and senses a closed switch when voltage on signal wire drops to less than one volt. ECM uses P/N signal as one of the inputs to control idle air and spark timing.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks for a closed switch to ground in park position. Different scan tools will read P/N differently. Check tester operator manual for type of display used.
2. This test checks for an open switch in drive range.
3. Ensure scan tool indicates drive, even while wiggling shifter to test for an intermittent or misadjusted switch in drive range.

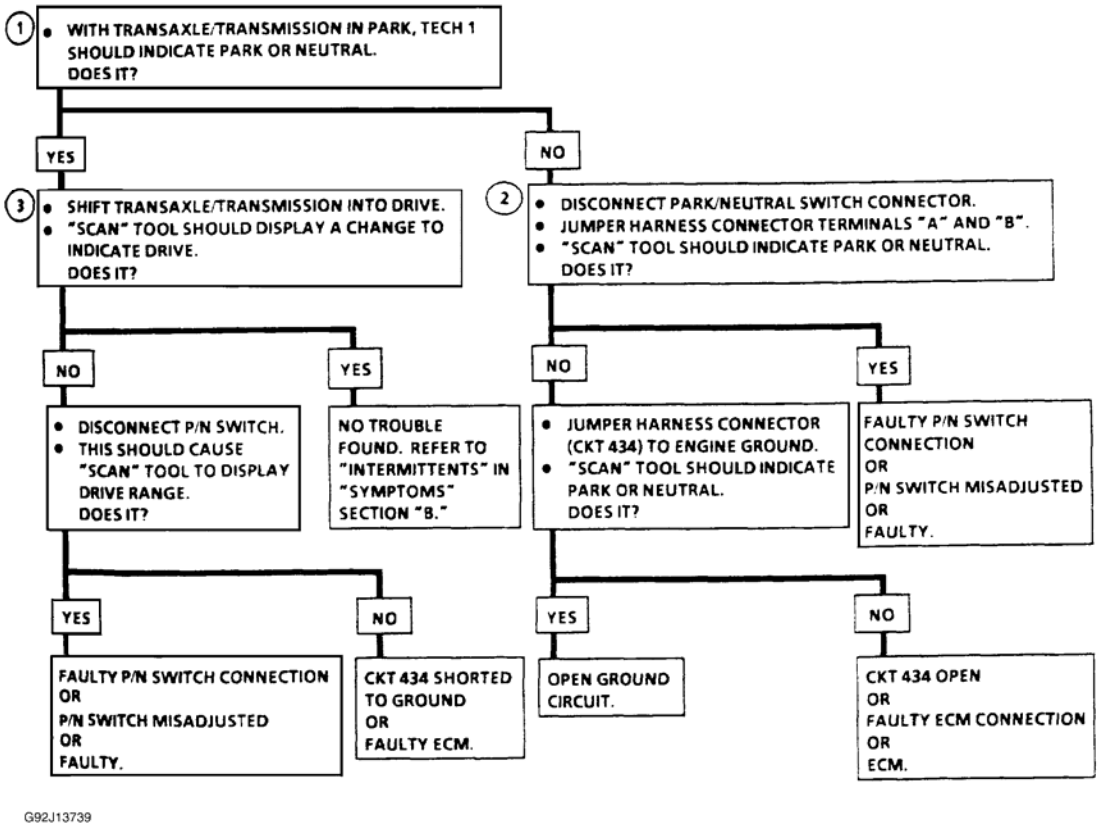


Fig. 145: Chart C-1A, Troubleshooting Diagram (2.0L & 2.5L TBI & PFI A, J & N Bodies)
Courtesy of GENERAL MOTORS CORP.

CHART C-1A, PARK/NEUTRAL SWITCH - 2.5L TBI W BODY

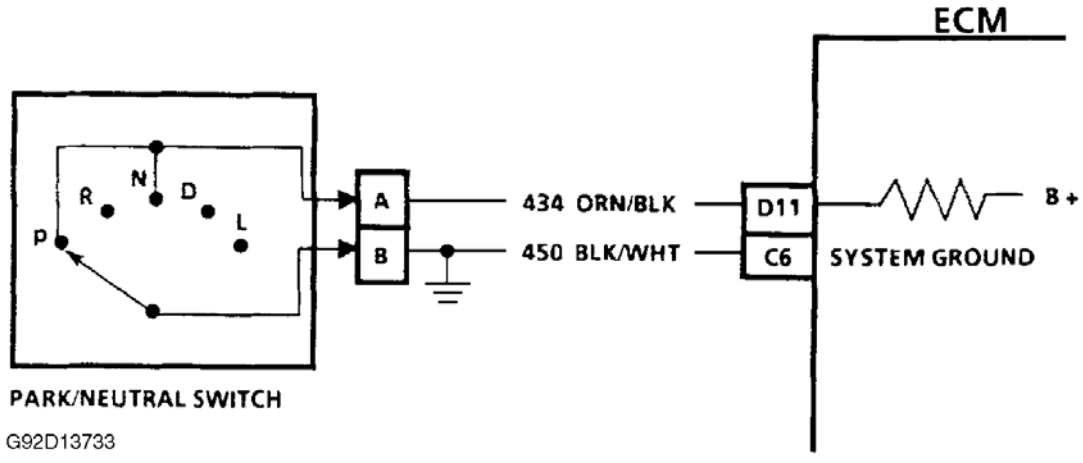


Fig. 146: Chart C-1A, Park/Neutral Switch Diagram (2.5L TBI W Body)
Courtesy of GENERAL MOTORS CORP.

ECM supplies ignition voltage through a current limiting resistor to circuit No. 434 and senses a closed switch when voltage on circuit No. 434 drops to less than one volt. ECM uses Park/Neutral signal as one of the inputs to control Idle Air Control (IAC) and Vehicle Speed Sensor (VSS).

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks for a closed switch to ground in park position. Use an ohmmeter instead of a test light. Resistance will be low indicating continuity to ground.
2. This test checks for an open switch in drive range.
3. Checks to this point indicate the Park/Neutral switch and wiring are okay. ECM signal voltage on circuit No. 434 may be mission. Ensure ECM connector is connected. Disconnect Park/Neutral switch and probe harness connector at circuit No. 434 with voltmeter to ground.

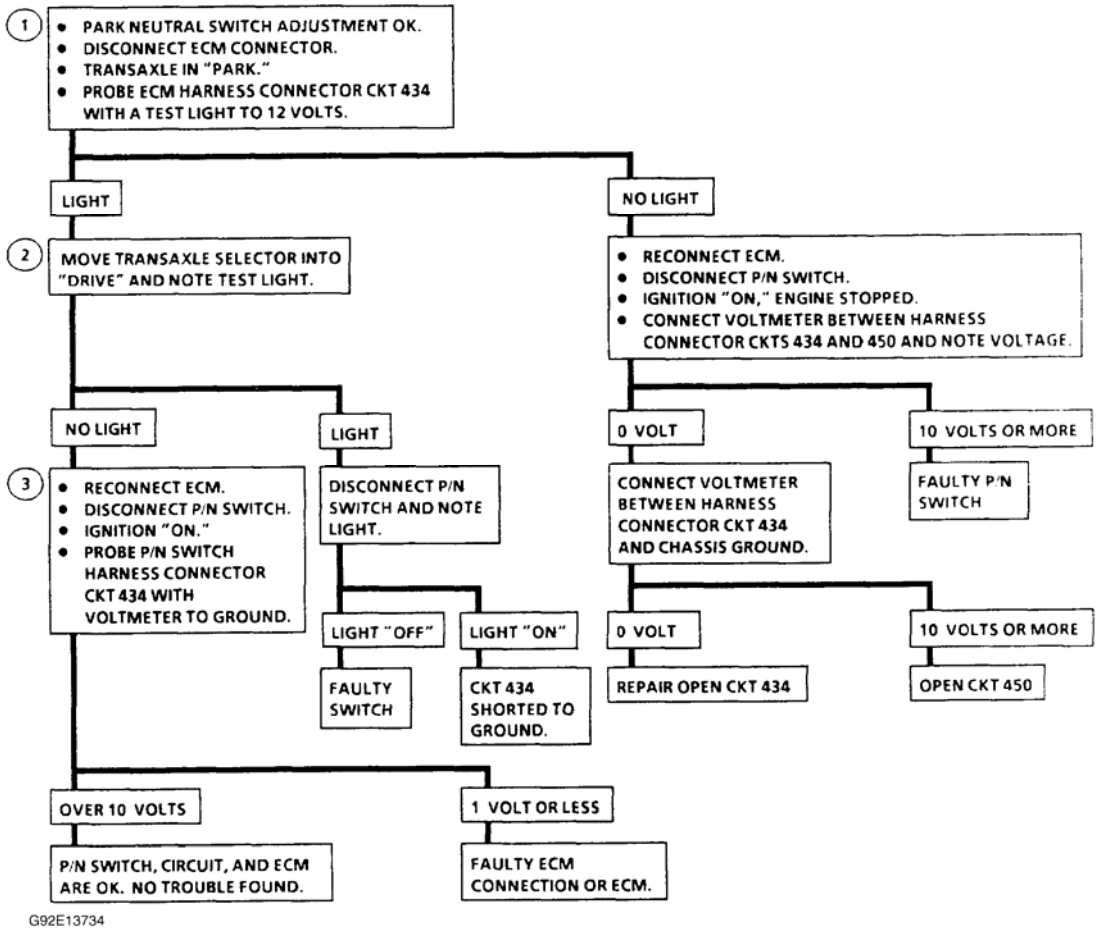


Fig. 147: Chart C-1A, Troubleshooting Diagram (2.5L TBI W Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-1A, PARK/NEUTRAL SWITCH 2.2L, 2.3L, 3.1L, 3.4L, 5.0L & 5.7L PFI 4.3L, 5.0L & 5.7L TBI A, B, F, J, L, N, W & Y BODIES

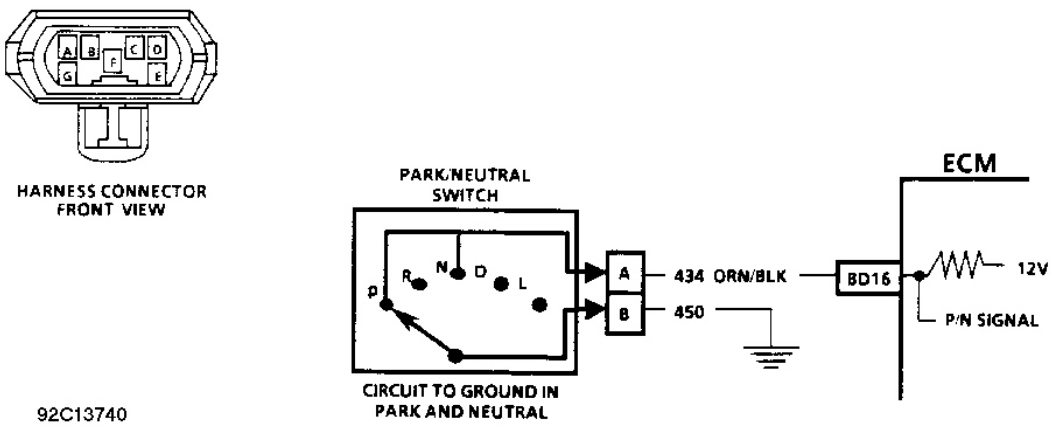


Fig. 148: Chart C-1A, Park/Neutral Switch Diagram (A & L Bodies PFI)
Courtesy of GENERAL MOTORS CORP.

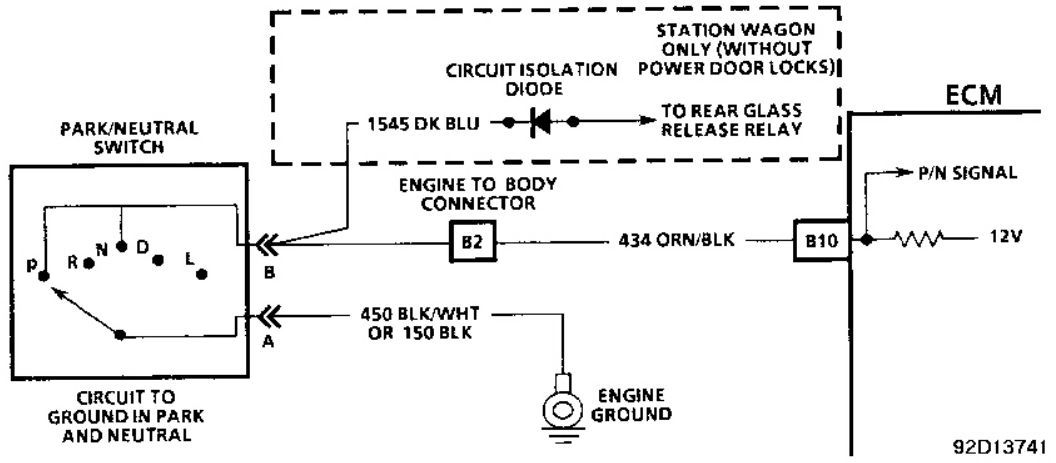


Fig. 149: Chart C-1A, Park/Neutral Switch Diagram (1991 - 4.3L, 5.0L & 5.7L TBI B Body)
Courtesy of GENERAL MOTORS CORP.

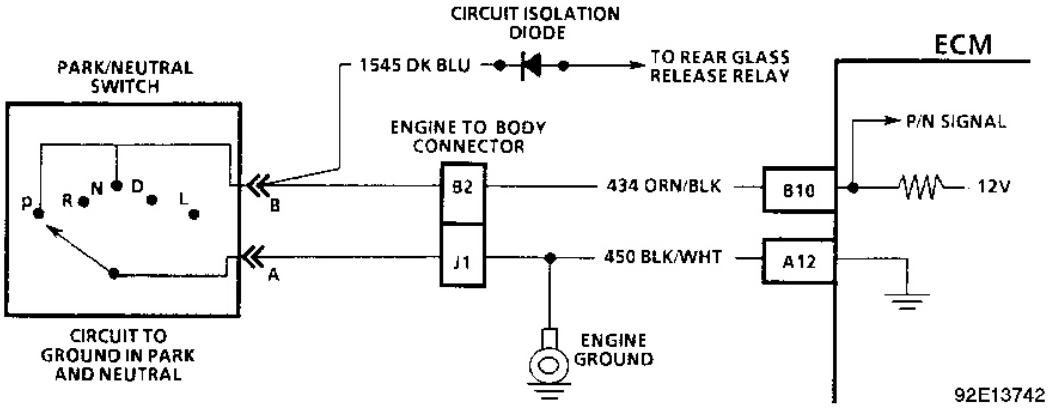


Fig. 150: Chart C-1A, Park/Neutral Switch Diagram (1992 - 5.0L & 5.7L TBI B Body)
Courtesy of GENERAL MOTORS CORP.

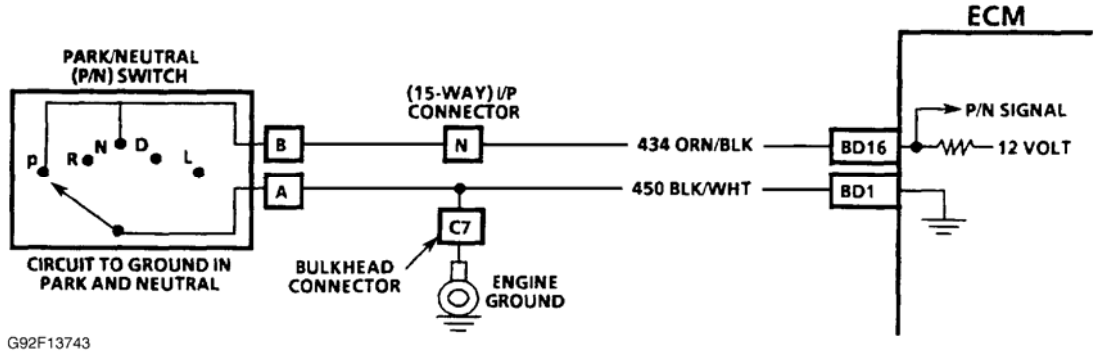


Fig. 151: Chart C-1A, Park/Neutral Switch Diagram (3.1L, 5.0L & 5.7L PFI F & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

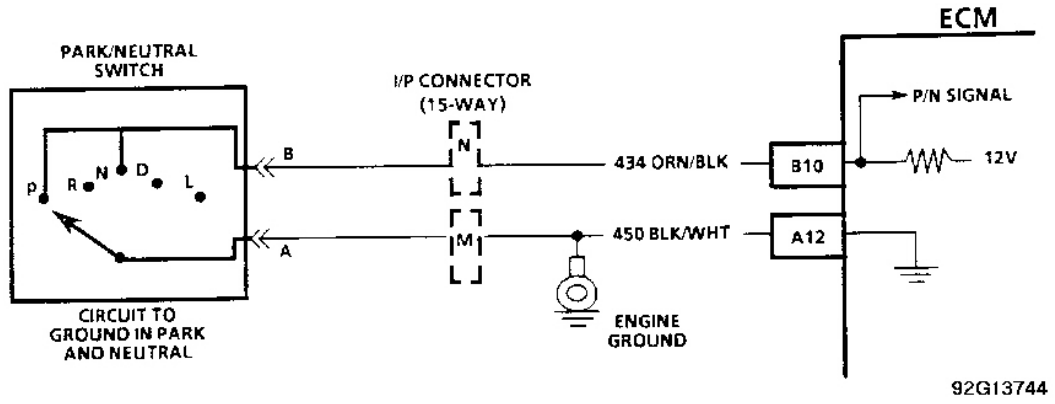


Fig. 152: Chart C-1A, Park/Neutral Switch Diagram (5.0L F Body TBI)
Courtesy of GENERAL MOTORS CORP.

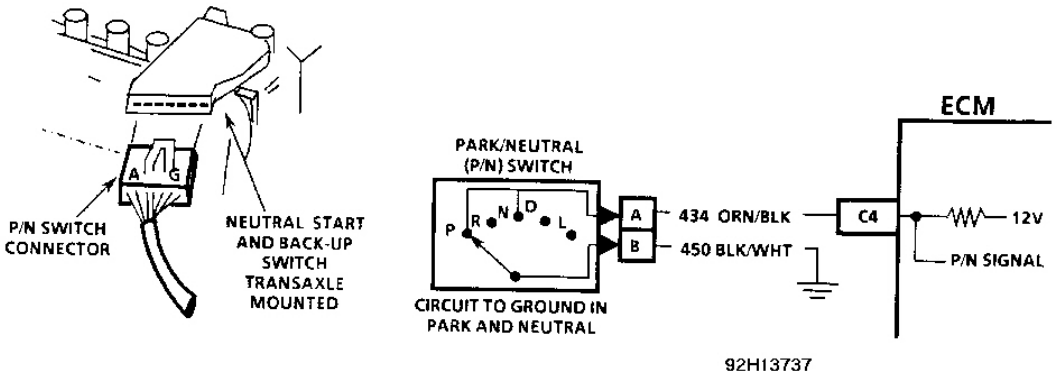


Fig. 153: Chart C-1A, Park/Neutral Switch Diagram (2.2L J Body PFI)
Courtesy of GENERAL MOTORS CORP.

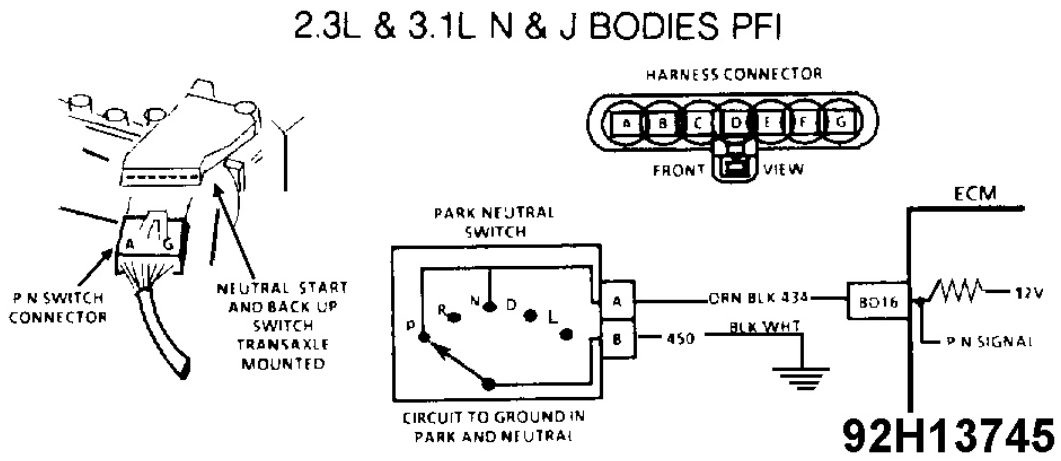


Fig. 154: Chart C-1A, Park/Neutral Switch Diagram (2.3L & 3.1L N & J Bodies PFI)
Courtesy of GENERAL MOTORS CORP.

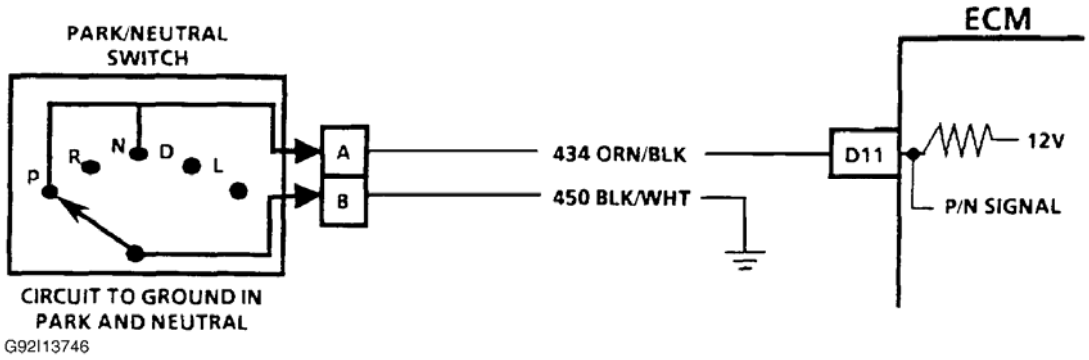


Fig. 155: Chart C-1A, Park/Neutral Switch Diagram (3.1L & 3.4L W Bodies)
Courtesy of GENERAL MOTORS CORP.

ECM supplies ignition voltage through a current limiting resistor to circuit No. 434 and senses a closed switch when voltage on circuit No. 434 drops to less than one volt. ECM uses Park/Neutral signal as one of the inputs to control Idle Air Control (IAC), Vehicle Speed Sensor (VSS) and Exhaust Gas Recirculation (EGR).

If circuit No. 434 indicates while in drive range, EGR would be inoperative, resulting in possible detonation. If circuit No. 434 indicates open, a drop in idle may occur when gear selector is moved into drive range.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks for a closed switch to ground in park position. Different makes of scan tools will read Park/Neutral differently. Check scan tool operator's manual for type of display used.

2. This test checks for an open switch in drive range.
3. Ensure scan tool indicates drive, even while wiggling shifter to test for an intermittent or misadjusted switch in drive or overdrive range.

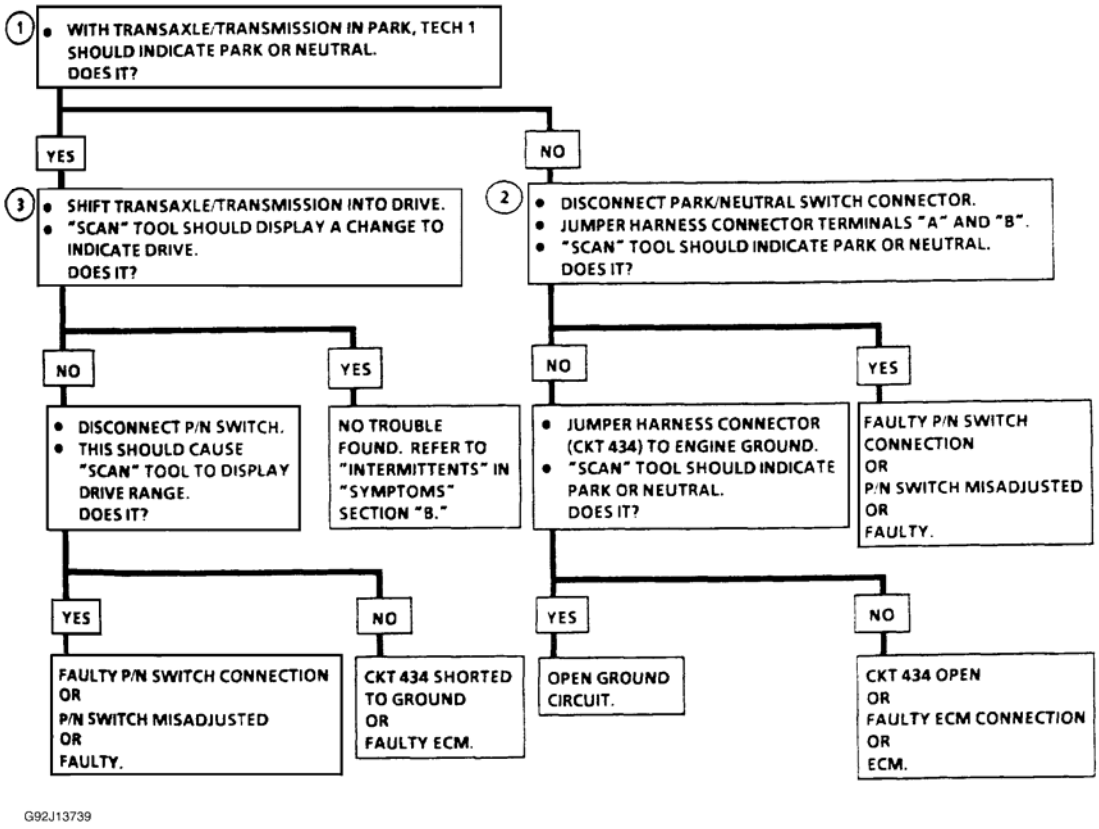


Fig. 156: Chart C-1A, Troubleshooting Diagram (A, B, F, J, L, N, W & Y Bodies)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH 1.6L & 2.2L TBI T & J BODIES

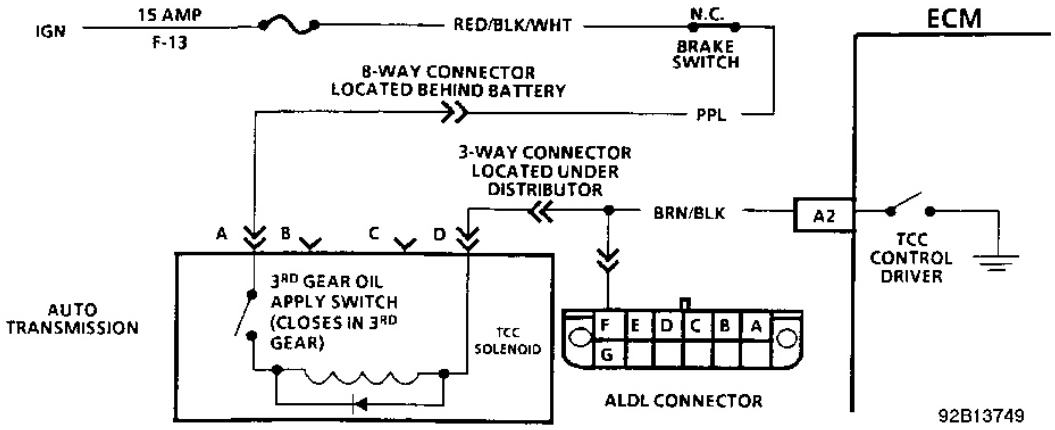


Fig. 157: Chart C-8A, Torque Converter Clutch Circuit (1.6L TBI T Body)
Courtesy of GENERAL MOTORS CORP.

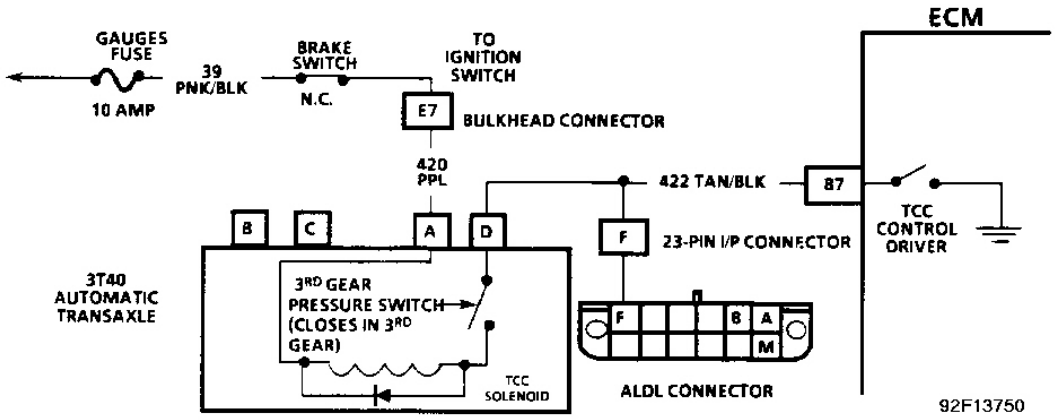


Fig. 158: Chart C-8A, Torque Converter Clutch Circuit (2.2L TBI J Body)
Courtesy of GENERAL MOTORS CORP.

Voltage is supplied to TCC solenoid through brake switch and transaxle 3rd gear apply switch. ECM will engage TCC by grounding circuit No. 422 to energize solenoid.

TCC will engage when:

- Vehicle speed is above 24 MPH.
- Engine is at normal operating temperature.
- Throttle position not changing, indication a steady speed.

- Brake switch and transmission 3rd gear switch are closed.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. Light off confirms transmission 3rd gear apply switch is open.
2. At 30 MPH, transmission 3rd gear switch should open. Test light will light and confirm battery supply and closed brake switch.
3. Grounding diagnostic terminal with ignition switch on, engine off, should turn on test light. This test checks capability of ECM to control the solenoid.

Diagnostic Aids

An engine coolant thermostat that is stuck open or opens at too low a temperature may result in a delayed TCC operation.

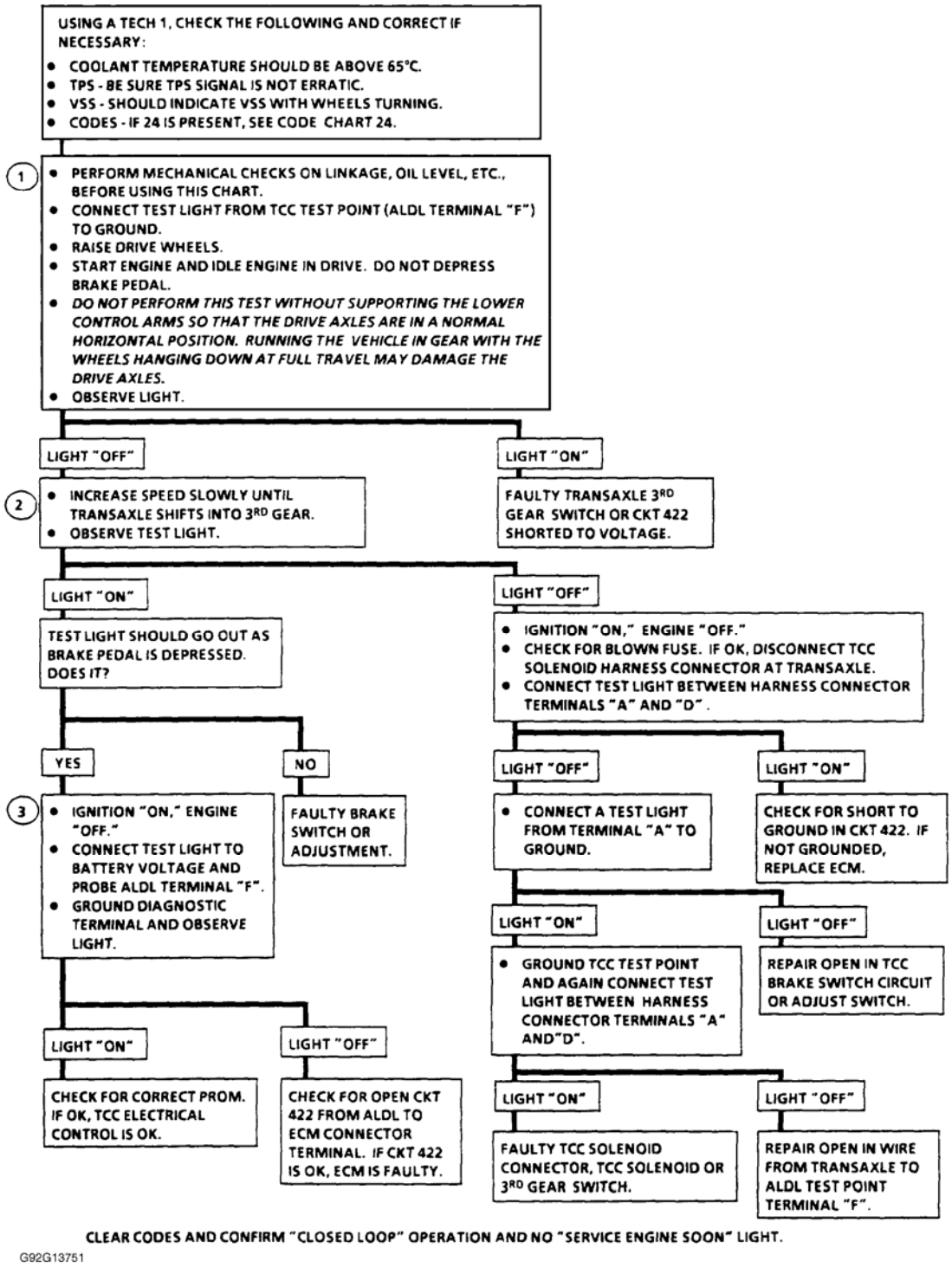


Fig. 159: Chart C-8A, Troubleshooting Chart (1.6L & 2.2L TBI T & J Bodies)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 2.0L & 2.2L PFI J BODIES

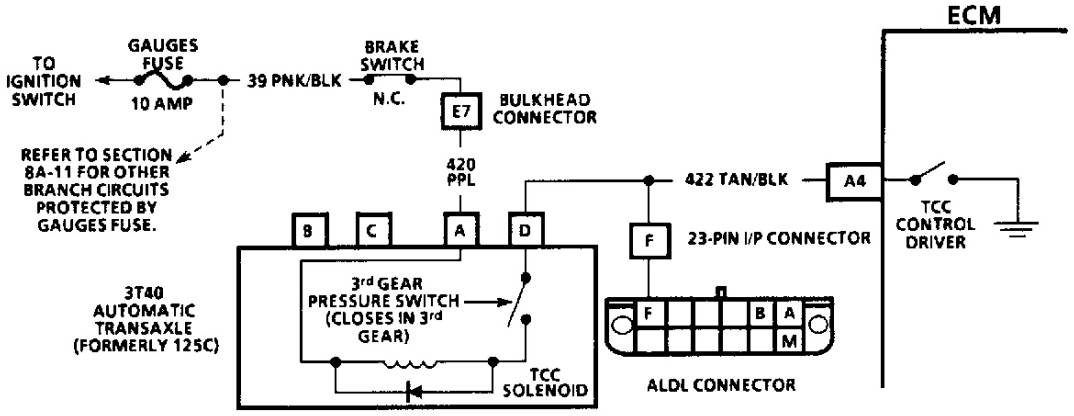


Fig. 160: Chart C-8A, Torque Converter Clutch Circuit (2.0L PFI J Bodies)
Courtesy of GENERAL MOTORS CORP.

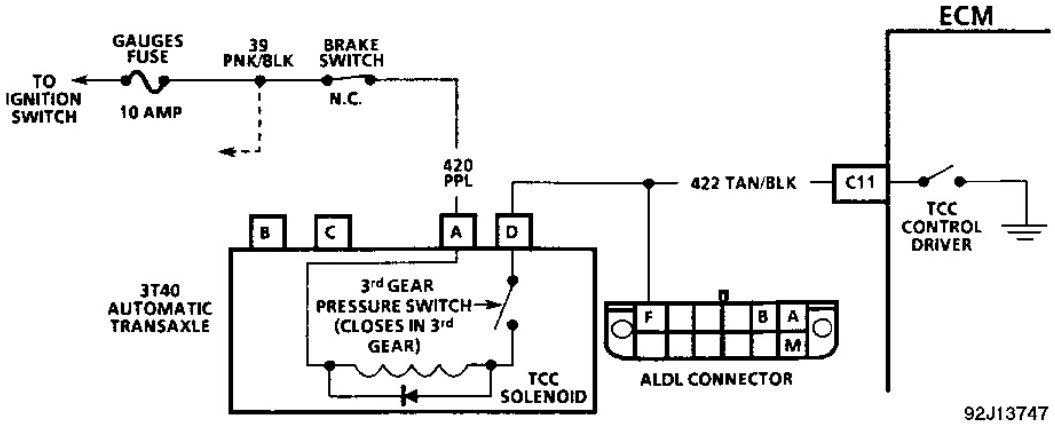


Fig. 161: Chart C-8A, Torque Converter Clutch Circuit (2.2L PFI J Bodies)
Courtesy of GENERAL MOTORS CORP.

Voltage is supplied to TCC solenoid through brake switch and transaxle 3rd gear apply switch. ECM will engage TCC by grounding circuit No. 422 to energize solenoid.

TCC will engage when:

- Vehicle speed is above 24 MPH>
- Engine is at normal operating temperature.
- Throttle position not changing, indicating a steady speed.
- Brake switch is closed and transmission is in 3rd or 4th gear.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. This test should be performed on a level road with the aid of a helper to operate scan tool and observe RPM fluctuation.
2. Entering Field Service Mode forces ECM to close TCC control driver circuit completing path for current which should light test light.
3. Perform this test with aid of a helper. The 3rd gear switch must be engaged while measuring TCC solenoid resistance.

Diagnostic Aids

An engine coolant thermostat that is stuck open or opens at too low a temperature may result in a delayed TCC operation.

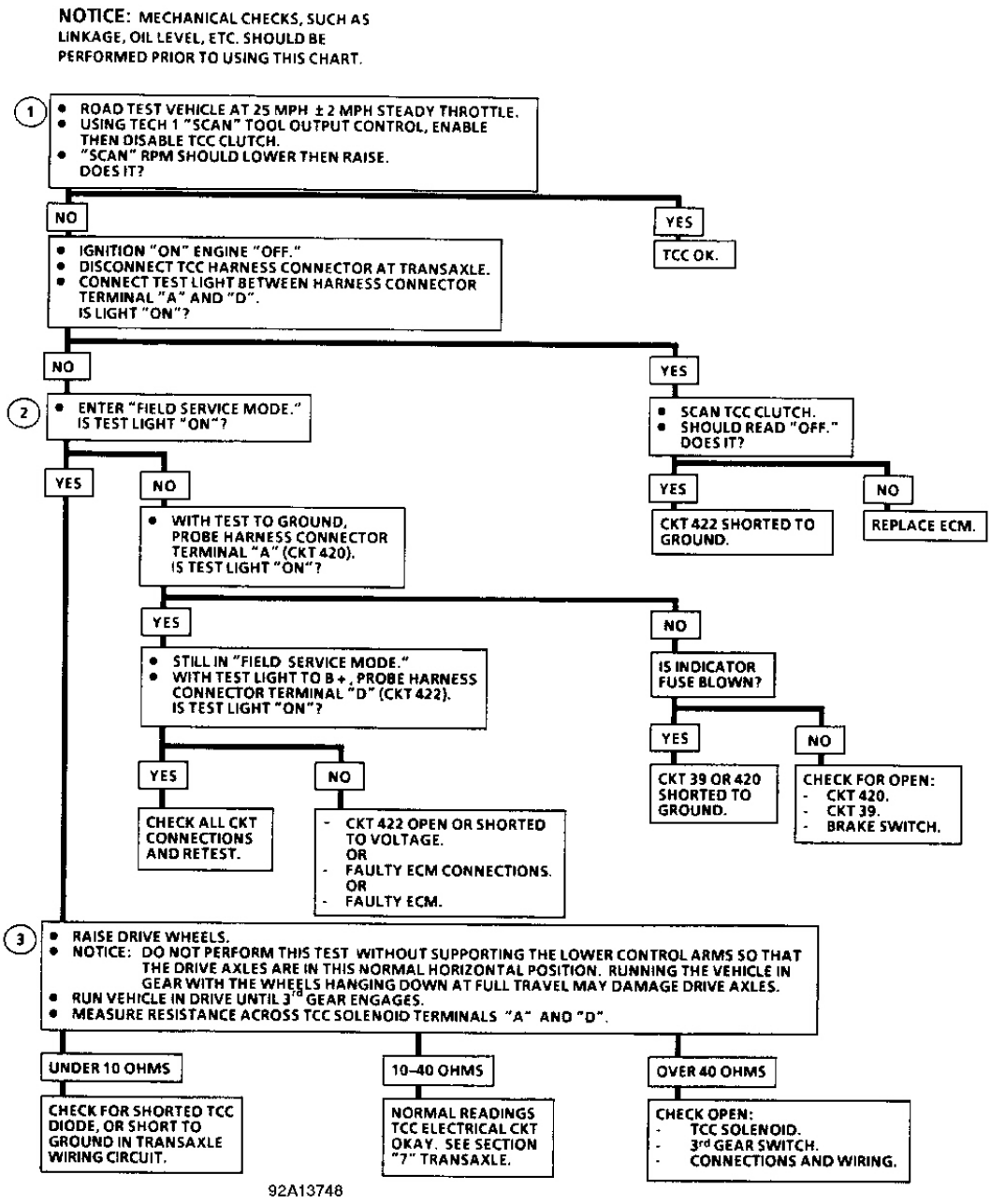


Fig. 162: Chart C-8A, Troubleshooting Chart (2.0L & 2.2L PFI J Bodies)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, 3T40 TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS 2.3L PFI N & W BODIES

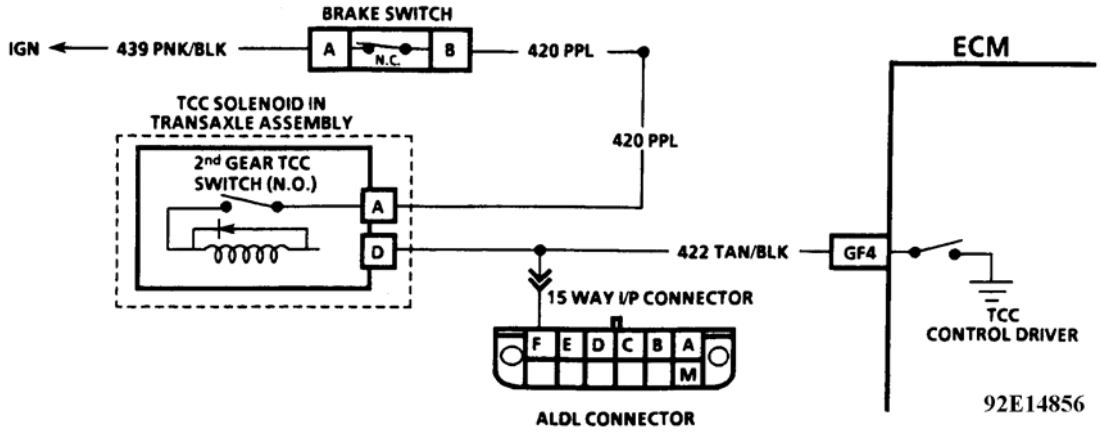


Fig. 163: Chart C-8A, 3T40 Torque Converter Clutch Circuit (2.3L N Body)
Courtesy of GENERAL MOTORS CORP.

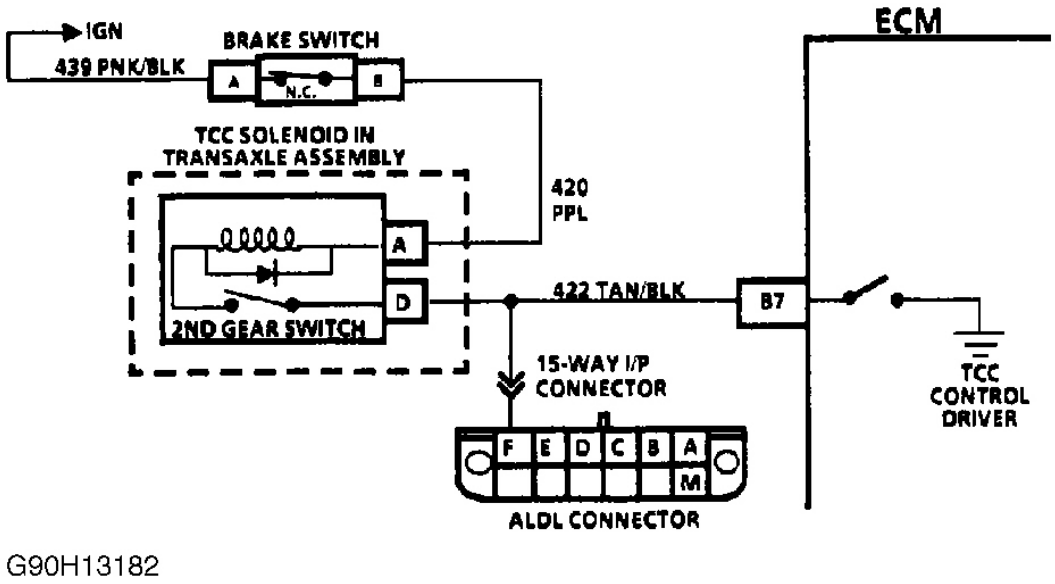


Fig. 164: Chart C-8A, 3T40 Torque Converter Clutch Circuit (2.3L W Body)
Courtesy of GENERAL MOTORS CORP.

Voltage is supplied to TCC solenoid through brake switch and transaxle second gear apply switch. ECM will engage TCC by grounding circuit No. 422 to energize solenoid.

TCC will engage when:

- Vehicle speed is above 34 MPH.

- Engine is at normal operating temperature.
- Throttle position not changing, indicating a steady speed.
- Brake switch and transmission 2nd gear switch are closed.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. Light off confirms transmission 2nd gear apply switch is open.
2. By 25 MPH, transmission 2nd gear TCC switch should close. Test light will light and confirm battery supply and closed brake switch.
3. Grounding diagnostic terminal with ignition switch on, engine off, should turn on test light. This test checks capability of ECM to supply a ground to the TCC solenoid. Test light will light when connected from 12 volts to ALDL terminal "F" as circuit No. 422 is grounded.

Diagnostic Aids

A scan tool only indicates when ECM has turned on TCC driver and does not confirm TCC has engaged. To determine if TCC is functioning properly, engine RPM should decrease when scan tool indicates TCC driver has turned on.

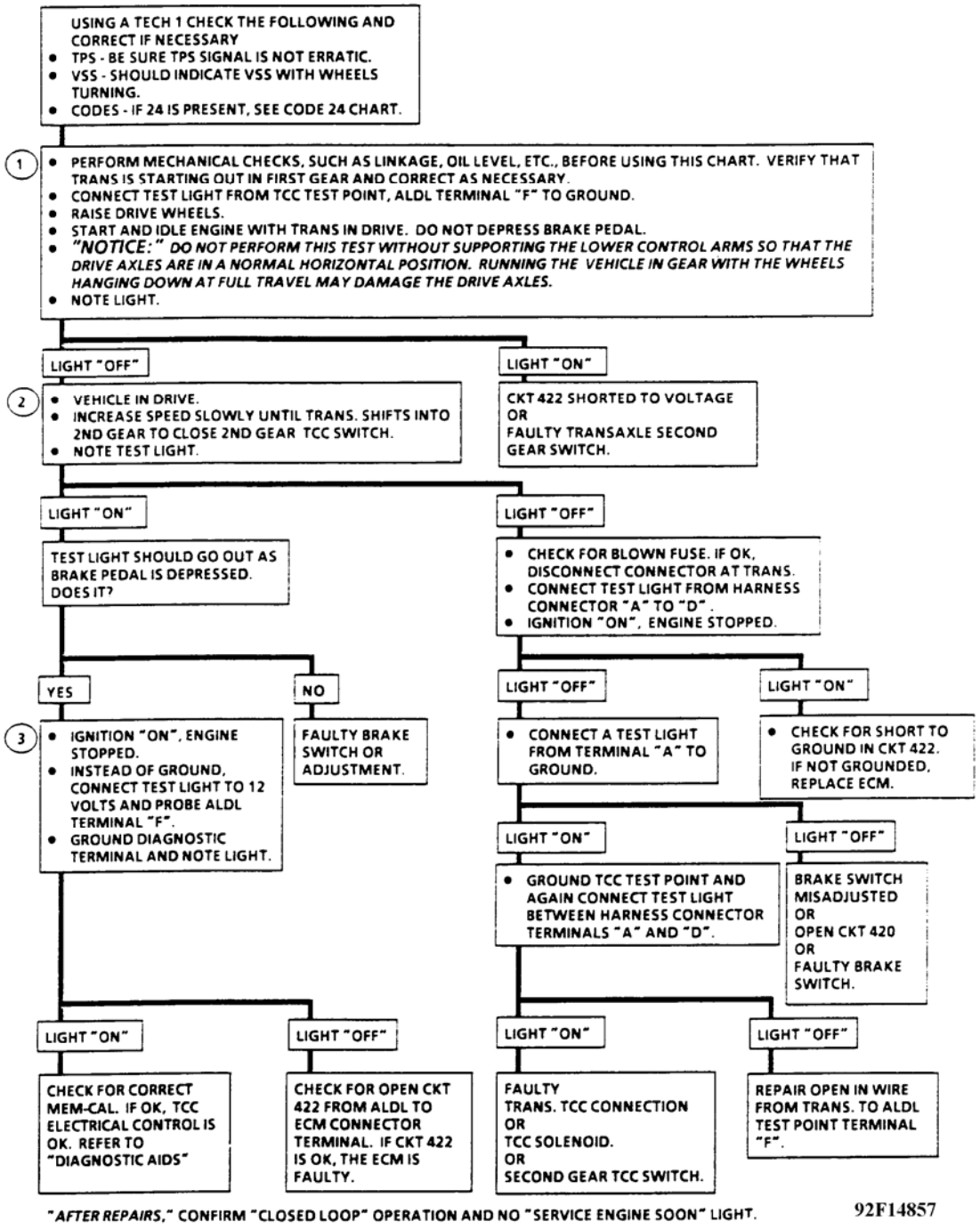


Fig. 165: Chart C-8A, 3T40 TCC Troubleshooting Chart (2.3L N & W Bodies)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 2.5L TBI A & N BODIES

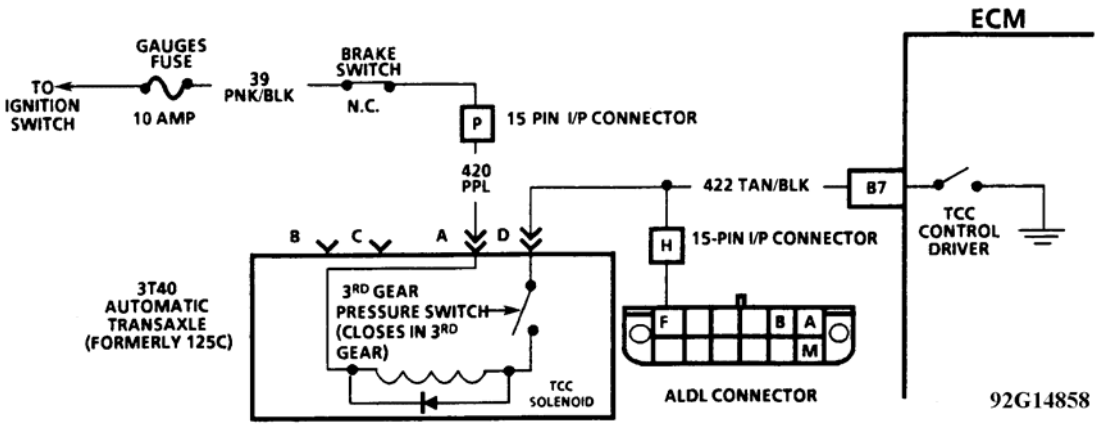


Fig. 166: Chart C-8A, TCC Circuit (2.5L A & N Bodies)
Courtesy of GENERAL MOTORS CORP.

Voltage is supplied to TCC solenoid through brake switch and transaxle third gear apply switch. ECM will engage TCC by grounding circuit No. 422 to energize solenoid.

TCC will engage when:

- Vehicle speed is above 34 MPH with air conditioning off, or above 44 MPH with air conditioning on.
- Engine is at normal operating temperature.
- Throttle position not changing, indicating a steady speed.
- Brake switch and transmission 3rd gear switch are closed.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. Light off confirms transmission 3rd gear apply switch is open.
2. At approximately 30 MPH, transmission 3rd gear switch should close. This depends on throttle position. Minimum speed at which 3rd gear switch will closed is approximately 21 MPH. Test light should light and confirm ignition voltage in circuit and a closed brake switch.
3. Grounding diagnostic terminal with ignition switch on, engine off, should turn on test light. This test checks capability of ECM to control the solenoid.

Diagnostic Aids

An engine coolant thermostat that is stuck open or opens at too low a temperature may result in an inoperative TCC.

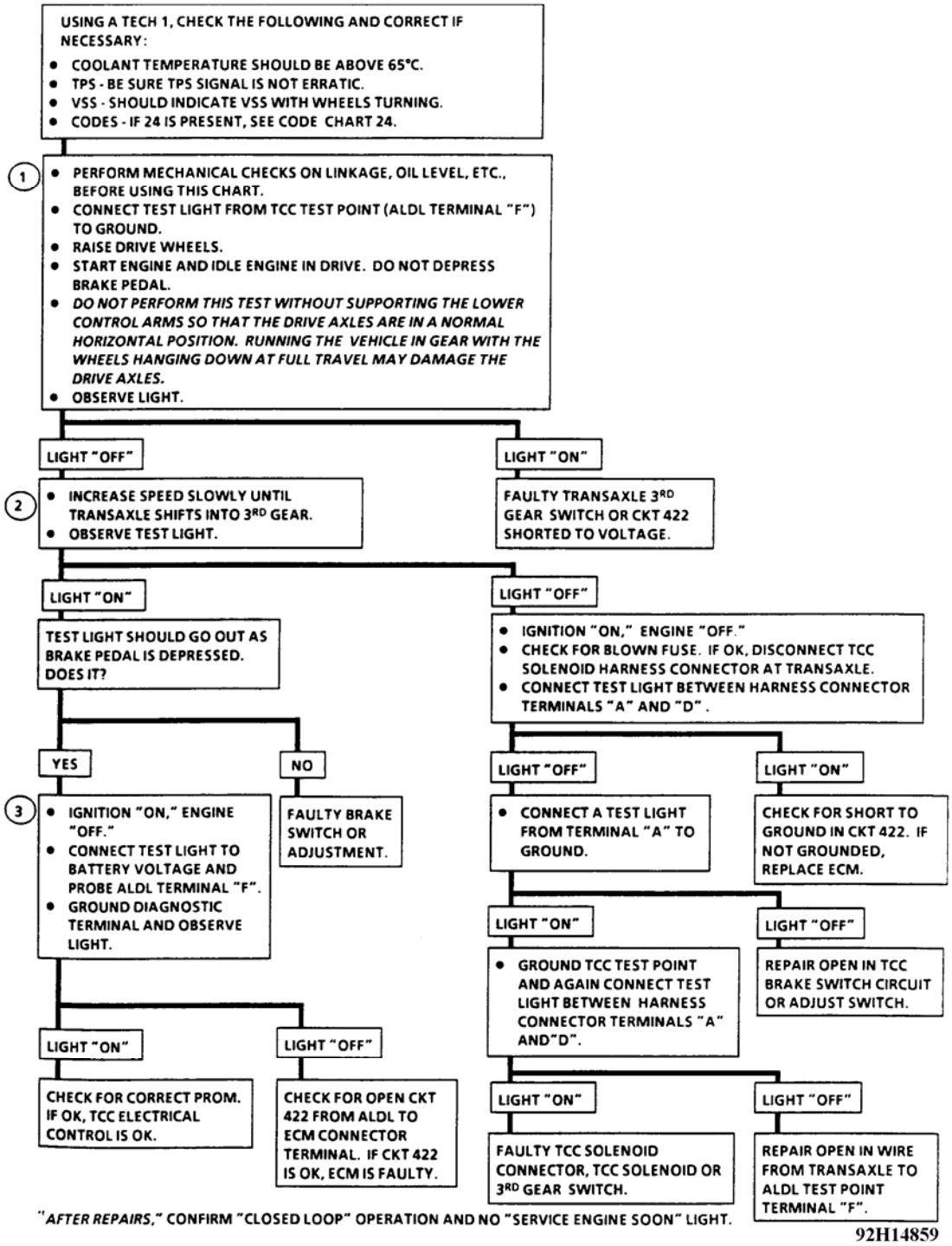


Fig. 167: Chart C-8A, TCC Troubleshooting Chart (2.5L TBI A & N Bodies)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS 2.5L TBI W BODY

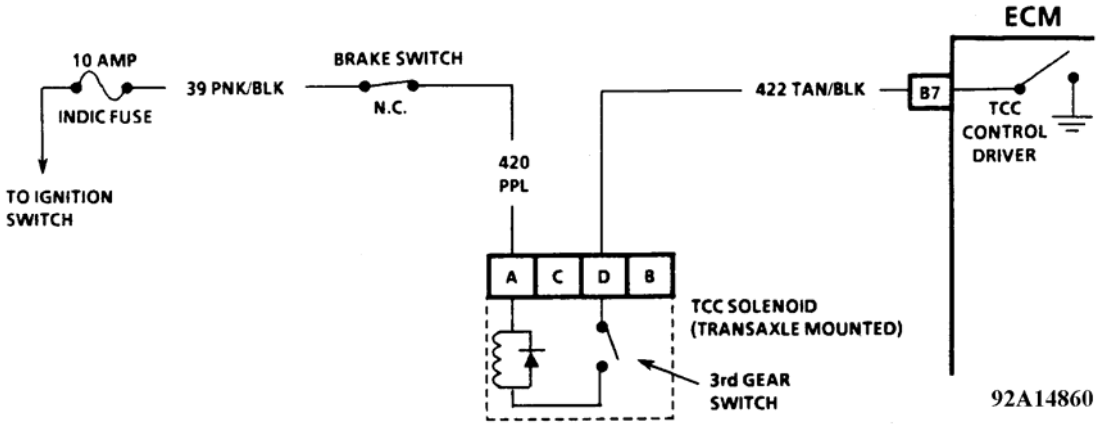


Fig. 168: Chart C-8A, TCC Circuit (2.5L W Bodies)
Courtesy of GENERAL MOTORS CORP.

Voltage is supplied to TCC solenoid through brake switch. ECM will engage TCC by grounding circuit No. 422 to energize solenoid.

TCC will engage when:

- Vehicle speed is above 22 MPH.
- Engine is at normal operating temperature.
- Throttle position not changing, indicating a steady speed.
- Brake switch is closed.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. This test should be performed on a level road with the aid of a helper to operate scan tool and observe RPM fluctuation.
2. Entering Field Service Mode forces ECM to close TCC control driver circuit completing path for current which should light test light.
3. Perform this test with aid of a helper. the 3rd gear switch must be engaged while measuring TCC solenoid resistance.

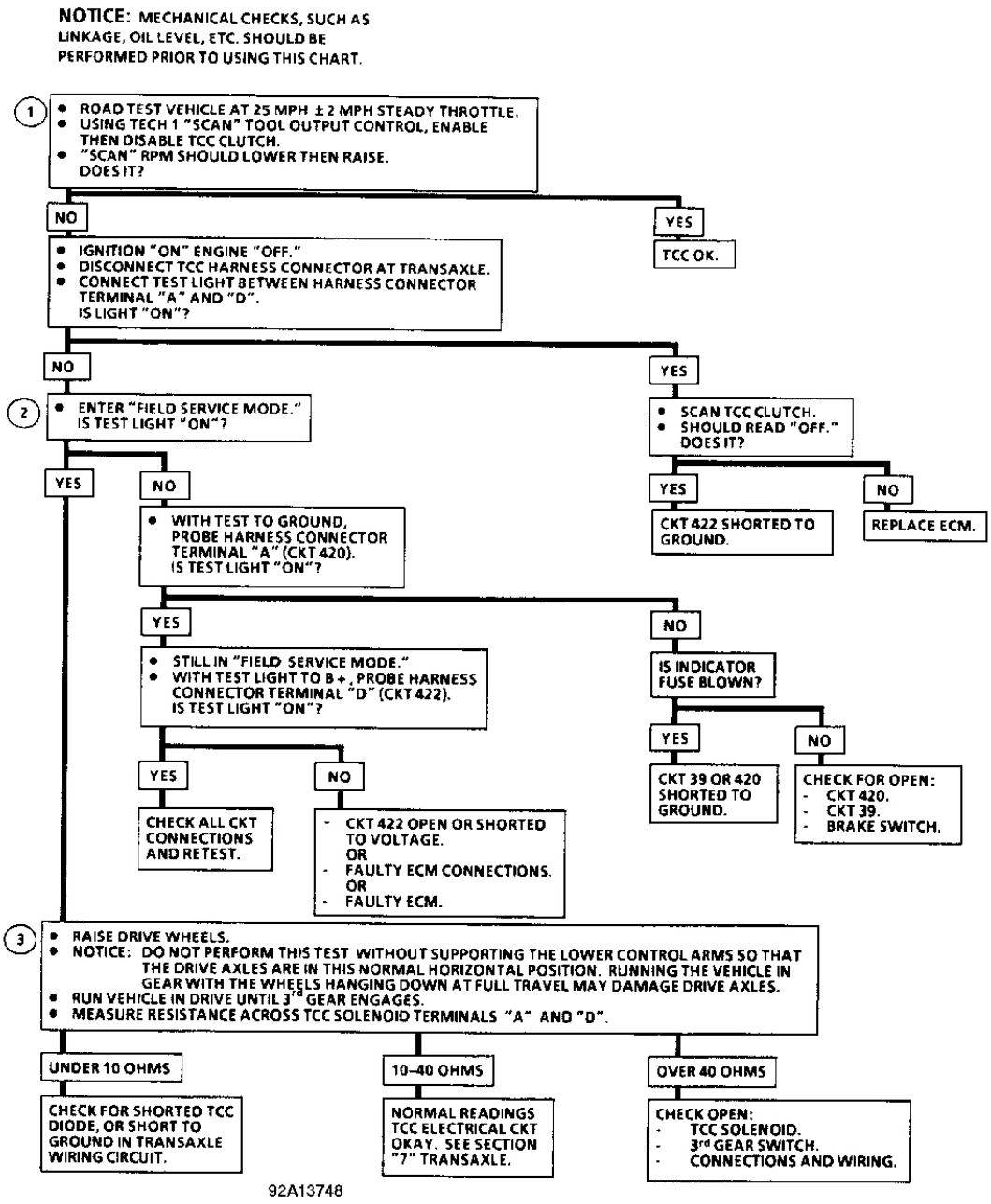


Fig. 169: Chart C-8A, TCC Troubleshooting Chart (2.5L TBI W Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-8, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 3.1L PFI A, J & L BODIES (1 OF 2)

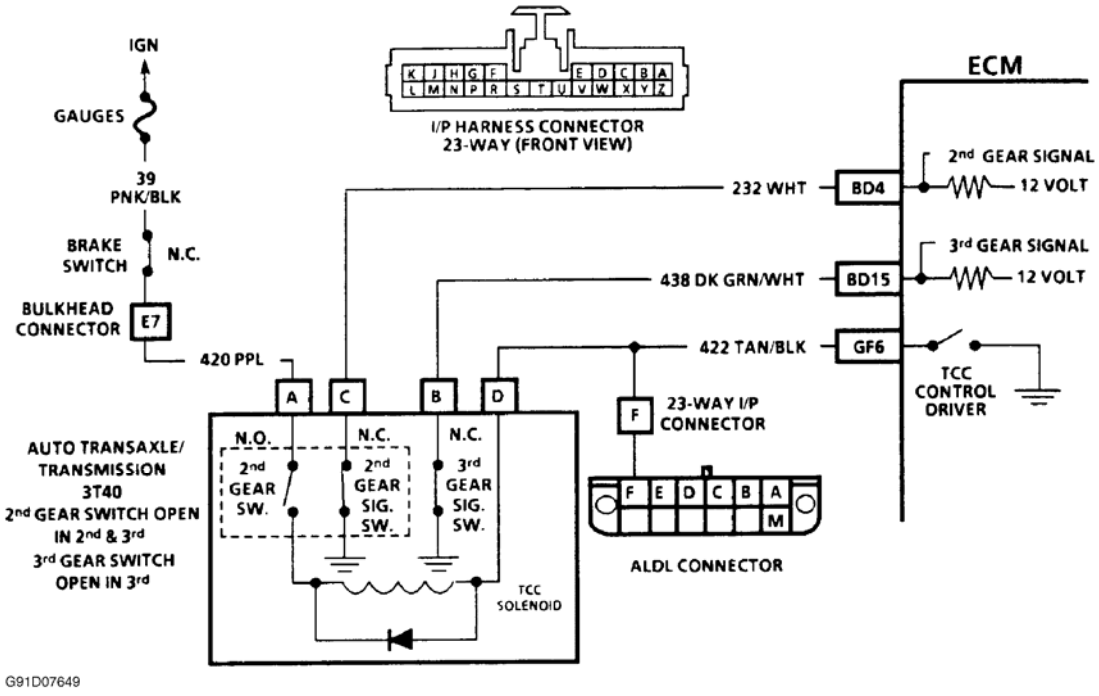


Fig. 170: Chart C-8, TCC Circuit Diagram (3.1L PFI J Body)
Courtesy of GENERAL MOTORS CORP.

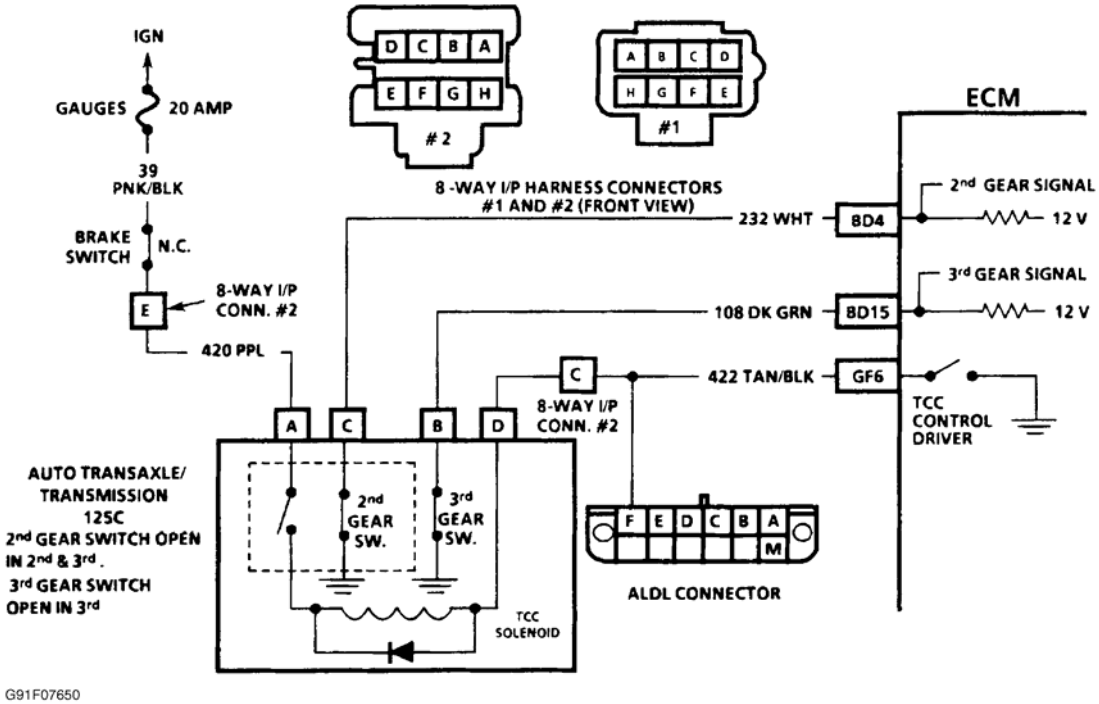


Fig. 171: Chart C-8, TCC Circuit Diagram (1991 - 3.1L PFI A & L Bodies)

Courtesy of GENERAL MOTORS CORP.

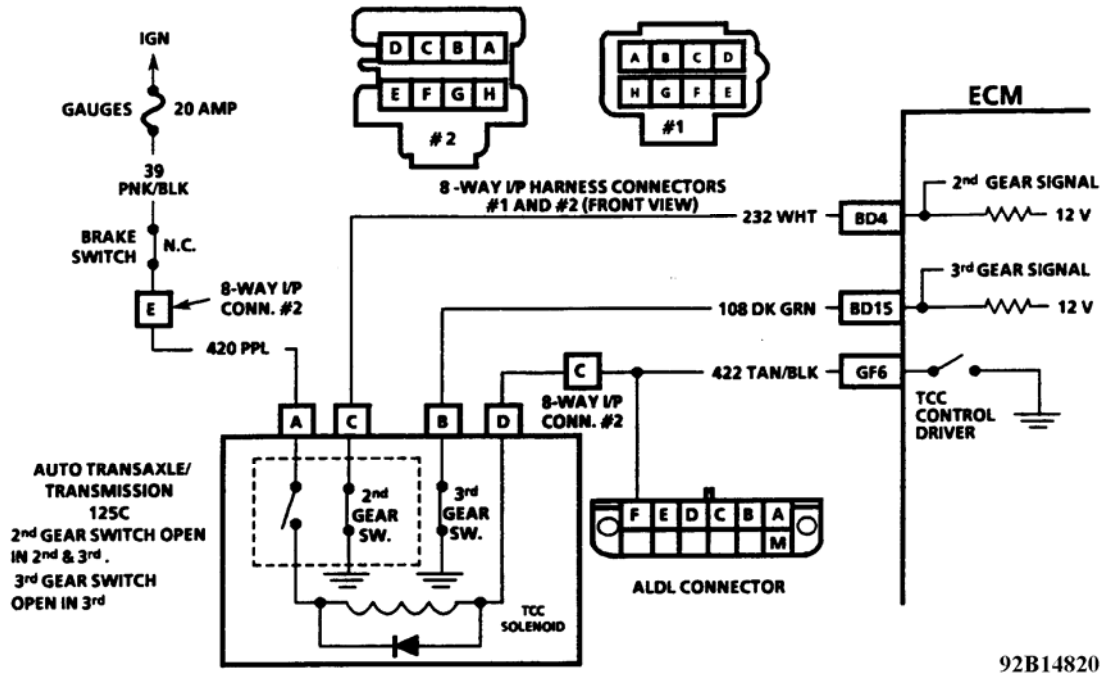


Fig. 172: Chart C-8, TCC Circuit Diagram (1992 - 3.1L PFI L Body)
Courtesy of GENERAL MOTORS CORP.

When solenoid coil is activated, TCC is applied which results in a straight through mechanical coupling from engine to wheels. When solenoid coil is deactivated, TCC is released which allows torque converter to operate in conventional manner. TCC will engage on a warm engine under given road load in 3rd gear. TCC will engage under the following conditions:

- Brake switch is closed.
- Coolant temperature is greater than 149°F (65°C).
- Vehicle speed above a calibrated value about 28 MPH.
- Throttle position not changing, indicating a steady speed.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks continuity of TCC circuit from fuse to ALDL connector.
2. Then brake pedal is released, light should come back on and then go off when diagnostic terminal is grounded. This tests circuit No. 422 and TCC driver in ECM.

Diagnostic Aids

A scan tool only indicates when ECM has turned on TCC driver and does not confirm TCC has engaged. To determine if TCC is functioning properly, test drive vehicle. Engine RPM should decrease when scan tool

indicates TCC driver has turned on. An engine coolant thermostat stuck open or opens at too low a temperature may result in an inoperative TCC.

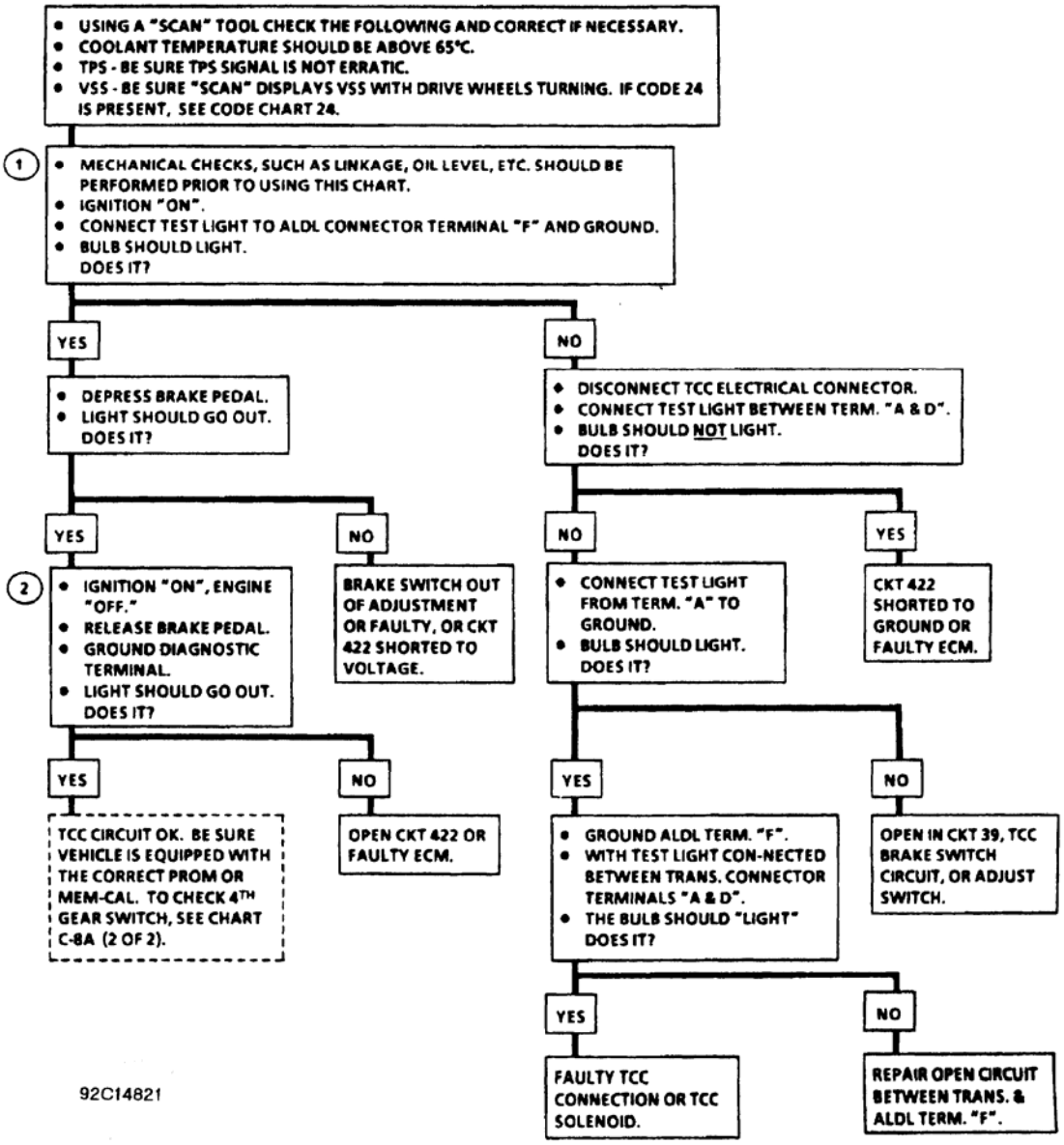


Fig. 173: Chart C-8A, TCC Troubleshooting Chart - 1 of 2 (3.1L PFI A, J & L Bodies)
Courtesy of GENERAL MOTORS CORP.

CHART C-8, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 3.1L PFI A & J BODIES (2 OF 2)

The 2nd gear signal switch in this vehicle should be open in 2nd and 3rd gear. ECM uses this 2nd gear signal to disengage TCC when going into a downshift. The 3rd gear switch should be open in 3rd gear. See **Fig. 170** through **Fig. 191**.

1st Gear

2nd gear switch opens

2nd gear signal switch closed

3rd gear signal switch closed

2nd Gear

2nd gear switch closed

2nd gear signal switch opens

3rd gear signal switch closed

3rd Gear

2nd gear switch closed

2nd gear signal switch opens

3rd gear signal switch opens

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Some scan tools display state of these switches in different ways. Be familiar with type of tool being used. since both switches should be in closed state during this test, tool should read the same for either 2nd or 3rd gear switch.
2. This test determines whether switch or signal circuit is open. Circuit can be checked for an open by measuring voltage with a DVOM at TCC connector. voltage should be about 12 volts.
3. Because switch(s) should be grounded in this step, disconnecting TCC connector should cause scan tool switch state to change.
4. Switch state should change when vehicle shifts into 2nd gear.

Diagnostic Aids

If vehicle is road tested because of a TCC related problem, ensure switch states do not change while in 3rd gear because TCC will disengage. If switches change state, carefully check wire routing and connections.

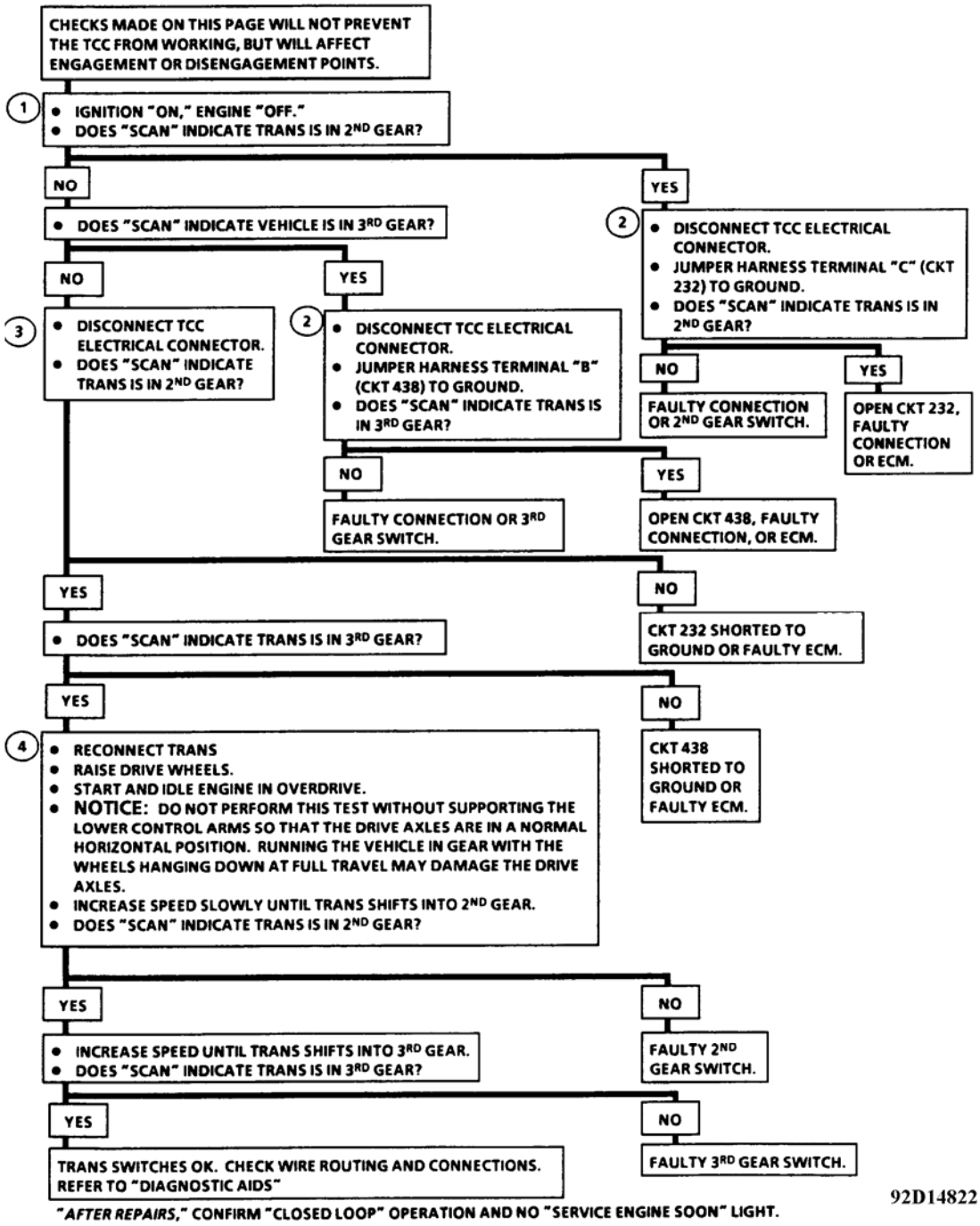


Fig. 174: Chart C-8A, TCC Troubleshooting Chart - 2 of 2 (3.1L PFI A, J & L Bodies)
Courtesy of GENERAL MOTORS CORP.

CLUTCH C-8B, 4T60 TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS, 3.1L PFI A & W BODIES

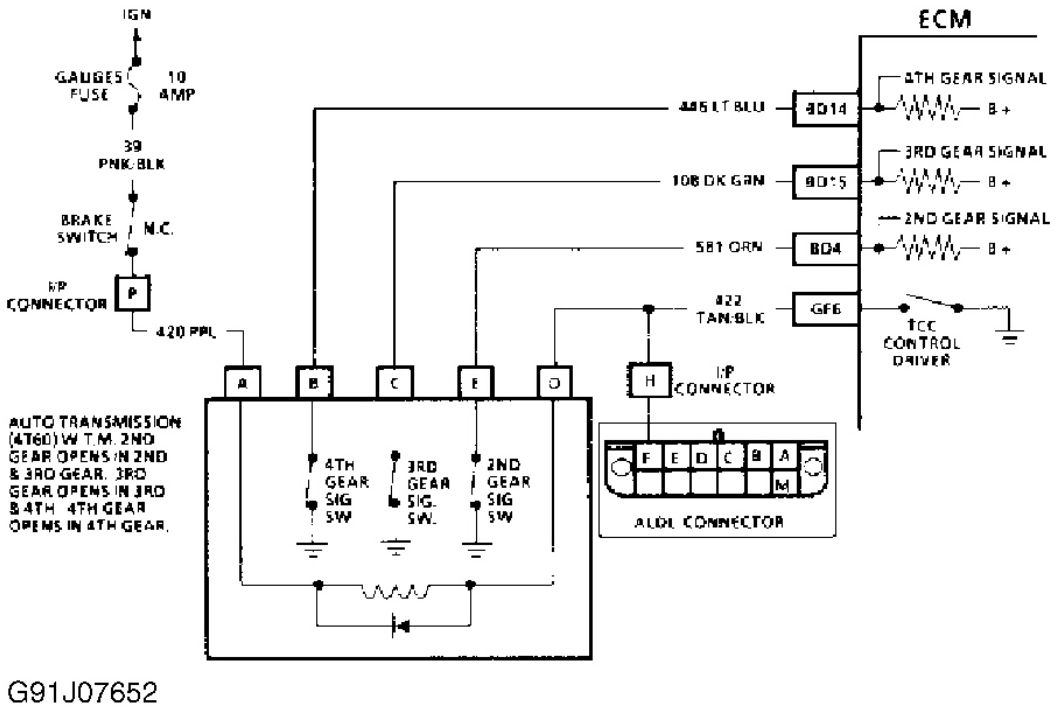


Fig. 175: Clutch C-8B, 4T60 TCC Circuit Diagram (3.1L A Body)
Courtesy of GENERAL MOTORS CORP.

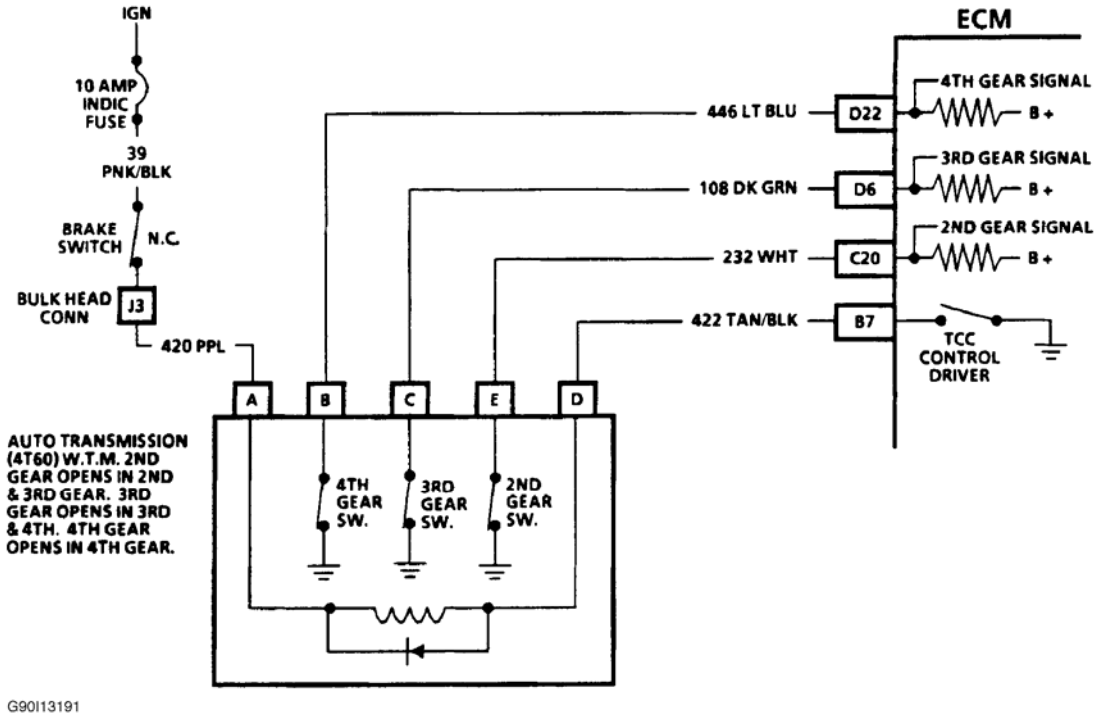


Fig. 176: Clutch C-8B, 4T60 TCC Circuit Diagram (3.1L W Body)
Courtesy of GENERAL MOTORS CORP.

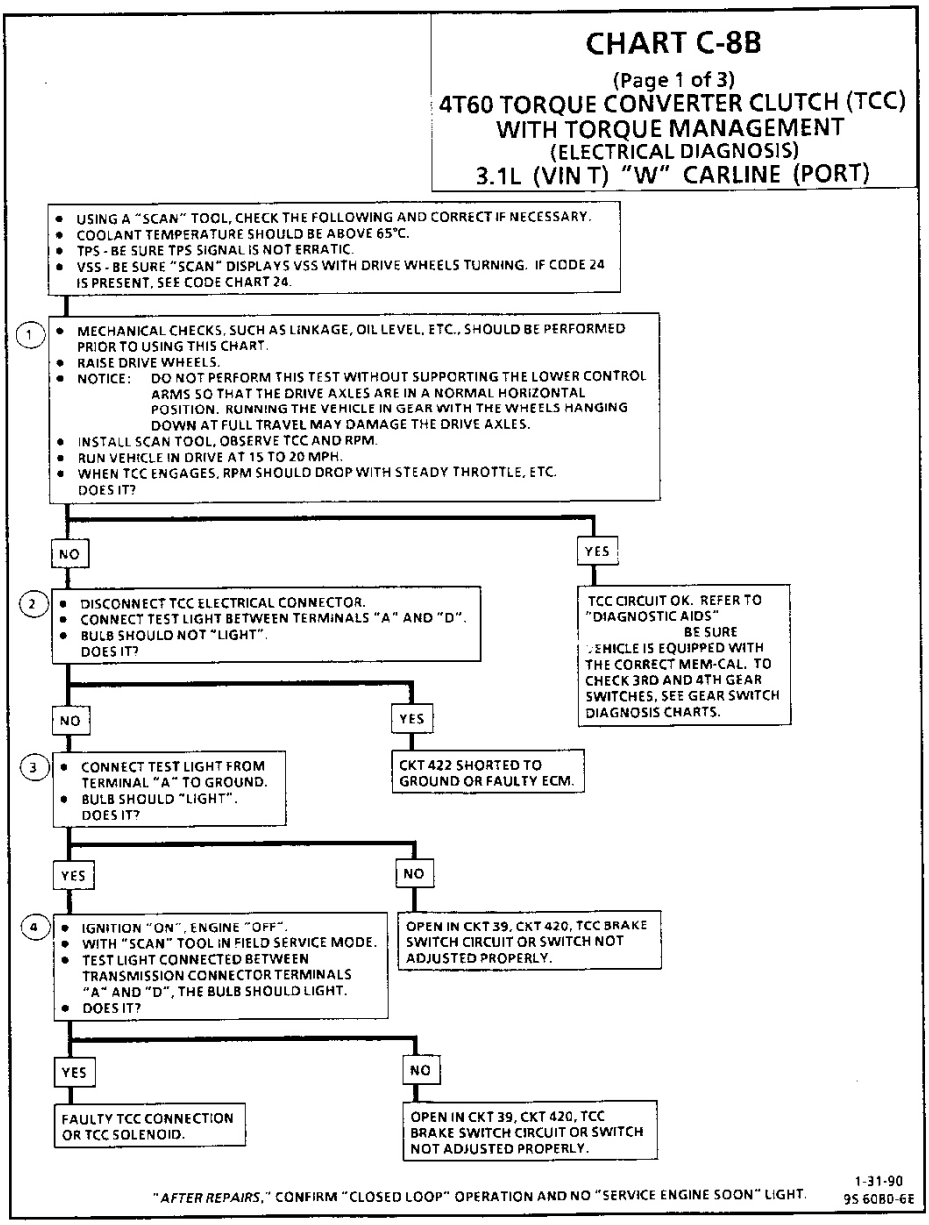
The purpose of the Torque Converter Clutch (TCC) feature is to eliminate power loss of the torque converter when the vehicle is in a cruise conditions. When the solenoid coil is activated by the ECM, the torque converter clutch is applied, resulting in a straight through mechanical coupling from the engine to the wheels. When the transmission solenoid is deactivated, the TCC is released, which allows the torque converter to operate in the conventional manner (fluidic coupling between engine and transmission).

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks the functional operation of the TCC circuit.
2. This test checks the TCC control driver in the ECM.
3. This test will confirm there is battery voltage to terminal "A".
4. This test will confirm that ECM has the ability to turn on TCC.

Diagnostic Aids

The "Scan" tester only indicates when the ECM has turned on the TCC driver. This does not confirm that the TCC has engaged. To determine if TCC is functioning properly, observe engine RPM. RPM should decrease when "Scan" tester indicates TCC driver has turned.



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Fig. 177: Chart C-8A, TCC Troubleshooting Chart 1 Of 3 (3.1L PFI A & W Bodies)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Some "Scan" testers display the gear switch state in different manners. Refer to manufacturer's operating manual for additional information. Since both switches should be in the closed state during this test, scan should read the same for either 3rd or 4th gear switch.
2. Determines whether the switch or signal circuit is open. The circuit can be checked for an open by measuring voltage at the TCC connector. Reading should be about 12 volts.
3. Because switch should be grounded in this step, disconnecting TCC connector should cause "Scan" tester display to change state.
4. Switch state should change when vehicle shifts into 3rd gear.

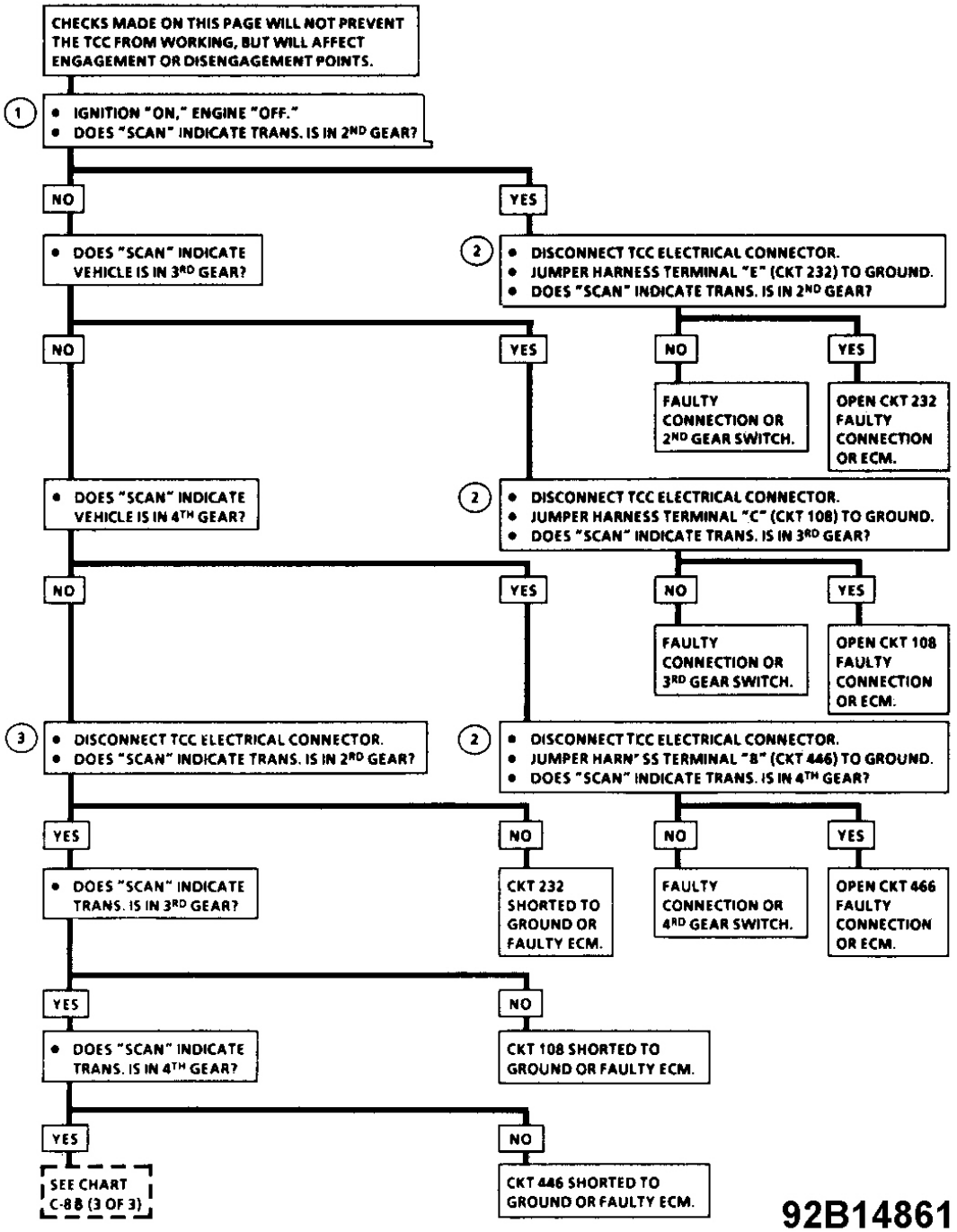


Fig. 178: Chart C-8A, TCC Troubleshooting Chart 2 Of 3 (3.1L PFI A & W Bodies)
Courtesy of GENERAL MOTORS CORP.

Diagnostic Aids

If vehicle is road tested for a TCC related problem, ensure the switch state does not change while in 4th gear because the TCC will disengage. If switch changes state, carefully inspect wire harness/routing and connections.

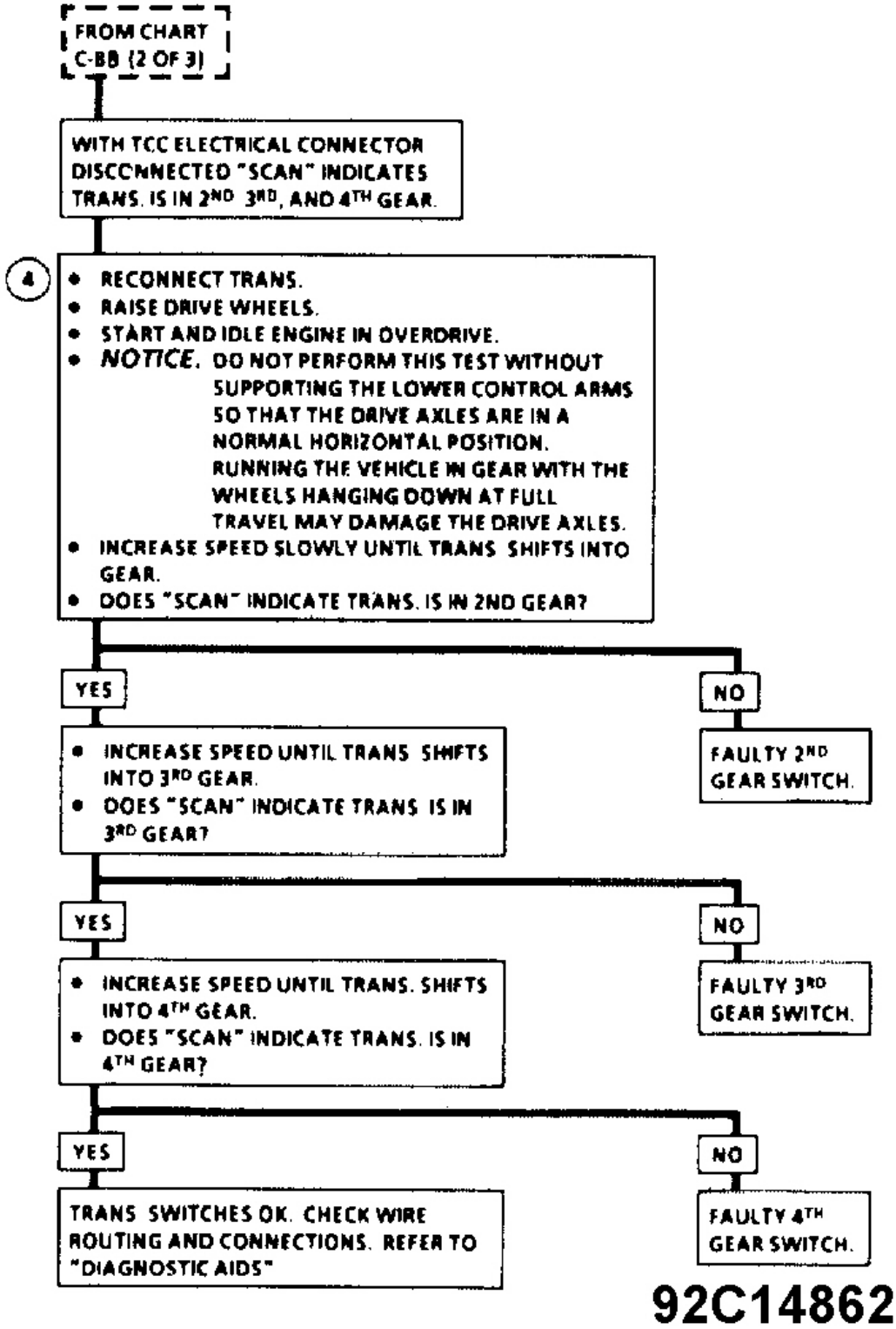

FROM CHART C-BB (2 OF 3)
WITH TCC ELECTRICAL CONNECTOR DISCONNECTED "SCAN" INDICATES TRANS. IS IN 2ND 3RD, AND 4TH GEAR.
4
• RECONNECT TRANS.
• RAISE DRIVE WHEELS.
• START AND IDLE ENGINE IN OVERDRIVE.
• NOTICE. DO NOT PERFORM THIS TEST WITHOUT SUPPORTING THE LOWER CONTROL ARMS SO THAT THE DRIVE AXLES ARE IN A NORMAL HORIZONTAL POSITION. RUNNING THE VEHICLE IN GEAR WITH THE WHEELS HANGING DOWN AT FULL TRAVEL MAY DAMAGE THE DRIVE AXLES.
• INCREASE SPEED SLOWLY UNTIL TRANS SHIFTS INTO GEAR.
• DOES "SCAN" INDICATE TRANS. IS IN 2ND GEAR?
YES
NO
FAULTY 2ND GEAR SWITCH.
• INCREASE SPEED UNTIL TRANS SHIFTS INTO 3RD GEAR.
• DOES "SCAN" INDICATE TRANS IS IN 3RD GEAR?
YES
NO
FAULTY 3RD GEAR SWITCH.
• INCREASE SPEED UNTIL TRANS. SHIFTS INTO 4TH GEAR.
• DOES "SCAN" INDICATE TRANS. IS IN 4TH GEAR?
YES
NO
TRANS SWITCHES OK. CHECK WIRE ROUTING AND CONNECTIONS. REFER TO "DIAGNOSTIC AIDS"
FAULTY 4TH GEAR SWITCH.
92C14862

Fig. 179: Chart C-8A, TCC Troubleshooting Chart 3 Of 3 (3.1L PFI A & W Bodies)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH - 3.1L PFI F BODY

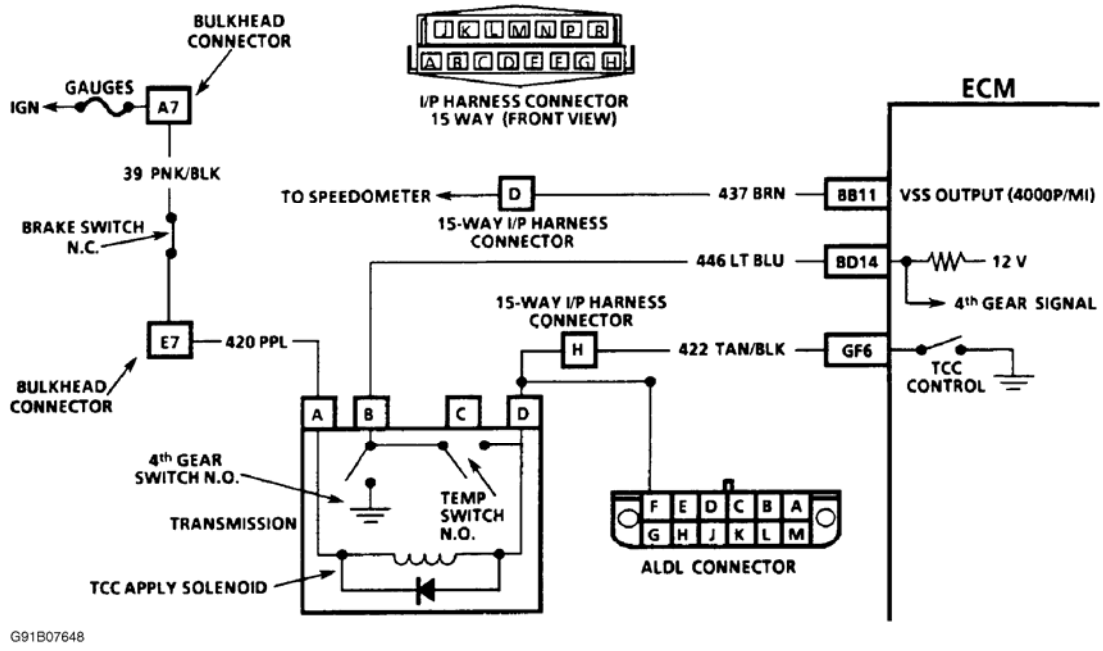


Fig. 180: Clutch C-8B, TCC Circuit Diagram (3.1L F Body)
Courtesy of GENERAL MOTORS CORP.

When solenoid coil is activated, TCC is applied which results in a straight through mechanical coupling from engine to wheels. When solenoid coil is deactivated, TCC is released which allows torque converter to operate in conventional manner. ECM turns on TCC when engine coolant temperature is greater than 149°F (65°C), TPS not changing and vehicle speed is greater than a specified value.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. When test light is connected from ALDL terminal "F" to ground, a test light on indicates battery voltage is okay and TCC solenoid is disengaged.
2. When diagnostic terminal is grounded, ECM should energize TCC solenoid and test light should go out.

Diagnostic Aids

A scan tool only indicates when ECM has turned on the TCC driver and does not confirm TCC has engage. To determine if TCC is functioning properly, test drive vehicle. Engine RPM should decrease when Scan tool indicates TCC driver has turned on.

To determine if 4th gear switch is functioning properly, perform checks is CHART C-8 (2 OF 2). Switches will not prevent TCC from functioning but will affect TCC lock and unlock points.

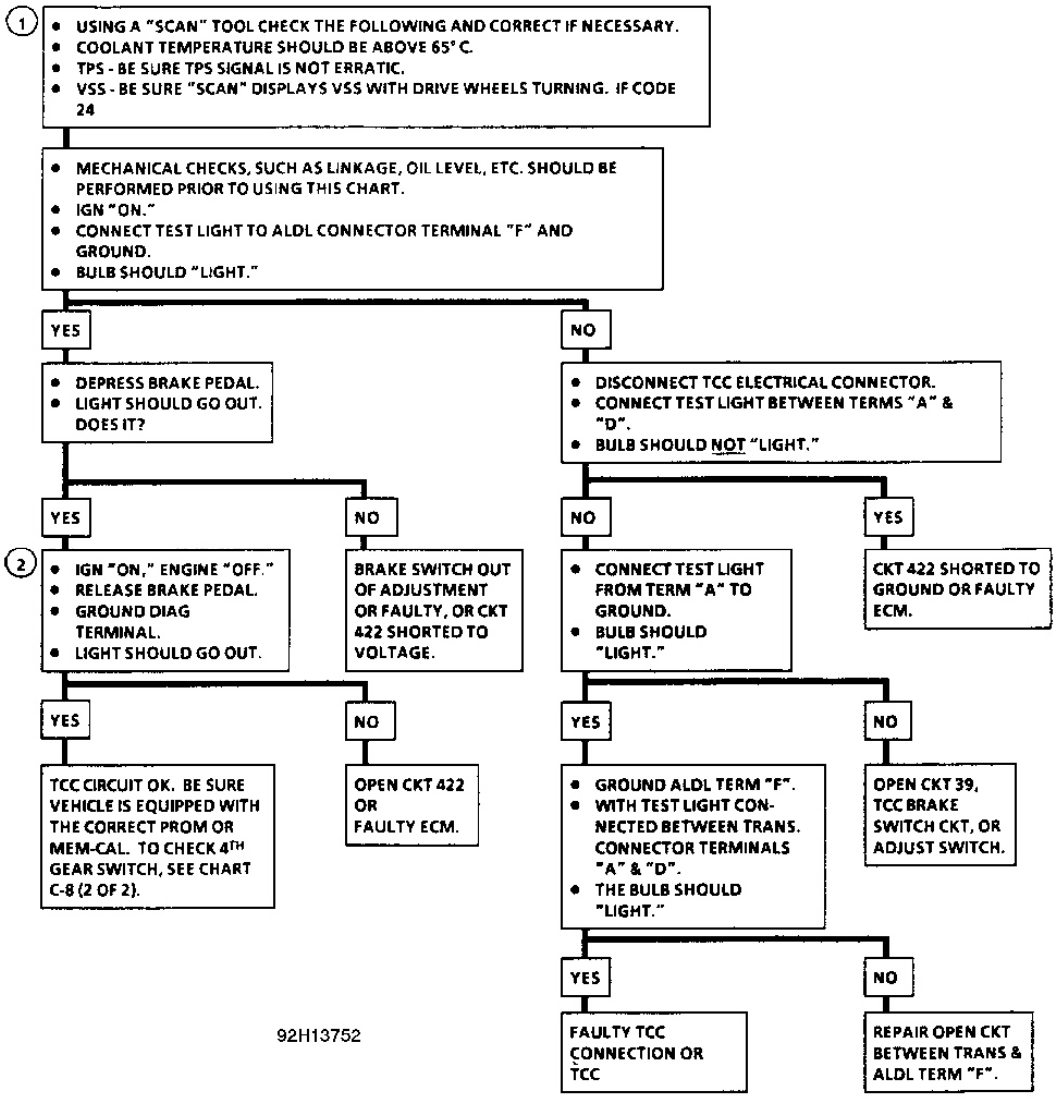


Fig. 181: Chart C-8A, TCC Troubleshooting Chart 1 Of 2 (3.1L PFI F Body)
Courtesy of GENERAL MOTORS CORP.

A 4th gear switch mounted inside transmission closes when transmission shifts into 4th gear and this switch is used by ECM to modify TCC lock and unlock points when in a 4-3 downshift maneuver.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Unless switch of circuit No. 446 is closed, scan tool should display NO, indicating transmission is not in 4th gear. The 4th gear switch should only be closed while in 4th gear.
2. This test checks operation of 4th gear switch. When transmission shifts into 4th gear, switch should close and scan tool should display YES.

3. Disconnecting TCC connector simulates an open switch to determine if circuit No. 446 is shorted to ground or problem is in transmission.
4. This step determines if ECM and wiring are okay. Grounding circuit No. 446 should cause scan tool to display YES indicating transmission is in 4th gear.

Diagnostic Aids

A road test may be necessary to verify customer complaint. If scan tool indicates TCC is turning on and off erratically, check state of 4th gear switch to be sure it is not changing states under a steady throttle position. If switch is changing states, check connections and wire routing carefully. Also, if 4th gear switch is always closed, TCC may engage as soon as sufficient oil pressure is reached.

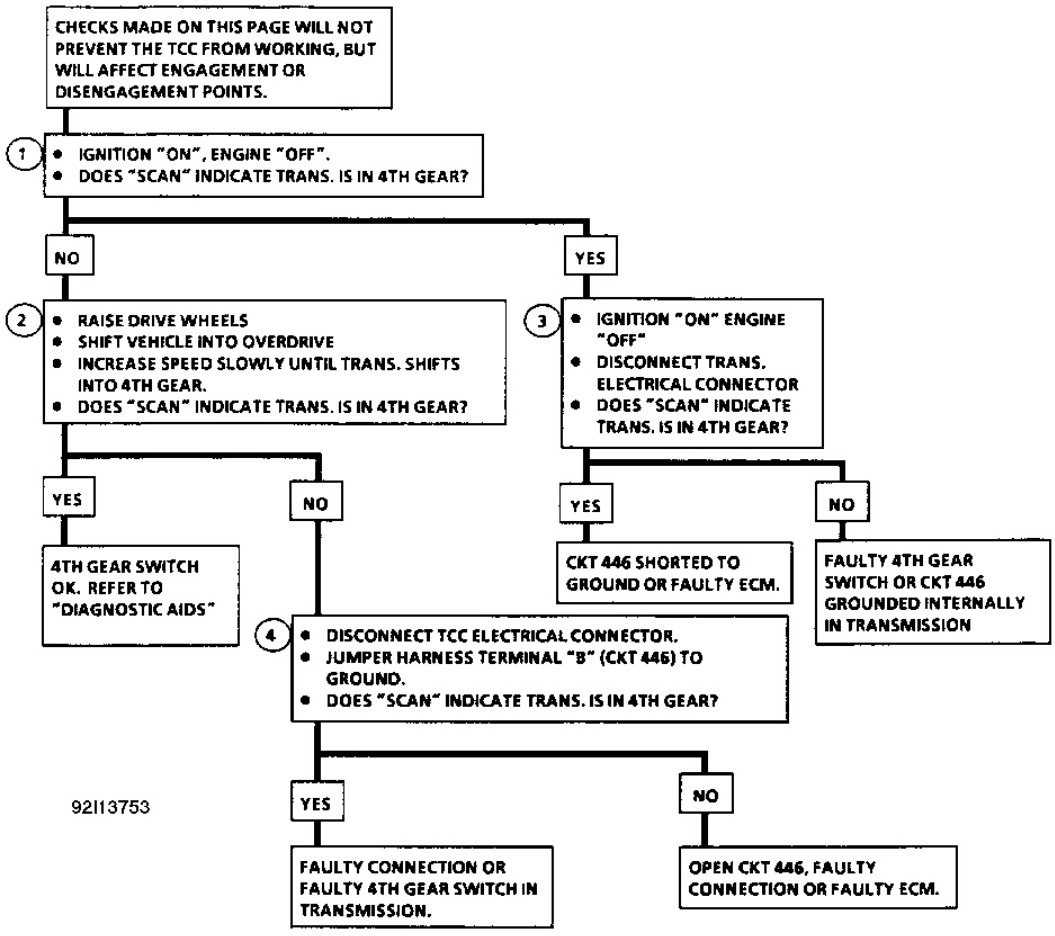


Fig. 182: Chart C-8A, TCC Troubleshooting Chart 2 Of 2 (3.1L PFI F Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, 3T40 TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 3.1L PFI W BODY

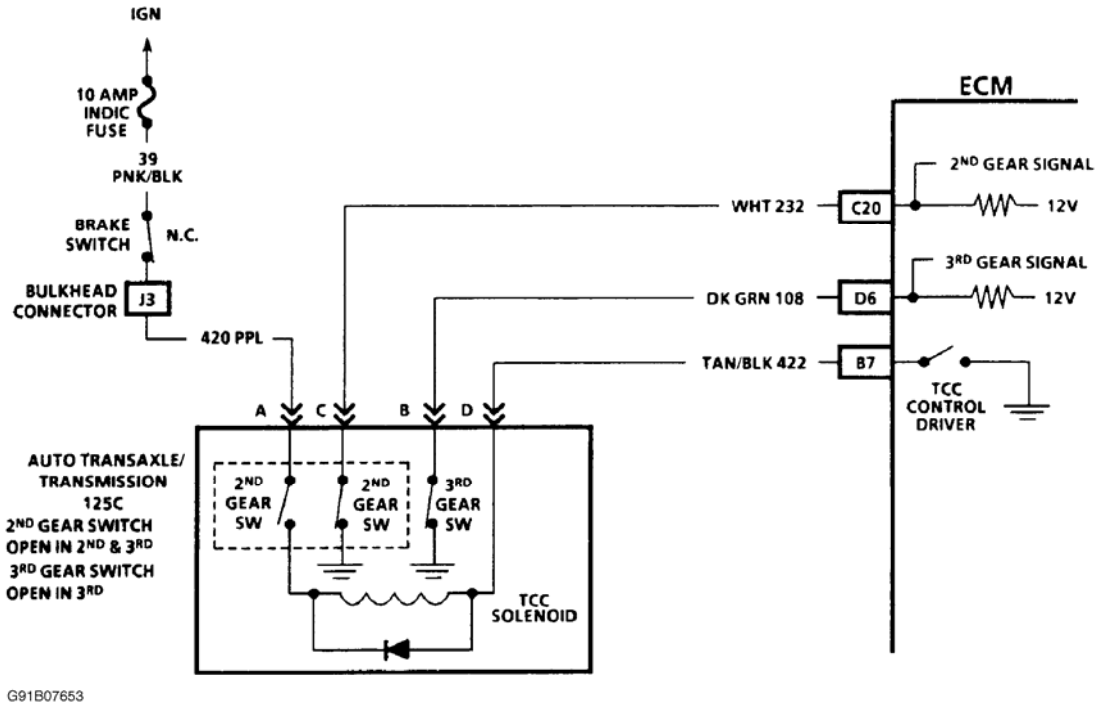


Fig. 183: Clutch C-8B, TCC Circuit Diagram (3.1L W Body)
Courtesy of GENERAL MOTORS CORP.

When solenoid coil is activated. TCC is applied which results in a straight through mechanical coupling from engine to wheels. When solenoid coil is deactivated, TCC is released which allows torque converter to operate in conventional manner. TCC will engage on a warm engine under given road load in 2nd and 3rd gear. TCC will engage under the following conditions:

- Brake switch is closed.
- Coolant temperature is greater than 149°F (65°C).
- Vehicle speed above a calibrator value about 28 MPH.
- Throttle position not changing, indicating a steady speed.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks functional operation of TCC circuit.
2. This test checks TCC control driver in ECM.
3. This test will confirm there is voltage to terminal "A".
4. This test confirms ECM has ability to turn TCC on.

Diagnostic Aids

A scan tool only indicates when ECM has turned on TCC driver and does not confirm TCC has engaged. To determine if TCC is functioning properly, test drive vehicle. Engine RPM should decrease when scan tool

indicates TCC driver has turned on. An engine coolant thermostat stuck open or opens at too low a temperature may result in an inoperative TCC.

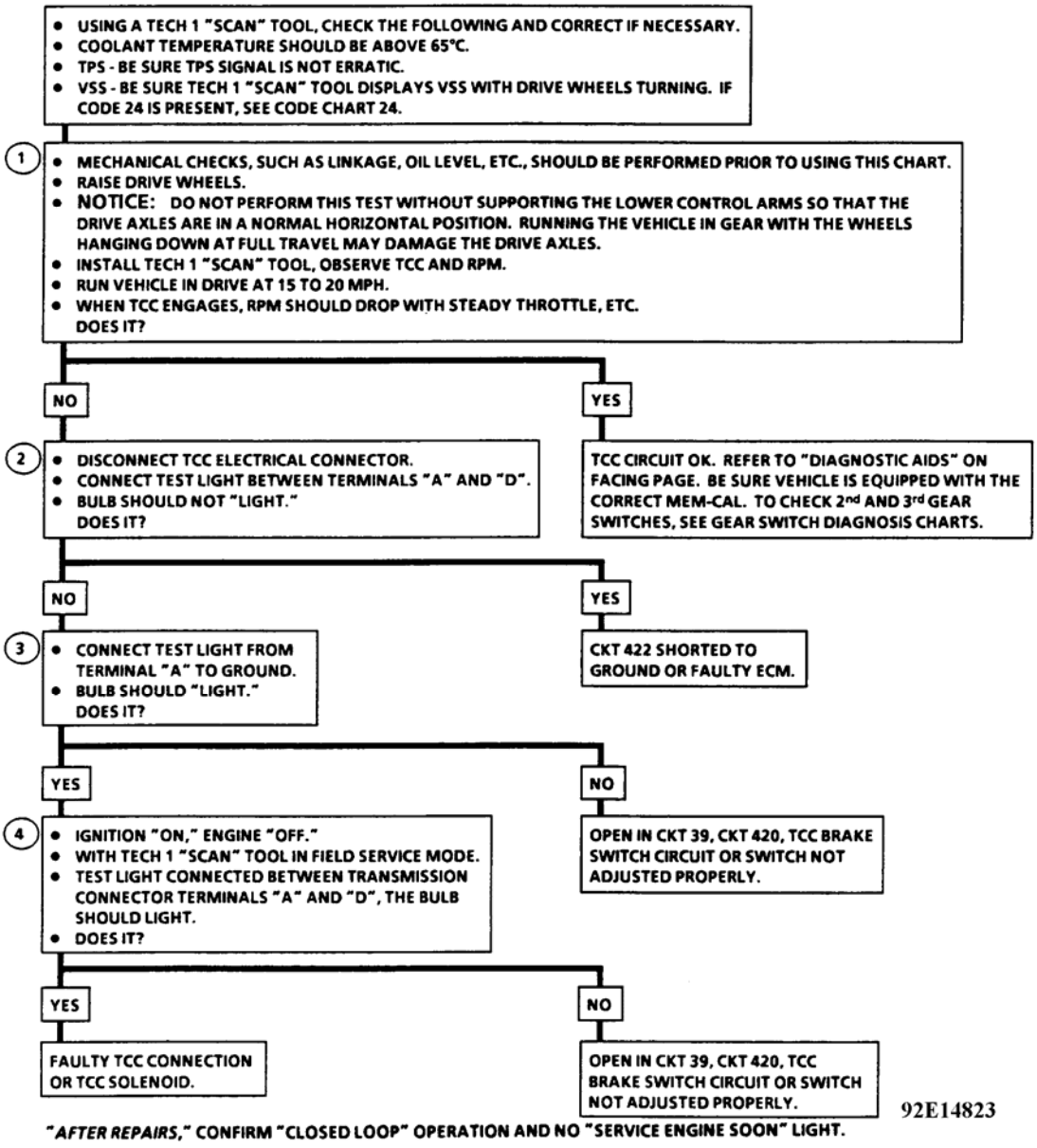


Fig. 184: Chart C-8A, TCC Troubleshooting Chart 1 Of 2 (3.1L PFI W Body)
Courtesy of GENERAL MOTORS CORP.

The 2nd gear switch will be open in 2nd and 3rd gear. ECM uses this signal to disengage TCC when going into a downshift. The 3rd gear switch will open in 3rd gear.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Different makes of scan tools will read differently. Be familiar with type of tool being used. All switches should be in closed state during this test and tool should read the same for 2nd and 3rd gear switches.
2. This test determines whether switch of signal circuit is open. circuit can be checked for an open by measuring voltage with a DVOM at TCC connector. Voltage should be about 12 volts.
3. Because switches should be grounded in this step, disconnecting TCC connector should cause displayed switch states to change.
4. Switch state should change when vehicle shifts into 2nd gear.

Diagnostic Aids

If vehicle is road tested because of a TCC related problem, ensure switch states do not change while in 3rd gear. TCC will engage. If switches change state, carefully check wire routing and connections. If ECM, TCC solenoid and control circuitry are functioning correctly and TCC still does not apply properly, problem may be hydraulic or mechanical.

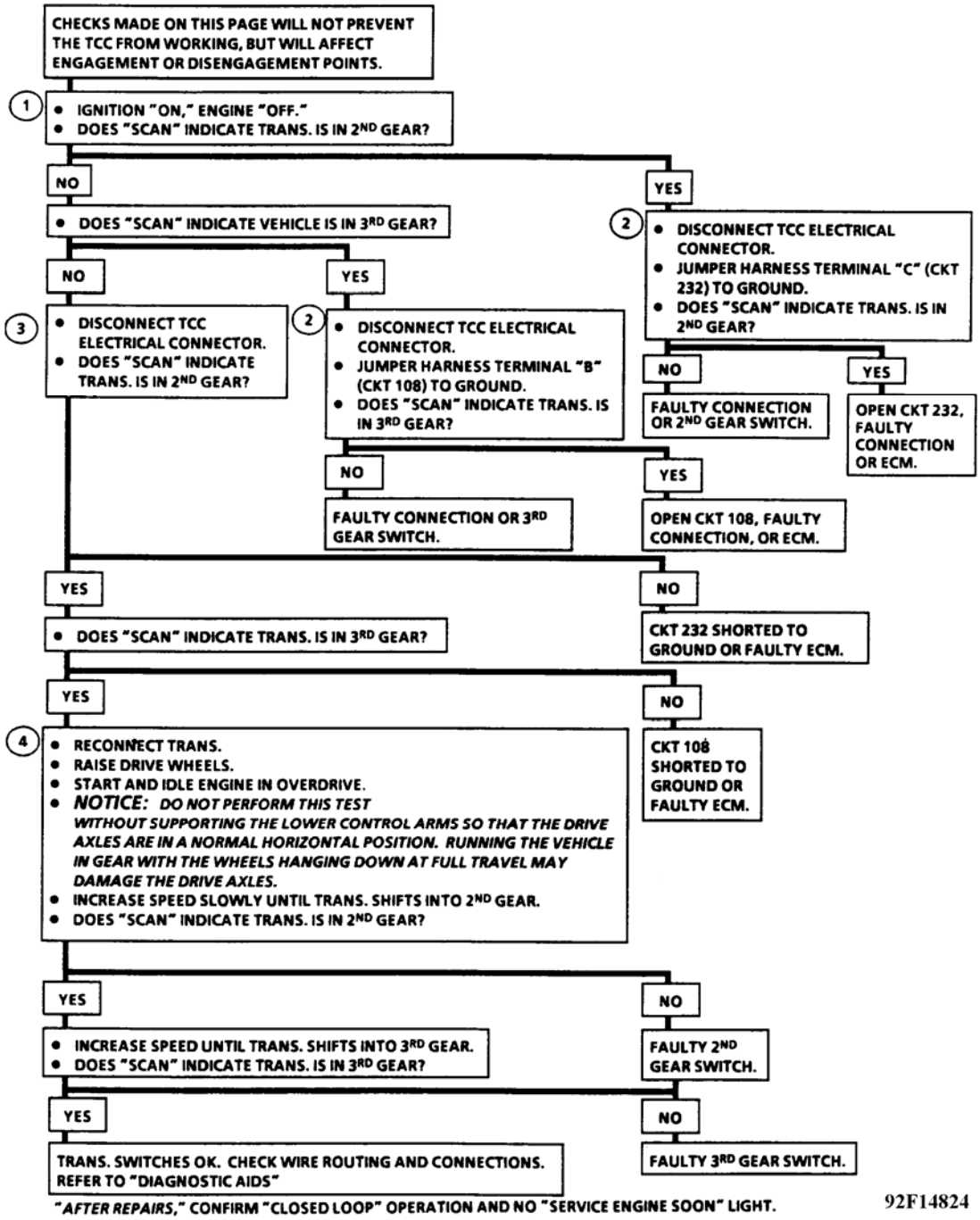


Fig. 185: Chart C-8A, TCC Troubleshooting Chart 2 Of 2 (3.1L PFI W Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, 3T40 TORQUE CONVERTER CLUTCH, 3.3L PFI A BODY

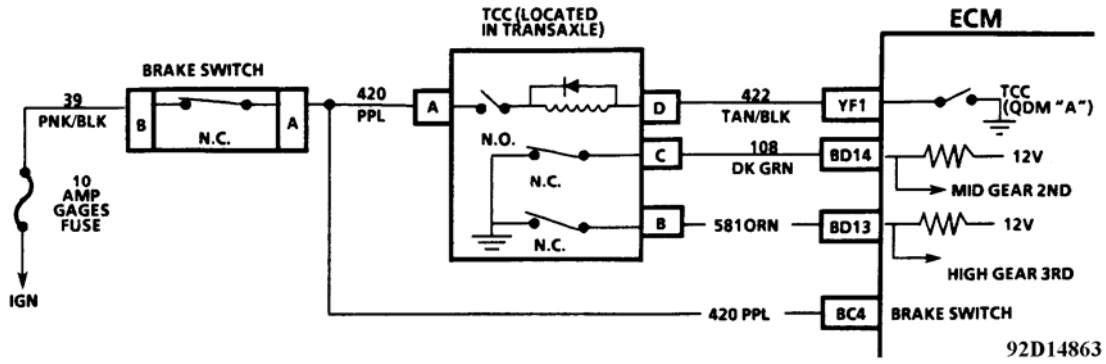


Fig. 186: Clutch C-8B, TCC Circuit Diagram (3.3L PFI - A Body)
Courtesy of GENERAL MOTORS CORP.

Voltage is supplied to TCC solenoid through brake switch and transmission 3rd gear apply switch. ECM engages TCC by grounding circuit No. 422 to energize the solenoid. TCC will engage when:

- Vehicle speed is above 33 MPH.
- Engine at normal operating temperature.
- Throttle position not changing, indicating a steady speed.
- Brake switch and transmission 3rd gear switch are closed.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. This test checks fuse and brake switch.
2. This test checks ECM for proper operation.
3. This test checks internal switches in transmission.

Diagnostic Aids

Scan tool only indicates when ECM has turned on TCC driver and does not confirm TCC engagement. To determine if TCC if functioning properly, road test vehicle. Engine RPM should decrease when scan tool indicates TCC driver has turned on.

If ECM TCC solenoid and control circuitry are functioning correctly but TCC still does not apply properly, problem may be hydraulic or mechanical. See appropriate AUTO TRANS OVERHAUL article.

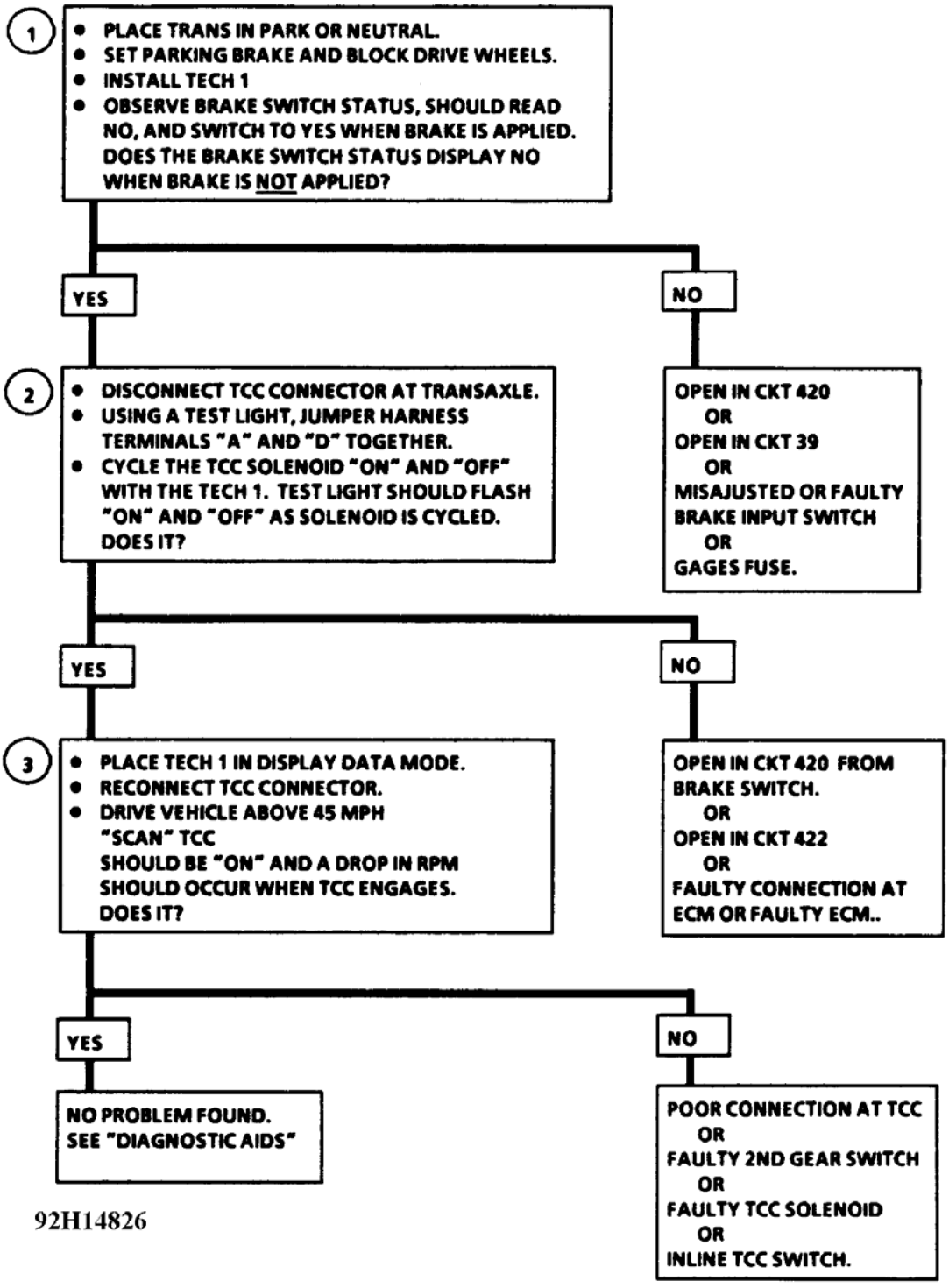


Fig. 187: Chart C-8A, TCC Troubleshooting Chart (3.3L PFI A Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-8B, 4T60 TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 3.3L PFI A BODY

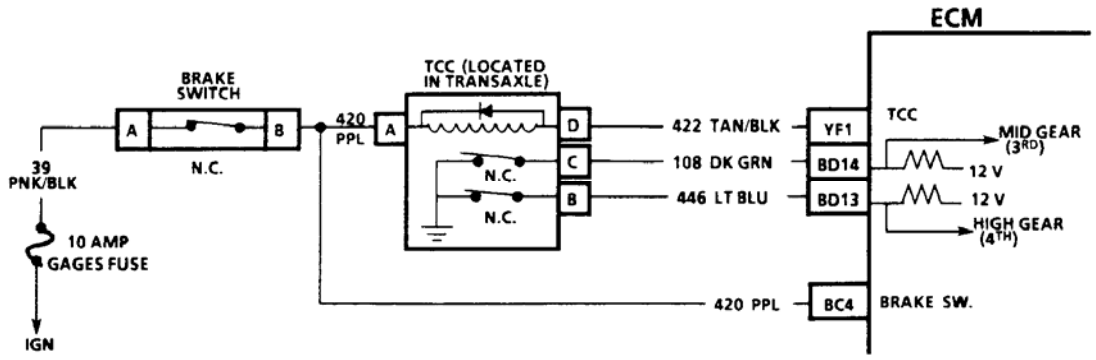


Fig. 188: Chart C-8B, 4T60 TCC Circuit Diagram - (3.3L PFI A Body)
Courtesy of GENERAL MOTORS CORP.

Each gear switch opens when appropriate clutch is applied. All gear switches are open in 4th gear. TCC will engage under the following conditions:

- Engine is warmed up.
- Vehicle speed above a calibrated value of about 35 MPH.
- Throttle position not changing, indicating a steady speed.
- Transmission 3rd gear switch closed.
- Brake switch closed.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks integrity of total circuit minus TCC solenoid.
2. This test checks for faulty brake switch or open circuit No. 422.

Diagnostic Aids

If vehicle is road tested because of a TCC related problem, ensure switch states do not change while in 4th gear. TCC will engage. If switches change state, carefully check wire routing and connections. If ECM, TCC solenoid and control circuitry are functioning correctly and TCC still does not apply properly, problem may be hydraulic or mechanical.

Each gear switch opens when appropriate clutch is applied. All gear switches are open in 4th gear.

NOTE: Test numbers refer to test numbers on diagnostic chart.

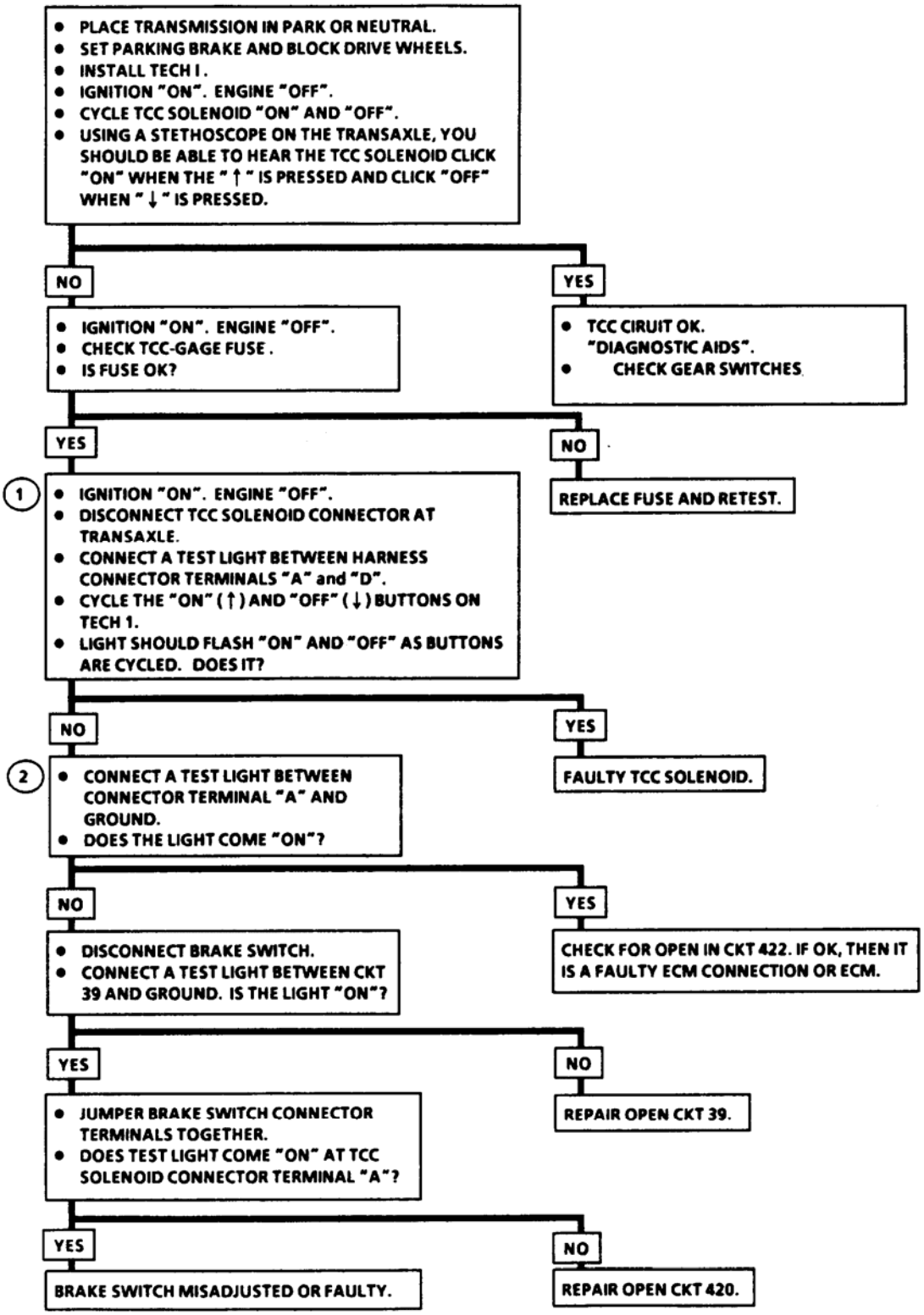
1. Some scan tools display state of these switches in different ways. Be familiar with type of tool being used. All switches should be in closed state during this test and tool should read the same for 3rd and 4th

gear switches.

2. This test determines whether switch of signal circuit is open. Circuit can be checked for an open by measuring voltage with a DVOM at TCC connector. Voltage should be about 12 volts.
3. Because switch(s) should be grounded in this step, disconnecting TCC connector should cause displayed switch states to change.
4. Switch state should change when vehicle shifts into 3rd gear.

Diagnostic Aids

If vehicle is road tested because of a TCC related problem, ensure switch states do not change while in 4th gear. TCC will engage. If switches change state, carefully check wire routing and connections. If ECM, TCC solenoid and control circuitry are functioning correctly and TCC still does not apply properly, problem may be hydraulic or mechanical. See appropriate AUTO TRANS OVERHAUL article.



"AFTER REPAIRS," CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

92I14827

Fig. 189: Chart C-8B, 4T60 TCC Troubleshooting 1 Of 2 (3.3L PFI A Body)
Courtesy of GENERAL MOTORS CORP.

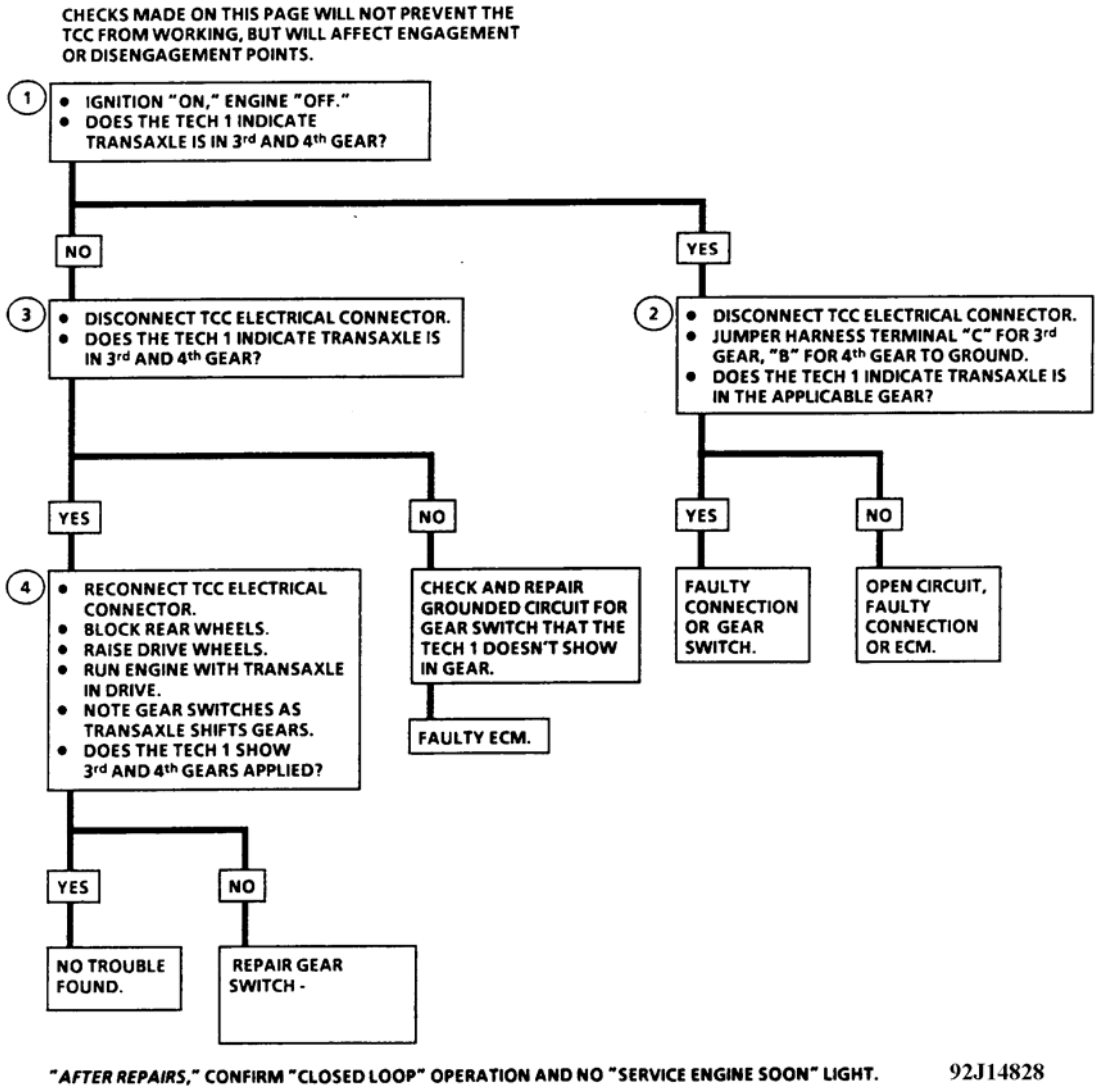


Fig. 190: Chart C-8B, 4T60 TCC Troubleshooting 2 Of 2 (3.3L PFI A Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, 3T40 TORQUE CONVERTER CLUTCH, 3.3L PFI N BODY

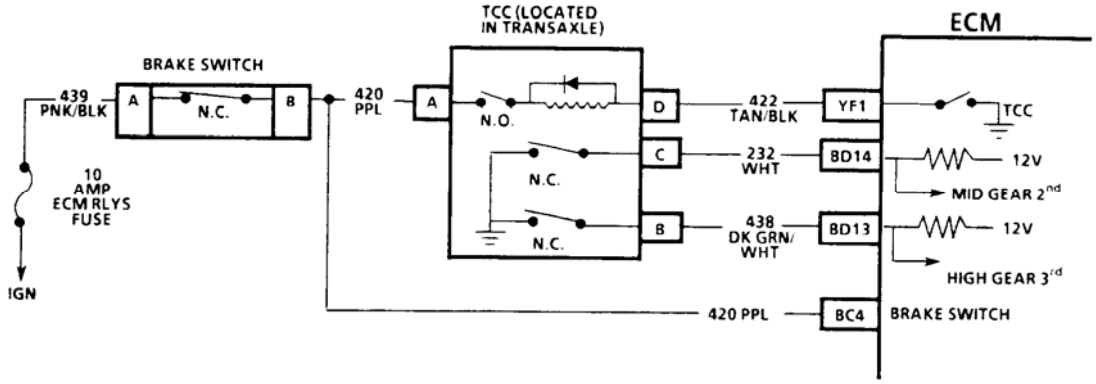


Fig. 191: Chart C-8A, 3T40 TCC Circuit Diagram (3.3L PFI N Body)
Courtesy of GENERAL MOTORS CORP.

Fused battery voltage is supplied to TCC solenoid through brake switch and transmission 3rd gear apply switch. ECM will engage TCC by grounding circuit No. 422 to energize solenoid.

TCC will engage under the following conditions:

- Engine is warmed up.
- Vehicle speed above a calibrated value of about 33 MPH.
- Throttle position not changing, indicating a steady speed.
- Transmission 3rd gear switch closed.
- Brake switch closed.
- TCC apply switch closed.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks gage fuse and brake switch.
2. this test checks ECM for proper operation.
3. This test checks internal switches in transmission.

Diagnostic Aids

A scan tool only indicates when ECM has turned on the TCC driver and does not confirm TCC has engaged. To determine if TCC if functioning properly, test drive vehicle. Engine RPM should decrease when Scan tool indicates TCC driver has turned on.

If ECM, TCC solenoid and control circuitry are functioning correctly and TCC still does not apply properly, problem may be hydraulic or mechanical.

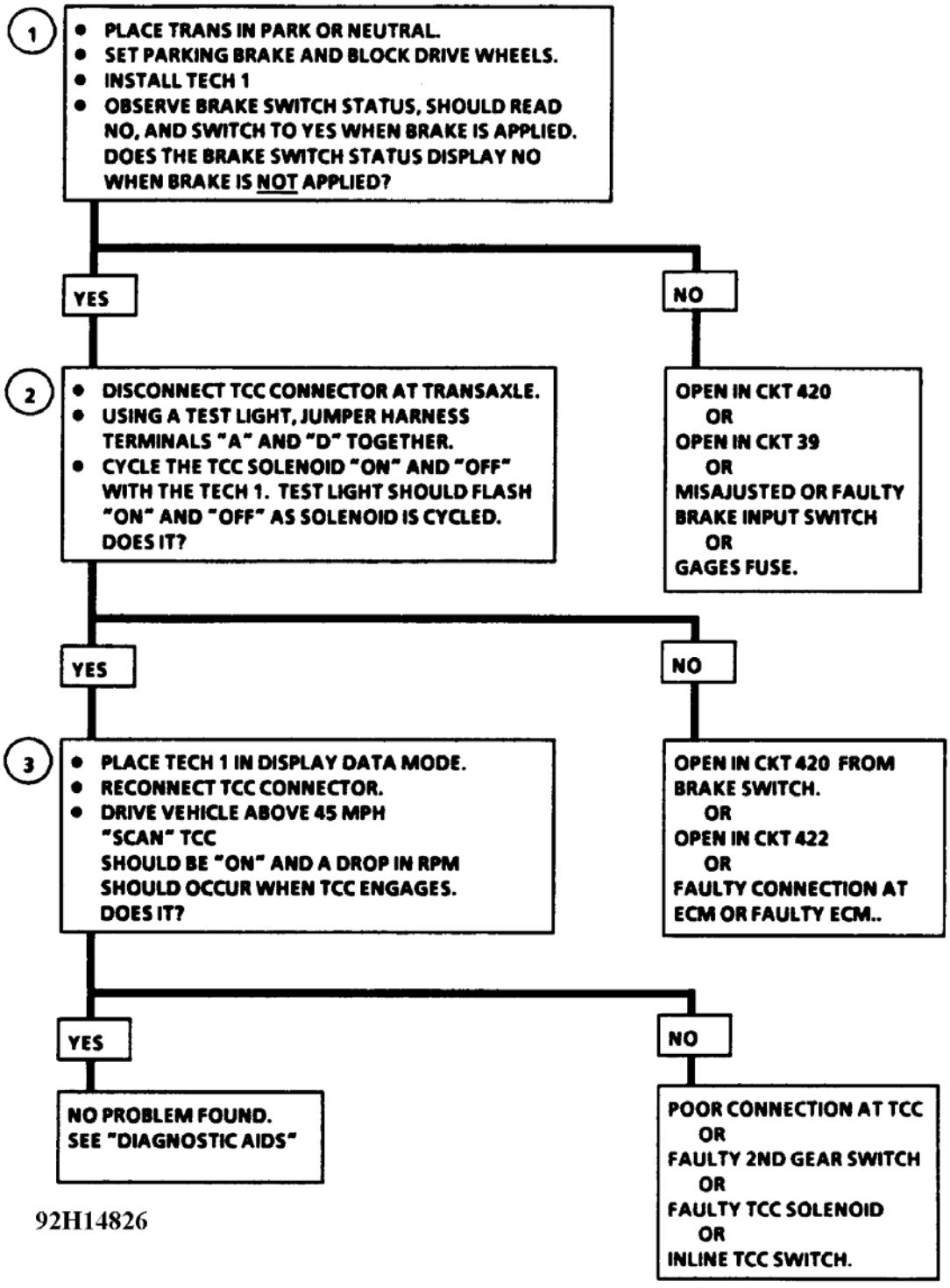


Fig. 192: Chart C-8A, 3T40 Troubleshooting Chart (3.3L PFI N Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-8B, 4T60 TRANSAXLE MODE SWITCH ELECTRICAL DIAGNOSIS - 3.4L PFI W BODY

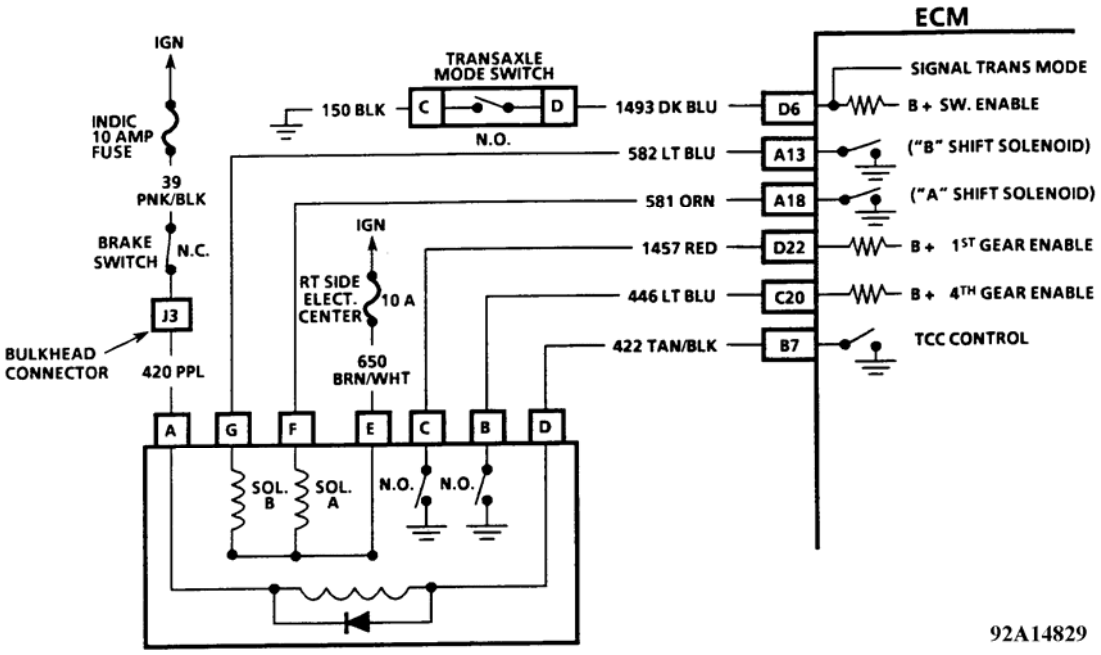


Fig. 193: Chart C-8B, 4T60 Transaxle Mode Switch Circuit (3.4L PFI W Body)
Courtesy of GENERAL MOTORS CORP.

Transmission uses 2 solenoids to control shifting. ECM monitors the TPS and vehicle speed to determine correct shift points.

NOTE: Test number refers to test number on diagnostic chart.

1. This test checks to see if transaxle mode switch is transmitting command to ECM to turn off solenoid "A" which enables 2nd gear. If solenoid "A" does not go off and transaxle mode switch is on, refer to CHART C-8A (4 OF 4) - TRANSAXLE SHIFT SOLENOID.

Diagnostic Aids

A scan tool only displays if transaxle mode switch is on or off. If information displayed is correct, solenoid "A" is off and transaxle is not in 2nd gear, refer to appropriate automatic transmission article for hydraulic or mechanical diagnosis.

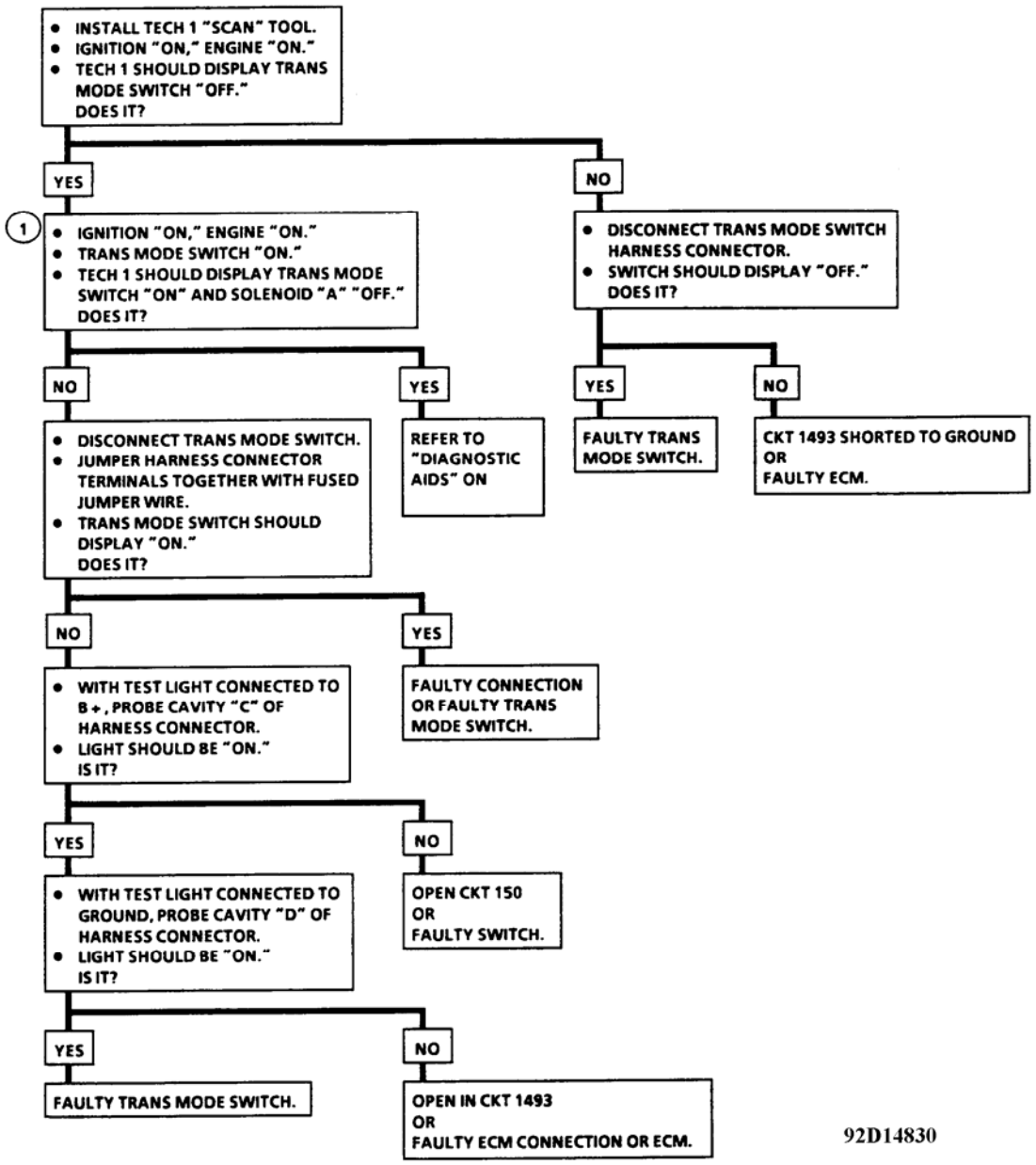


Fig. 194: Chart C-8B, 4T60 Transaxle Troubleshooting 1 Of 4 (3.4L PFI W Body)
Courtesy of GENERAL MOTORS CORP.

When solenoid coil is activated, TCC is applied which results in a straight through mechanical coupling from engine to wheels. When solenoid coil is deactivated, TCC is released which allows torque converter to operate in conventional manner. TCC will engage on a warm engine under given road load in 2nd, 3rd and 4th gears. TCC will engage under the following conditions:

- Engine is warmed up.
- Vehicle speed above a calibrated value of about 28 MPH.

- Throttle position not changing, indicating a steady speed.
- Brake switch is closed.

NOTE: Test number refers to test number on diagnostic chart.

1. This test checks functional operation of TCC circuit.
2. This test checks TCC control driver in ECM.
3. This test determines if voltage is present at terminal "A". If there is no voltage, check 10 amp fuse.
4. This test confirms ECM has ability to turn TCC on.

Diagnostic Aids

A scan tool only indicates when ECM has turned on the TCC driver and does not confirm TCC has engaged. To determine if TCC is functioning properly, test drive vehicle. Engine RPM should decrease when Scan tool indicates TCC driver has turned on.

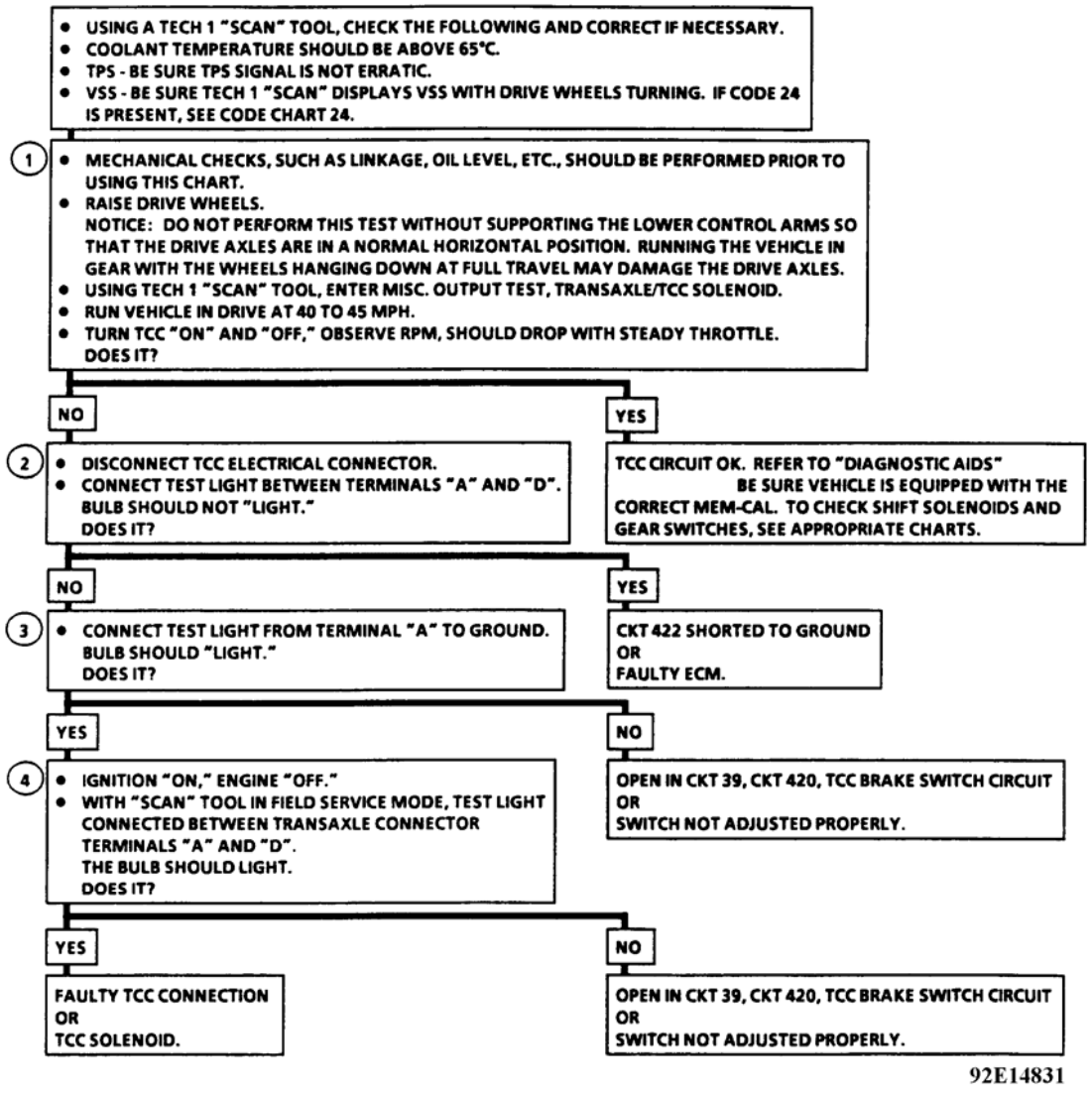


Fig. 195: Chart C-8B, 4T60 Transaxle Troubleshooting 2 Of 4 (3.4L PFI W Body)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test number refers to test number on diagnostic chart.

1. If there are any codes present, those codes must be repaired first. Transaxle will default to 3rd gear if Codes 21, 22, 24, 53 and 55 are present.
2. This test checks 1st gear switch status.
3. This test verifies 1st gear switch status change.
4. This test checks 4th gear switch status.

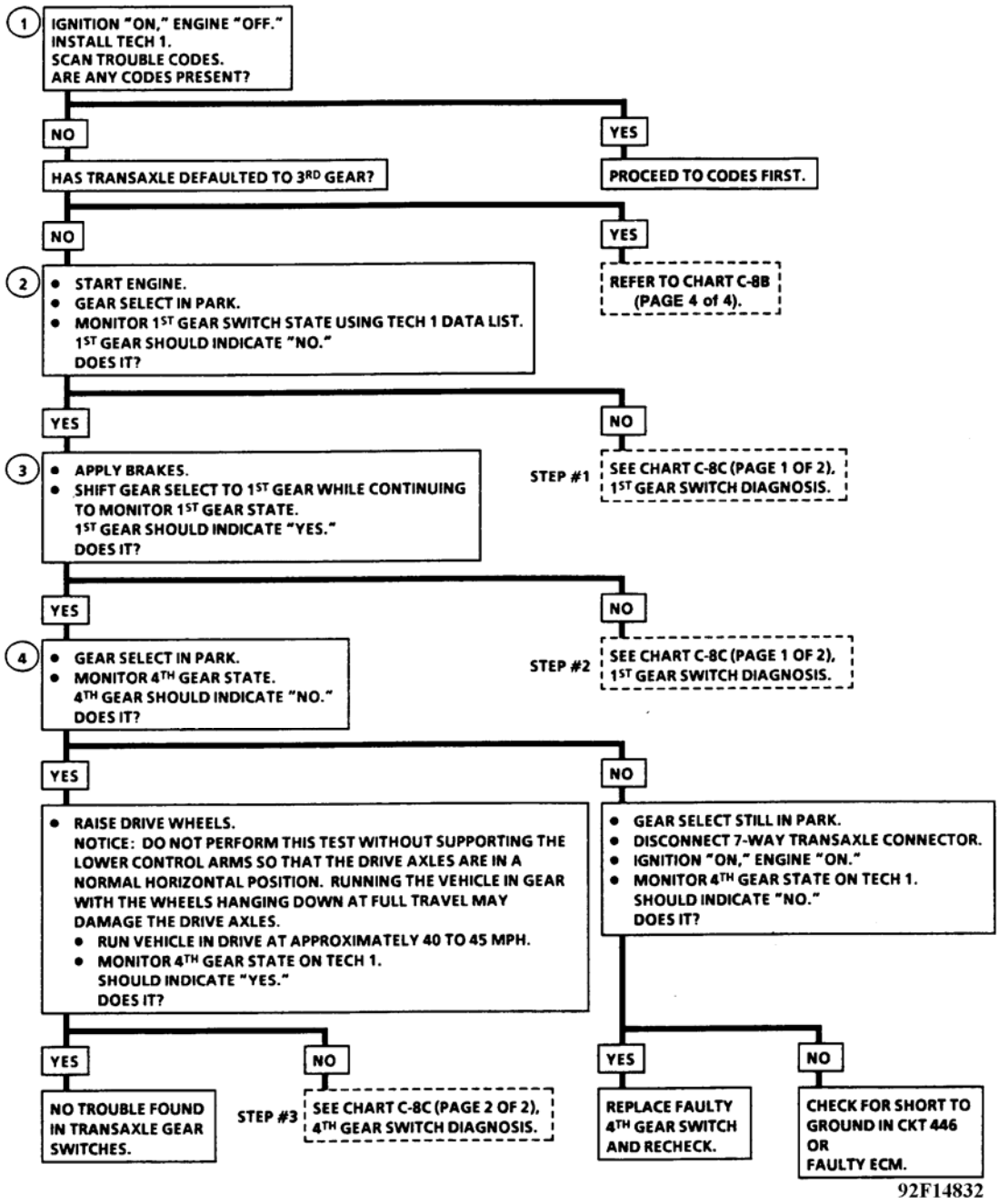


Fig. 196: Chart C-8B, 4T60 Transaxle Troubleshooting 3 Of 4 (3.4L PFI W Body)
Courtesy of GENERAL MOTORS CORP.

The 4T60 transaxle uses 2 solenoids to control shifting: Shift solenoid "A" and shift solenoid "B". ECM monitors TPS and vehicle speed versus engine speed to determine correct shift points.

SHIFT SOLENOID OPERATING SEQUENCE

Gear	Solenoid A	Solenoid B

1st Gear	On	On
2nd Gear	Off	On
3rd Gear	Off	Off
4th Gear	On	Off

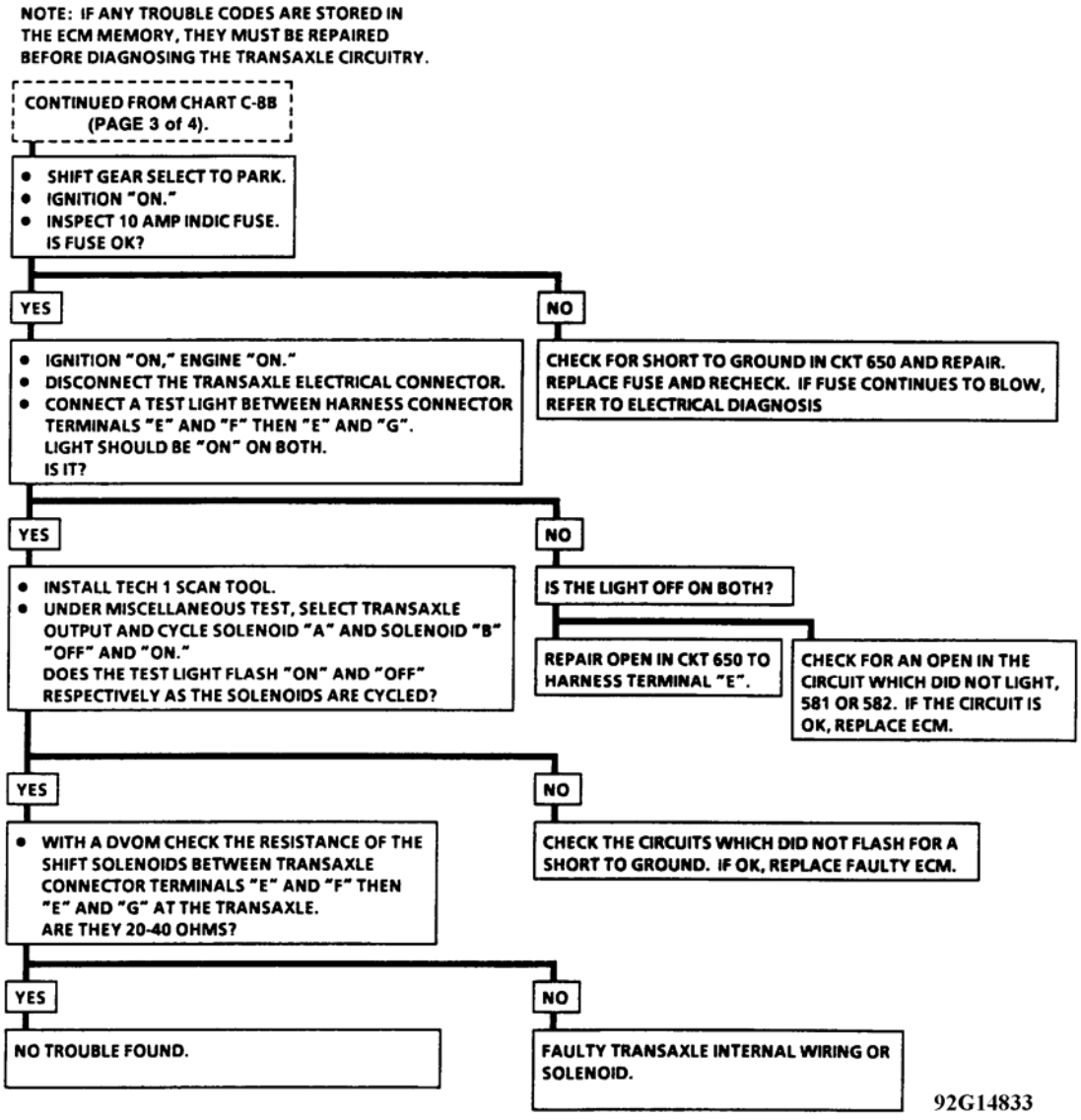


Fig. 197: Chart C-8B, 4T60 Transaxle Troubleshooting 4 Of 4 (3.4L PFI W Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-8C, 4T60 TRANSAXLE 1ST GEAR SWITCH ELECTRICAL DIAGNOSIS - 3.4L PFI W BODY

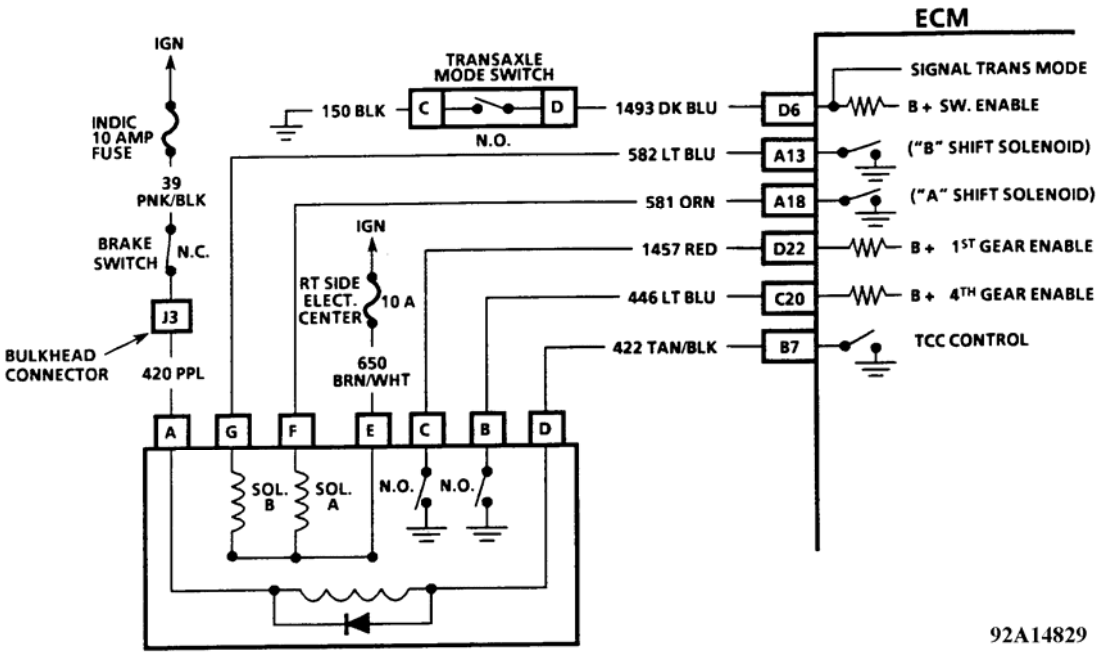


Fig. 198: Chart C-8C, 4T60 1st Gear Switch Circuit (3.4L PFI W Body)
Courtesy of GENERAL MOTORS CORP.

The 4T60 transaxle uses 2 solenoids to control shifting: Shift solenoid "A" and shift solenoid "B". ECM monitors TPS and vehicle speed verses engine speed to determine correct shift points.

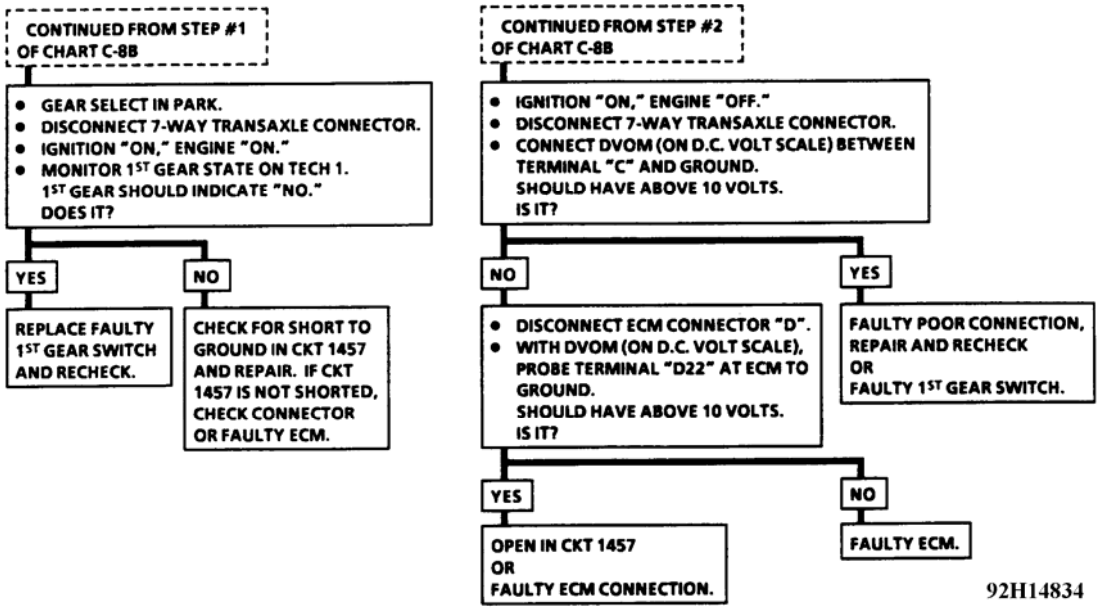


Fig. 199: Chart C-8C, 4T60 1st Gear Switch Troubleshooting 1 of 2 (3.4L PFI W Body)
Courtesy of GENERAL MOTORS CORP.

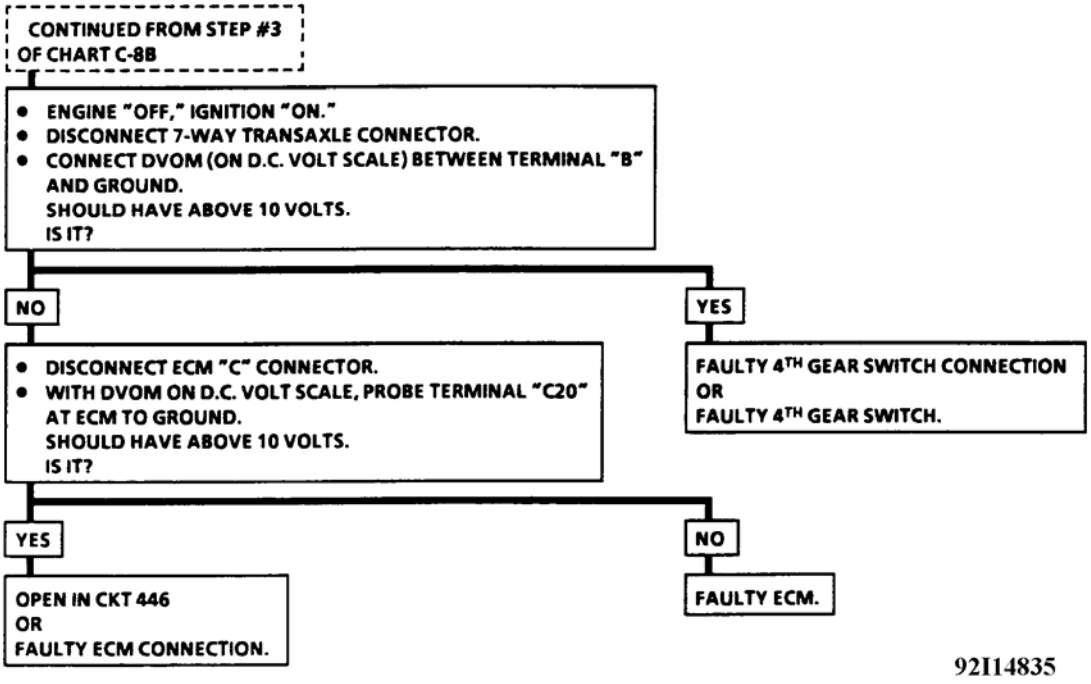


Fig. 200: Chart C-8C, 4T60 1st Gear Switch Troubleshooting 2 of 2 (3.4L PFI W Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 3.8L PFI C BODY

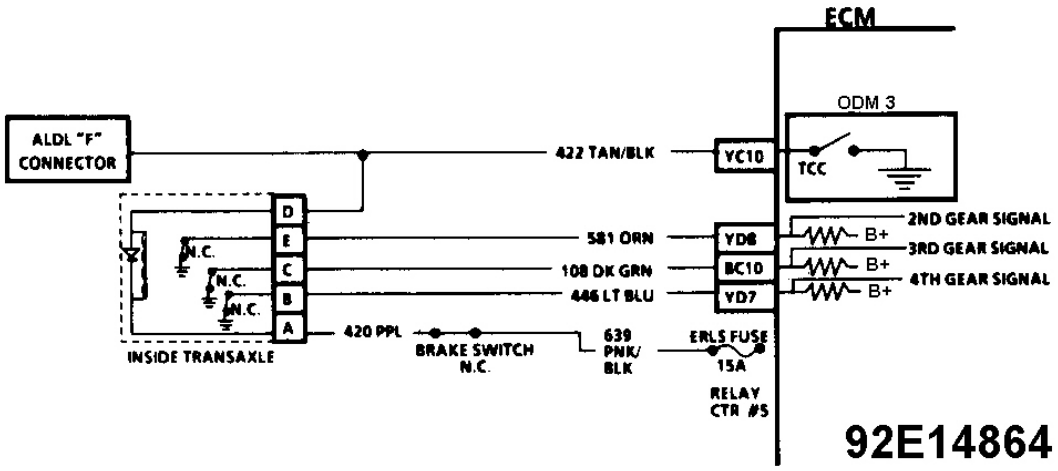


Fig. 201: Chart C-8A, TCC Circuit Diagram (3.8L PFI C Body)
Courtesy of GENERAL MOTORS CORP.

The TCC will engage when the engine is warmed up, vehicle speed is greater than 28 MPH, throttle position sensor output is not changing (indicating a steady road speed) and the brake switch is closed.

NOTE: Test numbers refer to test numbers on diagnostic charts.

1. This test checks the continuity of the TCC circuit from the fuse to the ALDL connector.
2. When the brake pedal is released and the diagnostic terminal is grounded, the light should come back on and then go off. This tests circuit No. 422 and the TCC driver in the ECM.
3. TCC electrical circuits have checked out properly. Fault may be an internal hydraulic problem.

Diagnostic Aids

The "Scan" tester only indicates when the ECM has turned on the TCC driver. This does not confirm that the TCC has engaged. To determine if TCC is functioning properly, monitor engine RPM. Engine RPM should decrease when the "Scan" tester indicates the TCC driver has turned on.

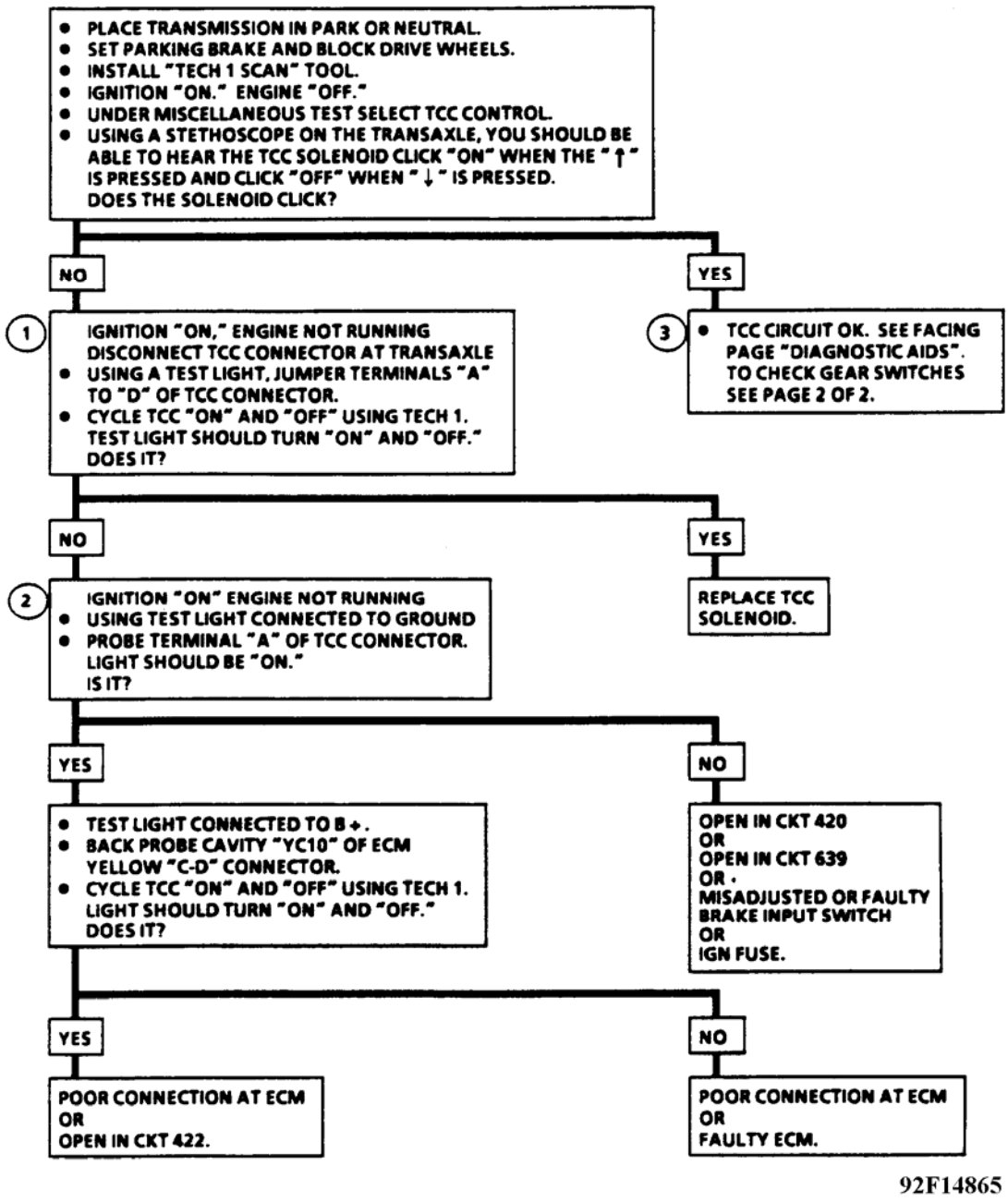


Fig. 202: Chart C-8A, TCC Troubleshooting Chart 1 Of 2 (3.8L PFI C Body)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to test numbers on diagnostic charts.

1. Some "Scan" testers display the state of these switches in different ways. Be familiar with the type of tester being used. All switches should be in the closed state during this test, the tester should read the same for 2nd, 3rd and 4th gear switches.

2. Determines whether the switch or signal circuit is open. The circuit can be checked for an open by measuring the voltage (with a voltmeter) at the TCC connector. Voltage should be about 12 volts.
3. Because the switch should be grounded in this test, disconnecting the TCC connector should cause the "Scan" test switch state to change.
4. The switch state should change when the vehicle shifts into 2nd, 3rd and 4th gear.

Diagnostic Aids

If vehicle is road tested because of a TCC related problem, be sure the switch states do not change while in 4th gear, because the TCC will disengage. If switches change state, carefully check wire routing and connections.

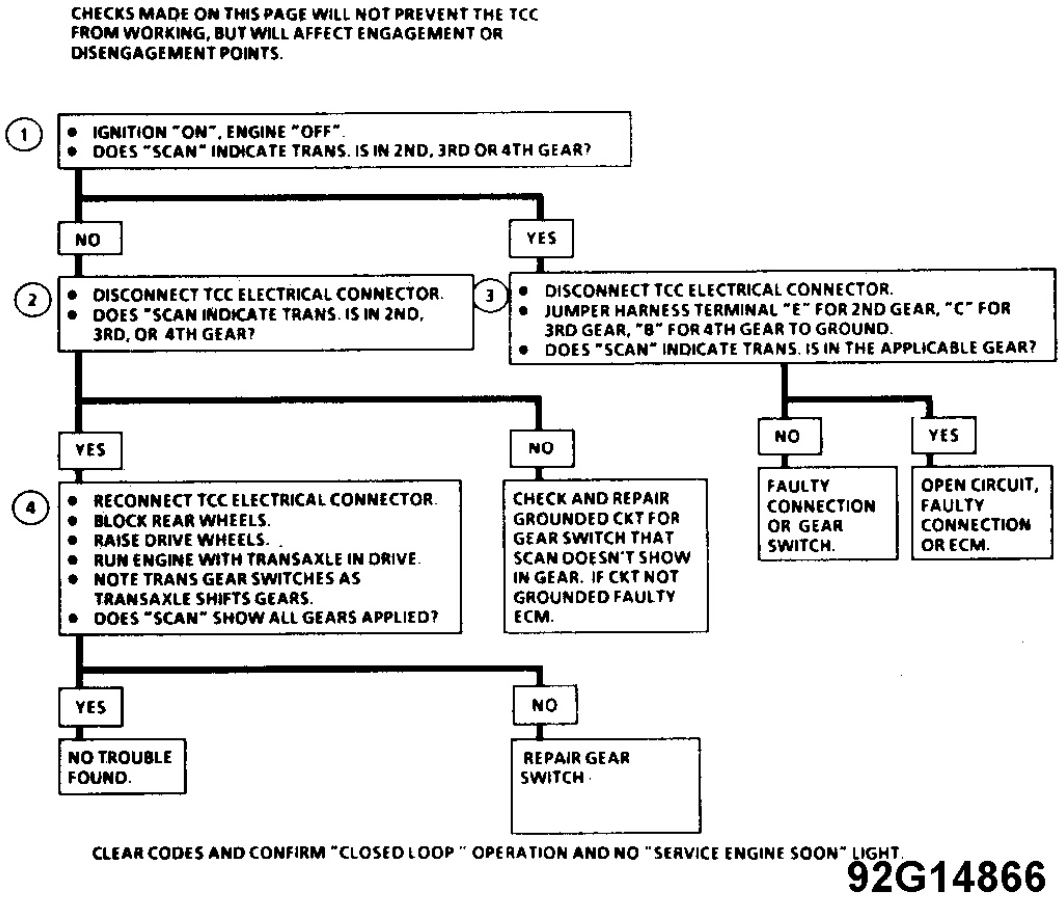


Fig. 203: Chart C-8A, TCC Troubleshooting Chart 2 Of 2 (3.8L PFI C Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 1991 E BODY (EXCEPT ELDORADO) 3.8L PFI (VIN L)

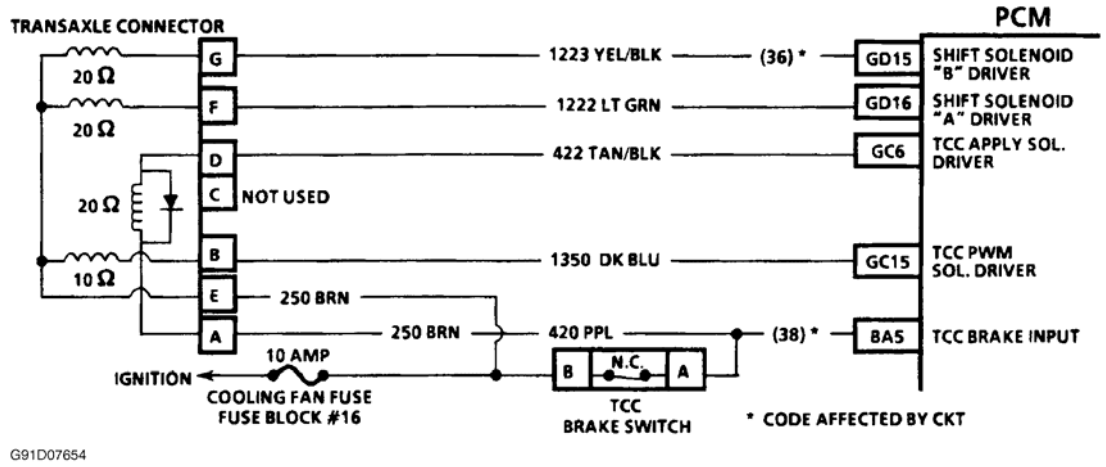


Fig. 204: Chart C-8A, TCC Circuit Diagram (1991 E Body (Except Eldorado) 3.8L PFI VIN L)
Courtesy of GENERAL MOTORS CORP.

When solenoid coil is activated, TCC is applied which results in a straight through mechanical coupling from engine to wheels. When solenoid coil is deactivated, TCC is released which allows torque converter to operate in conventional manner. PWN solenoid varies hydraulic pressure to make locking and unlocking of TCC smoother. TCC will engage under the following conditions:

- Engine is warmed up.
- Vehicle speed above a calibrated value of about 28 MPH.
- Throttle position not changing, indicating a steady speed.
- Brake switch is closed.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks fuse, brake switch and B+ circuit to TCC solenoid.
2. This test checks availability of voltage on circuit No. 420.
3. This test checks PCM's capability to pulse PWM solenoid on and off.
4. Electrical circuits have checked out okay. See appropriate AUTO TRANS OVERHAUL article for hydraulic and mechanical diagnosis.

Diagnostic Aids

A scan tool only indicates when ECM has turned on the TCC driver and does not confirm TCC has engaged. To determine if TCC is functioning properly, test drive vehicle. Engine RPM should decrease when Scan tool indicates TCC driver has turned on.

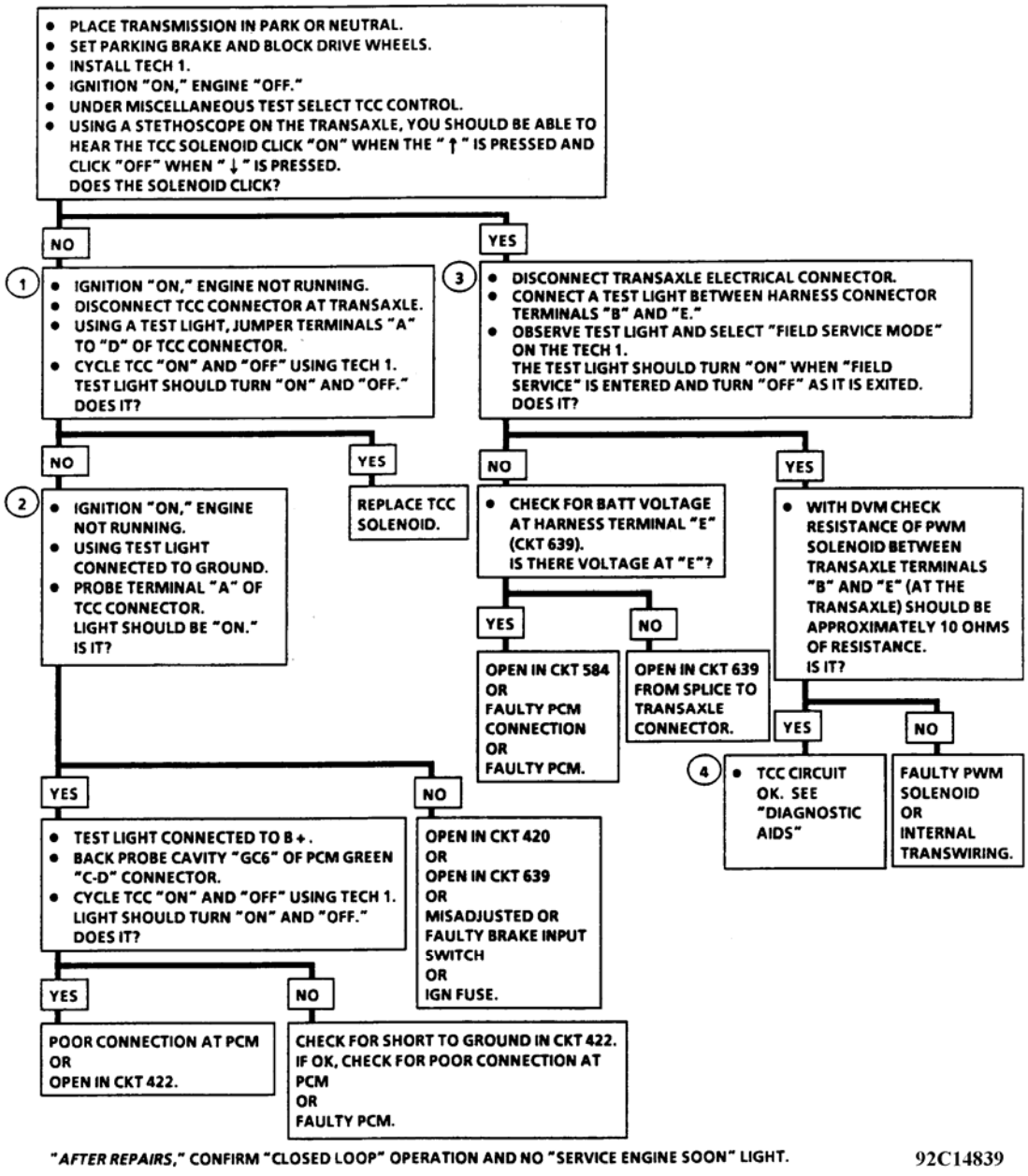


Fig. 205: Chart C-8A, TCC Troubleshooting Chart (1991 E Body (Except Eldorado) 3.8L PFI VIN L)
Courtesy of GENERAL MOTORS CORP.

CHART C-8B, 4T60 TRANSAXLE SHIFT SOLENOID FUNCTIONAL CHECK - 1991 E BODY (EXCEPT ELDORADO) 3.8L PFI (VIN L)

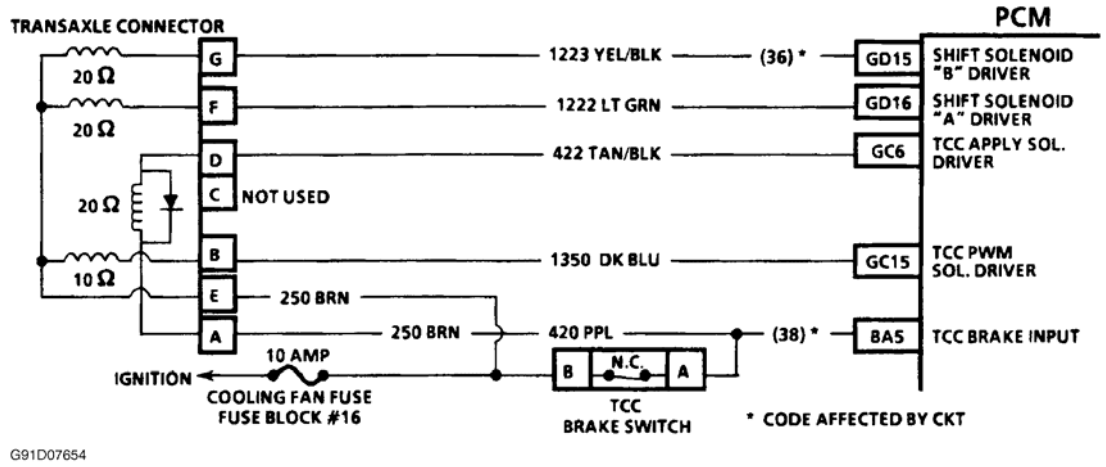


Fig. 206: Chart C-8A, 4T60 Shift Solenoid Circuit Diagram (1991 E Body (Except Eldorado) 3.8L PFI VIN L)
Courtesy of GENERAL MOTORS CORP.

The 4T60E transmission uses two solenoids to control shifting. Shift solenoid "A" and shift solenoid "B". See **4T60 SHIFT SOLENOID OPERATING SEQUENCE** table for solenoid operating sequence.

PCM monitors TPS and vehicle speed versus engine speed to determine the correct shift points. If PRNDL position indicates manual low position, PCM will keep both solenoids energized until 54 RPM at which point PCM will force a shift by de-energizing solenoid "A". Manual 2nd and manual 3rd are controlled hydraulically within transmission.

Diagnostic Aids

If PCM, control circuitry and shift solenoids are functioning properly and transmission still does not shift correctly, problem may be hydraulic or mechanical.

4T60 SHIFT SOLENOID OPERATING SEQUENCE

Gear	Solenoid A	Solenoid B
1st Gear	Closed	Closed
2nd Gear	Open (1)	Closed
3rd Gear	Open (1)	(1) Open
4th Gear	Closed	(1) Open
(1) Open = De-energized		

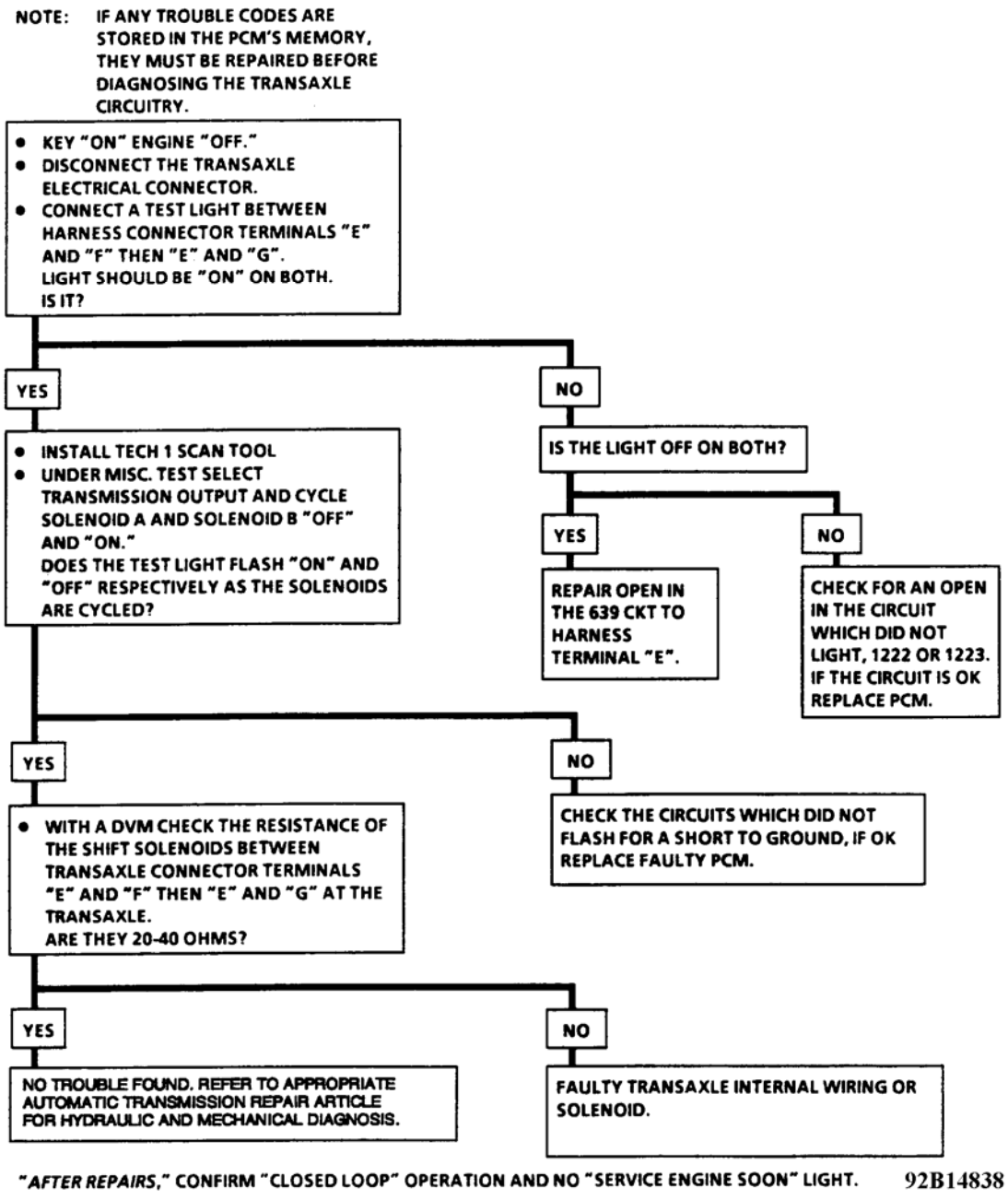


Fig. 207: Chart C-8A, 4T60 Shift Solenoid Troubleshooting (1991 E Body (Except Eldorado) 3.8L PFI VIN L)

Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH FUNCTIONAL CHECK - 1992 3.8L PFI (VIN L & 1)

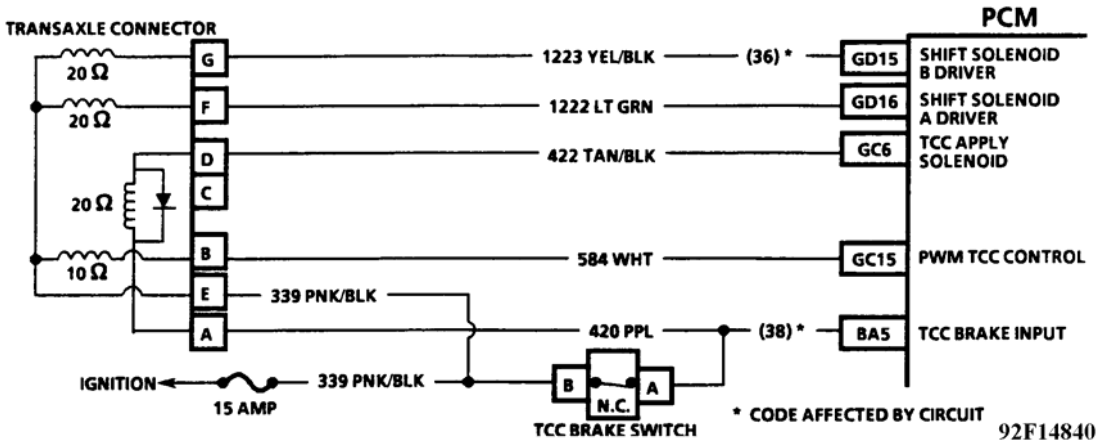


Fig. 208: Chart C-8A, TCC Functional Check Circuit (VIN L) 1992 3.8L PFI)
Courtesy of GENERAL MOTORS CORP.

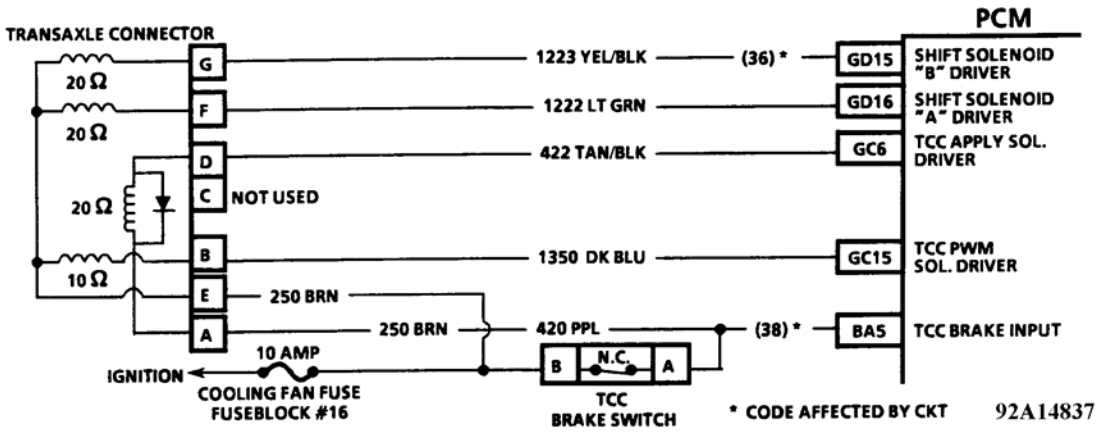


Fig. 209: Chart C-8A, TCC Functional Check Circuit (VIN 1) 1992 3.8L PFI)
Courtesy of GENERAL MOTORS CORP.

When solenoid coil is activated, TCC is applied which results in a straight through mechanical coupling from engine to wheels. When solenoid coil is deactivated, TCC is released which allows torque converter to operate in conventional manner. PWN solenoid varies hydraulic pressure to make locking and unlocking of TCC smoother. TCC will engage under the following conditions:

- Engine is warmed up.
- Vehicle speed above a calibrated value of about 28 MPH.
- Throttle position not changing, indicating a steady speed.
- Brake switch is closed.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test ensures transmission test box J-38791 is working properly, ignition power is being supplied to transmission solenoids and circuits No. 422, 584 and 1350 are not grounded.
2. This test ensures PCM can control TCC apply solenoid circuit No. 422 properly.
3. This test ensures PCM can control TCC apply solenoid circuit No. 584 and 1350.
4. **DO NOT** measure resistance until ignition has been off for at least 10 seconds to ensure PCM has powered down completely.

Diagnostic Aids

A scan tool only indicates when ECM has turned on the TCC driver and does not confirm TCC has engaged. To determine if TCC is functioning properly, test drive vehicle. Engine RPM should decrease when Scan tool indicates TCC driver has turned on.

Transaxle Prefunctional Check

Before using Test Box J-38791 in functional checks, perform prefunctional check to ensure proper diagnosis and avoid replacement of good parts.

1. Check for stored codes. If codes are present, refer to code charts and repair as necessary before preforming functional check.
2. Connect Test Box J-38791 to vehicle. with ignition on, observe test box indicator lights. Battery, Ignition, Brake, Shift "A", and Shift "B" indicator lights should be on. Converter Clutch Apply and MOD indicator lights should be off. Disregard Lo Discrete 2-3 and 3-4 indicator lights.
3. If indicator lights do not function as described in previous step, check all connections. If all connections are okay and light indicators still do not function properly, check the following symptoms.

No Indicator Lights On Or Ignition Indicator Light Only On

Check connection at lighter receptacle. If okay, fuse for lighter or lighter receptacle is faulty.

Battery Indicator Light On, All Other Indicator Lights Off

Check 10 amp cooling fan fuse. If fuse blown, repair short to ground in circuit No. 250. If fuse is okay, check for open in circuits No. 250 or 300.

Brake Indicator Light Not On

See Code 38 in code charts.

Shift "A" And/Or Shift "B" Indicator lights Not On

Use Chart C-8B, TRANSAXLE SHIFT SOLENOID FUNCTIONAL CHECK.

Converter Clutch Apply Indicator Light On All The Time

Disconnect PCM Green connector and check circuit No. 422 for short to ground. If okay, PCM is faulty.

Converter Clutch MOD Indicator Light On All the Time

Disconnect PCM Green connector and check circuit No. 1350 for short to ground. If okay, PCM is faulty.

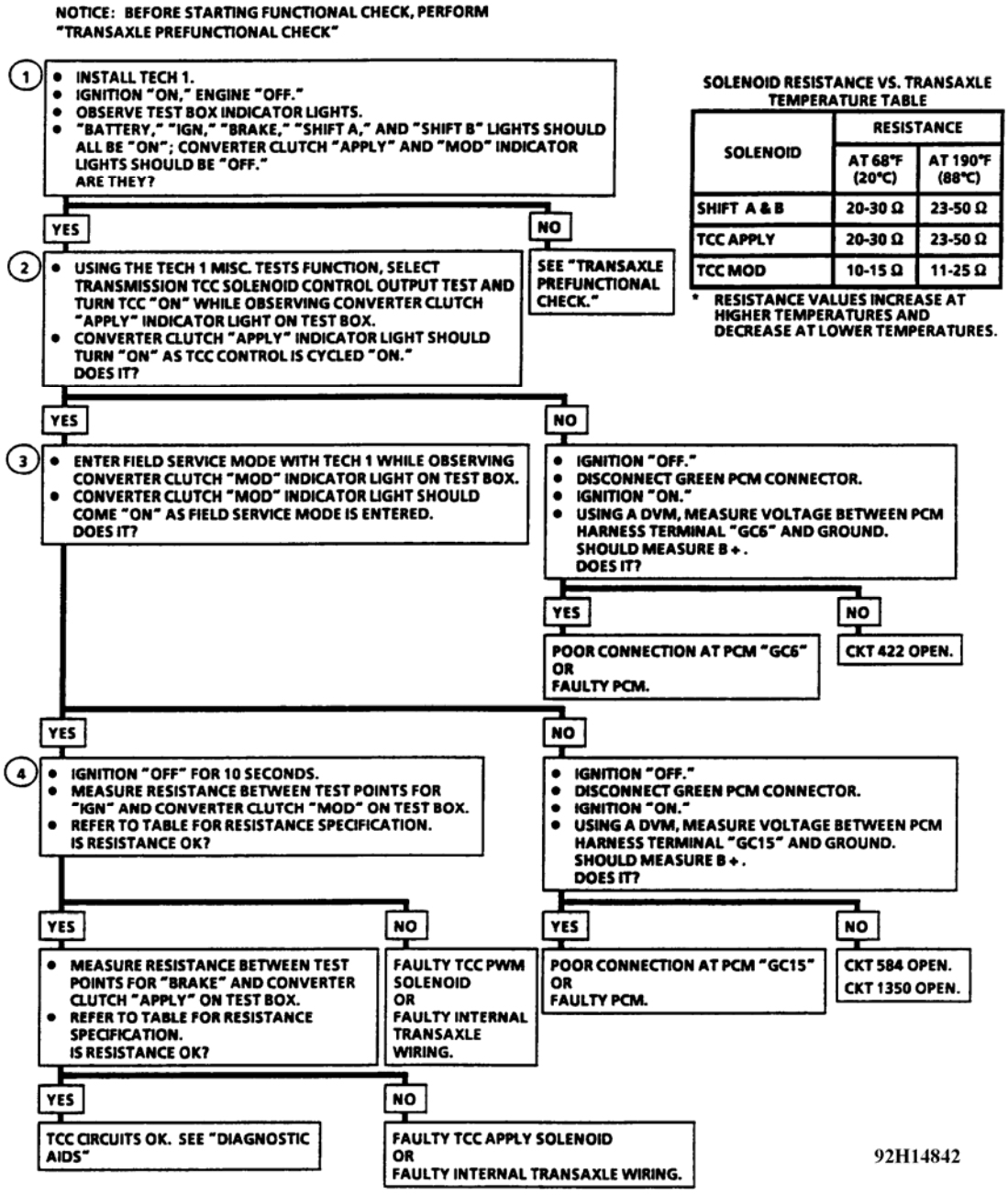


Fig. 210: Chart C-8A, TCC Functional Check Troubleshooting (VIN L & 1) 1992 3.8L PFI)
Courtesy of GENERAL MOTORS CORP.

CHART C-8B, 4T60 TRANSAXLE SHIFT SOLENOID FUNCTIONAL CHECK - 3.8L PFI (VIN L & 1) 1992

The 4T60 transmission uses two solenoids to control shifting. Shift solenoid "A" and shift solenoid "B". See **4T60 SHIFT SOLENOID OPERATING SEQUENCE** for solenoid operating sequence.

PCM monitors TPS and vehicle speed versus engine speed to determine the correct shift points. If PRNDL position indicates manual low position, PCM will keep both solenoids energized until 54 RPM at which point PCM will force a shift a de-energizing solenoid "A". Manual 2nd and manual 3rd are controlled hydraulically within transmission. See **Fig. 208** and **Fig. 228** .

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. With key on and engine off, PCM should be commanding 1st gear. Both shift solenoid control circuits will be grounded.
2. This test ensures PCM can control ground to shift solenoid "A" properly.
3. This test ensures PCM can control ground to shift solenoid "B" properly.
4. **DO NOT** measure resistance until ignition has been off for at least 10 seconds to ensure PCM has powered down completely.

Diagnostic Aids

If PCM, control circuitry and shift solenoids are functioning properly and transmission still does not shift correctly, problem may be hydraulic or mechanical.

Transaxle Prefunctional Check

Before using Test Box J-38791 in functional checks, perform prefunctional check to ensure proper diagnosis and avoid replacement of good parts.

1. Check for stored codes. If codes are present, refer to code charts and repair as necessary before performing functional check.
2. Connect Test Box J-38791 to vehicle. With ignition on, observe test box indicator lights. Battery, Ignition, Brake, Shift "A", and Shift "B" indicator lights should be on. Converter Clutch Apply and MOD indicator lights should be off. Disregard Lo Discrete 2-3 and 3-4 indicator lights.
3. If indicator lights do not function as described in previous step, check all connections. If all connections are okay and light indicators still do not function properly, check the following symptoms.

No Indicator Lights On Or Ignition Indicator Light Only On

Check connection at lighter receptacle. If okay, fuse for lighter or lighter receptacle is faulty.

Battery Indicator Light On, All Other Indicator Lights Off

Check 10 amp cooling fan fuse. If fuse blown, repair short to ground in circuit No. 250. If fuse is okay, check for open in circuits No. 250 or 300.

Brake Indicator Light Not On

See Code 38 in code charts.

Shift "A" And/Or Shift "B" Indicator Lights Not On

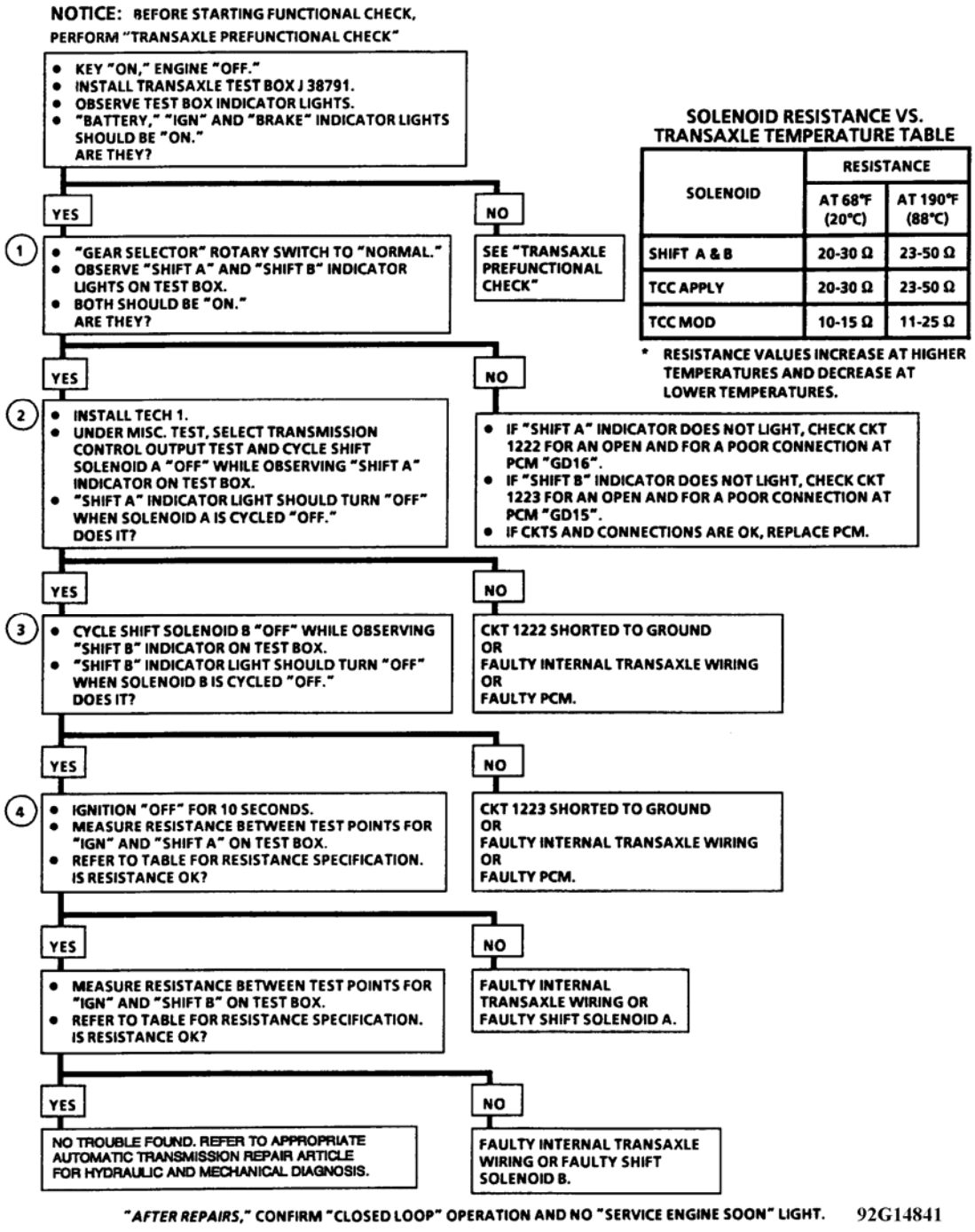
Use Chart C-8B, TRANSAXLE SHIFT SOLENOID FUNCTIONAL CHECK.

Converter Clutch Apply Indicator Light On All The Time

Disconnect PCM Green connector and check circuit No. 422 for short to ground. If okay, PCM is faulty.

Converter Clutch MOD Indicator Light On All the Time

Disconnect PCM Green connector and check circuit No. 1350 for short to ground. If okay, PCM is faulty.



SOLENOID RESISTANCE VS. TRANSAXLE TEMPERATURE TABLE

SOLENOID	RESISTANCE	
	AT 68°F (20°C)	AT 190°F (88°C)
SHIFT A & B	20-30 Ω	23-50 Ω
TCC APPLY	20-30 Ω	23-50 Ω
TCC MOD	10-15 Ω	11-25 Ω

* RESISTANCE VALUES INCREASE AT HIGHER TEMPERATURES AND DECREASE AT LOWER TEMPERATURES.

Fig. 211: Chart C-8A, Shift Solenoid Troubleshooting (VIN L & 1) 1992 3.8L PFI)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH FUNCTIONAL CHECK - 1992 3.8L PFI (VIN 1)

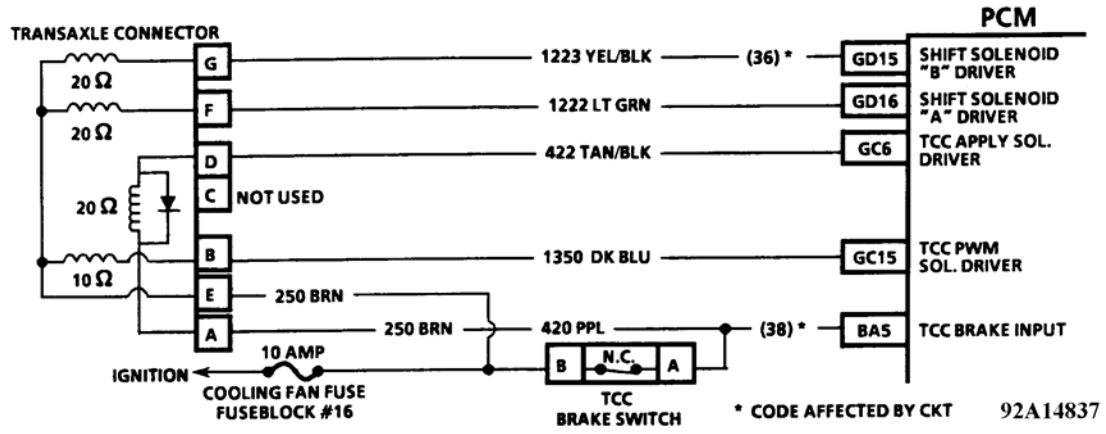


Fig. 212: Chart C-8A, TCC Circuit Diagram (1992 3.8L PFI VIN 1)
Courtesy of GENERAL MOTORS CORP.

When solenoid coil is activated, TCC is applied which results in a straight through mechanical coupling from engine to wheels. When solenoid coil is deactivated, TCC is released which allows torque converter to operate in conventional manner. PWN solenoid varies hydraulic pressure to make locking and unlocking of TCC smoother. TCC will engage under the following conditions:

- Engine is warmed up.
- Vehicle speed above a calibrated value of about 28 MPH.
- Throttle position not changing, indicating a steady speed.
- Brake switch is closed.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test determines whether fault is caused by a bad solenoid or control circuit.
2. This test checks availability of voltage on circuit No. 420.
3. This test checks PCM's capability to pulse PWM solenoid on and off.
4. Electrical circuits have checked out okay. Refer to appropriate AUTO TRANS DIAGNOSIS article for hydraulic and mechanical diagnosis.

Diagnostic Aids

A scan tool only indicates when ECM has turned on the TCC driver and does not confirm TCC has engaged. To determine if TCC is functioning properly, test drive vehicle. Engine RPM should decrease when Scan tool indicated TCC driver has turned on.

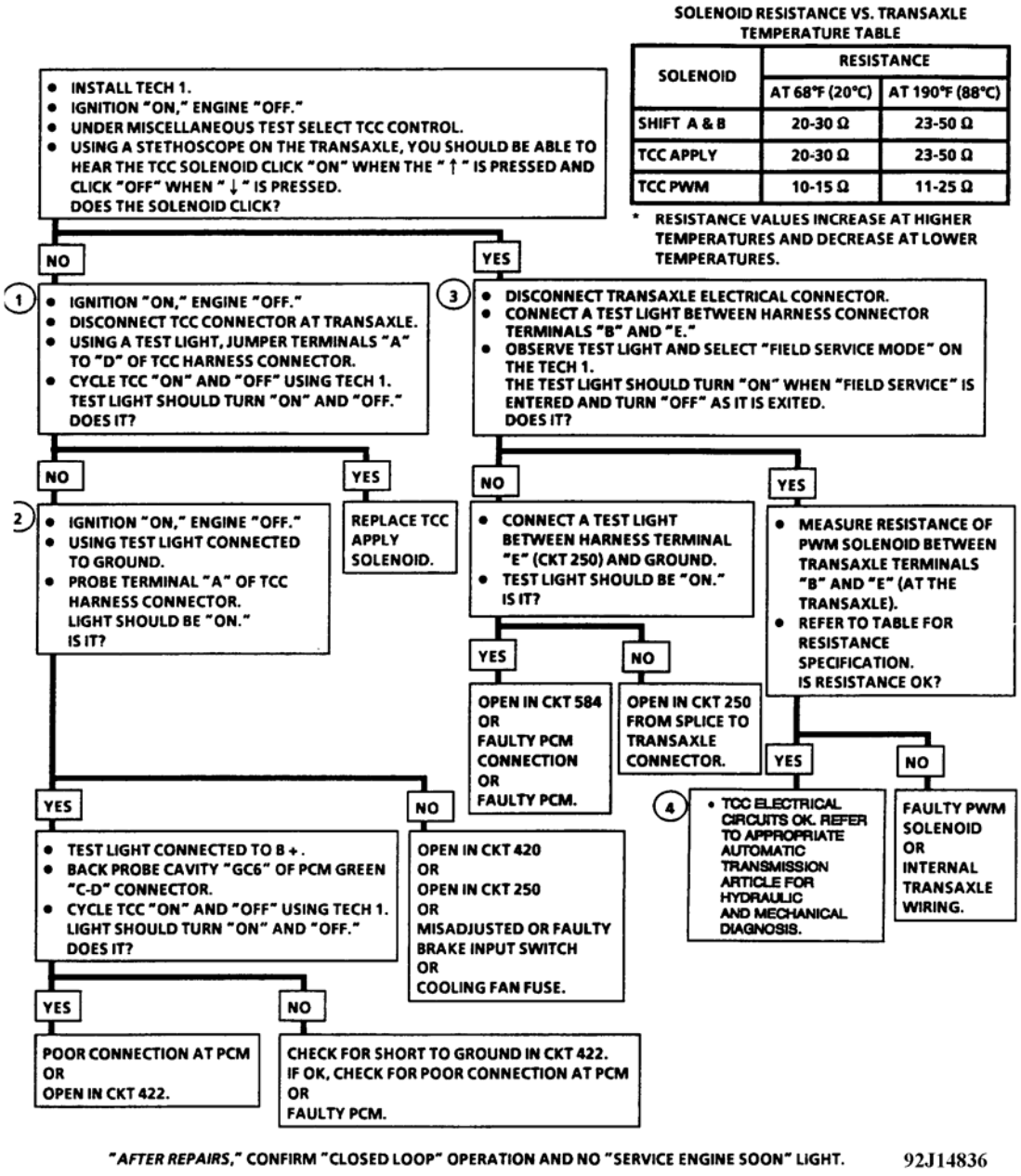


Fig. 213: Chart C-8A, TCC Troubleshooting Chart (1992 3.8L PFI VIN 1)
Courtesy of GENERAL MOTORS CORP.

CHART C-8B, 4T60 TRANSAXLE SHIFT SOLENOID FUNCTIONAL CHECK - 1992 3.8L PFI (VIN 1)

The 4T60E transmission uses two solenoids to control shifting. Shift solenoid "A" and shift solenoid "B". See **SHIFT SOLENOID OPERATING SEQUENCE** table for solenoid operating sequence.

PCM monitors TPS and vehicle speed versus engine speed to determine the correct shift points. If PRNDL

position indicates manual low position, PCM will keep both solenoids energized until 54 RPM at which point PCM will force a shift by de-energized solenoid "A". Manual 2nd and manual 3rd are controlled hydraulically within transmission. See **Fig. 209**.

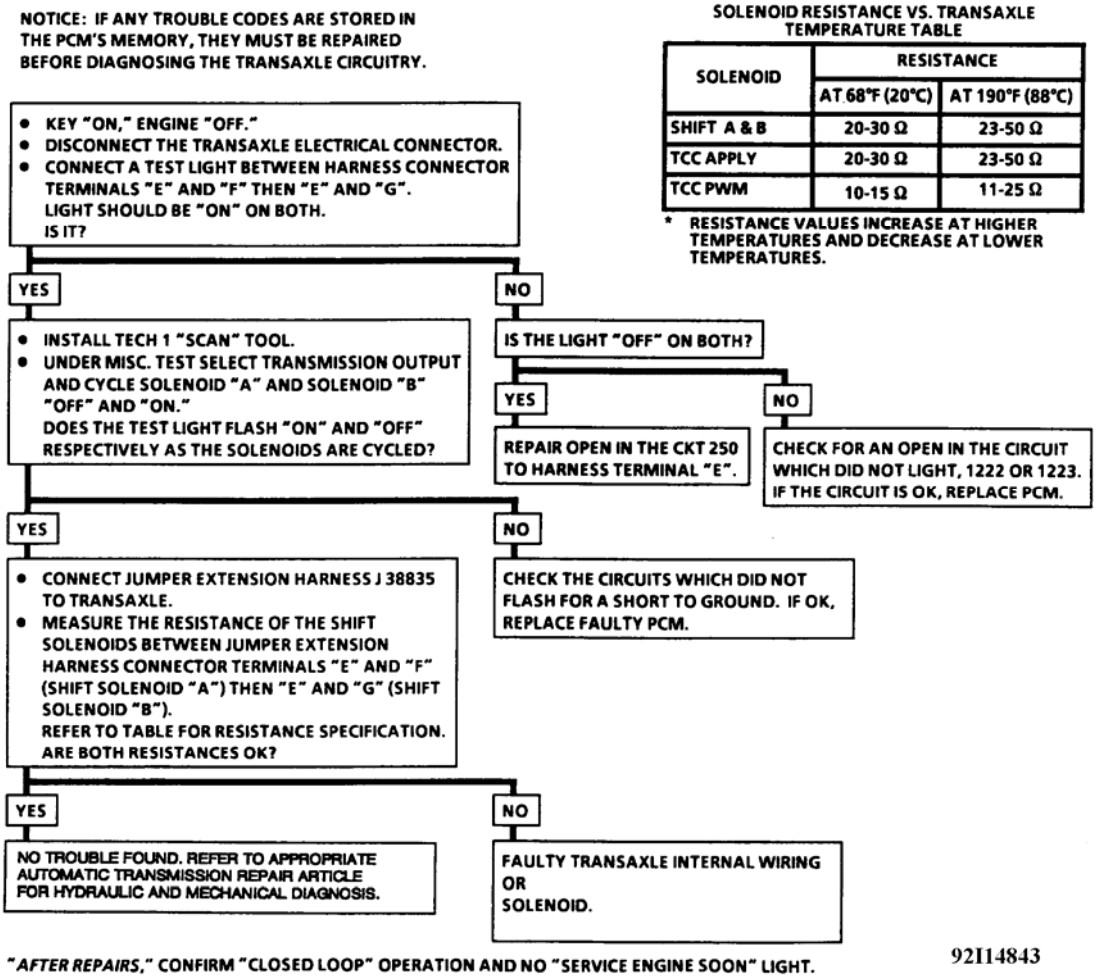


Fig. 214: Chart C-8B, 4T60 Shift Solenoid Troubleshooting Chart (1992 3.8L PFI VIN 1)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 3.8L PFI (VIN L) W BODY

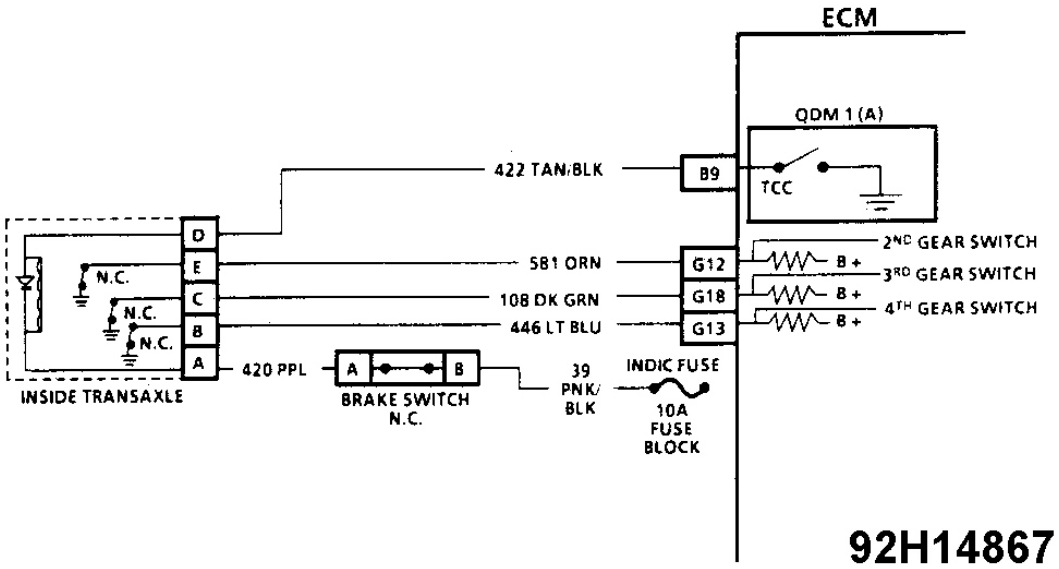


Fig. 215: Chart C-8A, TCC Circuit Diagram (3.8L PFI VIN L) W Body)
Courtesy of GENERAL MOTORS CORP.

Each gear switch opens when appropriate clutch is applied. All gear switches are open in 4th gear. TCC will engage when:

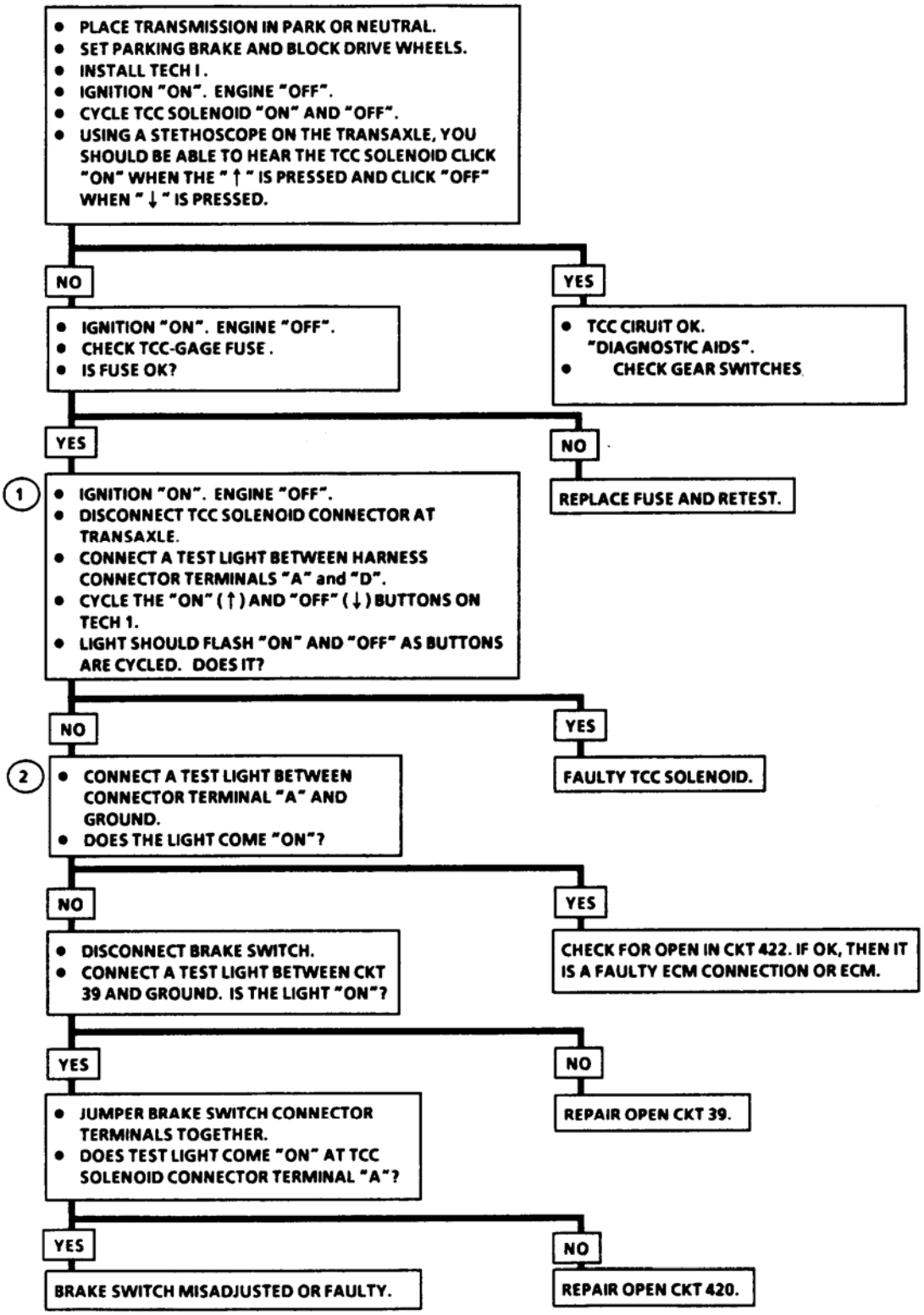
- Vehicle speed is above 40 MPH.
- Engine is at normal operating temperature.
- Throttle position not changing, indicating a steady speed.
- Brake switch closed.
- 3rd and 4th gear switch open.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks TCC solenoid for open.
2. This test checks fuse, brake switch and circuits No. 39 and 420 to TCC solenoid.

Diagnostic Aids

Scan tool only indicates when ECM has turned on TCC driver and does not confirm TCC engagement. To determine if TCC is functioning properly, road test vehicle. Engine RPM should decrease when scan tool indicates TCC driver has turned on.



"AFTER REPAIRS," CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

92I14827

Fig. 216: Chart C-8A, TCC Troubleshooting Chart 1 Of 2 (3.8L PFI VIN L) W Body)
Courtesy of GENERAL MOTORS CORP.

Each gear switch opens when appropriate clutch is applied. All gear switches are open in 4th gear.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Scan tool should display NO for 2nd, 3rd and 4th gear, indicating all switches are closed.
2. This test determines whether switch of signal circuit is open. circuit can be checked for an open by measuring voltage with a DVOM at TCC connector. Voltage should be about 12 volts.
3. Because switch should be grounded in this step, disconnecting TCC connector should cause displayed switch states to change.
4. Switch state should change when vehicle shifts into 3rd gear.

Diagnostic Aids

If vehicle is road tested because of a TCC related problem, ensure switch states do not change while in 4th gear. TCC will engage. If switches change state, carefully check wire routing and connections. If ECM, TCC solenoid and control circuitry are functioning correctly and TCC still does not apply properly, problem may be hydraulic or mechanical. See appropriate AUTO TRANS OVERHAUL article.

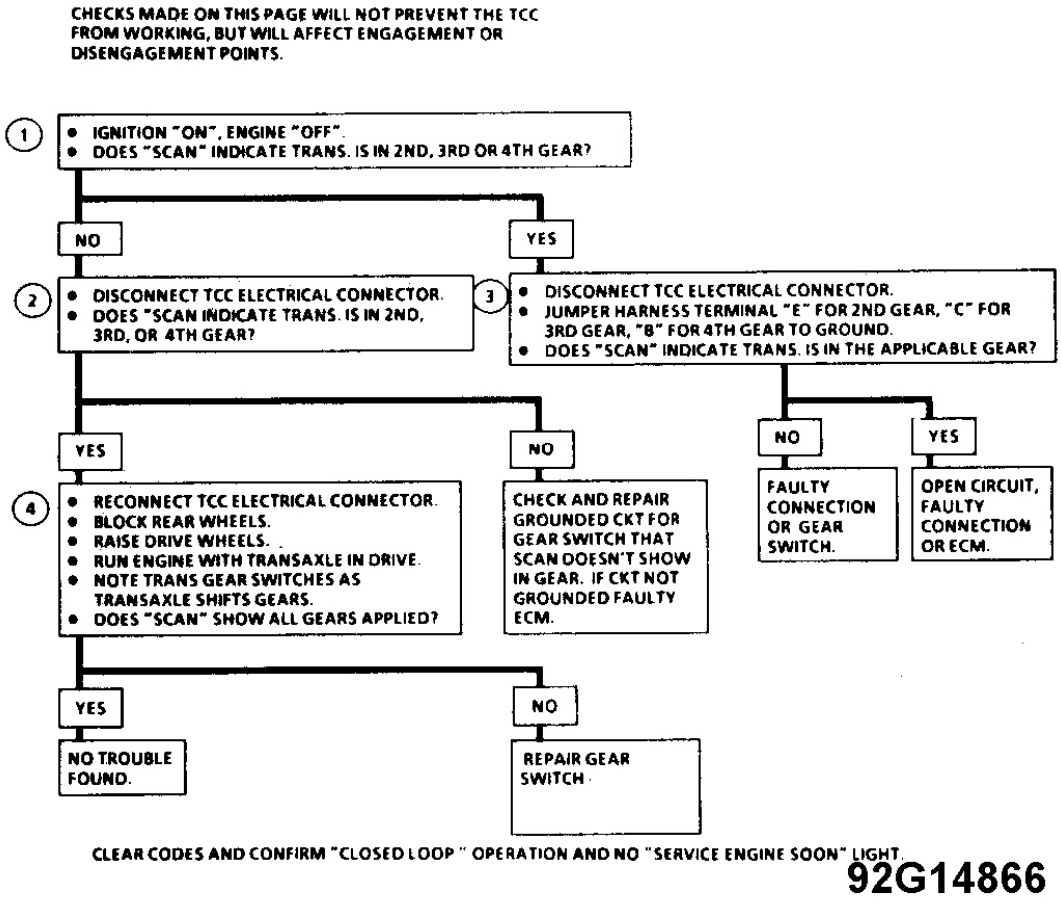


Fig. 217: Chart C-8A, TCC Troubleshooting Chart 2 Of 2 (3.8L PFI VIN L - W Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 4.3L, 5.0L & 5.7L TBI B & D BODIES

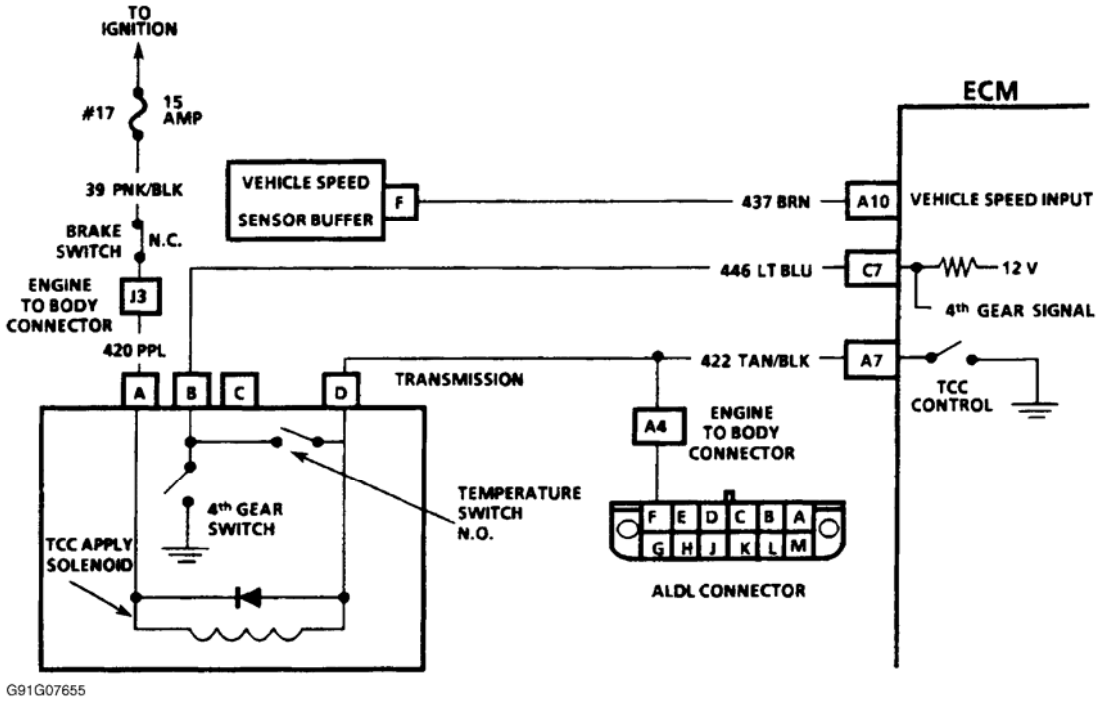


Fig. 218: Chart C-8A, TCC Circuit Diagram (4.3L, 5.0L & 5.7L TBI B & D Bodies)
Courtesy of GENERAL MOTORS CORP.

The purpose of automatic transmission torque converter clutch feature is to eliminate power loss of torque converter when vehicle is in cruise condition. This allows convenience of a automatic transmission and fuel economy of a manual transmission. Fused battery ignition is supplied to TCC solenoid through brake switch. The ECM will engage TCC by grounding circuit No. 422 to energize the solenoid. TCC will engage solenoid when vehicle speed is greater than 24 MPH, engine is at normal operating temperature, throttle position sensor output is not changing (indicating a steady road speed), and brake switch is closed.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Confirms 12-volt supply as well as continuity of TCC circuit.
2. Grounding the diagnostic test terminal with ignition on and engine off should energize the capability of the ECM to control the solenoid.
3. Solenoid coil resistance must measure more than 20 ohms. Less resistance will cause early failure to the ECM "driver". Using an ohmmeter, check the solenoid coil resistance of all ECM controlled solenoids and relays before installing a replacement ECM. Replace any solenoid or relay that measures less than 20 ohms.

Diagnostic Aids

An engine coolant thermostat that is stuck open, or opens at too low a temperature, may result in an inoperative TCC. If TCC engages before "Scan" indicates, solenoid or sump overtemperature switch may be faulty.

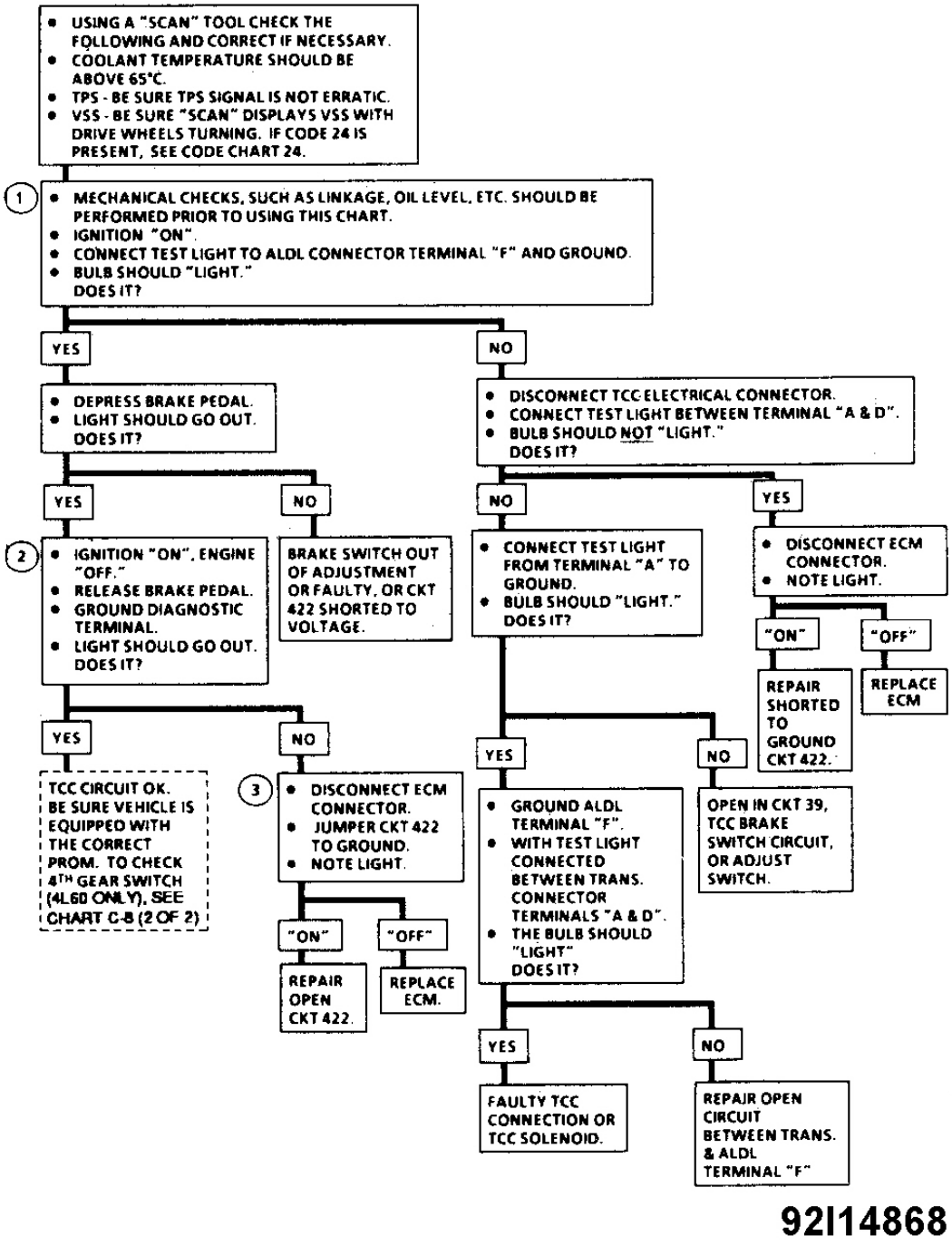


Fig. 219: Chart C-8A, TCC Troubleshooting Chart 1 Of 2 (4.3L, 5.0L & 5.7L TBI B & D Bodies)
Courtesy of GENERAL MOTORS CORP.

NOTE: **Test numbers refer to test numbers on diagnostic chart.**

1. Unless switch or circuit No. 446 is open, "Scan" tester should display "NO", indicating transmission is not in 4th gear. The 4th gear switch should only be open while in 4th gear.
2. This test determines if the ECM and wiring are okay. Grounding circuit NO. 446 should cause "Scan" tester to display "NO", indicating the transmission is not in 4th gear.
3. Checks operation of the 4th gear switch. When the transmission shifts into 4th gear the switch should open and "Scan" tester should display "YES".
4. Disconnecting the TCC connector simulates an open switch to determine if circuit No. 446 is shorted to ground or the problem is in the transmission.

Diagnostic Aids

A road test may be necessary to verify the customer complaint. If the "Scan" tester indicates TCC is turning "ON" and "OFF" erratically, check the state of the 4th gear switch to be sure it is not changing state under a steady throttle position. If the switch is changing state, check connections and wire routing carefully. Also if 4th gear switch is always open, the TCC may engage as soon as sufficient oil pressure is reached.

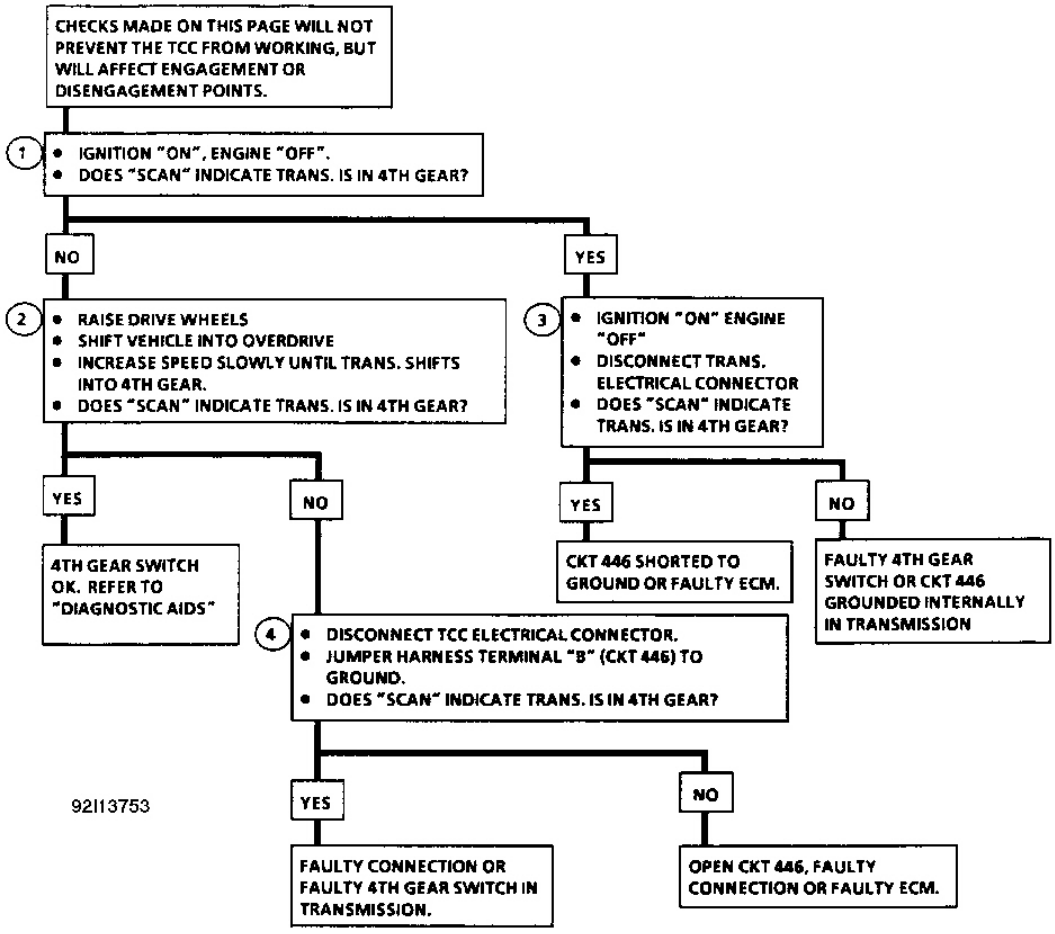


Fig. 220: Chart C-8A, TCC Troubleshooting Chart 2 Of 2 (4.3L, 5.0L & 5.7L TBI B & D Bodies)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 5.0L & 5.7L PFI F BODY

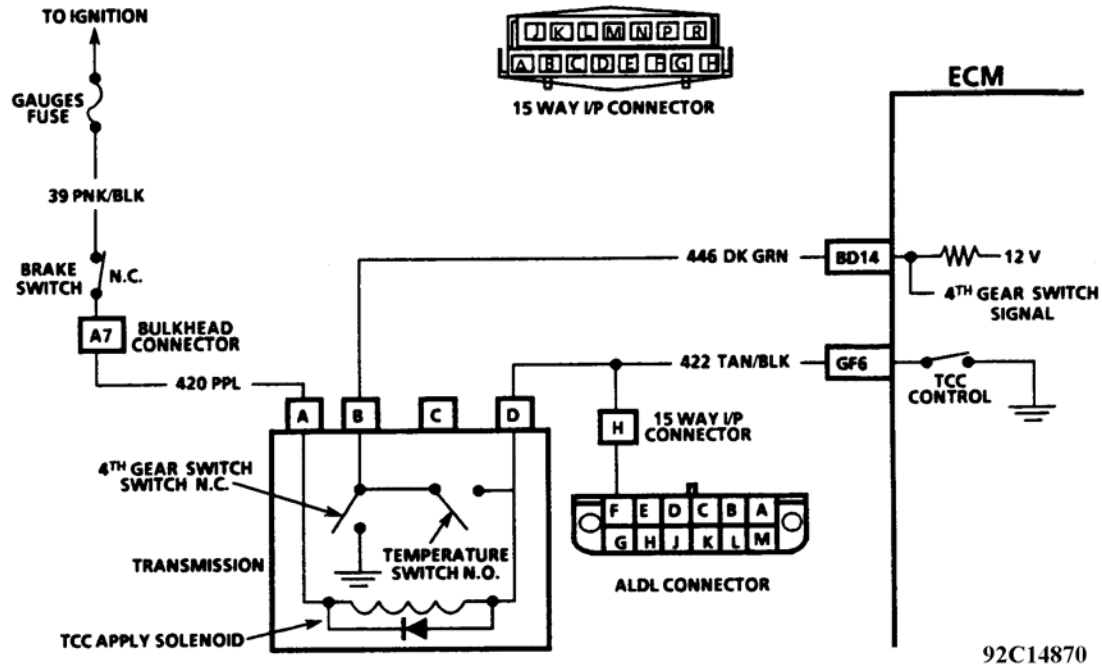


Fig. 221: Chart C-8A, TCC Circuit Diagram (5.0L & 5.7L PFI F Body)
Courtesy of GENERAL MOTORS CORP.

When solenoid coil is activated, TCC is applied which results in a straight through mechanical coupling from engine to wheels. When solenoid coil is deactivated, TCC is released which allows torque converter to operate in conventional manner. ECM turns on TCC when engine coolant temperature is greater than 149°F (65°C), TPS not changing and vehicle speed is greater than a specified value.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. When test light is connected from ALDL terminal "F to ground, a test light on indicates battery voltage is okay and TCC solenoid is disengaged.
2. When diagnostic terminal is grounded, ECM should energize TCC solenoid and test light should go out.

Diagnostic Aids

A scan tool only indicates when ECM has turned on the TCC driver and does not confirm TCC has engaged. To determine if TCC is functioning properly, test drive vehicle. Engine RPM should decrease when scan tool indicates TCC driver has turned on.

To determine if 4th gear switch is functioning properly, perform checks in CHART C-8 (2 of 2). Switches will not prevent TCC from functioning but will affect TCC lock and unlock points. If 4th gear switch is always closed, TCC may engage as soon as sufficient oil pressure is reached.

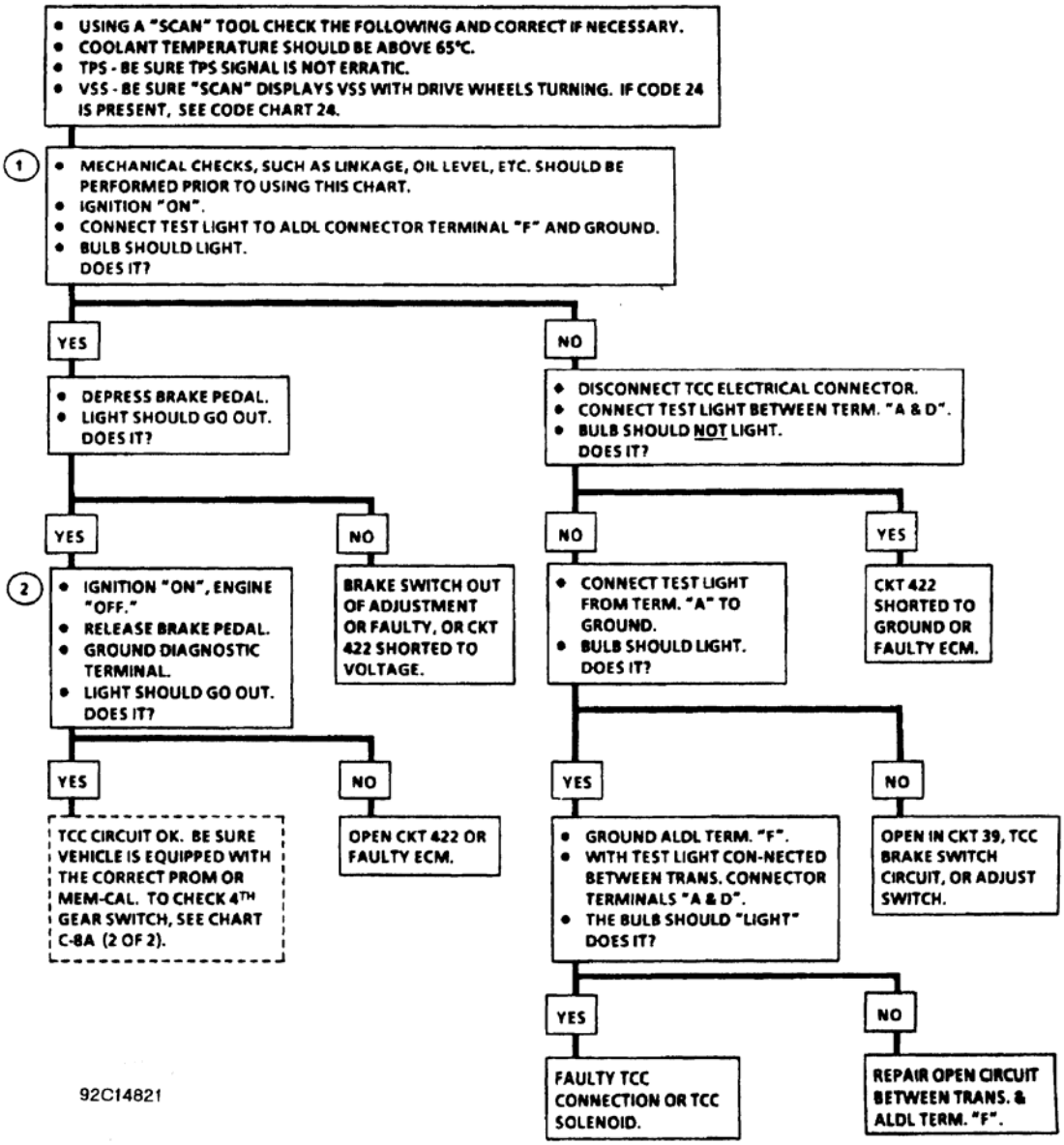


Fig. 222: Chart C-8A, TCC Troubleshooting Chart 1 of 2 (5.0L & 5.7L PFI F Body)
Courtesy of GENERAL MOTORS CORP.

A 4th gear switch mounted inside transmission closes when transmission shifts into 4th gear. This switch is used by ECM to modify TCC lock and unlock points when in a 4-3 downshift maneuver.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Unless switch is stuck closed or circuit No. 446 is shorted to ground scan tool should display NO, indicating transmission is not in 4th gear. The 4th gear switch should only be closed while in 4th gear.
2. This test checks operation of 4th gear switch. When transmission shifts into 4th gear, switch should close and scan tool should display YES.
3. Disconnecting TCC connector simulates an open switch to determine if circuit No. 446 is shorted to ground or problem is in transmission.
4. This step determines if ECM and wiring are okay. Grounding circuit No. 446 should cause scan tool to display TES indicating transmission is in 4th gear.

Diagnostic Aids

A road test may be necessary to verify customer complaint. If scan tool indicates TCC is turning on and off erratically, check state of 4th gear switch to be sure it is not changing states under a steady throttle position. If switch is changing states, check connections and wire routing carefully. Also, if 4th gear switch is always closed, TCC may engage as soon as sufficient oil pressure is reached.

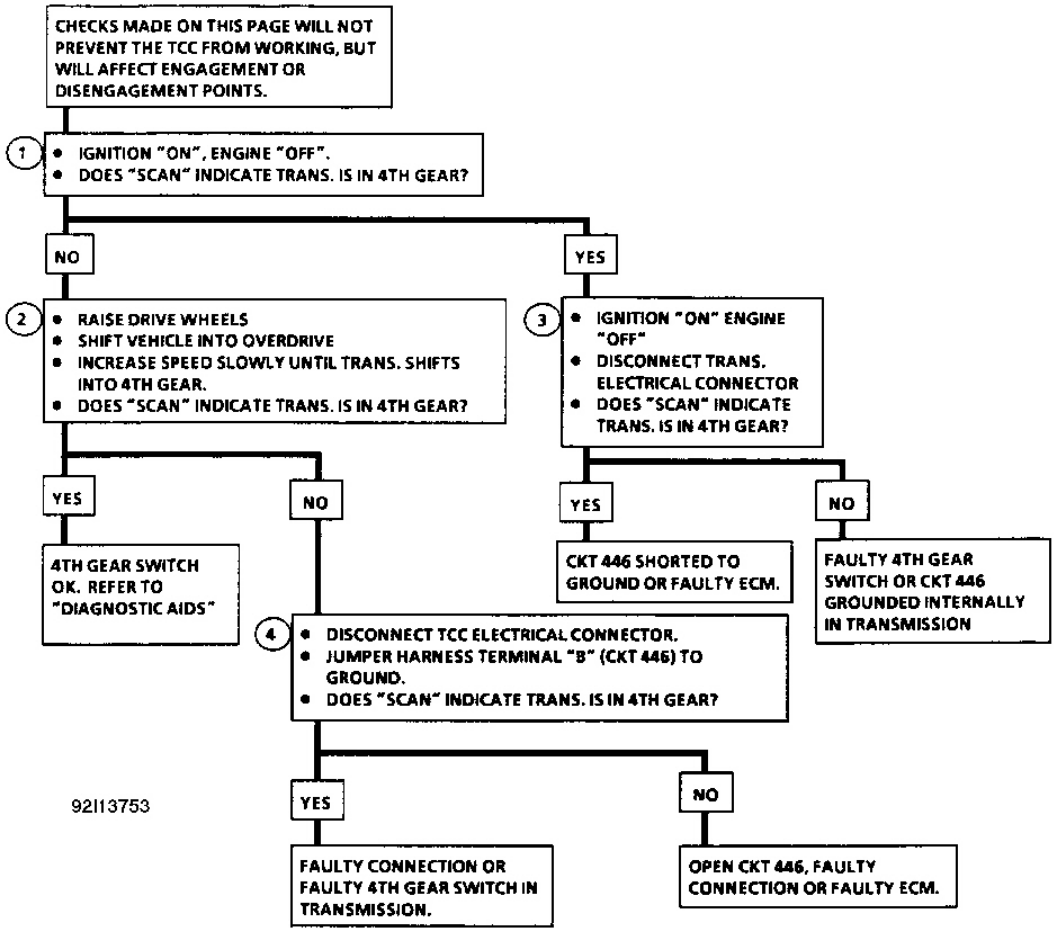


Fig. 223: Chart C-8A, TCC Troubleshooting Chart 2 Of 2 (5.0L & 5.7L PFI F Body)
Courtesy of GENERAL MOTORS CORP.

CHART C8-A, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 1991 5.7L PFI Y BODY

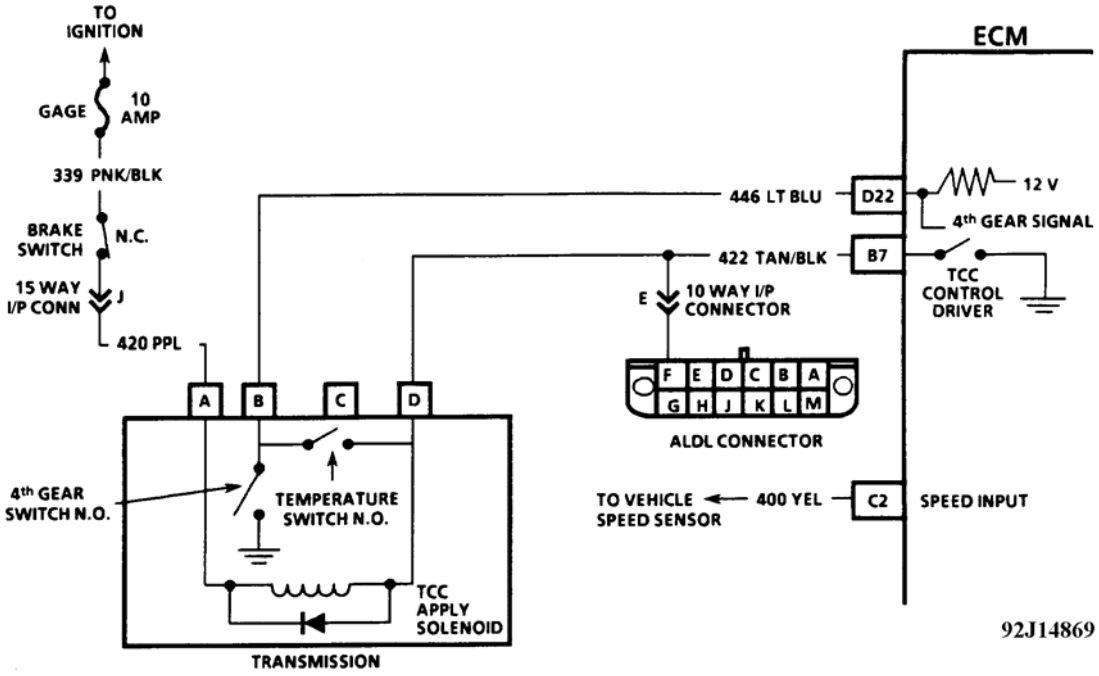


Fig. 224: Chart C8-A, TCC Circuit Diagram (1991 - 5.7L PFI Y Body)
Courtesy of GENERAL MOTORS CORP.

The purpose of Torque Converter Clutch (TCC) feature is to eliminate power loss of torque converter stage when vehicle is in cruise condition. This allows convenience of an automatic transmission and fuel economy of a manual transmission. Fused battery ignition is supplied to TCC solenoid through brake switch. The ECM will engage TCC by grounding circuit No. 422 to energize the solenoid. TCC will engage solenoid when vehicle speed is greater than 24 MPH, engine is at normal operating temperature, throttle position sensor output is not changing (indicating a steady road speed), and brake switch is closed.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Confirms 12-volt supply as well as continuity of TCC circuit.
2. Grounding the ALDL "test" terminal with ignition on and engine off should energize the capability of the ECM to control the solenoid.
3. Solenoid coil resistance must measure more than 20 ohms. Less resistance will cause early failure to the ECM "quad-driver". Using an ohmmeter, check the solenoid coil resistance of all ECM controlled solenoids and relays before installing a replacement ECM. Replace any solenoid or relay that measures less than 20 ohms.

Diagnostics Aids

Scan tool only indicates when ECM has turned on TCC driver but does not confirm TCC has engaged. To determine if TCC is functioning properly, engine RPM should decrease when scan tool indicates TCC driver has turned on. To determine if gear switches are functioning properly, perform checks in CHART C-8A (2 OF 2). Switches will not prevent TCC from functioning, but will effect TCC lock and unlock points. If 4th gear switch circuit is always open, TCC may engage as soon as sufficient oil pressure is reached.

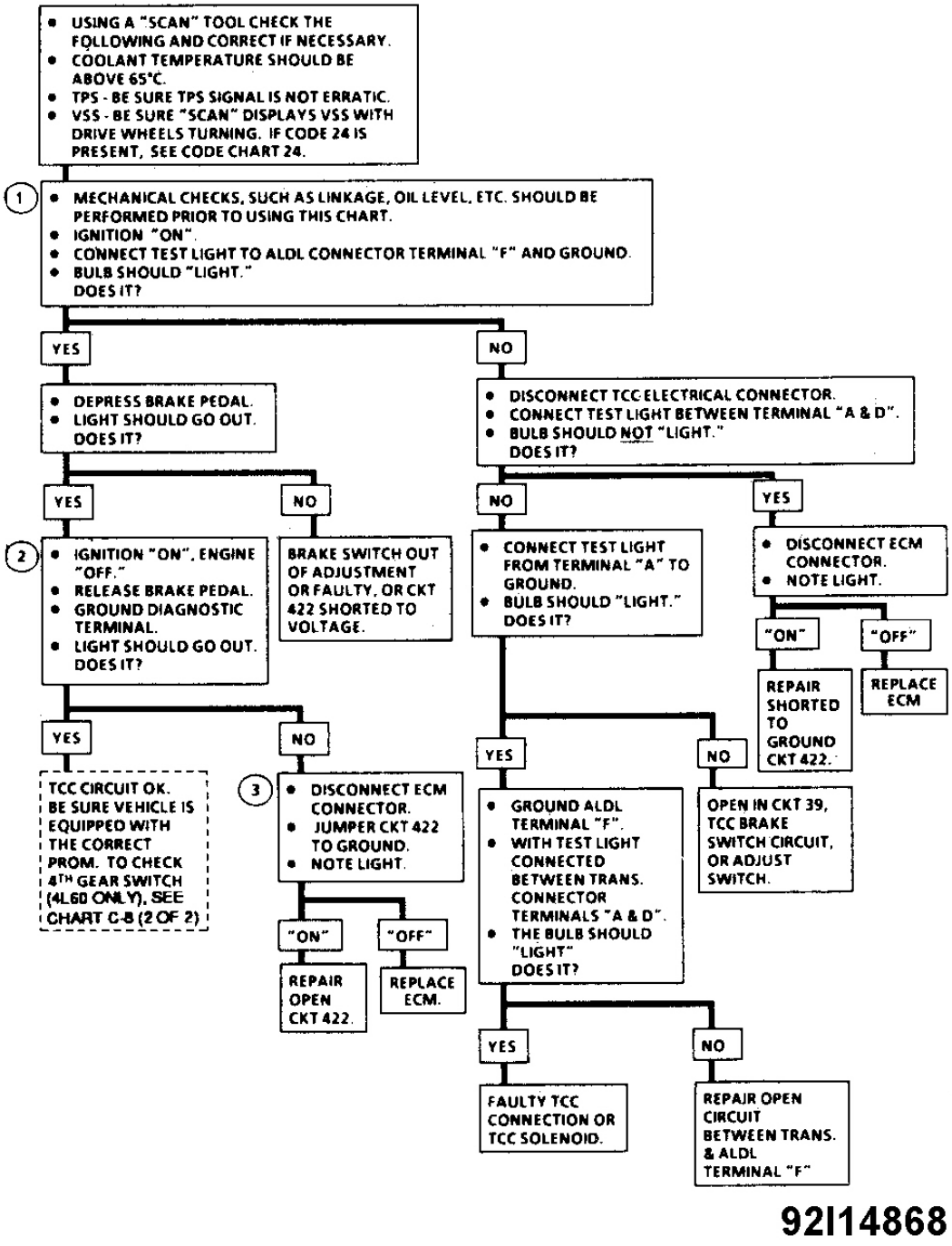


Fig. 225: Chart C8-A, TCC Troubleshooting Chart 1 of 2 (1991 - 5.7L PFI Y Body)
Courtesy of GENERAL MOTORS CORP.

A 4th gear switch, mounted in the transmission, opens when the transmission shifts into 4th gear. This switch is used by the ECM to modify TCC lock and unlock points when in a 4-3 downshift maneuver.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Unless switch or circuit No. 446 is open, "Scan" tester should display "NO" or "OFF", indicating transmission is not in 4th gear. The 4th gear switch should only be open while in 4th gear.
2. This test determines if the ECM and wiring are okay. Grounding circuit No. 446 should cause "Scan" tester to display "NO" or "OFF", indicating the transmission is not in 4th gear.
3. Checks operation of the 4th gear switch. When the transmission shifts into 4th gear the switch should open and "Scan" tester should display "YES" or "ON".
4. Disconnecting the TCC connector simulates an open switch to determine if circuit No. 446 is shorted to ground or the problem is in the transmission.

Diagnostic Aids

A road test may be necessary to verify the customer complaint. If the "Scan" tester indicates TCC is turning on and off erratically, check the state of the 4th gear switch to be sure it is not changing state under a steady throttle position. If the switch is changing state, check connections and wire routing carefully. Also, if 4th gear switch is always open, the TCC may engage as soon as sufficient oil pressure is reached.

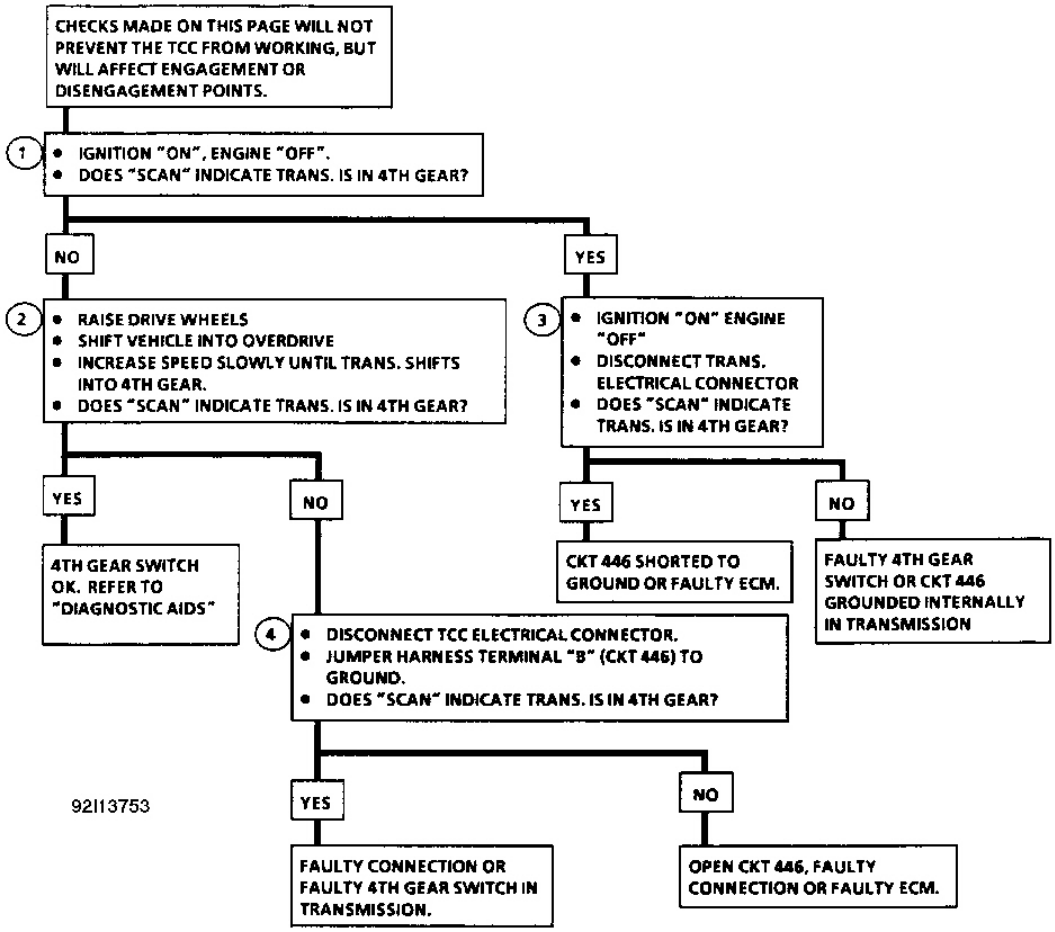


Fig. 226: Chart C8-A, TCC Troubleshooting Chart 2 of 2 (1991 - 5.7L PFI Y Body)
Courtesy of GENERAL MOTORS CORP.

CHART C-8A, TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - 1992 5.7L PFI Y BODY

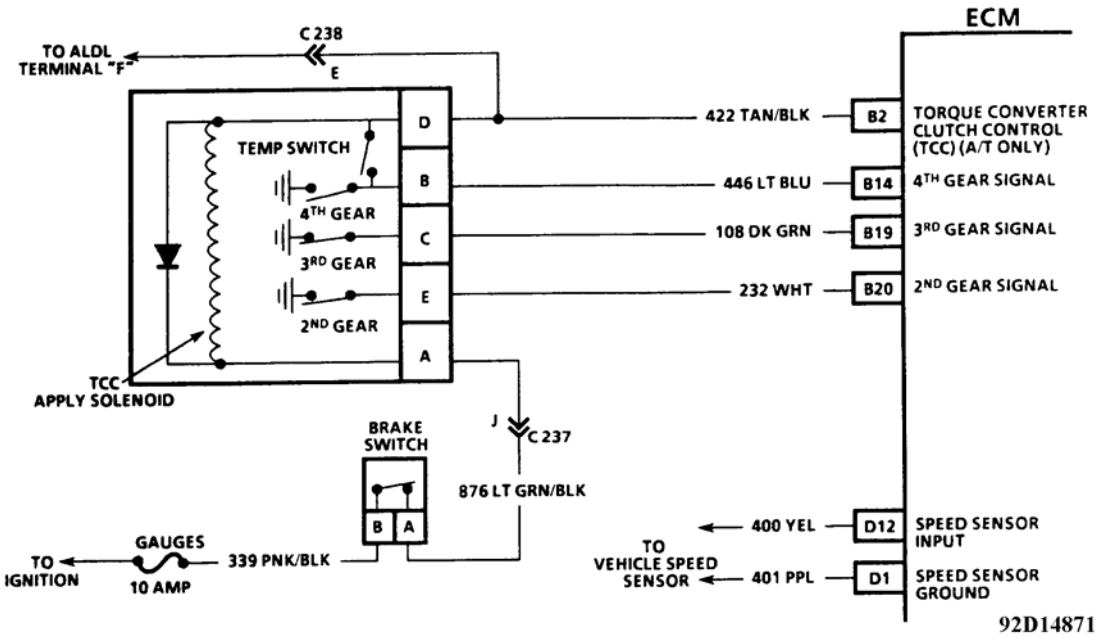


Fig. 227: Chart C-8A, TCC Circuit Diagram (1992 5.7L PFI Y Body)
Courtesy of GENERAL MOTORS CORP.

When solenoid coil is activated, TCC is applied which results in a straight through mechanical coupling from engine to wheels. When solenoid coil is deactivated, TCC is released which allows torque converter to operate in conventional manner. ECM turns on TCC when engine coolant temperature is greater than 149°F (65°C). TPS not changing and vehicle speed is greater than a specified value.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. This test confirms 12 volt supply as well as continuity of TCC circuit.
2. Grounding diagnostic test terminal with engine off should energize TCC solenoid.
3. TCC solenoid resistance must measure more than 20 ohms. Using an ohmmeter, check solenoid coil resistance of all ECM controlled solenoids and relays before installing a replacement ECM. Replace any solenoid or relay that measures less than 20 ohms.

Diagnostic Aids

A scan tool only indicates when ECM has turned on the TCC driver and does not confirm TCC has engaged. To determine if TCC is functioning properly, test drive vehicle. Engine RPM should decrease when scan tool indicates TCC driver has turned on.

To determine if gear switches are functioning properly, perform checks in all CHART C-8 charts. Switches will not prevent TCC from functioning but will affect TCC lock and unlock points. If 4th gear switch is always open, TCC may engage as soon as sufficient oil pressure is reached.

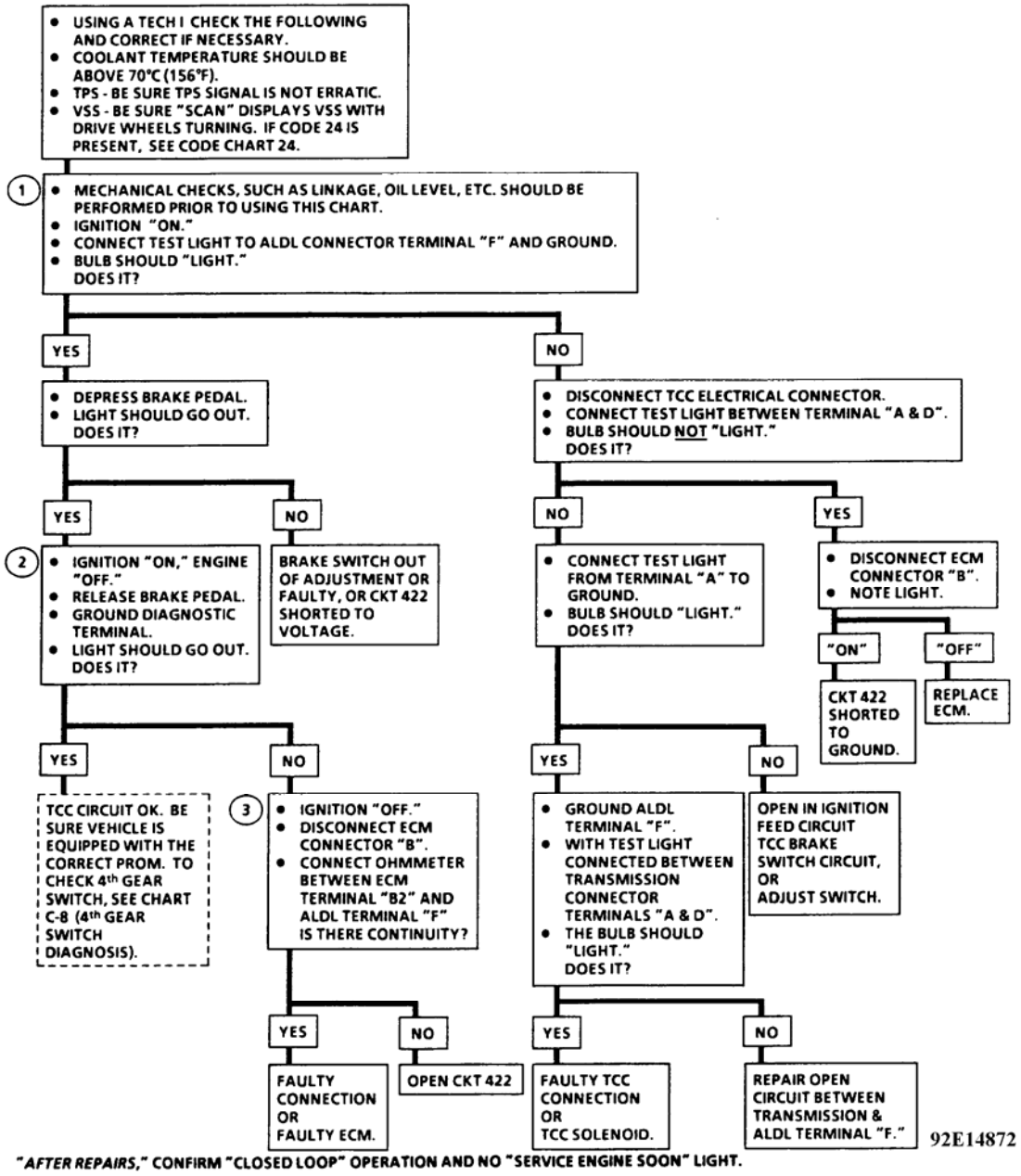


Fig. 228: Chart C-8A, TCC Troubleshooting Chart 1 of 4 (1992 5.7L PFI Y Body)
Courtesy of GENERAL MOTORS CORP.

A 2nd gear switch mounted inside transmission, is normally closed and opens when transmission shifts into 2nd gear. ECM uses gear switch signals to adjust ignition timing based on transmission shift points. Adjusting ignition timing after a transmission shift will allow for higher shift speeds.

NOTE: Test numbers refer to test numbers in diagnostic chart.

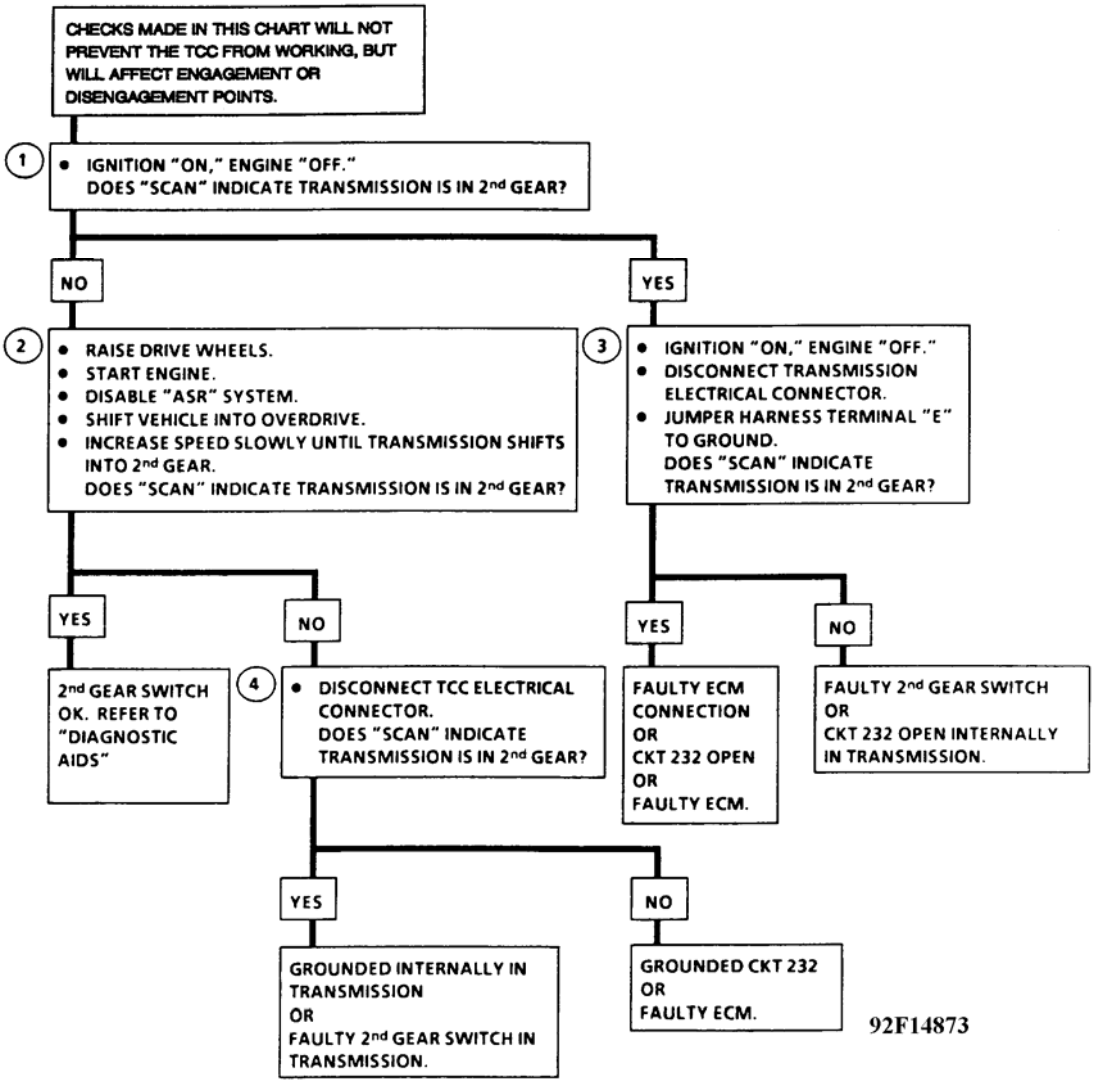
1. Unless switch is stuck open or circuit No. 232 is open, scan tool should display NO, indicating

transmission is not in 2nd gear. The 2nd gear switch should only be open while in 2nd gear.

2. The ASR system must be disabled when performing this step. Whenever ignition key is cycled to off position and then cycled back on. ASR system will default on . Check operation of 2nd gear switch. When transmission shifts into 2nd gear, switch should open and scan tool should display YES.
3. This step determines if ECM and wiring are okay. Grounding circuit No. 232 should cause scan tool to display YES, indicating transmission is in 2nd gear.
4. Disconnecting TCC connector simulates an open switch to determine if circuit No. 232 is shorted to ground or problem is in transmission.

Diagnostic Aids

A faulty 2nd and 3rd gear switch circuit can cause an ECM code 72. If 2nd gear switch is changing states, check connections and wire routing.



"AFTER REPAIRS," CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

Fig. 229: Chart C-8A, TCC Troubleshooting Chart 2 of 4 (1992 5.7L PFI Y Body)
Courtesy of GENERAL MOTORS CORP.

A 3rd gear switch mounted inside transmission, is normally closed and opens when transmission shifts into 3rd gear. ECM uses gear switch signals to adjust ignition timing based on transmission shift points. Adjusting ignition timing after a transmission shift will allow for higher shift speeds.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. Unless switch is stuck open or circuit No. 108 is open, scan tool should display NO, indicating transmission is not in 3rd gear. The 3rd gear switch should only be open while in 2nd gear.
2. The ASR system must be disabled when performing this step. Whenever ignition key is cycled to off position and then cycled back on, ASR system will default on. Check operation of 2nd gear switch. When transmission shifts into 3rd gear, switch should open and scan tool should display YES.
3. This step determines if ECM and wiring are okay. Grounding circuit No. 108 should cause scan tool to display YES, indicating transmission is in 3rd gear.
4. Disconnecting TCC connector simulates an open switch to determine if circuit No. 108 is shorted to ground or problem is in transmission.

Diagnostic Aids

A faulty 2nd and 3rd gear switch circuit can cause an ECM code 72. If 3rd gear switch is changing states, check connections and wire routing.

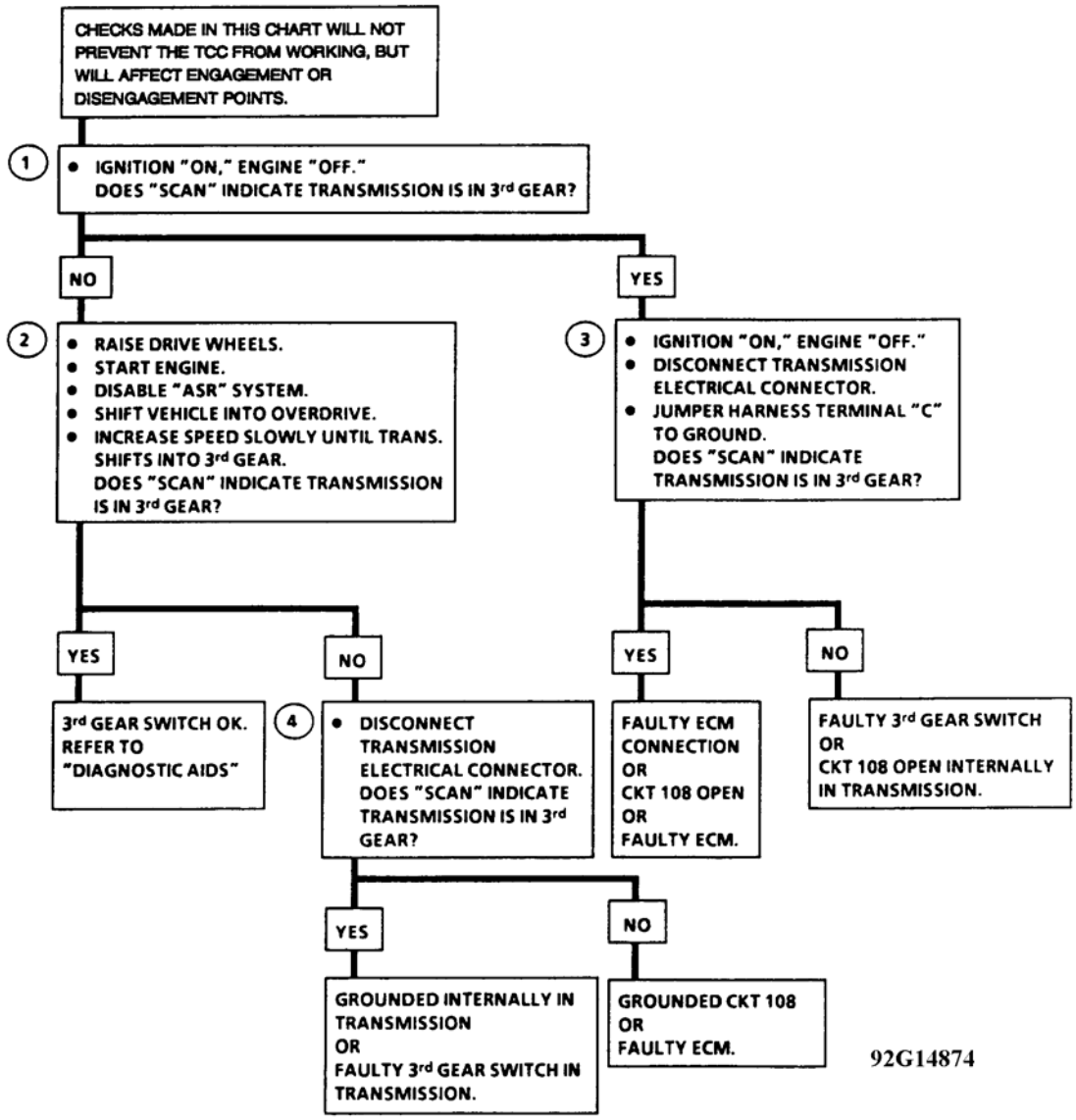


Fig. 230: Chart C-8A, TCC Troubleshooting Chart 3 of 4 (1992 5.7L PFI Y Body)
Courtesy of GENERAL MOTORS CORP.

A 4th gear switch mounted inside transmission, is normally closed and opens when transmission shifts into 4th gear. Switch is used by ECM to modify TCC lock and unlock points, when in a 4-3 downshift maneuver. Temperature switch is normally open. Transmission must be in 4th gear for temperature switch to apply TCC to cool transmission fluid. Temperature switch lock at 279°F (155°C) and unlocks at about 259°F (143°C).

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. Unless switch is stuck closed or circuit No. 446 is shorted to ground, scan tool should display NO, indicating transmission is not in 4th gear. The 4th gear switch should only be closed while in 4th gear.

2. The ASR system must be disabled when performing this step. Whenever ignition key is cycled to off position and then cycled back on, ASR system will default on. Check operation of 4th gear switch. When transmission shifts into 4th gear, switch should close and scan tool should display YES.
3. Disconnecting TCC connector simulates an open switch to determine if circuit No. 446 is shorted to ground or problem is in transmission.
4. This step determines if ECM and wiring are okay. Grounding circuit No. 446 should cause scan tool to display YES, indicating transmission is in 4th gear.

Diagnostic Aids

A road test may be necessary to verify customer complaint. If scan tool indicates TCC is turning on and off erratically, check state of 4th gear switch to ensure it is not changing states under a steady throttle position. If switch is changing states, check connections and wire routing carefully. If 4th gear switch is always closed, TCC may engage as soon as sufficient oil pressure is reached.

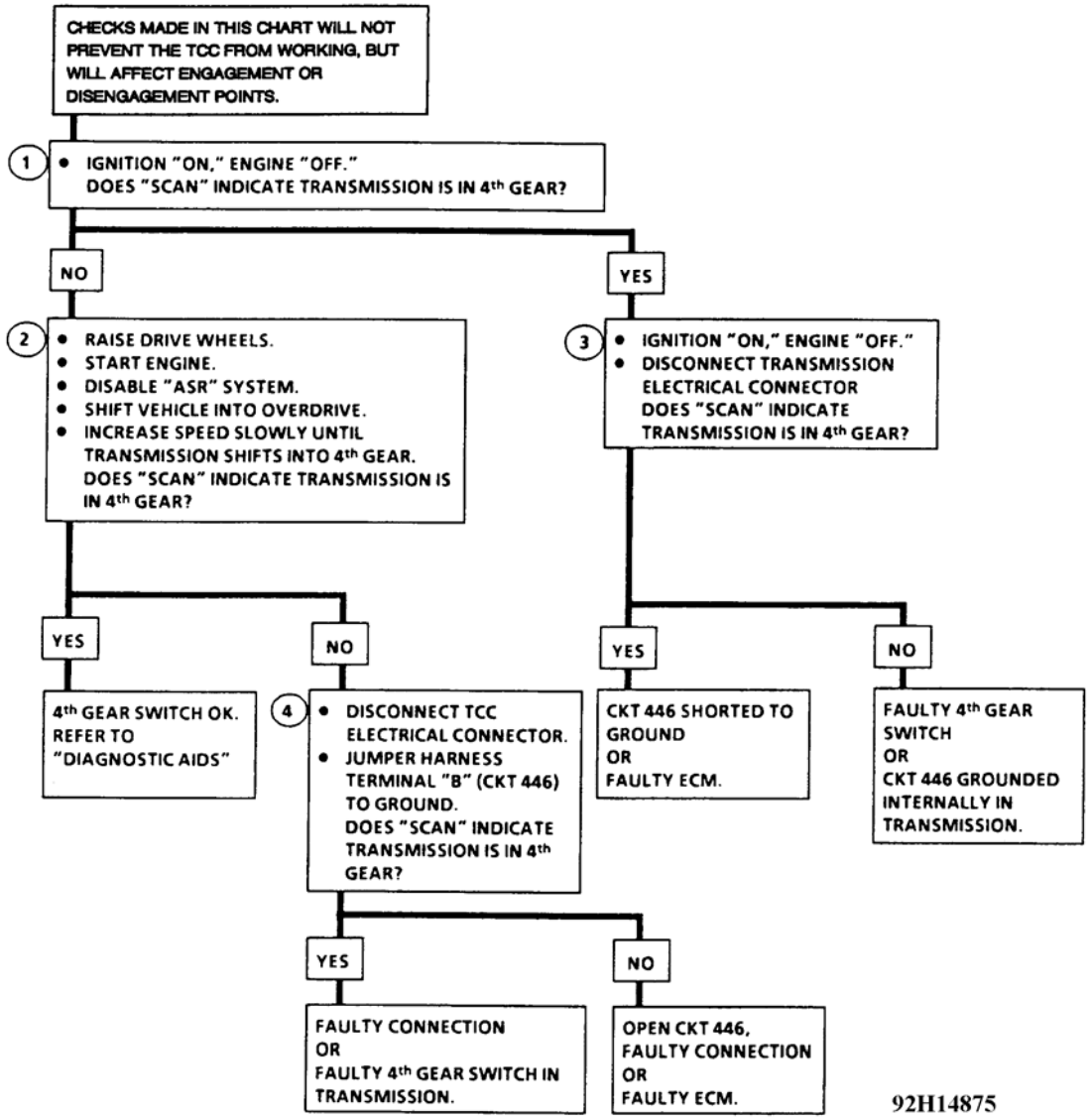


Fig. 231: Chart C-8A, TCC Troubleshooting Chart 4 of 4 (1992 5.7L PFI Y Body)
Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC CODE CHARTS (TRUCKS)

CODE 23, MAT SENSOR TEMP. LOW - 1991 2.5L & 4.3L TURBO

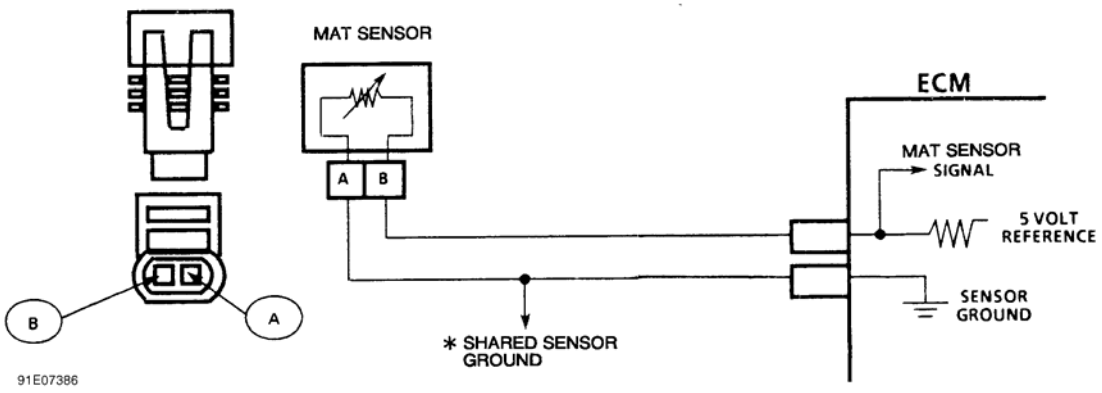


Fig. 232: Code 23, MAT Sensor Temp. Low Circuit Diagram (1991 2.5L & 4.3L Turbo)
Courtesy of GENERAL MOTORS CORP.

CODE 23 ECM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM Terminal	Wire Color
2.5L		
Signal	C12	Tan
MAT Ground	D2	Black/Red
4.3L Turbo		
Signal	GF16	Tan
MAT Ground	BB5	Black/Red

The ECM supplies and monitors a voltage signal (4.6 volts) to the sensor. When temperatures are low, sensor resistance is high and the ECM will see a high-monitored voltage signal. As temperature increases, sensor resistance decreases and voltage sensed by the ECM drops.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This checks is Code 23 is a hard failure or an intermittent condition. Code 23 will set if engine is running for one minute, MAT sensor temperature is less than -22°F (-30°C) for 12 seconds and speed sensor signal is not present.
2. This simulates conditions for a Code 25. If the Scan tester displays a high temperature, the ECM and wiring are not at fault.
3. This checks for continuity of sensor signal and ground circuits.

Diagnostic Aids

If the engine is allowed to cool overnight, the coolant and MAT sensors should read close to each other, when

measured with a Scan tester. A Code 23 will also result if signal and ground circuits become open.

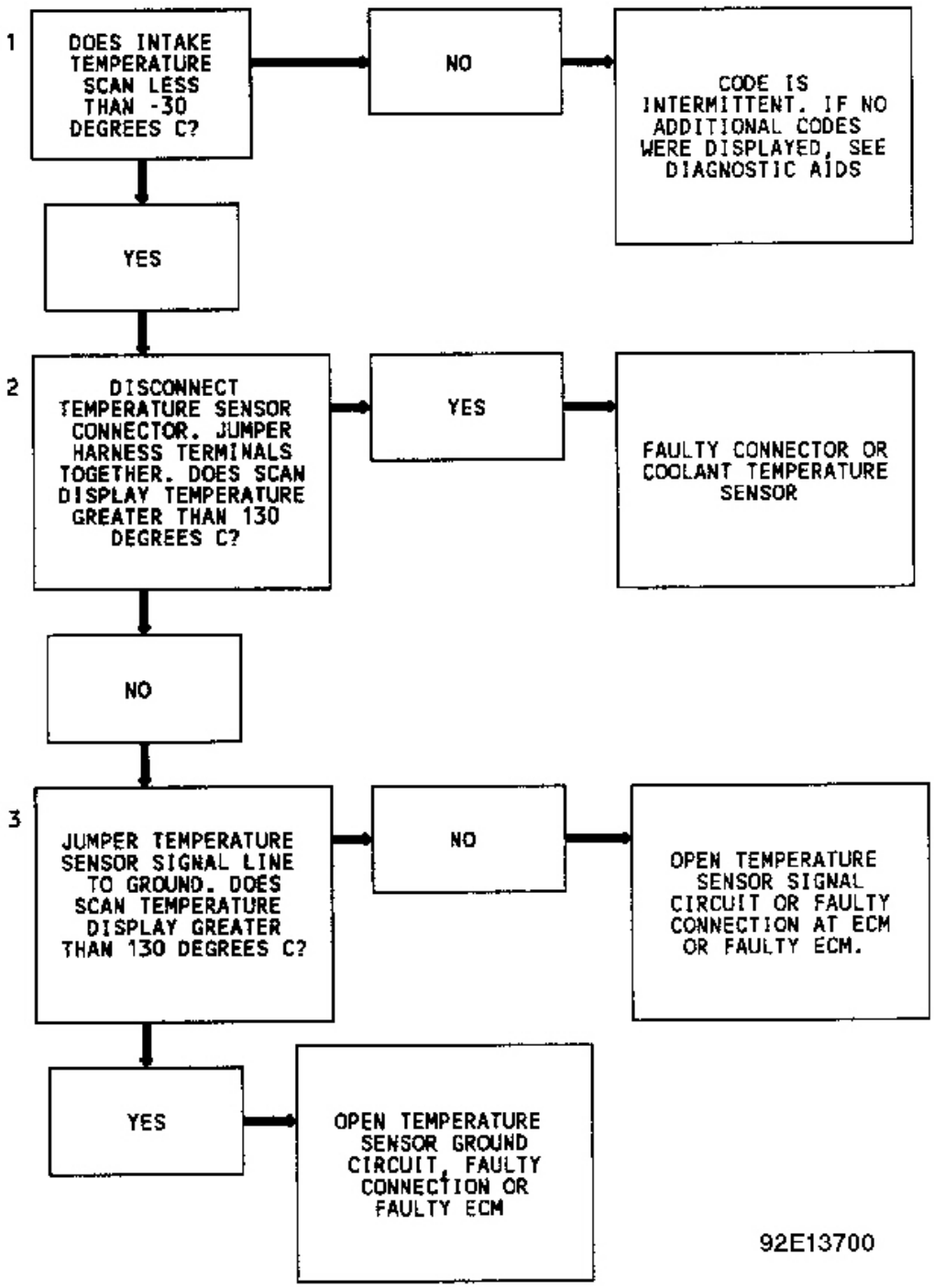


Fig. 233: Code 23, MAT Sensor Temp. Low Troubleshooting Chart (1991 2.5L & 4.3L Turbo)
Courtesy of GENERAL MOTORS CORP.

TEMPERATURE-TO-RESISTANCE VALUES

°F (°C) (1)	(2) Ohms
210 (100)	185
160 (70)	450
100 (38)	1,800
70 (20)	3,400
40 (4)	7,500
20 (-7)	13,500
0 (-18)	25,000
-40 (-40)	100,700
(1) Temperatures are approximate.	
(2) Measure resistance across sensor terminals.	

CODE 23 MAT SENSOR TEMP. LOW - 1992 2.5L & 4.3L TURBO

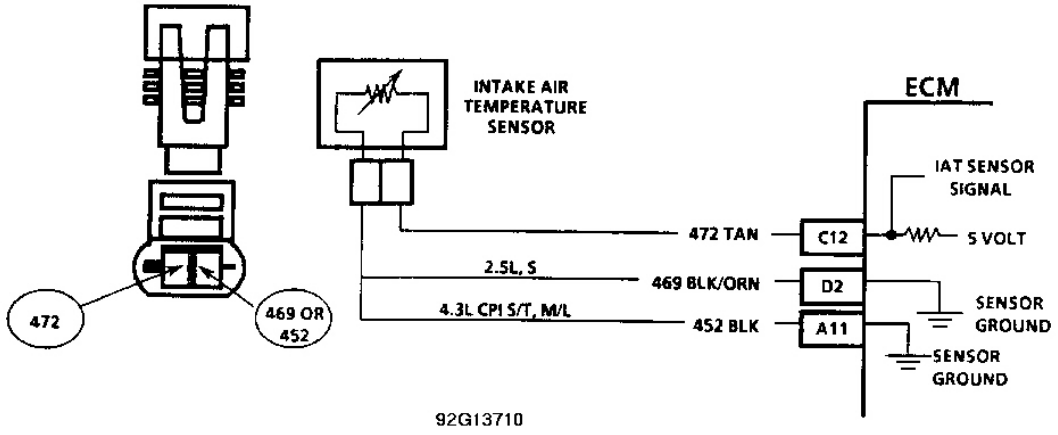


Fig. 234: Code 23, MAT Sensor Temp. Low Circuit Diagram (1992 2.5L & 4.3L Turbo)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. This step will determine if Code 23 is the result of a hard failure or an intermittent condition. Code 23 will set if a signal voltage indicates a intake air temperature below minus 22 degrees for 12 seconds, time since engine start is one minute or longer or no vehicle speed signal present.
2. Code 23 will set due to an open sensor, wire or connection. This test will determine if wiring and ECM

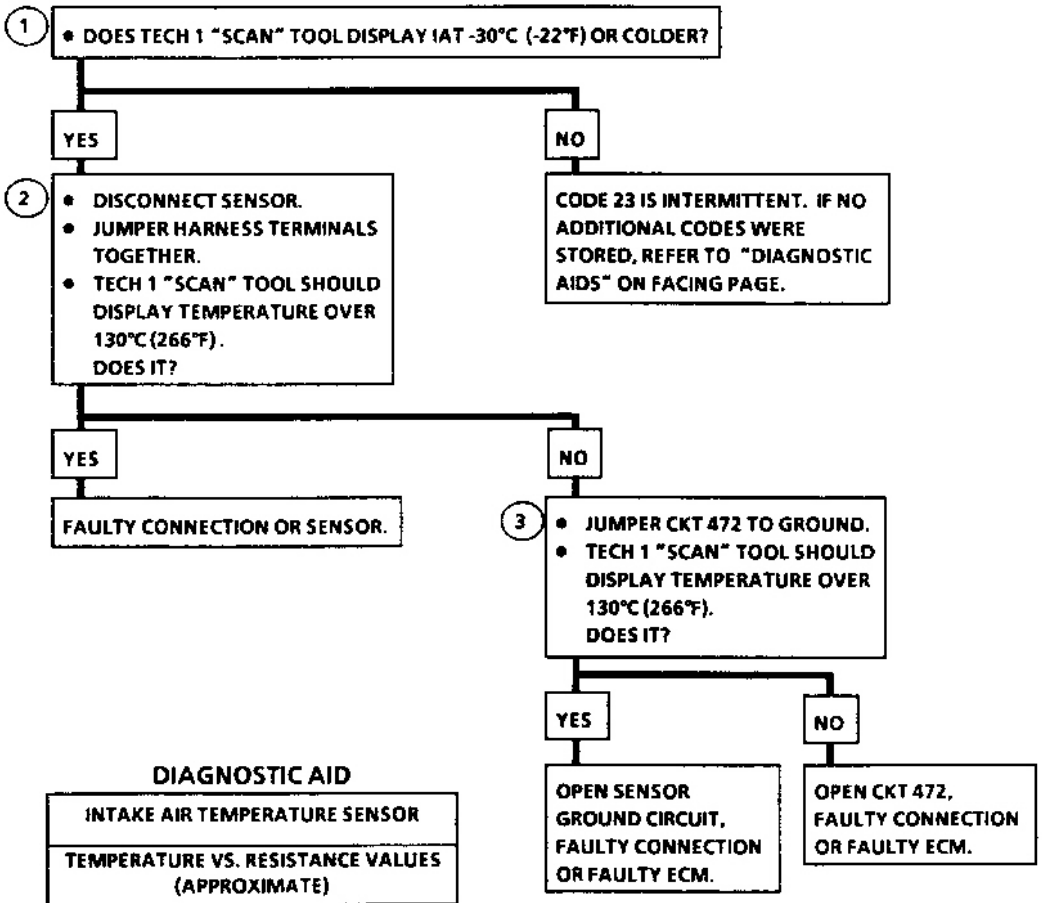
are okay.

3. This test will determine if signal from circuit No. 472 or the 5 volt return in circuit No. 469/452 is open.

Diagnostic Aids

A scan tester reads temperature of air entering engine and should read close to ambient air temperature when engine is cold, and rises as underhood temperature increases. Carefully check harness and connections for possible open in circuit No. 472 or 469/452.

Temperature to resistance value scale may be used to test sensor at various temperature levels to evaluate the possibility of malfunctioning sensor. This condition could cause a driveability problem.



DIAGNOSTIC AID

INTAKE AIR TEMPERATURE SENSOR		
TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

92H13711

Fig. 235: Code 23, MAT Sensor Temp. Low Troubleshooting Chart (1992 2.5L & 4.3L Turbo)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR - EXCEPT 3.1L, C & K SERIES & MODELS WITH 4L80-E TRANSMISSION

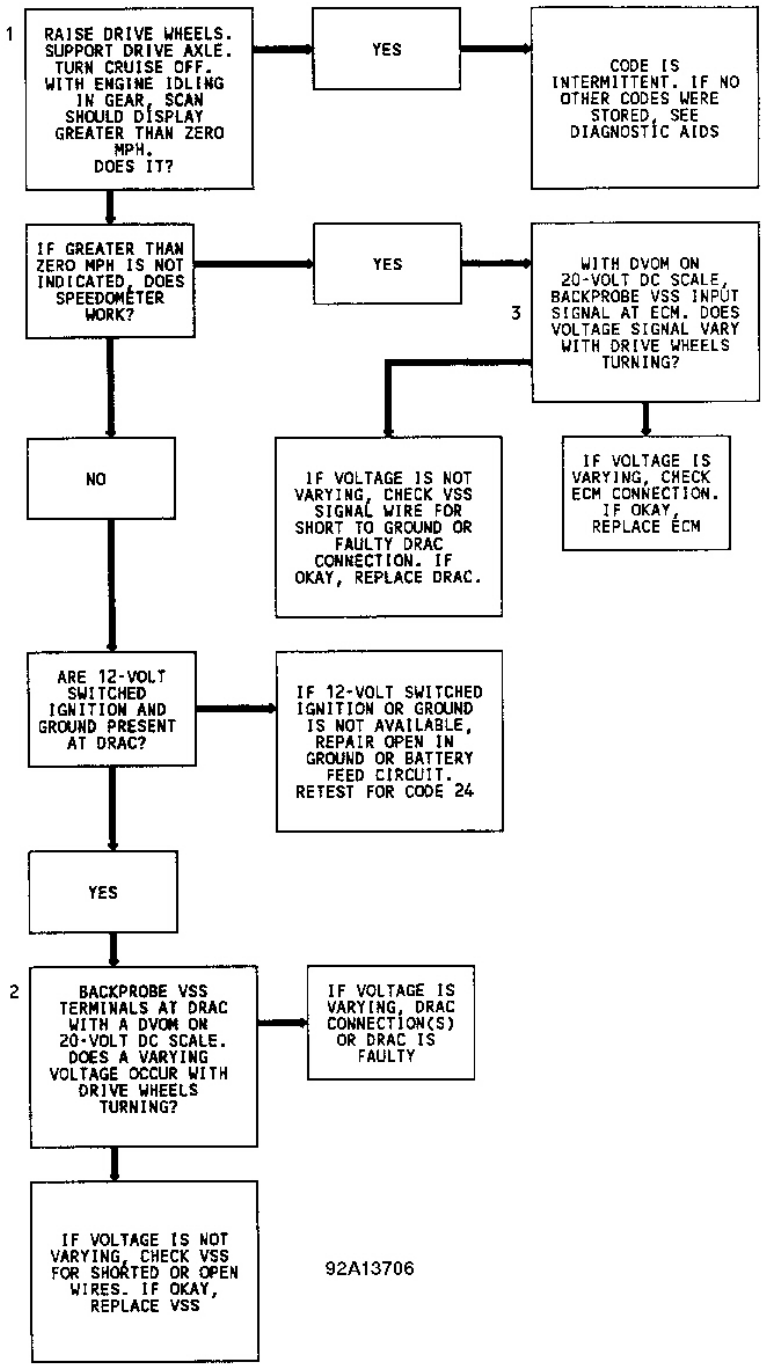


Fig. 236: Code 24, VSS Circuit Diagram (Except 3.1L, C, K & Models With 4L80-E Transmission)
Courtesy of GENERAL MOTORS CORP.

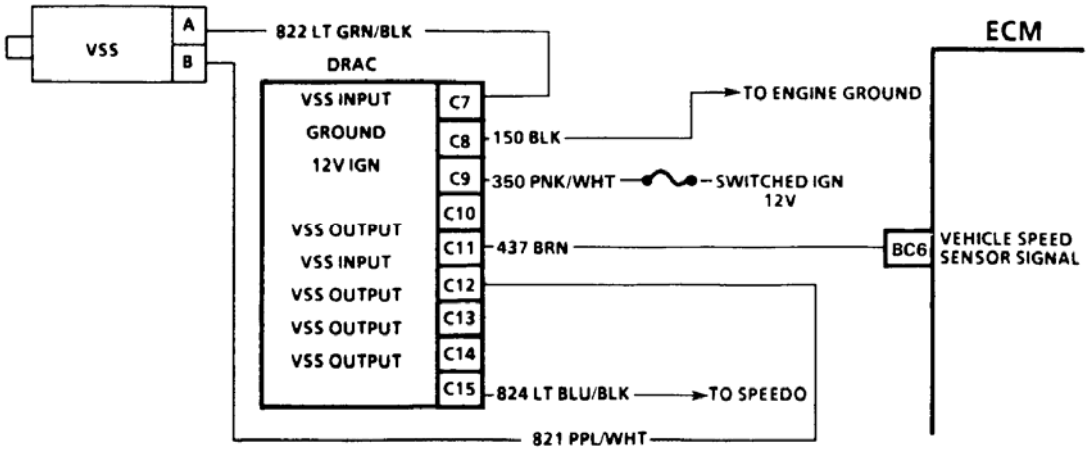


Fig. 237: Code 24, VSS Circuit Diagram (4.3L Turbo)
Courtesy of GENERAL MOTORS CORP.

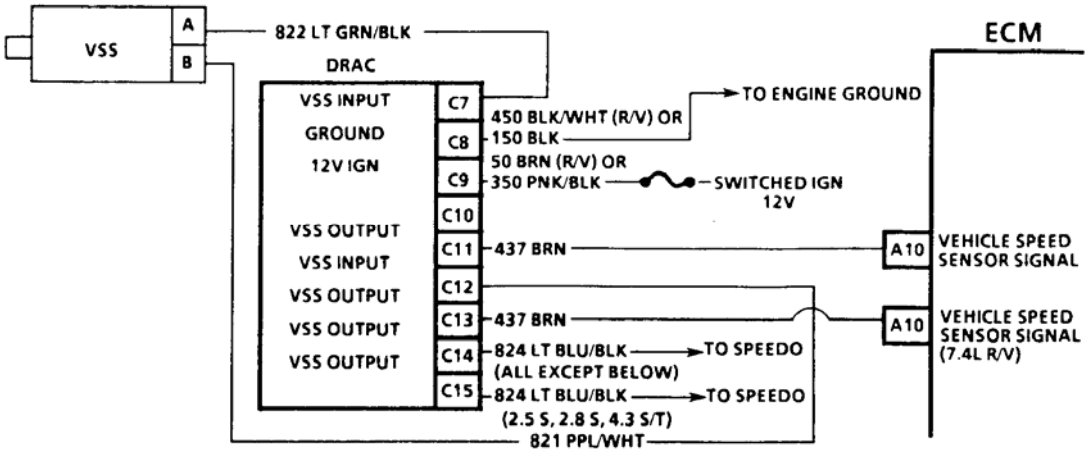


Fig. 238: Code 24, VSS Circuit Diagram (G, P, R & V Series W/O 4L80-E Transmission)
Courtesy of GENERAL MOTORS CORP.

The ECM applies and monitors 12 volts on circuit No. 437. Circuit No. 437 is connected to the digital Ratio Adapter Controller (DRAC) which alternately grounds this circuit when it is receiving voltage pulses from the Vehicle Speed Sensor (VSS). Scan test reading should closely match speedometer reading.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Code 24 will set if voltage on circuit No. 437 is constant, engine speed is greater than 1200 RPM, vehicle speed is less than 2 MPH vehicle is not in Park or Neutral and all conditions have been met for at least 5 seconds. These conditions are met during a road load deceleration.
2. This determines if DRAC is receiving the AC signal from the VSS.

3. This test monitors DRAC voltage on circuit No. 437. With wheels turning, pulsing voltage should be present. Voltage variation will be greater at a low speed to an average of 4-6 volts at about 20 MPH.

Diagnostic Aids

Scan tester reading should closely match speedometer reading with drive wheels turning. If vehicle is equipped with an automatic transmission, check park/neutral switch adjustment.

CODE 24, VEHICLE SPEED SENSOR - 1992 EXCEPT 4L80-E TRANS.

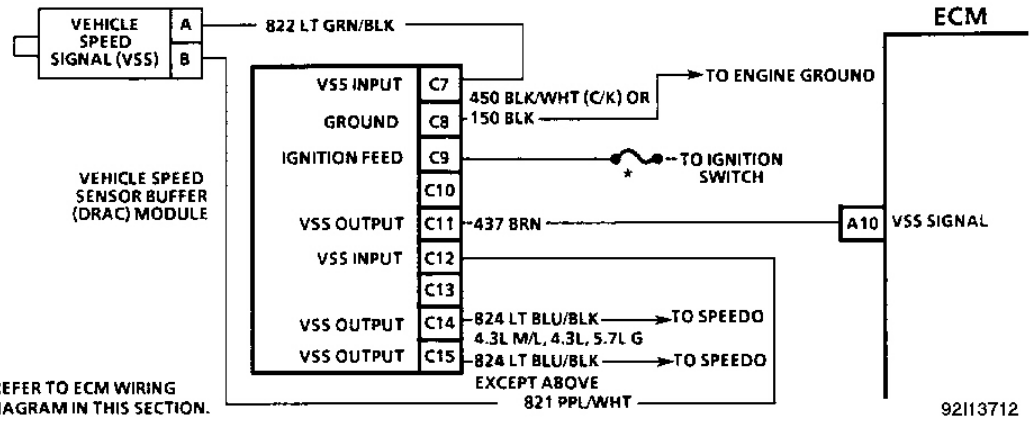


Fig. 239: Code 24, VSS Circuit Diagram (1992 Except 4L80-E Transmission)
Courtesy of GENERAL MOTORS CORP.

Vehicle speed sensor (VSS) circuit consists of a magnetic induction type sensor, VSS buffer (DRAC) module and wiring. Gear teeth pressed on the outside diameter of the output carrier assembly induce an alternating current in the sensor. On 2WD vehicles, this current is transmitted to a DRAC module where it is passed on to ECM. DRAC compensates for various axle ratios and converts signal to a square wave for use by the speedometer, cruise control and anti-lock brake system.

Since vehicle speed is taken from transfer case on 4wd vehicles, transmission vehicle speed sensor signal on these units goes directly to PCM. Code 24 will set when vehicle speed is less than 200 RPM for 1.5 seconds while engine speed is greater than 3000 RPM. Park/Neutral is not selected. If input speed sensor is not operational at start up, vehicle speed sensor may read zero.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. This test checks vehicle speed sensor signal to PCM.
2. This test checks vehicle speed sensor signal to DRAC.
3. This test verifies vehicle speed sensor signal.

Diagnostic Aids

Check all electrical connections, especially at transmission pass-through connector.

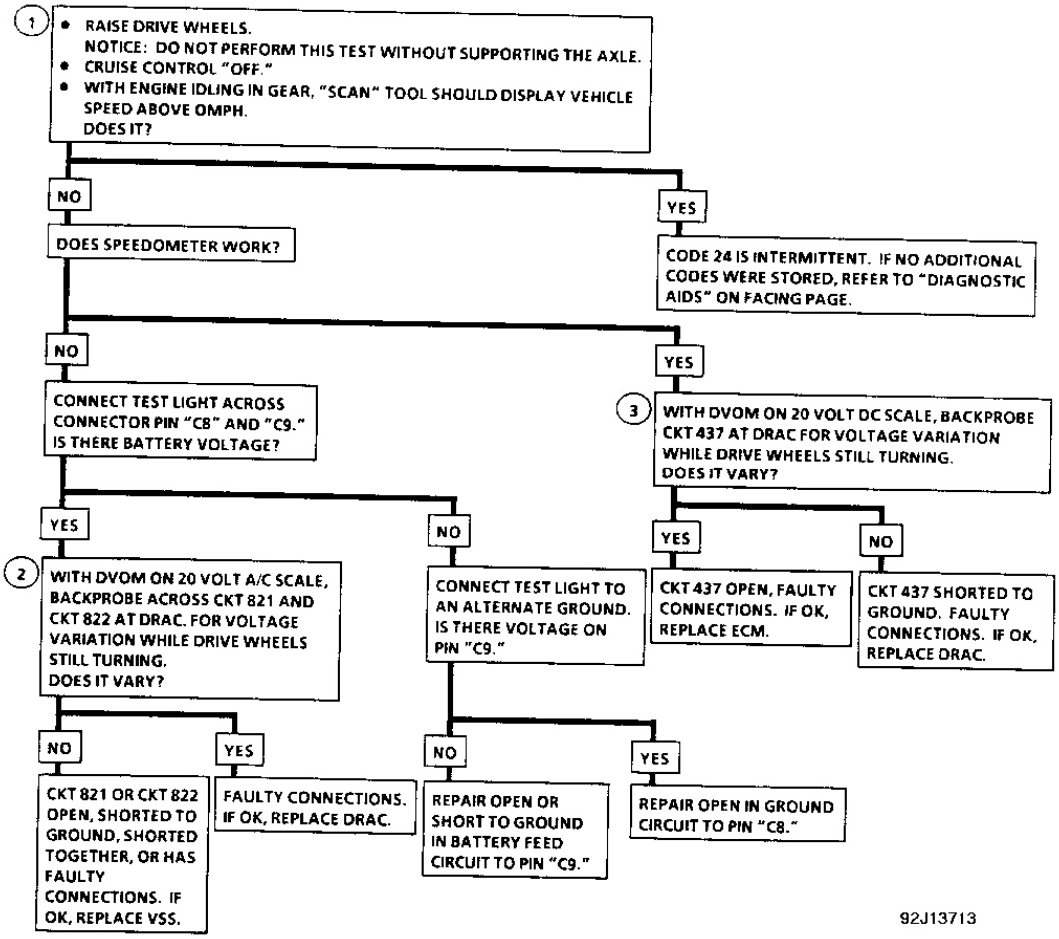


Fig. 240: Code 24, VSS Troubleshooting Chart (1992 Except 4L80-E Transmission)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR - C & K SERIES EXCEPT W/4L80-E TRANSMISSION

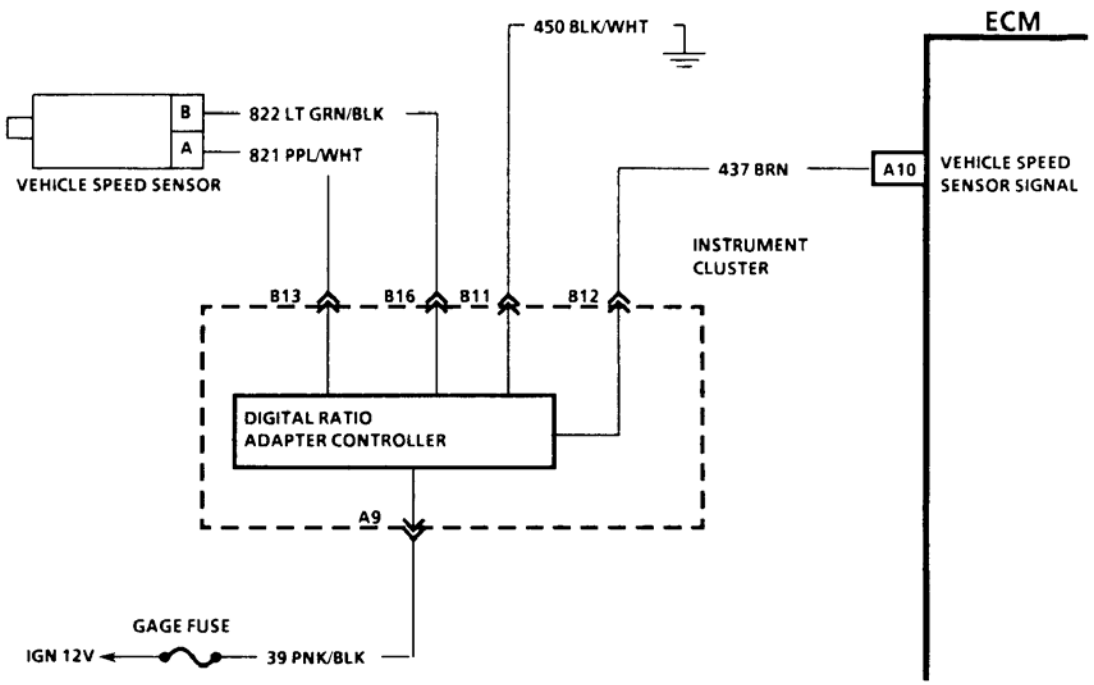


Fig. 241: Code 24, VSS Circuit Diagram (C & K Except W/4L80-E Transmission
Courtesy of GENERAL MOTORS CORP.

The ECM applies and monitors 12 volts on circuit No. 437. Circuit No. 437 is connected to the Digital Ratio Adapter Controller (DRAC) which alternately grounds this circuit when it is receiving voltage pulses from the Vehicle Speed Sensor (VSS). Scan tester reading should closely match speedometer reading.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Code 24 will set if voltage on circuit No. 437 is constant, engine speed is greater than 1200 RPM, vehicle speed is less than 2 MPH vehicle is not in Park or Neutral and all conditions have been met for at least 10 seconds. These conditions are met during a road load deceleration.
2. This test monitors DRAC voltage on circuit No. 437. With wheels turning, pulsing voltage should be present. Voltage variation will be greater at a low speed to an average of 4-6 volts at about 20 MPH.

Diagnostic Aids

Scan tester reading should closely match speedometer reading with drive wheels turning. If vehicle is equipped with an automatic transmission, check park/neutral switch adjustment.

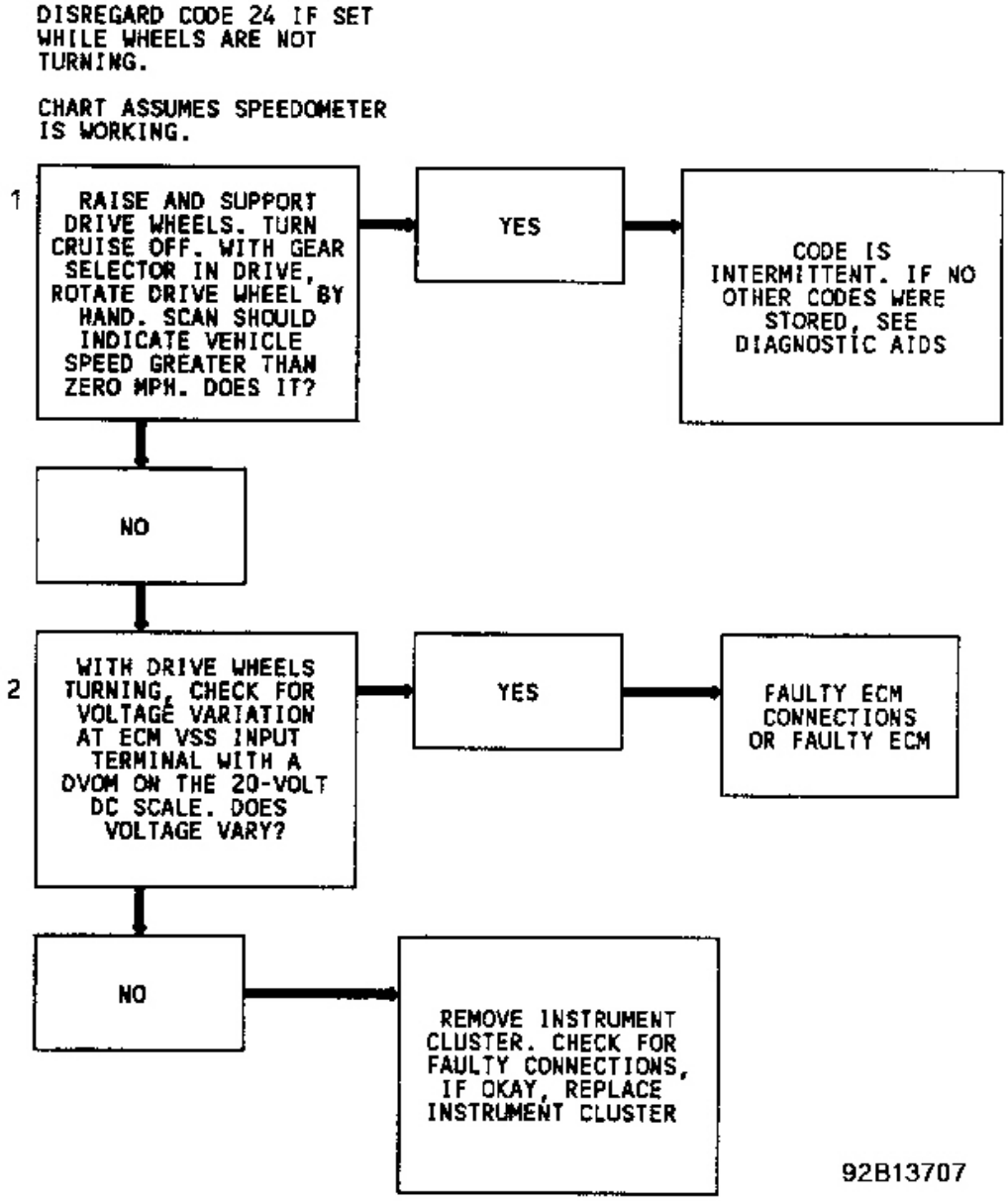


Fig. 242: Code 24, VSS Troubleshooting Chart (C & K Except W/4L80-E Transmission)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR - C & K SERIES 2WD WITH 4L80-E TRANSMISSION

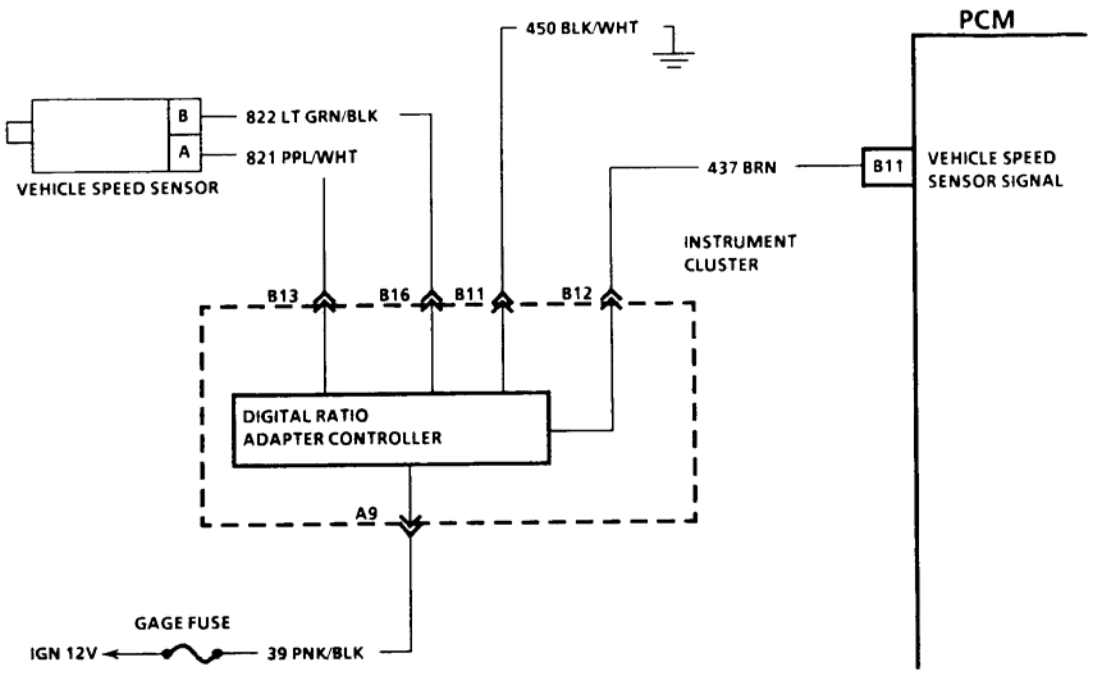


Fig. 243: Code 24, VSS Circuit Diagram (C & K Series 2WD W/4L80-E Transmission)
Courtesy of GENERAL MOTORS CORP.

VSS output sensor circuit consists of a magnetic induction type speed sensor, Digital Ratio Adapter Controller (DRAC), and wiring. Gear teeth cut in the outside diameter of the rear internal gear induce an alternating current in the sensor when drive wheels are turning. Signal is transmitted to the instrument cluster DRAC where it is converted to a square wave signal which is passed on to the PCM, cruise control, speedometer, and anti-lock brake system. Code 24 will set if gear selector is not in Park or Neutral, input speed is at least 3000 RPM and output speed is less than 200 RPM for at least one second. If input speed sensor is not operational at start up, this can cause VSS to read zero.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Test verifies VSS voltage at PCM.
2. Test verifies operation of VSS.
3. Test checks circuits No. 821 and 822 up to the instrument cluster.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector. While Code 24 is set, Scan tester will display an RPM derived from input speed.

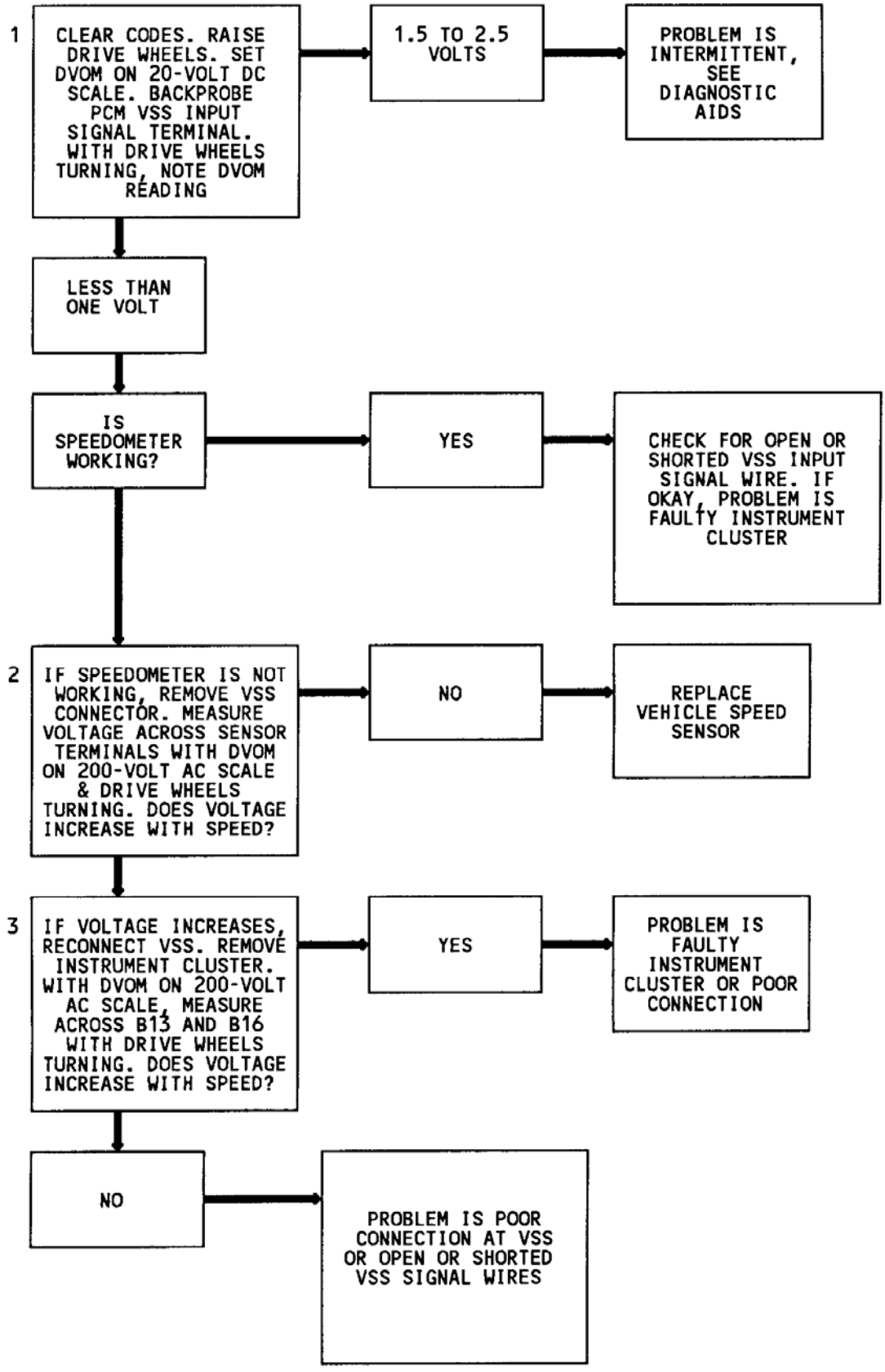

1
CLEAR CODES. RAISE DRIVE WHEELS. SET DVOM ON 20-VOLT DC SCALE. BACKPROBE PCM VSS INPUT SIGNAL TERMINAL. WITH DRIVE WHEELS TURNING, NOTE DVOM READING
1.5 TO 2.5 VOLTS
PROBLEM IS INTERMITTENT, SEE DIAGNOSTIC AIDS
LESS THAN ONE VOLT
IS SPEEDOMETER WORKING?
YES
CHECK FOR OPEN OR SHORTED VSS INPUT SIGNAL WIRE. IF OKAY, PROBLEM IS FAULTY INSTRUMENT CLUSTER
2
IF SPEEDOMETER IS NOT WORKING, REMOVE VSS CONNECTOR. MEASURE VOLTAGE ACROSS SENSOR TERMINALS WITH DVOM ON 200-VOLT AC SCALE & DRIVE WHEELS TURNING. DOES VOLTAGE INCREASE WITH SPEED?
NO
REPLACE VEHICLE SPEED SENSOR
3
IF VOLTAGE INCREASES, RECONNECT VSS. REMOVE INSTRUMENT CLUSTER. WITH DVOM ON 200-VOLT AC SCALE, MEASURE ACROSS B13 AND B16 WITH DRIVE WHEELS TURNING. DOES VOLTAGE INCREASE WITH SPEED?
YES
PROBLEM IS FAULTY INSTRUMENT CLUSTER OR POOR CONNECTION
NO
PROBLEM IS POOR CONNECTION AT VSS OR OPEN OR SHORTED VSS SIGNAL WIRES

Fig. 244: Code 24, VSS Troubleshooting Chart (C & K Series 2WD W/4L80-E Transmission)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR - 1992 WITH 4L80-E TRANSMISSION

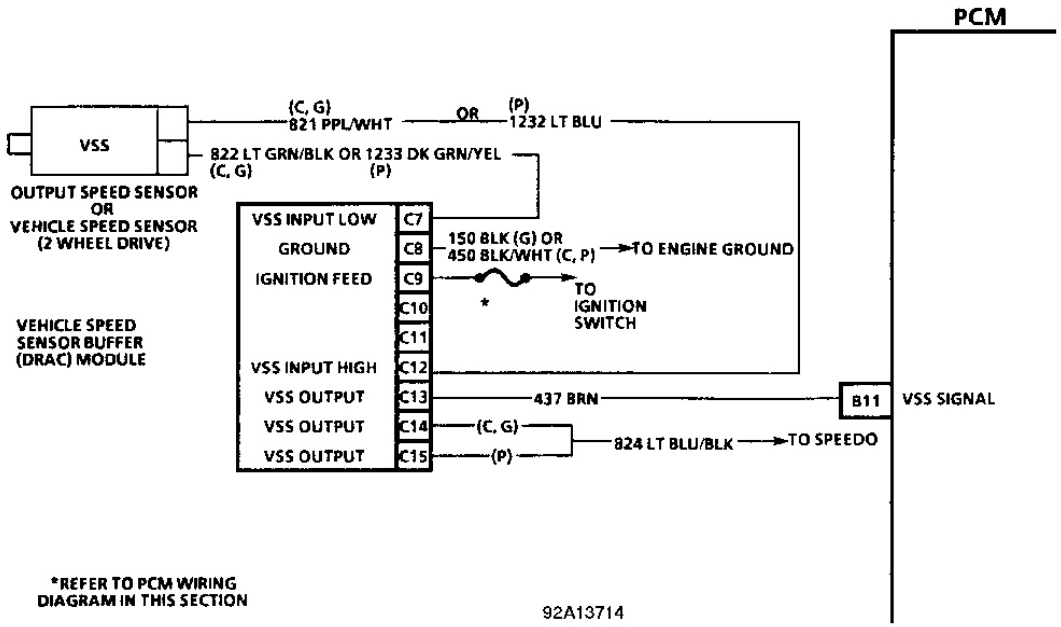


Fig. 245: Code 24, VSS Circuit Diagram (1992 W/4L80-E Transmission)
Courtesy of GENERAL MOTORS CORP.

Vehicle speed sensor (VSS) circuit consists of a magnetic induction type sensor, VSS buffer (DRAC) module and wiring. Gear teeth pressed on the outside diameter of the output carrier assembly induce an alternating current in the sensor. On 2WD vehicles, current is transmitted to a DRAC module where it is passed on to ECM. DRAC compensates for various axle ratios and converts signal to a square wave for use by the speedometer, cruise control and anti-lock brake system.

Since vehicle speed is taken from transfer case on 4WD vehicles, transmission vehicle speed sensor signal on these units goes directly to PCM. Code 24 will set when vehicle speed is less than 200 RPM for 1.5 seconds while engine speed is greater than 3000 RPM. Park/Neutral is not selected. If input speed sensor is not operational at start up, vehicle speed sensor may read zero.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. This test checks vehicle speed sensor signal to PCM.
2. This test checks vehicle speed sensor signal to DRAC.
3. This test verifies vehicle speed sensor signal.

Diagnostic Aids

Check all electrical connectors, especially at transmission pass-through connector.

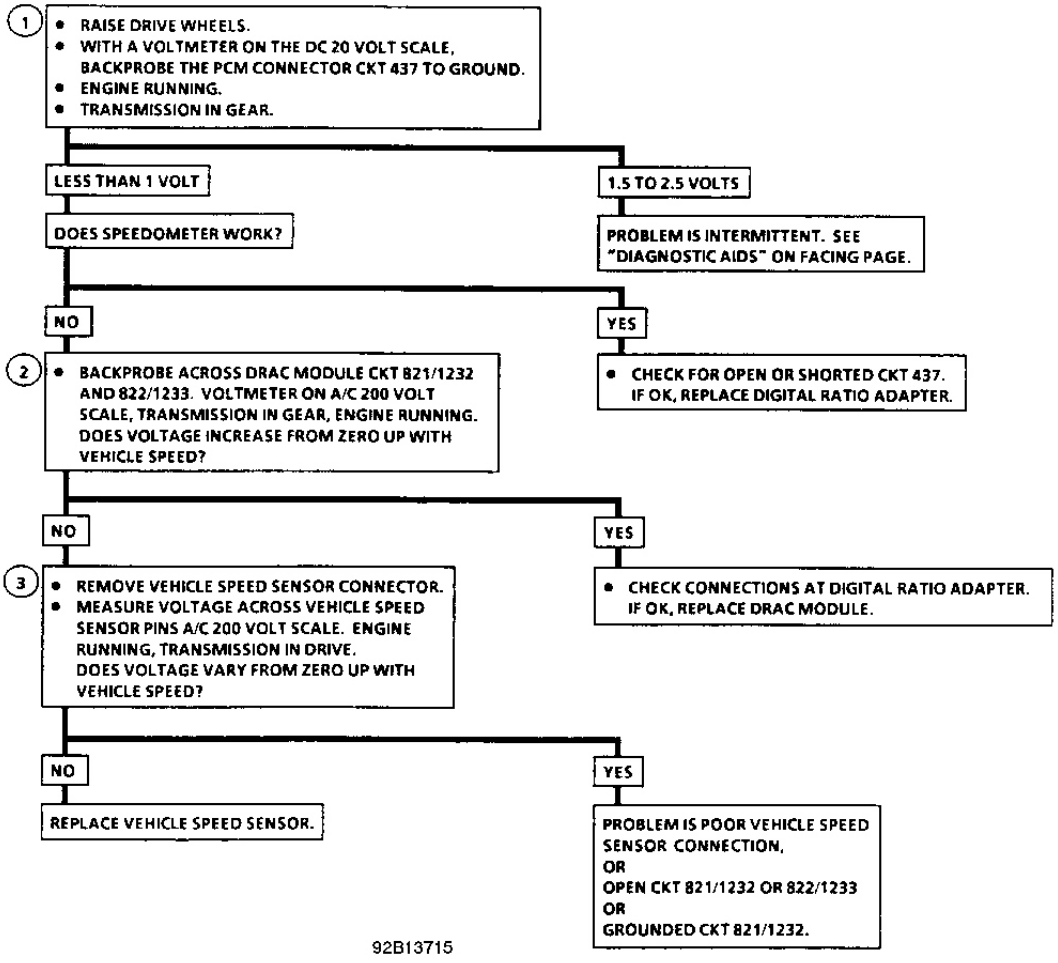


Fig. 246: Code 24, VSS Troubleshooting Chart (1992 W/4L80-E Transmission)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR - 2WD WITH 4L80-E TRANSMISSION EXCEPT C & K SERIES

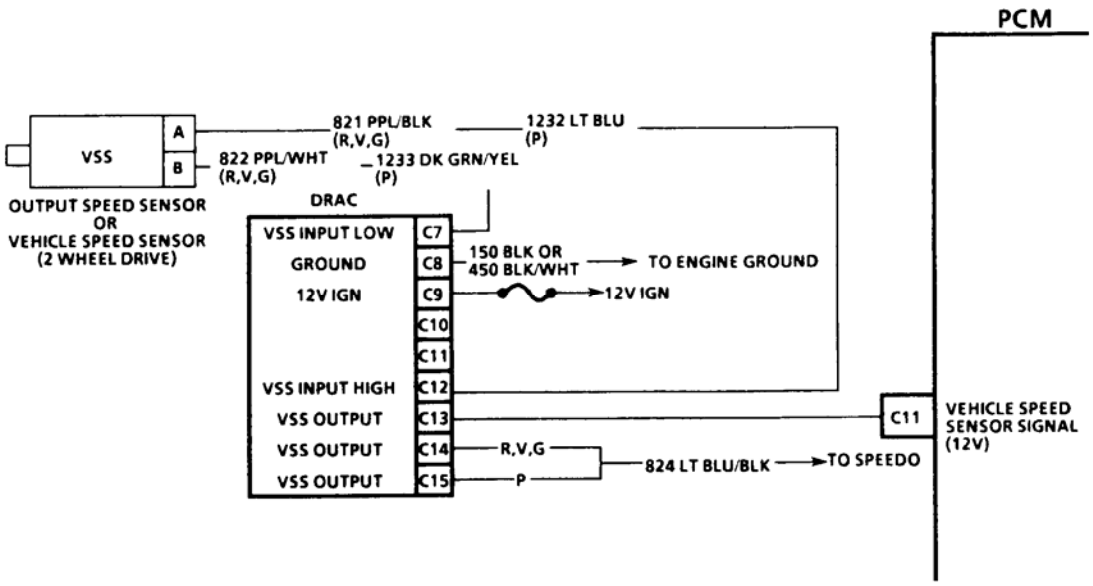


Fig. 247: Code 24, VSS Circuit Diagram (2WD W/4L80-E Transmission Except C & K Series)
Courtesy of GENERAL MOTORS CORP.

VSS output sensor circuit consists of magnetic induction type speed sensor, Digital Ratio Adapter Controller (DRAC), and wiring. Gear teeth pressed on the outside diameter of the output carrier assembly induce an alternating current in the sensor when drive wheels are turning. Signal is transmitted to the instrument cluster DRAC where it is converted to a square wave signal which is passed on to the PCM, cruise control, speedometer, and anti-lock brake system. Code 24 will set if gear selector is not in Park or Neutral, engine speed is at lease 3000 RPM and output speed is less than 200 RPM for at least 1.5 seconds. If input speed sensor is not operational at start-up, this can cause VSS to read zero.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Test verifies VSS voltage at PCM.
2. Test verifies VSS signal to DRAC.
3. Test verifies VSS signal at sensor.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector. While Code 24 is set, Scan tester will display an RPM derived from input speed.

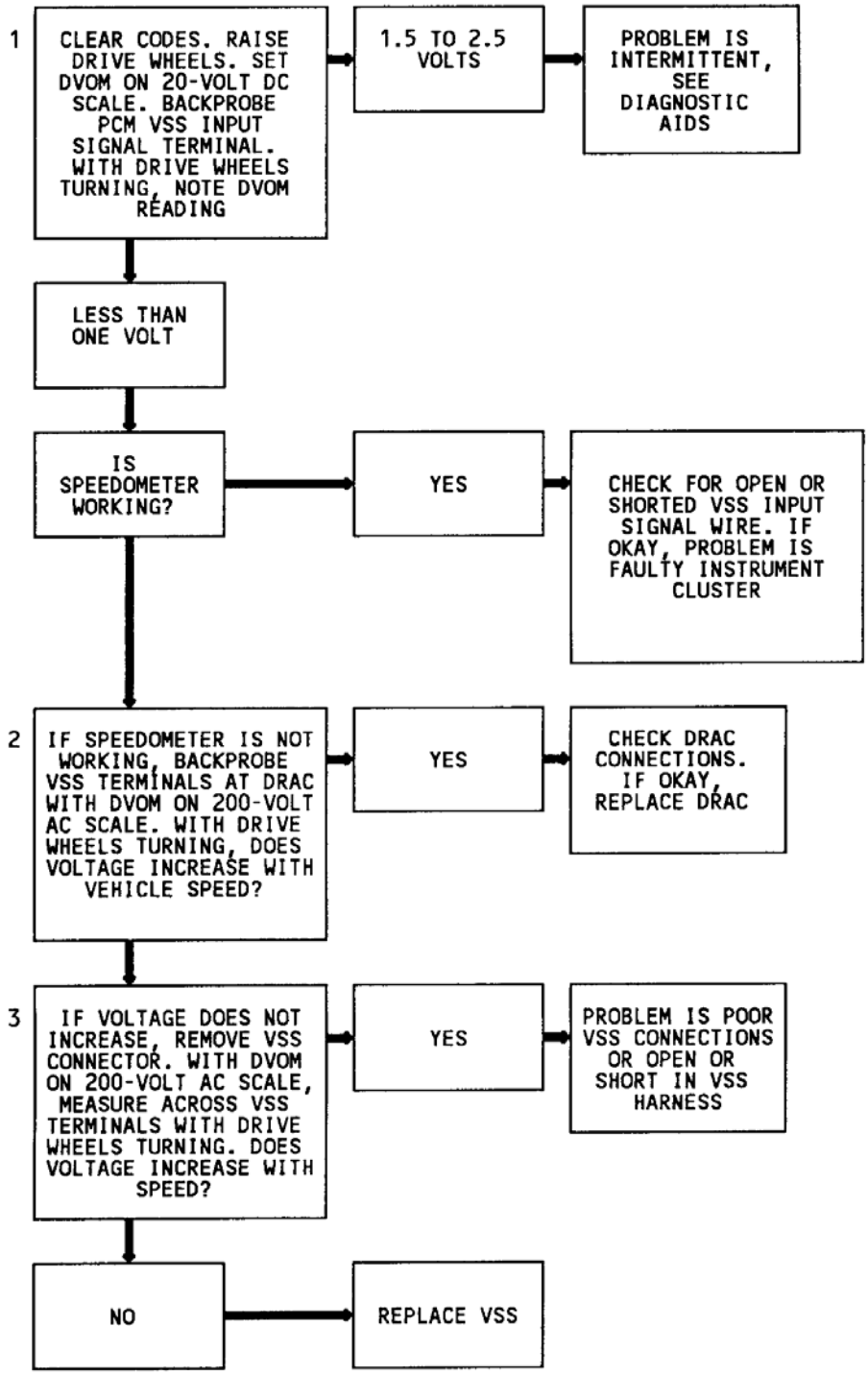


Fig. 248: Code 24, VSS Troubleshooting Chart (2WD W/4L80-E Trans. Except C & K Series)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR - 4WD WITH 4L80-E TRANSMISSION

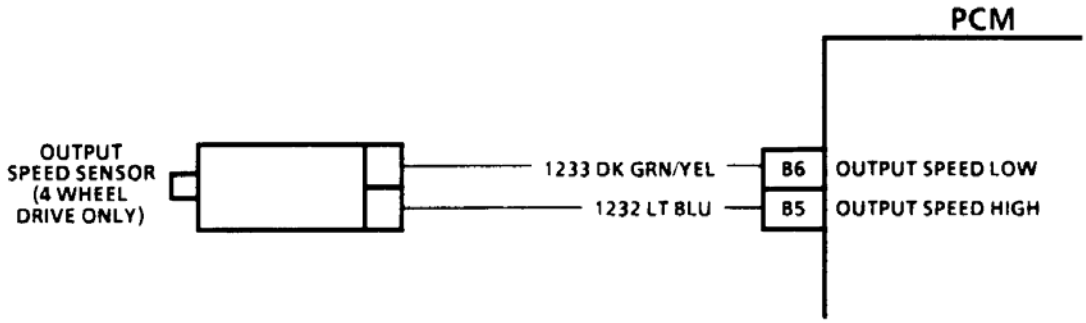


Fig. 249: Code 24, VSS Circuit Diagram (4WD With 4L80-E Transmission)
Courtesy of GENERAL MOTORS CORP.

VSS output sensor is a magnetic induction type. Gear teeth pressed on the outside diameter of the output carrier assembly induce an alternating current in the sensor when drive wheels are turning. Since vehicle speed is taken from the transfer case on 4WD vehicles, output speed sensor signal on these units goes directly to PCM. Code 24 will set if gear selector is not in Park or Neutral, engine speed is at least 3000 RPM and output speed is less than 200 RPM for at lease 1.5 seconds.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Test verifies VSS voltage at PCM.
2. Test verifies VSS signal at sensor.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector. While Code 24 is set, Scan tester will display an RPM derived from input speed. If input speed is not operational at start-up, this can cause VSS to read zero.

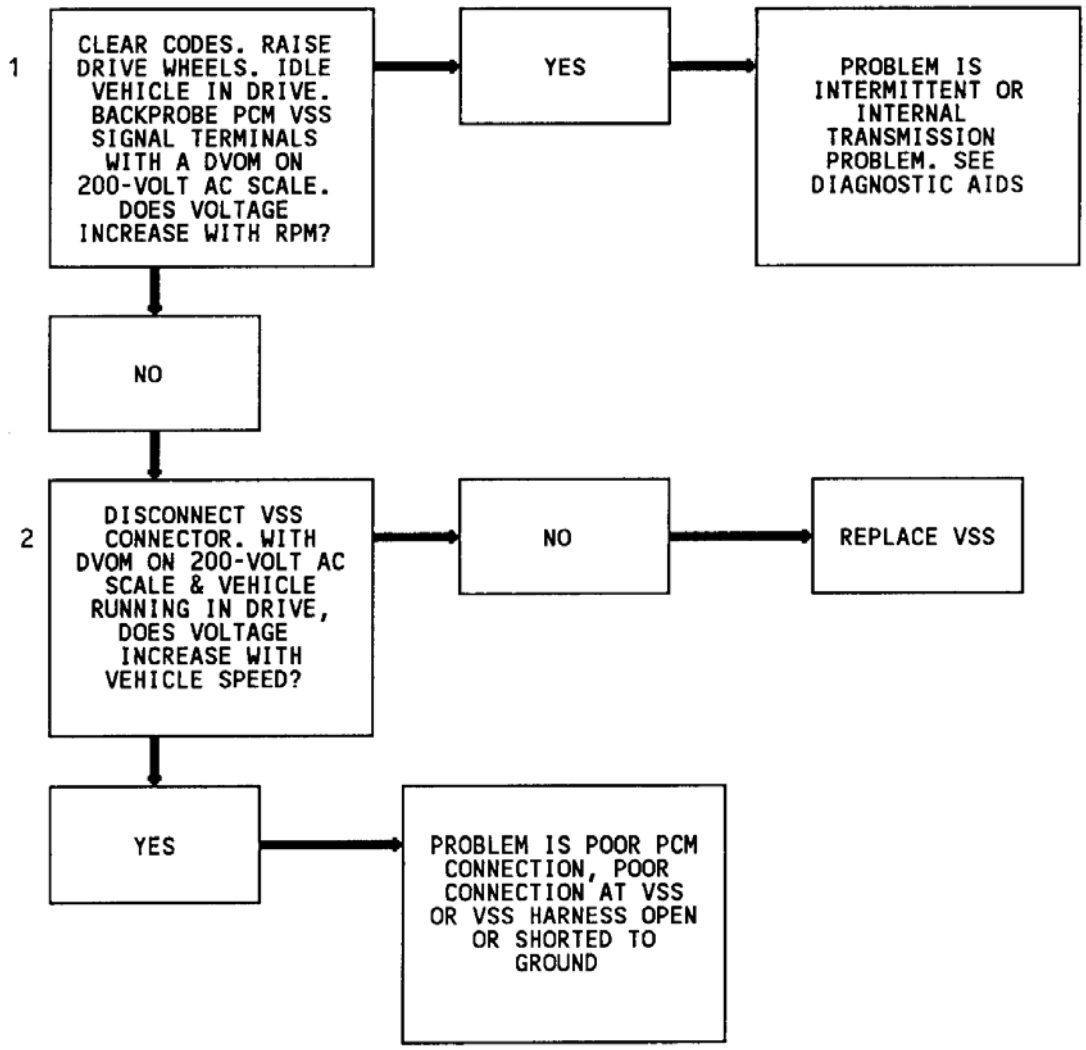


Fig. 250: Code 24, VSS Troubleshooting Chart (4WD With 4L80-E Transmission)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR - 3.1L

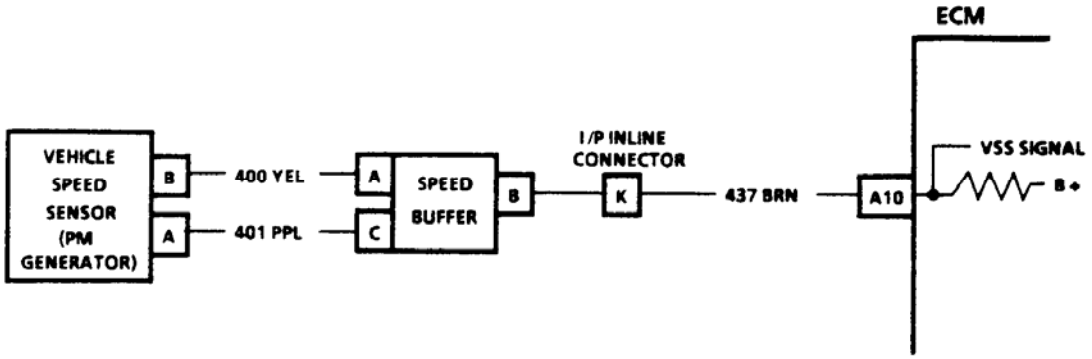


Fig. 251: Code 24, Vehicle Speed Sensor Circuit Diagram (3.1L)
Courtesy of GENERAL MOTORS CORP.

ECM applies and monitors a 12-volt signal on circuit No. 437 to Vehicle Speed Sensor (VSS). VSS is connected to speed sensor buffer which alternately grounds and opens circuit No. 437 when wheels are turning. This pulsing action takes place about 2000 times per mile. The voltage level and pulses increase with vehicle speed. The ECM converts the pulsing voltage to MPH. The ECM uses VSS information in calculations to determine vehicle adjustments. Scan tester reading should closely match speedometer reading when wheels are turning.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. A Code 24 sets when MPH is less than 2 MPH, transmission is not in Park or Neutral, engine speed is greater than 1400 RPM, TPS is greater than 5 percent, circuit No. 437 voltage is constant and all of these conditions are met for 30 seconds. These conditions are met during a road load deceleration.
2. A steady 8-12 volts at ECM connector indicates VSS circuit is open or speed sensor is faulty. A voltage of less than one volt at IP connector indicates circuit No. 437 wire is shorted to ground. Disconnect vehicle speed sensor connector. If voltage is now greater than 10 volts, vehicle speed sensor buffer is faulty. If voltage remains less than 8 volts, circuit is grounded. If circuit is not grounded, check for faulty ECM connector or ECM. Before replacing the ECM, PROM should be checked for correct application.

Diagnostic Aids

A faulty or misadjusted Park/Neutral switch may set a false Code 24. Use Scan tester and check for proper signal in Drive, while wiggling shifter. Scan tester MPH reading should closely match speedometer when vehicle is moving.

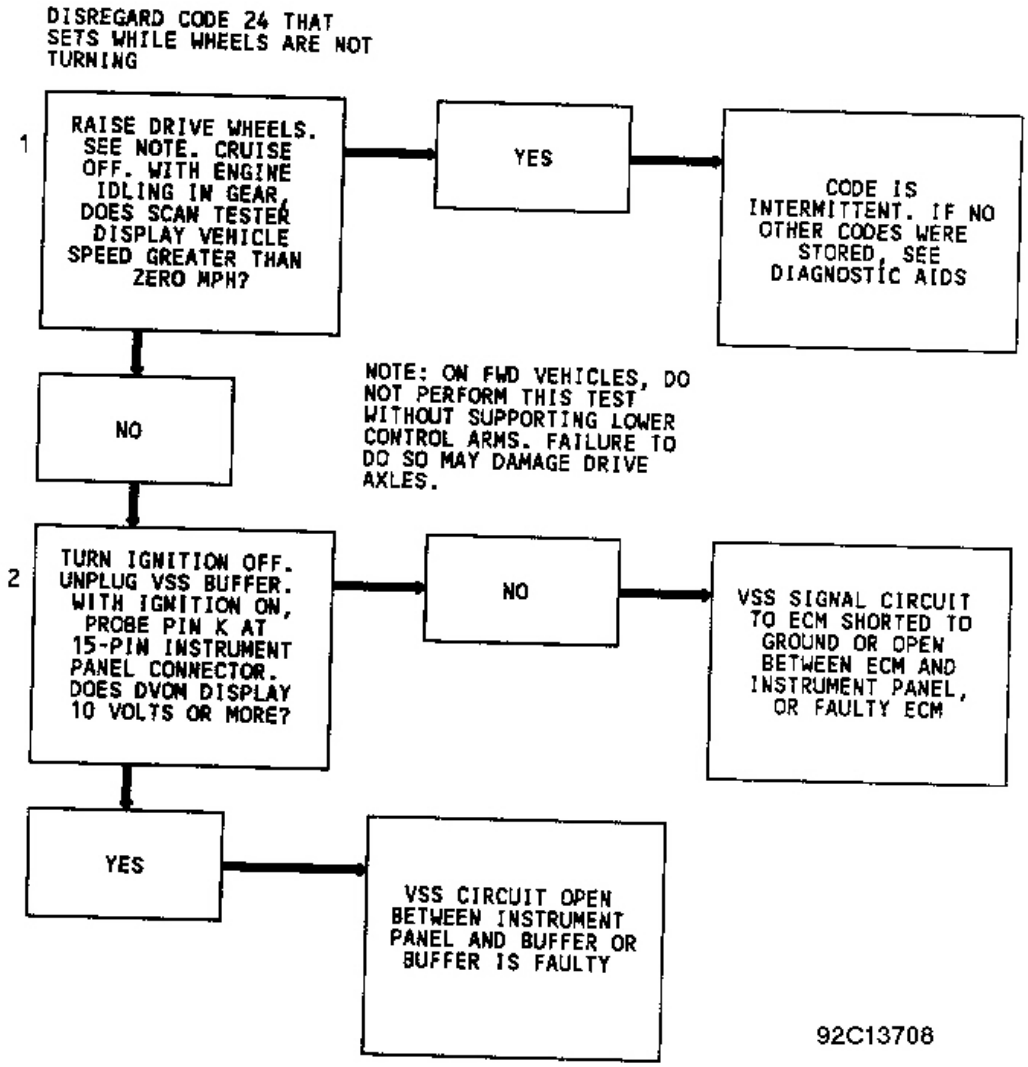


Fig. 252: Code 24, Vehicle Speed Sensor Troubleshooting Chart (3.1L)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR - 1991 DIESEL

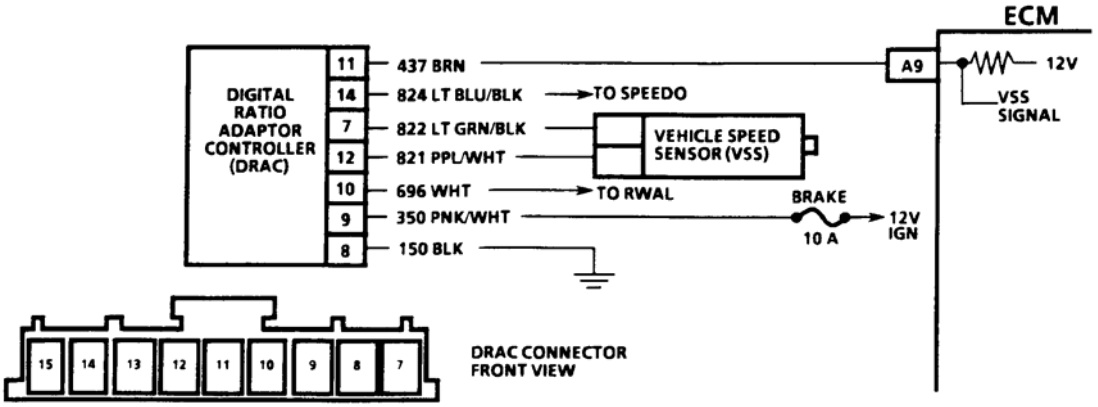


Fig. 253: Code 24, VSS Circuit Diagram (1991 Diesel)
Courtesy of GENERAL MOTORS CORP.

The ECM applies and monitors 12 volts on circuit No. 437. Circuit No. 437 connects to the Digital Ratio Adapter Controller (DRAC), which alternately grounds and opens circuit No. 437 when drive wheels are turning. The circuit is opened and closed at approximately 2000 times per mile when drive wheels are turning. The ECM calculates vehicle speed based on the time between pulses. Scan tester reading should closely match speedometer reading with drive wheels turning.

Code 24 will set under the following conditions are met for at least 10 seconds: Circuit No. 437 is constant, engine speed is more than 2000 RPM, vehicle speed signal at ECM terminal A9 is less than 5 MPH (8 Km/H).

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test monitors the ECM voltage on circuit No. 437. With wheels turning, the pulsating action causes varying voltage. the voltage variation will be greater at low wheel speeds, and an average of 4-6 volts at about 20 MPH (32 Km/H).
2. Less than one volt at ECM connector indicates circuit No. 437 wire is shorted to ground. Disconnect circuit No. 437 at DRAC. If voltage now reads more than 10 volts, the DRAC is faulty. If voltage remains less than 10 volts, then circuit No. 437 wire is grounded. If circuit No. 437 is not grounded, check for a faulty ECM connector or ECM.
3. A steady 8-12 volts reading at the ECM connector indicates that circuit No. 437 is open or DRAC is faulty.
4. Normal voltage indicates a possible intermittent condition.

Diagnostic Aids

With drive wheels turning, Scan tester and speedometer reading should closely match.

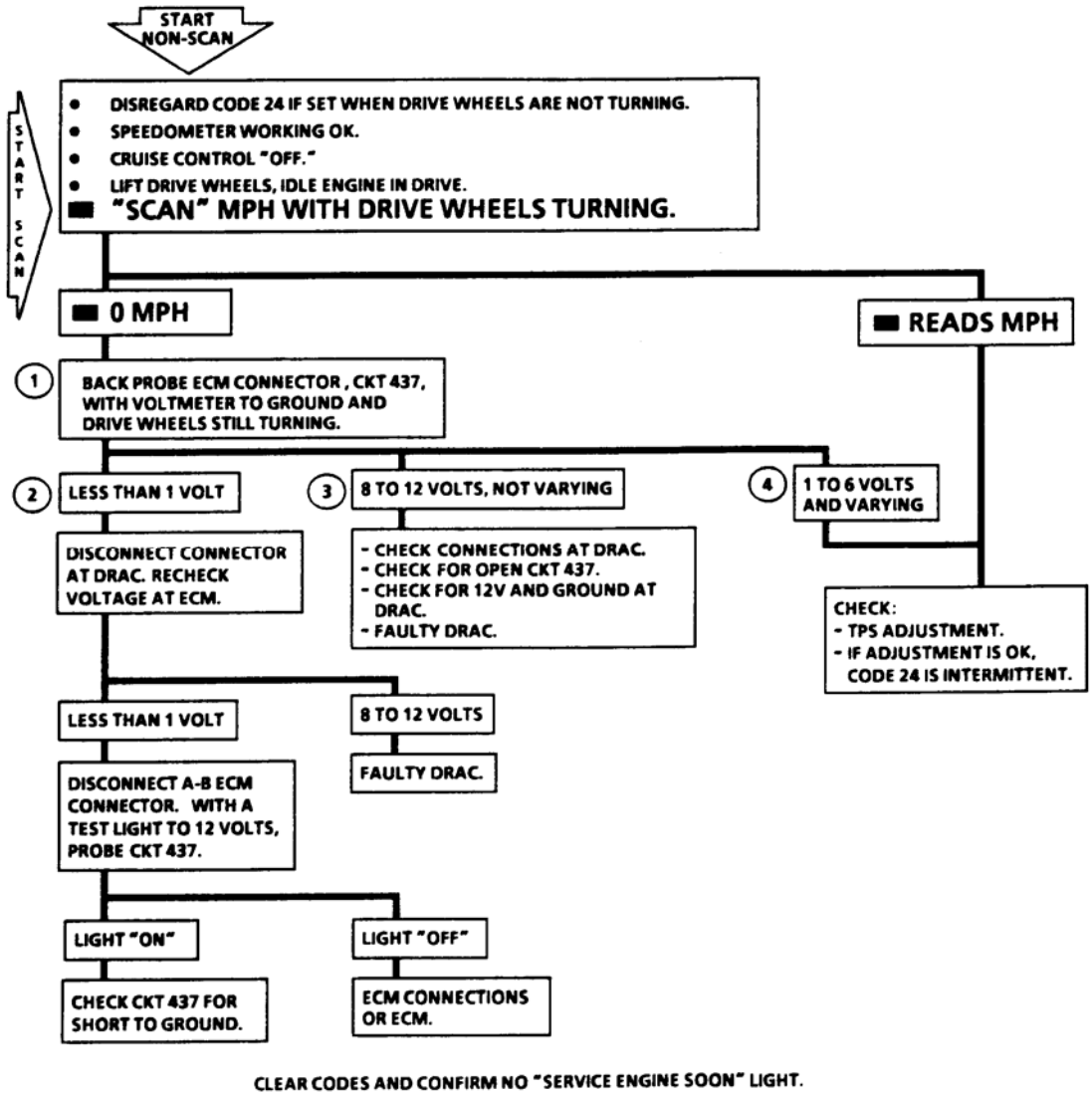


Fig. 254: Code 24, VSS Troubleshooting Chart (Diesel)
Courtesy of GENERAL MOTORS CORP.

CODE 24, VEHICLE SPEED SENSOR - 1992 6.2L DIESEL

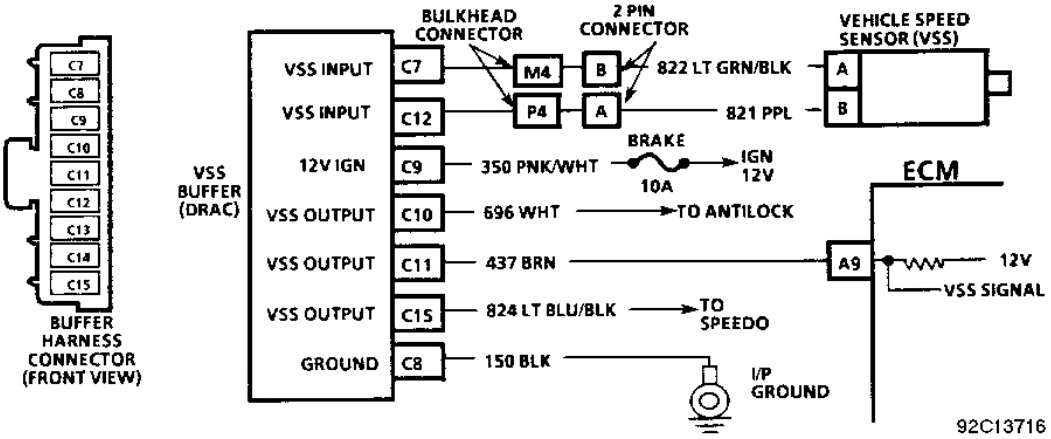


Fig. 255: Code 24, VSS Circuit Diagram (1992 6.2L Diesel)
Courtesy of GENERAL MOTORS CORP.

ECM applies and monitors 12 volts on circuit No. 437. Circuit No. 437 connects to vehicle speed sensor (VSS), which alternately grounds circuit No. 437 when drive wheels are turning. This pulsing action takes place about 2000 times per mile and ECM will calculate vehicle speed based on time between pulses.

Code 24 will set if circuit No. 437 voltage is constant, engine speed is more than 2000 RPM, or vehicle speed signal is less than 5 MPH. All conditions must be met for 40 seconds.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. This test monitors ECM voltage on circuit No. 437. With wheels turning, pulsing action will result in varying voltage. Variation will be greater at low wheel speeds to an average of 4 to 6 volts at about 20 MPH.
2. A voltage of less than one volt at ECM connector indicates circuit No. 437 wire is shorted to ground. Disconnect circuit No. 437 at vehicle speed sensor. If voltage reads above 10 volts, vehicle speed sensor is faulty. If voltage remains less than 10 volts, circuit No. 437 wire is grounded. If circuit No. 437 is not grounded, check for a faulty ECM connector or ECM.
3. A steady 8 to 12 volts at ECM connector indicates circuit No. 437 is open or a faulty vehicle speed sensor.
4. This is a normal voltage which indicates a possible intermittent condition.

Diagnostic Aids

A scan tester reading should closely match speedometer reading. See **Fig. 254**.

CODE 25, MAT SENSOR TEMP. HIGH - 1991 2.5L & 4.3L TURBO

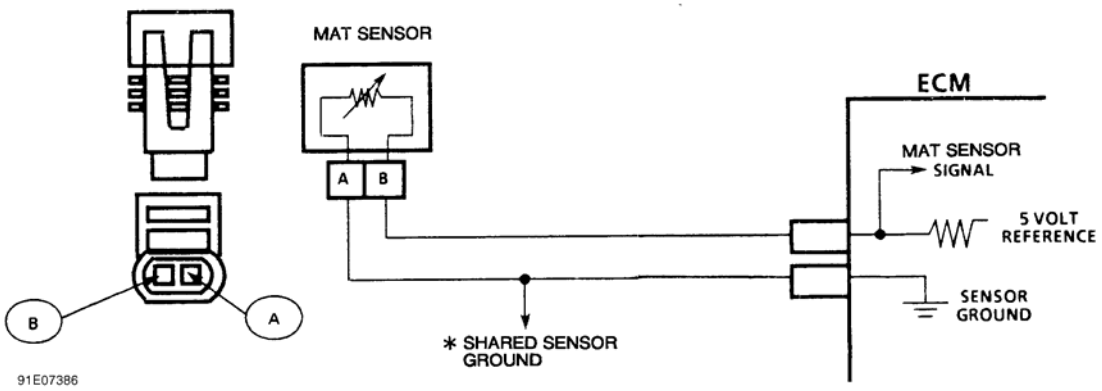


Fig. 256: Code 25, MAT Sensor Circuit Diagram (1991 2.5L & 4.3L Turbo)
Courtesy of GENERAL MOTORS CORP.

CODE 25 ECM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM Terminal	Wire Color
2.5L		
Signal	C12	Tan
MAT Ground	D2	Black/Red
4.3L Turbo		
Signal	GF16	Tan
MAT Ground	BB5	Black/Red

The ECM applies and monitors a voltage signal (4-6 volts) to MAT sensor. When manifold air is cold, the sensor resistance is high and ECM sees a high signal voltage. As air warms, resistance decreases and voltage sensed by the ECM drops. Sensor resistance can be measured at sensor terminals with harness disconnected.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This checks if the code is a hard failure or an intermittent condition. Code 25 will set if a MAT temperature greater than 266°F (130°C) is sensed for more than a precalibrated period.
2. This simulates condition for code 23. If control module recognizes the open circuit and "Scan" tester displays a temperature of less than -30°C, control module and wiring are okay.

Diagnostic Aids

If the engine is allowed to cool overnight, the coolant and MAT sensors should read close to each other, when measured with a Scan tester. A Code 25 will also result if signal and ground circuits become open. Refer to **TEMPERATURE-TO-RESISTANCE VALUES** table.

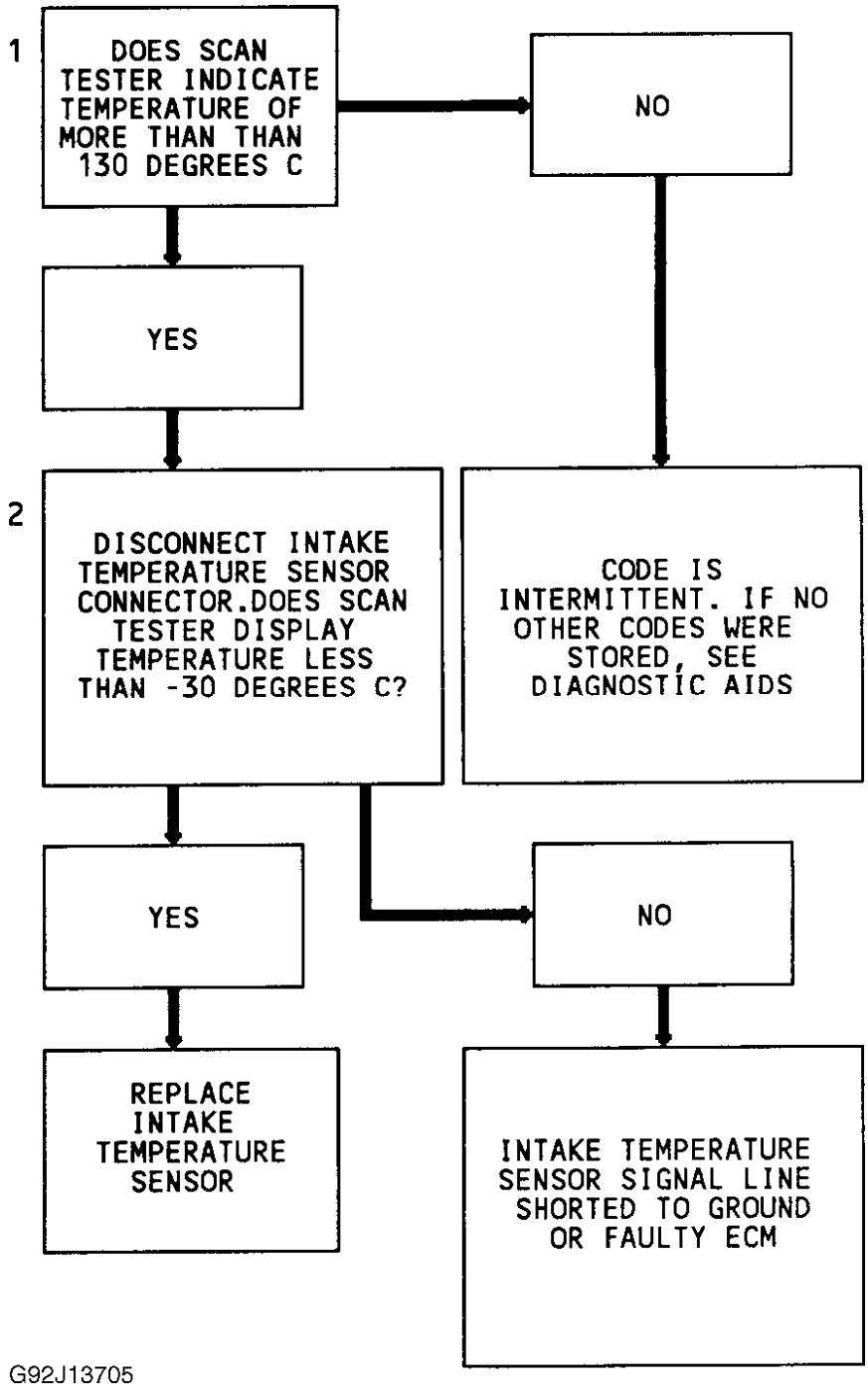


Fig. 257: Code 25, MAT Sensor Troubleshooting Chart (1991 2.5L & 4.3L Turbo)
Courtesy of GENERAL MOTORS CORP.

CODE 25, MAT SENSOR TEMP. HIGH - 1992 2.5L & 4.3L TURBO

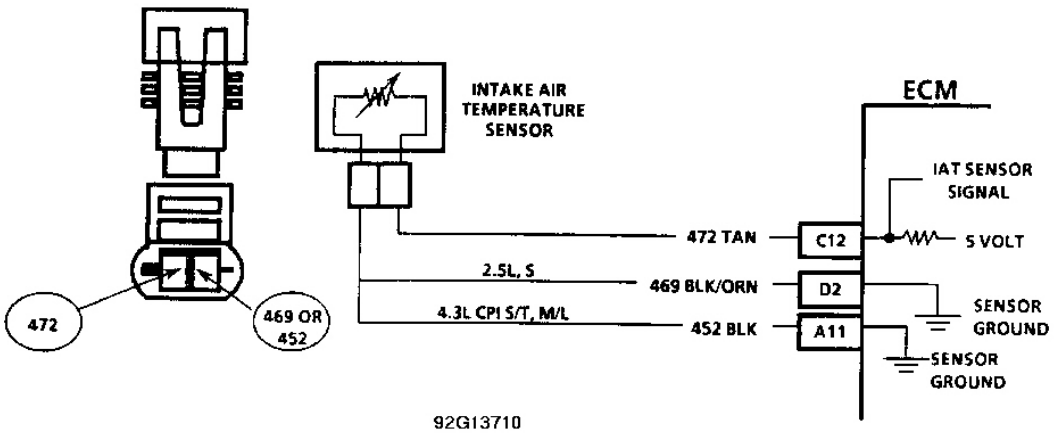


Fig. 258: Code 25, MAT Sensor Circuit Diagram (1992 2.5L & 4.3L Turbo)
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Code 25 will set if signal voltage indicates a intake air temperature above 302° for 2 seconds, time since engine start is one minute or longer or vehicle speed signal is present.

Diagnostic Aids

A scan tester reads temperature of air entering engine and should read close to ambient air temperature when engine is cold, and rises as underhood temperature increases. Carefully check harness and connections for possible short to ground in circuit No. 472.

Temperature to resistance value scale may be used to test sensor at various temperature levels to evaluate the possibility of malfunctioning sensor. This condition could cause a driveability problem.

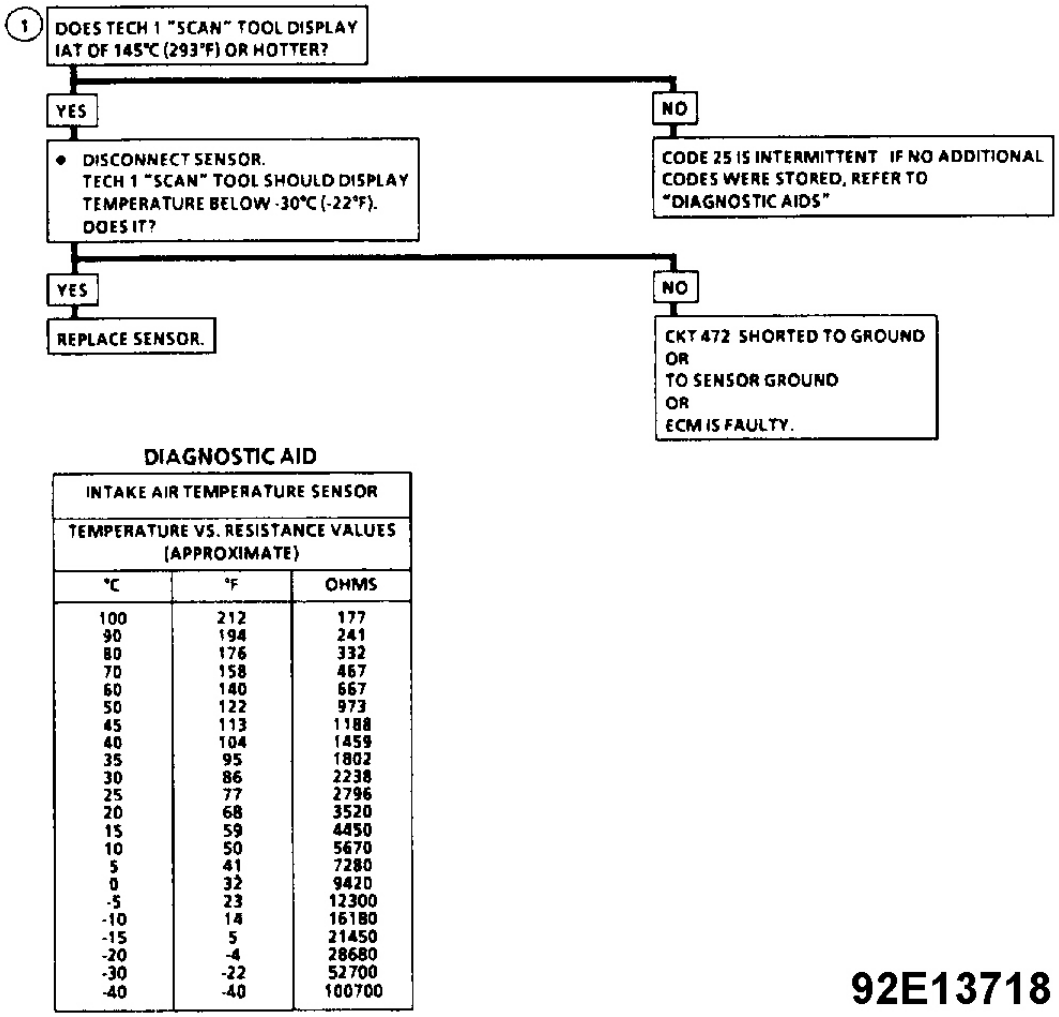


Fig. 259: Code 25, MAT Sensor Circuit Diagram (1992 2.5L & 4.3L Turbo)
Courtesy of GENERAL MOTORS CORP.

CODE 28, PRESSURE SWITCH MANIFOLD FAULT (LT. TRUCK)

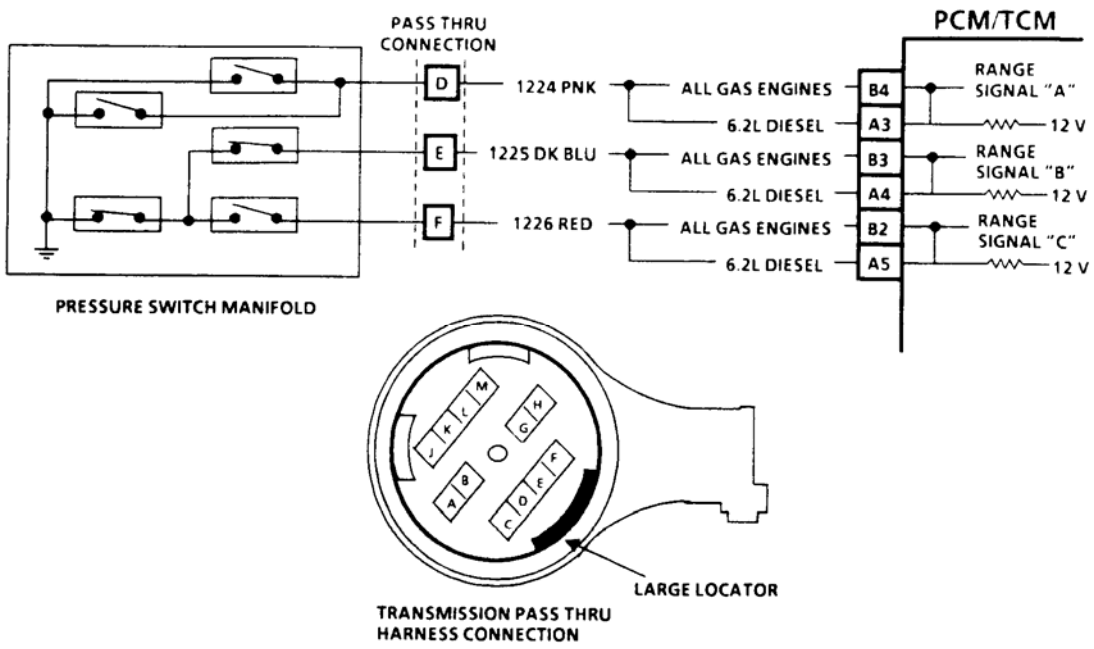


Fig. 260: Code 28, Pressure Switch Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

The Pressure Switch Manifold (PSM) is actually 5 pressure switches combined into one unit and mounted on the transmission valve body. The PCM/TCM supplies battery voltage to the PSM on 3 separate wires. By grounding one or more of these circuits through various combinations of the pressure switches inside the pressure switch manifold, the PCM/CM detects what gear range has been selected by the vehicle operator.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test compares the indicated range to the range actually selected.
2. This test checks for correct voltage from the PCM/TCM to the transmission pass-thru connector.
3. This test will detect a short to ground in any one of the 3 PSM range circuits.

Diagnostic Aids

Code 28 will set if PCM/TCM detects one of 2 "illegal" PSM combinations. See **VALID PSM COMBINATION CHART** table for various combinations. Check pass-thru connector for good contact.

VALID PSM COMBINATION CHART

Application	A	B	C
Park	12	0	12
Reverse	0	0	12
Neutral	12	0	12
4th	12	0	0

3rd	12	12	0
2nd	12	12	12
1st	0	12	12
Illegal	0	12	0
Illegal	0	0	0

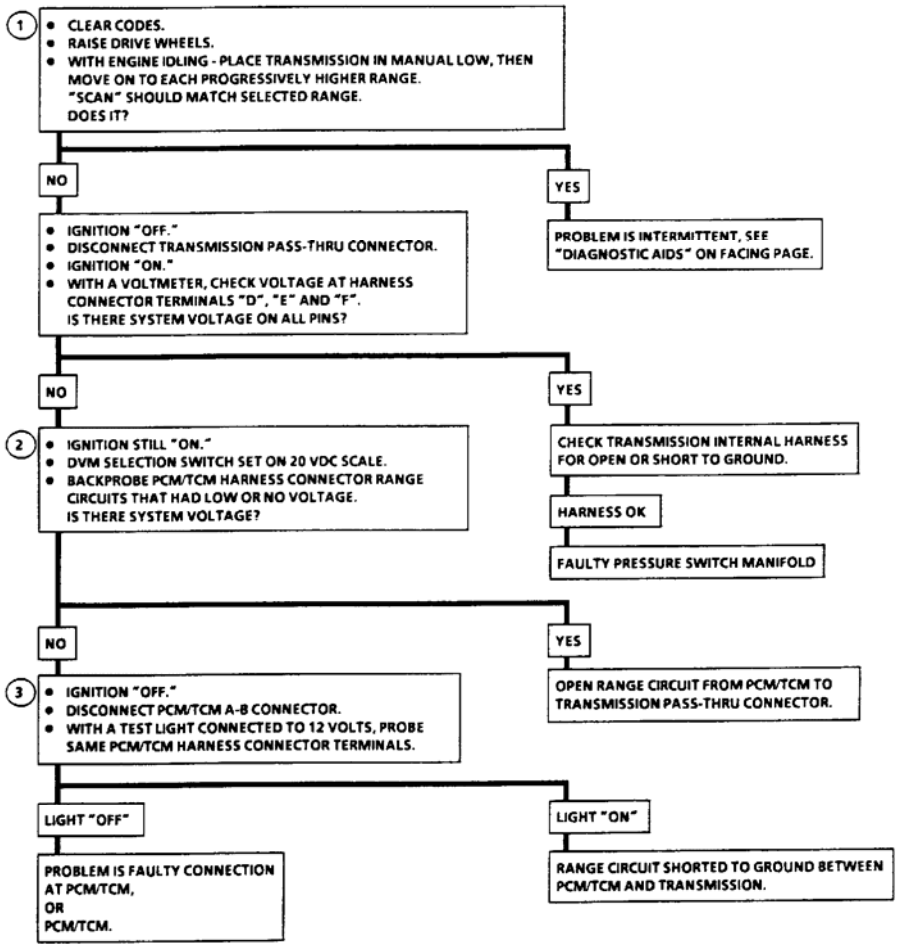


Fig. 261: Code 28, Pressure Switch Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 39, TORQUE CONVERTER CLUTCH STUCK IN "OFF" POSITION - LT. TRUCK

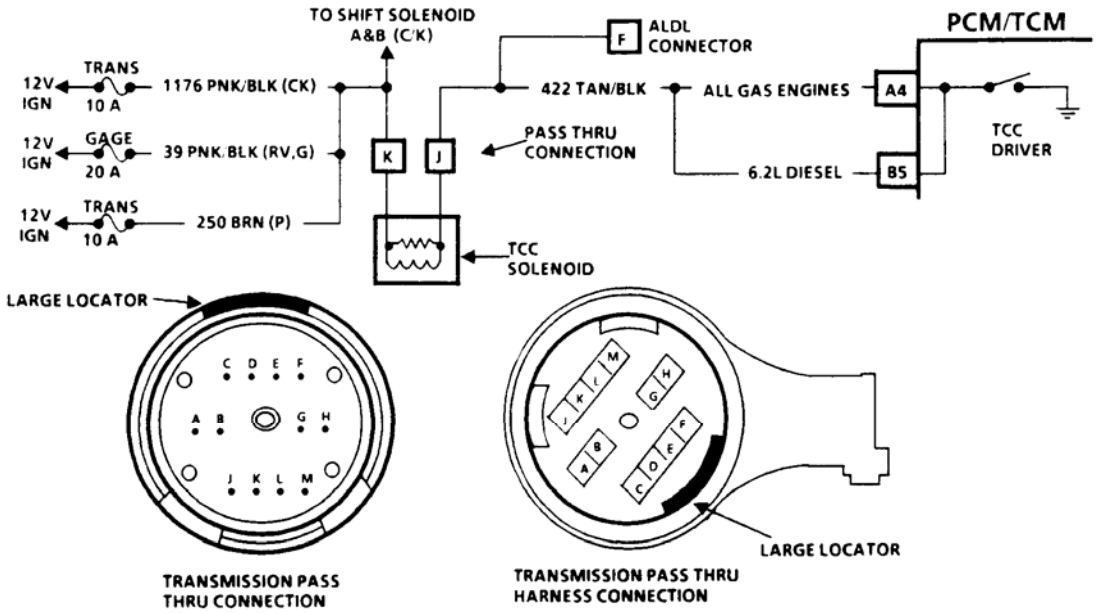


Fig. 262: Code 39, TCC Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

The purpose of the automatic transmission Torque Converter Clutch (TCC) feature is to eliminate power loss of the torque converter stage when vehicle is in a cruise condition. This allows the convenience of the automatic transmission, and fuel economy of a manual transmission.

Fused battery ignition voltage is supplied to the TCC solenoid, which is used inside the valve body to shift a spool valve to modulate pressure to the TCC. This modulated pressure normally allows some slight slippage of TCC.

The PCM/TCM will engage TCC by grounding circuit No. 422, energizing the solenoid.

Code 39 will set under the following conditions:

- TCC is engaged.
- TCC "slip" is greater than 65 RPM for 2 seconds.
- 2nd or 3rd gear is selected or indicated.

NOTE: Test numbers refer to test number on diagnostic chart.

1. This test determines if transmission is receiving a TCC Command from the pass-thru connector. If bidirectional Scan tester is not available, TCC may be activated by grounding ALDL test terminal B with ignition on and engine off.
2. This test checks for power to transmission.
3. This test determines if PCM/TCM is commanding TCC to be on.

Diagnostic Aids

Clear codes and re-check for Code 39. if code resets, problem could be internal to the transmission. Code 39 will only set in 3rd gear. TCC slip in 4th gear will set Code 68.

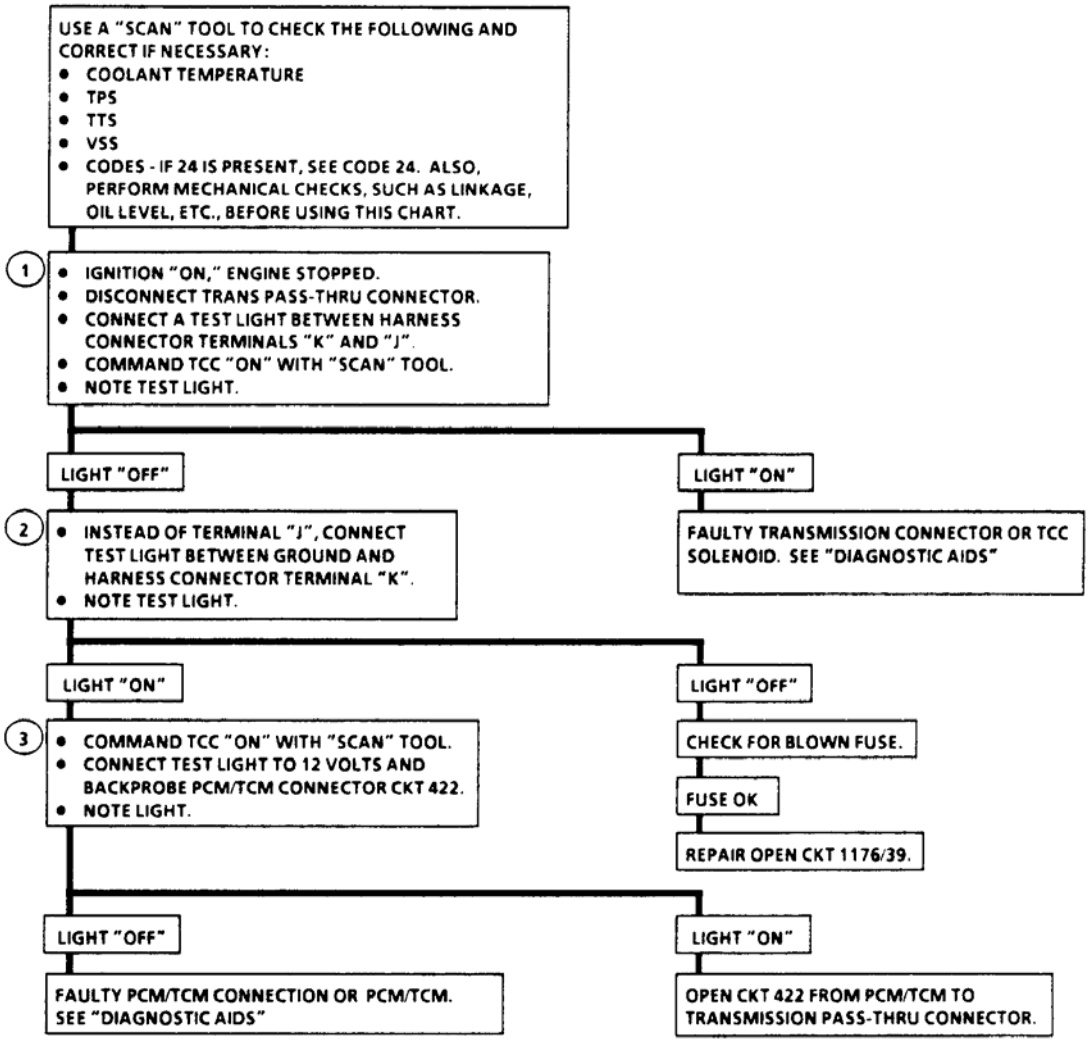


Fig. 263: Code 39, TCC Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 53, SYSTEM VOLTAGE HIGH - LT. TRUCK

Code 53 will set when ignition is on and PCM terminal D1 voltage is greater than 19.5 volts for about 2 seconds. During the time the failure is present, the force motor is turned off, transmission immediately shifts to 2nd gear, and TCC operation is inhibited. The sensing of additional codes may result.

NOTE: Test number refer to test numbers on diagnostic chart.

1. Normal battery voltage is 10-17.0 volts.
2. This test checks if high voltage reading is due to the alternator circuit No. 440 or PCM. With engine running, check voltage at battery. If voltage is greater then 19.5 volts, the PCM is okay.
3. This test checks if alternator is faulty under load condition. If voltage is greater than 19.5 volts, check alternator.

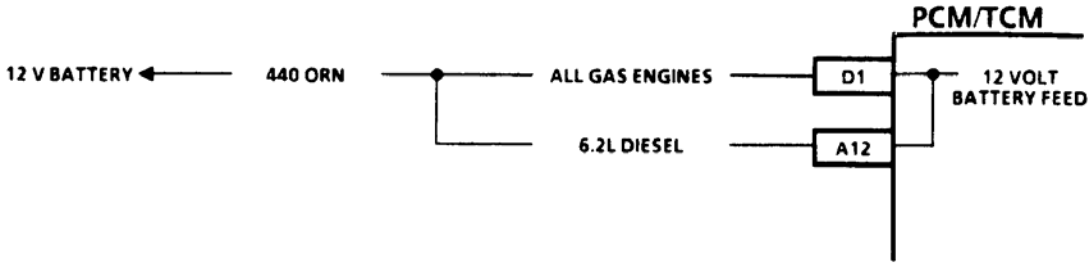


Fig. 264: Code 53, System Voltage High Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

Notes On Intermittents

Jump-starting engine, and charging battery with a battery charger may set Code 53. If code is set when an accessory is operated, check for poor connections or excessive current draw. Also, check for poor connections at starter solenoid or fusible link.

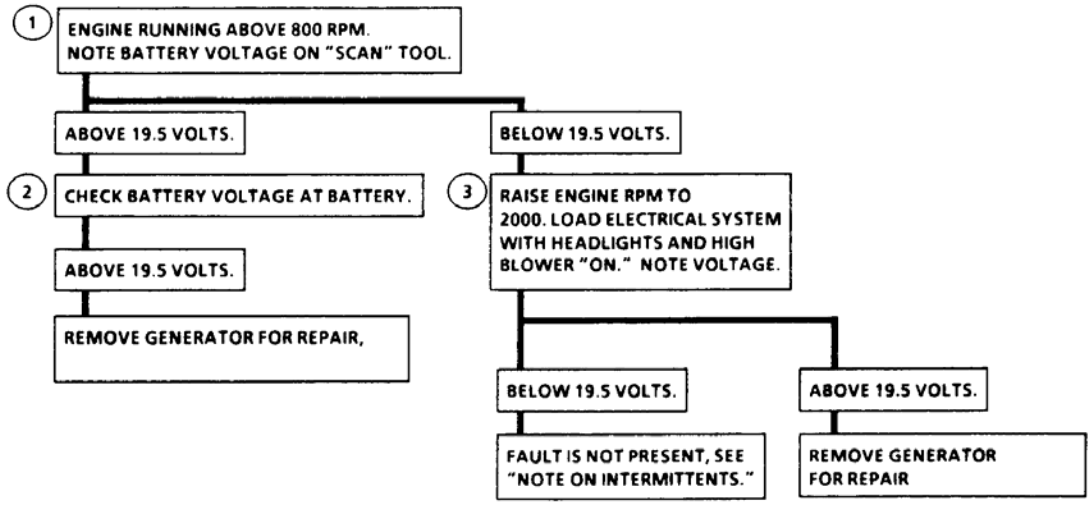


Fig. 265: Code 53, System Voltage High Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 58, TRANSMISSION TEMPERATURE SENSOR CIRCUIT (HIGH TEMPERATURE INDICATED) - LT. TRUCK

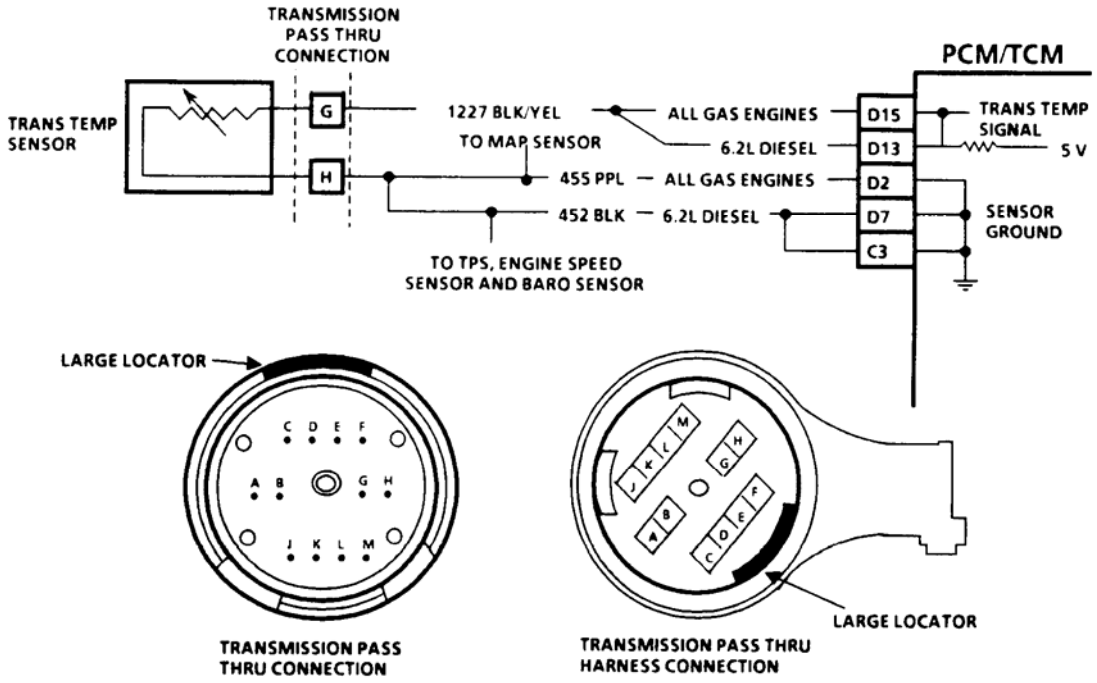


Fig. 266: Trans. Temp. Sensor Circuit (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

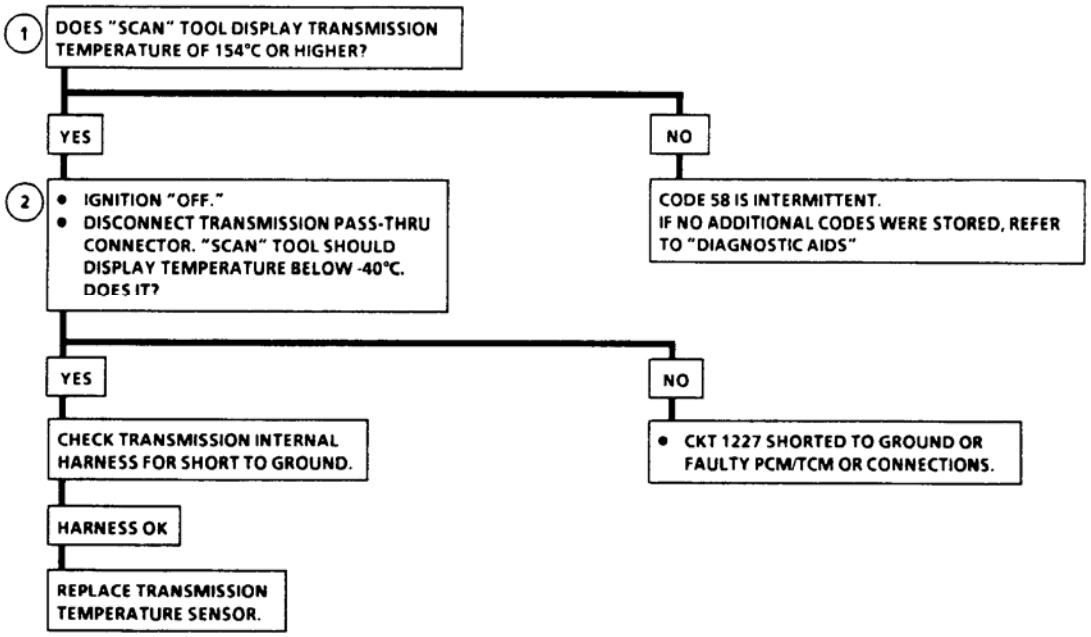
The transmission temperature sensor is a thermistor which controls the signal voltage to the PCM/TCM. The PCM/TCM applies and monitors voltage on circuit No. 1227 to the sensor. When transmission is cold sensor resistance is high; therefore, the PCM/TCM will see high signal voltage. As the transmission warms up, sensor resistance and voltage will drop. At normal transmission operating temperature of 212°F (100°C), voltage will be about 1.5-2.0 volts.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Code 58 will set if signal voltage indicates a transmission temperature greater than 309°F (154°C) for one second.
2. This test determines if circuit No. 1227 is shorted to ground, which will result in conditions for Code 58.

Diagnostic Aids

Check harness routing for a potential short to ground in circuit No. 1227. Scan tester displays transmission temperature in degrees Centigrade. After transmission is running, the temperature display should rise steadily to about 100°C then stabilize. Test the transmission sensor at various temperature levels to determine if sensor is out of calibration See TRANSMISSION SENSOR - TEMPERATURE TO RESISTANCE chart. An out-of-calibration sensor could result in delayed shifts; or TCC enabled complaint.



DIAGNOSTIC AID

TRANSMISSION SENSOR - TEMP TO RESISTNACE (APPROXIMATE)

°C	°F	MINIMUM RESISTANCE	NOMINAL RESISTANCE	MAXIMUM RESISTANCE
-40°C	-40°F	80965	100544	120123
-30°C	-20°F	42701	52426	62151
-20°C	-4°F	23458	28491	33524
-10°C	14°F	13366	16068	18770
0°C	32°F	7871	9370	10869
10°C	50°F	4771	5640	6508
20°C	68°F	2981	3500	4018
30°C	86°F	1915	2232	2550
40°C	104°F	1260	1460	1660
50°C	122°F	848.8	977.1	1105
60°C	140°F	584.1	668.7	753.4
70°C	158°F	410.3	467.2	524.2
80°C	176°F	293.7	332.7	371.7
90°C	194°F	213.9	241.0	268.2
100°C	212°F	158.1	177.4	196.8
110°C	?	118.8	132.6	146.5
120°C	?	90.40	100.6	110.8
130°C	?	69.48	77.29	85.11
140°C	?	53.96	60.13	66.29
150°C	?	42.43	47.31	52.20

Fig. 267: Code 58, Trans. Temp. Sensor Troubleshooting Chart (High Temp. - Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 59, TRANSMISSION TEMPERATURE SENSOR CIRCUIT (LOW TEMPERATURE INDICATED) - LT. TRUCK

The transmission temperature sensor is a thermistor which controls signal voltage to PCM/TCM. The PCM/TCM applies and monitors 5 volts to the sensor on circuit No. 1227. When transmission is cold, sensor resistance is high; therefore, the PCM/TCM will see high signal voltage. As transmission temperature warms up, sensor resistance and voltage drop. At normal transmission operating temperature of 212°F (100°C), voltage

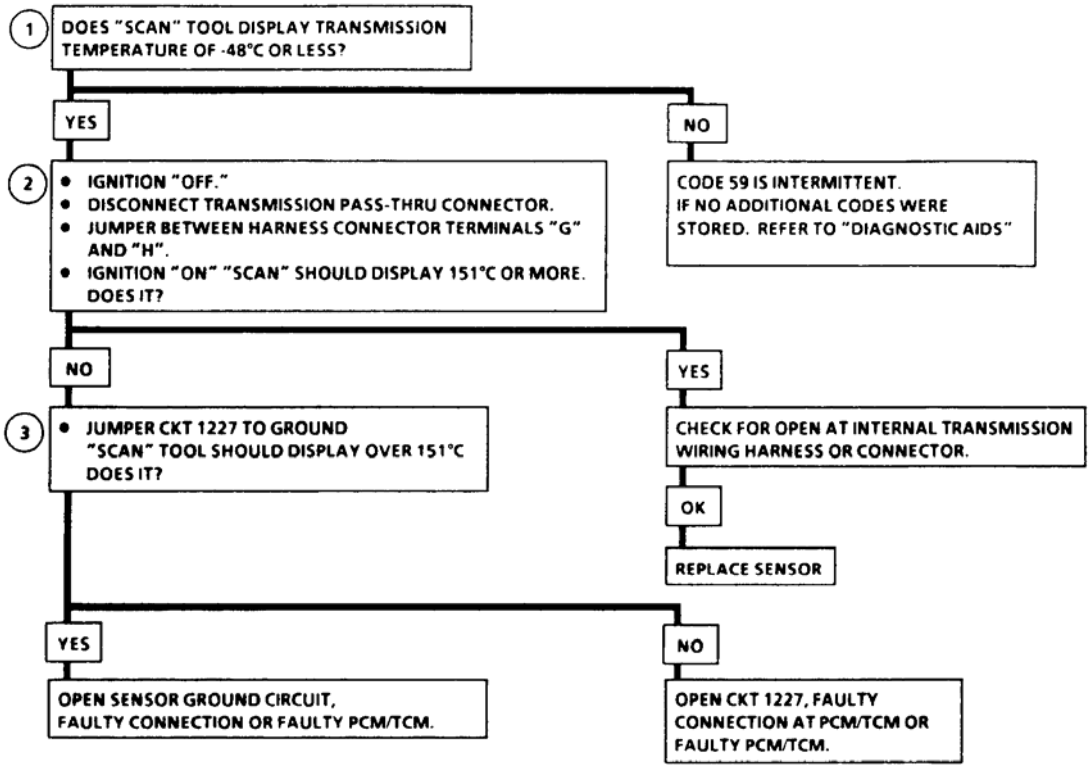
will be about 1.5-2.0 volts. See **Fig. 266**.

NOTE: The number refer to test numbers on diagnostic chart.

1. Code 59 will set if signal voltage indicates a transmission temperature less than -54°F (-48°C) for one second.
2. This test simulates Code 58. If PCM/TCM recognizes the low signal voltage (high temperature) and Scan tester reads 304°F (151°C) or greater, the PCM/TCM and wiring are okay.
3. This test determines if circuit No. 1227 is open. There should be 5 volts present at the sensor connector if measuring with a DVOM.

Diagnostic Aids

Scan tester displays transmission temperature in degrees centigrade After transmission is running, the displayed temperature should rise steadily to about 212°F (100°C) then stabilize. A faulty connection or an open in circuit No. 455 or circuit No. 1227 will result in a Code 59. Test the coolant sensor at various temperature levels to determine if sensor is out of calibration. See TRANSMISSION SENSOR - TEMPERATURE TO RESISTANCE chart. An out-of-calibration sensor could result in firm shifts, or TCC enabled complaint.



DIAGNOSTIC AID

TRANSMISSION SENSOR - TEMP TO RESISTANCE (APPROXIMATE)

°C	°F	MINIMUM RESISTANCE	NOMINAL RESISTANCE	MAXIMUM RESISTANCE
-40°C	-40°F	80965	100544	120123
-30°C	-20°F	42701	52426	62151
-20°C	-4°F	23458	28491	33524
-10°C	14°F	13366	16068	18770
0°C	32°F	7871	9370	10869
10°C	50°F	4771	5640	6508
20°C	68°F	2981	3500	4018
30°C	86°F	1915	2232	2550
40°C	104°F	1260	1460	1660
50°C	122°F	848.8	977.1	1105
60°C	140°F	584.1	668.7	753.4
70°C	158°F	410.3	467.2	524.2
80°C	176°F	293.7	332.7	371.7
90°C	194°F	213.9	241.0	268.2
100°C	212°F	158.1	177.4	196.8
110°C	?	118.8	132.6	146.5
120°C	?	90.40	100.6	110.8
130°C	?	69.48	77.29	85.11
140°C	?	53.96	60.13	66.29
150°C	?	42.43	47.31	52.20

Fig. 268: Code 59, Trans. Temp. Sensor Troubleshooting (Low Temp. - Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 68, OVERDRIVE RATIO ERROR - LT. TRUCK

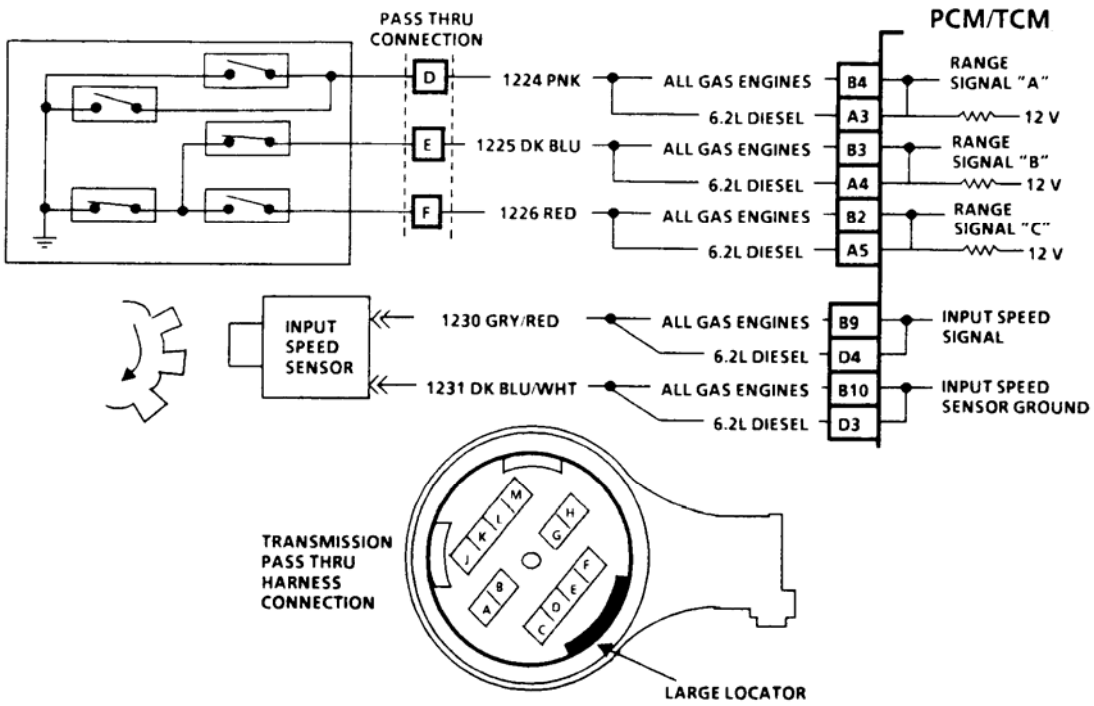


Fig. 269: Code 68, Overdrive Ratio Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

The PCM/TCM monitors the difference in engine RPM and input shaft RPM. With transmission in Drive, Scan tester reading should show engine speed closely matching input speed.

NOTE: Test numbers refer to test number on diagnostic chart.

1. Code 68 with set under the following conditions: engine speed is 200 RPM greater than input speed, 4th gear is indicated, TCC is enabled, or If all conditions are met for 2 seconds. 2 This test monitors signal sent to the PCM/TCM from transmission.
2. This test confirms engine RPM signal to PCM/TCM.

Diagnostic Aids

Check for spread connectors at pass-through connector. Code 68 will set when going to default (2nd gear).

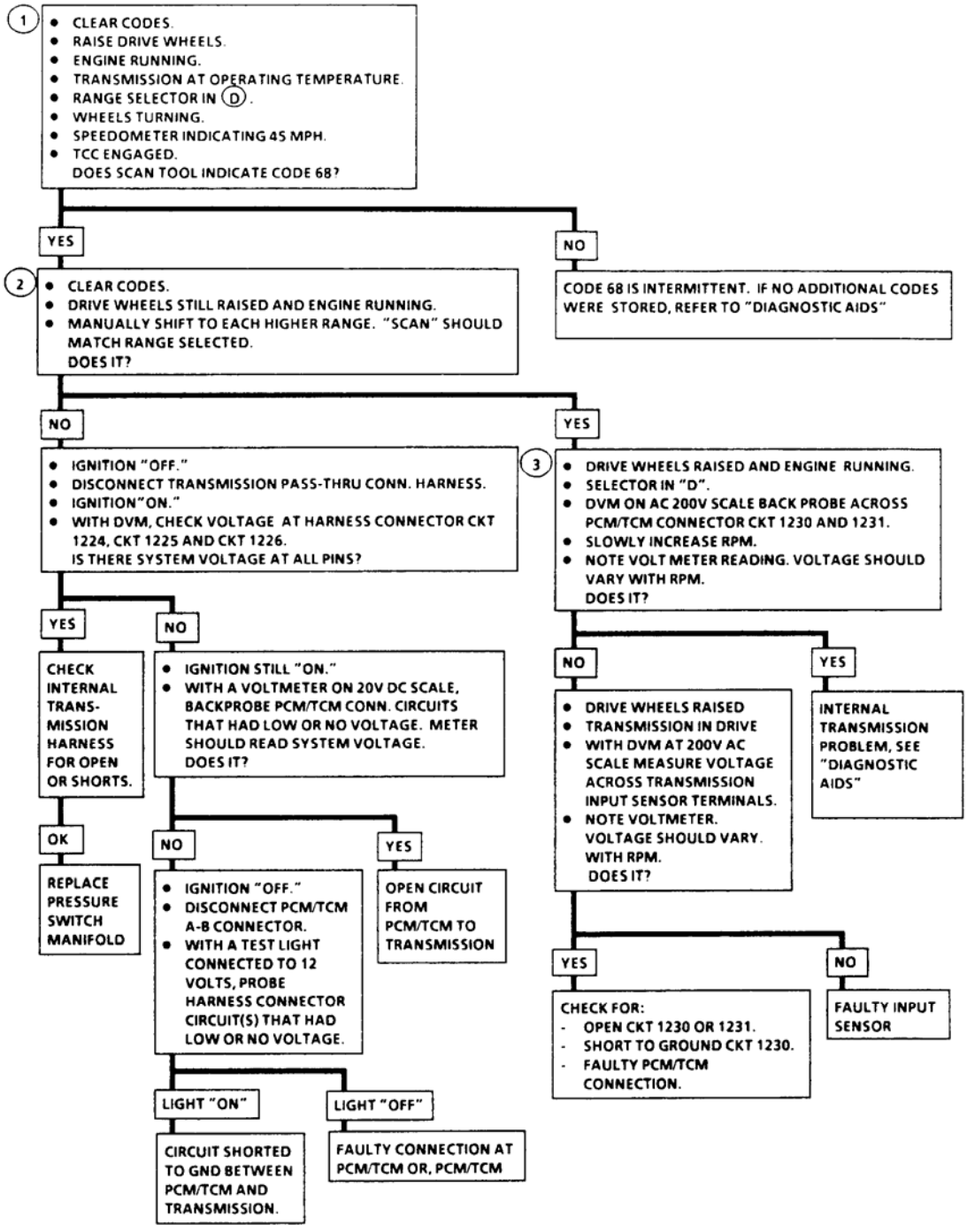


Fig. 270: Code 68, Overdrive Ratio Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 73, FORCE MOTOR CURRENT (CURRENT ERROR) - LT. TRUCK

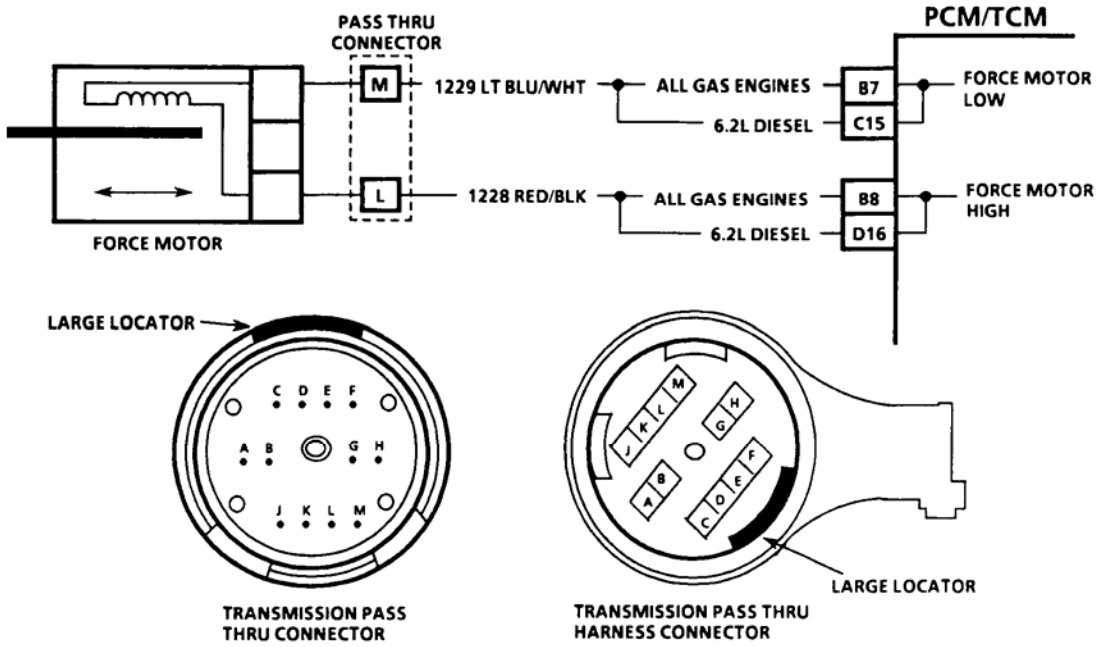


Fig. 271: Code 73, Force Motor Current Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

NOTE: This flow chart requires the use of a bidirectional (Tech 1) Scan tester.

The force motor is a PCM/TCM-controlled device used to regulate transmission line pressure. The PCM/TCM looks at TPS voltage, engine RPM and other inputs to determine appropriate line pressure for a given load, then regulates the pressure by applying a varying amperage. The applied amperage can vary from 1-1.1 amps.

The PCM/TCM then monitors amperage at the return line. If the return amperage varies more than .16 amp from the commanded amperage or the duration of at least one second, Code 73 will set. Once Code 73 is set, the force motor is disabled and full line pressure will be applied until the next time the ignition switch is cycled. Code 73 will remain stored, but the force motor will resume normal function until the conditions for Code 73 re-occur.

NOTE: The numbers refer to test numbers on diagnostic chart.

1. This procedure verifies an amperage difference of .16 amp or more, and tests the PCM/TCM's ability to control amperage to the force motor.
2. This test checks the force motor for internal shorts

Diagnostic Aids

Check for poor connections at PCM/TCM and transmission pass-thru connector.

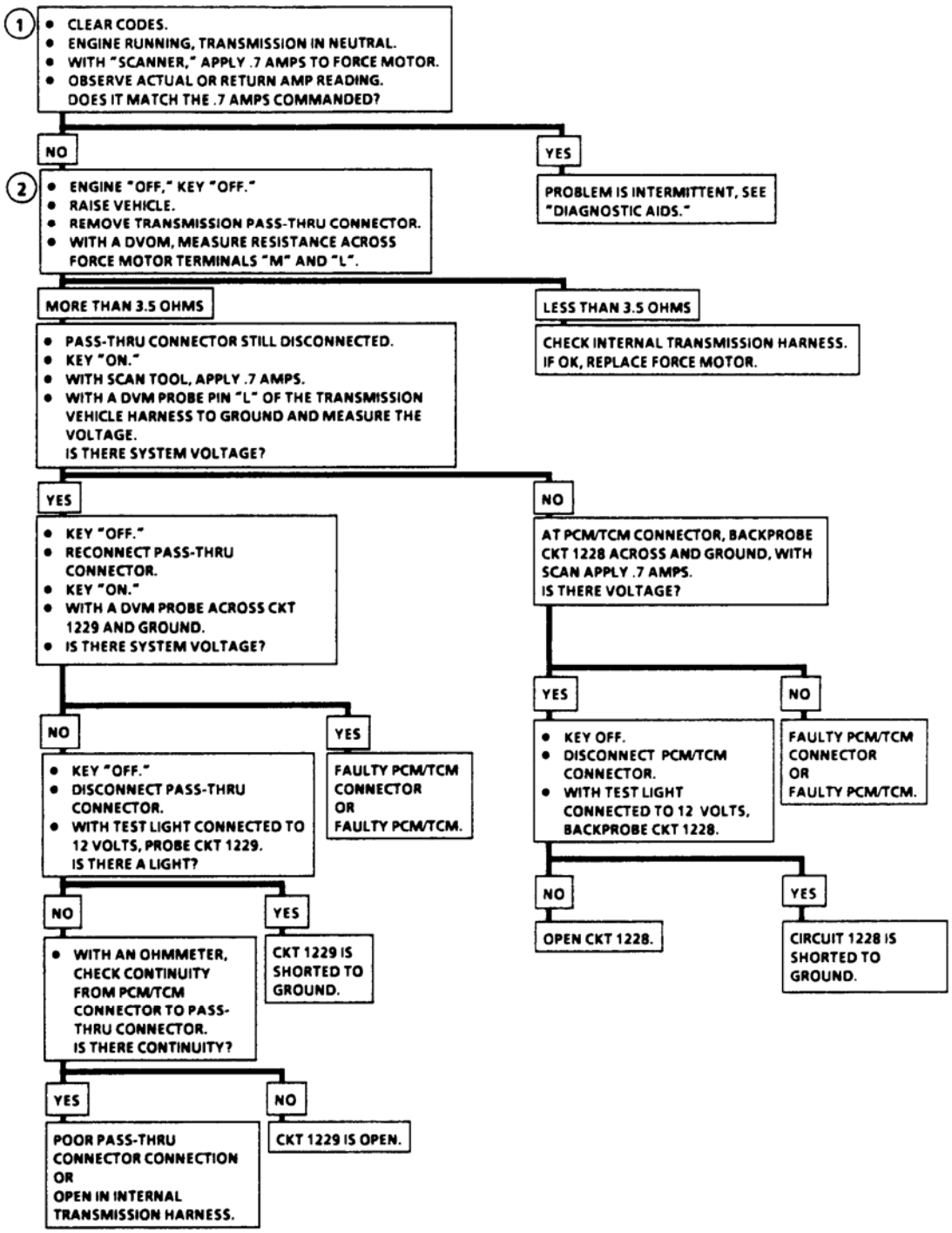


Fig. 272: Code 73, Force Motor Current Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 75, SYSTEM VOLTAGE LOW - LT. TRUCK

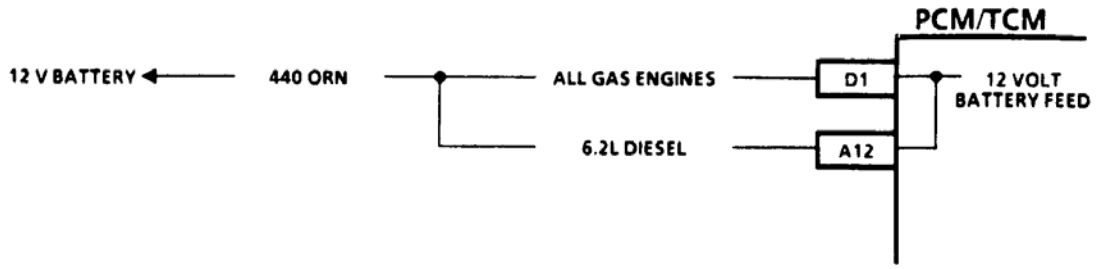


Fig. 273: Code 75, System Voltage Low Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

Code 75 will set when ignition is on and PCM terminal D1 voltage is less than 8.6 volts for about 4 seconds. During the time the failure is present, the force motor is turned off, maintaining only 2nd gear, and inhibiting 4th gear and TCC operation.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Normal battery voltage is 10-17.0 volts.
2. This test checks if the low voltage reading is due to the alternator, circuit No. 440 or PCM/TCM . With engine running, check voltage at the battery. If voltage is less than 8.6 volts, PCM/TCM is okay.

Note On Intermittents

If Code sets when an accessory is operated, check for poor connections or excessive current draw. Also, check for poor connections at starter solenoid or fusible link. Minimum voltage allowed or Code 75 to set is on a graduated scale, and will change with temperature. Minimum voltage at -40°F (-40°C) is 6.7 volts. Minimum voltage at 304°F 150°C) is 10.5 volts, and minimum voltage at 194°F (90°C) is 8.6 volts.

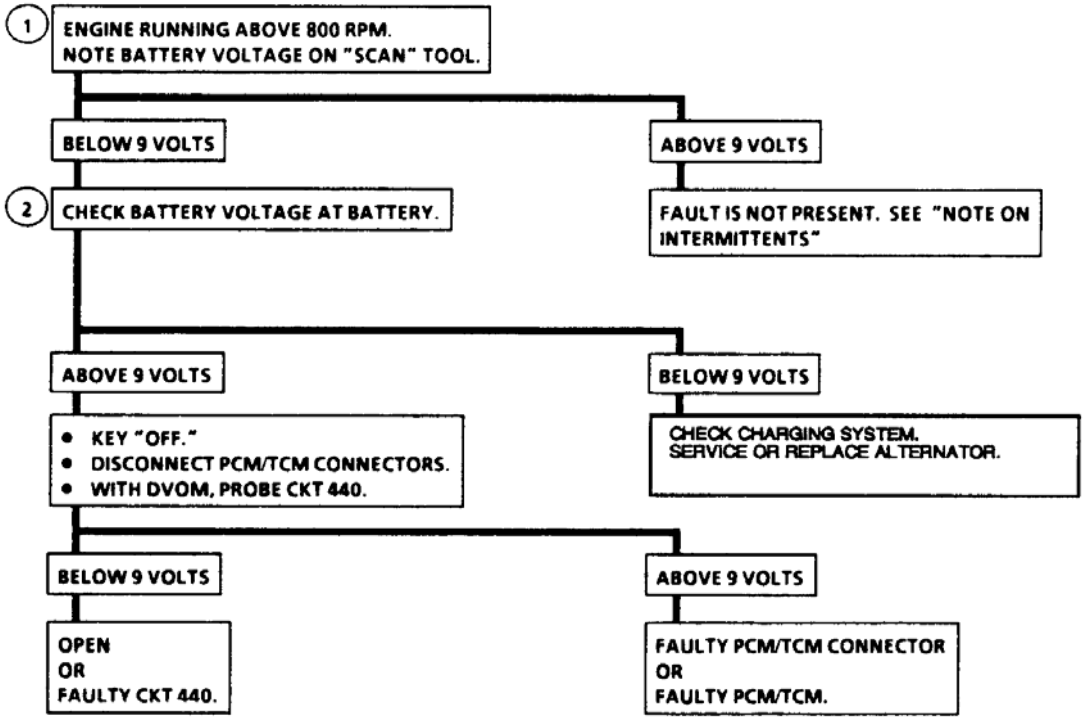


Fig. 274: Code 75, System Voltage Low Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 81, QDM FAULT SOLENOID "B" - LT. TRUCK

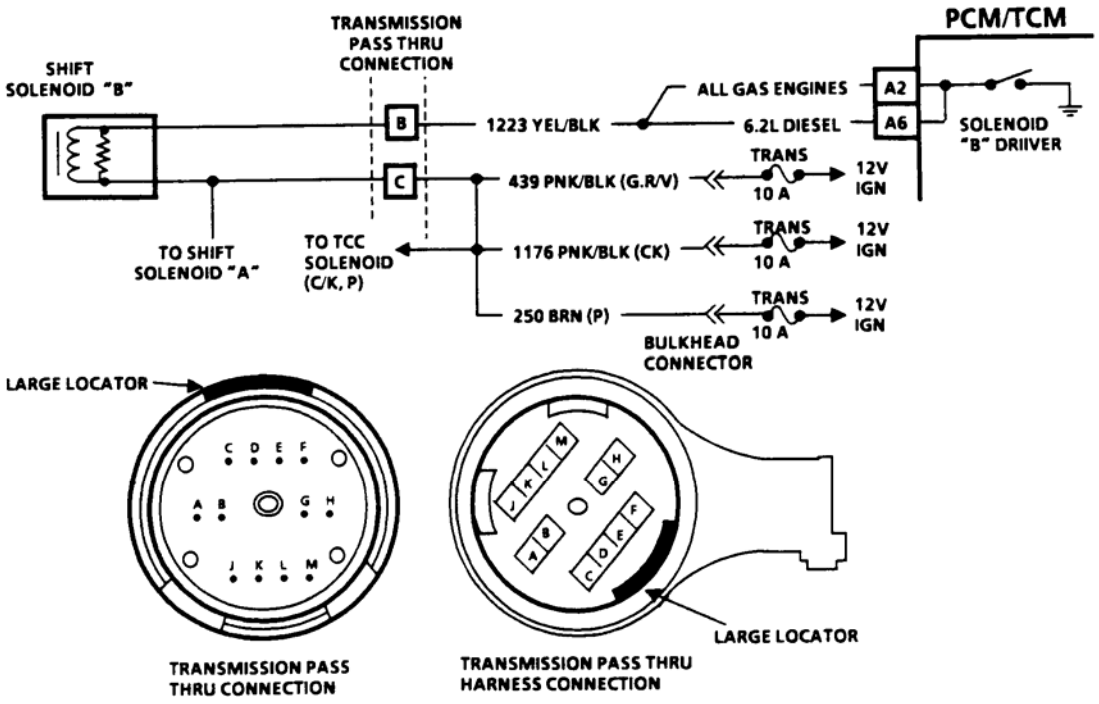


Fig. 275: Solenoid "B" Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

The PCM/TCM continually monitors voltage on each circuit connected to the quad driver, looking for either low or high voltage, depending on the commanded state of the devices connected to it. Code 81 will set if a fault has been detected on the shift solenoid "B" circuit. For example, if shift solenoid a is commanded on by this PCM/TCM, voltage on that circuit should drop when solenoid is grounded. If voltage stays up for at least .5 second, Code 61 will set. The opposite is also true. If shift solenoid "B" is off, voltage on the circuit should remain high. If voltage drops for more than .5 second, Code 81 will set.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This procedure checks shift solenoid "B" and internal transmission wiring for shorts.
2. This test checks for power, from the ignition through transmission fuse, to shift solenoid "B".
3. This test ensures circuit No. 1223 is not shorted to ground.
4. This test checks PCM/TCM's ability to ground or control shift solenoid "B". If bidirectional Scan tester is not available, solenoid may be activated by grounding ALDL test terminal "B" with ignition on and engine off.
5. This test ensures circuit No. 1223 is not shorted to ground.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector.

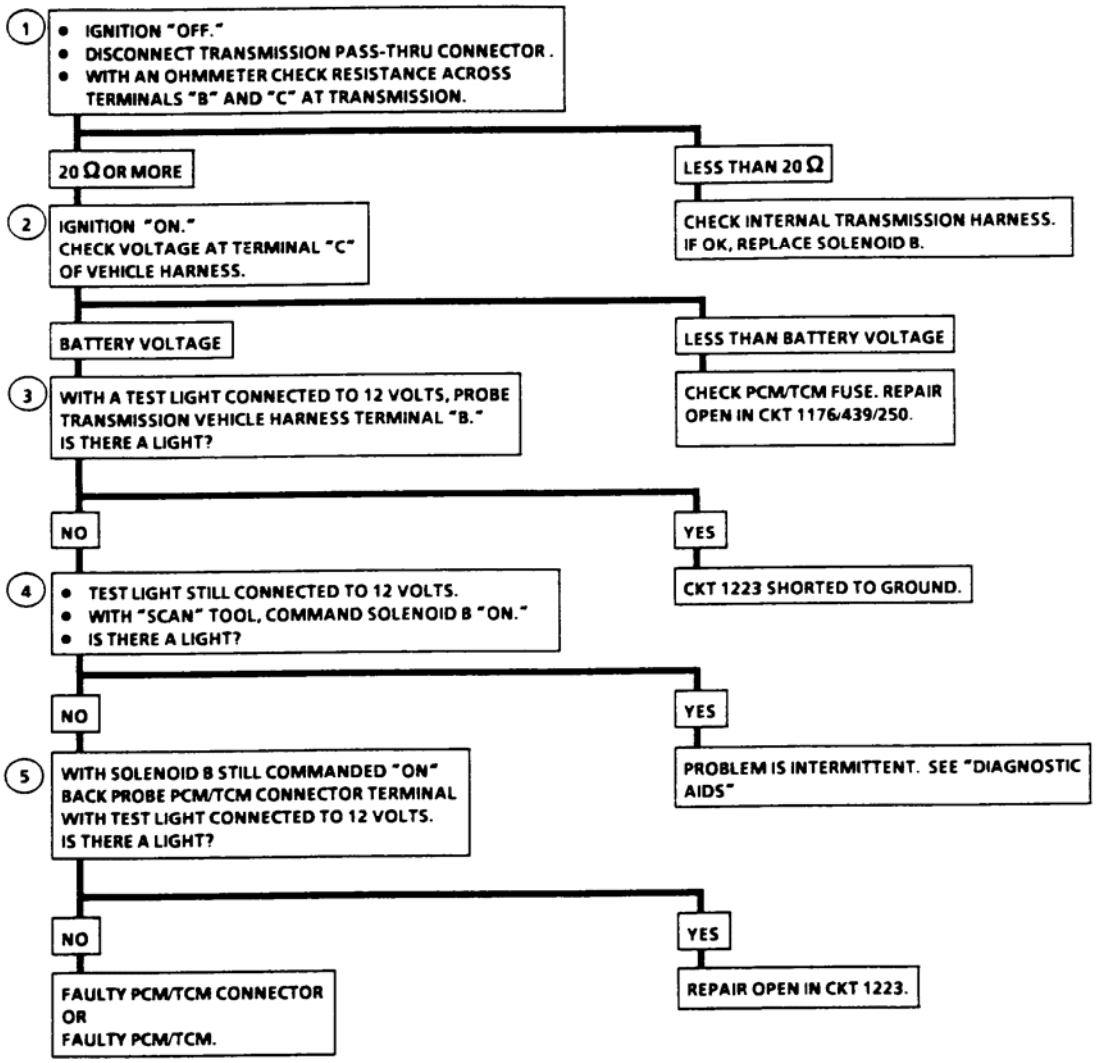


Fig. 276: Code 81, QDM Fault Solenoid "B" Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 82, QDM FAULT SOLENOID "A" - LT. TRUCK

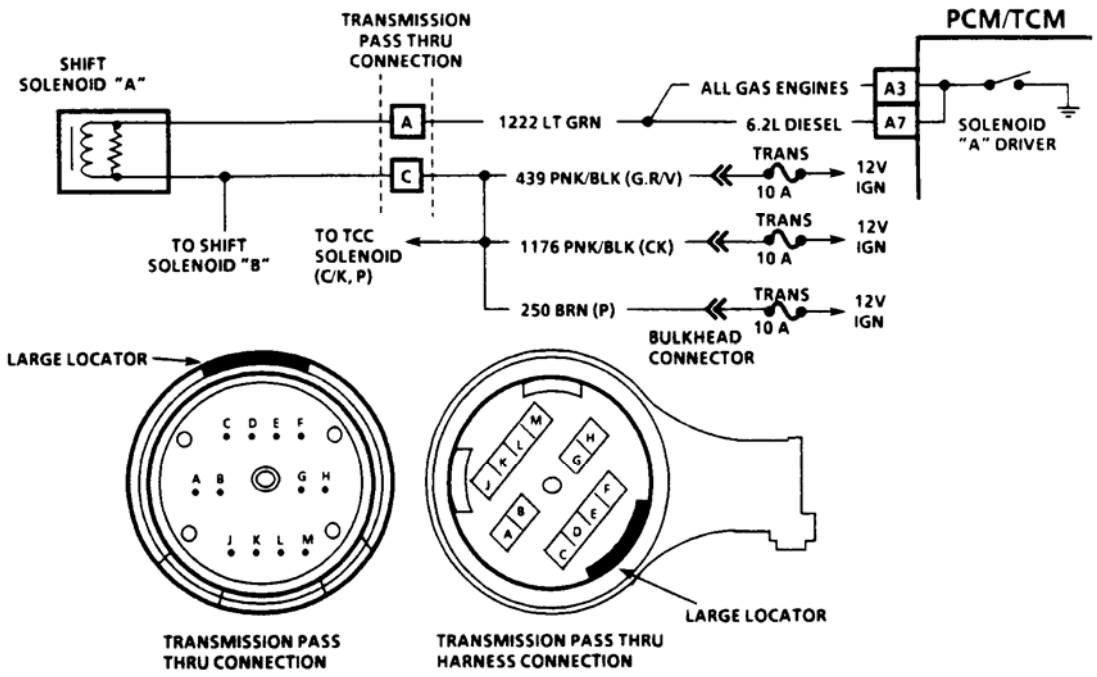


Fig. 277: Code 82, QDM Fault Solenoid "A" Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

The PCM/TCM continually monitors each circuit connected to the quad-driver or either low or high voltage, depending on the commanded state of the device connected to it. Code 82 will set if there is a fault detected on the shift solenoid "A" circuit. For example, if shift solenoid "A" is commanded on by the PCM/TCM, then voltage on circuit should drop as soon as solenoid is grounded.

However, it voltage remains high for 2 seconds after the "on" command is given, Code 82 will set. The opposite is also true. If shift solenoid "A" is off, voltage on the circuit should be high. If voltage drops for .5 second or longer, Code 82 will set.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This procedure checks shift solenoid "A" and internal transmission wiring harness for shorts.
2. This test checks for power, from the ignition through the fuse, to the shift solenoid.
3. This test checks circuit No. 1222 for short to ground.
4. This test checks PCM/TCM's ability to ground or control shift solenoid "A". If bidirectional Scan tester is not available, solenoid may be activated by grounding ALDL test terminal with ignition on and engine off.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector.

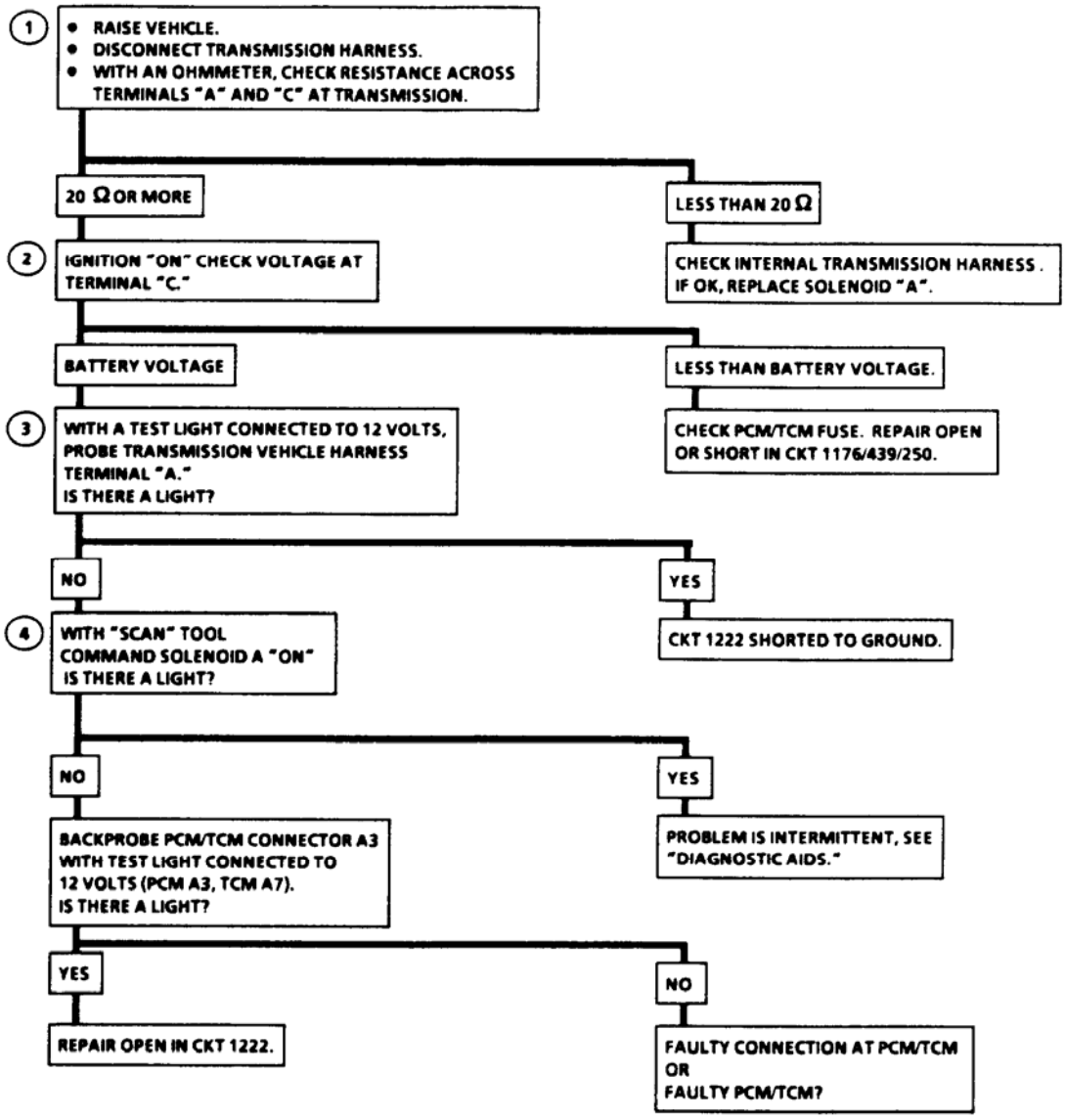


Fig. 278: Code 82, QDM Fault Solenoid "A" Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 83, TCC QDM FAULT - LT. TRUCK

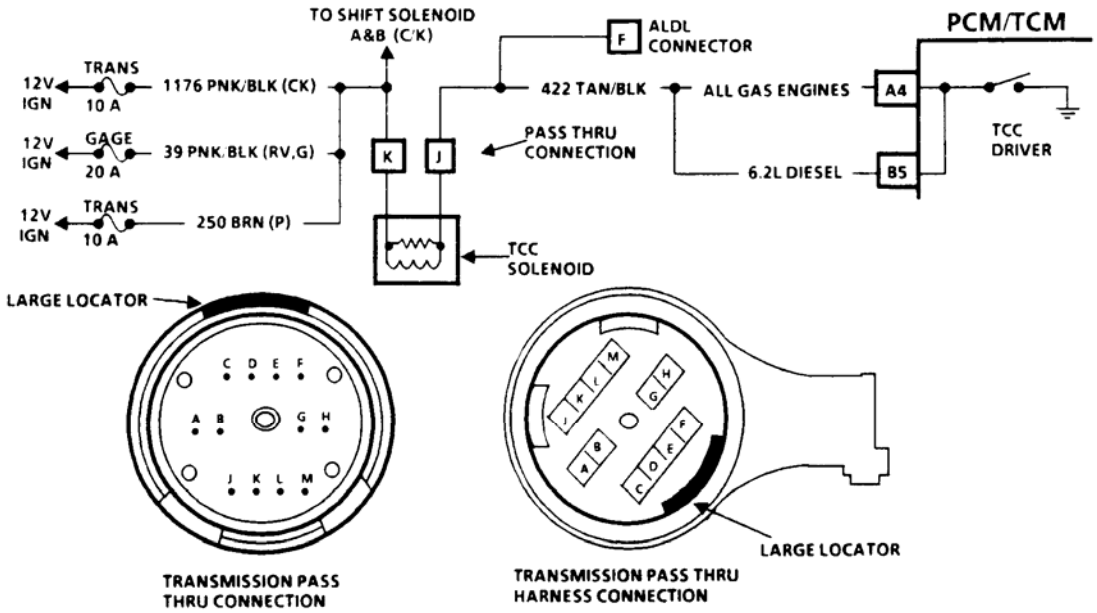


Fig. 279: Code 83, TCC QDM Fault Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

The PCM/TCM continually monitors voltage on each circuit connected to the quad-driver for either low or high voltage, depending on the commanded state of the device connected to it. Code 83 will set if PCM/TCM detects an inappropriate reading on the TCC circuit. For example, if the TCC duty cycle is zero, but voltage on the TCC circuit drops as if the solenoid were on, then Code 83 will set. The TCC solenoid, because of its large current draw, is connected to 2 terminals of a single quad driver.

NOTE: Test number refers to test number on diagnostic chart.

1. This test checks for low resistance in the solenoid or internal transmission harness. This test also determines which circuit triggered the fault. If bidirectional Scan tester is not available, TCC may be activated by grounding ALDL test terminal "B" with ignition on and engine off.

Diagnostic Aids

Check all connections. especially those at the transmission pass-through connector.

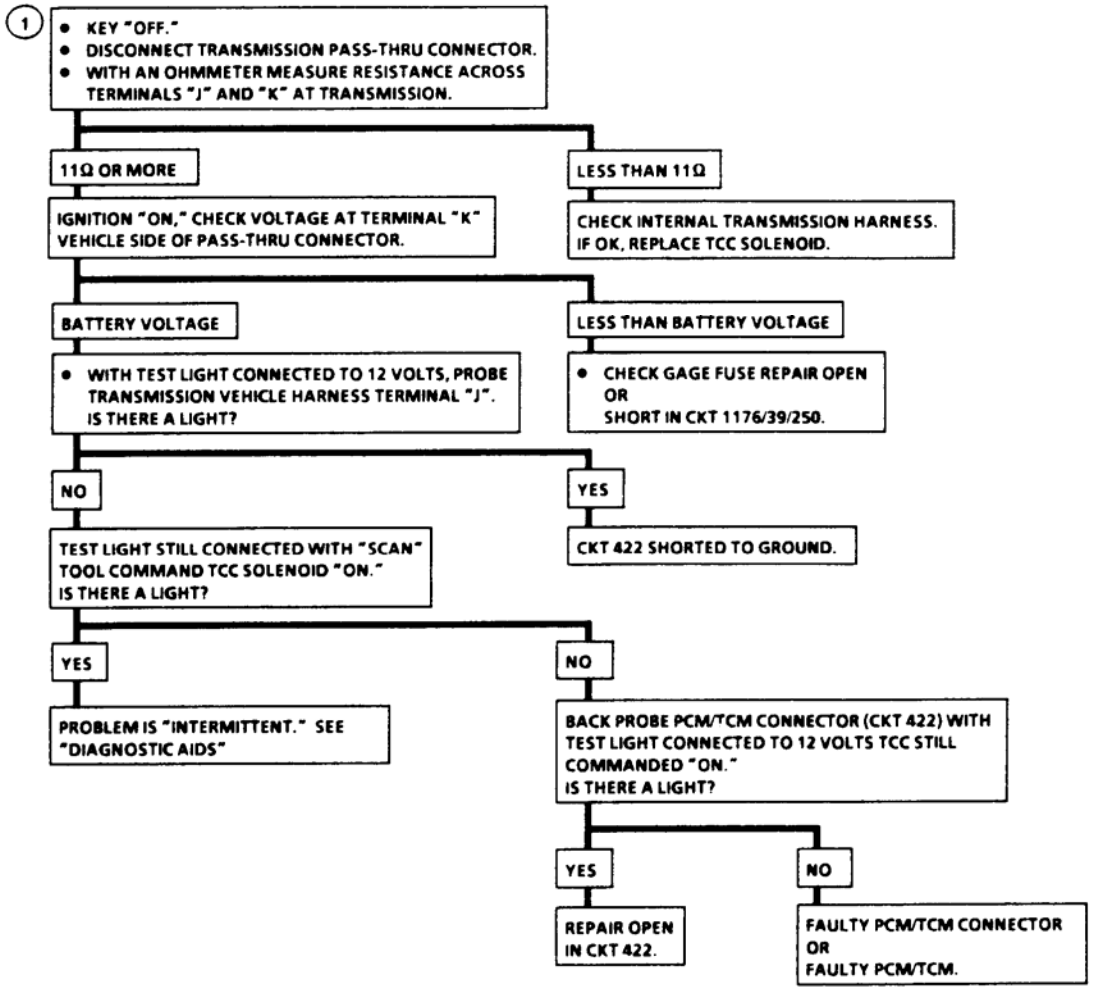


Fig. 280: Code 83, TCC QDM Fault Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 85, UNDEFINED RATIO - LT. TRUCK

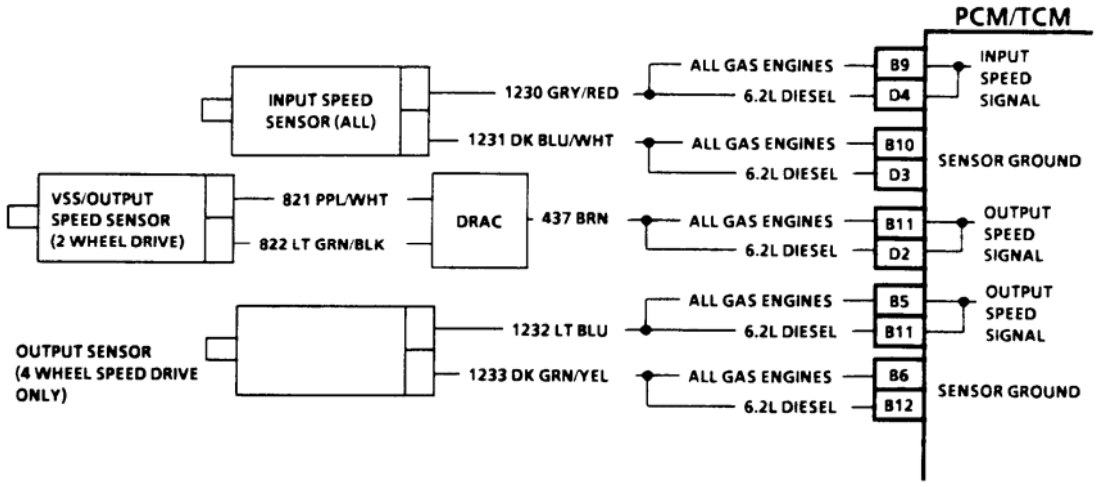


Fig. 281: Code 85, Undefined Ratio Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

The PCM/TCM calculates the actual gear ratio from input and output speed readings while in each gear, then compares these to what the gear ratio should be, taking into consideration the selected gear range. This monitor includes Reverse gear, but does not include Overdrive gear.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test verifies the proper function of the input sensor.
2. This test verifies the proper function of the output sensor.

Diagnostic Aids

The PCM/TCM relies on the Power Switch Module (PSM) to indicate what gear range has been selected. PSM must be functioning properly or Code 85 may be set. Check all connections, especially those at the transmission pass-through connector. Compare Scan tester gear ratio reading to specifications in GEAR RATIO table.

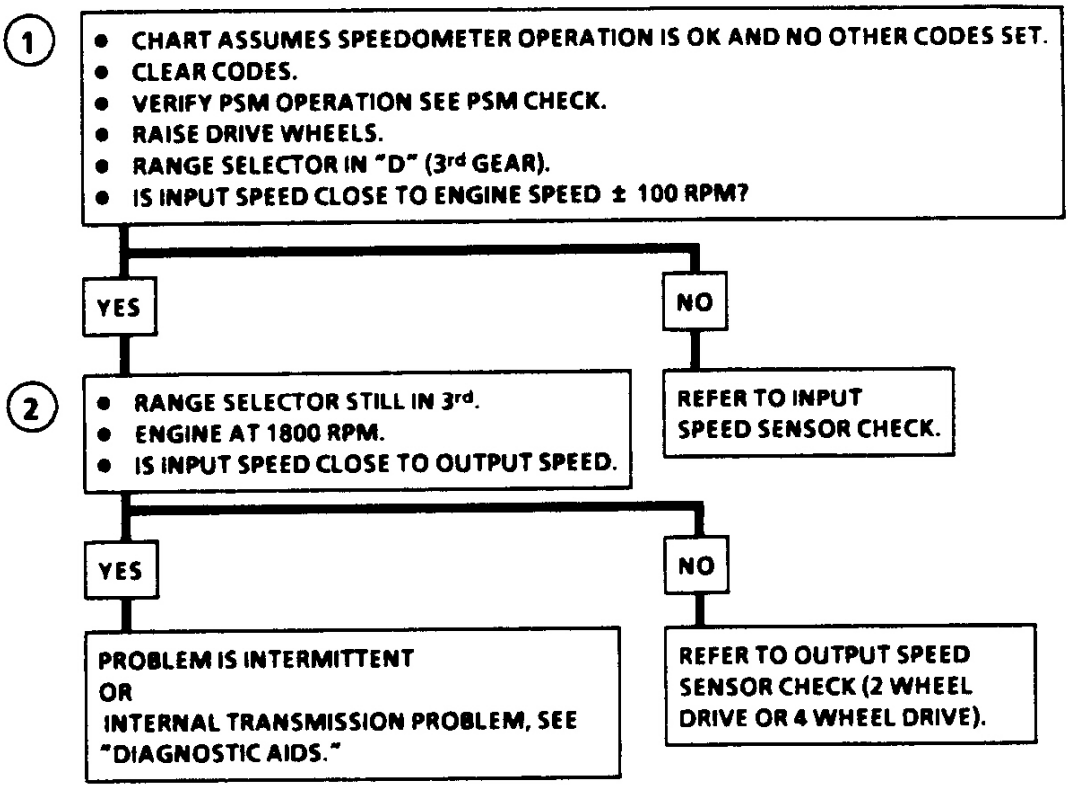


Fig. 282: Code 85, Undefined Ratio Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

GEAR RATIO

Gear	Less Than	More Than
1st	2.38	2.63
2nd	1.43	1.58
3rd	.95	1.05
Reverse	1.97	2.17

CODE 86, SHIFT SOLENOID "B" STUCK "ON" - LT. TRUCK

The shift solenoids are used inside the valve body to control spool valves, which determine the transmission gear.

Fused ignition power is supplied to solenoid "B". The PCM/TCM will engage solenoid B by grounding circuit No. 1223 to energize the solenoid. See **Fig. 275**.

Code 86 will set under the following conditions:

- Vehicle speed is greater than 7 MPH.

- TPS is more than 25 percent.
- PCM/TCM commands 1st or 2nd gear.
- Transmission ratio indicates transmission is in 3rd or 4th gear.
- Conditions are met or 6 seconds.

NOTE: Test number refers to test number on diagnostic chart.

1. This test determines if transmission is receiving a solenoid "B" on command.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector.

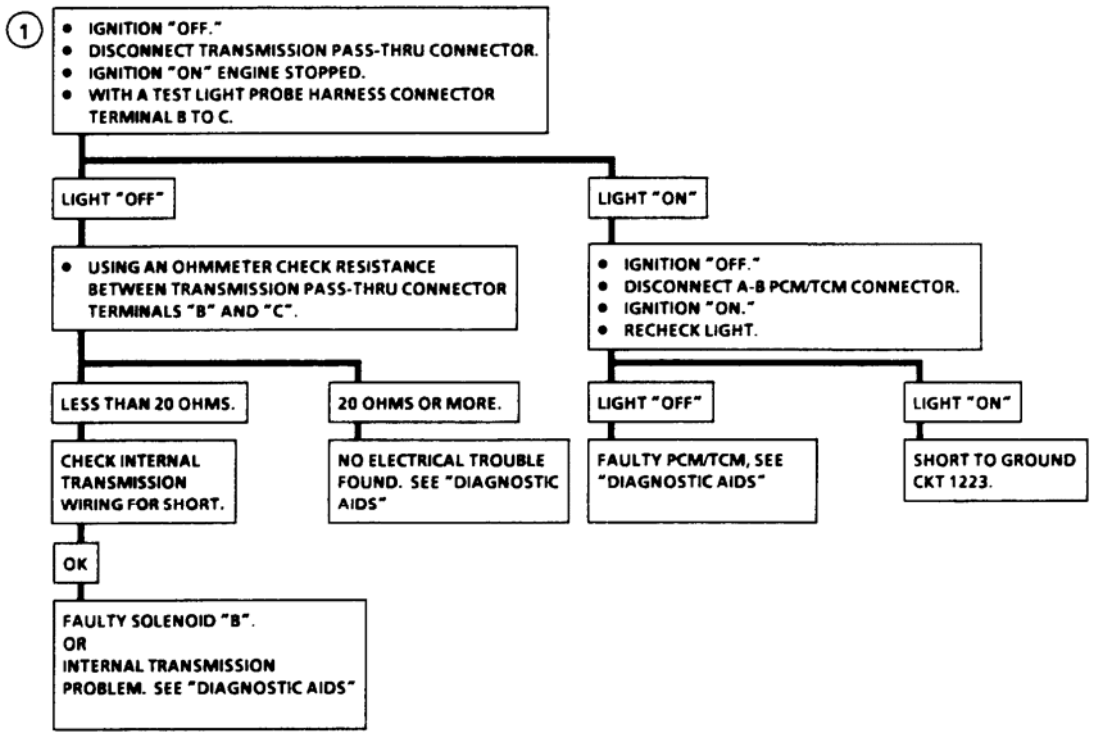


Fig. 283: Code 86, Shift Solenoid "B" On Troubleshooting (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

CODE 87, SHIFT SOLENOID "B" STUCK "OFF" - LT. TRUCK

The shift solenoids are used inside the valve body to control spool valve position, which determines the transmission gear.

Fused ignition power is supplied to solenoid "B". The PCM/TCM will engage solenoid "B" by grounding circuit No. 1223 to energize the solenoid. See **Fig. 275**.

Code 37 will set under the following conditions:

- Vehicle speed is greater than 7 MPH.
- TPS is more than 25 percent.
- PCM/TCM commands 3rd or 4th gear.
- Transmission ratio indicates transmission is in 1st or 2nd gear.
- Conditions are met for 6 seconds.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks PCM/TCM's ability to ground or control solenoid "B". If bidirectional Scan tester is not available, solenoid may be activated by grounding ALDL test terminal -E with ignition on and engine off.
2. This test checks the power supply and circuit No. 1223.
3. This test checks the internal transmission harness and solenoid "B".

Diagnostic Aids

Check all connections. especially those at the transmission pass-thru connector. Fault may be an internal transmission problem.

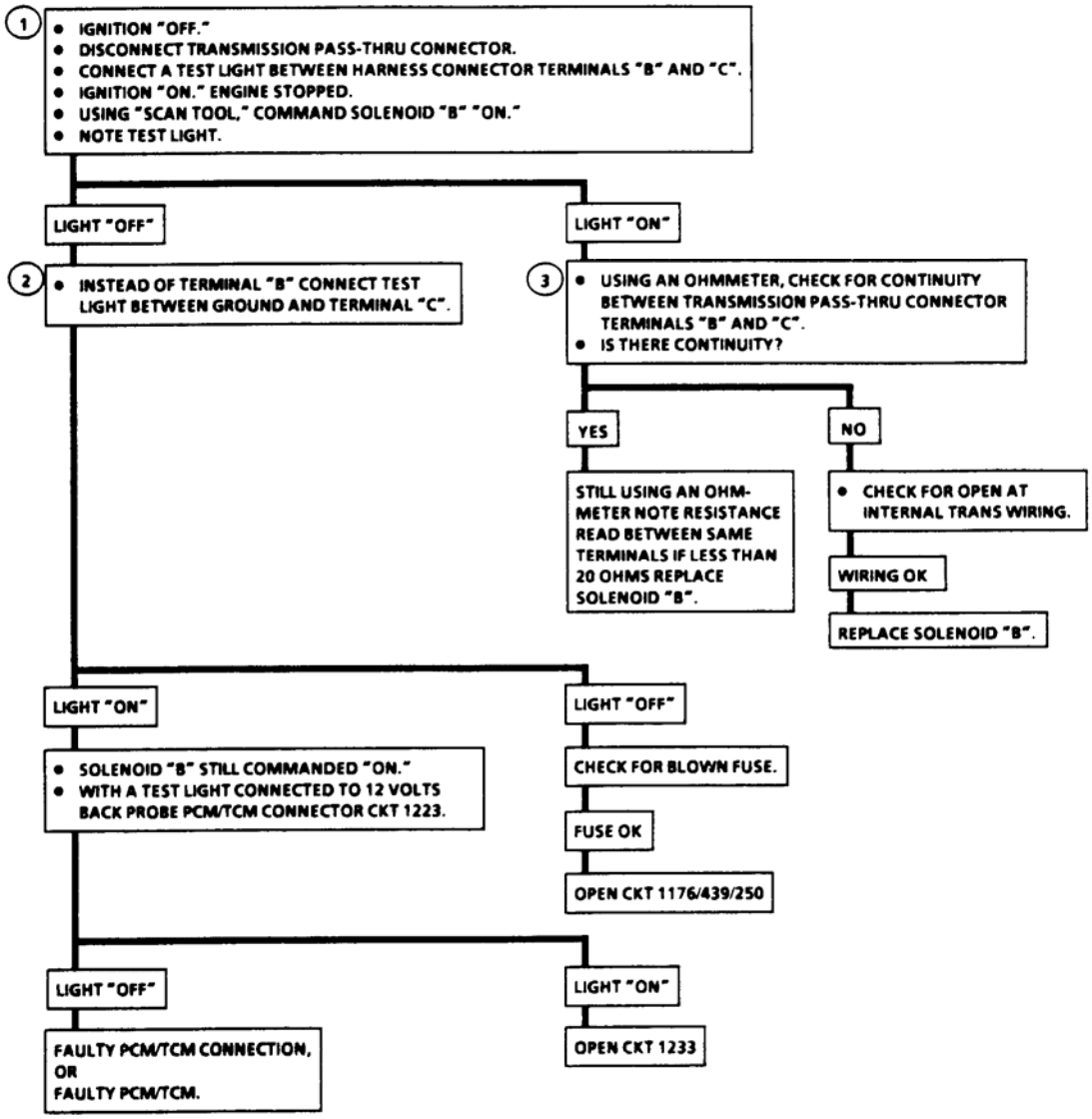


Fig. 284: Code 86, Shift Solenoid "B" Off Troubleshooting (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

PARK/NEUTRAL SWITCH TEST (TRUCKS)

CHART C-1A, PARK/NEUTRAL SWITCH - LIGHT TRUCKS & VANS

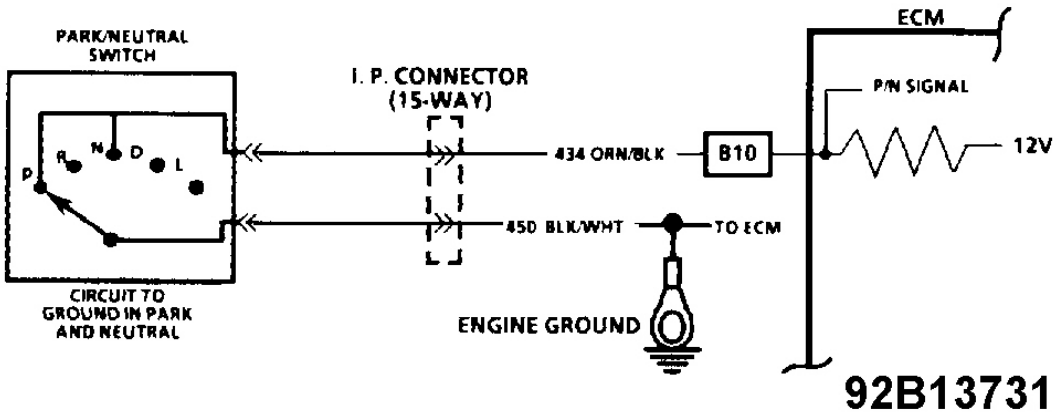


Fig. 285: Chart C-1A, Park/Neutral Switch Circuit Diagram (Lt. Trucks & Vans)
Courtesy of GENERAL MOTORS CORP.

The Park/Neutral switch contacts are closed to ground in Park or Neutral, and open in all Drive ranges. The ECM supplies ignition voltage, through a current limiting resistor, to circuit No. 434. The ECM senses a closed switch when voltage on circuit No. 434 drops to less than one volt. The ECM uses Park/Neutral signal as one of the inputs to control idle air, VSS diagnostics, and EGR flow.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Checks or closed switch to ground in Park position. Different makes of "SCAN" testers wild read Park/Neutral signal differently. Refer to testers instruction manual for type of display used for specific tester.
2. Checks for an open switch in Drive or Reverse.
3. Be sure "SCAN" tester indicates Drive, even while wiggling shifter, to test for an intermittent or misadjusted switch in Drive.

Diagnostic Aids

If circuit No. 434 indicates Park/Neutral switch grounded while in Drive, EGR would be inoperative, resulting in possible detonation.

If circuit No. 434 always indicates Drive (open), a drop in idle may exist when gear selector is moved into Drive.

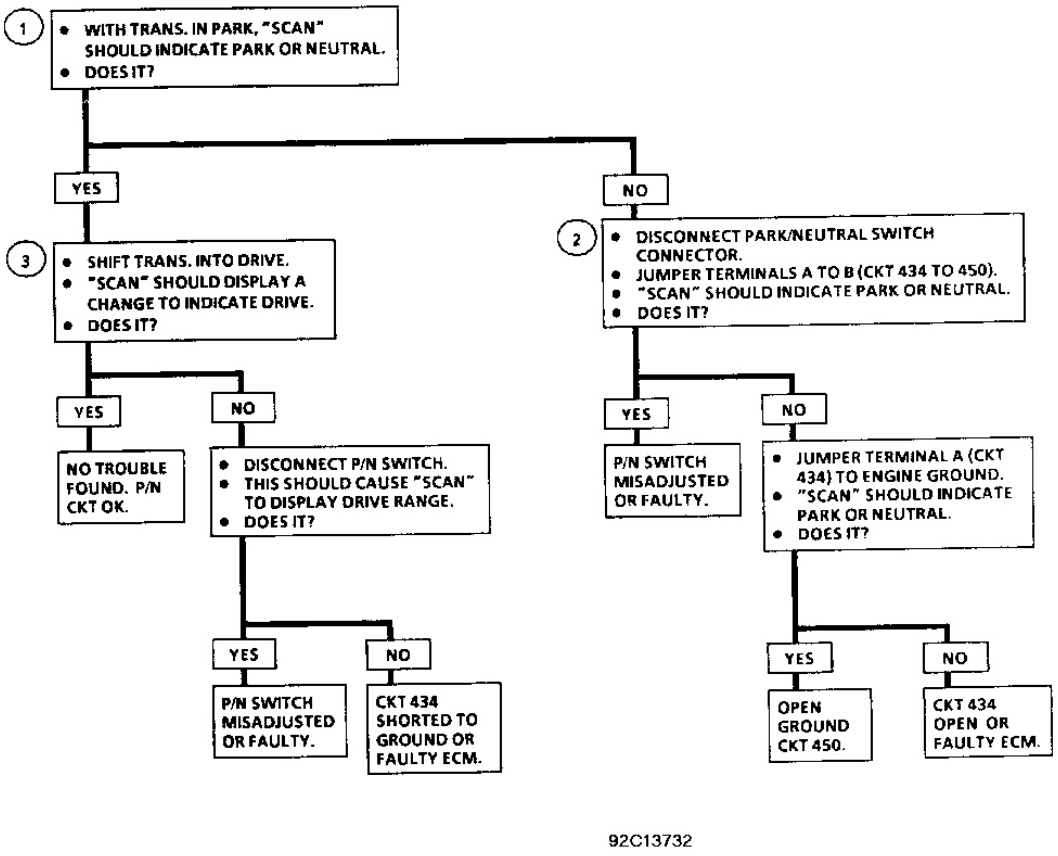


Fig. 286: Chart C-1A, Park/Neutral Switch Troubleshooting (Lt. Trucks & Vans)
Courtesy of GENERAL MOTORS CORP.

TORQUE CONVERTER CLUTCH CHARTS (TRUCKS)

CHART C-8, TORQUE CONVERTER CLUTCH - 2.5L & 2.8L LT. TRUCKS & VANS

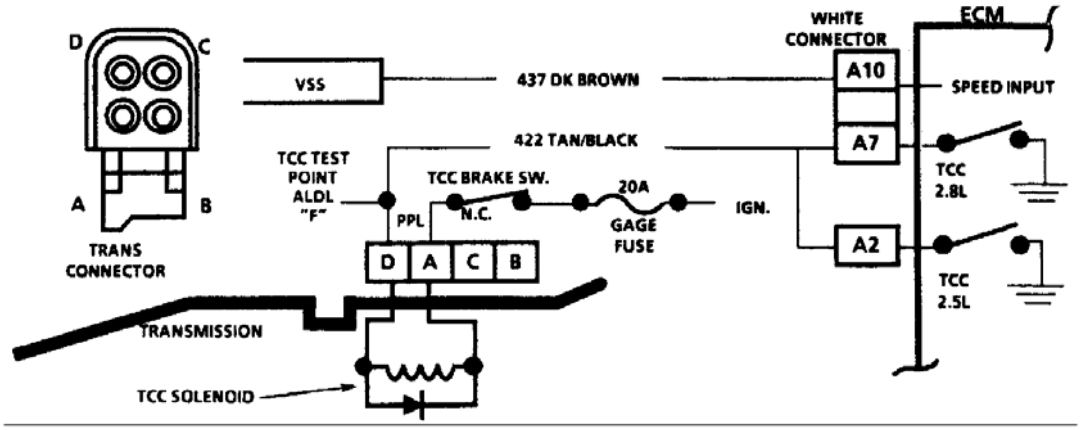


Fig. 287: Chart C-8, TCC Circuit Diagram 1991 (2.5L & 2.8L Lt. Trucks & Vans)
Courtesy of GENERAL MOTORS CORP.

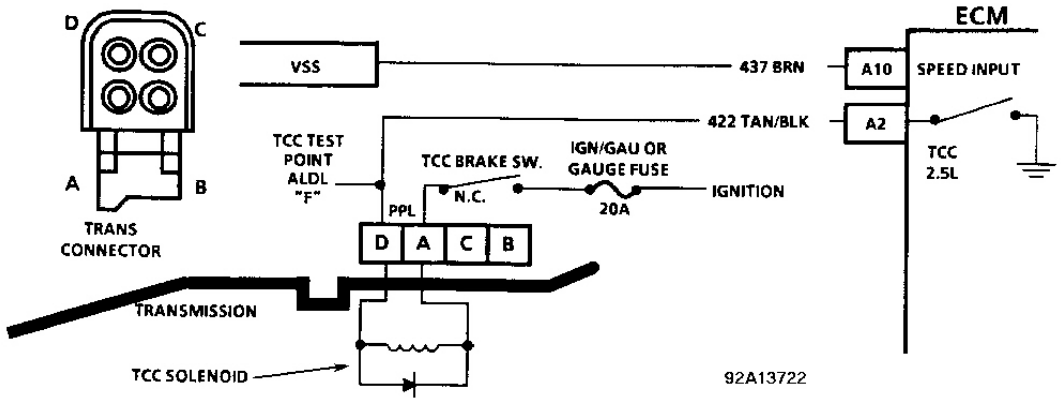


Fig. 288: Chart C-8, TCC Circuit Diagram 1992 (2.5L & 2.8L Lt. Trucks & Vans)
Courtesy of GENERAL MOTORS CORP.

The purpose of TCC is to eliminate the power loss of torque converter stage when vehicle is in cruise condition. This allows the use of an automatic transmission with the fuel economy of a manual transmission.

Fused battery ignition power is supplied to TCC solenoid through the TCC brake switch.

The ECM will engage TCC by grounding circuit No. 422 to energize the TCC solenoid.

Engagement of torque convener clutch will be executed under the following conditions:

- Vehicle speed greater than 24 MPH
- Engine temperature above 149°F (65°C)

- Steady TPS reading (not changing-steady road speed)
- Brake switch closed.
- Transmission in 3rd or 4th gear

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Check continuity through the brake switch and TCC solenoid.
2. Check ability of ECM to energize the TCC solenoid. Grounding the diagnostic connector should energize the relay and cause the light to go out.
3. This test by-passes the TCC solenoid and checks for an open or short in circuit No. 422

Diagnostic Aids

Solenoid coil resistance must measure more than 20 ohms. Less resistance will cause early failure of the ECM "DRIVER". Using an ohmmeter, check solenoid coil resistance of all ECM-controlled solenoids and relays before replacing ECM. Replace any solenoid or relay that measures less than 20 ohms resistance.

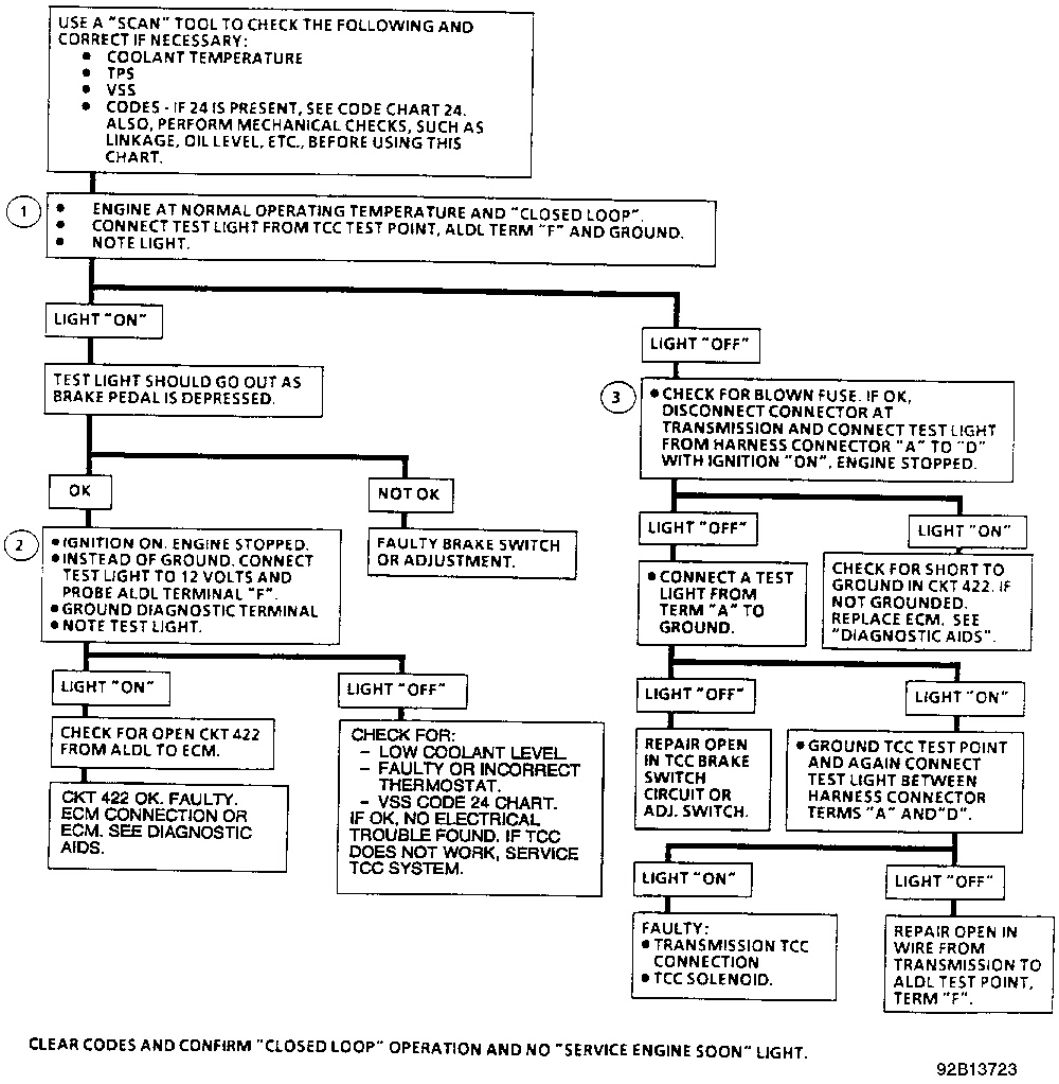


Fig. 289: Chart C-8, TCC Troubleshooting (2.5L & 2.8L Lt. Trucks & Vans)
Courtesy of GENERAL MOTORS CORP.

CHART C-8 TORQUE CONVERTER CLUTCH - 3.1L VANS

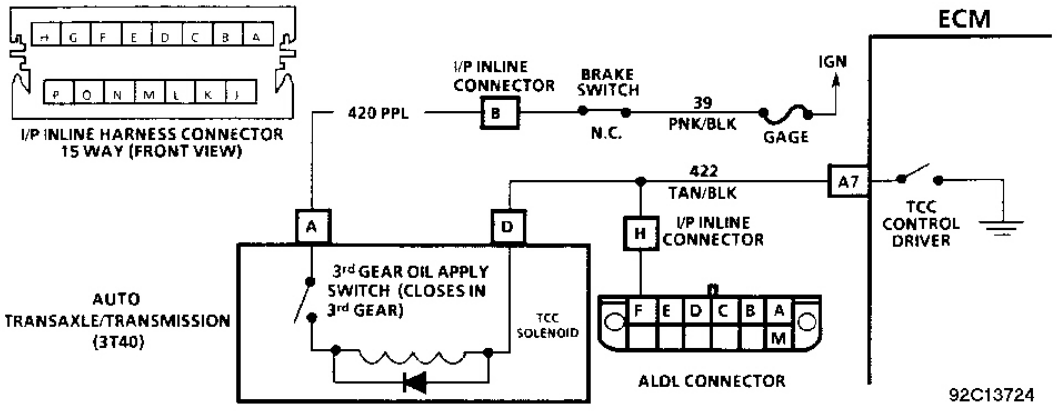


Fig. 290: Chart C-8 TCC Circuit Diagram (3.1L Vans)
Courtesy of GENERAL MOTORS CORP.

Fused battery voltage is supplied to TCC solenoid through TCC brake switch and 3rd gear apply switch. ECM will engage TCC by grounding circuit No. 422 to energize solenoid. TCC will engage when:

- Vehicle speed is above 30 MPH.
- Engine is at normal operating temperature.
- Throttle position not changing, indicating a steady speed.
- Brake switch and 3rd gear switch are closed.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. If test light does not light, 3rd gear apply switch is open.
2. At 25 MPH, 3rd gear apply switch should close. Test light should glow and confirm battery voltage exist and closed brake switch.
3. Grounding diagnostic terminal with ignition switch on and engine off, should energize TCC solenoid by grounding circuit No. 422. This test checks ability of ECM to supply a ground to the TCC solenoid. Test light will glow if connected from 12 volts to ALDL terminal "F" when circuit No. 422 is grounded.

Diagnostic Aids

A scan tool only indicates when ECM has turned on the TCC driver, and does not confirm that TCC has engaged. To determine if TCC is functioning properly, engine RPM should decrease when scan tool indicates TCC driver has turned on.

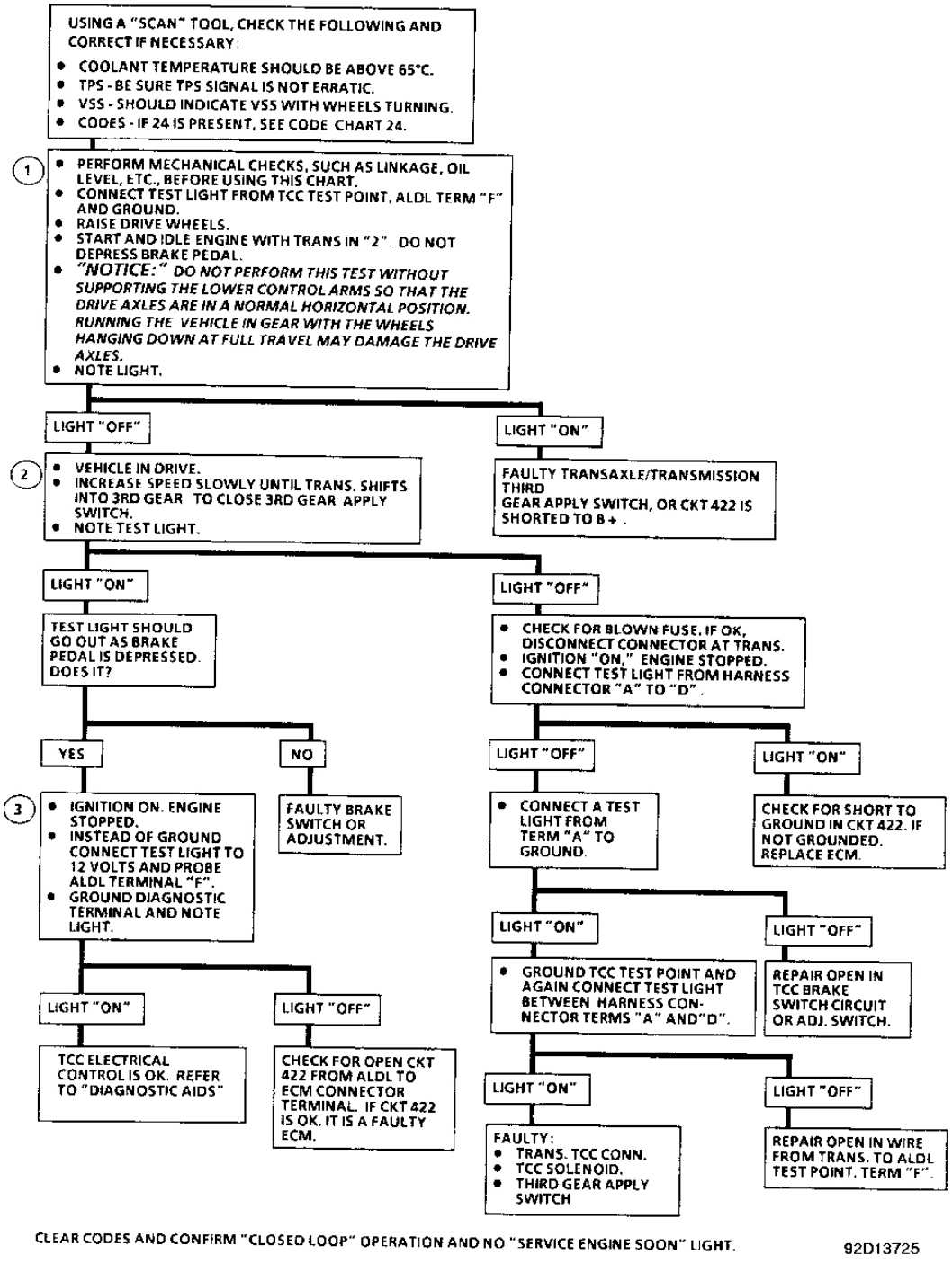


Fig. 291: Chart C-8 TCC Troubleshooting Chart (3.1L Vans)
Courtesy of GENERAL MOTORS CORP.

CHART C-8 TORQUE CONVERTER CLUTCH - 4.3L TURBO PFI

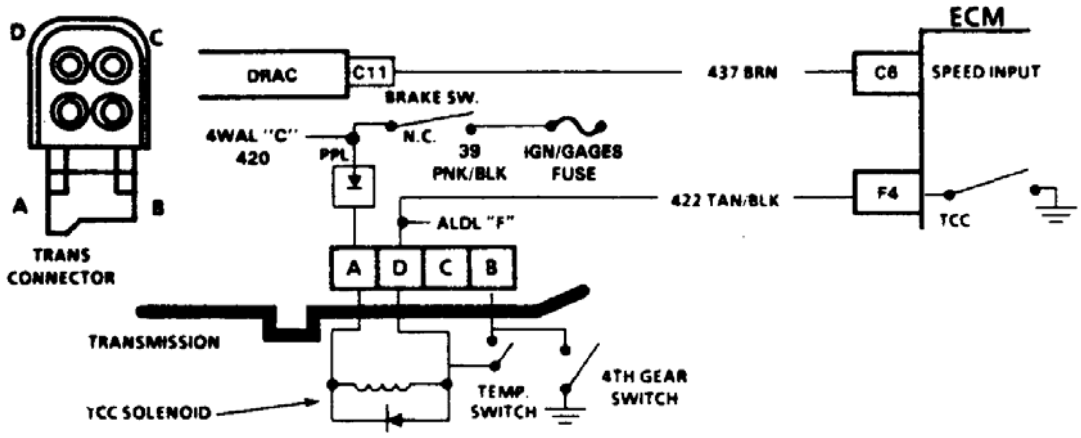


Fig. 292: Chart C-8, TCC Circuit Diagram (4.3L Turbo PFI)
Courtesy of GENERAL MOTORS CORP.

Fused battery voltage is supplied to TCC solenoid through TCC brake switch. ECM will engage TCC by grounding circuit No. 422 to energize solenoid. TCC will engage when:

- Vehicle speed is above 30 MPH.
- Engine is at normal operating temperature.
- Throttle position not changing, indicating a steady speed
- Brake switch is closed and transmission is in 3rd or 4th gear.

NOTE: Test numbers refer to test numbers in diagnostic chart.

1. If test light glows, battery voltage and continuity through TCC solenoid.
2. Using a scan tool, check for vehicle speed sensor signal (VSS) to ECM.

Diagnostic Aids

Solenoid Coil resistance must measure more than 20 ohms. Less resistance will cause early failure of ECM driver. Before installing a replacement ECM, use a DVOM to check solenoid coil resistance of all ECM controlled solenoids and relays. Replace any solenoid or relay that measures less than 20 ohms resistance.

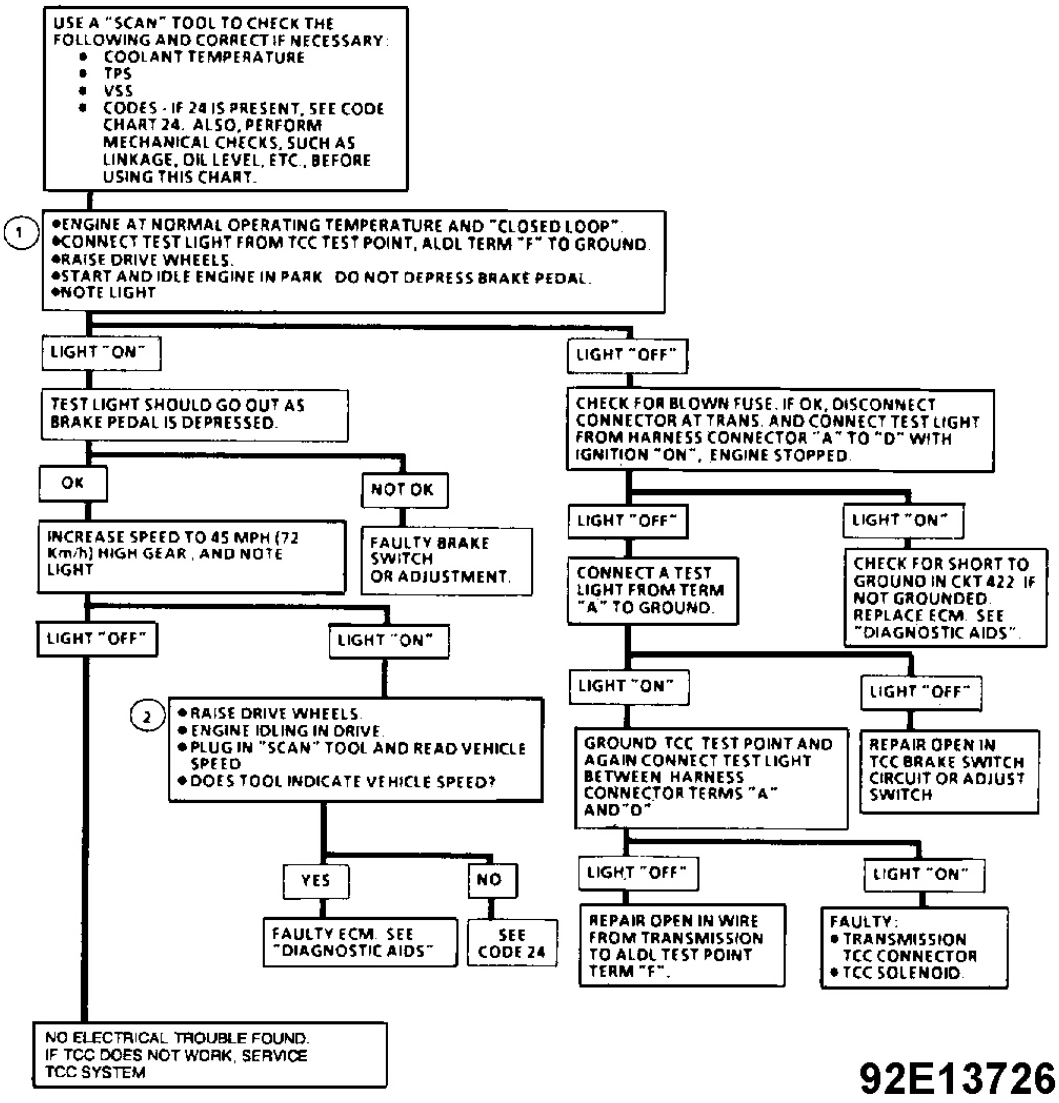


Fig. 293: Chart C-8, TCC Troubleshooting Chart (4.3L Turbo PFI)
Courtesy of GENERAL MOTORS CORP.

CHART C-8, TORQUE CONVERTER CLUTCH - 4.3L, 5.0L, 5.7L LT. TRUCKS & VANS

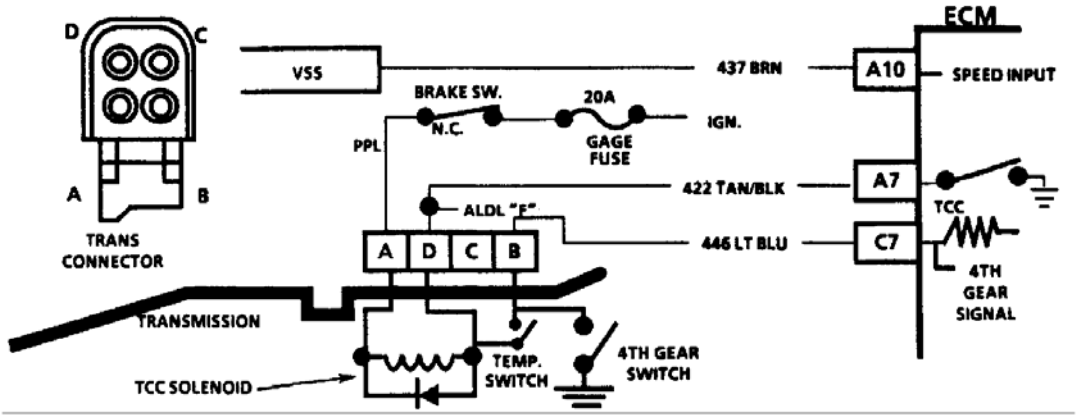


Fig. 294: Chart C-8, TCC Circuit Diagram (4.3L, 5.0L, 5.7L Lt. Trucks & Vans)
Courtesy of GENERAL MOTORS CORP.

The purpose of TCC is to eliminate the power loss of torque converter stage when vehicle is in cruise condition. This allows the use of an automatic transmission with the fuel economy of a manual transmission.

Fused battery ignition power is supplied to TCC solenoid through the TCC brake switch.

The ECM will engage TCC by grounding circuit No. 422 to energize the TCC solenoid.

Engagement of torque converter Clutch will be executed under the following conditions:

- Vehicle speed greater than 24 MPH.
- Engine temperature above 149°F (65°C).
- Steady TPS reading (not changing-steady road speed).
- Brake switch closed.
- Transmission in 3rd or 4th gear.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Glowing test light indicates that battery voltage and continuity through TCC solenoid are okay.
2. Checks for vehicle speed sensor (VSS) signal to ECM, using a "SCAN" tester.
3. Checks for 4th gear signal to ECM. This signal will not prevent TCC engagement, but could cause a change in engage/disengage speed points.

Diagnostic Aids

Solenoid coil resistance must measure more than 20 ohms. Less resistance will cause early failure of the ECM "DRIVER". Using an ohmmeter, check solenoid coil resistance of all ECM-controlled solenoids and relays before replacing ECM. Replace any solenoid or relay that measures less than 20 ohms resistance.

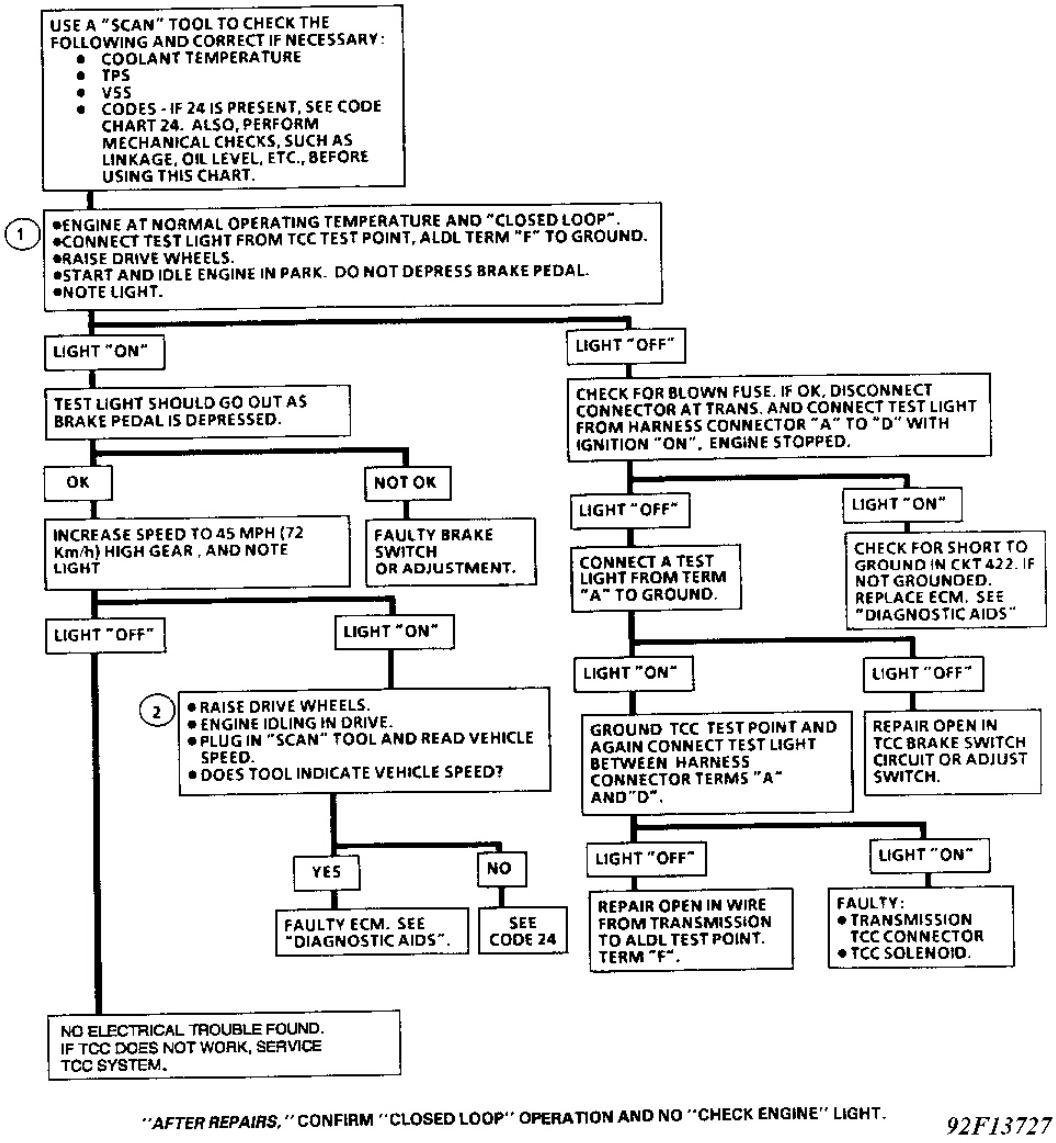


Fig. 295: Chart C-8, TCC Troubleshooting Chart (4.3L, 5.0L, 5.7L Lt. Trucks & Vans)
Courtesy of GENERAL MOTORS CORP.

TORQUE CONVERTER CLUTCH ELECTRICAL DIAGNOSIS - DIESEL ELECTRONIC CONTROL SYSTEM

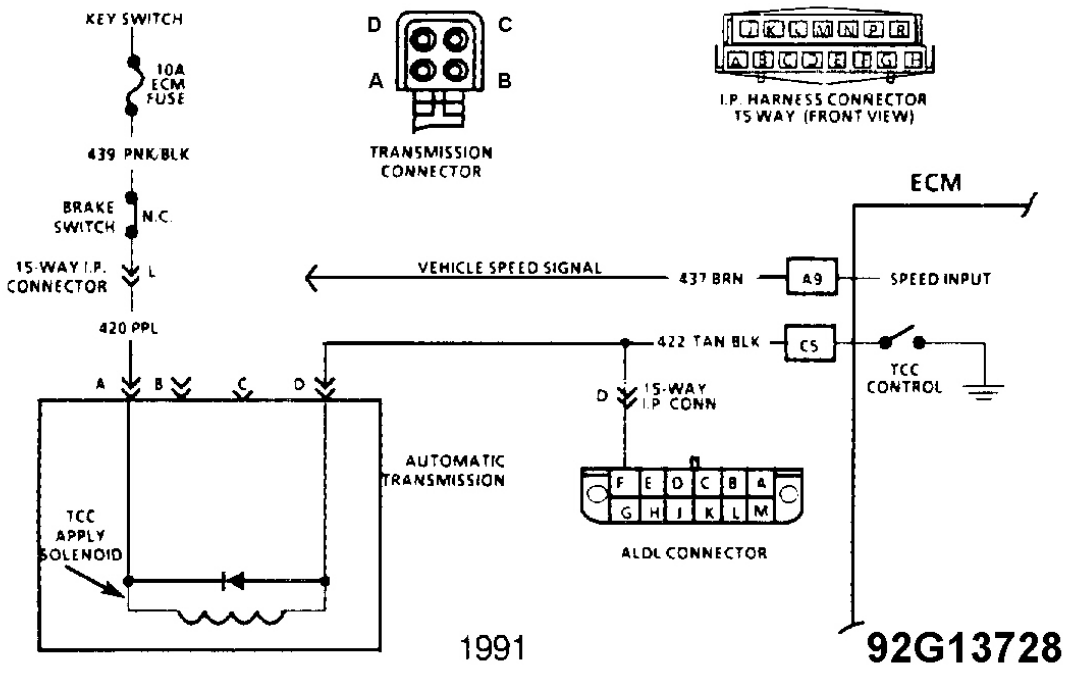


Fig. 296: TCC Circuit Diagram 1991 (Diesel ECS)
Courtesy of GENERAL MOTORS CORP.

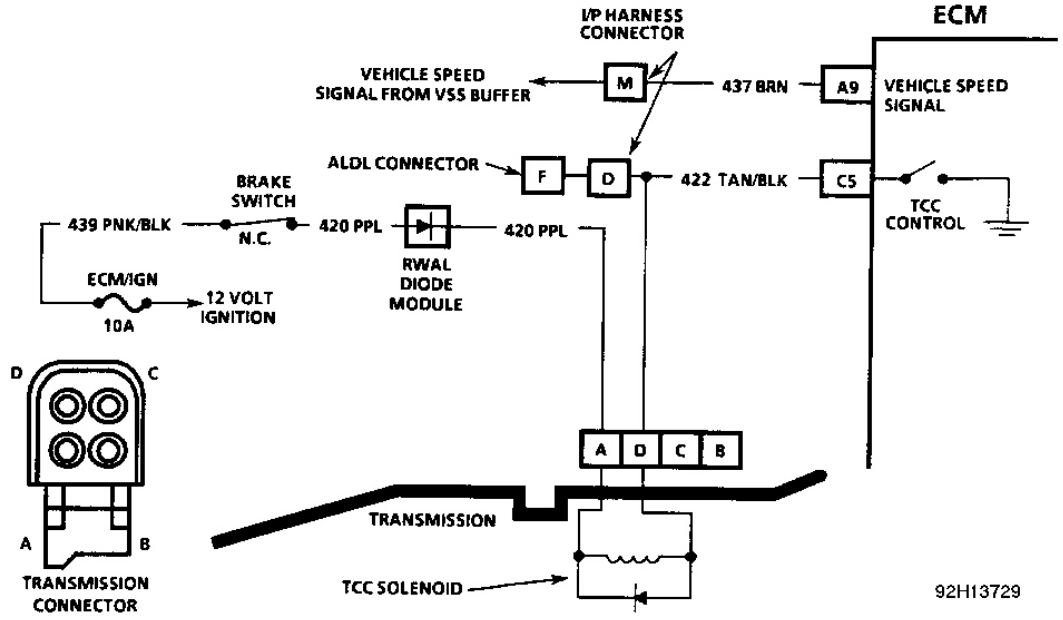


Fig. 297: TCC Circuit Diagram 1992 (Diesel ECS)
Courtesy of GENERAL MOTORS CORP.

The purpose of the Torque Converter Clutch (TCC is to eliminate the power loss of the torque converter stage when the vehicle is in a cruise condition. This allows the convenience of an automatic transmission and the fuel economy of a manual transmission.

Fused battery voltage is supplied to the TCC solenoid through the TCC brake switch The ECM will engage TCC by grounding circuit No. 422 to energize the TCC apply solenoid inside the transmission. The ECM completes circuit whenever TPS exceeds a calibrated value for throttle opening.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks for a complete circuit, from ignition switch, through solenoid, and up to test point. Test light should normally be on, since the ECM has not completed the circuit.
2. This test checks for continuity through TCC brake switch and TCC apply solenoid.
3. This test checks for ECM to complete circuit to ground, to energize TCC apply solenoid and engage TCC. Test light should normally go out when ECM completes circuit.
4. This test checks for TPS signal 1 signal to ECM is correct fault is in ECM connection or ECM. TPS voltage signal to ECM is incorrect proper operation will not occur.
5. This test checks for ground in circuit to ECM terminal "C5". Test light should normally be off.
6. This test checks for voltage to terminal "A" of TCC connector. Test light should normally be on.
7. This test checks for a complete circuit from voltage to ground, via TCC test terminal in ALDL connector. Normally. test light should come on, if harness is good.

Diagnostic Aids

Solenoid coil resistance must measure more than 20 ohms. A lower resistance value will cause early failure to the ECM driver Check the solenoid coil resistance of all ECM controlled solenoids and relays, before Installing replacement ECM. Replace any solenoid or relay that measures less than 20 ohms resistance.

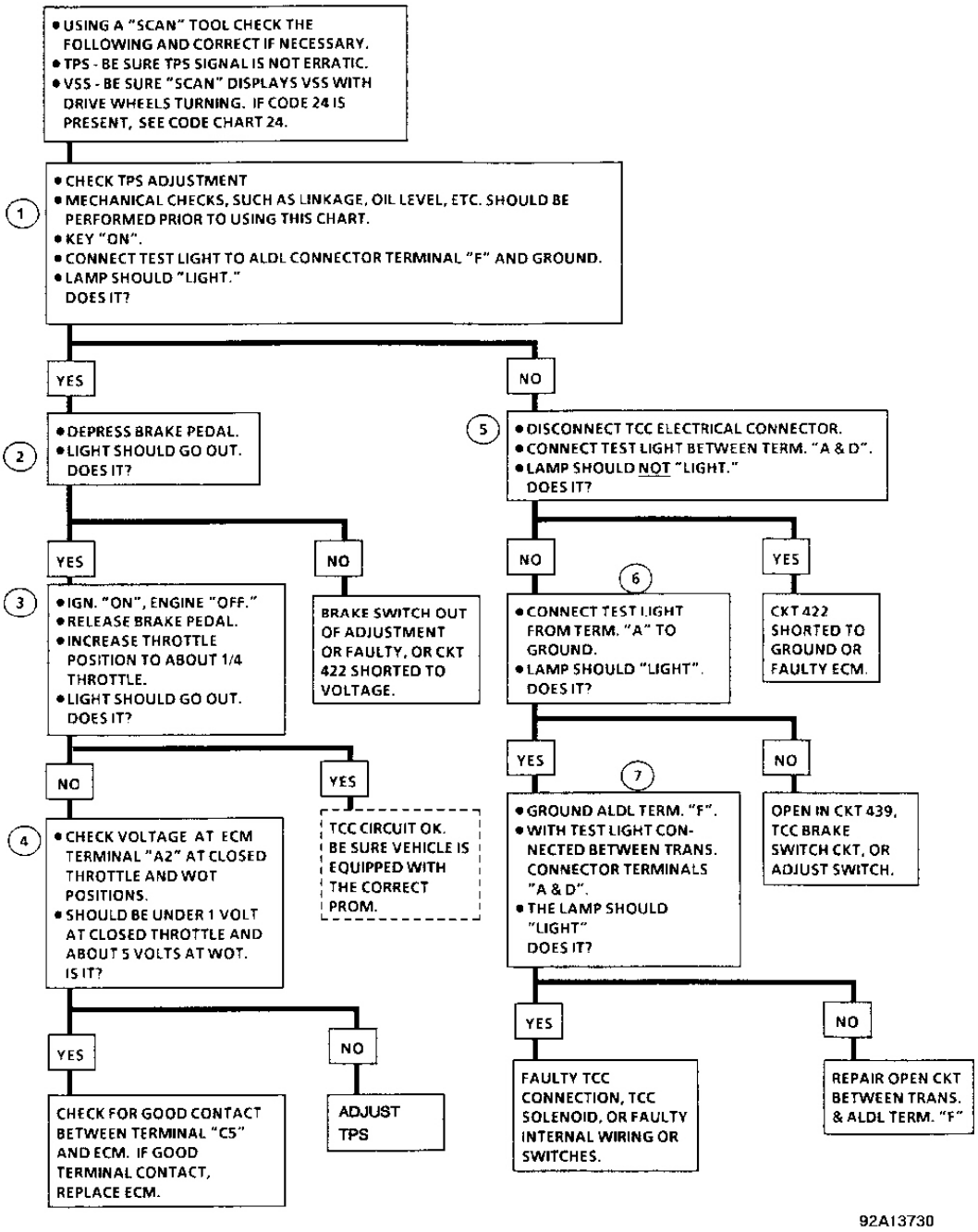


Fig. 298: TCC Troubleshooting Chart (Diesel ECS)
Courtesy of GENERAL MOTORS CORP.

COMPONENT CHECK CHARTS (TRUCKS)

OUTPUT SPEED SENSOR CIRCUIT CHECK - 2WD EXCEPT "C" & "K" SERIES

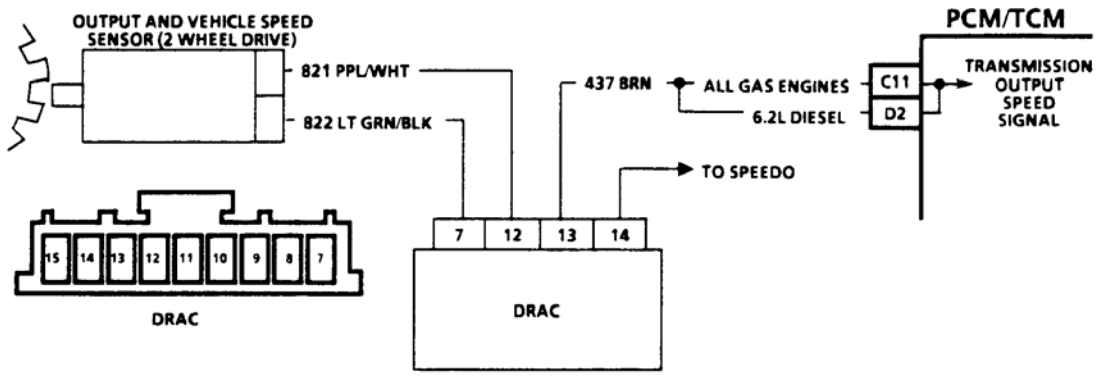


Fig. 299: Output Speed Sensor Circuit Diagram (2WD Except "C" & "K" Series)
Courtesy of GENERAL MOTORS CORP.

The output sensor circuit consists of a magnetic induction-type sensor, digital ratio adapter, and wiring. Gear teeth pressed on the outside diameter of the output carrier assembly induce an alternating current in the sensor,

This current is transmitted to a digital ratio adapter, where it is passed on to the PCM/TCM. The digital ratio adapter compensates for various axle ratios, and converts the signal to a square wave for use by the speedometer, cruise control and anti-lock brake system.

It the input sensor is not operational at start up, it can cause the output sensor to read zero.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks the speed signal on circuit No. 437 at the PCM/TCM from the digital ratio adapter.
2. This test checks for a speed signal from the output speed sensor to the digital ratio adapter.
3. This test checks the output speed sensor.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector.

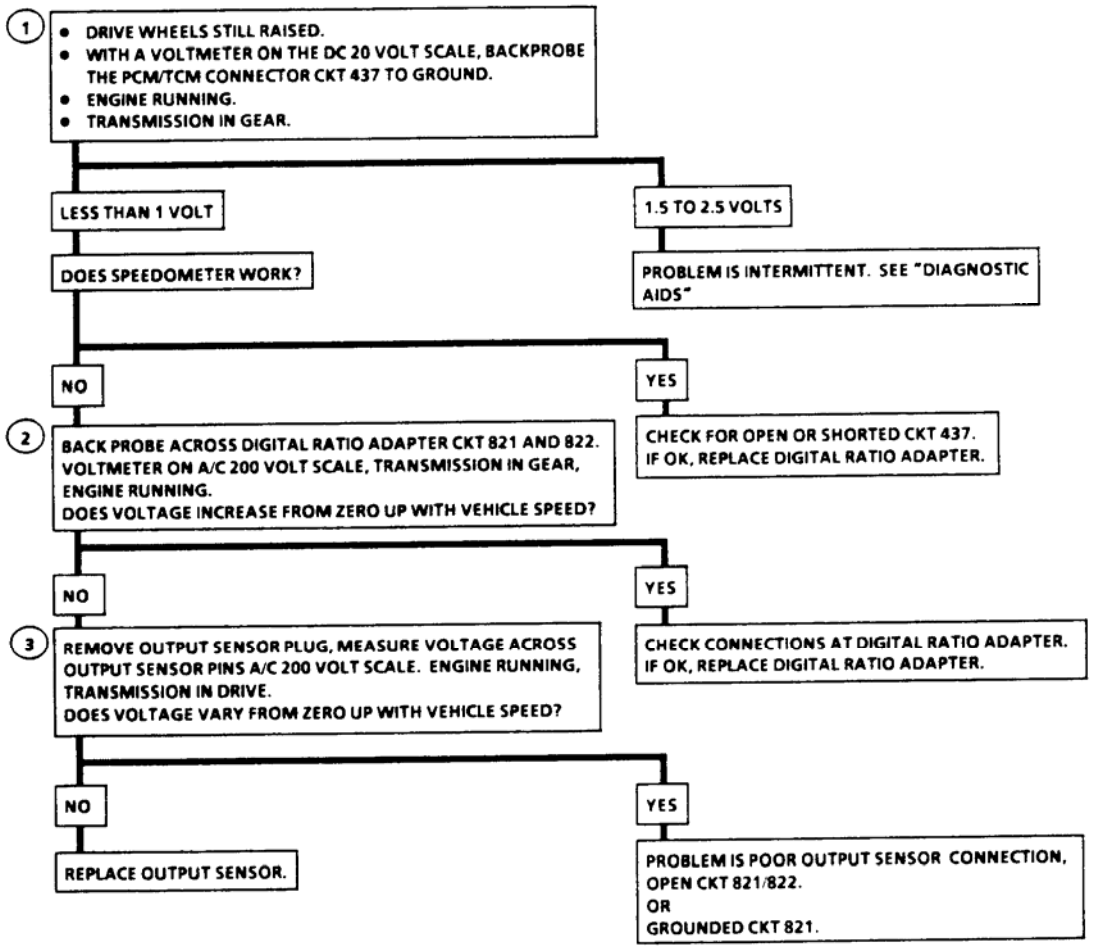


Fig. 300: Output Speed Sensor Troubleshooting (2WD Except "C" & "K" Series)
Courtesy of GENERAL MOTORS CORP.

OUTPUT SPEED SENSOR CIRCUIT CHECK - 2WD - "C" & "K" SERIES

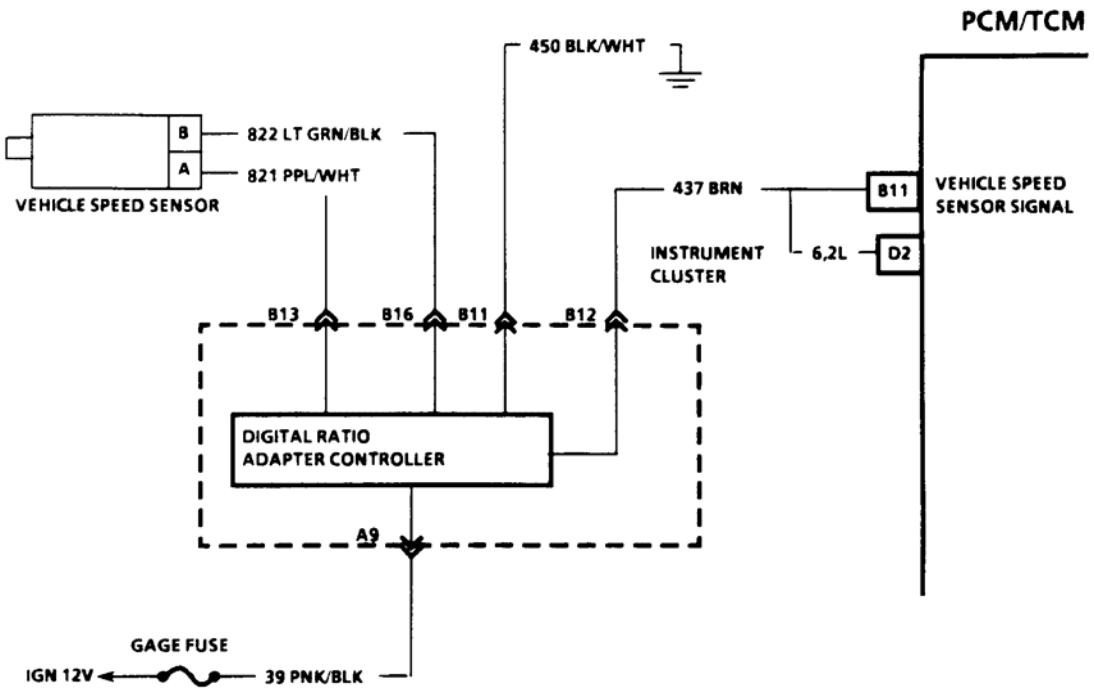


Fig. 301: Output Speed Sensor Circuit Diagram (2WD - "C" & "K" Series)
Courtesy of GENERAL MOTORS CORP.

The output sensor circuit consists of a magnetic induction-type sensor, digital ratio adapter located in the instrument cluster, and wiring. Gear teeth pressed on the outside diameter of the output carrier assembly induce an alternating current in the sensor.

This current is transmitted to the instrument cluster, where it is passed on to the PCM. The digital ratio adapter compensates for various axle ratios, and converts the signal to a square wave for use by the speedometer, cruise control and anti-lock brake system.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test verifies output speed sensor voltage at PCM.
2. This test directly verifies operation of output speed sensor.
3. This test checks circuits No. 821 and 822 up to the instrument cluster.

Diagnostic Aids

Check all connections, especially those at the transmission pass-thru connector. If the input sensor is not functioning at start up, it will cause the output sensor to read zero. While Code 24 is set, the Scan tester will display an RPM derived from input speed.

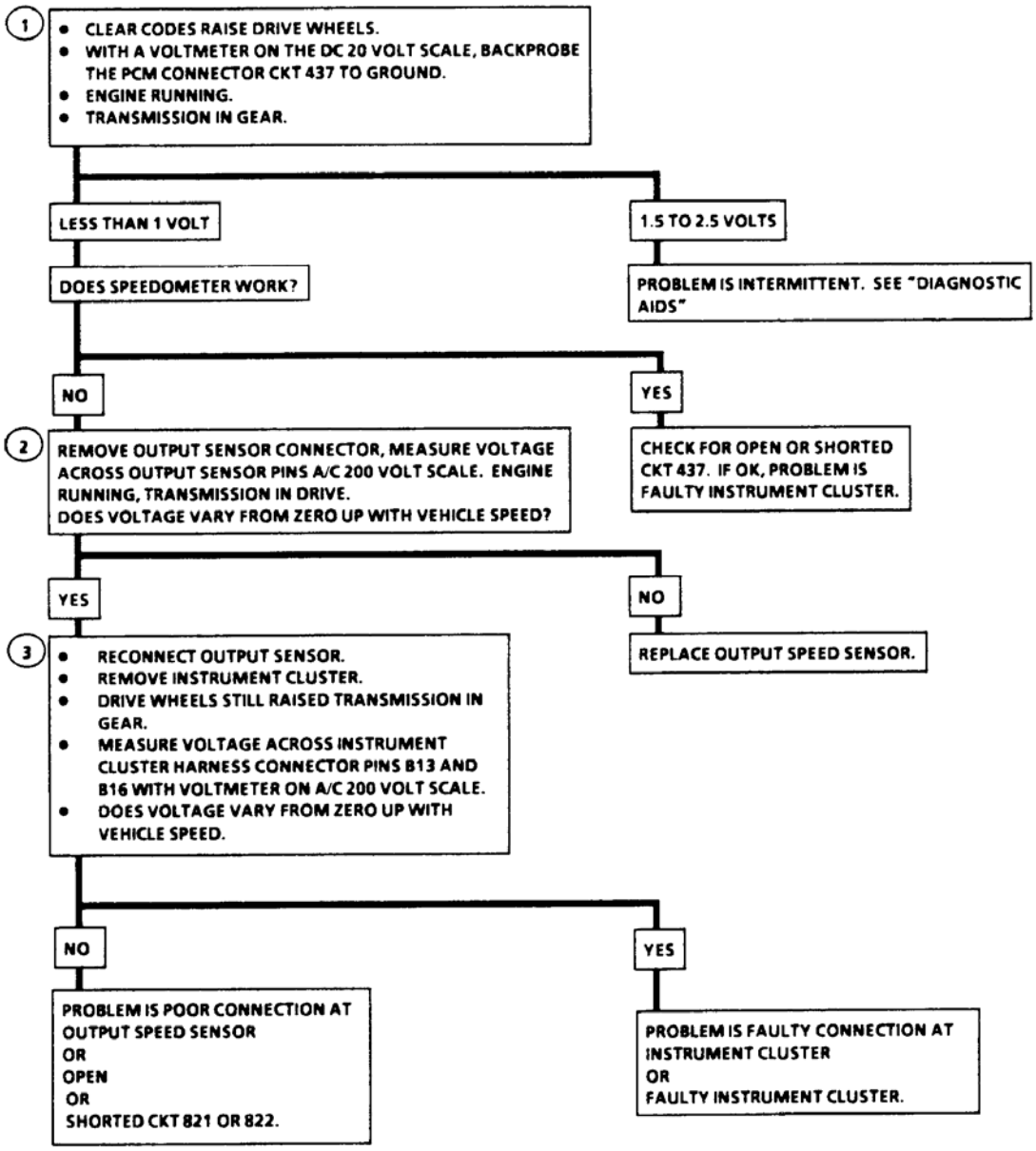


Fig. 302: Output Speed Sensor Troubleshooting (2WD - "C" & "K" Series)
Courtesy of GENERAL MOTORS CORP.

OUTPUT SPEED SENSOR CIRCUIT CHECK - 4WD VEHICLES

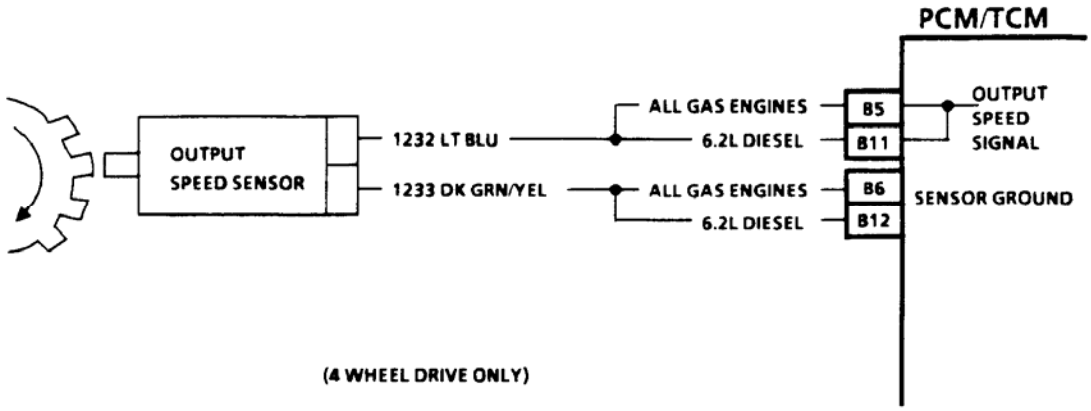


Fig. 303: Output Speed Sensor Circuit Diagram (4WD)
Courtesy of GENERAL MOTORS CORP.

The output sensor is a magnetic induction type. Gear teeth pressed on the outside diameter of the output carrier assembly induce an alternating current in the sensor. Since vehicle speed is taken from the transfer case on 4WD drive vehicles, the transmission output sensor signal on these units goes directly to the PCM/TCM. If input sensor is not operational at start up, it can cause the output sensor to read zero.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks for a speed signal at the PCM/TCM.
2. This test checks the output sensor directly.

Diagnostic Aids

Check an connections, especially those at the transmission pass-through connector.

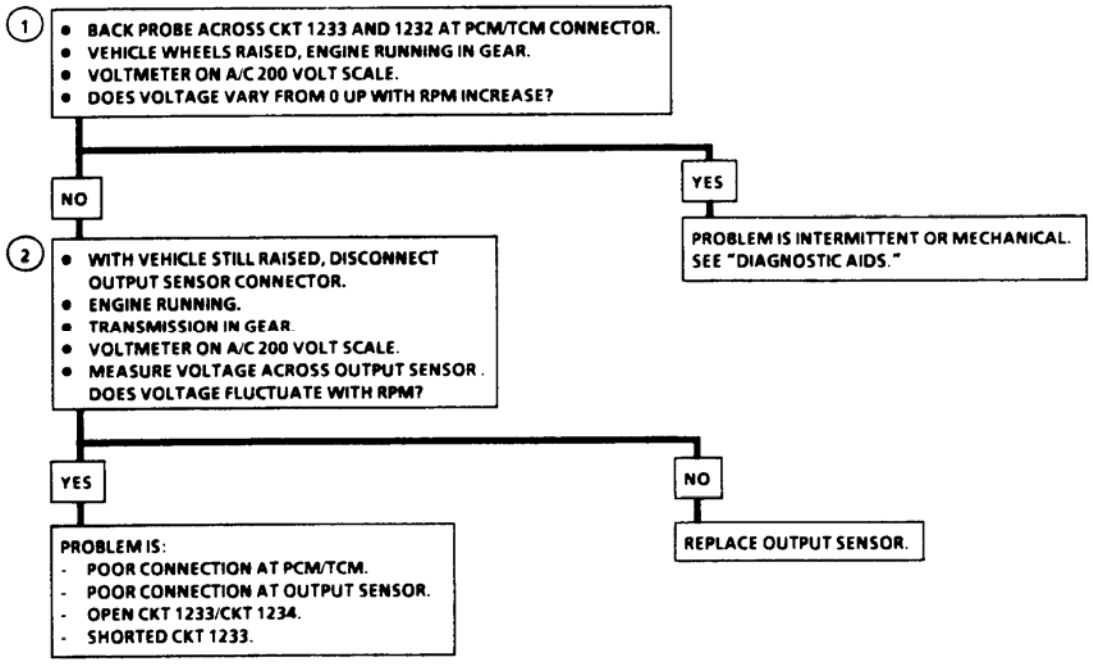


Fig. 304: Output Speed Sensor Troubleshooting (4WD)
Courtesy of GENERAL MOTORS CORP.

INPUT SPEED SENSOR CIRCUIT CHECK - LT. TRUCK

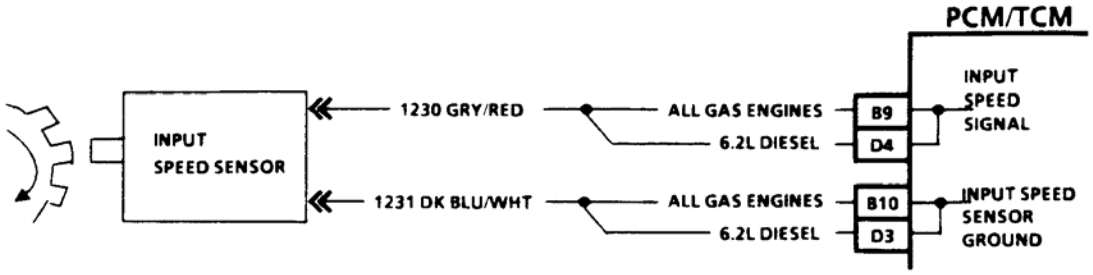


Fig. 305: Input Speed Sensor Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

The input sensor is of the magnetic induction type and is located on the left side of the transmission, forward of center. Serrations in the forward clutch housing induce a small A/C current as they pass by the input sensor. While there is no specific code for an input sensor problem, the PCM/TCM uses input sensor readings to calculate gear ratio, turbine speed, TCC slip, and determine if the engine is running.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks the input sensor circuit up to the PCM/TCM.

2. This test checks the sensor output.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector.

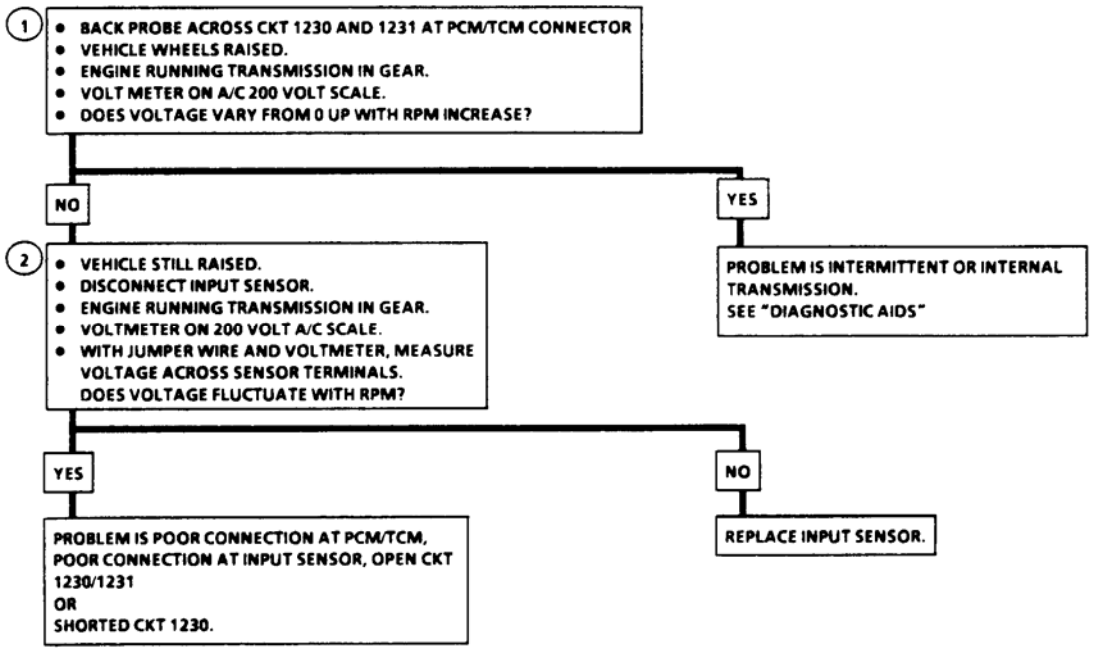


Fig. 306: Input Speed Sensor Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

BRAKE SIGNAL CIRCUIT CHECK - ALL ENGINES, LT. TRUCK

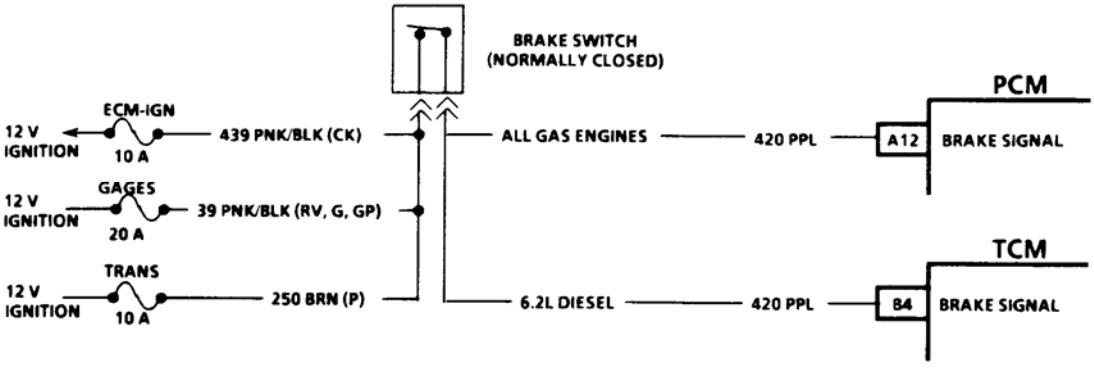


Fig. 307: Brake Signal Circuit Diagram (All Engines, Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

The normally closed brake switch supplies a 12-volt signal on circuit No. 420 to the PCM/TCM. The signal voltage is removed when brakes are applied. An incorrect brake signal may affect TCC operation.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks for voltage at brake switch.
2. This test simulates closed brake switch (brakes off).
3. This test checks circuit No. 420 from brake switch to PCM/TCM.
4. This test opens circuit No. 420 and simulates condition of brakes being applied.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector. Check customer driving habits and/or unusual traffic conditions (i.e. stop and go expressway traffic.)

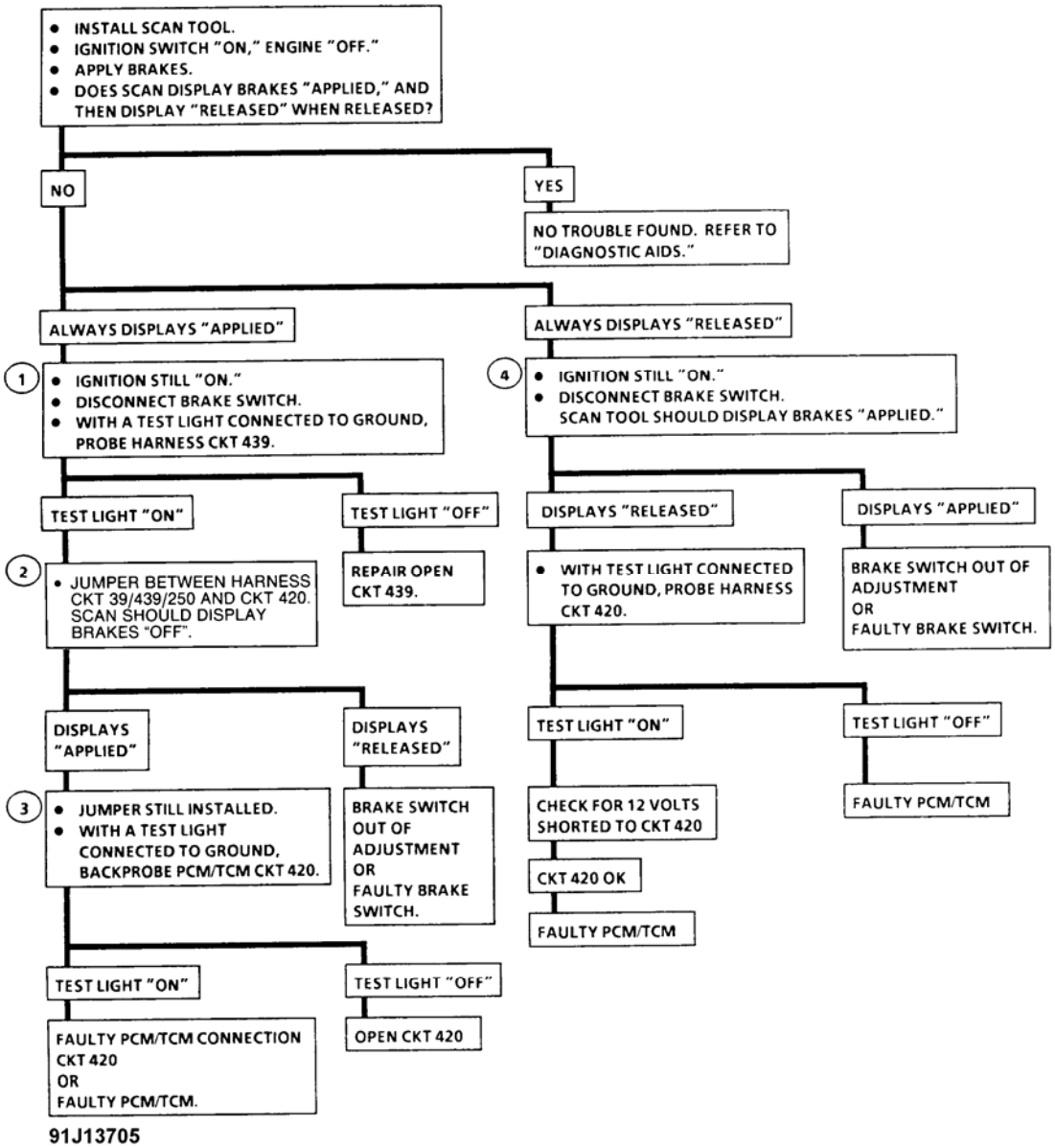


Fig. 308: Brake Signal Troubleshooting (All Engines, Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

TORQUE CONVERTER CLUTCH CIRCUIT CHECK - LT. TRUCK

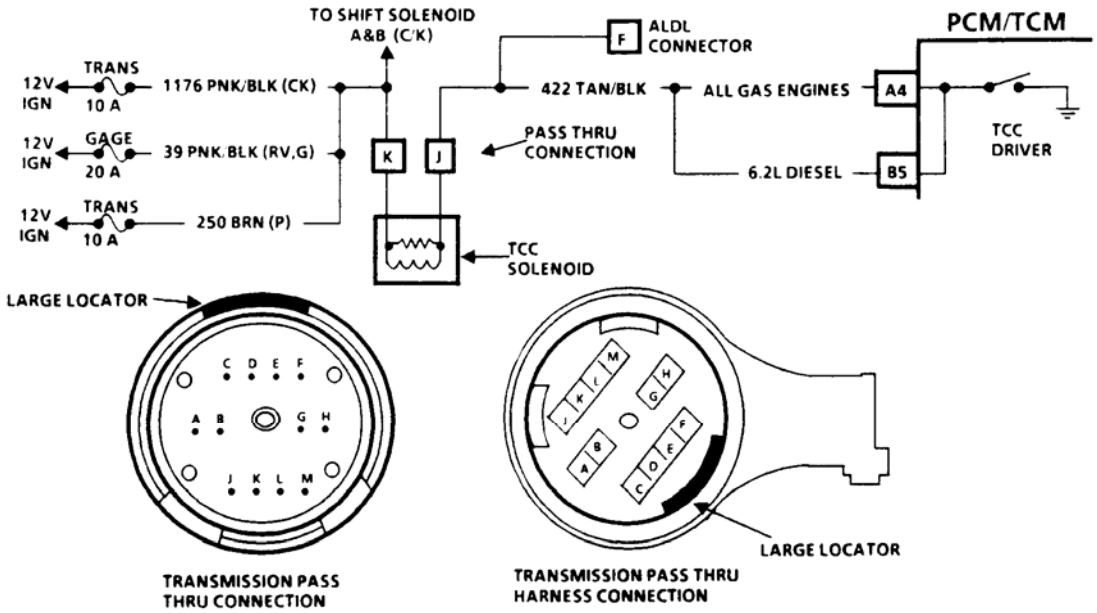


Fig. 309: TCC Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

The automatic transmission TCC eliminates power loss of torque converter stage when vehicle is in a cruise condition. This allows the convenience of the automatic transmission, and fuel economy of a manual transmission.

Fused battery ignition is supplied to the TCC solenoid, located inside valve body, to shift a spool valve in order to modulate pressure to the TCC.

The PCM/TCM will engage TCC by grounding circuit No. 422 to energize the solenoid.

TCC will engage under the following conditions:

- Vehicle speed is greater than 30 MPH (48 km/h).
- Engine at normal operating temperature greater than 149°F (65°C).
- Transmission at normal operating temperature of 195°F 91°C).
- Throttle position sensor output is not changing, indicating a steady road speed.
- Brake switch is closed.
- 4th gear is indicated.
- No codes are stored.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This step checks for a shorted internal transmission harness or TCC solenoid .
2. This step verifies power supply to the TCC solenoid.

3. This step checks circuit No. 422 for a short to ground.
4. This step checks PCM/TCM s ability to control the TCC solenoid. If bidirectional Scan tester is not available, TCC may be activated by grounding ALDL test terminal "B" with ignition on and engine off.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector. The TCC is pulse width modulated, and is designed to keep the TCC right at the point of engagement. Therefore, some slight slippage is normal.

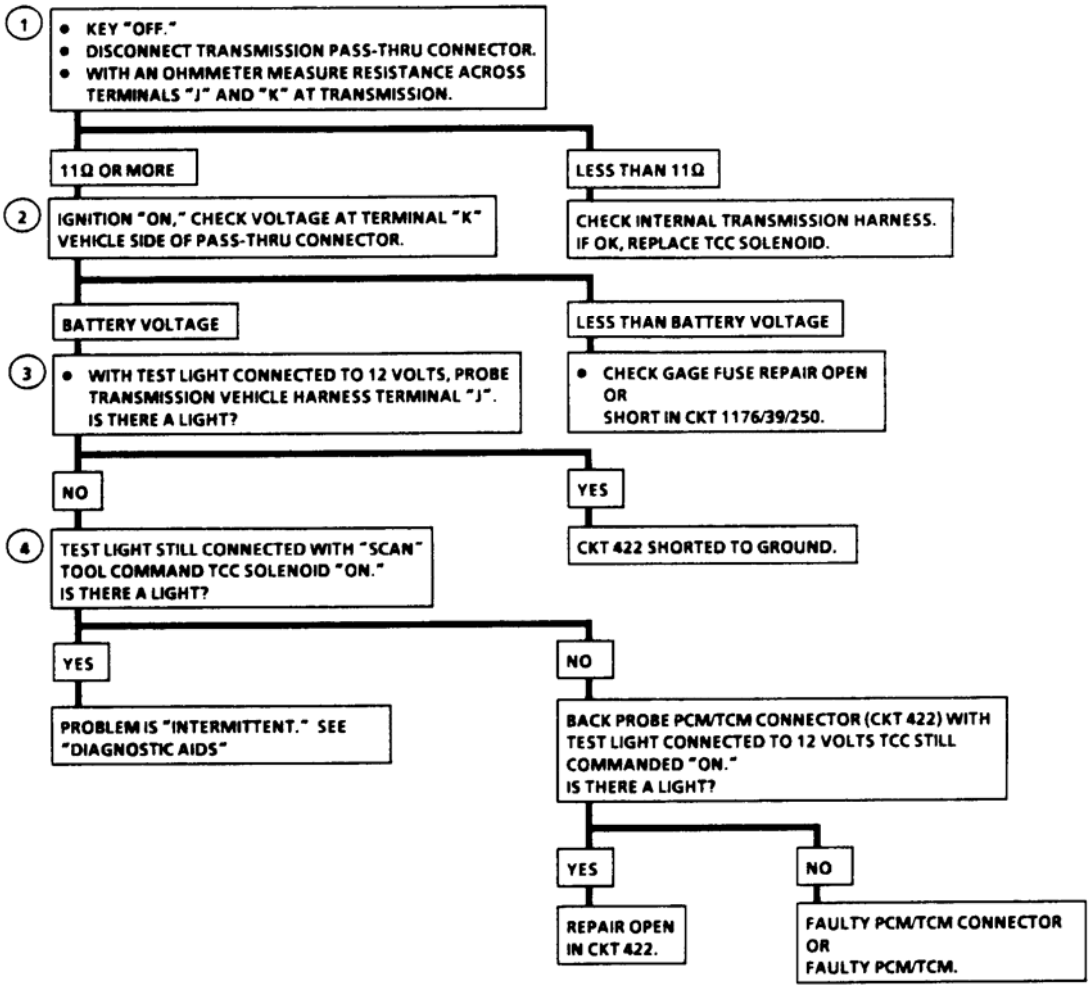


Fig. 310: TCC Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

SHIFT SOLENOID "A" CIRCUIT CHECK - LT. TRUCK

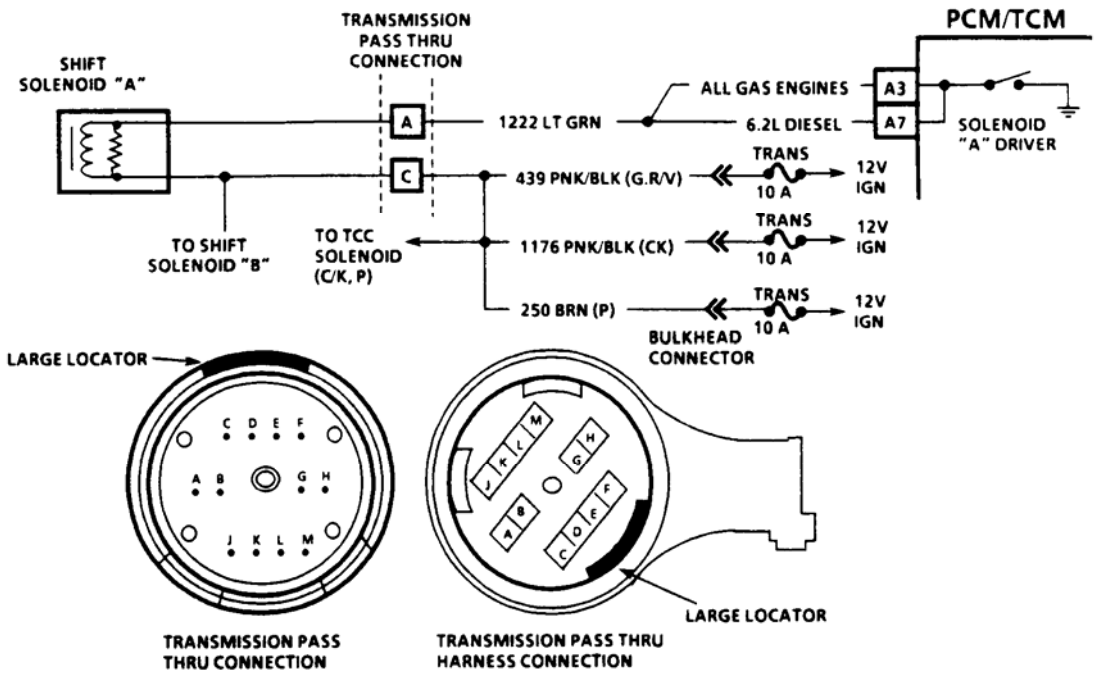


Fig. 311: Shift Solenoid "A" Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

Shift solenoid "A" is attached to the valve body and is a normally open exhaust valve. The PCM/TCM activates he solenoid by grounding it through an internal quad driver. Solenoid "A" (Blue) is on in 1st and 4th gears, but is off in 2nd and 3rd gears. When solenoid is on, it redirects fluid to act on the shift valves.

NOTE: Test number refer to test numbers on diagnostic charts.

1. This test checks shift solenoid "A" and the internal transmission wiring harness for shorts.
2. This test checks for power, from the ignition switch through the fuse, to the shift solenoid.
3. This test checks circuit No. 1222 for a short to ground.
4. This test checks PCM/TCM's ability to ground or control the shift solenoid "A". If bidirectional Scan tester is not available, TCC may be activated by grounding ALDL test terminal "B" With ignition on and engine off.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector.

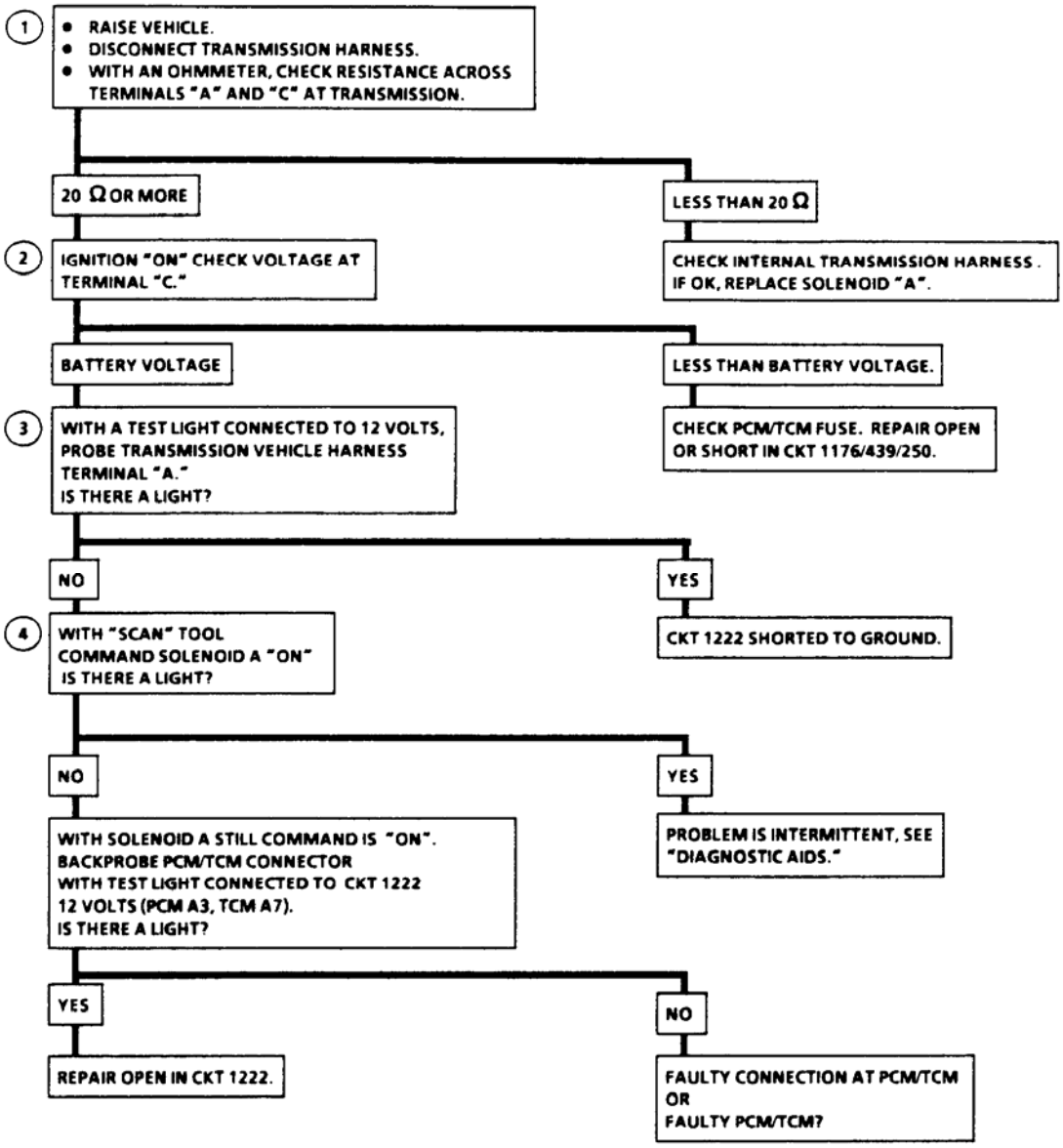


Fig. 312: Shift Solenoid "A" Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

SHIFT SOLENOID "B" CIRCUIT CHECK - LT. TRUCK

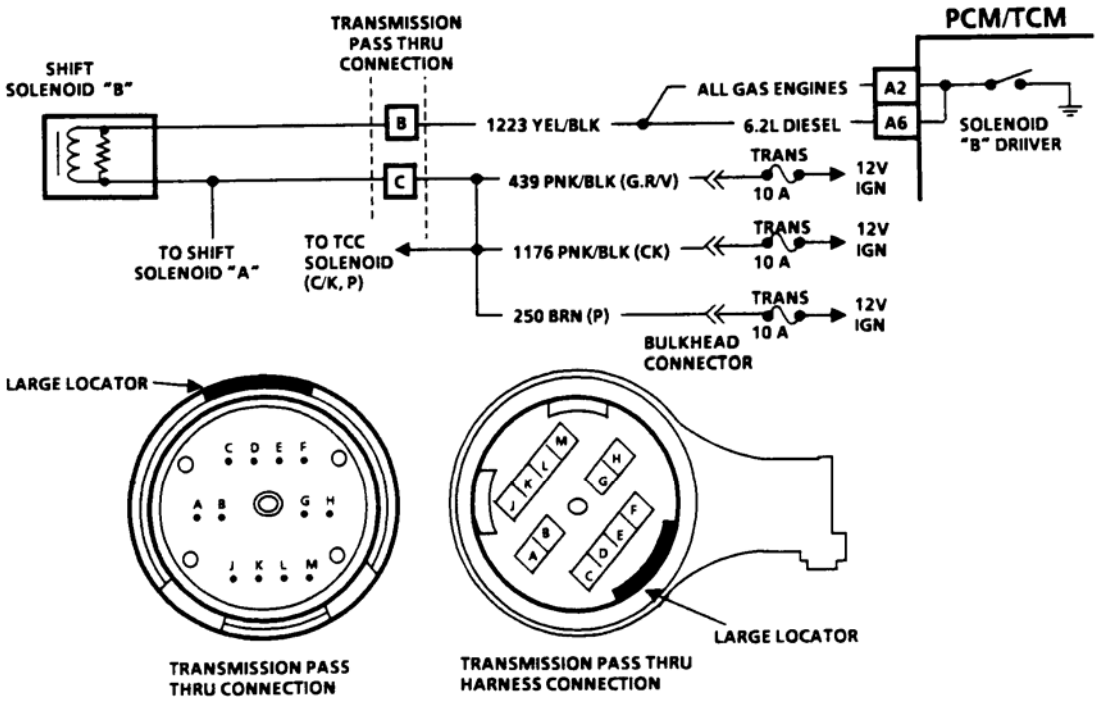


Fig. 313: Shift Solenoid "B" Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

The shift solenoids are used inside the valve body to control the spool valves, which determine the transmission gear. Fused ignition is supplied to solenoid "B". The PCM/TCM will engage solenoid "B" by grounding circuit No. 1223 to energize the solenoid.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks shift solenoid "B" and the internal transmission wiring for shorts.
2. This test checks for power, from the ignition through the transmission fuse, to the shift solenoid
3. This test checks PCM/TCM's ability to ground or control the shift solenoid.
4. This test ensures circuit No. 1223 is not shorted to ground.
5. This test checks PCM/TCM's ability to ground or control the shift solenoid "B". If bidirectional Scan tester is not available, TCC may be activated by grounding ALDL test terminal "B" with ignition on and engine Off.
6. This test ensures circuit No. 1223 is not shorted to ground.

Diagnostic Aids

Check all connections, especially those at the transmission pass-through connector.

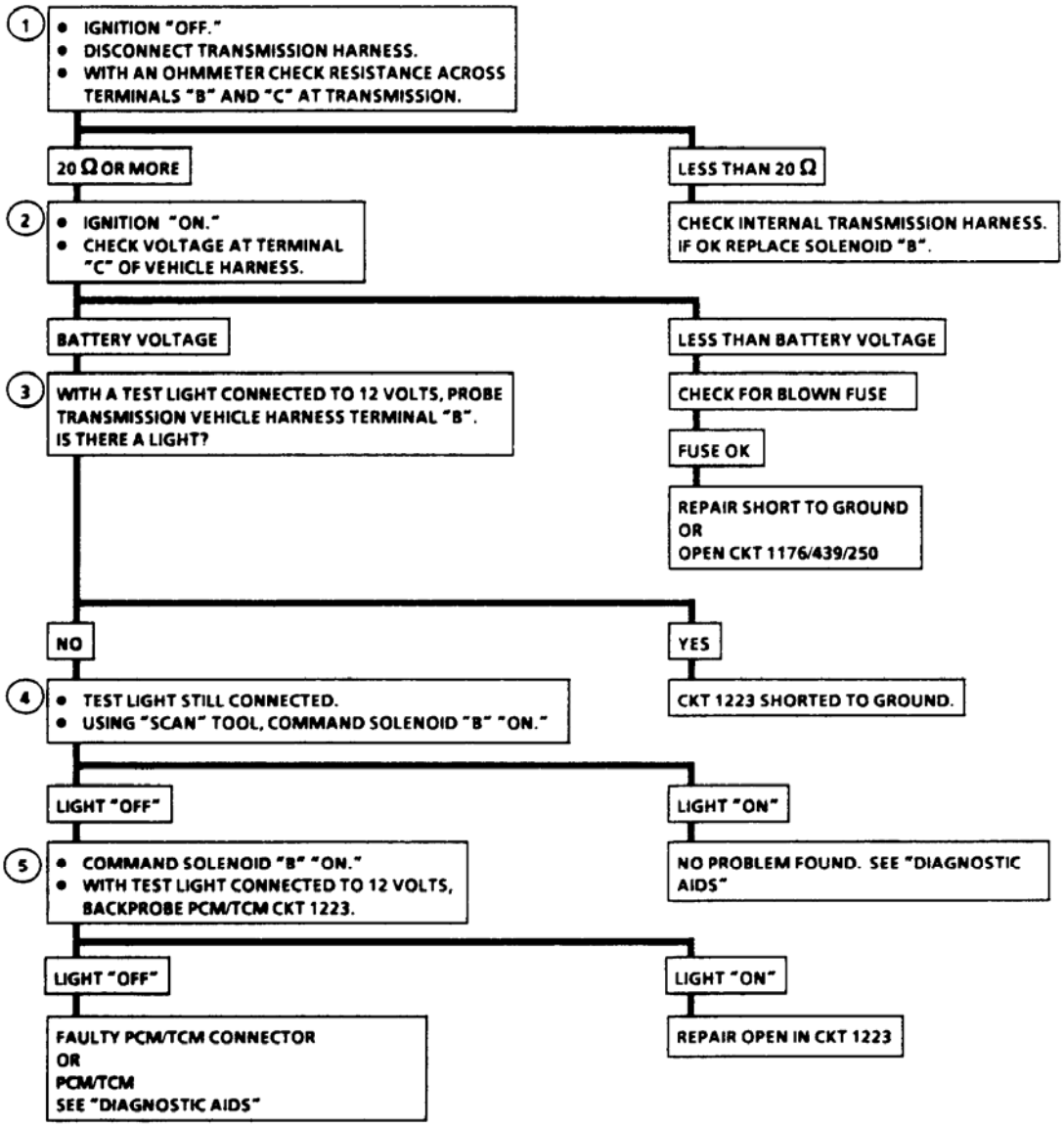


Fig. 314: Shift Solenoid "B" Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

FORCE MOTOR CIRCUIT CHECK (LT. TRUCK)

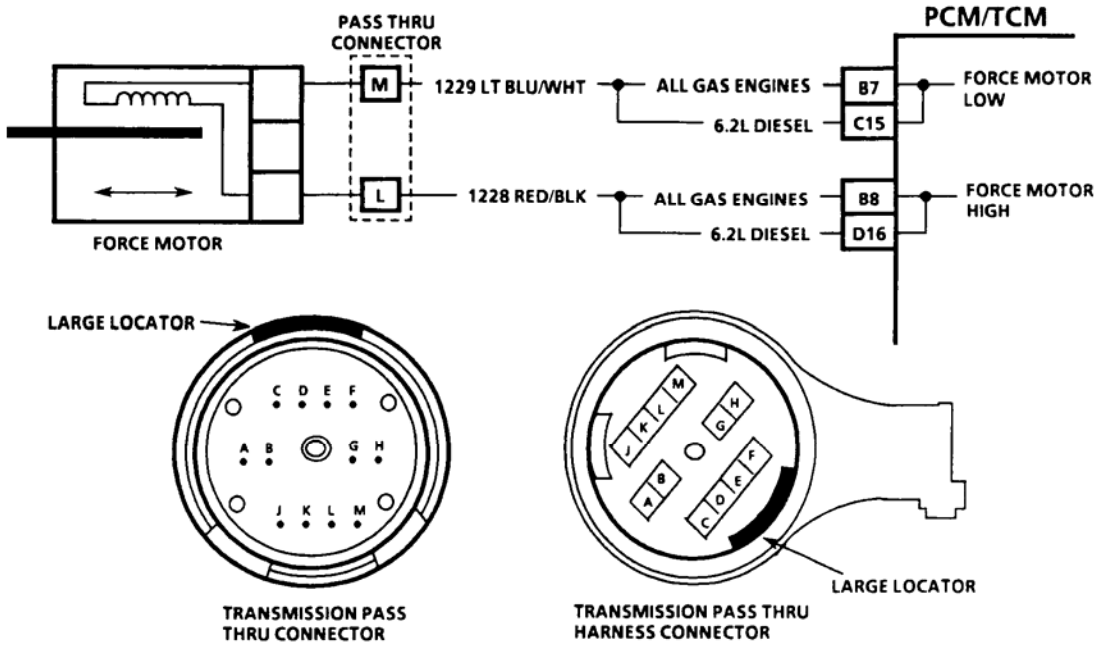


Fig. 315: Force Motor Circuit Diagram (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

NOTE: This flow chart requires the use of a bidirectional (Tech 1) Scan tester.

The force motor is a PCM/TCM-controlled device used to regulate transmission line pressure. The PCM/TCM looks at TPS voltage, engine RPM, and other inputs to determine the appropriate line pressure or a given load, then regulates the pressure by applying a variable amperage to the force motor. The applied amperage varies from .1-1.1 amps.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test verifies an amperage difference of .16 amp or more, and tests the PCM/TCM's ability to control amperage to the force motor.
2. This test checks the force motor for internal shorts.

Diagnostic Aids

Check or poor connections at PCM/TCM, especially at transmission pass-thru connector.

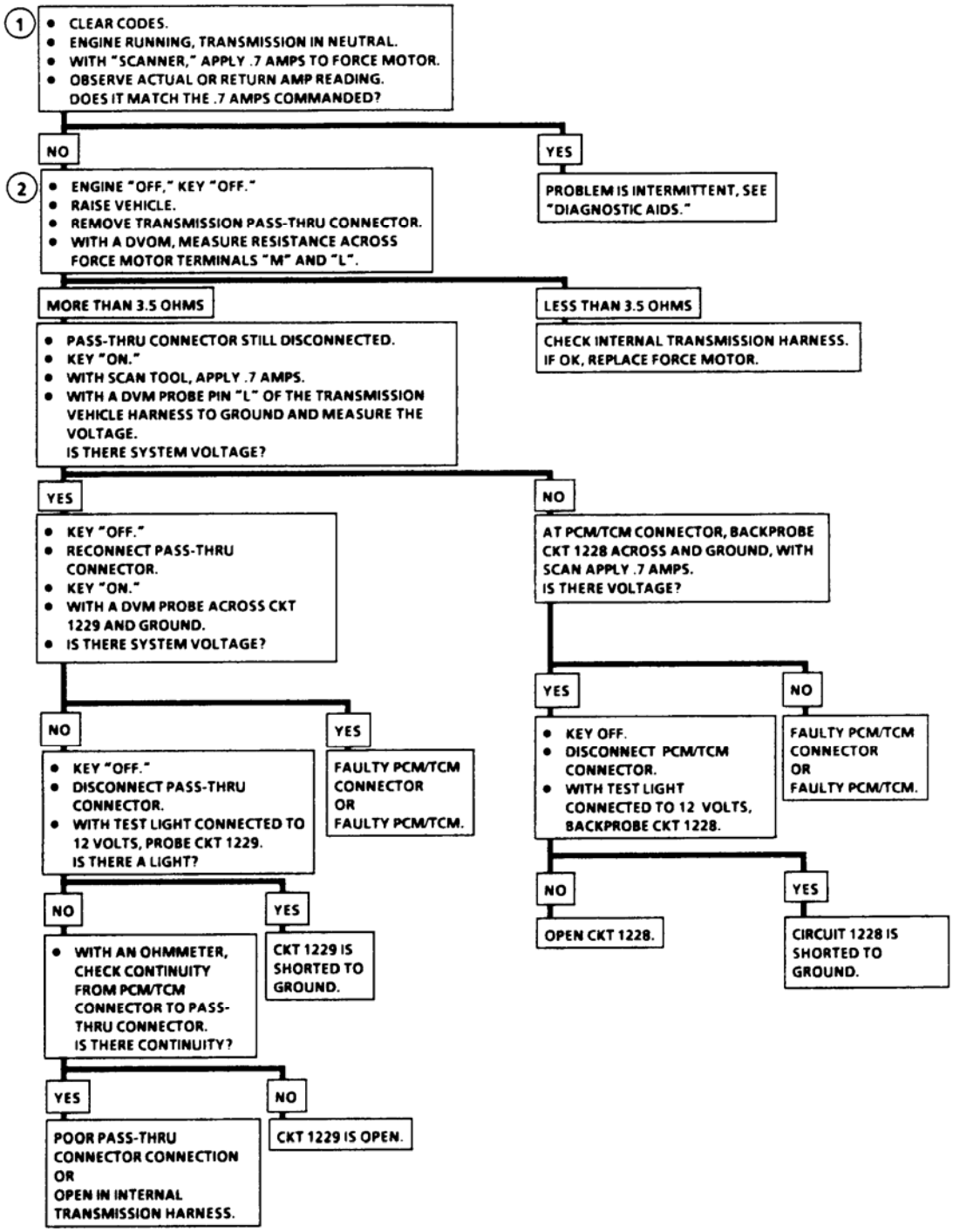


Fig. 316: Force Motor Troubleshooting Chart (Lt. Truck)
Courtesy of GENERAL MOTORS CORP.

WIRING DIAGRAMS

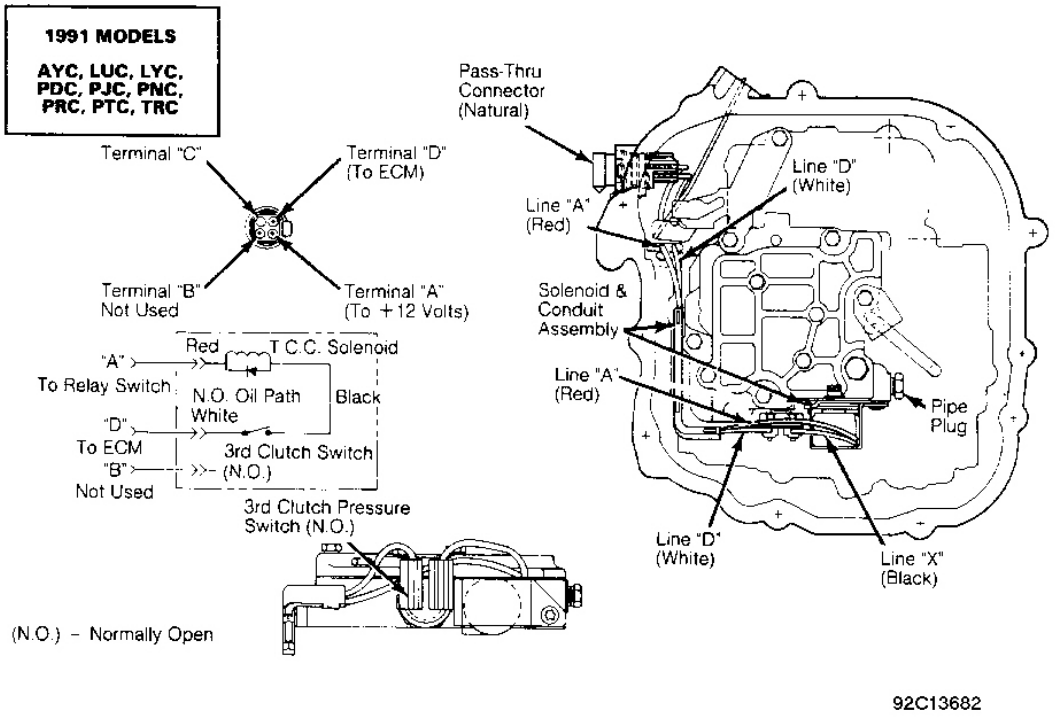


Fig. 317: THM 3T40 Torque Converter Clutch Solenoid & Wiring (1 Of 5)
Courtesy of GENERAL MOTORS CORP.

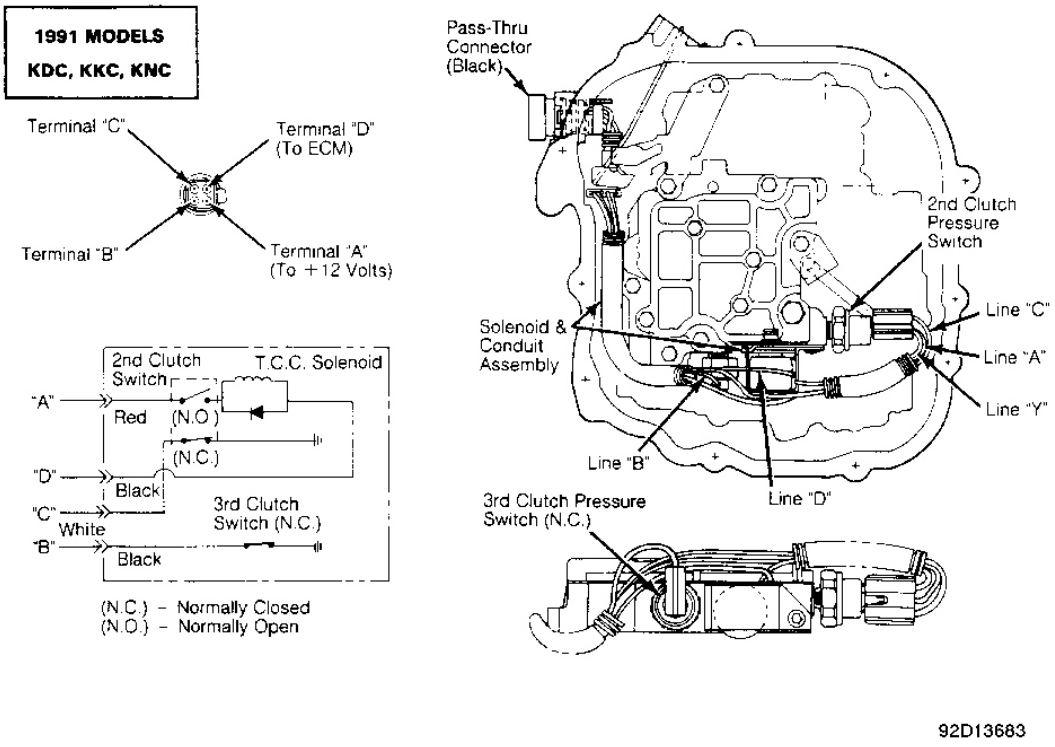


Fig. 318: THM 3T40 Torque Converter Clutch Solenoid & Wiring (2 Of 5)
Courtesy of GENERAL MOTORS CORP.

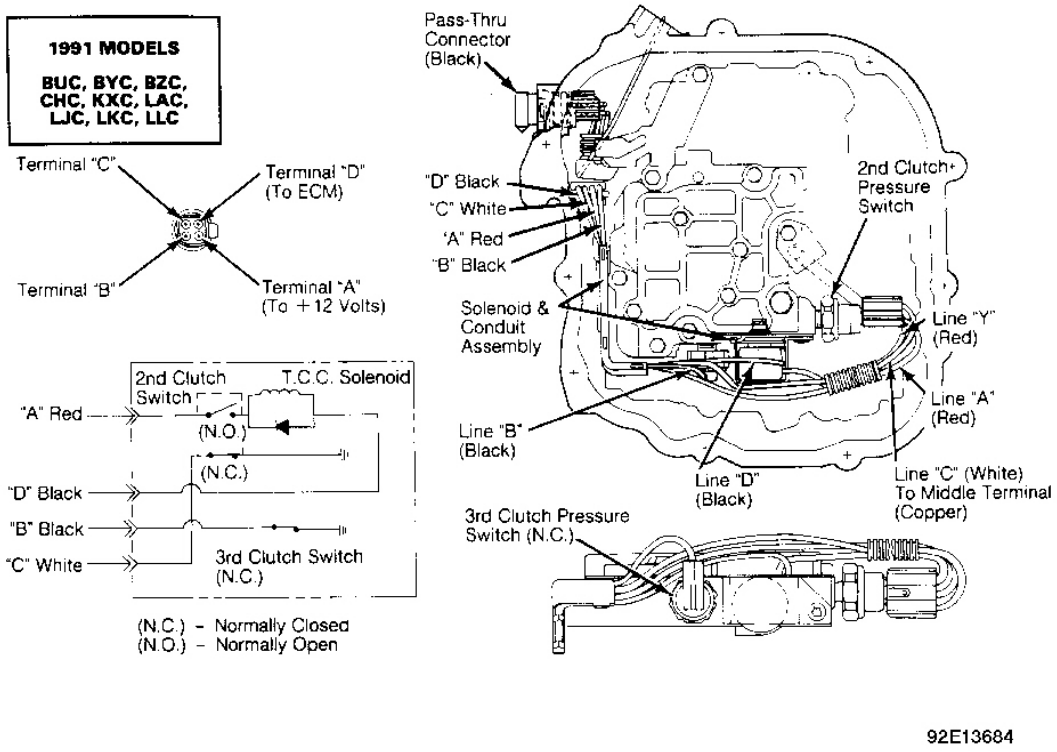


Fig. 319: THM Torque Converter Clutch Solenoid & 3T40 Wiring (3 Of 5)
Courtesy of GENERAL MOTORS CORP.

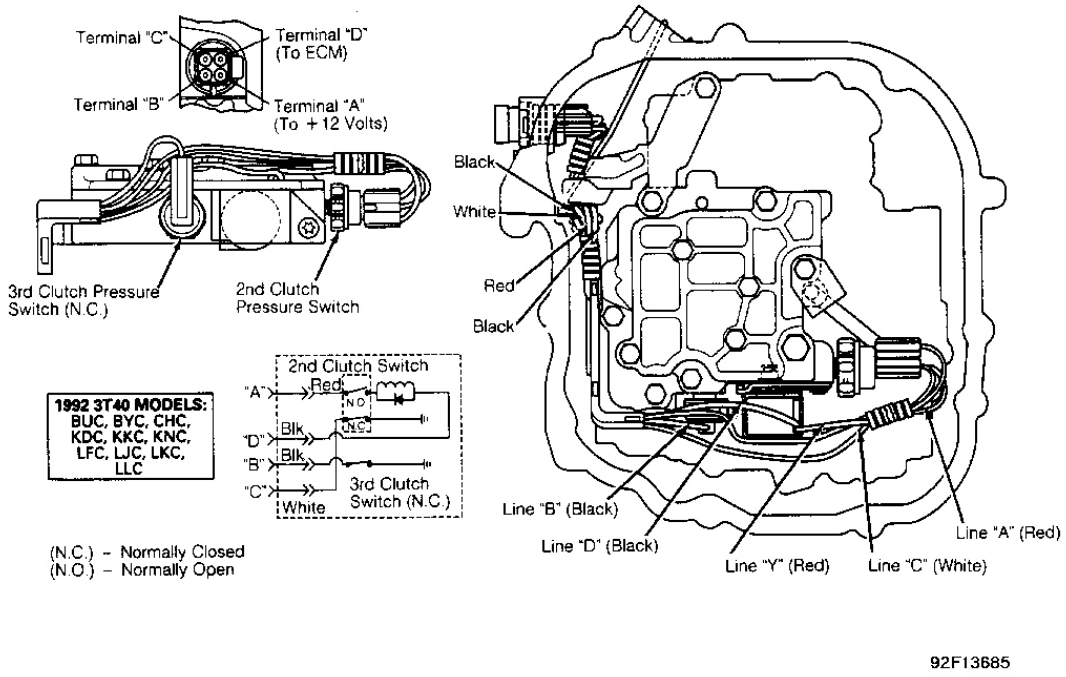


Fig. 320: THM 3T40 Torque Converter Clutch Solenoid & Wiring (4 Of 5)
Courtesy of GENERAL MOTORS CORP.

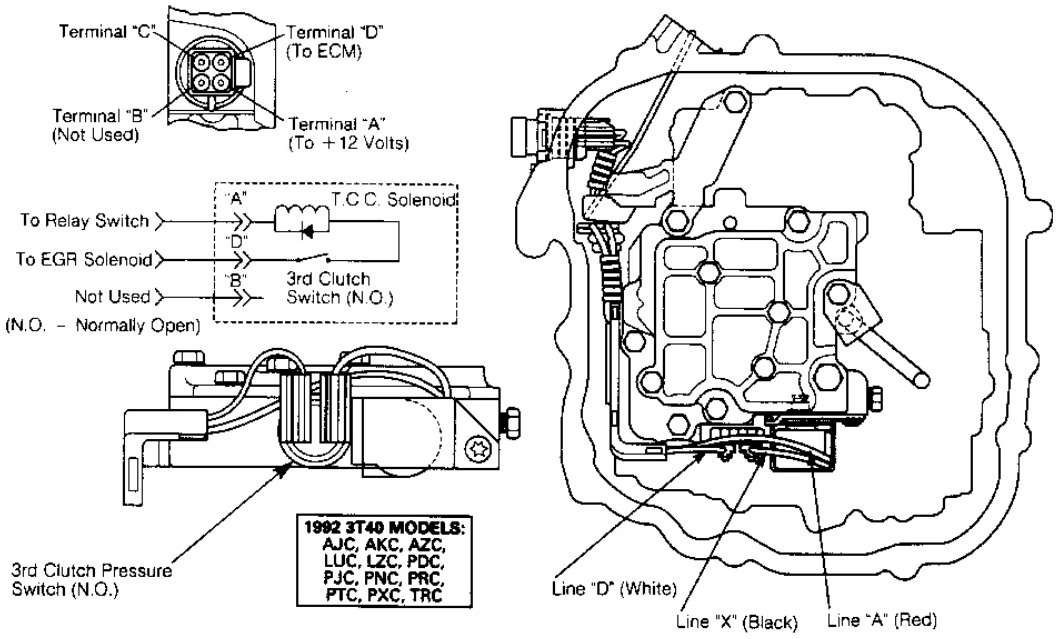


Fig. 321: THM 3T40 Torque Converter Clutch Solenoid & Wiring (5 Of 5)
Courtesy of GENERAL MOTORS CORP.

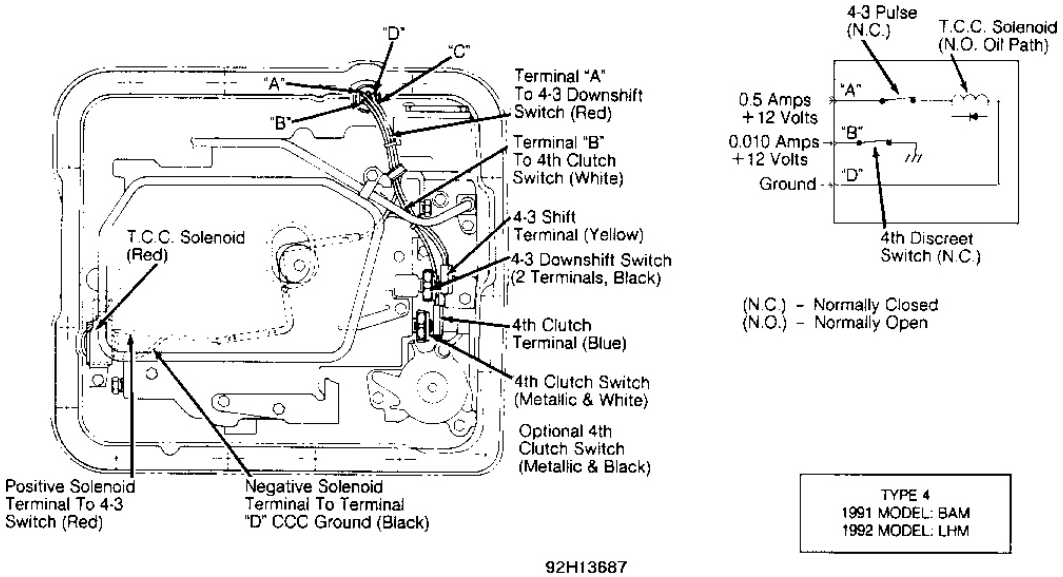
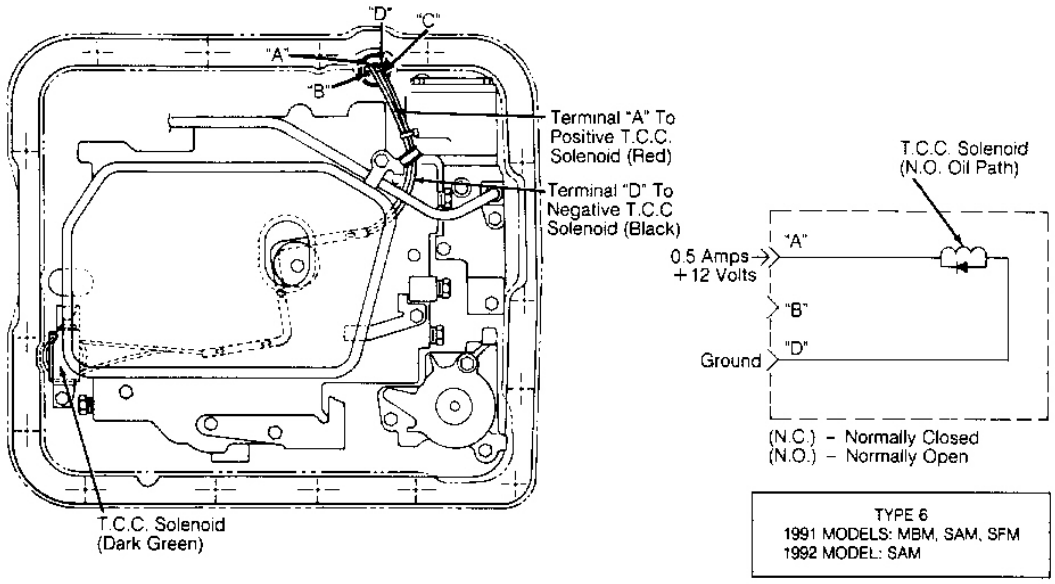
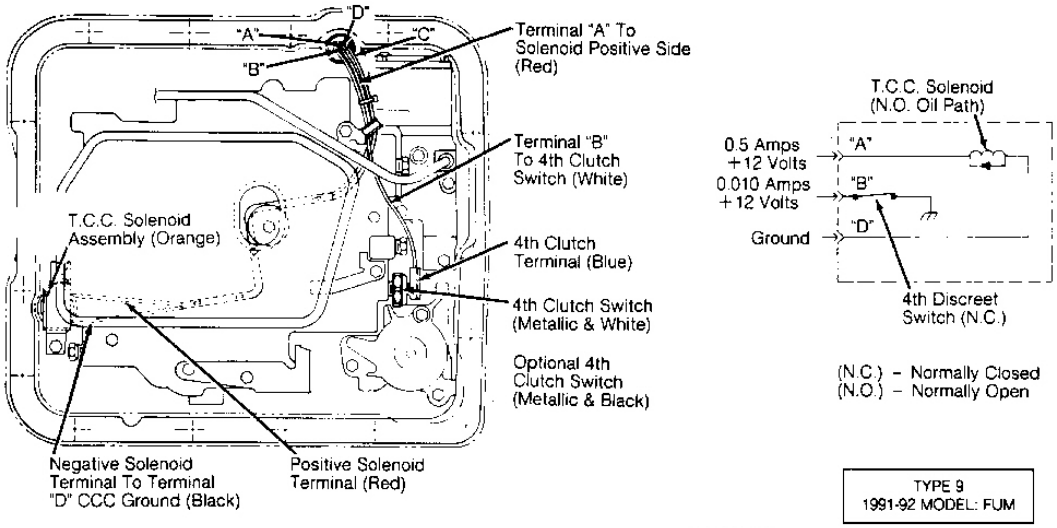


Fig. 322: THM 4L60 Torque Converter Clutch Solenoid & Wiring (1 Of 7)
Courtesy of GENERAL MOTORS CORP.



92I13688

Fig. 323: THM 4L60 Torque Converter Clutch Solenoid & Wiring (2 Of 7)
Courtesy of GENERAL MOTORS CORP.



92J13689

Fig. 324: THM 4L60 Torque Converter Clutch Solenoid & Wiring (3 Of 7)
Courtesy of GENERAL MOTORS CORP.

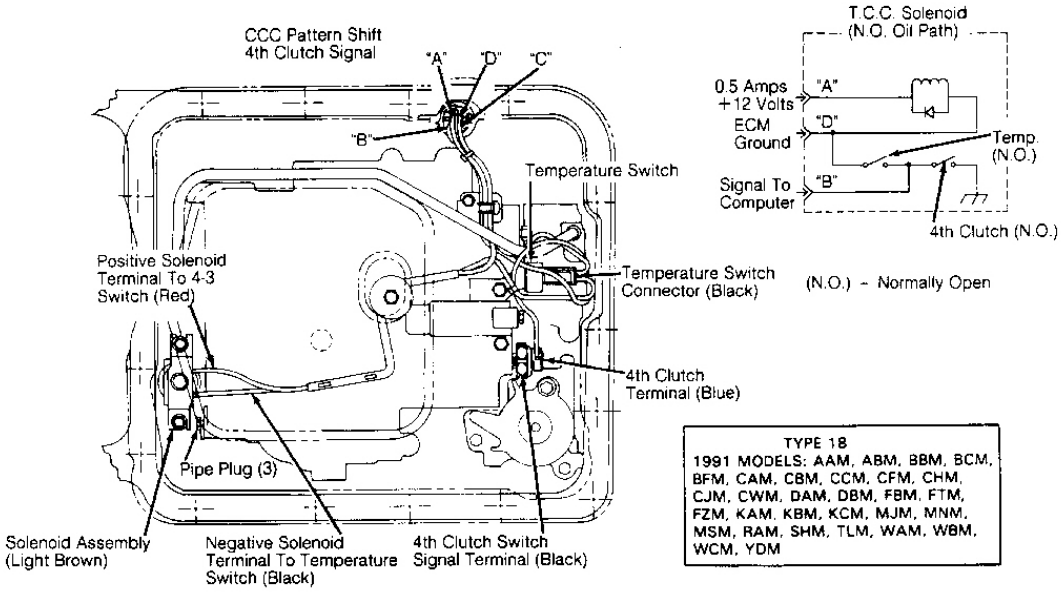


Fig. 325: THM 4L60 Torque Converter Clutch Solenoid & Wiring (4 Of 7)
Courtesy of GENERAL MOTORS CORP.

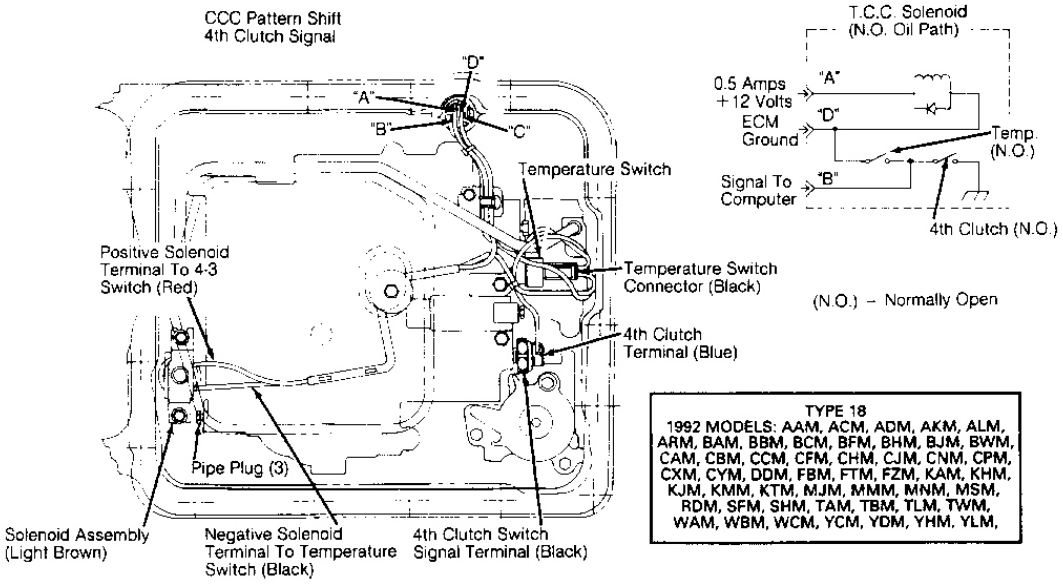


Fig. 326: THM 4L60 Torque Converter Clutch Solenoid & Wiring (5 Of 7)
Courtesy of GENERAL MOTORS CORP.

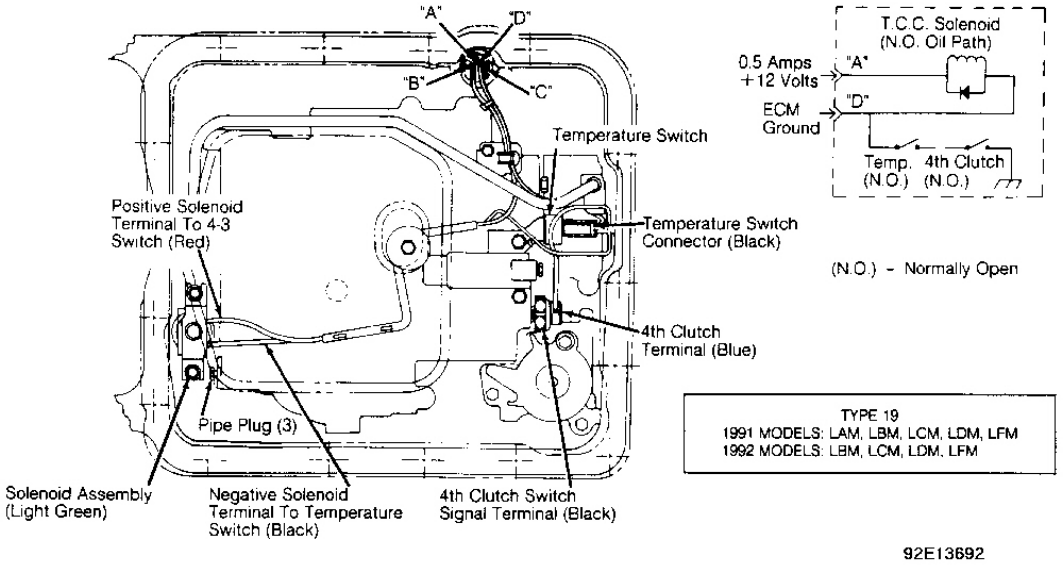


Fig. 327: THM 4L60 Torque Converter Clutch Solenoid & Wiring (6 Of 7)
Courtesy of GENERAL MOTORS CORP.

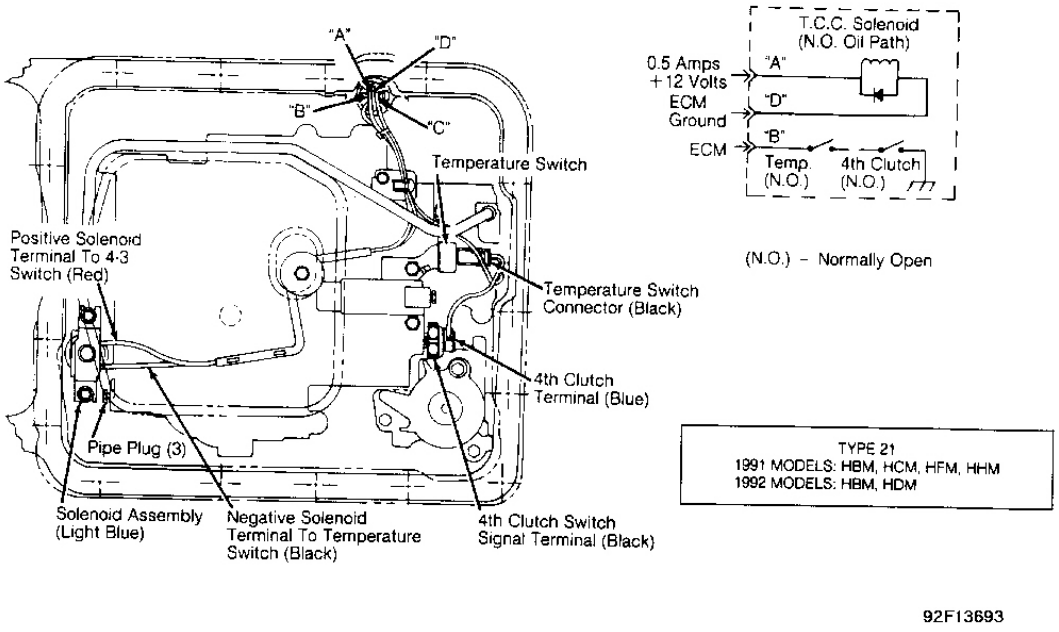


Fig. 328: THM 4L60 Torque Converter Clutch Solenoid & Wiring (7 Of 7)
Courtesy of GENERAL MOTORS CORP.

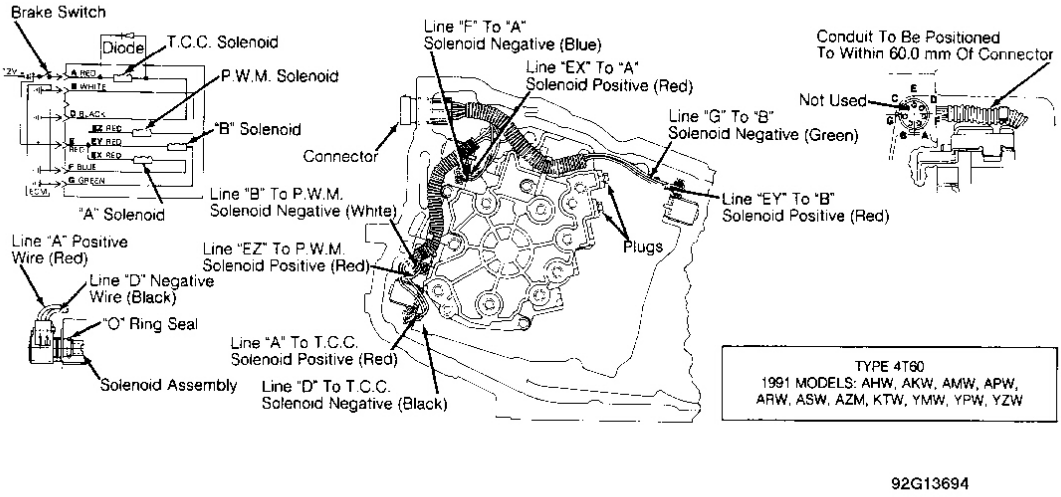


Fig. 329: THM 4T60 Torque Converter Clutch Solenoid & Wiring (1 Of 5)
Courtesy of GENERAL MOTORS CORP.

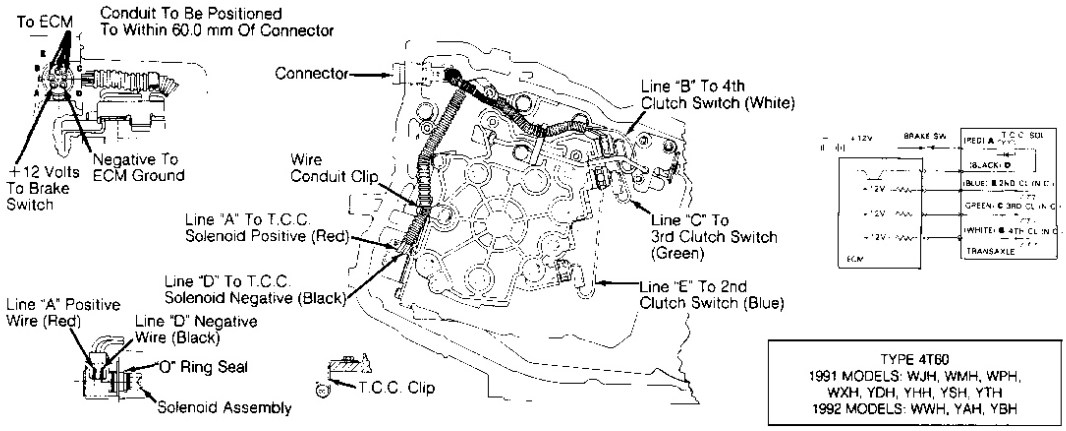


Fig. 330: THM 4T60 Torque Converter Clutch Solenoid & Wiring (2 Of 5)
Courtesy of GENERAL MOTORS CORP.

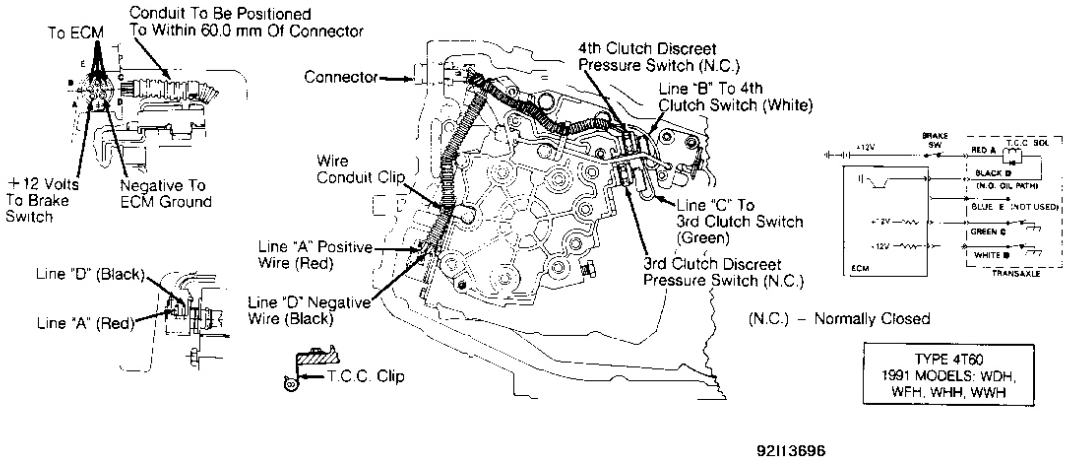


Fig. 331: THM 4T60 Torque Converter Clutch Solenoid & Wiring (3 Of 5)
Courtesy of GENERAL MOTORS CORP.

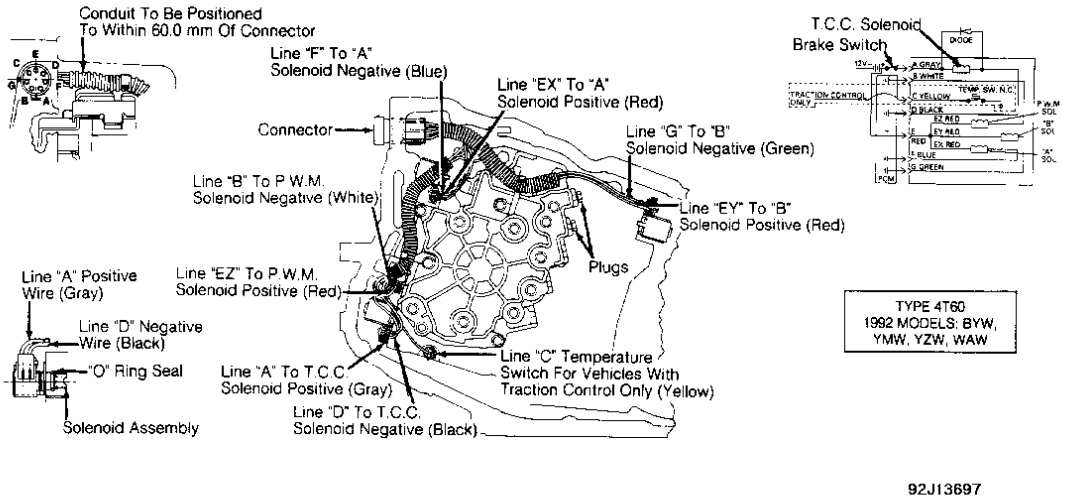


Fig. 332: THM 4T60 Torque Converter Clutch Solenoid & Wiring (4 Of 5)
Courtesy of GENERAL MOTORS CORP.

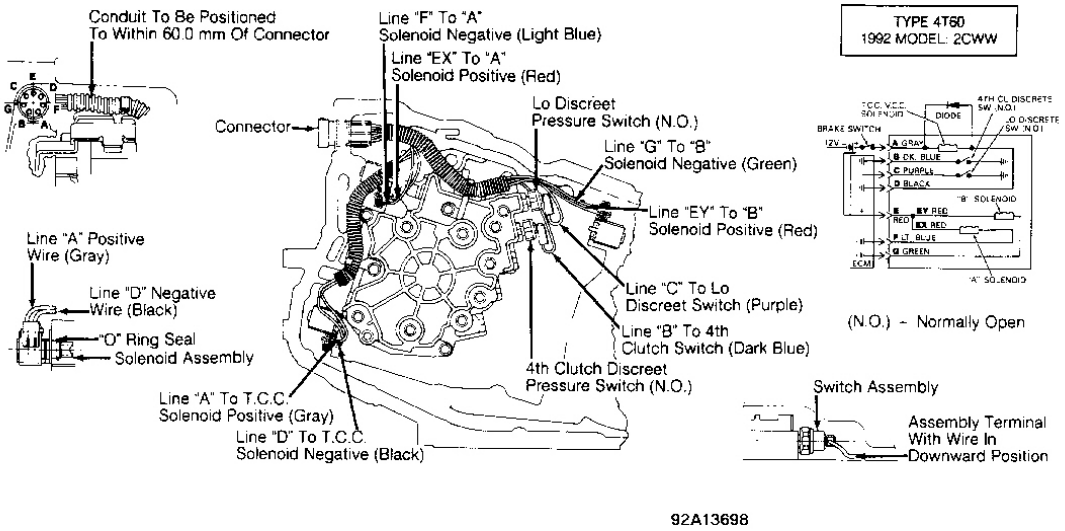


Fig. 333: THM 4T60 Torque Converter Clutch Solenoid & Wiring (5 Of 5)
Courtesy of GENERAL MOTORS CORP.

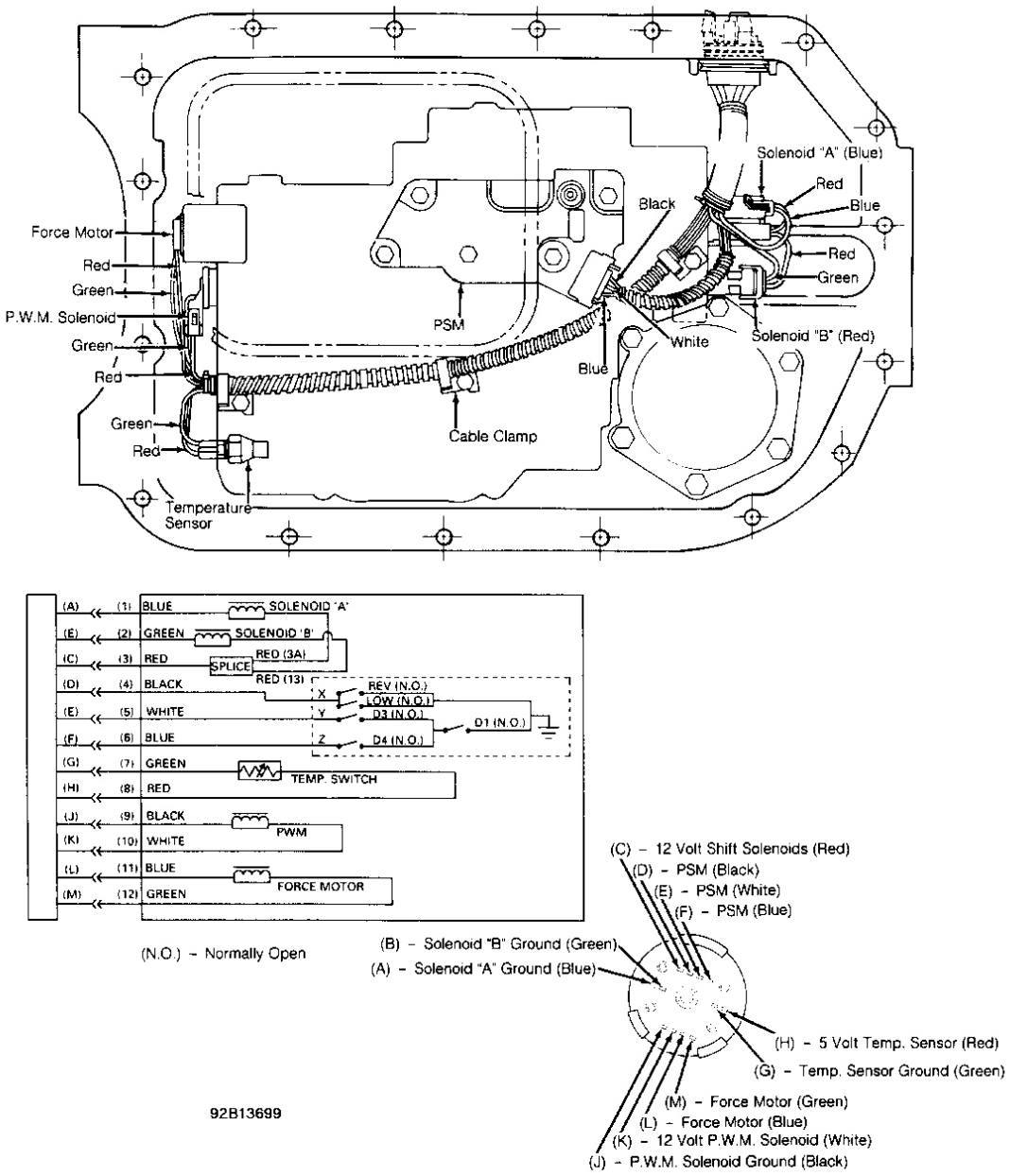


Fig. 334: THM 4L80 Torque Converter Clutch Solenoid & Wiring Diagram
Courtesy of GENERAL MOTORS CORP.

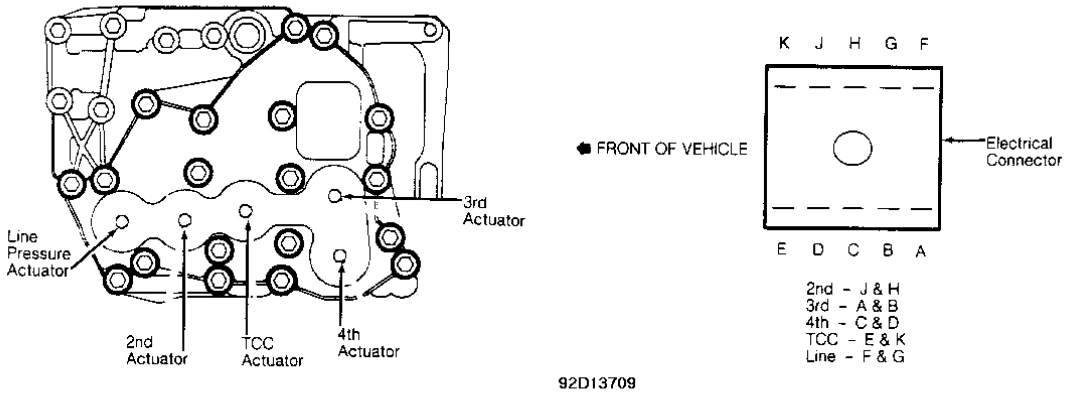


Fig. 335: Saturn MP6 & MP7 Torque Converter Clutch Actuators & Electrical Connector Wire Locations
Courtesy of GENERAL MOTORS CORP.

THM 3T40 APPLICATION

Application (Body Code)	Engine
Buick	
Century (A)	2.5L & 3.3L
Skylark (N)	2.3L, (1) 2.5L & 3.3L
Chevrolet	
Beretta (L)	2.2L, 2.3L & 3.1L
Cavalier (J)	2.2L & 3.1L
Corsica (L)	2.2L, 2.3L & 3.1L
Lumina (W)	2.5L & 3.1L
Lumina APV	3.1L
Oldsmobile	
Achieva (N) (2)	2.3L & 3.3L
Cutlass Calais (N) (1)	2.3L, 2.5L & 3.3L
Cutlass Ciera (A) & Cutlass Cruiser (A)	2.5L & 3.3L
Cutlass Supreme (W)	(1) 2.3L & (2) 3.1L
Silhouette	3.1L
Pontiac	
Grand Am (N)	2.3L, (1) 2.5L & (2) 3.3L
Grand Prix (W)	(1) 2.3L & (2) 3.1L
LeMans (T)	1.6 & 2.0L
Sunbird (J)	2.0L & 3.1L

Trans Sport	3.1L
6000 (A) (1)	2.5L & 3.1L

(1) Applies to 1991 models.

(2) Applies to 1992 models.

THM 4L60/700-R4 APPLICATION (1991-92)

Application (Body Code)	Engine
Buick	
Roadmaster (B)	5.0L, 5.7L
Cadillac	
Brougham (D)	5.0L, 5.7L
Chevrolet	
Astro	4.3L
Blazer	2.5L, 4.3L, 5.7L, 6.2L
Camaro (F)	3.1L, 5.0L, 5.7L
Caprice (B)	5.0L, 5.7L
Corvette (Y)	5.7L
Cutaway Van	5.7L, 6.2L, 7.4L
Hi-Cube Van	5.7L, 6.2L, 7.4L
Passenger Van	4.3L, 5.0L, 5.7L, 6.2L, 7.4L
Sport Van	4.3L, 5.0L, 5.7L, 6.2L, 7.4L
Suburban	5.7L, 6.2L, 7.4L
Pickup	2.5L, 4.3L, 5.0L, 5.7L, 6.2L, 6.5L, 7.4L
GMC	
Cutaway Van	4.3L, 5.7L
Jimmy	5.7L, 6.2L
Magnavan	5.7L, 6.2L, 7.4L
Passenger Van	4.3L
Rally Van	4.3L, 5.0L, 5.7L, 6.2L
Safari	4.3L
School Bus	4.3L, 5.7L
Sierra	4.3L, 5.7L, 6.2L, 7.4L
Pickup	2.5L, 4.3L, 5.7L, 6.2L

Vandura	4.3L, 5.0L, 5.7L, 6.2L
Yukon	5.7L
Oldsmobile	
Bravada	4.3L
Custom Cruiser (B)	5.0L, 5.7L
Pontiac	
Firebird (F)	3.1L, 5.0L, 5.7L

THM 4T60 & 4T60-E APPLICATION (1991-92)

Application (Body Code)	**Engine**
Buick	
Century (A)	3.3L
LeSabre (H), Park Avenue (C), Riviera (E) & 1991 Reatta (E)	(1) 3.8L
Regal (W)	3.1L & 3.8L
Chevrolet	
Lumina (W)	3.1L & (1) 3.4L
Lumina APV	(1) 3.8L
Oldsmobile	
Cutlass Ciera (A) & Cutlass Cruiser (A)	3.3L
Cutlass Supreme (W)	3.1L & (1) 3.4L
Eighty Eight (Royale) (H), Ninety-Eight (C), Silhouette, Toronado (E) & Trofeo (E)	(1) 3.8L
Pontiac	
Bonneville (H) & Trans Sport	(1) 3.8L
Grand Prix (W)	3.1L & (1) 3.4L
1991 6000 (A)	3.1L
(1) These 1992 models, including 1991 Reatta, use THM 4T60-E transaxles.	

THM 4L80-E APPLICATION

Application (1)	**Engine**
Chevrolet	
"C", "G", "K", "P", "R" & "V" Series	4.3L, 5.7L, 6.2L & 7.4L
GMC	
"C", "G", "K", "R" & "V" Series	4.3L, 5.7L, 6.2L & 7.4L

(1) See **THM 4L80-E SERIES CODE DESIGNATION** table.

THM 4L80-E SERIES CODE DESIGNATION

Model	Designation
1991	
Blazer & Jimmy	"V" Series
Parcel Van	"P" Series
Pickup	
2WD	"C" & "R" Series
4WD	"K" & "V" Series
Suburban	
2WD	"R" Series
4WD	"V" Series
Van	"G" Series
1992	
Blazer	"K" Series
Parcel Van	"P" Series
Pickup	
2WD	"C" Series
4WD	"K" Series
Sierra & Suburban	
2WD	"C" Series
4WD	"K" Series
Van	"G" Series
Yukon	"K" Series

MP6 & MP7 APPLICATIONS

Manufacturer	Engine
Saturn	1.9L

ECM & BCM TROUBLE CODES

Application	Circuit Affected
ECM Code	
E024	Vehicle Speed Sensor (VSS)
E031	Park/Neutral Switch
E038	Brake Switch
BCM Code	
B127	PRNDD21 Sensor

CODE 23 ECM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM Terminal	Wire Color
2.0L, 2.2L J Body & 2.5L A & N Bodies		
MAT Signal	B5	Tan
MAT Ground	W14	Black/Orange
2.2L L Body		
MAT Signal	B5	Black/Pink
MAT Ground	W14	Black
2.3L L Body		
MAT Signal	GF16	Black/Pink
MAT Ground	BB5	Black
2.3L W Body, 2.5L W Body & 3.1L W Body & 3.4L W Body		
MAT Signal	C4	Tan
MAT Ground	C5	Black
3.1L A, F & J Bodies & 5.0L & 5.7L PFI F Body		
MAT Signal	GF16	Tan
MAT Ground	BB5	Black
3.1L L Body		
MAT Signal	GF16	Pink/Black
MAT Ground	BB5	Black
3.8L C & E Bodies		
MAT Signal	BB7	Tan
MAT Ground	BA7	Black
3.8L H Body		
MAT Signal	YD11	Tan
MAT Ground	YD5	Black
3.8L W Body		
MAT Signal	R12	Tan
MAT Ground	R2	Black/White
5.0L & 5.7L TBI		
MAT Signal	C12	Tan
MAT Ground	A11	Black
5.7L Y Body		
MAT Signal	C4	Tan
MAT Ground	C5	Black/Pink

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	Ohms
210 (100)	185
160 (70)	450
100 (38)	1800

70 (20)	3400
20 (-7)	13,500
0 (-18)	25,000
-40 (-40)	100,700
NOTE:	Measure resistance across sensor terminals.

CODE 25 ECM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM Terminal	Wire Color
2.0L, 2.2L J Body & 2.5L A & N Bodies		
MAT Signal	B5	Tan
MAT Ground	W14	Black/Orange
2.2L L Body		
MAT Signal	B5	Black/Pink
MAT Ground	W14	Black
2.3L L Body		
MAT Signal	GF16	Black/Pink
MAT Ground	BB5	Black
2.3L W Body, 2.5L W Body & 3.1L W Body & 3.4L W Body		
MAT Signal	C4	Tan
MAT Ground	C5	Black
3.1L A, F & J Bodies & 5.0L & 5.7L PFI F Body		
MAT Signal	GF16	Tan
MAT Ground	BB5	Black
3.1L L Body		
MAT Signal	GF16	Pink/Black
MAT Ground	BB5	Black
3.8L C & E Bodies		
MAT Signal	BB7	Tan
MAT Ground	BA7	Black
3.8L H Body		
MAT Signal	YD11	Tan
MAT Ground	YD5	Black
3.8L W Body		
MAT Signal	R12	Tan
MAT Ground	R2	Black/White
5.0L & 5.7L TBI		
MAT Signal	C12	Tan
MAT Ground	A11	Black
5.7L Y Body		
MAT Signal	C4	Tan
MAT Ground	C5	Black/Pink

SHIFT SOLENOID OPERATING SEQUENCE

Gear	Solenoid A	Solenoid B
1st Gear	On	On
2nd Gear	Off	On
3rd Gear	Off	Off
4th Gear	On	Off

4T60 SHIFT SOLENOID OPERATING SEQUENCE

Gear	Solenoid A	Solenoid B
1st Gear	Closed	Closed
2nd Gear	Open (1)	Closed
3rd Gear	Open (1)	(1) Open
4th Gear	Closed	(1) Open
(1) Open = De-energized		

CODE 23 ECM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM Terminal	Wire Color
2.5L		
Signal	C12	Tan
MAT Ground	D2	Black/Red
4.3L Turbo		
Signal	GF16	Tan
MAT Ground	BB5	Black/Red

TEMPERATURE-TO-RESISTANCE VALUES

°F (°C) (1)	(2) Ohms
210 (100)	185
160 (70)	450
100 (38)	1,800
70 (20)	3,400
40 (4)	7,500
20 (-7)	13,500
0 (-18)	25,000
-40 (-40)	100,700
(1) Temperatures are approximate.	
(2) Measure resistance across sensor terminals.	

CODE 25 ECM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM Terminal	Wire Color
2.5L		

Signal	C12	Tan
MAT Ground	D2	Black/Red
4.3L Turbo		
Signal	GF16	Tan
MAT Ground	BB5	Black/Red

VALID PSM COMBINATION CHART

Application	A	B	C
Park	12	0	12
Reverse	0	0	12
Neutral	12	0	12
4th	12	0	0
3rd	12	12	0
2nd	12	12	12
1st	0	12	12
Illegal	0	12	0
Illegal	0	0	0

GEAR RATIO

Gear	Less Than	More Than
1st	2.38	2.63
2nd	1.43	1.58
3rd	.95	1.05
Reverse	1.97	2.17

APPLICATION

4L60-E APPLICATION

Manufacturer	Model (Body Code)	Engine
Buick	Roadmaster ("B")	5.7L
Cadillac	Fleetwood ("D")	5.7L
Chevrolet	Astro ("L & M")	4.3L
Chevrolet	Blazer ("S & T")	2.2L/4.3L
Chevrolet	Camaro ("F")	3.4L/5.7L
Chevrolet	Caprice ("B")	4.3L/5.7L
Chevrolet	Corvette ("Y")	5.7L
Chevrolet	Impala SS ("B")	5.7L
Chevrolet	Suburban & ("C" & "K") Pickup	All
Chevrolet	Tahoe ("C & K")	5.7L
Chevrolet	Van ("G")	All
GMC	Jimmy ("S & T")	4.3L
GMC	Passenger Van ("G")	4.3L
GMC	Safari ("L & M")	4.3L
GMC	Sierra ("C & K")	All
GMC	Sonoma ("S & T")	2.2L/4.3L
GMC	Sport Van ("G")	All
GMC	Vandura ("G")	All
GMC	Yukon ("C & K")	5.7L
Oldsmobile	Bravada ("S & T")	4.3L
Pontiac	Firebird ("F")	3.4L/5.7L

DESCRIPTION

The 4L60-E transmission uses 2 electric shift solenoids to control transmission upshifts and downshifts. In addition, a pressure control (force motor) solenoid controls hydraulic line pressure, and a Torque Converter Clutch (TCC) solenoid controls TCC application. A TCC Pulse Width Modulated (PWM) solenoid is used to control fluid acting on converter clutch valve, which then controls TCC apply and release. A 3-2 control solenoid modulates hydraulic pressure for the 2-4 band and 3-4 clutch to improve 3-2 downshift. Solenoids are turned on and off by Powertrain Control Module (PCM).

PCM receives signals from various transmission sensors. Sensors include engine speed and throttle position, transmission speed, hydraulic pressure and transmission fluid temperature. PCM has on-board self-diagnostics to help identify any parts or circuits which may need further testing.

OPERATION

Shift solenoid holds hydraulic pressure (solenoid on) or releases hydraulic pressure (solenoid off). This action controls shift valves inside valve body. By switching one or both solenoids on or off, different combinations of clutches, sprags and bands are operated. See **CLUTCH & BAND APPLICATION** under TROUBLE SHOOTING.

INTRODUCTION

PCM

PCM is located under air cleaner on Caprice, Fleetwood, Impala SS and Roadmaster, at right rear corner of engine compartment on Camaro and Firebird, and above power brake booster on Corvette.

On light trucks and vans (gasoline), PCM is located behind glove box on "C" and "K" series vehicles, under driver's seat on "G" series vehicles, or at right rear corner of engine compartment on "L", "M", "S" and "T" series vehicles. For series identification, see BODY CODE in **APPLICATION** table.

On light trucks and vans (diesel), PCM is located behind right side of dash on "C" and "K" series truck. PCM is located under driver's seat or behind right side of dash on "G" series van. PCM controls TCC, pressure control solenoid, (hydraulic pressure), PWM solenoid and shift solenoids 1-2 and 2-3. In addition, PCM also controls ignition, fuel and emission devices related to engine.

PCM receives electronic signals from sensors and switches. These signals help PCM determine when to operate various relays and solenoids related to engine and transmission components.

SENSORS & SWITCHES

PCM controls converter clutch lock-up, upshifts and downshifts based on transmission temperature, system voltage, throttle position, transmission oil pressure switches (5), and transmission output and input (engine) speed sensors. See **Fig. 1**. System includes several other sensors and switches that are used for engine control (gasoline engines). For additional information and testing of engine components, see appropriate SYSTEM/COMPONENT TESTS article in ENGINE PERFORMANCE section.

SOLENOIDS

Shift Solenoids 1-2 & 2-3

Transmission is shifted up or down by 2 electric shift solenoids. Both solenoids are located on valve body. See **Fig. 1**. Ignition power is supplied to each solenoid by transmission fuse. Solenoid 1-2 controls hydraulic pressure to 1-2 shift valve. Solenoid 2-3 controls hydraulic pressure to 2-3 shift valve.

NOTE: The 3-4 shift valve is directly controlled by hydraulic circuits in valve body.

Pressure Control

Pressure control (force motor) solenoid has a spool valve and operates pressure regulator valve. See **Fig. 1**.

PCM sends a frequency signal to pressure control solenoid to regulate hydraulic line pressure. Frequency signal (duty cycle) is measured with a dwell meter or lab scope. When duty cycle is zero, line pressure is at maximum, and pressure control solenoid draws zero amps. When duty cycle is 60 percent, line pressure is at minimum, and pressure control solenoid draws 1.1 amps at 4.5 volts.

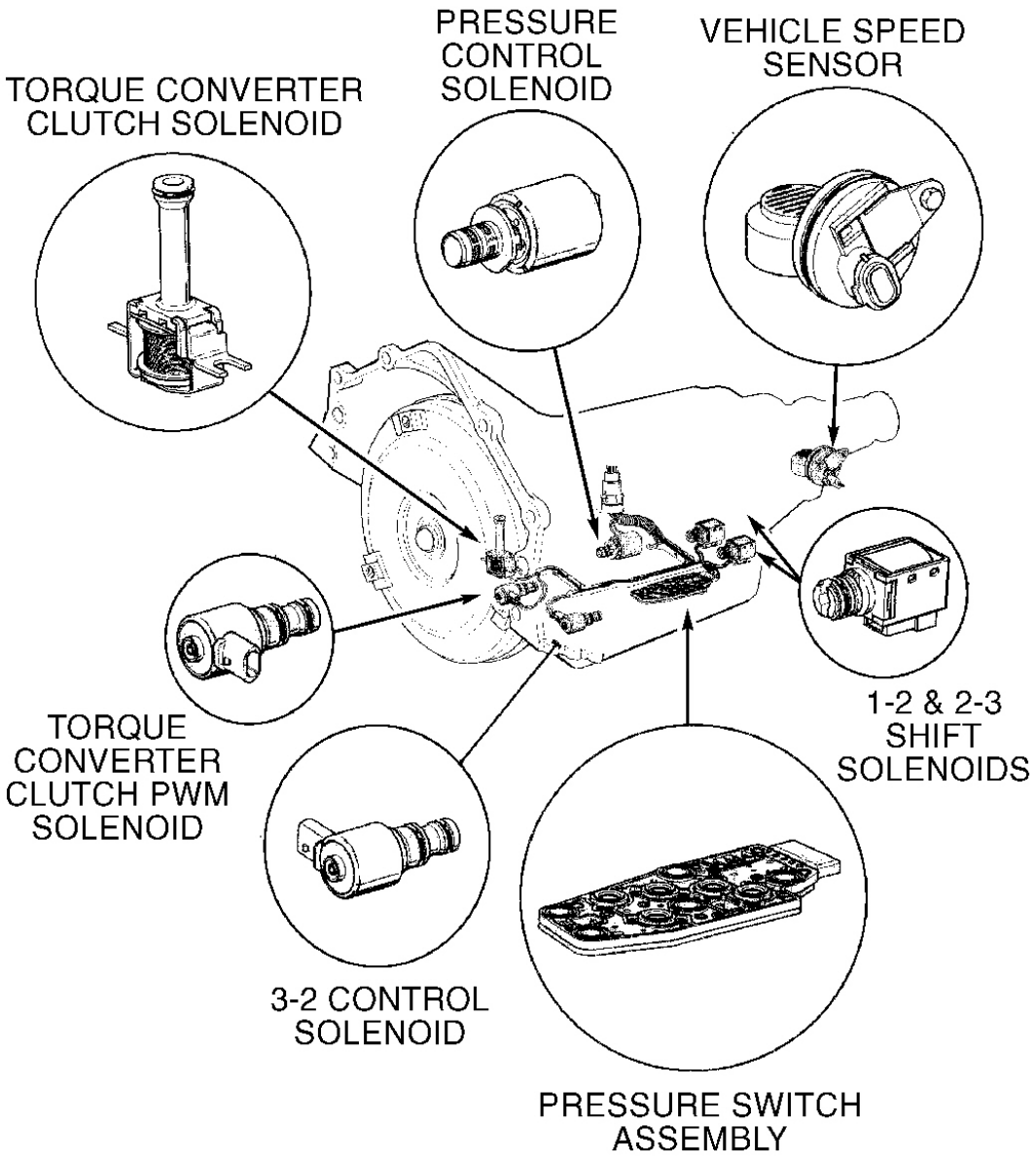


Fig. 1: Locating Transmission Solenoids, Sensors & Switches Courtesy of General Motors Corp.

TCC Solenoid

This solenoid is used to control TCC apply valve. PCM sends a frequency signal to TCC solenoid to gradually

apply or release TCC. See **Fig. 1**.

3-2 Control Solenoid

PCM modulates current (duty cycle) to control 3-2 control solenoid. The 3-2 control solenoid is off in first gear. In all other gears, 3-2 control solenoid is 90 percent on. Hydraulic pressure is regulated to smoothly release 3-4 clutch and 2-4 band during 3-2 downshift.

TCC PWM Solenoid

TCC PWM solenoid is used to control fluid acting on converter clutch valve, which then controls TCC apply and release. See **Fig. 1**. TCC PWM solenoid is used to provide smooth engagement of torque converter clutch by operating on a negative duty cycle percent of on time.

SELF-DIAGNOSTICS

PCM constantly monitors all electrical circuits. If PCM detects circuit problems or sensors out of range, it will record a Diagnostic Trouble Code (DTC). If problem continues for a predetermined time, Malfunction Indicator Light (MIL) will glow.

If MIL is on all the time, DTC(s) are currently being detected. If MIL is off, but PCM had detected a circuit or sensor problem, DTC(s) will be stored in computer memory.

Stored DTCs may be retrieved from PCM memory. Depending on vehicle, several methods may be used. The most basic method (non-scan) uses a jumper wire to activate MIL, which will flash a series of codes. Other method includes using a factory recommended Tech 1 scan tool or aftermarket scan tool.

NOTE: Faulty engine sensors and actuators may cause transmission related DTCs or driveability problems. Engine faults and related DTCs must be diagnosed and repaired before transmission codes are repaired. For additional information on diagnosing and repairing engine-related PCM trouble codes, see appropriate TESTS W/CODES article in ENGINE PERFORMANCE section.

TROUBLE SHOOTING

NOTE: For trouble shooting procedures, see TROUBLE SHOOTING in the AUTO TRANS OVERHAUL - 4L60-E article.

CLUTCH & BAND APPLICATION

CLUTCH & BAND APPLICATION CHART (4L60-E)

Selector Lever Position	Solenoid Position	Shift Elements In Use
"D" (Overdrive)		
First Gear	1-2 ON/2-3 ON	Forward Clutch, Forward Sprag & Low Roller Clutch

Second Gear	1-2 OFF/2-3 ON	Forward Clutch, Forward Sprag 2-4 Band
Third Gear	1-2 OFF/2-3 OFF	Forward Clutch, Forward Sprag 3-4 Clutch
Overdrive	1-2 ON/2-3 OFF	Forward Clutch 2-4 Band & 3-4 Clutch
"D" (Drive)		
First Gear	1-2 ON/2-3 ON	Forward Clutch, Forward Sprag & Low Roller Clutch
Second Gear	1-2 OFF/2-3 ON	Forward Clutch, Forward Sprag 2-4 Band
Third Gear	1-2 OFF/2-3 OFF	Forward Clutch, Forward Sprag, Overrun Clutch 3-4 Clutch
"2" (Intermediate)		
First Gear	1-2 ON/2-3 ON	Forward Clutch, Forward Sprag, Low Roller Clutch & Overrun Clutch
Second Gear	1-2 OFF/2-3 ON	Forward Clutch, Forward Sprag, Overrun Clutch 2-4 Band
"1" (Low)		
First Gear	1-2 ON/2-3 ON	Forward Clutch, Forward Sprag, Low Reverse Clutch, Low Roller Clutch & Overrun Clutch
Second Gear (1)	1-2 OFF/2-3 ON	Forward Clutch, Forward Sprag, Overrun Clutch 2-4 Band
"R" (Reverse)	1-2 ON/2-3 ON	Low Reverse Clutch & Reverse Input Clutch
"N" Or "P" Neutral Or Park)	1-2 ON/2-3 ON	All Clutches & Bands Released Or Ineffective
(1) Gear is only available above 30-35 MPH.		

ELECTRONIC SELF-DIAGNOSTICS

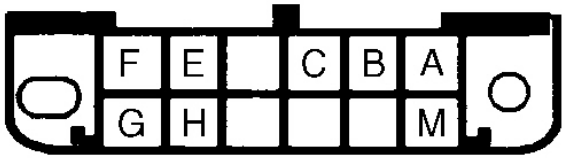
NOTE: To test electronic control of transmission solenoids without using self-diagnostics or if self-diagnostics does not function, go to COMPONENT TESTS under ELECTRONIC TESTING. After repairs are made, trouble codes should be erased from computer memory. See CLEARING TROUBLE CODES under ELECTRONIC SELF-DIAGNOSTICS.

RETRIEVING CODES WITHOUT SCAN TOOL - GASOLINE ENGINES

NOTE: Following procedure is for vehicles equipped with a 12-pin Data Link Connector (DLC). On vehicles equipped with 16-pin DLC (OBD-II vehicles), DTCs can only be retrieved using scan tool.

1. Turn ignition on. **DO NOT** start engine. MIL should glow. Locate Data Link Connector (DLC) attached to control module wiring harness. Most DLCs are located under dash on driver's side of vehicle. Turn ignition on with engine not running. Connect jumper wire from terminal "B" (diagnostic test terminal) to terminal "A" (ground) of DLC. See **Fig. 2**.

   NOTE: Connecting jumper wire into test and ground terminals of DLC with engine running will cause fuel injected vehicles to enter field service mode. MIL will not indicate codes if this is done.



TERMINAL IDENTIFICATION

"A" - Ground
"B" - Diagnostic Terminal
"C" - Air Injection (If Used)
"E" - Serial Data Line
"F" - TCC
"G" - Fuel Pump
"H" - Brake Switch Sense Input
"M" - Serial Data Line

92G14130

Fig. 2: DLC Terminal Identification Courtesy of General Motors Corp.

2. MIL should begin to flash codes. Each code will be repeated 3 times. For example, FLASH, FLASH, pause, FLASH, longer pause, identifies Code 21. First series of flashes is first digit of trouble code. Second series of flashes is second digit of trouble code.
3. Trouble codes are displayed starting with lowest numbered code. Codes will continue to repeat as long as DLC test terminal is grounded. If codes are not flashed, or MIL does not glow, self-diagnostics will not work. For diagnosis of this condition, see DIAGNOSTIC CIRCUIT CHECK in appropriate BASIC

TESTING article in ENGINE PERFORMANCE section. To exit diagnostic mode, turn ignition off and remove jumper wire from DLC.

NOTE: Trouble codes will be recorded at various operating times. Some codes require operation of affected sensor or switch for 5 seconds; others may require operation for 5 minutes or longer at normal operating temperature, road speed and load. Therefore, some codes may not set in a service bay operational mode and may require road testing vehicle in order to duplicate condition under which code will set.

RETRIEVING CODES WITH SCAN TOOL - GASOLINE ENGINES

NOTE: Plugging scan tool into DLC enables user to read trouble codes and check voltages in system on serial data line.

Scan tools may also furnish information on status of output devices (solenoids and relays). However, status parameters are only an indication that output signals have been sent to devices by control module; they do not indicate if devices have responded properly to signal. Check for proper response at output device using a voltmeter or test light.

If trouble codes are not present, this is not necessarily an indication a problem does not exist. Driveability related problems with codes displayed occur about 20 percent of the time, while driveability problems without codes occur about 80 percent of the time. Sensors that are out of specification WILL NOT set a trouble code but WILL cause driveability problems. Using scan tool is the easiest method of checking sensor specifications and other data parameters. Scan tool is also useful in finding intermittent wiring problems by wiggling wiring harness and connections (key on, engine off) while observing scan tool.

NOTE: If erroneous voltage signals are suspected, it will be necessary to verify scan tool information using a digital voltmeter and wiring schematic. If non-existent codes are displayed, turn ignition off, remove scan tool, turn ignition on and ground DLC test terminal "B". See Fig. 2. Same codes flashed by MIL should be indicated by scan tool.

DIAGNOSTIC PROCEDURE (DIESEL ENGINES)

Preliminary Inspection

1. Check all vacuum hoses for correct routing, restrictions, cuts or other damage. Inspect difficult-to-see vacuum hoses beneath air cleaner assembly and other engine components.
2. Inspect all engine compartment wiring for proper connections. Also check wires for pinched or chafed spots, as well as contact with sharp edges or exhaust manifolds.
3. The preliminary inspection is very important and should be performed carefully and thoroughly, as it can often fix a problem without requiring further diagnosis.

NOTE: Begin all diagnosis with ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK chart. After any DEC/electronically-controlled transmission systems repair, repeat On-

Board Diagnostic (OBD) system check.

Diagnostic Procedure

1. Ensure all non-controlled systems NOT related to the Diesel Electronic Control (DEC)/electronically-controlled transmission systems are operating properly. **DO NOT** proceed with testing unless all non-DEC/electronically-controlled transmission systems problems are repaired.
2. ALWAYS begin diagnosis with On-Board Diagnostic (OBD) system check to determine if DEC/electronically-controlled transmission systems and PCM are working properly. See ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK chart. Refer to LIGHT TRUCKS & VANS (DIESEL) diagnostic charts. If trouble codes, other than Diagnostic Trouble Code (DTC) 12 are displayed, determine if they are hard or intermittent trouble codes.
3. A hard code is present while working on vehicle, and problem persists. Hard codes will cause Malfunction Indicator Light (MIL) to come on.

NOTE: SERVICE ENGINE SOON light, located on instrument cluster, is also referred to as the Malfunction Indicator Light (MIL).

4. An intermittent code does not reset itself and is NOT present while working on vehicle. Intermittent codes are often caused by loose connections. MIL will go out 10 seconds after fault goes away.

Entering Or Exiting Diagnostic Mode

1. With ignition on and engine off, connect a jumper wire between Data Link Connector (DLC) terminal "B" (diagnostic terminal) and terminal "A" (ground). See **Fig. 2**. Diesel Electronic Control (DEC)/electronically-controlled transmission systems will enter diagnostic mode.
2. In this mode, PCM will display DTC 12 by flashing the MIL once, followed by a short pause, then 2 flashes in quick succession. DTC 12 will be displayed 3 times. If no other codes are stored, DTC 12 will continue to flash until diagnostic terminal is ungrounded. To exit diagnostic mode, turn ignition off and remove jumper from DLC.

TROUBLE CODE DEFINITIONS

NOTE: Only transmission-related trouble codes are listed. For engine-related DTCs, see appropriate TESTS W/CODES article in ENGINE PERFORMANCE section. Engine-related DTCs must be repaired first, as engine performance and related component signals will affect transmission operation and diagnosis.

PCM TROUBLE CODE DEFINITIONS (CARS)

Code No.	Circuit Affected
12 (1)	No RPM Reference Pulse
14	Coolant Temp. Sensor Signal Voltage Low
15	Coolant Temp. Sensor Signal Voltage High
21	Throttle Position Sensor Signal Voltage High
22	Throttle Position Sensor Signal Voltage Low

24	Vehicle Speed Sensor
28	Trans. Range Pressure Switch
37	TCC Brake Switch Error
38 (2)	Brake Switch Error
53	System Voltage High
58	Trans. Temp. Sensor High Temperature
59	Trans. Temp. Sensor Low Temperature
72	Vehicle Speed Sensor Loss
73 (2)	Pressure Control Solenoid
74 (2)	Traction Control Voltage Low
75 (2)	Transmission Voltage Low
79	Transmission Fluid Overtemp
80 (3)	Transmission Component Slipping
81 (2)	2-3 Shift Solenoid Circuit Fault
82 (2)	1-2 Shift Solenoid Circuit Fault
83 (2)	TCC PWM Solenoid
84 (2)	3-2 Control Solenoid
85 (2)	TCC Stuck On
90	TCC Solenoid Circuit
93 (3)	Pressure Control Solenoid
96 (3)	Transmission Voltage Low

(1) Display of a Code 12 is normal when no reference pulses are received by control module (engine not running).

(2) Does not apply to 3.4L "F" body.

(3) Applies to 3.4L "F" body only.

PCM TROUBLE CODE DEFINITIONS (LIGHT TRUCKS & VANS - GASOLINE EXCEPT "S" & "T" 4.3L VIN W)

Code No.	Circuit Affected
12 (1)	No RPM Reference Pulse
14	Coolant Temp. Sensor Signal Voltage Low
15	Coolant Temp. Sensor Signal Voltage High
21	Throttle Position Sensor Voltage High
22	Throttle Position Sensor Voltage Low
24	Vehicle Speed Sensor Trans. Output Signal
28	Trans. Range Pressure Switch
37/38	TCC Brake Switch On/Off
52/53	System Voltage High

58	Trans. Fluid Temp. High
59	Trans. Fluid Temp. Low
66	3-2 Control Solenoid Circuit Fault
67	TCC Solenoid Circuit Check
69	Torque Converter Clutch Stuck On
72	VSS Circuit Loss Transmission Output Signal
73	Pressure Control Solenoid
75	System Voltage Low
79	Trans. Fluid Temperature High
81	Trans. 2-3 Solenoid Circuit Fault
82	Trans. 1-2 Solenoid Circuit Fault
83	TCC Solenoid Circuit Fault

(1) Display of a Code 12 is normal when no reference pulses are received by control module (engine not running).

PCM TROUBLE CODE DEFINITIONS (LIGHT TRUCKS & VANS - DIESEL)

Code No.	Circuit Affected
14	Coolant Temp. Sensor Circuit Low
15	Coolant Temp. Sensor Circuit High
24	Vehicle Speed Sensor Circuit Low
28	Trans. Range Pressure Switch
37/38	TCC Brake Switch Stuck On/Off
52/53	System Voltage High Long
58	Trans. Fluid Temp. Sensor Circuit Low
59	Trans. Fluid Temp. Sensor Circuit High
66	3-2 Control Solenoid Circuit Fault
67	TCC Solenoid Circuit Fault
69	TCC Stuck On
72	VSS Circuit Loss
73	Pressure Control Solenoid Circuit
75	System Voltage Low
79	Transmission Fluid Overtemp
81	2-3 Shift Solenoid Circuit Fault
82	1-2 Shift Solenoid Circuit Fault
83	TCC PWM Solenoid Circuit Fault

PCM TROUBLE CODE DEFINITIONS ("S" & "T" SERIES 4.3L VIN W)

Code No.	Circuit Affected
P0117	Coolant Temp. Sensor Temp. Low
P0118	Coolant Temp. Sensor Temp. High
P0122	Throttle Position Sensor Signal Low

P0123	Throttle Position Sensor Signal High
P0502/P0503	Vehicle Speed Sensor Circuit Low/High
P0560	System Voltage Malfunction
P0703	TCC Brake Input Circuit
P0712	Trans. Temp. Sensor Signal Voltage Low
P0713	Trans. Temp. Sensor Signal Voltage High
P0742	TCC Stuck On
P0748	Pressure Control Solenoid
P0753	1-2 Shift Solenoid
P0756	2-3 Shift Solenoid Performance
P0758	2-3 Shift Solenoid Electrical
P1810	Trans. Range Switch Assembly Circuit
P1812	Trans. Fluid Overtemp
P1860	TCC PWM Solenoid Electrical Circuit
P1864	TCC Solenoid Electrical Circuit
P1870	Transmission Component Slipping
P1886	3-2 Solenoid Electrical Circuit

HARD OR INTERMITTENT TROUBLE CODE DETERMINATION (GASOLINE)

During any diagnostic procedure, it must be determined if codes are hard failure codes or intermittent failure codes. Diagnostic charts will not usually help analyze intermittent codes. To determine hard codes and intermittent codes, proceed as follows:

1) Enter diagnostic mode. See RETRIEVING CODES. Read and record all stored trouble codes. Exit diagnostic mode and clear trouble codes. See **CLEARING TROUBLE CODES**.

2) Apply parking brake and place transmission in Neutral or Park. Block drive wheels and start engine. MIL should go out. Run warm engine at specified curb idle for 2 minutes and note MIL.

3) If MIL comes on, enter diagnostic mode. Read and record DTCs. This will reveal hard failure codes. DTCs may require a road test to reset hard failure after clearing DTC. If MIL does not come on, all stored DTCs were intermittent failures.

CLEARING TROUBLE CODES

NOTE: To prevent PCM damage, ensure ignition switch is in OFF position when disconnecting or reconnecting power to PCM.

Diesel

To clear codes, use Tech 1 scan tester. If scan tester is not available, perform the following procedure. With ignition off, connect a jumper wire between Data Link Connector (DLC) terminal "B" (diagnostic terminal) and terminal "A" (ground). See **Fig. 2**. Turn ignition on. Fully apply brake pedal, then fully apply accelerator pedal. Check MIL for DTC 12. Release brake pedal, then release accelerator pedal. Check MIL again for DTC 12.

Remove jumper wire from DLC. Turn ignition off.

Gasoline

Turn ignition switch to ON position, and ground diagnostic test terminal "B" at DLC connector. See **Fig. 1**. Turn ignition switch to OFF position, and remove control module fuse from fuse block for 30 seconds. Replace fuse. Remove diagnostic terminal ground lead. If fuse cannot be located, disconnect pigtail at battery. However, this may result in loss of other on-board memory data, such as preset radio tuning. After power to PCM is removed, poor driveability may occur until control module "relearns" operating parameters.

DIAGNOSTIC CHARTS - CARS

INTRODUCTION

Diagnostic Charts

Following charts are DTC specific. For terminal locations, see **WIRING DIAGRAMS**. For engine-related DTCs, see appropriate TESTS W/CODES article in ENGINE PERFORMANCE section.

Diagnostic Aids

Diagnostic aids located in many trouble code charts are additional tips used to help diagnose trouble codes when circuit checks do not find a problem.

NOTE: In following diagnostic tests, schematics and illustrations are courtesy of General Motors Corp. Powertrain Control Module (PCM) may also be referred to as Electronic Control Module (ECM) or Transmission Control Module (TCM) in some diagnostic charts and figures. Terms are used interchangeably.

CODE 14, CTS SIGNAL VOLTAGE LOW (HIGH TEMPERATURE INDICATED)

Circuit Description

CODE 14 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
3.4L "F" Body		
CTS Signal	A31	Yellow
CTS Ground	A17	Black
4.3L "B" Body & 5.7L "B", "F" & "Y" Bodies		
CTS Signal	C25	Yellow
CTS Ground	B6	Black
5.7L "D" Body		
CTS Signal	C25	Yellow
CTS Ground	B16	Purple

- - For shared sensor ground tie-offs, see appropriate wiring diagram in **WIRING DIAGRAMS**.

Set Condition

Code will set if PCM sees an extremely high temperature signal (low voltage). Most likely causes of code are: sensor signal circuit shorted to ground, faulty coolant temperature sensor or faulty PCM.

Test Description

NOTE: This chart assumes engine cooling system is functioning properly (not overheating). Test numbers refer to numbers on diagnostic chart.

1. This checks if conditions for code still exist.
2. This tests for grounded sensor signal line between control module and coolant sensor.

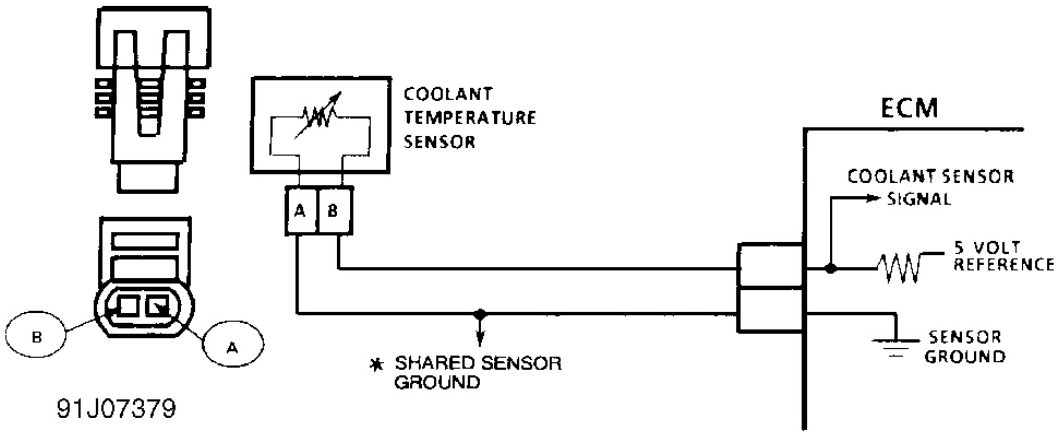


Fig. 3: Code 14, Circuit Diagram (Cars) Courtesy of General Motors Corp.

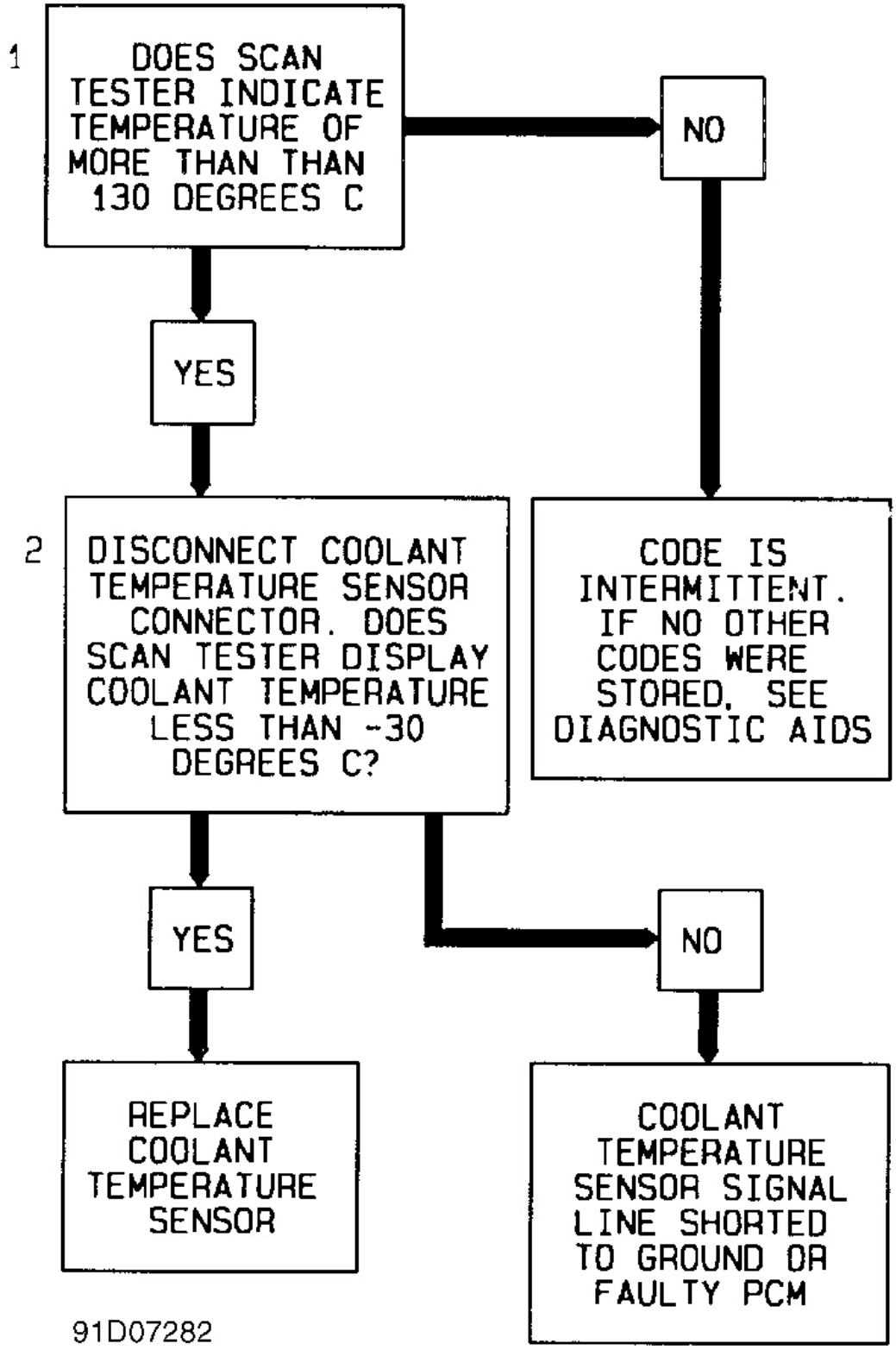

1
DOES SCAN TESTER INDICATE TEMPERATURE OF MORE THAN THAN 130 DEGREES C
NO
YES
2
DISCONNECT COOLANT TEMPERATURE SENSOR CONNECTOR. DOES SCAN TESTER DISPLAY COOLANT TEMPERATURE LESS THAN -30 DEGREES C?
CODE IS INTERMITTENT. IF NO OTHER CODES WERE STORED, SEE DIAGNOSTIC AIDS
YES
NO
REPLACE COOLANT TEMPERATURE SENSOR
COOLANT TEMPERATURE SENSOR SIGNAL LINE SHORTED TO GROUND OR FAULTY PCM
91D07282

Fig. 4: Code 14, Flow Chart (Cars) Courtesy of General Motors Corp.

Diagnostic Aids

After engine is started, temperature should rise steadily to about 194°F (90°C) and then stabilize when thermostat opens. At normal operating temperature, signal voltage at control module terminal should be 1.5-2.0 volts. Check sensor for shifted calibration by using sensor TEMPERATURE-TO-RESISTANCE VALUES table. When code is set, control module will turn on electric cooling fan(s) if equipped.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	**(1) Ohms**
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700
(1) Measure resistance across sensor terminals.	

CODE 15, CTS SIGNAL VOLTAGE HIGH (LOW TEMPERATURE INDICATED)

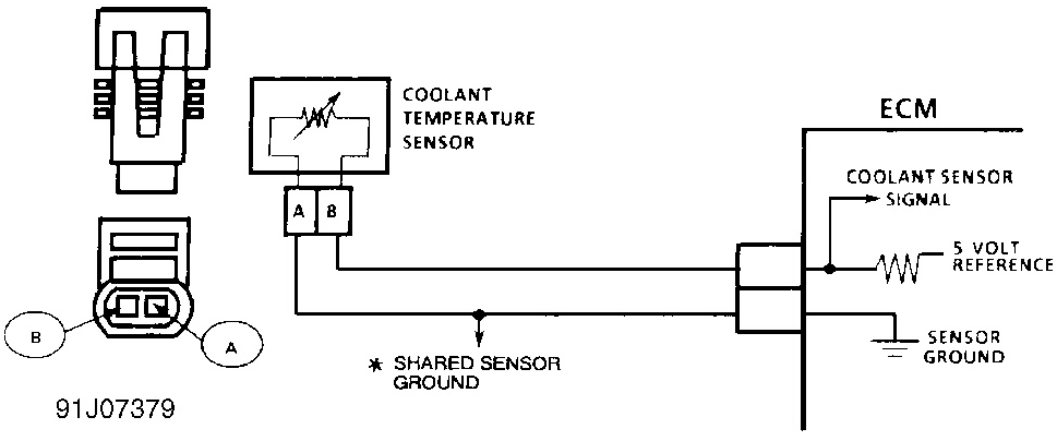


Fig. 5: Code 15, Circuit Diagram (Cars) Courtesy of General Motors Corp.

CODE 15 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
3.4L "F" Body		
CTS Signal	A31	Yellow
CTS Ground	A17	Black
4.3L "B" Body & 5.7L "B", "F" & "Y" Bodies		
CTS Signal	C25	Yellow
CTS Ground	B6	Black
5.7L "D" Body		
CTS Signal	C25	Yellow
CTS Ground	B16	Purple

- - For shared sensor ground tie-offs, see appropriate wiring diagram in **WIRING DIAGRAMS**.

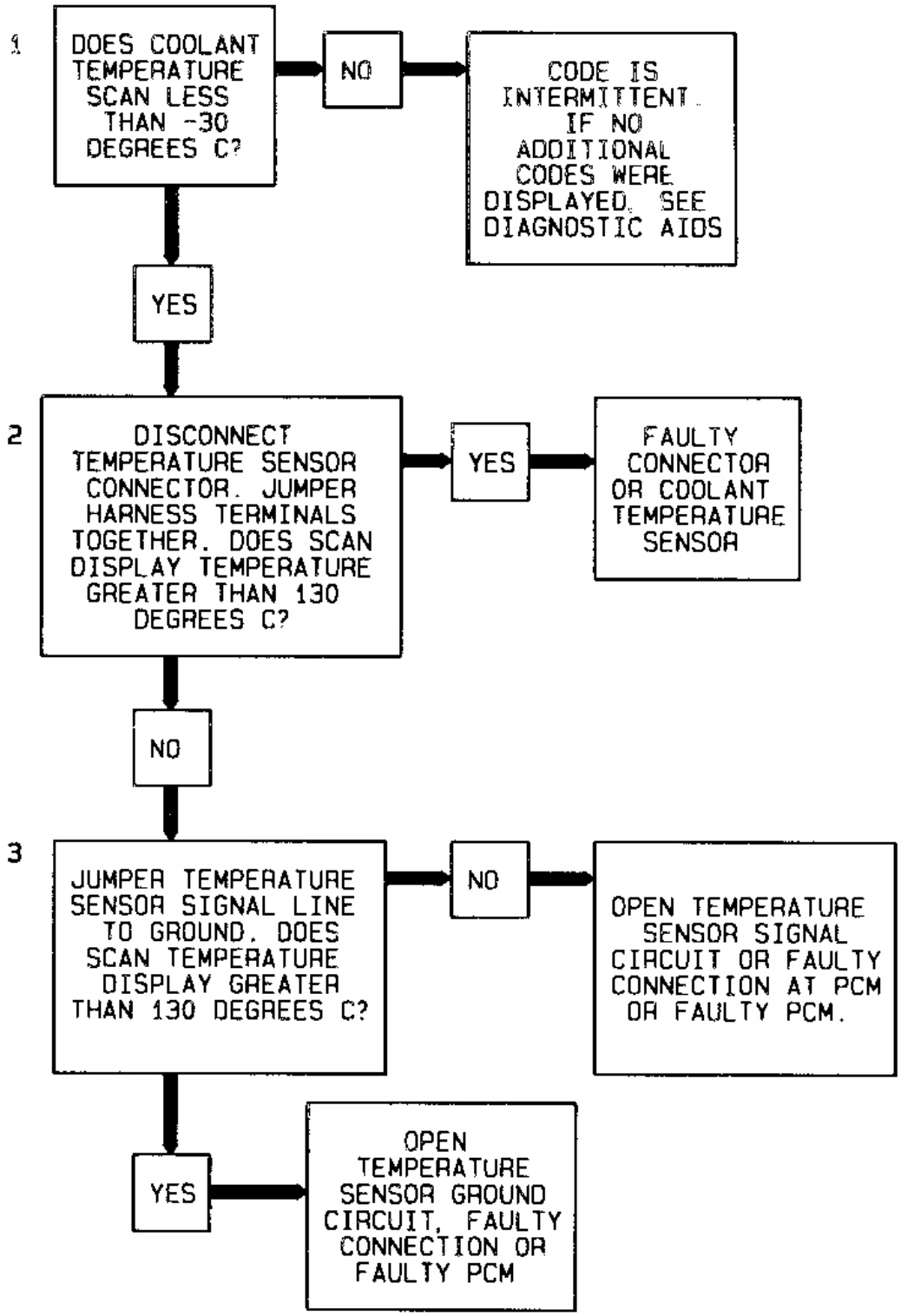
Code indicates control module has seen high resistance (high monitored voltage) in coolant sensor circuit. This could be due to high resistance (cold temperature) or high voltage at coolant sensor terminal at control module for a precalibrated period of time. Most likely causes of code are: open sensor signal circuit, open sensor ground circuit (not allowing path to ground for 5-volt reference), faulty sensor connection, faulty sensor, faulty PCM connection or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This checks if conditions for code still exist.
2. This test simulates a low voltage condition. If control module recognizes low voltage signal, scan tester will display greater than about 266°F (130°C). This indicates control module and wiring are not at fault.
3. This test determines if coolant sensor ground or signal circuit is open.

Diagnostic Aids

After engine is started, temperature should rise steadily to about 194°F (90°C) and then stabilize when thermostat opens. At normal operating temperature, signal voltage at control module terminal should be 1.5-2.0 volts. Check sensor for shifted calibration by using sensor TEMPERATURE-TO-RESISTANCE VALUES table. When code is set, control module will turn on electric cooling fan(s) if equipped.


1
DOES COOLANT TEMPERATURE SCAN LESS THAN -30 DEGREES C?
NO
CODE IS INTERMITTENT. IF NO ADDITIONAL CODES WERE DISPLAYED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TEMPERATURE SENSOR CONNECTOR. JUMPER HARNESS TERMINALS TOGETHER. DOES SCAN DISPLAY TEMPERATURE GREATER THAN 130 DEGREES C?
YES
FAULTY CONNECTOR OR COOLANT TEMPERATURE SENSOR
NO
3
JUMPER TEMPERATURE SENSOR SIGNAL LINE TO GROUND. DOES SCAN TEMPERATURE DISPLAY GREATER THAN 130 DEGREES C?
NO
OPEN TEMPERATURE SENSOR SIGNAL CIRCUIT OR FAULTY CONNECTION AT PCM OR FAULTY PCM.
YES
OPEN TEMPERATURE SENSOR GROUND CIRCUIT, FAULTY CONNECTION OR FAULTY PCM

91F07283

Fig. 6: Code 15, Flow Chart (Cars) Courtesy of General Motors Corp.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	(1) Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700
(1) Measure resistance across sensor terminals.	

CODE 21, THROTTLE POSITION SENSOR SIGNAL VOLTAGE HIGH

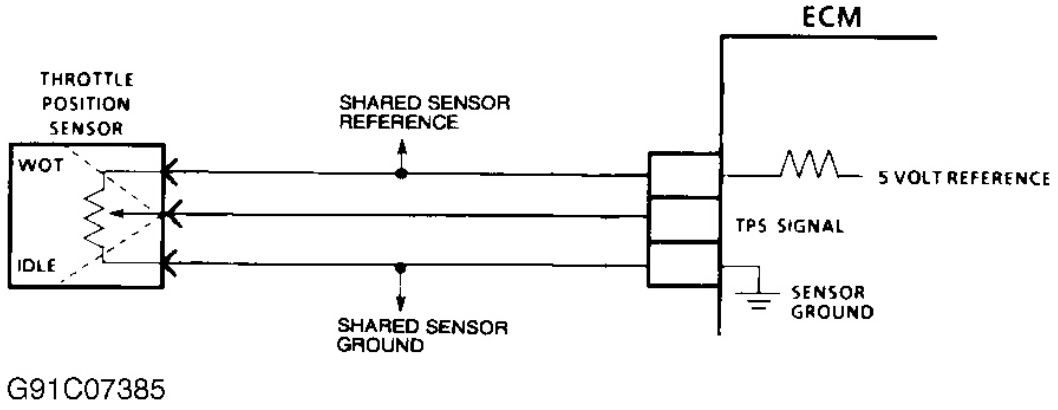


Fig. 7: Code 21, Circuit Diagram (Cars) Courtesy of General Motors Corp.

CODE 21 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
3.4L "F" Body		
TPS Signal	A30	Dark Blue
TPS Ground	A17	Black
TPS Reference	B31	Gray

4.3L "B" Body & 5.7L "B", "D", "F" & "Y" Bodies		
TPS Signal	C22	Dark Blue
TPS Ground	B6	Black
TPS Reference	B28	Gray

- - For shared sensor ground tie-offs, see appropriate wiring diagram in **WIRING DIAGRAMS**.

Code will set if engine is idling (closed throttle), MAP value is low, a MAP code is not set and PCM sees high TP sensor voltage. Most likely causes for code are: TP sensor signal circuit shorted to voltage, open sensor ground circuit, faulty sensor connection, faulty TP sensor or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks if code is result of a hard failure or an intermittent condition.
2. This test simulates a low-voltage condition. If control module recognizes change of state, control module and wiring are okay.
3. This step isolates a faulty sensor, control module or open sensor ground circuit. If sensor ground is shared by another sensor, an accompanying code related to that sensor may exist.

Diagnostic Aids

A scan tester displays throttle position in volts. Closed throttle voltage should be low. Voltage should increase gradually to about 4.5 volts at a steady rate as throttle angle is increased.

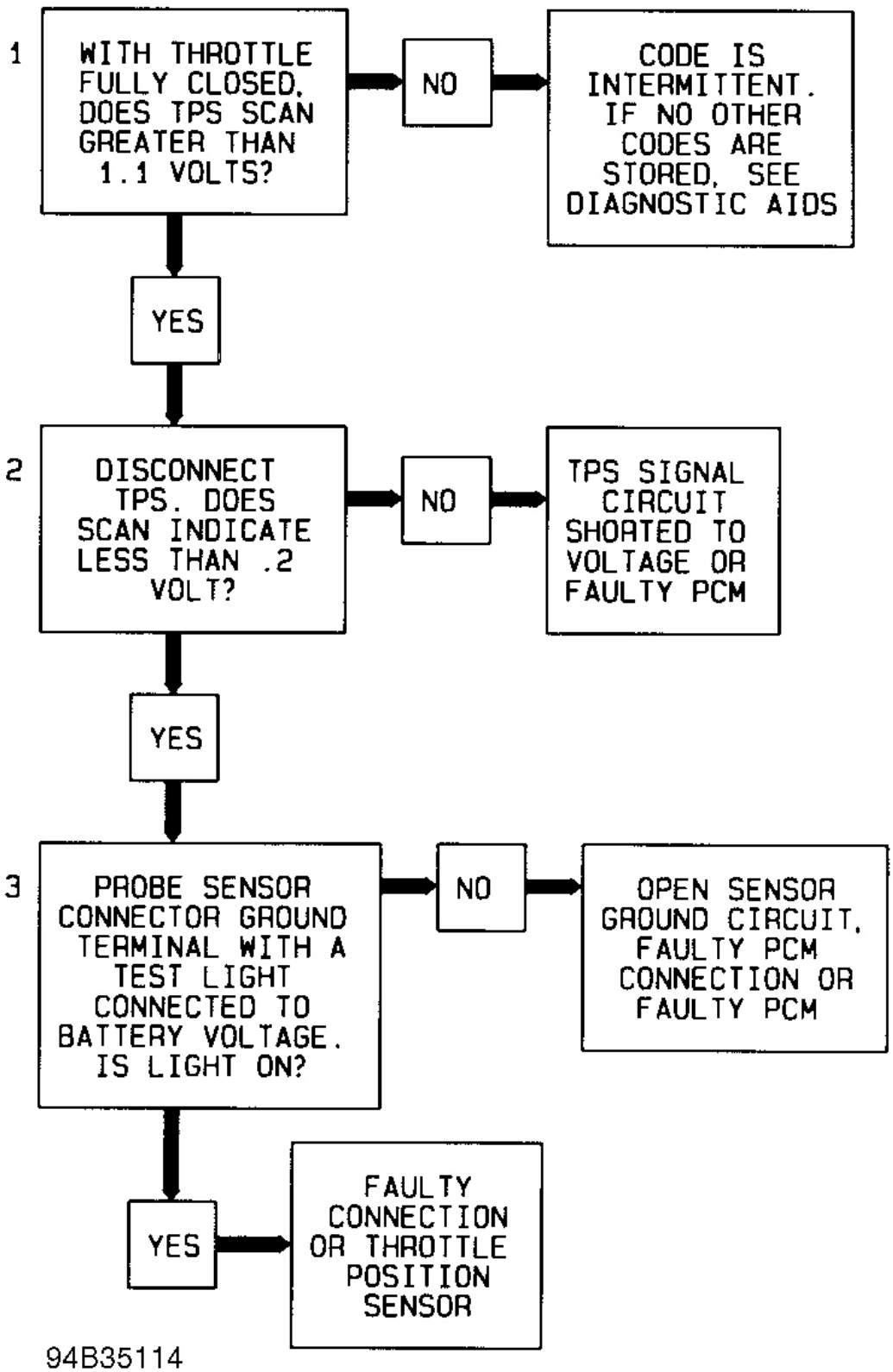

1
WITH THROTTLE FULLY CLOSED, DOES TPS SCAN GREATER THAN 1.1 VOLTS?
NO
CODE IS INTERMITTENT. IF NO OTHER CODES ARE STORED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TPS. DOES SCAN INDICATE LESS THAN .2 VOLT?
NO
TPS SIGNAL CIRCUIT SHORTED TO VOLTAGE OR FAULTY PCM
YES
3
PROBE SENSOR CONNECTOR GROUND TERMINAL WITH A TEST LIGHT CONNECTED TO BATTERY VOLTAGE. IS LIGHT ON?
NO
OPEN SENSOR GROUND CIRCUIT, FAULTY PCM CONNECTION OR FAULTY PCM
YES
FAULTY CONNECTION OR THROTTLE POSITION SENSOR
94B35114

Fig. 8: Code 21, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 22, THROTTLE POSITION SENSOR SIGNAL VOLTAGE LOW

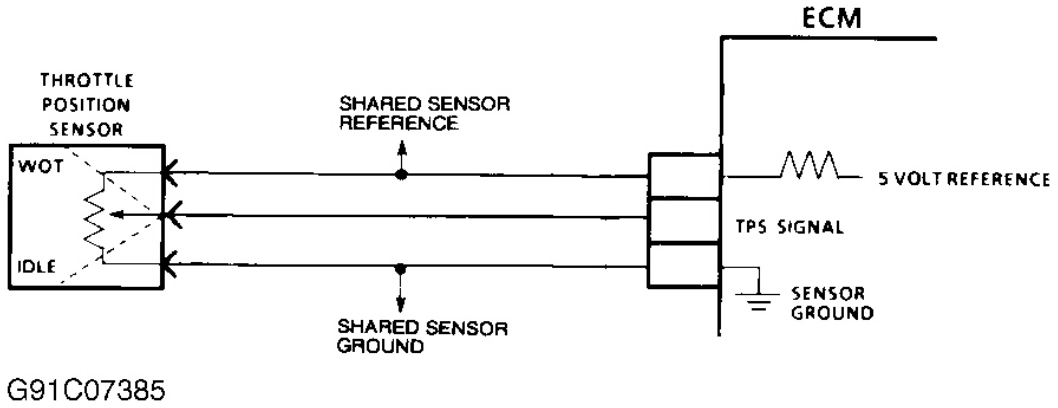


Fig. 9: Code 22, Circuit Diagram (Cars) Courtesy of General Motors Corp.

CODE 22 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
3.4L "F" Body		
TPS Signal	A30	Dark Blue
TPS Ground	A17	Black
TPS Reference	B31	Gray
4.3L "B" Body & 5.7L "B", "D", "F" & "Y" Bodies		
TPS Signal	C22	Dark Blue
TPS Ground	B6	Black
TPS Reference	B28	Gray

- - For shared sensor ground tie-offs, see appropriate wiring diagram in **WIRING DIAGRAMS**.

Code will set if engine is running and TP sensor voltage is lower than base idle voltage (auto zero voltage). Most likely causes of code are: TP sensor signal circuit open or shorted to ground, 5-volt reference open or shorted to ground (should also set other codes), faulty sensor connection, faulty sensor, faulty PCM connection or faulty PCM.

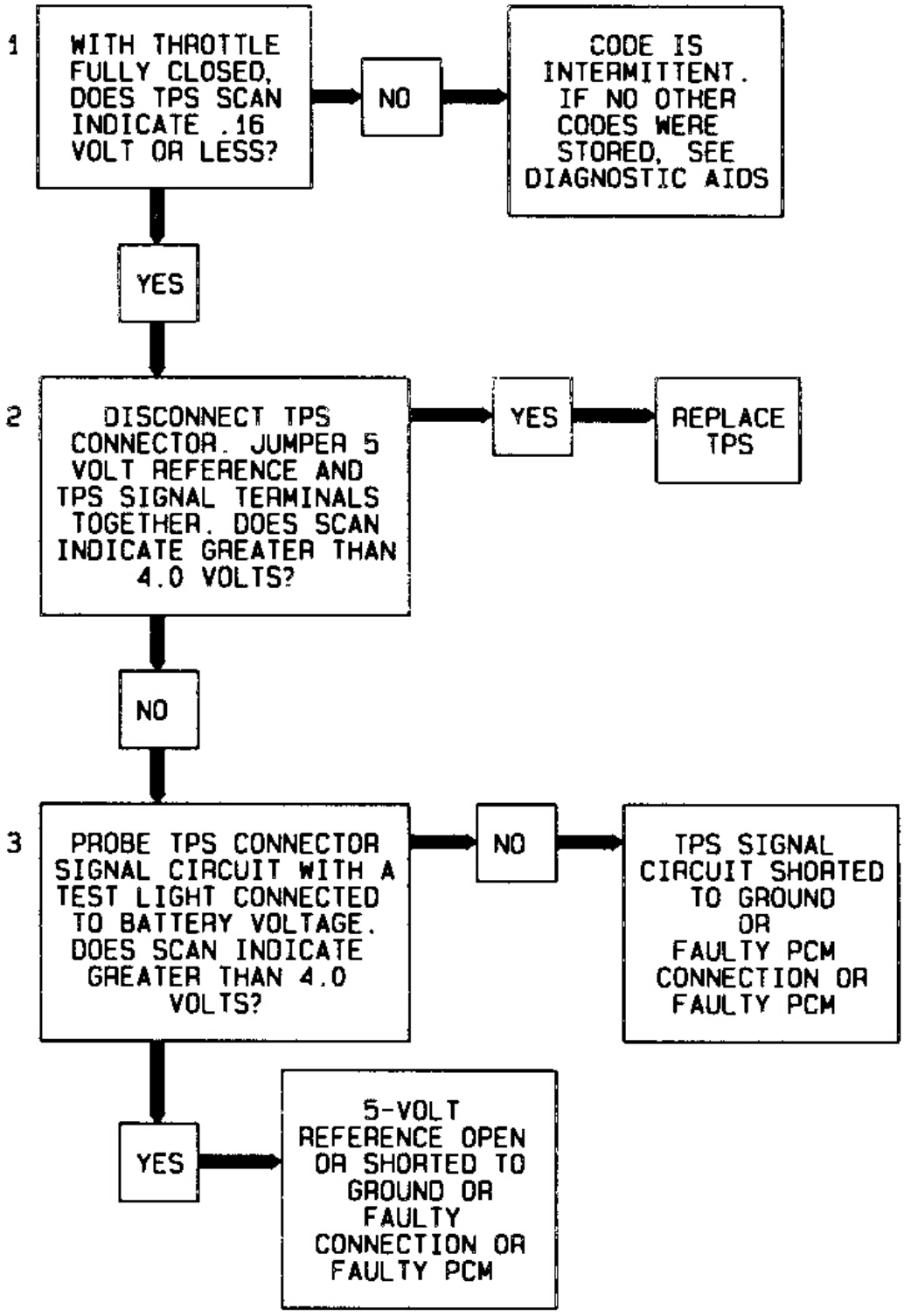
NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks if code is result of a hard failure or an intermittent condition.
2. This test simulates high voltage conditions. If control module recognizes change of state, control module and wiring are okay.

3. This simulates a high signal voltage to check for an open in TP sensor signal line to control module. Scan tester should recognize this signal and display high TP sensor voltage.

Diagnostic Aids

A scan tester displays throttle position in volts. Closed throttle voltage should be low. Voltage should increase gradually to about 4.5 volts at a steady rate as throttle angle is increased.


1
WITH THROTTLE FULLY CLOSED, DOES TPS SCAN INDICATE .16 VOLT OR LESS?
NO
CODE IS INTERMITTENT. IF NO OTHER CODES WERE STORED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TPS CONNECTOR. JUMPER 5 VOLT REFERENCE AND TPS SIGNAL TERMINALS TOGETHER. DOES SCAN INDICATE GREATER THAN 4.0 VOLTS?
YES
REPLACE TPS
NO
3
PROBE TPS CONNECTOR SIGNAL CIRCUIT WITH A TEST LIGHT CONNECTED TO BATTERY VOLTAGE. DOES SCAN INDICATE GREATER THAN 4.0 VOLTS?
NO
TPS SIGNAL CIRCUIT SHORTED TO GROUND OR FAULTY PCM CONNECTION OR FAULTY PCM
YES
5-VOLT REFERENCE OPEN OR SHORTED TO GROUND OR FAULTY CONNECTION OR FAULTY PCM

94I35111

Fig. 10: Code 22, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 24, VEHICLE SPEED SENSOR - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES

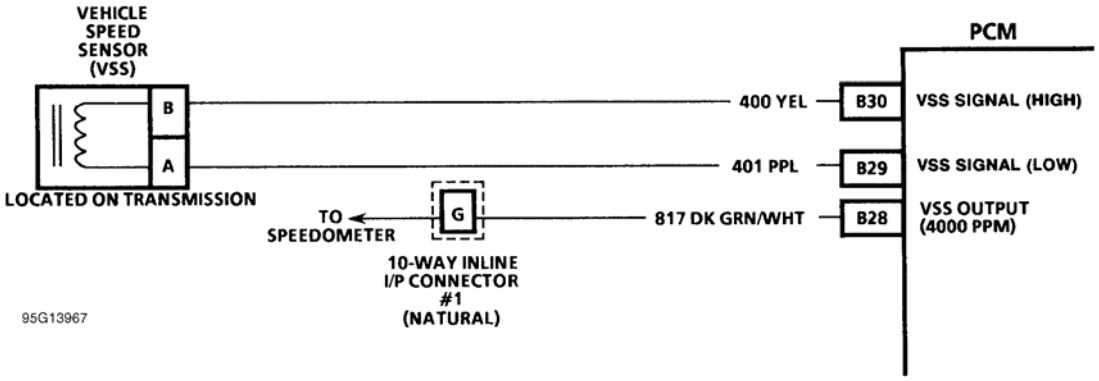


Fig. 11: Code 24, Circuit Diagram (3.4L F Body) Courtesy of General Motors Corp.

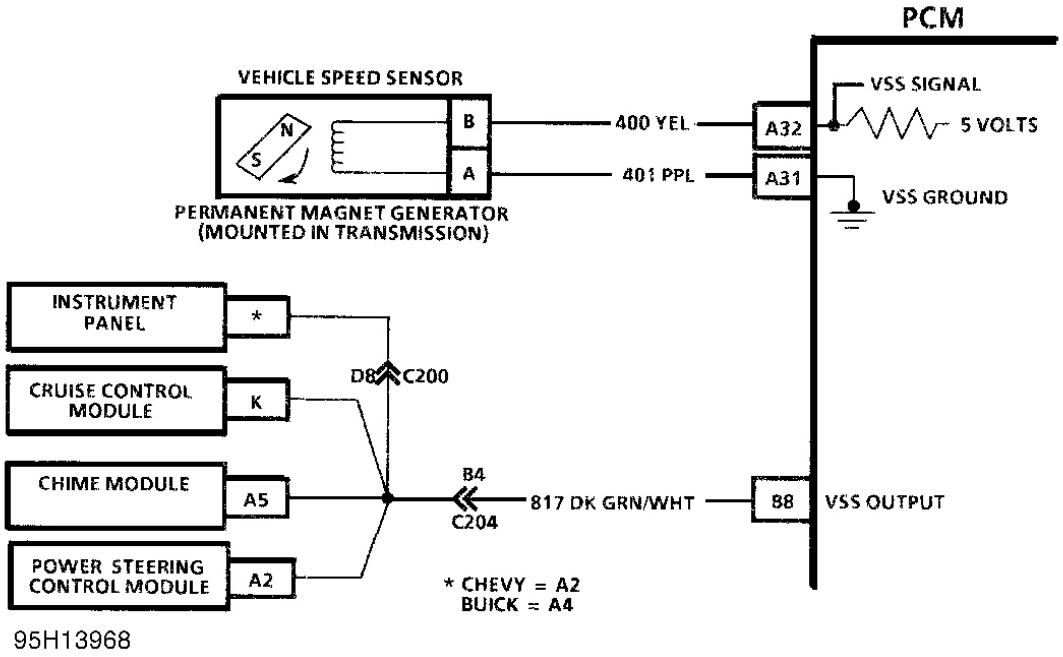


Fig. 12: Code 24, Circuit Diagram (4.3L & 5.7L B Body) Courtesy of General Motors Corp.

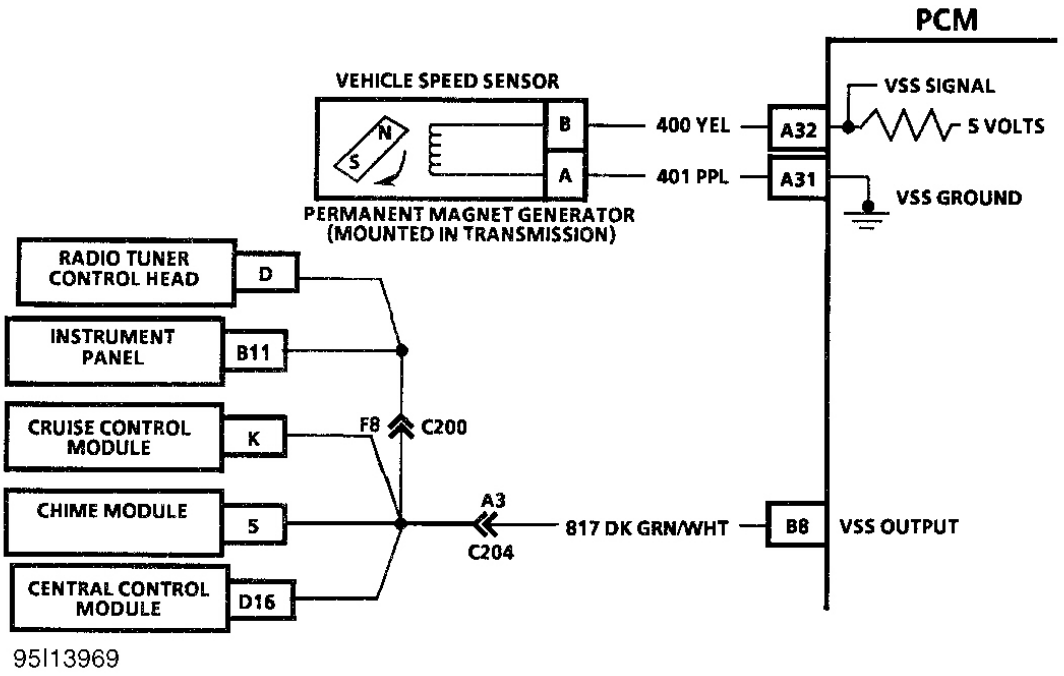


Fig. 13: Code 24, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

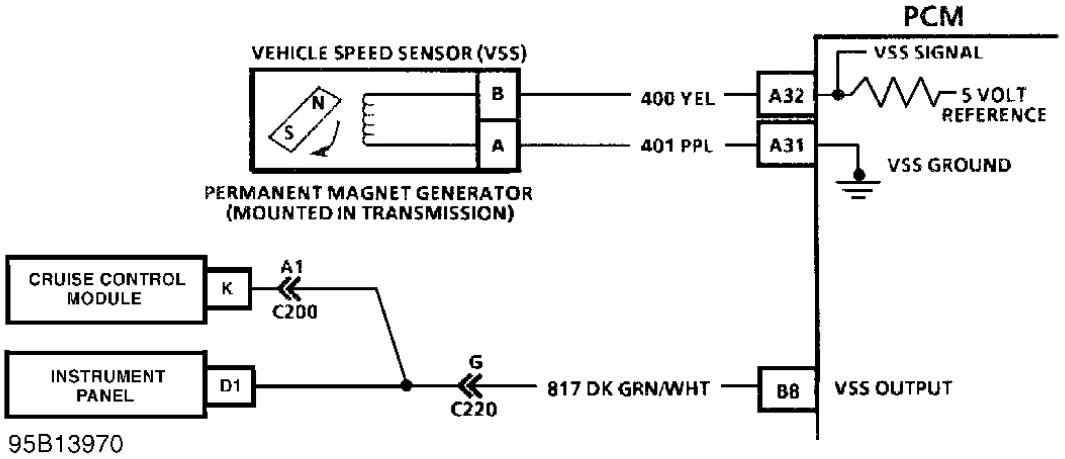


Fig. 14: Code 24, Circuit Diagram (5.7L F Body) Courtesy of General Motors Corp.

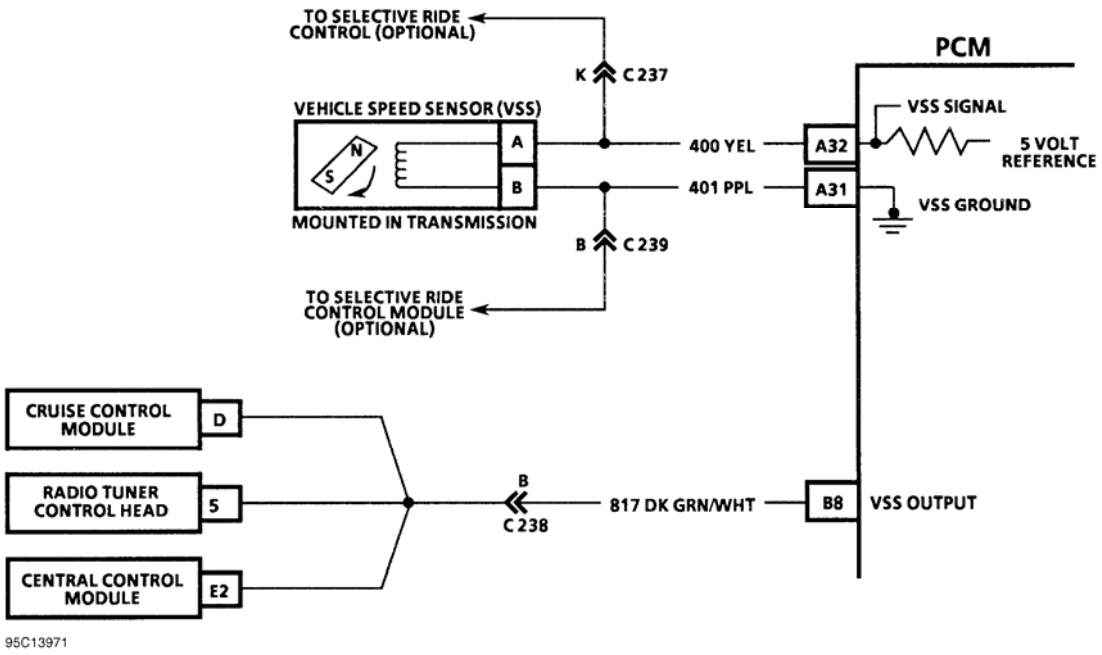


Fig. 15: Code 24, Circuit Diagram (5.7L Y Body) Courtesy of General Motors Corp.

Speed sensor, which is a Permanent Magnet (PM) generator, provides control module with vehicle speed information. PM generator, mounted in transmission, produces a pulsing AC voltage signal whenever vehicle speed is greater than about 2 MPH. Voltage level and pulses increase with vehicle speed. Control module converts pulsing voltage to MPH, which is used by control module to calculate vehicle adjustments.

NOTE: Test numbers refer to numbers on diagnostic chart.

NOTE: Prior to testing Corvette for Code 24, disable Acceleration Slip Regulation (ASR) system.

1. PM generator only produces a voltage signal if drive wheels are turning greater than about 2 MPH.

Diagnostic Aids

A faulty or misadjusted park/neutral switch may set a false Code 24. Use scan tester to check for proper signal in Drive while wiggling shifter. Code 24 may set if vehicle is power braked (brakes applied and throttle depressed) for more than 10 seconds.

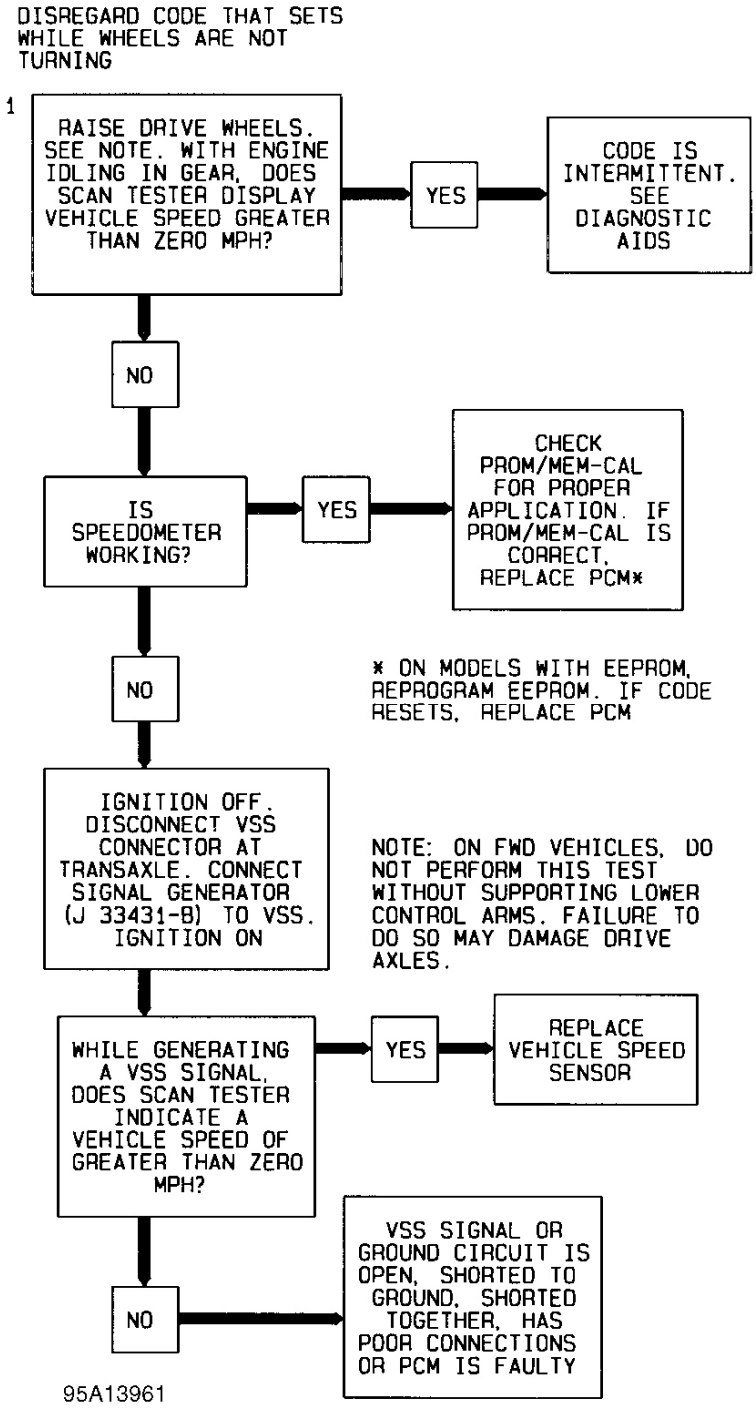


Fig. 16: Code 24, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 28, TRANS. RANGE PRESSURE SWITCH - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES

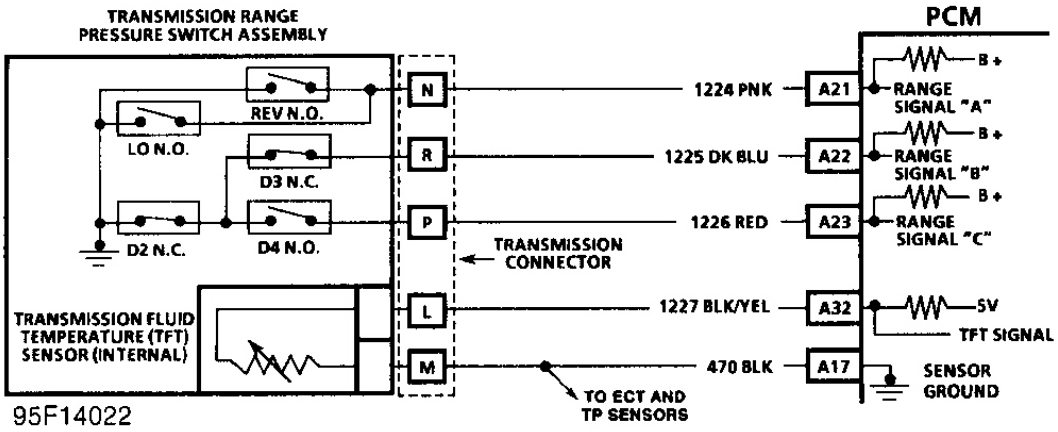


Fig. 17: Code 28, Circuit Diagram (3.4L F Body) Courtesy of General Motors Corp.

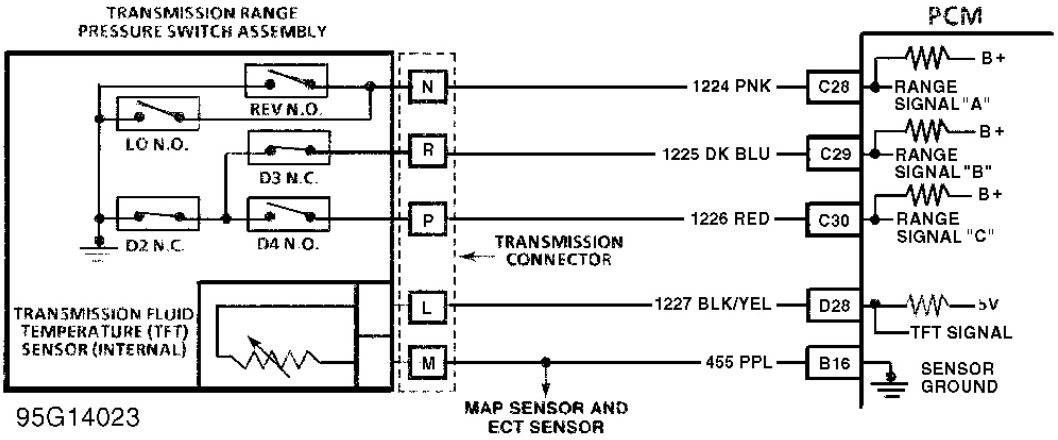


Fig. 18: Code 28, Circuit Diagram (4.3L & 5.7L B Body) Courtesy of General Motors Corp.

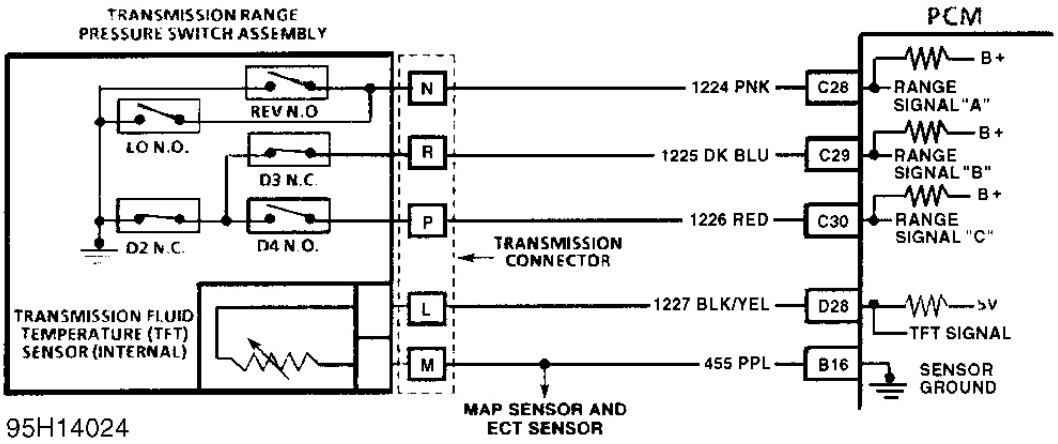


Fig. 19: Code 28, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

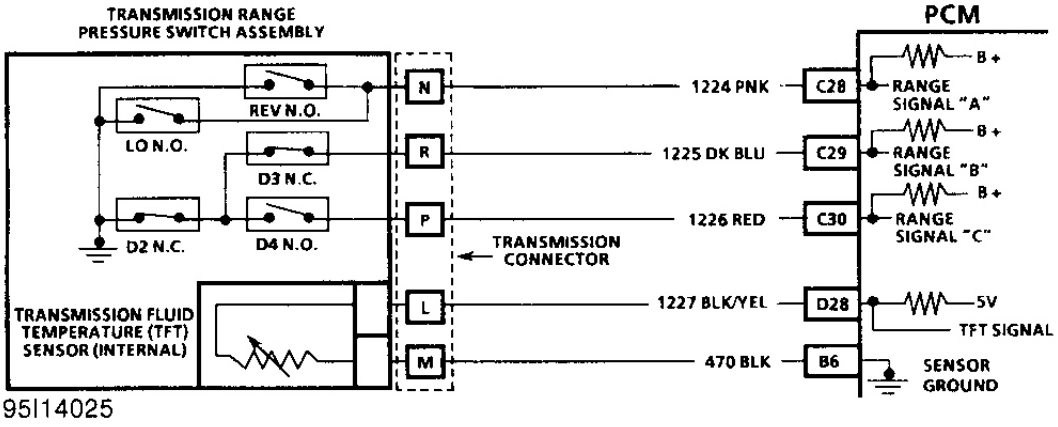


Fig. 20: Code 28, Circuit Diagram (5.7L F Body) Courtesy of General Motors Corp.

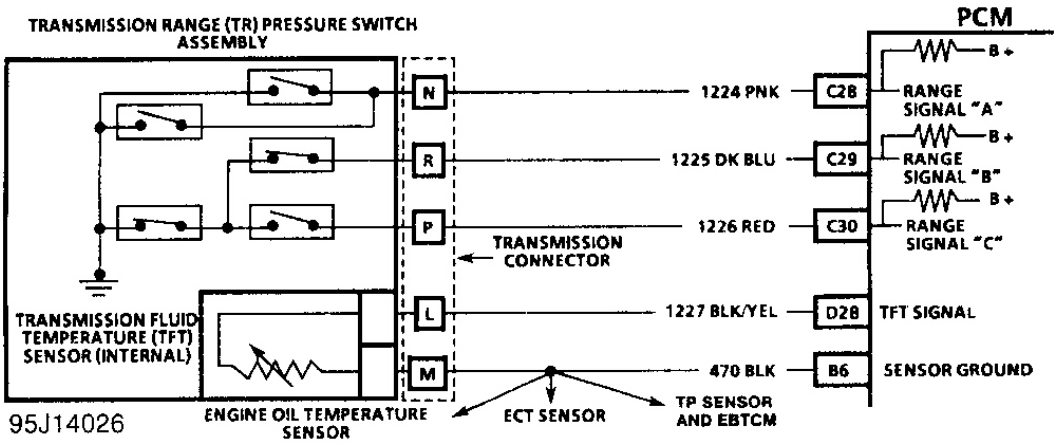


Fig. 21: Code 28, Circuit Diagram (5.7L Y Body) Courtesy of General Motors Corp.

Transmission range pressure switch assembly consists of 5 pressure switches (2 normally closed, 3 normally open), and a fluid temperature sensor combined into one unit and mounted on the valve body. PCM supplies voltage to each range signal. By grounding one or more of these circuits through various combinations of pressure switches, PCM detects which manual valve position has been selected. With ignition on and engine off, Park/Neutral will be indicated. Code 28 will set when range signals "A" and "C" are both zero volts (on) for 2 seconds.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks indicated range signal to valve position signal actually selected.
2. Checks for correct voltage from PCM to transmission external connector.
3. Checks for short to ground in any one of the 3 valve position circuits.

Diagnostic Aids

Code will set if PCM detects one of 2 illegal combinations. Check all connections for good contact.

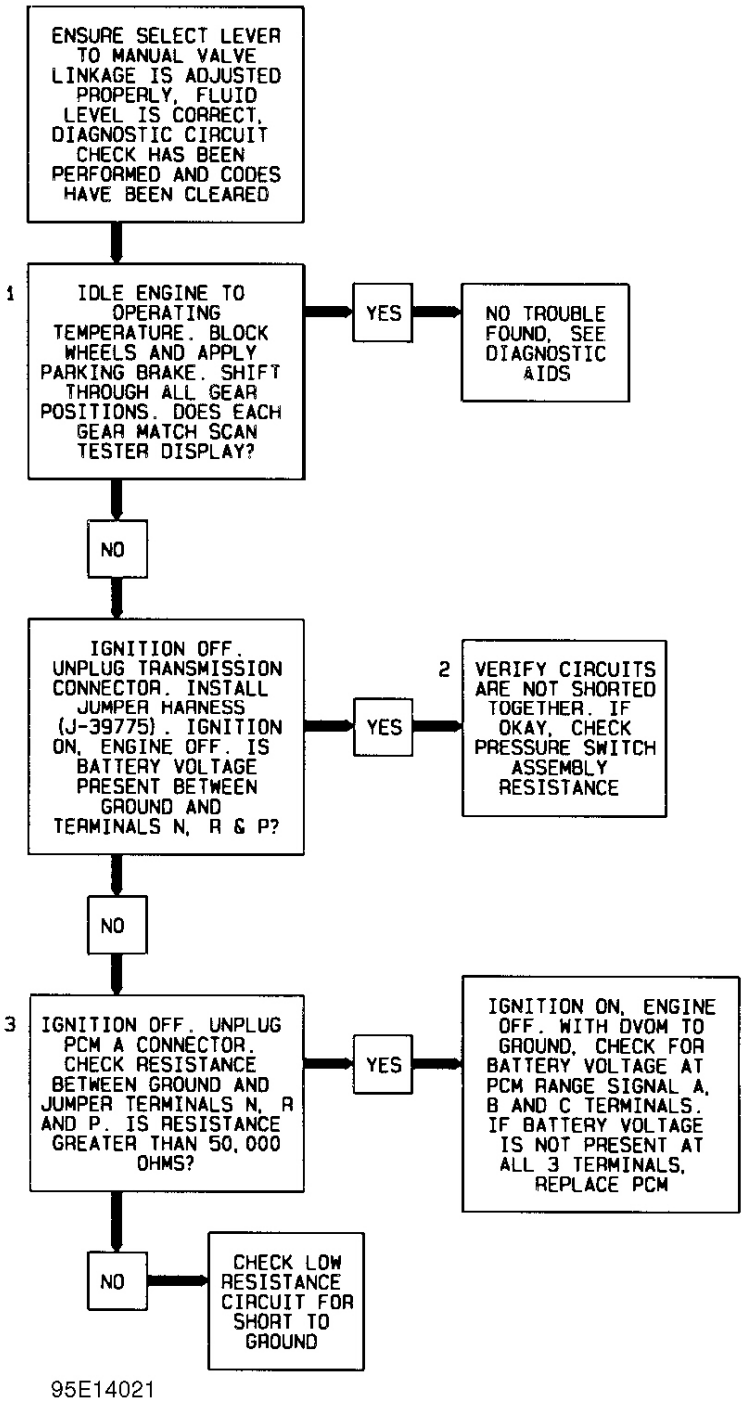


Fig. 22: Code 28, Flow Chart (Cars)

CODE 37, TCC BRAKE SWITCH ERROR - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES

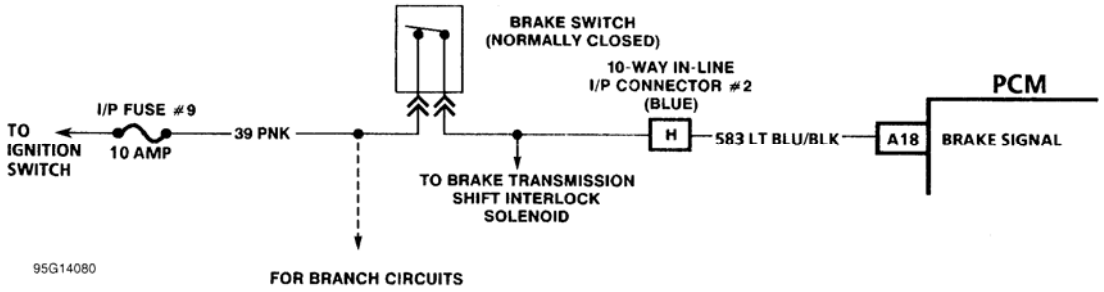


Fig. 23: Code 37, Circuit Diagram (3.4L F Body) Courtesy of General Motors Corp.

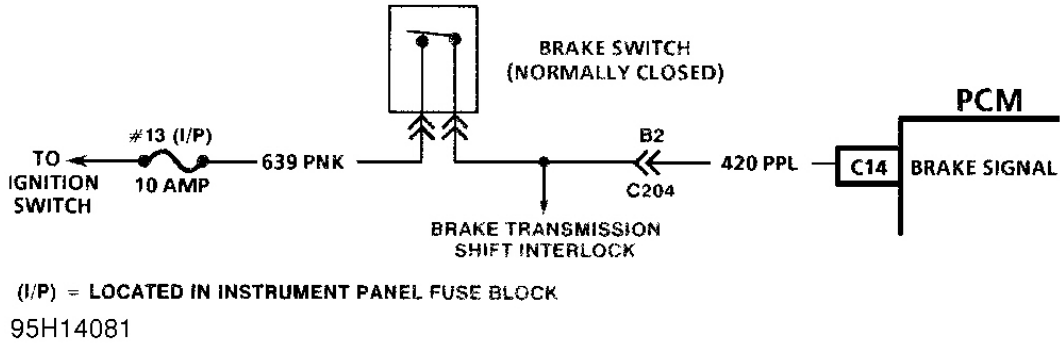


Fig. 24: Code 37, Circuit Diagram (4.3L & 5.7L B & Y Bodies) Courtesy of General Motors Corp.

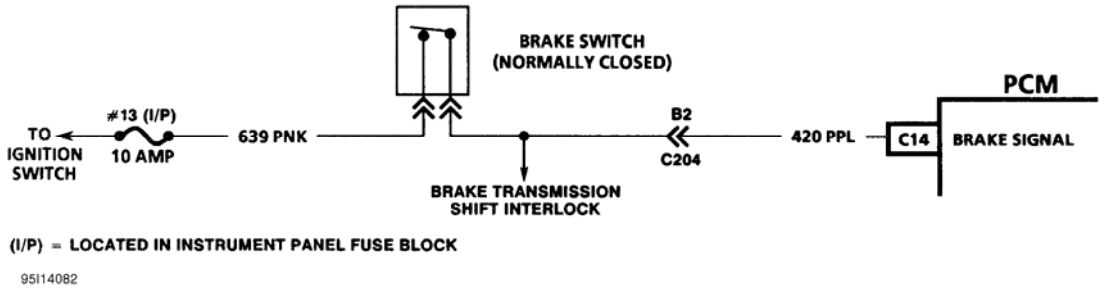


Fig. 25: Code 37, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

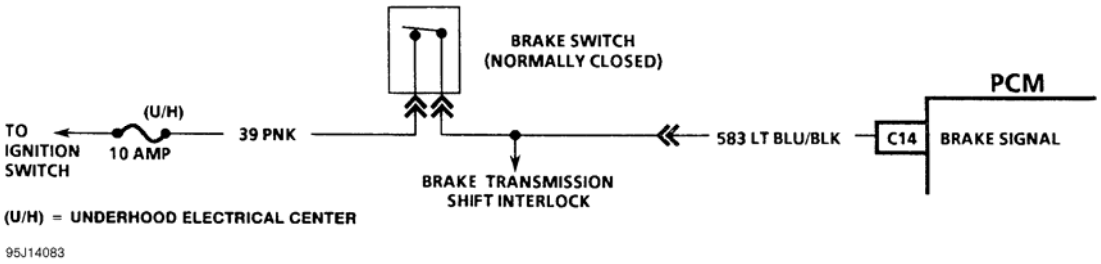


Fig. 26: Code 37, Circuit Diagram (5.7L F Body) Courtesy of General Motors Corp.

PCM monitors activity of the normally-closed brake switch. Switch opens when brake pedal is applied.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for voltage at brake switch.
2. Simulates brake switch closed or brakes off.
3. Checks TCC brake switch circuit between PCM and switch.

Diagnostic Aids

Code 37 can be caused by a misadjusted brake switch or a poor connection. Code may also be set by unusual driving habits (i.e. stop-and-go expressway driving).

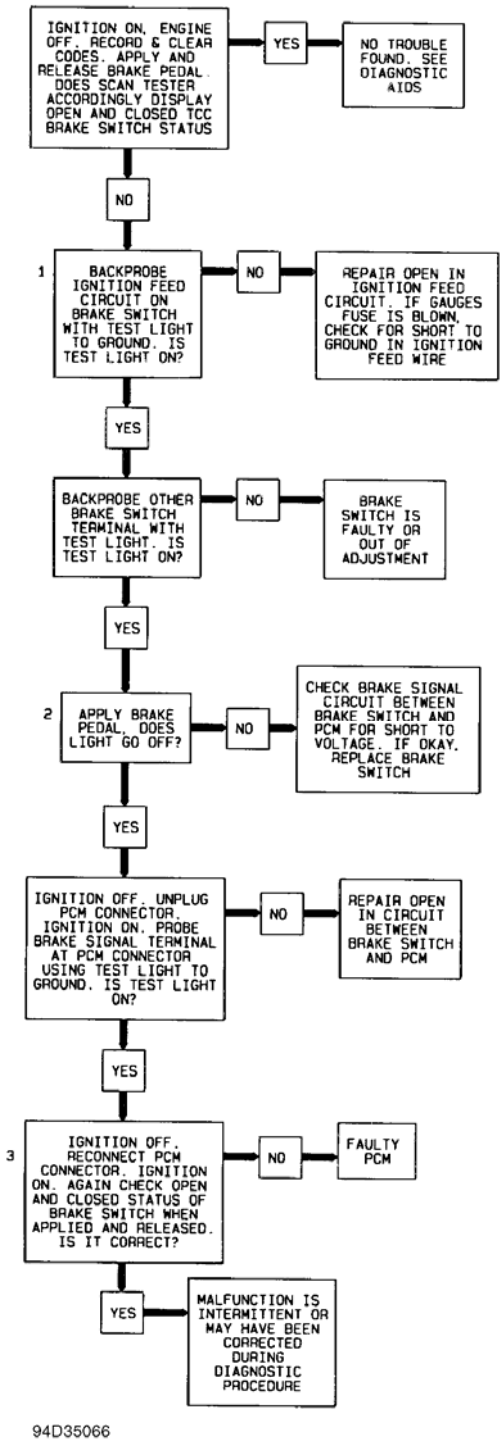


Fig. 27: Code 37, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 38, BRAKE SWITCH ERROR - 4.3L & 5.7L "B/D/F/Y" BODIES

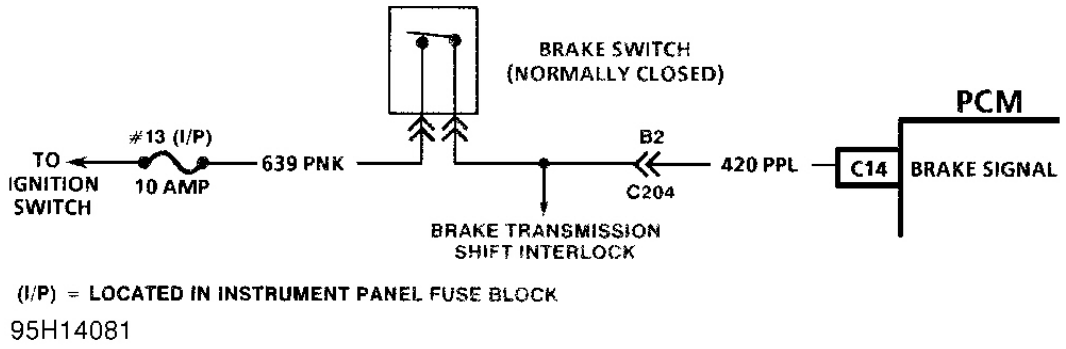


Fig. 28: Code 38, Circuit Diagram (4.3L & 5.7L B & Y Bodies) Courtesy of General Motors Corp.

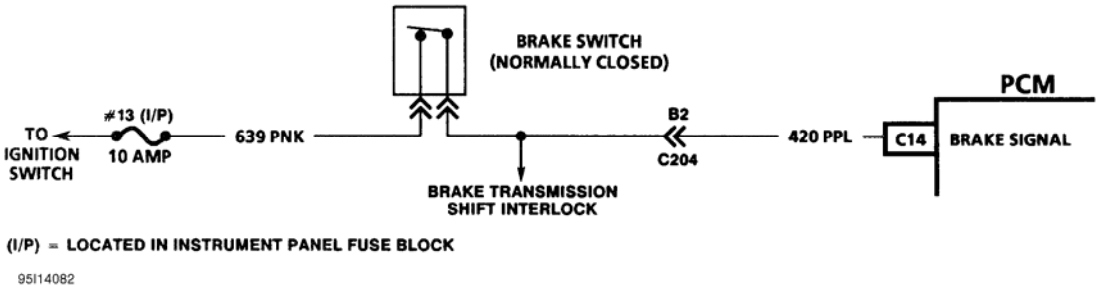


Fig. 29: Code 38, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

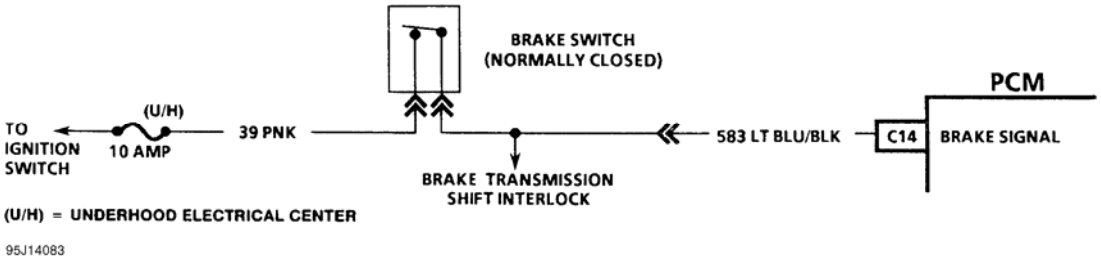


Fig. 30: Code 38, Circuit Diagram (5.7L F Body) Courtesy of General Motors Corp.

PCM monitors activity of the normally-closed brake switch. Switch opens when brake pedal is applied. Code will set if PCM has seen conditions which would have required brake applications at least 7 times and no transition in brake switch has been detected.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for voltage at brake switch.

2. Simulates brake switch closed or brakes off. Checks brake switch circuit between PCM and switch.
3. Checks circuit between brake switch and PCM.

Diagnostic Aids

Code may also be set by unusual driving habits (i.e. stop-and-go expressway driving).

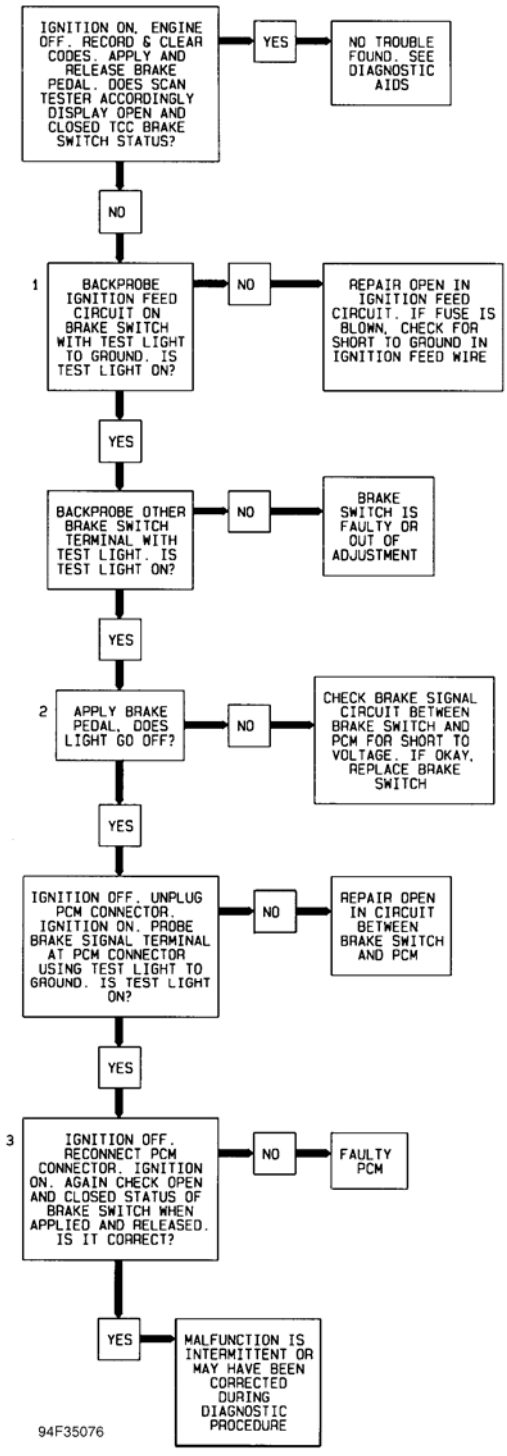


Fig. 31: Code 38, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 53, SYSTEM VOLTAGE HIGH - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES

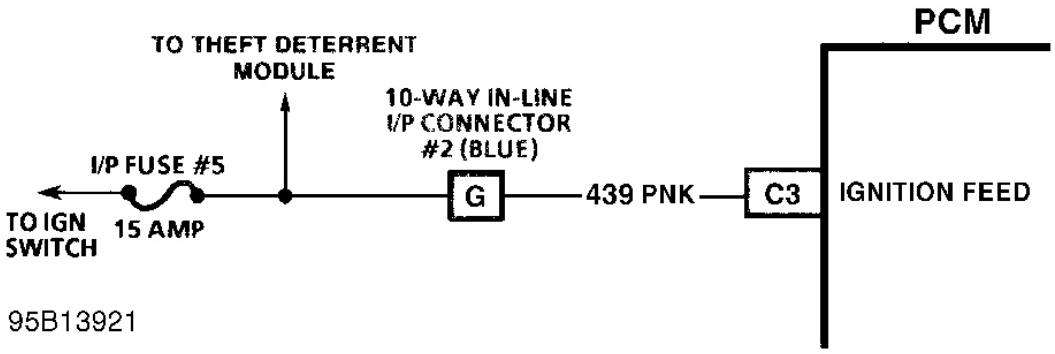


Fig. 32: Code 53, Circuit Diagram (3.4L F Body) Courtesy of General Motors Corp.

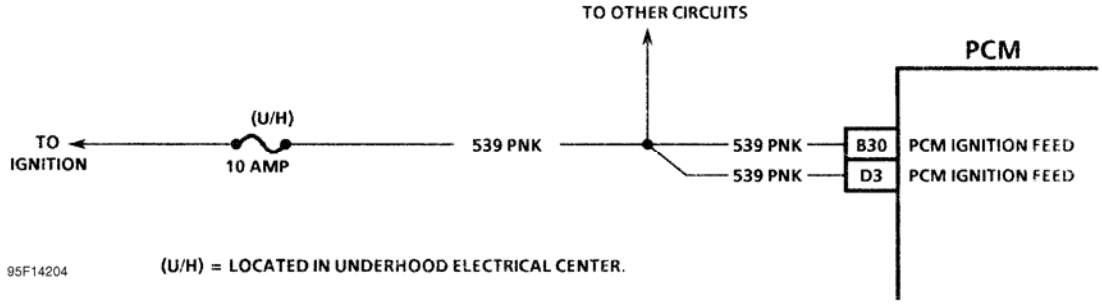


Fig. 33: Code 53, Circuit Diagram (4.3L & 5.7L B & D Bodies) Courtesy of General Motors Corp.

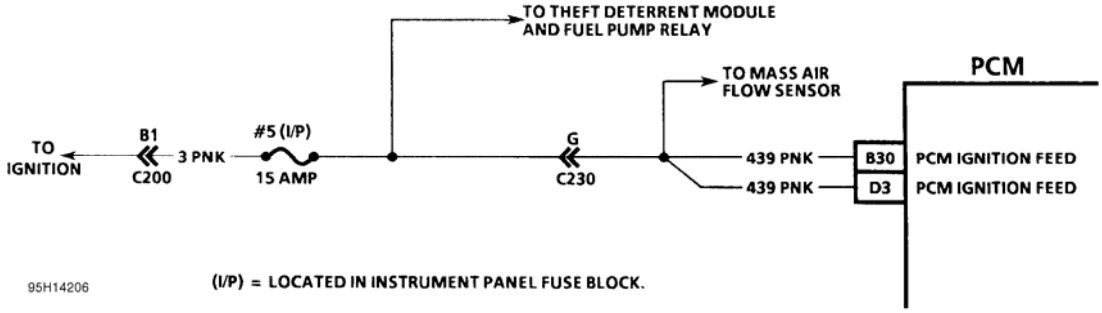


Fig. 34: Code 53, Circuit Diagram (5.7L F Body) Courtesy of General Motors Corp.

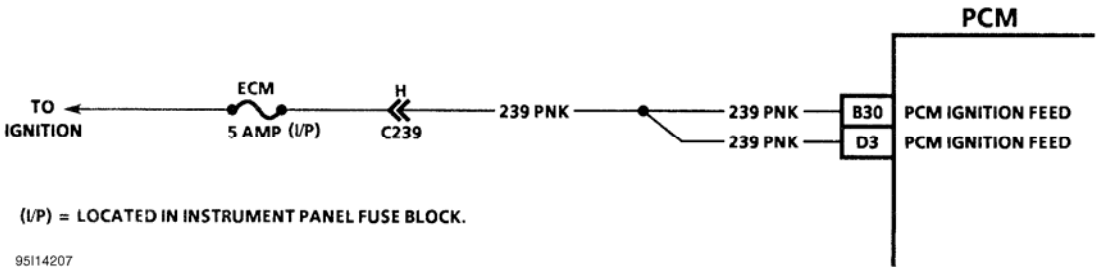


Fig. 35: Code 53, Circuit Diagram (5.7L Y Body) Courtesy of General Motors Corp.

This code indicates a basic charging system problem. Code 53 will set when voltage at control module terminal is greater than specification for a precalibrated time. If voltage at PCM battery voltage terminal is not within specification, check and repair charging system.

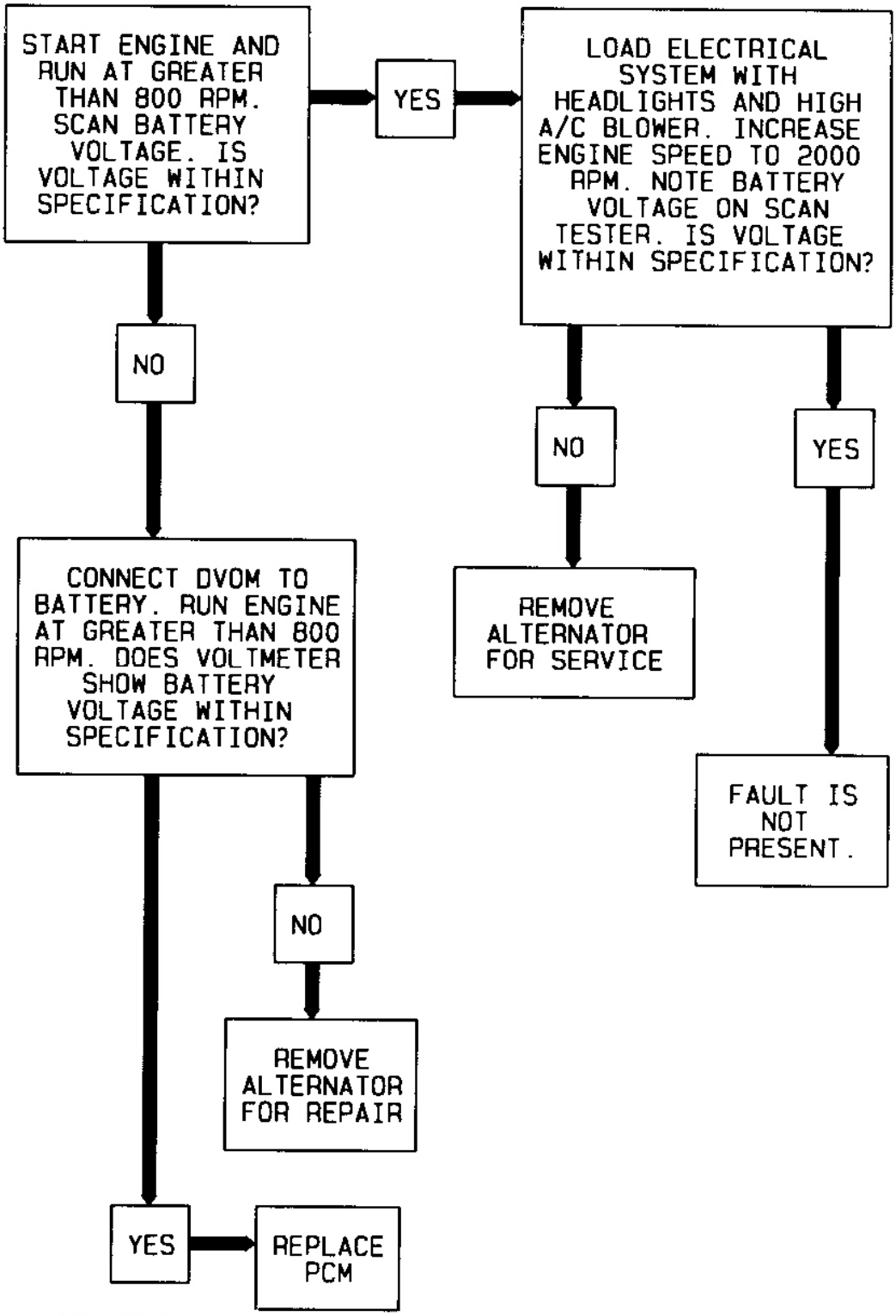

START ENGINE AND RUN AT GREATER THAN 800 RPM. SCAN BATTERY VOLTAGE. IS VOLTAGE WITHIN SPECIFICATION?
YES
LOAD ELECTRICAL SYSTEM WITH HEADLIGHTS AND HIGH A/C BLOWER. INCREASE ENGINE SPEED TO 2000 RPM. NOTE BATTERY VOLTAGE ON SCAN TESTER. IS VOLTAGE WITHIN SPECIFICATION?
NO
NO
YES
CONNECT DVOM TO BATTERY. RUN ENGINE AT GREATER THAN 800 RPM. DOES VOLTMETER SHOW BATTERY VOLTAGE WITHIN SPECIFICATION?
REMOVE ALTERNATOR FOR SERVICE
FAULT IS NOT PRESENT.
NO
REMOVE ALTERNATOR FOR REPAIR
YES
REPLACE PCM
95I14173

Fig. 36: Code 53, Flow Chart (Cars) Courtesy of General Motors Corp.

CHARGING SYSTEM SPECIFICATIONS

Application	Minimum Charge	Maximum Charge
3.4L		
"F" Body	10	16.5
4.3L & 5.7L	9.6	16.0

CODE 58, TRANS. TEMP. SENSOR HIGH - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES

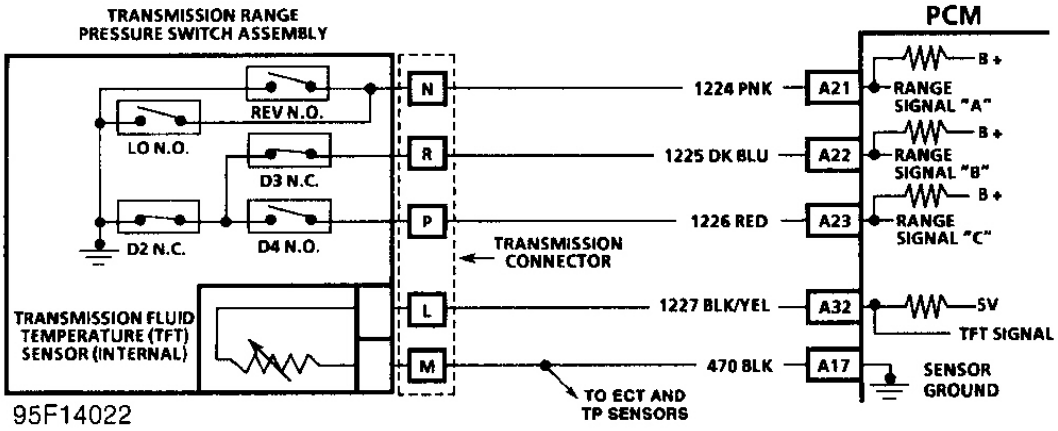


Fig. 37: Code 58, Circuit Diagram (3.4L F Body) Courtesy of General Motors Corp.

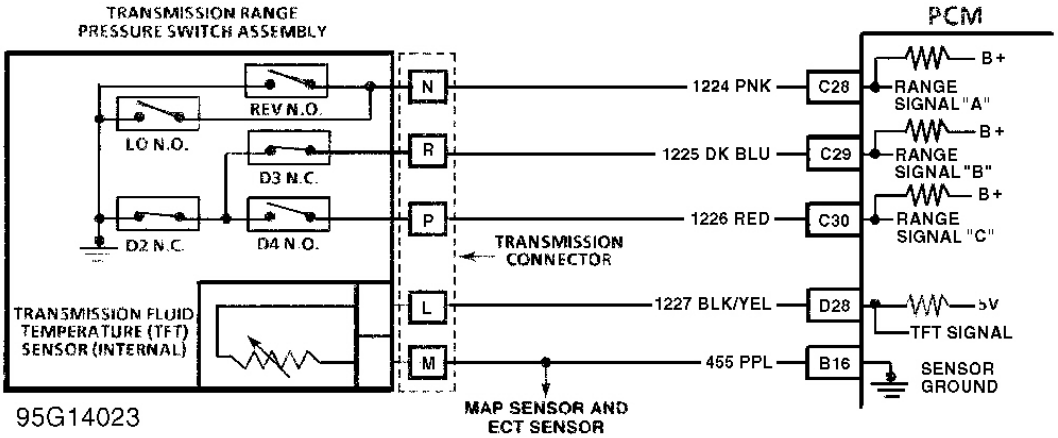


Fig. 38: Code 58, Circuit Diagram (4.3L & 5.7L B Body) Courtesy of General Motors Corp.

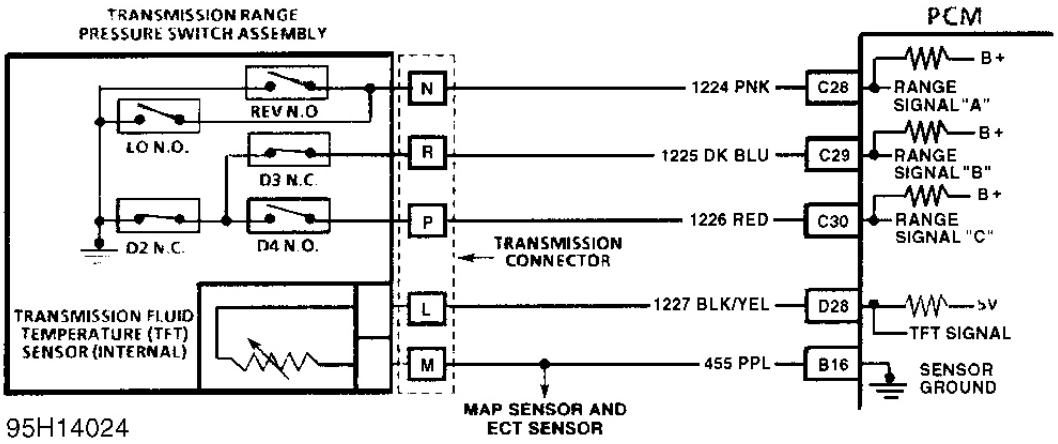


Fig. 39: Code 58, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

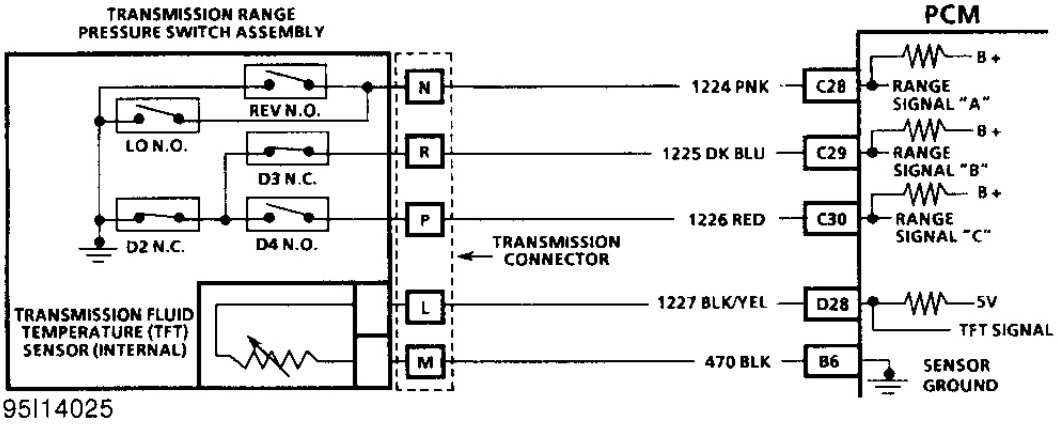


Fig. 40: Code 58, Circuit Diagram (5.7L F Body) Courtesy of General Motors Corp.

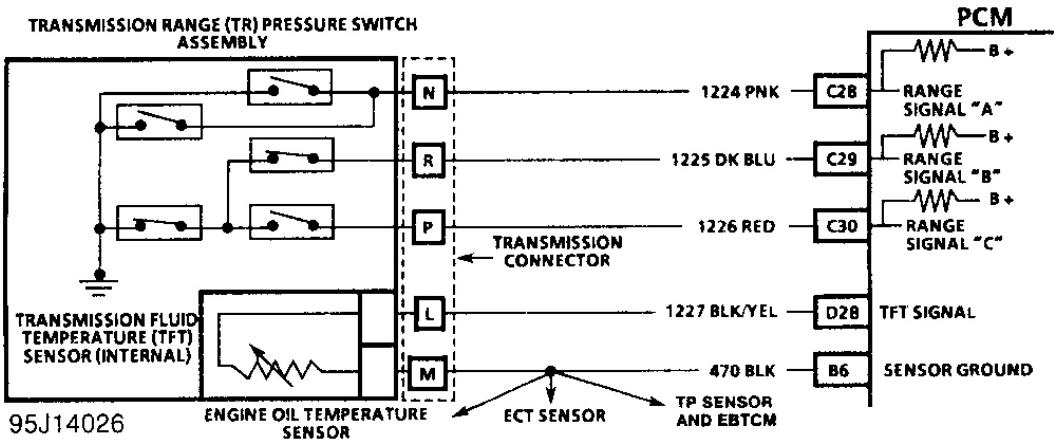


Fig. 41: Code 58, Circuit Diagram (5.7L Y Body) Courtesy of General Motors Corp.

Temperature sensor is a 2 wire thermistor located in transaxle. This sensor operates in the same manner as engine coolant temperature sensor and intake air temperature sensor. PCM applies 5 volts to sensor on signal circuit. Voltage sensed at PCM signal circuit terminal will be high when transmission fluid is cold and as fluid warms voltage signal will drop. A very low signal voltage indicates a high fluid temperature or a failure in sensor circuit. Normal fluid temperature range is 167-212°F (75-100°C).

Code 58 will set when sensor indicates a high fluid temperature for a precalibrated period of time. Malfunction Indicator Light (MIL) will illuminate and PCM will use a warm default sensor value.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for a short to ground or an out-of-calibration sensor.
2. Checks for an internal fault within the transmission by creating an open.

Diagnostic Aids

Check harness routing for a potential short to ground in signal circuit. Temperature should rise steadily to about 194°F (90°C) then stabilize. A skewed sensor could result in delayed shifts or TCC enabled complaints.

Use temperature-to-resistance table to check sensor at various levels to determine if sensor is out-of-calibration, which could result in firm shifts or TCC enable.

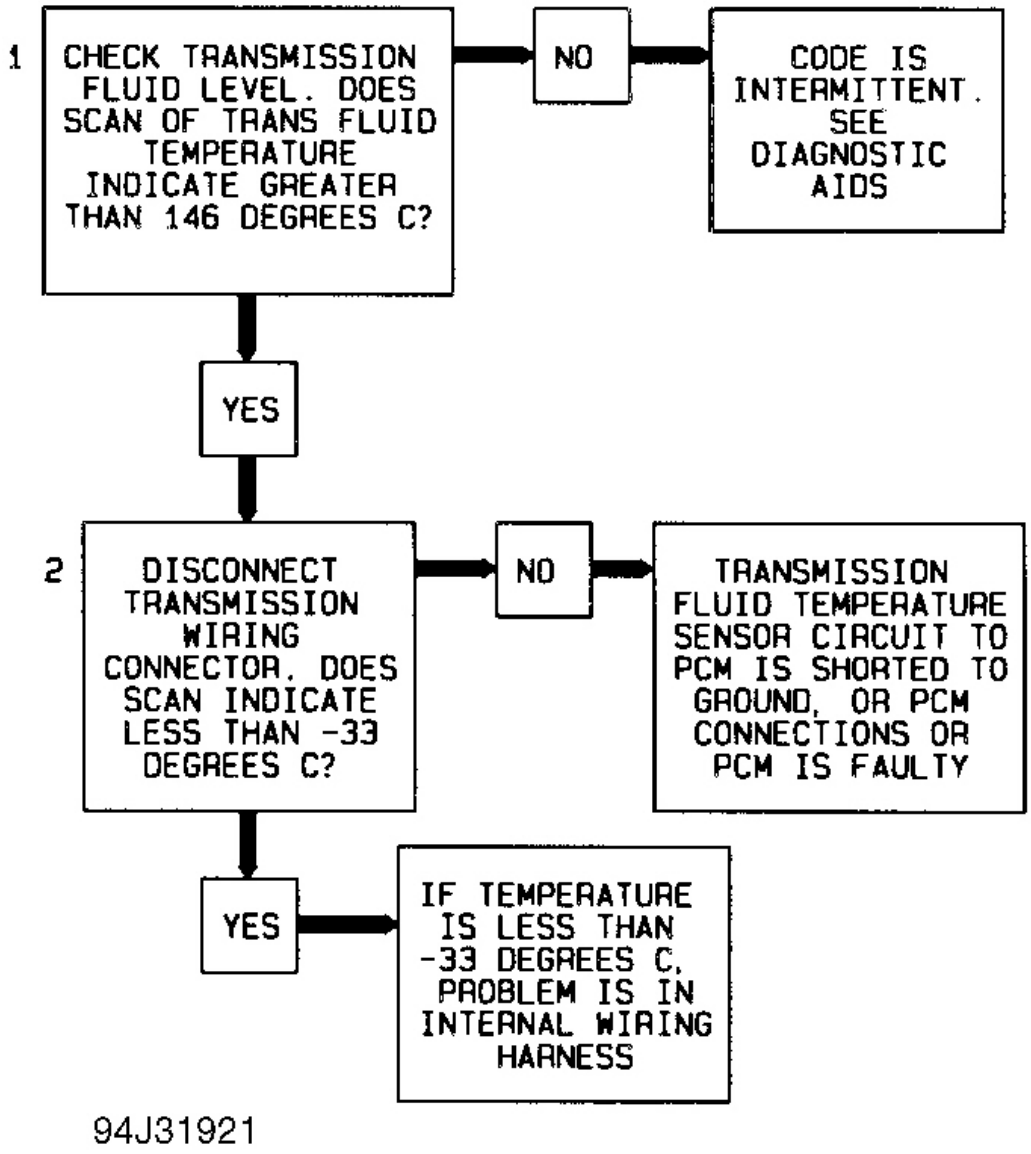


Fig. 42: Code 58, Flow Chart (Cars) Courtesy of General Motors Corp.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	**(1) Ohms**
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459

68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700
(1) Measure resistance across sensor terminals.	

CODE 59, TRANS. TEMPERATURE SENSOR LOW TEMPERATURE - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES

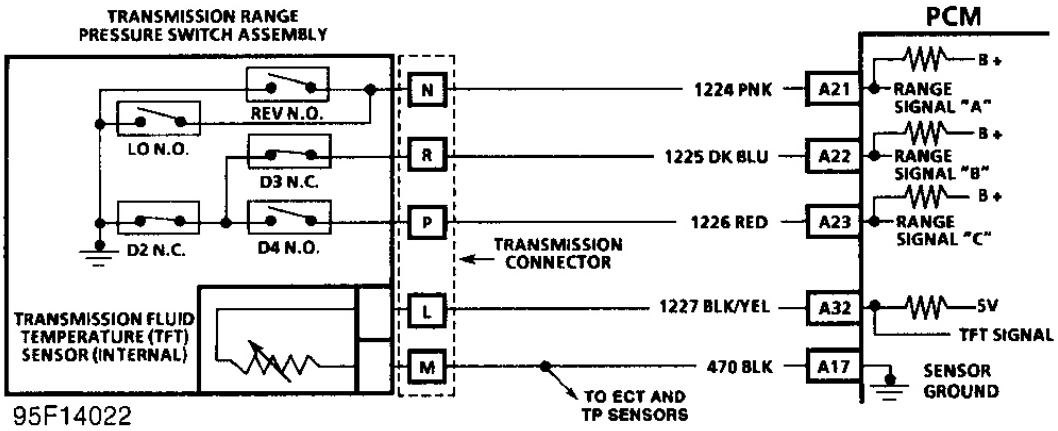


Fig. 43: Code 59, Circuit Diagram (3.4L F Body) Courtesy of General Motors Corp.

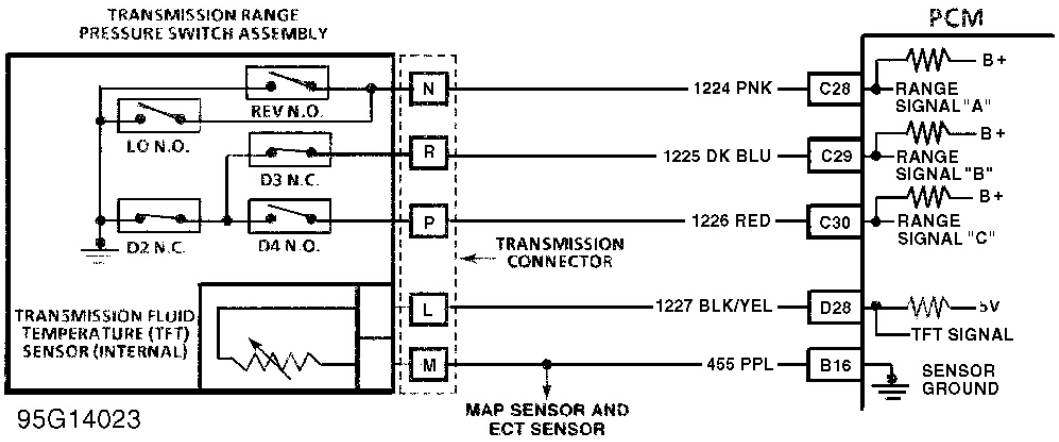


Fig. 44: Code 59, Circuit Diagram (4.3L & 5.7L B Body) Courtesy of General Motors Corp.

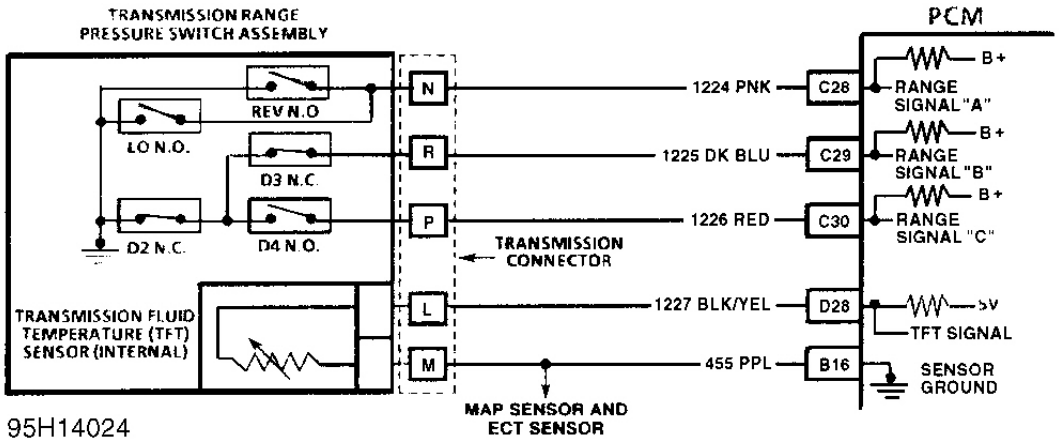


Fig. 45: Code 59, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

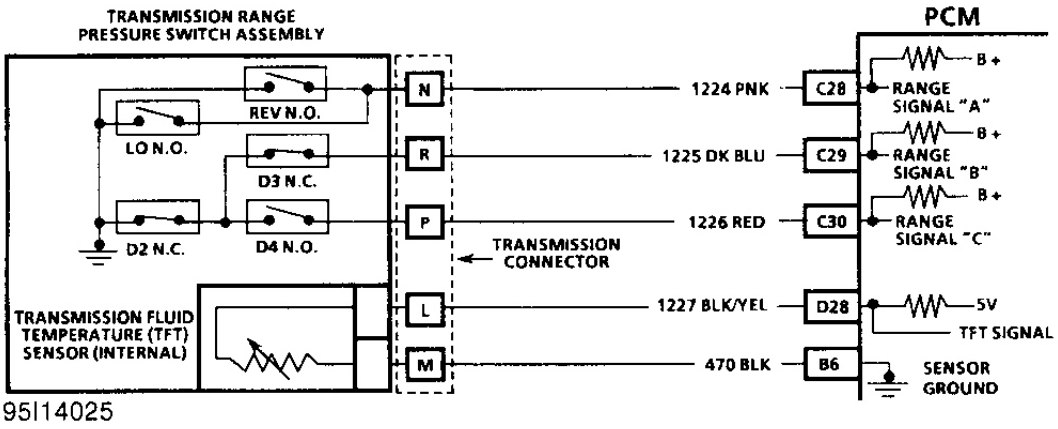


Fig. 46: Code 59, Circuit Diagram (5.7L F Body) Courtesy of General Motors Corp.

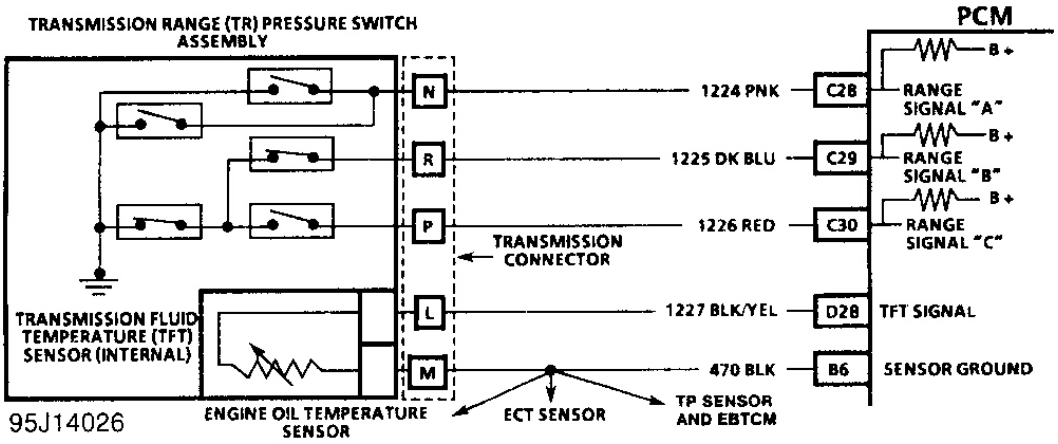


Fig. 47: Code 59, Circuit Diagram (5.7L Y Body) Courtesy of General Motors Corp.

Temperature sensor is a 2 wire thermistor located in transaxle. This sensor operates in the same manner as engine coolant temperature sensor and intake air temperature sensor. PCM applies 5 volts to sensor on signal circuit. Voltage sensed at PCM signal circuit terminal will be high when transmission fluid is cold and as fluid warms voltage signal will drop. A very high signal voltage indicates a low fluid temperature or a failure in sensor circuit. Normal fluid temperature range is 167-212°F (75-100°C).

Code 59 will set when sensor indicates a low temperature for a precalibrated period of time. Malfunction Indicator Light (MIL) will not illuminate and PCM will use a warm default sensor value.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test determines if a current condition exists.
2. Simulates a Code 58. If PCM recognizes low signal voltage, and scan displays about 295°F (146°C) or higher, PCM and wiring are okay.
3. Checks if signal circuit is open. Five volts should be present at sensor connector.

Diagnostic Aids

Temperature should rise steadily to about 194°F (90°C), then stabilize. A faulty connection or an open in ground or signal circuit can result in Code 59. A skewed sensor could result in firm shifts or TCC enabled complaints.

Use temperature-to-resistance table to check sensor at various levels to determine if sensor is out-of-calibration, which could result in firm shifts or TCC enable.

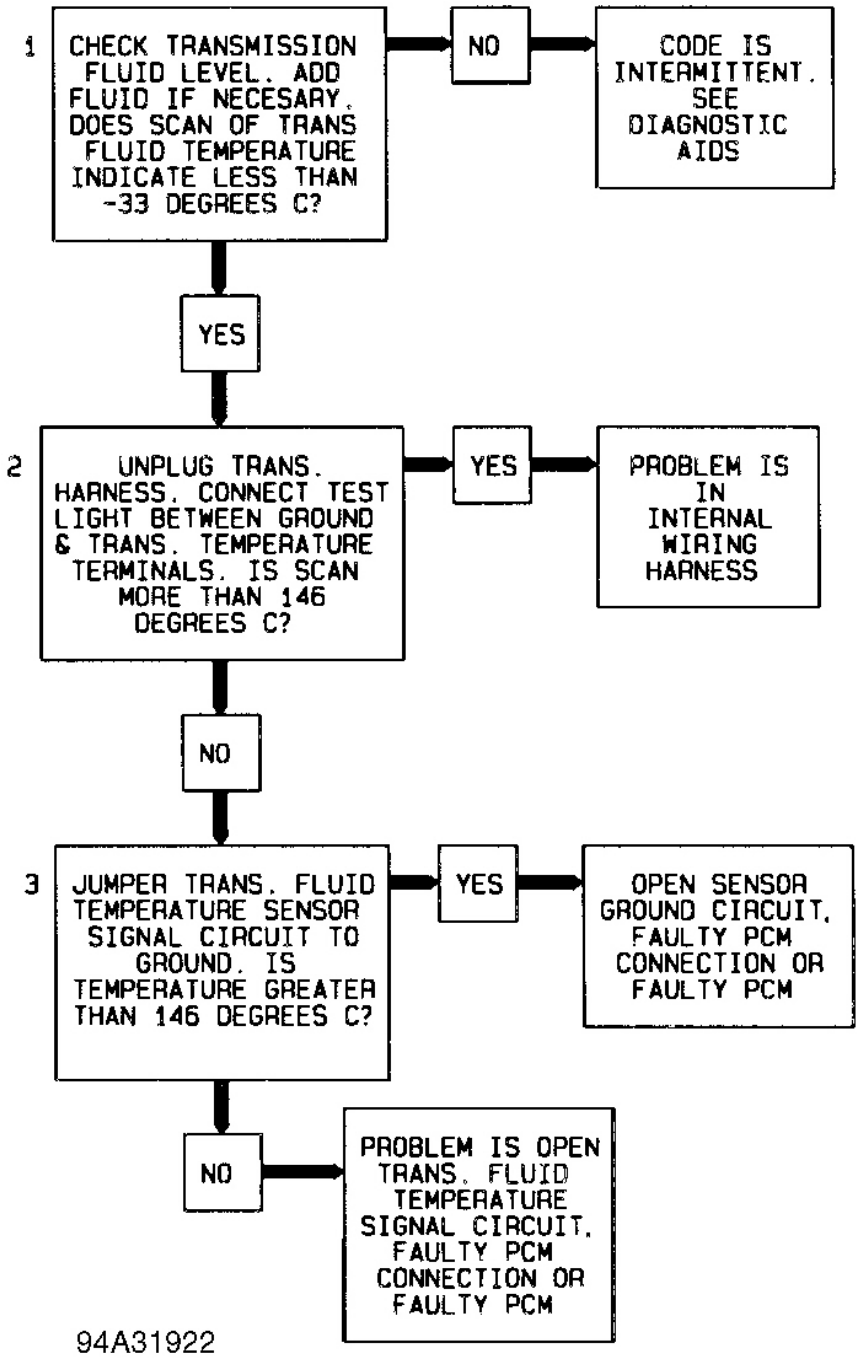


Fig. 48: Code 59, Flow Chart (Cars) Courtesy of General Motors Corp.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	(1) Ohms

212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700
(1) Measure resistance across sensor terminals.	

CODE 72, VEHICLE SPEED SENSOR LOSS - 3.4L "F" BODY, 4.3L & 5.7L "B", "D" & "F" BODIES

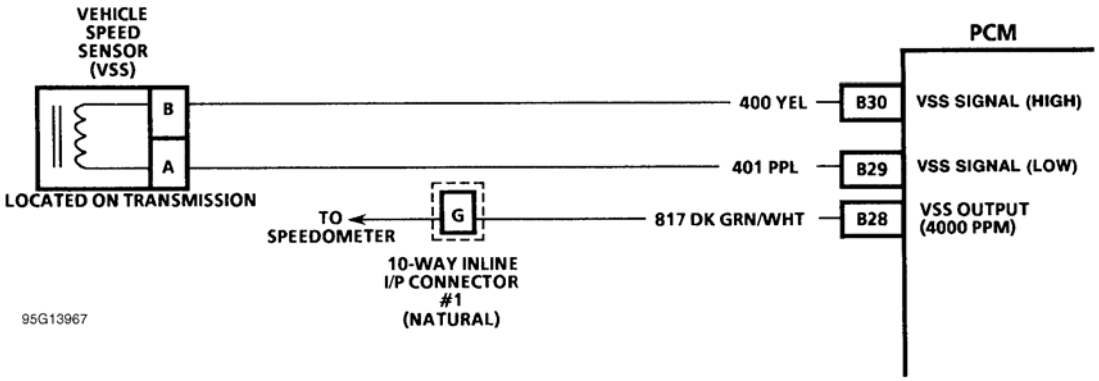


Fig. 49: Code 72, Circuit Diagram (3.4L F Body) Courtesy of General Motors Corp.

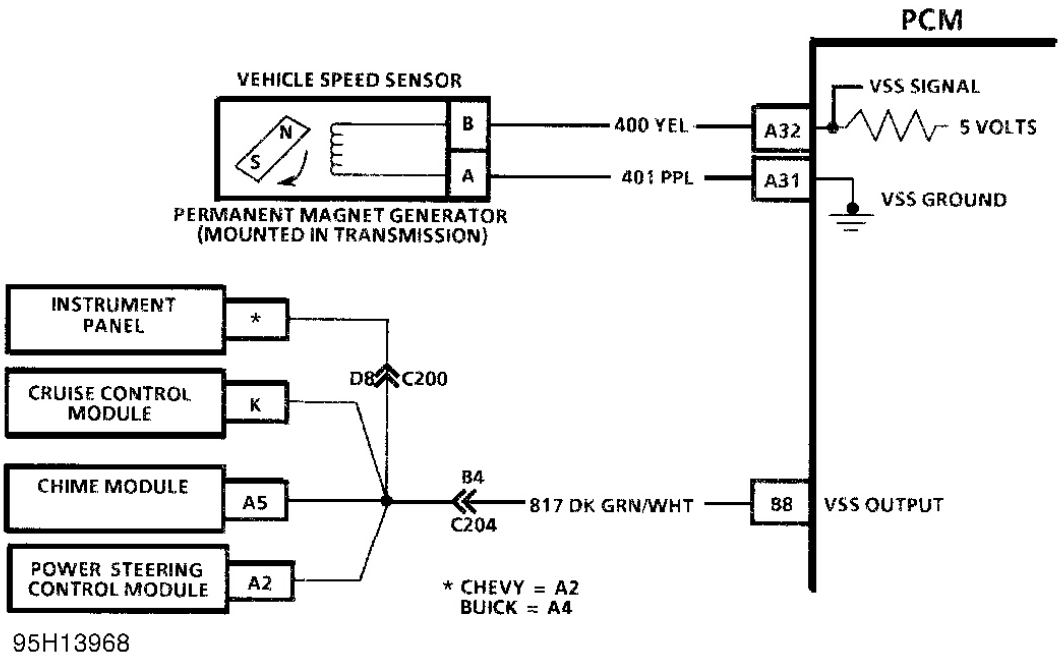


Fig. 50: Code 72, Circuit Diagram (4.3L & 5.7L B Body) Courtesy of General Motors Corp.

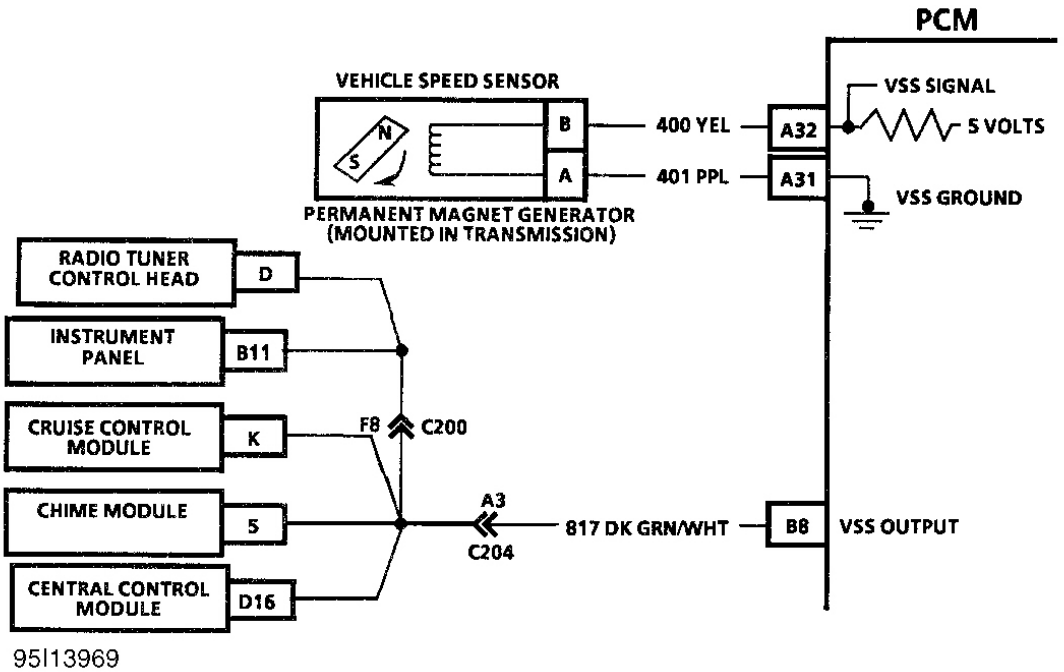


Fig. 51: Code 72, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

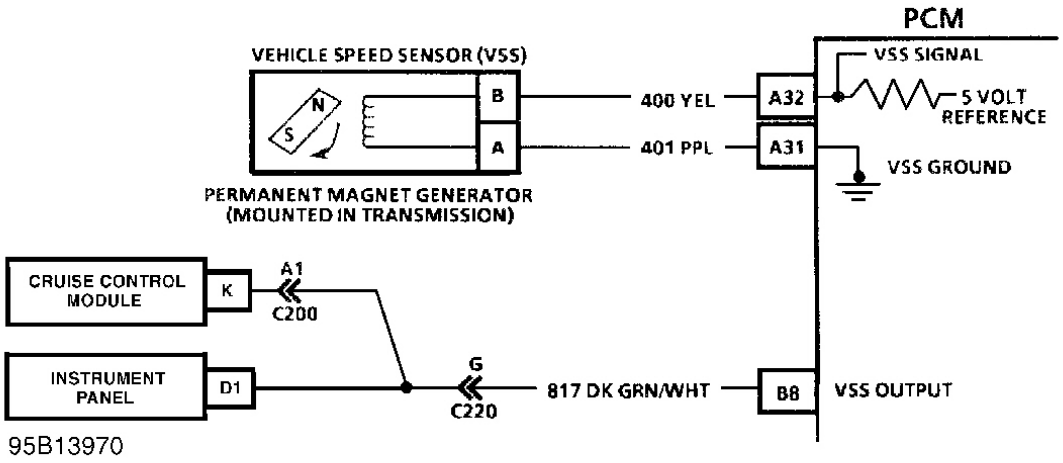


Fig. 52: Code 72, Circuit Diagram (5.7L F Body) Courtesy of General Motors Corp.

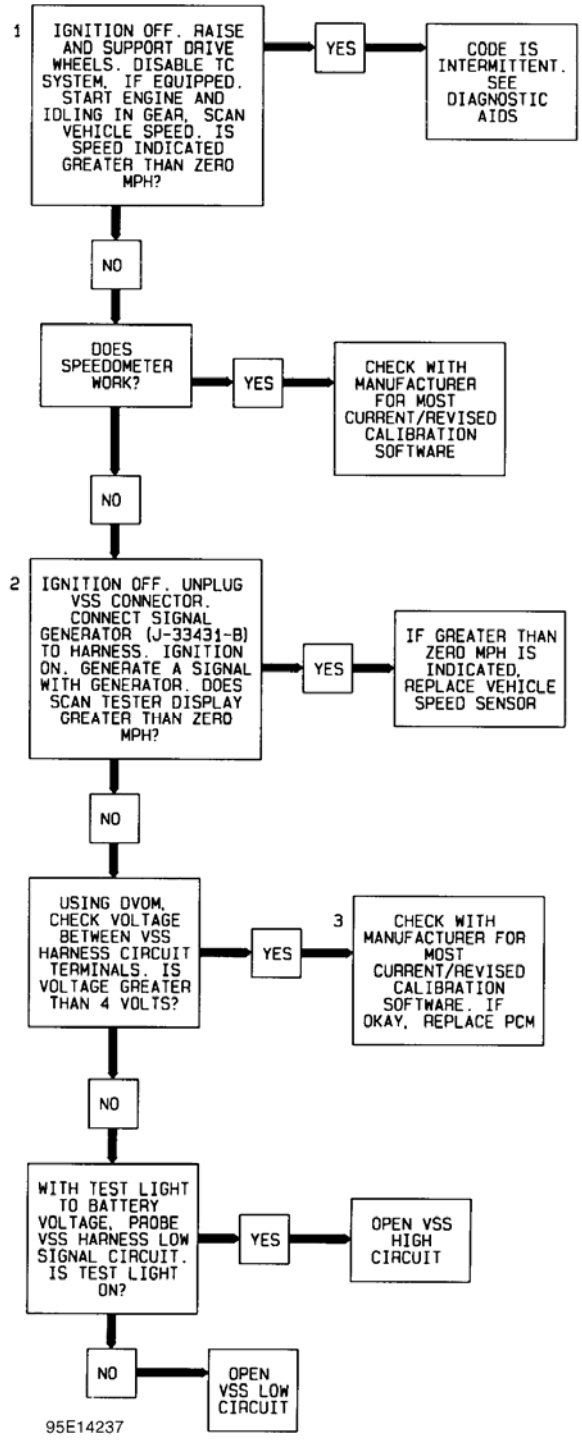


Fig. 53: Code 72, Flow Chart (B, F & D Bodies) Courtesy of General Motors Corp.

Speed sensor, which is a Permanent Magnet (PM) generator, provides control module with vehicle speed information. PM generator, mounted in transmission, produces a pulsing AC voltage signal whenever vehicle speed is greater than about 2 MPH. Voltage level and pulses increase with vehicle speed. Control module

converts pulsing voltage to MPH, which is used by control module to calculate vehicle adjustments.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. An intermittent connection at VSS or PCM may cause code to set. Inspect harness and all related connections. Check for damage or pushed out terminals.
2. Ensure harness is routed away from hot exhaust components.
3. If software/calibration is incorrect, code will set. Ensure calibration is correct before replacing PCM.

CODE 72, VEHICLE SPEED SENSOR LOSS - 5.7L "Y" BODY

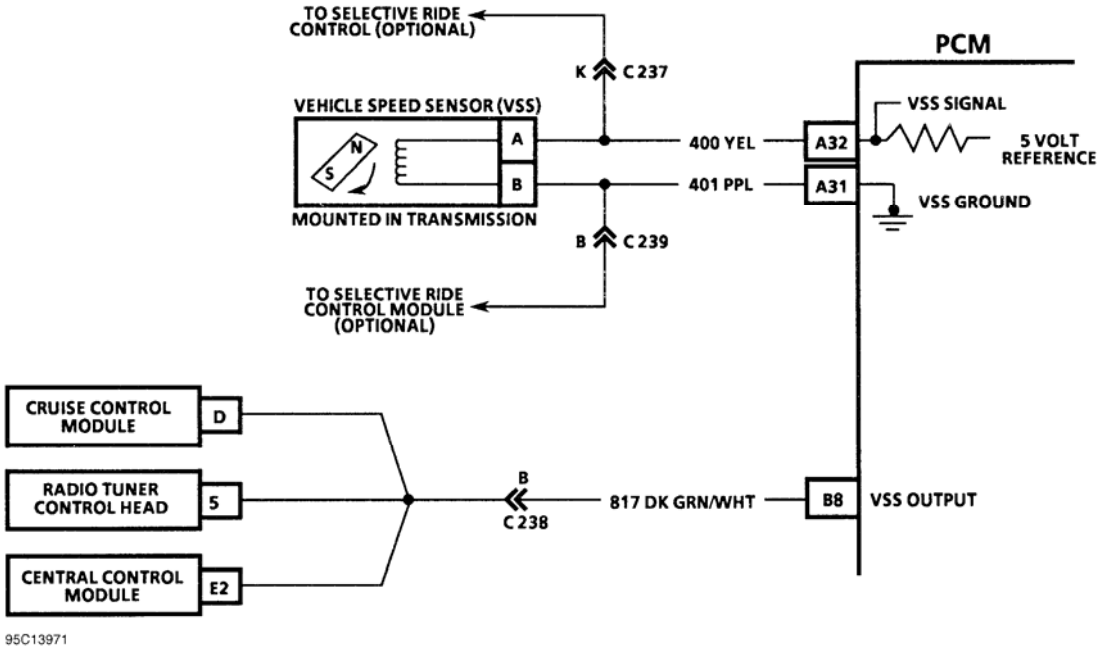


Fig. 54: Code 72, Circuit Diagram (5.7L Y Body) Courtesy of General Motors Corp.

Speed sensor is a PM generator located on transmission output shaft.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Disable TC system (if equipped) when performing this step. Whenever ignition is cycled to off position and then back to on, TC system will default on. An intermittent connection at VSS or PCM may cause code to set. Inspect harness and all related connections. Check for damage or pushed out terminals. Prior to replacing PCM, check for correct software calibration (reprogrammable).

Diagnostic Aids

Code 72 will set when vehicle speed has been detected and then lost.

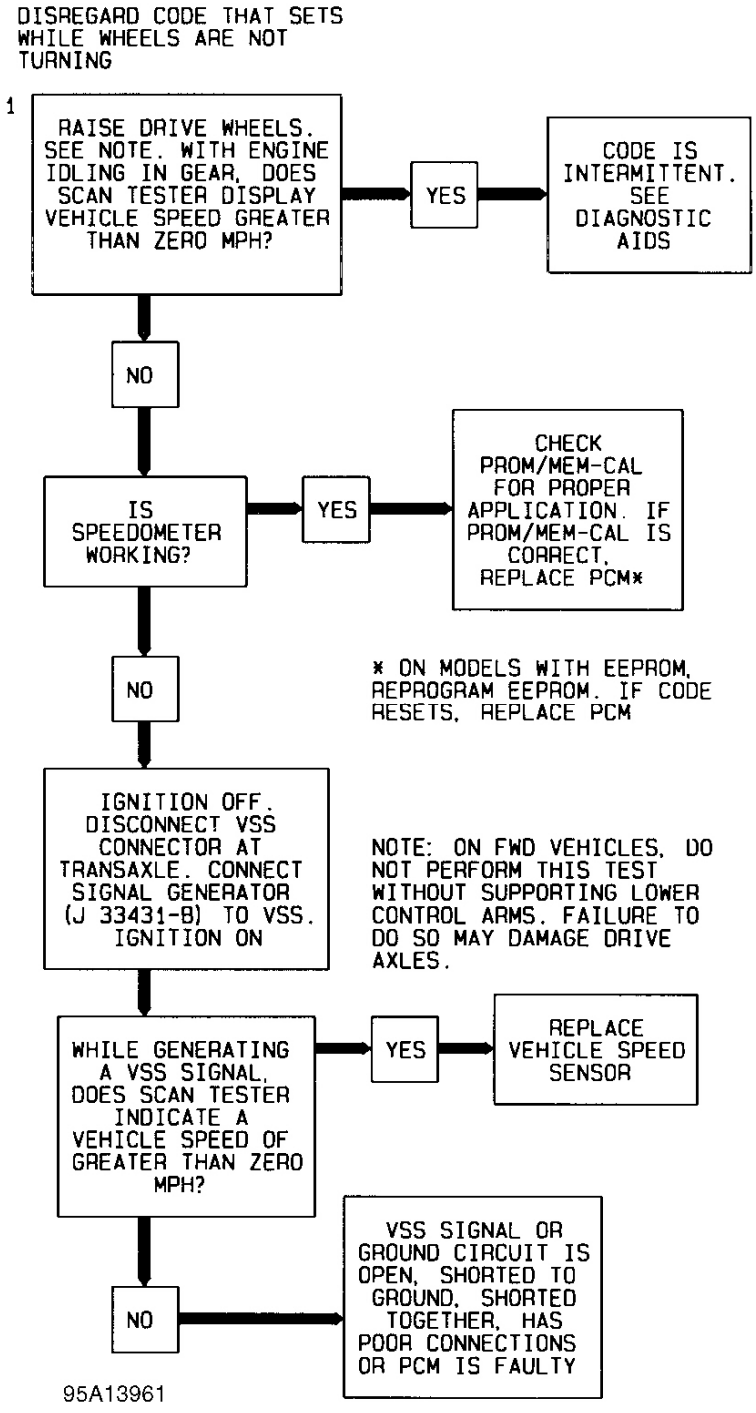


Fig. 55: Code 72, Flow Chart (Y Body) Courtesy of General Motors Corp.

CODE 73, PRESSURE CONTROL SOLENOID - 4.3L/5.7L "B/D/F/Y" BODIES

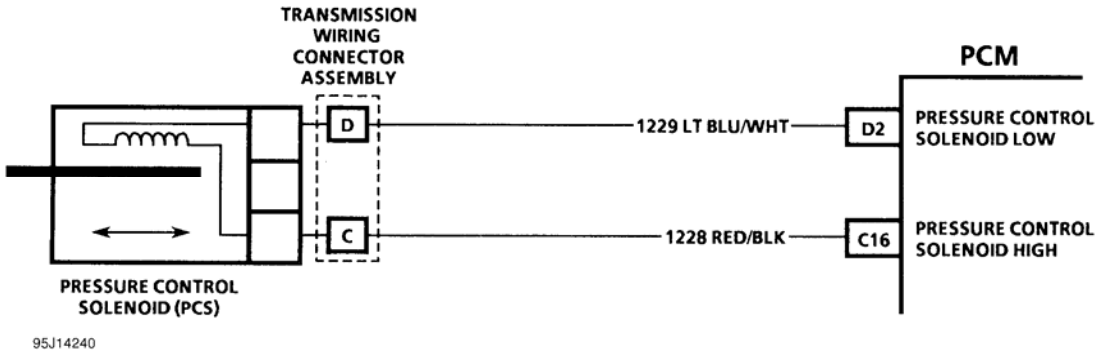


Fig. 56: Code 73, Circuit Diagram (Cars) Courtesy of General Motors Corp.

Pressure control solenoid is a PCM-controlled device used to regulate transmission line pressure. PCM compares TPS voltage, engine RPM and other inputs to determine proper line pressure for a given load. PCM regulates pressure by applying a varying amperage to pressure control solenoid. Amperage varies from 0.1 to 1.1 amps.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks ability of the PCM to command pressure control solenoid.
2. Checks for voltage at PCM.

Diagnostic Aids

Check for poor connections at PCM and at transmission connector.

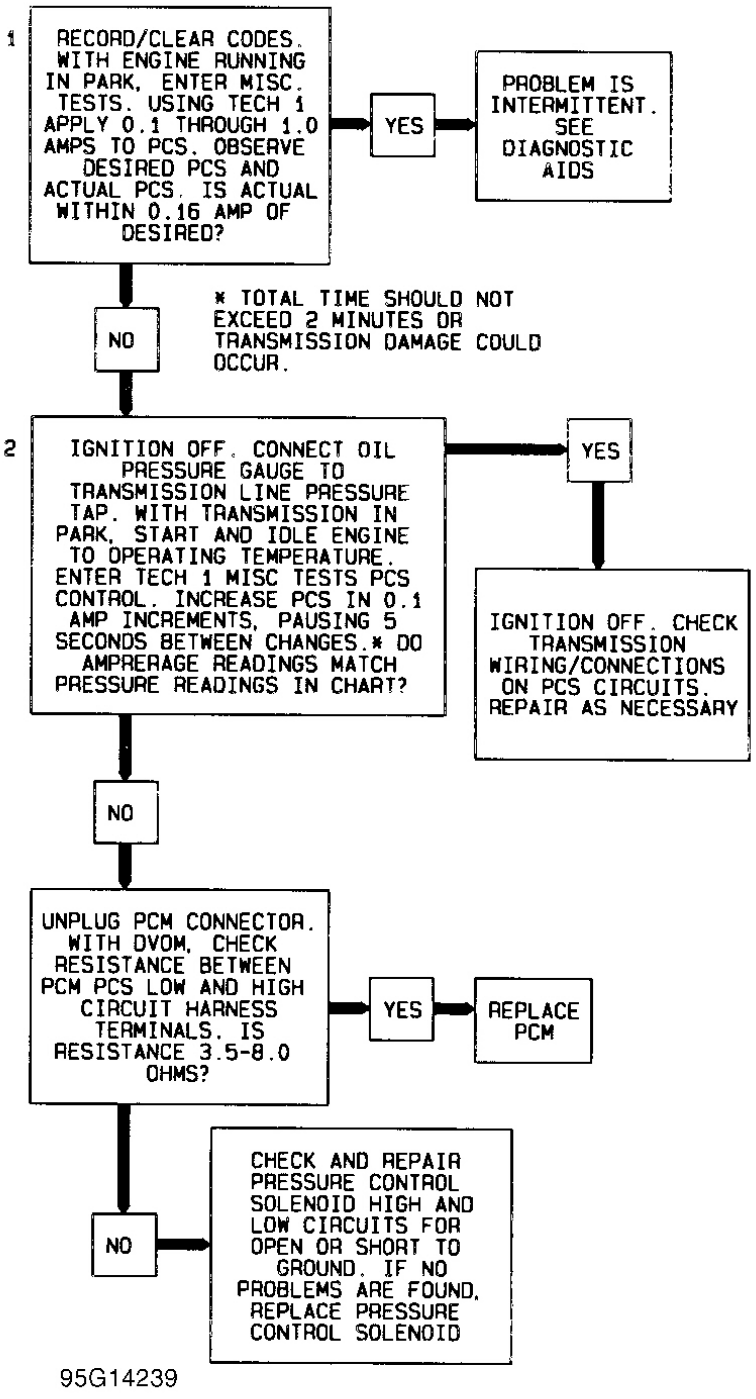


Fig. 57: Code 73, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 74, TRACTION CONTROL VOLTAGE LOW - 5.7L "D/F/Y" BODIES

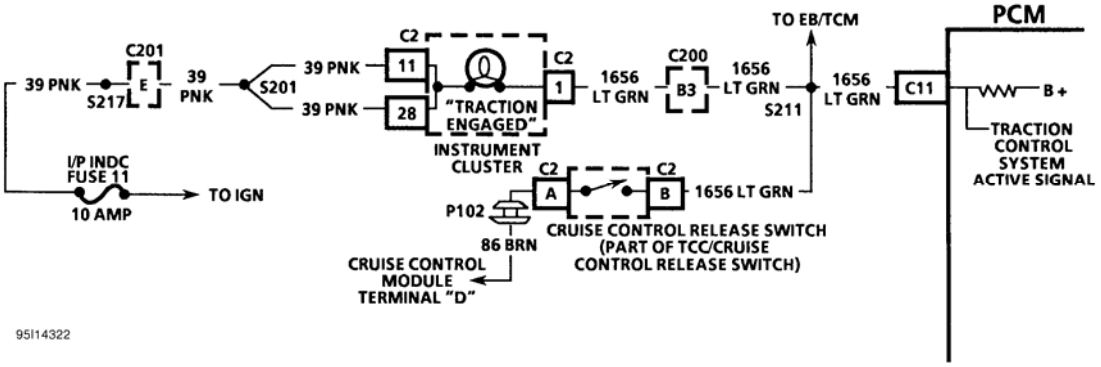


Fig. 58: Code 74, Circuit Diagram (Cars) Courtesy of General Motors Corp.

PCM monitors traction control system activity (battery voltage input signal) and inhibit upshifts, downshifts and TCC operation during system activity (zero volts on signal line).

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If fault exists, scan tester will display TCS activity. A short to ground in an external component or wiring could be the cause for setting of code.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals. Wiggle harness while monitoring scan tester TCS status. If status changes, wiring is faulty.

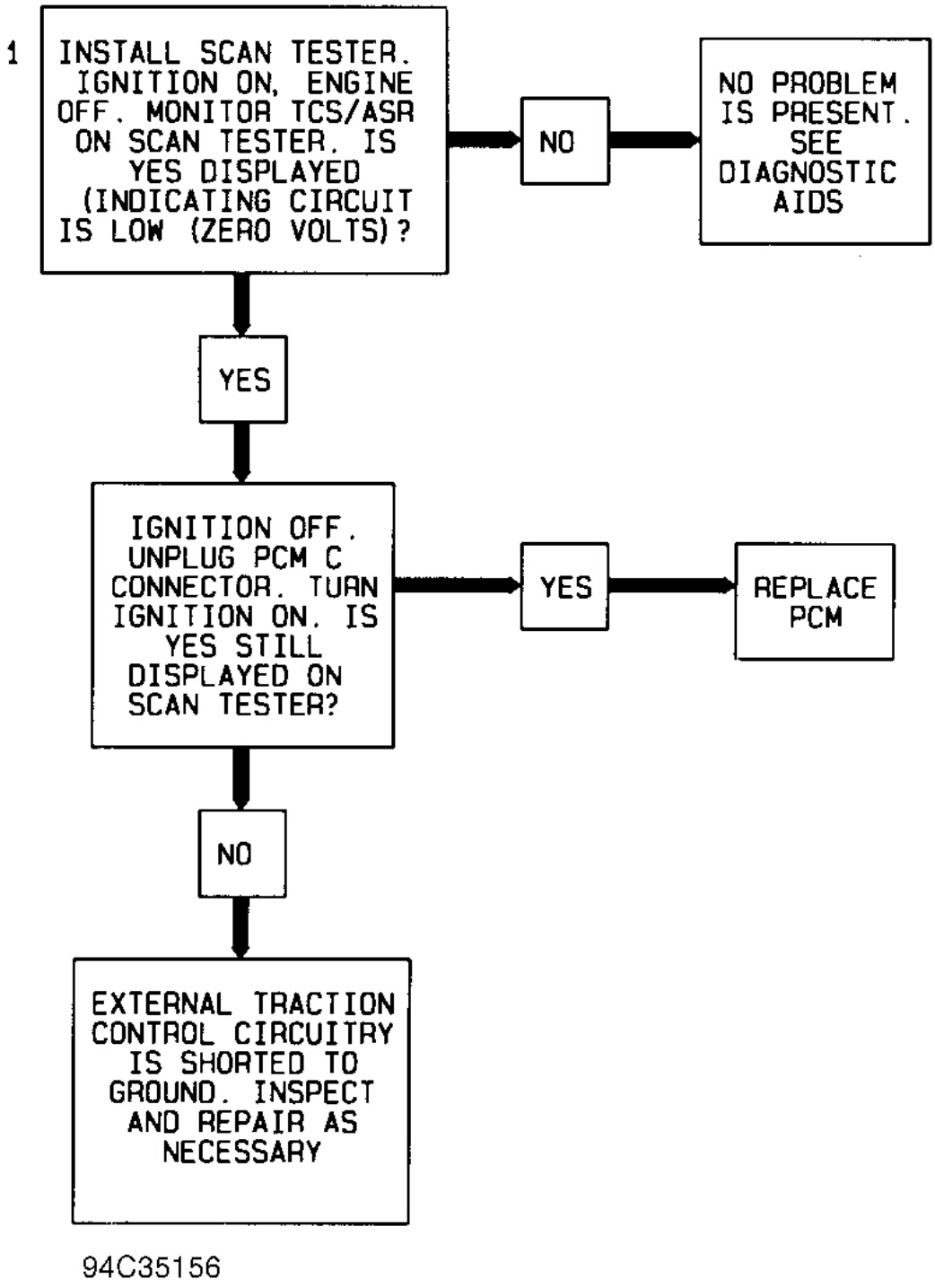


Fig. 59: Code 74, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 75, TRANS. VOLTAGE LOW - 4.3/5.7L "B/D/F/Y" BODIES

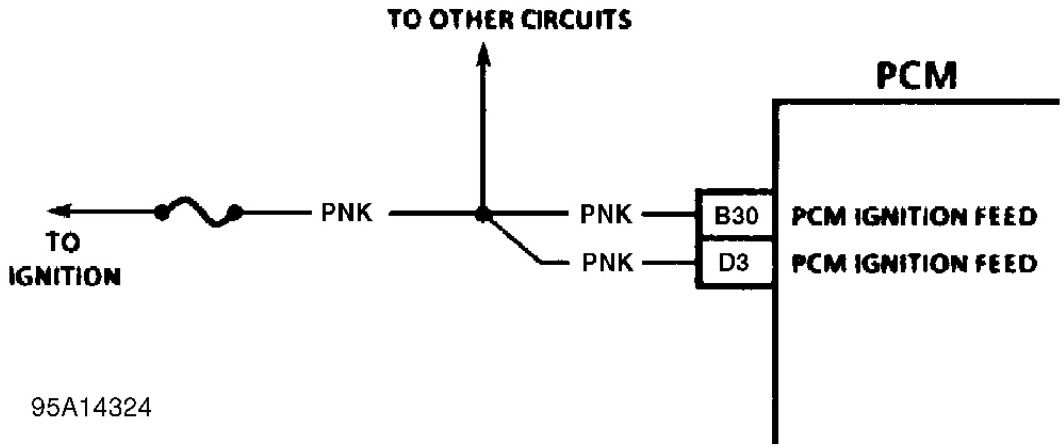


Fig. 60: Code 75, Circuit Diagram (Cars) Courtesy of General Motors Corp.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for normal battery voltage of 9-15 volts.
2. Checks if low voltage is due to generator voltage supply circuit, or PCM. If voltage is less than 9 volts, PCM is okay.

Diagnostic Aids

If code sets when an accessory is operated, check for poor connections or excessive current draw. Also, check for poor connections at starter solenoid or fusible link.

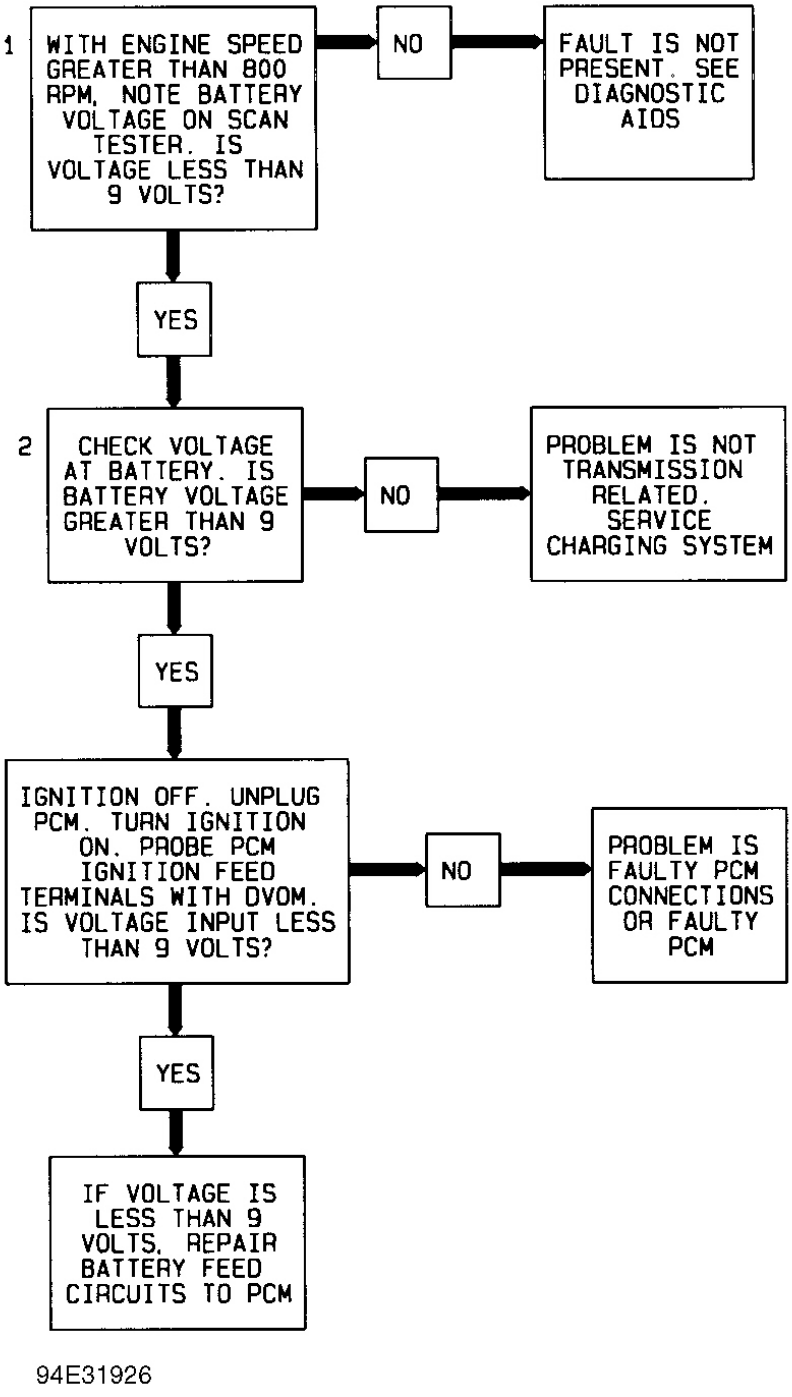


Fig. 61: Code 75, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 79, TRANSMISSION FLUID OVERTEMP - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES

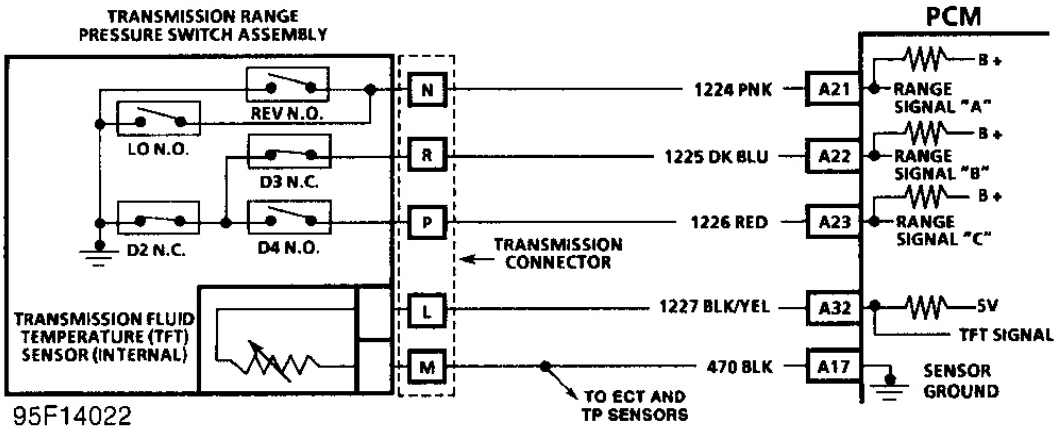


Fig. 62: Code 79, Circuit Diagram (3.4L F Body) Courtesy of General Motors Corp.

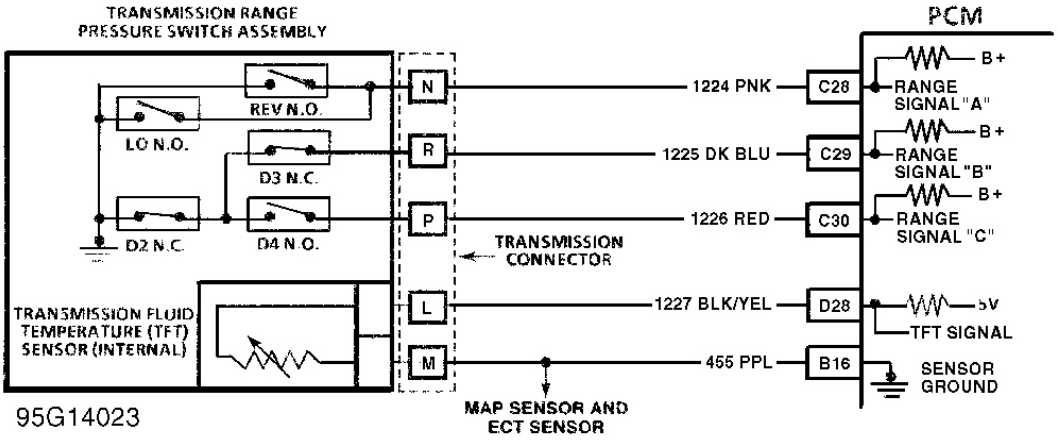


Fig. 63: Code 79, Circuit Diagram (4.3L & 5.7L B Bodies) Courtesy of General Motors Corp.

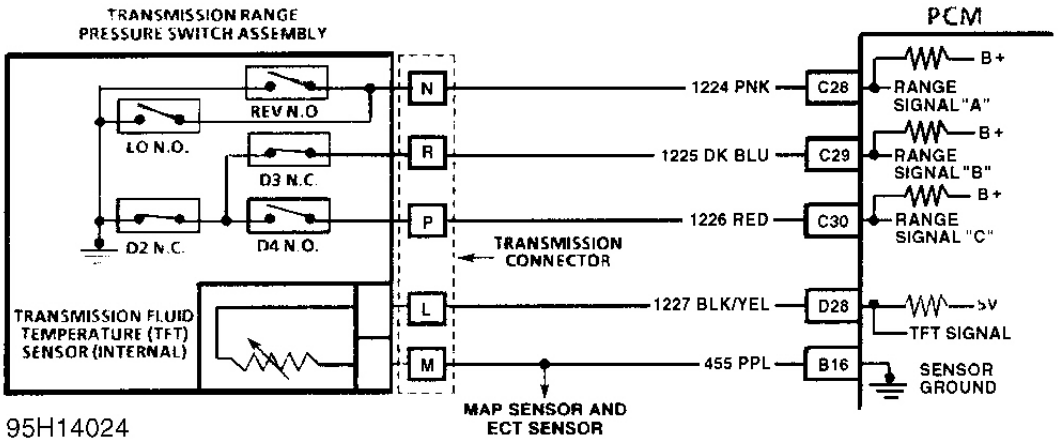


Fig. 64: Code 79, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

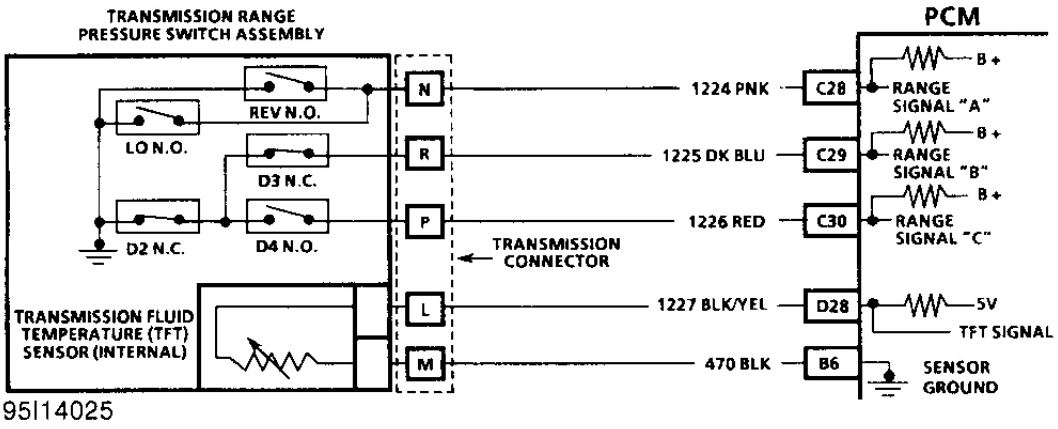


Fig. 65: Code 79, Circuit Diagram (5.7L F Body) Courtesy of General Motors Corp.

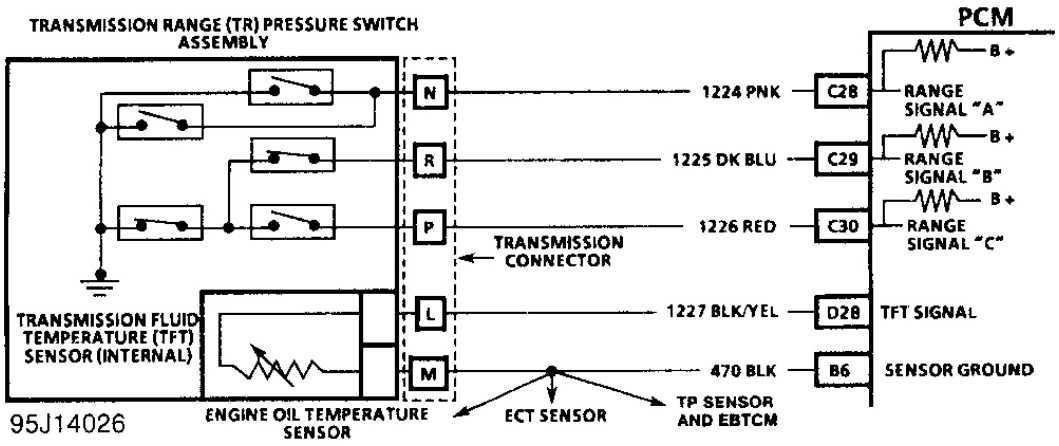


Fig. 66: Code 79, Circuit Diagram (5.7L Y Body) Courtesy of General Motors Corp.

PCM supplies and monitors a 5-volt reference to sensor. As transmission temperature changes, sensor resistance changes, affecting monitored voltage. When fluid is cold, resistance is high, resulting in a high monitored voltage. When fluid is hot, resistance is low, resulting in a low monitored voltage. Code will set if transmission temperature is 248-266°F (120-130°C) for 5 seconds and Codes 58 and 59 are not set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for out-of-calibration sensor or shorted circuit.
2. Simulates Code 59.

Diagnostic Aids

Check harness for potential short to ground. See Code 59 chart to check transmission temperature sensor temperature-to-resistance values. Also, check transmission fluid level. Check for conditions which could cause transmission to overheat i.e. trailer towing, steep grades, etc.

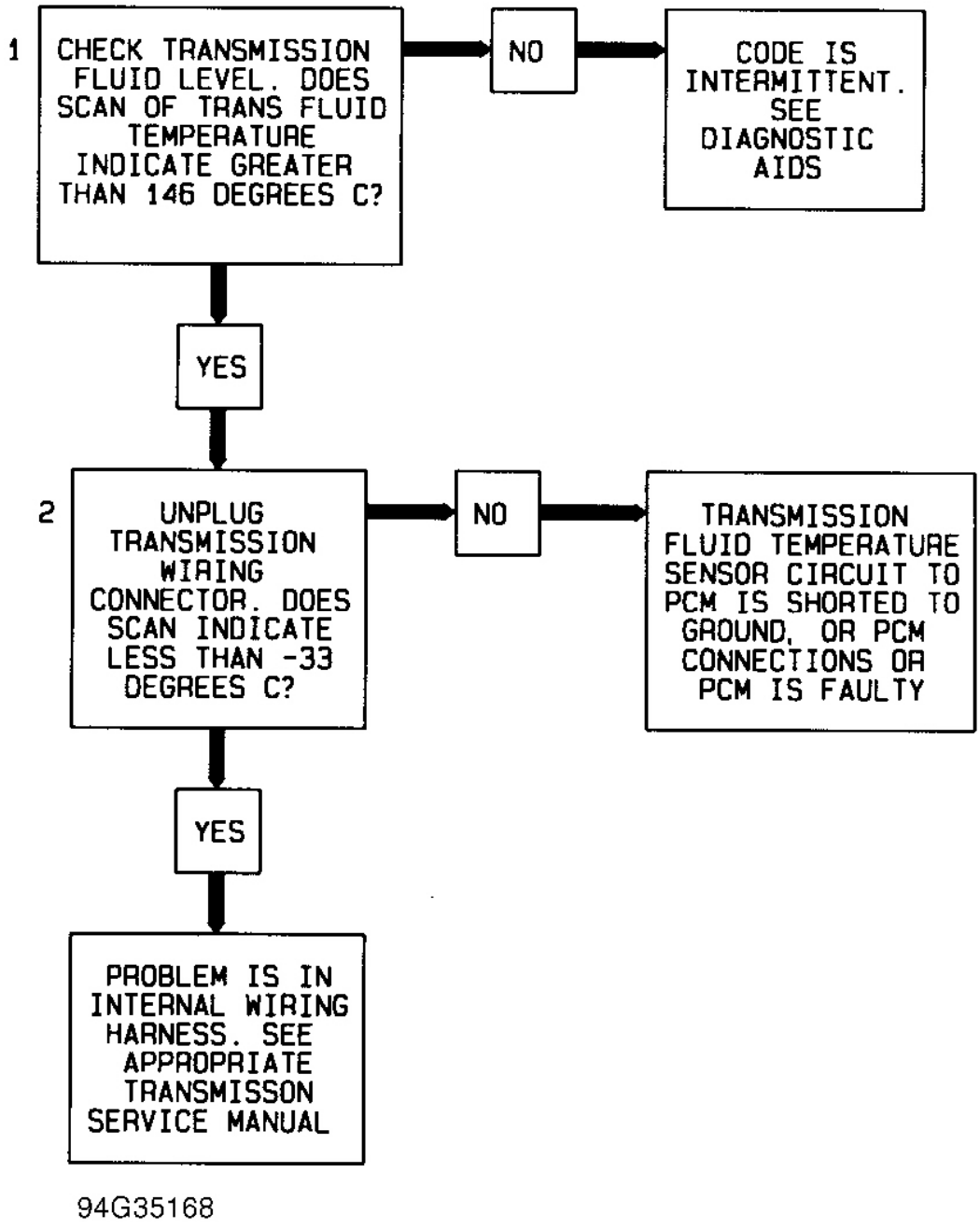


Fig. 67: Code 79, Flow Chart (Cars) Courtesy of General Motors Corp.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	**(1) Ohms**
212 (100)	177

194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700
(1) Measure resistance across sensor terminals.	

CODE 80, TRANSMISSION COMPONENT SLIPPING - 3.4L "F" BODY

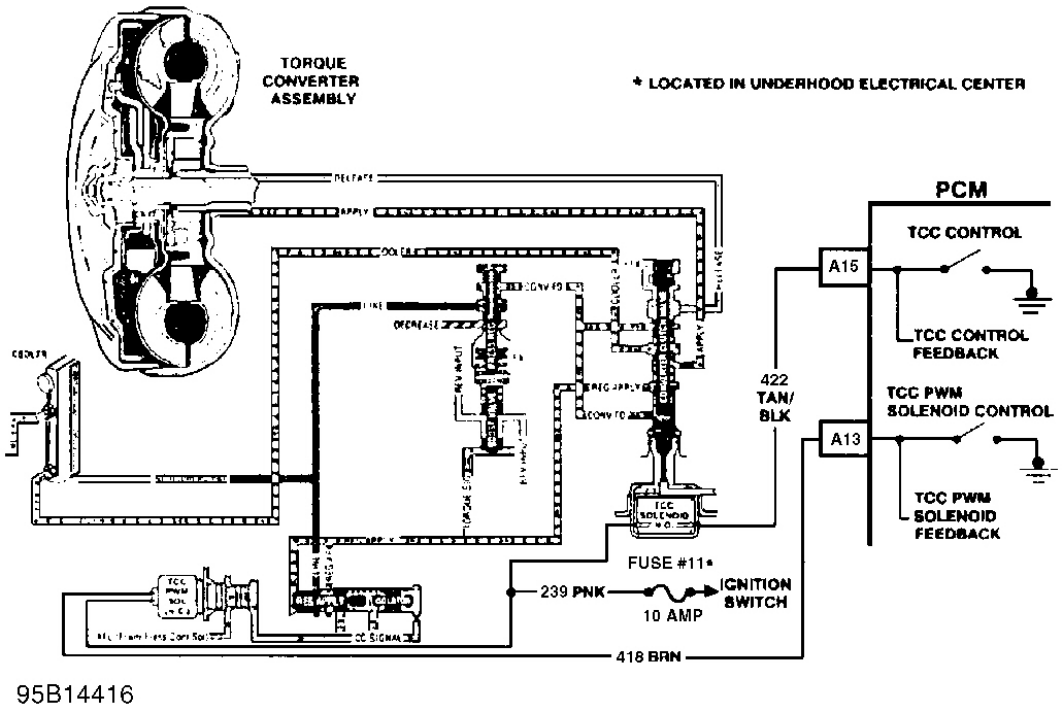


Fig. 68: Code 80, Circuit Diagram (Cars) Courtesy of General Motors Corp.

PCM monitors difference between engine speed and transmission input shaft speed. With selector in D3 or D4 (indicated gear 2, 3 or 4), and TCC is locked, scan should display engine speed closely matching input speed.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks indicated range signal to the actual selected range.
2. Checks torque converter for slippage while in a commanded locked-up state.

Diagnostic Aids

Check for poor connections at pass-through connector. A faulty transmission range pressure switch assembly may set Code 80.

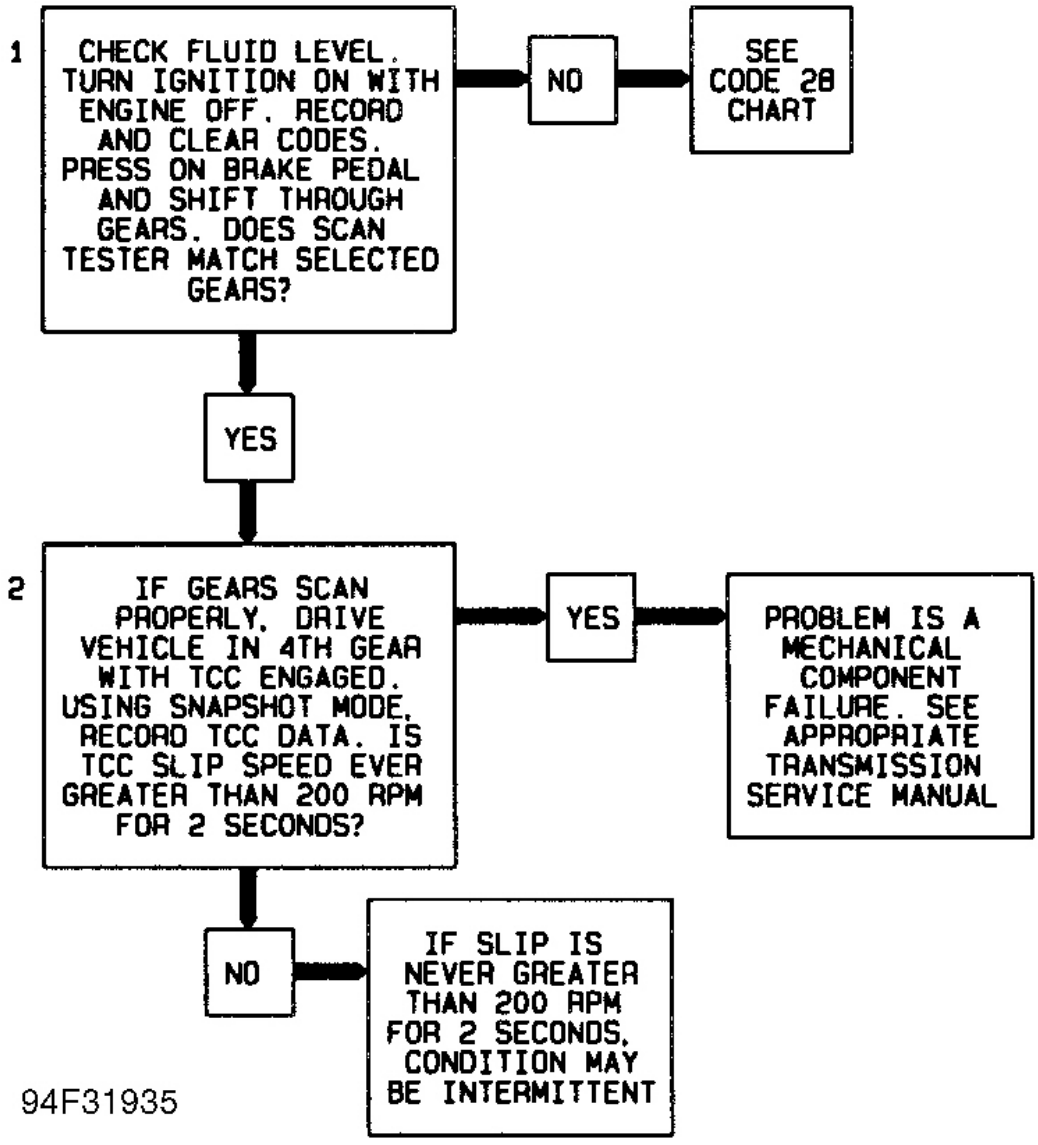


Fig. 69: Code 80, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 81, 2-3 SHIFT SOLENOID - 4.3L & 5.7L "B/D/F/Y" BODIES

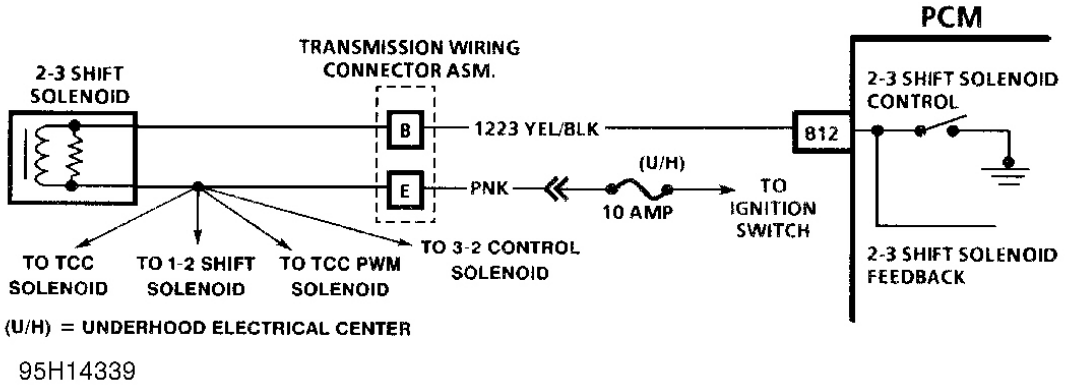


Fig. 70: Code 81, Circuit Diagram (4.3L & 5.7L B & F Bodies) Courtesy of General Motors Corp.

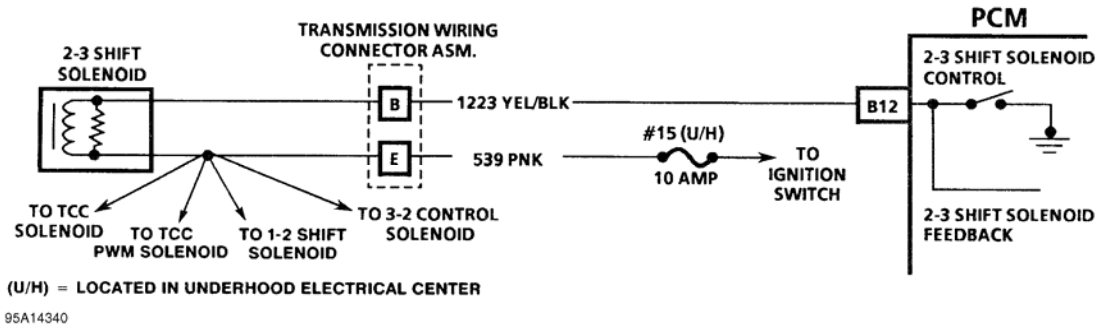


Fig. 71: Code 81, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

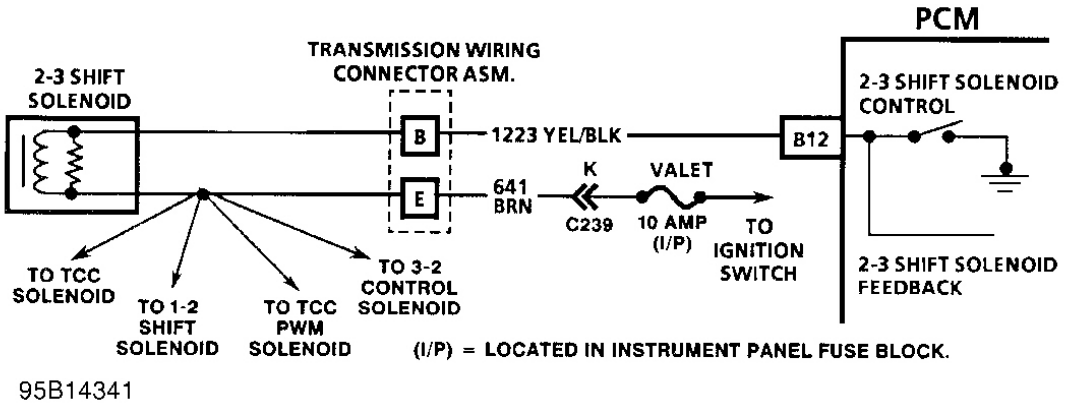


Fig. 72: Code 81, Circuit Diagram (5.7L Y Body) Courtesy of General Motors Corp.

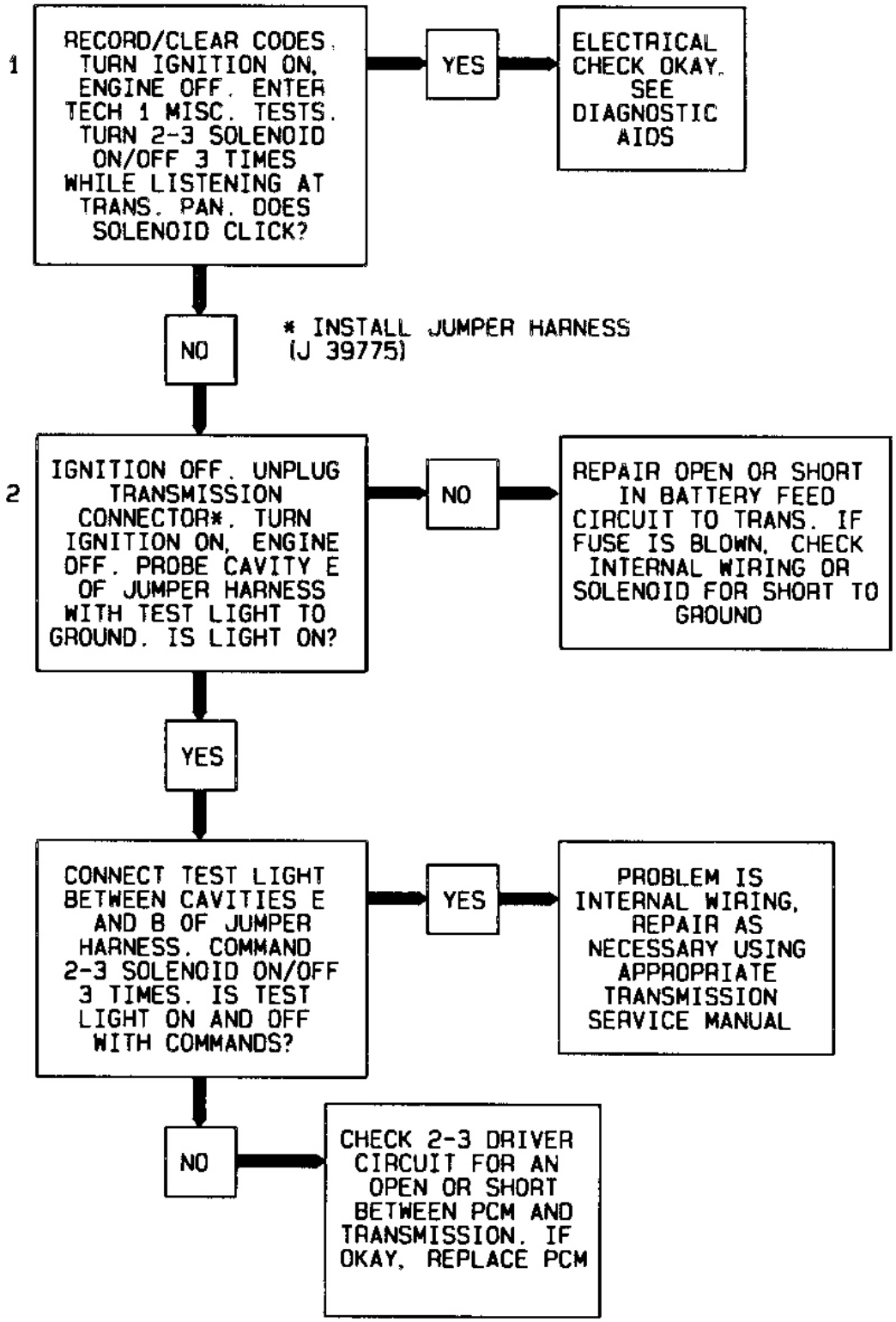
Voltage is supplied directly to solenoid. PCM controls solenoid by providing a ground circuit.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks 2-3 shift solenoid and internal transmission for shorts.
2. Checks for power to 2-3 shift solenoid from ignition through the fuse.

Diagnostic Aids

Check all connections at the transmission. An open in ignition feed circuit can cause multiple codes to set.


1
RECORD/CLEAR CODES. TURN IGNITION ON, ENGINE OFF. ENTER TECH 1 MISC. TESTS. TURN 2-3 SOLENOID ON/OFF 3 TIMES WHILE LISTENING AT TRANS. PAN. DOES SOLENOID CLICK?
YES
ELECTRICAL CHECK OKAY. SEE DIAGNOSTIC AIDS
NO
* INSTALL JUMPER HARNESS (J 39775)
2
IGNITION OFF. UNPLUG TRANSMISSION CONNECTOR*. TURN IGNITION ON, ENGINE OFF. PROBE CAVITY E OF JUMPER HARNESS WITH TEST LIGHT TO GROUND. IS LIGHT ON?
NO
REPAIR OPEN OR SHORT IN BATTERY FEED CIRCUIT TO TRANS. IF FUSE IS BLOWN, CHECK INTERNAL WIRING OR SOLENOID FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN CAVITIES E AND B OF JUMPER HARNESS. COMMAND 2-3 SOLENOID ON/OFF 3 TIMES. IS TEST LIGHT ON AND OFF WITH COMMANDS?
YES
PROBLEM IS INTERNAL WIRING, REPAIR AS NECESSARY USING APPROPRIATE TRANSMISSION SERVICE MANUAL
NO
CHECK 2-3 DRIVER CIRCUIT FOR AN OPEN OR SHORT BETWEEN PCM AND TRANSMISSION. IF OKAY, REPLACE PCM

94C31940

Fig. 73: Code 81, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 82, 1-2 SHIFT SOLENOID - 4.3L & 5.7L "B/D/F/Y" BODIES

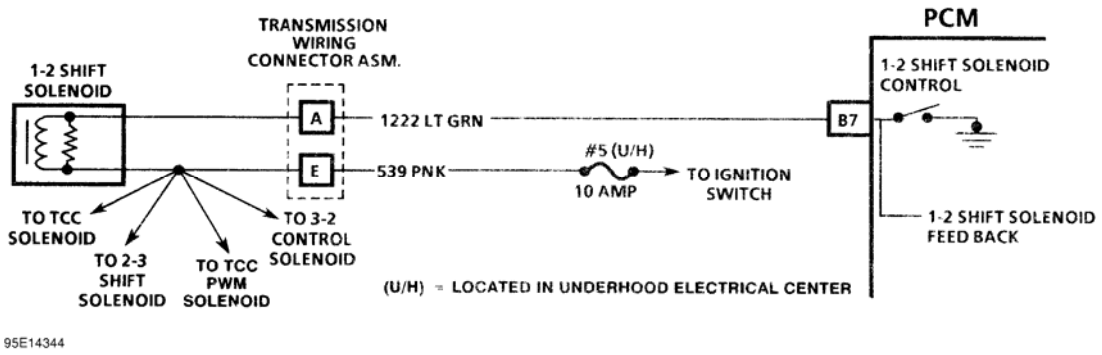


Fig. 74: Code 82, Circuit Diagram (4.3L & 5.7L B Bodies) Courtesy of General Motors Corp.

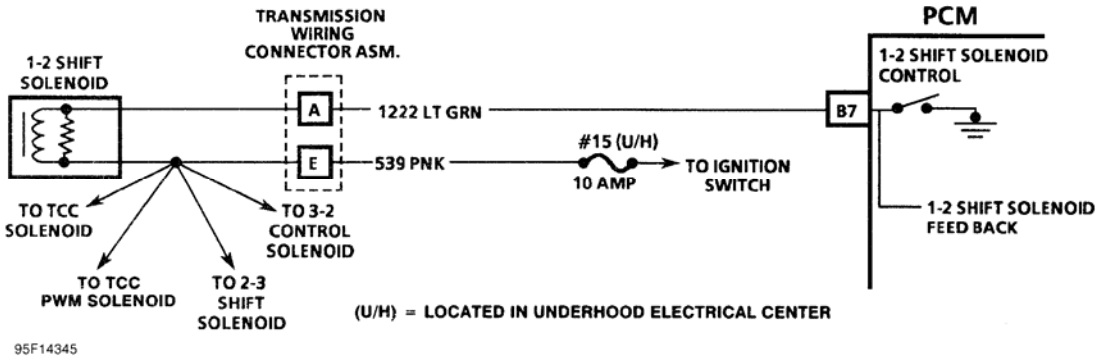


Fig. 75: Code 82, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

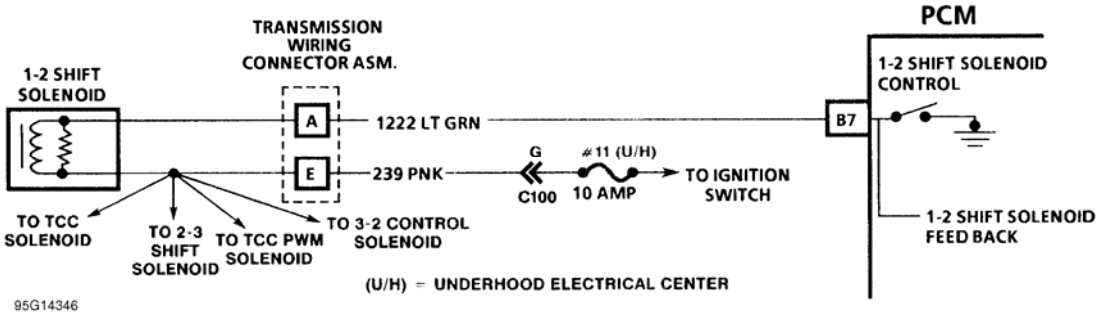


Fig. 76: Code 82, Circuit Diagram (5.7L F Body) Courtesy of General Motors Corp.

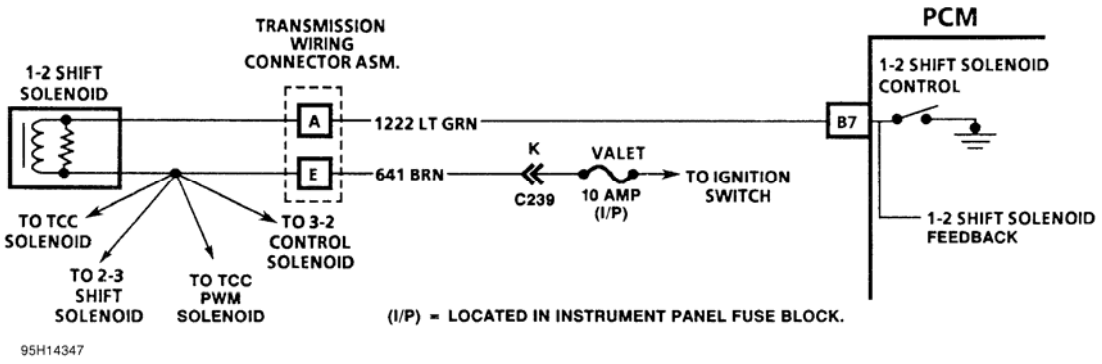


Fig. 77: Code 82, Circuit Diagram (5.7L Y Body) Courtesy of General Motors Corp.

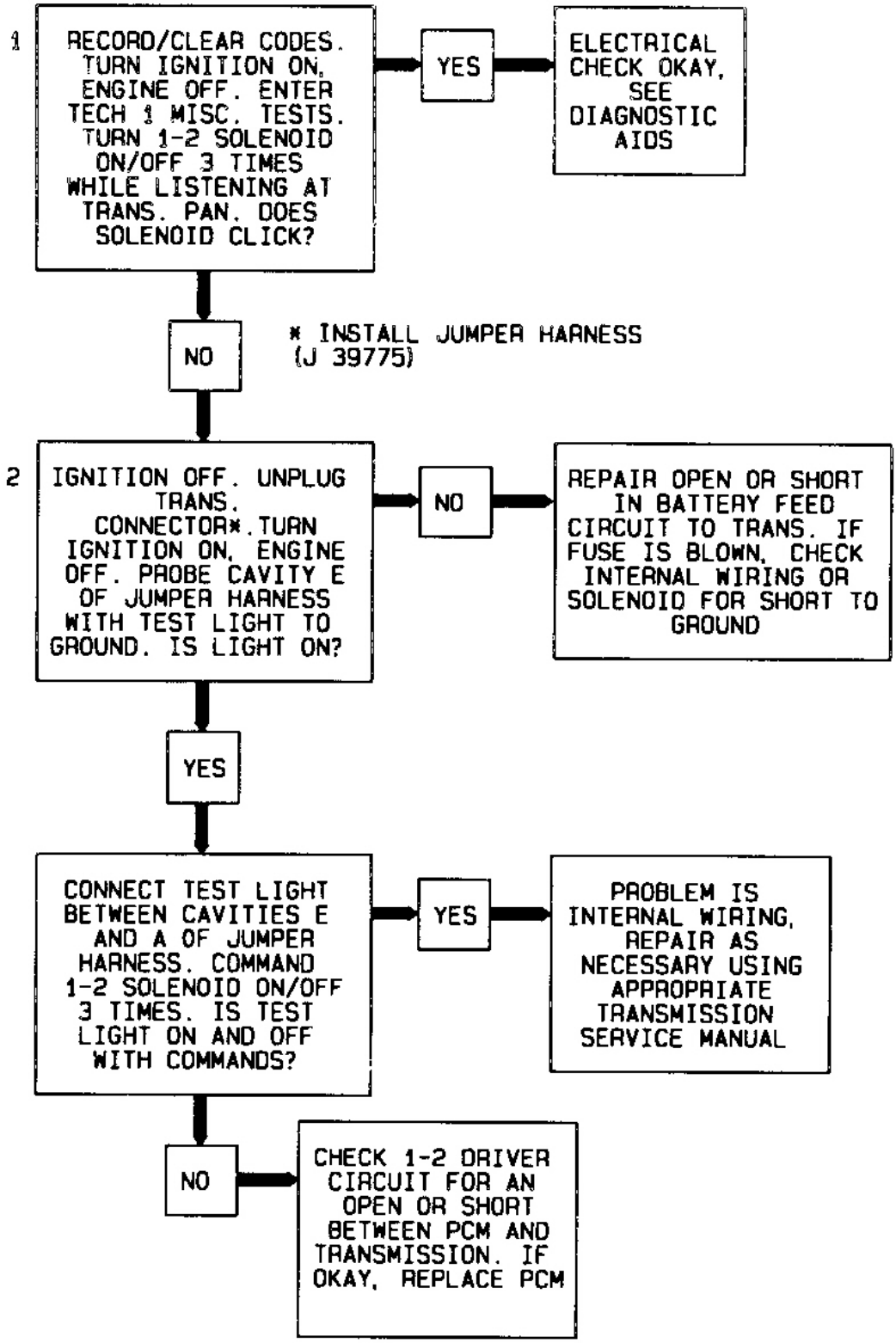
Voltage is supplied directly to solenoid. PCM controls solenoid by providing a ground circuit for solenoid.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks 1-2 shift solenoid and internal transmission for shorts.
2. Checks for power to 1-2 shift solenoid from ignition through the fuse.

Diagnostic Aids

Check all connections at the transmission. An open in ignition feed circuit can cause multiple codes to set.


1
RECORD/CLEAR CODES. TURN IGNITION ON, ENGINE OFF. ENTER TECH 1 MISC. TESTS. TURN 1-2 SOLENOID ON/OFF 3 TIMES WHILE LISTENING AT TRANS. PAN. DOES SOLENOID CLICK?
YES
ELECTRICAL CHECK OKAY, SEE DIAGNOSTIC AIDS
NO
* INSTALL JUMPER HARNESS (J 39775)
2
IGNITION OFF. UNPLUG TRANS. CONNECTOR*. TURN IGNITION ON, ENGINE OFF. PROBE CAVITY E OF JUMPER HARNESS WITH TEST LIGHT TO GROUND. IS LIGHT ON?
NO
REPAIR OPEN OR SHORT IN BATTERY FEED CIRCUIT TO TRANS. IF FUSE IS BLOWN, CHECK INTERNAL WIRING OR SOLENOID FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN CAVITIES E AND A OF JUMPER HARNESS. COMMAND 1-2 SOLENOID ON/OFF 3 TIMES. IS TEST LIGHT ON AND OFF WITH COMMANDS?
YES
PROBLEM IS INTERNAL WIRING, REPAIR AS NECESSARY USING APPROPRIATE TRANSMISSION SERVICE MANUAL
NO
CHECK 1-2 DRIVER CIRCUIT FOR AN OPEN OR SHORT BETWEEN PCM AND TRANSMISSION. IF OKAY, REPLACE PCM

94H31952

Fig. 78: Code 82, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 83, TCC PWM SOLENOID - 4.3L & 5.7L "B/D/F/Y" BODIES

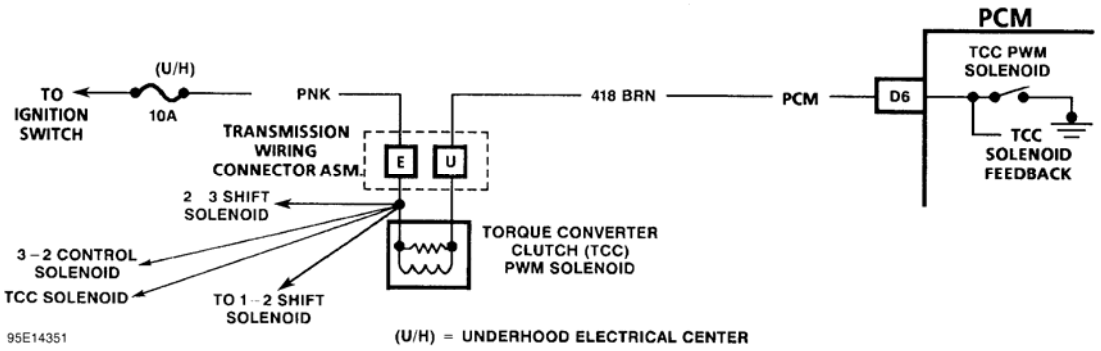


Fig. 79: Code 83, Circuit Diagram (4.3L & 5.7L B & F Bodies) Courtesy of General Motors Corp.

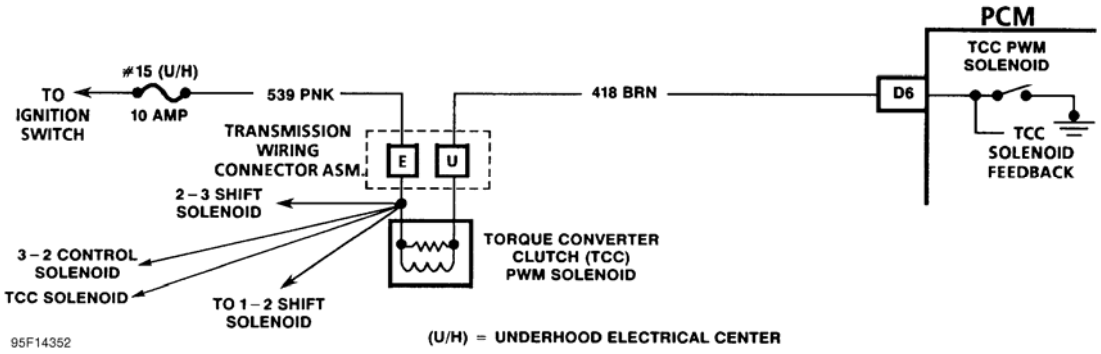


Fig. 80: Code 83, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

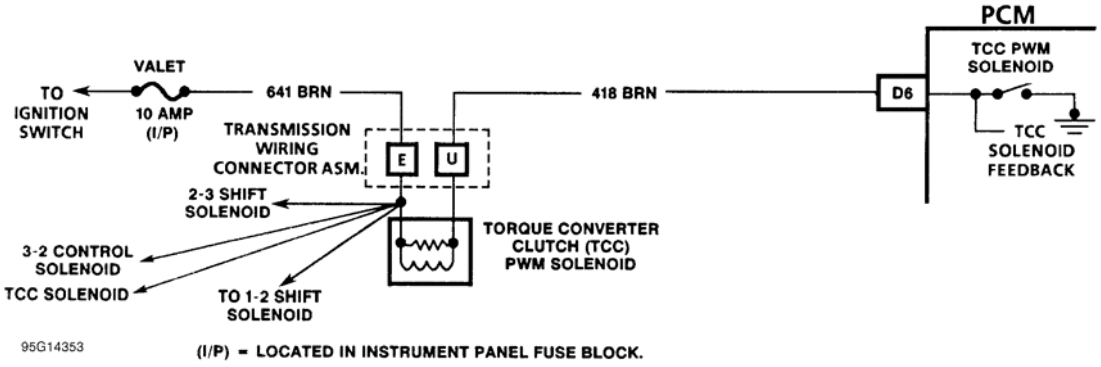


Fig. 81: Code 83, Circuit Diagram (5.7L Y Body) Courtesy of General Motors Corp.

PCM controls and monitors TCC PWM solenoid drive circuit. If voltage remains high when solenoid is

commanded on or remains low when commanded off, code will set.

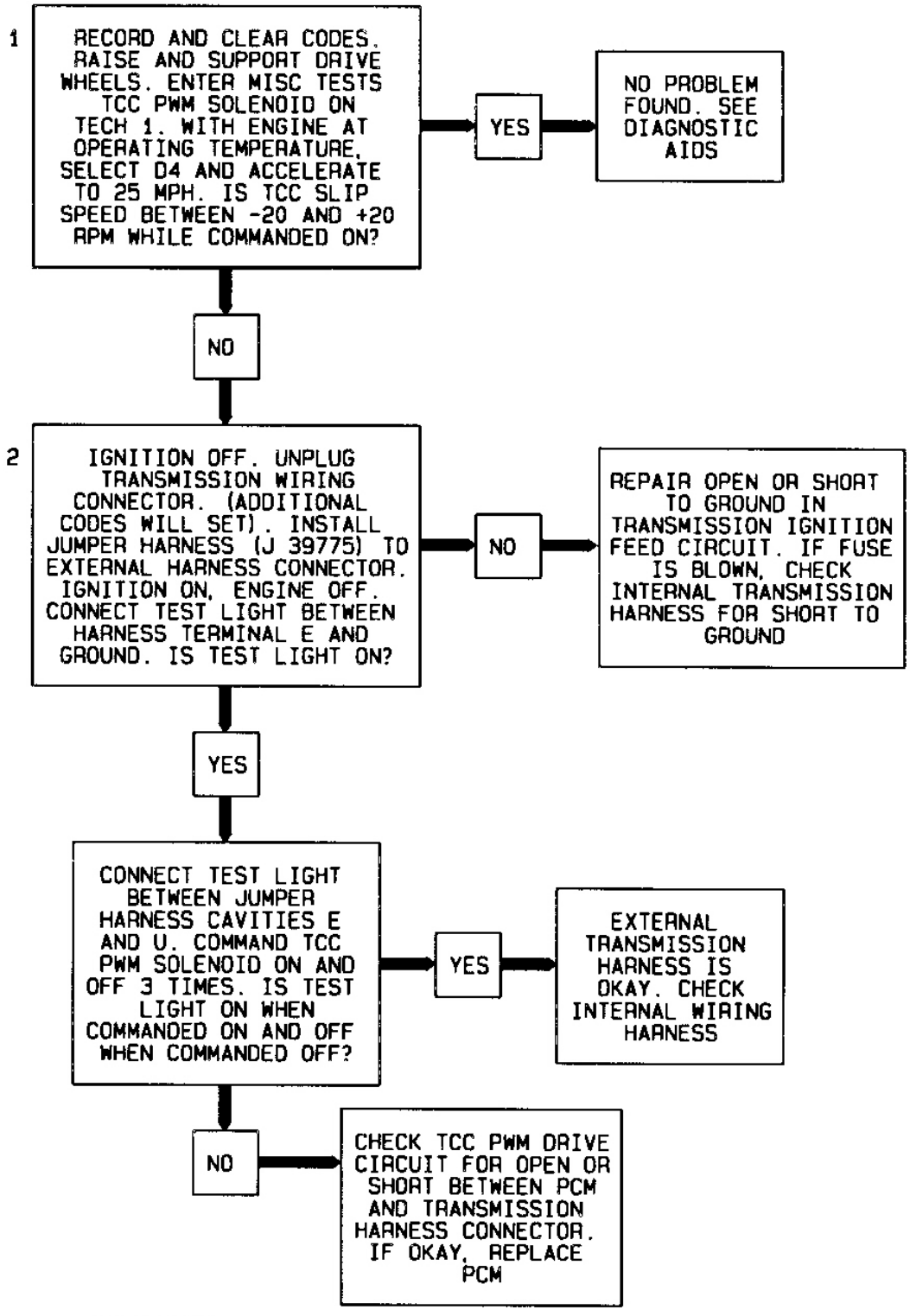
NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks if PCM is commanding TCC solenoid on.
2. Checks for voltage to solenoid.

Diagnostic Aids

Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connections or damaged harness.

Perform intermittent check by monitoring circuit and code status while wiggling related wiring and connectors. If failure is induced, monitored circuit status will change rapidly and/or related code will set.


1
RECORD AND CLEAR CODES. RAISE AND SUPPORT DRIVE WHEELS. ENTER MISC TESTS TCC PWM SOLENOID ON TECH 1. WITH ENGINE AT OPERATING TEMPERATURE, SELECT D4 AND ACCELERATE TO 25 MPH. IS TCC SLIP SPEED BETWEEN -20 AND +20 RPM WHILE COMMANDED ON?
YES
NO PROBLEM FOUND. SEE DIAGNOSTIC AIDS
NO
2
IGNITION OFF. UNPLUG TRANSMISSION WIRING CONNECTOR. (ADDITIONAL CODES WILL SET). INSTALL JUMPER HARNESS (J 39775) TO EXTERNAL HARNESS CONNECTOR. IGNITION ON, ENGINE OFF. CONNECT TEST LIGHT BETWEEN HARNESS TERMINAL E AND GROUND. IS TEST LIGHT ON?
NO
REPAIR OPEN OR SHORT TO GROUND IN TRANSMISSION IGNITION FEED CIRCUIT. IF FUSE IS BLOWN, CHECK INTERNAL TRANSMISSION HARNESS FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN JUMPER HARNESS CAVITIES E AND U. COMMAND TCC PWM SOLENOID ON AND OFF 3 TIMES. IS TEST LIGHT ON WHEN COMMANDED ON AND OFF WHEN COMMANDED OFF?
YES
EXTERNAL TRANSMISSION HARNESS IS OKAY. CHECK INTERNAL WIRING HARNESS
NO
CHECK TCC PWM DRIVE CIRCUIT FOR OPEN OR SHORT BETWEEN PCM AND TRANSMISSION HARNESS CONNECTOR. IF OKAY, REPLACE PCM

95D14350

Fig. 82: Code 83, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 84, 3-2 CONTROL SOLENOID - 4.3L & 5.7L "B/D/F/Y" BODIES

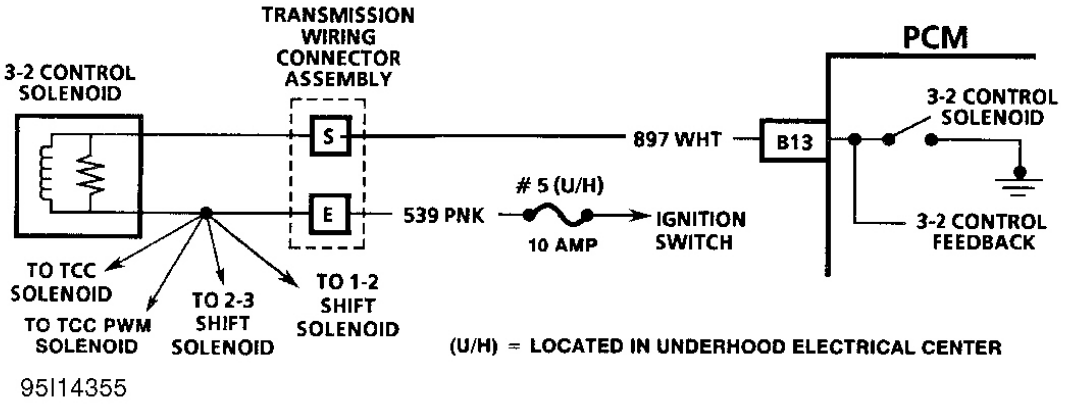


Fig. 83: Code 84, Circuit Diagram (4.3L & 5.7L B Body) Courtesy of General Motors Corp.

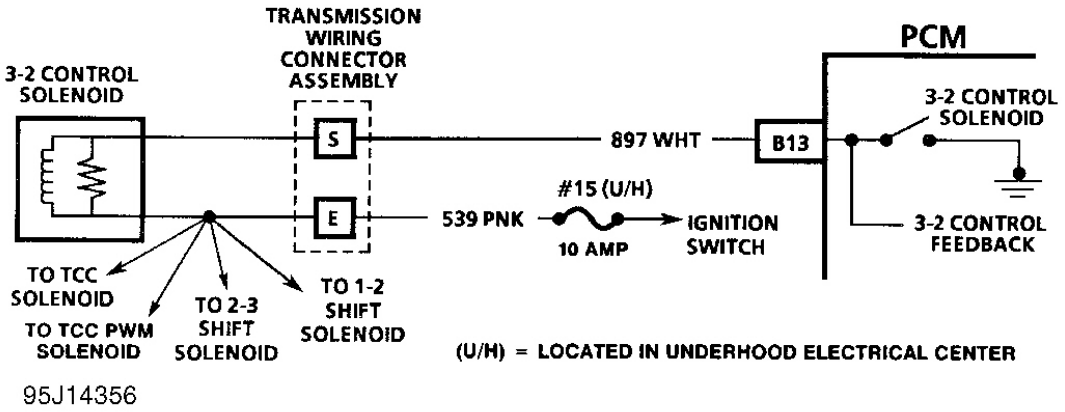


Fig. 84: Code 84, Circuit Diagram (5.7L D Body) Courtesy of General Motors Corp.

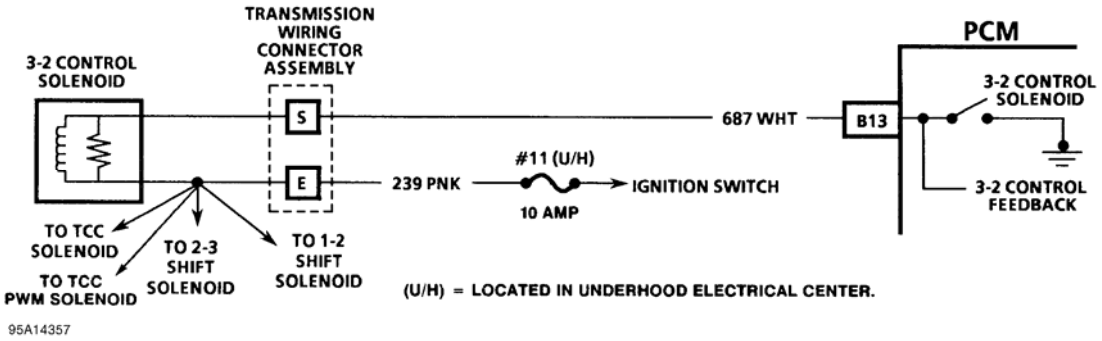


Fig. 85: Code 84, Circuit Diagram (5.7L F Body) Courtesy of General Motors Corp.

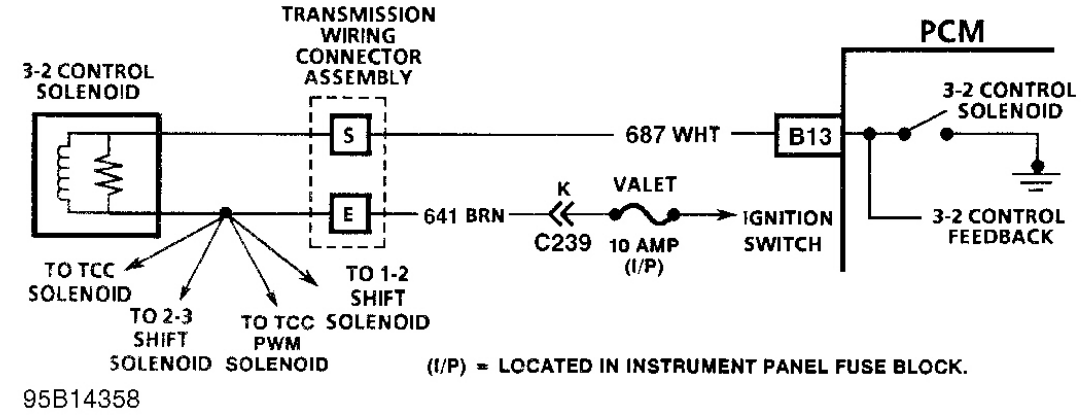


Fig. 86: Code 84, Circuit Diagram (5.7L Y Body) Courtesy of General Motors Corp.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks 3-2 shift solenoid and internal transmission harness for shorts.
2. Checks for power to 3-2 shift solenoid from ignition through the fuse.

Diagnostic Aids

Check all connections at the transmission. An open in ignition feed circuit can cause multiple codes to set.

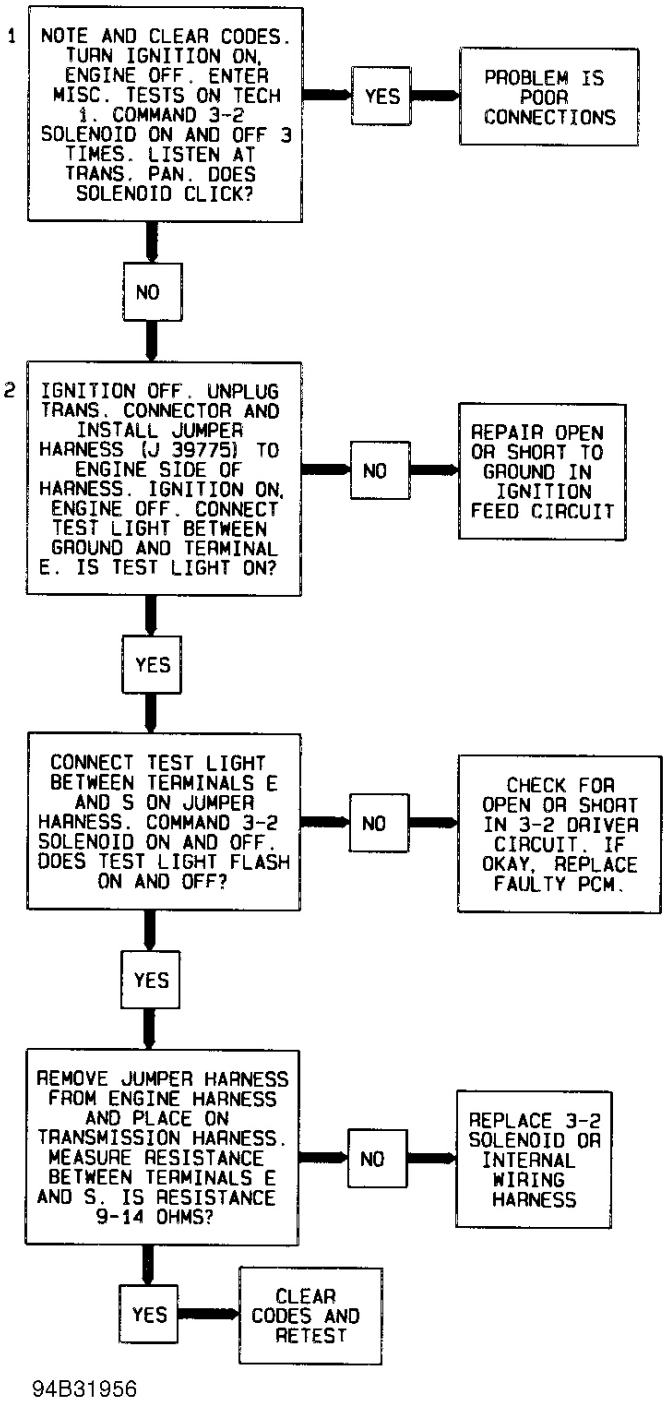


Fig. 87: Code 84, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 85, TCC STUCK ON - 4.3L & 5.7L "B", "D", "F" & "Y" BODIES

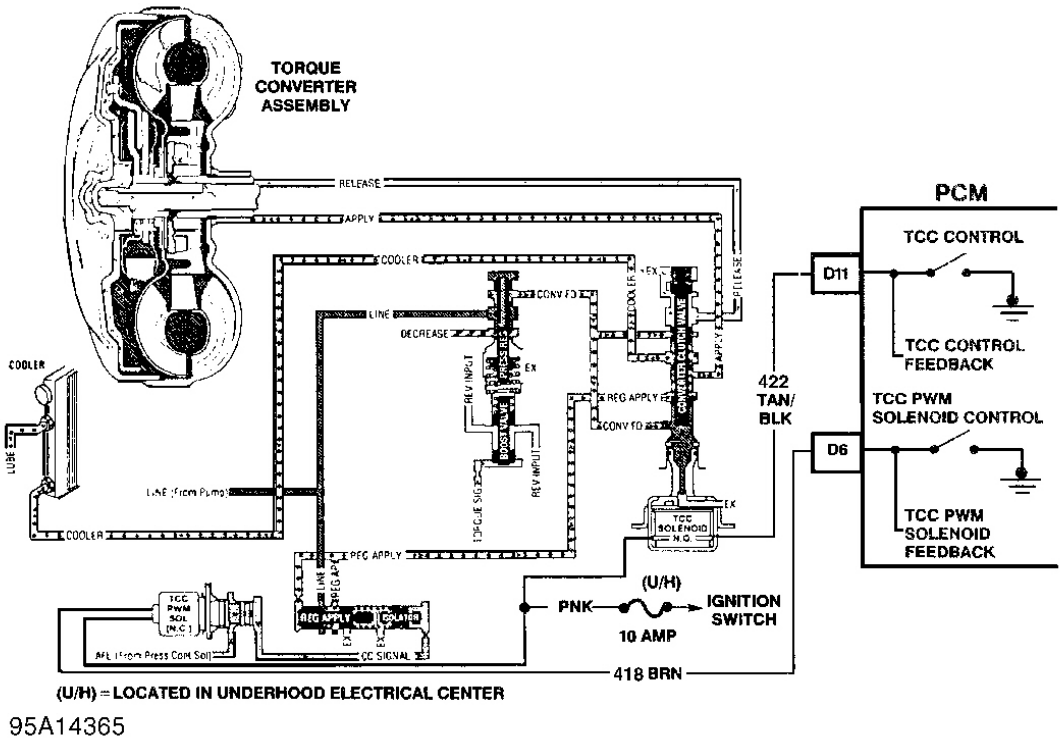


Fig. 88: Code 85, Circuit Diagram (Cars) Courtesy of General Motors Corp.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks mechanical state of TCC when PCM commands TCC solenoid off. TCC slip speed should increase.

Diagnostic Aids

Check for proper TP sensor operation. If TCC is mechanically stuck on, vehicle speed is zero, brakes are applied, and D2 is selected, TCC fluid will mechanically apply the TCC, causing an engine stall.

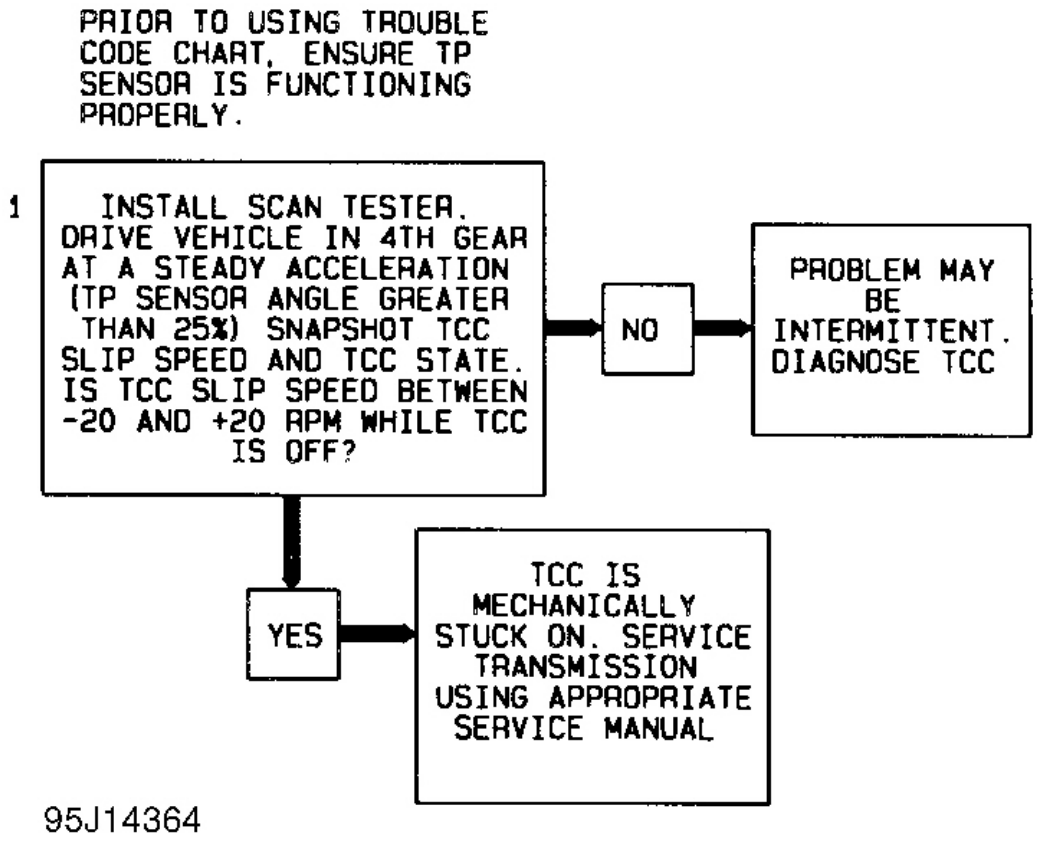


Fig. 89: Code 85, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 90, TCC SOLENOID CIRCUIT - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES

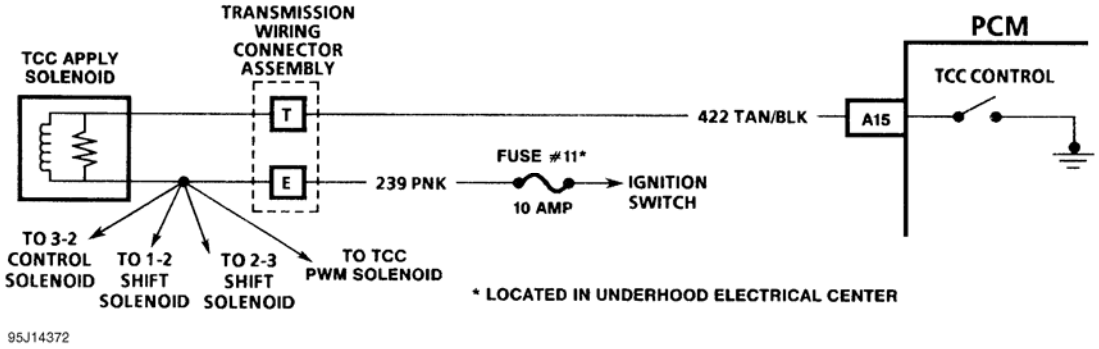


Fig. 90: Code 90, Circuit Diagram (3.4L F Body) Courtesy of General Motors Corp.

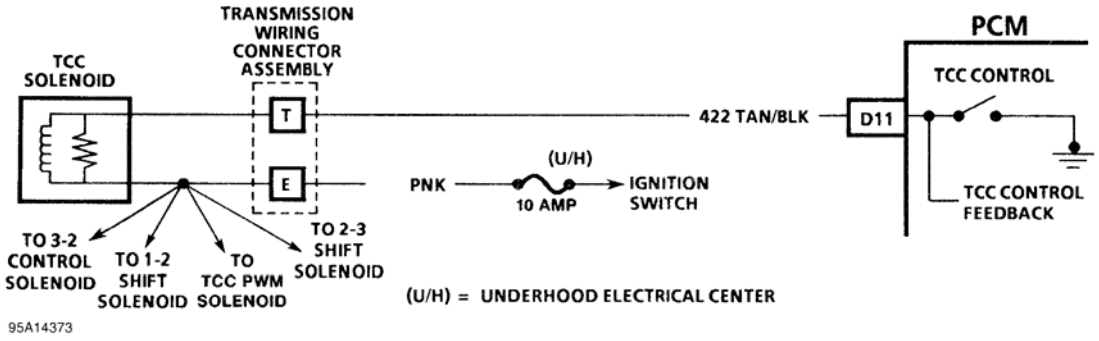


Fig. 91: Code 90, Circuit Diagram (4.3L & 5.7L B, D, F & Y Bodies) Courtesy of General Motors Corp.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for a shorted internal transmission harness or TCC solenoid.
2. Checks power supply to TCC solenoid.

Diagnostic Aids

Check all connections to transmission pass-through connector. An open in the ignition feed circuit will cause multiple codes to set.

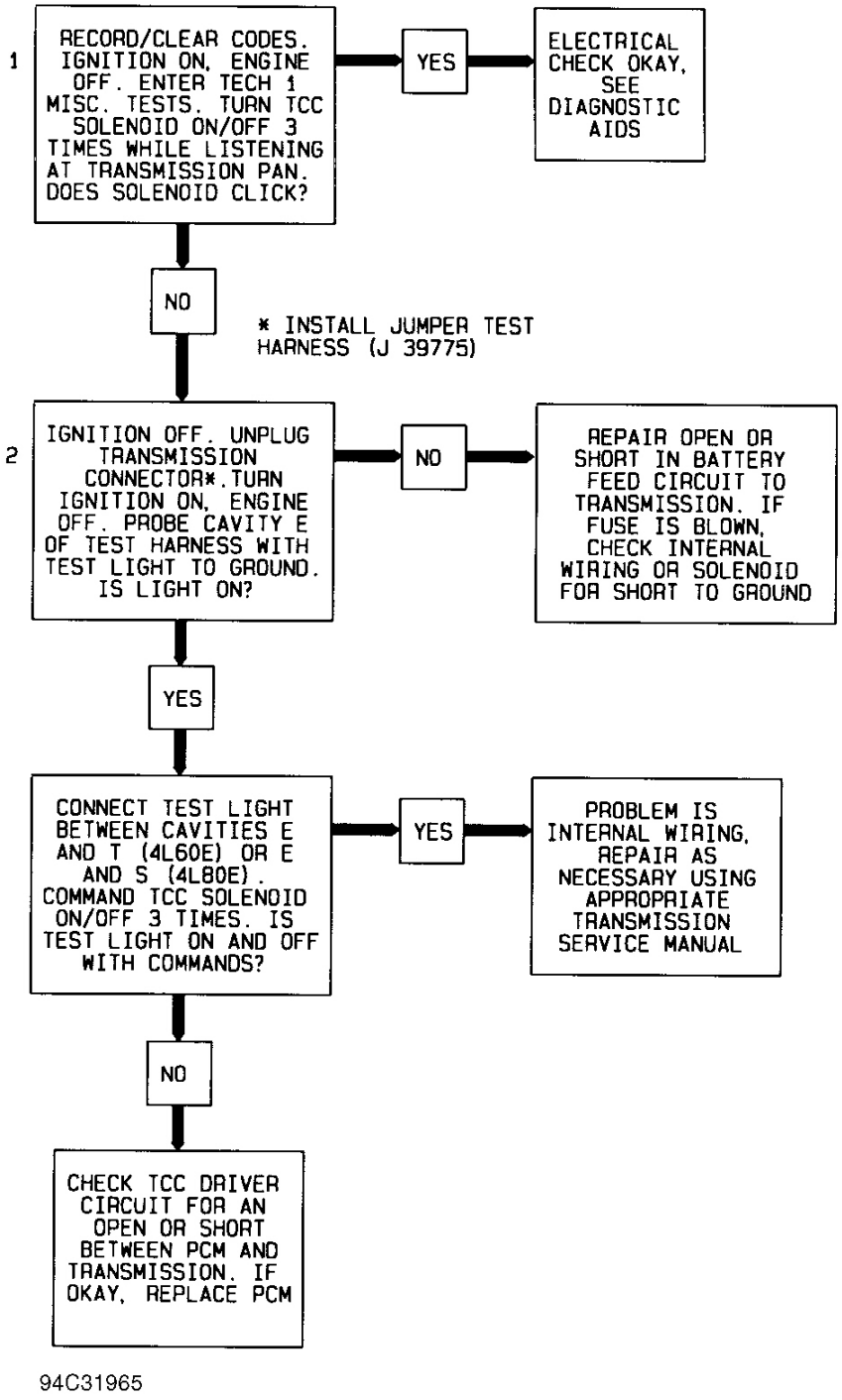


Fig. 92: Code 90, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 93, PRESSURE CONTROL SOLENOID - 3.4L "F" BODY

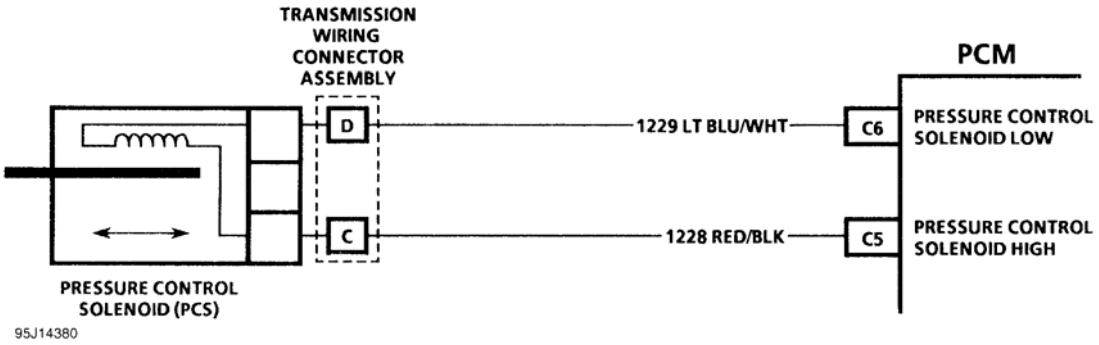


Fig. 93: Code 93, Circuit Diagram (Cars) Courtesy of General Motors Corp.

Pressure control solenoid is a PCM-controlled device used to regulate transmission line pressure. PCM compares TPS voltage, engine RPM and other inputs to determine proper line pressure for a given load. PCM regulates pressure by applying a varying amperage to pressure control solenoid. Amperage varies from 0.1 to 1.1 amps.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks ability of PCM to command pressure control solenoid.
2. Checks for voltage at PCM.

Diagnostic Aids

Check for poor connections at PCM and at transmission connector.

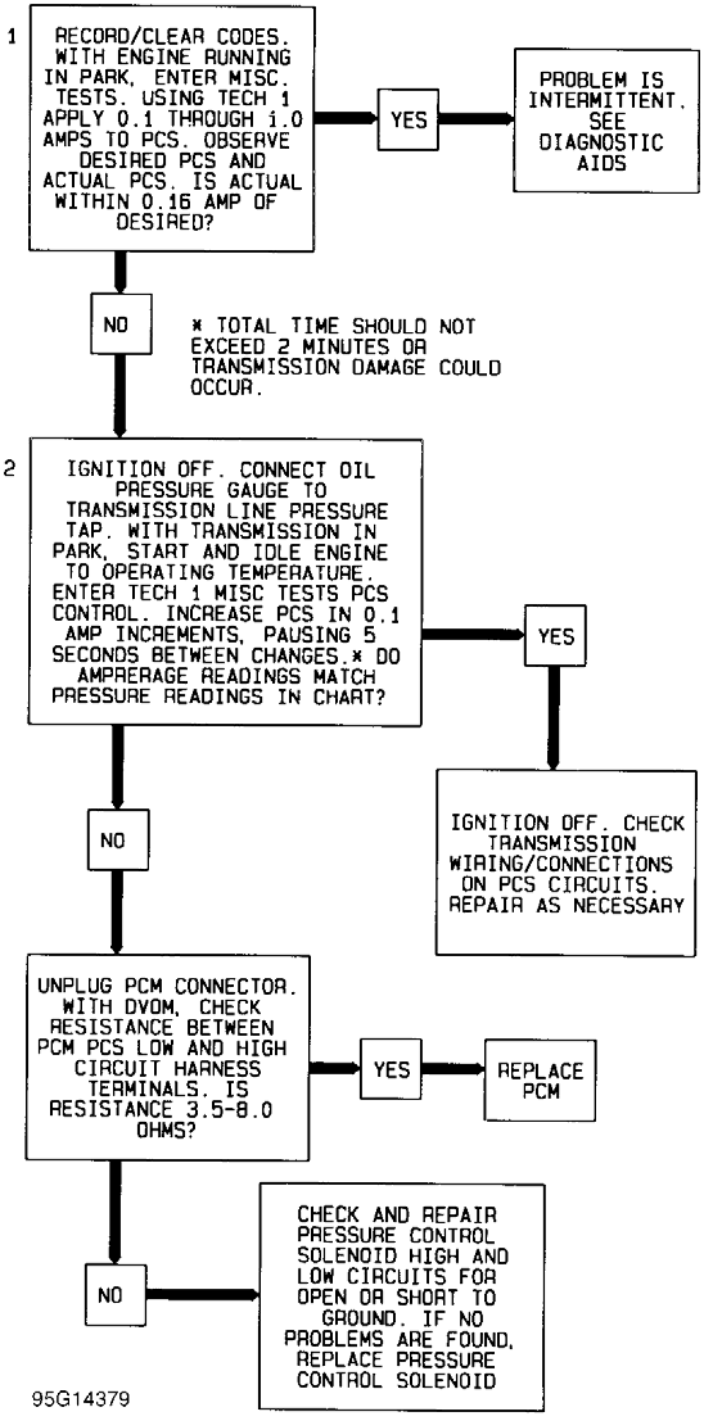


Fig. 94: Code 93, Flow Chart (Cars) Courtesy of General Motors Corp.

CODE 96, TRANSMISSION VOLTAGE LOW - 3.4L "F" BODY

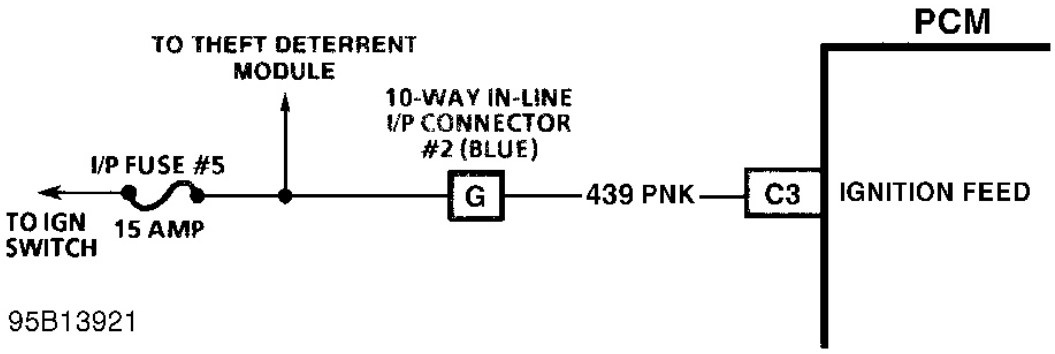


Fig. 95: Code 96, Circuit Diagram (Cars) Courtesy of General Motors Corp.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for normal battery voltage of 9-15 volts.
2. Checks if low voltage is due to generator voltage supply circuit, or PCM. If voltage is less than 9 volts, PCM is okay.

Diagnostic Aids

If code sets when an accessory is operated, check for poor connections or excessive current draw. Also, check for poor connections at starter solenoid or fusible link.

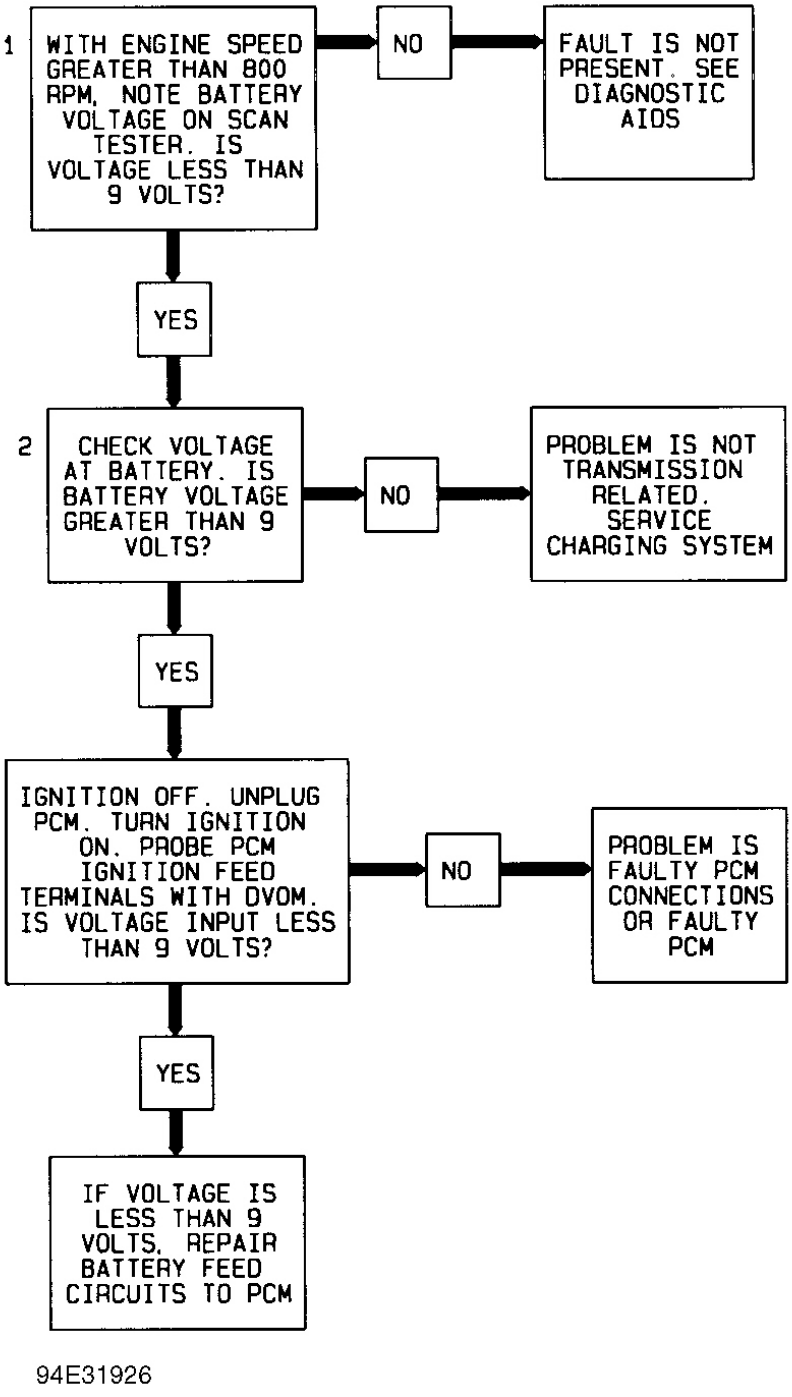


Fig. 96: Code 96, Flow Chart (Cars) Courtesy of General Motors Corp.

DIAGNOSTIC CHARTS - LIGHT TRUCKS & VANS - GASOLINE EXCEPT "S" & "T" SERIES 4.3L VIN W

INTRODUCTION

Diagnostic Charts

Following charts are DTC specific. For terminal locations, see **WIRING DIAGRAMS**. For engine-related DTCs, see appropriate TESTS W/CODES article in ENGINE PERFORMANCE section.

Diagnostic Aids

Diagnostic aids located in many trouble code charts are additional tips used to help diagnose trouble codes when circuit checks do not find a problem.

NOTE: In following diagnostic tests, schematics and illustrations are courtesy of General Motors Corp. Powertrain Control Module (PCM) may also be referred to as Electronic Control Module (ECM) or Transmission Control Module (TCM) in some diagnostic charts and figures. Terms are used interchangeably.

CODE 14, COOLANT TEMPERATURE SENSOR SIGNAL VOLTAGE LOW

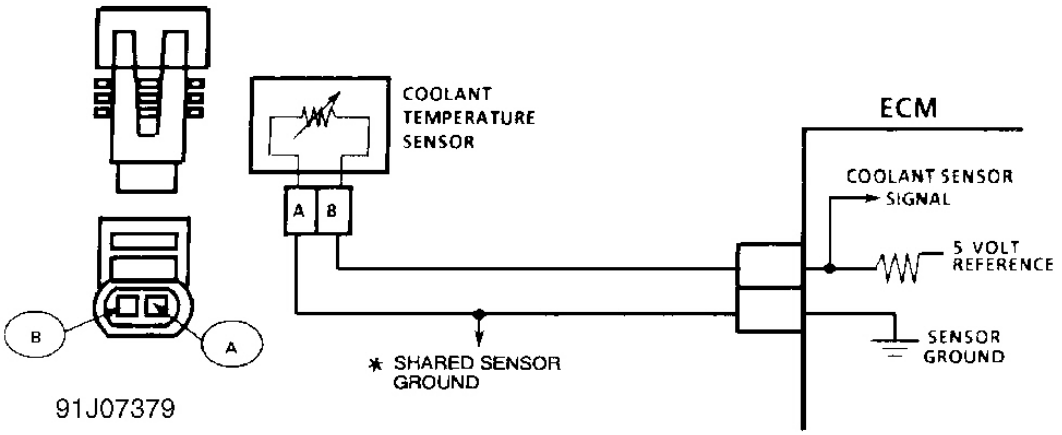


Fig. 97: Code 14, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

CODE 14 TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM/PCM Terminal	Wire Color
"C" & "K" Series 4.3L, 5.0L & 5.7L		
ECT Sensor Signal	B8	Yellow
ECT Sensor Ground	B3	Black
"G" Series 4.3L, 5.0L & 5.7L		
ECT Sensor Signal	B8	Yellow
ECT Sensor Ground	B3	Black

"L" & "M" Series 4.3L		
ECT Sensor Signal	B8	Yellow
ECT Sensor Ground	B3	Black
"S" & "T" Series 2.2L, 4.3L (VIN Z) Pickup & 4.3L (VIN W) Pickup & Utility		
ECT Sensor Signal	B8	Yellow
ECT Sensor Ground	B3	Black

Coolant temperature sensor input is used to determine control of fuel delivery, engine timing, idle speed and converter clutch (TCC) application. As engine warms, sensor resistance reduces. At normal operating temperature, voltage signal will be about 1.5-2.0 volts at coolant sensor signal terminal.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This tests if code was set because of a hard failure or intermittent condition.
2. This simulates conditions for a Code 15. If scan tester displays a low temperature, control module and wiring are not at fault.

Diagnostic Aids

After engine is started, temperature should rise steadily to about 194°F (90°C), then stabilize when thermostat opens. Test sensor at various temperature levels to determine if sensor is out of calibration. See **TEMPERATURE-TO-RESISTANCE VALUES** chart. If engine is allowed to cool overnight, coolant temperature sensor and intake air temperature sensor (if equipped) should read close to each other, when measured with a scan tester.

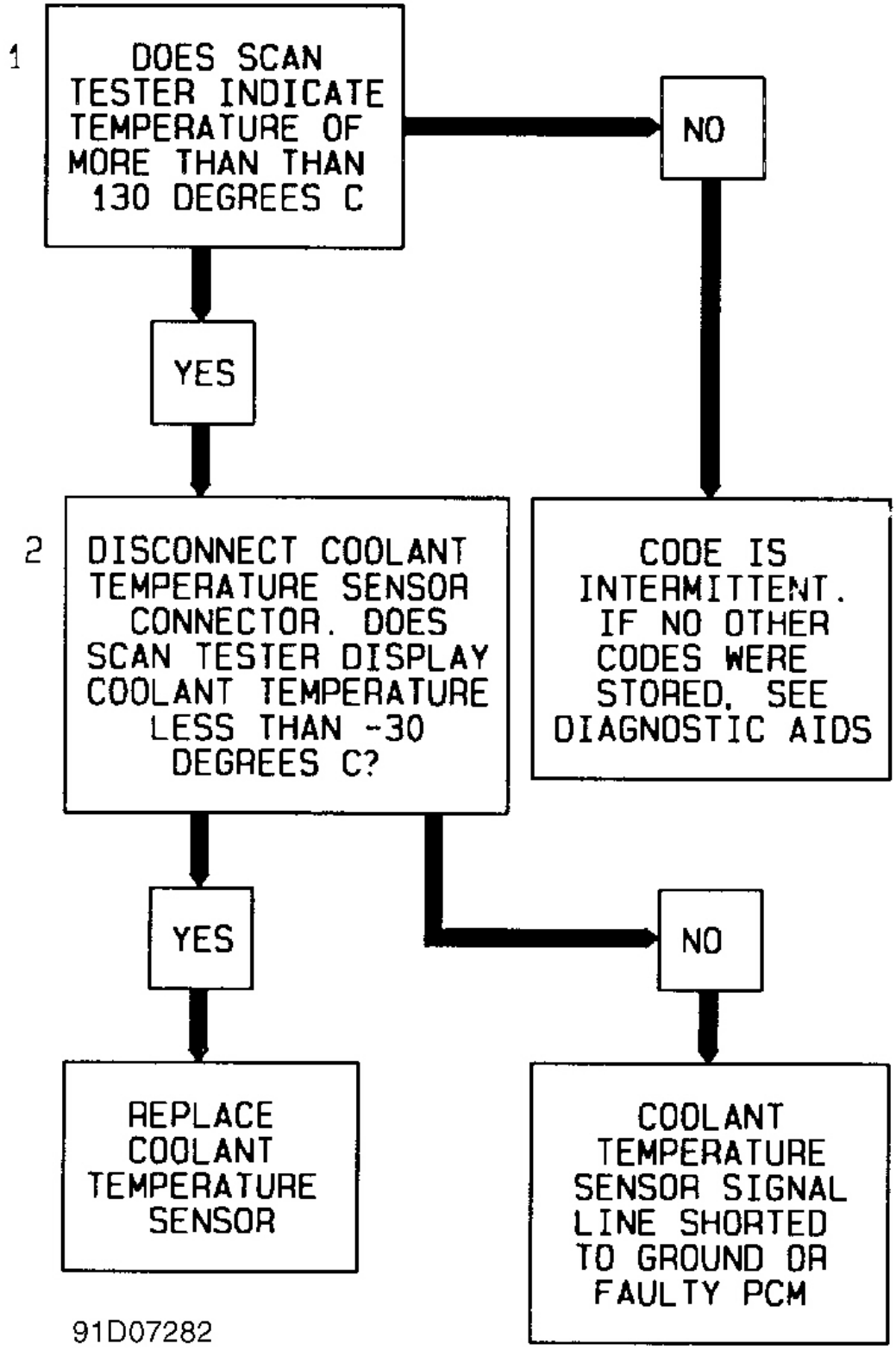

1
DOES SCAN TESTER INDICATE TEMPERATURE OF MORE THAN THAN 130 DEGREES C
NO
YES
2
DISCONNECT COOLANT TEMPERATURE SENSOR CONNECTOR. DOES SCAN TESTER DISPLAY COOLANT TEMPERATURE LESS THAN -30 DEGREES C?
CODE IS INTERMITTENT. IF NO OTHER CODES WERE STORED, SEE DIAGNOSTIC AIDS
YES
NO
REPLACE COOLANT TEMPERATURE SENSOR
COOLANT TEMPERATURE SENSOR SIGNAL LINE SHORTED TO GROUND OR FAULTY PCM
91D07282

Fig. 98: Code 14, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	(1) (2) Ohms
210 (100)	177
160 (70)	450
100 (38)	1800
70 (20)	3400
40 (4)	7500
20 (-7)	13,500
0 (-18)	25,000
-40 (-40)	100,700
(1) Measure resistance across sensor terminals.	
(2) Values are approximates.	

CODE 15, COOLANT TEMPERATURE SENSOR SIGNAL VOLTAGE HIGH

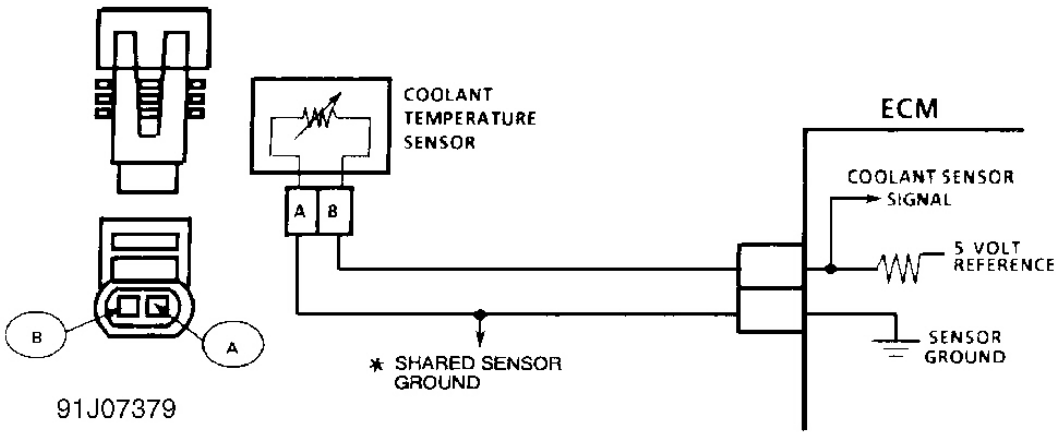


Fig. 99: Code 15, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

CODE 15 TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM/PCM Terminal	Wire Color
"C" & "K" Series		
4.3L, 5.0L & 5.7L		
ECT Sensor Signal	B8	Yellow
ECT Sensor Ground	B3	Black
"G" Series		
4.3L, 5.0L & 5.7L		

ECT Sensor Signal	B8	Yellow
ECT Sensor Ground	B3	Black
"L" & "M" Series		
4.3L		
ECT Sensor Signal	B8	Yellow
ECT Sensor Ground	B3	Black
"S" & "T" Series		
2.2L, 4.3L (VIN Z) Pickup & 4.3L (VIN W) Pickup & Utility		
ECT Sensor Signal	B8	Yellow
ECT Sensor Ground	B3	Black

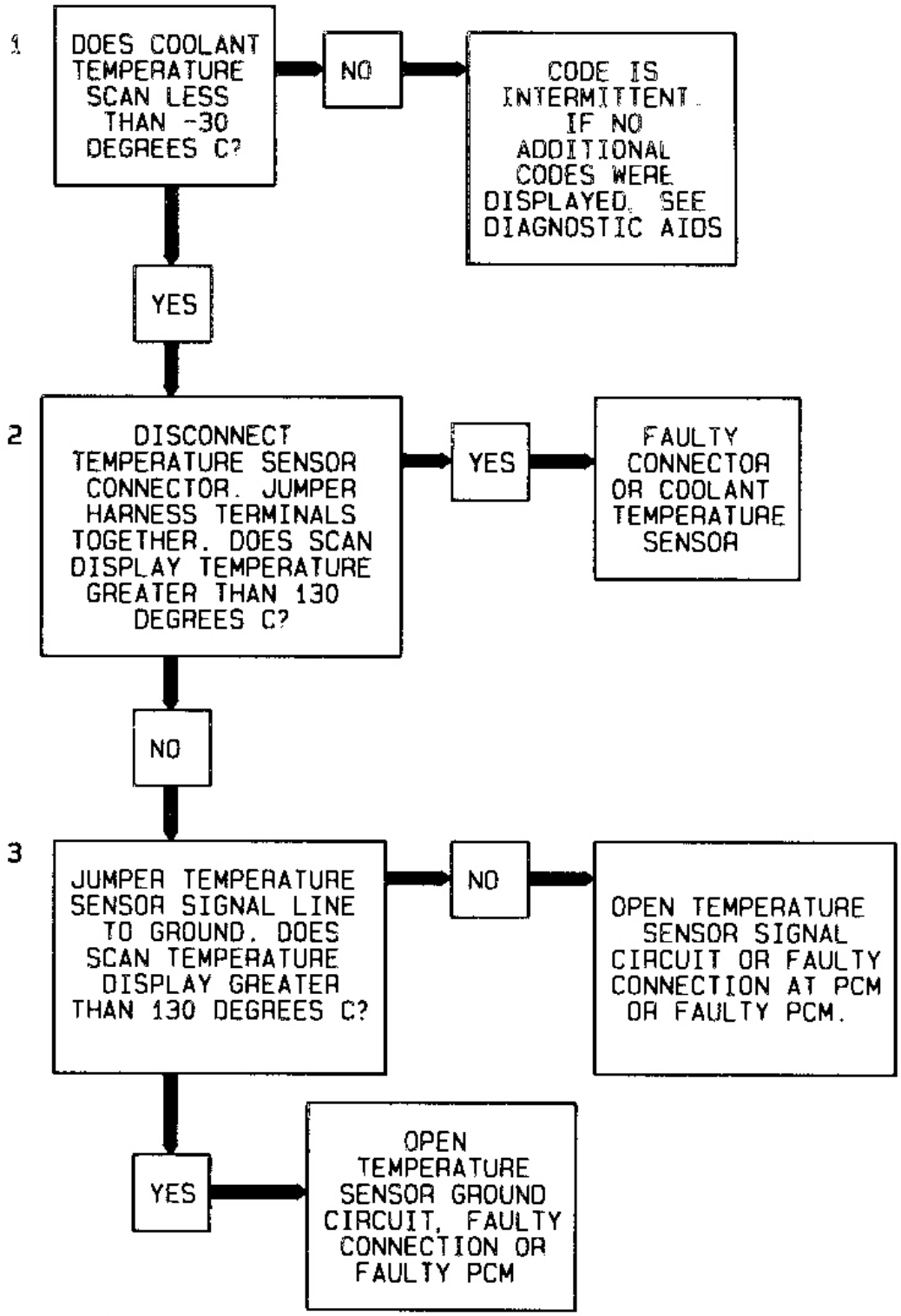
As engine warms, sensor resistance reduces and voltage drops. At normal operating temperature, voltage signal will be about 1.5-2.0 volts at control module coolant sensor signal terminal. If sensor signal circuit opens, control module will see -56°F (-49°C) and deliver fuel for this temperature.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This checks if code was set as a result of a hard failure or intermittent condition.
2. This simulates conditions for a Code 14. If control module recognizes grounded circuit and displays a high temperature, control module and wiring are okay.
3. This determines if problem is control module or wiring. There should be 5 volts present at sensor when measured with a DVOM.

Diagnostic Aids

After engine starts, temperature should rise steadily to about 194°F (90°C) and stabilize when thermostat opens. Test sensor at various temperature levels to determine if sensor is out of calibration. See the **TEMPERATURE-TO-RESISTANCE VALUES** chart. If engine is allowed to cool overnight, coolant temperature sensor and intake air temperature sensor (if equipped) should read close to each other when measured with a scan tester. Code 15 will also set if sensor signal or ground circuit is open.


1
DOES COOLANT TEMPERATURE SCAN LESS THAN -30 DEGREES C?
NO
CODE IS INTERMITTENT. IF NO ADDITIONAL CODES WERE DISPLAYED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TEMPERATURE SENSOR CONNECTOR. JUMPER HARNESS TERMINALS TOGETHER. DOES SCAN DISPLAY TEMPERATURE GREATER THAN 130 DEGREES C?
YES
FAULTY CONNECTOR OR COOLANT TEMPERATURE SENSOR
NO
3
JUMPER TEMPERATURE SENSOR SIGNAL LINE TO GROUND. DOES SCAN TEMPERATURE DISPLAY GREATER THAN 130 DEGREES C?
NO
OPEN TEMPERATURE SENSOR SIGNAL CIRCUIT OR FAULTY CONNECTION AT PCM OR FAULTY PCM.
YES
OPEN TEMPERATURE SENSOR GROUND CIRCUIT, FAULTY CONNECTION OR FAULTY PCM

91F07283

Fig. 100: Code 15, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	(1) (2) Ohms
210 (100)	177
160 (70)	450
100 (38)	1800
70 (20)	3400
40 (4)	7500
20 (-7)	13,500
0 (-18)	25,000
-40 (-40)	100,700

(1) Measure resistance across sensor terminals.

(2) Values are approximates.

CODE 21, TPS SIGNAL VOLTAGE HIGH

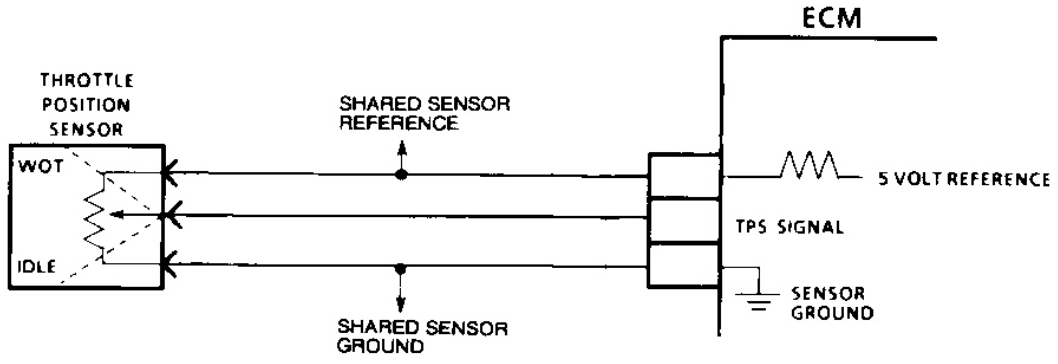


Fig. 101: Code 21, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

CODE 21 TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM/PCM Terminal	Wire Color
"C" & "K" Series		
4.3L, 5.0L & 5.7L		
TP Sensor Signal	A15	Dark Blue
TP Sensor Ground	B3	Black
TP Sensor Reference	F14	Gray
"G" Series		

4.3L, 5.0L & 5.7L		
TP Sensor Signal	A15	Dark Blue
TP Sensor Ground	B3	Black
TP Sensor Reference	F14	Gray
"L" & "M" Series		
4.3L		
TP Sensor Signal	A15	Dark Blue
TP Sensor Ground	B3	Black
TP Sensor Reference	F14	Gray
"S" & "T" Series		
2.2L, 4.3L (VIN Z) Pickup & 4.3L (VIN W) Pickup & Utility		
TP Sensor Signal	A15	Dark Blue
TP Sensor Ground	B3	Black
TP Sensor Reference	F14	Gray

Throttle Position Sensor (TPS) provides a varying voltage signal depending on throttle valve angle. Signal voltage varies from about .50 volt at idle to 4 volts at wide open throttle. Each time TPS voltage drops to less than 1.25 volts and stops, control module assumes this is zero degrees throttle angle and measures throttle percentage angle from this point.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test confirms Code 21 and checks if fault is a hard failure or an intermittent condition.
2. This test simulates conditions for Code 22. If control module recognizes low voltage signal and sets Code 22, control module and power and signal circuits are not at fault.
3. This step isolates a faulty sensor, control module or an open ground circuit.

Diagnostic Aids

A scan tester displays throttle position in volts. Closed throttle voltage should be less than 1.25 volts. TPS voltage should increase at a steady rate to about 4.5 volts as throttle angle increases. Code 21 will also result if ground circuit is open or TPS signal circuit is shorted to voltage.

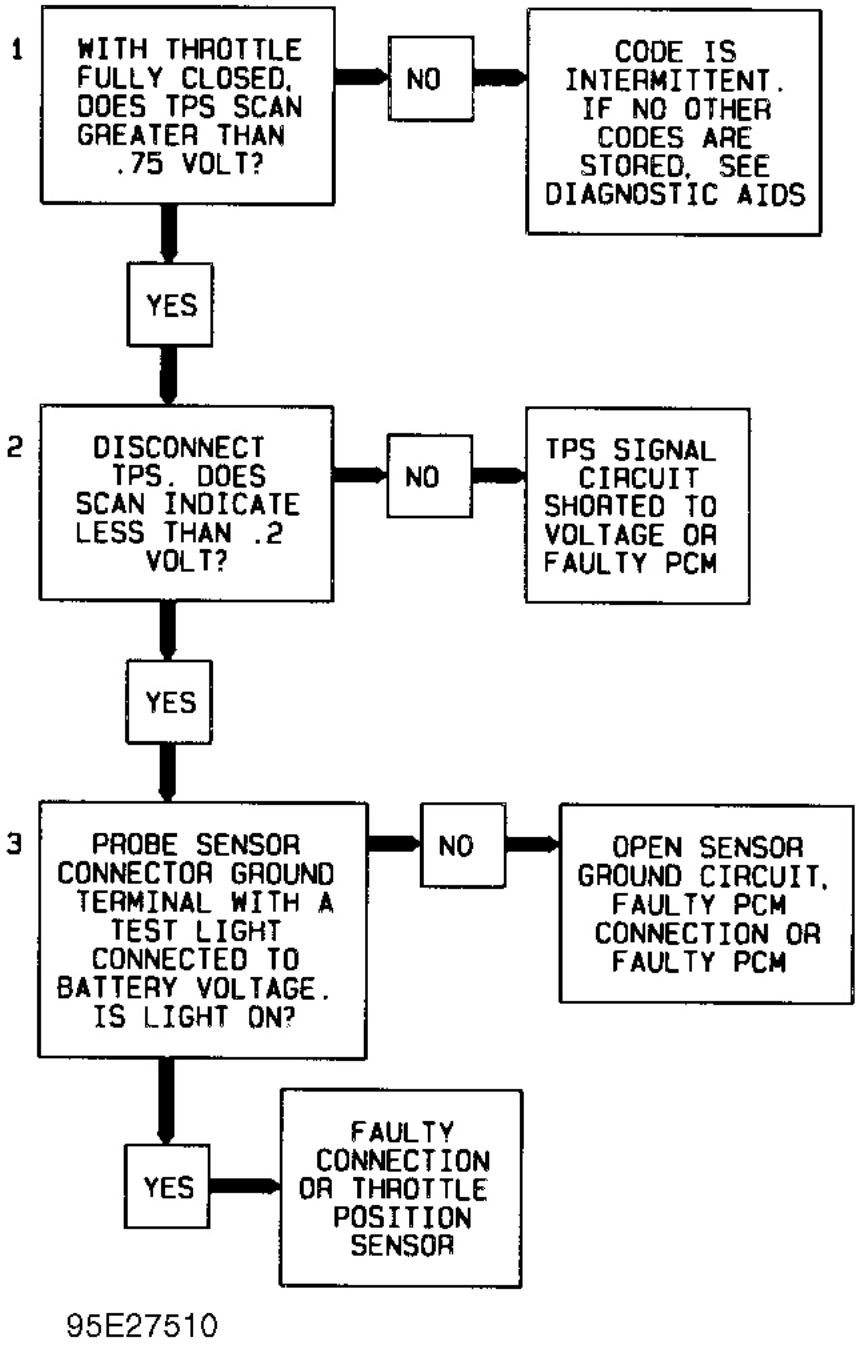


Fig. 102: Code 21, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 22, TPS SIGNAL VOLTAGE LOW

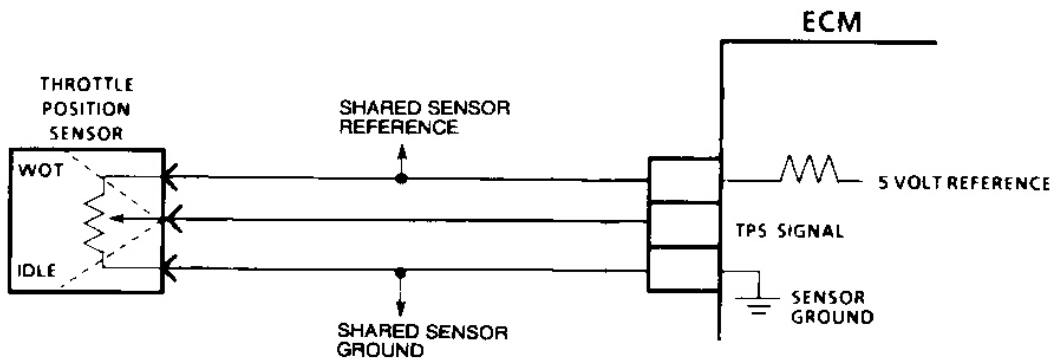


Fig. 103: Code 22, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

CODE 22 TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	ECM/PCM Terminal	Wire Color
"C" & "K" Series		
4.3L, 5.0L & 5.7L		
TP Sensor Signal	A15	Dark Blue
TP Sensor Ground	B3	Black
TP Sensor Reference	F14	Gray
"G" Series		
4.3L, 5.0L & 5.7L		
TP Sensor Signal	A15	Dark Blue
TP Sensor Ground	B3	Black
TP Sensor Reference	F14	Gray
"L" & "M" Series		
4.3L		
TP Sensor Signal	A15	Dark Blue
TP Sensor Ground	B3	Black
TP Sensor Reference	F14	Gray
"S" & "T" Series		
2.2L, 4.3L (VIN Z) Pickup & 4.3L (VIN W) Pickup & Utility		
TP Sensor Signal	A15	Dark Blue
TP Sensor Ground	B3	Black
TP Sensor Reference	F14	Gray

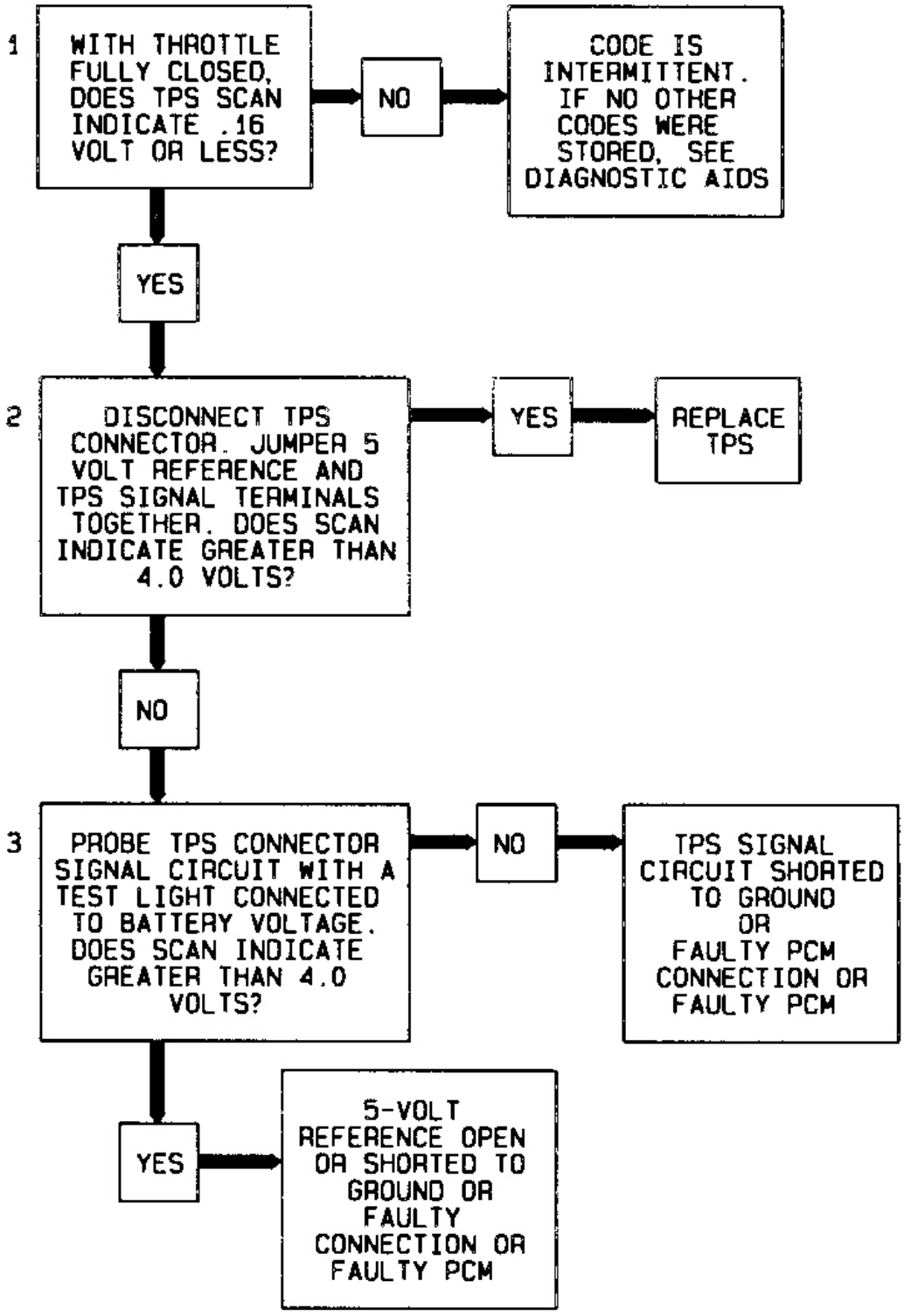
Throttle Position Sensor (TPS) provides a varying voltage signal depending on throttle valve angle. Signal voltage varies from less than about .50 volt at idle to 4 volts at wide open throttle.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test confirms Code 22 and tests if fault is a hard failure or an intermittent condition.
2. This simulates Code 21. If control module recognizes a high voltage signal and sets Code 21, control module and wiring are not at fault. Replace TPS.
3. This simulates a high voltage signal to check for on open TPS signal circuit.

Diagnostic Aids

A scan tester displays throttle position in volts. Closed throttle voltage should be less than 1.0 volt. TPS voltage should increase at a steady rate to about 4.5 volts as throttle angle increases. Code 22 will also set if TPS signal or ground circuits are open or grounded.


1
WITH THROTTLE FULLY CLOSED, DOES TPS SCAN INDICATE .16 VOLT OR LESS?
NO
CODE IS INTERMITTENT. IF NO OTHER CODES WERE STORED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TPS CONNECTOR. JUMPER 5 VOLT REFERENCE AND TPS SIGNAL TERMINALS TOGETHER. DOES SCAN INDICATE GREATER THAN 4.0 VOLTS?
YES
REPLACE TPS
NO
3
PROBE TPS CONNECTOR SIGNAL CIRCUIT WITH A TEST LIGHT CONNECTED TO BATTERY VOLTAGE. DOES SCAN INDICATE GREATER THAN 4.0 VOLTS?
NO
TPS SIGNAL CIRCUIT SHORTED TO GROUND OR FAULTY PCM CONNECTION OR FAULTY PCM
YES
5-VOLT REFERENCE OPEN OR SHORTED TO GROUND OR FAULTY CONNECTION OR FAULTY PCM

94I35111

Fig. 104: Code 22, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 24, VEHICLE SPEED SENSOR TRANSMISSION OUTPUT SIGNAL

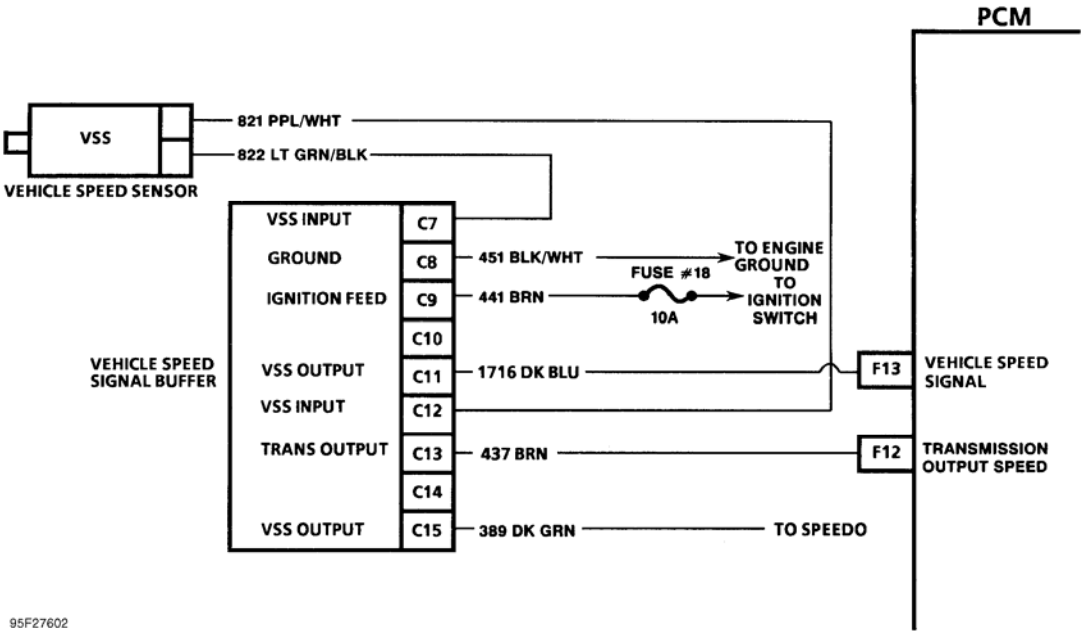


Fig. 105: Code 24, Circuit Diagram (C & K Series) Courtesy of General Motors Corp.

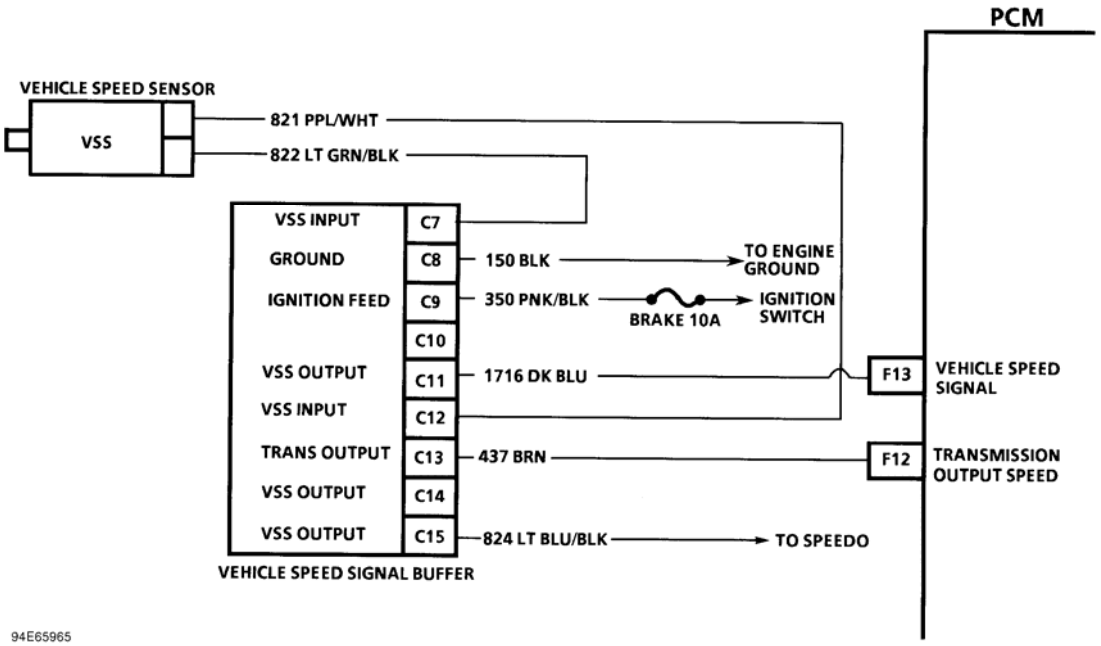


Fig. 106: Code 24, Circuit Diagram (G Series) Courtesy of General Motors Corp.

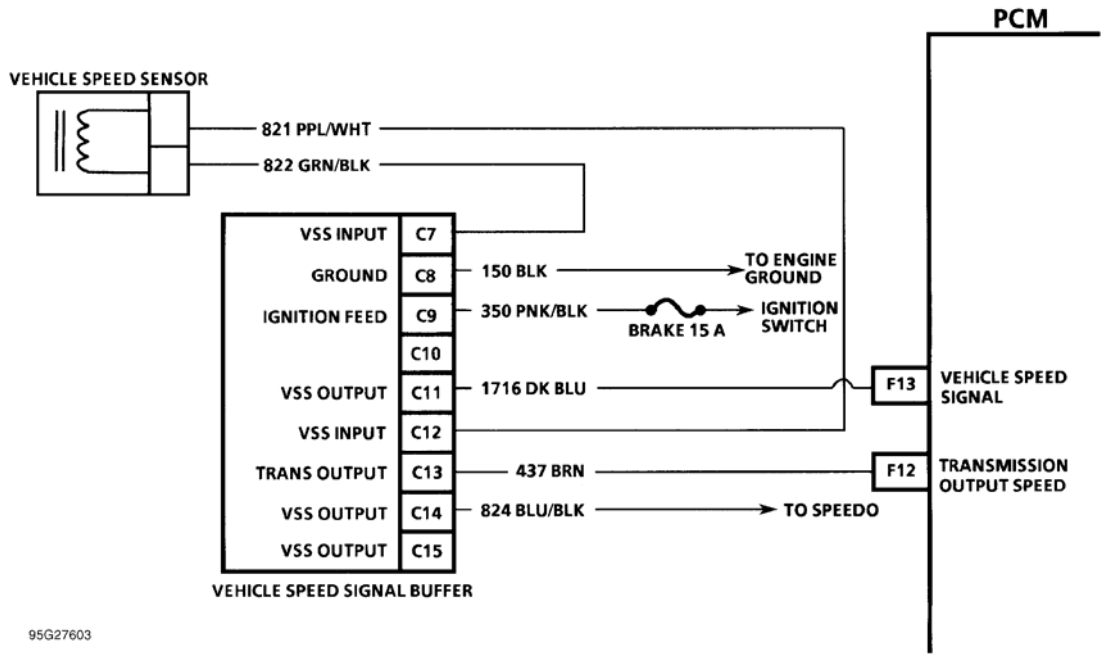


Fig. 107: Code 24, Circuit Diagram (L & M Series) Courtesy of General Motors Corp.

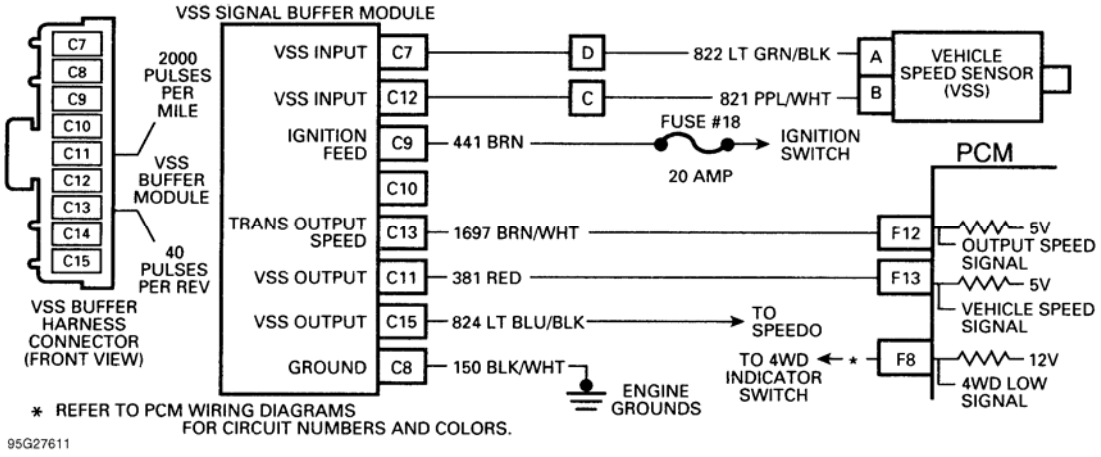


Fig. 108: Code 24, Circuit Diagram (S & T Series) Courtesy of General Motors Corp.

VSS output sensor is a magnetic induction type. Gear teeth pressed on outside diameter of output carrier assembly induce an alternating current in sensor when drive wheels are turning. Since vehicle speed is taken from transfer case on 4WD vehicles, output speed sensor signal on these units goes directly to control module. Code 24 will set if gear selector is not in Park or Neutral, engine speed is at least 3000 RPM and output speed is less than 250 RPM for at least 1.5 seconds.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Test verifies voltage at buffer module.
2. Test checks VSS buffer ground circuit.
3. Test checks VSS circuit at buffer module.
4. Test verifies VSS signal at from module.

Diagnostic Aids

Code 24 will set when no vehicle speed is detected at vehicle start off. Code 72 will set when VSS signal is present and is lost. Check all connections, especially those at transmission pass-through connector. While Code 24 is set, scan tester will display an RPM derived from input speed. If input speed sensor is not operational at start-up, this can cause VSS to read zero.

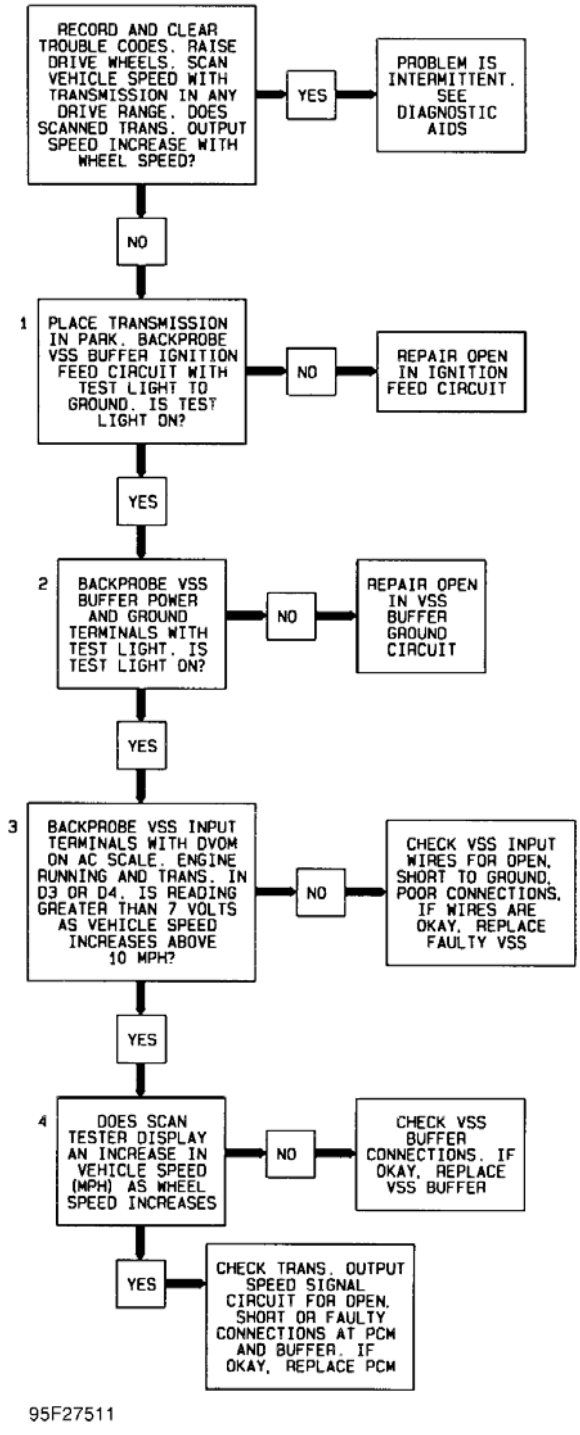


Fig. 109: Code 24, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 28, TRANS. RANGE PRESSURE SWITCH

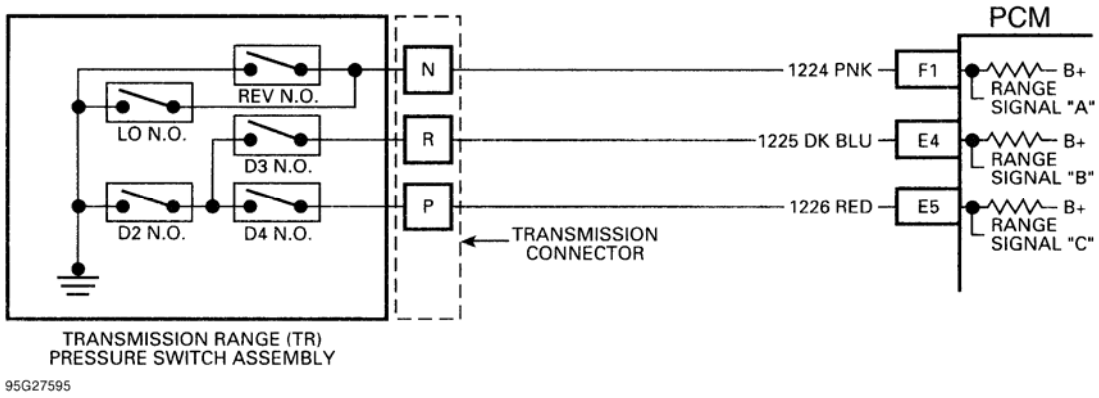


Fig. 110: Code 28, Circuit Diagram (C & K Series) Courtesy of General Motors Corp.

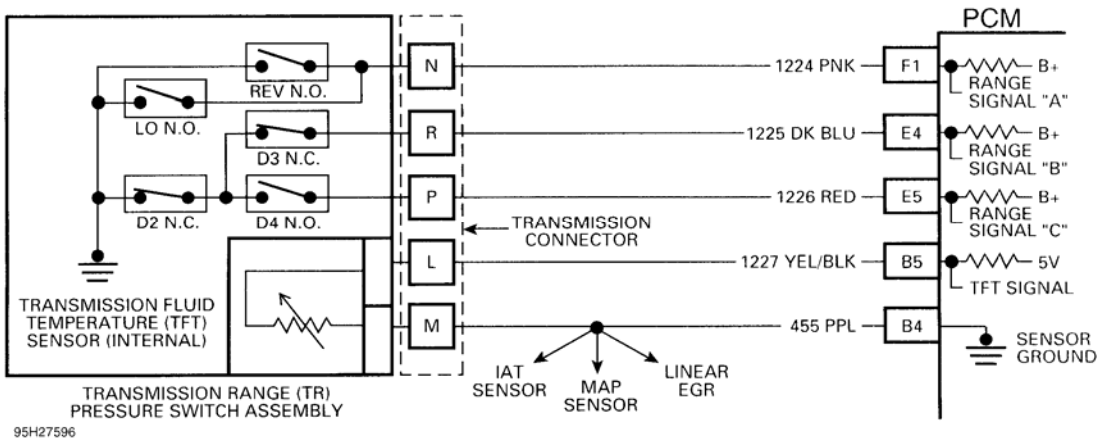


Fig. 111: Code 28, Circuit Diagram (G, L, M, S & T Series) Courtesy of General Motors Corp.

Transmission range pressure switch assembly consists of 5 pressure switches (2 normally closed, 3 normally open), and a fluid temperature sensor combined into one unit and mounted on valve body. Control module supplies voltage to each range signal. By grounding one or more of these circuits through various combinations of pressure switches, control module detects which manual valve position has been selected. With ignition on and engine off, Park/Neutral will be indicated. Code 28 will set when range signals "A" and "C" are both zero volts (on) for 2 seconds.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks indicated range signal to valve position signal actually selected.
2. Checks for correct voltage from control module to transmission external connector.
3. Checks for short to ground in any one of 3 valve position circuits.

Diagnostic Aids

Code will set if control module detects one of 2 illegal combinations. Check all connections for good contact. An intermittent may be caused by a poor connection, chaffed wire insulation or a broken wire. Monitor voltage of each terminal while moving related harness connectors. If failure is induced, voltage reading will change.

VALID PSM COMBINATION

Application	**A**	**B**	**C**
Park	Off	On	Off
Reverse	On	On	Off
Neutral	Off	On	Off
4th	Off	On	On
3rd	Off	Off	On
2nd	Off	Off	Off
1st	On	Off	Off
Illegal	On	Off	On
Illegal	On	On	On

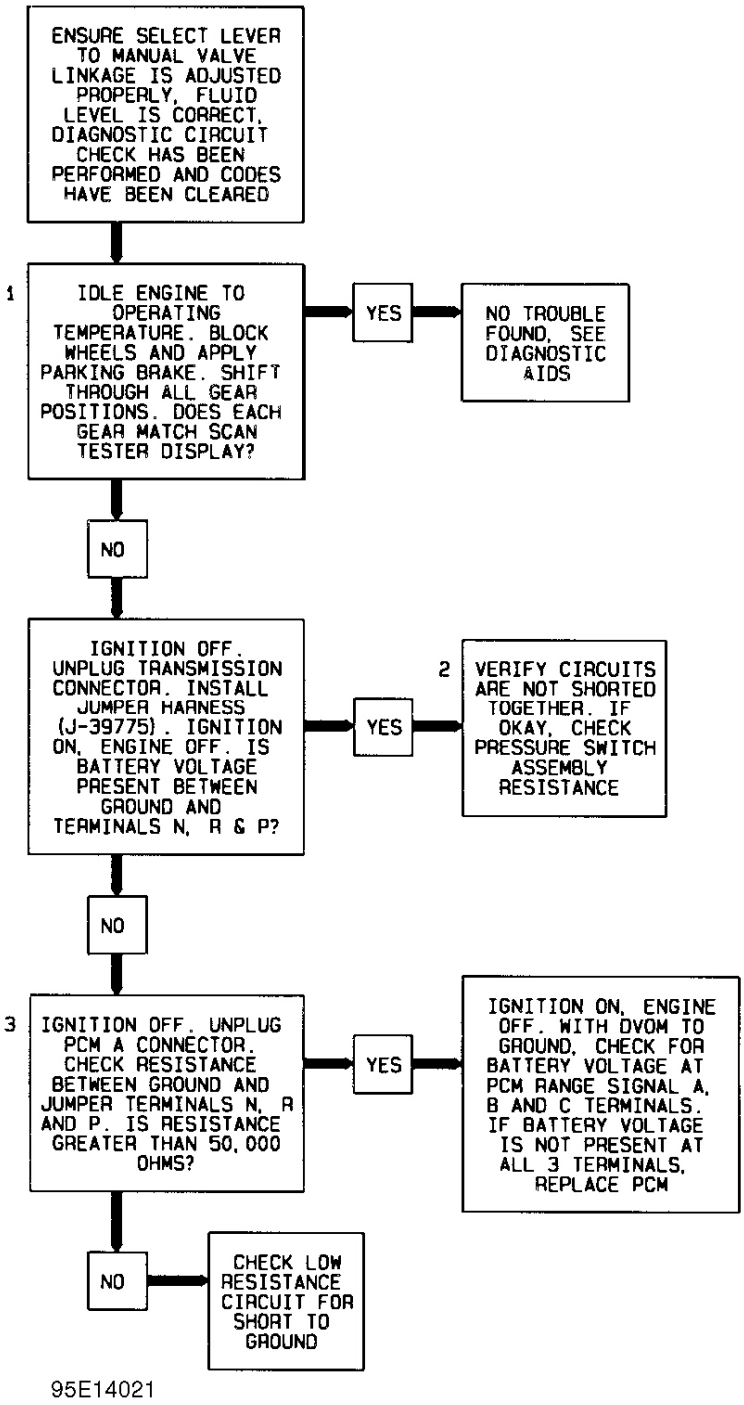


Fig. 112: Code 28, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODES 37/38, TCC BRAKE SWITCH ON/OFF

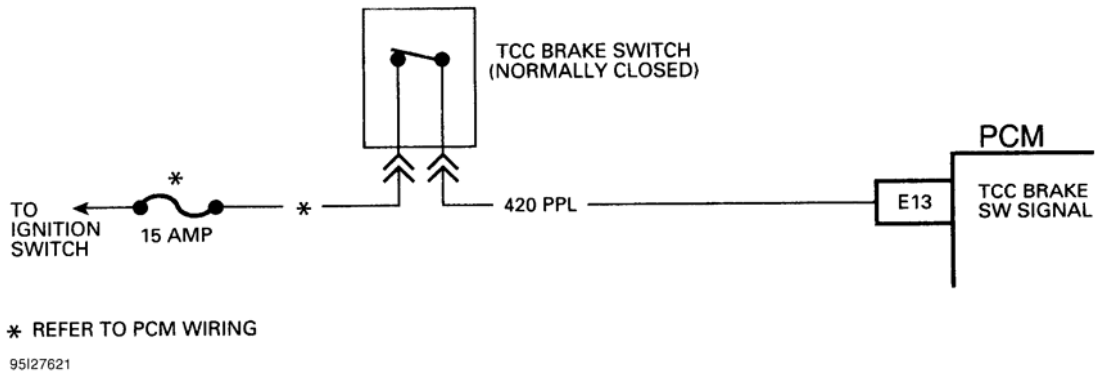


Fig. 113: Code 37/38, Circuit Diagram (C, G & K Series) Courtesy of General Motors Corp.

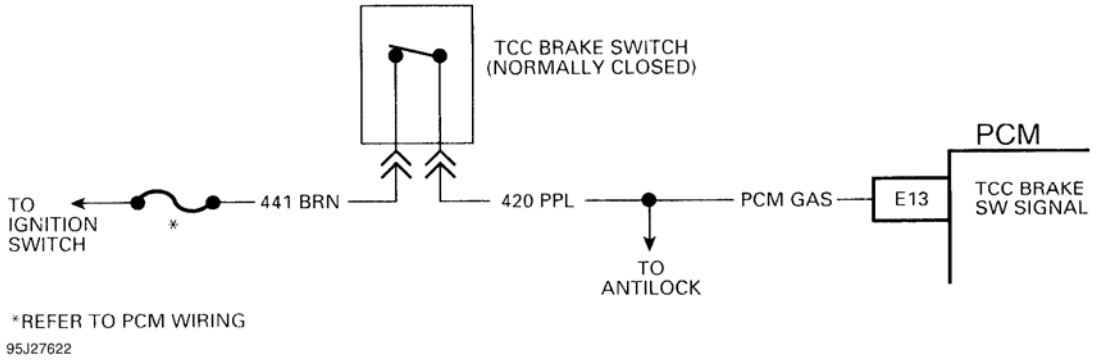


Fig. 114: Code 37/38, Circuit Diagram (L, M, S & T Series) Courtesy of General Motors Corp.

The normally closed brake switch supplies battery voltage to control module. Signal voltage will drop to zero volts when brake pedal is applied.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks if voltage is available at brake switch.
2. Checks brake switch function.
3. Checks circuit from brake switch to control module.

Diagnostic Aids

If code is intermittent, check customer driving habits (driving with foot resting on brake pedal) or for unusual traffic conditions (stop and go expressway traffic).

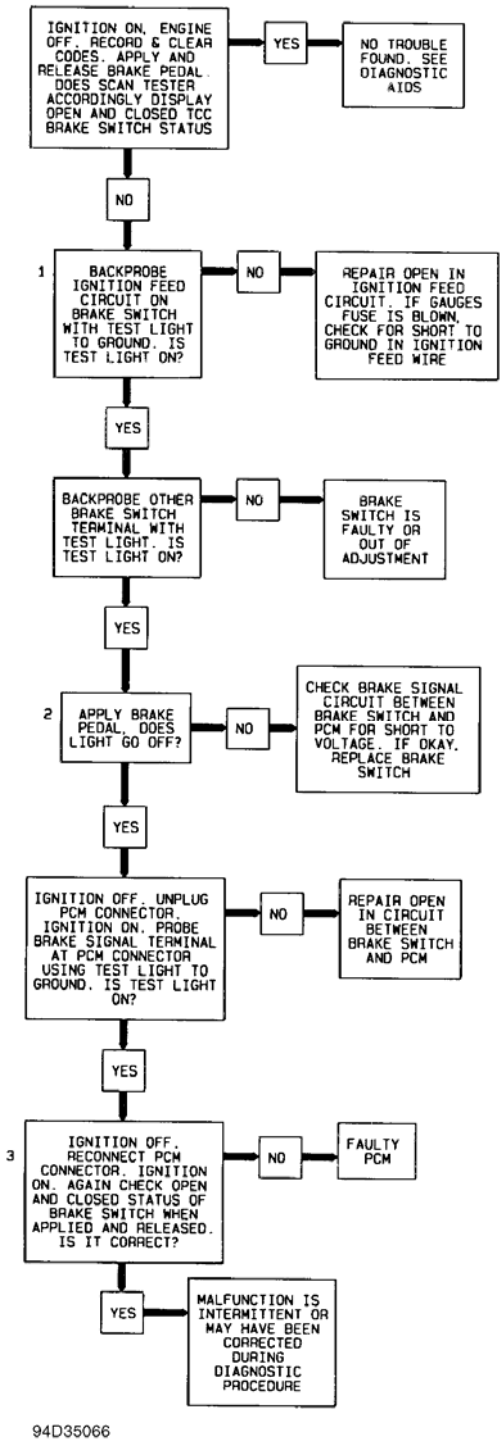


Fig. 115: Code 37/38, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 52/53, SYSTEM VOLTAGE HIGH

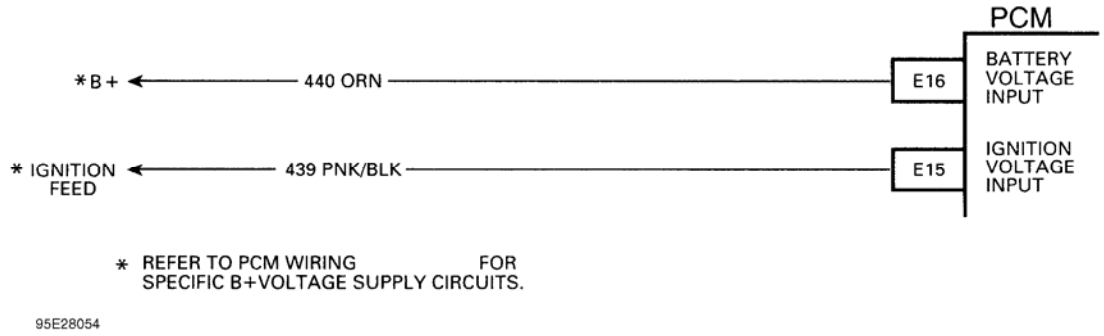


Fig. 116: Code 52/53, Circuit Diagram (C & K Series) Courtesy of General Motors Corp.

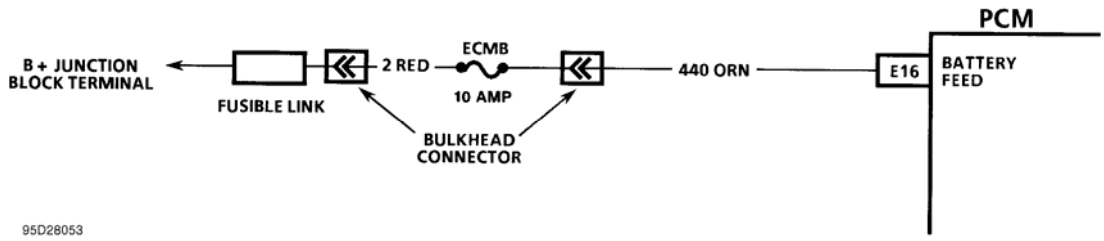


Fig. 117: Code 52/53, Circuit Diagram (G, L & M Series) Courtesy of General Motors Corp.

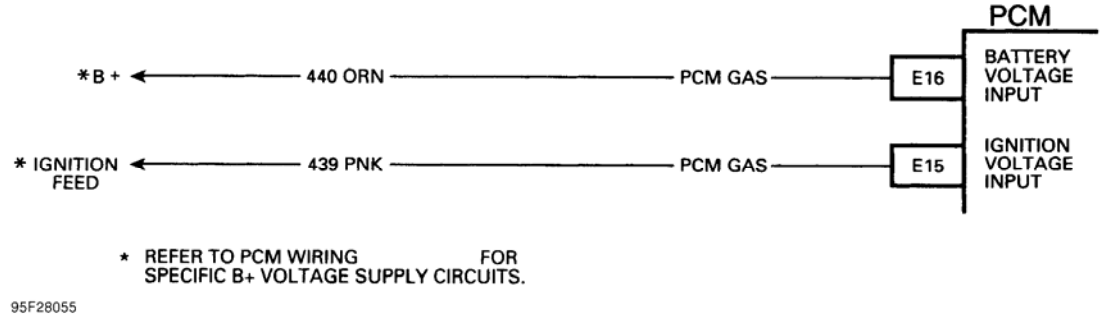


Fig. 118: Code 52/53, Circuit Diagram (S & T Series) Courtesy of General Motors Corp.

Code 53 will set when ignition is on and control module 12-volt battery feed voltage is greater than 19.5 volts for about 2 seconds. During the time failure is present, force motor is turned off, transmission immediately shifts to 2nd gear, and TCC operation is inhibited. The setting of additional codes may result.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Normal voltage is 9-15 volts.
2. Checks if alternator is faulty under load.

Diagnostic Aids

Jump-starting engine or charging battery with a battery charger may set code. If code is set when an accessory is operated, check for poor connections or excessive current draw. Also, check for poor connections at starter solenoid or fusible link.

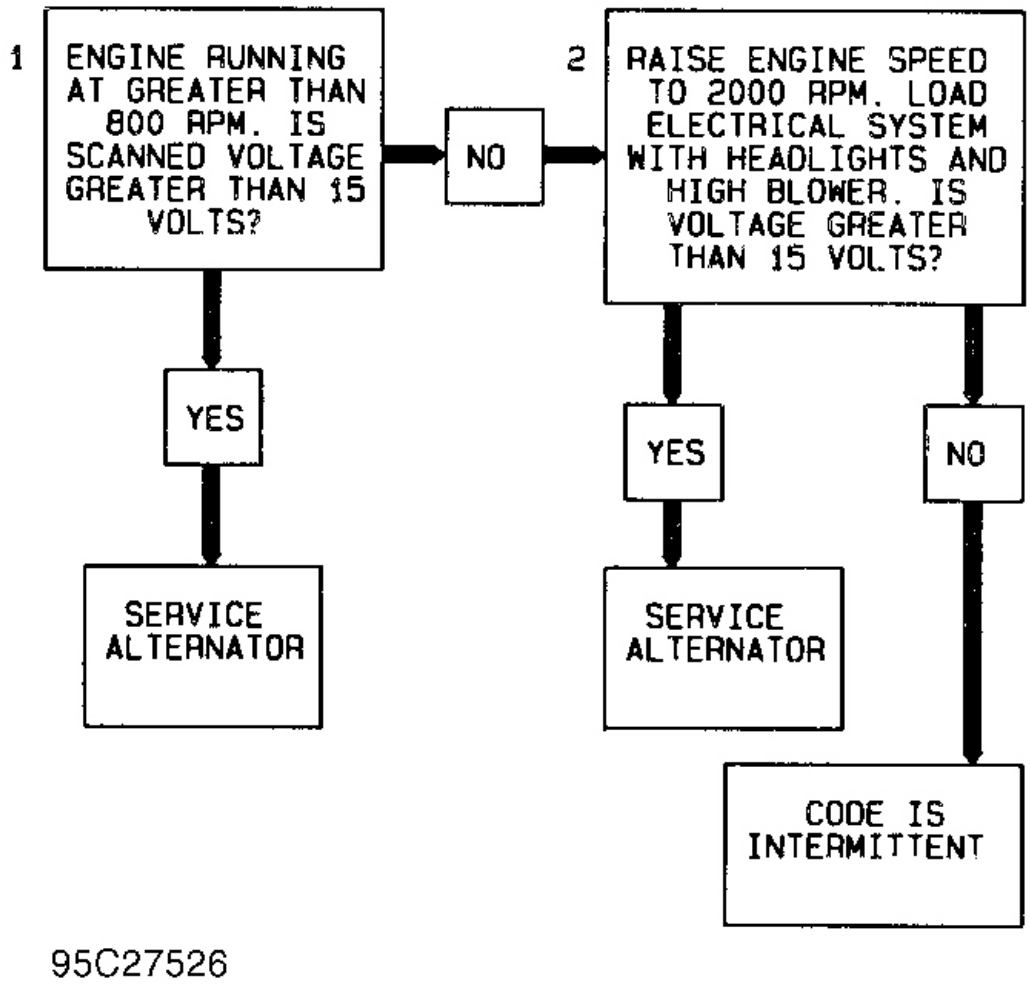


Fig. 119: Code 52/53, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 58, TRANS. FLUID TEMP. HIGH

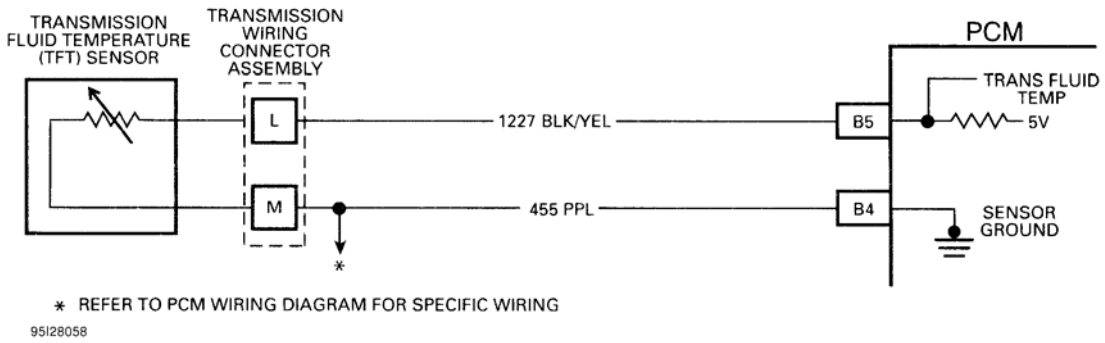


Fig. 120: Code 58, Circuit Diagram (C & K Series) Courtesy of General Motors Corp.

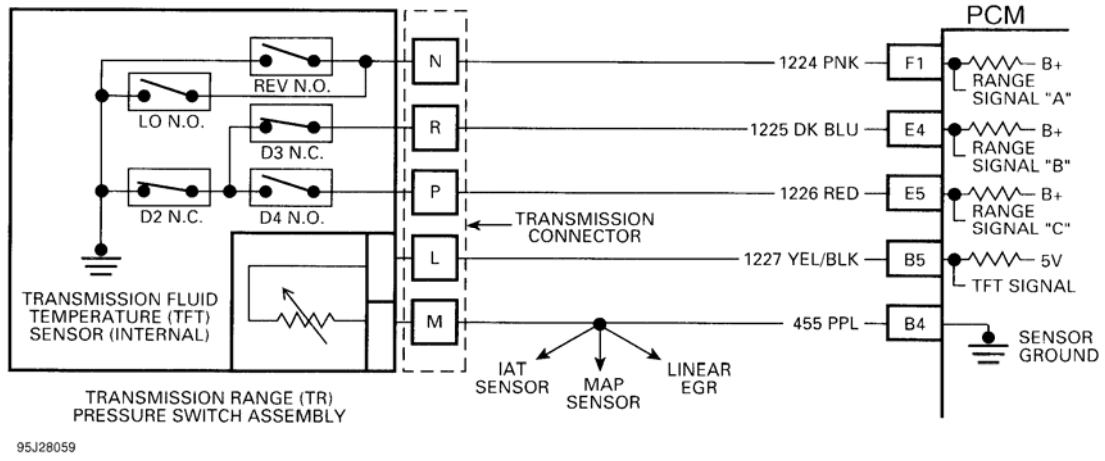


Fig. 121: Code 58, Circuit Diagram (G, L, M, S & T Series) Courtesy of General Motors Corp.

Transmission fluid temperature sensor is a thermistor which controls signal voltage to control module. Control module applies and monitors voltage to sensor. When transmission fluid is cold, sensor resistance is high; therefore, control module will see high signal voltage. As transmission fluid warms, sensor resistance and voltage will drop. At normal transmission operating temperature of 212°F (100°C), voltage will be about 1.5-2.0 volts.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Code 58 will set if signal voltage indicates a transmission fluid temperature greater than 305°F (151°C) for one second.
2. This test determines if circuit is shorted to ground, which will result in conditions for Code 58.

Diagnostic Aids

Check harness routing for a potential short to ground in TFT signal circuit. Scan tester displays transmission fluid temperature in degrees Centigrade. After transmission is running, temperature display should rise steadily to about 212°F (100°C) then stabilize. Test transmission sensor at various temperature levels to determine if

sensor is out of calibration. See TEMPERATURE-TO-RESISTANCE VALUES chart. An out-of-calibration sensor could result in delayed shifts or TCC enabled complaint.

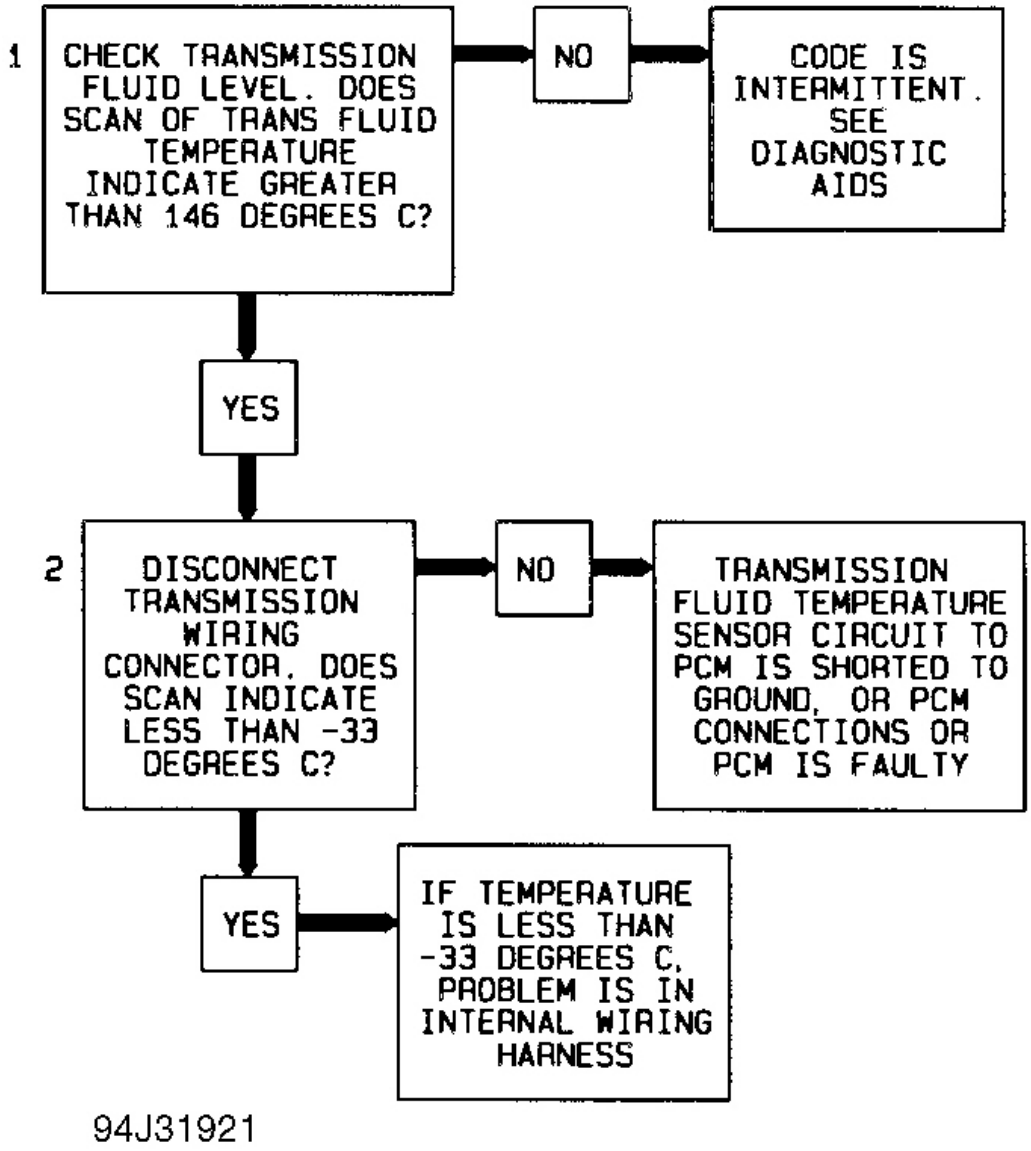


Fig. 122: Code 58, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	**(1) (2) Ohms**
150 (66)	42-56
100 (38)	159-198

70 (20)	420-514
40 (4)	1308-1609
20 (-7)	3088-3941
0 (-18)	7902-10,943
-40 (-40)	73,556-127,857
(1) Measure resistance across sensor terminals.	
(2) Temperatures are approximates.	

CODE 59, TRANS. FLUID TEMP. LOW

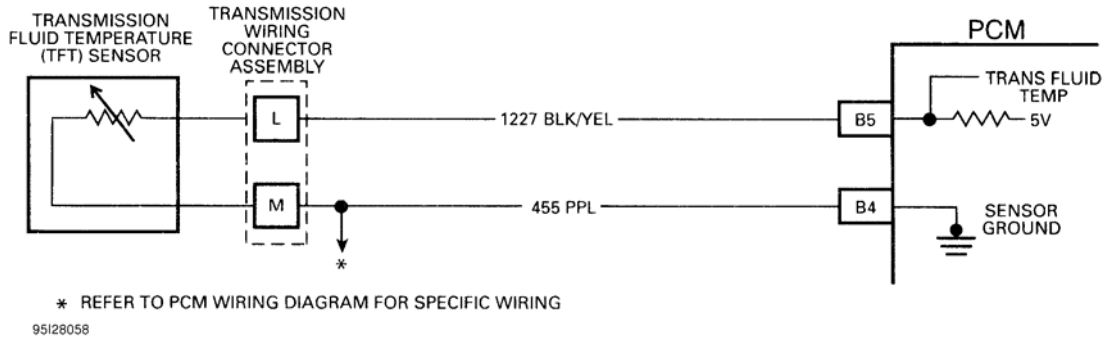


Fig. 123: Code 59, Circuit Diagram (C & K Series) Courtesy of General Motors Corp.

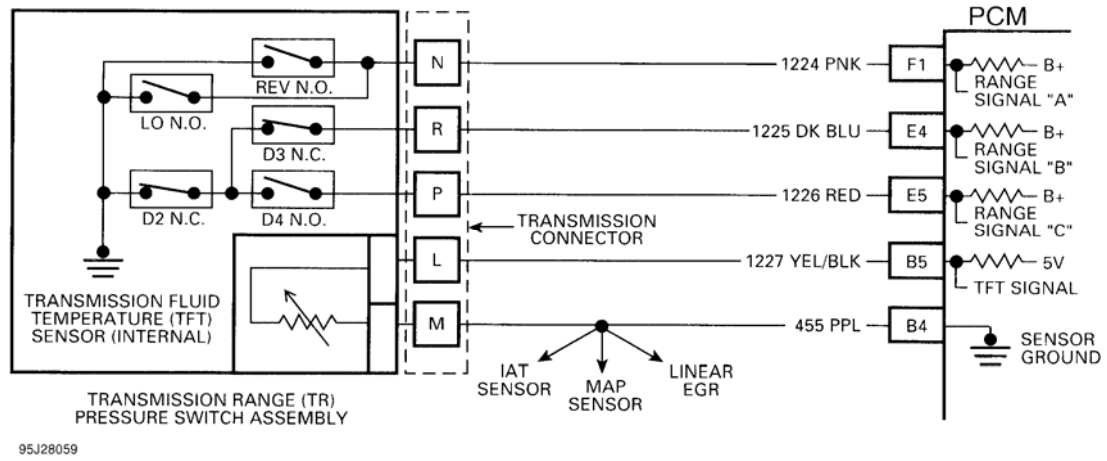


Fig. 124: Code 59, Circuit Diagram (G, L, M, S & T Series) Courtesy of General Motors Corp.

Transmission fluid temperature sensor is a thermistor which controls signal voltage to control module. Control module applies and monitors 5 volts to sensor. When transmission fluid is cold, sensor resistance is high; therefore, control module will see high signal voltage. As transmission fluid temperature warms, sensor resistance and voltage drop. At normal transmission operating temperature of 212°F (100°C), voltage will be about 1.5-2.0 volts.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Code 59 will set if signal voltage indicates a transmission fluid temperature less than -34°F (-37°C) for one second.
2. This test simulates Code 58. If control module recognizes low signal voltage (high temperature) and scan tester reads 305°F (151°C) or greater, control module and wiring are okay.
3. This test determines if signal circuit is open. There should be 5 volts present at sensor connector if measuring with a DVOM.

Diagnostic Aids

Scan tester displays transmission fluid temperature in degrees Centigrade. After transmission is running, displayed temperature should rise steadily to about 212°F (100°C) then stabilize. A faulty connection or an open in ground circuit or signal circuit will result in a Code 59. Test transmission sensor at various temperature levels to determine if sensor is out of calibration. See TEMPERATURE-TO-RESISTANCE VALUES. An out-of-calibration sensor could result in firm shifts or TCC enabled complaint.

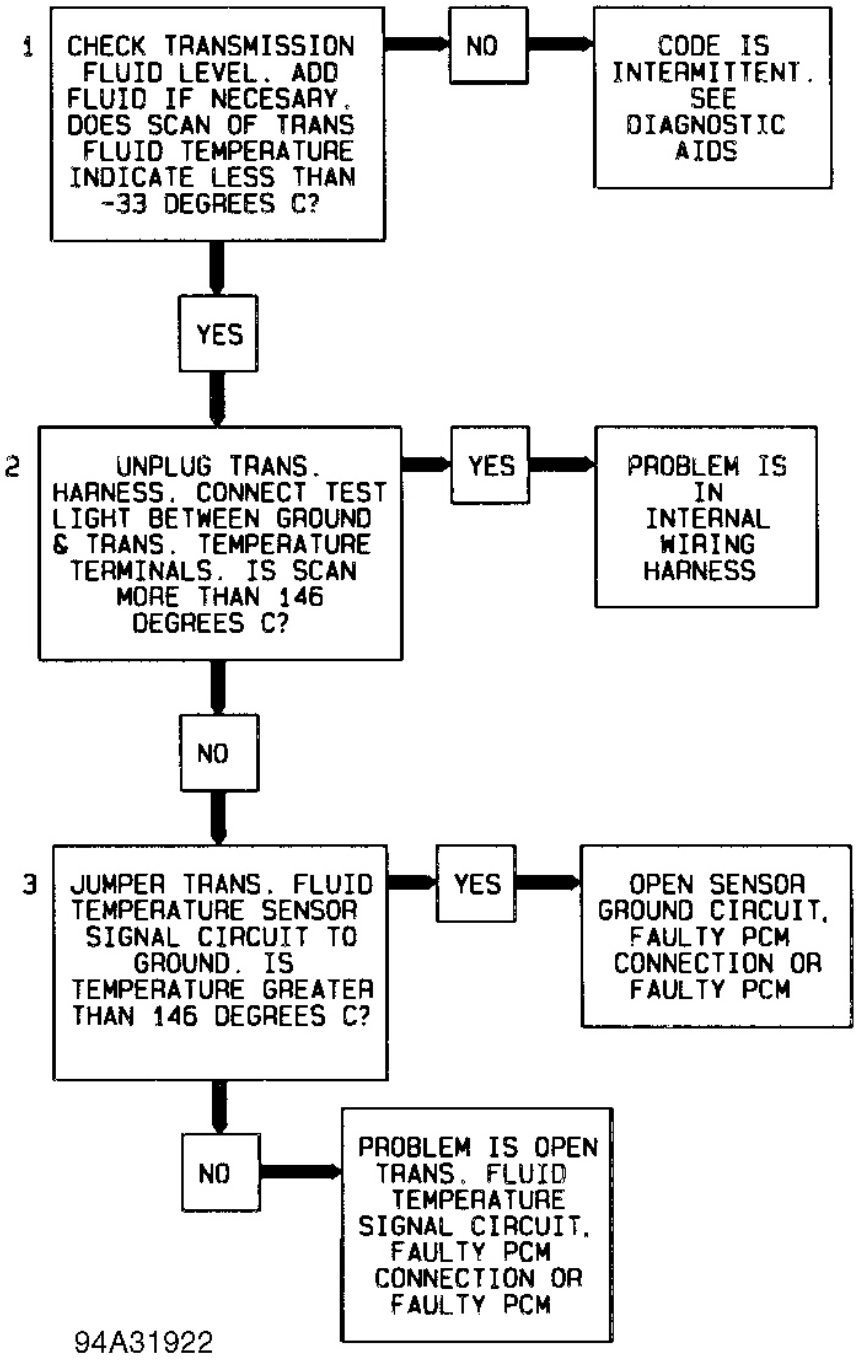


Fig. 125: Code 59, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	(1) (2) Ohms

150 (66)	42-56
100 (38)	159-198
70 (20)	420-514
40 (4)	1308-1609
20 (-7)	3088-3941
0 (-18)	7902-10,943
-40 (-40)	73,556-127,857
(1) Measure resistance across sensor terminals. (2) Temperatures are approximates.	

CODE 66, 3-2 CONTROL SOLENOID CIRCUIT FAULT

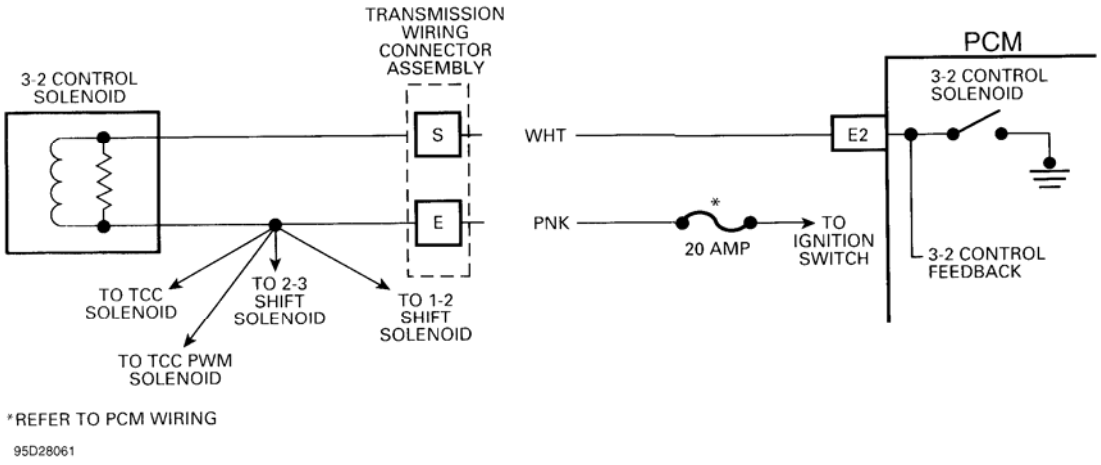


Fig. 126: Code 66, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

The 3-2 control solenoid hydraulically coordinates apply rate of 2-4 band with hydraulic release of 3-4 clutch during a 3-2 downshift. The 3-2 circuit duty cycle is continually monitored by control module depending one command state of circuit. When transmission is in 1st gear, duty cycle of solenoid is equal to zero. When transmission is in 2nd gear or higher, duty cycle of solenoid will be about 90 percent. When transmission downshifts 3-2, duty cycle of solenoid will be about 20 percent.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks 3-2 control solenoid and internal transmission harness for short circuits.
2. This test checks for power, from ignition through fuse, to 3-2 control solenoid.

Diagnostic Aids

Check all connections, especially those at transmission pass-thru connector. Some slight TCC slippage is normal. The 3-2 control solenoid feedback normally oscillates on/off when duty cycle is applied.

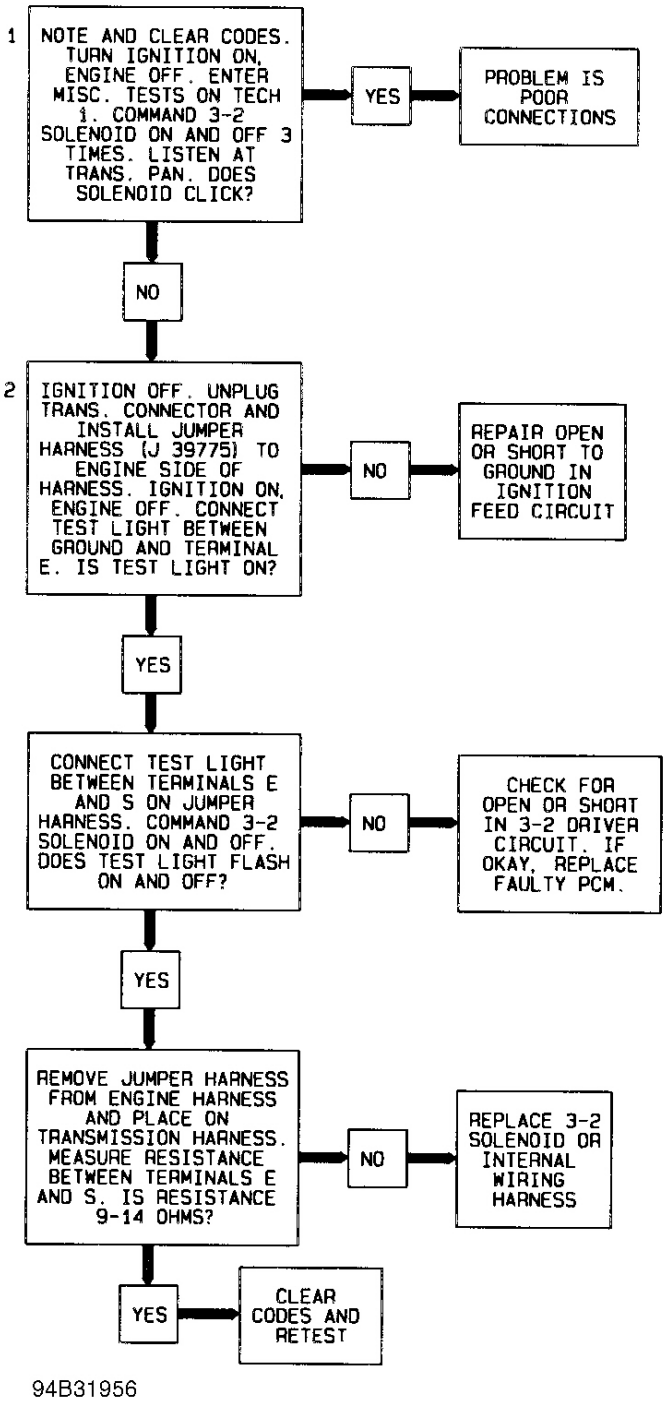


Fig. 127: Code 66, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 67, TCC SOLENOID CIRCUIT CHECK

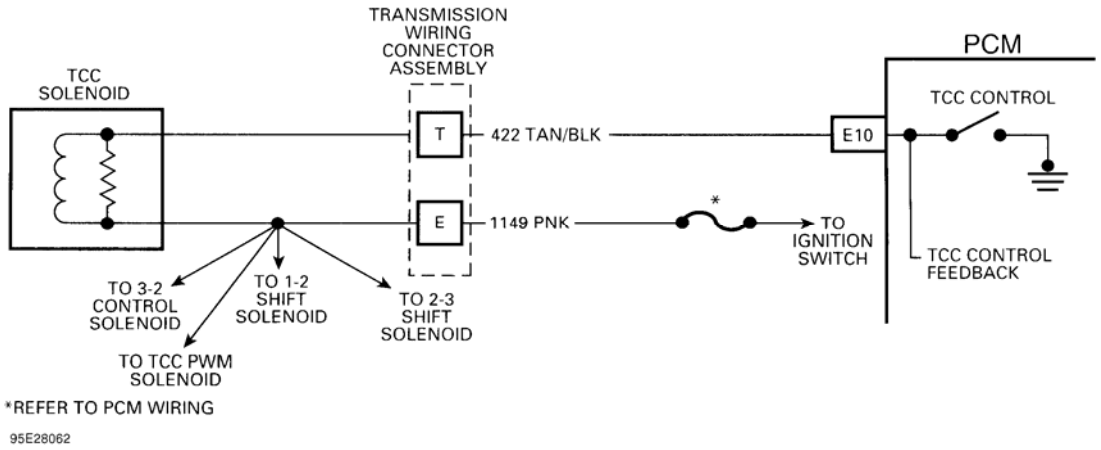


Fig. 128: Code 67, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

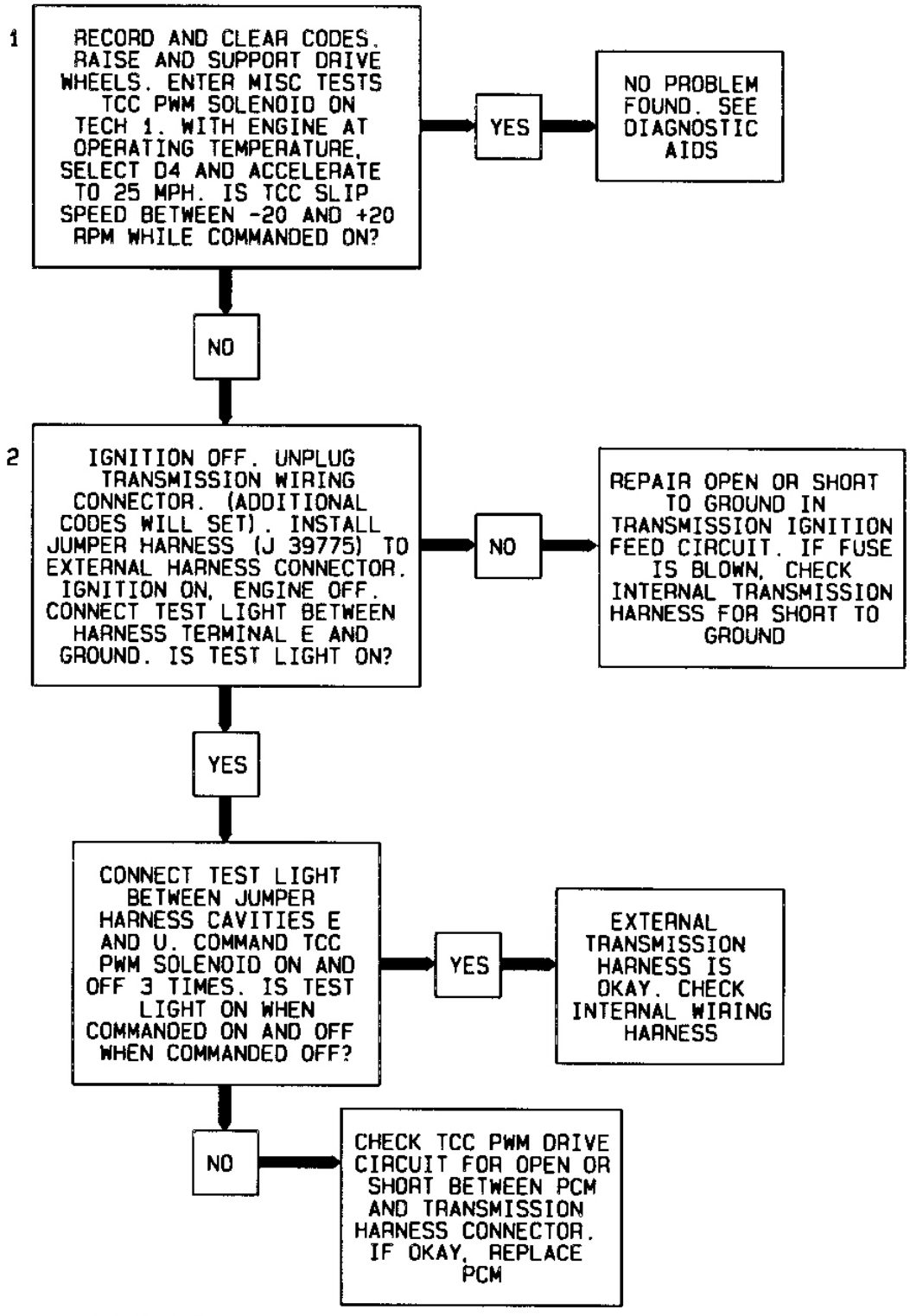
TCC solenoid is a normally open exhaust valve. Control module will engage solenoid by grounding circuit with an internal quad-driver.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks ability of control module to control solenoid.
2. This test checks for power, from ignition through fuse, to TCC solenoid.

Diagnostic Aids

Check all connections, especially those at transmission pass-thru connector. Some slight TCC slippage is normal.


1
RECORD AND CLEAR CODES. RAISE AND SUPPORT DRIVE WHEELS. ENTER MISC TESTS TCC PWM SOLENOID ON TECH 1. WITH ENGINE AT OPERATING TEMPERATURE, SELECT D4 AND ACCELERATE TO 25 MPH. IS TCC SLIP SPEED BETWEEN -20 AND +20 RPM WHILE COMMANDED ON?
YES
NO PROBLEM FOUND. SEE DIAGNOSTIC AIDS
NO
2
IGNITION OFF. UNPLUG TRANSMISSION WIRING CONNECTOR. (ADDITIONAL CODES WILL SET). INSTALL JUMPER HARNESS (J 39775) TO EXTERNAL HARNESS CONNECTOR. IGNITION ON, ENGINE OFF. CONNECT TEST LIGHT BETWEEN HARNESS TERMINAL E AND GROUND. IS TEST LIGHT ON?
NO
REPAIR OPEN OR SHORT TO GROUND IN TRANSMISSION IGNITION FEED CIRCUIT. IF FUSE IS BLOWN, CHECK INTERNAL TRANSMISSION HARNESS FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN JUMPER HARNESS CAVITIES E AND U. COMMAND TCC PWM SOLENOID ON AND OFF 3 TIMES. IS TEST LIGHT ON WHEN COMMANDED ON AND OFF WHEN COMMANDED OFF?
YES
EXTERNAL TRANSMISSION HARNESS IS OKAY. CHECK INTERNAL WIRING HARNESS
NO
CHECK TCC PWM DRIVE CIRCUIT FOR OPEN OR SHORT BETWEEN PCM AND TRANSMISSION HARNESS CONNECTOR. IF OKAY, REPLACE PCM

95D14350

Fig. 129: Code 67, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 69, TORQUE CONVERTER CLUTCH STUCK ON

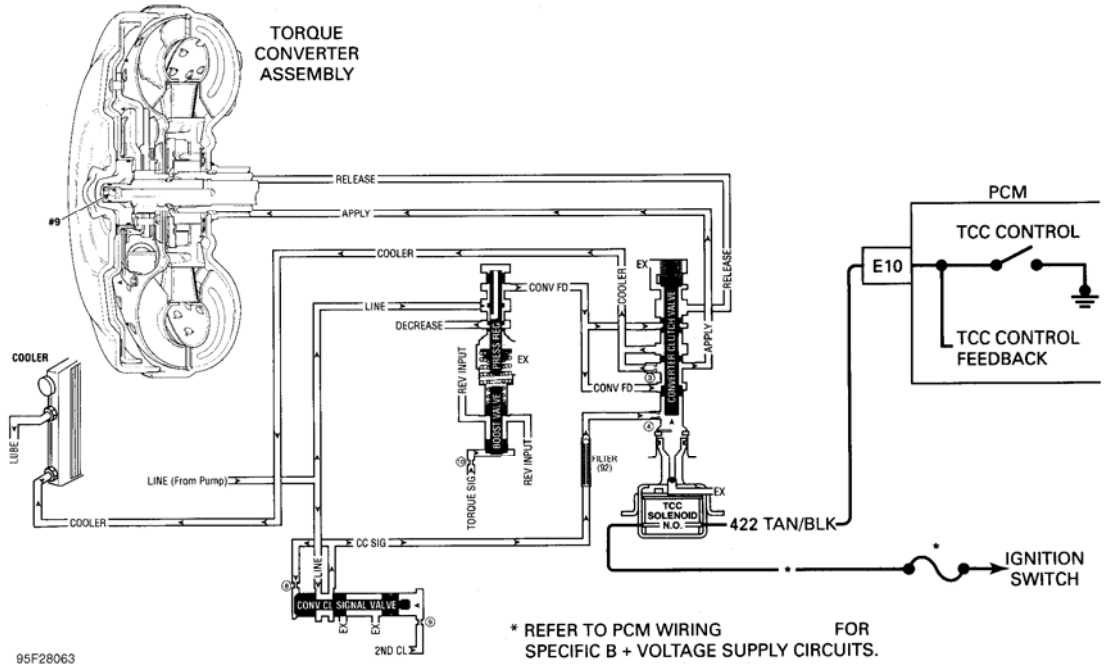


Fig. 130: Code 69, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

Control module commands TCC PWM solenoid on by modulating signal fluid on converter clutch shift valve. TCC apply fluid applies torque converter clutch.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks mechanical state of TCC. When TCC is commanded off, slip speed should increase.

Diagnostic Aids

If TCC is mechanically stuck on, TCC fluid will apply TCC, causing an engine stall.

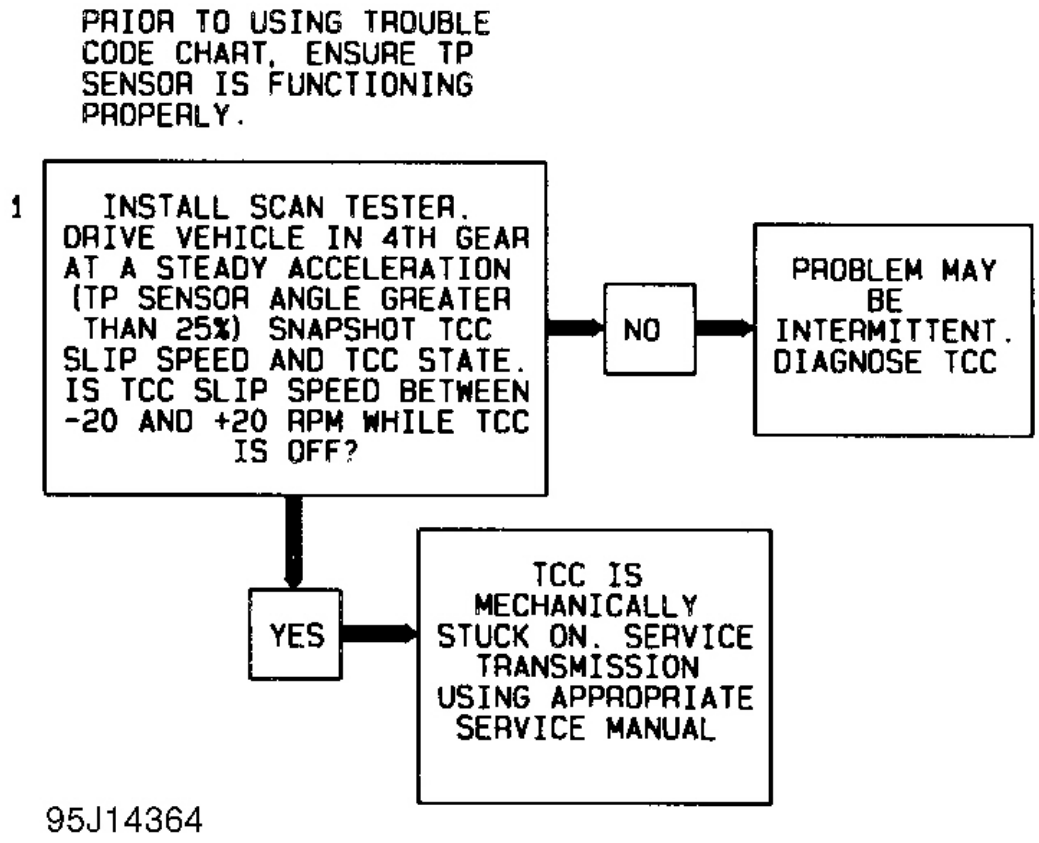


Fig. 131: Code 69, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 72, VSS CIRCUIT LOSS TRANSMISSION OUTPUT SIGNAL

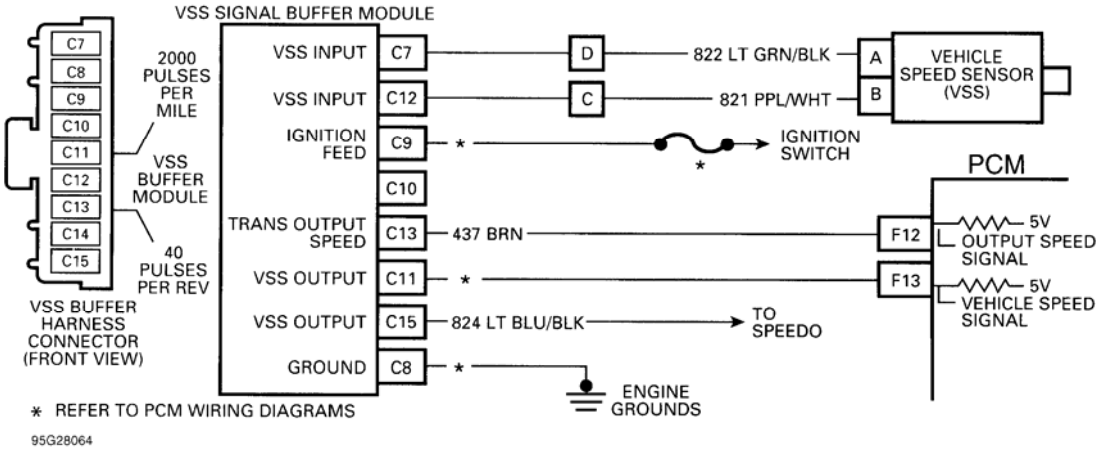


Fig. 132: Code 72, Circuit Diagram (C, G, K, L & M Series) Courtesy of General Motors Corp.

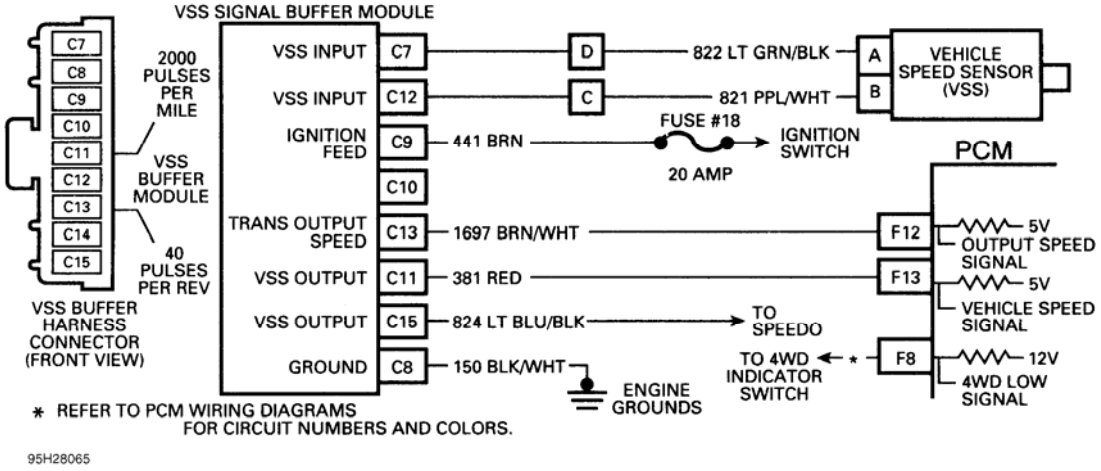


Fig. 133: Code 72, Circuit Diagram (S & T Series) Courtesy of General Motors Corp.

VSS output sensor is a magnetic induction type. Gear teeth pressed on outside diameter of output carrier assembly induce an alternating current in sensor when drive wheels are turning.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Test verifies VSS voltage at control module.
2. Test checks VSS buffer ground circuit.
3. Test checks VSS circuit at buffer module.
4. Test verifies VSS signal at sensor.

Diagnostic Aids

Code 72 will set when VSS signal is present and is lost. Code 24 will set when no vehicle speed is detected at

vehicle start off. Check all connections, especially those at transmission pass-through connector.

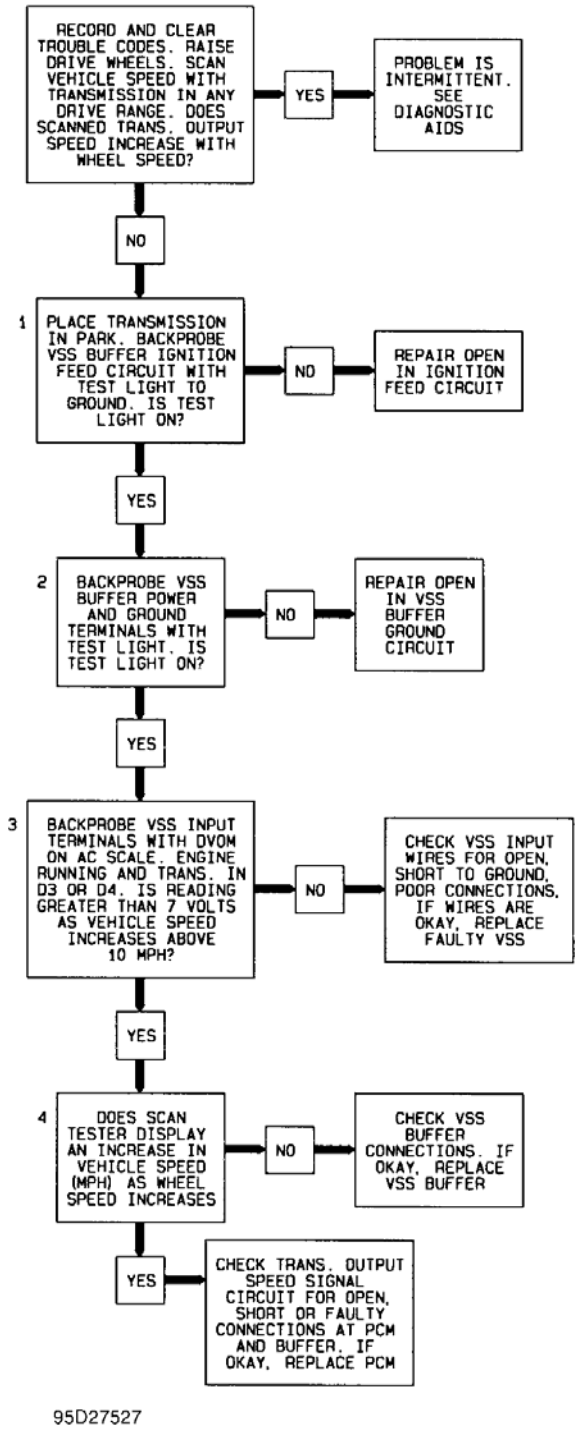


Fig. 134: Code 72, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 73, PRESSURE CONTROL SOLENOID (CURRENT ERROR)

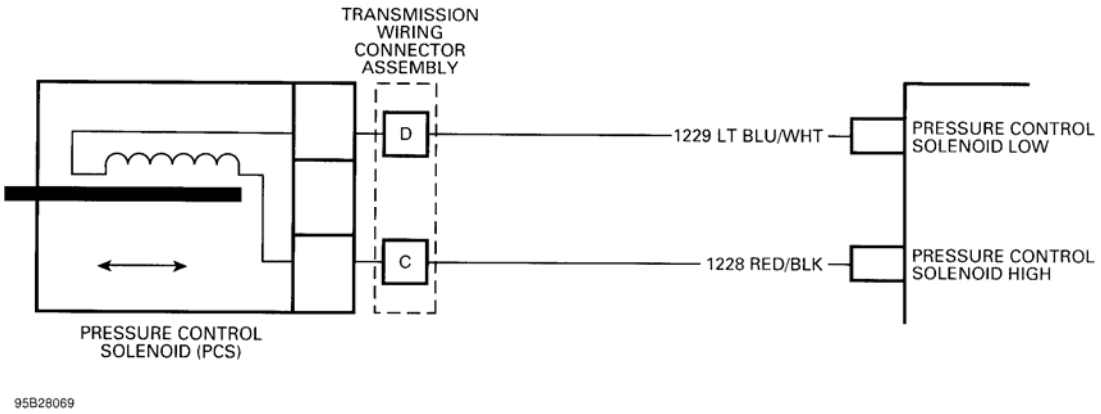


Fig. 135: Code 73, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

NOTE: This flow chart requires the use of a bidirectional (Tech 1) scan tester.

Pressure control solenoid is controlled by control module to regulate transmission line pressure. Control module looks at TPS voltage, engine RPM and other inputs to determine appropriate line pressure for a given load, then regulates pressure by applying a varying amperage. Applied amperage can vary from 1 to 1.1 amps. Control module then monitors amperage at return line.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks ability of control module to command solenoid.
2. Checks internal transmission harness and solenoid for incorrect resistance.

Diagnostic Aids

Check for poor connections at control module and transmission pass-thru connector.

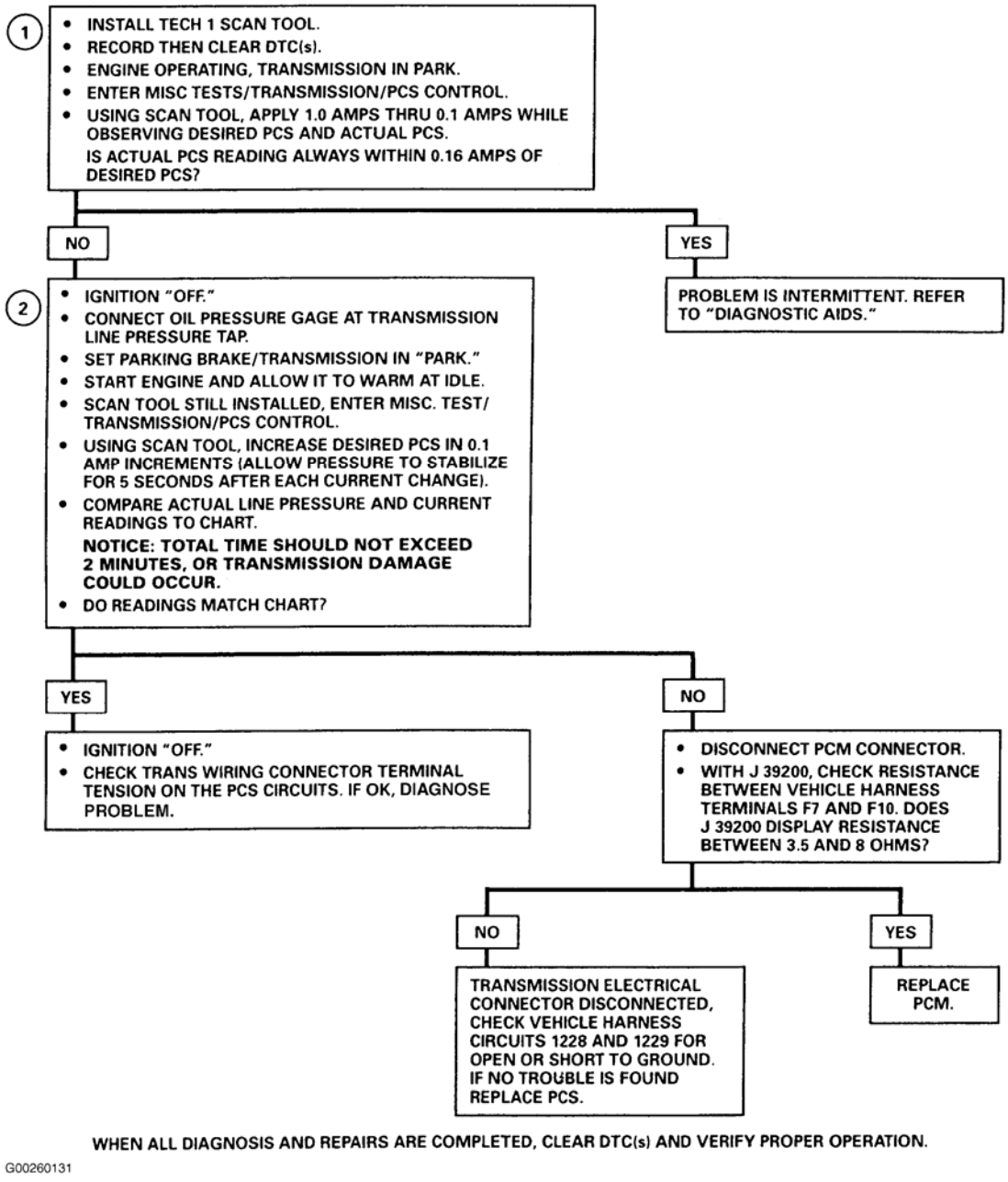


Fig. 136: Code 73, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.
Courtesy of GENERAL MOTORS CORP.

CODE 75, SYSTEM VOLTAGE LOW

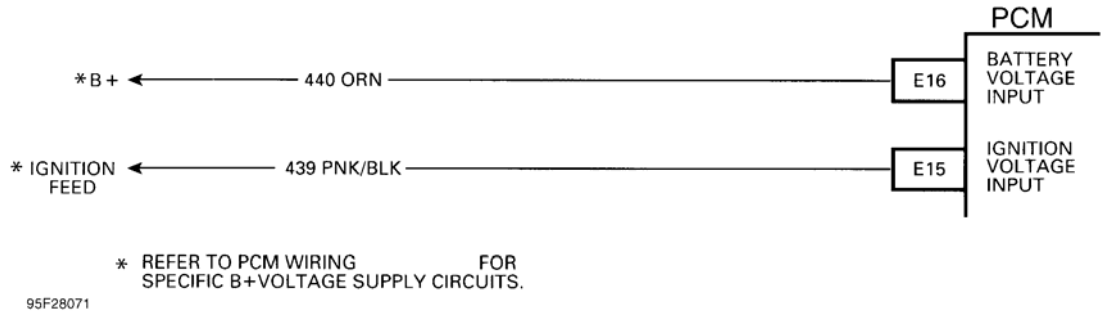


Fig. 137: Code 75, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

Code 75 will set when ignition is on and control module 12-volt battery feed voltage is less than 9 volts for about 4 seconds. During time failure is present, force motor, also referred to as pressure control solenoid, is turned off, maintaining only 2nd gear and inhibiting TCC operation.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for normal battery voltage.
2. Checks if low voltage display is due to generator, battery voltage input circuit or control module.

Diagnostic Aids

Charging battery with a charger and jump starting engine may set this code. If code sets when an accessory is operated, check for poor connections or excessive current draw. Also, check for poor connections at starter solenoid or fusible link. Minimum voltage allowed for Code 75 to set is on a graduated scale and changes with temperature from a low of 7.3 volts at -40°F (-40°C) to a voltage of 11.7 volts at 304°F (150°C).

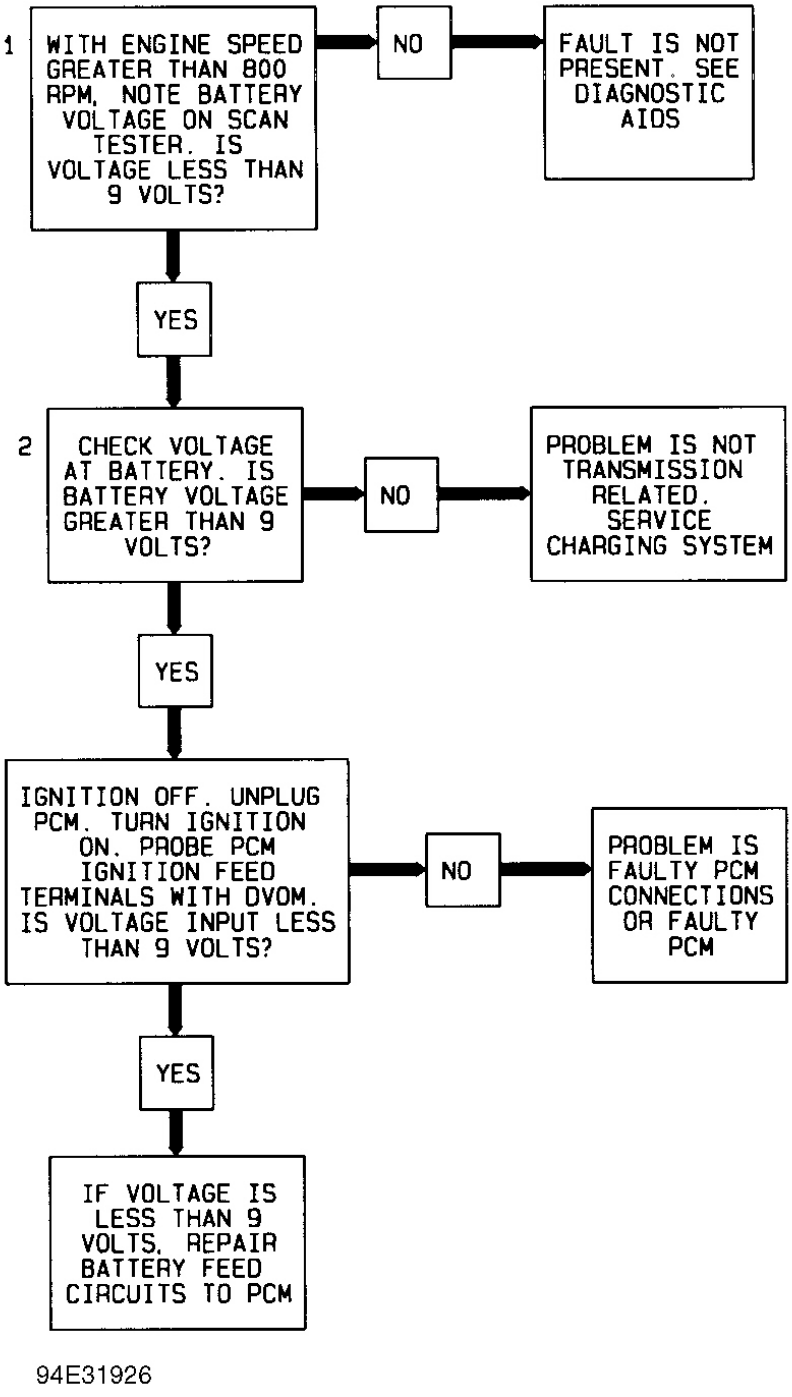


Fig. 138: Code 75, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 79, TRANS. FLUID TEMPERATURE HIGH

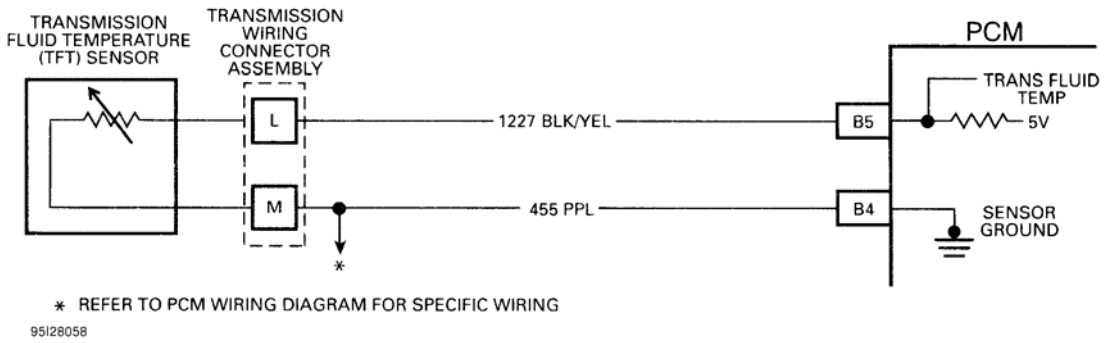


Fig. 139: Code 79, Circuit Diagram (C & K Series) Courtesy of General Motors Corp.

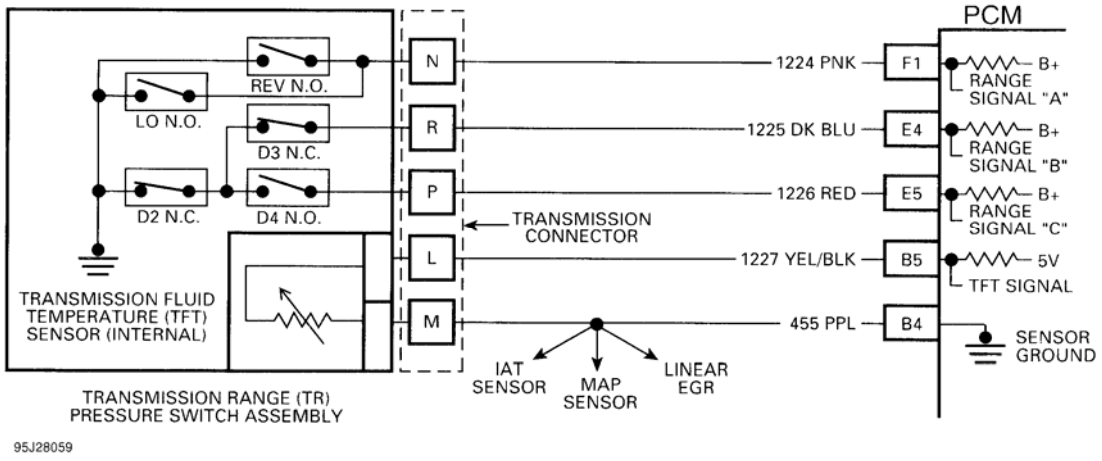


Fig. 140: Code 79, Circuit Diagram (G, L, M, S & T Series) Courtesy of General Motors Corp.

Transmission fluid temperature sensor is a thermistor which controls signal voltage to control module. Control module applies and monitors voltage to sensor. When transmission fluid is cold, sensor resistance is high; therefore, control module will see high signal voltage. As transmission fluid warms, sensor resistance and voltage will drop. At normal transmission operating temperature of 212°F (100°C), voltage will be about 1.5-2.0 volts.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Code 79 will set if signal voltage indicates a transmission fluid temperature greater than 151°C for one second.
2. This test determines if circuit is shorted to ground, which will result in conditions for Code 79.

Diagnostic Aids

Check harness routing for a potential short to ground in signal circuit. Scan tester displays transmission fluid temperature in degrees Centigrade. After transmission is running, temperature display should rise steadily to about 212°F (100°C) then stabilize. Test transmission sensor at various temperature levels to determine if sensor

is out of calibration. See **TEMPERATURE-TO-RESISTANCE VALUES** chart. An out-of-calibration sensor could result in delayed shifts or TCC enabled complaint.

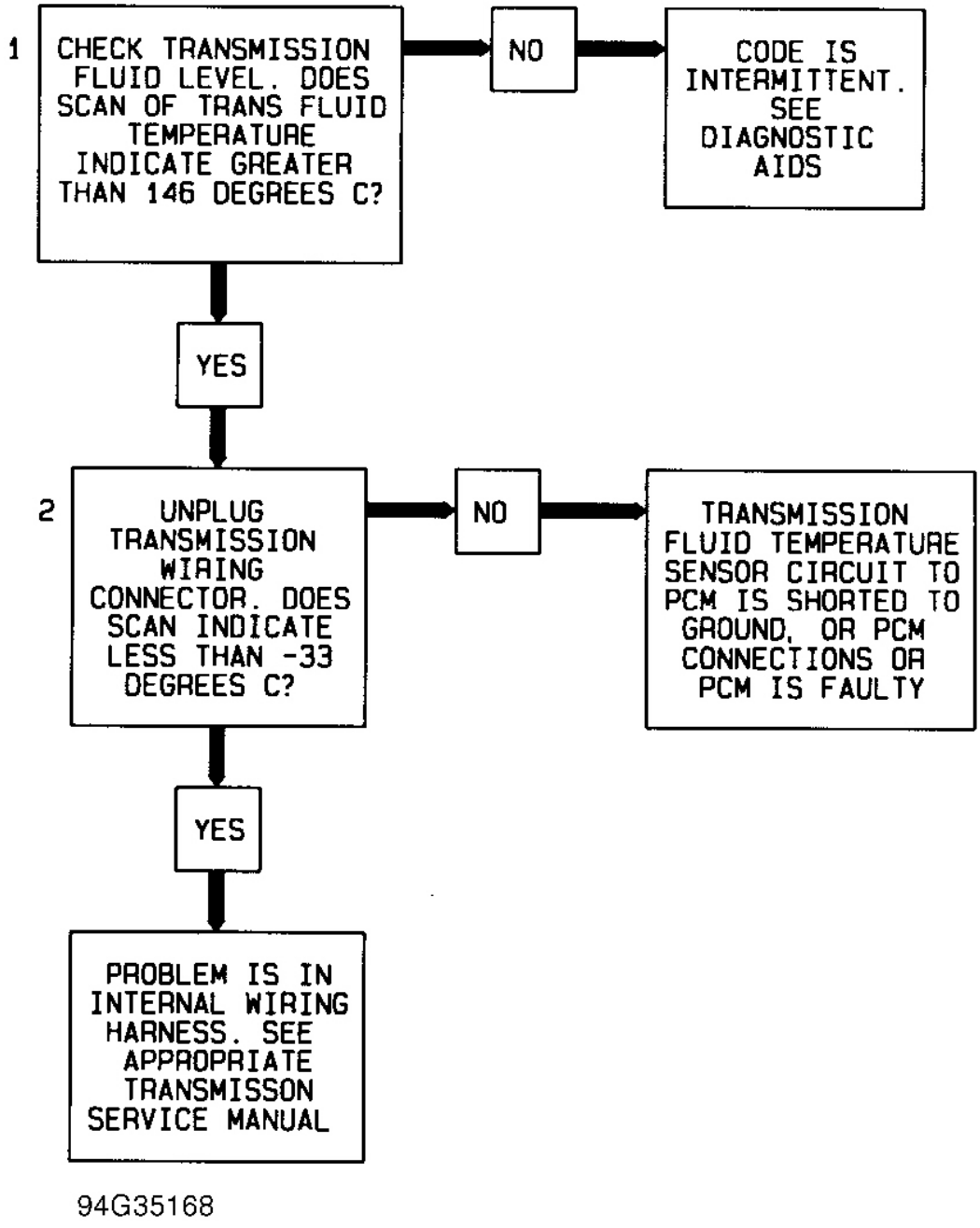


Fig. 141: Code 79, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	(1) (2) Ohms
150 (66)	42-56
100 (38)	159-198
70 (20)	420-514
40 (4)	1308-1609
20 (-7)	3088-3941
0 (-18)	7902-10,943
-40 (-40)	73,556-127,857
(1) Measure resistance across sensor terminals.	
(2) Temperatures are approximates.	

CODE 81, TRANS. 2-3 ERROR

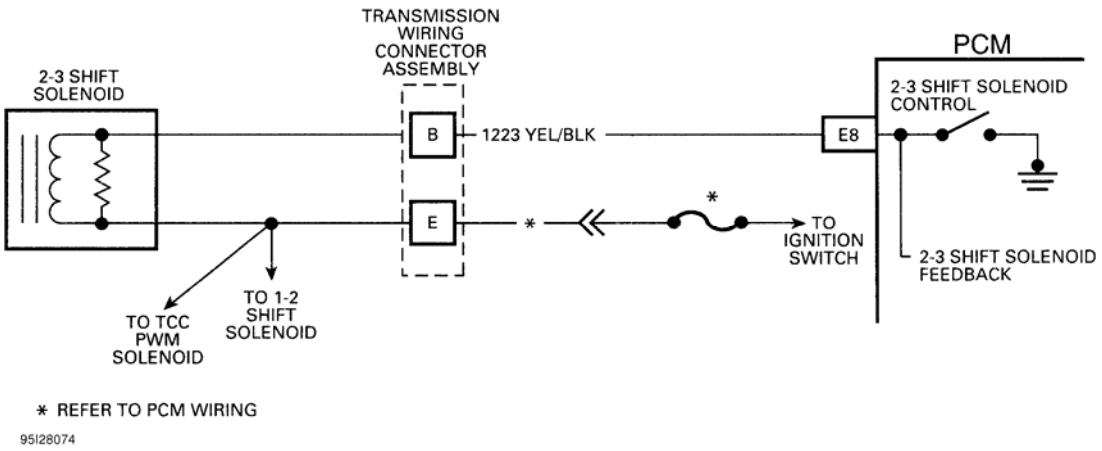


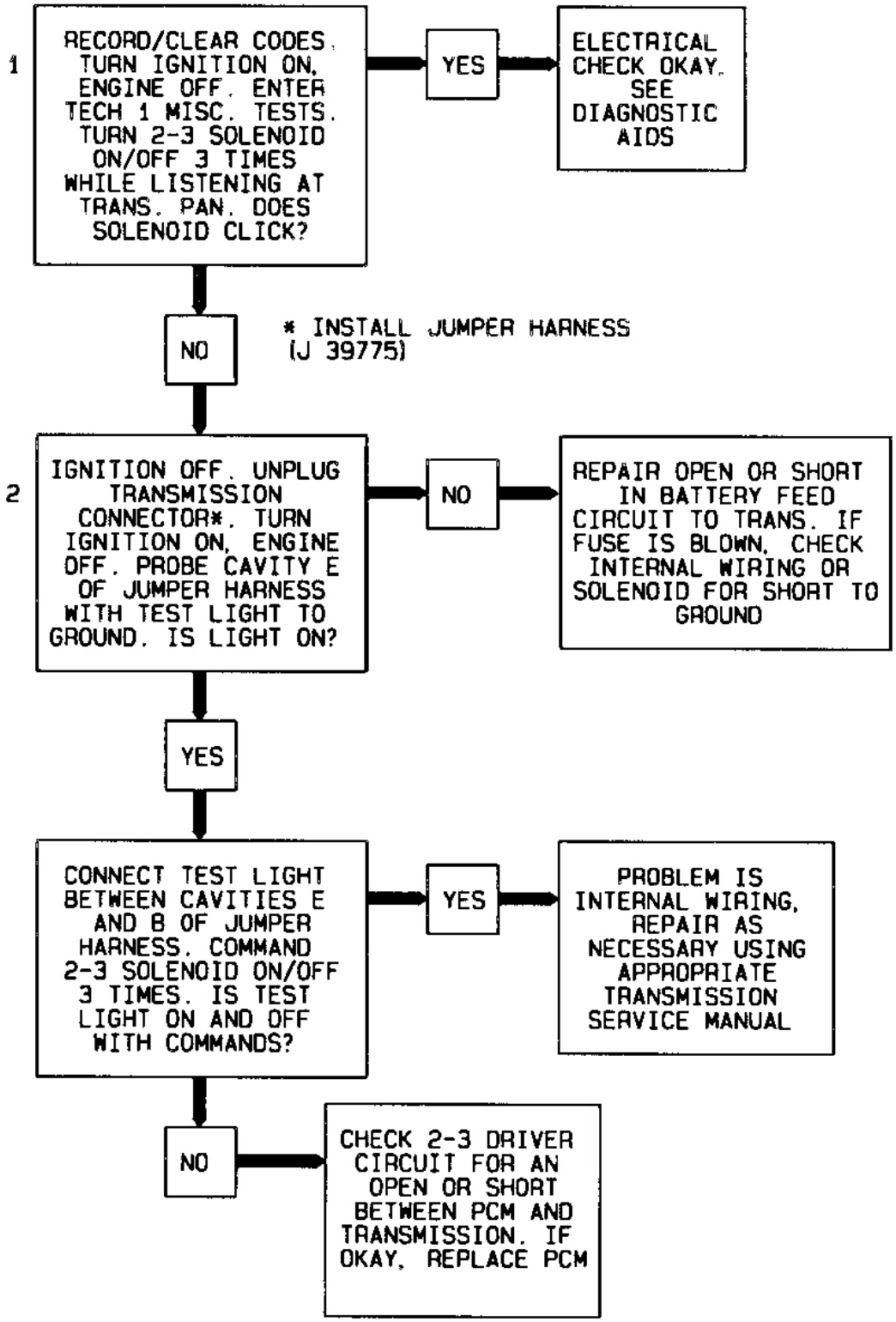
Fig. 142: Code 81, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks function of 2-3 shift solenoid and internal transmission wiring.
2. Checks for power to 2-3 shift solenoid from ignition.

Diagnostic Aids

Check all connections, especially those at transmission pass-thru connector.


1
RECORD/CLEAR CODES. TURN IGNITION ON, ENGINE OFF. ENTER TECH 1 MISC. TESTS. TURN 2-3 SOLENOID ON/OFF 3 TIMES WHILE LISTENING AT TRANS. PAN. DOES SOLENOID CLICK?
YES
ELECTRICAL CHECK OKAY. SEE DIAGNOSTIC AIDS
NO
* INSTALL JUMPER HARNESS (J 39775)
2
IGNITION OFF. UNPLUG TRANSMISSION CONNECTOR*. TURN IGNITION ON, ENGINE OFF. PROBE CAVITY E OF JUMPER HARNESS WITH TEST LIGHT TO GROUND. IS LIGHT ON?
NO
REPAIR OPEN OR SHORT IN BATTERY FEED CIRCUIT TO TRANS. IF FUSE IS BLOWN, CHECK INTERNAL WIRING OR SOLENOID FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN CAVITIES E AND B OF JUMPER HARNESS. COMMAND 2-3 SOLENOID ON/OFF 3 TIMES. IS TEST LIGHT ON AND OFF WITH COMMANDS?
YES
PROBLEM IS INTERNAL WIRING, REPAIR AS NECESSARY USING APPROPRIATE TRANSMISSION SERVICE MANUAL
NO
CHECK 2-3 DRIVER CIRCUIT FOR AN OPEN OR SHORT BETWEEN PCM AND TRANSMISSION. IF OKAY, REPLACE PCM

94C31940

Fig. 143: Code 81, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 82, TRANS. 1-2 ERROR

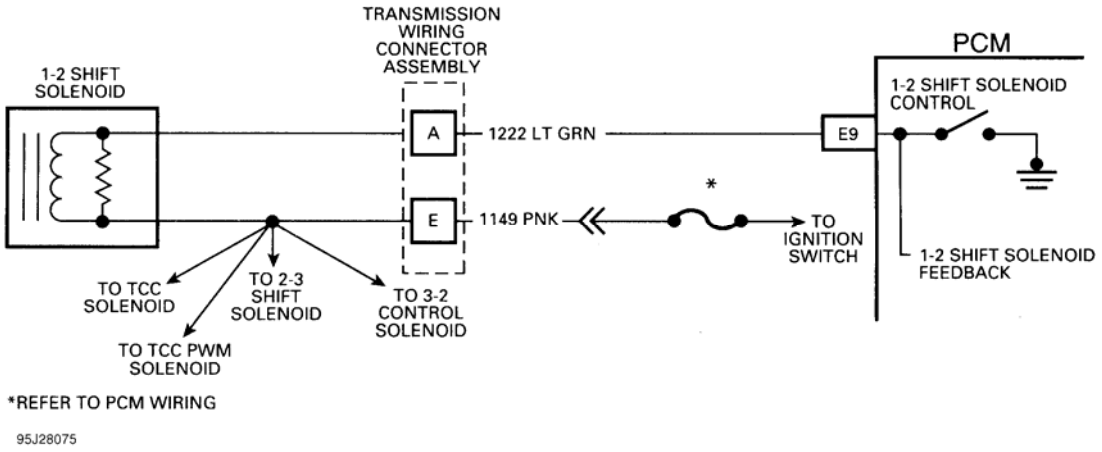


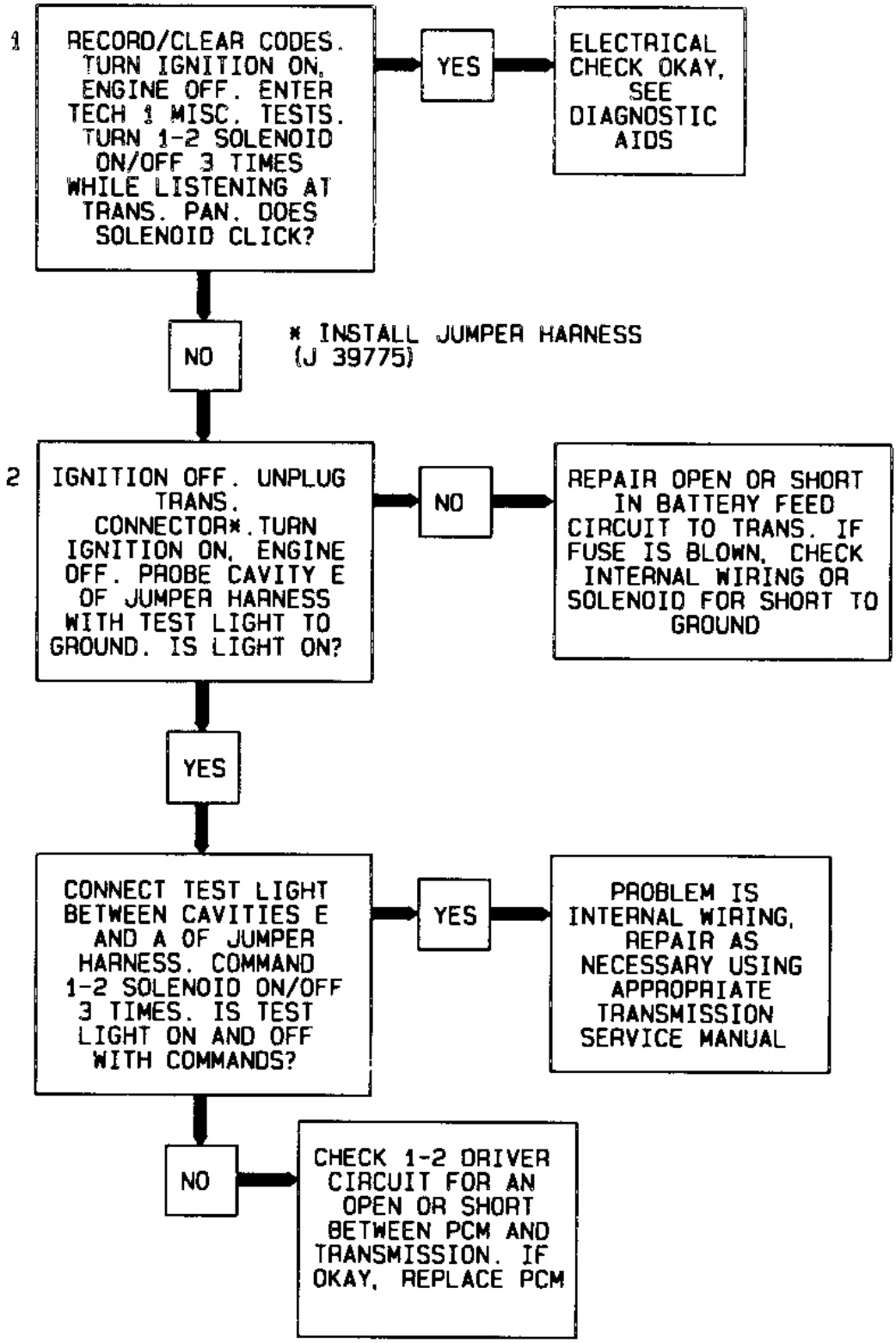
Fig. 144: Code 82, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks 1-2 shift solenoid and internal transmission wiring harness for short circuits.
2. This test checks for power, from ignition through fuse, to shift solenoid.

Diagnostic Aids

Check all connections, especially at transmission pass-thru connector.


1
RECORD/CLEAR CODES. TURN IGNITION ON, ENGINE OFF. ENTER TECH 1 MISC. TESTS. TURN 1-2 SOLENOID ON/OFF 3 TIMES WHILE LISTENING AT TRANS. PAN. DOES SOLENOID CLICK?
YES
ELECTRICAL CHECK OKAY, SEE DIAGNOSTIC AIDS
NO
* INSTALL JUMPER HARNESS (J 39775)
2
IGNITION OFF. UNPLUG TRANS. CONNECTOR*. TURN IGNITION ON, ENGINE OFF. PROBE CAVITY E OF JUMPER HARNESS WITH TEST LIGHT TO GROUND. IS LIGHT ON?
NO
REPAIR OPEN OR SHORT IN BATTERY FEED CIRCUIT TO TRANS. IF FUSE IS BLOWN, CHECK INTERNAL WIRING OR SOLENOID FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN CAVITIES E AND A OF JUMPER HARNESS. COMMAND 1-2 SOLENOID ON/OFF 3 TIMES. IS TEST LIGHT ON AND OFF WITH COMMANDS?
YES
PROBLEM IS INTERNAL WIRING, REPAIR AS NECESSARY USING APPROPRIATE TRANSMISSION SERVICE MANUAL
NO
CHECK 1-2 DRIVER CIRCUIT FOR AN OPEN OR SHORT BETWEEN PCM AND TRANSMISSION. IF OKAY, REPLACE PCM

94H31952

Fig. 145: Code 82, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

CODE 83, TCC SOLENOID CIRCUIT FAULT

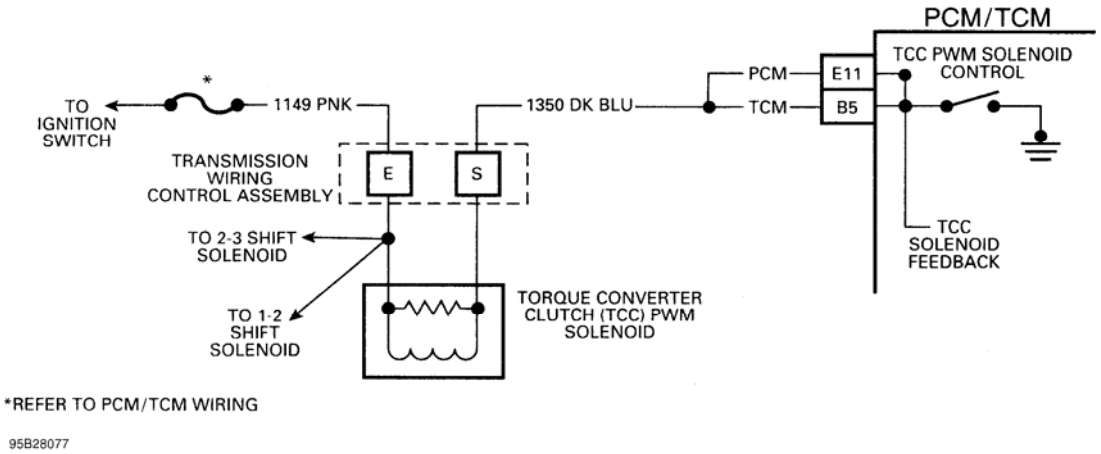


Fig. 146: Code 83, Circuit Diagram (Trucks & Vans) Courtesy of General Motors Corp.

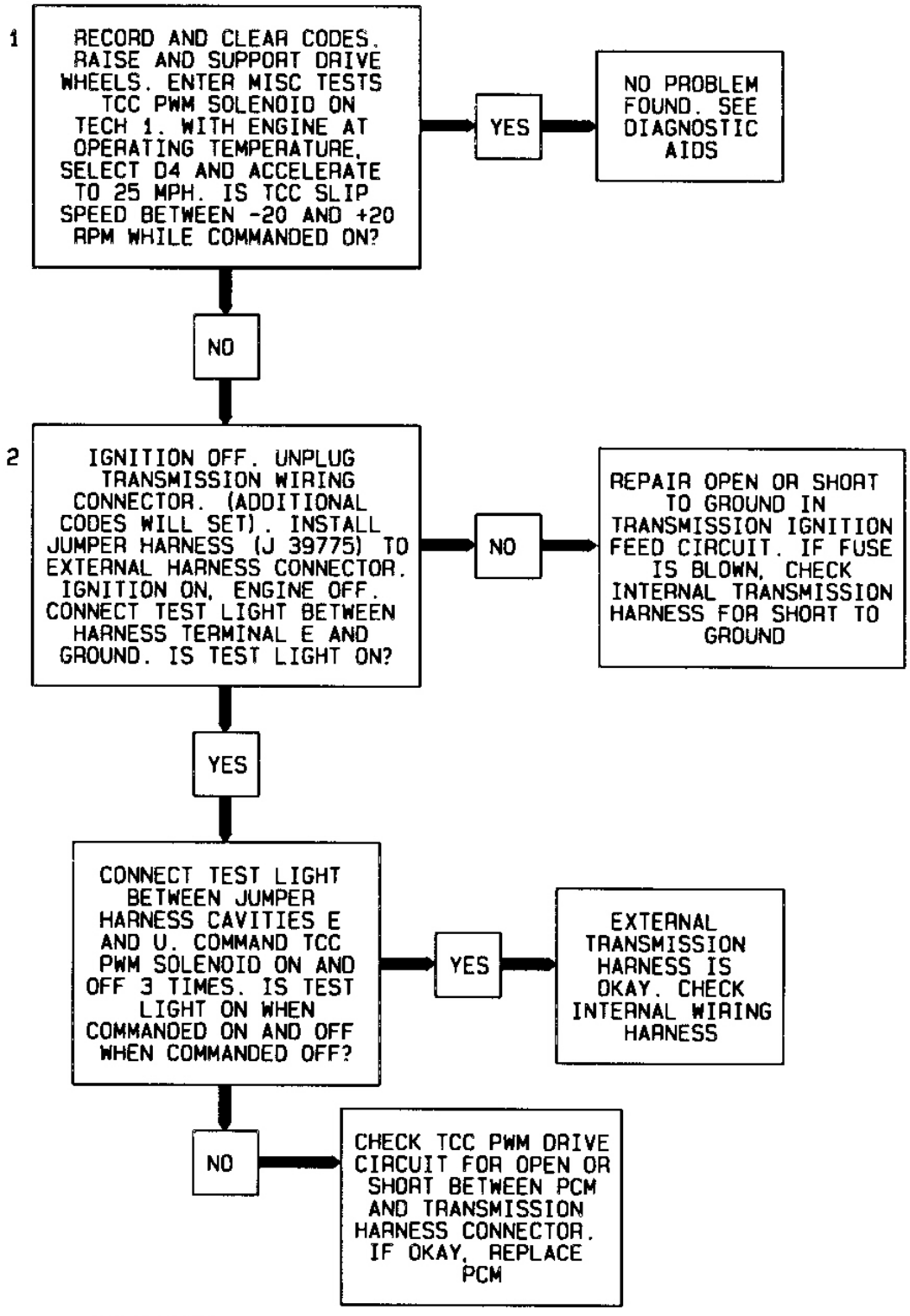
Control module continually monitors voltage on each circuit connected to quad-driver for either low or high voltage, depending on commanded state of device connected to it. Code 83 will set if control module detects an inappropriate reading on TCC circuit. For example, if TCC duty cycle is zero, but voltage on TCC circuit drops as if solenoid were on, then Code 83 will set. TCC solenoid, because of its large current draw, is connected to 2 terminals of a single quad-driver.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks if control module is commanding TCC solenoid on.
2. This test checks for voltage to solenoid.

Diagnostic Aids

Check all connections, especially those at transmission pass-thru connector.


1
RECORD AND CLEAR CODES. RAISE AND SUPPORT DRIVE WHEELS. ENTER MISC TESTS TCC PWM SOLENOID ON TECH 1. WITH ENGINE AT OPERATING TEMPERATURE, SELECT D4 AND ACCELERATE TO 25 MPH. IS TCC SLIP SPEED BETWEEN -20 AND +20 RPM WHILE COMMANDED ON?
YES
NO PROBLEM FOUND. SEE DIAGNOSTIC AIDS
NO
2
IGNITION OFF. UNPLUG TRANSMISSION WIRING CONNECTOR. (ADDITIONAL CODES WILL SET). INSTALL JUMPER HARNESS (J 39775) TO EXTERNAL HARNESS CONNECTOR. IGNITION ON, ENGINE OFF. CONNECT TEST LIGHT BETWEEN HARNESS TERMINAL E AND GROUND. IS TEST LIGHT ON?
NO
REPAIR OPEN OR SHORT TO GROUND IN TRANSMISSION IGNITION FEED CIRCUIT. IF FUSE IS BLOWN, CHECK INTERNAL TRANSMISSION HARNESS FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN JUMPER HARNESS CAVITIES E AND U. COMMAND TCC PWM SOLENOID ON AND OFF 3 TIMES. IS TEST LIGHT ON WHEN COMMANDED ON AND OFF WHEN COMMANDED OFF?
YES
EXTERNAL TRANSMISSION HARNESS IS OKAY. CHECK INTERNAL WIRING HARNESS
NO
CHECK TCC PWM DRIVE CIRCUIT FOR OPEN OR SHORT BETWEEN PCM AND TRANSMISSION HARNESS CONNECTOR. IF OKAY, REPLACE PCM

95D14350

Fig. 147: Code 83, Flow Chart (Trucks & Vans) Courtesy of General Motors Corp.

DIAGNOSTIC CHARTS - LIGHT TRUCKS & VANS - DIESEL

INTRODUCTION

Diagnostic Charts

Following charts are DTC specific. For terminal locations, see **WIRING DIAGRAMS**. For engine-related DTCs, see appropriate TESTS W/CODES article in ENGINE PERFORMANCE section.

Diagnostic Aids

Diagnostic aids located in many trouble code charts are additional tips used to help diagnose trouble codes when circuit checks do not find a problem.

NOTE: In following diagnostic tests, schematics and illustrations are courtesy of General Motors Corp. Powertrain Control Module (PCM) may also be referred to as Electronic Control Module (ECM) or Transmission Control Module (TCM) in some diagnostic charts and figures. Terms are used interchangeably.

ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK

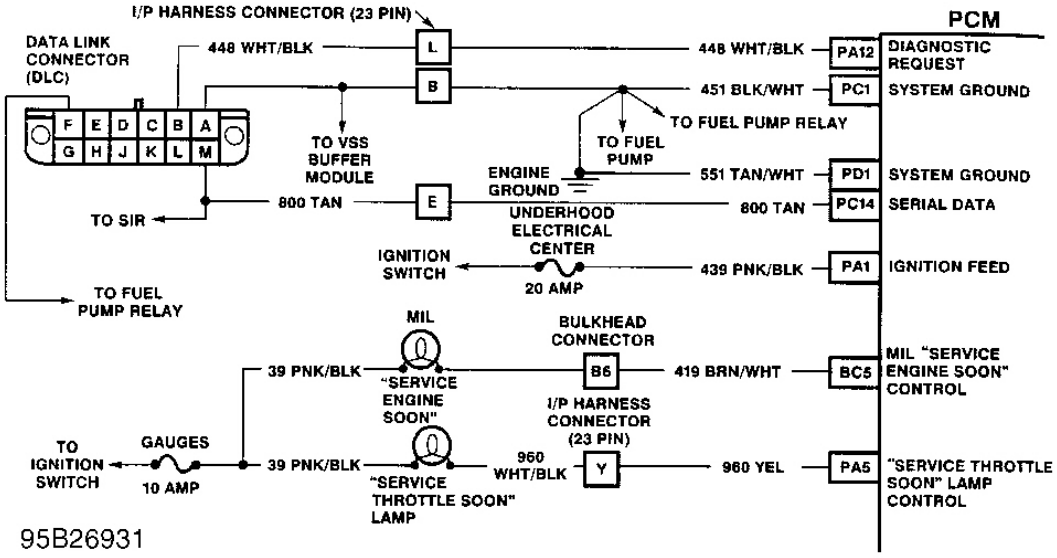


Fig. 148: On-Board Diagnostic System Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

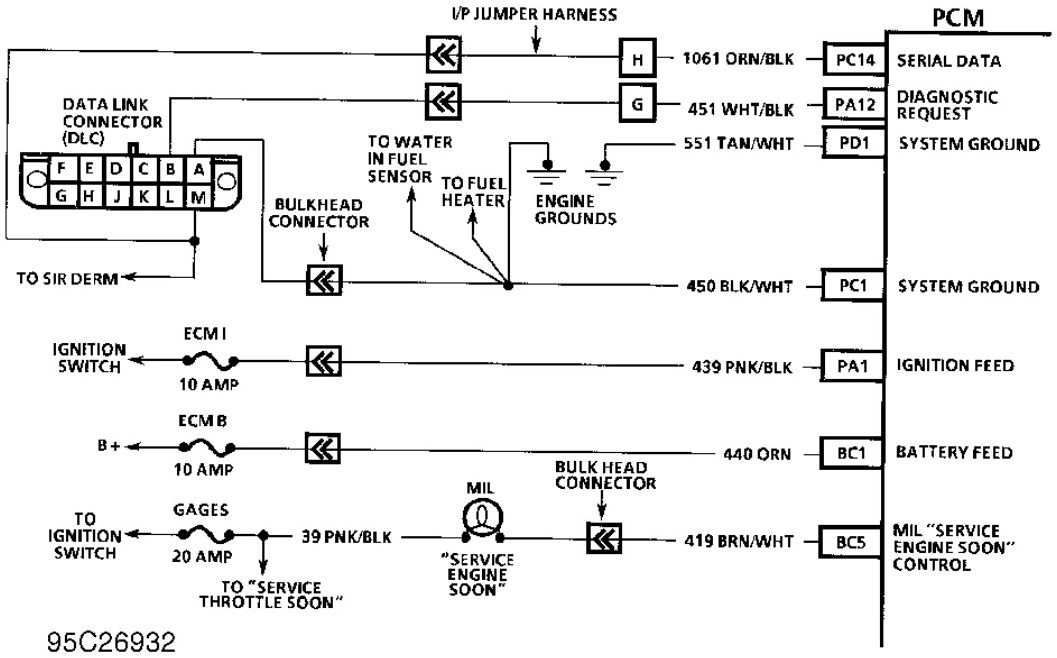


Fig. 149: On-Board Diagnostic System Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

The On-Board Diagnostic (OBD) system check is an organized approach to identifying a problem created by a control module system malfunction. This is the starting point for any driveability complaint diagnosis, as it directs technician to the next logical step in diagnosis, helps reduce diagnostic time and prevents the unnecessary replacement of good parts.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This tests MIL operation. With ignition on and engine off, light should be on.
2. This step will isolate if customer complaint is a MIL or driveability problem.
3. Although the control module is powered up, a symptom could exist because of a system fault.
4. Use Tech-1 to aid in diagnosis (to check if serial data is available). If a PROM error is present, the PCM may have been able to flash DTC 12 or 51, but not enable serial data.
5. Although the control module is powered up, a "CRANKS BUT WILL NOT RUN" symptom could exist because of a PCM or system fault.
6. This step will isolate if customer complaint is a MIL or driveability problem with no MIL displayed. See PCM TROUBLE CODE DEFINITIONS table under **TROUBLE CODE DEFINITIONS**, to determine if code is valid. An invalid DTC may be the result of a faulty scan tester, PROM or PCM.
7. Comparison of actual control system data with typical scan tester data values is a quick check to determine if any parameter is not within limits. A base engine problem (i.e. advanced cam timing) may substantially alter sensor values.

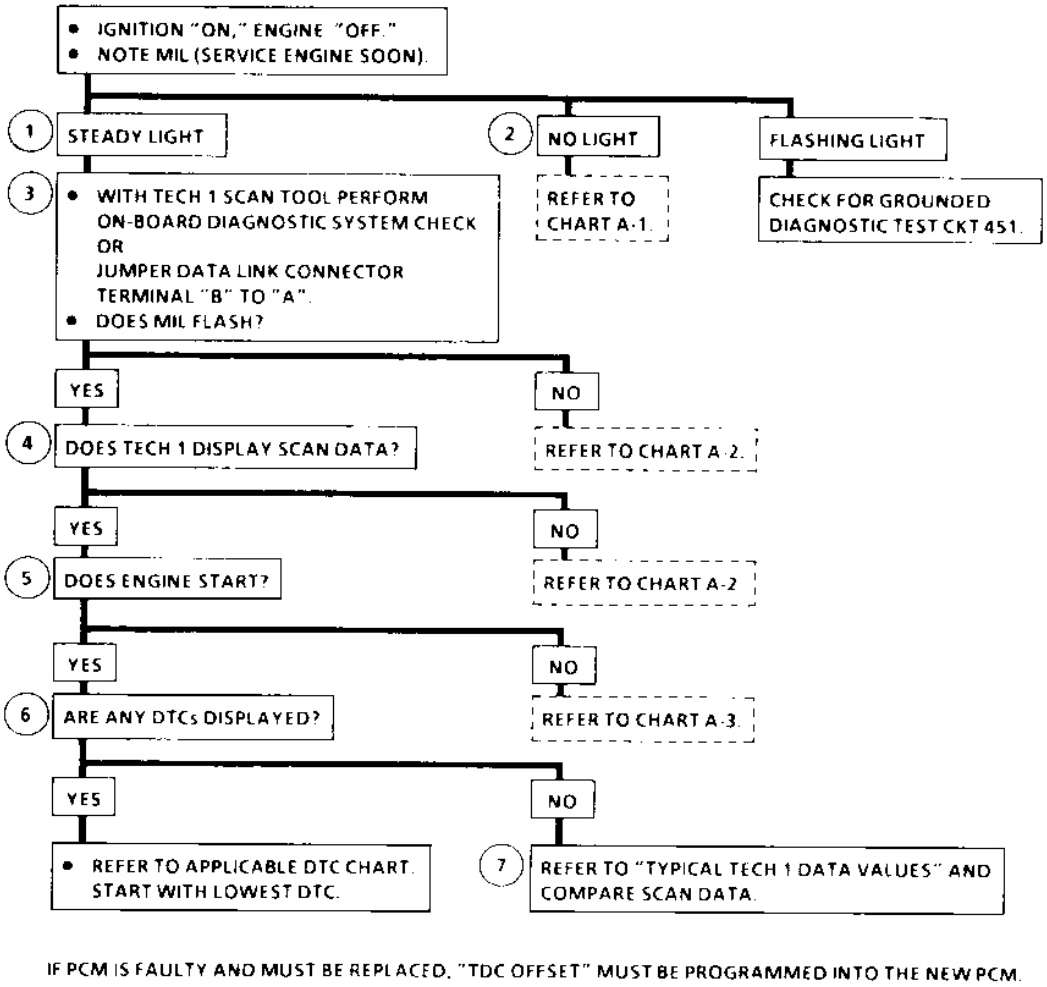


Fig. 150: On-Board Diagnostic System Flow Chart (Diesel) Courtesy of General Motors Corp.

CHART A-1, NO MIL (SERVICE ENGINE SOON LIGHT)

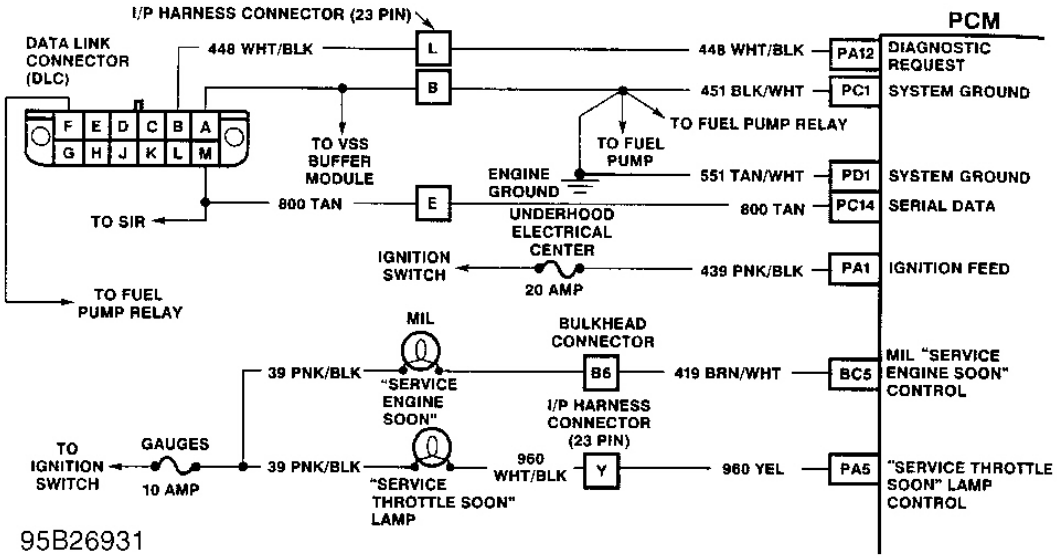


Fig. 151: Chart A-1, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

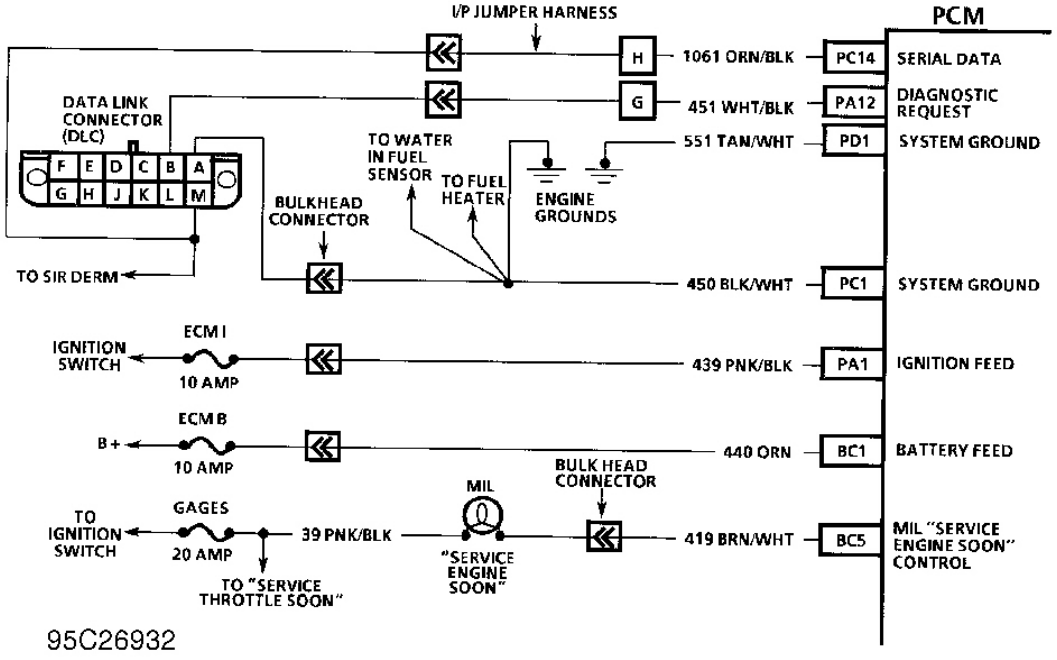


Fig. 152: Chart A-1, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

MIL should be on when engine is off and ignition is on. Switched battery voltage is supplied to MIL. The PCM

turns light on by providing a ground path through the MIL (SERVICE ENGINE SOON) control circuit.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If fusible link or ECM-B fuse is blown, refer to the **WIRING DIAGRAMS** for complete circuit.
2. Using a test light connected to 12 volts, probe each of the system ground circuits to ensure a good ground is present.

Diagnostic Aids

If engine functions properly, check for a burned out bulb, blown GAUGES or ALT fuse, or an open in the MIL (SERVICE ENGINE SOON) control circuit. This will result in no brake warning light, oil or generator lights, seat belt reminder, etc.

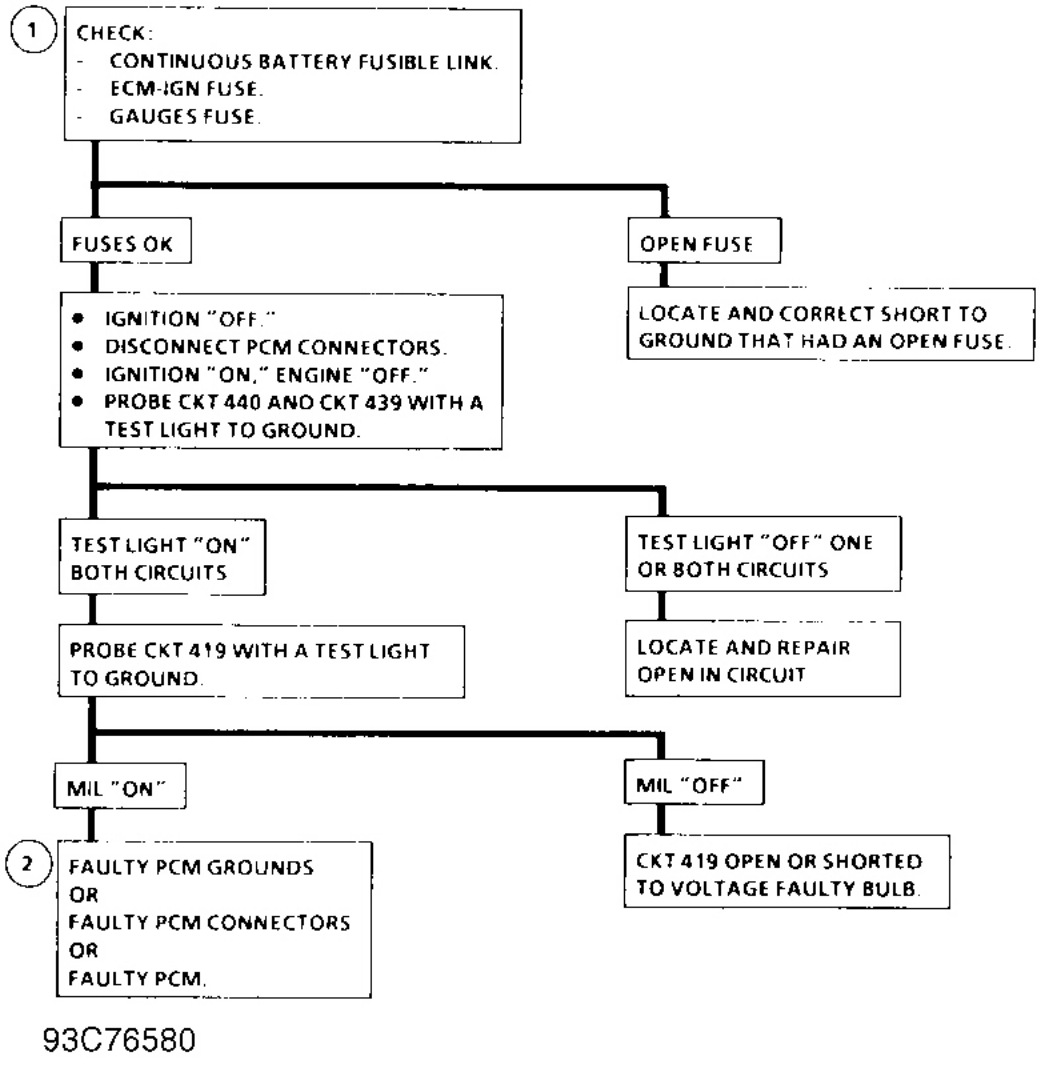


Fig. 153: Chart A-1, Flow Chart (Diesel) Courtesy of General Motors Corp.

CHART A-2, NO SCAN DATA, MIL (SES) ALWAYS ON OR WON'T FLASH

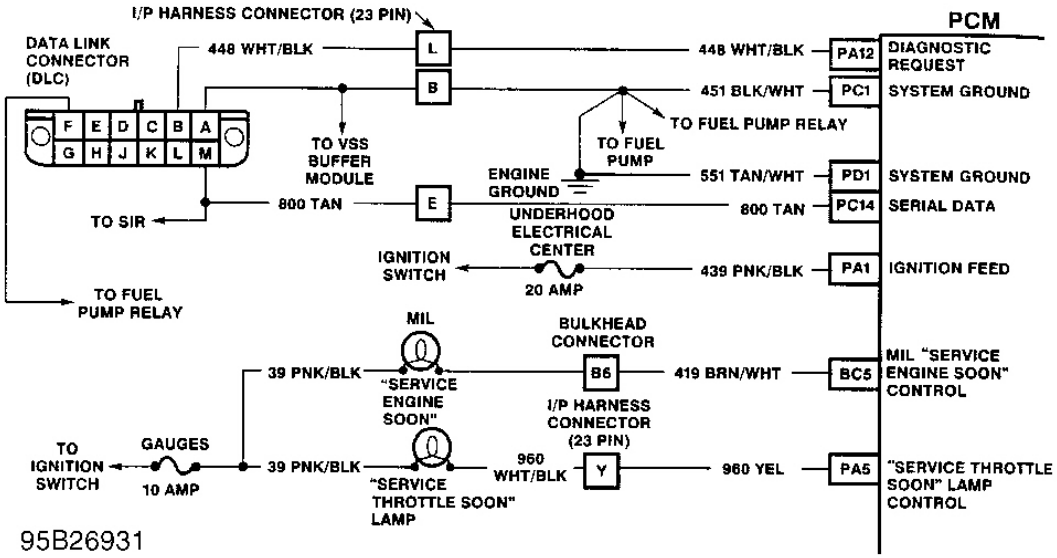


Fig. 154: Chart A-2, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

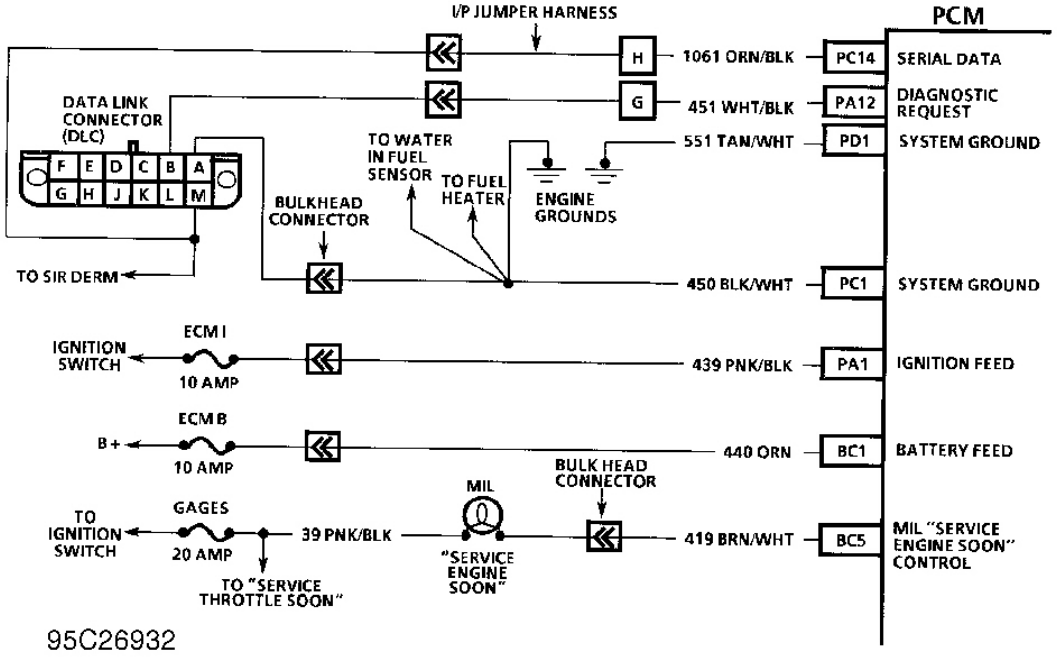


Fig. 155: Chart A-2, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

MIL should be on when engine is off and ignition is on. Switched battery voltage is supplied to MIL. The PCM

turns light on by providing a ground path through the MIL (SERVICE ENGINE SOON) control circuit. With diagnostic terminal grounded, MIL should flash DTC 12, followed by any other DTC stored in memory. A steady light on indicates a short to ground in the MIL (SERVICE ENGINE SOON) control circuit or an open in the diagnostic request circuit.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If there is a problem with PCM that causes scan tester not to read serial data, PCM should not flash DTC 12. If DTC 12 does flash, ensure scan tester is functioning properly (on another vehicle). If scan tester is functioning properly, and serial data circuit is okay, PROM, PCM or SIR DERM may be at fault for the NO DLC symptom.
2. If light goes off when PCM connector is disconnected, MIL (SERVICE ENGINE SOON) control circuit is not shorted to ground.
3. This step checks for an open in the diagnostic request circuit.
4. At this point, MIL wiring is okay. Problem is a faulty PROM. If DTC 12 does not flash, PCM should be replaced using original PROM. Replace PROM only after trying a PCM. A defective PROM usually is an unlikely cause of problem.

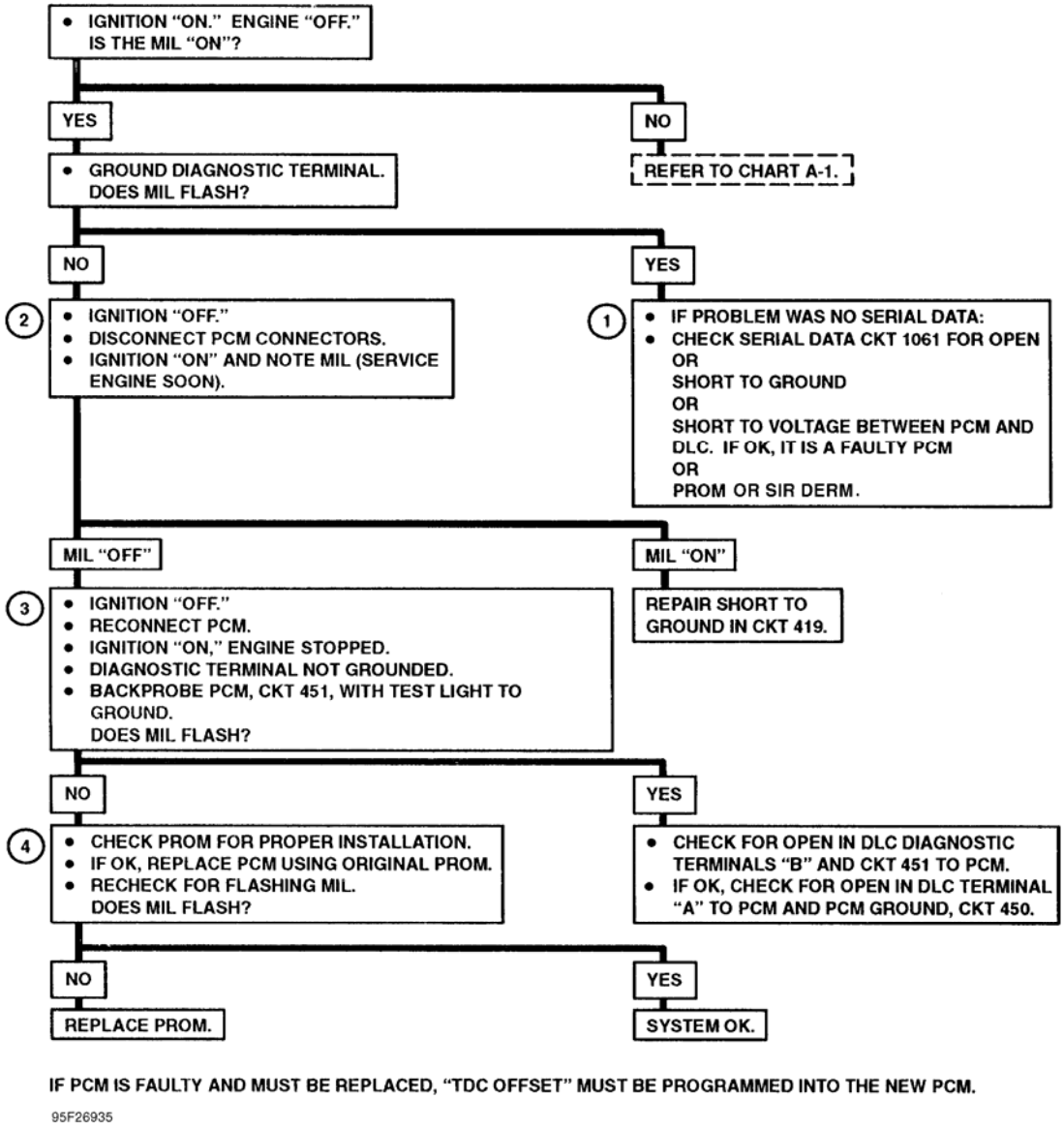


Fig. 156: Chart A-2, Flow Chart (Diesel) Courtesy of General Motors Corp.

CHART A-3, ENGINE CRANKS BUT WILL NOT RUN

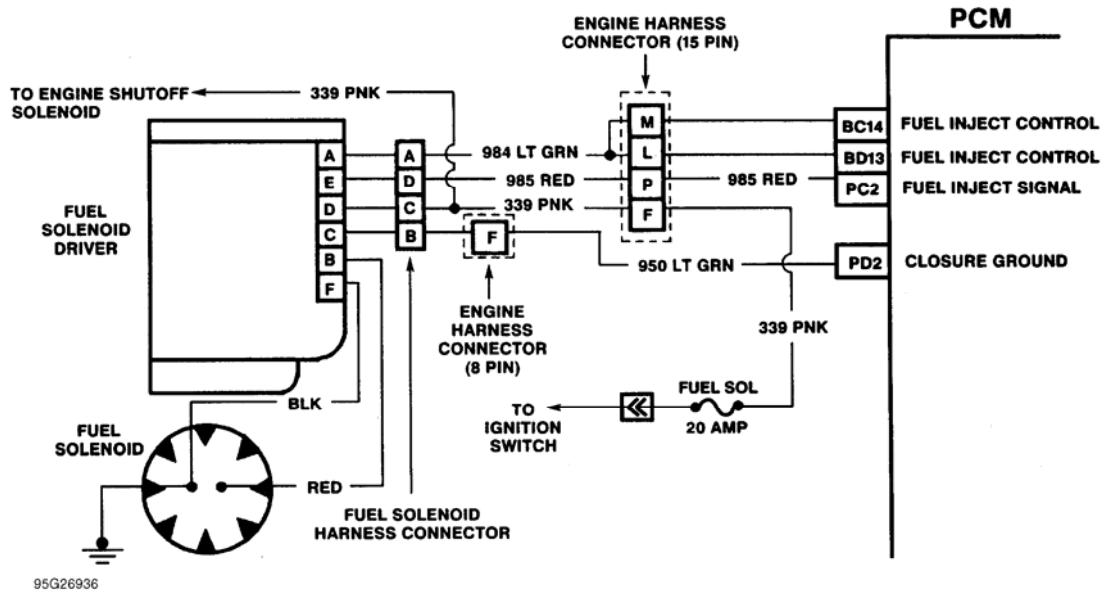


Fig. 157: Chart A-3, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

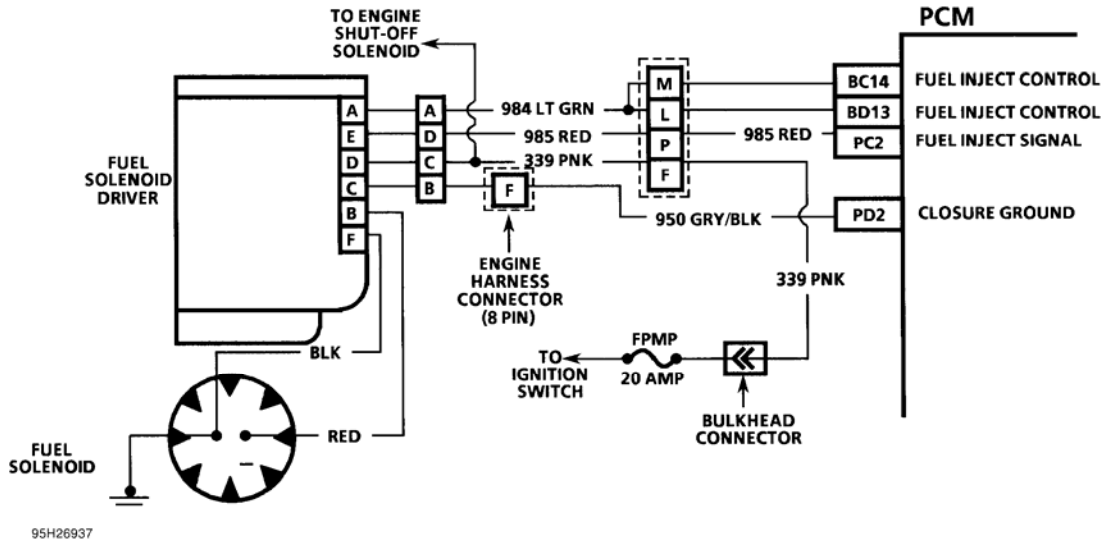


Fig. 158: Chart A-3, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

This chart assumes battery condition and engine cranking speed are okay, there is adequate fuel in tank, and glow plug system is operating okay.

NOTE: Test numbers refer to numbers on diagnostic chart.

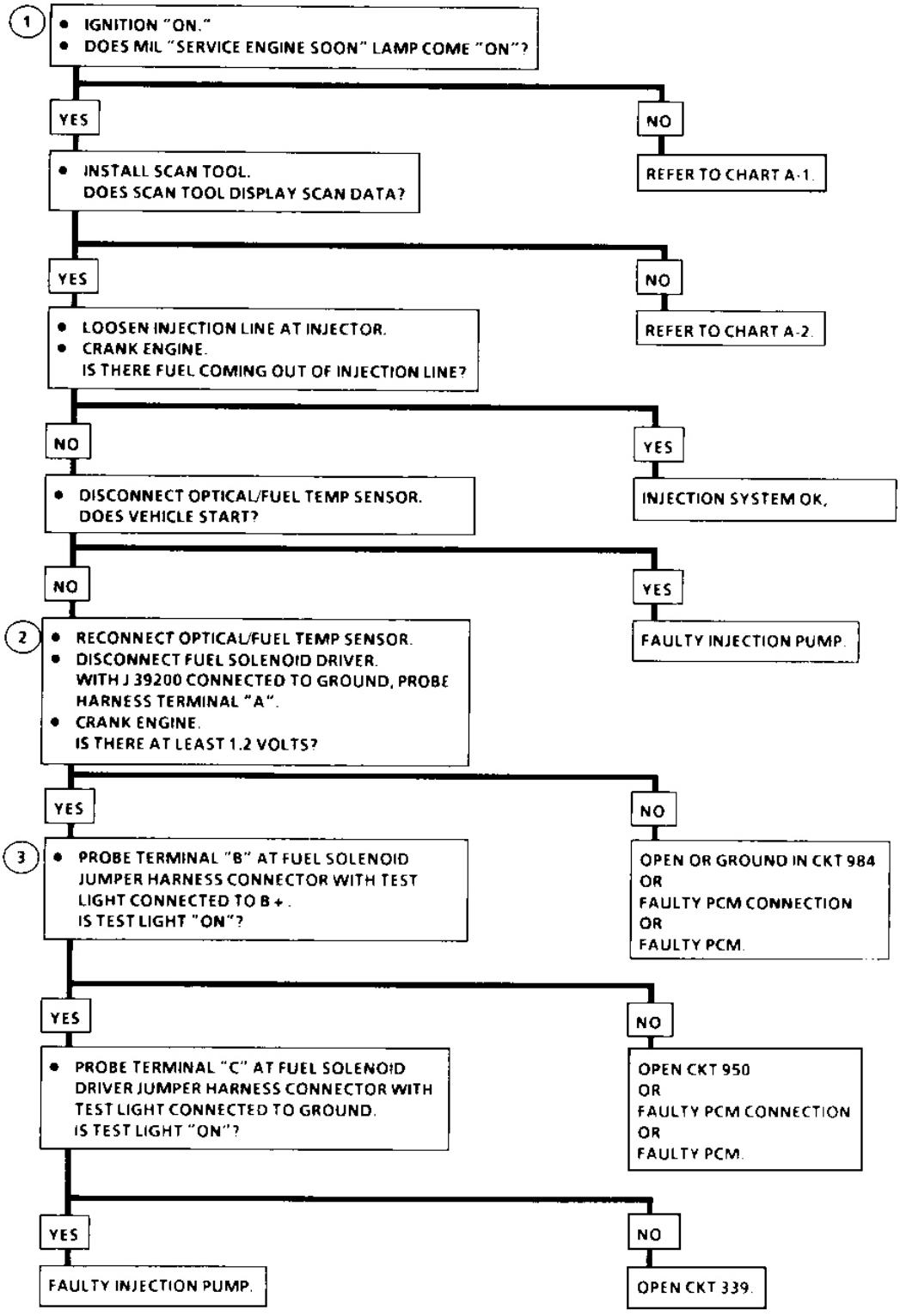
1. A MIL on is a basic test to determine if there is a 12 volts supply and ignition 12 volts to PCM. No DLC may be due to a PCM problem and CHART A-2 will diagnose PCM.

2. This step will check to see if there is an inject command coming from PCM.
3. This step will check ground circuit.

Diagnostic Aids

If no problem is found in fuel pump circuit or ignition system and cause of a "ENGINE CRANKS BUT WILL NOT RUN" has not been found, check for: water or foreign material in fuel system, and/or a basic engine problem.

NOTE: If crankshaft position sensor and optical sensor are disconnected or inoperable at the same time this will cause an "ENGINE CRANKS BUT WILL NOT RUN" condition.



IF PCM IS FAULTY AND MUST BE REPLACED, "TDC OFFSET" MUST BE PROGRAMMED INTO THE NEW PCM

94C65609

Fig. 159: Chart A-3, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 14, ECT SENSOR CKT LOW (HIGH TEMPERATURE INDICATED)

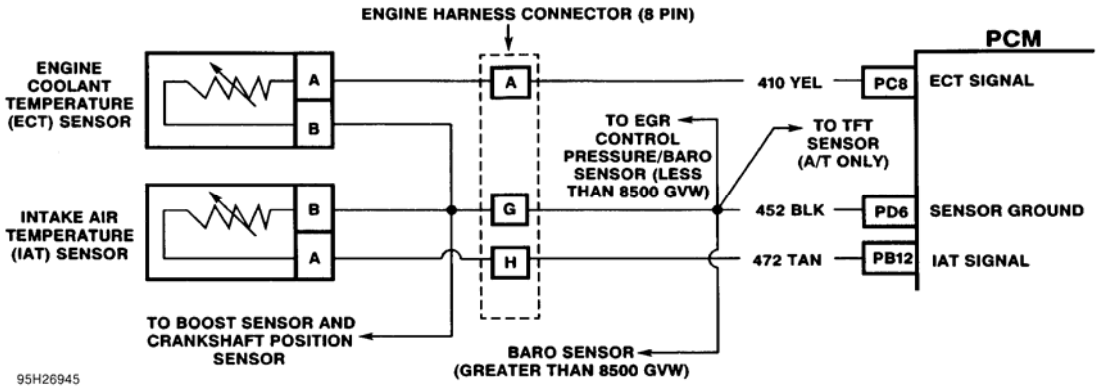


Fig. 160: DTC 14, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

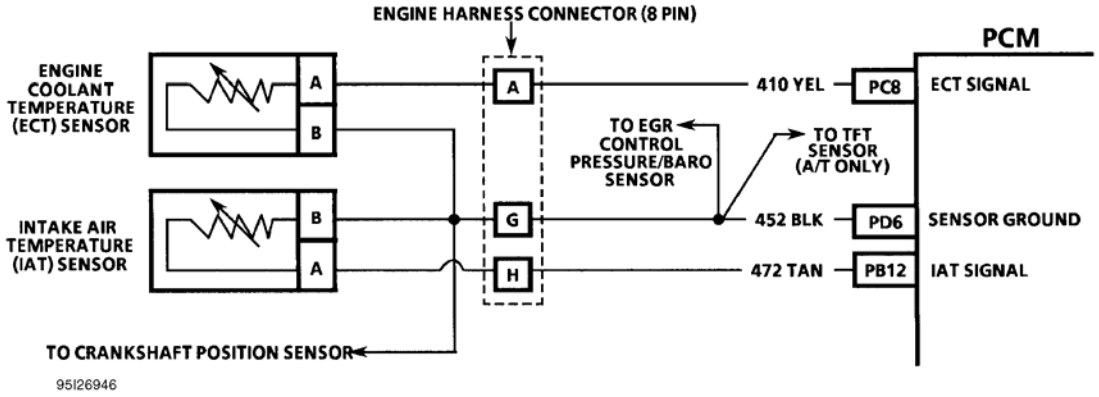


Fig. 161: DTC 14, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

Engine Coolant Temperature (ECT) sensor is a thermistor that controls signal voltage to PCM. When engine is cold, sensor resistance is high, and PCM will sense a high signal voltage. As engine warms, sensor resistance becomes less and voltage drops. DTC 14 will set when engine coolant temperature is greater than 304°F (151° C) for 2 seconds.

PCM will default to a engine coolant temperature of 171°F 77°C).

NOTE: Test numbers refer to numbers on diagnostic chart.

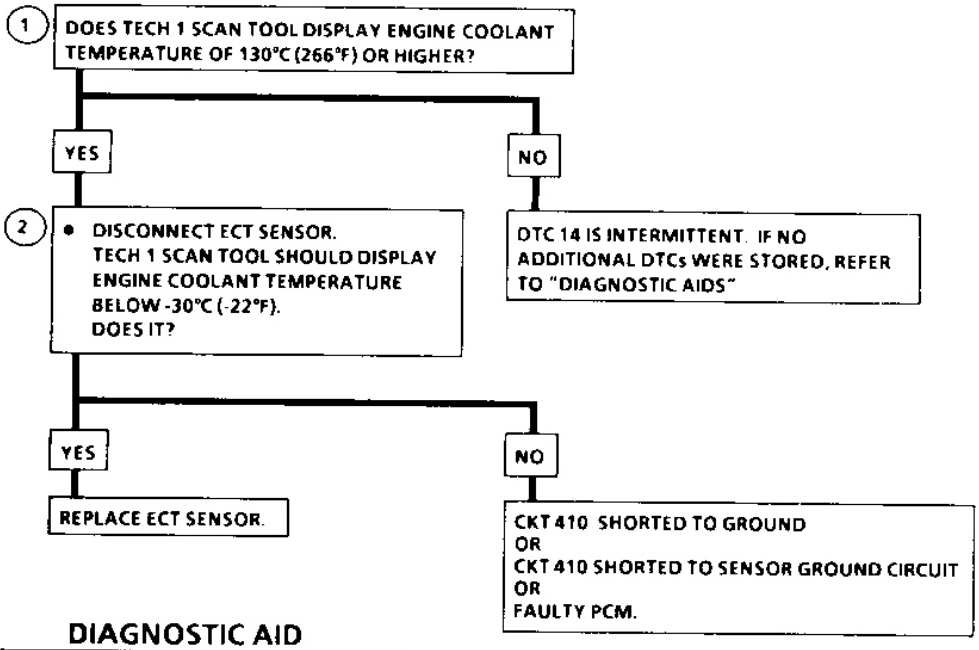
1. This step determines if DTC 14 is the result of a hard failure or an intermittent condition.
2. This step determines if ECT signal circuit is shorted to ground.

Diagnostic Aids

Check wiring harness routing for a potential short circuit to ground. After starting engine, coolant temperature should rise to about 185°F (85°C). PCM default value will flash on data screen intermittently.

Test engine coolant temperature sensor at various temperature levels to evaluate possibility of a skewed (mis-scaled) sensor. See TEMPERATURE VS. RESISTANCE VALUES table. A skewed sensor could result in poor driveability complaints.

* IF DTC 57 IS ALSO STORED, REFER TO THAT CHART FIRST.



DIAGNOSTIC AID

ENGINE COOLANT TEMPERATURE SENSOR TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

IF PCM IS FAULTY AND MUST BE REPLACED, "TDC OFFSET" MUST BE PROGRAMMED INTO THE NEW PCM.

WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION.

94H65620

Fig. 162: DTC 14, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 15, ECT SENSOR CKT HIGH (LOW TEMPERATURE INDICATED)

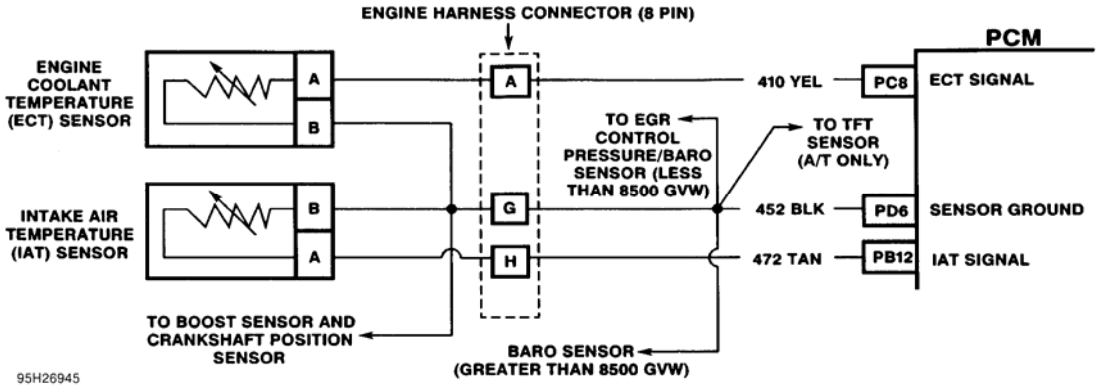


Fig. 163: DTC 15, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

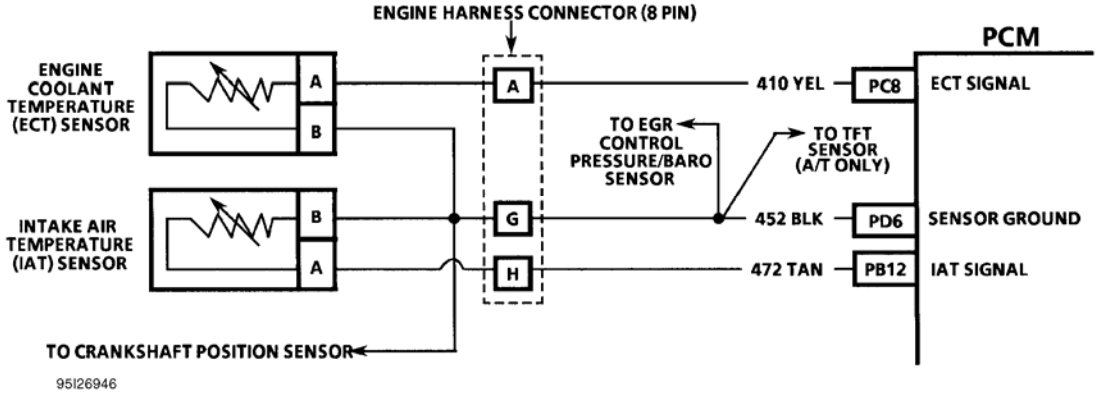


Fig. 164: DTC 15, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

Engine Coolant Temperature (ECT) sensor is a thermistor that controls signal voltage to PCM. When engine is cold, sensor resistance is high, and PCM will sense a high signal voltage. As engine warms, sensor resistance becomes less and voltage drops. DTC 15 will set when engine coolant temperature is less than -33°F (-36°C) and engine has been running for at least 8 minutes.

PCM will default to a engine coolant temperature of 64°F 18°C) and increase idle speed.

NOTE: Test numbers refer to numbers on diagnostic chart.

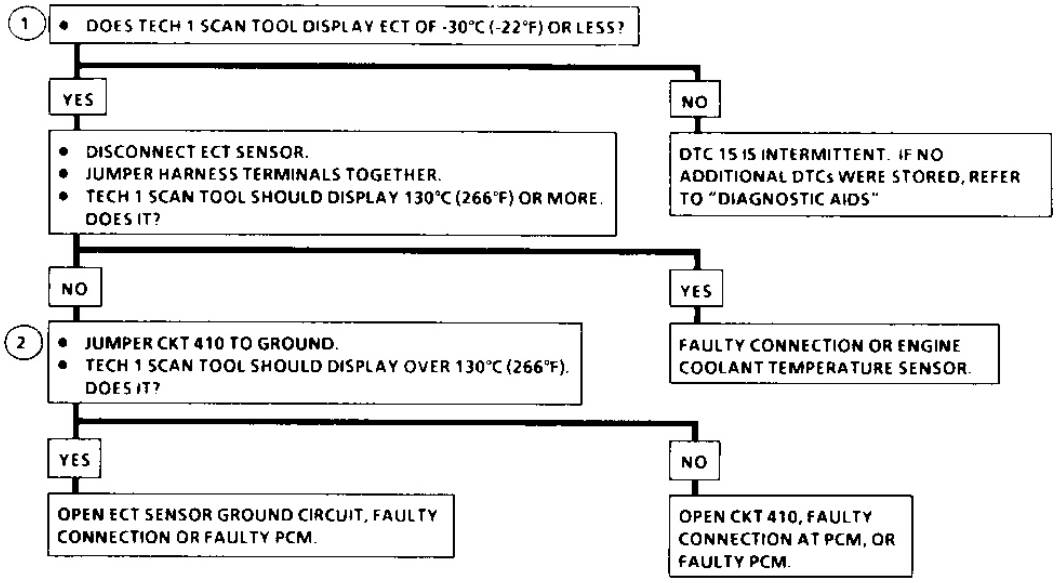
1. This step determines if DTC 15 is the result of a hard failure or an intermittent condition.
2. This step determines if ECT signal circuit is open or for a faulty PCM.

Diagnostic Aids

Check wiring harness routing for a potential short circuit to ground. After starting engine, coolant temperature

should rise to about 185°F (85°C). PCM default value will flash on data screen intermittently.

Test engine coolant temperature sensor at various temperature levels to evaluate possibility of a skewed (mis-scaled) sensor. See TEMPERATURE VS. RESISTANCE VALUES table. A skewed sensor could result in poor driveability complaints.



DIAGNOSTIC AID

ENGINE COOLANT TEMPERATURE SENSOR TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

IF PCM IS FAULTY AND MUST BE REPLACED, "TDC OFFSET" MUST BE PROGRAMMED INTO THE NEW PCM.

WHEN ALL DIAGNOSIS AND REPAIRS ARE COMPLETED, CLEAR DTC(s) AND VERIFY PROPER OPERATION

94165621

Fig. 165: DTC 15, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 24, VSS CIRCUIT LOW (TRANS OUTPUT SPEED SIGNAL)

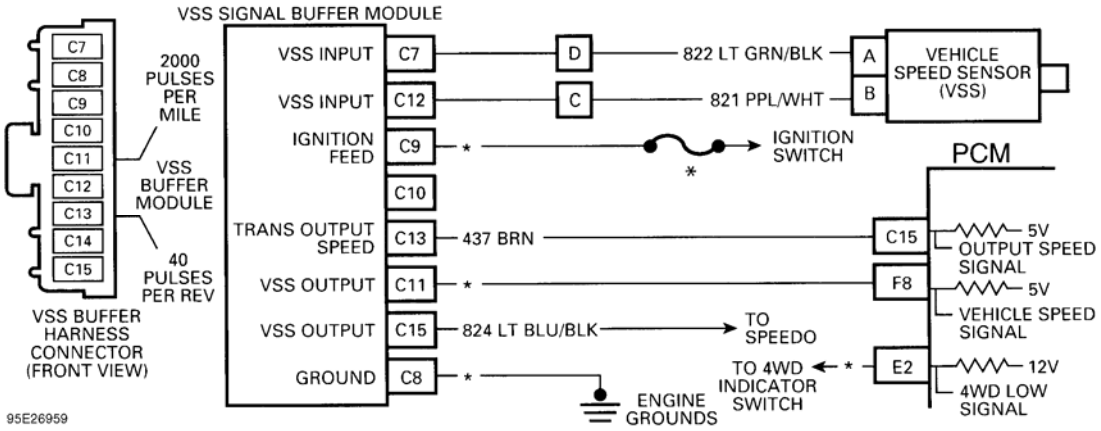


Fig. 166: DTC 24, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

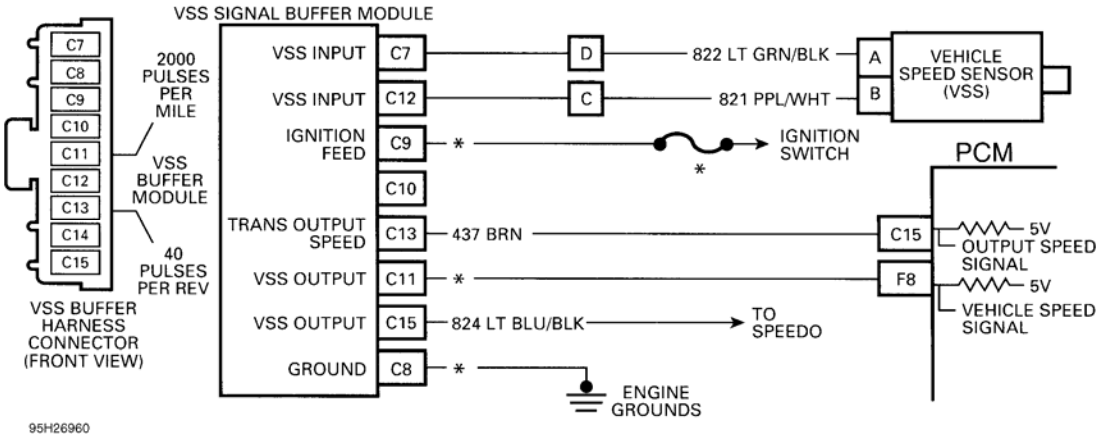


Fig. 167: DTC 24, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

Vehicle Speed Sensor (VSS) circuit consists of a magnetic induction type sensor, VSS buffer module, 4WD low switch (if equipped), and wiring. Gear teeth pressed onto output shaft induces an alternating voltage into sensor. This signal is transmitted to VSS buffer module. VSS buffer module compensates for various final drive ratios. VSS buffer module will also convert AC VSS signal into a 40 pulse per revolution DC signal on trans output speed circuit to indicate transmission output speed. On 4WD vehicles, 4WD low signal will also be used for adjustment of 40 pulse per revolution signal to PCM.

DTC 24 will set when:

- Gear selector is not in Park or Neutral.
- Trans output speed circuit voltage is constant.
- Engine speed is greater than 3000 RPM.
- Output speed is less than 250 RPM.
- MAP is less than 100 kPa.

- Throttle position is 10-100 percent.
- All conditions are met for 3 seconds.
- DTCs 21, 22, 28, 33 or 34 are not set. PCM will default to 2nd gear only at maximum line pressure.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks for voltage to VSS buffer module.
2. This test checks ground circuit to VSS buffer module.
3. This test checks VSS circuit at VSS buffer module.
4. This test checks for an output speed signal from VSS buffer module.

Diagnostic Aids

DTC 24 will set when no vehicle speed is detected at vehicle start off. DTC 72 will set when vehicle speed has been detected and is lost.

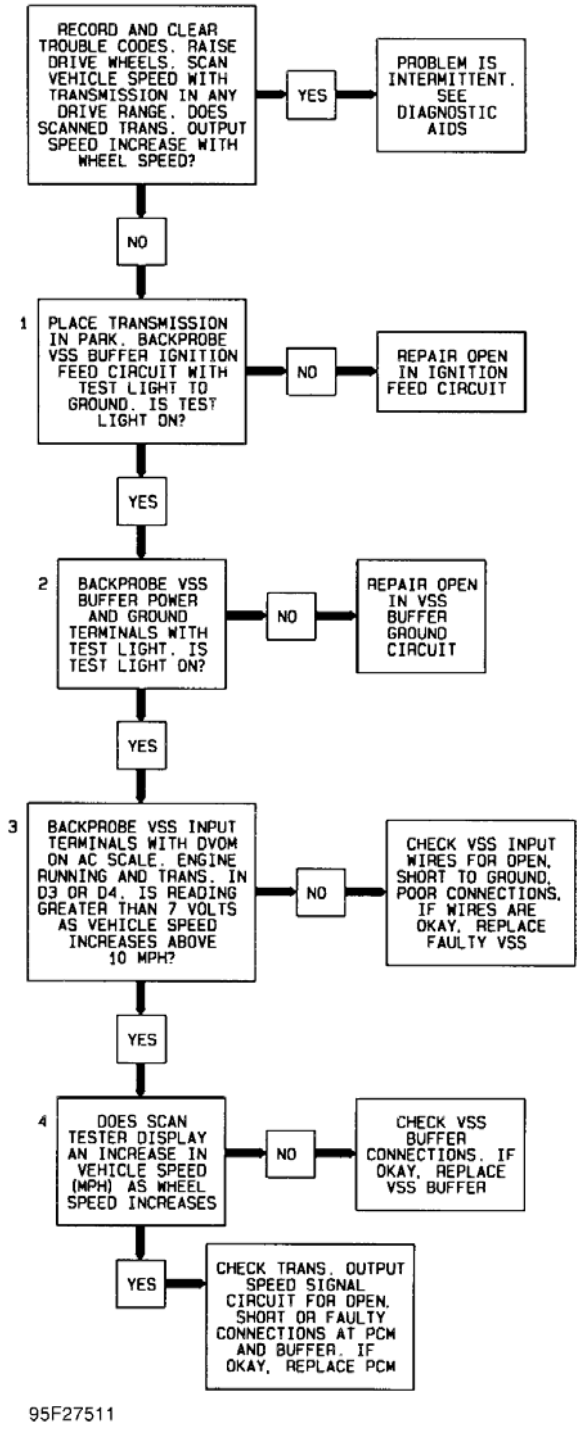


Fig. 168: DTC 24, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 28, TRANS. RANGE PRESSURE SWITCH CIRCUIT FAULT

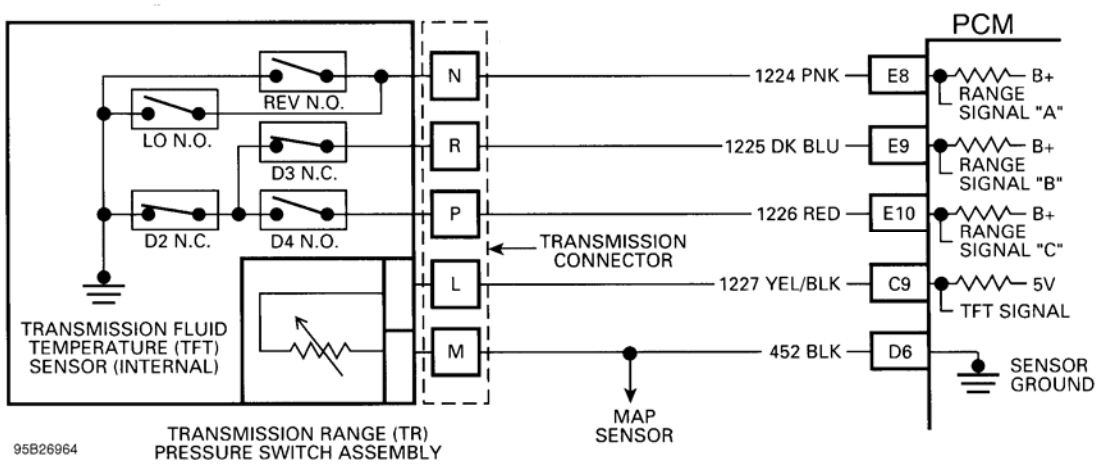


Fig. 169: DTC 28, Circuit Diagram (Diesel) Courtesy of General Motors Corp.

Transmission range pressure switch assembly consists of 5 pressure switches (2 normally closed, 3 normally open), and a fluid temperature sensor combined into one unit and mounted on valve body. PCM supplies voltage to each range signal. By grounding one or more of these circuits through various combinations of pressure switches, PCM detects which manual valve position has been selected. With ignition on and engine off, Park/Neutral will be indicated. When transmission electrical connector is disconnected, ground potential for the 3 signals to PCM will be removed, and with ignition on, D2 will be indicated. DTC 28 will set when range signals "A" and "C" are both zero volts (on) for 2 seconds.

PCM will default to harsh shifts, D4 shift control. TCC will be inhibited, and if in hot mode, 4th gear will not be available. DTC 28 will be stored in PCM memory, but will not turn on MIL.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks indicated range signal to manual valve position actually selected.
2. This test checks for correct voltage from PCM to transmission external connector.
3. This test checks for short to ground from PCM to transmission external connector in any one of the 3 circuits.

Diagnostic Aids

DTC 28 will set if PCM detects one of 2 illegal combinations. See **TRANSMISSION RANGE PRESSURE SWITCH COMBINATIONS** table. Check all wiring connectors for proper terminal tension. For current DTC 28, range signal will default to D4 while A/B/C range values continue to read actual trans. range pressure switch output for each range selection.

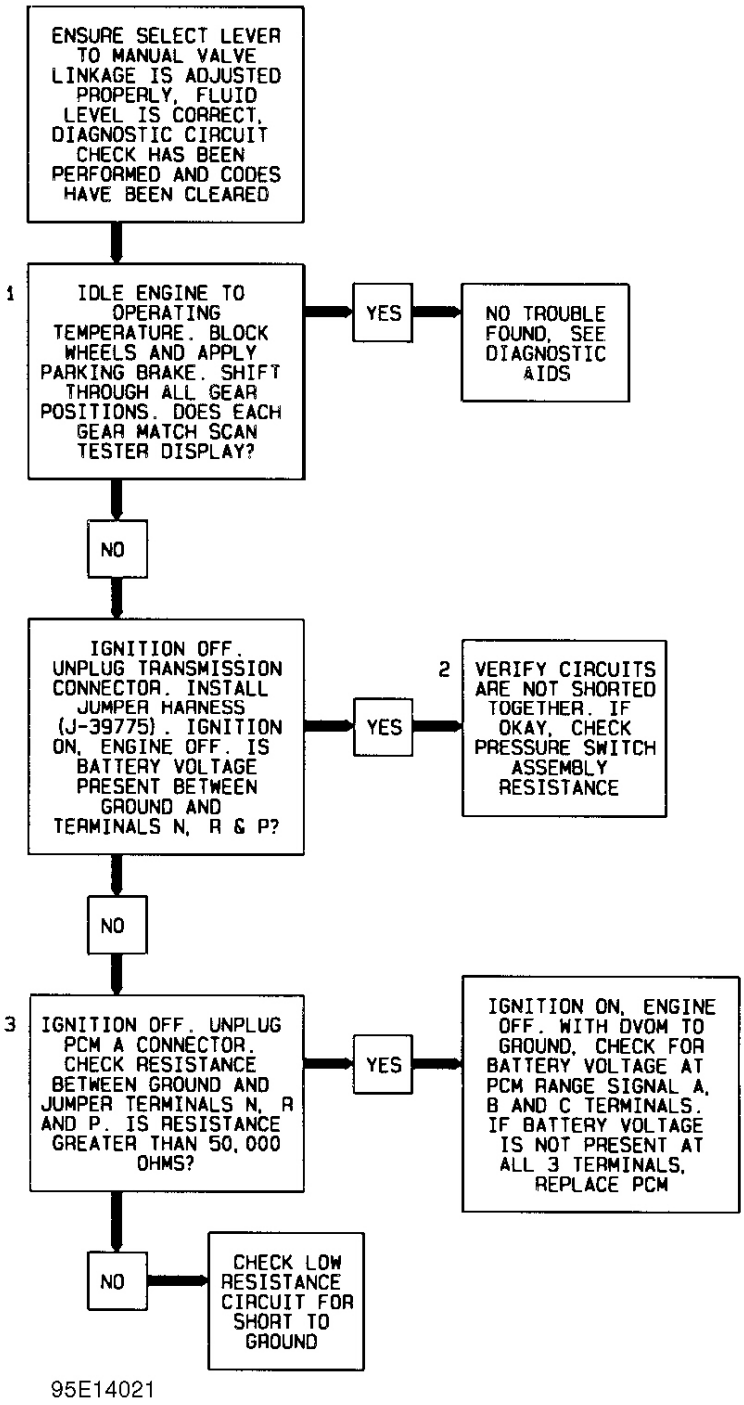


Fig. 170: DTC 28, Flow Chart (Diesel) Courtesy of General Motors Corp.

TRANSMISSION RANGE PRESSURE SWITCH COMBINATIONS (1)

Application	A	B	C

Park	Off	On	Off
Reverse	On	On	Off
Neutral	Off	On	Off
4th	Off	On	On
3rd	Off	Off	On
2nd	Off	Off	Off
1st	On	Off	Off
Illegal	On	Off	On
Illegal	On	On	On
(1) On - Battery voltage/Off - Zero volt.			

DTCS 37/38, TCC BRAKE SWITCH STUCK ON/OFF

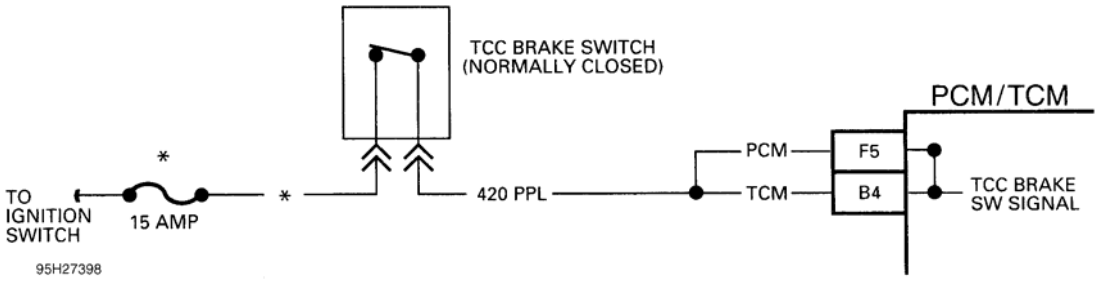


Fig. 171: DTC 37/38, Circuit Diagram (Diesel) Courtesy of General Motors Corp.

Normally closed brake switch supplies a B+ signal on TCC brake switch signal circuit to PCM. When brakes are applied signal voltage is opened.

DTC 37 will set when:

- TCC brake switch signal circuit is open.
- Vehicle speed is less than 5 MPH for greater than 6 seconds.
- Then vehicle speed is 5-20 MPH for greater than 6 seconds.
- Then vehicle speed is greater than 20 MPH for greater than 6 seconds.
- For a total of 7 times.

DTC 38 will set when:

- TCC brake switch signal circuit has constant voltage.
- Vehicle speed is greater than 20 MPH for greater than 6 seconds.
- Then vehicle speed is 5-20 MPH for greater than 6 seconds.
- For a total of 7 times.

PCM will default to an incorrect brake signal can affect TCC scheduling. Also, an incorrect brake signal can inhibit 4th gear operation, if in hot mode. DTCS 37/38 will be stored in PCM memory, but will not turn on MIL.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks for voltage at brake switch.
2. This test checks brake switch.
3. This test checks TCC brake switch signal circuit at PCM.

Diagnostic Aids

If DTC is intermittent, check customer driving habits and/or for unusual traffic conditions (stop and go, expressway traffic).

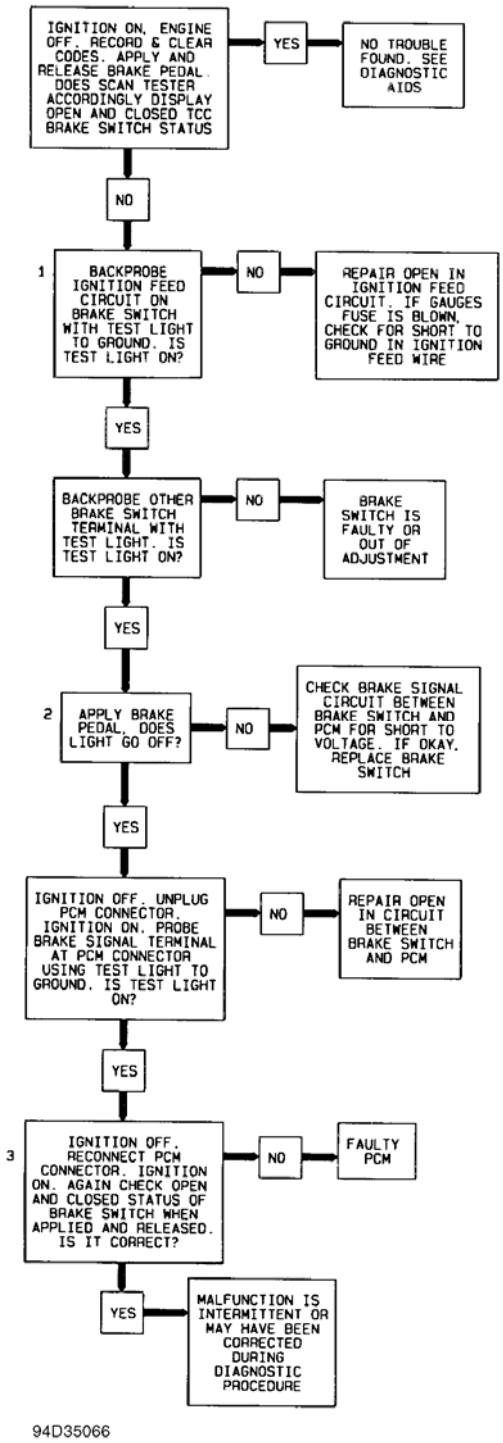


Fig. 172: DTC 37/38, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTCS 52/53, SYSTEM VOLTAGE HIGH TOO LONG

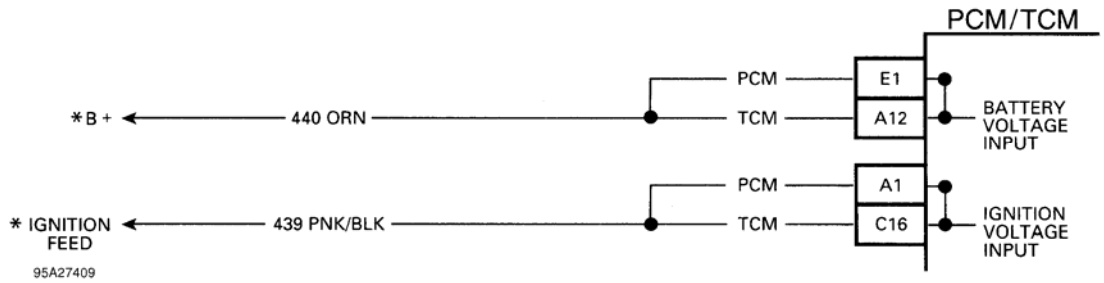


Fig. 173: DTC 52/53, Circuit Diagram (Diesel) Courtesy of General Motors Corp.

Battery voltage input circuit is battery feed for PCM. Ignition voltage input circuit is ignition feed for PCM. DTC 52 will set when ignition is on and PCM battery voltage input circuit terminal voltage is greater than 16 volts for 109 minutes.

DTC 53 will set when ignition is on and PCM battery voltage input circuit terminal voltage is greater than 19.5 volts for 2 seconds.

PCM will default to the pressure control solenoid is turned off, 3-2 control solenoid is turned off, transmission shifts immediately to 3rd gear, and TCC operation will be inhibited. The setting of additional DTCs may result.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks that normal battery voltage is 9-15 volts.
2. This test checks if generator is faulty under load conditions.

Diagnostic Aids

Battery voltage input circuit supplies battery voltage to PCM. Charging battery with a battery charger and jump-starting an engine may set DTCs 52/53. If DTC sets when an accessory is operated, check for faulty connections or excessive current draw. Check for faulty connections at starter solenoid or fusible link.

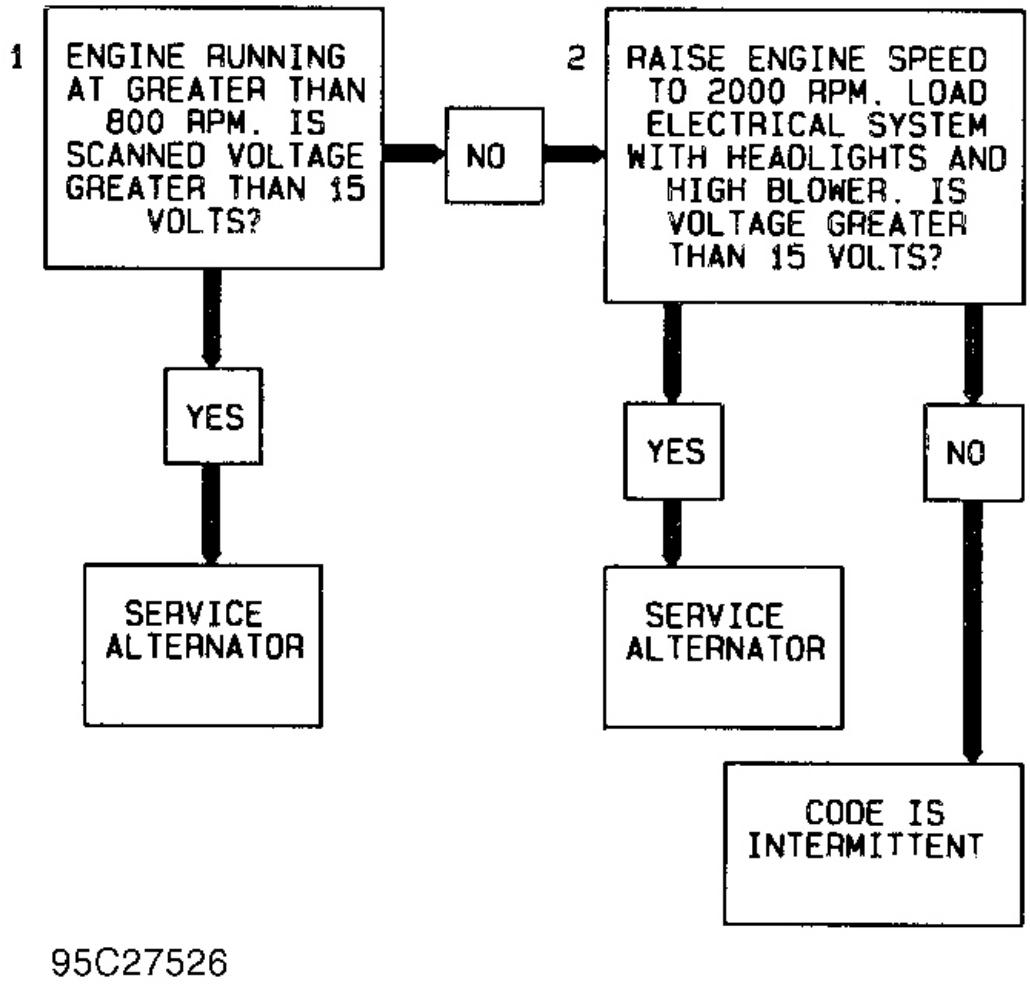


Fig. 174: DTC 52/53, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 58, TRANS. FLUID TEMP. SENSOR CK LOW HIGH TEMPERATURE INDICATED)

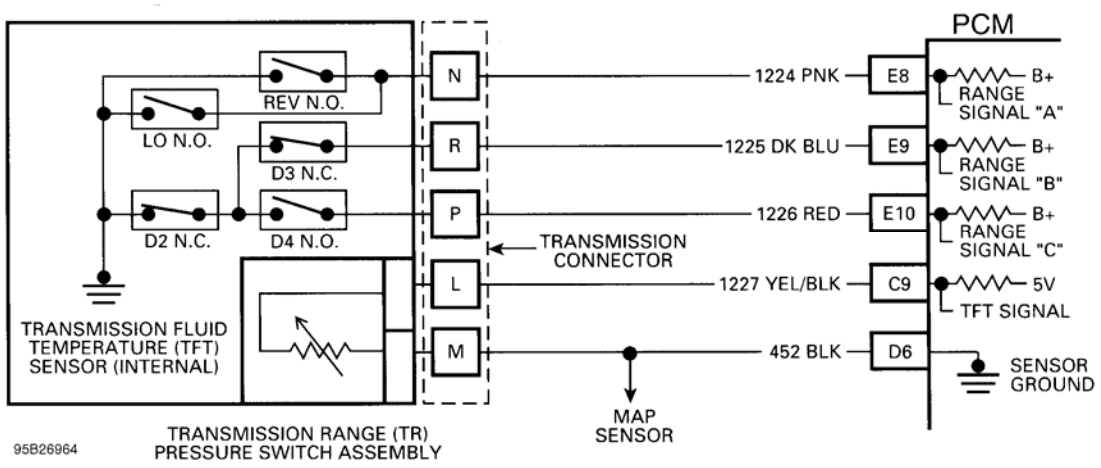


Fig. 175: DTC 58, Circuit Diagram (Diesel) Courtesy of General Motors Corp.

Transmission Fluid Temperature (TFT) sensor is a thermistor within transmission range pressure switch assembly, that controls signal voltage to PCM. PCM applies voltage on 5V TFT signal circuit to sensor. When transmission fluid is cold, sensor resistance is high and PCM will sense high signal voltage.

As transmission fluid temperature warms to normal transmission operating temperature of 212°F (100°C), sensor resistance becomes less and voltage decreases to 1.5-2.0 volts. If DTC 79 is also set, check transmission cooling system. DTC 58 will set when signal voltage indicates TFT greater than 306°F (151°C) for one second.

PCM will default to when DTC 58 is set, transmission will use a warm value for operation, but scan tester will display actual fluid temperature. TCC solenoid will be on in 3rd and 4th gears. Shifts will occur early. DTC 58 will be stored in PCM memory but will not turn on MIL.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks for a short to ground or a skewed sensor.
2. This test checks for an internal fault within transmission by creating an open.

Diagnostic Aids

Check harness routing for a potential short to ground in 5V TFT signal circuit. Scan tester TFT display should rise steadily to about 212°F (100°C) then stabilize.

Test transmission fluid temperature sensor at various temperature levels to evaluate the possibility of a skewed (mis-scaled) sensor. See TEMPERATURE VS. RESISTANCE VALUES table. A skewed sensor could result in delayed garage shifts or TCC complaints.

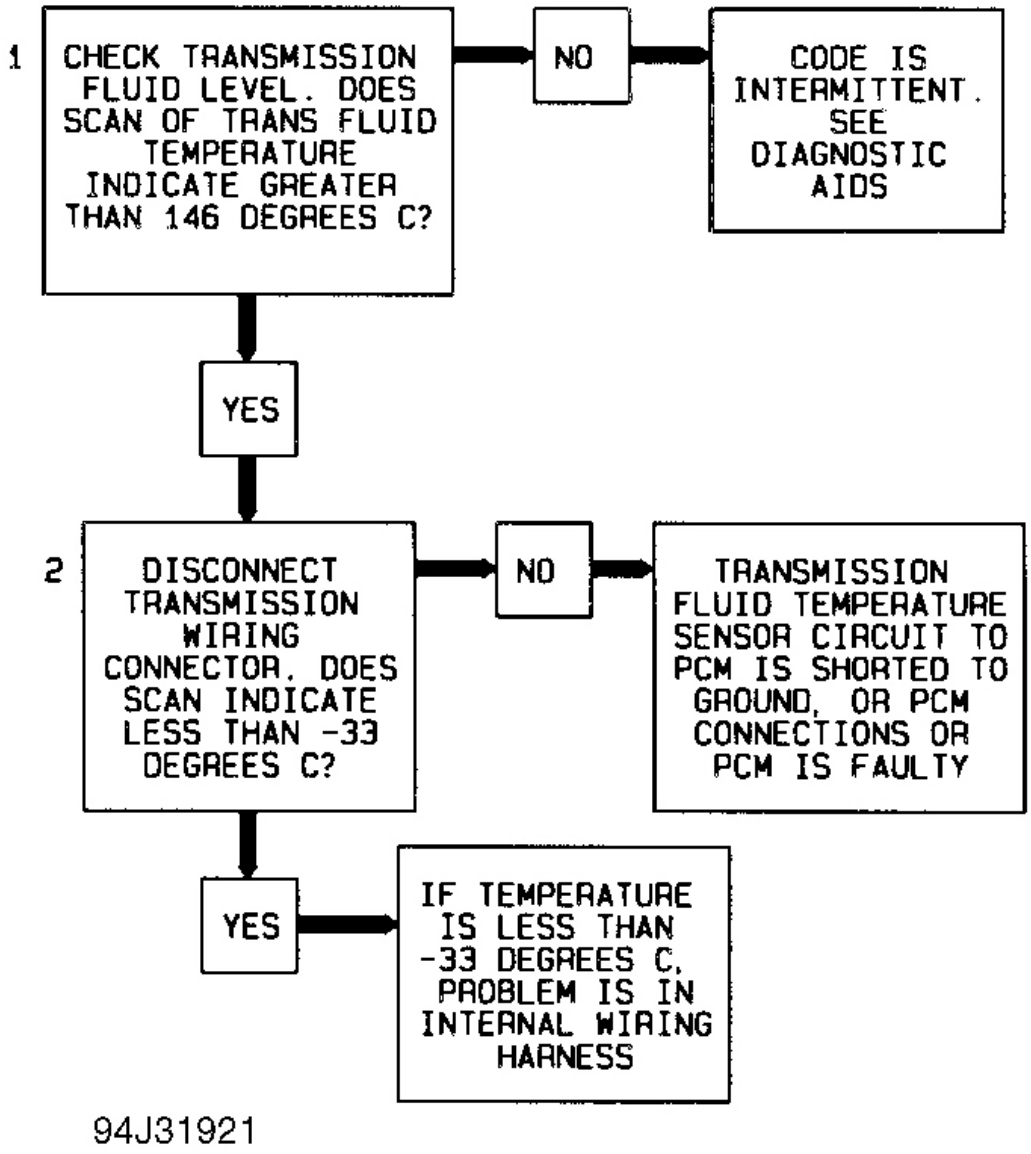


Fig. 176: DTC 58, Flow Chart (Diesel) Courtesy of General Motors Corp.

TEMPERATURE VS. RESISTANCE VALUES

Temperature °F (°C)	**(1) (2) Ohms**
-40 (-40)	100,700
-22 (-30)	52,700
-4 (-20)	28,680
55 (-15)	21,450

14 (-10)	16,180
23 (-5)	12,300
32 (0)	9,420
41 (5)	7,280
50 (10)	5,670
59 (15)	4,450
68 (20)	3,520
77 (25)	2,796
86 (30)	2,238
95 (35)	1,802
104 (40)	1,459
113 (45)	1,188
122 (50)	973
140 (60)	667
158 (70)	467
176 (80)	332
194 (90)	241
212 (100)	177
(1) Measure resistance across sensor terminals. (2) Temperatures are approximate.	

DTC 59, TRANS. FLUID TEMP. SENSOR CKT HIGH LOW TEMPERATURE INDICATED)

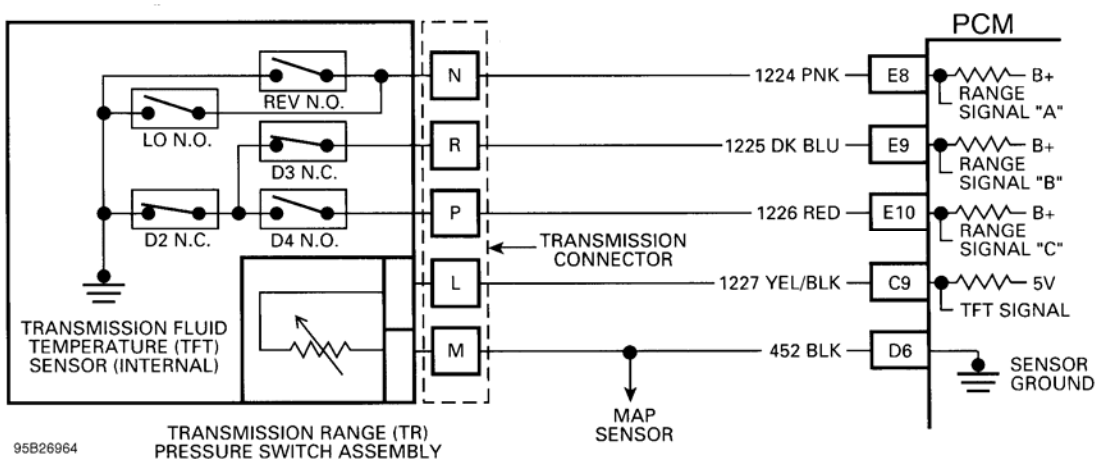


Fig. 177: DTC 59, Circuit Diagram (Diesel) Courtesy of General Motors Corp.

Transmission Fluid Temperature (TFT) sensor is a thermistor within transmission range pressure switch assembly that controls signal voltage to the PCM. PCM applies voltage on 5-volt TFT signal circuit to sensor. When transmission fluid is cold, sensor resistance is high and PCM will sense high signal voltage.

As transmission fluid temperature warms to normal transmission operating temperature of 212°F (100°C), sensor resistance becomes less and voltage decreases to 1.5-2.0 volts. DTC 59 will set when signal voltage indicates TFT less than 40°F (40°C) for one second.

PCM will default to when DTC 59 is set, transmission will use a warm value for operation, but scan tester will display actual fluid temperature. TCC may not apply properly. DTC 59 will be stored in PCM memory but will not turn on MIL.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks for a skewed sensor.
2. This test simulates a DTC 58. If PCM recognizes low signal voltage (high temperature), and scan tester displays 295°F (146°C) or greater, PCM and wiring are okay.
3. This test checks if 5-volt TFT signal circuit is open. Five volts should be present at sensor connector when measure using DVOM.

Diagnostic Aids

Scan tester displays transmission fluid temperature in degrees. After transmission is operating, temperature should rise steadily to about 212°F (100°C) then stabilize. A faulty connection or open in sensor ground circuit or 5-volt TFT signal circuit may cause DTC 59 to set.

Test transmission fluid temperature sensor at various temperature levels to evaluate possibility of a skewed (mis-scaled) sensor. See TEMPERATURE VS. RESISTANCE VALUES table. A skewed sensor could result in firm shifts or TCC complaints.

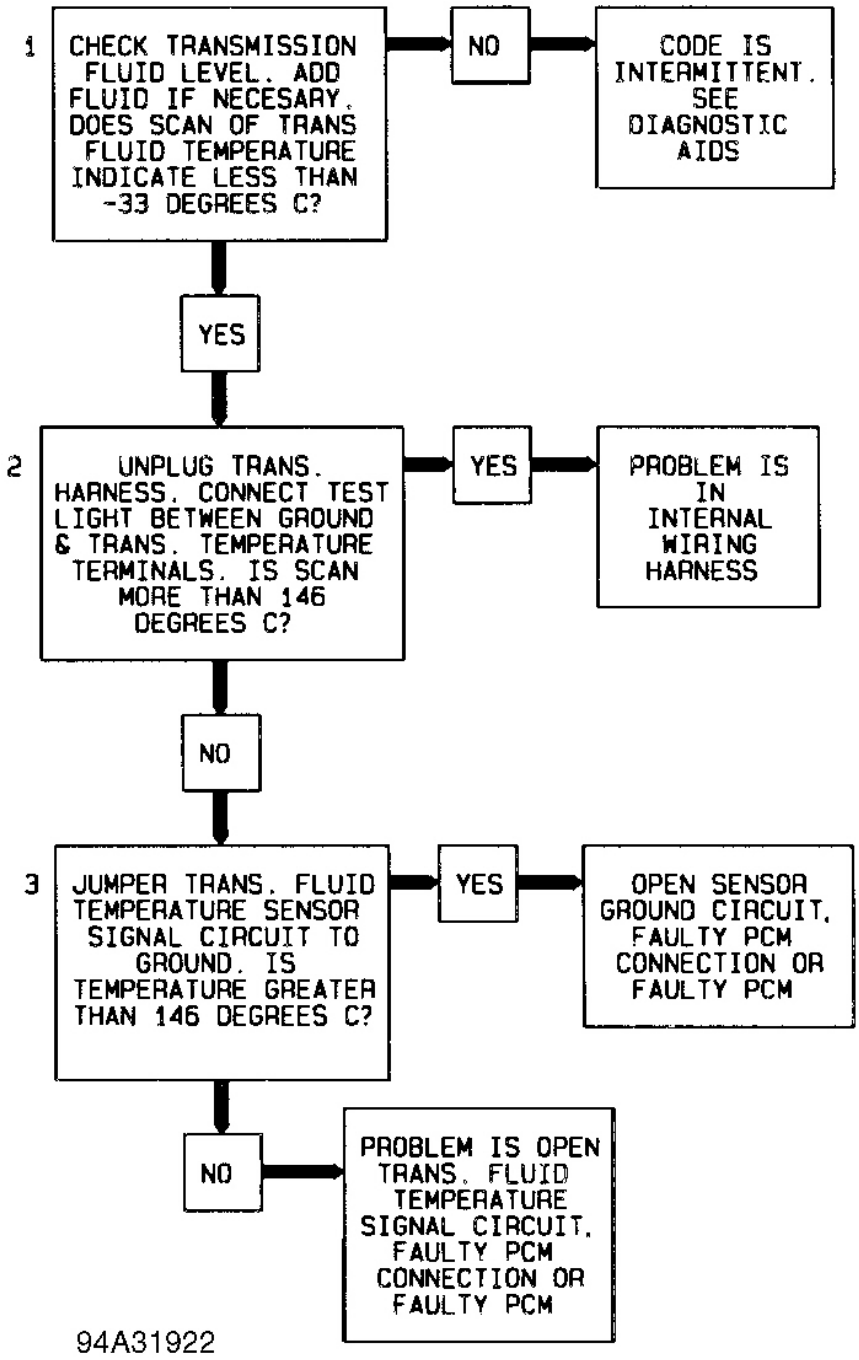


Fig. 178: DTC 59, Flow Chart (Diesel) Courtesy of General Motors Corp.

TEMPERATURE VS. RESISTANCE VALUES

Temperature °F (°C)	(1) (2) Ohms

-40 (-40)	100,700
-22 (-30)	52,700
-4 (-20)	28,680
5 (-15)	21,450
14 (-10)	16,180
23 (-5)	12,300
32 (0)	9,420
41 (5)	7,280
50 (10)	5,670
59 (15)	4,450
68 (20)	3,520
77 (25)	2,796
86 (30)	2,238
95 (35)	1,802
104 (40)	1,459
113 (45)	1,188
122 (50)	973
140 (60)	667
158 (70)	467
176 (80)	332
194 (90)	241
212 (100)	177
(1) Measure resistance across sensor terminals. (2) Temperatures are approximate.	

DTC 66, 3-2 CONTROL SOLENOID CIRCUIT FAULT

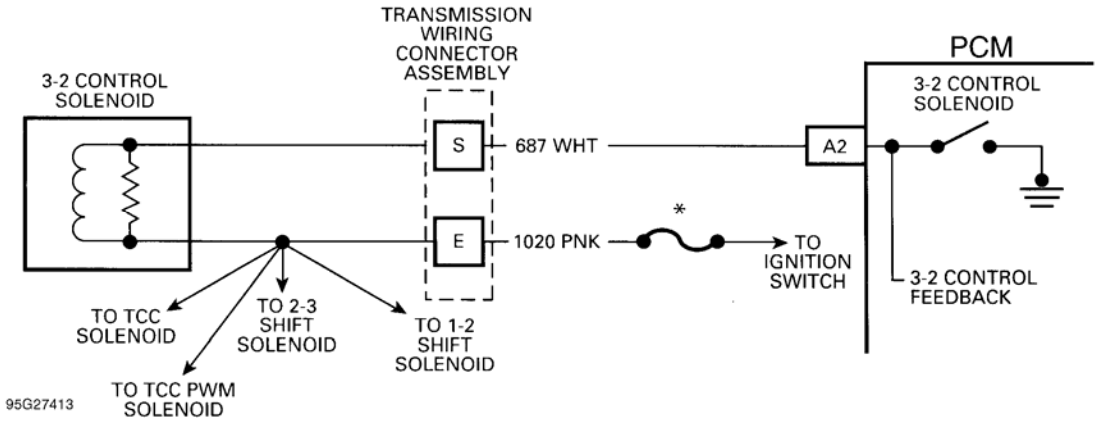


Fig. 179: DTC 66, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

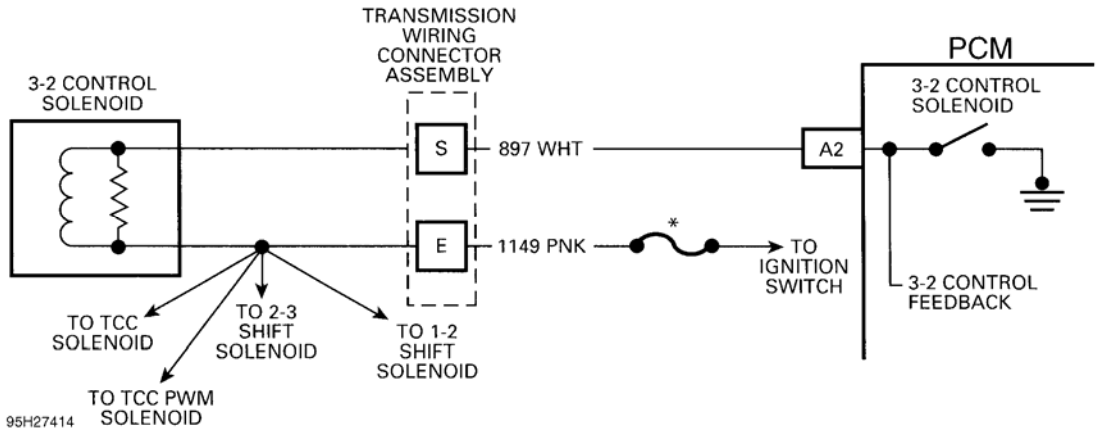


Fig. 180: DTC 66, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

Hydraulically, the 3-2 control solenoid coordinates apply rate of 2-4 band with hydraulic release, of 3-4 clutch during a 3-2 downshift. PCM continually monitors 3-2 circuit duty cycle depending on commanded state of circuit. When transmission is in 1st gear, duty cycle of solenoid is equal to zero. When transmission is in 2nd gear or higher, duty cycle of solenoid will be about 90 percent. When transmission downshifts, 3-2, duty cycle of solenoid will drop. DTC 66 will set when:

- PCM commands solenoid on and voltage remains high (B+) for 4 seconds.
- PCM commands solenoid off and voltage remains low (zero volts) for 4 seconds.

PCM will default to a delayed (soft) landing to 3rd gear and 3rd gear starts.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks function of 3-2 control solenoid and internal transmission harness.
2. This test checks for power to 3-2 control solenoid from ignition through fuse.

Diagnostic Aids

Check all connections at transmission connector. 3-2 control solenoid feedback normally oscillate on/off when duty cycle is applied. An open in ignition feed circuit will cause multiple DTCS to set.

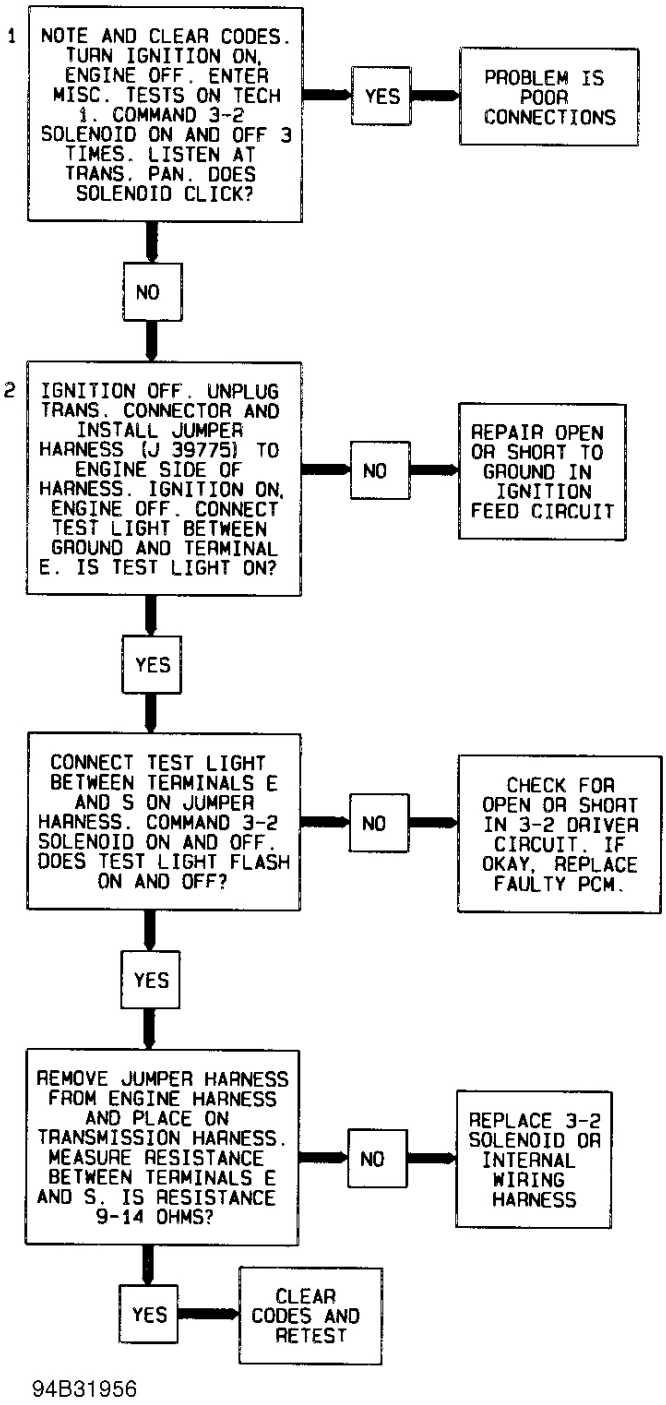


Fig. 181: DTC 66, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 67, TCC SOLENOID CIRCUIT FAULT

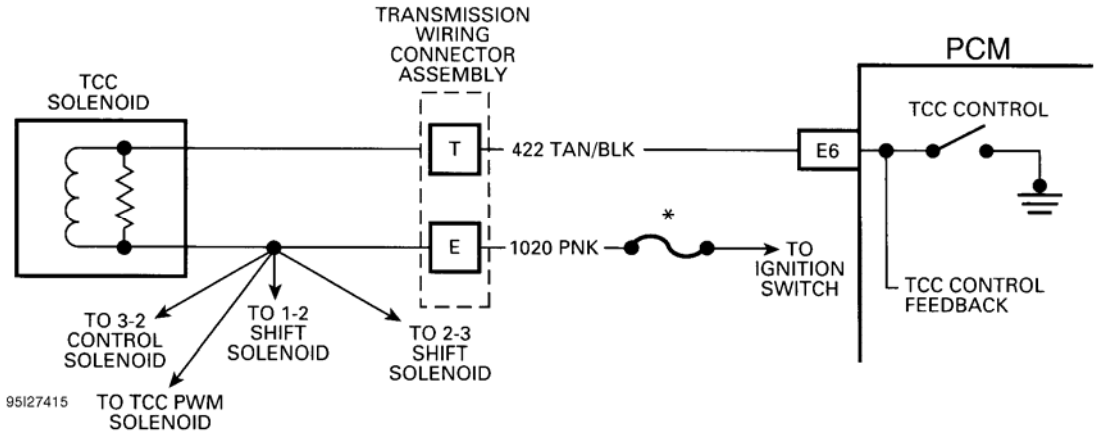


Fig. 182: DTC 67, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

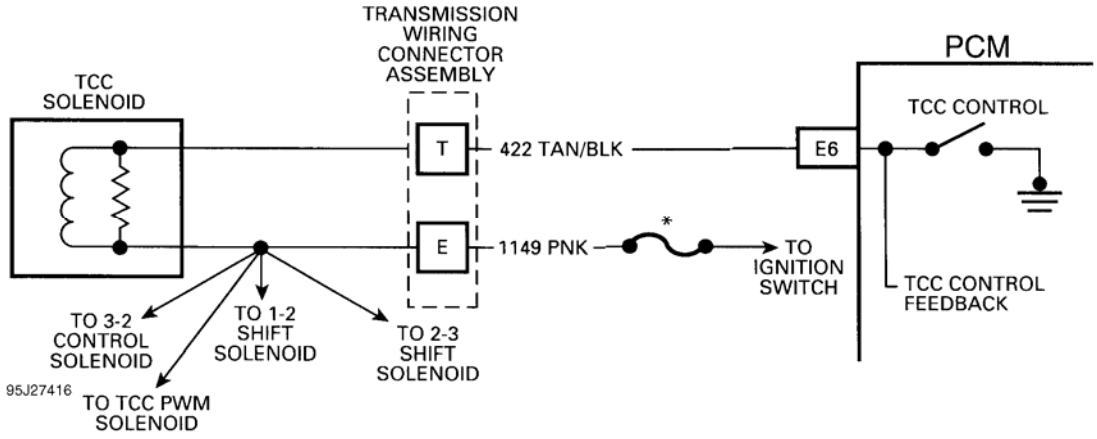


Fig. 183: DTC 67, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

Ignition voltage is supplied directly to TCC solenoid. PCM controls solenoid by providing ground path through TCC control circuit. DTC 67 will set when:

- PCM commands solenoid on and voltage remains high (B+) for 2 seconds.
- PCM commands solenoid off and voltage remains low (zero volts) for 2 seconds.

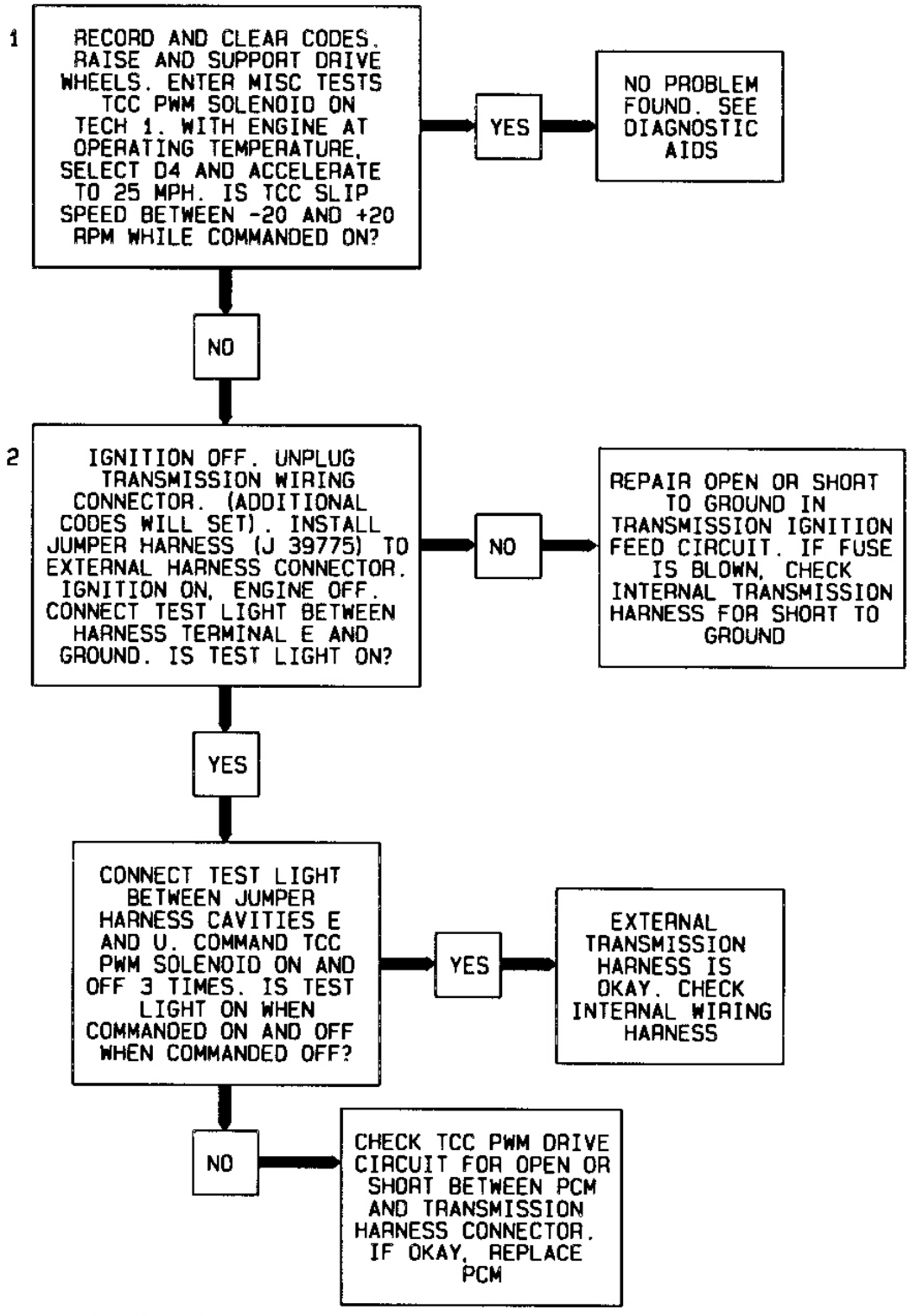
PCM will default to no TCC and no 4th gear in hot mode.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks PCM's ability to control solenoid.
2. This test checks power supply to TCC solenoid.

Diagnostic Aids

Check all connections at transmission connector. Some slight TCC slip is normal. An open in ignition feed circuit will cause multiple DTCS to set. A short to ground in TCC circuit may also cause DTC 69 to set. If TCC circuit is shorted to ground, TCC will hydraulically engage in D2.


1
RECORD AND CLEAR CODES. RAISE AND SUPPORT DRIVE WHEELS. ENTER MISC TESTS TCC PWM SOLENOID ON TECH 1. WITH ENGINE AT OPERATING TEMPERATURE, SELECT D4 AND ACCELERATE TO 25 MPH. IS TCC SLIP SPEED BETWEEN -20 AND +20 RPM WHILE COMMANDED ON?
YES
NO PROBLEM FOUND. SEE DIAGNOSTIC AIDS
NO
2
IGNITION OFF. UNPLUG TRANSMISSION WIRING CONNECTOR. (ADDITIONAL CODES WILL SET). INSTALL JUMPER HARNESS (J 39775) TO EXTERNAL HARNESS CONNECTOR. IGNITION ON, ENGINE OFF. CONNECT TEST LIGHT BETWEEN HARNESS TERMINAL E AND GROUND. IS TEST LIGHT ON?
NO
REPAIR OPEN OR SHORT TO GROUND IN TRANSMISSION IGNITION FEED CIRCUIT. IF FUSE IS BLOWN, CHECK INTERNAL TRANSMISSION HARNESS FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN JUMPER HARNESS CAVITIES E AND U. COMMAND TCC PWM SOLENOID ON AND OFF 3 TIMES. IS TEST LIGHT ON WHEN COMMANDED ON AND OFF WHEN COMMANDED OFF?
YES
EXTERNAL TRANSMISSION HARNESS IS OKAY. CHECK INTERNAL WIRING HARNESS
NO
CHECK TCC PWM DRIVE CIRCUIT FOR OPEN OR SHORT BETWEEN PCM AND TRANSMISSION HARNESS CONNECTOR. IF OKAY, REPLACE PCM

95D14350

Fig. 184: DTC 67, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 69, TCC STUCK ON

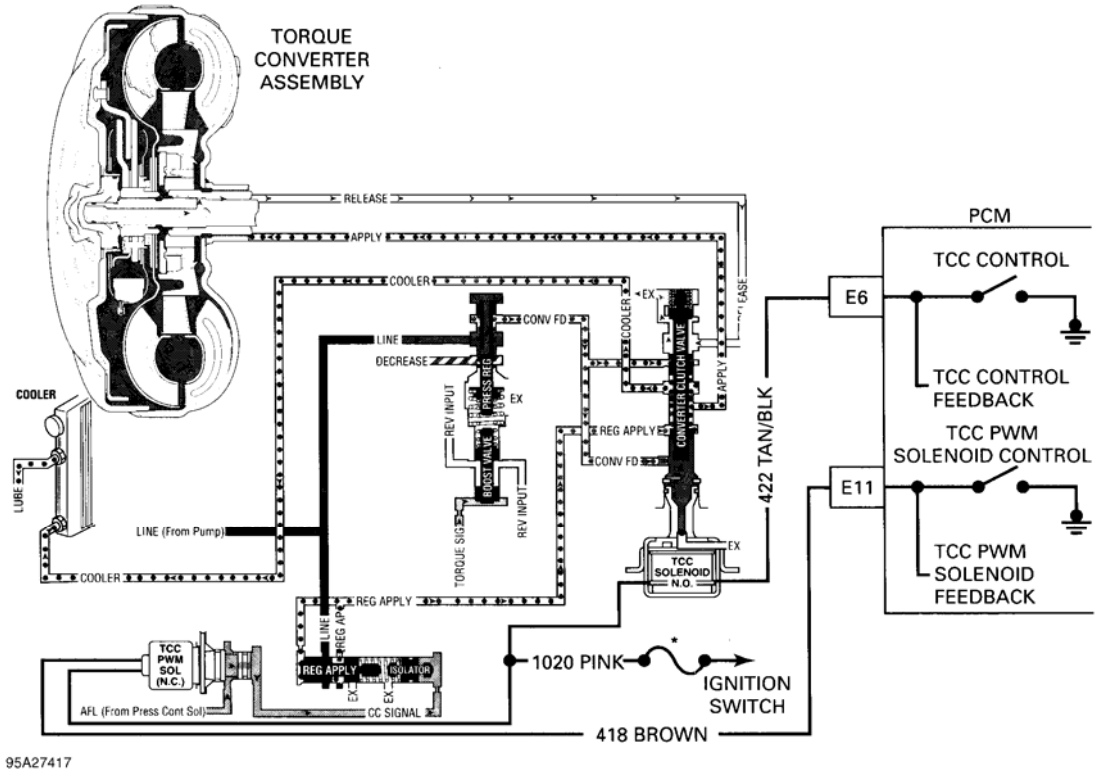


Fig. 185: DTC 69, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

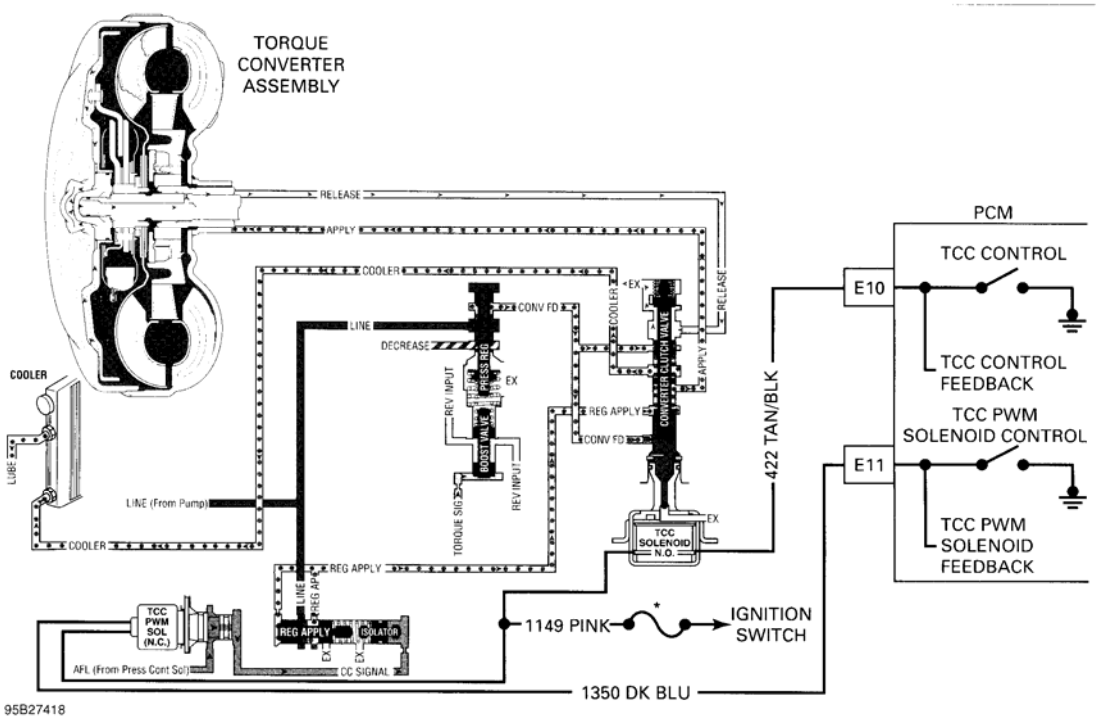


Fig. 186: DTC 69, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

PCM energizes TCC solenoid by grounding TCC control circuit with an internal quad-driver. When grounded (energized) by PCM, TCC solenoid stops converter signal oil from exhausting. TCC solenoid will de-energize when quad-driver no longer provides a ground. When TCC solenoid is de-energized, it will block exhaust fluid and release TCC.

DTC 69 will set when:

- DTCs 21, 22 or 28 are not set.
- TCC slip speed indicates -20 to 20 RPM.
- TCC solenoid is commanded off.
- TP sensor signal is greater than 25 percent.
- Trans. range switch indicates D3 or D4.
- Commanded gear indicates 3rd or 4th gear.
- Engine speed is greater than 300 RPM.
- All conditions are met for 4 seconds. PCM will default to early shift pattern.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks mechanical state of TCC. When PCM commands TCC solenoid off, TCC slip speed should increase.

Diagnostic Aids

If TCC is mechanically stuck on, vehicle speed is zero, brakes are applied and D2 is selected, TCC fluid will mechanically apply TCC causing an engine stall.

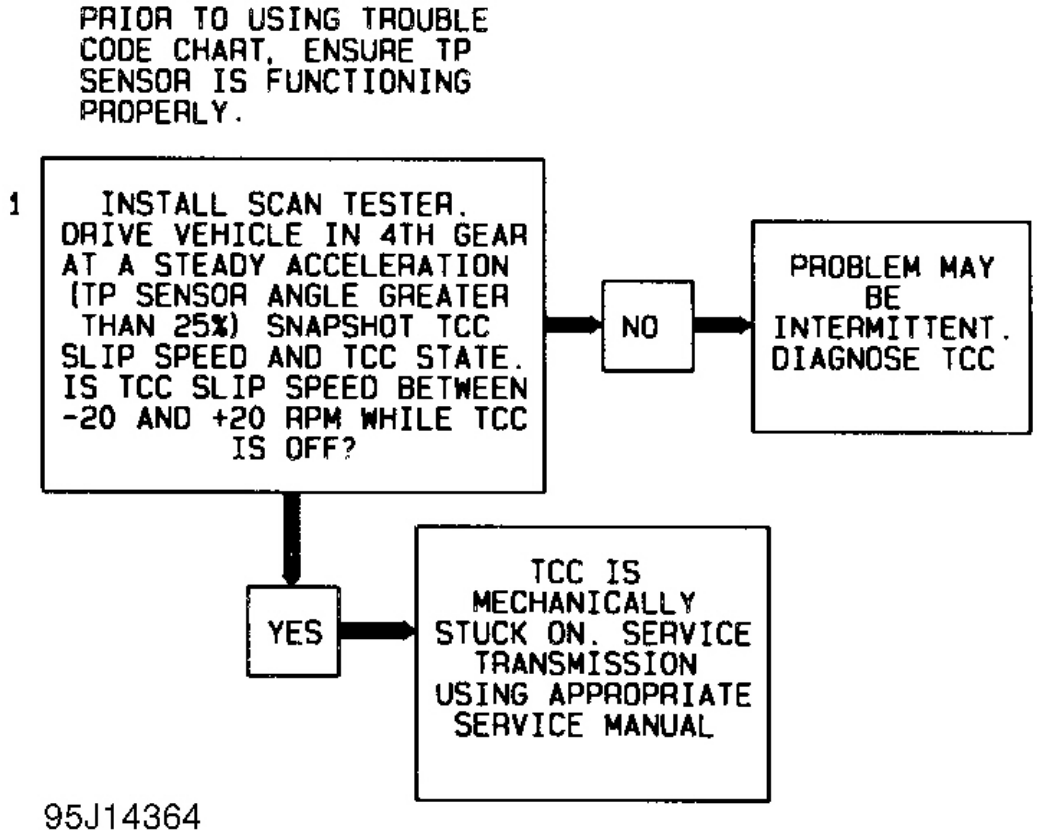


Fig. 187: DTC 69, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 72, VEHICLE SPEED SENSOR CIRCUIT LOSS (TRANS OUTPUT SPEED SIGNAL)

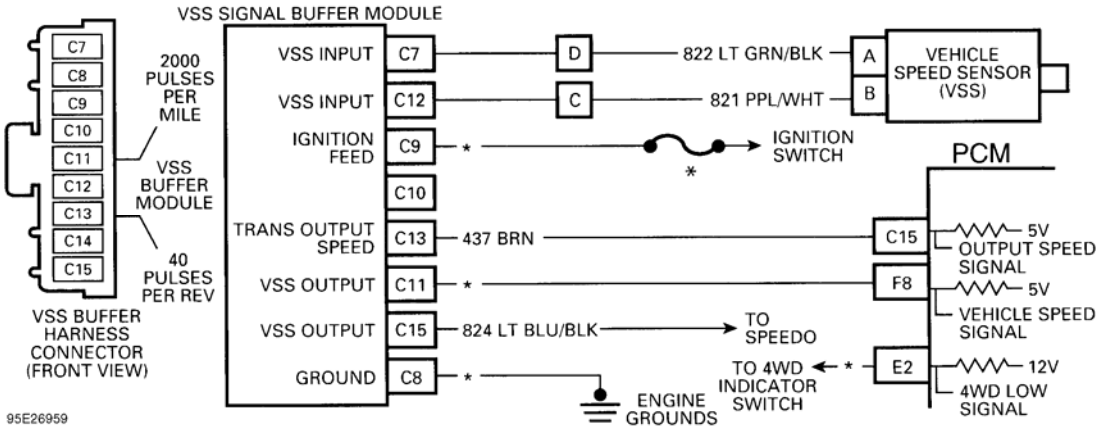


Fig. 188: DTC 72, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

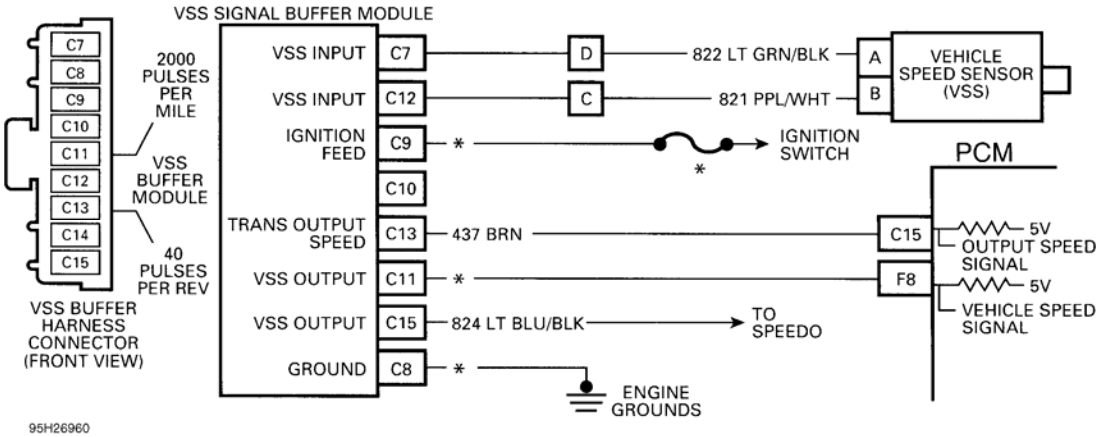


Fig. 189: DTC 72, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

Vehicle Speed Sensor (VSS) circuit consists of a magnetic induction type sensor, VSS buffer module, 4WD low switch (if equipped) and wiring. Gear teeth pressed onto output shaft induces an alternating voltage into sensor. This signal is transmitted to VSS buffer module. VSS buffer module compensates for various final drive ratios. VSS buffer module will also convert AC VSS signal into a 40 pulse per revolution DC signal on trans. output speed circuit to indicate transmission output speed. On 4WD vehicles, 4WD low signal will also be used for adjustment of the 40 pulse per revolution signal to PCM.

DTC 72 will set when gear selector is not in Park or Neutral and:

- Trans. output speed change is greater than 1000 RPM.
- Engine speed is greater than 200 RPM.
- All conditions are met for 2 seconds.
- DTC 28 is not set.

Or when gear selector is in Park or Neutral and:

- Trans. output speed change is greater than 2050 RPM.
- Engine speed is greater than 200 RPM.
- All conditions are met for 2 seconds.
- DTC 28 is not set.

PCM will default to a soft (delayed) downshift to 2nd gear and 2nd gear starts.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks for voltage to VSS buffer module.
2. This test checks ground circuit to VSS buffer module.
3. This test checks VSS circuit at VSS buffer module.
4. This test checks for an output speed signal from VSS buffer module.

Diagnostic Aids

DTC 24 will set when no vehicle speed is detected at vehicle start off. DTC 72 will set when vehicle speed has been detected and is lost.

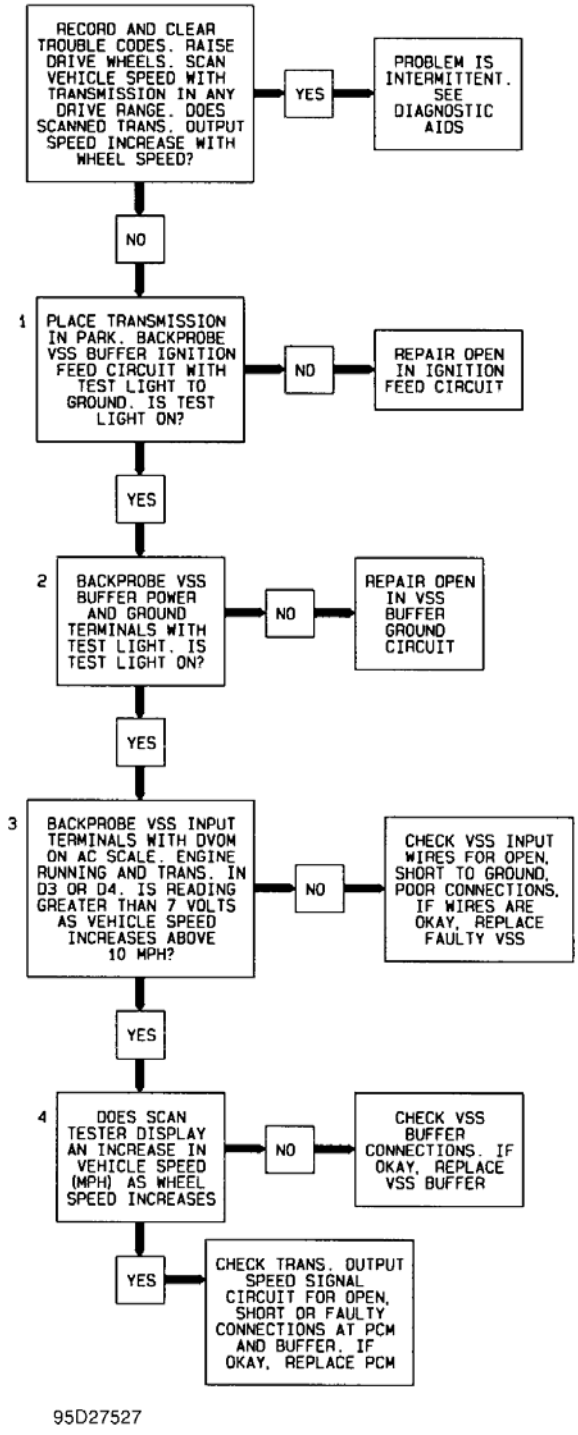


Fig. 190: DTC 72, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 73, PRESSURE CONTROL SOLENOID CIRCUIT (CURRENT ERROR)

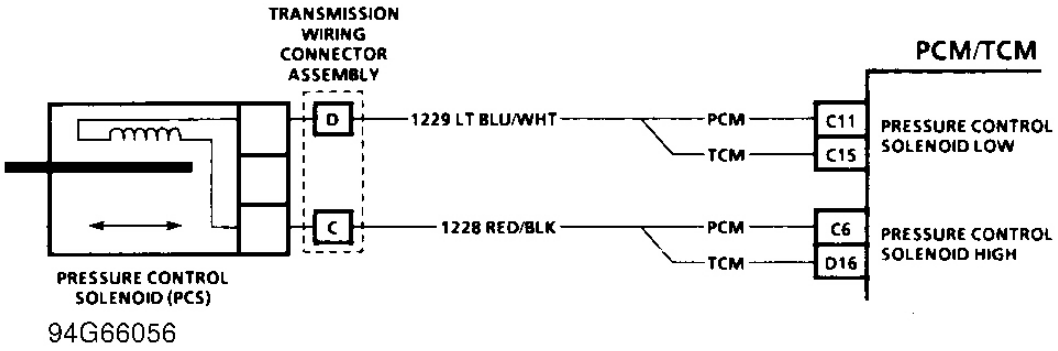


Fig. 191: DTC 73, Circuit Diagram (Diesel) Courtesy of General Motors Corp.

Pressure control solenoid is a PCM-controlled device used to regulate transmission line pressure. PCM compares TP voltage, engine RPM and other inputs to determine line pressure appropriate for a given load. PCM will regulate pressure by applying a varying amperage to pressure control solenoid. The applied amperage can vary from .1-1.1 amp. PCM then monitors amperage at the return line.

DTC 73 will set when return amperage varies greater than .16 amp from commanded amperage for at least one second and DTC 75 is not set.

PCM will default to full line pressure being applied, causing harsh shifts. DTC 73 will be stored in PCM memory but will not turn on MIL.

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. This test checks PCM's ability to command pressure control solenoid.
2. This test checks internal transmission harness and pressure control solenoid for correct resistance.

Diagnostic Aids

Check for poor connections at PCM and transmission connector.

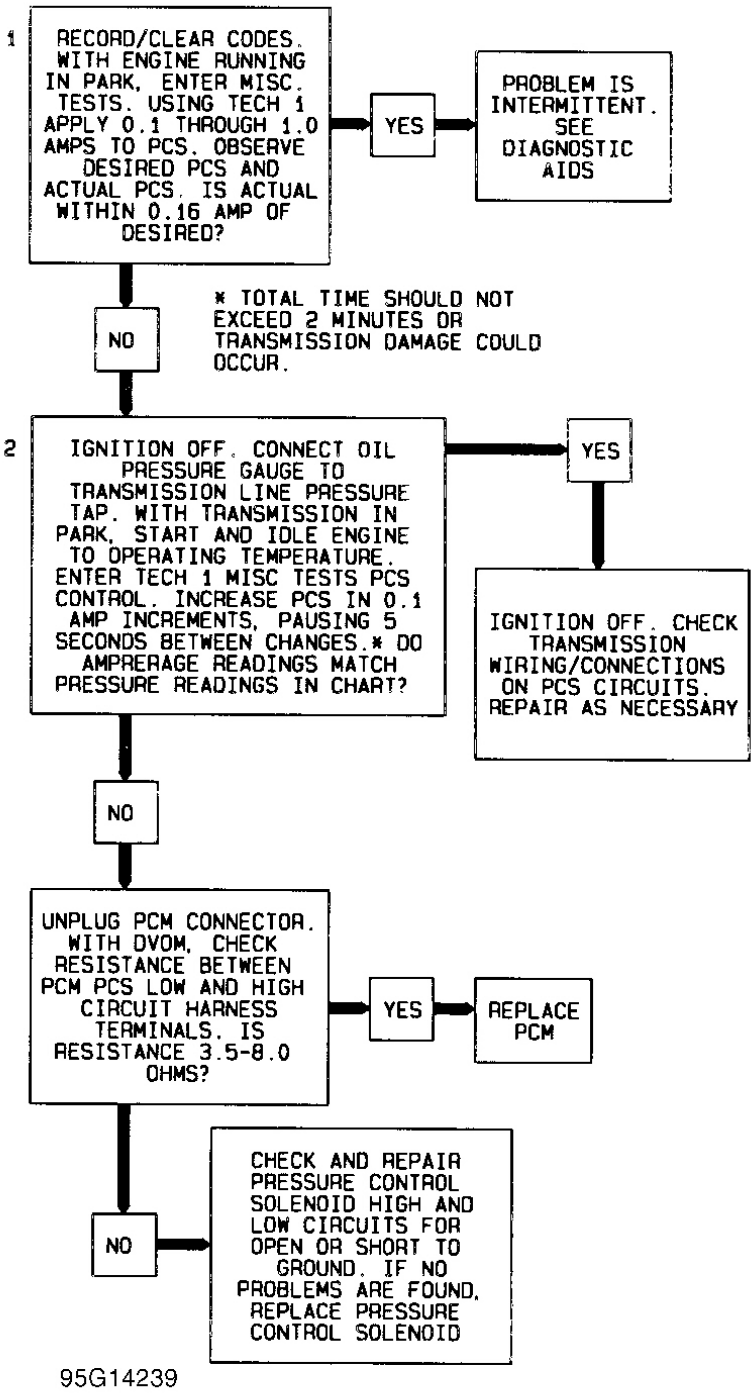


Fig. 192: DTC 73, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 75, SYSTEM VOLTAGE LOW

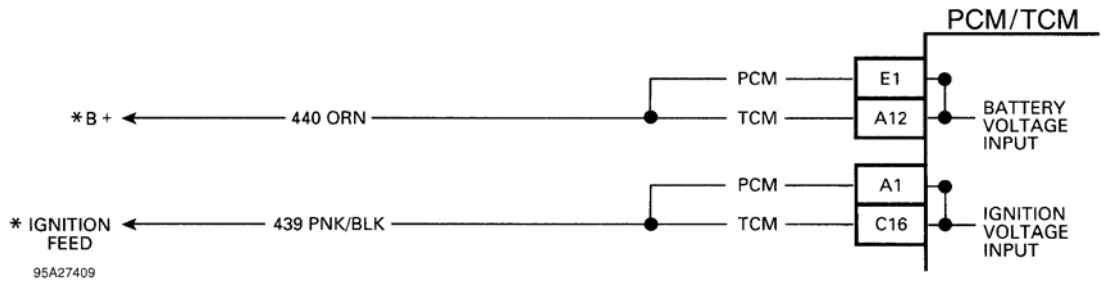


Fig. 193: DTC 75, Circuit Diagram (Diesel) Courtesy of General Motors Corp.

Battery voltage input circuit is battery feed for PCM. Ignition voltage input circuit is ignition feed for PCM. DTC 75 will set when ignition is on and PCM battery voltage input terminal voltage is less than graduated scale of:

- -40°F (-40°C) equals 7.3 volts
- 194°F (90°C) equals 10.3 volts
- 304°F (150°C) equals 11.7 volts with engine speed greater than 1000 RPM for 4 seconds.

Pressure control solenoid is turned off, soft landing to default 3rd gear and TCC operation is inhibited. The setting of additional DTCs may result. DTC 75 will be stored in PCM memory but will not turn on MIL.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks that normal battery voltage is 9-15 volts.
2. This test checks if low voltage display is due to generator, battery voltage input circuit or PCM, while engine is running. If voltage is less than 8.6 volts, PCM is okay.

Diagnostic Aids

Battery voltage input circuit supplies battery voltage to PCM. Charging battery with a battery charger and jump-starting an engine may set DTC 53. If DTC sets when an accessory is operated, check for faulty connections or excessive current draw. Check for faulty connections at starter solenoid or fusible link.

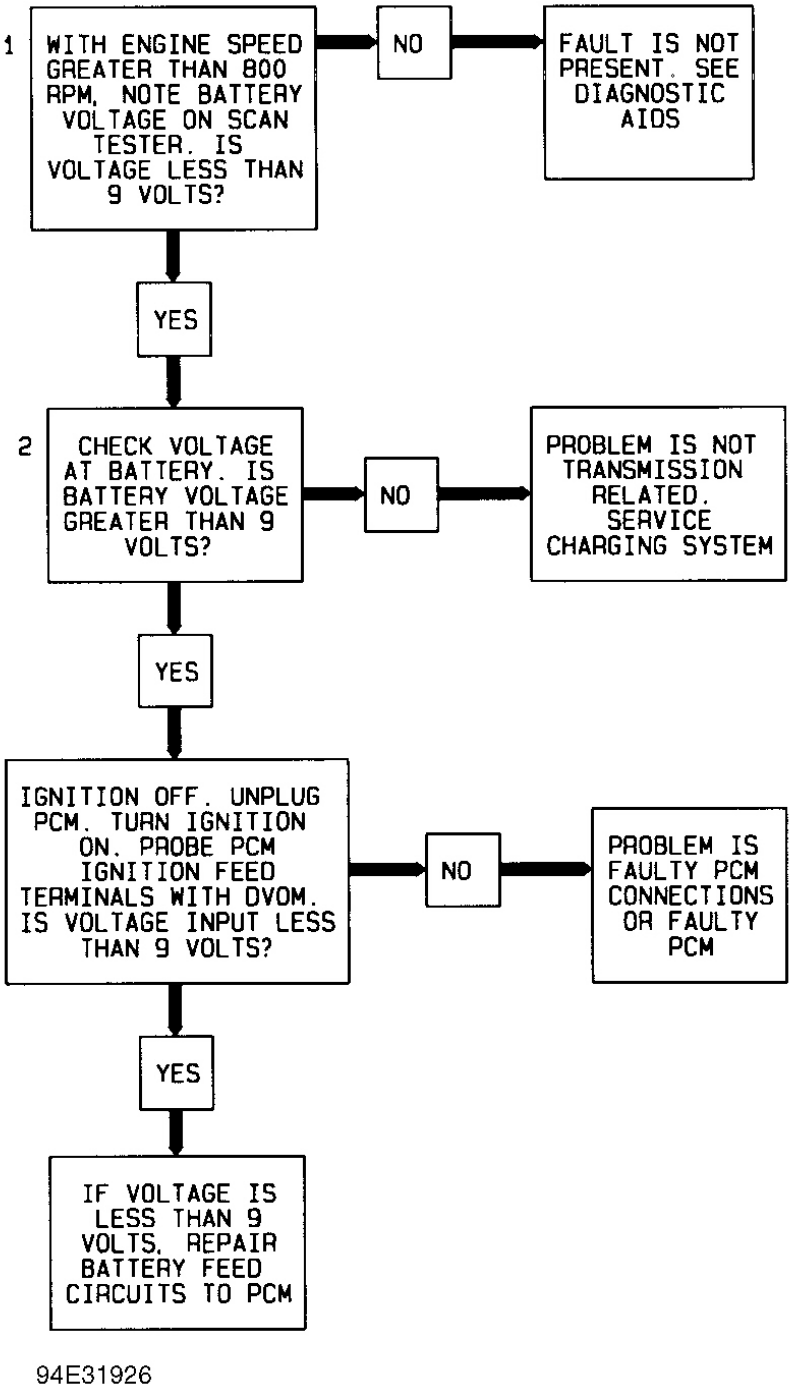


Fig. 194: DTC 75, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 79, TRANSMISSION FLUID OVERTEMP

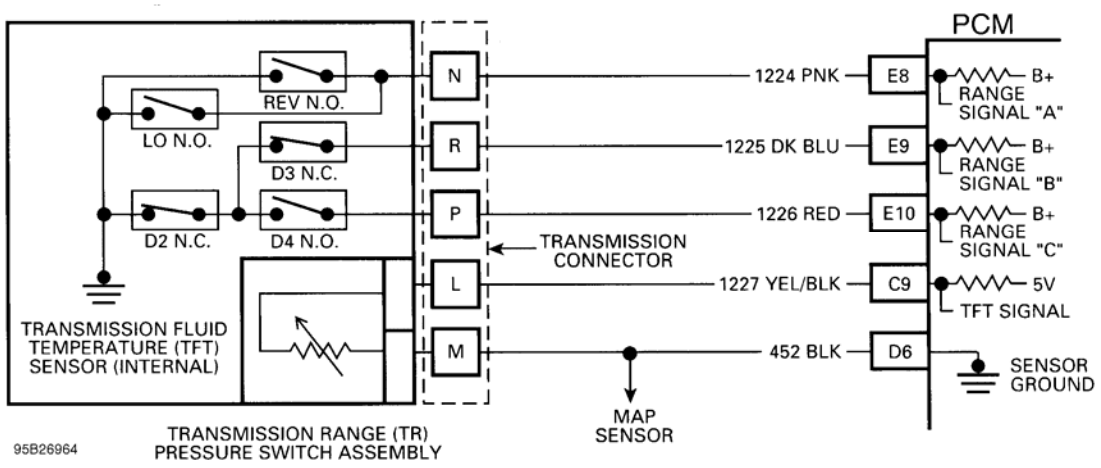


Fig. 195: DTC 79, Circuit Diagram (Diesel) Courtesy of General Motors Corp.

Transmission Fluid Temperature (TFT) sensor is a thermistor within transmission range pressure switch assembly, that controls signal voltage to PCM. PCM applies voltage on 5-volt TFT signal circuit to sensor. When transmission fluid is cold, sensor resistance is high and PCM will sense high signal voltage.

As transmission fluid temperature warms to normal transmission operating temperature of 212°F (100°C), sensor resistance becomes less and voltage decreases to 1.5-2.0 volts. DTC 79 will set when signal voltage indicates TFT greater than 295°F (146°C) for 30 seconds, and DTC 58 or 59 is not set.

DTC 79 will be stored in PCM memory but will not turn on MIL.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks for a shorted circuit or a skewed sensor.
2. This test simulates a DTC 59.

Diagnostic Aids

Check harness routing for a potential short to ground in 5-volt TFT signal circuit. Scan tester TFT display should rise steadily to about 212°F (100°C) then stabilize.

Test transmission fluid temperature sensor at various temperature levels to evaluate possibility of a skewed (mis-scaled) sensor. See TEMPERATURE VS. RESISTANCE VALUES table. A skewed sensor could result in delayed garage shifts or TCC complaints.

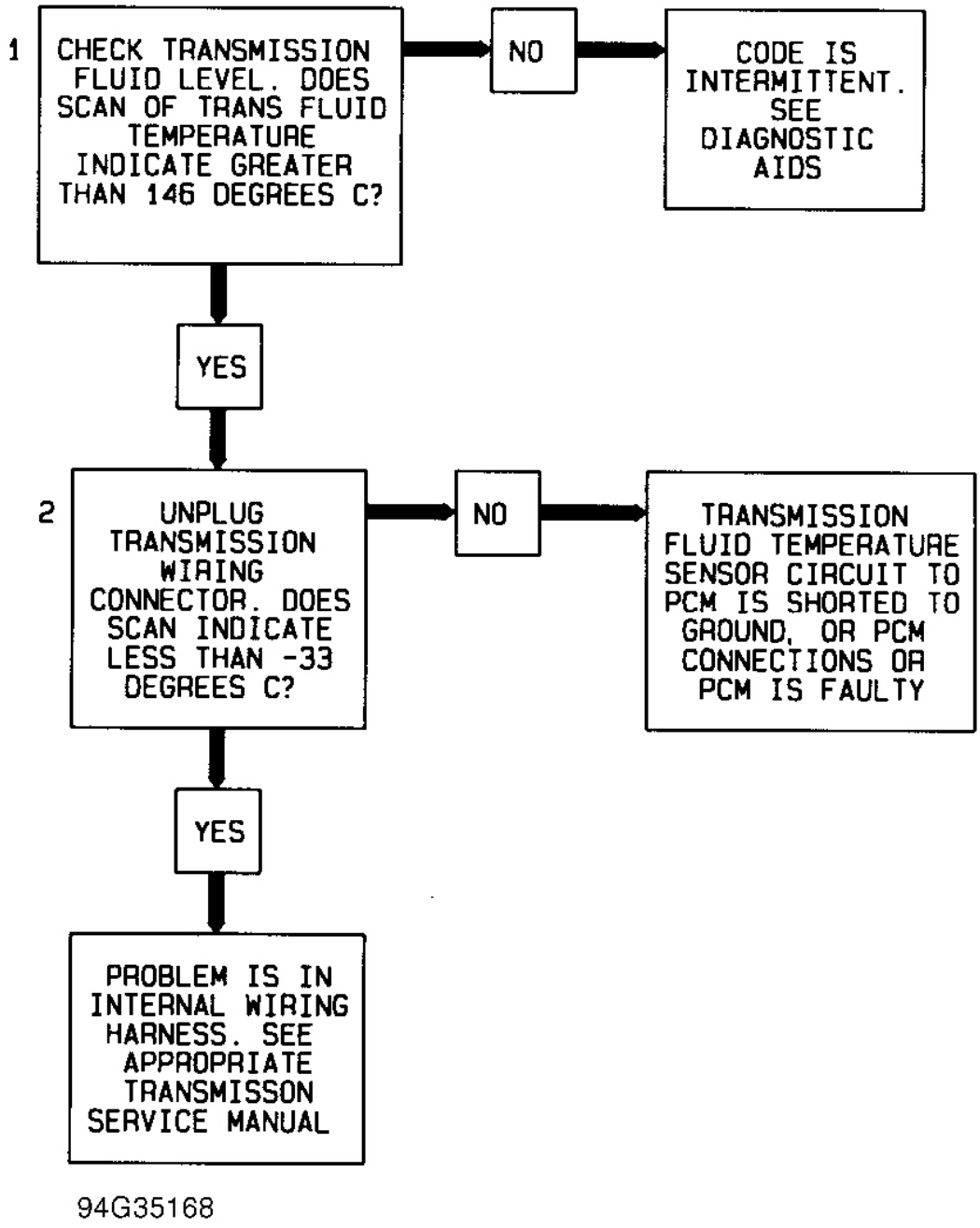


Fig. 196: DTC 79, Flow Chart (Diesel) Courtesy of General Motors Corp.

TEMPERATURE VS. RESISTANCE VALUES

Temperature °F (°C)	**(1) (2) Ohms**
-40 (-40)	100,700

-22 (-30)	52,700
-4 (-20)	28,680
5 (-15)	21,450
14 (-10)	16,180
23 (-5)	12,300
32 (0)	9,420
41 (5)	7,280
50 (10)	5,670
59 (15)	4,450
68 (20)	3,520
77 (25)	2,796
86 (30)	2,238
95 (35)	1,802
104 (40)	1,459
113 (45)	1,188
122 (50)	973
140 (60)	667
158 (70)	467
176 (80)	332
194 (90)	241
212 (100)	177

(1) Measure resistance across sensor terminals.

(2) Temperatures are approximate.

DTC 81, 2-3 SHIFT SOLENOID CIRCUIT FAULT

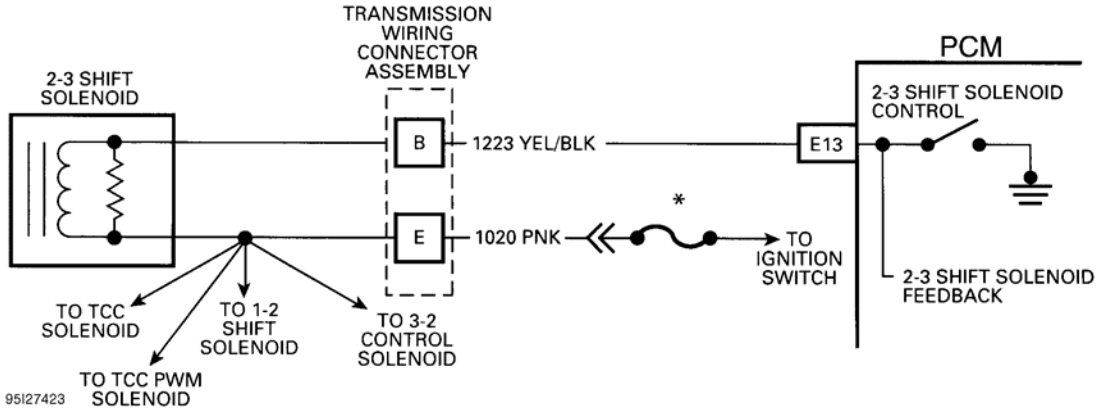


Fig. 197: DTC 81, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

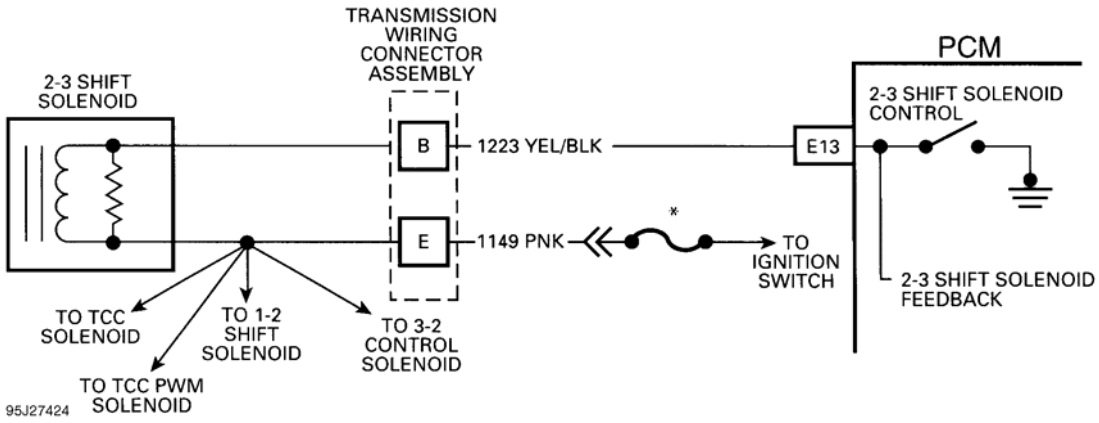


Fig. 198: DTC 81, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

Ignition voltage is supplied directly to 2-3 shift solenoid. PCM controls solenoid by providing ground path through 2-3 shift solenoid control circuit. DTC 81 will set when PCM commands solenoid on and voltage remains high for 2 seconds, or PCM commands solenoid off and voltage remains low for 2 seconds.

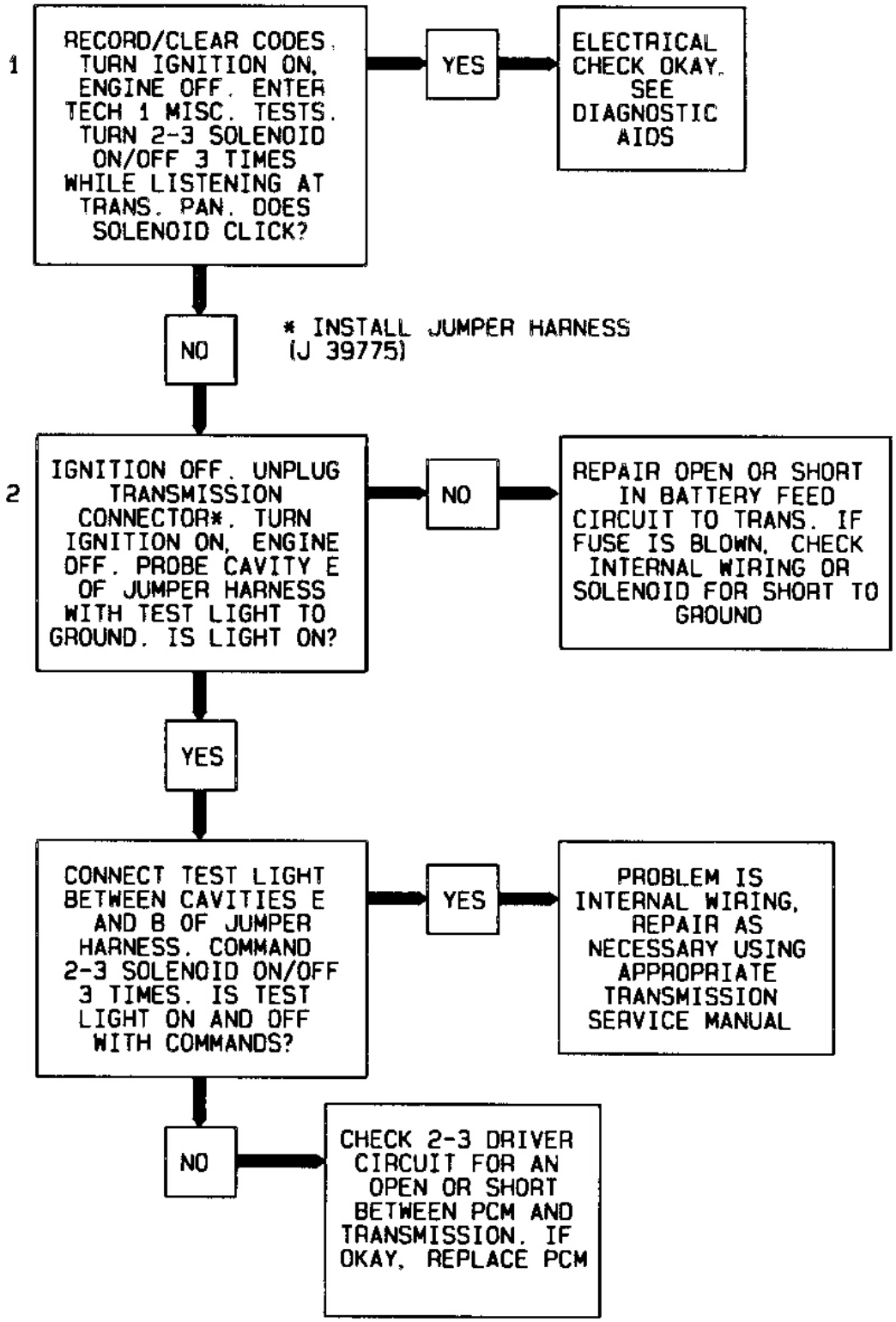
If solenoid is shorted off, 3rd gear only will occur. If solenoid is shorted on, 2nd gear only will occur. DTC 81 will be stored in PCM memory but will not turn on MIL.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks the function of 2-3 shift solenoid and internal transmission wiring.
2. This test checks for power to 2-3 shift solenoid from ignition, through fuse.

Diagnostic Aids

Check all connections at transmission. An open in ignition feed circuit can cause multiple DTCs to set.


1
RECORD/CLEAR CODES. TURN IGNITION ON, ENGINE OFF. ENTER TECH 1 MISC. TESTS. TURN 2-3 SOLENOID ON/OFF 3 TIMES WHILE LISTENING AT TRANS. PAN. DOES SOLENOID CLICK?
YES
ELECTRICAL CHECK OKAY. SEE DIAGNOSTIC AIDS
NO
* INSTALL JUMPER HARNESS (J 39775)
2
IGNITION OFF. UNPLUG TRANSMISSION CONNECTOR*. TURN IGNITION ON, ENGINE OFF. PROBE CAVITY E OF JUMPER HARNESS WITH TEST LIGHT TO GROUND. IS LIGHT ON?
NO
REPAIR OPEN OR SHORT IN BATTERY FEED CIRCUIT TO TRANS. IF FUSE IS BLOWN, CHECK INTERNAL WIRING OR SOLENOID FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN CAVITIES E AND B OF JUMPER HARNESS. COMMAND 2-3 SOLENOID ON/OFF 3 TIMES. IS TEST LIGHT ON AND OFF WITH COMMANDS?
YES
PROBLEM IS INTERNAL WIRING, REPAIR AS NECESSARY USING APPROPRIATE TRANSMISSION SERVICE MANUAL
NO
CHECK 2-3 DRIVER CIRCUIT FOR AN OPEN OR SHORT BETWEEN PCM AND TRANSMISSION. IF OKAY, REPLACE PCM

94C31940

Fig. 199: DTC 81, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 82, 1-2 SHIFT SOLENOID CIRCUIT FAULT

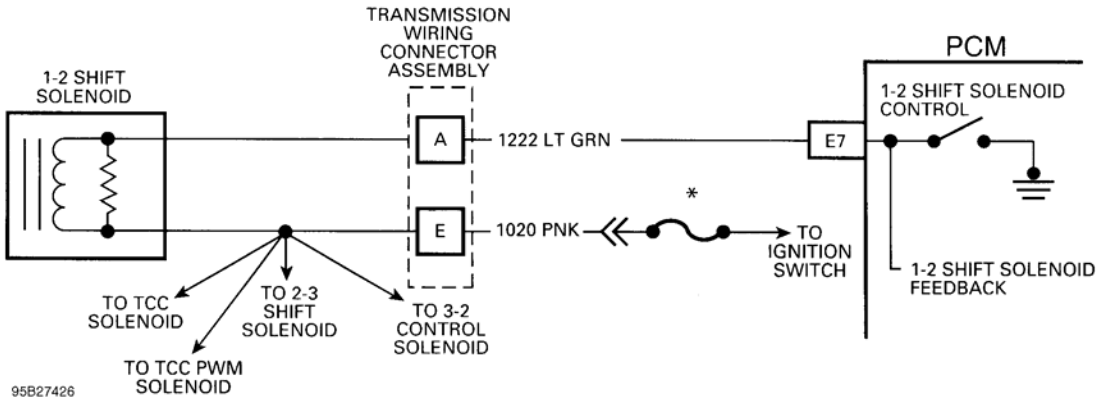


Fig. 200: DTC 82, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

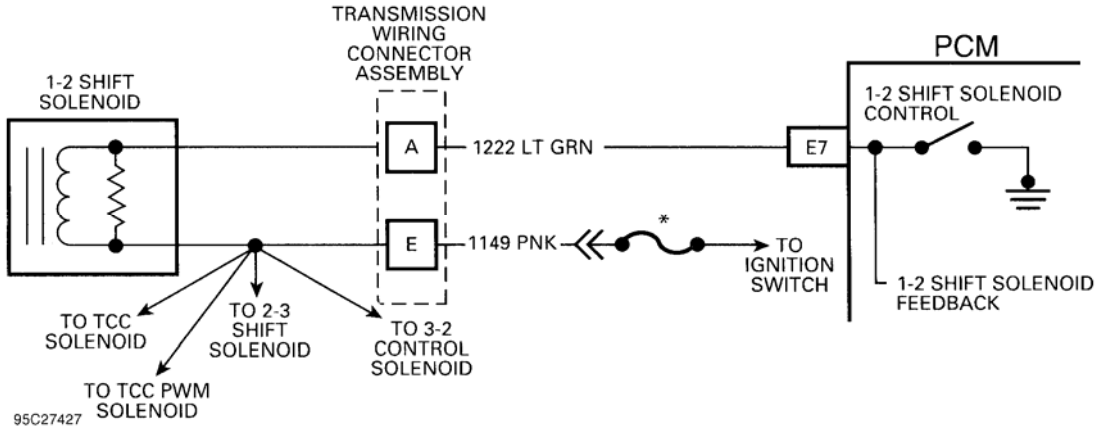


Fig. 201: DTC 82, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

Ignition voltage is supplied directly to 1-2 shift solenoid. PCM controls solenoid by providing ground path through 1-2 shift solenoid control circuit. DTC 82 will set when PCM commands solenoid on and voltage remains high for 2 seconds, or PCM commands solenoid off and voltage remains low for 2 seconds.

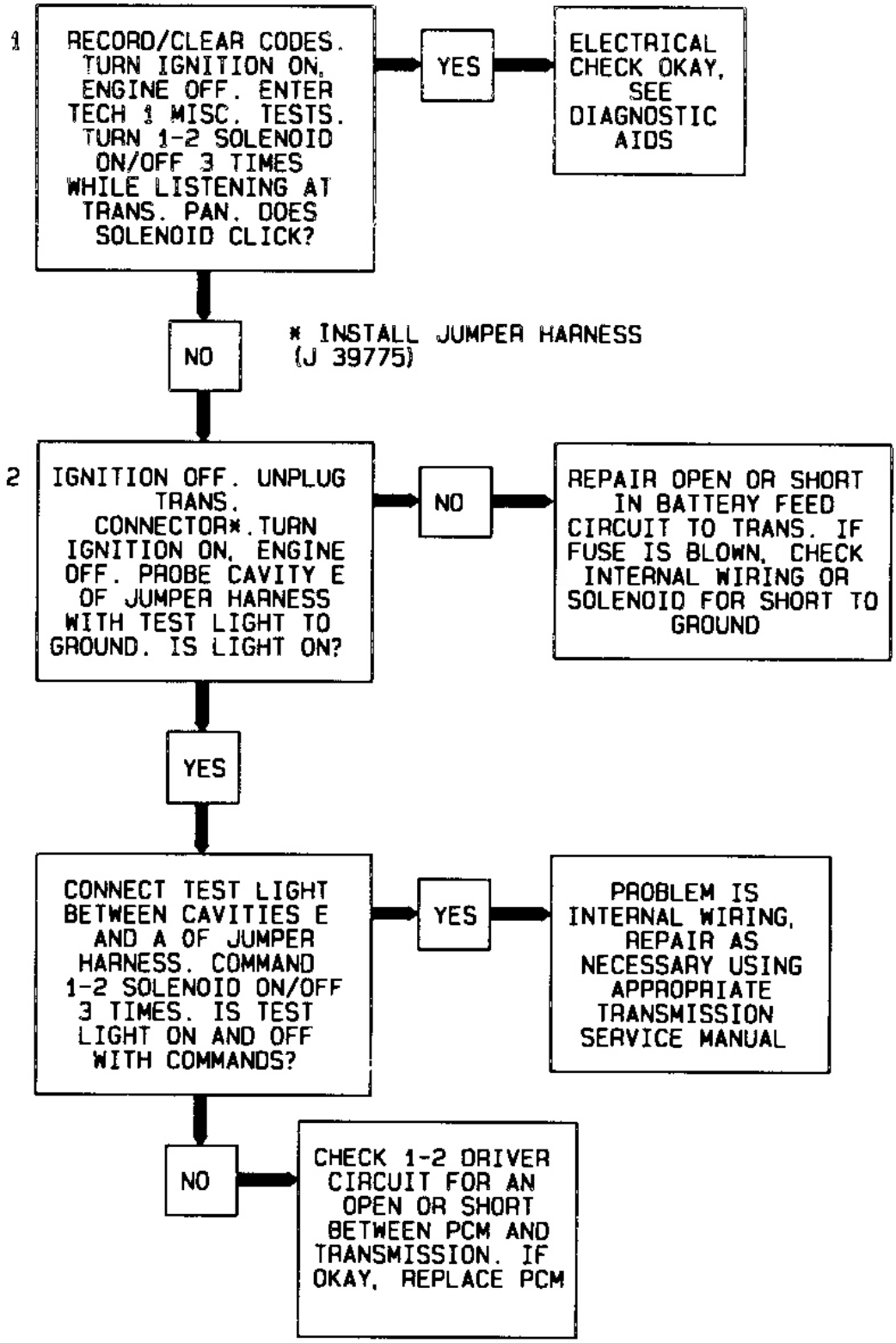
PCM will only allow 2nd and 3rd gear, or 1st and 4th gear. DTC 82 will be stored in PCM memory but will not turn on MIL.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks the function of 1-2 shift solenoid and internal transmission wiring.
2. This test checks for power to 1-2 shift solenoid from ignition through fuse.

Diagnostic Aids

Check all connections at transmission. An open in ignition feed circuit can cause multiple DTCs to set.


1
RECORD/CLEAR CODES. TURN IGNITION ON, ENGINE OFF. ENTER TECH 1 MISC. TESTS. TURN 1-2 SOLENOID ON/OFF 3 TIMES WHILE LISTENING AT TRANS. PAN. DOES SOLENOID CLICK?
YES
ELECTRICAL CHECK OKAY, SEE DIAGNOSTIC AIDS
NO
* INSTALL JUMPER HARNESS (J 39775)
2
IGNITION OFF. UNPLUG TRANS. CONNECTOR*. TURN IGNITION ON, ENGINE OFF. PROBE CAVITY E OF JUMPER HARNESS WITH TEST LIGHT TO GROUND. IS LIGHT ON?
NO
REPAIR OPEN OR SHORT IN BATTERY FEED CIRCUIT TO TRANS. IF FUSE IS BLOWN, CHECK INTERNAL WIRING OR SOLENOID FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN CAVITIES E AND A OF JUMPER HARNESS. COMMAND 1-2 SOLENOID ON/OFF 3 TIMES. IS TEST LIGHT ON AND OFF WITH COMMANDS?
YES
PROBLEM IS INTERNAL WIRING, REPAIR AS NECESSARY USING APPROPRIATE TRANSMISSION SERVICE MANUAL
NO
CHECK 1-2 DRIVER CIRCUIT FOR AN OPEN OR SHORT BETWEEN PCM AND TRANSMISSION. IF OKAY, REPLACE PCM

94H31952

Fig. 202: DTC 82, Flow Chart (Diesel) Courtesy of General Motors Corp.

DTC 83, TCC PWM SOLENOID CIRCUIT FAULT

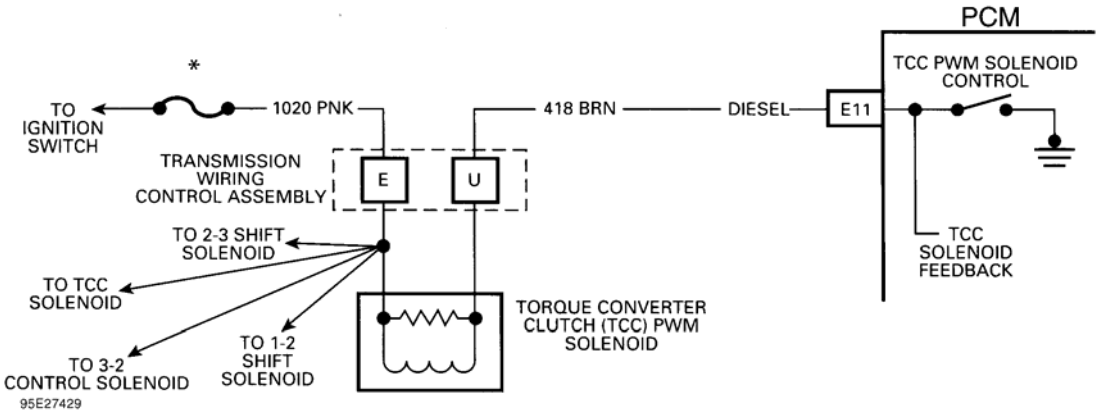


Fig. 203: DTC 83, Circuit Diagram (C & K Series Diesel) Courtesy of General Motors Corp.

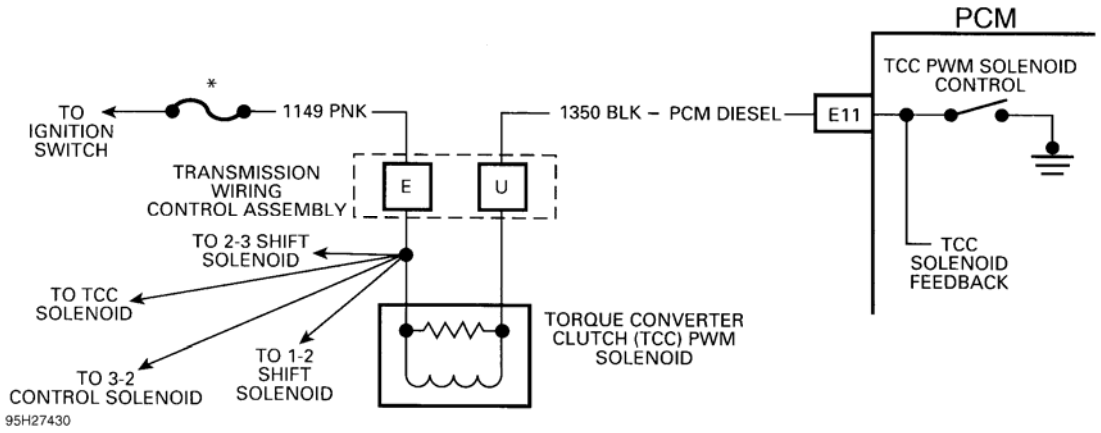


Fig. 204: DTC 83, Circuit Diagram (G Series Diesel) Courtesy of General Motors Corp.

TCC PWM is used in combination with TCC solenoid to regulate fluid to torque converter and attached to transmission control valve body. PCM supplies a ground, allowing current to flow through solenoid coil according to duty cycle (percentage of on and off time). This current flow through solenoid coil creates a magnetic field that magnetizes the solenoid core. The magnetized core attracts the check ball to seat against spring pressure. This blocks the exhaust for the TCC signal fluid and allows 2-3 drive fluid to feed TCC signal circuit. TCC signal fluid pressure acts on TCC regulator valve to regulate line pressure and to apply fluid pressure to torque converter clutch shift valve. When TCC shift valve is in apply position, regulated fluid pressure is directed through TCC valve to apply torque converter clutch.

DTC 83 will set when:

- PCM commands solenoid on and voltage remains high (B+).

Or

- PCM commands solenoid off and voltage remains low (zero volt).
- All conditions are met for 2 seconds.

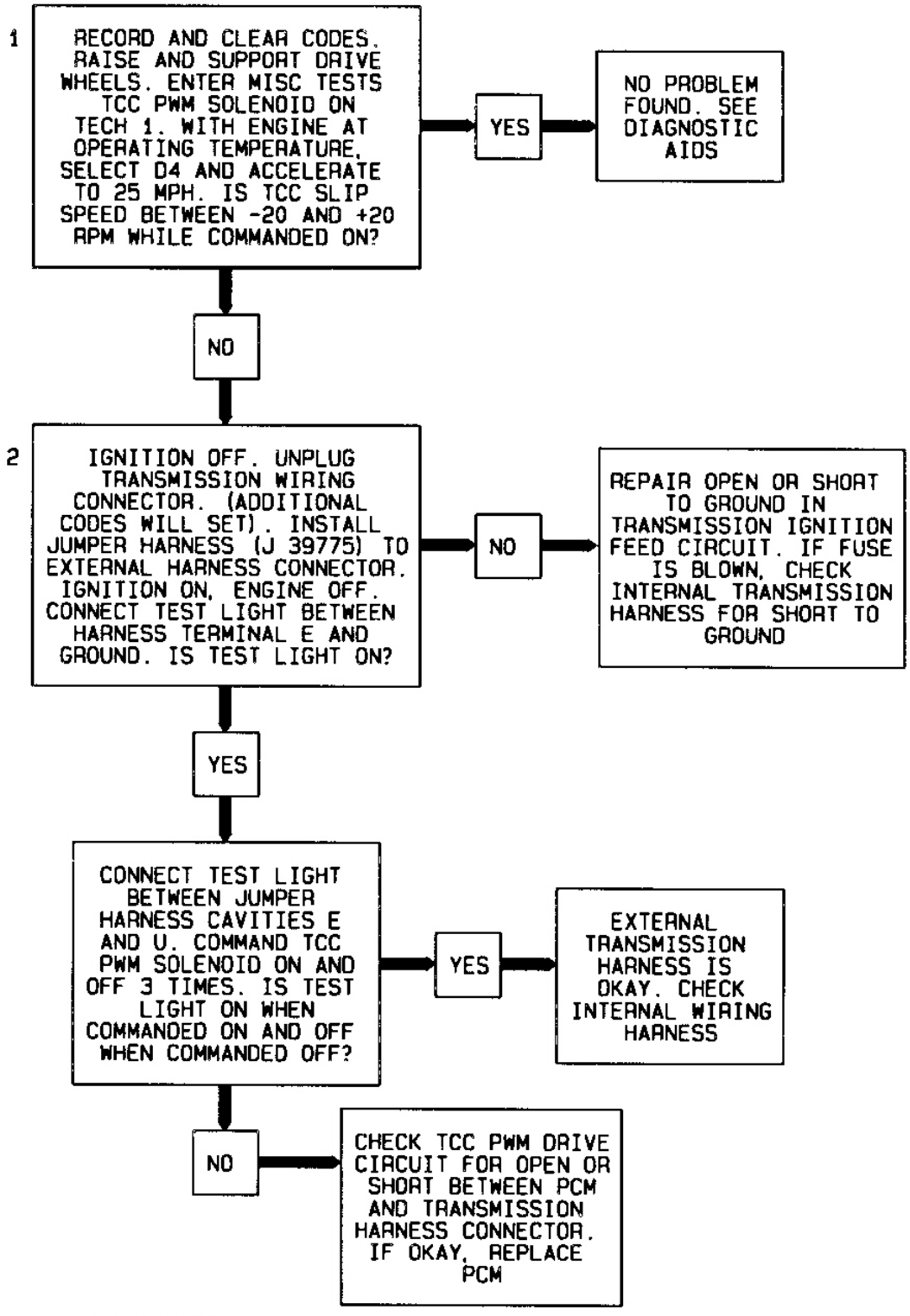
PCM will default to inhibit TCC operation and inhibit 4th gear operation if in hot mode.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks if PCM is commanding TCC solenoid on.
2. This test checks for voltage to solenoid.

Diagnostic Aids

Check all connections, especially those at transmission pass-thru connector.


1
RECORD AND CLEAR CODES. RAISE AND SUPPORT DRIVE WHEELS. ENTER MISC TESTS TCC PWM SOLENOID ON TECH 1. WITH ENGINE AT OPERATING TEMPERATURE, SELECT D4 AND ACCELERATE TO 25 MPH. IS TCC SLIP SPEED BETWEEN -20 AND +20 RPM WHILE COMMANDED ON?
YES
NO PROBLEM FOUND. SEE DIAGNOSTIC AIDS
NO
2
IGNITION OFF. UNPLUG TRANSMISSION WIRING CONNECTOR. (ADDITIONAL CODES WILL SET). INSTALL JUMPER HARNESS (J 39775) TO EXTERNAL HARNESS CONNECTOR. IGNITION ON, ENGINE OFF. CONNECT TEST LIGHT BETWEEN HARNESS TERMINAL E AND GROUND. IS TEST LIGHT ON?
NO
REPAIR OPEN OR SHORT TO GROUND IN TRANSMISSION IGNITION FEED CIRCUIT. IF FUSE IS BLOWN, CHECK INTERNAL TRANSMISSION HARNESS FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN JUMPER HARNESS CAVITIES E AND U. COMMAND TCC PWM SOLENOID ON AND OFF 3 TIMES. IS TEST LIGHT ON WHEN COMMANDED ON AND OFF WHEN COMMANDED OFF?
YES
EXTERNAL TRANSMISSION HARNESS IS OKAY. CHECK INTERNAL WIRING HARNESS
NO
CHECK TCC PWM DRIVE CIRCUIT FOR OPEN OR SHORT BETWEEN PCM AND TRANSMISSION HARNESS CONNECTOR. IF OKAY, REPLACE PCM

95D14350

Fig. 205: DTC 83, Flow Chart (Diesel) Courtesy of General Motors Corp.

DIAGNOSTIC CHARTS - "S" & "T" SERIES 4.3L VIN W

INTRODUCTION

Diagnostic Charts

Following charts are DTC specific. For terminal locations, see **WIRING DIAGRAMS**. For engine-related DTCs, see appropriate TESTS W/CODES article in ENGINE PERFORMANCE section.

Diagnostic Aids

Diagnostic aids located in many trouble code charts are additional tips used to help diagnose trouble codes when circuit checks do not find a problem.

NOTE: In following diagnostic tests, schematics and illustrations are courtesy of General Motors Corp. Powertrain Control Module (PCM) may also be referred to as Electronic Control Module (ECM) or Transmission Control Module (TCM) in some diagnostic charts and figures. Terms are used interchangeably.

CODE P0117, CTS TEMPERATURE LOW - "S" & "T" 4.3L (VIN W)

Circuit Description

Coolant sensor uses a thermistor to control signal voltage to Vehicle Control Module (VCM). VCM applies and monitors a 5 volts to sensor. When engine coolant is cold, sensor (thermistor) resistance is high and VCM will sense a high signal voltage. As engine coolant warms, sensor resistance becomes less and VCM voltage drops. With Code P0117 set, VCM will turn cooling fans on and use a default engine coolant temperature value based on run time. VCM will illuminate Malfunction Indicator Light (MIL).

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This step determines if conditions necessary to set Code P0117 exist.
2. Simulates Code P0118. If VCM recognizes high signal voltage, VCM and wiring are okay.
3. Determines if 5-volt reference is open. This determines if there is a wiring problem or faulty VCM.

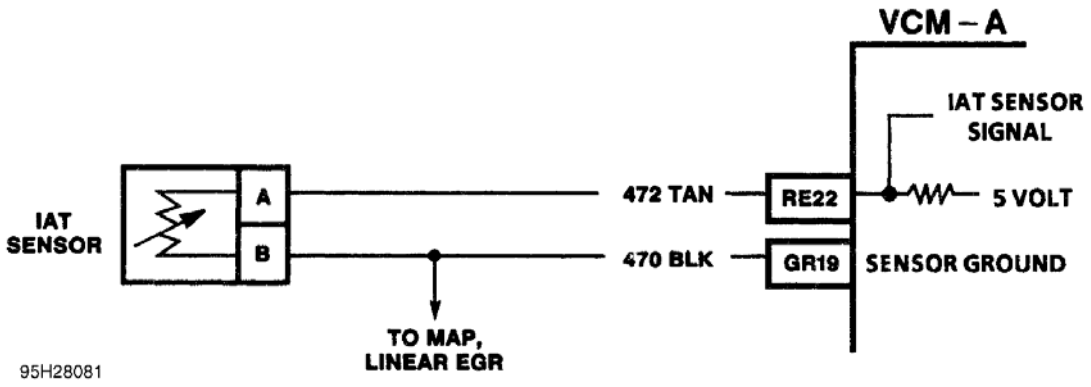
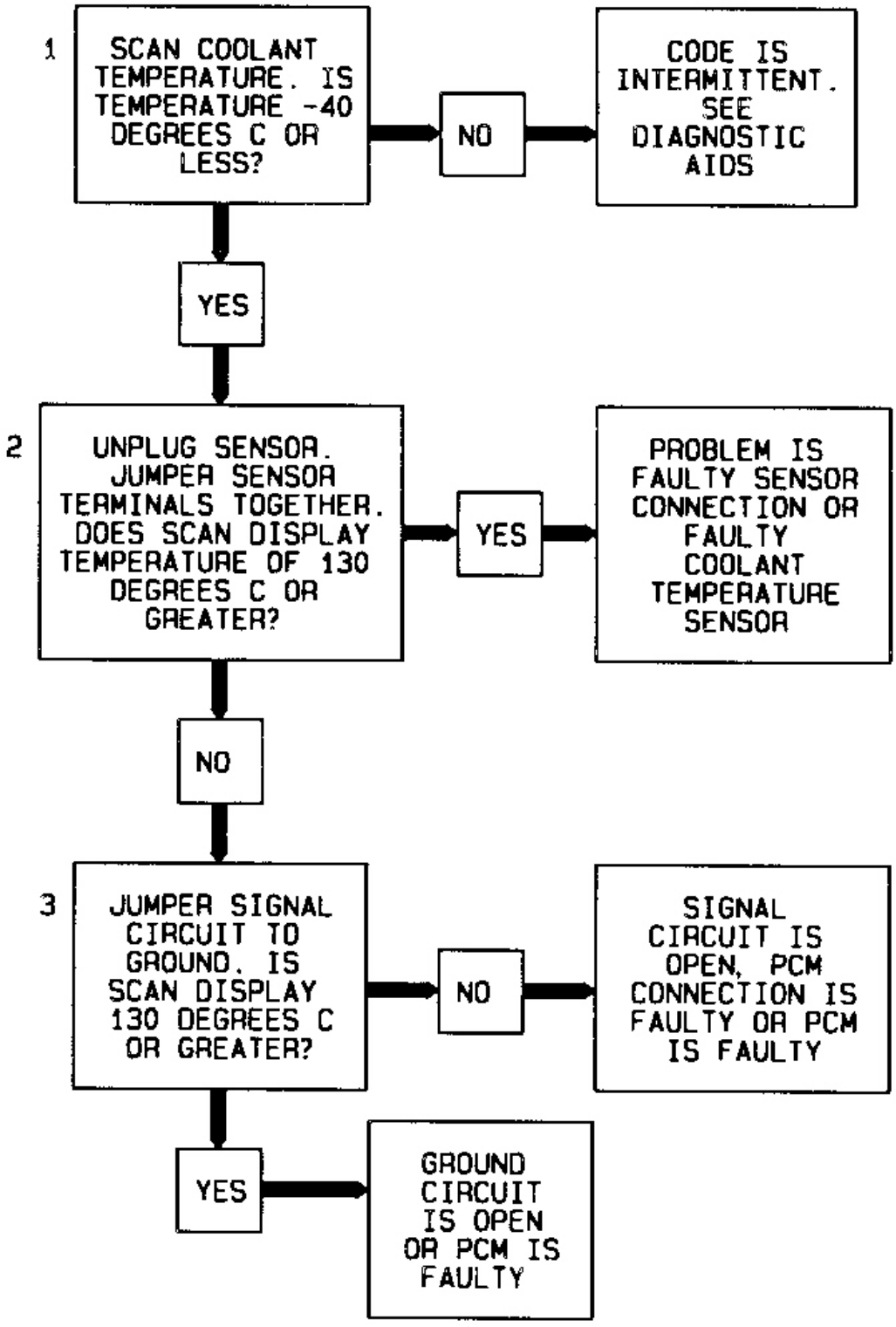


Fig. 206: Code P0117, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.


1
SCAN COOLANT TEMPERATURE. IS TEMPERATURE -40 DEGREES C OR LESS?
NO
CODE IS INTERMITTENT. SEE DIAGNOSTIC AIDS
YES
2
UNPLUG SENSOR. JUMPER SENSOR TERMINALS TOGETHER. DOES SCAN DISPLAY TEMPERATURE OF 130 DEGREES C OR GREATER?
YES
PROBLEM IS FAULTY SENSOR CONNECTION OR FAULTY COOLANT TEMPERATURE SENSOR
NO
3
JUMPER SIGNAL CIRCUIT TO GROUND. IS SCAN DISPLAY 130 DEGREES C OR GREATER?
NO
SIGNAL CIRCUIT IS OPEN, PCM CONNECTION IS FAULTY OR PCM IS FAULTY
YES
GROUND CIRCUIT IS OPEN OR PCM IS FAULTY

94I35103

Fig. 207: Code P0117, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Tech 1 displays engine temperature in degrees Celsius (°C) and Fahrenheit (°F). After engine is started, temperature should rise steadily to 194°F (90°C), then stabilize when thermostat opens. An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside insulation. Check for:

Poor Connection Or Damaged Harness

Inspect VCM harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness.

Intermittent Test

Using Tech 1, monitor engine coolant temperature while moving related connectors and wiring harness. If failure is induced, display will change. This may assist in isolating location of malfunction.

Shifted Sensor

See **TEMPERATURE-TO-RESISTANCE VALUES - "S" & "T" 4**.3L (VIN W) table to test ECT sensor at various temperature levels to evaluate the possibility of a out-of-range sensor which may result in driveability complaints.

NOTE: A faulty connection, or an open in sensor circuits will cause Code P0117 to set.

TEMPERATURE-TO-RESISTANCE VALUES - "S" & "T" 4.3L (VIN W)

Temperature °F (°C)	(1) Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700
(1) Measure resistance across sensor terminals.	

CODE P0118, CTS TEMPERATURE HIGH - "S" & "T" 4.3L (VIN W)

Circuit Description

Coolant sensor uses a thermistor to control signal voltage to VCM. VCM applies and monitors a 5 volts to sensor. When engine coolant is cold, sensor (thermistor) resistance is high and VCM will sense a high signal voltage. As engine coolant warms, sensor resistance becomes less and VCM voltage drops. With Code P0118 set, VCM will turn cooling fans on and use a default engine coolant temperature value based on run time. VCM will illuminate Malfunction Indicator Light (MIL).

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This step determines if conditions necessary to set code exist.
2. Simulates Code P0117. If VCM recognizes low voltage, VCM and wiring are okay.

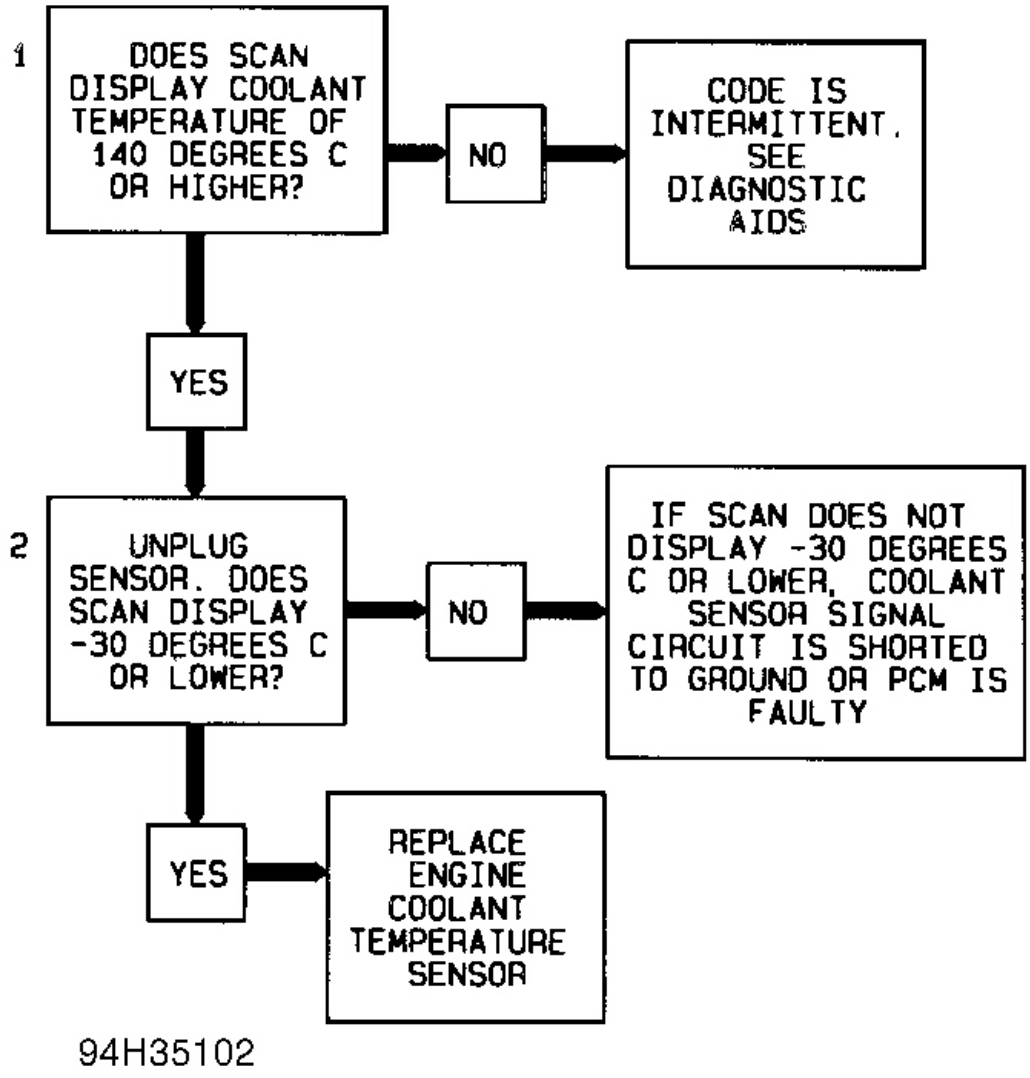


Fig. 208: Code P0118, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

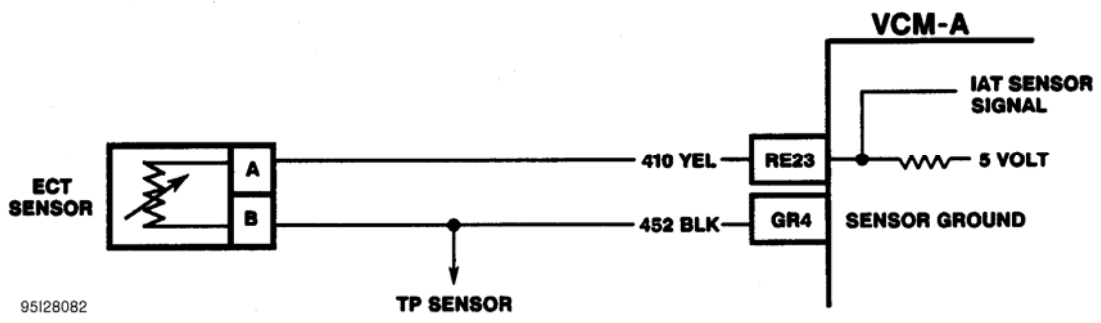


Fig. 209: Code P0118, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Tech 1 displays engine temperature in degrees Celsius (°C) and Fahrenheit (°F). After engine is started, temperature should rise steadily to 194°F (90°C), then stabilize when thermostat opens. An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside insulation. Check the following for:

- A short to ground in 5-volt reference circuit.

Intermittent Test

Using Tech 1, monitor engine coolant temperature while moving related connectors and wiring harness. If failure is induced, display will change. This may assist in isolating location of malfunction.

Shifted Sensor

See **TEMPERATURE-TO-RESISTANCE VALUES - "S" & "T" 4**.3L (VIN W) table to test ECT sensor at various temperature levels to evaluate the possibility of a out-of-range sensor which may result in driveability complaints.

TEMPERATURE-TO-RESISTANCE VALUES - "S" & "T" 4.3L (VIN W)

Temperature °F (°C)	(1) Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700

-40 (-40)	100,700
(1) Measure resistance across sensor terminals.	

CODE P0122, TPS SIGNAL LOW - "S" & "T" 4.3L (VIN W)

Circuit Description

Throttle Position (TP) sensor provides a voltage signal that changes relative to throttle blade angle. Signal voltage will vary from .20-.74 volt at idle to greater than 4 volts at Wide Open Throttle (WOT). TP sensor signal is one of the most important inputs used by VCM for fuel control and for most other VCM control outputs.

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Determines if conditions necessary to set code exist.
2. Simulates Code P0123 (high voltage). If VCM recognizes high signal voltage, VCM and wiring are okay.
3. Simulates a high signal voltage. Checks signal circuit for an open.

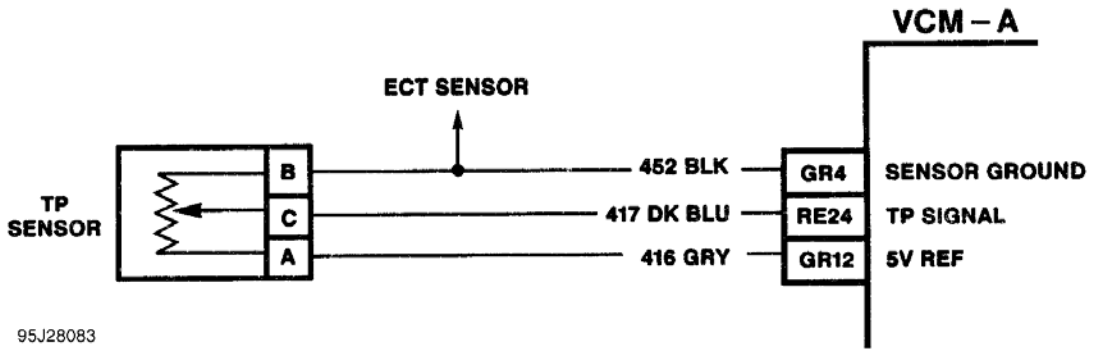
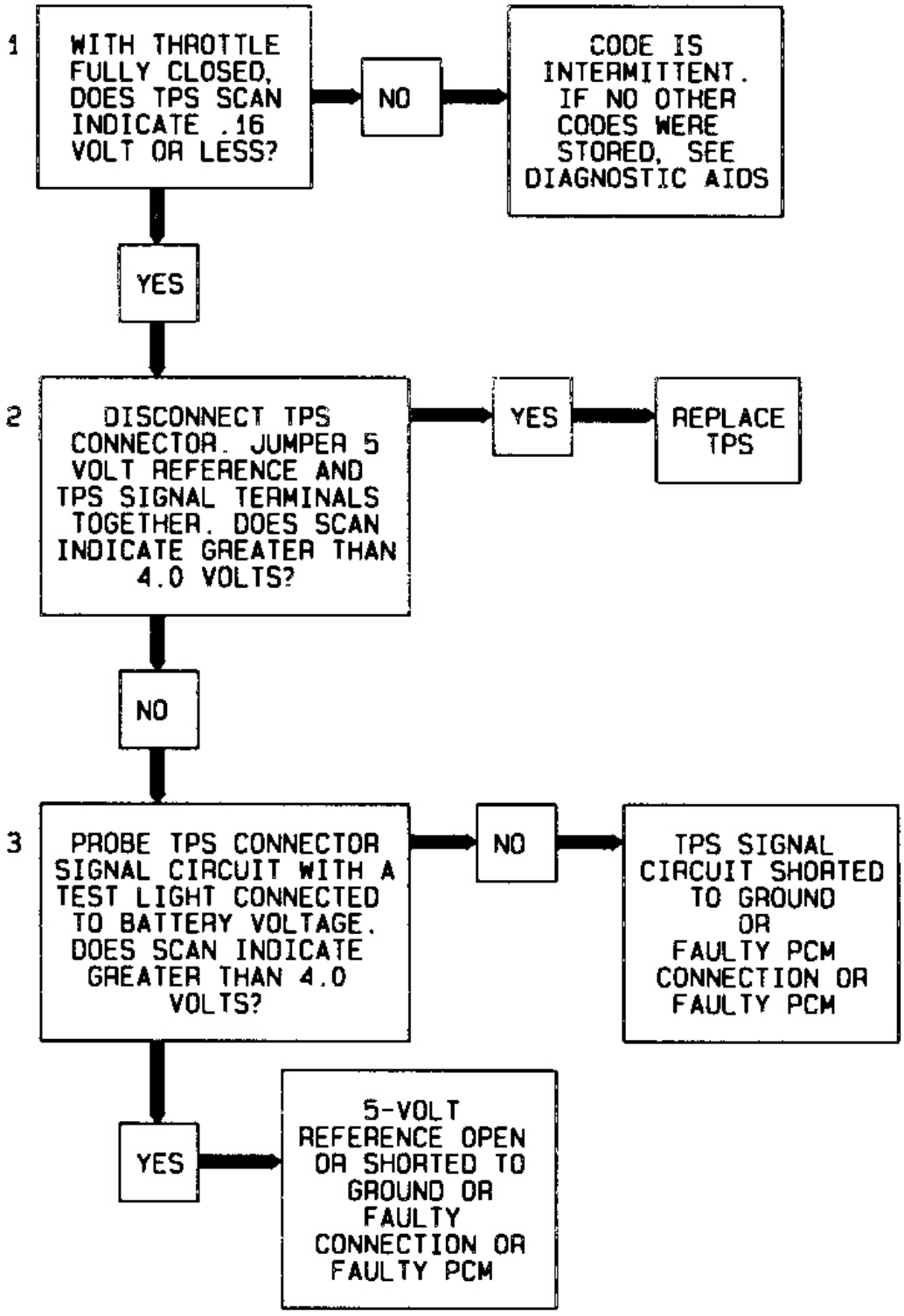


Fig. 210: Code P0122, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.


1
WITH THROTTLE FULLY CLOSED, DOES TPS SCAN INDICATE .16 VOLT OR LESS?
NO
CODE IS INTERMITTENT. IF NO OTHER CODES WERE STORED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TPS CONNECTOR. JUMPER 5 VOLT REFERENCE AND TPS SIGNAL TERMINALS TOGETHER. DOES SCAN INDICATE GREATER THAN 4.0 VOLTS?
YES
REPLACE TPS
NO
3
PROBE TPS CONNECTOR SIGNAL CIRCUIT WITH A TEST LIGHT CONNECTED TO BATTERY VOLTAGE. DOES SCAN INDICATE GREATER THAN 4.0 VOLTS?
NO
TPS SIGNAL CIRCUIT SHORTED TO GROUND OR FAULTY PCM CONNECTION OR FAULTY PCM
YES
5-VOLT REFERENCE OPEN OR SHORTED TO GROUND OR FAULTY CONNECTION OR FAULTY PCM

94I35111

Fig. 211: Code P0122, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Tech 1 displays throttle position in volts. Voltage should increase steadily as throttle is moved toward WOT.

An open or short to ground in reference and signal circuits will cause code to set. Check for:

Poor Connection Or Damaged Harness

Inspect VCM harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness.

Intermittent Test

Monitor TP sensor voltage display on Tech 1 while moving related connectors and wiring harness. If failure is induced, display will change. This may assist in isolating location of malfunction.

TP Sensor Scaling

Observe TP sensor voltage display while depressing accelerator pedal with engine stopped and ignition on. Display should vary from closed throttle TP sensor voltage when throttle is closed (less than 1.25 volts) to greater than 4.5 volts when throttle is held at WOT position.

CODE P0123, TPS SIGNAL HIGH - "S" & "T" 4.3L (VIN W)

Circuit Description

Throttle Position (TP) sensor provides a voltage signal that changes relative to throttle blade angle. Signal voltage will vary from about .5 volt or at idle to about 4 volts at Wide Open Throttle (WOT). TP sensor signal is one of the most important inputs used by VCM for fuel control and for most other VCM control outputs. On non-adjustable TPS sensors, each time voltage drops below 1.25 volts and stops, VCM assumes this value as 0 throttle angle and measures percent throttle from this point on.

Set Condition

With Code P0123 set, throttle position will default to 19 percent and Tech 1 will not indicate fault value. VCM will illuminate Malfunction Indicator Light (MIL).

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If TP signal is greater than 4.8 volts, fault is present.
2. With TP sensor disconnected, TP sensor voltage should decrease. This test verifies that VCM and wiring are okay.
3. Probing ground circuit with a test light checks sensor ground circuit. This isolates a faulty sensor, VCM or open ground circuit.

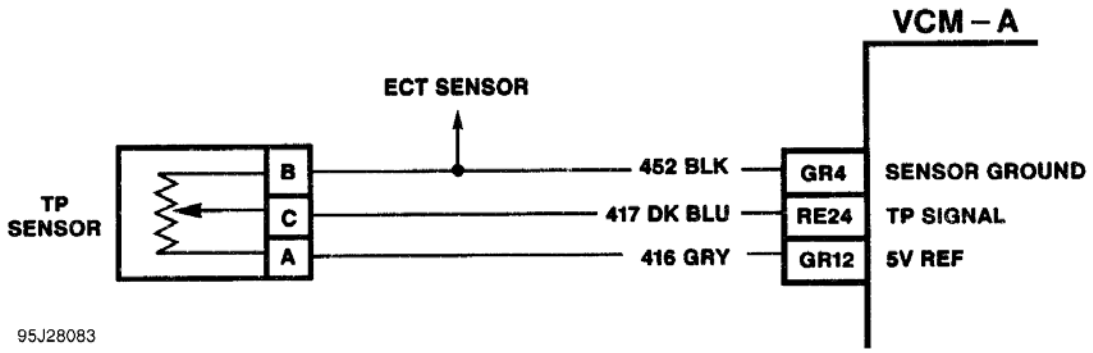


Fig. 212: Code P0123, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

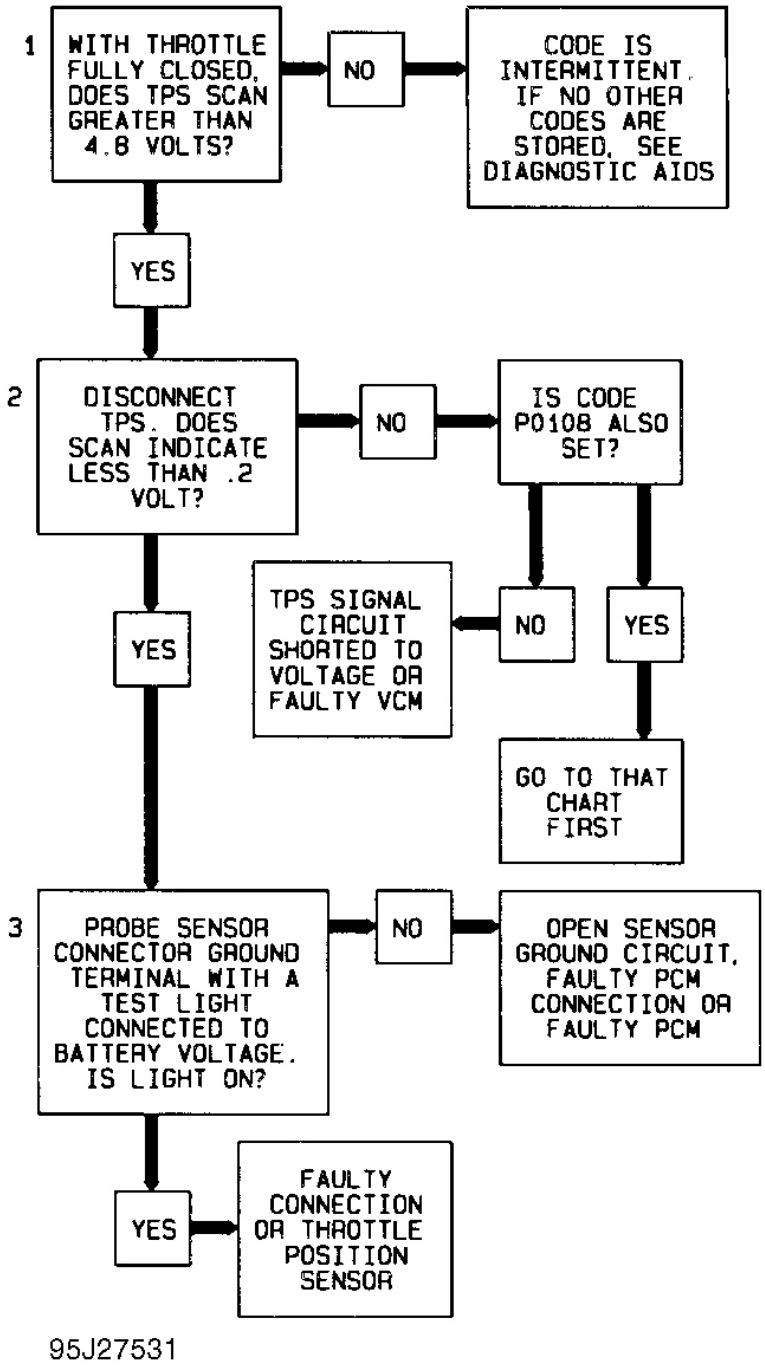


Fig. 213: Code P0123, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Tech 1 displays throttle position in volts. With closed throttle, ignition on, or at idle, voltage should be .45-.85

volt. If voltage is not as specified, replace TP sensor. Check for:

Poor Connection Or Damaged Harness

Inspect VCM harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection, and damaged harness.

Intermittent Test

Monitor TP sensor voltage display on Tech 1 while moving related connectors and wiring harness. If failure is induced, display will change. This may assist in isolating location of malfunction.

TP Sensor Scaling

Observe TP sensor voltage display while depressing accelerator pedal with engine stopped and ignition on. Display should vary from closed throttle TP sensor voltage when throttle is closed (less than 1.25 volts) to greater than 4.5 volts when throttle is held at WOT position.

CODES P0502/P0503, VSS CK LOW/HIGH - "S" & "T" 4.3L (VIN W)

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks VSS circuit.
2. Checks integrity of sensor.
3. Checks 5-volt and ground circuits to VCM.

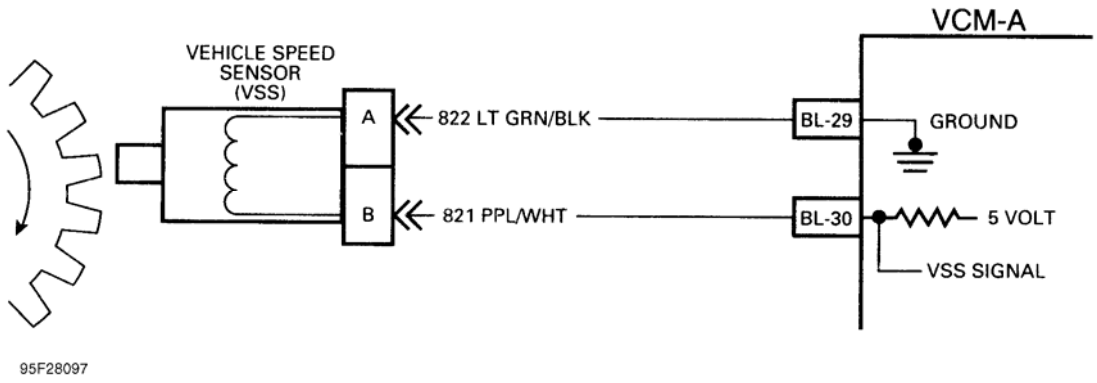


Fig. 214: Code P0502/503, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

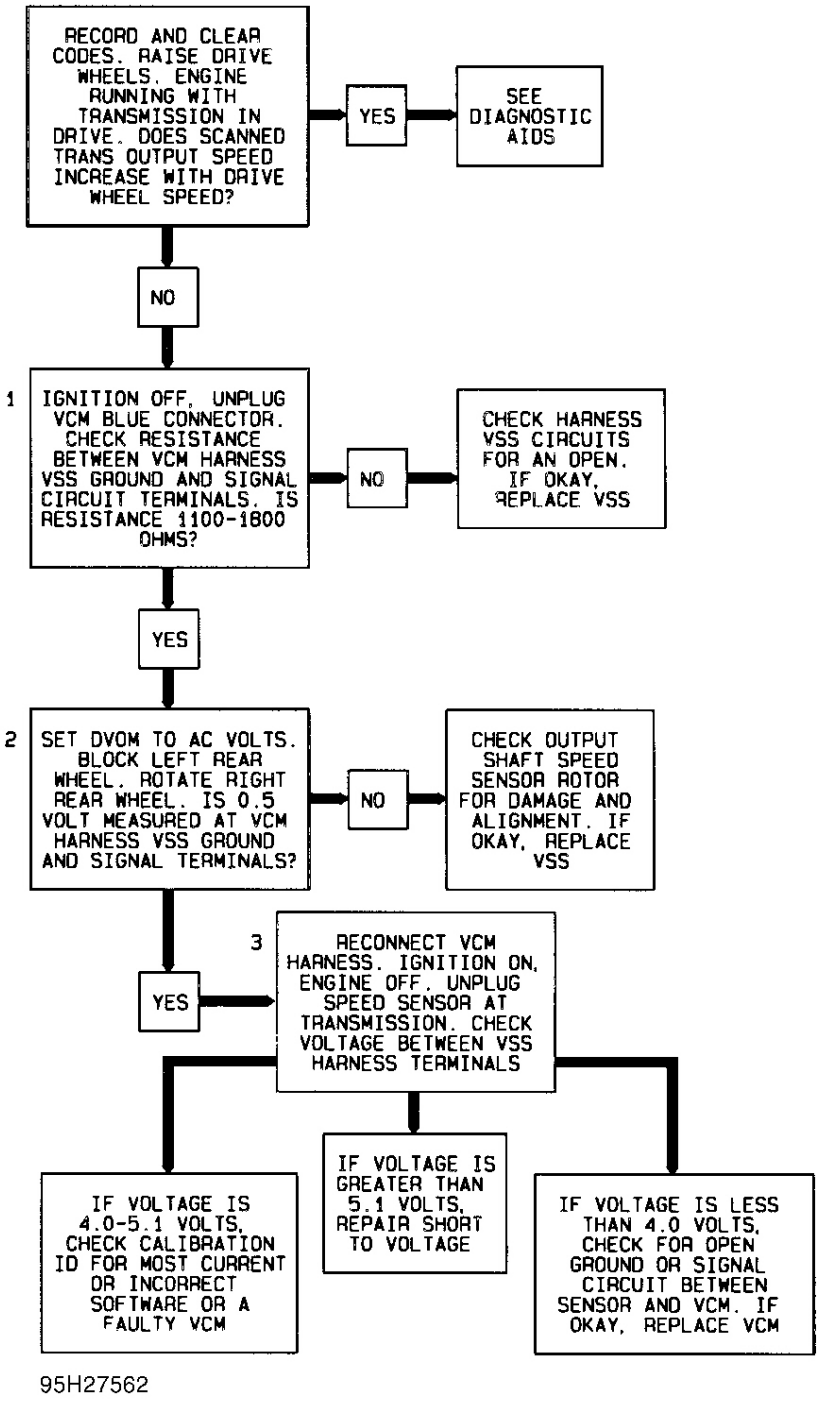


Fig. 215: Code P0502/503, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Code P0502 will set if no vehicle speed is detected at start off. Code P0503 will set when vehicle speed has

been detected and lost. Inspect all harnesses and related wiring, including VCM connectors.

CODE P0560, SYSTEM VOLTAGE MALFUNCTION - "S" & "T" SERIES 4.3L (VIN W)

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Verifies normal charging system voltage is between 13.0 and 15.8 volts.
2. Checks actual battery voltage against voltage at VCM.

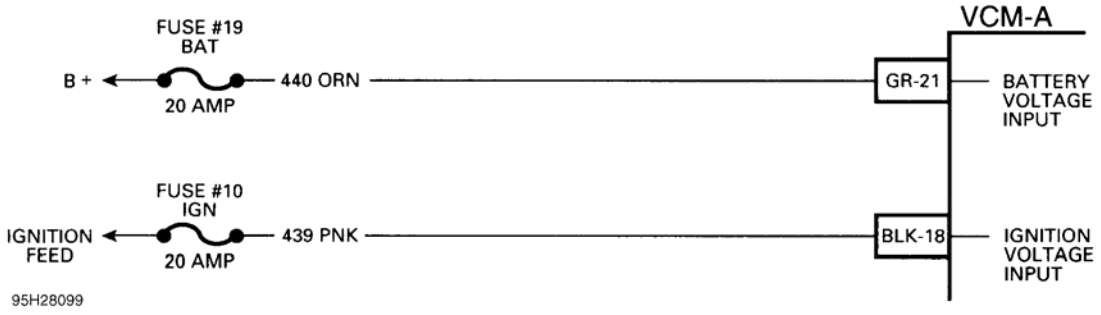


Fig. 216: Code P0560, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

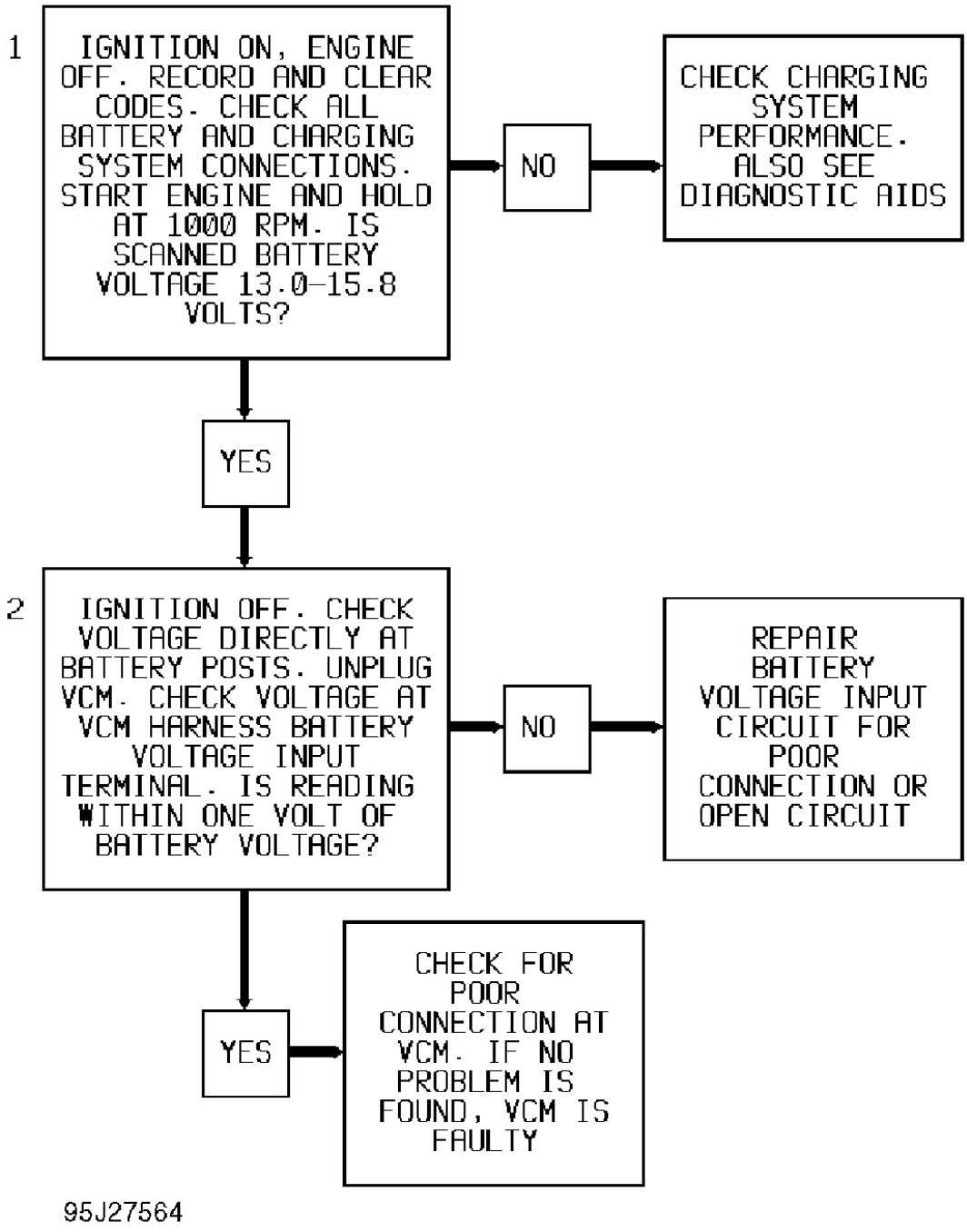


Fig. 217: Code P0560, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Charging battery with a battery charger and jump-starting engine may set this code. If code sets when an accessory is operated, check for faulty connections or excessive current draw. Check for faulty connections at

starter solenoid and fusible link. Check for loose or damaged terminals at generator. Check belt tension and wear.

CODE P0703, TCC BRAKE INPUT CIRCUIT - "S" & "T" SERIES 4.3L (VIN W)

Circuit Description

TCC brake switch input is used by VCM to determine when to energize TCC solenoid.

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for voltage at brake switch.
2. Checks brake switch.
3. Checks TCC brake switch signal at VCM.

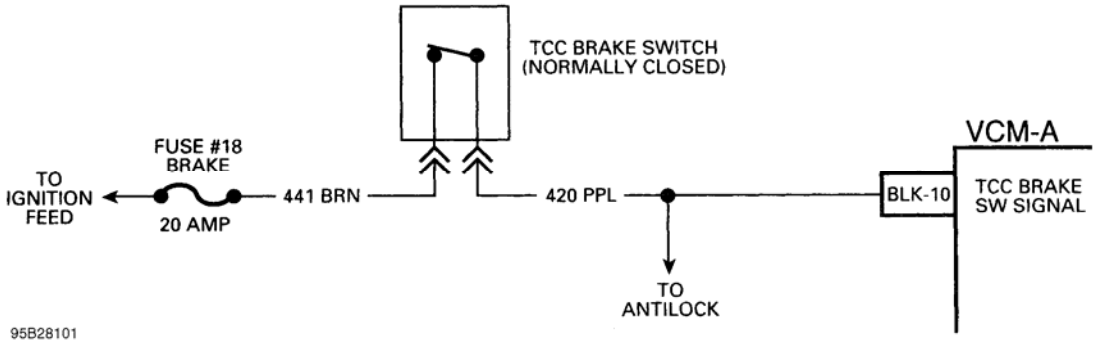


Fig. 218: Code P0703, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

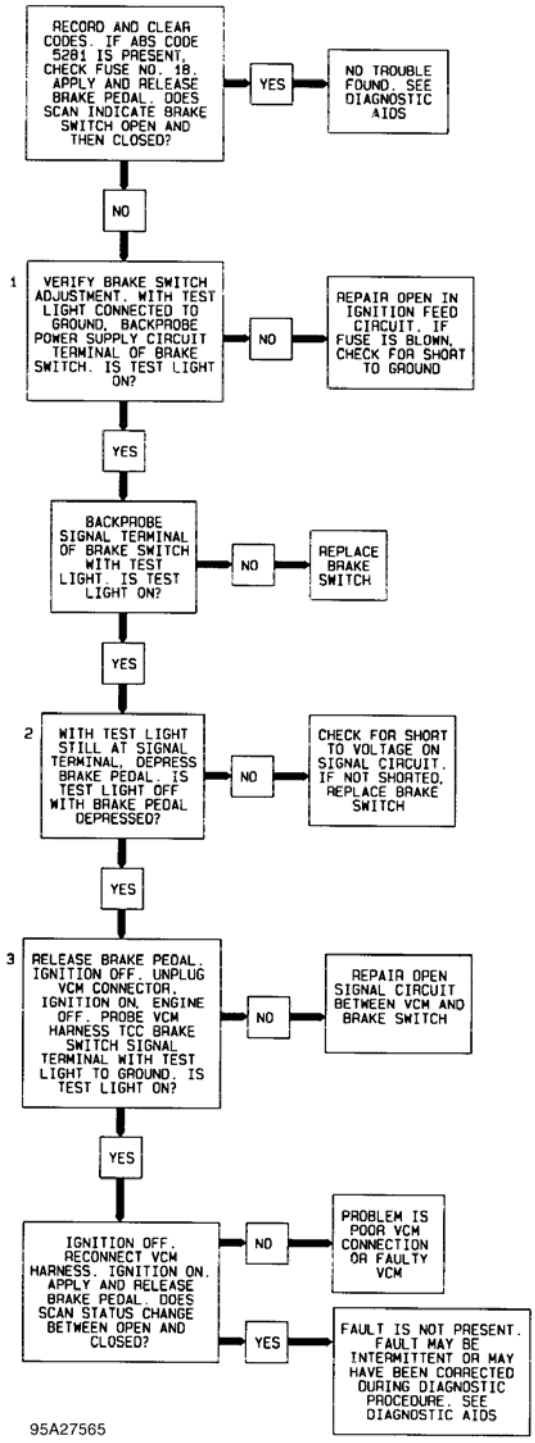


Fig. 219: Code P0703, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Check customer driving habits and/or unusual traffic conditions, i.e. stop and go freeway traffic. Check brake

switch adjustment. Check for most current VCM calibration software.

CODE P0712, TRANS. TEMP. SENSOR VOLTAGE LOW "S" & "T" SERIES 4.3L (VIN W)

Circuit Description

VCM sends a voltage signal to sensor and monitors return voltage. Transmission temperature sensor varies resistance as temperature of transmission fluid changes. Temperature sensor resistance is high when transmission fluid is cold. As fluid temperature increases, sensor resistance decreases.

Test Description

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Checks for short to ground or sensor out-of-range.
2. Checks for an internal fault within transmission by creating an open.

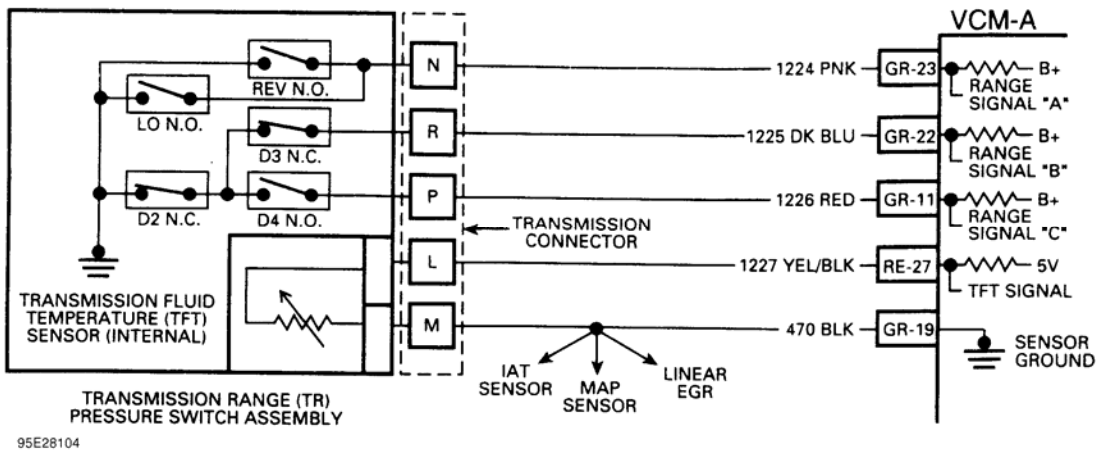


Fig. 220: Code P0712, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

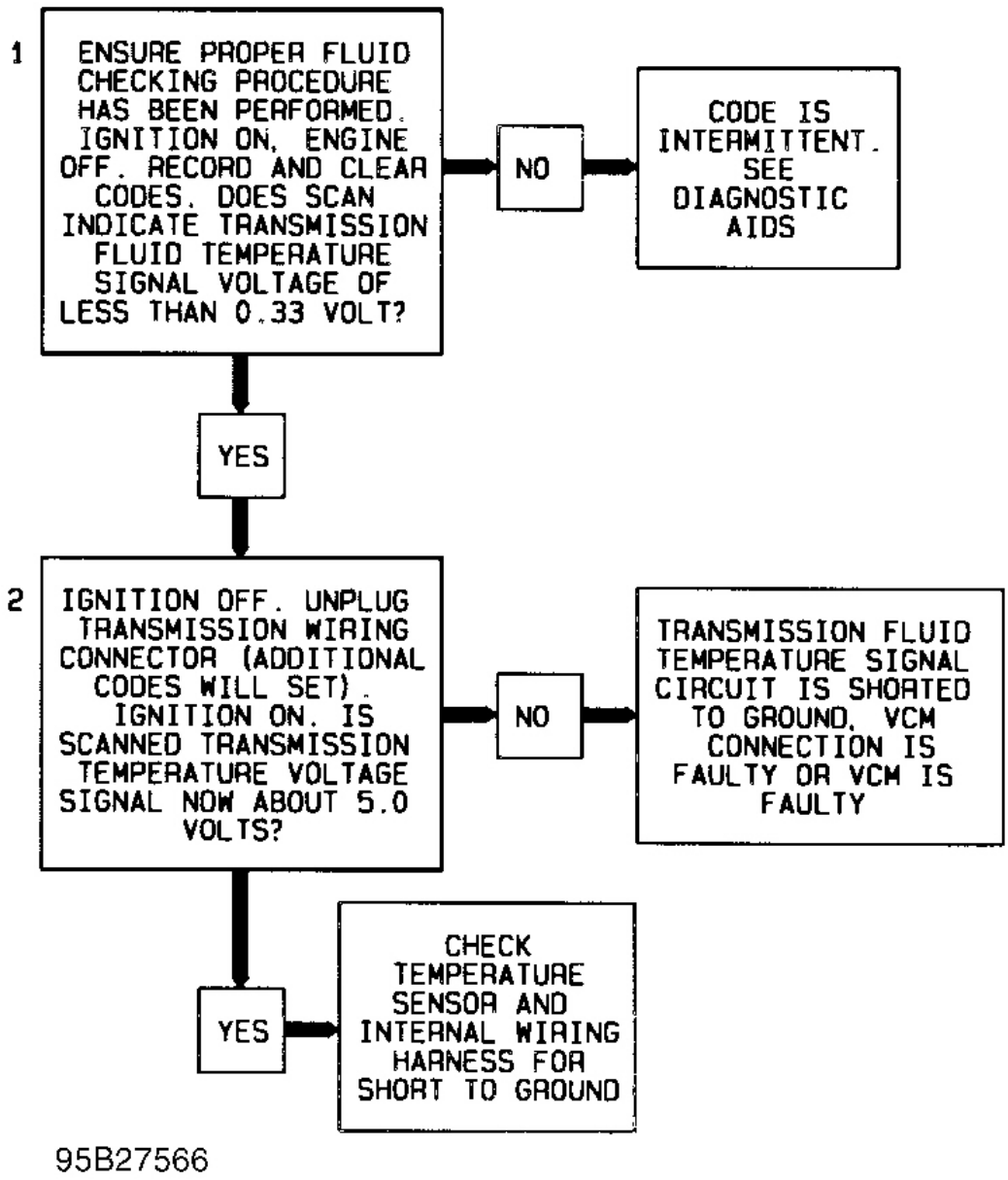


Fig. 221: Code P0712, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

After engine is started, temperature should rise steadily to about 212°F (100°C). Check sensor for shifted calibration by using sensor **TEMPERATURE-TO-RESISTANCE VALUES** table. An intermittent may be caused by a poor connection, chaffed wire insulation or a broken wire. Monitor voltage of each terminal while moving related harness connectors. If failure is induced, voltage reading will change.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	(1) (2) Ohms
150 (66)	42-56
100 (38)	159-198
70 (20)	420-514
40 (4)	1308-1609
20 (-7)	3088-3941
0 (-18)	7902-10,943
-40 (-40)	73,556-127,857

(1) Measure resistance across sensor terminals.

(2) Temperatures are approximates.

CODE P0713, TRANS. TEMP. SENSOR VOLTAGE HIGH - "S" & "T" SERIES 4.3L (VIN W)

Circuit Description

VCM sends a voltage signal to sensor and monitors return voltage. Transmission temperature sensor varies resistance as temperature of transmission fluid changes. Temperature sensor resistance is high when transmission fluid is cold. As fluid temperature increases, sensor resistance decreases.

Test Description

NOTE: Test numbers refer to test numbers on diagnostic chart.

1. Verifies a problem in sensor circuit.
2. Simulates Code P0712. If VCM recognizes low signal voltage, VCM and wiring are okay.
3. Checks 5-volt reference for open. There should be 5 volts present at sensor connector.

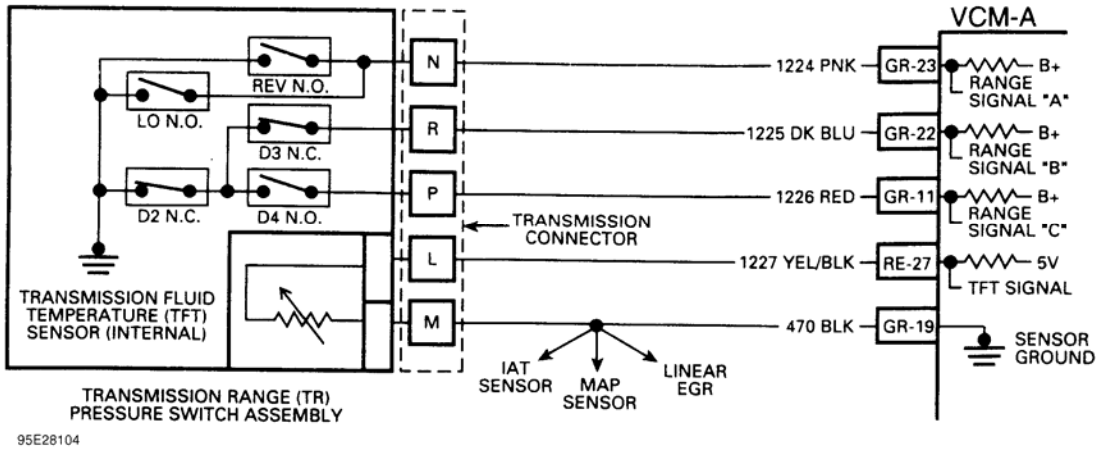


Fig. 222: Code P0713, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

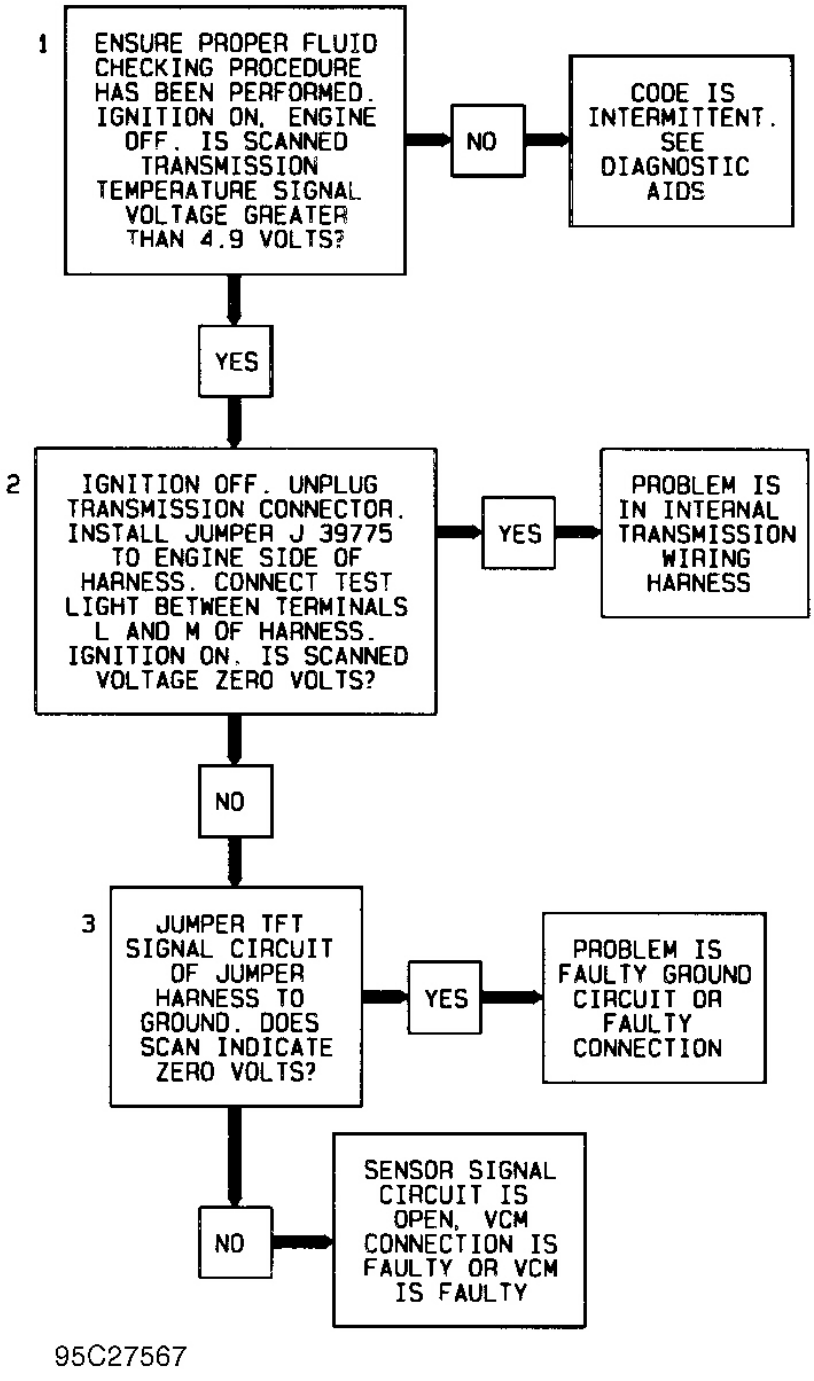


Fig. 223: Code P0713, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

After engine is started, temperature should rise steadily to about 212°F (100°C). Check sensor for shifted

calibration by using sensor **TEMPERATURE-TO-RESISTANCE VALUES** table. An intermittent may be caused by a poor connection, chaffed wire insulation or a broken wire. Monitor voltage of each terminal while moving related harness connectors. If failure is induced, voltage reading will change.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	**(1) (2) Ohms**
150 (66)	42-56
100 (38)	159-198
70 (20)	420-514
40 (4)	1308-1609
20 (-7)	3088-3941
0 (-18)	7902-10,943
-40 (-40)	73,556-127,857

(1) Measure resistance across sensor terminals.

(2) Temperatures are approximates.

CODE P0742, TCC STUCK ON - "S" & "T" SERIES 4.3L (VIN W)

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks mechanical state of TCC when VCM commands TCC solenoid off. TCC slip speed should increase.

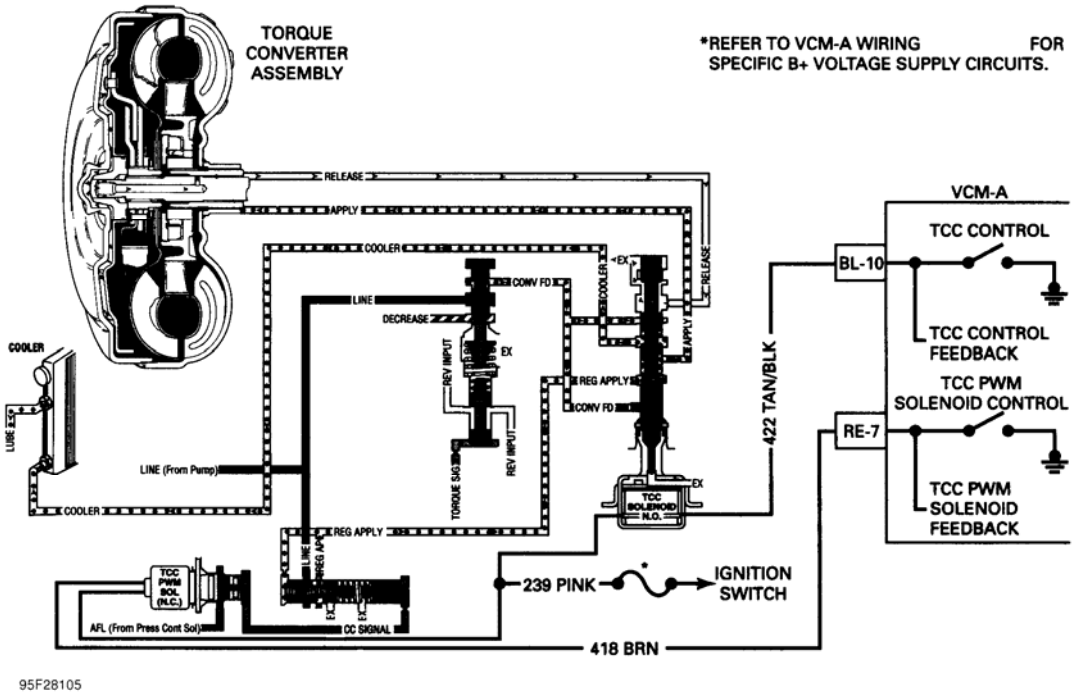


Fig. 224: Code P0742, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

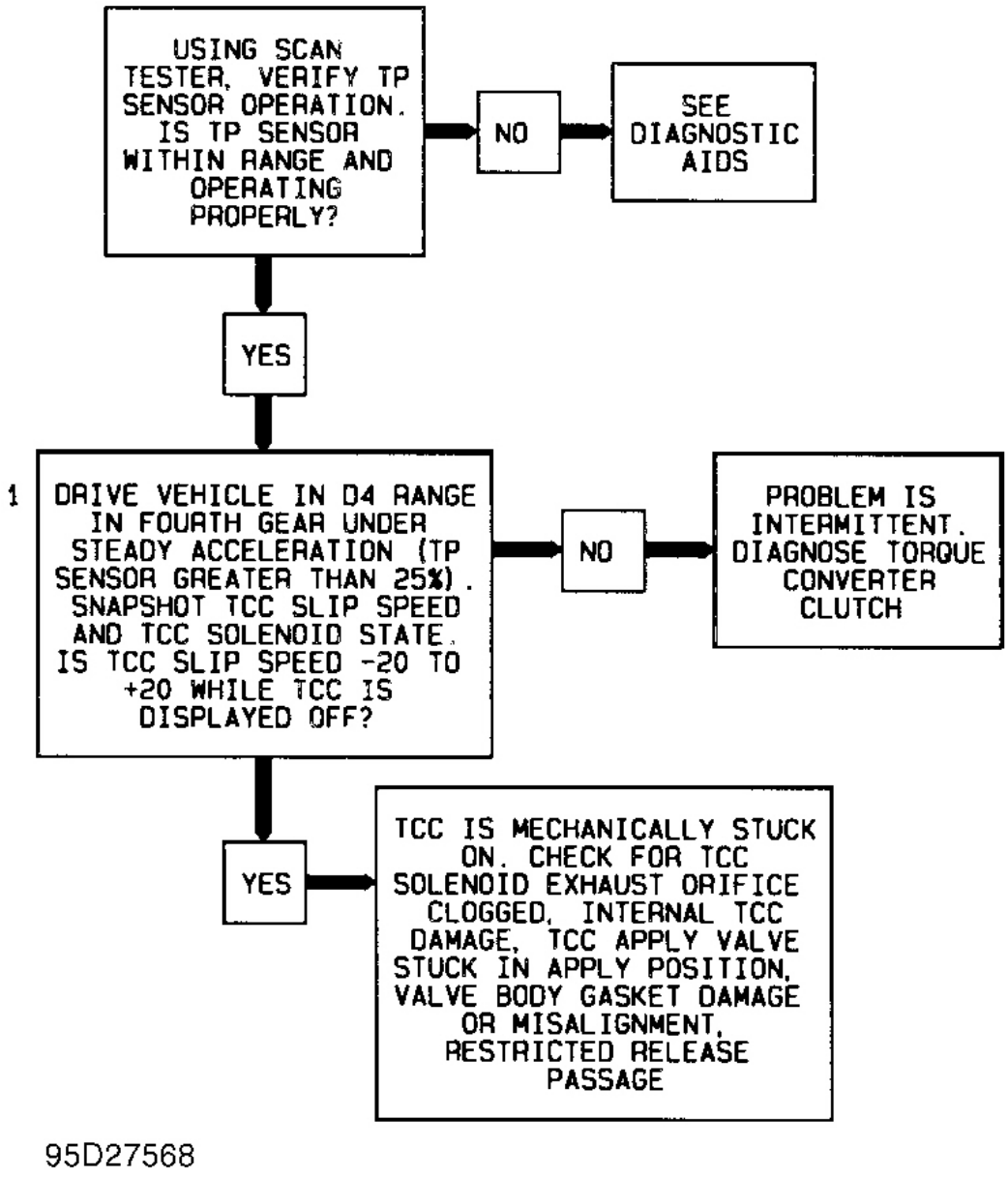


Fig. 225: Code P0742, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Check for proper TP sensor operation. If TCC is mechanically stuck on, vehicle speed is zero, brakes are applied, and D2 is selected, TCC fluid will mechanically apply TCC, causing an engine stall.

CODE P0748, PRESSURE CONTROL SOLENOID - "S" & "T" SERIES 4.3L (VIN W)

Circuit Description

Pressure control solenoid is used to regulate transmission line pressure. VCM compares TPS voltage, engine RPM and other inputs to determine proper line pressure for a given load. VCM regulates pressure by applying a varying amperage to pressure control solenoid. Amperage varies from 0.1 to 1.1 amps.

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks ability of VCM to command pressure control solenoid.
2. Checks for voltage at VCM.

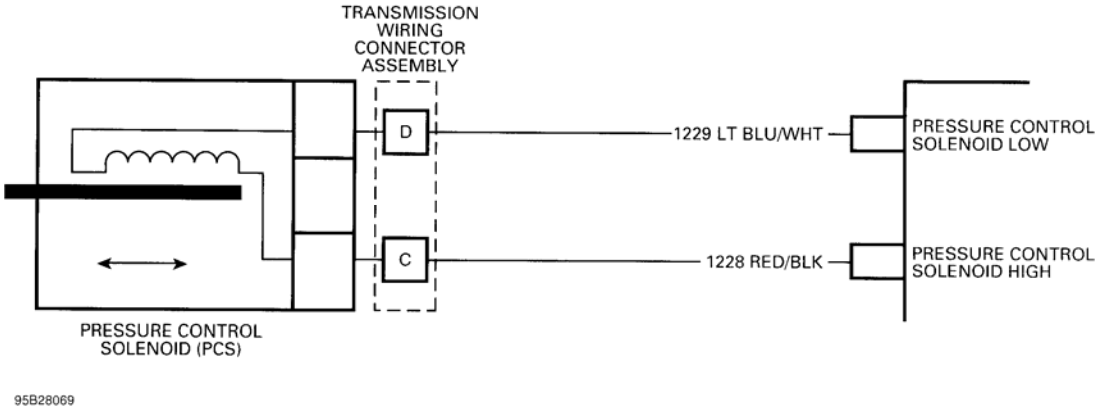


Fig. 226: Code P0748, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

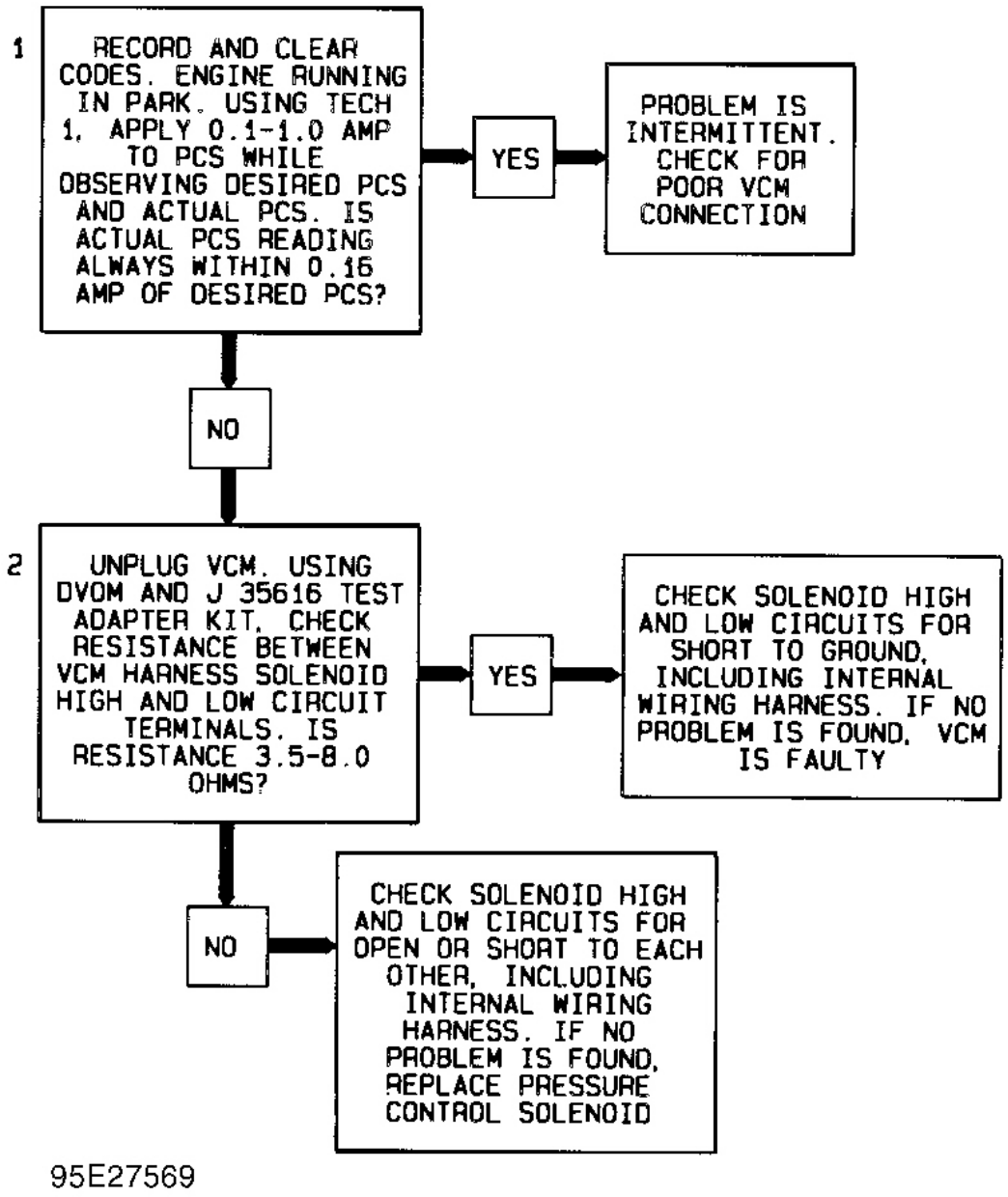


Fig. 227: Code P0748, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Check for poor connections at VCM and at transmission connector.

CODE P0753, 1-2 SHIFT SOLENOID - "S" & "T" 4.3L (VIN W)

Circuit Description

Voltage is supplied directly to solenoid. VCM energizes solenoid by providing a ground circuit for solenoid.

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks 1-2 shift solenoid and internal transmission for shorts.
2. Checks for power to 1-2 shift solenoid from ignition through fuse.

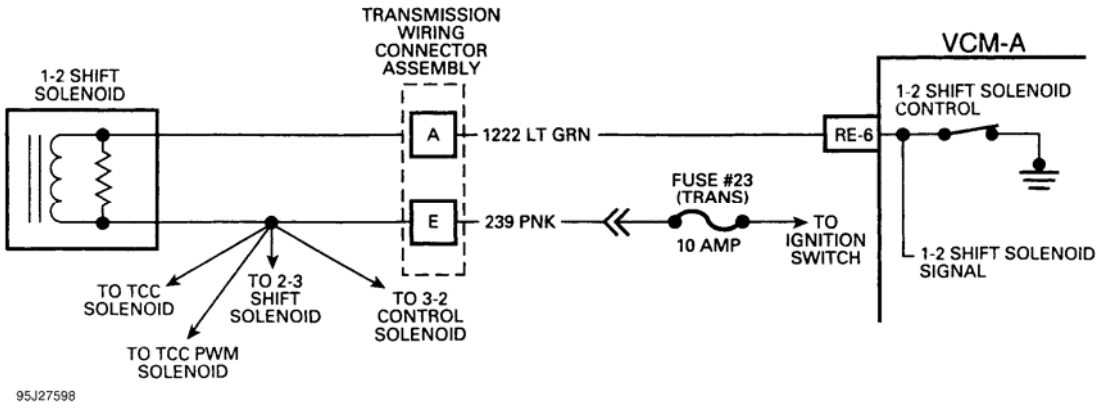


Fig. 228: Code P0753, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

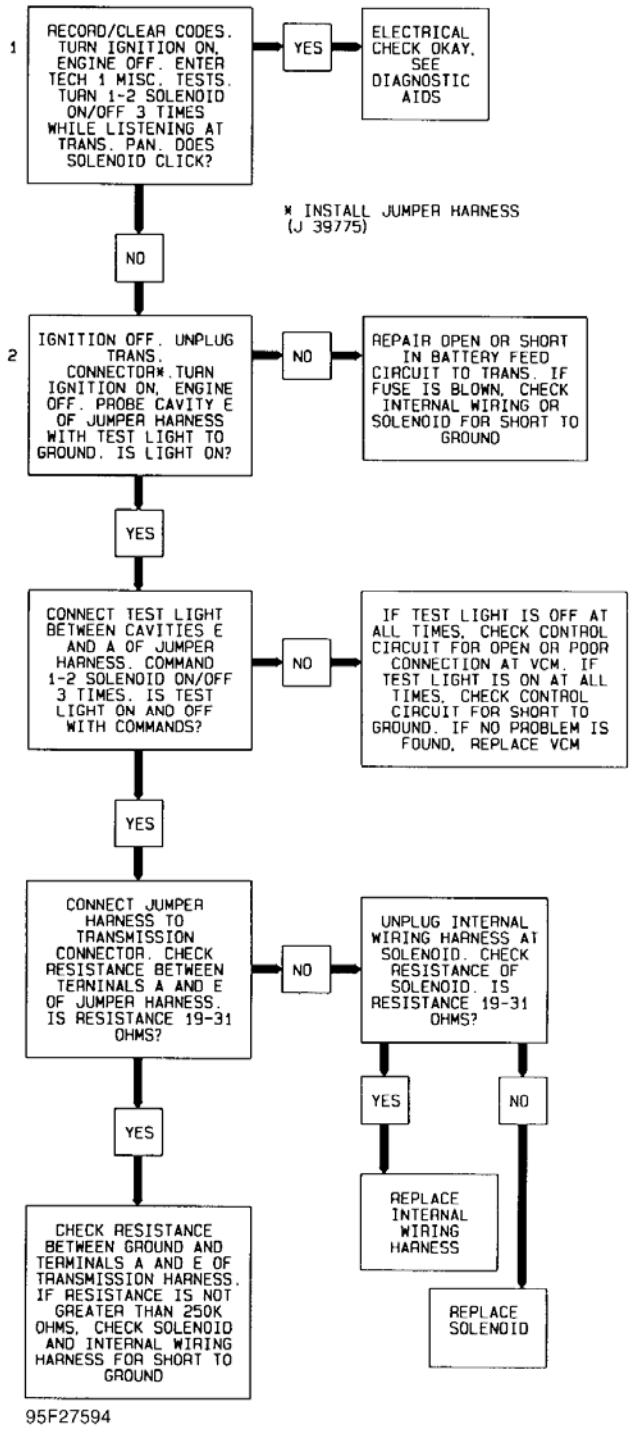


Fig. 229: Code P0753, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Check all connections at transmission. An open in ignition feed circuit can cause multiple codes to set.

CODE P0756, 2-3 SHIFT SOLENOID PERFORMANCE - "S" & "T" SERIES 4.3L (VIN W)

Circuiot Description

Voltage is supplied directly to solenoid. VCM energizes solenoid by providing a ground circuit for solenoid.

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks function of transmission range switch.
2. Checks for proper selected gear ratio.

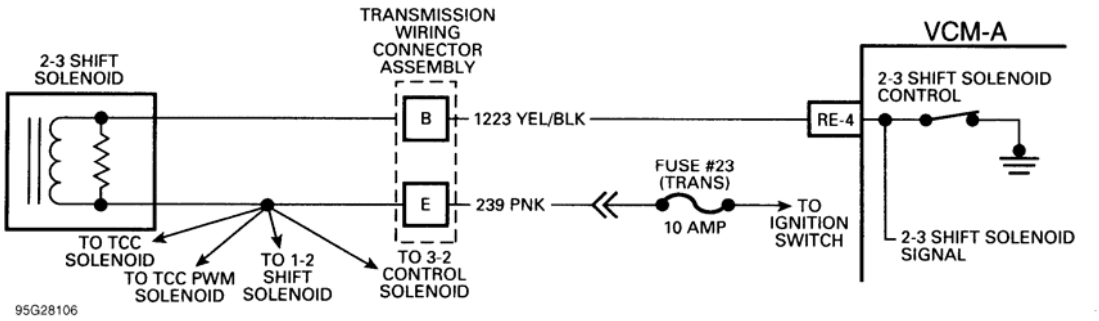


Fig. 230: Code P0756, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

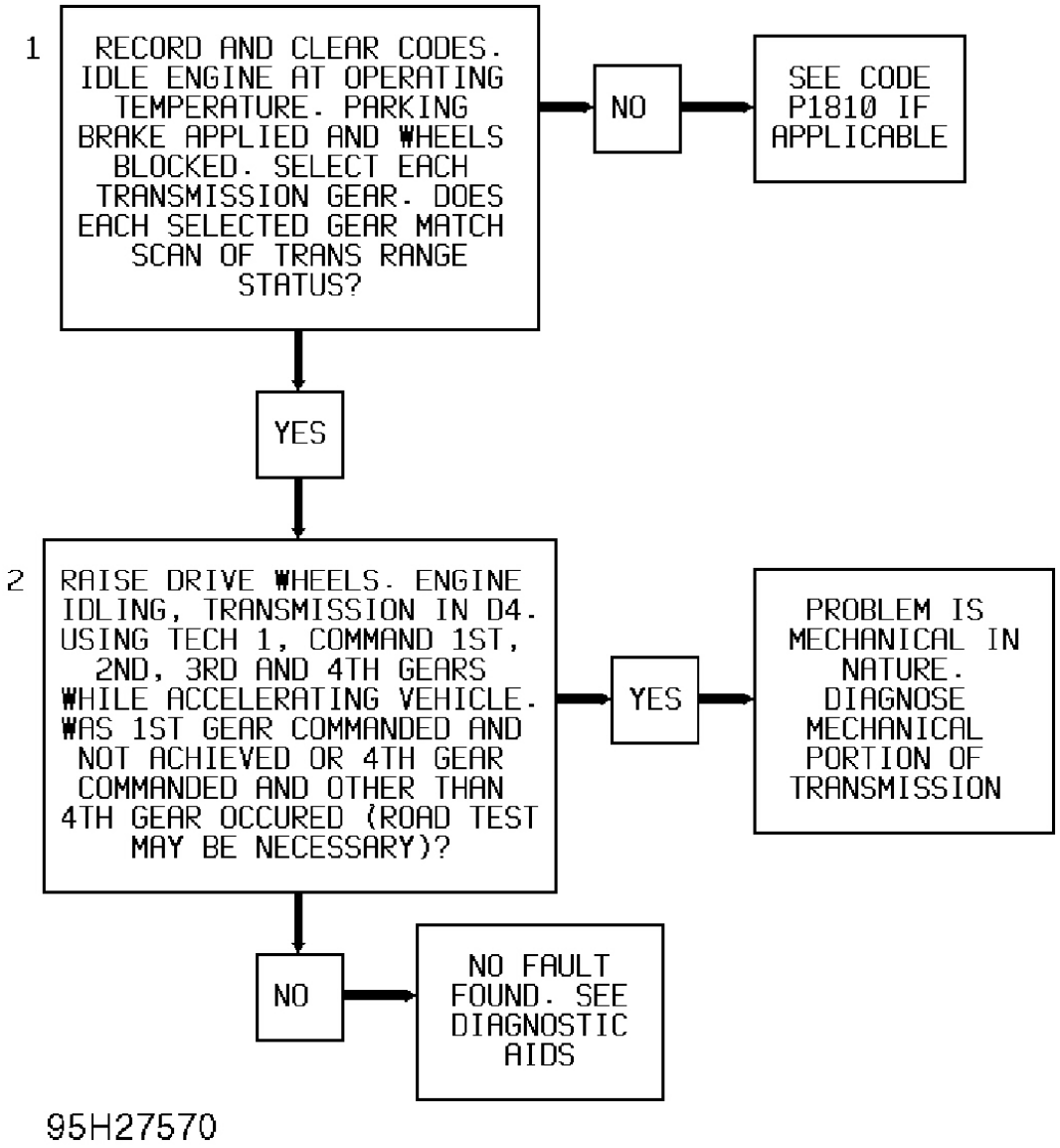


Fig. 231: Code P0756, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Check all related wiring, including VCM connectors. A 4WD switch/wiring problem may set this code.

CODE P0758, 2-3 SHIFT SOLENOID ELECTRICAL - "S" & "T" SERIES 4.3L (VIN W)

Circuit Description

Voltage is supplied directly to solenoid. VCM energizes solenoid by providing a ground circuit for solenoid.

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks 2-3 shift solenoid and internal transmission for shorts.
2. Checks for power to 2-3 shift solenoid from ignition through fuse.
3. Checks ability of VCM and wiring to control ground (driver) circuit.

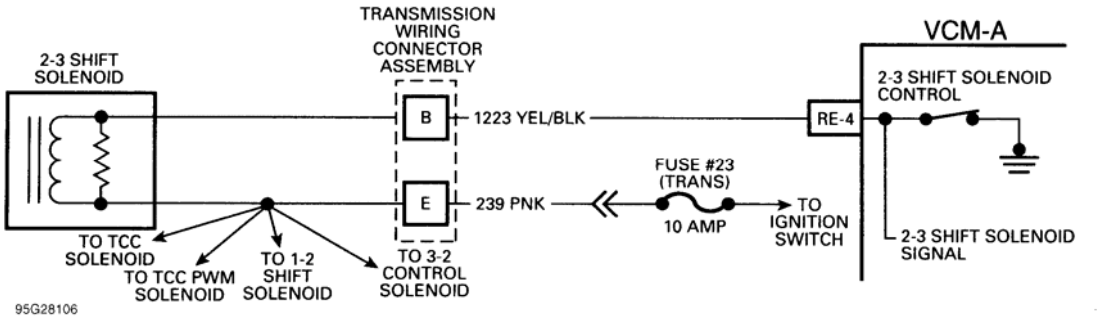


Fig. 232: Code P0758, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

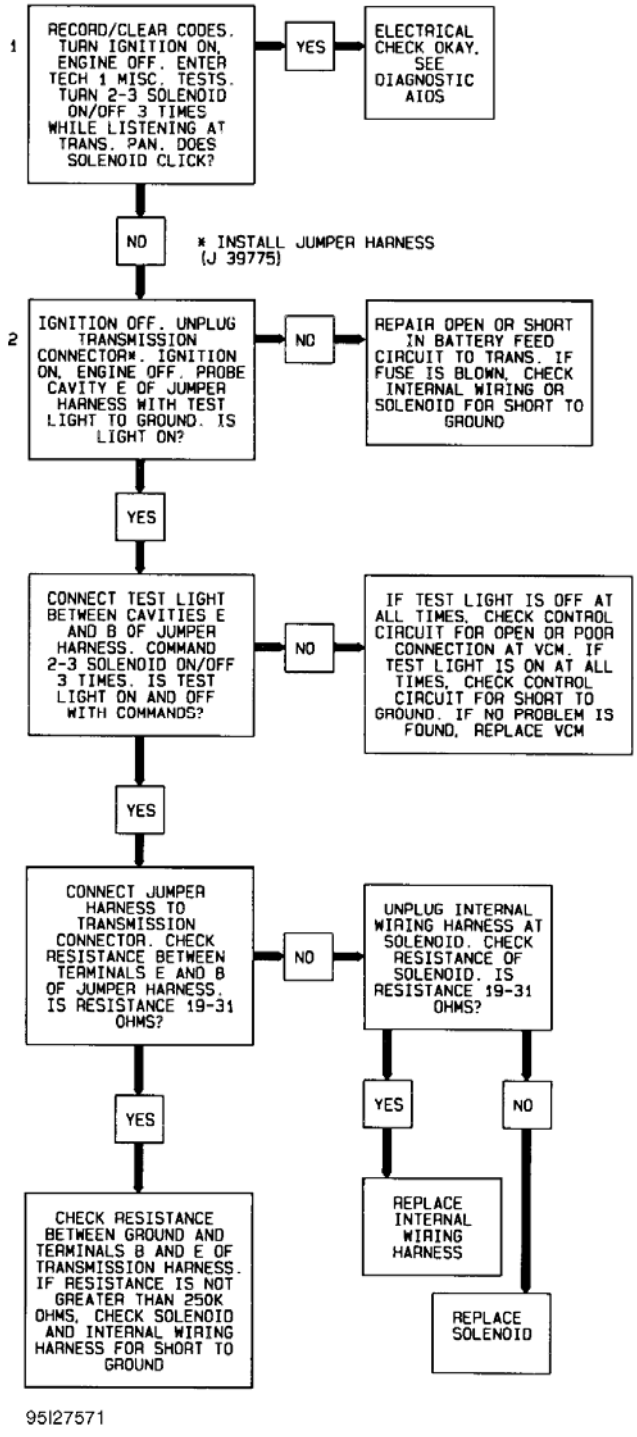


Fig. 233: Code P0758, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Check all related wiring, including VCM connectors. An open ignition feed circuit may set this code.

CODE P1810, TRANSMISSION RANGE SWITCH ASSEMBLY CIRCUIT S" & "T" SERIES 4.3L (VIN W)

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks indicated range to actual manual valve position.
2. Checks for correct voltage from VCM to transmission external connector.
3. Checks for a short to ground or an open in any one of the 3 circuits.

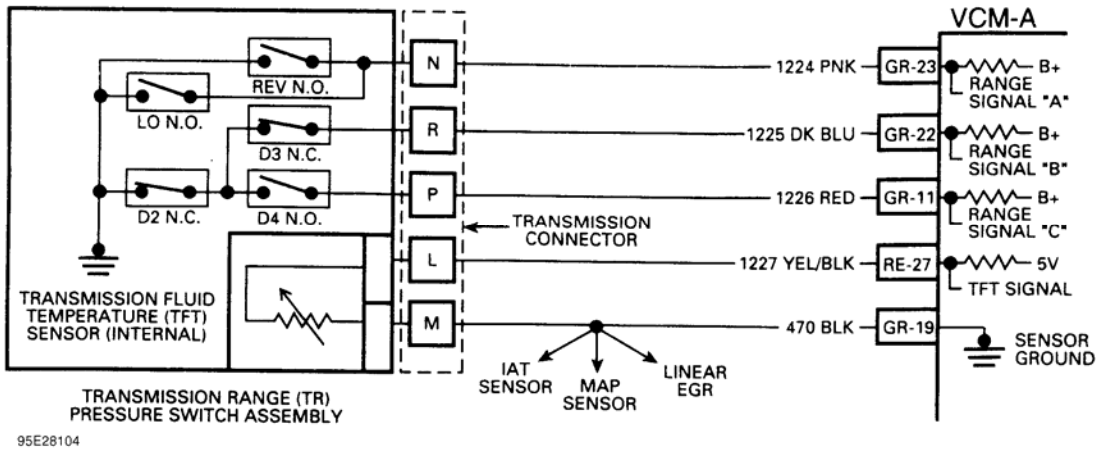
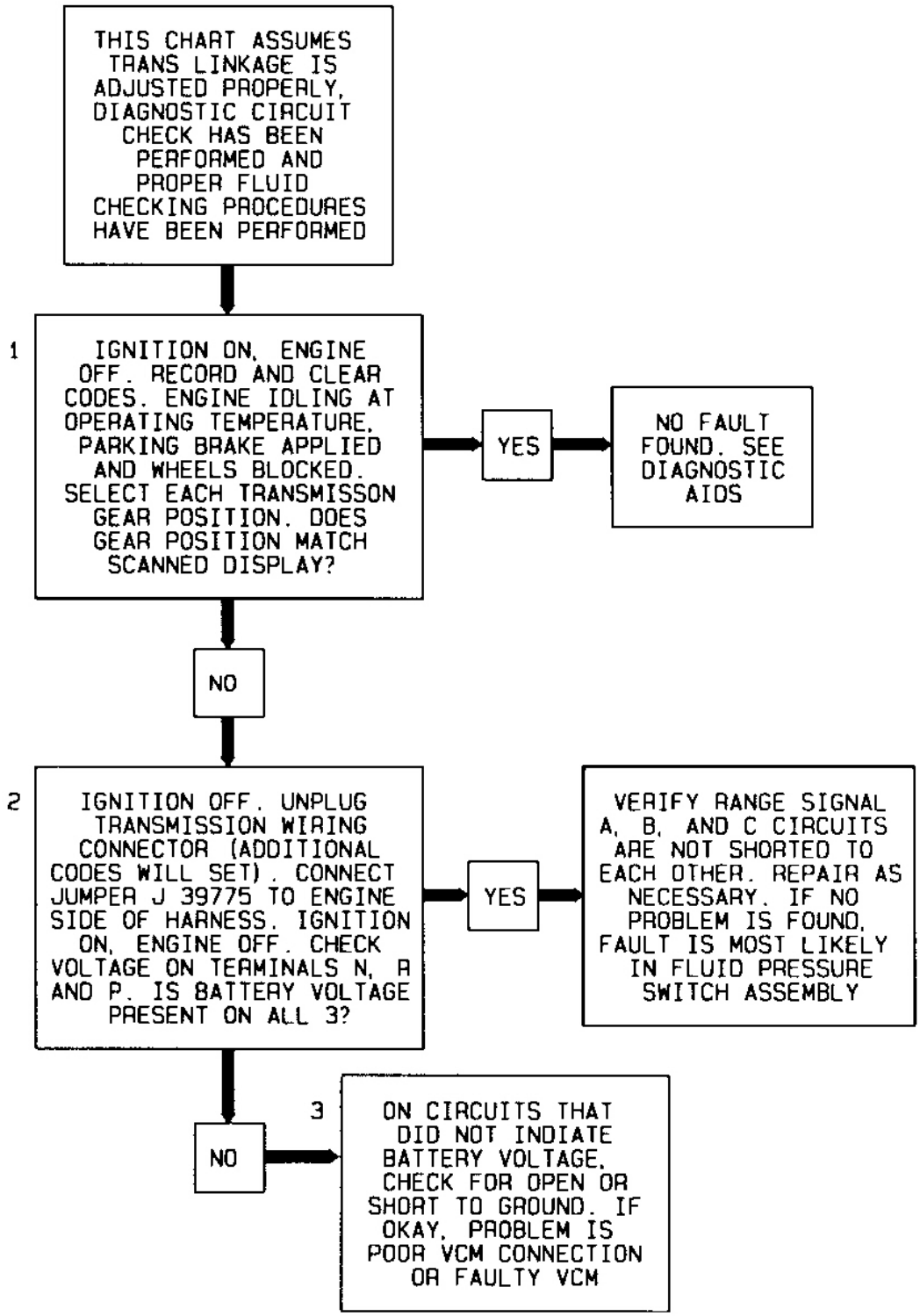


Fig. 234: Code P1810, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.


THIS CHART ASSUMES TRANS LINKAGE IS ADJUSTED PROPERLY, DIAGNOSTIC CIRCUIT CHECK HAS BEEN PERFORMED AND PROPER FLUID CHECKING PROCEDURES HAVE BEEN PERFORMED
1
IGNITION ON, ENGINE OFF. RECORD AND CLEAR CODES. ENGINE IDLING AT OPERATING TEMPERATURE, PARKING BRAKE APPLIED AND WHEELS BLOCKED. SELECT EACH TRANSMISSON GEAR POSITION. DOES GEAR POSITION MATCH SCANNED DISPLAY?
YES
NO FAULT FOUND. SEE DIAGNOSTIC AIDS
NO
2
IGNITION OFF. UNPLUG TRANSMISSION WIRING CONNECTOR (ADDITIONAL CODES WILL SET). CONNECT JUMPER J 39775 TO ENGINE SIDE OF HARNESS. IGNITION ON, ENGINE OFF. CHECK VOLTAGE ON TERMINALS N, R AND P. IS BATTERY VOLTAGE PRESENT ON ALL 3?
YES
VERIFY RANGE SIGNAL A, B, AND C CIRCUITS ARE NOT SHORTED TO EACH OTHER. REPAIR AS NECESSARY. IF NO PROBLEM IS FOUND, FAULT IS MOST LIKELY IN FLUID PRESSURE SWITCH ASSEMBLY
NO
3
ON CIRCUITS THAT DID NOT INDIATE BATTERY VOLTAGE, CHECK FOR OPEN OR SHORT TO GROUND. IF OKAY, PROBLEM IS POOR VCM CONNECTION OR FAULTY VCM

95F27586

Fig. 235: Code P1810, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Check scan tester accompanying value combinations chart. Check all wiring connectors for proper connections and tension.

VALUE COMBINATION CHART

Application	A	B	C
Park	Off	On	Off
Reverse	On	On	Off
Neutral	Off	On	Off
4th	Off	On	On
3rd	Off	Off	On
2nd	Off	Off	Off
1st	On	Off	Off
Illegal	On	Off	On
Illegal	On	On	On

CODE P1812, TRANS. FLUID OVERTEMP - "S" & "T" SERIES 4.3L (VIN W)

Circuit Description

Transmission fluid temperature sensor is a thermistor which controls signal voltage to VCM. VCM applies and monitors voltage to sensor. When transmission fluid is cold, sensor resistance is high; therefore, VCM will see high signal voltage. As transmission fluid warms, sensor resistance and voltage will drop. At normal transmission operating temperature of 212°F (100°C), voltage will be about 1.5-2.0 volts.

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for out-of-range sensor or shorted circuit.
2. Simulates Code P0713.

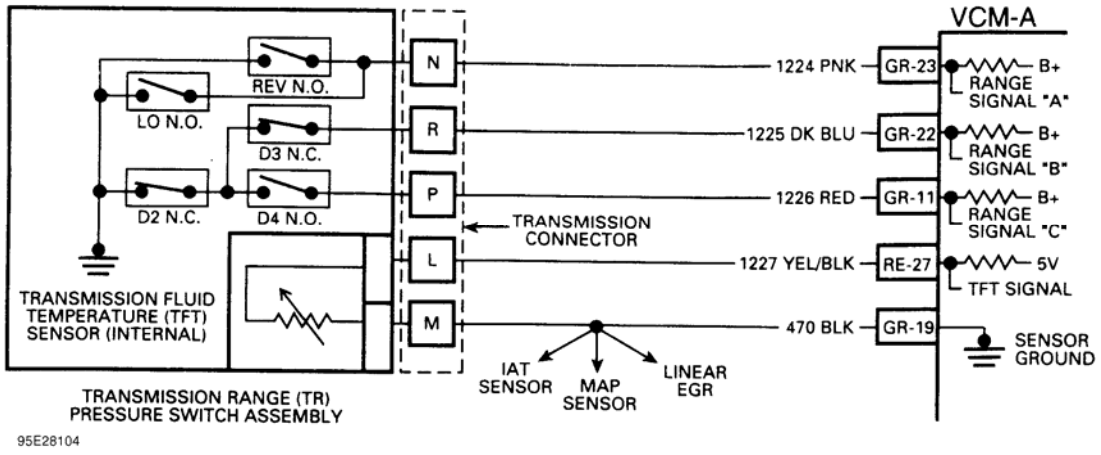


Fig. 236: Code P1812, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

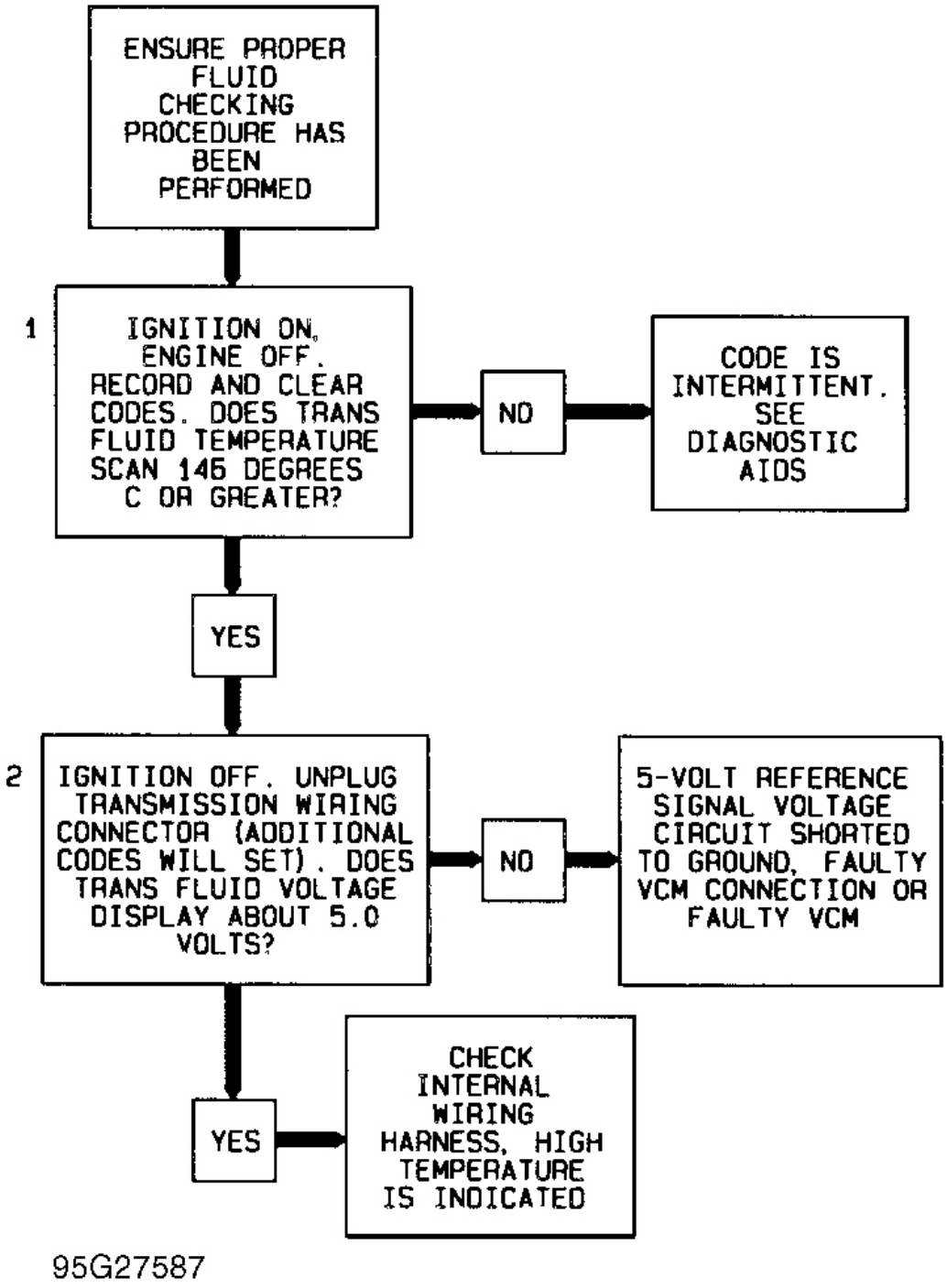


Fig. 237: Code P1812, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Check harness routing for a potential short to ground in signal circuit. Scan tester displays transmission fluid temperature in degrees Centigrade. After transmission is running, temperature display should rise steadily to about 212°F (100°C) then stabilize. Test transmission sensor at various temperature levels to determine if sensor is out of calibration. See **TEMPERATURE-TO-RESISTANCE VALUES** table. An out-of-calibration sensor could result in delayed shifts or TCC enabled complaint.

TEMPERATURE-TO-RESISTANCE VALUES

Temperature °F (°C)	(1) Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700
(1) Measure resistance across sensor terminals.	

CODE P1860, TCC PWM SOLENOID ELECTRICAL CKT - "S" & "T" SERIES 4.3L (VIN W)

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks if VCM is commanding solenoid on.
2. This test checks for voltage to solenoid.

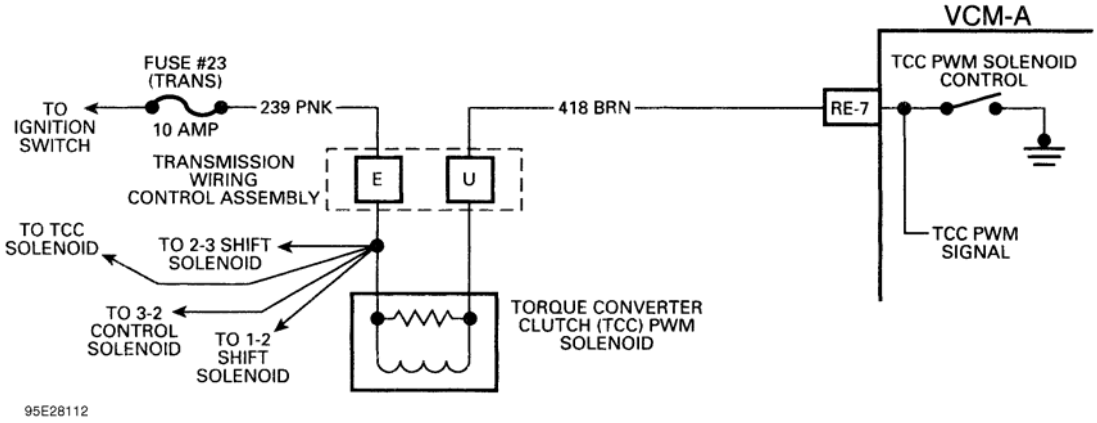


Fig. 238: Code P1860, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

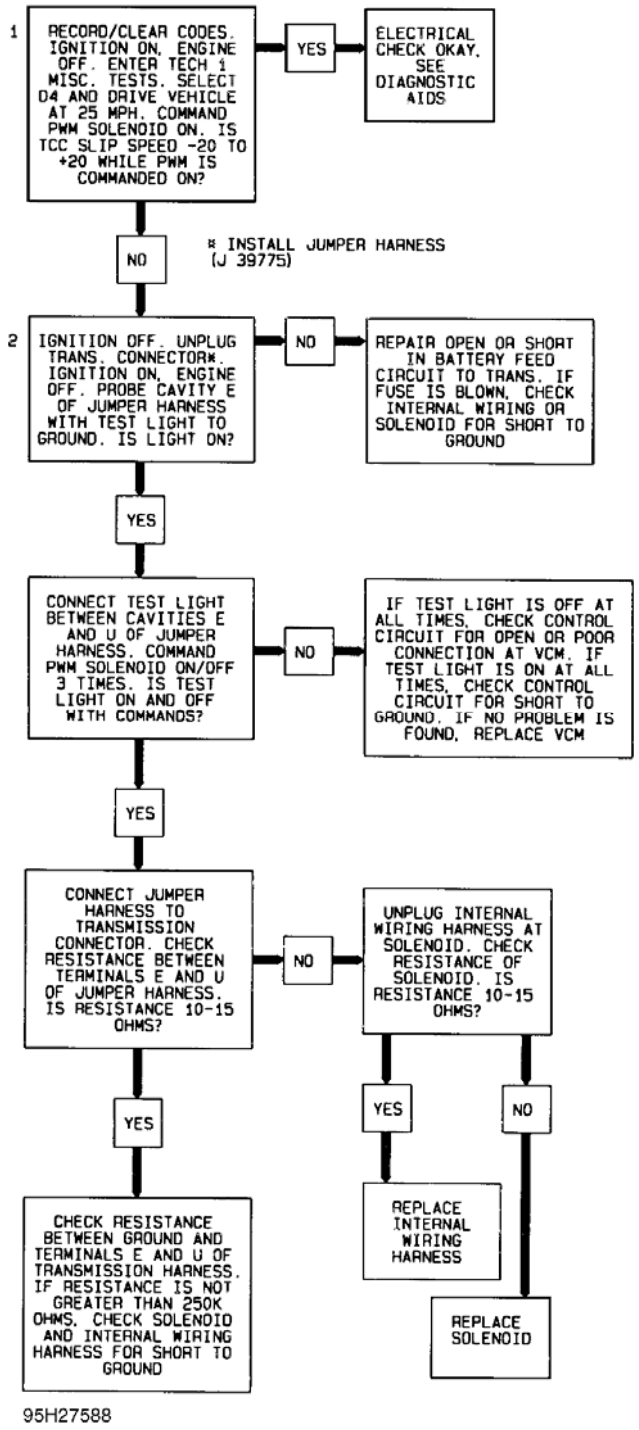


Fig. 239: Code P1860, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Check all connections, especially those at transmission pass-thru connector.

CODE P1864, TCC SOLENOID ELECTRICAL CKT - "S" & "T" SERIES 4.3L (VIN W)

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks VCM's ability to control solenoid.
2. Checks power supply to TCC solenoid.

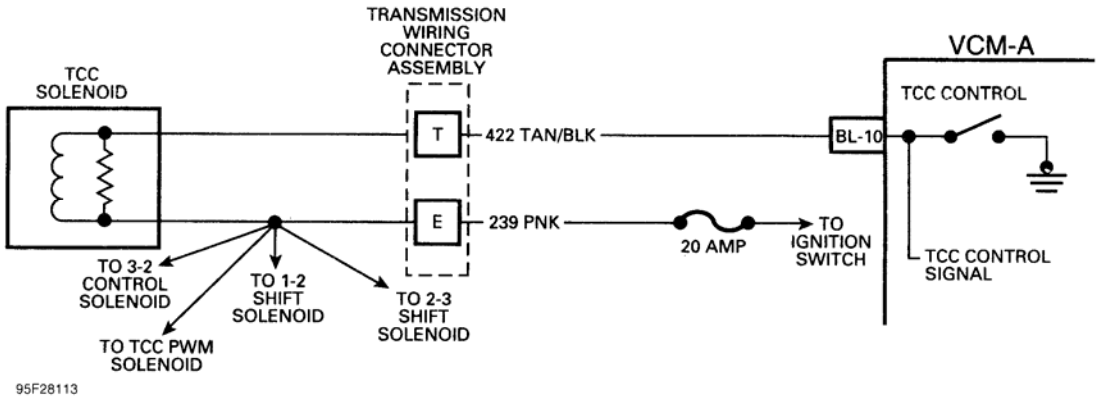


Fig. 240: Code P1864, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

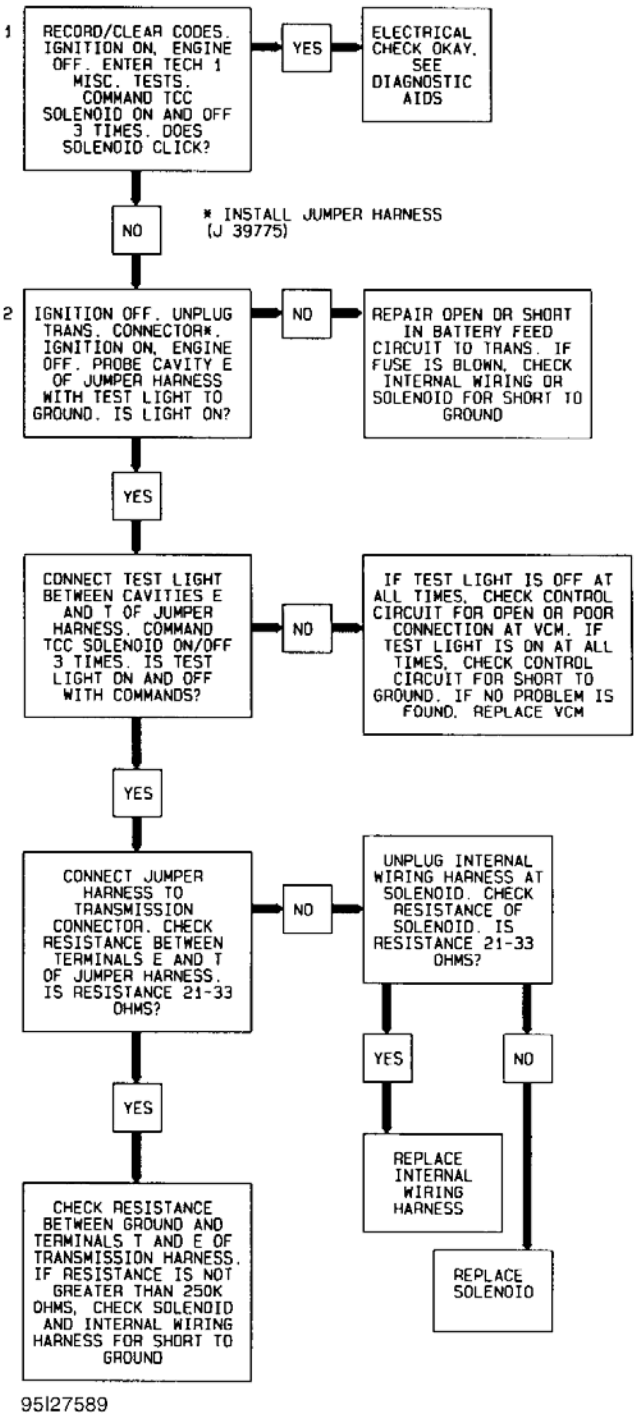


Fig. 241: Code P1864, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Some slight TCC slip is normal. An open in ignition feed circuit will cause multiple codes to set. A short to

ground in TCC circuit may also cause Code P0742 to set.

CODE P1870, TRANSMISSION COMPONENT SLIPPING - "S" & "T" SERIES 4.3L (VIN W)

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks indicated range signal to actual selected range. A faulty switch could set this code.
2. Checks TCC for slippage while in a commanded lock-up state.

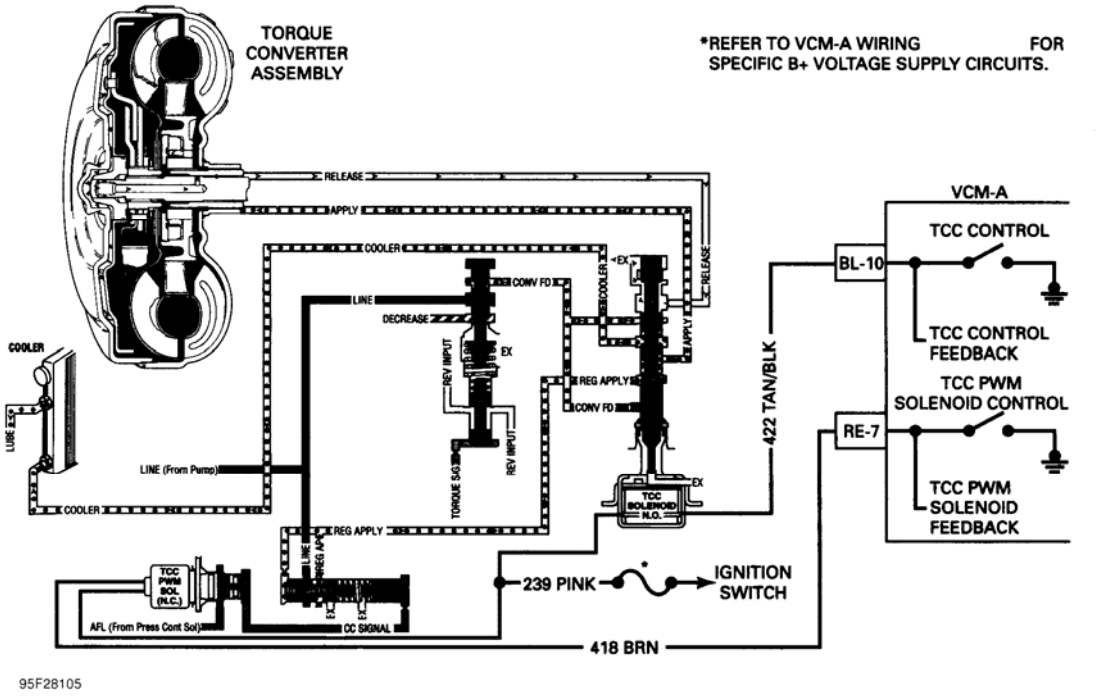


Fig. 242: Code P1870, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

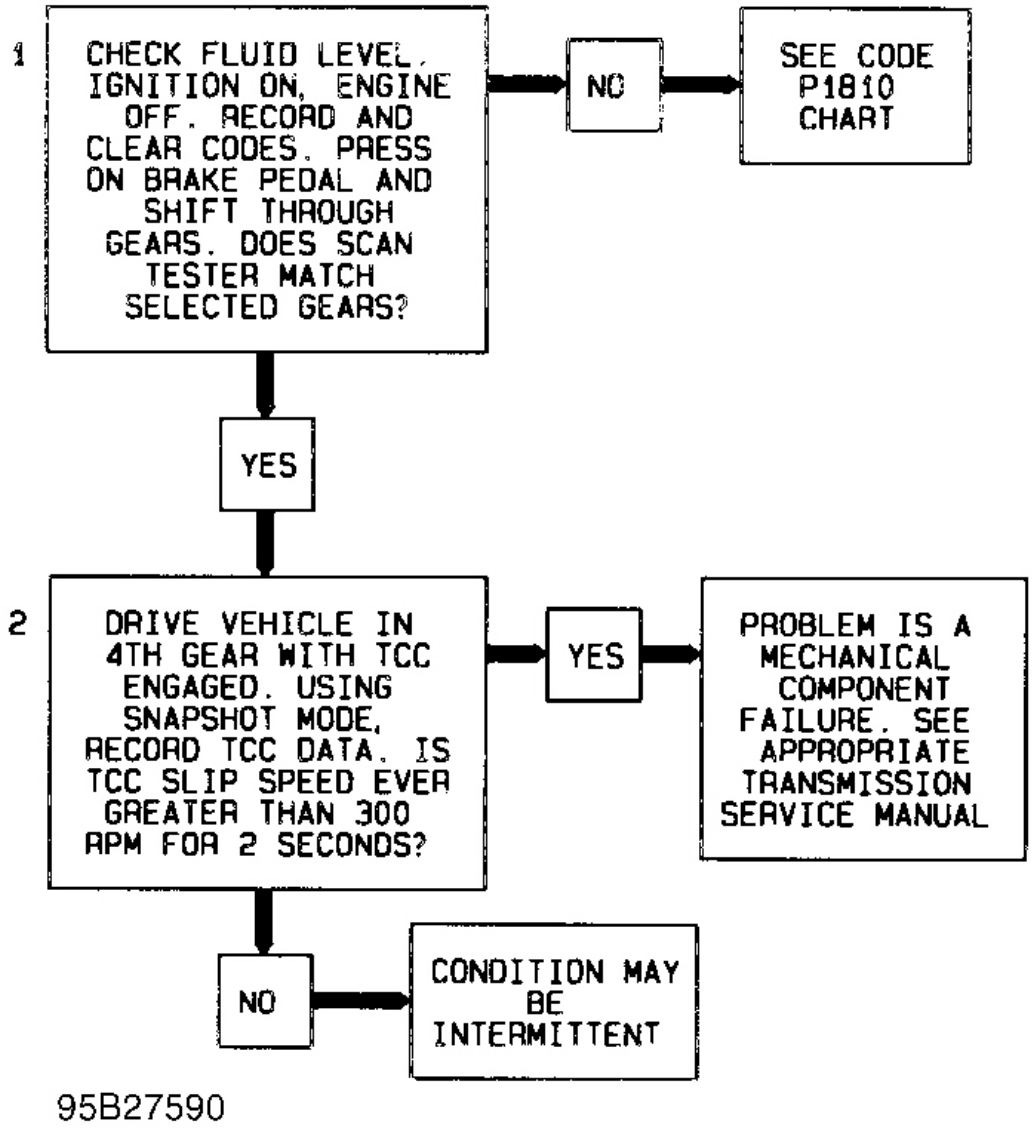


Fig. 243: Code P1870, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

An intermittent incorrect engine speed signal lasting more than 10 seconds could set this code. A 1-2 (A) shift solenoid stuck off or a 2-3 (B) shift solenoid stuck on could set this code.

CODE P1886, 3-2 SOLENOID ELECTRICAL CIRCUIT - "S" & "T" SERIES 4.3L (VIN W)

Test Description

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks function of 3-2 control solenoid and internal transmission harness.
2. Checks power to 3-2 solenoid from ignition through fuse.

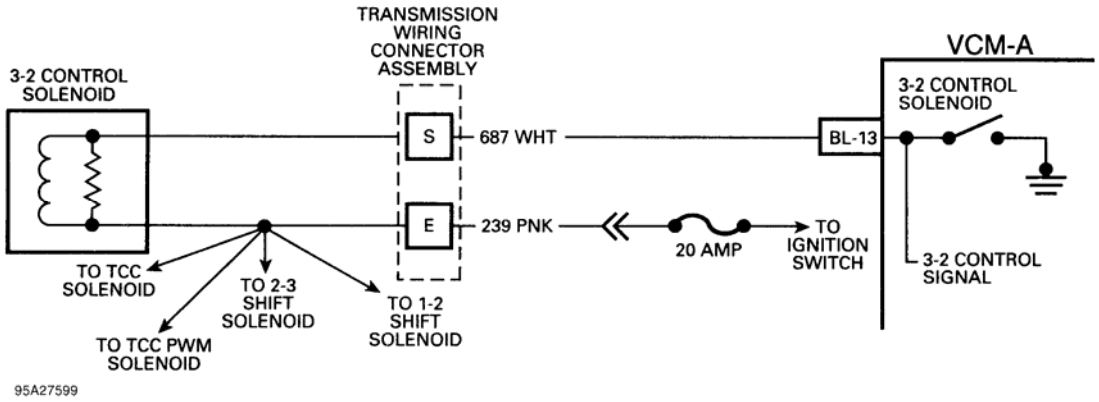


Fig. 244: Code P1886, Circuit Diagram (4.3L S & T Series) Courtesy of General Motors Corp.

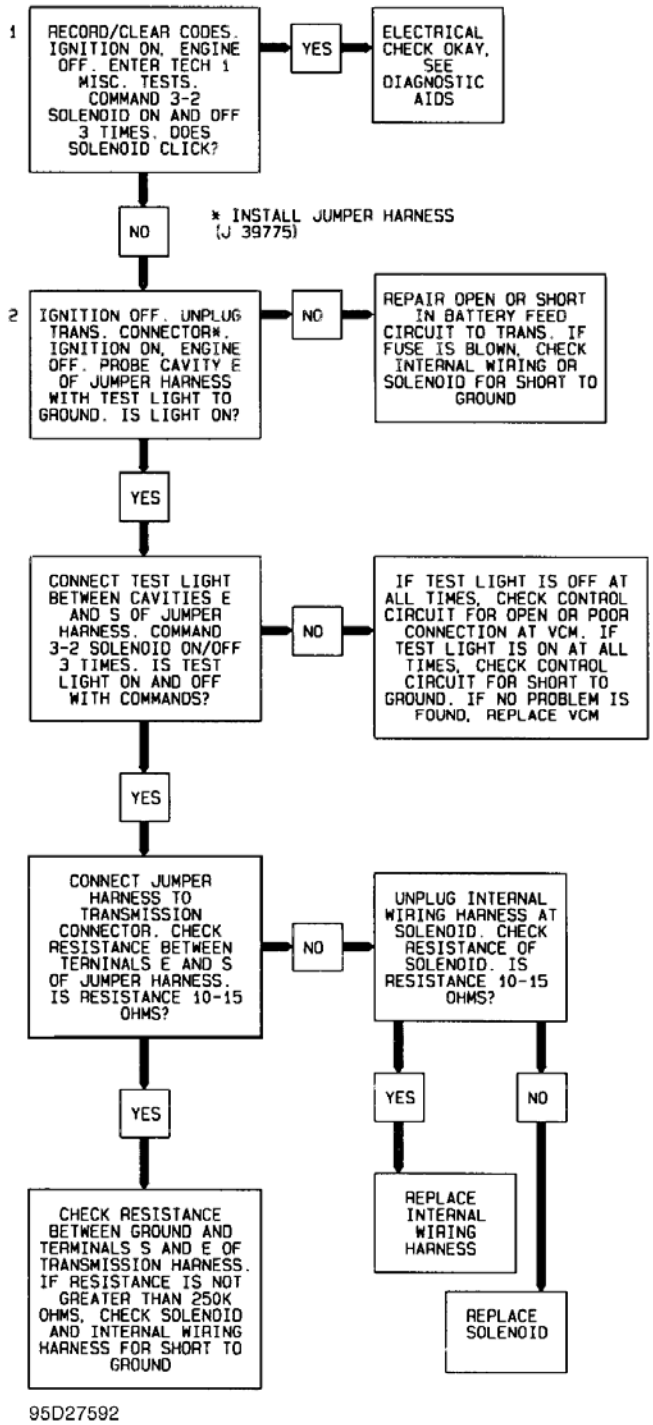


Fig. 245: Code P1886, Flow Chart (4.3L S & T Series) Courtesy of General Motors Corp.

Diagnostic Aids

Check all connections at transmission connector. An open ignition feed circuit will cause multiple codes to set.

COMPONENT TESTS

COMPONENT & WIRING HARNESS RESISTANCE CHECK

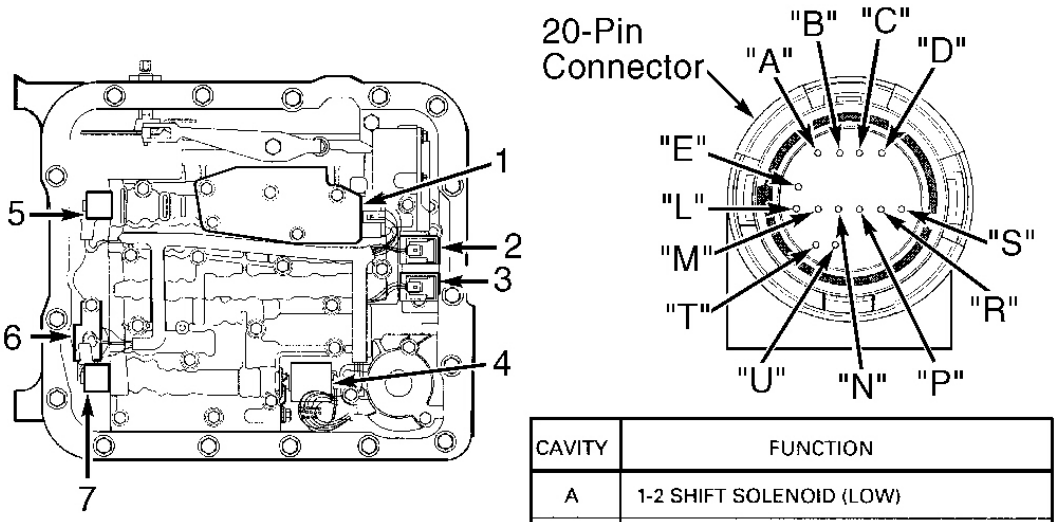
1. Install Jumper Harness (J-39775) to transmission 20-pin connector. Using an ohmmeter, measure resistance between specified terminals for each component. See **Fig. 246**. Compare resistance reading to known values. See **TRANSMISSION COMPONENT RESISTANCE SPECIFICATIONS** table.
2. If resistance reading is okay, go to next step. If resistance reading is not okay, disconnect wiring harness at component and measure component resistance. Replace component if resistance is not as specified. If resistance is as specified, repair wiring harness between component and 20-pin connector.
3. Measure resistance between ground and each terminal at transmission 20-pin connector. See **Fig. 246**. Resistance should be more than 250 k/ohms for each solenoid and less than 10 megohms for transmission temperature and vehicle speed sensors. Resistance for temperature sensor will vary with temperature. If resistance is within specification, problem is intermittent. If resistance is low, disconnect wiring harness at component.
4. Measure resistance between component terminals and ground. If resistance is low, replace component. If resistance is high, inspect wiring harness for short to ground. Repair as necessary.

PRESSURE SWITCH ASSEMBLY

Install Jumper Harness (J39775) to transmission 20-pin connector. Compare resistance of pressure switches with gear selector in each position to known values. See **Fig. 247**. If resistance values are the same as chart, problem is intermittent. If resistance values are not the same, complete chart until problem is found.

TRANSMISSION COMPONENT RESISTANCE SPECIFICATIONS

Component	Ohms
Pressure Control Solenoid	3-7
TCC Solenoid	21-33
TCC PWM & 3-2 Control Solenoid	10-15
1-2 & 2-3 Shift Solenoids	19-31
TFT Sensor	
At 68°F (20°C)	3088-3942
At 212°F (100°C)	159-198
Vehicle Speed Sensor	
At 68°F (20°C)	1150-1250
At 212°F (100°C)	1725-1825

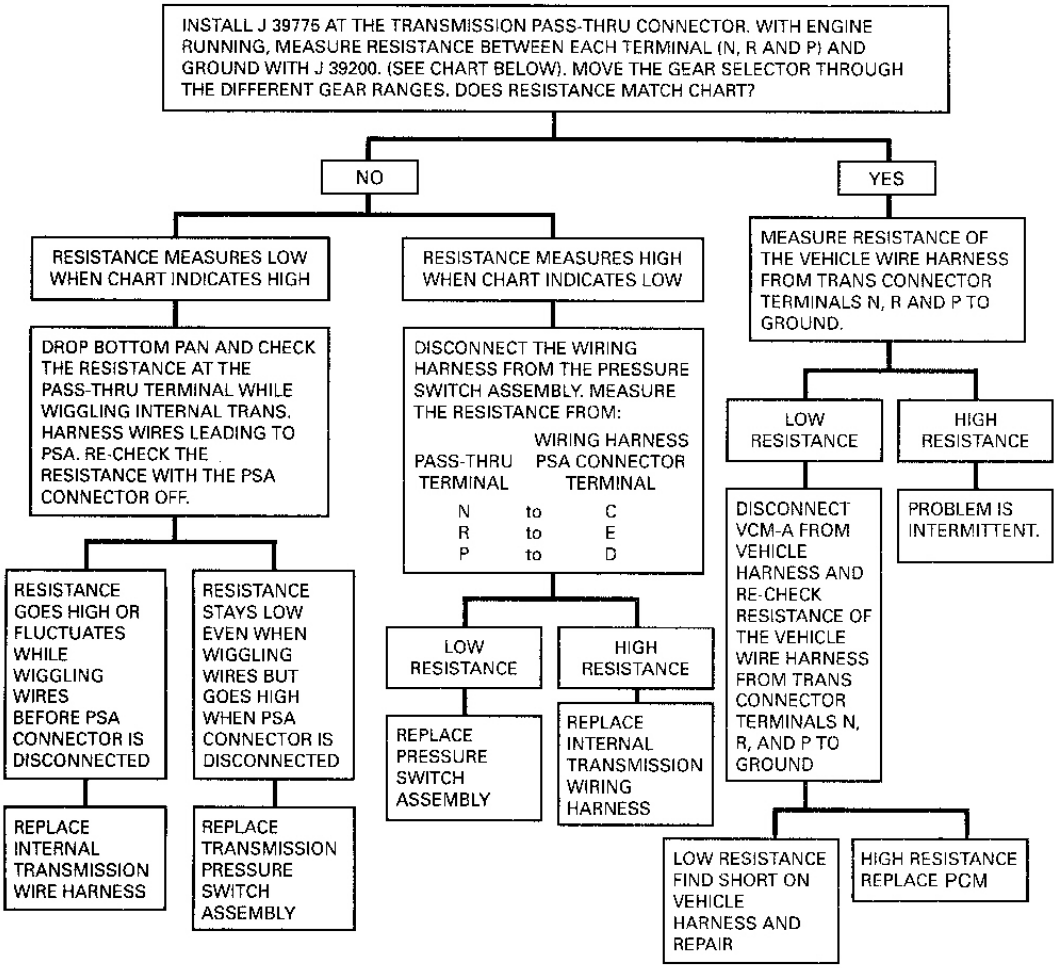


1. Pressure Switch Assembly
2. 1-2 Shift Solenoid
3. 2-3 Shift Solenoid
4. Pressure Control Solenoid
5. 3-2 Control Solenoid
6. TCC Solenoid
7. TCC Control Solenoid

CAVITY	FUNCTION
A	1-2 SHIFT SOLENOID (LOW)
B	2-3 SHIFT SOLENOID (LOW)
C	PRESSURE CONTROL SOLENOID (HIGH)
D	PRESSURE CONTROL SOLENOID (LOW)
E	BOTH SHIFT SOLENOIDS, TCC SOLENOID, AND 3-2 CONTROL SOLENOID (HIGH)
L	TRANSMISSION FLUID TEMPERATURE (HIGH)
M	TRANSMISSION FLUID TEMPERATURE (LOW)
N	RANGE SIGNAL "A"
P	RANGE SIGNAL "C"
R	RANGE SIGNAL "B"
S	3-2 CONTROL SOLENOID (LOW)
T	TCC SOLENOID (LOW)
U	TCC PWM SOLENOID

96D04453

Fig. 246: Identifying Component & Connector Terminal Locations Courtesy of General Motors Corp.



Pressure Switch Assembly (PSA) Resistance Chart
NOTE:Engine must be running

Gear Selector Position	Range		
	A	B	C
PARK	H	L	H
REVERSE	L	L	H
NEUTRAL	H	L	H
D4	H	L	L
D3	H	H	L
D2	H	H	H
D1	L	H	H

When range "X" is measured for resistance to ground,
H = High resistance (over 50K Ohms) - open circuit
L = Low resistance (under 200 Ohms) - grounded circuit

IMPORTANT:

Whenever the transmission pass-thru connector is disconnected from the vehicle harness and the engine is running, multiple transmission Diagnostic Trouble Codes will set. Be sure to clear these codes when finished with this procedure.

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Fig. 247: Pressure Switch Assembly Resistance Chart Courtesy of General Motors Corp.

TECHNICAL SERVICE BULLETINS (TSB)

NOTE: Review TSBs before using diagnostic charts to ensure problems are not addressed by these TSBs.

PROM (MEMCAL) REPLACEMENT

"C", "G" & "K" Series Trucks & Vans With 5.7L (VIN K) & 4L60-E (GM TSB No. 67-65-16 2/96)

PCM may set false Codes 13, 32, 44 or 45 (O2S or EGR diagnostics). Cause of false code(s) is due to system diagnostics not optimally calibrated for non-O2S and non-EGR equipped vehicles. To correct this condition, replace PROM with NEW calibration programmed into it. See PROM IDENTIFICATION table.

PROM IDENTIFICATION

Application	NEW Prom Kit No.	Prom I.D. (Scan Tool)
Pickup		
C1500	16221003	1005
C1500	16221006	1015
C1500	16221008	1025
C2500	16221006	1015
K1500	16221006	1015
K2500	16221006	1015
Van		
G2500	16221008	1025
G3500	16221006	1015

PCM REPLACEMENT

1991-95 GM Trucks & Vans (ATRA TSB No. 352)

If replacement of PCM is required, see PCM APPLICATION table to identify correct PCM for specified year.

PCM APPLICATION

Year & Engine	PCM No.
1991-93 6.2L Diesel	16168625
1993 5.0L & 5.7L	16168625
1994-95 All Gasoline	16197427
1994 6.5L Diesel	16183977
6.5L Diesel	16212488

DRIVELINE GROWL &/OR VIBRATION (REPLACE MEMCAL)

1995 "L" & "M" Series W/ 4.3L RPO 35, VIN Prior To 255435 On Chevrolet & 559796 On GMC (GM TSB No. 57-71-1910/95)

A driveline growl and/or vibration in 4th gear may occur after TCC is applied. This condition occurs when TCC

apply speed is too low. To correct this condition, replace PROM with appropriate updated part. See **PROM IDENTIFICATION** table. Prior to replacement, check vehicle PROM identification to ensure vehicle was not already updated.

PROM IDENTIFICATION

Previous MEMCAL Part No./Code	NEW MEMCAL Part No./Code
"L" Series	
16219012/BPKY	16231843/BSWX
16212105/BNBD	16232453/BTAA
16219055/BPLA	16231848/BSWZ
"M" Series	
16219009/BPKX	16231839/BSWW
16212115/BNBF	16232456/BTAB
16219045/BPKZ	16231846/BSWY

DTC 72 (VSS) DIAGNOSTICS

1993-95 GM Trucks & Vans With PCM (ATRA TSB No. 302)

This 2 part technical bulletin is designed to cover in depth diagnostic strategies for Vehicle Speed Sensor. Bulletin is model specific and includes circuit and component testing and conditions which may cause DTC 72 to set (loose connections, poor ground connections, add-on components which may cause electromagnetic interference). This bulletin may be used in addition to diagnostic procedures for DTC 72 in this article.

LACK OF POWER, EARLY, LATE OR ERRATIC SHIFTS

1993-95 "C", "G", "K" & "T" 4WD Vehicles (ATRA TSB No. 343)

Vehicles may have one or all of the following conditions:

- Lack of power, especially when carrying loads or during heavy acceleration.
- Early upshifts regardless of throttle position.
- Late shifts in 4WD-Low position only.
- Erratic shifting including shifts which are early during one upshift sequence and normal during next sequence, or some of the upshifts during shift sequence are early while others are normal.
- Incorrect forced downshift shift points or no forced downshifts at normal road speeds.

These conditions may occur on either 2WD or 4WD vehicles, but are most common on 4WD vehicles. These conditions may be intermittent and could occur without setting trouble codes. If any of these conditions occur, perform following test to assist in diagnosis.

Early, Late Or Erratic Shifts (All Models)

1. Check for trouble codes which may relate to condition. If no codes are present, go to next step. If codes

are present, correct affected systems, then check for correct shift timing. If condition still exists, go to next step.

2. Operate vehicle through 2/4 high position shifts. If shifts are early and/or erratic, go to next step. If shifts are late and/or erratic, go to step 5). If shifts are correct, problem is intermittent. Operate vehicle until condition occurs, then repeat step 1). If condition does not occur, check for stuck 4WD switch, loose connections at PCM and 4WD switch, or for circuits which may be shorted to ground. Repair as necessary.
3. Using a scan tool, monitor 4WD-low input. If 4WD-low input indicates low position even though vehicle is in high position, go to next step. If 4WD-low input indicates truck is not in low position, scan tool value for 4WD-low reading will be NO at all times. If condition exists, check TP sensor, MAP sensor or VSS sensor for proper operation. Repair or replace as necessary.
4. Scan tool value for 4WD-low position will be YES at all times if 4WD-low input indicates low position even though vehicle is in high position. A short to ground in 4WD-low position circuit, 4WD switch or related circuit may exist. Perform appropriate 4WD-LOW DIAGNOSTIC CHECK.
5. Check TP sensor, MAP sensor or VSS sensor for proper operation. Repair or replace as necessary. If sensors are okay, check tire size and axle ratio. If tire size and axle ratio has been modified from stock applications, buffer (DRAC) must be recalibrated or replaced with correct calibration.

4WD-Low Diagnostic Check ("K" Series With Manually Or Electronically Shifted Transfer Case In High Position)

1. Disconnect transfer case switch connector at transfer case. Turn ignition switch to ON position. Using a scan tool, monitor 4WD-low position. If scan tool indicates YES for 4WD-low position, go to next step. If scan tool indicates NO for 4WD-low position, check for internal short to ground in transfer case switch. Replace switch as necessary.
2. A short to ground in Dark Blue wire (Gray/Black wire on vehicles with VCM) between transfer case switch connector and PCM terminal F8 (terminal No. 23 on vehicles with VCM), or a faulty PCM/VCM is indicated.
3. Disconnect connector located behind distributor at center of torque converter housing. If scan tool indicates YES for 4WD-low position, go to next step. If scan tool indicates NO for 4WD-low position, check for short to ground in Dark Blue wire (Gray/Black wire on vehicles with VCM) between transfer case switch and connector located behind distributor. Repair wire as necessary.
4. Turn ignition off. Disconnect PCM **Blue** connector (Black connector on vehicles with VCM). Using an ohmmeter, measure resistance between ground and PCM **Blue** connector terminal F8 (terminal No. 23 on vehicles with VCM). If resistance is less than 100 ohms, repair short to ground in Dark Blue wire (Gray/Black wire on vehicles with VCM).

4WD-Low Diagnostic Check ("T" Series With PCM & Manually Shifted Transfer Case In High Position)

1. Disconnect 6-pin power distribution center connector located at left kick panel. Turn ignition switch to ON position. Using a scan tool, monitor 4WD-low position. If scan tool indicates YES for 4WD-low position, go to step 4).
2. If scan tool indicates NO for 4WD-low position, check for short to ground in Gray/Black wire between 6-pin connector and shift quadrant switch, or check for a faulty shift quadrant switch, located to right of shift lever at console. Repair as necessary. If wire and switch are okay, connect 6-pin connector and disconnect indicator assembly connector, located forward of shift lever.
3. If scan tool still indicates NO, check for short to ground in indicator assembly or shift quadrant switch.

Repair as necessary. If scan tool indicates YES, check for short to ground in Gray/Black wire between 6-pin connector and indicator assembly connector. Repair as necessary.

4. A short to ground in Gray/Black wire between 6-pin connector and PCM terminal F8, or a faulty PCM is indicated. Turn ignition off. Disconnect PCM **Blue** connector. Using an ohmmeter, backprobe from PCM **Blue** connector terminal F8 to ground. If resistance is less than 100 ohms, repair short to ground in Gray/Black wire.

4WD-Low Diagnostic Check ("T" Series With VCM & Manually Shifted Transfer Case In High Position)

1. Disconnect in-line connector (Gray/Black wire) located behind glove box. Turn ignition switch to ON position. Using a scan tool, monitor 4WD-low position. If scan tool indicates YES for 4WD-low position, go to step 4).
2. If scan tool indicates NO for 4WD-low position, check for short to ground in Gray/Black wire between in-line connector and shift quadrant switch, or check for a faulty shift quadrant switch, located to right of shift lever at console. Repair as necessary. If wire and circuit and switch are okay, connect in-line connector and disconnect indicator assembly connector, located forward of shift lever.
3. If scan tool still indicates NO, check for short to ground in indicator assembly or shift quadrant switch. Repair as necessary. If scan tool indicates YES, check for short to ground in Gray/Black wire between in-line connector and indicator assembly connector. Repair as necessary.
4. A short to ground in Gray/Black wire between in-line connector and VCM terminal No. 23, or a faulty VCM is indicated. Turn ignition off. Disconnect VCM Black connector. Using an ohmmeter, backprobe from VCM Black connector terminal No. 23 to ground. If resistance is less than 100 ohms, repair short to ground in Gray/Black wire.

4WD-Low Diagnostic Check ("T" Series With Electronically Shifted Transfer Case In High Position)

1. Disconnect 16-pin connector from Transfer Case Control Module (TCCM). On 1993-1994 1/2 vehicles with PCM, TCCM is mounted to PCM. Connector is located behind glove box. On 1994 1/2-1995 vehicles with PCM, connector is located in center of dash, behind ash tray. On vehicles with VCM, connector is located in center of dash, behind ash tray.
2. On all models, turn ignition switch to ON position. Using a scan tool, monitor 4WD-low position. If scan tool indicates YES for 4WD-low position, go to step 4).
3. If scan tool indicates NO for 4WD-low position, check for internal short to ground in TCCM or a stuck selector switch exists. On vehicles with PCM, Dark Green/White wire is shorted to battery voltage. Repair as necessary.
4. A short to ground in Gray/Black wire between 16-pin connector and PCM terminal F8 (terminal No. 23 on vehicles with VCM), or a faulty PCM/VCM is indicated. Turn ignition off. Disconnect PCM **Blue** connector (Black connector on vehicles with VCM) and TCCM 16-pin connector. Using an ohmmeter, measure resistance between ground and PCM **Blue** connector terminal F8 (terminal No. 23 on vehicles with VCM). If resistance is less than 100 ohms, repair short to ground in Gray/Black wire.

WIRING DIAGRAMS

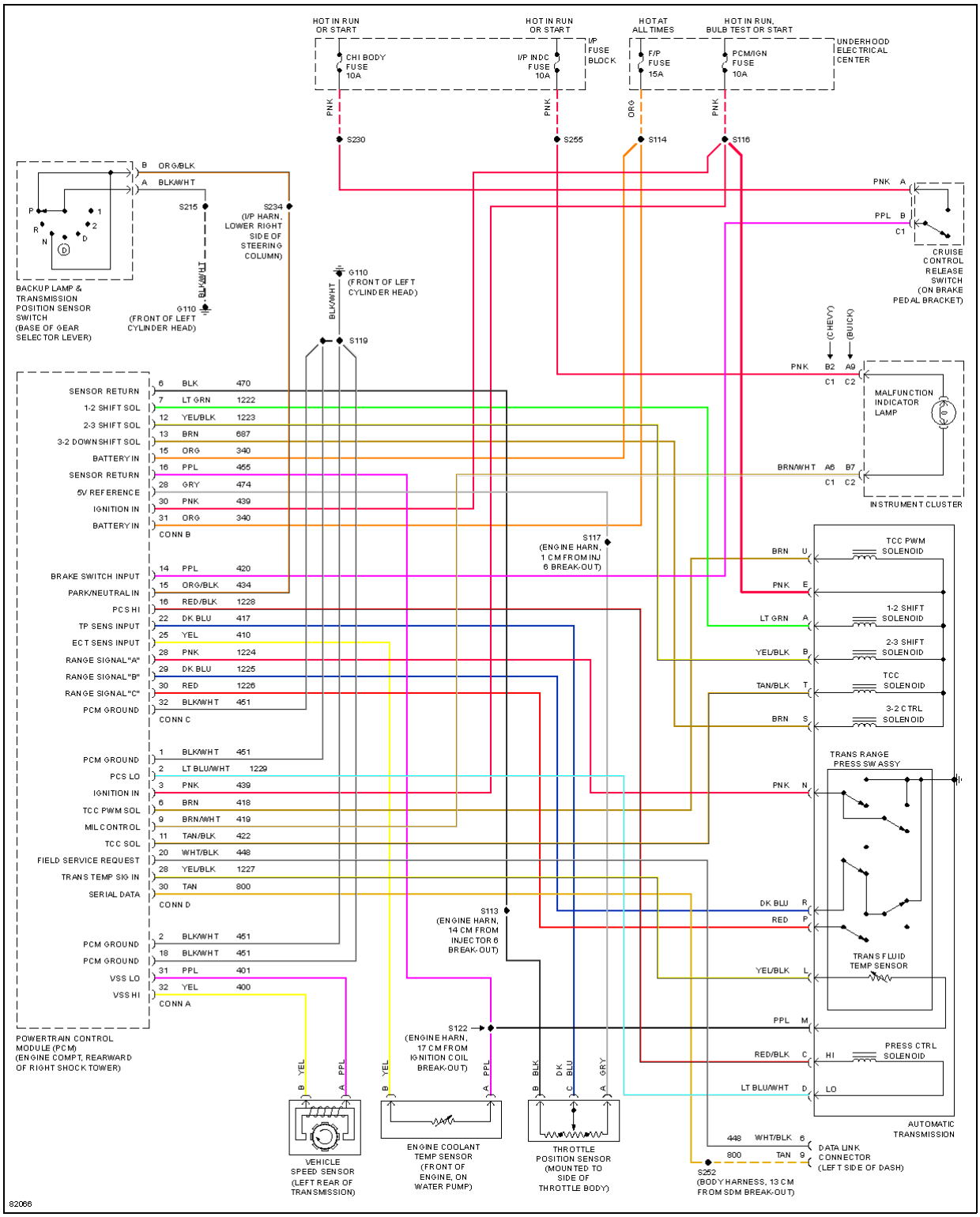


Fig. 248: 1995 "B" Body - 4.3L & 5.7L (Caprice, Impala SS & Roadmas Wiring Diagramter)

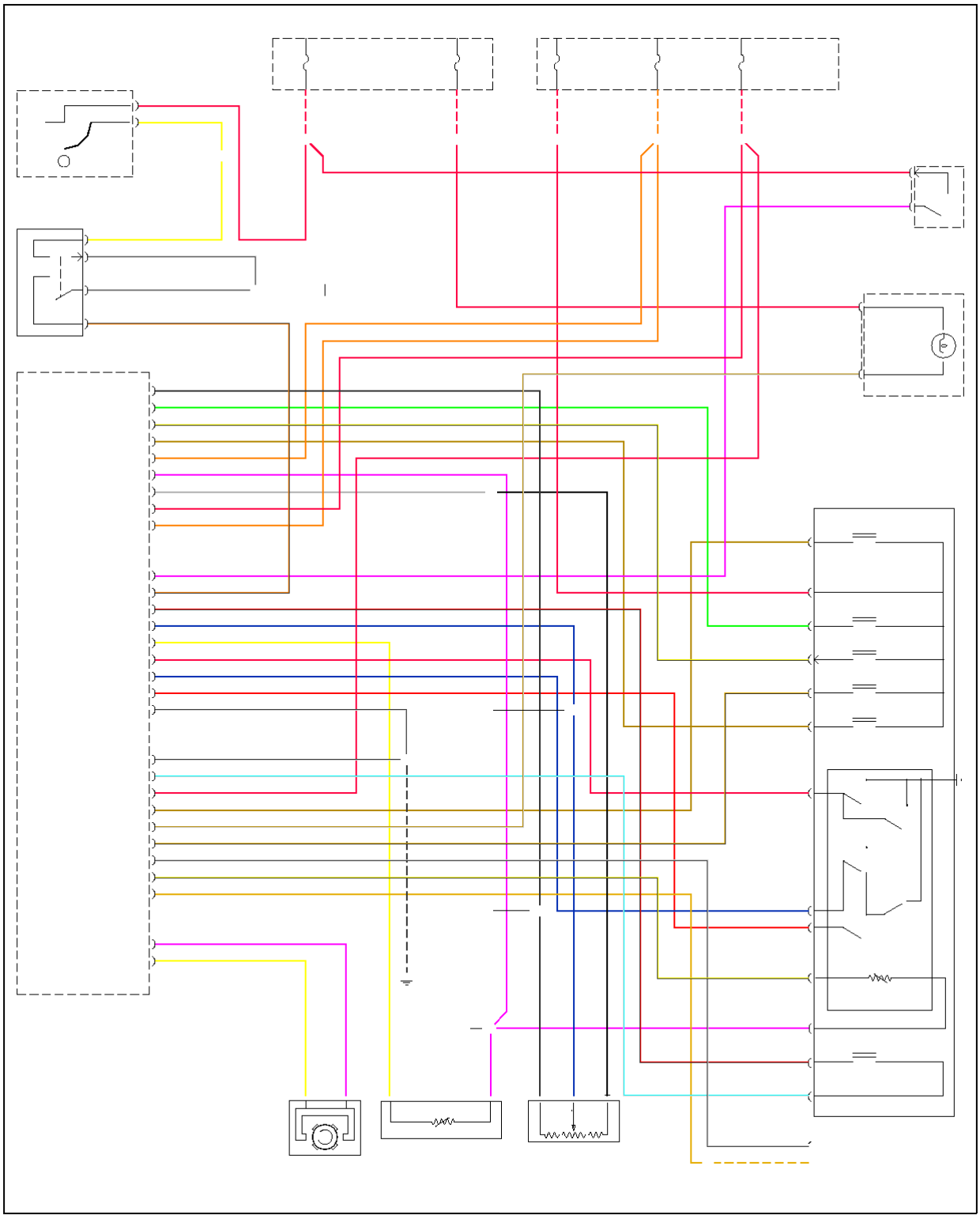


Fig. 249: 1995 "D" Body - 5.7L (Fleetwood) Wiring Diagram

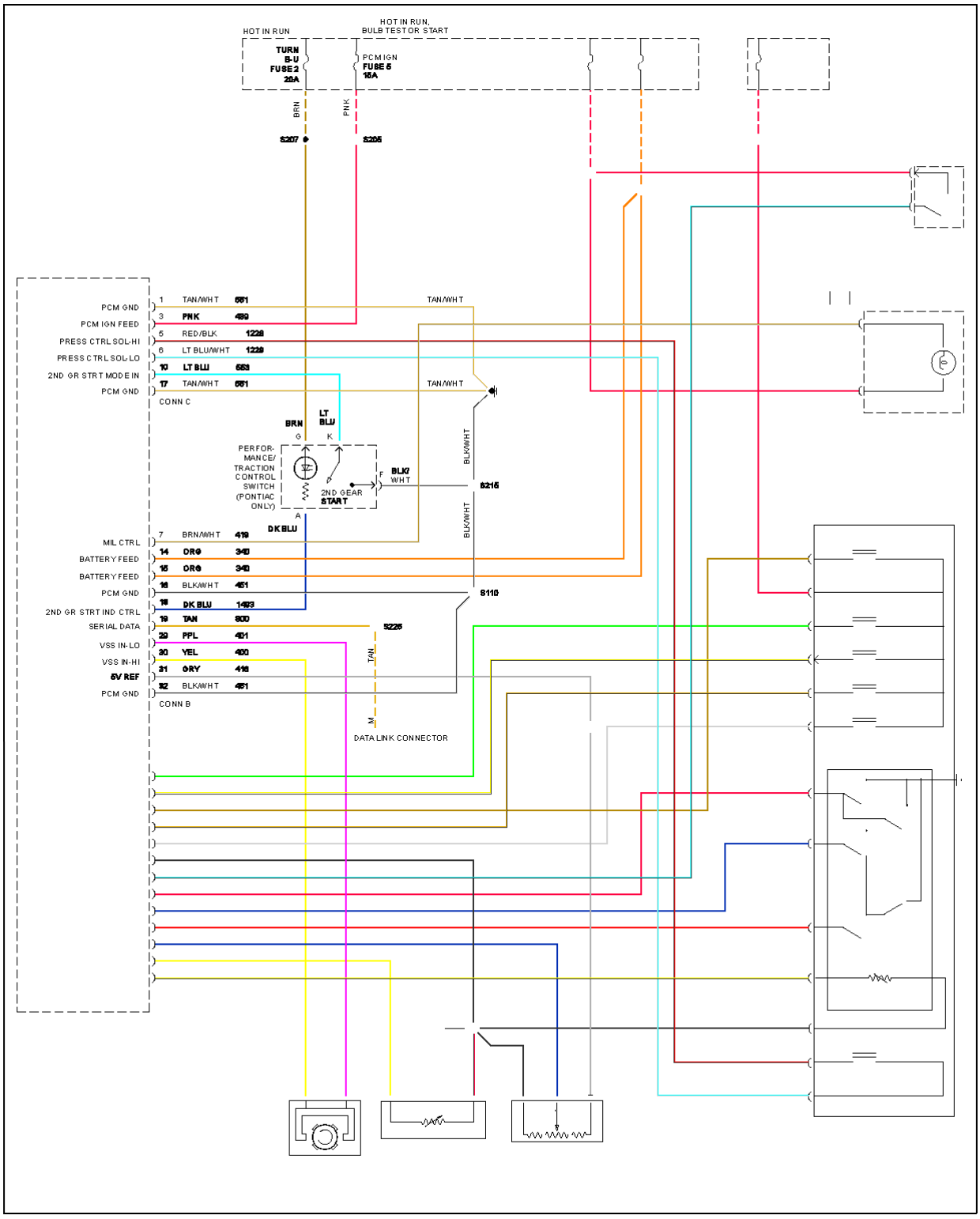


Fig. 250: 1995 "F" Body - 3.4L (Camaro & Firebird) Wiring Diagram

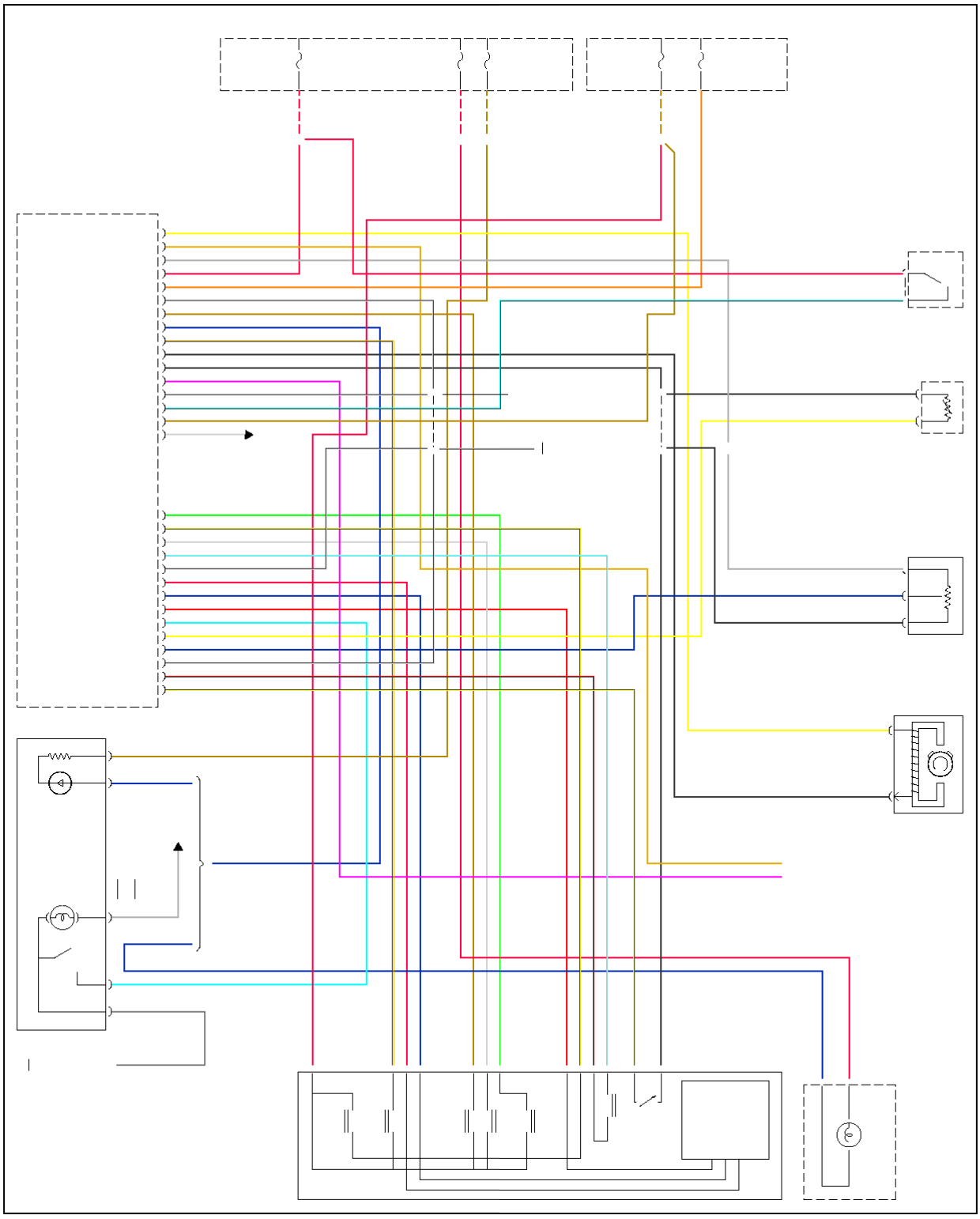


Fig. 251: 1995 "F" Body - 3.8L (Camaro & Firebird) Wiring Diagram

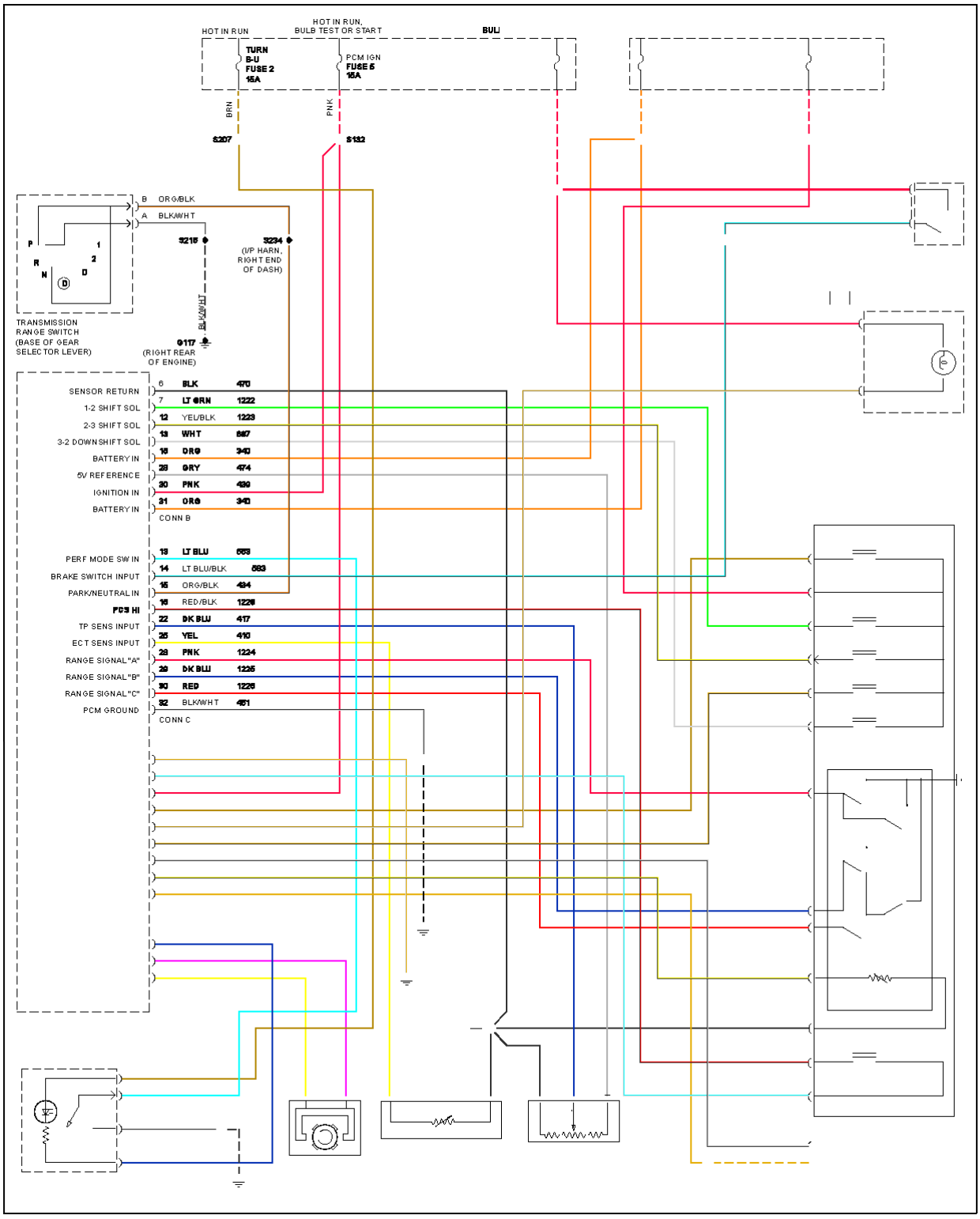


Fig. 252: 1995 "F" Body - 5.7L (Camaro & Firebird) Wiring Diagram

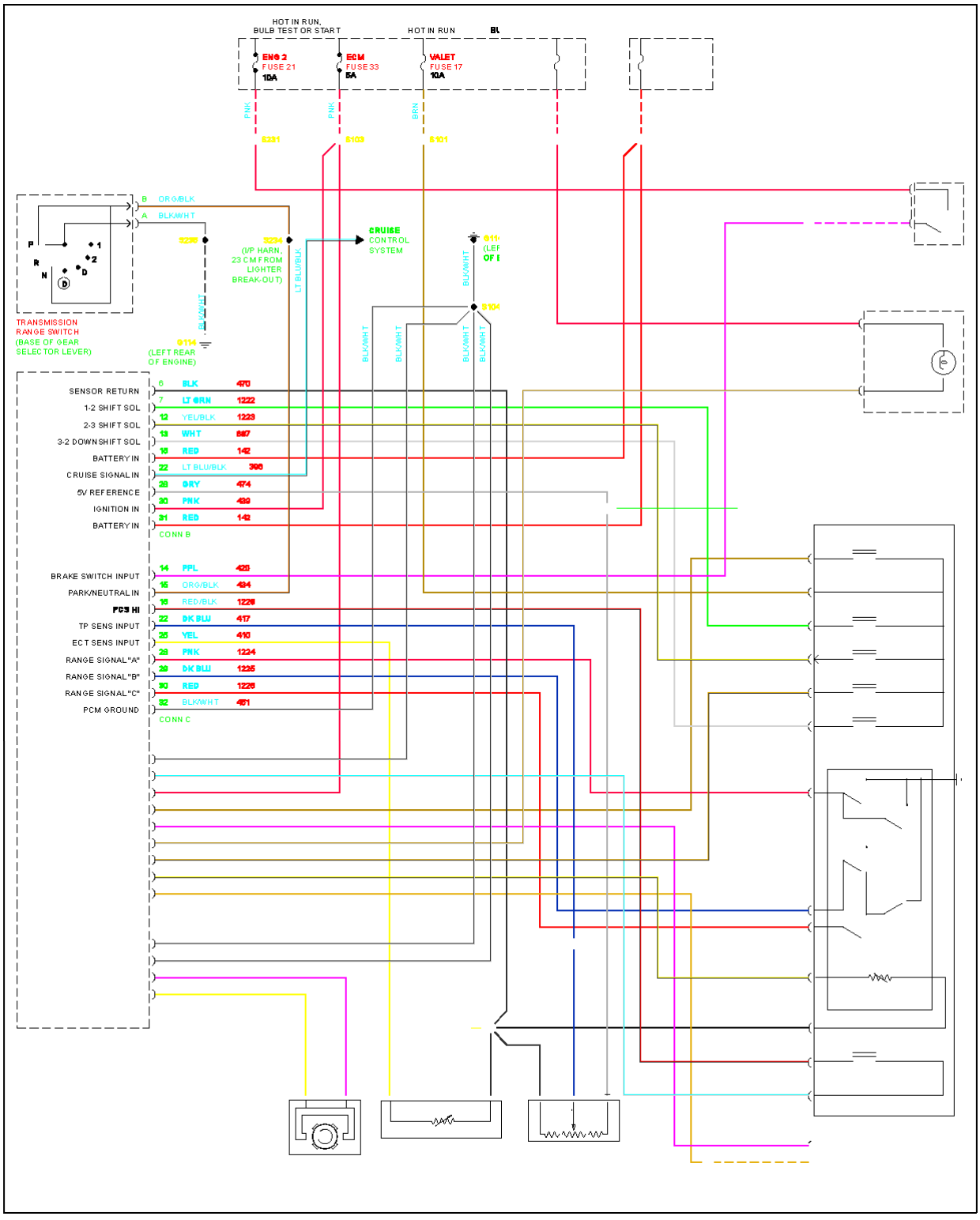


Fig. 253: 1995 "Y" Body - 5.7L (Corvette) Wiring Diagram

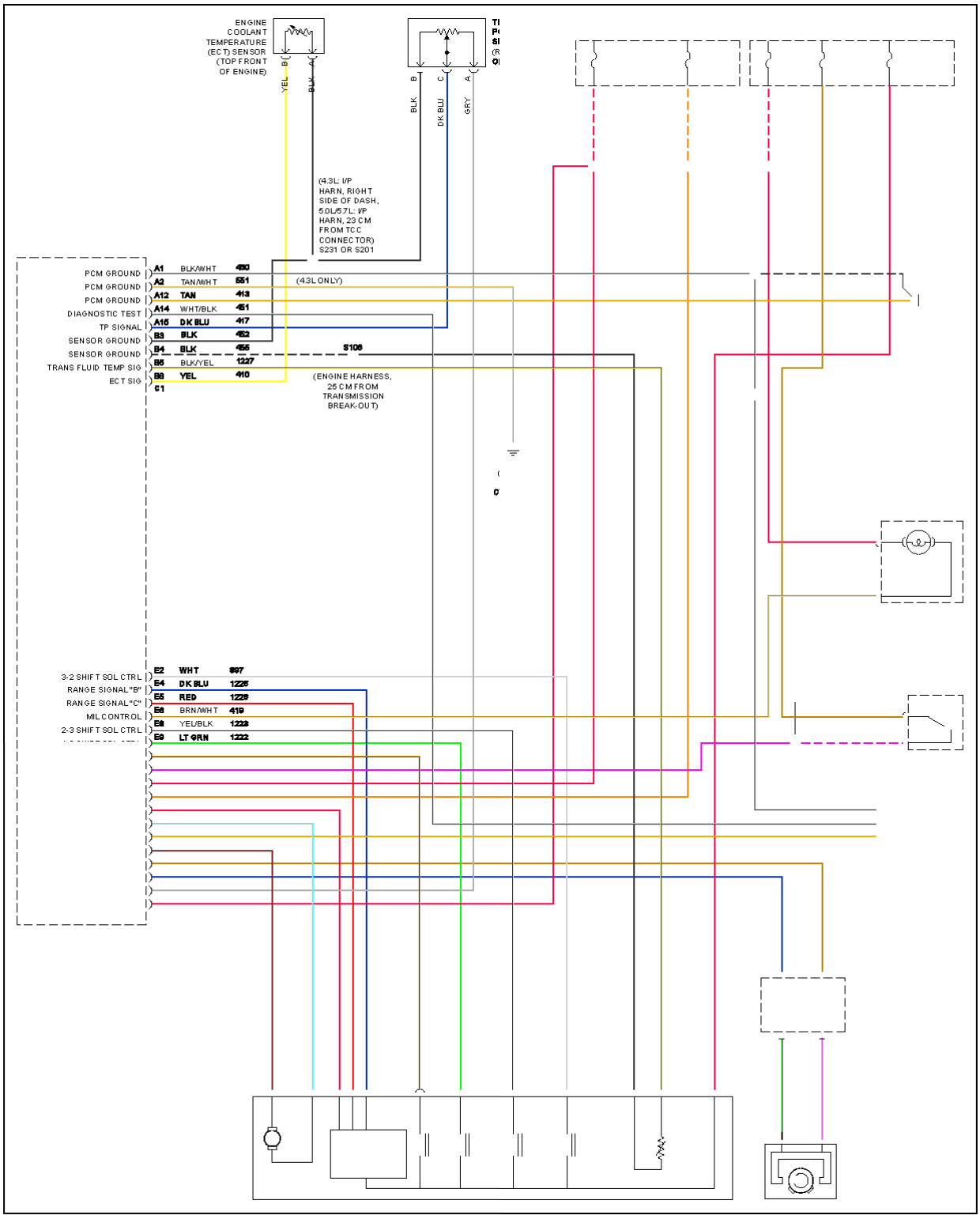


Fig. 254: 1995 "C" & "K" Series - 4.3L, 5.0L & 5.7L (Pickup, Sierra, Suburban, Tahoe & Yukon)

Wiring Diagram

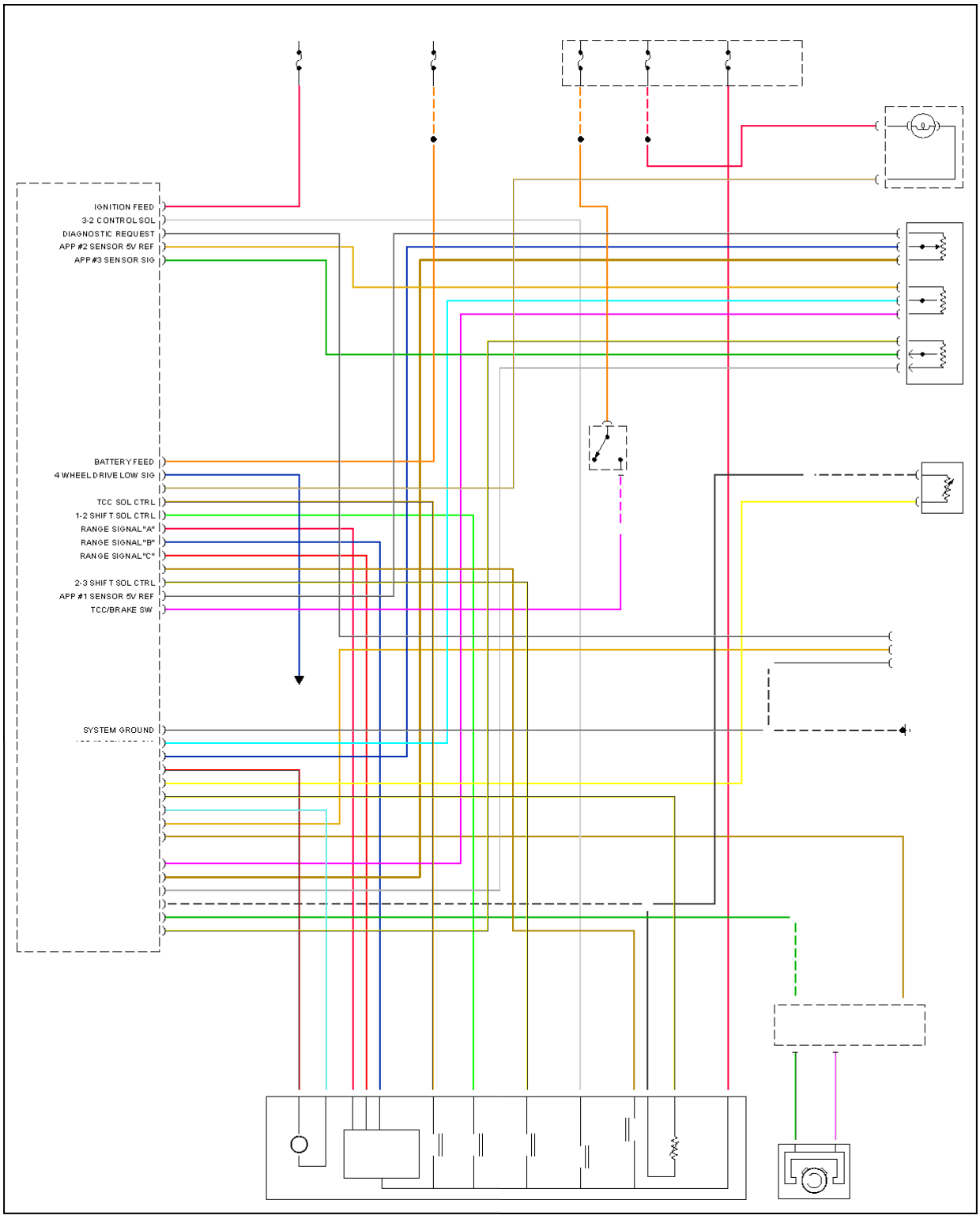


Fig. 255: 1995 "C" & "K" Series - 6.5L (Pickup) Wiring Diagram

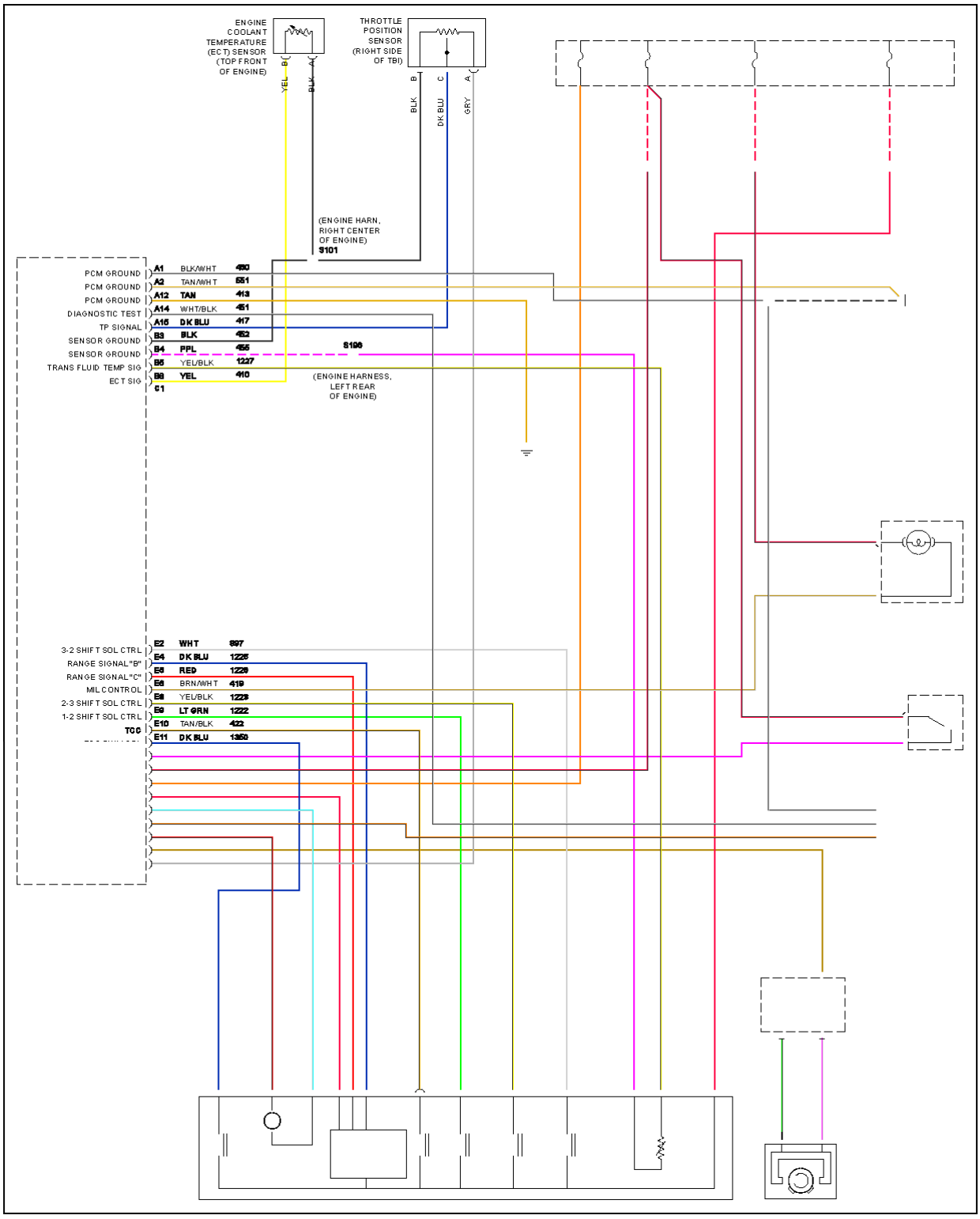


Fig. 256: 1995 "G" Series - 4.3L, 5.0L & 5.7L (Van) Wiring Diagram

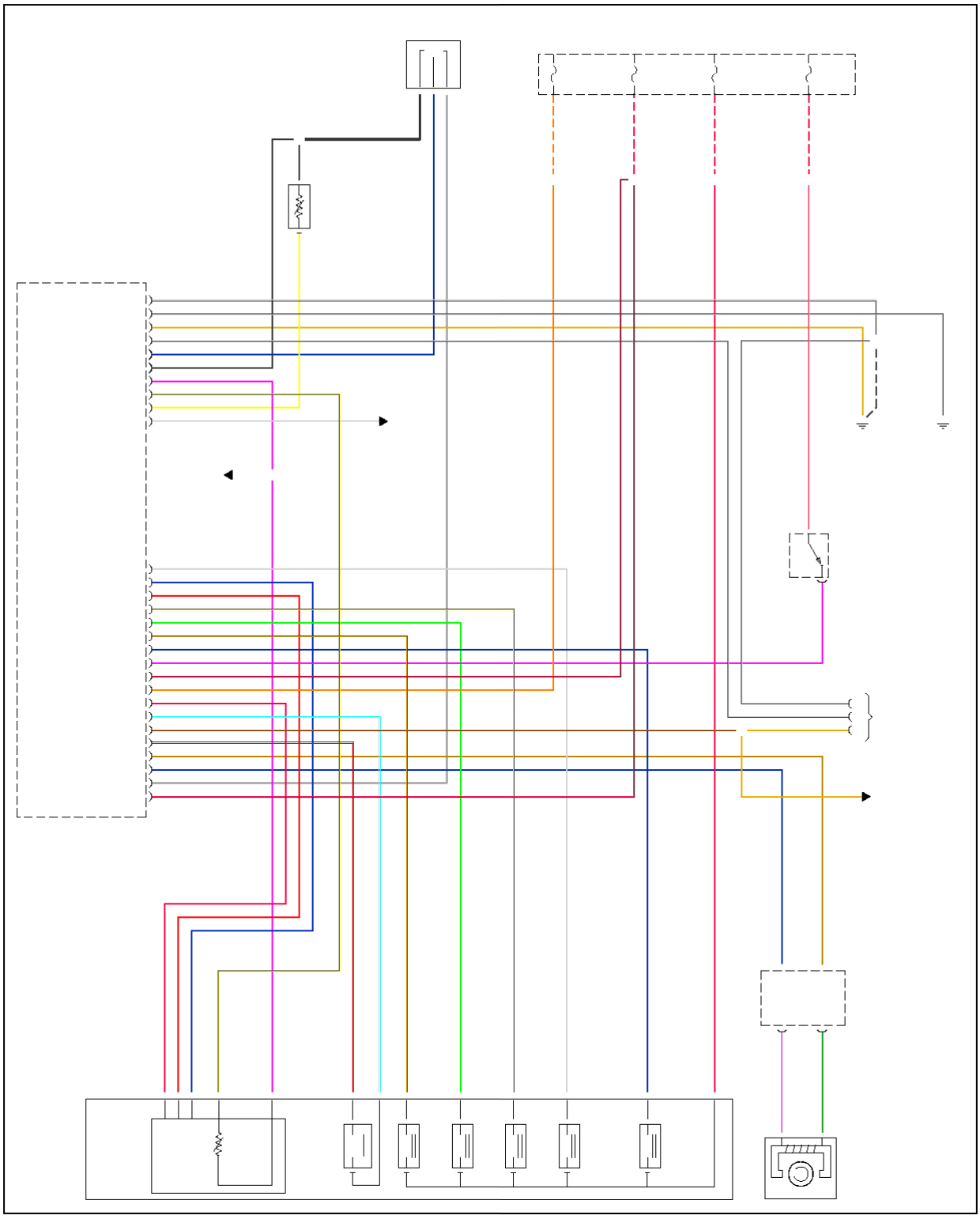


Fig. 257: 1995 "L" & "M" Series - 4.3L (Astro & Safari) Wiring Diagram

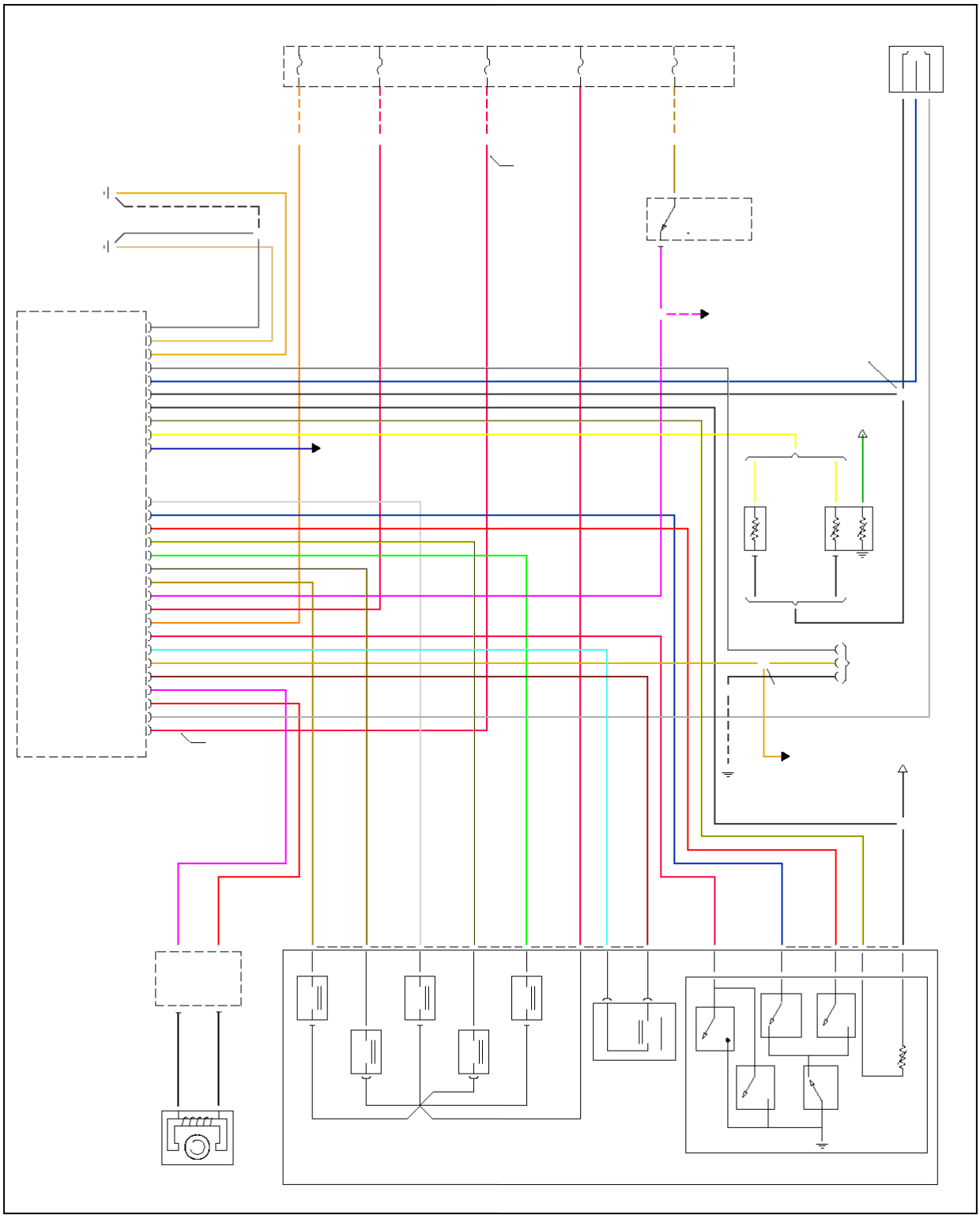


Fig. 258: 1995 "S" & "T" Series - 2.2L & 4.3L VIN Z (Blazer, Jimmy, Pickup & Sonoma) Wiring

Diagram

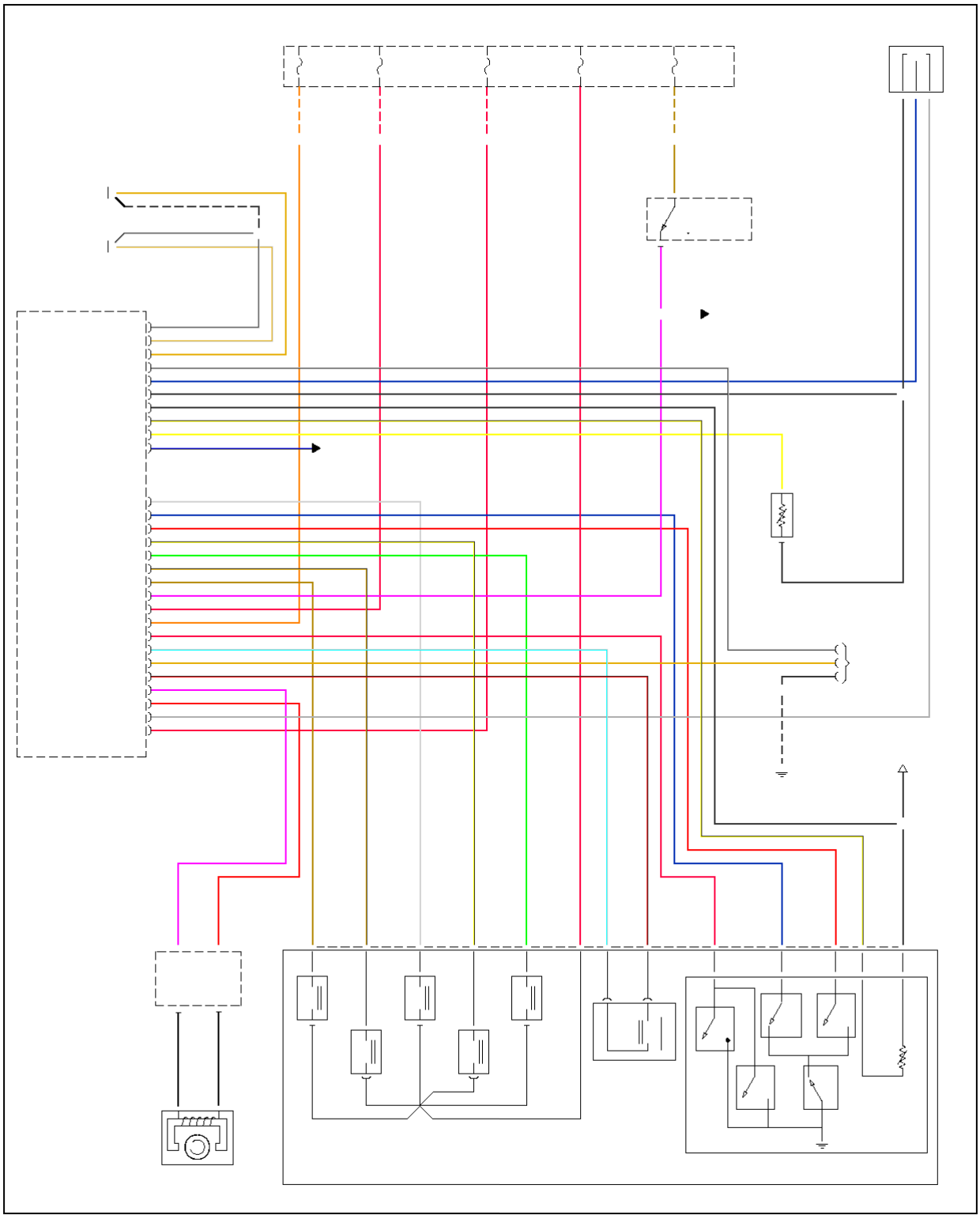


Fig. 259: 1995 "S" & "T" Series - 4.3L VIN W With PCM (Blazer, Jimmy, Pickup & Sonoma) Wiring

Diagram

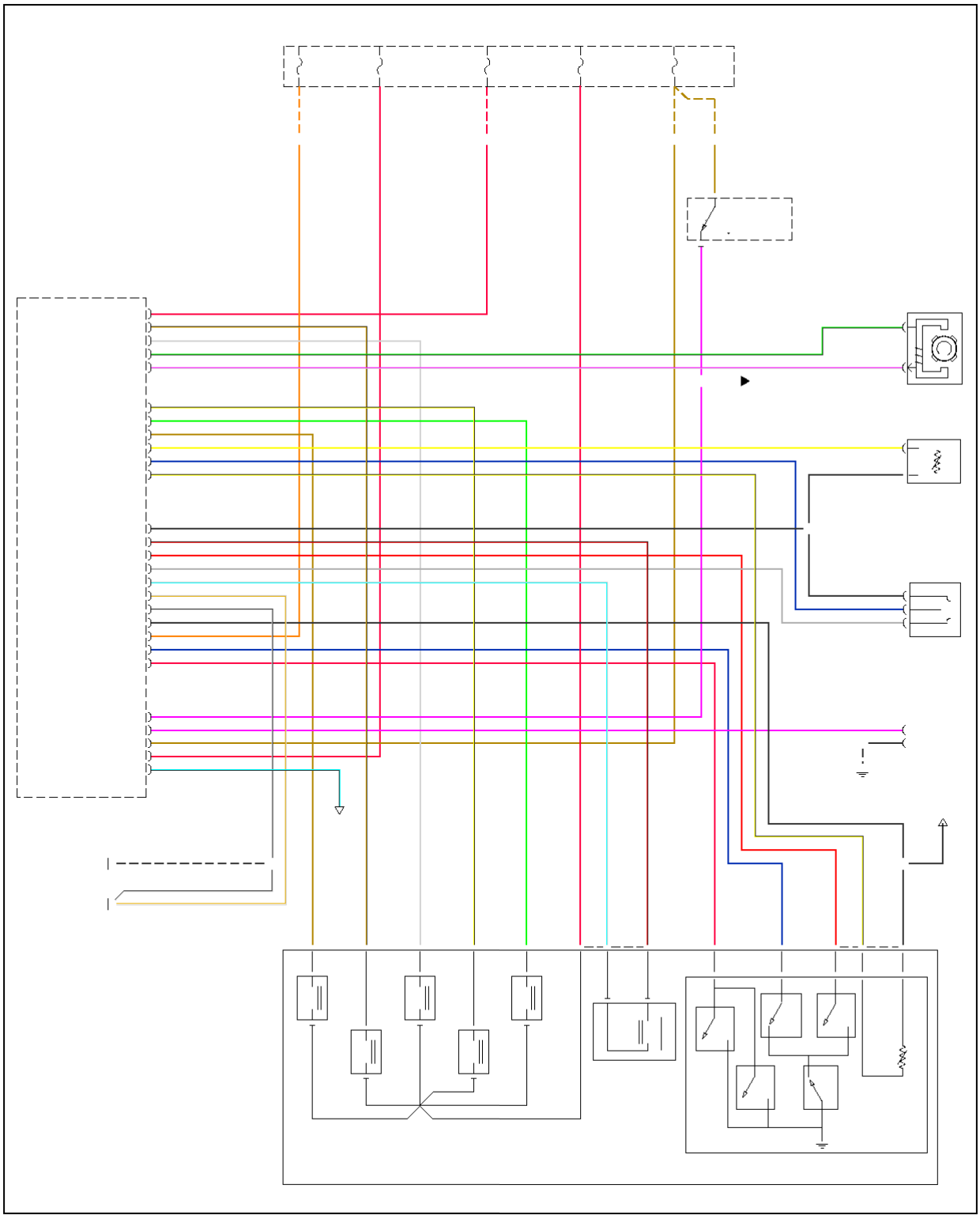


Fig. 260: 1995 "S" & "T" Series - 4.3L VIN W With VCM (Blazer, Jimmy, Pickup & Sonoma) Wiring

Diagram

OIL CIRCUIT DIAGRAMS

Hydra-Matic 4L60

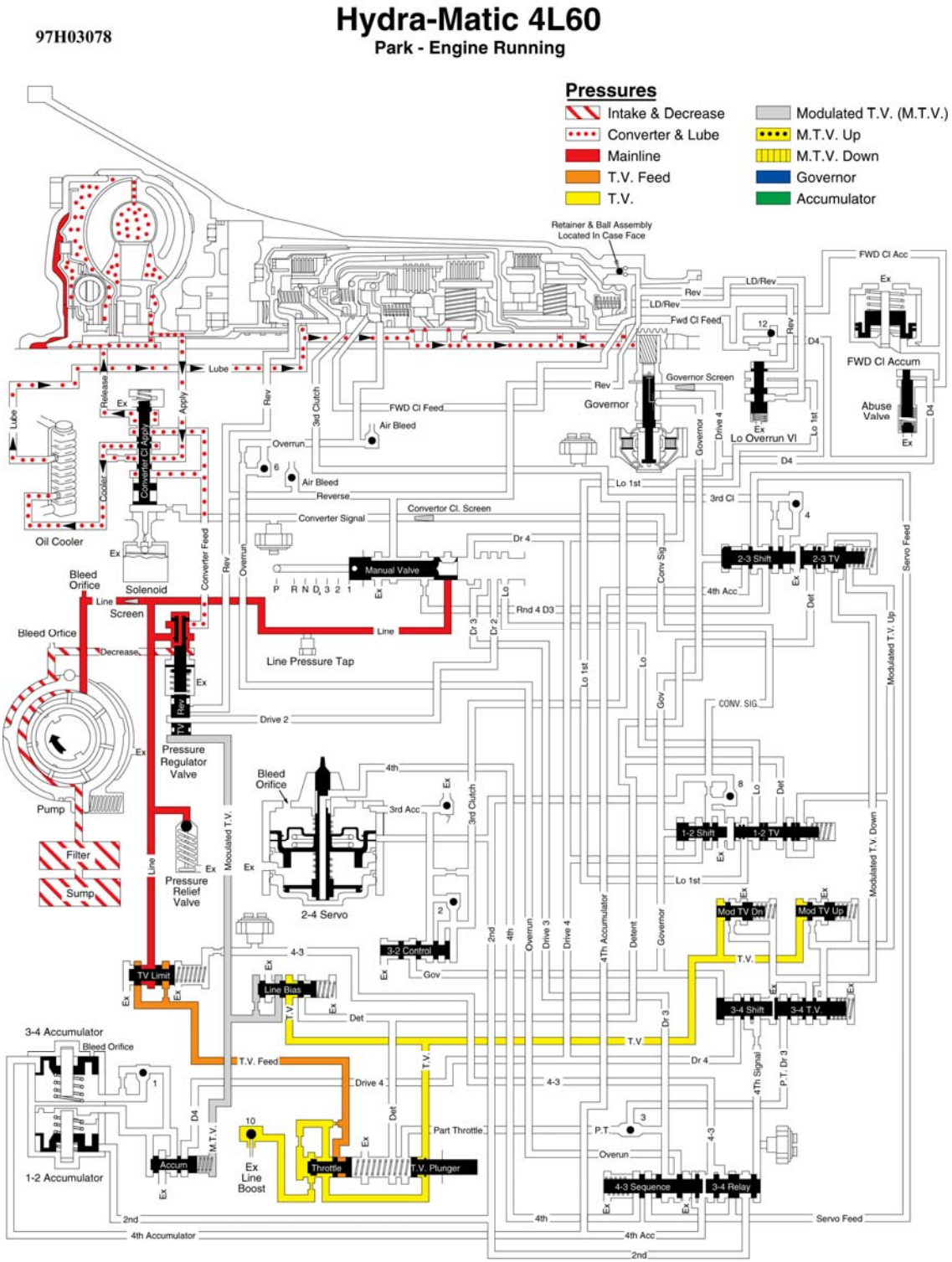


Fig. 1: Engine Running - Park

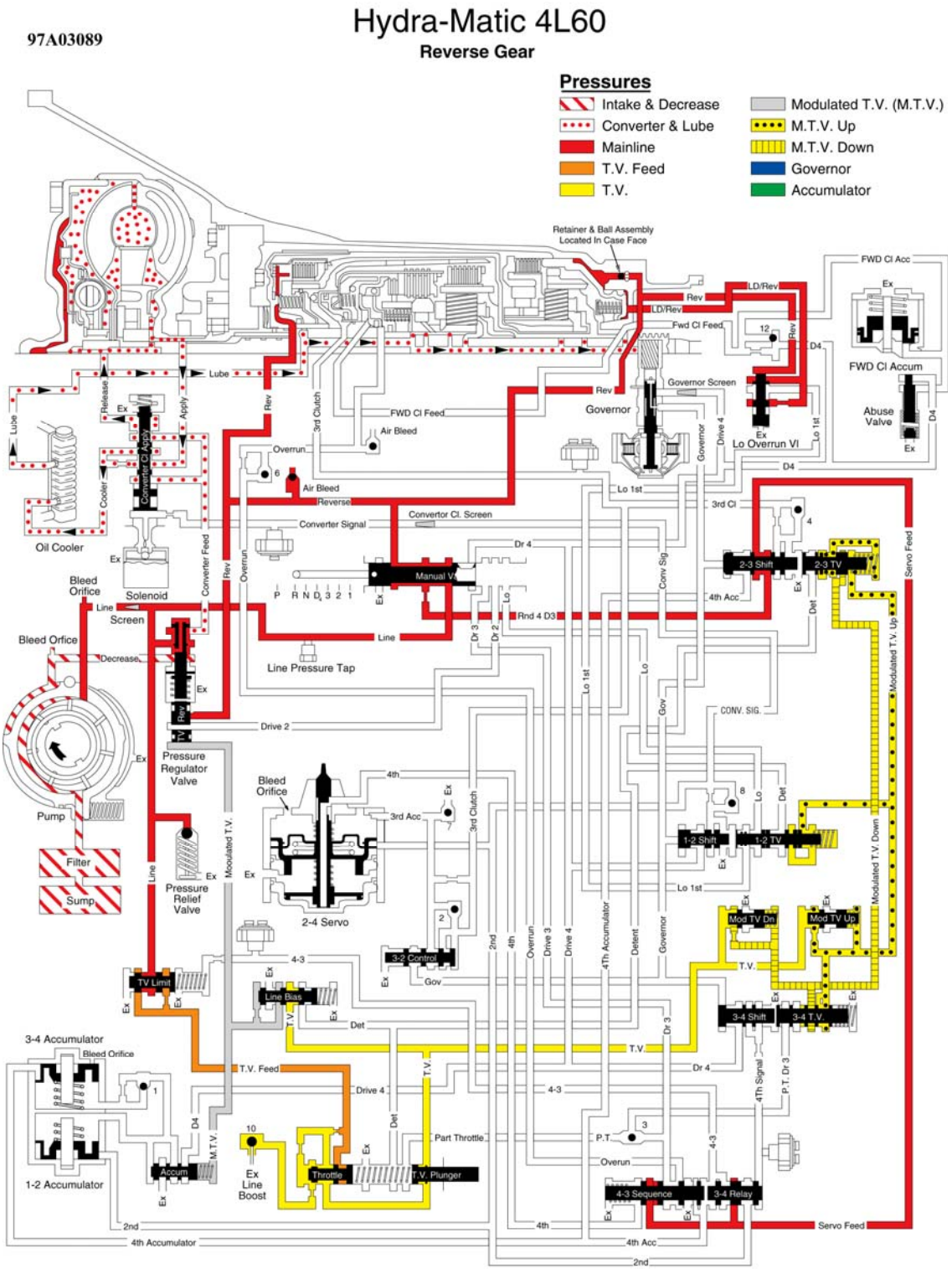


Fig. 2: Reverse Gear

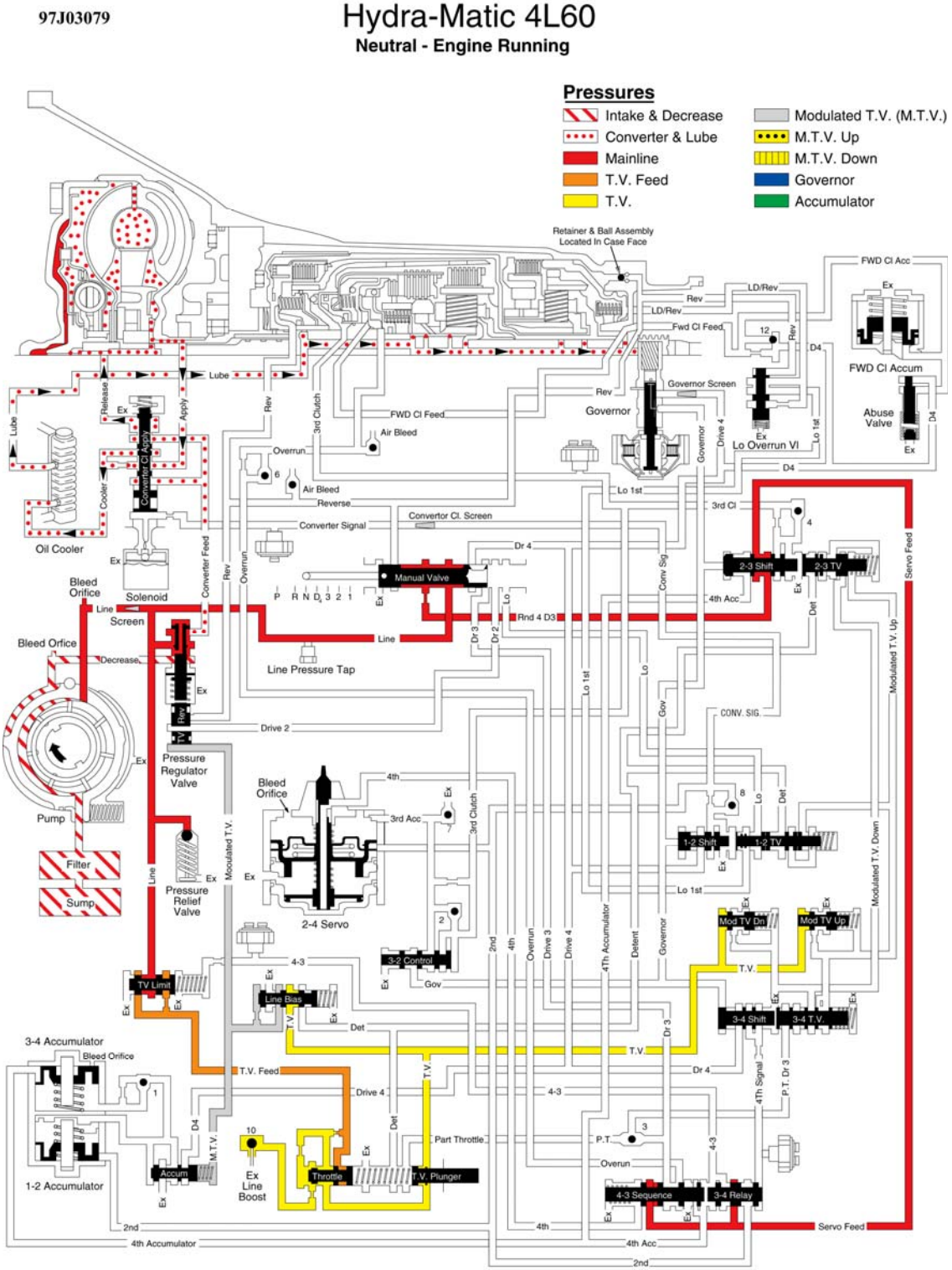


Fig. 3: Engine Running - Neutral

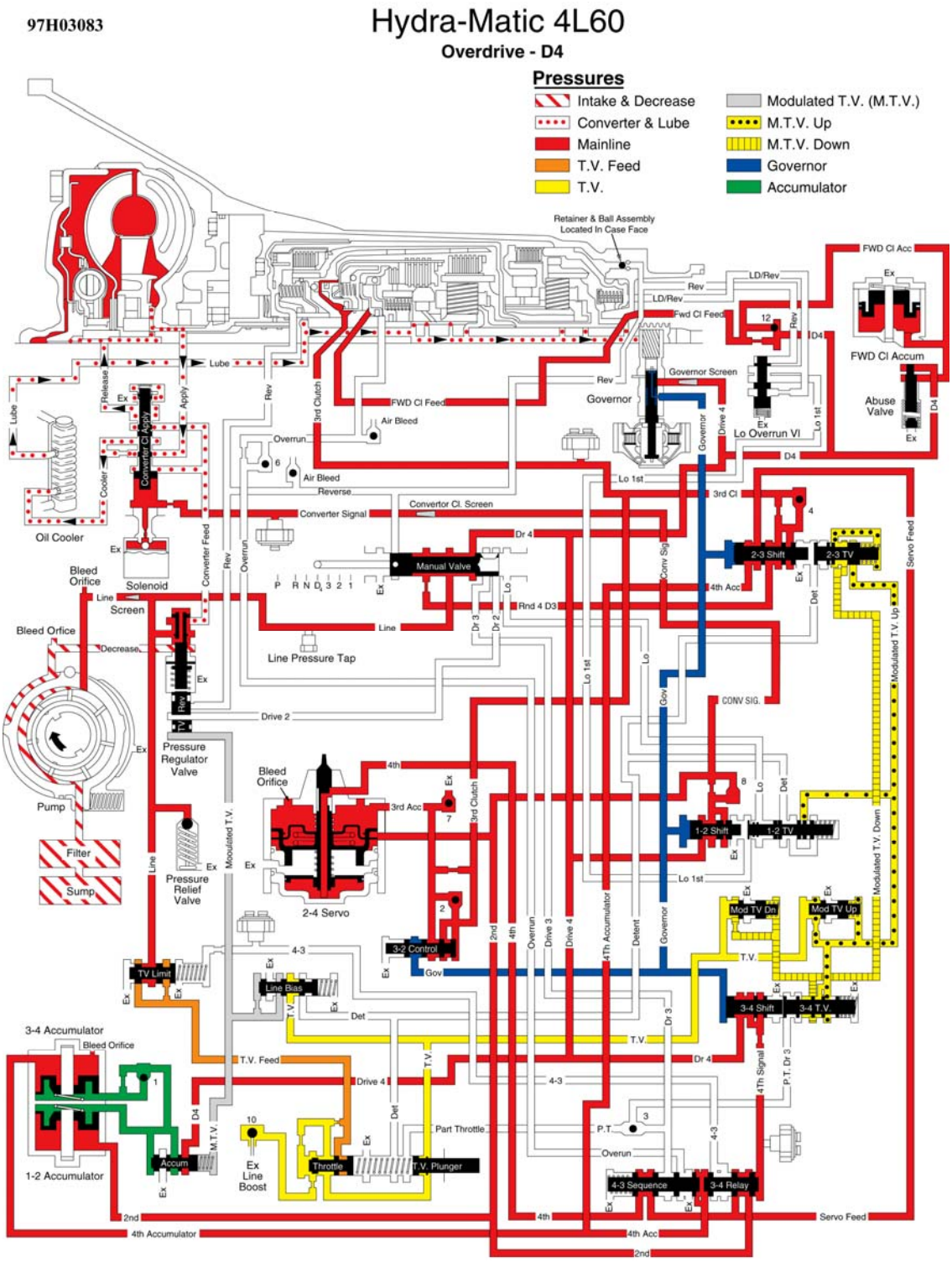


Fig. 4: Overdrive - D4

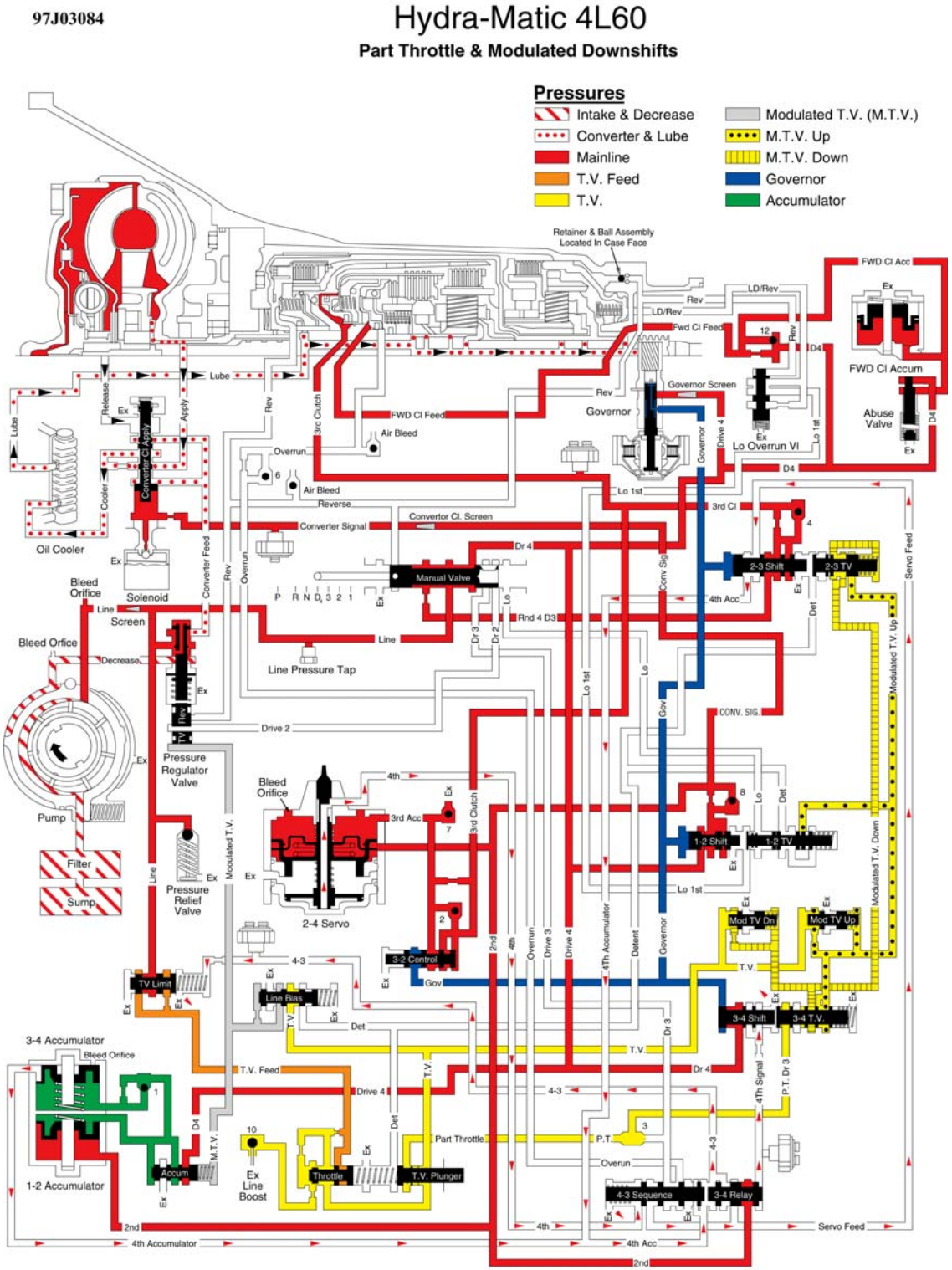


Fig. 5: Part Throttle 4-3 & Modulated Downshifts

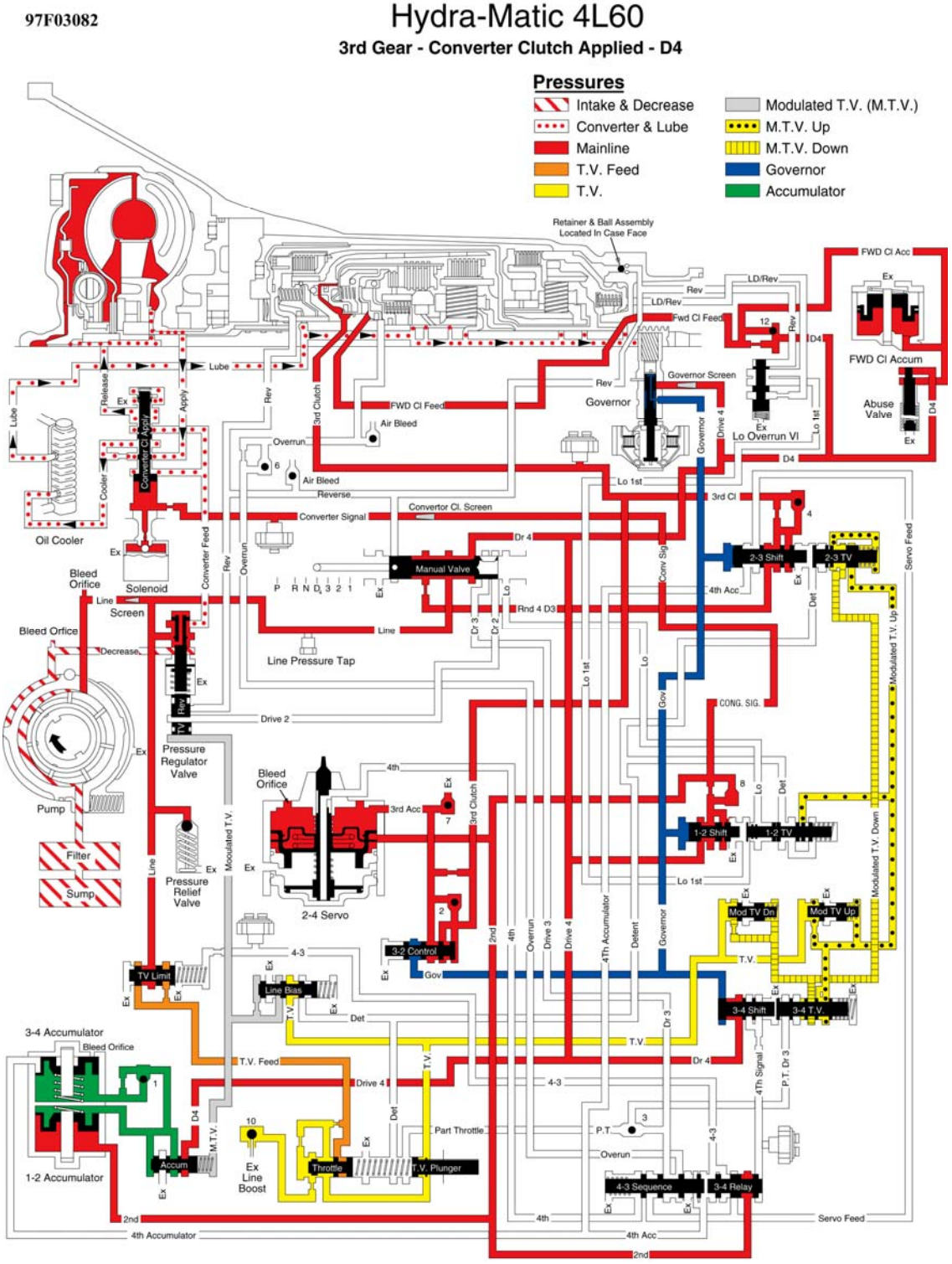


Fig. 6: 3rd Gear - D4 (Converter Clutch Applied)

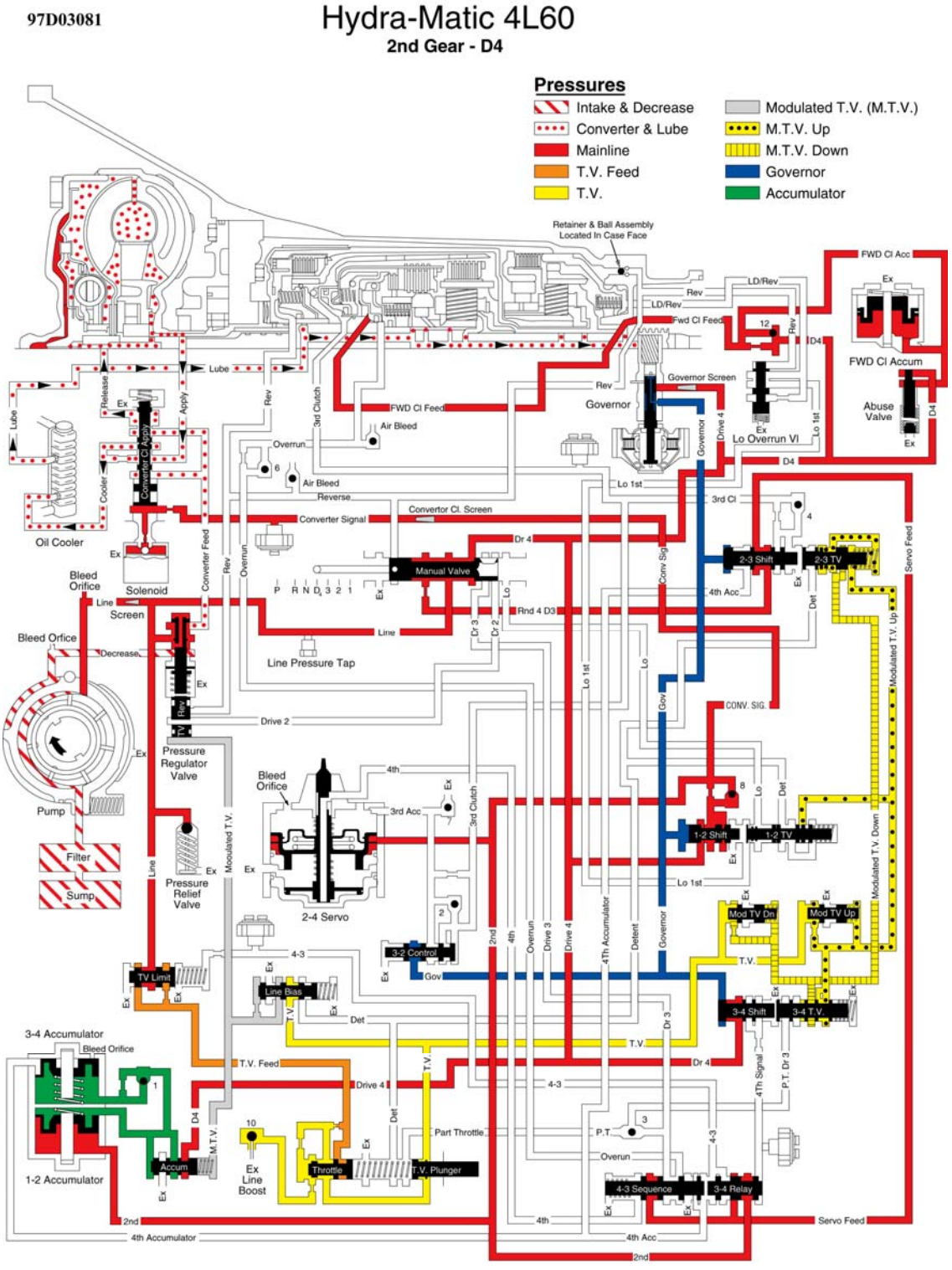


Fig. 7: 2nd Gear - D4

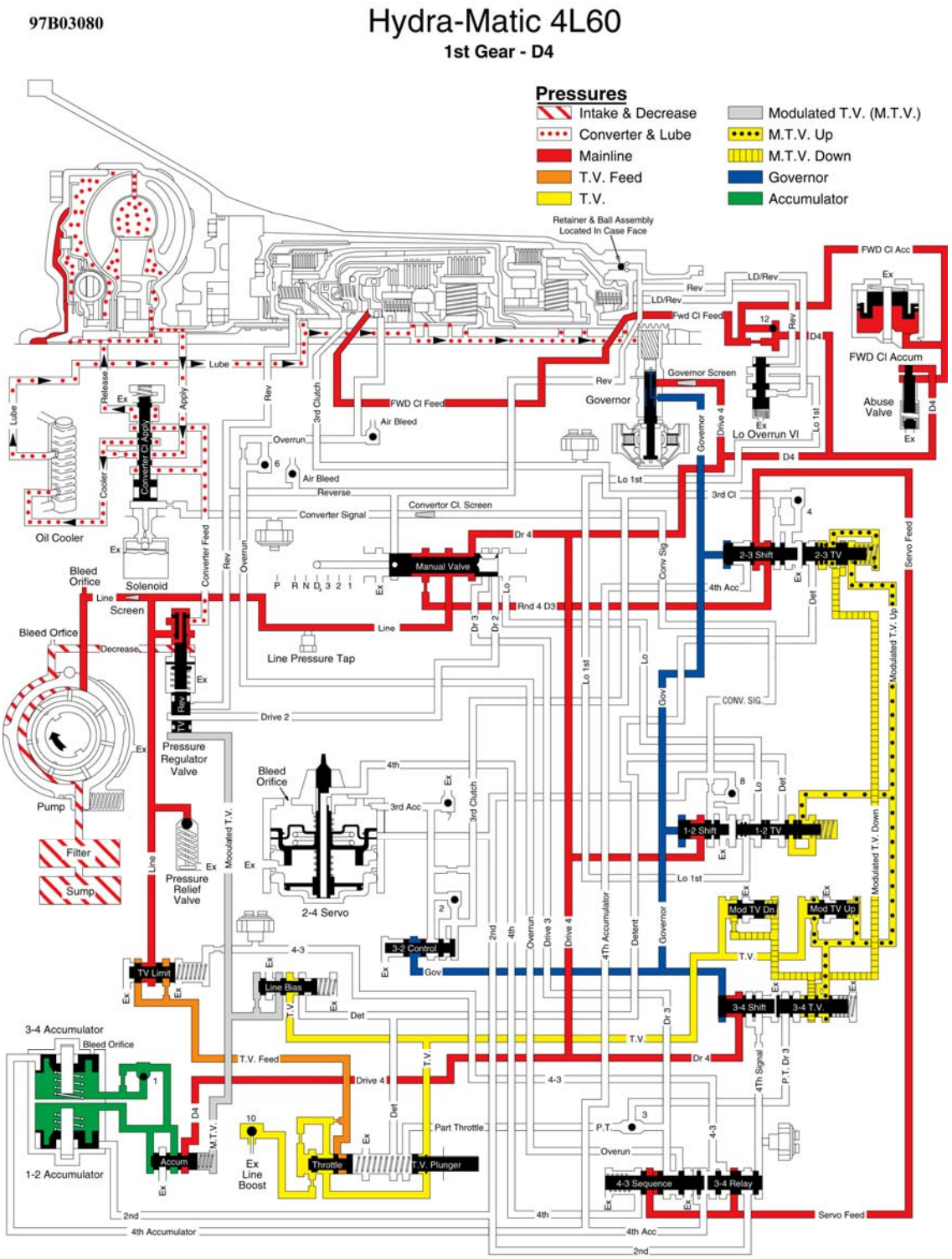


Fig. 8: 1st Gear - D4

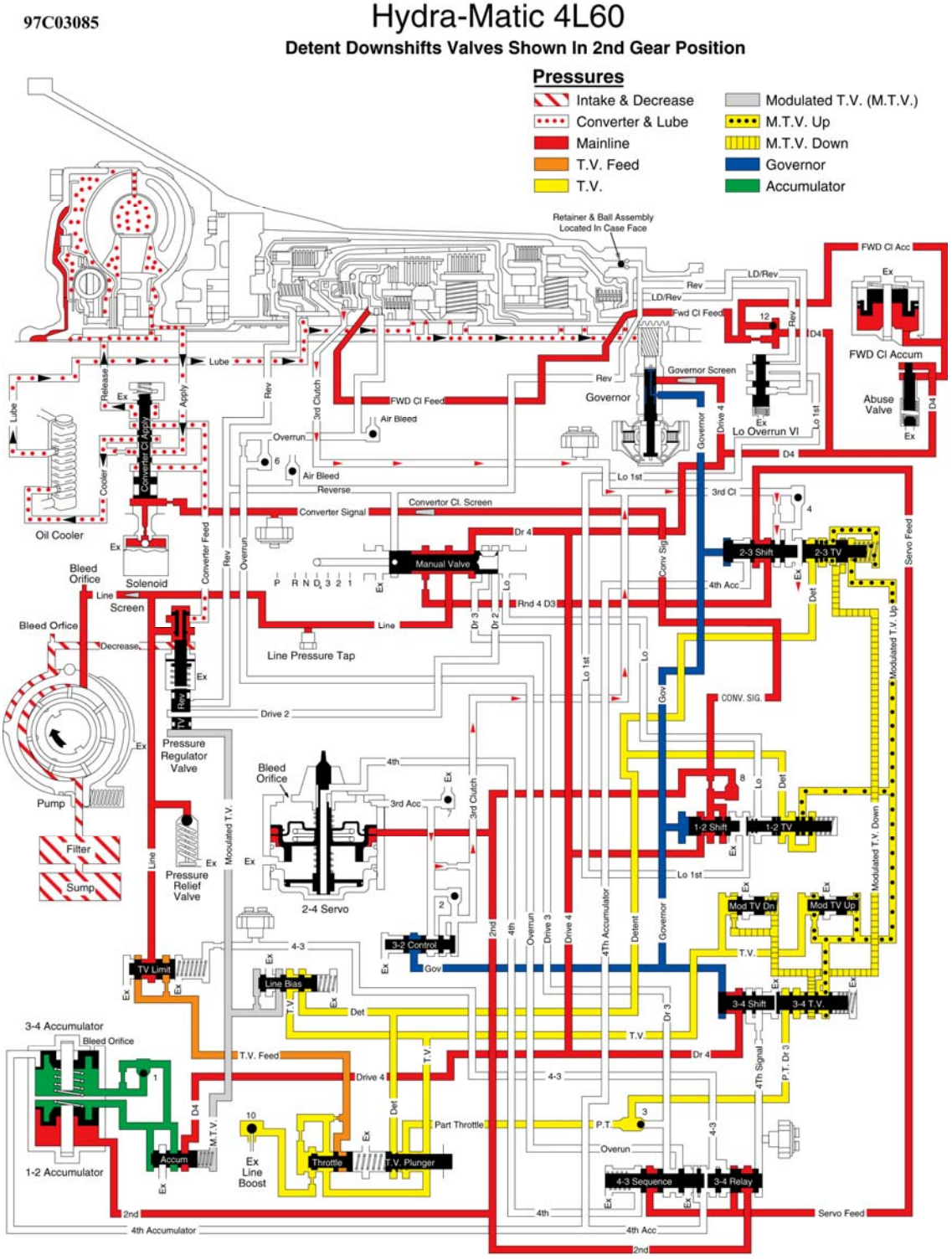


Fig. 9: Detent Downshifts (Valves Shown In 2nd Gear Position)

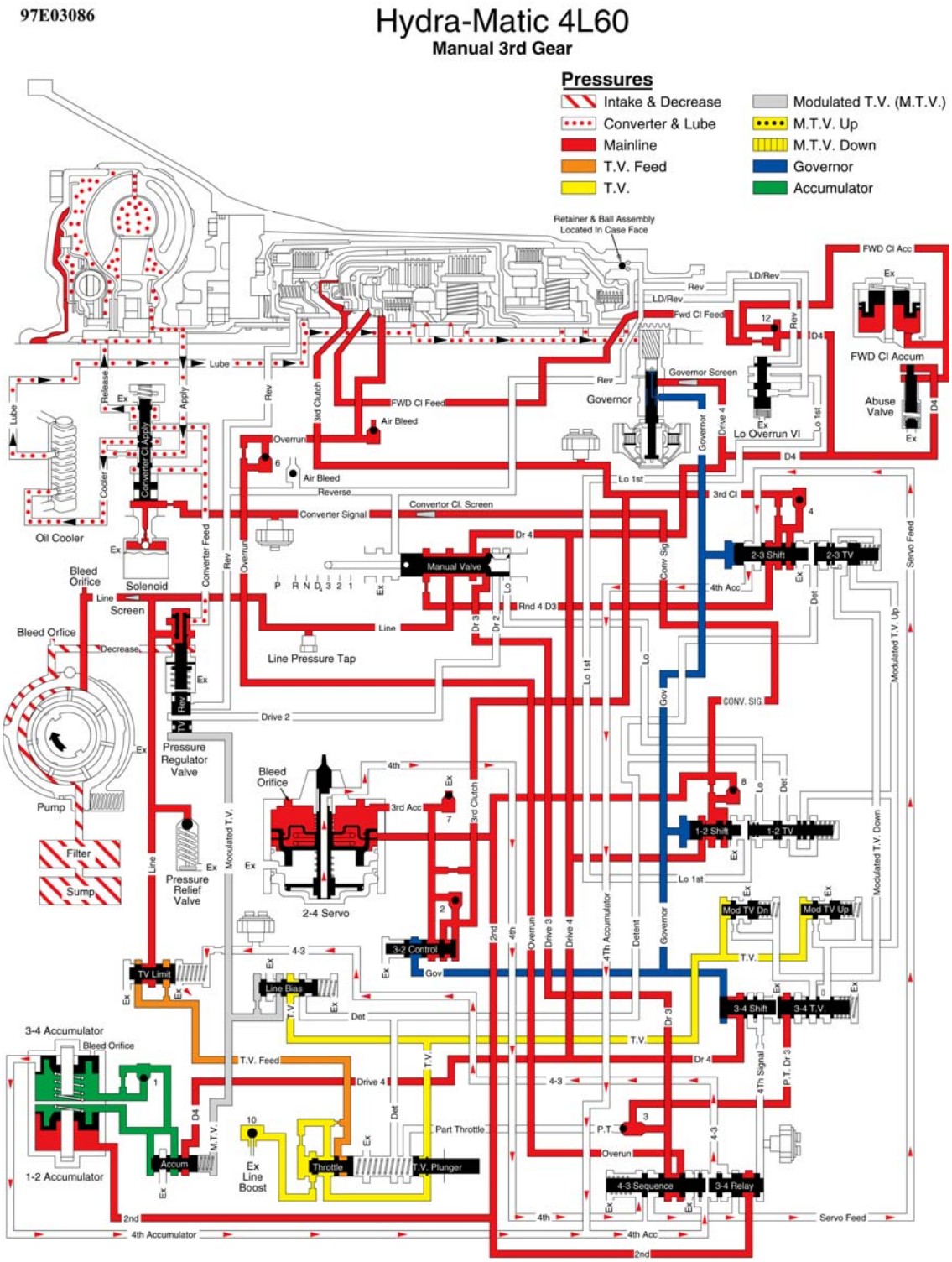


Fig. 10: Manual 3rd Gear

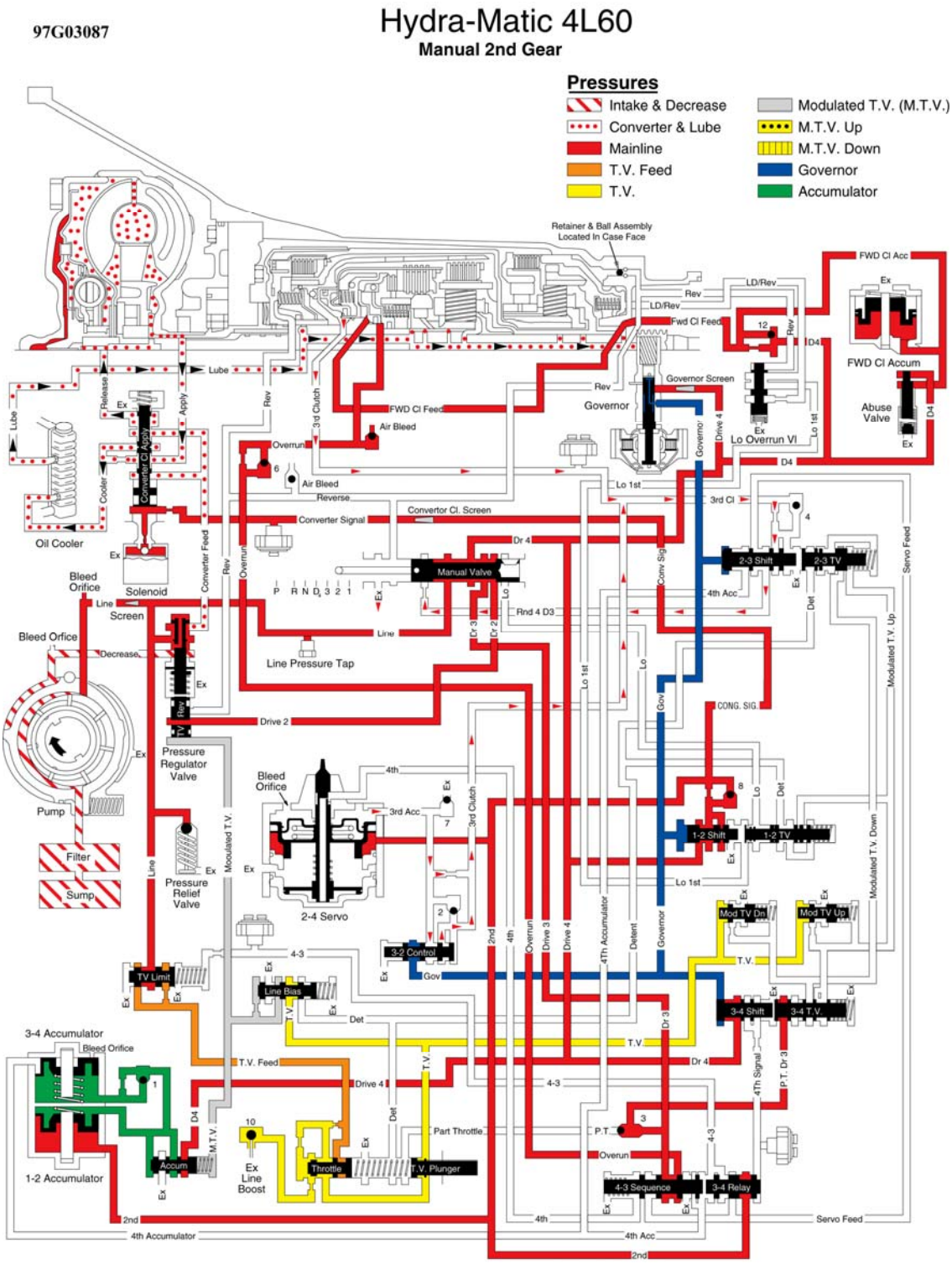


Fig. 11: Manual 2nd Gear

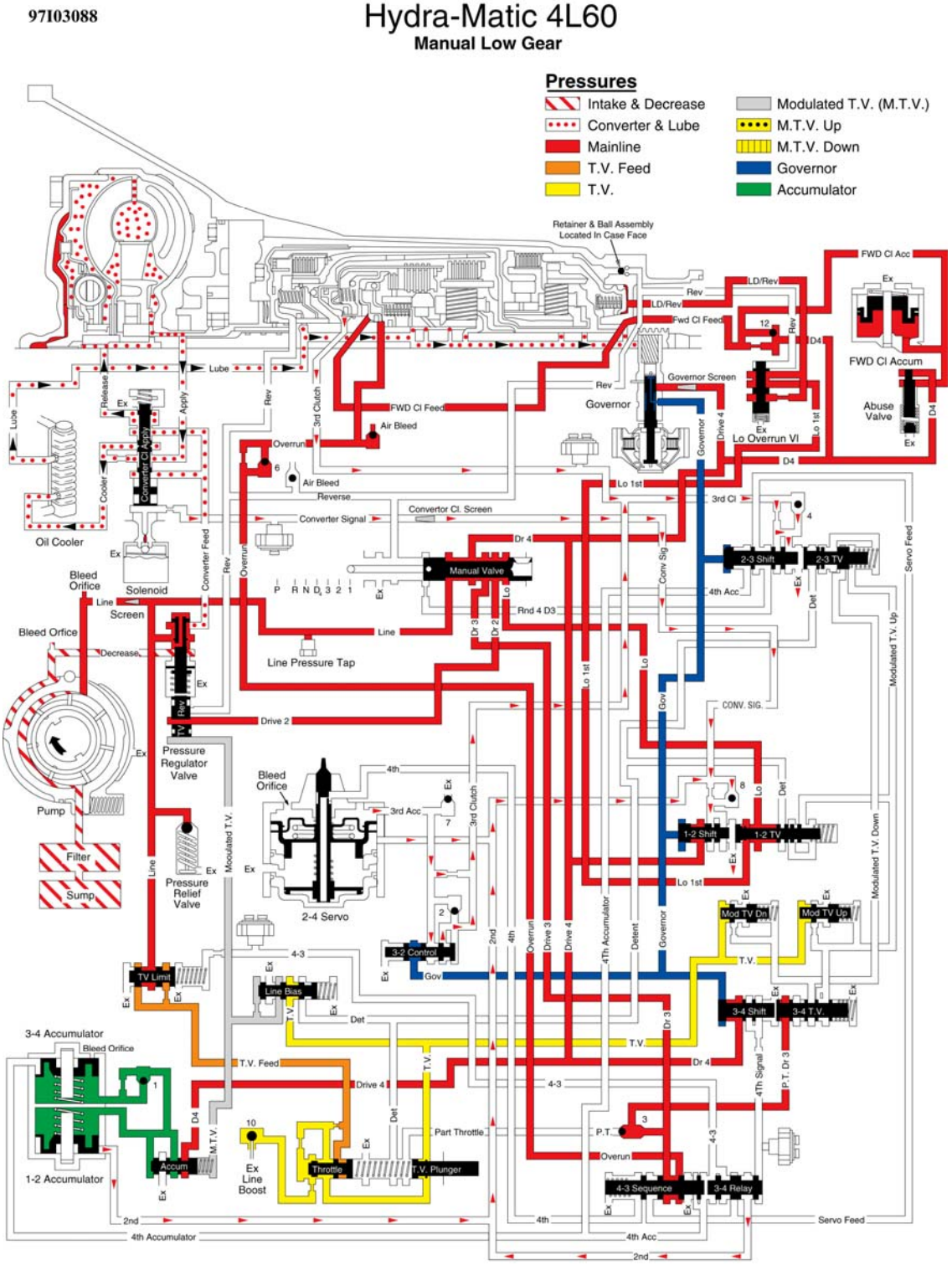


Fig. 12: Manual Low Gear

OIL CIRCUIT DIAGRAMS

Hydra-Matic 4L60-E

AUTOMATIC TRANSMISSION HYDRAULIC DIAGRAMS

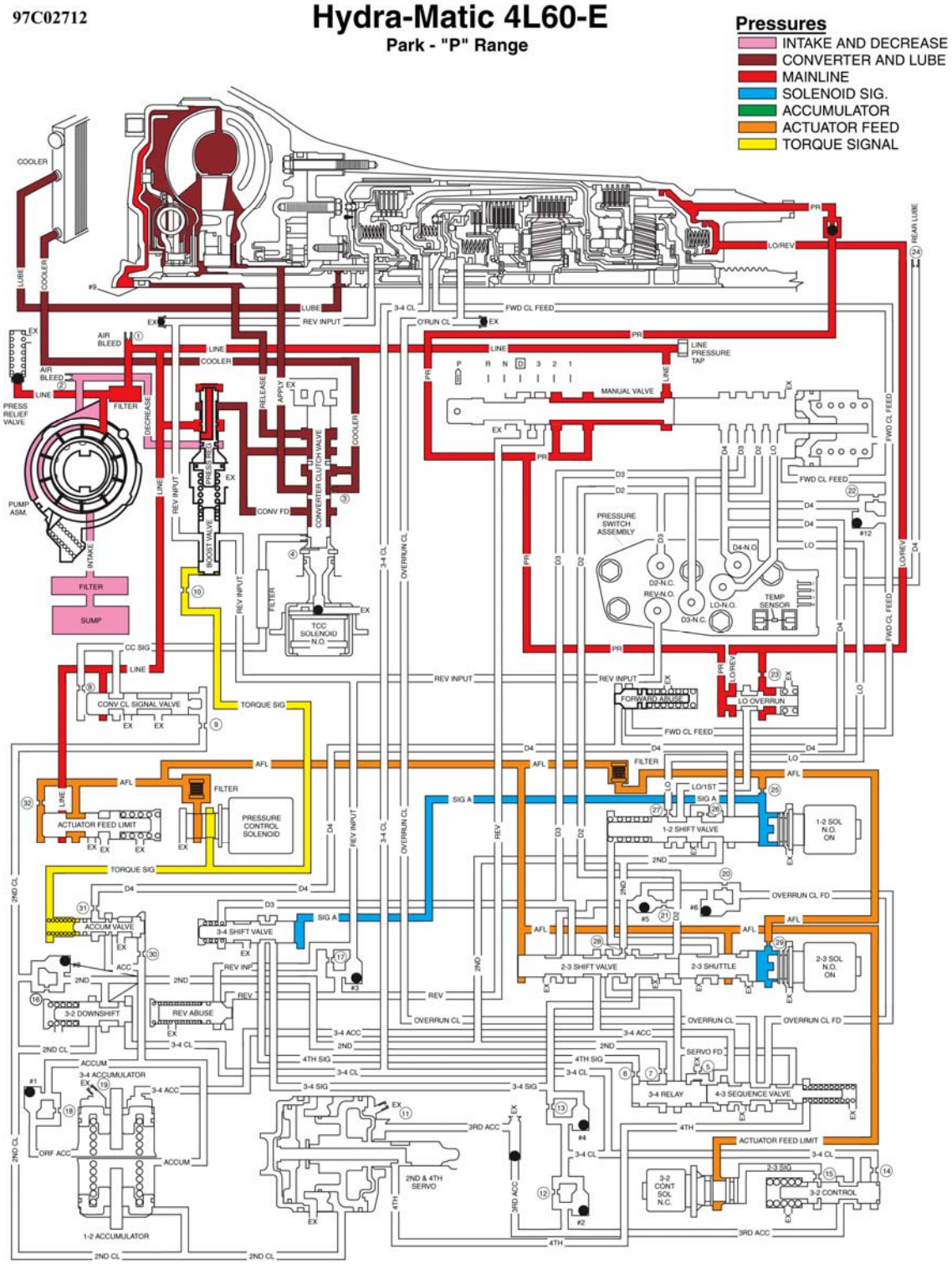


Fig. 1: Park - "P" Range

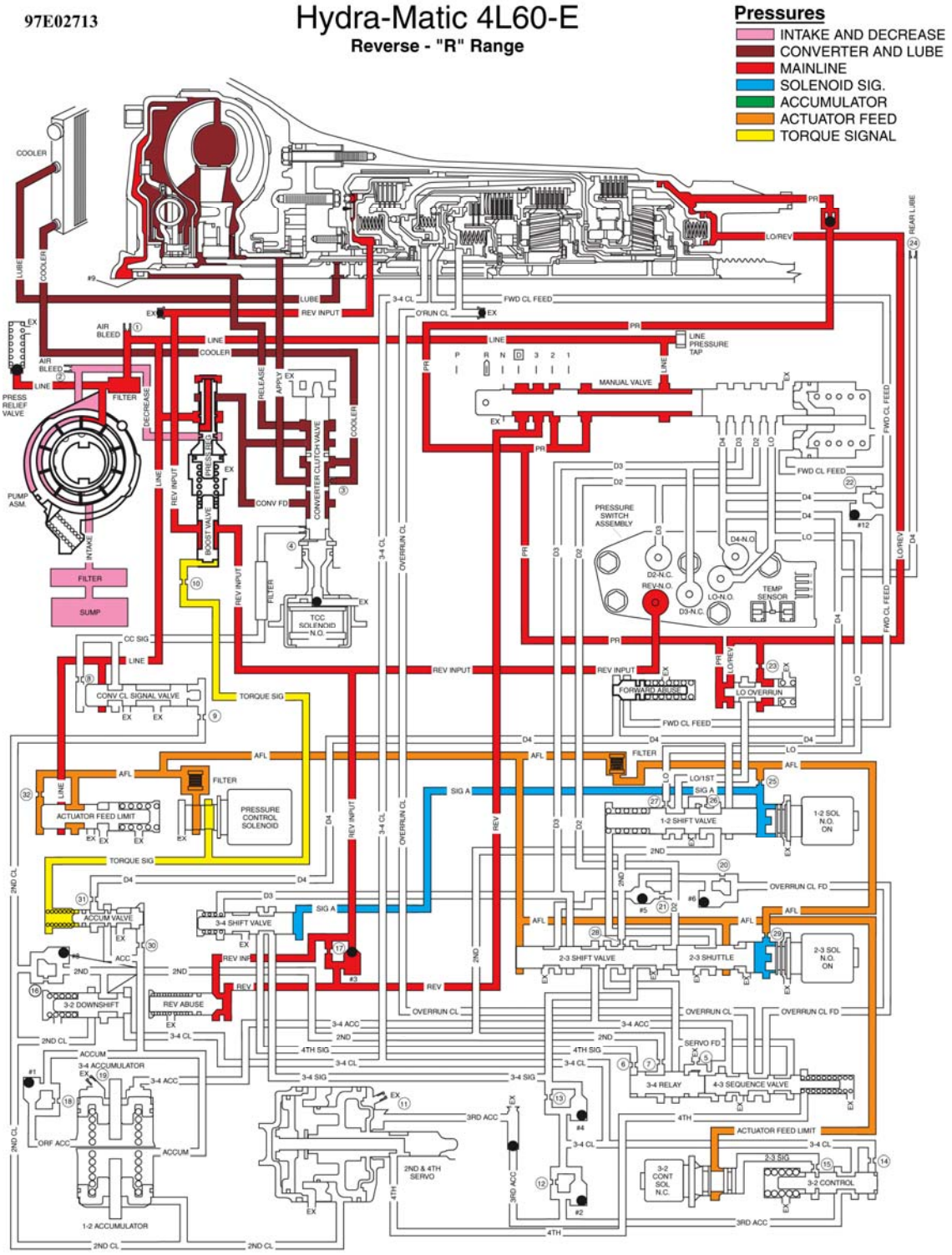


Fig. 2: Reverse - "R" Range

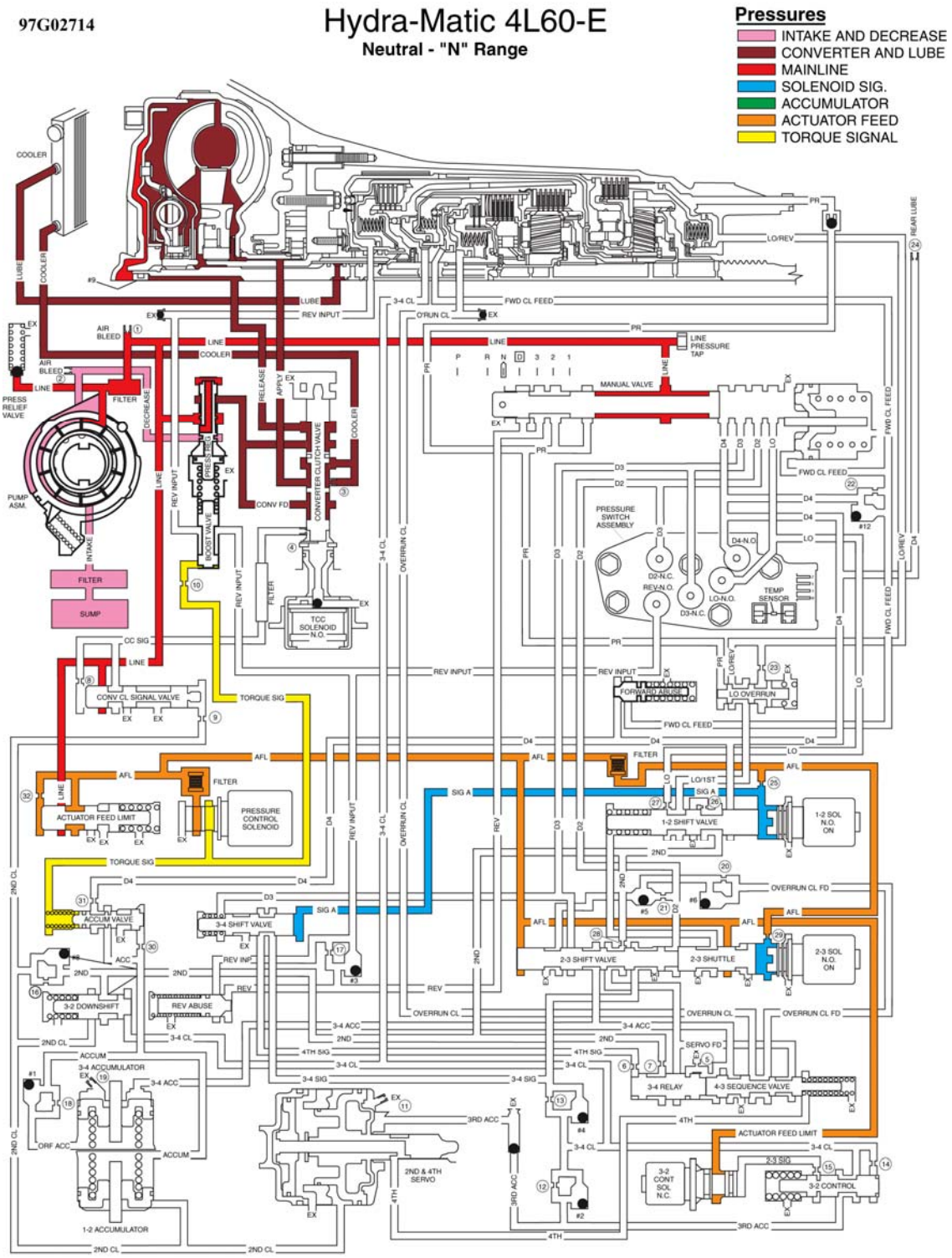


Fig. 3: Neutral - "N" Range

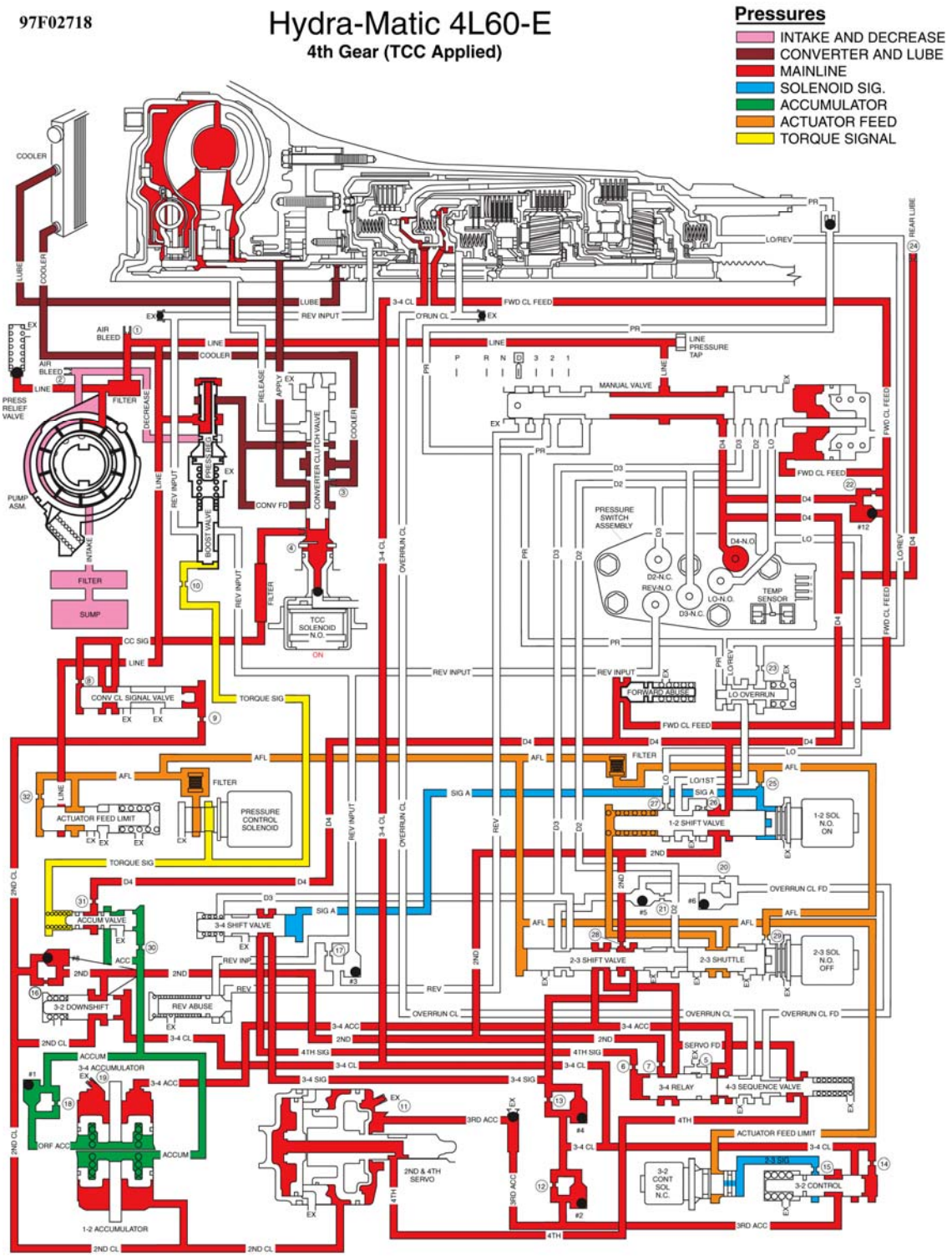


Fig. 4: 4th Gear - "OD" Range (TCC Applied)

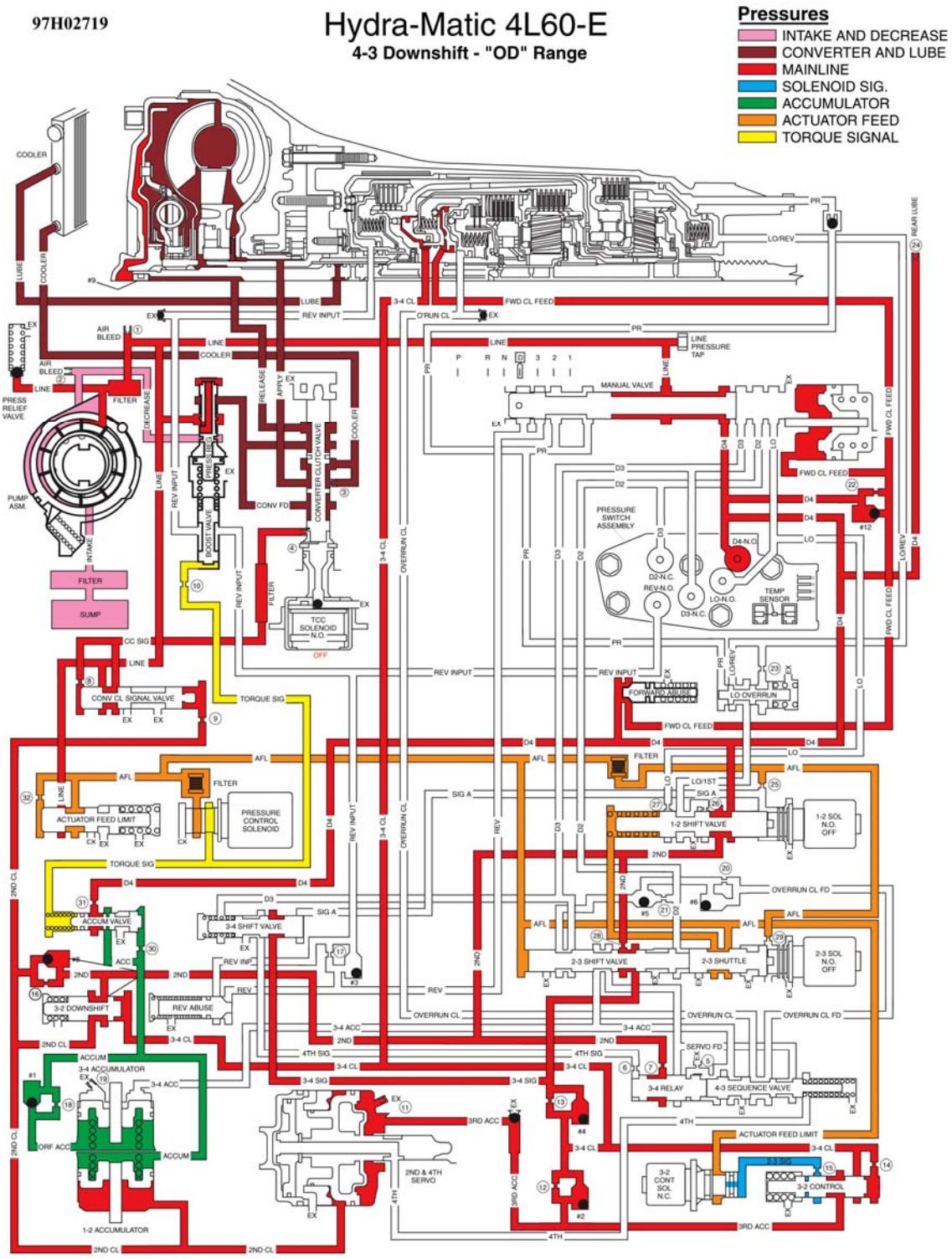


Fig. 5: 4-3 Downshift - "OD" Range

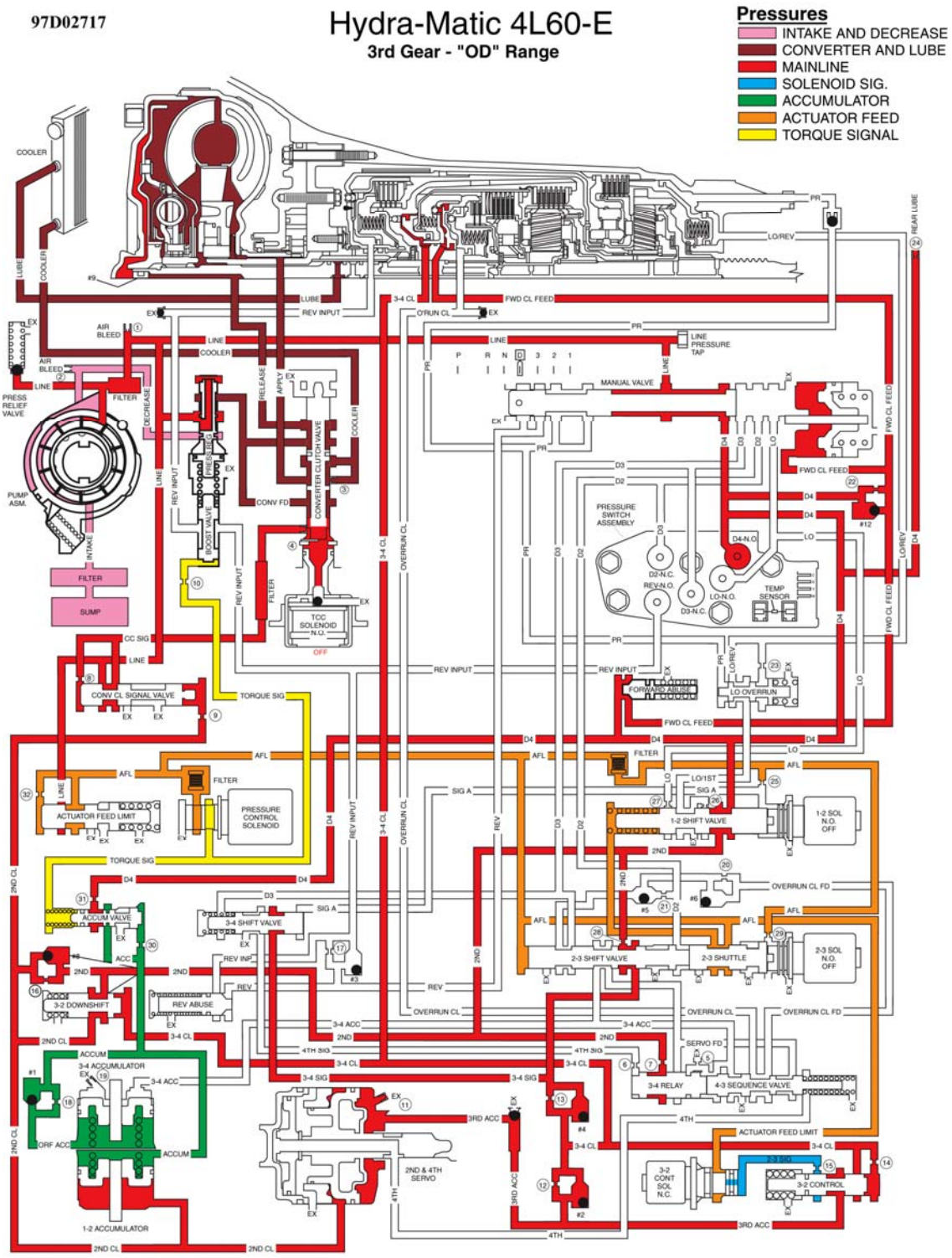


Fig. 6: 3rd Gear - "OD" Range

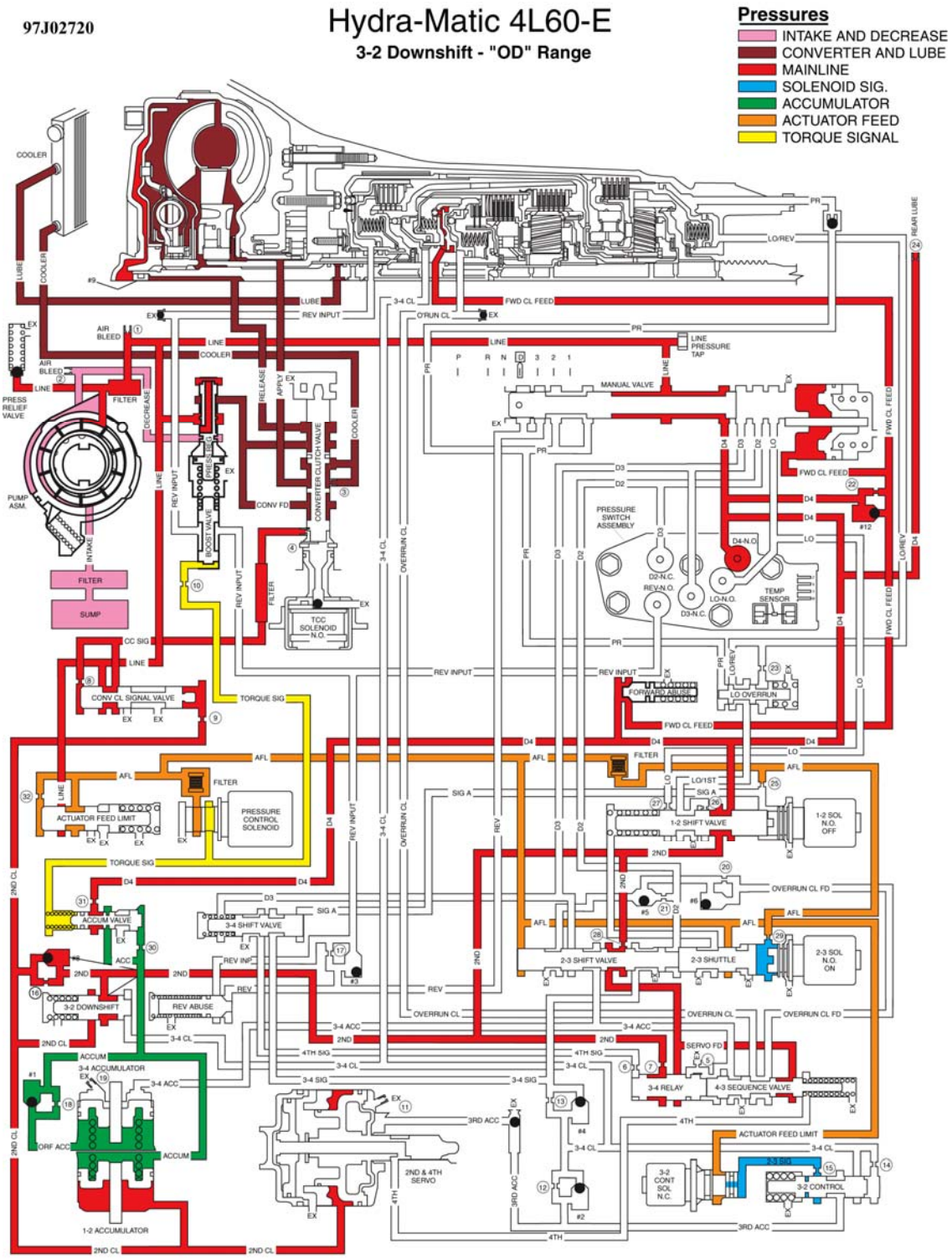


Fig. 7: 3-2 Downshift - "OD" Range

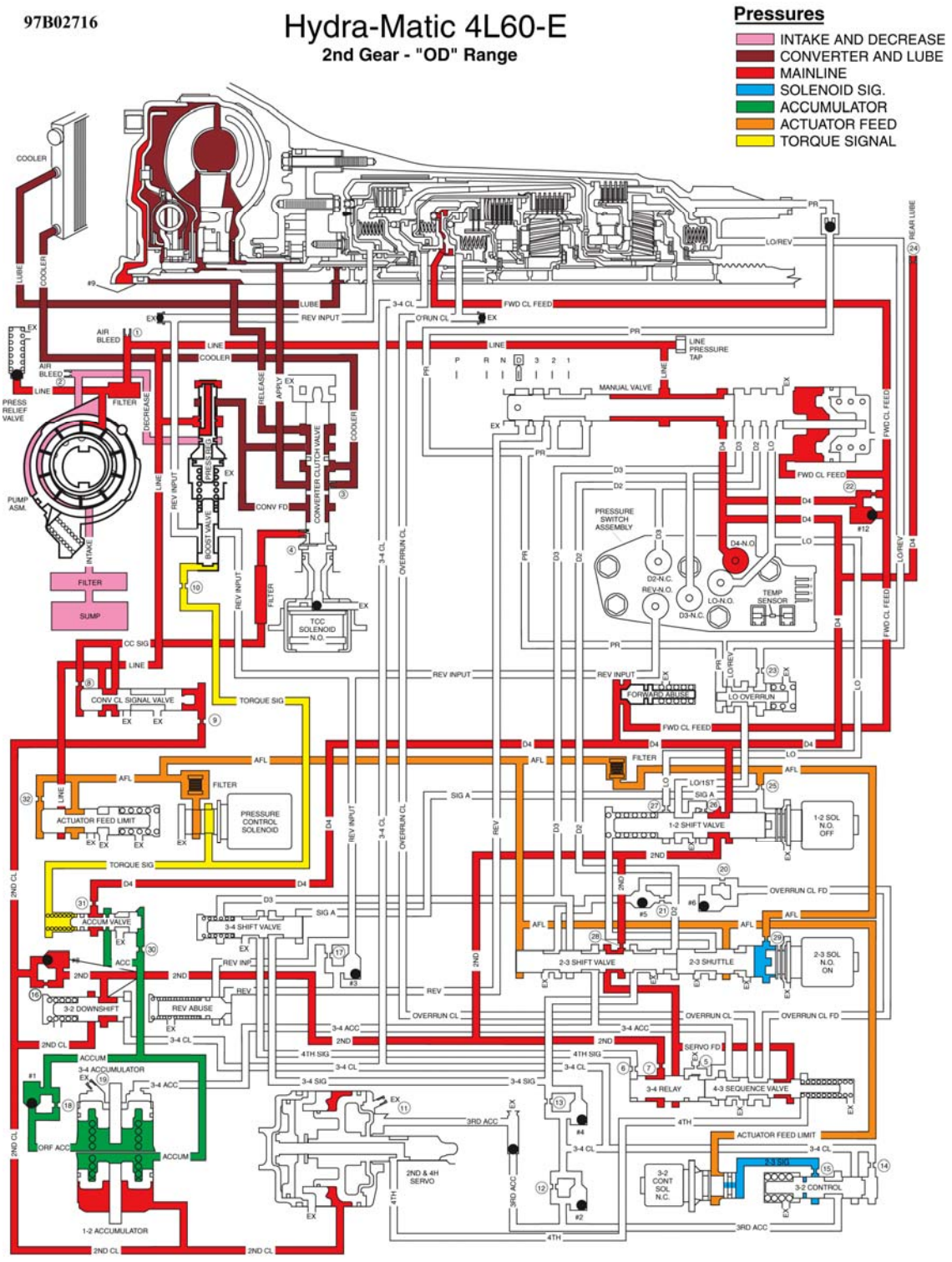


Fig. 8: 2nd Gear - "OD" Range

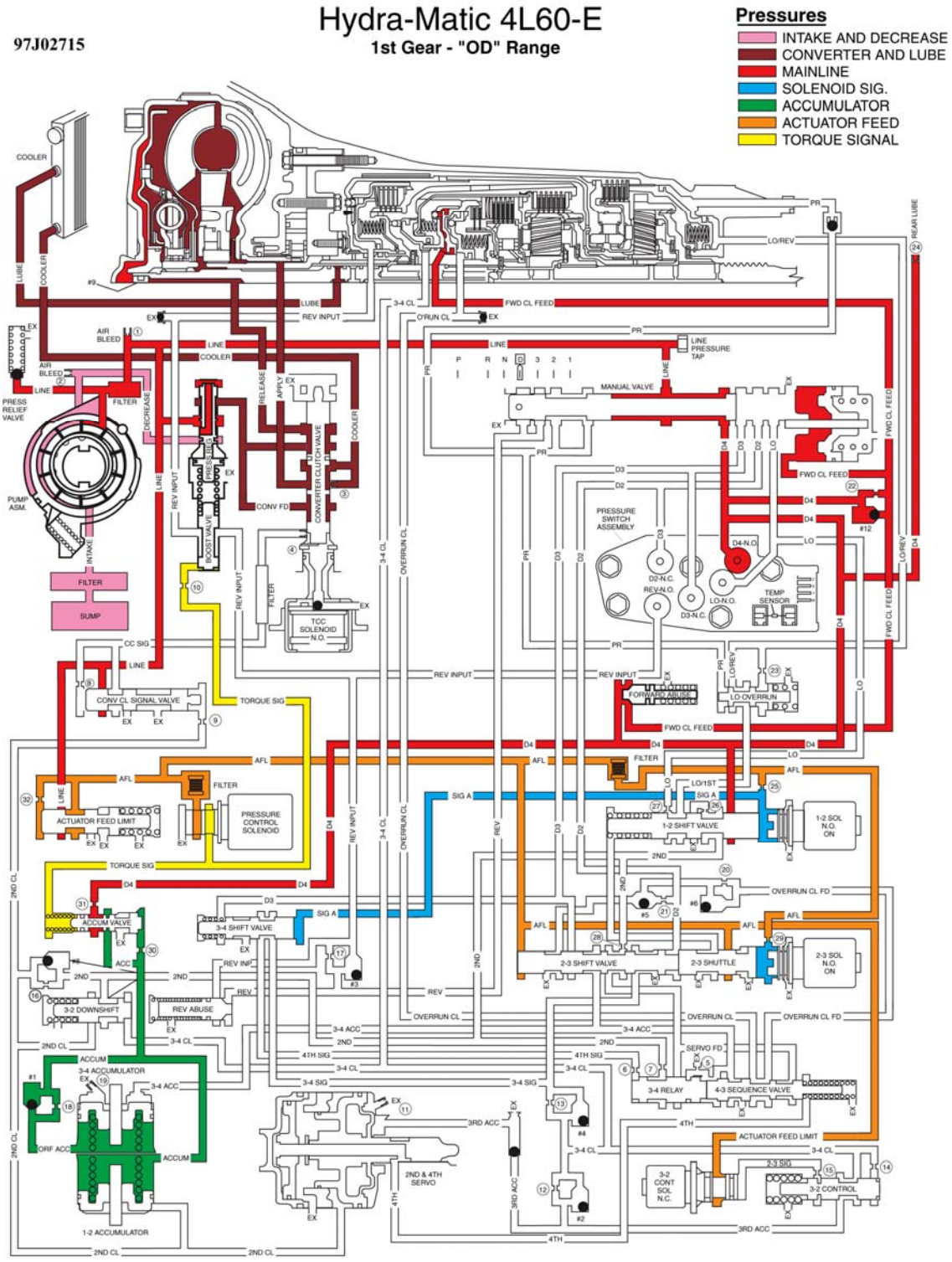


Fig. 9: 1st Gear - "OD" Range

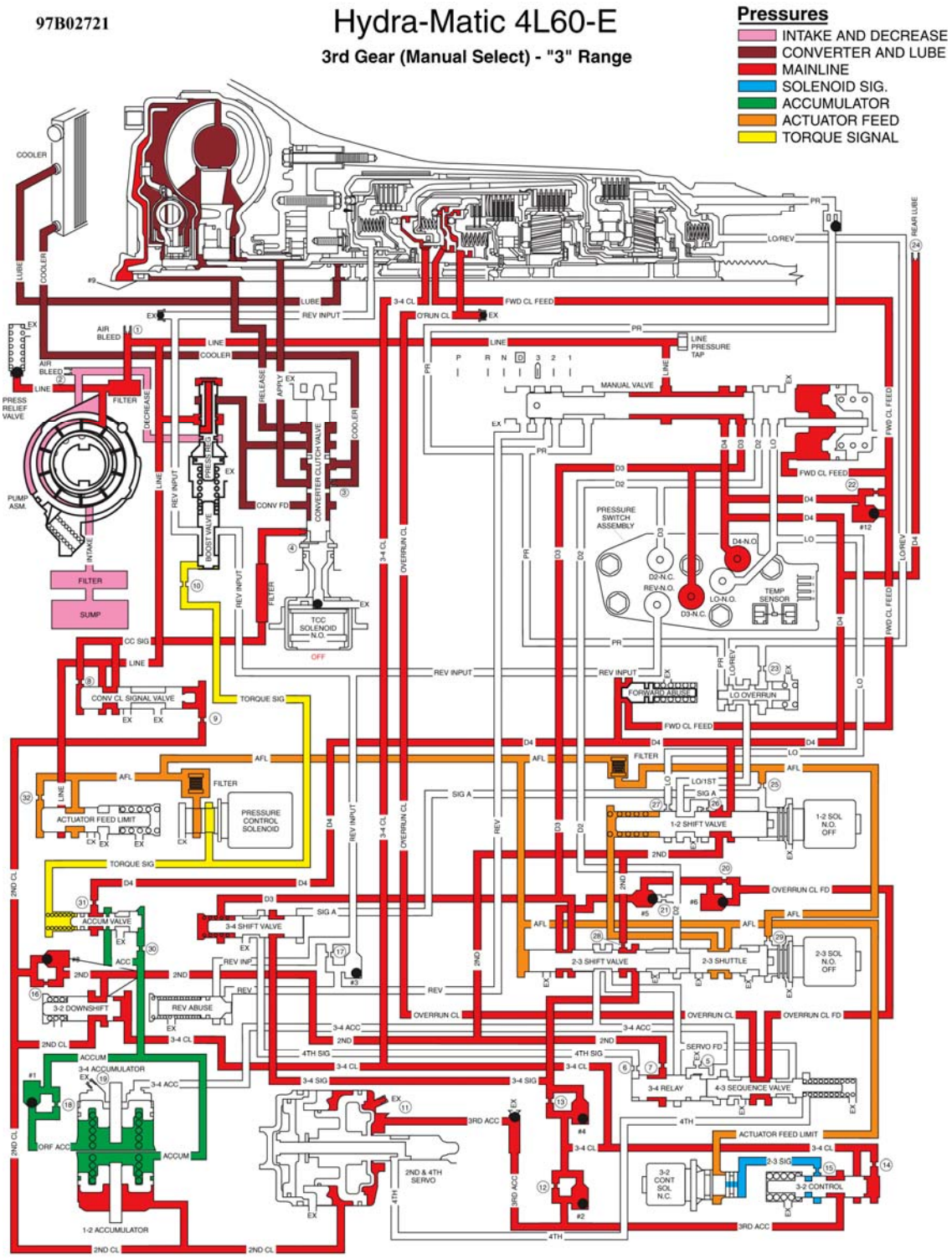


Fig. 10: 3rd Gear - "3" Range (Manual Select)

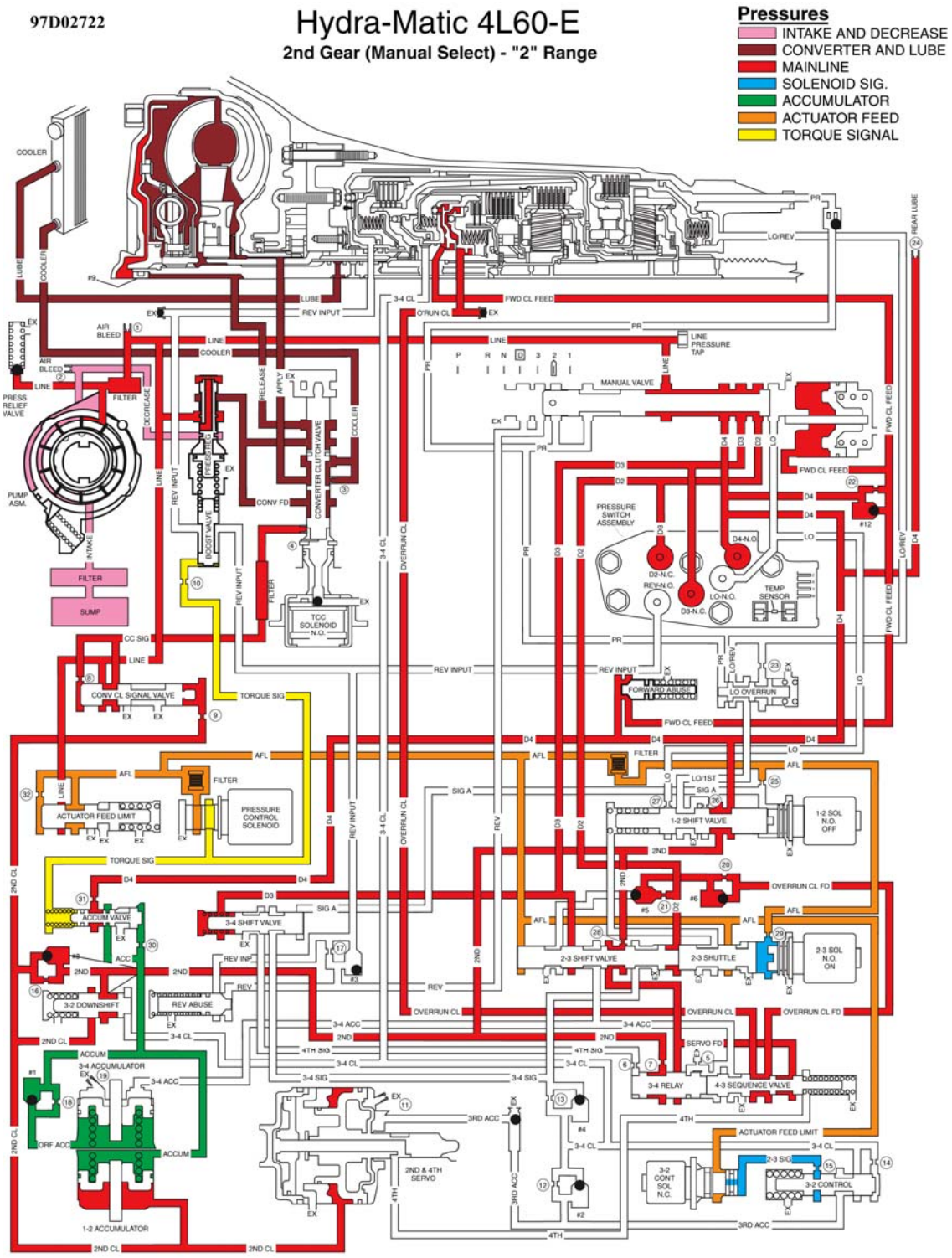


Fig. 11: 2nd Gear - "2" Range (Manual Select)

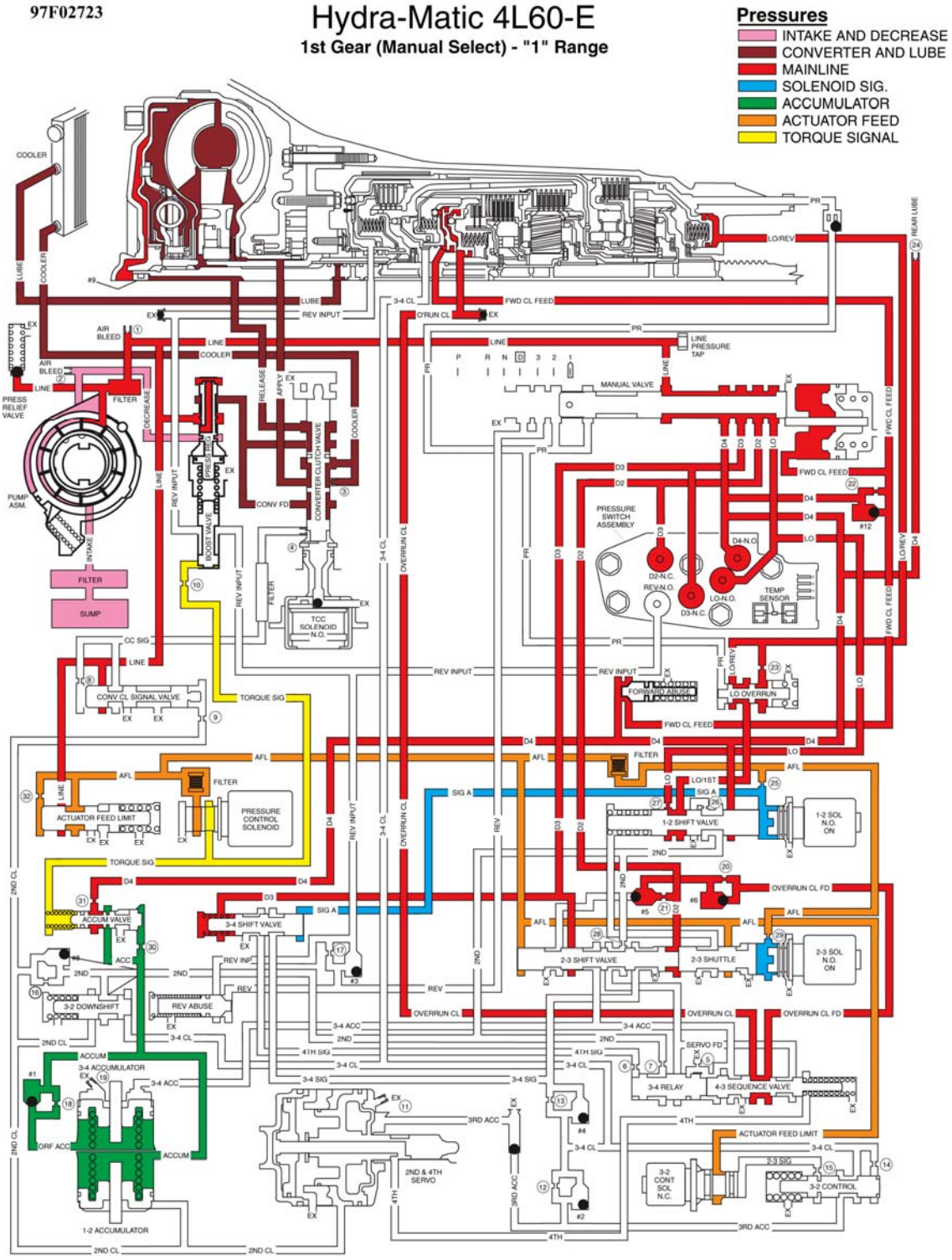


Fig. 12: 1st Gear - "1" Range (Manual Select)

APPLICATION

THM 700-R4/4L60 APPLICATIONS

Vehicle Application	Engine
Buick	
Electra	5.0L
LeSabre	5.0L
Roadmaster	5.0L, 5.7L
Cadillac	
Brougham	5.0L, 5.7L
Fleetwood	5.7L
Chevrolet	
Astro	2.5L & 4.3L
Blazer	2.5L, 4.3L, 5.0L, 5.7L & 6.2L
Camaro	2.5L, 2.8L, 3.1L, 5.0L & 5.7L
Caprice	4.3L, 4.4L, 5.0L & 5.7L
Corvette	5.7L
Cutaway Van	5.7L, 6.2L, 7.4L
El Camino	4.3L & 5.0L
Hi-Cube Van	5.7L, 6.2L, 7.4L
Impala	4.3L, 4.4L, 5.0L & 5.7L
Monte Carlo	4.3L & 5.0L
Passenger Van	4.3L, 5.0L, 5.7L, 6.2L, 7.4L
Sport Van	4.3L, 5.0L, 5.7L, 6.2L, 7.4L
Suburban	5.7L, 6.2L, 7.4L
Pickup	2.5L, 4.3L, 5.0L, 5.7L, 6.2L, 6.5L, 7.4L
S10 & S10 Blazer	2.0L, 2.2L, 2.5L, 2.8L & 4.3L
Suburban	5.0L, 5.7L & 6.2L
GMC	
Caballero	4.3L & 5.0L
Cutaway Van	4.3L, 5.7L
Jimmy	5.0L, 5.7L & 6.2L
Magnavan	5.7L, 6.2L, 7.4L
Passenger Van	4.1L, 4.3L, 5.0L, 5.7L & 6.2L
Rally Van	4.3L, 5.0L, 5.7L, 6.2L
Safari	2.5L & 4.3L
School Bus	4.3L, 5.7L

Sierra	4.3L, 5.7L, 6.2L, 7.4L
Sonoma	2.5L & 4.3L
Pickup	2.5L, 4.1L, 4.3L, 5.7L & 6.2L
S15 Pickup & Jimmy	2.0L, 2.5L, 2.8L & 4.3L
Suburban	5.0L, 5.7L & 6.2L
Vandura	4.1L, 4.3L, 5.0L, 5.7L & 6.2L
Yukon	5.7L
Oldsmobile	
Bravada	4.3L
Custom Cruiser	5.0L, 5.7L
Pontiac	
Bonneville	4.3L & 5.0L
Firebird	2.5L, 2.8L, 3.1L, 5.0L & 5.7L
Grand Prix	4.3L & 5.0L
Parisienne	4.3L, 5.0L & 5.7
Safari	5.0L

IDENTIFICATION

Turbo Hydra-Matic 4L60 (previously 700-R4) transmission can be identified by a letter code contained in identification number. Identification number is stamped on transmission case above oil pan rail on right rear side. See **Fig. 1** . Identification number contains information which must be used when ordering replacement parts.

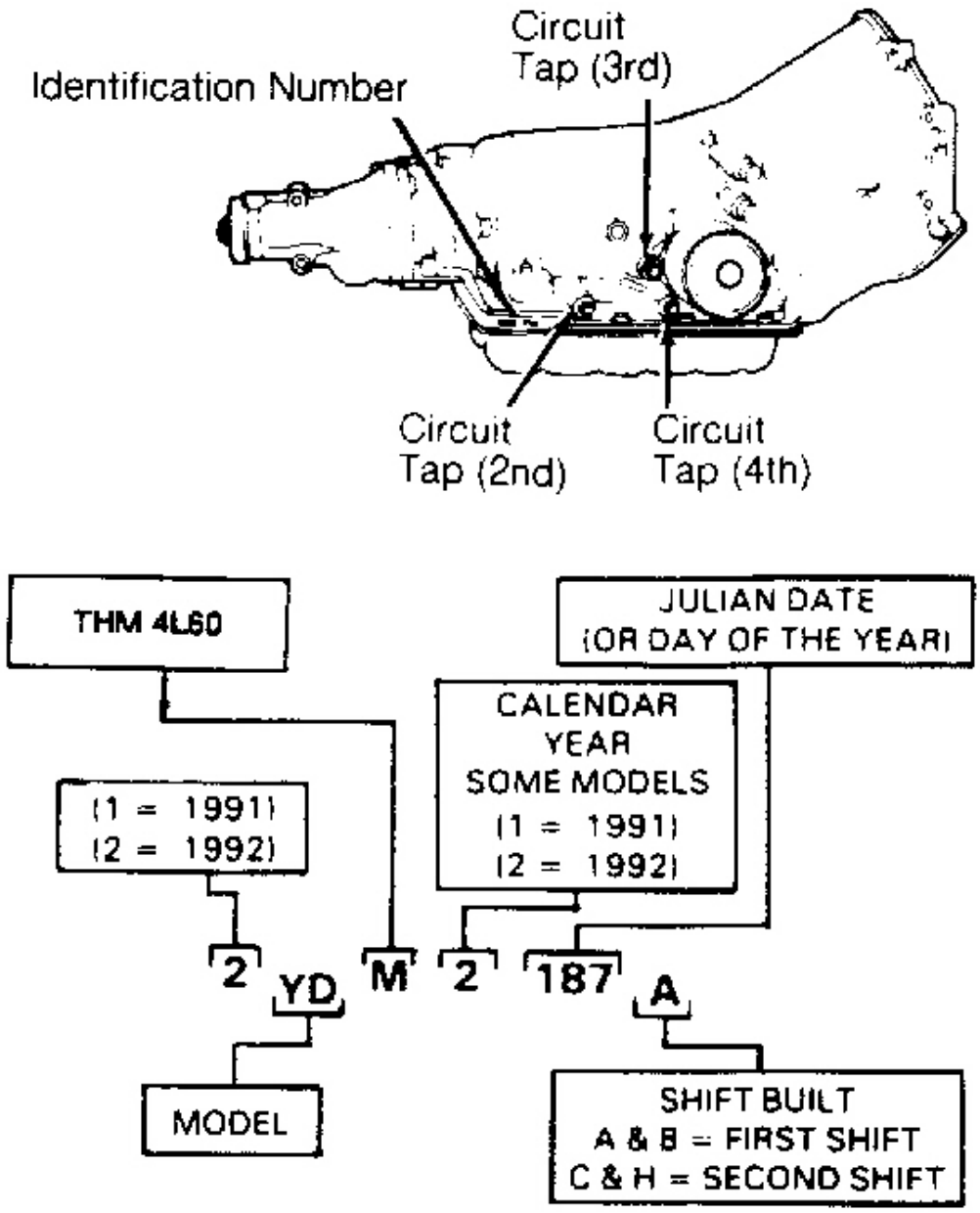


Fig. 1: Identifying Transmission & Locating Circuit Taps
Courtesy of GENERAL MOTORS CORP.

DESCRIPTION

Turbo Hydra-Matic (THM) 4L60 is a fully automatic trans-mission consisting of a 3-element hydraulic torque converter with a Torque Converter Clutch (TCC). Two planetary gear sets, 5 multiple-disc clutches, one sprag clutch, one roller clutch and a band provide friction elements necessary to produce 4 forward speeds, last of which is Overdrive. See **Fig. 2** .

A hydraulic system, pressurized by a variable capacity vane type pump, provides pressure required to operate friction elements and automatic controls. Transmission contains an auxiliary valve body for smoother Drive and Reverse engagement. Temperature switch may be used to apply TCC to prevent transmission overheating. Temperature switch reduces fluid temperature in Overdrive when TCC is not applied.

Temperature switch mounts on valve body and sits in transmission pan fluid. See **Fig. 37** . At normal operating temperature or less, switch is open. As fluid in pan heats to 270-286°F (134-140°C), switch closes to allow TCC to apply until fluid in pan cools to 250-268°F (121-131°C). Heat is reduced when TCC is applied and torque multiplication function of converter is bypassed.

CAUTION: Ensure transmission contains auxiliary valve body before performing repairs. See Fig. 3 .

NOTE: See AUTO TRANS DIAGNOSIS - GM TORQUE CONVERTER CLUTCH article in AUTOMATIC TRANSMISSIONS for information on converter clutch system used in THM 4L60 transmission.

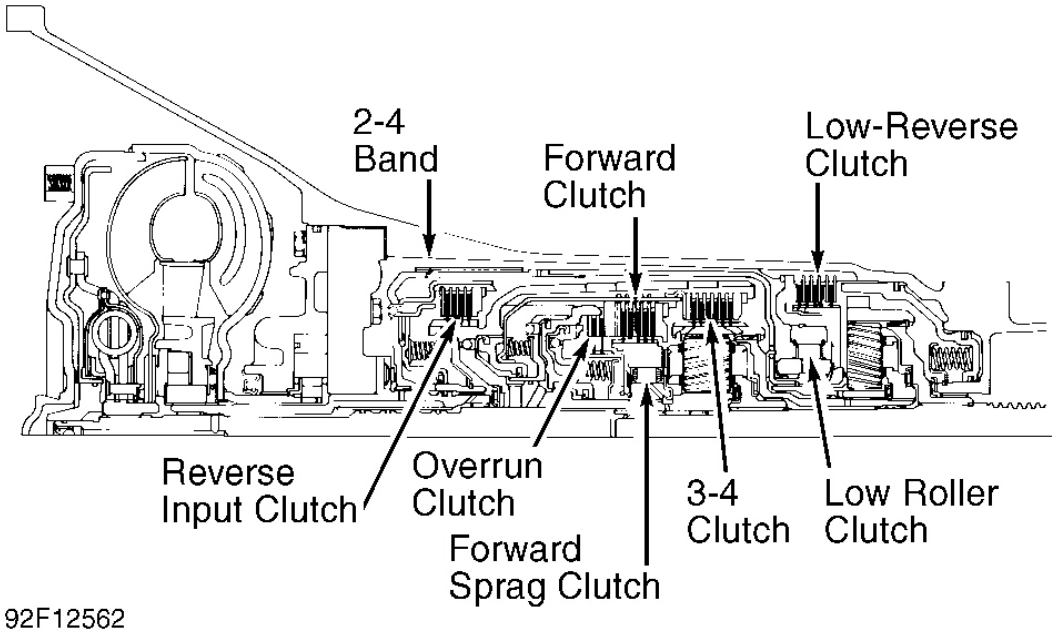


Fig. 2: Cut-Away View of 4L60 Transmission
Courtesy of GENERAL MOTORS CORP.

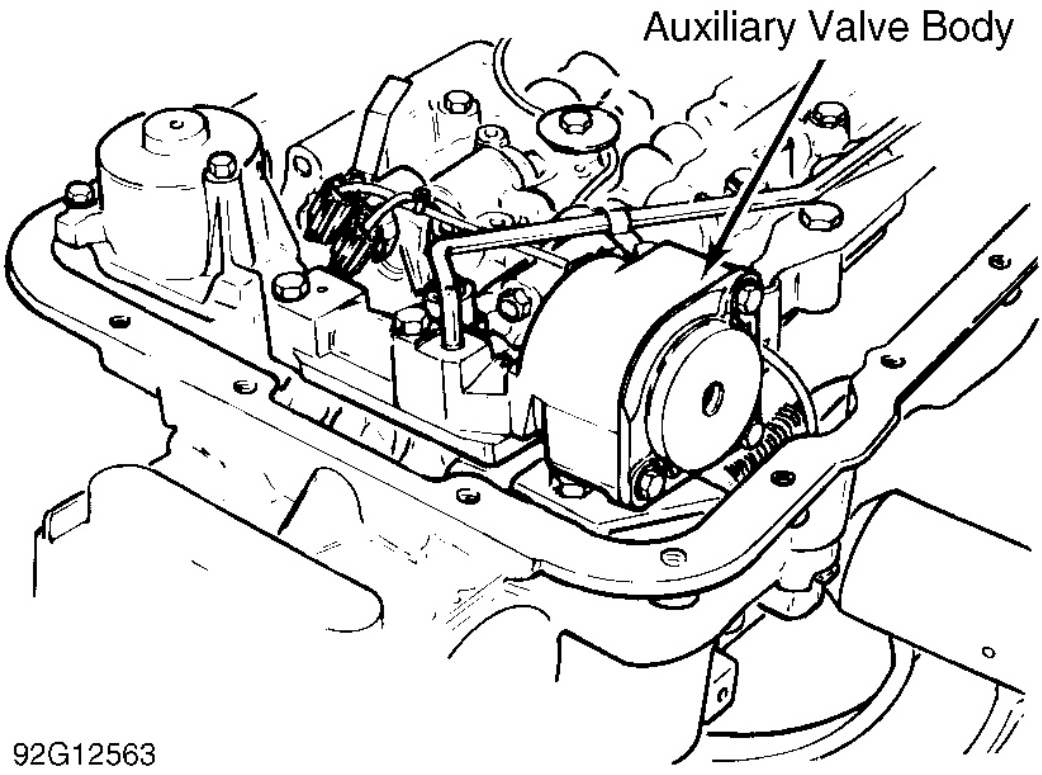


Fig. 3: Locating Auxiliary Valve Body
Courtesy of GENERAL MOTORS CORP.

LUBRICATION & ADJUSTMENTS

See appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section.

ON-VEHICLE SERVICE

THROTTLE VALVE CABLE

Removal

Remove air cleaner. Disconnect throttle valve cable from throttle linkage. Compress locking tabs. Remove cable from mounting bracket. Raise and support vehicle. Remove cable retaining bolt from transmission. Disconnect cable from transmission. Remove seal.

Installation

To install, reverse removal procedure. Install NEW seal. Once cable is fully installed, pull upper end of cable.

Slight resistance should be felt due to return spring. Ensure cable fully returns. Adjust cable. See appropriate TRANSMISSION SERVICING - A/T article in the TRANSMISSION SERVICING section.

GOVERNOR ASSEMBLY

Removal

Raise and support vehicle. On some models, exhaust system components may require removal and transmission may require lowering to access governor cover. Remove governor cover and "O" ring. Remove governor assembly.

Inspection

Inspect governor valve and sleeve for binding and scoring. See **Fig. 4** . Ensure weights operate freely. Inspect governor drive gear for damage and loose fit on shaft. Replace governor if necessary.

Installation

To install, reverse removal procedure. Install NEW cover seal or gasket. Apply thin coat of Loctite sealant on cover before installation. Ensure cover is fully seated. Ensure fluid level is correct.

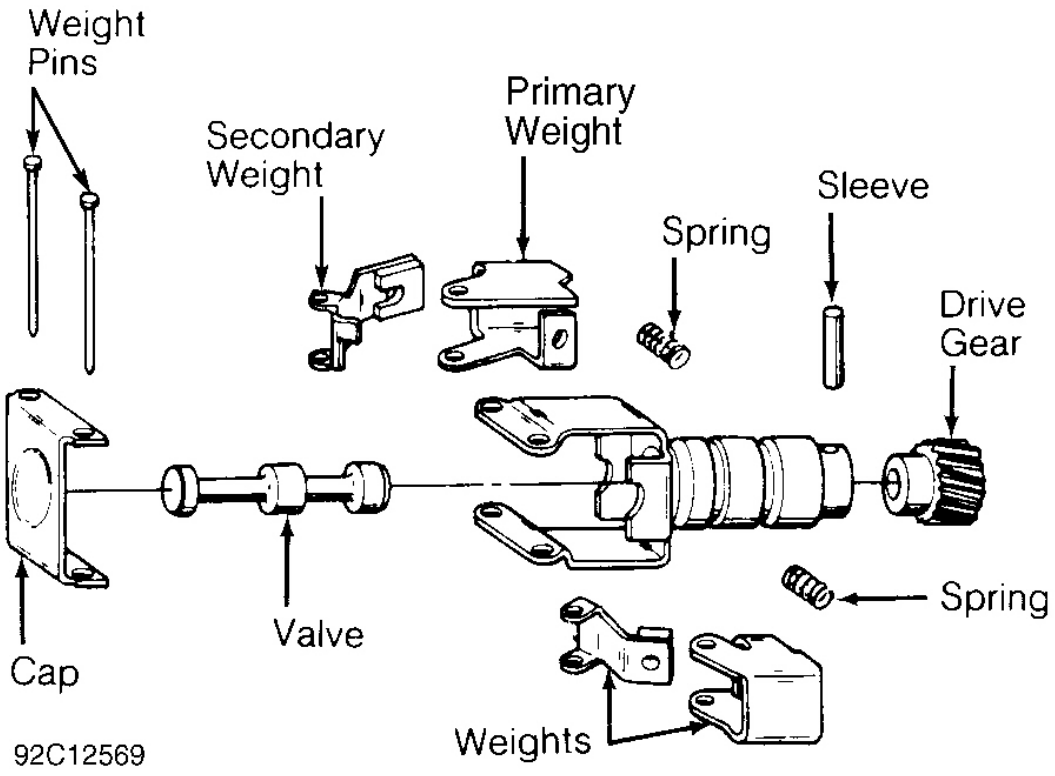


Fig. 4: Exploded View of Governor Assembly

Courtesy of GENERAL MOTORS CORP.

2-4 SERVO ASSEMBLY

Removal & Installation

1. Raise and support vehicle. On some models, exhaust system, drive shaft and crossmember may require removal and transmission may require lowering to access servo assembly. Install piston compressor (J-29714) on 2 oil pan bolts.
2. Compress servo cover, and remove retaining ring. See **Fig. 31** . Remove servo cover and "O" ring. Remove 2-4 servo assembly. To install, reverse removal procedure. For servo pin length check, see **2-4 SERVO ASSEMBLY** under TRANSMISSION DISASSEMBLY.

REAR OIL SEAL

Removal

Raise and support vehicle. On some models, exhaust system may require removal to access rear oil seal. Remove drive shaft. Pry oil seal from extension housing.

Installation

Coat NEW oil seal O.D. with non-hardening sealer. Using Seal Installer (J-21426), install oil seal into housing. To complete installation, reverse removal procedure. Check fluid level.

AUXILIARY VALVE BODY

Removal

Raise and support vehicle. Remove transmission oil pan. Remove oil filter and "O" ring. Ensure "O" ring is removed from transmission case. Remove clamp and pressure tube. Remove auxiliary valve body retaining bolts. Remove auxiliary valve body and check ball. See **Fig. 5** . Note location of check ball.

Installation

Coat check ball with petroleum jelly before installation. Install check ball in auxiliary valve body. To complete installation, reverse removal procedure. Lubricate "O" ring with petroleum jelly. Install new filter and "O" ring. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** table. Fill transmission with fluid.

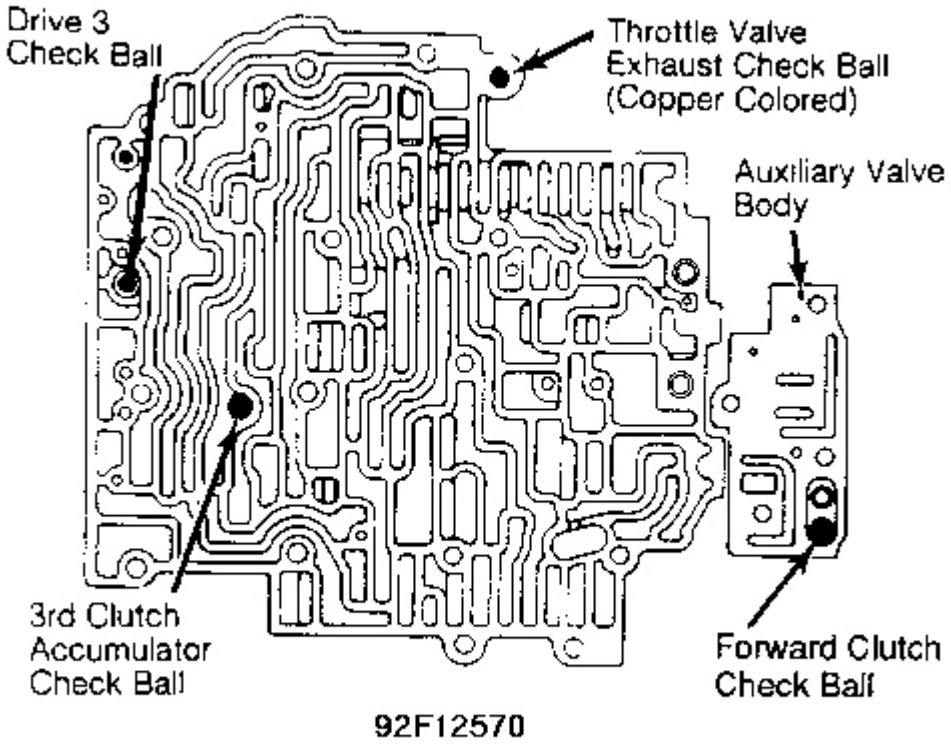


Fig. 5: Locating Valve Body Check Balls
Courtesy of GENERAL MOTORS CORP.

VALVE BODY

CAUTION: Note valve body bolt length and location during removal procedure. Transmission case damage may occur if bolts are incorrectly installed.

Removal

1. Disconnect throttle valve cable from throttle lever. Raise and support vehicle, and remove transmission oil pan. Remove oil filter and "O" ring. Ensure "O" ring is removed from transmission case.
2. Remove electrical connectors from switches (if required), and tag. Remove auxiliary valve tube to access valve body. Remove valve body bolts. Note length and location of bolts for installation.
3. Note direction of manual valve link. Remove manual valve link from manual valve at valve body. See **Fig. 6** . Note direction of throttle valve link. See **Fig. 7** . Remove throttle valve bracket and throttle valve link. Remove valve body. Note location of check balls. **DO NOT** lose balls. See **Fig. 5** .

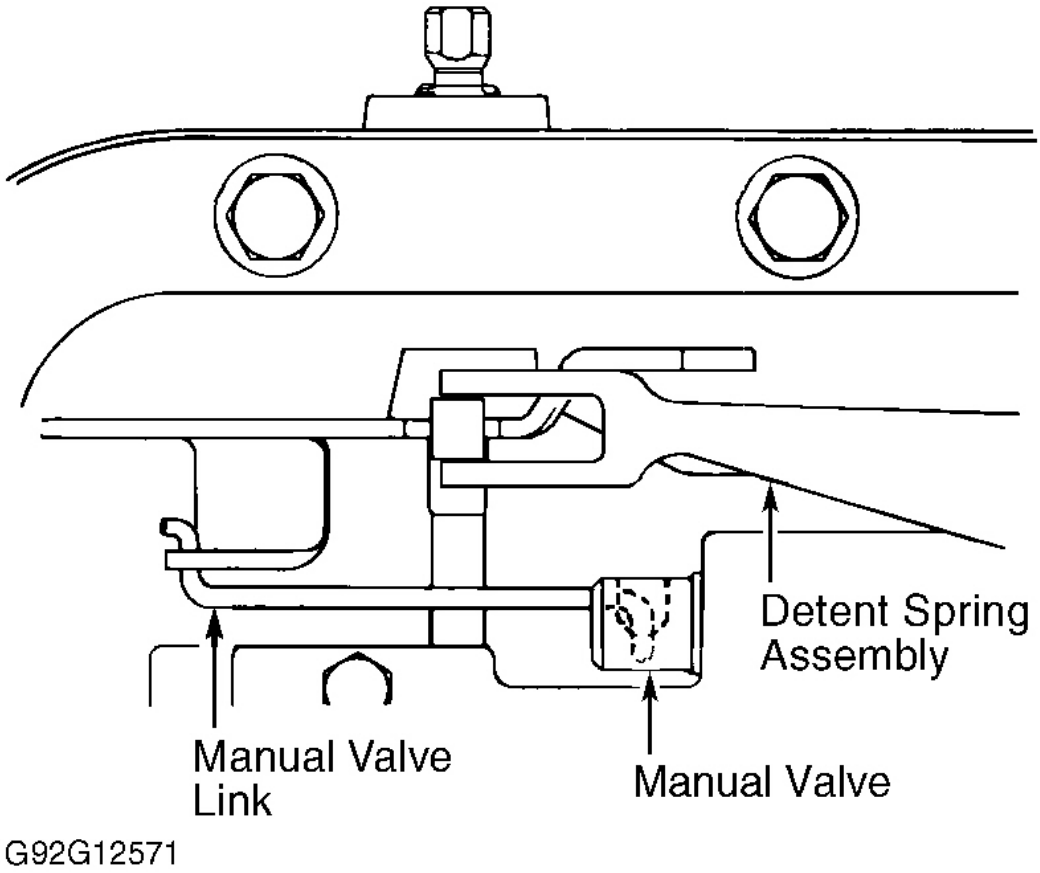


Fig. 6: Installing Manual Valve Link
Courtesy of GENERAL MOTORS CORP.

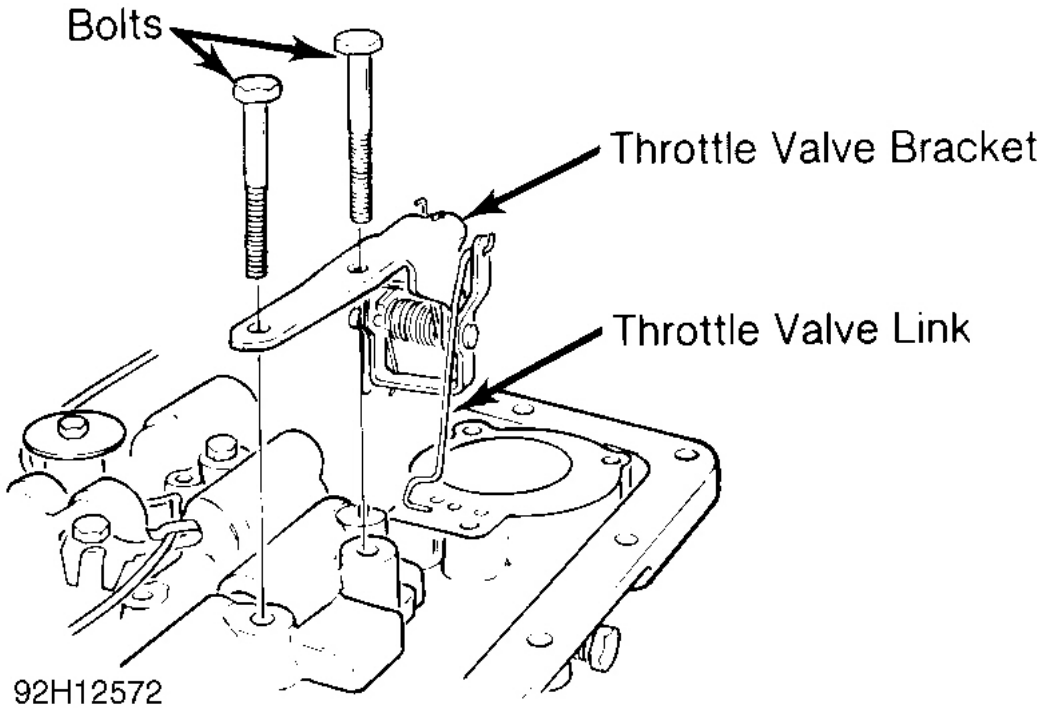


Fig. 7: Installing Throttle Valve Link
Courtesy of GENERAL MOTORS CORP.

Installation

1. Coat check balls with petroleum jelly. Install check balls in proper locations on separator plate. See **Fig. 5** . Install manual valve link. Ensure manual valve link is properly seated in manual valve. See **Fig. 6** . Improper positioning may prevent vehicle operation in "D" range.

   NOTE: Improper positioning of throttle valve link will result in erratic shift points or high main line oil pressure.

2. Install throttle link. Ensure link is properly positioned with lower hook facing outside of transmission case. See **Fig. 7** . Install valve body and retaining bolts. Tighten bolts to specification. To complete installation, reverse removal procedure.
3. Lubricate oil filter "O" ring with ATF before installation. Tighten all bolts to specification. See **TORQUE SPECIFICATIONS** . Fill transmission with fluid.

TROUBLE SHOOTING

NOTE: For additional trouble shooting, see SERVICE BULLETINS . For clutch and band

application, see CLUTCH & BAND APPLICATION CHART under CLUTCH & BAND APPLICATION.

1ST GEAR ONLY, NO UPSHIFT

Check governor assembly. Governor valve sticking. Driven gear loose or damaged. Drive gear retaining pin missing. Nicks or burrs on output shaft, governor sleeve or case bore. Improper support pin length. Governor weights or springs missing, damaged or binding.

1-2 shift valve sticking in valve body. Spacer plate or gaskets damaged or not positioned properly. Case-to-valve body face damaged or not flat. Governor screen restricted or damaged. 2-4 servo assembly restricted or blocked case passages. Nicks or burrs on servo pin or case pin bore. Missing or damaged piston or pin seals. 4th servo piston installed backward. 2-4 band worn or damaged or band anchor pin not engaged.

SLIPS IN 1ST

Defective forward clutch assembly. Clutch plates worn. Piston porous or damaged. Piston seals missing or damaged. Input housing-to-forward clutch housing "O" ring seal missing or damaged. Damaged housing. Housing retainer and ball assembly damaged or not seating. Input housing and shaft assembly turbine shaft seals missing or damaged. Accumulator valve stuck in valve body.

Valve body face not flat, damaged lands, or interconnected passages. Spacer plate or gaskets incorrect, damaged or not positioned properly. Binding or broken T.V. cable. Defective 1-2 accumulator piston assembly. Porosity in piston or cover and pin assembly. Damaged piston ring grooves. Piston seal missing or damaged. Cover gasket missing or damaged. Broken accumulator spring.

Improper oil pressure. Torque converter stator roller clutch not holding or 4th servo piston in backward. Damage to low roller clutch lugs or inner ramps. Rollers not free moving, inadequate spring tension or damage to inner splines. Oil passage plugged. Forward clutch accumulator piston seal missing or damaged. Piston out of its bore. Porosity in piston or auxiliary valve body. Abuse valve stuck in auxiliary valve body.

HIGH OR LOW 1-2 SHIFT SPEEDS

T.V. cable binding, broken or improperly adjusted. Governor assembly valve sticking. Driven gear loose or damaged. Drive gear retaining pin missing. Nicks or burrs on output shaft, governor sleeve or case bore. Improper support pin length. Governor weights or springs missing, damaged or binding.

Throttle lever and bracket assembly damaged, binding or not installed properly. T.V. link missing, binding or damaged. Valve body face not flat, T.V. exhaust check ball stuck or T.V. plunger sticking. Oil pump assembly or case face not flat.

SLIPPING OR ROUGH 1-2 SHIFT

Throttle lever and bracket assembly damaged, not installed properly or T.V. cable broken or binding. Valve body assembly throttle valve sticking. T.V. bushing turned in bore. Defective valve body assembly. 1-2 shift valve train, line bias valve, accumulator valve or T.V. limit valve stuck. Gaskets or spacer plate incorrect, damaged or not installed properly. Body face not flat.

Defective 2-4 servo assembly. Apply pin incorrect length. Servo seals or "O" ring seals missing or damaged. Restricted or missing oil passages. Case servo bore damaged. Defective 2nd accumulator. Porosity in 1-2 accumulator housing or piston. Piston seal or groove damaged. Nicks or burrs in 1-2 accumulator housing. Missing or restricted oil passages or 2-4 band worn or not positioned properly. Oil pump assembly or case faces not flat.

SLIPPING, ROUGH OR NO 2-3 SHIFT

Internal converter damage. Governor valve sticking. Drive gear retaining pin missing or loose. Governor weights binding. Governor drive gear damaged. Support pin in case incorrect length. Oil pump stator shaft sleeve scored or not located properly. Valve body 2-3 valve train or accumulator valve stuck. Spacer plate or gaskets incorrect, damaged or not positioned properly. Throttle valve or T.V. limit valve stuck. Input housing assembly forward or 3-4 clutch plates worn. Excessive clutch plate travel.

Forward or 3-4 piston seals damaged. Porosity in 3-4 clutch housing or piston, or 3-4 piston check ball stuck, damaged or not sealing. Restricted apply passages. Forward clutch piston or 3rd accumulator retainer and ball assembly not seating. Sealing balls loose or missing. 2-4 servo assembly or 2nd apply piston seals missing or damaged.

SLIPPING, ROUGH OR NO 3-4 SHIFT

Governor weights binding. Governor valve sticking. Drive gear damaged or retaining pin missing or loose. Support pin in case incorrect length. Oil pump assembly faces not flat or pump cover retainer and ball assembly omitted or damaged. Valve body assembly 2-3 valve train, accumulator valve, throttle valve, T.V. limit valve, 1-2 shift valve or 3-2 control valve stuck. Manual valve link bent or damaged. Spacer plate or gaskets incorrect, damaged or not positioned properly. Defective 2-4 servo assembly.

Incorrect band apply pin. Servo seals missing or damaged. Porosity in pistons, cover or case. Plugged or missing orifice cup plug. Case 3rd accumulator retainer and ball assembly leaking. Porosity in 3-4 accumulator piston or bore. 3-4 accumulator piston seal or seal grooves damaged. Restricted oil passage. Defective input housing assembly. Forward or 3-4 clutch plates worn, or excessive plate travel.

Forward or 3-4 piston seals damaged. Porosity in 3-4 clutch housing or piston. 3-4 piston check ball stuck, damaged or not sealing. Restricted apply passages. Forward clutch piston retainer and ball assembly not seating. 2-4 band worn or not positioned properly. Sealing balls loose or missing.

NO "R" OR SLIPS IN "R"

Defective input housing assembly. 3-4 apply ring stuck in applied position. Forward clutch not releasing. Turbine shaft seals missing or damaged. Manual valve link disconnected. Defective oil pump assembly. Retainer and ball assembly missing or damaged. Stator shaft seal rings or ring grooves damaged. Stator shaft sleeve scored or damaged. Reverse boost valve stuck, damaged or not assembled properly. Cup plug missing.

Restricted oil passage. Faces not flat. Converter clutch apply valve stuck. Defective valve body assembly. 2-3 shift valve stuck. Manual linkage out of adjustment. Spacer plate and gaskets incorrect, damaged or not positioned properly. Defective reverse input clutch assembly. Clutch plate worn. Housing and drum assembly cracked at weld. Clutch plate or return spring assembly retaining ring out of groove. Piston deformed or dished.

Seals damaged or missing. Retainer and ball assembly not sealing. Restricted apply passage. Defective low-reverse clutch. Clutch plates worn or retaining ring not positioned properly. Porosity in piston. Seals damaged. Return spring assembly retaining ring not positioned properly. Case porosity. Case cover plate not tightened properly or gasket missing or damaged. Auxiliary valve body low overrun valve stuck. Cup plug restricted, missing or damaged.

NO PART THROTTLE OR DELAYED DOWNSHIFTS

T.V. cable loose or not adjusted properly. T. V. bracket assembly bent. Defective 2-4 servo assembly. Servo cover retaining ring missing or not assembled properly. 4th apply piston damaged or not assembled properly. Inner housing damaged or not assembled properly. Governor weights binding or governor valve stuck. Defective valve body assembly. Throttle valve, 3-2 control valve or T.V. modulated downshift valve stuck. T.V. sleeve turned in bore. 4-3 sequence valve body channel blocked. No. 5 check ball missing.

NO OVERRUN BRAKING IN MANUAL 3-2-1

T.V. cable loose or not adjusted properly. Defective valve body assembly. 4-3 sequence valve or throttle valve stuck. No. 3 check ball not positioned properly. Spacer plate and gaskets incorrect, damaged or not positioned properly. Defective input clutch assembly. Turbine shaft oil passages plugged or not drilled. Turbine shaft seal rings damaged. Turbine shaft sealing balls loose or missing. Porosity in forward or overrun clutch piston. Overrun piston seals damaged or cut. Overrun piston check ball not sealing.

DRIVES (CREEPS) IN NEUTRAL

Forward clutch not releasing. Manual valve link disconnected. Converter clutch apply valve stuck in oil pump. Face of transmission case not flat or internal leakage in case.

STARTS IN 2ND IN "D"

Governor support pin too long or missing or governor valve stuck. Forward sprag clutch assembly installed backward.

NO PARK

Parking linkage binding, loose, missing or not positioned properly.

OIL PRESSURE HIGH OR LOW

Perform PRELIMINARY CHECKING PROCEDURE. See **CONTROL PRESSURE TEST** under TESTING. Oil pressure regulator valve stuck or valve spring damaged. Rotor guide omitted or not assembled properly. Rotor cracked or broken. T.V. or reverse boost valve or sleeve stuck, damaged or not assembled properly. Orifice valve in pressure regulator valve plugged. Sticking slide or excessive rotor clearance. Pressure relief ball not seated or damaged. Pump cover or body has porosity. Incorrect pump cover or pump face not flat. Excessive rotor clearance.

Intake pipe restricted by casting flash. Cracks in filter body or intake pipe. "O" ring seal missing, cut or damaged. Incorrect grease used during rebuild procedure. T.V. exhaust ball stuck or damaged. Throttle link, lever and bracket assembly binding, damaged or not assembled properly.

Manual valve scored or damaged. Spacer plate or gaskets incorrect, damaged or not assembled properly. Face not flat. Throttle valve or T.V. limit valve sticking. Modulated downshift valve, line bias valve or 2-3 shift valve stuck. Check balls omitted or not assembled properly. Case-to-valve body face not flat.

HIGH OR LOW SHIFT POINTS

T.V. cable binding or not adjusted properly. T.V. exhaust ball stuck or damaged. Throttle lever and bracket assembly binding, damaged or not assembled properly. Pressure regulator valve or T.V. boost valve stuck. Pump slide sticking.

Throttle valve or plunger sticking. Modulated T.V. upshift or downshift valves, T.V. limit valve or line bias valve sticking. Spacer plate or gaskets damaged, incorrect or not assembled properly.

Valve body pad porous or damaged. Governor filter restricted or damaged. 2-4 accumulator has porosity. Servo piston seals damaged. Apply pin damaged or has improper length. 2-4 band burned or anchor pin not engaged.

NO CONVERTER CLUTCH APPLY

Transmission not supplied 12 volts. Outside electrical connector damaged. Inside electrical connector wiring harness or solenoid damaged. Solenoid wire pinched. Solenoid not grounded. Pressure switches incorrect or damaged. Temperature switch damaged. Converter internal damage.

Converter clutch valve stuck or assembled backward, or retaining ring not positioned properly. Pump-to-case gasket not positioned properly. Orifice cup plug restricted or damaged. Solenoid "O" ring seal cut or damaged. Pump-to-body cover high or uneven bolt torque.Turbine shaft "O" ring seal cut or damaged. Turbine shaft retainer and ball assembly restricted or damaged. TCC shift valve or apply valve stuck. Solenoid "O" ring leaking. Solenoid screen is blocked.

CONVERTER SHUDDER

Torque converter has internal damage. Converter clutch valve stuck. Restricted oil passages. Crack in filter body. Flash restricting filter neck. "O" ring seal cut or damaged.Turbine shaft "O" ring cut or damaged. Turbine shaft retainer and ball assembly restricted or damaged. Low oil pressure. Engine not tuned properly.

NO CONVERTER CLUTCH RELEASE

Solenoid external ground. Converter internal damage. Converter clutch valve stuck. Converter clutch apply valve stuck in apply position. ECM external ground.

RATCHETING NOISE

Parking pawl return spring weak, damaged or not assembled properly.

OIL LEAKING OUT VENT

Chamfer in pump body rotor pocket too large. T.V. limit valve stuck. Fluid level overfilled. Cross leak out of pump body and cover.

VIBRATION IN REVERSE & WHINING NOISE IN PARK

Oil pump broken vane rings.

FRONT OIL LEAK

Torque converter welded seam leaking. Damaged torque converter hub. Damaged front seal.

NO REVERSE, SLIPS IN REVERSE, BAD ENGAGEMENT (NO BRAKING OR WEAK BRAKING IN MANUAL LOW)

No. 5 check ball missing. Faulty low-reverse clutch. Reverse boost valve sticking. Reverse boost valve installed backward.

PUMP BUSHING SPINS OUT, "WALKS" INTO SEAL, OR SEIZES TO CONVERTER HUB

Transmission and engine center lines do not match. Excessive crankshaft runout (common on 6.2L). Bent flexplate (drive plate). Excessive converter hub runout. Pump bushing I.D. not centered in pump. Bushing too loose in pump. Not enough hub-to-bushing clearance.

SLIP ON 2-3 SHIFT, FALLING OUT OF 3RD, REPEATED 3-4 CLUTCH OR 2-4 BAND FAILURE

Leaking No. 7 check ball (direct clutch accumulator check valve located in case, visible through servo). Cracked input shaft. Input shaft sealing rings leaking. Leak at base of input shaft where shaft is pressed into drum. Pump cover bore (sealing ring surface) worn. Servo air bleed cup plug loose or blown out of case. Pump-to-case gasket misaligned or ripped. 3-4 air bleed ball in back of input drum leaking. 3-4 clutch piston seals leaking. Servo release side (large) sealing ring leaking in 2nd gear and dragging 3rd clutch. Band apply pin in case worn. Servo seized in case. Damaged pump. Stator sleeve turned in pump and partly blocking feed passage. Throttle valve sticking, causing delayed 3rd clutch circuit pressure rise during 2-3 shift.

DELAYED OR NO FORWARD CLUTCH ENGAGEMENT, SLIPS OR CHATTERS IN 1ST GEAR

Leak at forward clutch accumulator (auxiliary valve body) caused by accumulator pin "walking" out of oval hole in cover.

NO 4TH GEAR, NO 3-4 UPSHIFT (STAYS IN 3RD, 2ND USUALLY OKAY)

Leaking 4th gear piston sealing ring (inside servo cover). Excessive servo clearance allowing 4th piston to "walk" out of cover, leaking 4th apply oil out servo vent hole. Servo vent hole blocked (hole is at pan gasket surface). Leaking 4th signal switch. 3-4 relay valve installed backward. Aluminum disc missing from between 3-4 relay valve and hole pin. Servo feed tunnel cup missing from valve body. 3-4 shift valve stuck. Incorrect spring or spring too stiff at 3-4 shift valve. 3-4 accumulator air bleed cup plug blown out of case. Throttle valve sticks.

FALLS OUT OF 4TH GEAR DURING COASTING

Low line pressure at idle (weak pressure regulator spring).

BINDS UP ON 3-4 SHIFT (FEELS LIKE BRAKE DRAG)

Forward pressure plate installed incorrectly. Too many plates in overrun clutch. Incorrect top steel plate installed in overrun clutch.

NO FORWARD OR REVERSE GEARS (LINE PRESSURE READING OKAY)

Mismatched converter input shaft or broken turbine hub.

BINDS UP IN REVERSE

Stator sleeve rotated out of position. Stuck 2-3 shift valve. Servo pin jammed in case. Stuck 3-4 relay or 4-3 sequence valve.

NO REVERSE

Reverse input drum cracked at weld or seals damaged.

NO DRIVE IN DRIVE RANGE

Torque converter stator roller clutch not holding.

NO DRIVE IN OVERDRIVE RANGE

Faulty output sprag. Teeth "hammered" out of forward friction plates.

CLUTCH & BAND APPLICATION

CLUTCH & BAND APPLICATION CHART

Selector Lever Position	Elements In Use
"D" (Overdrive)	
First Gear	Forward Clutch, Forward Sprag & Low Roller Clutch
Second Gear	Forward Clutch, Forward Sprag & 2-4 Band
Third Gear	Forward Clutch, Forward Sprag & 3-4 Clutch
Overdrive	Forward Clutch, 2-4 Band & 3-4 Clutch
"D" (Drive)	
First Gear	Forward Clutch, Forward Sprag, Low Roller Clutch & Overrun Clutch
Second Gear	Forward Clutch, Forward Sprag, Overrun Clutch & 2-4 Band

Third Gear	Forward Clutch, Forward Sprag, Overrun Clutch & 3-4 Clutch
"2" (Intermediate)	
First Gear	Forward Clutch, Forward Sprag, Low Roller Clutch & Overrun Clutch
Second Gear	Forward Clutch, Forward Sprag, Overrun Clutch & 2-4 Band
"1" (Low)	
First Gear	Forward Clutch, Forward Sprag, Low Reverse Clutch, Low Roller Clutch & Overrun Clutch
"R" (Reverse)	Low Reverse Clutch & Reverse Input Clutch
"N" Or "P" (Neutral Or Park)	All Clutches & Bands Released Or Ineffective

TESTING

ROAD TEST

1. Operate vehicle in Overdrive. Accelerate using steady throttle pressure. Note shift points for 2nd, 3rd, Overdrive and TCC application. TCC application should occur in 3rd or Overdrive.
2. Torque converter clutch will not engage until engine coolant has reached a temperature of 130°F (54°C). Compare shift points to shift speed charts. See SHIFT SPEED CHARTS. If TCC application is not obtained, see **AUTO TRANS DIAGNOSIS - GM TORQUE CONVERTER CLUTCH** article in the AUTOMATIC TRANSMISSIONS section.
3. Operate vehicle in Overdrive normally at 40-55 MPH with throttle in half-open position. Ensure TCC releases, and note 3rd gear downshift point. Repeat procedure with wide open throttle. Ensure TCC releases, and note 2nd gear downshift point.
4. Operate vehicle in Overdrive normally at 40-55 MPH. Release accelerator while manually shifting transmission to 3rd gear. Ensure TCC releases and engine braking is felt, and note 3rd gear downshift point.
5. Operate vehicle in Overdrive normally at 40-45 MPH. Release accelerator while manually shifting transmission into 2nd gear. Ensure TCC releases and engine braking is felt, and note 2nd gear downshift point.
6. With transmission in Overdrive, accelerate normally to 25 MPH, allowing vehicle to upshift normally. Release accelerator while manually shifting transmission into 1st gear. Ensure TCC releases and engine braking is felt, and note 1st gear downshift point.
7. With transmission in Overdrive, accelerate to 4th gear with TCC applied. Release accelerator. Lightly apply brakes, and ensure TCC releases and note speed at which downshifts occur. Compare shift points noted to shift speed charts. See **SHIFT SPEED CHARTS** .

8. Place transmission in 3rd gear with vehicle stopped. Accelerate, and note 1st-2nd and 2nd-3rd shift points. Repeat procedure with transmission in 2nd gear. Note 1st-2nd shift point. Accelerate to 25 MPH. Ensure 2nd-3rd gear upshift does not occur and TCC does not engage.
9. Place transmission in 1st gear with vehicle stopped. Accelerate to 15 MPH. Ensure upshifts do not occur and TCC does not engage. With vehicle stopped, place transmission in Reverse and slowly accelerate to observe reverse gear operation.
10. Compare all shift points to shift speed charts. See **SHIFT SPEED CHARTS** . If shift points are not within approximate speed listed, see **TROUBLE SHOOTING** . Control pressure can also be checked. See **CONTROL PRESSURE TEST** .

SHIFT SPEED CHARTS

NOTE: Shift speed charts are not available for 1983 through 1986 models.

Model	1-2 Min Throt	2-3 Min Throt	3-4 Min Throt	4-3 Part Throt	3-2 Part Throt	4-3 Coast Down	3-2 Coast Down	2-1 Coast Down
FAM	12-15	20-32	33-55 +	55 +	38-55 +	28-54	17-28	11-14
MDM	13-16	22-30	37-55 +	55 +	42-55 +	32-55	19-27	12-14
MHM	9-11	17-24	28-47	55 +	27-45	25-44	14-22	8-10
MPM	11-14	19-26	33-51	55 +	37-55	28-49	16-24	10-13
NTM	13-19	23-38	46-55 +	55 +	44-55 +	38-55 +	19-31	12-17
PAM	9-11	17-24	28-47	55 +	27-45	25-44	14-22	8-10
TAM	9-11	15-22	23-51	55 +	27-51	20-47	11-20	8-10
TSM	8-10	16-22	25-53	55 +	26-55	23-48	13-20	7-9
YMM	9-10	13-19	24-44	55 +	22-52	18-38	10-16	8-9
YTM	12-14	19-25	36-55	55 +	38-55 +	31-53	15-23	11-13
YWM	8-9	12-17	24-44	55 +	23-53	19-39	9-14	7-9
YXM	10-12	16-27	35-52	55 +	36-54	30-49	13-23	9-11
YZM	11-13	13-24	34-46	55 +	10-20	30-44	10-20	13-24
YLM	10-12	16-23	32-37	55 +	31-47	28-45	12-19	16-23
YKM	10-12	19-25	31-48	55 +	31-52	27-45	15-23	19-25
YFM	11-14	18-25	31-54	55 +	28-51	26-51	15-23	10-13
YCM	11-12	15-22	32-55 +	55 +	30-55 +	24-51	12-18	9-11
YAM	9-10	13-18	27-48	55 +	25-55 +	21-43	10-16	8-9
YPM	11-13	19-26	28-43	55 +	35-55	25-41	16-24	10-12

NOTES:
1. ALL SPEEDS INDICATED ARE IN MILES PER HOUR.
2. SHIFT POINTS WILL VARY SLIGHTLY DUE TO ENGINE LOADS AND VEHICLE OPTIONS.
3. SPEEDS LISTED WITH + EXCEED 55 MPH.

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Fig. 8: Shift Speed Chart (1987 Models Except Corvette)
Courtesy of GENERAL MOTORS CORP.

MODEL	1-2 MIN THROTTLE	2-3 MIN THROTTLE	3-4 MIN THROTTLE	4-3 PART THROTTLE	3-2 PART THROTTLE	4-3 COAST DOWN	3-2 COAST DOWN	2-1 COAST DOWN
FAM, MAM, MFM, MMM, MRM, MXM	12-15	13-24	33-55 +	55 +	38-55 +	28-54	17-28	11-14
MCM, MTM, PRM	9-13	16-27	32-55	55 +	31-48	27-53	14-22	8-12
MDM, MKM, MUM, TJM, TKM	13-16	22-30	37-55 +	55 +	42-55 +	32-55	19-27	12-14
MHM, PAM, PBM, PCM, TNM, TRM	9-11	17-24	28-47	55 +	27-45	25-44	14-22	8-10
MPM, MWM, MZM, TUM, TXM	11-14	19-26	33-51	55 +	37-55	28-49	16-24	10-13
TAM, TBM	9-11	15-22	23-51	52-55 +	27-51	20-47	11-20	8-10
TSM	8-10	16-22	32-47	55 +	26-55	26-43	13-20	7-9
YAM	9-10	13-18	27-48	55 +	25-55 +	21-43	10-16	8-9
YCM, YDM	11-12	15-22	32-55 +	55 +	30-55 +	24-51	12-18	9-11
YFM	11-14	18-25	31-54	55 +	28-51	26-51	15-23	10-13
YKM	10-12	19-25	31-48	55 +	31-52	27-45	15-23	9-11
YLM	10-12	16-23	32-47	55 +	31-47	28-45	12-19	9-11
YMM	9-10	13-19	24-44	55 +	22-52	18-38	10-16	8-9
YPM	11-13	19-26	28-43	55 +	35-55	25-41	16-24	10-12
YSM	10-12	15-22	31-55	55 +	29-55 +	24-50	12-18	9-11
YTM	12-14	19-25	36-55	55 +	38-55 +	31-53	15-23	11-13
YWM	8-9	12-17	24-44	55 +	23-53	19-39	9-14	7-9
YXM	10-12	16-27	35-52	55 +	36-54	30-49	13-23	9-11
YZM	11-13	13-24	34-46	55 +	36-53	30-44	10-20	10-12

NOTES:
1. ALL SPEEDS INDICATED ARE IN MILES PER HOUR.
2. SHIFT POINTS WILL VARY SLIGHTLY DUE TO ENGINE LOADS AND VEHICLE OPTIONS.
3. SPEEDS LISTED WITH + EXCEED 55 MPH.

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Fig. 9: Shift Speed Chart (1987 Corvette)
Courtesy of GENERAL MOTORS CORP.

MODEL	1-2 MIN THROTTLE	2-3 MIN THROTTLE	3-4 MIN THROTTLE	1-2 W.O.T.	3-2 PART THROTTLE	4-3 COAST DOWN	3-2 COAST DOWN	2-1 COAST DOWN
FAM, FMM, MAM	12-15	19-26	41-51	31-43	37-55+	37-48	15-24	11-14
MFM, MRM, MXM	12-15	20-38	41-51	32-44	38-55+	37-48	17-28	11-14
MCM, MTM, PRM	10-13	14-22	40-49	24-37	26-46	37-47	10-18	9-12
MDM, MKM, MLM, TJM, TKM	13-15	22-30	43-54	33-46	42-55+	39-50	19-27	12-14
MPM, MWM, MZM, TUM, TXM	11-13	19-26	38-47	29-41	37-55	34-45	16-24	10-13
MHM, PAM, PBM, PCM, TNM	9-11	17-24	34-43	25-34	27-45	29-40	14-22	8-10
TAM, TBM	9-11	15-22	35-42	30-44	27-50	30-38	11-20	8-10
THM, TLM	12-14	20-27	48-55+	30-42	38-55+	44-54	17-24	11-13
YNM	10-11	17-23	37-54	28-46	29-55+	30-49	13-21	8-10
YKM	10-12	19-25	35-45	32-46	31-52	30-42	15-23	9-11
YTM	11-13	17-23	41-52	29-43	34-55	36-48	13-20	9-11
YPM	11-13	19-26	36-42	31-44	35-55	32-39	16-24	10-12
YXM	10-12	16-27	40-48	31-42	35-53	36-45	13-23	9-11
YZM	11-13	13-24	39-43	36-46	36-53	35-40	10-20	10-12
YWM	8-9	12-17	32-39	23-41	23-53	23-34	9-14	7-9
YDM	10-12	15-22	41-51	30-53	30-55+	30-44	12-18	9-11
YMM	9-10	13-19	32-39	23-41	23-52	21-33	10-16	7-9

NOTES:
1. ALL SPEEDS INDICATED ARE IN MILES PER HOUR. CONVERSION TO KPH = MPH x 1.609.
2. SHIFT POINTS WILL VARY SLIGHTLY.DUE TO ENGINE LOADS AND VEHICLE OPTIONS.
3. SPEEDS LISTED WITH + EXCEED 55 MPH.

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Fig. 10: Shift Speed Chart (1988 Car Models)
Courtesy of GENERAL MOTORS CORP.

MODEL	1-2 MIN THROTTLE	2-3 MIN THROTTLE	3-4 MIN THROTTLE	1-2 W.O.T.	3-2 PART THROTTLE	4-3 COAST DOWN	3-2 COAST DOWN	2-1 COAST DOWN
FAM, FMM, MAM	12-15	19-26	41-51	31-43	37-55+	37-48	15-24	11-14
MFM, MRM, MXM	12-15	20-38	41-51	32-44	38-55+	37-48	17-28	11-14
MCM, MTM, PRM	10-13	14-22	40-49	24-37	26-46	37-47	10-18	9-12
MDM, MKM, MLM, TJM, TKM	13-15	22-30	43-54	33-46	42-55+	39-50	19-27	12-14
MPM, MWM, MZM, TUM, TXM	11-13	19-26	38-47	29-41	37-55	34-45	16-24	10-13
MHM, PAM, PBM, PCM, TNM	9-11	17-24	34-43	25-34	27-45	29-40	14-22	8-10
TAM, TBM	9-11	15-22	35-42	30-44	27-50	30-38	11-20	8-10
THM, TLM	12-14	20-27	48-55+	30-42	38-55+	44-54	17-24	11-13
YNM	10-11	17-23	37-54	28-46	29-55+	30-49	13-21	8-10
YKM	10-12	19-25	35-45	32-46	31-52	30-42	15-23	9-11
YSM	10-12	15-22	40-50	29-52	29-55+	29-43	12-18	9-11
YTM	11-13	17-23	41-52	29-43	34-55	36-48	13-20	9-11
YPM	11-13	19-26	36-42	31-44	35-55	32-39	16-24	10-12
YXM	10-12	16-27	40-48	31-42	35-53	36-45	13-23	9-11
YZM	11-13	13-24	39-43	36-46	36-53	35-40	10-20	10-12
YWM	8-9	12-17	32-39	23-41	23-53	23-34	9-14	7-9
YDM	10-12	15-22	41-51	30-53	30-55+	30-44	12-18	9-11
YAM	9-10	13-18	34-43	25-45	25-55+	25-37	10-16	8-9
YMM	9-10	13-19	32-39	23-41	23-52	21-33	10-16	7-9

NOTES:
1. ALL SPEEDS INDICATED ARE IN MILES PER HOUR. CONVERSION TO KPH = MPH x 1.609.
2. SHIFT POINTS WILL VARY SLIGHTLY DUE TO ENGINE LOADS AND VEHICLE OPTIONS.
3. SPEEDS LISTED WITH + EXCEED 55 MPH.

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Fig. 11: Shift Speed Chart (1988 Truck Models)
Courtesy of GENERAL MOTORS CORP.

1989 THM 4L60 SHIFT SPEED CHART

MODEL	1-2 MIN THROTTLE	2-3 MIN THROTTLE	3-4 MIN THROTTLE	1-2 W.O.T.	3-2 PART THROTTLE	4-3 COAST DOWN	3-2 COAST DOWN	2-1 COAST DOWN
FKM, FXM	10-12	17-24	29-38	25-41	27-54	25-31	14-21	9-11
FMM, MAM, MFM, MRM, MXM	12-15	19-26	41-51	31-43	37-56	37-48	15-24	11-14
HBM	11-13	18-26	34-43	27-44	35-63	27-36	15-22	10-12
HDM	11-14	19-27	31-39	29-41	35-56	28-35	16-25	10-12
MCM, PRM	10-13	14-22	40-49	24-37	26-46	37-47	10-18	9-12
MDM, MKM, MLM, TJM, TKM	13-15	19-27	42-51	33-46	37-59	37-47	14-24	12-14
MHM, PAM, PBM, PCM, TNM	9-11	17-24	34-43	25-34	26-44	29-40	14-22	8-10
MPM, MWM, MZM, TUM, TXM	11-13	18-24	38-47	29-41	35-53	34-45	15-21	10-13
THM, TLM	12-14	19-26	41-51	30-42	36-55	37-48	15-24	11-13
YDM	10-12	15-22	41-51	30-53	30-65+	30-44	12-18	9-11
YNM	11-13	20-28	33-40	31-48	33-65	29-33	17-24	10-12
YPM	11-13	17-25	36-42	28-41	33-54	31-39	13-22	10-12
YTM	11-13	17-23	41-52	29-43	36-56	36-48	13-20	9-11
YXM	10-12	16-27	40-48	31-42	36-53	36-45	13-23	9-11
YZM	11-13	13-24	39-43	36-46	36-53	34-39	10-19	10-12

NOTES:
1. ALL SPEEDS INDICATED ARE IN MILES PER HOUR. CONVERSION TO km/h = MPH x 1.609.
2. SHIFT POINTS WILL VARY SLIGHTLY DUE TO ENGINE LOADS AND VEHICLE OPTIONS.
3. SPEEDS LISTED WITH + EXCEED 65 MPH.

For transmission model identification, *see Fig. 1*.

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Fig. 12: Shift Speed Chart (1989 Models)
Courtesy of GENERAL MOTORS CORP.

1990 HYDRA-MATIC 4L60 SHIFT SPEED CHART

MODEL	1-2 MIN THROTTLE	2-3 MIN THROTTLE	3-4 MIN THROTTLE	1-2 W.O.T.	4-3 COAST DOWN	3-2 COAST DOWN	2-1 COAST DOWN
BAM	13-16	22-27	50+	29-43	36-48	13-20	9-11
BPM	14-18	26-31	40-52	31-48	29-33	17-24	10-12
CAM, CBM, KAM, MJM, MNM, WAM	14-18	24-42	49+	31-43	37-48	15-24	11-14
CCM, CFM, KBM, WBM	16-19	25-31	50+	33-46	37-47	14-24	12-14
CHM, CJM, KCM, RAM, WCM	14-17	22-28	46-53	29-41	34-45	15-21	10-13
DBM	14-18	27-31	38-51	31-43	28-33	16-24	9-12
FBM	14-18	26-33	42-53	37-51	28-35	16-24	10-12
FTM	12-15	22-25	40-49	28-41	31-39	13-22	10-12
FUM	12-15	22-25	39-47	25-41	25-31	14-21	9-11
FZM	12-16	24-31	44-52	36-46	34-39	10-19	10-12
HBM, HHM	12-16	21-25	40-48	27-44	26-35	15-22	9-12
HCM, HDM	15-18	25-28	40-48	31-45	28-34	19-29	12-15
HJM	14-17	27-31	51+	30-44	31-47	16-27	11-13
LAM, LBM, LCM, LDM, LFM	12-14	21-26	45-51	24-33	28-38	14-21	7-9
MBM, SAM	12-14	20-25	47-53	24-37	37-47	10-18	9-12
MSM	10-13	20-23	40-46	22-36	26-37	11-19	7-9
SHM, TLM	13-18	24-31	50+	30-42	37-48	19-26	11-13
YDM	13-16	21-25	39-51	39-53	22-28	13-19	9-11

Notes:
1. All Speeds Indicated Are In Miles Per Hour. Conversion To KPH = MPH x 1.609.
2. Shift Points Will Vary Slightly Due To Engine Loads And Vehicle Options.
3. Speeds Listed With + Exceed 65 MPH.

For transmission model identification, *see Fig. 1.*

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Fig. 13: Shift Speed Chart (1990 Models)
Courtesy of GENERAL MOTORS CORP.

1991 HYDRA-MATIC 4L60 SHIFT SPEED CHART

MODEL	1-2 MIN THROTTLE	2-3 MIN THROTTLE	3-4 MIN THROTTLE	1-2 W.O.T.	4-3 COAST DOWN	3-2 COAST DOWN	2-1 COAST DOWN
BBM	13-18	26-33	40-52	31-46	25-30	14-25	9-11
CAM, CBM, KAM	14-17	22-29	46-52	31-43	37-48	15-24	11-14
CCM, CFM, KBM, WBM	12-17	21-26	42-48	33-46	37-47	14-24	12-14
CHM, CJM, KCM, RAM, WCM	15-18	23-30	49+	29-41	34-45	15-21	10-13
FBM	15-17	24-30	39-45	37-51	28-35	16-24	10-12
FTM	12-15	21-26	39-48	28-41	31-39	13-22	10-12
FUM	13-15	23-25	38-46	25-41	25-31	14-21	9-11
FZM	13-17	24-32	44-52	36-46	34-39	10-19	10-12
LAM, LBM, LCM, LDM, LFM	10-13	20-24	38-43	25-34	29-40	14-22	8-10
MJM, MNM, WAM	13-17	22-29	46-52	28-39	34-44	14-22	10-12
MSM	11-13	20-23	41-46	22-36	26-37	11-19	7-9
SAM	12-14	18-24	47-53	24-37	37-47	10-18	9-12
SHM, TLM	14-17	24-31	49+	30-42	37-48	19-26	11-13

Notes:
1. All speeds indicated are in miles per hour. Conversion to KM/H = MPH x 1.609.
2. Shift points will vary slightly due to engine loads and vehicle options.
3. Speeds listed with + exceed 65 MPH.
4. Speeds are based on TPS of 10 or 20. Use scan tool to measure correct TPS.

For transmission model identification, see Fig. 1.

Fig. 14: Shift Speed Chart (1991 Models)
Courtesy of GENERAL MOTORS CORP.

1992 HYDRA-MATIC 4L60 SHIFT SPEED CHART

MODEL	1-2 MIN THROTTLE	2-3 MIN THROTTLE	3-4 MIN THROTTLE	1-2 W.O.T.	4-3 COAST DOWN	3-2 COAST DOWN	2-1 COAST DOWN
AAM	13-17	26-32	37-51	30-41	28-33'	16-24	7-10
ACM	13-17	25-32	41-51	28-40	25-36	17-24	10-12
ADM, AKM	13-17	26-32	37-52	30-41	28-33	16-24	7-10
BBM	14-18	26-33	40-52	31-46	25-30	14-25	9-11
BCM	14-18	25-32	42-53	31-45	27-34	14-24	9-11
BFM	13-16	24-28	38-52	27-42	25-29	14-21	8-10
BWM	13-17	26-31	39-52	31-45	25-30	14-24	9-11
CAM, CBM, KMM	14-17	22-28	46-52	28-39	34-44	14-22	10-12
CCM, CFM, KHM, WBM	13-16	21-26	42-48	27-39	31-39	12-20	10-12
CHM, CJM, KJM, WCM	15-18	23-30	48-56	31-44	36-47	16-23	11-13
DDM	16-19	26-32	35-47	33-55	24-31	15-23	10-13
FBM	14-18	26-34	43-53	37-51	28-35	16-24	10-12
FTM	12-15	21-26	39-50	28-41	31-39	13-22	10-12
FUM	12-15	22-26	38-47	25-41	24-30	14-20	9-11
FZM	13-16	2332	44-52	36-46	35-40	10-19	10-12
LAM, LBM, LCM, LDM, LFM	11-13	21-24	39-45	24-33	28-38	14-21	7-9
LHM	12-14	21-26	48-53	23-33	35-47	13-21	8-10
MJM, MNM, WAM	13-17	22-28	46-52	28-39	34-44	14-22	10-12
MMM	12-15	24-28	39-47	29-48	29-35	15-26	9-11
MSM	12-15	24-28	38-47	22-36	27-36	12-19	7-8
SAM	12-15	18-24	47-53	24-37	37-47	10-18	9-12
SFM	10-12	18-23	43-52	25-37	38-45	13-19	8-10
SHM, TLM	14-17	24-31	49-56	30-42	37-48	15-24	11-13
TAM, TBM	15-18	28-34	48-53	31-52	32-39	17-28	10-12
TWM	12-17	23-27	32-38	25-33	26-30	15-22	9-11
YDM	13-17	22-28	38-51	29-53	21-27	13-19	9-11

Notes:
1. All speeds indicated are in miles per hour. Conversion to KM/H = MPH x 1.609.
2. Shift points will vary slightly due to engine loads and vehicle options.
3. Speeds listed with + exceed 65 MPH.
4. Speeds are based on TPS of 10 or 20. Use scan tool to measure correct TPS.

For transmission model identification, see Fig. 1.

Fig. 15: Shift Speed Chart (1992 Models)
Courtesy of GENERAL MOTORS CORP.

CONTROL PRESSURE TEST

Preliminary Checking Procedure

1. Ensure fluid level is correct and engine is in good operating condition before performing control pressure test. Ensure shift linkage is properly adjusted. See appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section.
2. Control pressure can be checked to ensure proper throttle valve cable adjustment. If control pressure is not within specification, adjust throttle valve cable before attempting any other corrections. See THROTTLE VALVE CONTROL PRESSURE CHECK.

Throttle Valve Control Pressure Check

1. Install pressure gauge on transmission line pressure tap. See **Fig. 16** . Install tachometer on engine. Apply parking brake. Ensure engine is at normal operating temperature.
2. Operate engine at 1000 RPM. With gear selector in "P" position, note oil pressure reading. Move gear selector to "D" position, and note oil pressure reading.
3. Oil pressure "D" reading must be equal to "P" reading or must not exceed it by more than 10 psi (.70 kg/cm). Operate engine at 1400 RPM. Oil pressure should increase. Adjust throttle valve cable if pressure does not increase. See appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section.

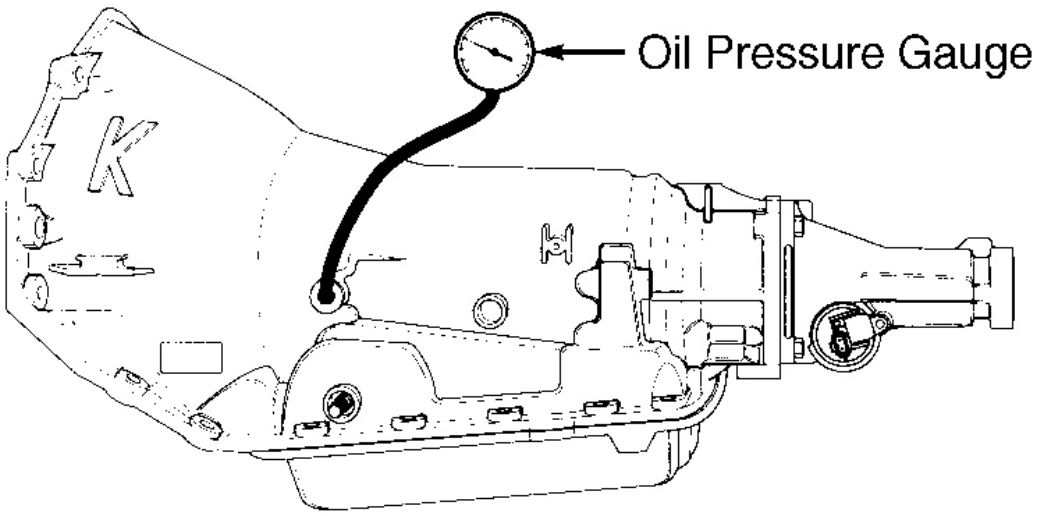


Fig. 16: Locating Line Pressure Tap
Courtesy of GENERAL MOTORS CORP.

CAUTION: DO NOT perform following pressure tests for longer than 2 minutes or transmission damage may occur.

Minimum Throttle Valve Pressure Check

1. Ensure throttle valve cable is properly adjusted. Attach pressure gauge to line pressure tap. See **Fig. 16** . Apply parking brake and service brakes.
2. Check line pressure as specified. See **OIL PRESSURE SPECIFICATION CHARTS** . Pressure readings must be within specification. If pressure reading is not within specification, see **TROUBLE SHOOTING** .

Full Throttle Valve Pressure Check

1. Attach pressure gauge to line pressure tap. See **Fig. 16** . Apply parking brake and service brakes. Ensure throttle valve cable is secured in fully extended position.
2. Check line pressure as specified. See **OIL PRESSURE SPECIFICATION CHARTS** . Pressure readings must be within specification. If pressure reading is not within specification, see **TROUBLE SHOOTING** .

Pressure Differential Check

1. Possible leakage in clutch circuits may be determined by checking oil pressure differential between line pressure and 2nd, 3rd and 4th clutches. Attach pressure gauges to line pressure tap and appropriate clutch circuit tap on transmission.
2. Circuit tap for 2nd clutch is located on right rear side of transmission, above pan. Circuit tap for 3rd clutch is located next to 2-4 servo, above 4th clutch circuit tap. See **Fig. 1** . Drive vehicle, and note both pressure readings. Pressure differential between line pressure and clutch circuits exceeding 10 psi (0.70 kg/cm^2) indicates possible leakage in clutch circuit.

OIL PRESSURE SPECIFICATION CHARTS

***NOTICE** Total running time for this combination not to exceed 2 minutes.

CAUTION Brakes must be applied at all times.

AUTOMATIC TRANSMISSION OIL PRESSURES

RANGE	MODEL	NORMAL OIL PRESSURE AT MINIMUM T.V.		NORMAL OIL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK & NEUTRAL @ 1000 RPM	TC, MB, MC, MJ, VN	385 - 445	55 - 65	880 - 1,190	130 - 170
	TE, TH, TK, MD, ME, MK, MW, VH	385 - 445	55 - 65	880 - 1,190	130 - 170
	VA, ML, T7, MP, MS, PQ, YN, YK, YP, YG, YF, T2	385 - 445	55 - 65	880 - 1,190	130 - 170
	T8, TZ, TP, TS, MH, VJ, TL	450 - 515	65 - 75	880 - 1,190	130 - 170
	YH	450 - 515	65 - 75	965 - 1,240	140 - 180
	Y9	385 - 445	55 - 65	965 - 1,240	140 - 180
REVERSE @ 1000 RPM	TC, MB, MC, MJ, VN	630 - 730	90 - 105	1,445 - 1,955	210 - 285
	TE, TH, TK, MD, ME, MK, MW, VH	630 - 730	90 - 105	1,445 - 1,955	210 - 285
	VA, ML, T7, MP, MS, PQ, YN, YK, YP, YG, YF, T2	630 - 730	90 - 105	1,445 - 1,955	210 - 285
	T8, TZ, TP, TS, MH, VJ, TL	740 - 845	110 - 120	1,445 - 1,955	210 - 285
	YH	740 - 845	110 - 120	1,550 - 2,070	225 - 300
	Y9	630 - 730	90 - 105	1,550 - 2,070	225 - 300
DRIVE & MANUAL THIRD @ 1000 RPM	TC, MB, MC, MJ, VN	385 - 445	55 - 65	880 - 1,190	130 - 170
	TE, TH, TK, MD, ME, MK, MW, VH	385 - 445	55 - 65	880 - 1,190	130 - 170
	VA, ML, T7, MP, MS, PQ, YN, YK, YP, YG, YF, T2	385 - 445	55 - 65	880 - 1,190	130 - 170
	T8, TZ, TP, TS, MH, VJ, TL	450 - 515	65 - 75	880 - 1,190	130 - 170
	YH	450 - 515	65 - 75	965 - 1,240	140 - 180
	Y9	385 - 445	55 - 65	965 - 1,240	140 - 180
MANUAL SECOND & LO @ 1000 RPM	TC, MB, MC, MJ, VN	705 - 815	100 - 120	705 - 815	100 - 120
	TE, TH, TK, MD, ME, MK, MW, VH	705 - 815	100 - 120	705 - 815	100 - 120
	VA, ML, T7, MP, MS, PQ, YN, YK, YP, YG, YF, T2	705 - 815	100 - 120	705 - 815	100 - 120
	T8, TZ, TP, TS, MH, VJ, TL	705 - 815	100 - 120	705 - 815	100 - 120
	YH	705 - 815	100 - 120	705 - 815	100 - 120
	Y9	705 - 815	100 - 120	705 - 815	100 - 120

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Fig. 17: Oil Pressure Specifications (1983 Models)
Courtesy of GENERAL MOTORS CORP.

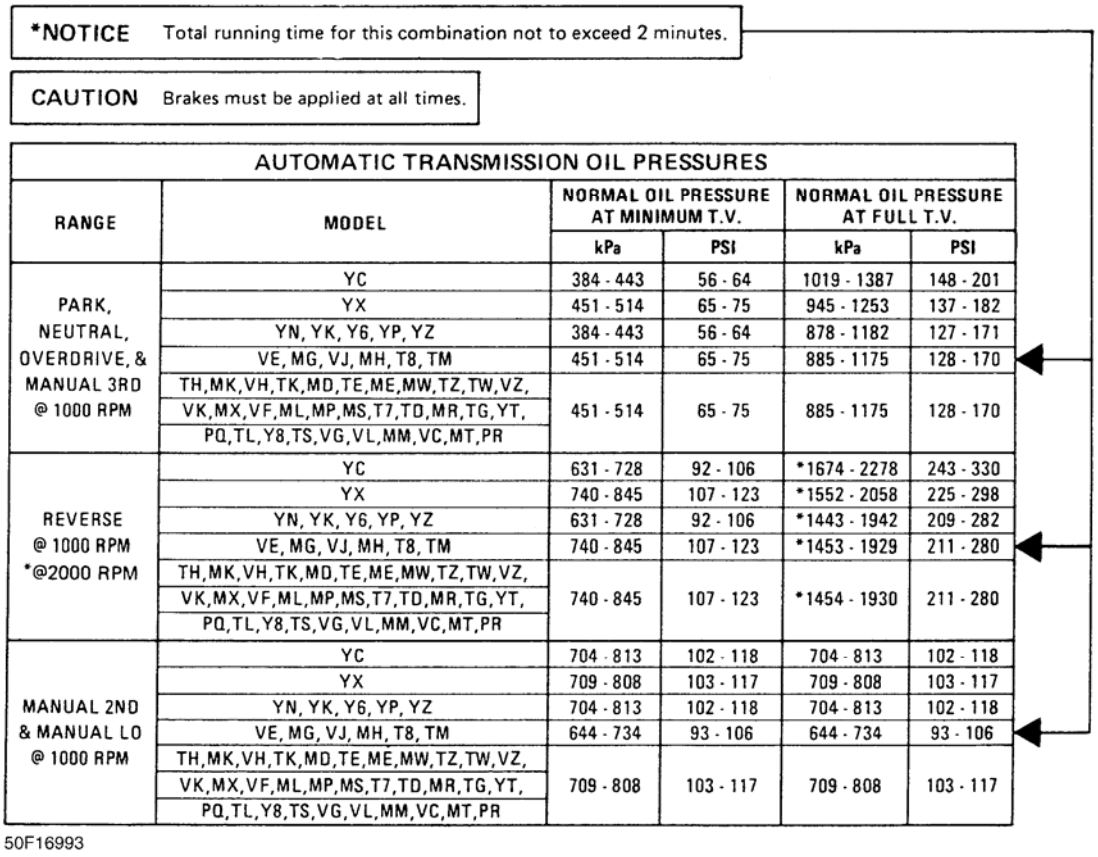
***NOTICE** Total running time for this combination not to exceed 2 minutes.

CAUTION Brakes must be applied at all times.

AUTOMATIC TRANSMISSION OIL PRESSURES					
RANGE	MODEL	NORMAL OIL PRESSURE AT MINIMUM T.V.		NORMAL OIL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK & NEUTRAL @ 1000 RPM	TC, MB, MC, MJ, VN	385 - 445	55 - 65	880 - 1,190	130 - 170
	TE, TH, TK, MD, ME, MK, MW, VH	385 - 445	55 - 65	880 - 1,190	130 - 170
	VA, ML, T7, MP, MS, PQ, YN, YK, YP, YG, YF, Y6	385 - 445	55 - 65	880 - 1,190	130 - 170
	T8, TZ, TM, MG, VE, MH, VJ, TL, TD, MR, TG, Y7, Y8	450 - 515	65 - 75	880 - 1,190	130 - 170
	YH	450 - 515	65 - 75	965 - 1,240	140 - 180
	Y9	385 - 445	55 - 65	965 - 1,240	140 - 180
REVERSE @ 1000 RPM	TC, MB, MC, MJ, VN	630 - 730	90 - 105	1,445 - 1,955	210 - 285
	TE, TH, TK, MD, ME, MK, MW, VH	630 - 730	90 - 105	1,445 - 1,955	210 - 285
	VA, ML, T7, MP, MS, PQ, YN, YK, YP, YG, YF, Y6	630 - 730	90 - 105	1,445 - 1,955	210 - 285
	T8, TZ, TM, MG, VE, MH, VJ, TL, TD, MR, TG, Y7, Y8	740 - 845	110 - 120	1,445 - 1,955	210 - 285
	YH	740 - 845	110 - 120	1,550 - 2,070	225 - 300
	Y9	630 - 730	90 - 105	1,550 - 2,070	225 - 300
OVERDRIVE & MANUAL THIRD @ 1000 RPM	TC, MB, MC, MJ, VN	385 - 445	55 - 65	880 - 1,190	130 - 170
	TE, TH, TK, MD, ME, MK, MW, VH	385 - 445	55 - 65	880 - 1,190	130 - 170
	VA, ML, T7, MP, MS, PQ, YN, YK, YP, YG, YF, Y6	385 - 445	55 - 65	880 - 1,190	130 - 170
	T8, TZ, TM, MG, VE, MH, VJ, TL, TD, MR, TG, Y7, Y8	450 - 515	65 - 75	880 - 1,190	130 - 170
	YH	450 - 515	65 - 75	965 - 1,240	140 - 180
	Y9	385 - 445	55 - 65	965 - 1,240	140 - 180
MANUAL SECOND & LO @ 1000 RPM	TC, MB, MC, MJ, VN	705 - 815	100 - 120	705 - 815	100 - 120
	TE, TH, TK, MD, ME, MK, MW, VH	705 - 815	100 - 120	705 - 815	100 - 120
	VA, ML, T7, MP, MS, PQ, YN, YK, YP, YG, YF, Y6	705 - 815	100 - 120	705 - 815	100 - 120
	T8, TZ, TM, MG, VE, MH, VJ, TL, TD, MR, TG, Y7, Y8	705 - 815	100 - 120	705 - 815	100 - 120
	YH	705 - 815	100 - 120	705 - 815	100 - 120
	Y9	705 - 815	100 - 120	705 - 815	100 - 120

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Fig. 18: Oil Pressure Specifications (1984 Models)
Courtesy of GENERAL MOTORS CORP.



***NOTICE** Total running time for this combination not to exceed 2 minutes.

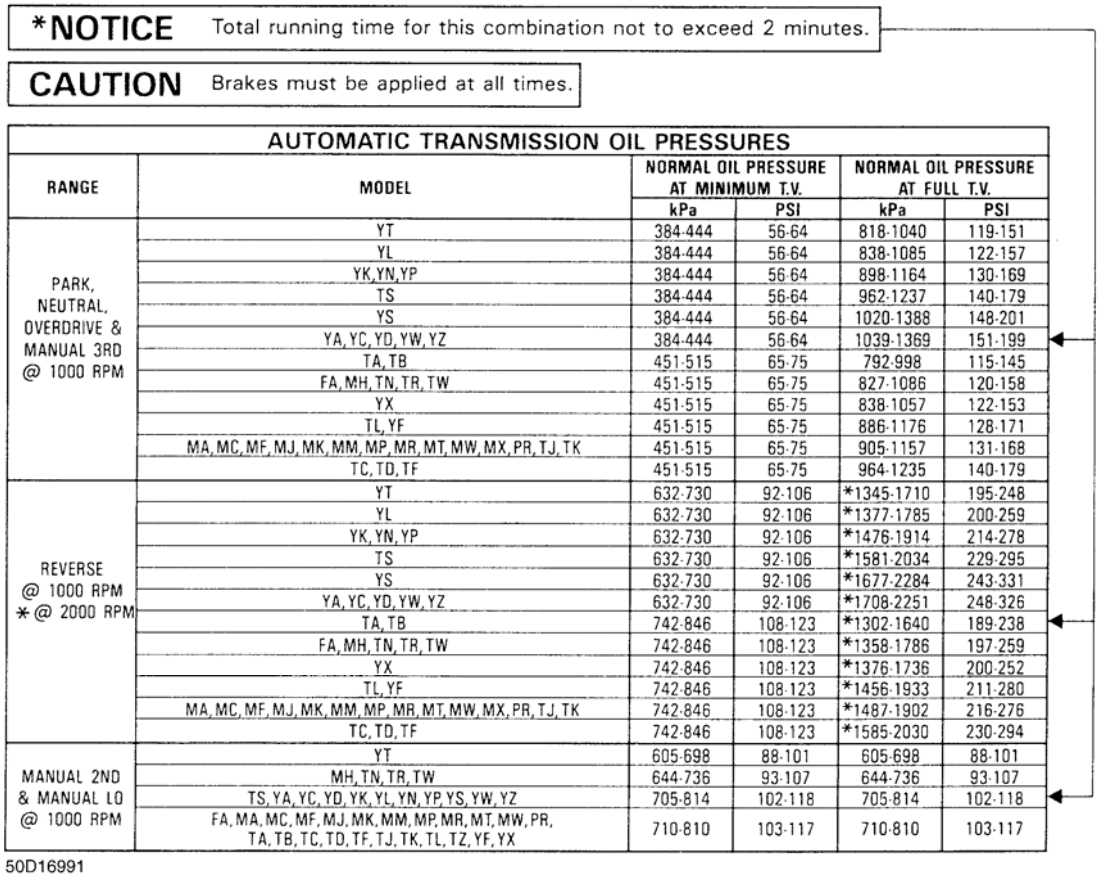
CAUTION Brakes must be applied at all times.

AUTOMATIC TRANSMISSION OIL PRESSURES

RANGE	MODEL	NORMAL OIL PRESSURE AT MINIMUM T.V.		NORMAL OIL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK, NEUTRAL, OVERDRIVE, & MANUAL 3RD @ 1000 RPM	YC	384 - 443	56 - 64	1019 - 1387	148 - 201
	YX	451 - 514	65 - 75	945 - 1253	137 - 182
	YN, YK, Y6, YP, YZ	384 - 443	56 - 64	878 - 1182	127 - 171
	VE, MG, VJ, MH, T8, TM	451 - 514	65 - 75	885 - 1175	128 - 170
	TH,MK,VH,TK,MD,TE,ME,MW,TZ,TW,VZ, VK,MX,VF,ML,MP,MS,T7,TD,MR,TG,YT, PQ,TL,Y8,TS,VG,VL,MM,VC,MT,PR	451 - 514	65 - 75	885 - 1175	128 - 170
REVERSE @ 1000 RPM *@2000 RPM	YC	631 - 728	92 - 106	*1674 - 2278	243 - 330
	YX	740 - 845	107 - 123	*1552 - 2058	225 - 298
	YN, YK, Y6, YP, YZ	631 - 728	92 - 106	*1443 - 1942	209 - 282
	VE, MG, VJ, MH, T8, TM	740 - 845	107 - 123	*1453 - 1929	211 - 280
	TH,MK,VH,TK,MD,TE,ME,MW,TZ,TW,VZ, VK,MX,VF,ML,MP,MS,T7,TD,MR,TG,YT, PQ,TL,Y8,TS,VG,VL,MM,VC,MT,PR	740 - 845	107 - 123	*1454 - 1930	211 - 280
MANUAL 2ND & MANUAL LO @ 1000 RPM	YC	704 - 813	102 - 118	704 - 813	102 - 118
	YX	709 - 808	103 - 117	709 - 808	103 - 117
	YN, YK, Y6, YP, YZ	704 - 813	102 - 118	704 - 813	102 - 118
	VE, MG, VJ, MH, T8, TM	644 - 734	93 - 106	644 - 734	93 - 106
	TH,MK,VH,TK,MD,TE,ME,MW,TZ,TW,VZ, VK,MX,VF,ML,MP,MS,T7,TD,MR,TG,YT, PQ,TL,Y8,TS,VG,VL,MM,VC,MT,PR	709 - 808	103 - 117	709 - 808	103 - 117

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Fig. 19: Oil Pressure Specifications (1985 Models)
Courtesy of GENERAL MOTORS CORP.



***NOTICE** Total running time for this combination not to exceed 2 minutes.

CAUTION Brakes must be applied at all times.

AUTOMATIC TRANSMISSION OIL PRESSURES

RANGE	MODEL	NORMAL OIL PRESSURE AT MINIMUM T.V.		NORMAL OIL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK, NEUTRAL, OVERDRIVE & MANUAL 3RD @ 1000 RPM	YT	384-444	56-64	818-1040	119-151
	YL	384-444	56-64	838-1085	122-157
	YK,YN,YP	384-444	56-64	898-1164	130-169
	TS	384-444	56-64	962-1237	140-179
	YS	384-444	56-64	1020-1388	148-201
	YA, YC, YD, YW, YZ	384-444	56-64	1039-1369	151-199
	TA, TB	451-515	65-75	792-998	115-145
	FA, MH, TN, TR, TW	451-515	65-75	827-1086	120-158
	YX	451-515	65-75	838-1057	122-153
	TL, YF	451-515	65-75	886-1176	128-171
	MA, MC, MF, MJ, MK, MM, MP, MR, MT, MW, MX, PR, TJ, TK	451-515	65-75	905-1157	131-168
	TC, TD, TF	451-515	65-75	964-1235	140-179
REVERSE @ 1000 RPM *@ 2000 RPM	YT	632-730	92-106	*1345-1710	195-248
	YL	632-730	92-106	*1377-1785	200-259
	YK, YN, YP	632-730	92-106	*1476-1914	214-278
	TS	632-730	92-106	*1581-2034	229-295
	YS	632-730	92-106	*1677-2284	243-331
	YA, YC, YD, YW, YZ	632-730	92-106	*1708-2251	248-326
	TA, TB	742-846	108-123	*1302-1640	189-238
	FA, MH, TN, TR, TW	742-846	108-123	*1358-1786	197-259
	YX	742-846	108-123	*1376-1736	200-252
	TL, YF	742-846	108-123	*1456-1933	211-280
	MA, MC, MF, MJ, MK, MM, MP, MR, MT, MW, MX, PR, TJ, TK	742-846	108-123	*1487-1902	216-276
	TC, TD, TF	742-846	108-123	*1585-2030	230-294
MANUAL 2ND & MANUAL LO @ 1000 RPM	YT	605-698	88-101	605-698	88-101
	MH, TN, TR, TW	644-736	93-107	644-736	93-107
	TS, YA, YC, YD, YK, YL, YN, YP, YS, YW, YZ	705-814	102-118	705-814	102-118
	FA, MA, MC, MF, MJ, MK, MM, MP, MR, MT, MW, PR, TA, TB, TC, TD, TF, TJ, TK, TL, TZ, YF, YX	710-810	103-117	710-810	103-117

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Fig. 20: Oil Pressure Specifications (1986 Car Models)
Courtesy of GENERAL MOTORS CORP.

***NOTICE** Total running time for this combination not to exceed 2 minutes.

CAUTION Brakes must be applied at all times.

AUTOMATIC TRANSMISSION OIL PRESSURES

RANGE	MODEL	NORMAL OIL PRESSURE AT MINIMUM T.V.		NORMAL OIL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK, NEUTRAL, OVERDRIVE & MANUAL 3RD @ 1000 RPM	YC	384-443	56-64	1019-1387	148-201
	YT,YX	451-514	65-75	945-1253	137-182
	YA, YD, YK, YL, YN, YP, YR, YS, YW, YZ	384-443	56-64	878-1182	127-171
	MH, TN, TR	451-514	65-75	885-1175	128-170
	FA, MA, MC, MD, MF, MK, MM, MP, MR, MT, MW, MX, PL, PR, TA, TB, TC, TD, TF, TJ, TK, TS, TW, YF	451-514	65-75	885-1175	128-170
REVERSE @ 1000 RPM *@ 2000 RPM	YC	631-728	92-106	*1674-2278	243-330
	YT, YX	740-845	107-123	*1552-2058	225-298
	YA, YD, YK, YL, YN, YP, YR, YS, YW, YZ	631-728	92-106	*1443-1942	209-282
	MH, TN, TR	740-845	107-123	*1453-1929	211-280
	FA, MA, MC, MD, MF, MK, MM, MP, MR, MT, MW, MX, PL, PR, TA, TB, TC, TD, TF, TJ, TK, TS, TW, YF	740-845	107-123	*1454-1930	211-280
MANUAL 2ND & MANUAL LO @ 1000 RPM	YC	704-813	102-118	704-813	102-118
	YT, YX	709-808	103-117	709-808	103-117
	YA, YD, YK, YL, YN, YP, YR, YS, YW, YZ	704-813	102-118	704-813	102-118
	MH, TN, TR	644-734	93-106	644-734	93-106
	FA, MA, MC, MD, MF, MK, MM, MP, MR, MT, MW, MX, PL, PR, TA, TB, TC, TD, TF, TJ, TK, TS, TW, YF	709-808	103-117	709-808	103-117

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Fig. 21: Oil Pressure Specifications (1986 Truck Models)
Courtesy of GENERAL MOTORS CORP.

Range	Model	NORMAL OIL PRESSURE AT MINIMUM T.V.		NORMAL OIL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
Park, Neutral, Overdrive & Manual 3rd @ 1000 RPM	YSM	384-444	56-64	994-1277	144-185
	YLM, YTM	384-444	56-64	818-1040	119-151
	YMM	451-515	65-75	1115-1430	162-207
	YXM	451-515	65-75	840-1053	122-153
	MCM, MHM, MTM, PAM, PBM, PCM, PRM, TAM, TBM, TNM, TRM, YFM	451-515	65-75	844-1068	122-155
	FAM, MAM, MDM, MFM, MKM, MMM, MPM, MRM, MSM, MUM, MWM, MXM, MZM, TJM, TKM, TUM, TXM	451-515	65-75	851-1063	123-154
	YPM	384-444	56-64	876-1333	127-193
	YKM	384-444	56-64	883-1129	128-164
	TSM	384-444	56-64	962-1237	139-179
	YAM, YCM, YDM, YWM, YZM	384-444	56-64	1049-1359	152-197
	YSM	632-729	92-106	*1634-2100	237-305
Reverse @ 1000 RPM * @ 2000 RPM	YTM	632-729	92-106	*1345-1710	195-248
	YMM	742-846	108-123	*1834-2351	266-341
	YLM	632-729	92-106	*1380-1782	200-258
	YXM	742-847	108-123	*1381-1731	200-251
	MCM, MHM, MTM, PAM, PBM, PCM, PRM, TAM, TBM, TNM, TRM, YFM	742-847	108-123	*1388-1755	201-254
	FAM, MAM, MDM, MFM, MKM, MMM, MPM, MRM, MSM, MUM, MWM, MXM, MZM, TJM, TKM, TUM, TXM	742-847	108-123	*1399-1747	203-253
	YPM	632-730	92-106	*1441-2191	209-318
	YKM	632-730	92-106	*1452-1856	211-269
	TSM	632-730	92-106	*1581-2034	229-295
	YAM, YCM, YDM, YWM, YZM	632-730	92-106	*1724-2234	250-324
Manual 2nd & Manual 1st @ 1000 RPM	TSM, YAM, YCM, YDM, YKM, YLM, YPM, YSM, YTM, YWM, YZM	1120-1293	162-187	1120-1293	162-187
	FAM,MAM,MCM,MDM,MHM,MKM,MMM,MPM,MRM,MSM,MTM,MUM,MWM,MXM, MZM,PAM,PBM,PCM,PRM,TAM,TBM,TJM,TKM,TNM,TRM,TUM,TXM,YFM,YMM,YXM	1127-1286	163-186	1127-1286	163-186

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Fig. 22: Oil Pressure Specifications (1987 Models Except Astro & Safari)
Courtesy of GENERAL MOTORS CORP.

Range	Model	NORMAL OIL PRESSURE AT MINIMUM T.V.		NORMAL OIL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
Park, Neutral, Overdrive & Manual 3rd @ 1000 RPM	YC	384-443	56-64	1019-1387	148-201
	YT, YX	451-514	65-75	945-1253	137-182
	YA, YD, YK, YL, YN, YP, YR, YS, YW, YZ	384-443	56-64	878-1182	127-171
	MH, TN, TR	451-514	65-75	885-1175	128-170
	FA, MA, MC, MD, MF, MK, MM, MP, MR, MT, MW, MX, PL, PR, TA, TB, TC, TD, TF, TJ, TK, TS, TW, YF	451-514	65-75	885-1175	128-170
Reverse @ 1000 RPM * @ 2000 RPM	YC	631-728	92-106	*1674-2278	243-330
	YT, YX	740-845	107-123	*1552-2058	225-298
	YA, YD, YK, YL, YN, YP, YR, YS, YW, YZ	631-728	92-106	*1443-1942	209-282
	MH, TN, TR	740-845	107-123	*1453-1929	211-280
	FA, MA, MC, MD, MF, MK, MM, MP, MR, MT, MW, MX, PL, PR, TA, TB, TC, TD, TF, TJ, TK, TS, TW, YF	740-845	107-123	*1454-1930	211-280
Manual 2nd & Manual 1st @ 1000 RPM	YC	704-813	102-118	704-813	102-118
	YT, YX	709-808	103-117	709-808	103-117
	YA, YD, YK, YL, YN, YP, YR, YS, YW, YZ	704-813	102-118	704-813	102-118
	MH, TN, TR	644-734	93-106	644-734	93-106
	FA, MA, MC, MD, MF, MK, MM, MP, MR, MT, MW, MX, PL, PR, TA, TB, TC, TD, TF, TJ, TK, TS, TW, YF	709-808	103-117	709-808	103-117

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Fig. 23: Oil Pressure Specifications (1987 Astro & Safari)
Courtesy of GENERAL MOTORS CORP.

RANGE	MODEL	NORMAL OIL PRESSURE AT MINIMUM T.V.		NORMAL OIL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK, NEUTRAL, OVERDRIVE & MANUAL 3RD @ 1000 RPM	YSM	384-444	56-64	994-1277	144-185
	YTM	451-515	65-75	947-1185	137-172
	YMM	451-515	65-75	1073-1354	155-196
	YXM	451-515	65-75	1002-1267	145-184
	MCM, MHM, MTM, PAM, PBM, PCM, PRM, TAM, TBM, TNM,	451-515	65-75	844-1068	122-155
	FAM, FMM, MAM, MDM, MFM, MKM, MLM, MPM, MRM, MWM, MXM, MZM, THM, TJM, TKM, TLM, TUM, TXM	451-515	65-75	851-1063	123-154
	YPM	384-444	56-64	1006-1285	146-186
	YKM	384-444	56-64	883-1129	128-164
	YNM	384-444	56-64	962-1237	139-179
	YAM, YDM, YWM, YZM	384-444	56-64	1049-1359	152-197
REVERSE @ 1000 RPM *@ 2000 RPM	YSM	632-729	92-106	*1634-2100	237-305
	YTM	742-847	108-123	*1557-1948	226-283
	YMM	742-846	108-123	*1763-2225	256-323
	YXM	742-847	108-123	*1647-2082	239-302
	MCM, MHM, MTM, PAM, PBM, PCM, PRM, TAM, TBM, TNM	742-847	108-123	*1388-1755	201-254
	FAM, FMM, MAM, MDM, MFM, MKM, MLM, MPM, MRM, MWM, MXM, MZM, THM, TJM, TKM, TLM, TUM, TXM	742-847	108-123	*1399-1747	203-253
	YPM	632-730	92-106	*1654-2112	240-306
	YKM	632-730	92-106	*1452-1856	211-269
	YNM	632-730	92-106	*1581-2034	229-295
	YAM, YDM, YWM, YZM	632-730	92-106	*1724-2234	250-324
MANUAL 2ND & MANUAL LO @ 1000 RPM	YXM	1316-1501	191-217	1316-1501	191-217
	YAM, YDM, YKM, YLM, YNM, YPM, YSM, YTM, YWM, YZM	1120-1293	162-187	1120-1293	162-187
	FAM, FMM, MAM, MCM, MDM, MHM, MKM, MLM, MPM, MRM, MSM, MTM, MWM, MXM, MZM, PAM, PBM, PCM, PRM, TAM, TBM, THM, TJM, TKM, TLM, TNM, TUM, TXM, YMM, YXM	1127-1286	163-186	1127-1286	163-186

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Fig. 24: Oil Pressure Specifications (1988 Car Models)
Courtesy of GENERAL MOTORS CORP.

RANGE	MODEL	NORMAL OIL PRESSURE AT MINIMUM T.V.		NORMAL OIL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK, NEUTRAL, OVERDRIVE & MANUAL 3RD @ 1000 RPM	YTM	451-515	65-75	947-1185	137-172
	YMM	451-515	65-75	1073-1354	155-196
	YXM	451-515	65-75	1002-1267	145-184
	MCM, MHM, MTM, PAM, PBM, PCM, PRM, TAM, TBM, TNM,	451-515	65-75	844-1068	122-155
	FAM, FMM, MAM, MDM, MFM, MKM, MLM, MPM, MRM, MWM, MXM, MZM, THM, TJM, TKM, TLM, TUM, TXM	451-515	65-75	851-1063	123-154
	YPM	384-444	56-64	1006-1285	146-186
	YKM	384-444	56-64	883-1129	128-164
	YNM	384-444	56-64	962-1237	139-179
	YDM, YWM, YZM	384-444	56-64	1049-1359	152-197
REVERSE @ 1000 RPM *@ 2000 RPM	YTM	742-847	108-123	*1557-1948	226-283
	YMM	742-846	108-123	*1763-2225	256-323
	YXM	742-847	108-123	*1647-2082	239-302
	MCM, MHM, MTM, PAM, PBM, PCM, PRM, TAM, TBM, TNM	742-847	108-123	*1388-1755	201-254
	FAM, FMM, MAM, MDM, MFM, MKM, MLM, MPM, MRM, MWM, MXM, MZM, THM, TJM, TKM, TLM, TUM, TXM	742-847	108-123	*1399-1747	203-253
	YPM	632-730	92-106	*1654-2112	240-306
	YKM	632-730	92-106	*1452-1856	211-269
	YNM	632-730	92-106	*1581-2034	229-295
	YDM, YWM, YZM	632-730	92-106	*1724-2234	250-324
MANUAL 2ND & MANUAL LO @ 1000 RPM	YDM, YKM, YLM, YNM, YPM, YTM, YWM, YZM	1120-1293	162-187	1120-1293	162-187
	FAM,FMM,MAM,MCM,MDM,MHM,MKM,MLM,MPM,MRM,MSM,MTM,MWM,MXM, MZM,PAM,PBM,PCM,PRM,TAM,TBM,THM,TJM,TKM,TLM,TNM,TUM,TXM,YMM,YXM	1127-1286	163-186	1127-1286	163-186

50G16986

Fig. 25: Oil Pressure Specifications (1988 Truck Models)
Courtesy of GENERAL MOTORS CORP.

1989 THM 4L60 TRANSMISSION PRESSURES

RANGE	MODEL	NORMAL PRESSURE AT MINIMUM T.V.		NORMAL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK, NEUTRAL, OVERDRIVE & MANUAL 3RD @ 1000 RPM	FKM, FXM, YPM, YZM	451-515	65-75	1073-1354	155-196
	FMM, HDM, MAM, MFM, MRM, MXM	451-515	65-75	851-1063	123-154
	HBM	451-515	65-75	1029-1308	149-190
	MCM, PRM	451-515	65-75	845-1068	123-155
	MDM, MKM, MLM, TJM, TKM	451-515	65-75	947-1185	137-172
	MHM, PAM, PBM, PCM, TNM	451-515	65-75	899-1134	130-164
	MPM, MWM, MZM, TUM, TXM	451-515	65-75	914-1149	133-167
	THM, TLM	451-515	65-75	969-1231	141-179
	YDM	384-444	56-64	1049-1359	152-197
	YNM	451-515	65-75	1025-1306	149-189
	YTM	451-515	65-75	816-1016	118-147
	YXM	451-515	65-75	865-1080	125-157
REVERSE @ 1000 RPM	FKM, FXM, YPM, YZM	742-847	108-123	1763-2225	256-323
	FMM, HDM, MAM, MFM, MRM, MXM	742-847	108-123	1400-1747	203-253
	HBM	742-847	108-123	1691-2150	245-312
	MCM, PRM	580-662	84-96	1085-1372	157-199
	MDM, MKM, MLM, TJM, TKM	742-847	108-123	1556-1948	226-283
	MHM, PAM, PBM, PCM, TNM	741-845	107-123	1474-1860	214-270
	MPM, MWM, MZM, TUM, TXM	742-847	108-123	1503-1889	218-274
	THM, TLM	742-847	108-123	1593-2023	231-293
	YDM	632-730	92-106	1724-2234	250-324
	YNM	742-847	108-123	1686-2146	245-311
	YTM	742-847	108-123	1342-1670	195-242
	YXM	580-662	84-96	1111-1387	161-201
MANUAL 2ND & MANUAL LO @ 1000 RPM	FKM, FXM, HBM, HDM, MAM, MCM, MDM, MFM, MKM, MLM, MPM, MRM, MWM, MXM, MZM, PRM, THM, TJM, TKM, TLM, TUM, TXM, YMM, YNM, YPM, YTM, YUM, YXM, YZM	1127-1286	163-186	1127-1286	163-186
	MHM, PAM, PBM, PCM, TNM	1191-1359	173-197	1191-1359	173-197
	YDM	1120-1293	162-187	1120-1293	162-187

For transmission model identification, *see Fig. 1.*

50H16979

Fig. 26: Oil Pressure Specifications (1989 Models)
Courtesy of GENERAL MOTORS CORP.

1990 HYDRA-MATIC 4L60 TRANSMISSION PRESSURES					
RANGE	MODEL	NORMAL PRESSURE AT MINIMUM T.V.		NORMAL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK, NEUTRAL, OVERDRIVE & MANUAL 3RD @ 1000 RPM	BAM, FTM	451-515	65-75	816-1016	118-147
	BPM	451-515	65-75	1025-1306	149-189
	CAM, CBM, HCM, HDM, KAM, MJM, MNM, WAM	451-515	65-75	851-1063	123-154
	CCM, CFM, TNM, WBM	451-515	65-75	947-1185	137-172
	CHM, CJM, RAM, TMM, WCM	451-515	65-75	914-1149	133-167
	DBM	483-622	70-90	883-1170	128-170
	FBM	451-515	65-75	918-1146	133-166
	FUM, FZM	451-515	65-75	1073-1354	155-196
	HBM, HHM	483-622	70-90	1019-1347	148-195
	HJM, YDM	451-515	65-75	1116-1430	162-207
	LAM, LBM, LCM, LDM, LFM	451-515	65-75	899-1134	130-164
	MBM, SAM	451-515	65-75	845-1068	123-155
	MSM	483-622	70-90	797-1079	116-157
	SHM, TLM	451-515	65-75	969-1231	141-179
REVERSE @ 1000 RPM	BAM, FTM	742-847	108-123	1342-1670	195-242
	BPM	742-847	108-123	1686-2146	245-311
	CAM, CBM, HCM, HDM, KAM, MJM, MNM, WAM	742-847	108-123	1400-1747	203-253
	CCM, CFM, TNM, WBM	742-847	108-123	1556-1948	226-283
	CHM, CJM, RAM, TMM, WCM	742-847	108-123	1503-1889	218-274
	DBM	793-1023	115-148	1451-1924	210-279
	FBM	580-662	84-96	1180-1472	171-214
	FUM, FZM	742-847	108-123	1763-2225	256-323
	HBM, HHM	793-1023	115-148	1676-2214	243-320
	HJM, YDM	742-847	108-123	1834-2351	265-340
	LAM, LBM, LCM, LDM, LFM	741-845	107-123	1474-1860	214-270
	MBM, SAM	580-662	84-96	1085-1372	157-199
	MSM	793-1023	115-148	1311-1773	190-257
	SHM, TLM	742-847	108-123	1593-2023	231-293
MANUAL 2ND & MANUAL LO @ 1000 RPM	BAM, BPM, CAM, CBM, CCM, CFM, CHM, CJM, FBM, FTM, FUM, FZM, HCM, HDM, HJM, KAM, MBM, MJM, MNM, RAM, SAM, SHM, TLM, TMM, TNM, WAM, WBM, WCM, YDM	1127-1286	163-186	1127-1286	163-186
	DBM, HBM, HHM, MSM	1205-1554	175-226	1205-1554	175-226
	LAM, LBM, LCM, LDM, LFM	1191-1359	173-197	1191-1359	173-197

For transmission model identification, *see Fig. 1.*

50A16980

Fig. 27: Oil Pressure Specifications (1990 Models)
Courtesy of GENERAL MOTORS CORP.

1991 HYDRA-MATIC 4L60 TRANSMISSION PRESSURES					
RANGE	MODEL	NORMAL PRESSURE AT MINIMUM T.V.		NORMAL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK, NEUTRAL, OVERDRIVE & MANUAL 3RD @ 1000 RPM	BBM	483-622	70-90	866-1146	125-166
	CAM, CBM, KAM, MJM, MNM, WAM	451-515	65-75	851-1063	123-154
	CCM, CFM, KBM, WBM	451-515	65-75	947-1185	137-172
	CHM, CJM, KCM, RAM, WCM	451-515	65-75	914-1149	133-167
	FBM	451-515	65-75	918-1146	133-166
	FTM, FUM, FZM	451-515	65-75	1073-1354	155-196
	LAM, LBM, LCM, LDM, LFM	451-515	65-75	899-1134	130-164
	MSM	483-622	70-90	797-1079	116-157
	SAM	451-515	65-75	845-1068	123-155
	SHM, TLM	451-515	65-75	969-1231	141-179
REVERSE @ 1000 RPM	BBM	793-1023	115-148	1424-1883	206-273
	CAM, CBM, KAM, MJM, MNM, WAM	742-847	108-123	1400-1747	203-253
	CCM, CFM, KBM, WBM	742-847	108-123	1556-1948	226-283
	CHM, CJM, KCM, RAM, WCM	742-847	108-123	1503-1889	218-274
	FBM	580-662	84-96	1180-1472	171-214
	FTM, FUM, FZM	742-847	108-123	1763-2225	256-323
	LAM, LBM, LCM, LDM, LFM	741-845	107-123	1474-1860	214-270
	MSM	793-1023	115-148	1311-1773	190-257
	SAM	580-662	84-96	1085-1372	157-199
	SHM, TLM	742-847	108-123	1583-2023	231-293
MANUAL 2ND & MANUAL LO @ 1000 RPM	CAM, CBM, CCM, CFM, CHM, CJM, FBM, FTM, FUM, FZM, KAM, KBM, KCM, MJM, MNM, RAM, SAM, SHM, TLM, WAM, WBM, WCM	1127-1286	163-186	1127-1286	163-186
	BBM, MSM	1205-1554	175-226	1205-1554	175-226
	LAM, LBM, LCM, LDM, LFM	1191-1359	173-197	1191-1359	173-197

For transmission model identification, see Fig. 1.

92A12567

Fig. 28: Oil Pressure Specifications (1991 Models)
Courtesy of GENERAL MOTORS CORP.

1992 HYDRA-MATIC 4L60 TRANSMISSION PRESSURES

RANGE	MODEL	NORMAL PRESSURE AT MINIMUM T.V.		NORMAL PRESSURE AT FULL T.V.	
		kPa	PSI	kPa	PSI
PARK, NEUTRAL, OVERDRIVE & MANUAL 3RD @ 1000 RPM	AAM	518-587	75-85	866-1063	126-154
	ACM	451-515	65-75	823-1020	119-148
	ADM, AKM, APM	518-587	75-85	1097-1381	159-200
	BFM, BJM, FUM, YDM	451-515	65-75	1116-1430	1162-208
	BHM, BWM, CAM, CBM, DBM, KAM, KMM, MJM, MNM, WAM	451-515	65-75	851-1063	123-154
	CCM, CFM, KHM, KLM, TMM, WBM	451-515	65-75	947-1185	137-172
	CHM, CJM, KJM, RAM, TNM, WCM	451-515	65-75	914-1149	133-167
	DDM	518-587	75-85	981-1221	142-177
	FBM	451-515	65-75	918-1146	133-166
	FTM, FZM	451-515	65-75	1073-1354	155-196
	FUM	518-587	75-85	1350-1732	195-251
	LAM, LBM, LCM, LDM, LFM	451-515	65-75	871-1091	126-158
	LHM	518-587	75-85	1332-1766	193-256
	MMM, MSM	518-587	75-85	935-1173	135-170
	SAM, SFM	451-515	65-75	845-1068	123-155
	SHM, SPM, TLM	451-515	65-75	969-1231	141-179
	TAM, TBM	451-515	65-75	914-1188	132-172
	TWM	451-515	65-75	1002-1267	145-183
REVERSE @ 1000 RPM	AAM	738-836	107-121	1234-1515	197-220
	ACM, BCM, DAM	742-847	108-123	1354-1677	197-244
	ADM, AKM, APM	738-836	107-121	1563-1967	226-285
	BFM, BJM, YDM	742-847	108-123	1834-2351	266-341
	BHM, BWM, CAM, CBM, DBM, KAM, KMM, MJM, MNM, WAM	742-847	108-123	1400-1747	203-253
	CCM, CFM, KHM, KLM, TMM, WBM	742-847	108-123	1556-1948	226-283
	CHM, CJM, KJM, RAM, TNM, WCM	742-847	108-123	1503-1869	218-274
	DDM	738-836	108-123	1397-1739	202-252
	FBM	580-662	84-96	1180-1472	171-214
	FTM, FZM	742-847	108-123	1763-2225	256-323
	FUM	665-754	97-109	1734-2225	251-322
	LAM, LBM, LCM, LDM, LFM	741-845	107-123	1429-1790	207-260
	LHM	665-754	97-109	1710-2268	248-329
	MMM, MSM	738-836	108-123	1331-1671	193-242
	SAM, SFM	580-662	84-96	1085-1372	157-199
	SHM, SPM, TLM	742-847	108-123	1593-2023	231-293
	TAM, TBM	741-845	107-123	1503-1952	218-283
	TWM	741-845	107-123	1846-2082	238-301
MANUAL 2ND & MANUAL LO @ 1000 RPM	AAM, ADM, AKM, APM, BBM, DDM, MMM, MSM	1121-1269	163-184	1121-1269	163-180
	ACM, BCM, BFM, BHM, BJM, BWM, CAM, CBM, CCM, CFM CHM,CJM, DAM, DBM, FBM, FTM, FZM, KAM, KHM, KJM, KMM, MJM, MNM, RAM, SAM, SFM, SHM, SPM, TAM, TBM, TLM, TMM, TNM, TWM, WAM, WBM, WCM, YDM	1127-1286	163-186	1127-1286	163-186
	LAM, LBM, LCM, LDM, LFM	1191-1359	173-197	1191-1359	173-197
	FUM, LHM	1293-1465	188-223	1293-1465	188-213

For transmission model identification, see Fig. 1.

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Fig. 29: Oil Pressure Specifications (1992 Models)
Courtesy of GENERAL MOTORS CORP.

TORQUE CONVERTER

NOTE: Torque converter is a sealed unit and must be serviced as complete assembly.

STALL TEST

1. Torque converter whine is usually noticed when vehicle is stopped and transmission is in Reverse or Drive. Whine will increase when engine RPM is increased and will stop when vehicle is moving or when torque converter clutch is applied. Stall test is to ensure whine is coming from torque converter.
2. Start engine, and allow it to reach normal operating temperature. Apply parking and service brakes. Put transmission in Drive. Depress accelerator to approximately 1200 RPM for less than 6 seconds. **DO NOT** depress accelerator for more than 6 seconds or transmission damage may occur. Torque converter noise will increase under this load.

NOTE: Torque converter whine should not be confused with pump whine, which is usually noticeable in Park, Neutral and all other gear ranges.

STATOR CHECK

1. Torque converter stator roller clutch can either remain locked up at all times or freewheel in both directions. If stator is freewheeling at all times, vehicle tends to have poor acceleration from a stop. Vehicle may act normal at speeds above 30-35 MPH.
2. If poor acceleration is noted, ensure exhaust system is not blocked, engine timing is correct and transmission is in 1st gear when starting from a stop. If stator is locked up at all times, performance from a stop appears normal. Engine RPM and acceleration is limited at high speeds. Engine may overheat from this condition.
3. A visual inspection of torque converter may reveal converter is Blue from overheating. If torque converter has been removed from vehicle, stator roller clutch can be checked by inserting a finger into splined inner race of roller clutch and trying to turn race in both directions. Inner race should turn freely clockwise but should not turn or should be difficult to turn counterclockwise.

END PLAY CHECK

1. Inspect torque converter for hub scoring, cracks or weld area cracks before checking end play. Install End Play Checking Tool (J-35138) on torque converter. See **Fig. 30** .
2. Note end play of torque converter. End play must be within specification. See **TORQUE CONVERTER END PLAY SPECIFICATIONS** . Replace torque converter if end play is not within specification or damage to hub area exists.

TORQUE CONVERTER END PLAY SPECIFICATIONS

Converter Diameter: In. (mm)	End Play: In. (mm)
9.65 (245.0)	.000-.020 (.00-.50)
11.73 (298.0)	.000-.024 (.00-.61)

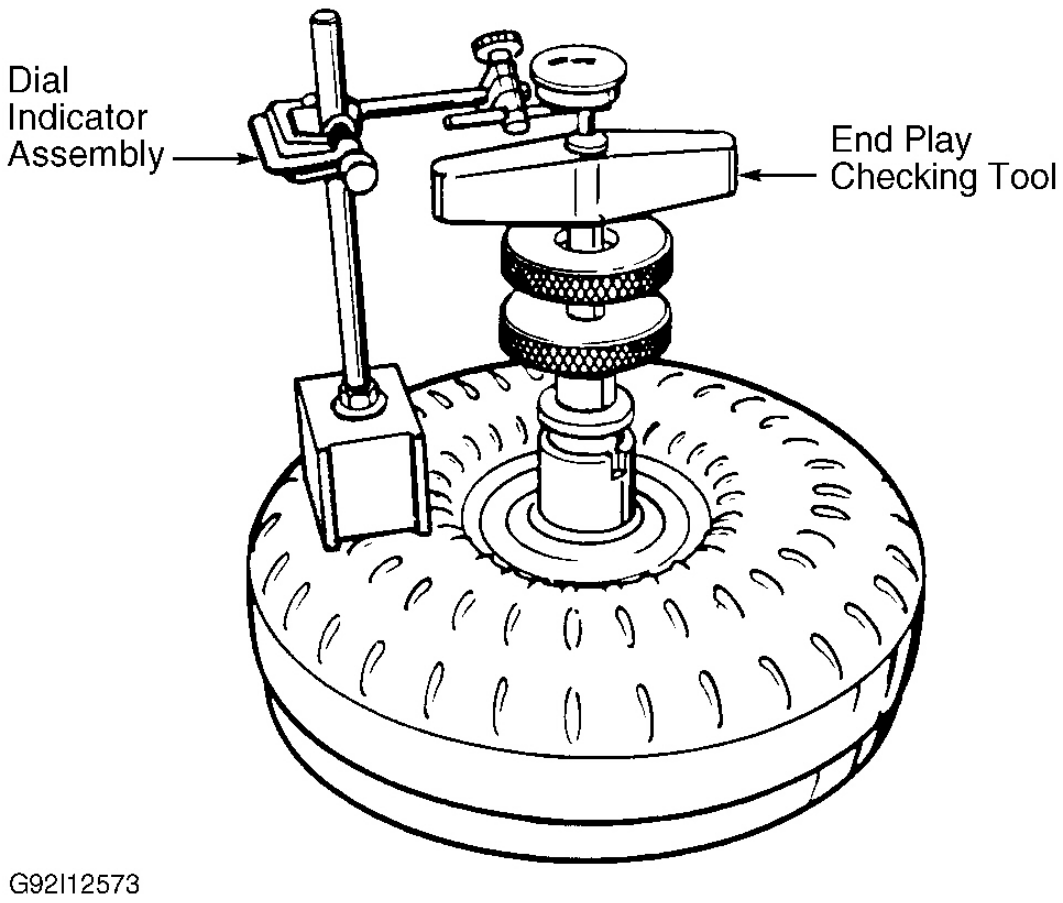


Fig. 30: Checking Torque Converter End Play
Courtesy of GENERAL MOTORS CORP.

CONVERTER FLUSHING

Torque converter flushing is not recommended. Replace torque converter if contamination is found during oil cooler flushing procedure.

NOTE: For additional information on Torque Converter Clutch (TCC), see AUTO TRANS DIAGNOSIS - GM TORQUE CONVERTER CLUTCH article in the AUTOMATIC TRANSMISSIONS section.

REMOVAL & INSTALLATION

See appropriate TRANSMISSION REMOVAL & INSTALLATION - A/T article in the TRANSMISSION SERVICING section.

TRANSMISSION DISASSEMBLY

2-4 SERVO ASSEMBLY

1. Mount transmission in Holding Fixture (J-8763-02). Remove torque converter. Clean outside of transmission case if necessary. Install Servo Cover Compressor (J-29714) on 2 oil pan bolts. See **Fig. 31** . Compress servo cover. Remove retaining ring. Remove servo cover and "O" ring.
2. Remove 2-4 servo assembly. Servo pin length should be checked before disassembling assembly to determine 2-4 band and reverse input drum wear or damage.

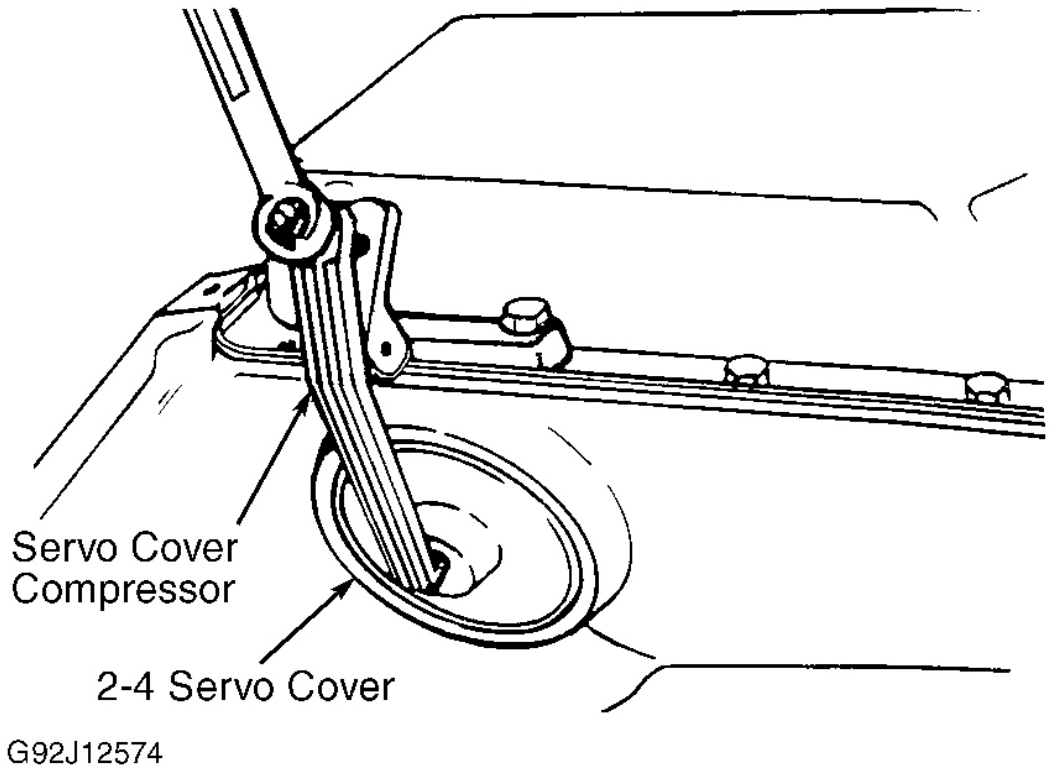


Fig. 31: Compressing Servo Cover
Courtesy of GENERAL MOTORS CORP.

CHECKING SERVO PIN LENGTH

1. Remove 4th apply piston and return spring. See **Fig. 32** . Remove retainer ring, washer, apply pin spring and 2nd apply piston pin. Install Piston Compressor (J-22269-01) on 2nd apply piston. See **Fig. 33** .
2. Remove retainer ring, cushion spring and spring retainer. Install Band Apply Pin Tool (J-33037) and apply pin. See **Fig. 34** . Apply 100 INCH lbs. (11 N.m) torque. Note White line on band apply tool.
3. White line should appear within gauge slot if pin length is correct. If White line does not appear, inspect

2-4 band and reverse input drum for wear and damage during disassembly.

4. Servo pin length must be checked during reassembly. Servo pin is preset and must not be readjusted. See **SERVO PIN SPECIFICATIONS** under **2-4 BAND & SERVO ASSEMBLY** under TRANSMISSION REASSEMBLY.

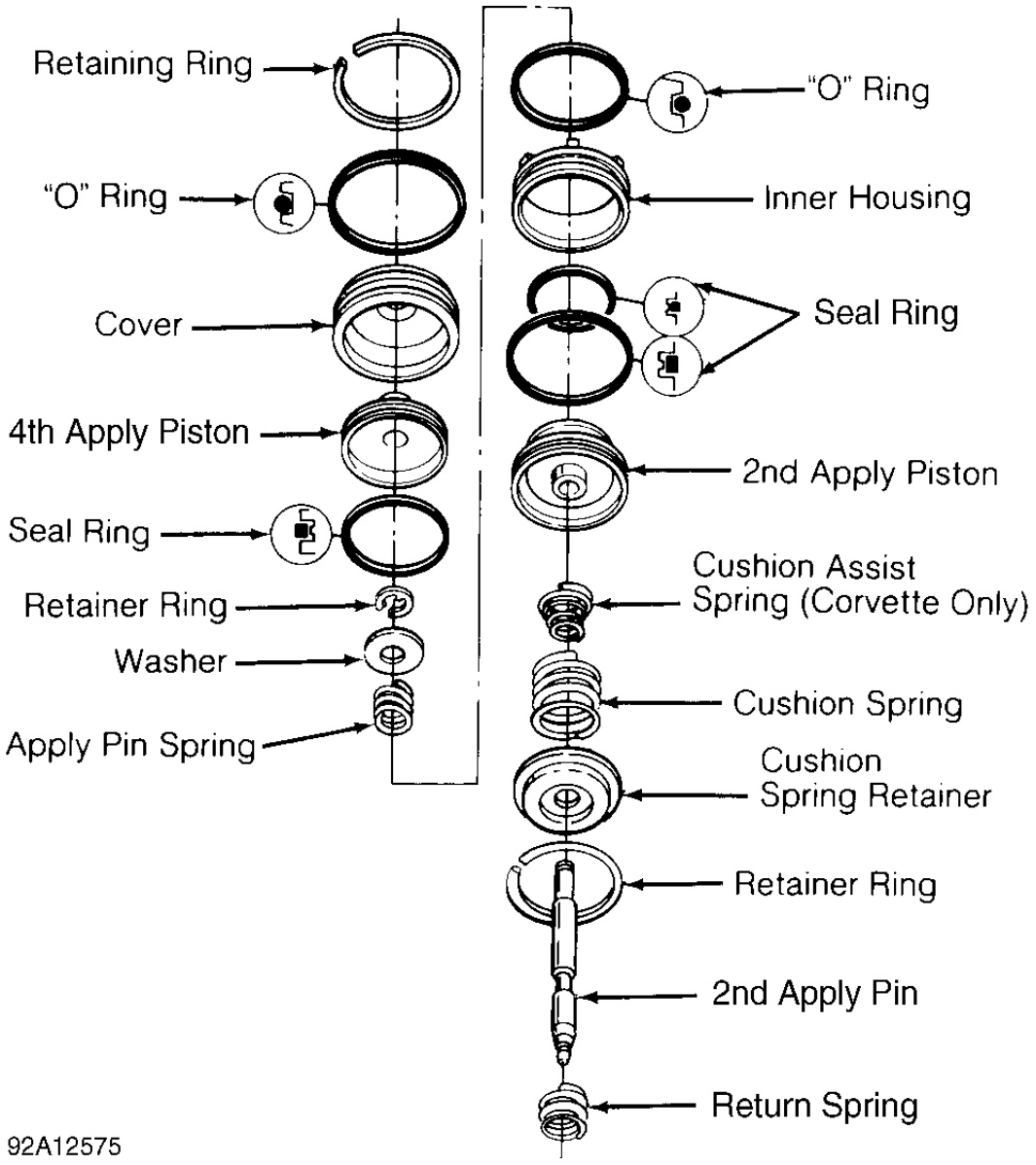


Fig. 32: Exploded View of 2-4 Servo Assembly
Courtesy of GENERAL MOTORS CORP.

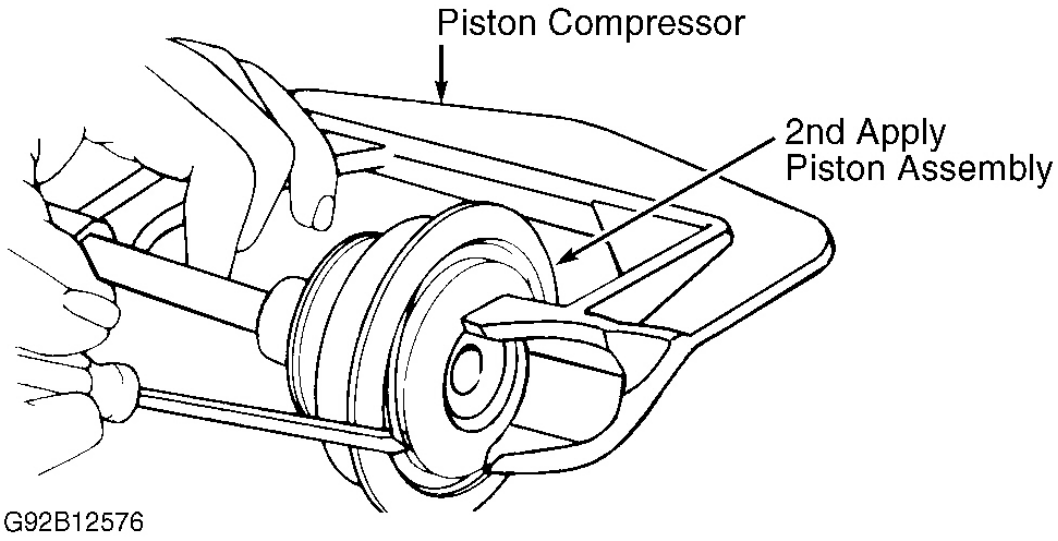


Fig. 33: Compressing 2nd Apply Piston
Courtesy of GENERAL MOTORS CORP.

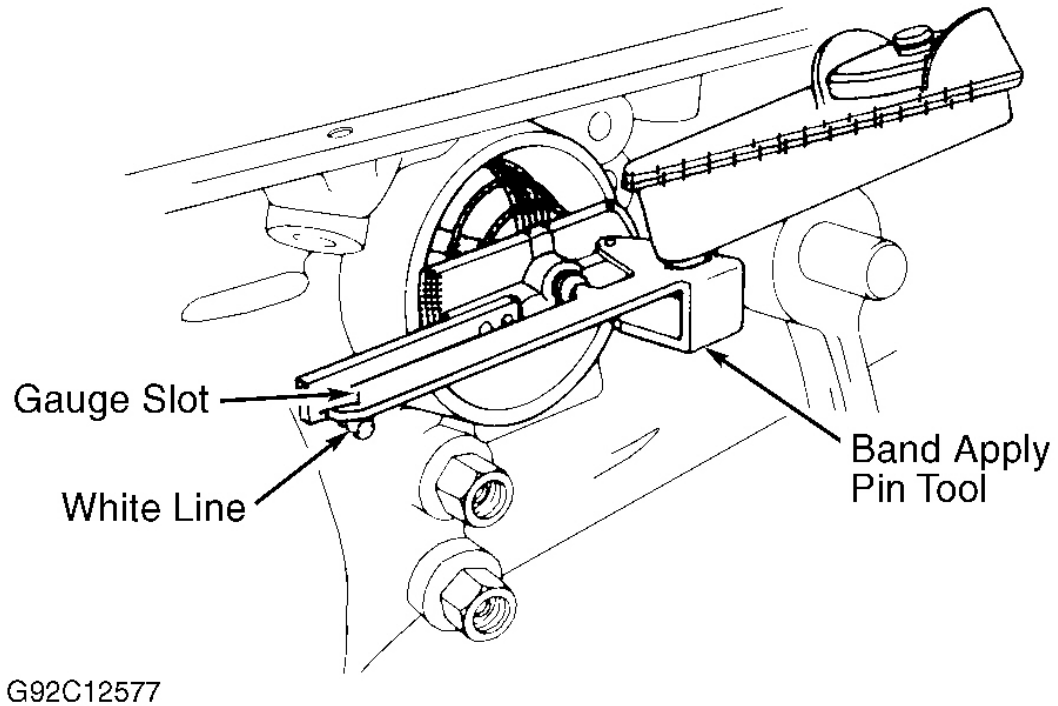


Fig. 34: Measuring Servo Pin Length

Courtesy of GENERAL MOTORS CORP.

EXTENSION HOUSING

1. Remove governor cover and "O" ring. Remove governor assembly. On models with mechanical speedometers, remove retaining bolt, washer and retainer. Remove speedometer driven gear assembly, driven gear and "O" ring.
2. On models with internal speed sensor, remove retaining bolt and washer. Remove speed sensor assembly and "O" ring. Remove extension housing retaining bolts. Remove extension housing and seal. Remove output shaft sleeve and "O" ring (if equipped). Speed sensor rotor must be removed from output shaft.
3. Install Gear Puller (J-21427-01) and Adapter (J-8433) on rotor. Pull rotor from output shaft. On models with mechanical speedometers, push retaining clip tab. Remove speedometer gear from output shaft.

VALVE BODY & AUXILIARY VALVE BODY

Remove valve body and auxiliary valve body. See **VALVE BODY** and **AUXILIARY VALVE BODY** under ON-VEHICLE SERVICE. Note bolt length and location during removal. Note check ball location for reassembly reference.

1-2 ACCUMULATOR & SPACER PLATES

1. Remove solenoid retaining bolts. Remove solenoid and "O" ring. Remove wiring harness, and note location for reassembly reference. Carefully remove accumulator cover retaining bolts, 1-2 accumulator cover and pin assembly.
2. Remove 1-2 accumulator piston, seal and spring. Remove spacer plate, and note check ball and filter locations. Remove spring, 3-4 accumulator piston and pin. Note spacer plate and gasket locations. See **Fig. 35** for check ball and filter locations.

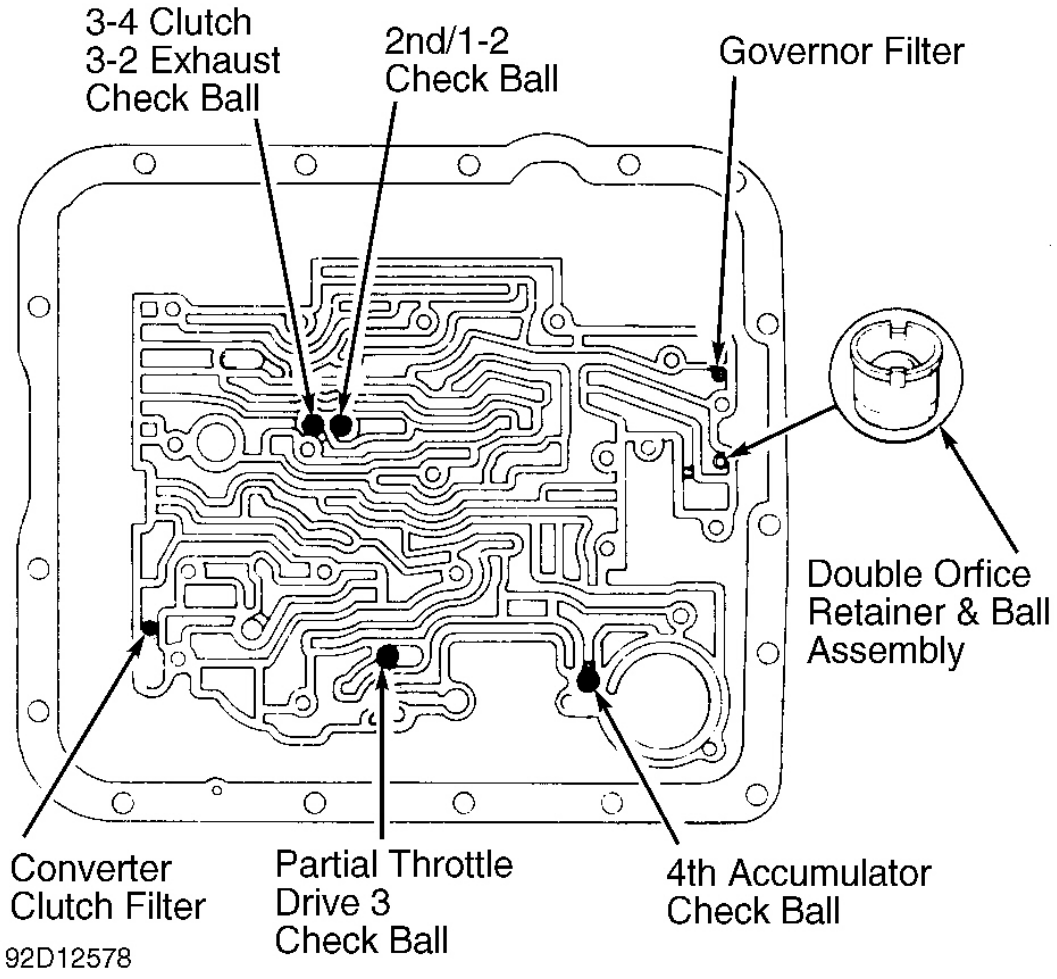


Fig. 35: Locating Check Balls & Filters
Courtesy of GENERAL MOTORS CORP.

TRANSMISSION END PLAY CHECK

NOTE: Check transmission end play before disassembly. If end play is not within specification, check for damaged components.

1. Position transmission with oil pump facing up. Remove one oil pump retaining bolt and washer, and replace it using an 11" bolt and lock nut. Install Pump Remover/End Play Fixture (J-24773-A) and End Play Adapter (J-25022-A) on end of turbine shaft. See **Fig. 36** .
2. Clamp dial indicator on long bolt. Position indicator tip on end play fixture. Zero dial indicator. Pull up on pump remover. Note dial indicator reading. Transmission end play should be .005-.036" (.13-.91 mm). Check for worn components if end play is not within specification.

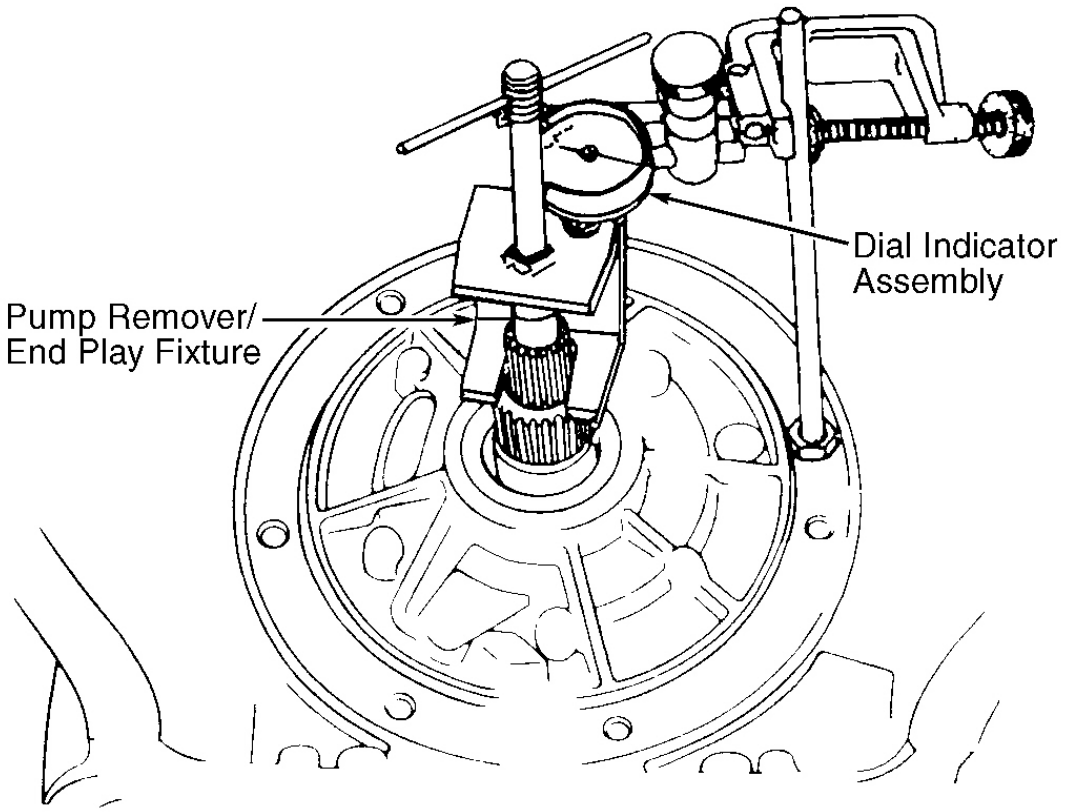


Fig. 36: Checking Transmission End Play
Courtesy of GENERAL MOTORS CORP.

OIL PUMP, INPUT CLUTCH & REVERSE CLUTCH

1. Ensure solenoid assembly and oil filter are removed before oil pump removal. Remove oil pump retaining bolts. Using Oil Pump Remover (J-37789-A) and Adapter (J-39119), pull pump assembly free from case.
2. Remove oil pump seal and gasket. Remove reverse input clutch-to-pump thrust washer from pump. Remove reverse and input clutch assembly by lifting out along with turbine shaft.

2-4 BAND & INPUT GEAR SET

1. Remove band anchor pin from case. See **Fig. 37** . Remove 2-4 band assembly from case. Remove input sun gear. See **Fig. 38** .

CAUTION: Output shaft must be held in place when removing input carrier retaining ring.

2. Install Output Shaft Support (J-29837) on output shaft. See **Fig. 39** . Remove input carrier to output shaft retaining ring. Remove input carrier. Remove output shaft. Remove input carrier thrust washer from reaction carrier shaft.

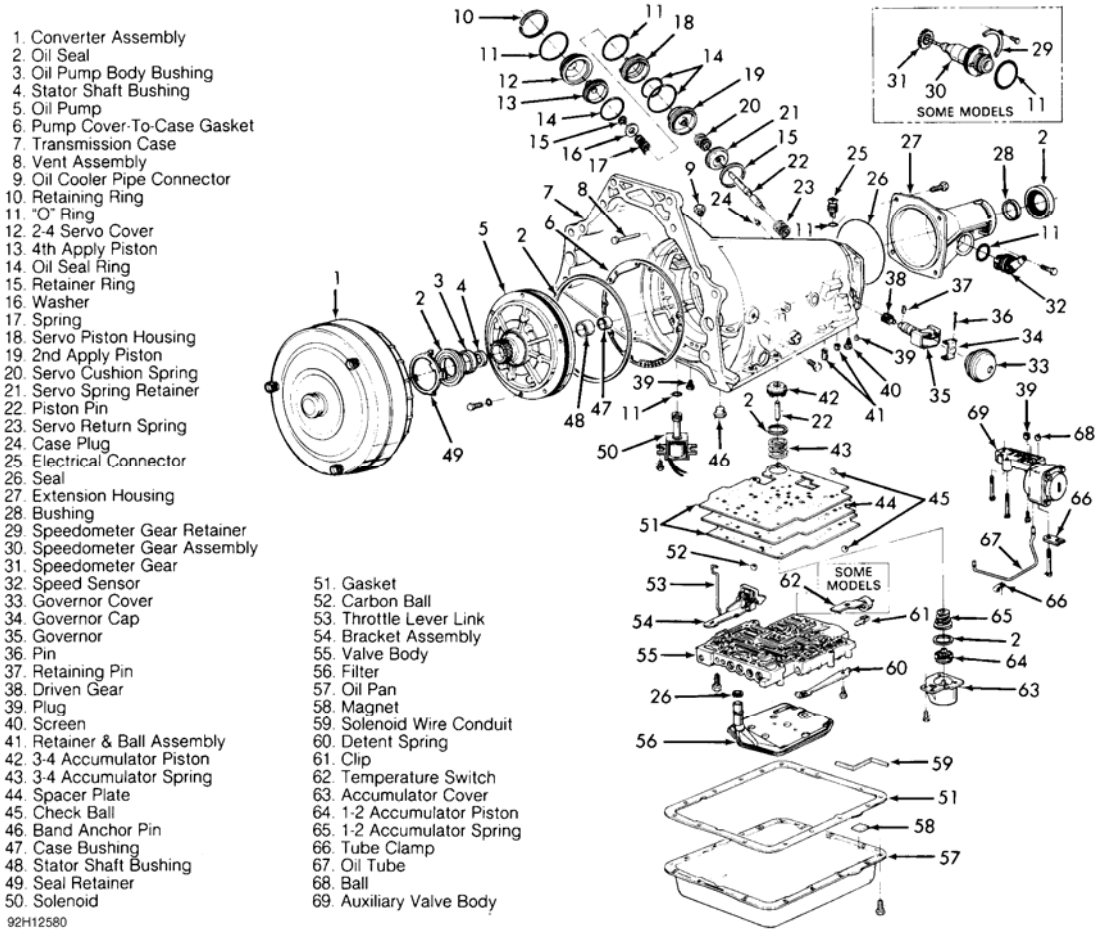


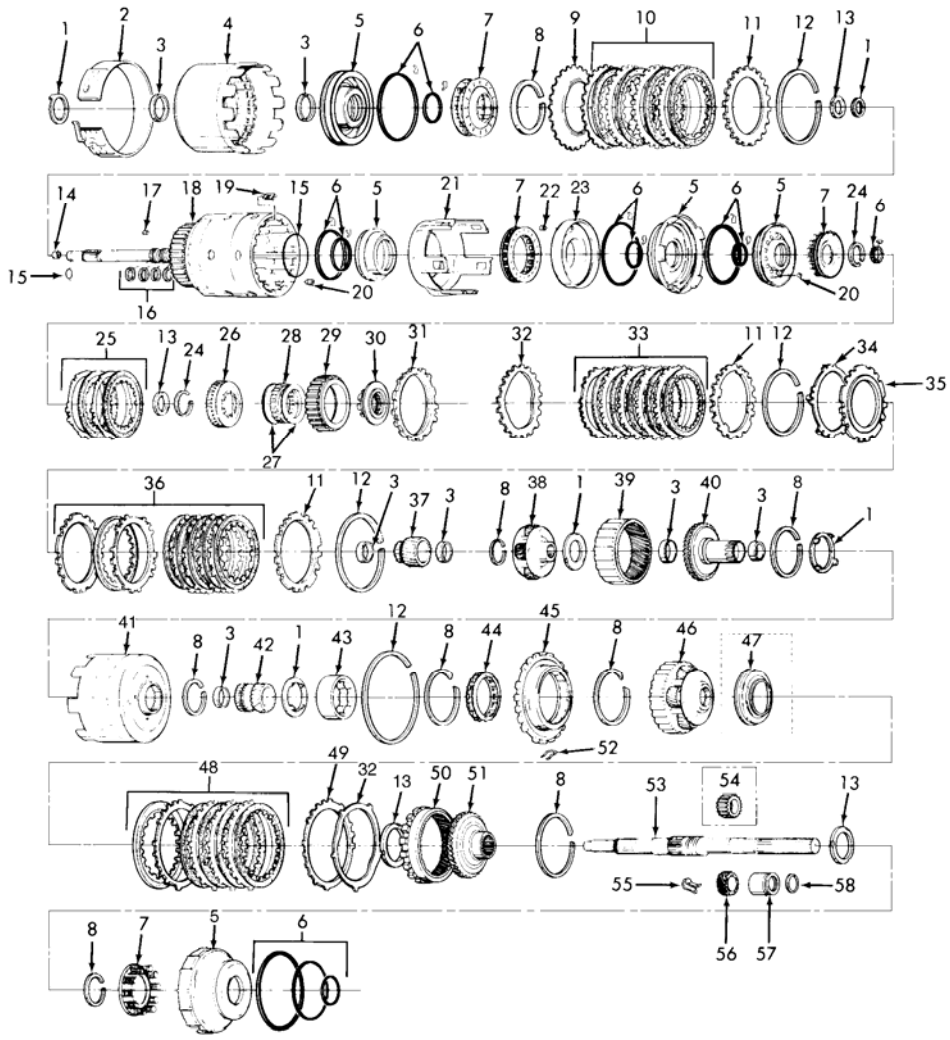
Fig. 37: Exploded View of 4L60 Transmission External Components
Courtesy of GENERAL MOTORS CORP.

LEGEND FOR FIGURE 37

Item No.	Description
1	Converter Assembly
2	Oil Seal
3	Oil Pump Body Bushing
4	Stator Shaft Bushing
5	Oil Pump
6	Pump Cover-To-Case Gasket
7	Transmission Case
8	Vent Assembly

9	Oil Cooler Pipe Connector
10	Retaining Ring
11	"O" Ring
12	2-4 Servo Cover
13	4th Apply Piston
14	Oil Seal Ring
15	Retainer Ring
16	Washer
17	Spring
18	Servo Piston Housing
19	2nd Apply Piston
20	Servo Cushion Spring
21	Servo Spring Retainer
22	Piston Pin
23	Servo Return Spring
24	Case Plug
25	Electrical Connector
26	Seal
27	Extension Housing
28	Bushing
29	Speedometer Gear Retainer
30	Speedometer Gear Assembly
31	Speedometer Gear
32	Speed Sensor
33	Governor Cover
34	Governor Cap
35	Governor
36	Pin
37	Retaining Pin
38	Driven Gear
39	Plug
40	Screen
41	Retainer & Ball Assembly
42	3-4 Accumulator Piston
43	3-4 Accumulator Spring
44	Spacer Plate
45	Check Ball
46	Band Anchor Pin
47	Case Bushing
48	Stator Shaft Bushing
49	Seal Retainer
50	

	Solenoid
51	Gasket
52	Carbon Ball
53	Throttle Lever Link
54	Bracket Assembly
55	Valve Body
56	Filter
57	Oil Pan
58	Magnet
59	Solenoid Wire Conduit
60	Detent Spring
61	Clip
62	Temperature Switch
63	Accumulator Cover
64	1-2 Accumulator Piston
65	1-2 Accumulator Spring
66	Tube Clamp
67	Oil Tube
68	Ball
69	Auxiliary Valve Body



1. Thrust Washer
2. 2-4 Band
3. Bushing
4. Reverse Input Clutch Housing
5. Piston
6. Seal
7. Spring Assembly
8. Retainer Ring
9. Belleville Plate
10. Clutch Assembly
11. Backing Plate
12. Retaining Ring
13. Bearing Assembly
14. Check Valve
15. "O" Ring
16. Oil Seal
17. Cup Plug
18. Input Shaft Housing Assembly
19. Clutch Boost Spring Assembly
20. Check Ball
21. 3-4 Clutch Apply Ring
22. Retainer & Ball Assembly
23. Forward Clutch Housing
24. Snap Ring
25. Overrun Clutch Assembly
26. Overrun Clutch Hub
27. Sprag Retainer Rings
28. Sprag Assembly
29. Forward Clutch Race
30. Sprag Retainer & Race
31. Forward Clutch Apply Plate
32. Waved Plate
33. Forward Clutch Assembly
34. Clutch Retainer Plate
35. 3-4 Clutch Apply Plate
36. 3-4 Clutch Assembly
37. Input Sun Gear
38. Input Carrier Assembly
39. Input Internal Gear
40. Reaction Carrier Shaft
41. Reaction Sun Gear Shell
42. Reaction Sun Gear
43. Low-Reverse Clutch Race
44. Low-Reverse Roller Clutch
45. Support
46. Reaction Carrier Assembly
47. Oil Deflector
48. Low-Reverse Clutch Assembly
49. Spacer Plate
50. Internal Reaction Gear
51. Internal Reaction Gear Support
52. Retainer Spring
53. Output Shaft
54. Rotor
55. Clip
56. Speedometer Drive Gear
57. Output Shaft Sleeve
58. Output Shaft Seal

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Fig. 38: Exploded View of 4L60 Transmission Internal Components
Courtesy of GENERAL MOTORS CORP.

LEGEND FOR FIGURE 38

Item No.	Description
1	Thrust Washer
2	2-4 Band

3	Bushing
4	Reverse Input Clutch Housing
5	Piston
6	Seal
7	Spring Assembly
8	Retainer Ring
9	Belleville Plate
10	Clutch Assembly
11	Backing Plate
12	Retaining Ring
13	Bearing Assembly
14	Check Valve
15	"O" Ring
16	Oil Seal
17	Cup Plug
18	Input Shaft Housing Assembly
19	Clutch Boost Spring Assembly
20	Check Ball
21	3-4 Clutch Apply Ring
22	Retainer & Ball Assembly
23	Forward Clutch Housing
24	Snap Ring
25	Overrun Clutch Assembly
26	Overrun Clutch Hub
27	Sprag Retainer Rings
28	Sprag Assembly
29	Forward Clutch Race
30	Sprag Retainer & Race
31	Forward Clutch Apply Plate
32	Waved Plate
33	Forward Clutch Assembly
34	Clutch Retainer Plate
35	3-4 Clutch Apply Plate
36	3-4 Clutch Assembly
37	Input Sun Gear
38	Input Carrier Assembly
39	Input Internal Gear
40	Reaction Carrier Shaft
41	Reaction Sun Gear Shell
42	Reaction Sun Gear
43	Low-Reverse Clutch Race
44	

	Low-Reverse Roller Clutch
45	Support
46	Reaction Carrier Assembly
47	Oil Deflector
48	Low-Reverse Clutch Assembly
49	Spacer Plate
50	Internal Reaction Gear
51	Internal Reaction Gear Support
52	Retainer Spring
53	Output Shaft
54	Rotor
55	Clip
56	Speedometer Drive Gear
57	Output Shaft Sleeve
58	Output Shaft Seal

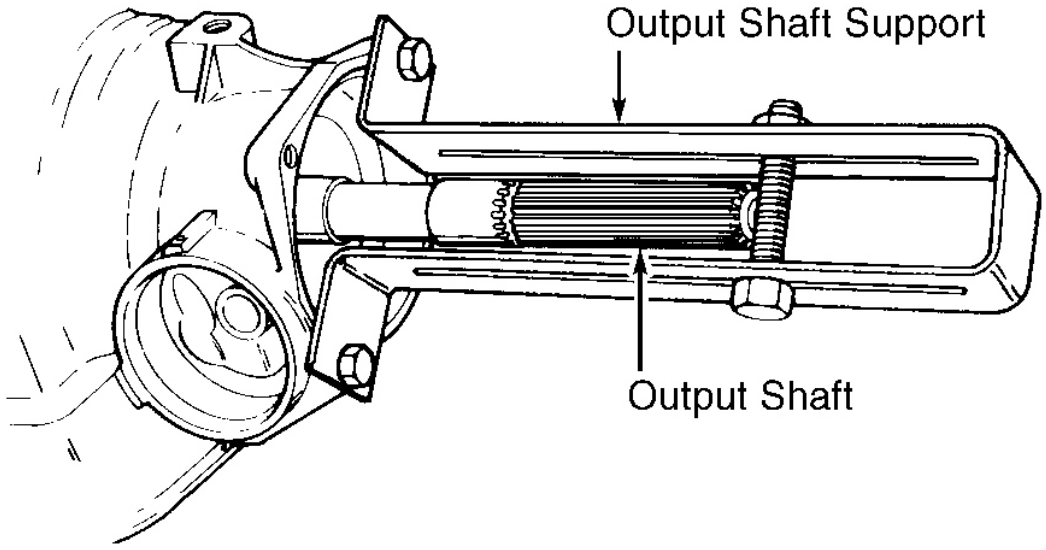


Fig. 39: Installing Output Shaft Support
Courtesy of GENERAL MOTORS CORP.

REACTION GEAR SET

1. Remove input internal gear and reaction carrier shaft. Remove reaction sun shell and thrust washer. Remove sun shell-to-clutch race thrust washer. Remove support-to-case retaining ring.

2. Remove spring retainer from low-reverse support. Remove reaction sun gear, low-reverse clutch race, clutch roller, support assembly and reaction carrier assembly. See **Fig. 38** .
3. Remove low-reverse clutch assembly. Note locations of components. Remove internal reaction gear and bearing assembly. Remove internal reaction support-to-case bearing assembly.

LOW-REVERSE CLUTCH

NOTE: Parking pawl may require removal to access low-reverse clutch.

1. Remove parking lock bracket retaining bolts. Remove lock bracket. Using screw extractor, remove shaft plug. Remove parking pawl shaft, parking pawl and return spring if necessary.
2. Using Clutch Spring Compressor (J-23327), compress low reverse clutch spring retainer. Remove spring retaining ring and low-reverse spring assembly. Remove low-reverse clutch piston by applying air pressure in case apply passage. See **Fig. 40** .

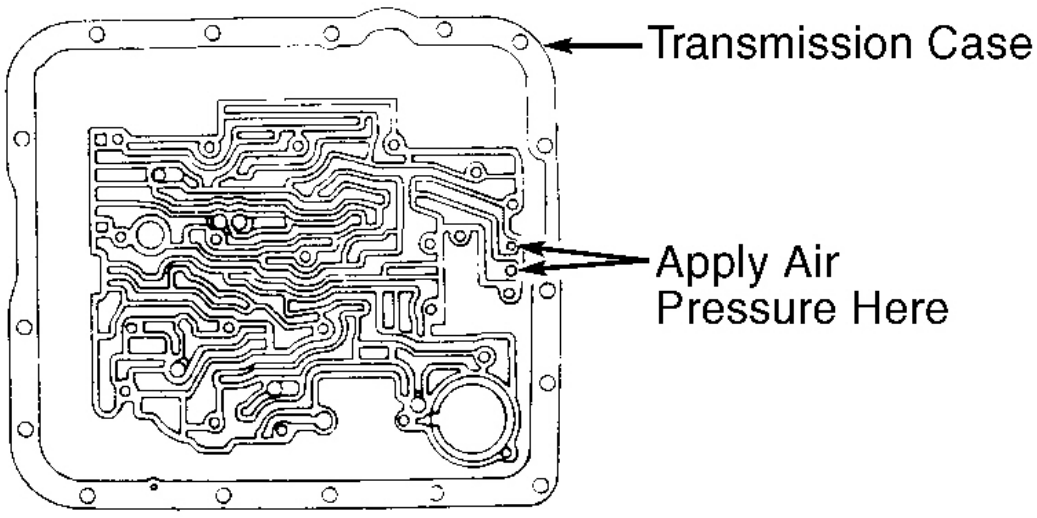


Fig. 40: Removing Low-Reverse Clutch Piston
Courtesy of GENERAL MOTORS CORP.

INNER MANUAL SHAFT LINKAGE

Remove manual shaft nut. Remove manual shaft and retainer. Remove parking lock actuator assembly and inner detent lever. Using a screwdriver, remove manual shaft seal from transmission case.

3RD ACCUMULATOR CHECK VALVE

1. Check 3rd accumulator check valve before removing it. **DO NOT** remove check valve unless it is leaking. Install servo assembly in bore. Install servo cover and retaining ring. See **Fig. 31** . Pour clean solvent in bore. Inspect for leaks in transmission case. Replace check valve assembly if it leaks. See **Fig. 41** . Remove servo assembly.
2. For check valve removal, install No. 4 screw extractor in check valve assembly. Remove check valve. Ensure bore is free of burrs. Installation tool must be made to ensure proper installation depth is obtained. Using a 3/8" O.D. rod, scribe indicator mark at 1.653" (41.98 mm) from end of rod. Install check valve until scribe mark on rod is flush with case. See **Fig. 41** .

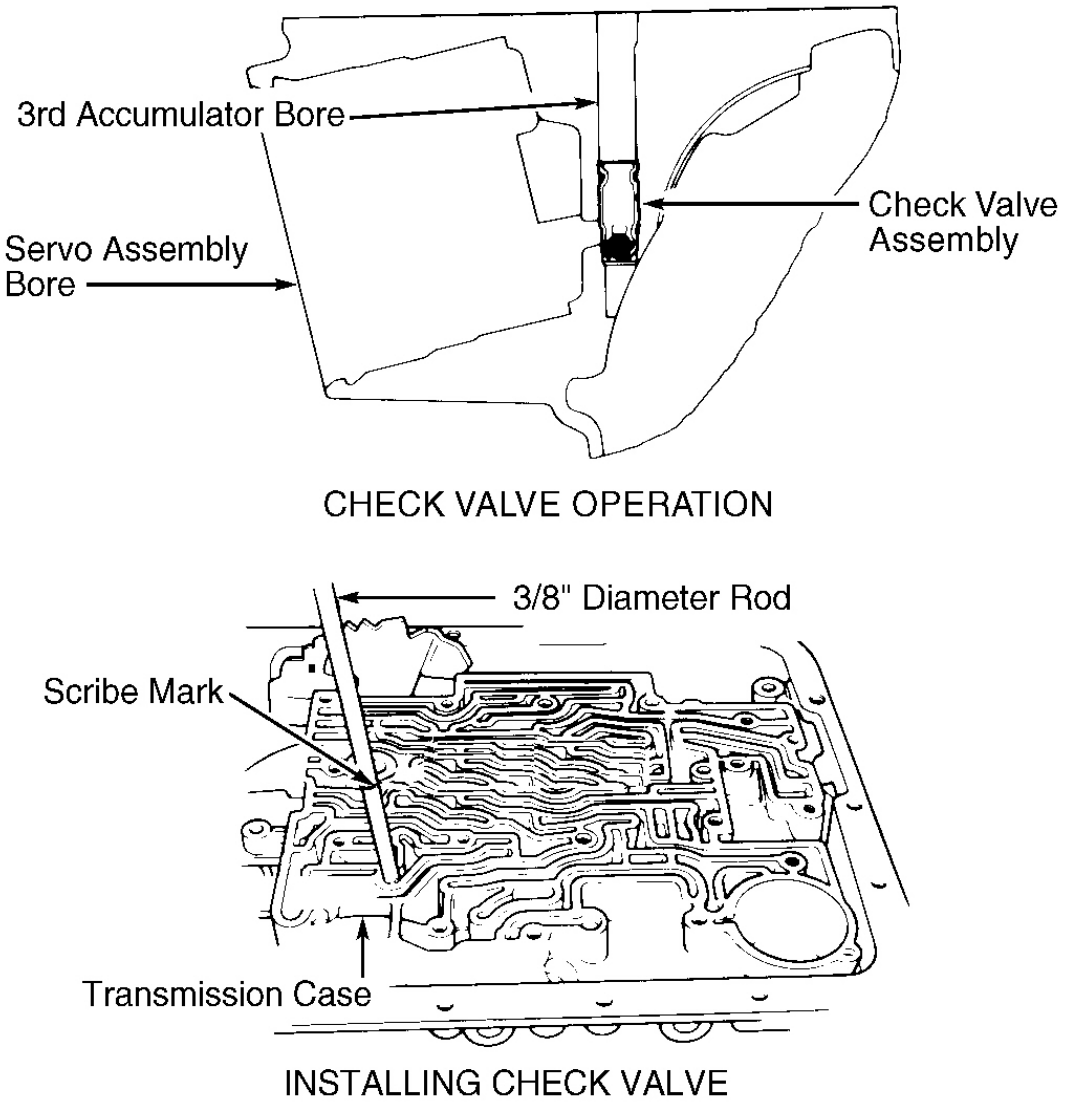


Fig. 41: Installing 3rd Accumulator Check Valve Assembly
Courtesy of GENERAL MOTORS CORP.

COMPONENT DISASSEMBLY & REASSEMBLY

REVERSE INPUT CLUTCH

Disassembly

1. Remove retaining ring from reverse input clutch housing. Remove backing plate, steel clutch plates, composition plates and Belleville plate. See **Fig. 38** . Note number of clutch plates used. Using Clutch Spring Compressor (J-23327), compress reverse input spring assembly.
2. Remove retaining ring. Remove clutch spring compressor, and remove spring assembly. Remove piston and seals. Thickness of composition plates should be .068-.074" (1.73-1.88 mm). Selective thickness backing plate is also used.

Inspection

1. Inspect backing plate and steel clutch plates for damage, distortion, flatness and burred edges. Inspect composition plates for signs of excessive heat and damage to tang areas.
2. Inspect spring retainer for distortion. Check piston for deformation or damage in seal ring area. Inspect clutch housing bushings for wear. Inspect clutch housing for dishing. Replace worn or damaged components as necessary. If components are replaced, ensure replacement components match those previously used.

NOTE: Soak clutch plates in ATF before installation.

Reassembly

1. Lubricate piston seals with ATF. Install seals on piston with seal lips facing away from hub. Install piston in clutch housing. Use small feeler gauge to position seals. Install spring assembly with large opening toward piston.
2. Using clutch spring compressor, compress spring assembly. Install retaining ring. Remove spring compressor.

CAUTION: Ensure correct retaining ring is used. Ensure reverse input clutch retaining ring is not interchanged with low-reverse retaining ring.

3. Install Belleville plate. Note number of clutch plates to be installed. Install clutch plates. Install backing plate with chamfered side upward. Install retaining ring. Clearance must be checked to determine proper selective backing plate usage. Apply even pressure to backing plate using fingers.
4. **DO NOT** apply excessive pressure or Belleville plate will be distorted, resulting in inaccurate measurement. Using feeler gauge, measure clearance between retaining ring and backing plate. Clearance should be 040-.076" (1.02-1.94 mm). Select backing plate to obtain correct clearance. See **BACKING PLATE SPECIFICATIONS** .

BACKING PLATE SPECIFICATIONS

Identification	Thickness: In. (mm)

5	.293-.299 (7.44-7.59)
6	.267-.273 (6.78-6.93)
7	.241-.247 (6.12-6.27)
8	.215-.221 (5.46-5.61)

VALVE BODY

NOTE: Valves are held in valve body by pins. Use care when removing pins. Valves may be under spring pressure. Note locations of all components during disassembly for reassembly reference.

Disassembly

1. Remove valve train, and note direction of valve installation. Remove all outside pins by pushing pins through from rough casting side of valve body. See **Fig. 42** .
2. Remove blind pins using modified drill bit. Grind taper on end of a 1/16" drill bit. Drive drill bit into pin. Pull drill bit and pin straight out. Remove pressure switches. Note locations of all components.

Inspection

1. Clean all components with clean solvent, and dry using compressed air. Ensure all components are placed in sequence for correct reassembly.
2. Inspect valves and sleeves for scoring and cracks. Ensure valves move freely in bores. Inspect valve body for cracks and scored bores. Inspect machined surfaces for damage. Inspect springs for damaged coils. Replace damaged components as necessary.

Reassembly

For reassembly, reverse disassembly procedure. Ensure all components are installed in correct location. See **Fig. 42** . Ensure pins are fully installed and do not extend into machined areas. Note position of valve lands and bushing passages.

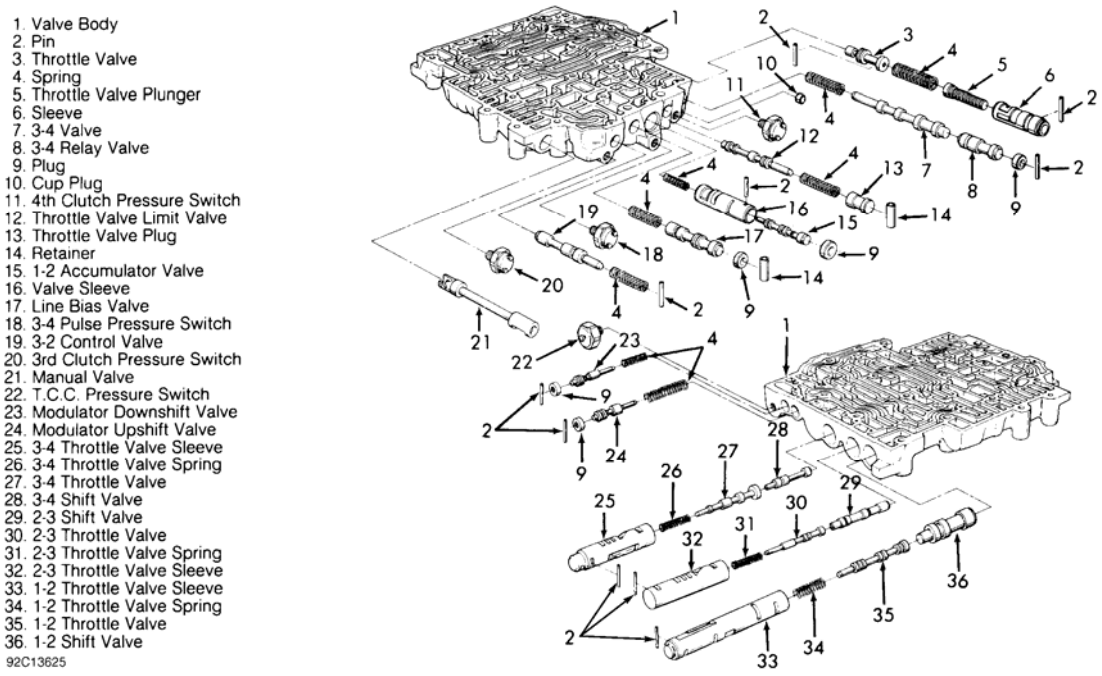


Fig. 42: Exploded View of Valve Body
Courtesy of GENERAL MOTORS CORP.

LEGEND FOR FIGURE 42

Item No.	Description
1	Valve Body
2	Pin
3	Throttle Valve
4	Spring
5	Throttle Valve Plunger
6	Sleeve
7	3-4 Valve
8	3-4 Relay Valve
9	Plug
10	Cup Plug
11	4th Clutch Pressure Switch
12	Throttle Valve Limit Valve
13	Throttle Valve Plug
14	Retainer
15	1-2 Accumulator Valve
16	Valve Sleeve
17	Line Bias Valve
18	3-4 Pulse Pressure Switch
19	3-2 Control Valve

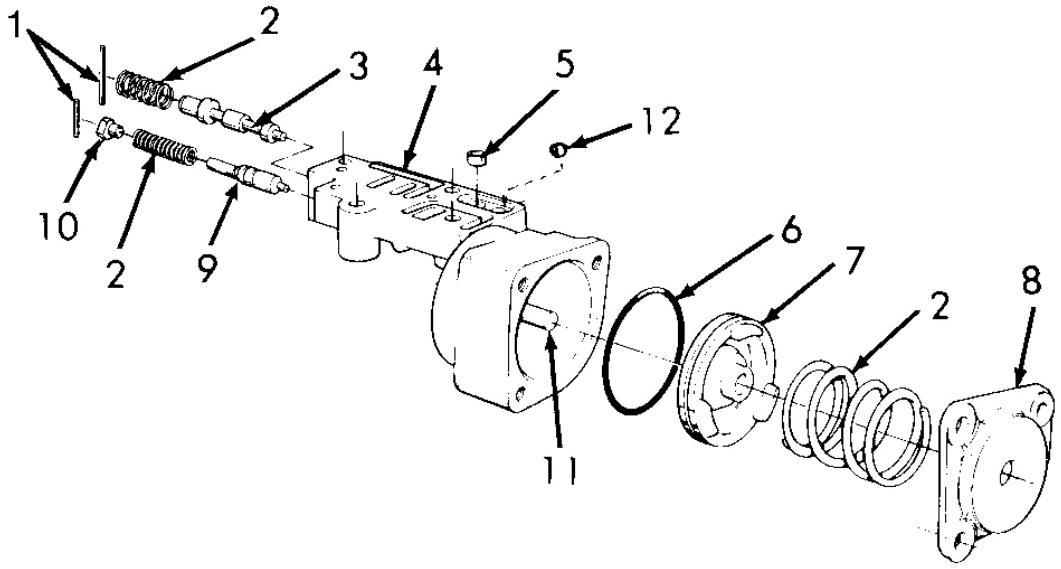
20	3rd Clutch Pressure Switch
21	Manual Valve
22	T.C.C. Pressure Switch
23	Modulator Downshift Valve
24	Modulator Upshift Valve
25	3-4 Throttle Valve Sleeve
26	3-4 Throttle Valve Spring
27	3-4 Throttle Valve
28	3-4 Shift Valve
29	2-3 Shift Valve
30	2-3 Throttle Valve
31	2-3 Throttle Valve Spring
32	2-3 Throttle Valve Sleeve
33	1-2 Throttle Valve Sleeve
34	1-2 Throttle Valve Spring
35	1-2 Throttle Valve
36	1-2 Shift Valve

AUXILIARY VALVE BODY

CAUTION: Note location of all components during disassembly for reassembly reference.

Disassembly

1. Auxiliary valve cover is under spring tension. Carefully remove cover retaining bolts. Remove cover and spring. Remove piston and "O" ring. See **Fig. 43** . Press low-overrun clutch valve downward.
2. Remove pin, spring and low-overrun valve. Remove pin, abuse valve stop, spring and abuse valve. **DO NOT** remove orifice plug unless it is damaged.



1. Pin
2. Spring
3. Low-Overrun Clutch Valve
4. Auxiliary Valve Body
5. Orifice Plug
6. "O" Ring
7. Piston
8. Cover
9. Abuse Valve
10. Abuse Valve Stop
11. Piston Pin
12. Check Ball

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Fig. 43: Exploded View of Auxiliary Valve Body
Courtesy of GENERAL MOTORS CORP.

LEGEND FOR FIGURE 43

Item No.	Description
1	Pin
2	Spring
3	Low-Overrun Clutch Valve
4	Auxiliary Valve Body
5	Orifice Plug
6	"O" Ring
7	Piston
8	Cover
9	Abuse Valve
10	Abuse Valve Stop
11	Piston Pin
12	Check Ball

Inspection

1. Clean all components with clean solvent, and dry using compressed air. Inspect piston for cracks and roughness. Inspect valves and piston bore for nicks and scoring. Inspect springs for damaged coils.
2. Ensure valves operate freely in bores. Inspect valve body for damaged or rough machined surfaces. Ensure overrun valve pin is tight in valve body. If pin has come out of valve body, loss or slipping in "D" range may occur or forward and overrun clutches may be burnt.

Reassembly

1. Install orifice plug (if removed) using 3/8" diameter rod. Orifice plug must be positioned flush with mounting surface. For reassembly, reverse disassembly procedure.
2. Install NEW "O" ring on piston. Lubricate "O" ring with petroleum jelly. Install piston and spring. Install cover and retaining bolts. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

LOW-REVERSE SUPPORT ASSEMBLY

CAUTION: Note direction roller clutch is installed in support. Roller clutch must be installed in proper direction to provide lockup of inner race when rotated.

Disassembly & Inspection

Remove inner race and retainer ring. Remove roller clutch assembly. Check inner race for damage and surface finish. See **Fig. 44** . Inspect roller and springs for damage and distortion. Inspect support for loose cam, cracks and damaged surface finish. Replace damaged components as necessary.

Reassembly

1. Install roller clutch assembly in low-reverse support. See **Fig. 44** . Place support in case with hub facing downward. Install inner race. Rotate inner race while pushing downward. Use care not to damage roller and springs during installation.
2. Ensure inner race is fully seated. Bottom tangs will be flush with carrier hub when fully seated. Inner race should rotate clockwise and lock counterclockwise with clutch hub downward. Insert support retainer spring into case between case lug and open notch in support.

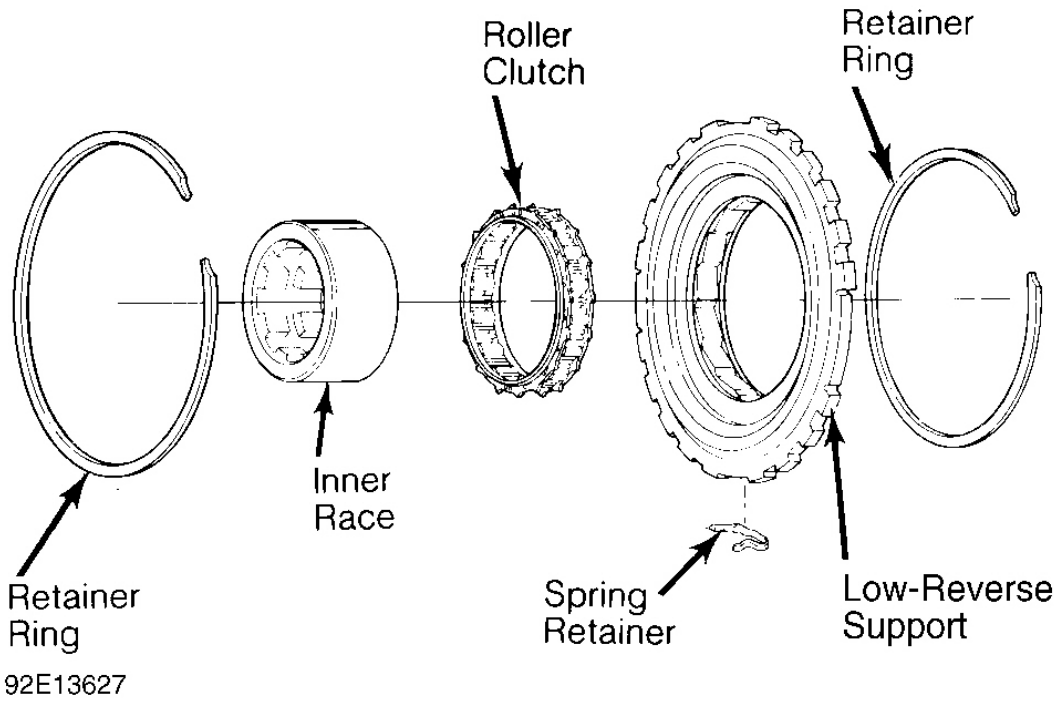


Fig. 44: Exploded View of Low-Reverse Clutch Assembly
Courtesy of GENERAL MOTORS CORP.

INPUT CLUTCH & FORWARD CLUTCH HUB ASSEMBLY

Disassembly

1. Position input clutch assembly on bench. Remove snap ring retaining 3-4 clutch backing plate. Remove backing plate. Remove 3-4 clutch plates. Note number and locations of components. Remove 3-4 apply plate and clutch ring retainer. See **Fig. 38** .
2. Remove forward clutch retainer ring, and remove backing plate. Remove forward clutch sprag assembly and bearing. Remove input housing seal. Remove forward clutch plates. Note number and locations of components.
3. Remove waved and apply plates. Remove overrun clutch plates (2 steel and 2 composition). Using Clutch Spring Compressor (J-23456) and Adapter (J-25018-A), compress overrun clutch spring retainer.
4. Remove retainer ring. Remove compressor, adapter and spring assembly. Remove overrun piston and forward clutch piston. Remove seals from pistons. Note direction of seals. Remove forward clutch housing. Remove 3-4 spring, 3-4 apply ring and piston. Remove "O" ring from input housing. Remove turbine shaft seal rings.
5. Remove forward clutch race. Remove snap ring and overrun clutch hub. Remove sprag retainer and race. Note direction race is installed. Use care not to lose rollers from roller cage.

Inspection

1. Inspect sprag assembly for weak or damaged springs and retainers and worn rollers. Inspect overrun clutch hub for spline damage, excessive wear and open oil passages. Inspect retainer and race for spline damage, surface wear and damaged ring grooves.
2. Replace sprag assembly if damaged. Inspect forward clutch race for spline damage, excessive wear and open oil passages. Inspect input shaft and housing for spline damage, wear and open feed passages.
3. Inspect 3 sealing balls located in rear of turbine shaft for tightness. Turbine shaft contains one open lubrication hole. Ensure orifice plug is installed.
4. Inspect check valve located in end of turbine shaft for tightness in shaft. Check ball must move freely. Replace check valve if damaged. Inspect turbine shaft seal areas for roughness and burrs.
5. Inspect check ball located in input housing for free operation. Pour solvent in check ball, and check for leakage. Replace check ball if it leaks.
6. Inspect pistons for wear, damage and porosity. Inspect spring assemblies for damage and distortion. Inspect steel clutch plates for damaged tang ends, high or burned spots, excessive wear and distortion caused by heat.
7. Inspect composition clutch plates for damaged tang ends, burning, flaking and excessive wear. Inspect retainer rings for distortion and damage. Check backing plates for flatness and distortion. Inspect clutch apply rings for distortion and damaged tangs.
8. Inspect forward clutch housing check ball for proper operation (if equipped). Inspect housing for cracks and damage in seal areas. Inspect bearings for excessive wear, flatness, damage and flat rollers.

Reassembly

1. If turbine shaft check valve requires replacement, straighten tangs of retainer and remove check ball. Using No. 4 screw extractor, remove check valve. Remove retainer from shaft by turning.
2. Position check valve in turbine shaft. Using a 3/8" diameter rod, drive retainer and check valve assembly into shaft. Check valve must be positioned 1/8" below top surface of turbine shaft. Ensure check ball is loose.
3. For input housing check ball replacement, drive retainer and ball assembly from housing using 1/4" diameter drift. Install NEW check ball assembly using 1/4" drift. Check ball assembly should seat on housing shoulder. Assemble forward clutch sprag assembly.
4. Install sprag assembly in forward clutch race. Notches located in sprag must face upward. See **Fig. 45** . Install retainer ring on sprag retainer and race. Retainer ring flange must face away from retainer and race.

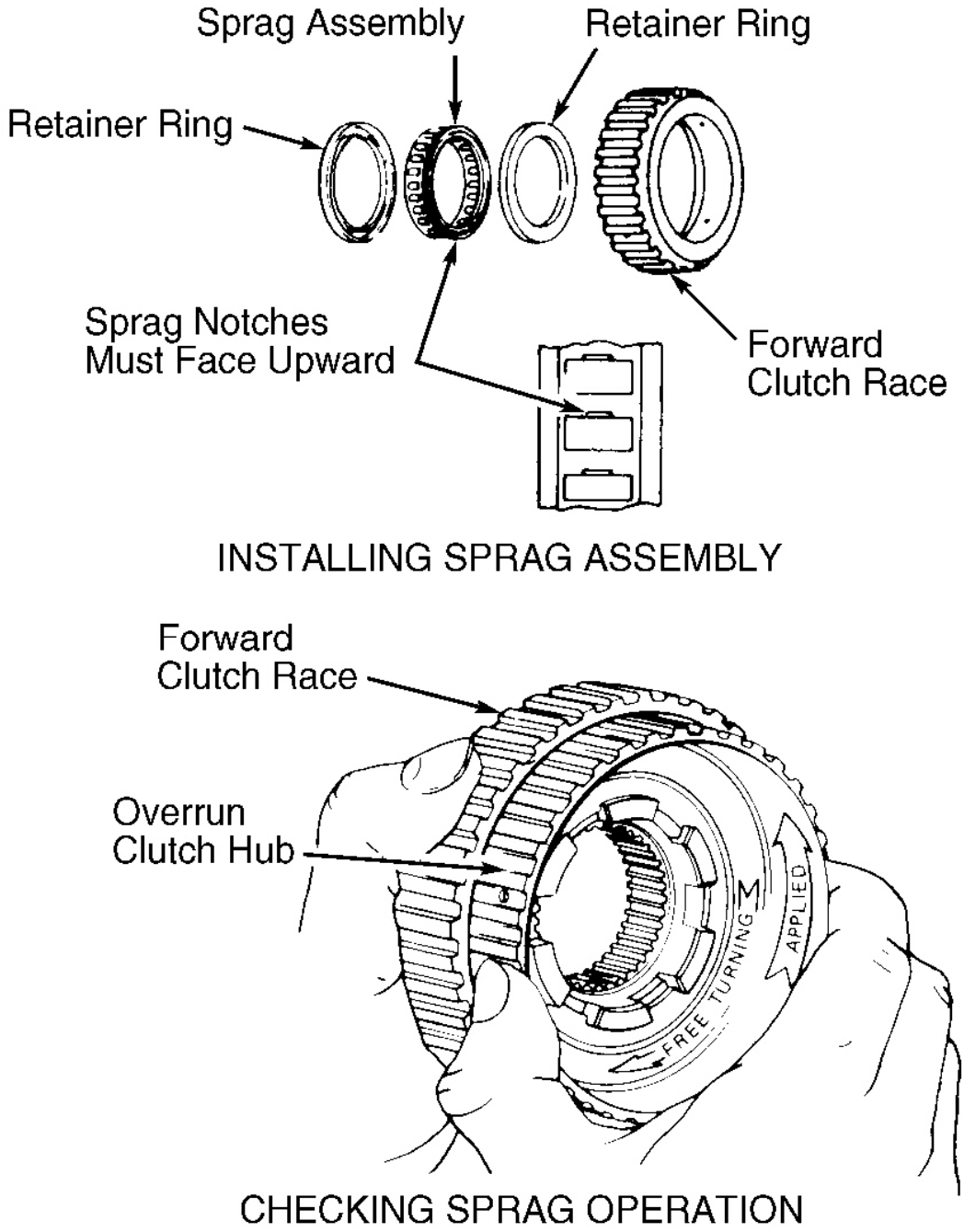


Fig. 45: Installing & Checking Clutch Sprag Assembly
Courtesy of GENERAL MOTORS CORP.

5. Hold outer race in left hand. Support sprag assembly. Install sprag retainer and race in sprag assembly.

Rotate retainer and race left. Install remaining retainer ring. Install overrun clutch hub. Install snap ring.

6. Check sprag operation. Holding forward clutch race, rotate overrun clutch hub. Overrun clutch hub should turn freely clockwise and lock counterclockwise. See **Fig. 45** . If lock operation is not correct, sprag assembly is installed backward.
7. Place input clutch housing with turbine shaft downward. Install 3-4 piston seals with lips facing away from hub. Install 3-4 piston in input housing. Rotate and gently push downward. Ensure piston is fully seated. Measure 3-4 clutch apply ring from end of arm to base area that sets against 3-4 piston. Different size apply rings are used.
8. Install 3-4 clutch apply ring. Install "O" ring in input clutch housing. Install forward clutch housing. Install seals on forward clutch piston with lips facing away from tangs.
9. Install forward clutch piston in forward clutch housing. Install 3-4 spring on 3-4 clutch apply ring. Install forward clutch assembly on3-4 spring assembly. Align forward clutch piston legs with tangs of 3-4 apply ring. Install Seal Protector (J-29883) on input housing.
10. Install 3-4 apply ring and forward clutch assembly in input clutch housing. Hold apply ring tangs while installing. **DO NOT** allow forward clutch piston to separate from assembly. Ensure assembly is firmly seated.
11. Install Seal Protector (J-29883) on input housing. Install overrun clutch piston with hub facing upward. Remove seal protector. If fully seated, overrun piston should be 3/16" below top of snap ring groove in input housing hub.
12. Install spring assembly on overrun piston. Install Spring Compressor (J-23456) and Adapter (J-25018-A) on spring assembly. Compress springs, and install snap ring. Remove spring compressor. Install input housing seal.

NOTE: Soak clutch plates in ATF before installation. Coat all seals and "O" rings with ATF. Coat thrust washers and bearings with petroleum jelly.

13. Install 4 overrun clutch plates, starting with steel plate. Align wide notches with case lugs. Install remaining clutch plates, alternating steel and composition plates.
14. Install bearing assembly on input clutch hub. Bearing inner race must face input housing hub. Ensure bearing is centered. Align clutch plate tabs. Install forward clutch sprag assembly in input housing. Align overrun clutch hub with clutch plates.
15. Install forward clutch apply plate in input housing. Install waved forward clutch plate. Ensure all plates are aligned with input housing tangs. Starting with steel plate, install clutch plates, alternating steel and composition plates. Install backing plate and retainer ring.
16. Using 2 feeler gauges, measure clearance between backing plate and retainer ring. Clearance should be .030-.063" (.75-1.60 mm). Install correct amount of clutch plates for model application. See **FORWARD CLUTCH PLATE SPECIFICATIONS** . Install backing plate with chamfered side upward. For backing plate thickness, see **FORWARD CLUTCH BACKING PLATE SPECIFICATIONS** . Install retainer ring.

FORWARD CLUTCH PLATE SPECIFICATIONS

Plate Type	Quantity	Thickness In. (mm)
Apply	1	.169 (4.29)
Waved Steel	1	.070 (1.78)

Flat Steel	5	.090 (2.29)
Composition	5	.070 (1.78)
Backing	1	Selective

FORWARD CLUTCH BACKING PLATE SPECIFICATIONS

Identification	Thickness In. (mm)
A	.274-.278 (6.96-7.06)
B	.251-.255 (6.38-6.48)
C	.228-.232 (5.79-5.89)
D	.205-.208 (5.20-5.28)
E	.180-.185 (4.57-4.70)

17. Install steel plate, composition plate and backing plate in reverse order of disassembly. Install clutch plates and backing plate with chamfered side upward. Install retainer ring.
18. Using feeler gauge, measure clearance between backing plate and first composition plate. Clearance is different depending on transmission model. See **3-4 CLUTCH PLATE SPECIFICATIONS** .
19. Select proper backing plate to obtain correct clearance. See **3-4 BACKING PLATE SPECIFICATIONS** . Air check all clutches by applying air pressure at feed holes in turbine shaft.
20. During overrun clutch test, air pressure will blow past forward clutch piston seals and exit out forward clutch feed hole in turbine shaft. Turbine shaft seals require sizing and should be installed just before oil pump installation.

3-4 CLUTCH PLATE SPECIFICATIONS

Plate Type	Quantity	Thickness In. (mm)
Stepped Apply	1	.183 (4.65)
Flat Steel (1)	1	.070 (1.78)
Flat Steel (2)	5 Or 6	.070 (1.78)
Composition (3)	5 Or 6	.079 (2.01)
Backing	1	Selective

(1) Same spline configuration as apply plate.

(2) 6 plates on FBM, MBM and SAM models.

(3) 5 plates on FBM, MBM and SAM models.

3-4 BACKING PLATE SPECIFICATIONS

Identification	Thickness In. (mm)
FBM & SAM Models	
5	.251-.259 (6.38-6.58)
6	.218-.226 (5.54-5.74)
All Others	
7	.186-.194 (4.72-4.93)

8	.153-.161 (3.89-4.09)

OIL PUMP ASSEMBLY

Disassembly

1. Remove reverse input clutch drum-to-pump thrust washer, pump-to-case gasket and pump-to-case oil seal ring from pump assembly. Remove pump cover retaining bolts. Separate pump cover from pump body.

CAUTION: Pump slide spring and pressure relief spring rivet are under high pressure. To prevent possible injury, cover springs during removal.

2. Using needle-nose pliers, compress pump slide spring. Remove from pump by pulling straight out. Remove pump vane rings, pump vanes, pump rotor and rotor guide from pump pocket.
3. Remove slide from pump pocket. Remove slide seal and seal support from pump slide. See **Fig. 46** . Remove pivot pin and pivot pin spring. Remove seal ring and "O" ring from pump slide. Remove seal retainer and seal from pump body.
4. Check condition of pump bushing. If bushing is in good condition, **DO NOT** remove it. Push inward on converter clutch valve stop to compress spring. Remove snap ring. Remove valve stop, converter clutch apply valve and springs.
5. Using a small punch, remove pressure relief spring retaining rivet. Remove relief spring and ball. Remove oil screen and "O" ring from pump cover. Using a small screwdriver, compress throttle valve boost valve bushing. Remove snap ring.
6. Remove Throttle Valve (T.V.) boost bushing, throttle valve boost valve and reverse boost valve sleeve. Remove reverse boost valve, pressure regulator valve spring and pressure regulator valve.

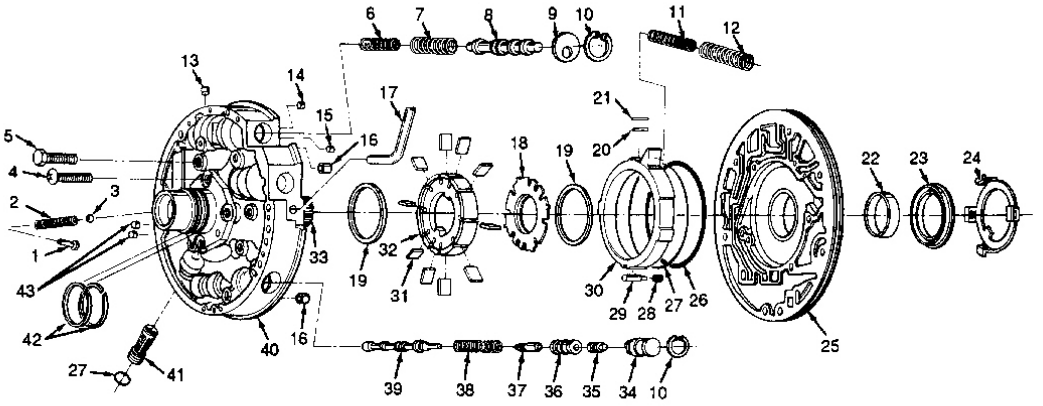


Fig. 46: Exploded View of Oil Pump Assembly
Courtesy of GENERAL MOTORS CORP.

LEGEND FOR FIGURE 46

Item No.	Description
1	Rivet
2	Pressure Relief Spring
3	Check Ball
4	Stator Shaft Screw
5	Cover-To-Body Bolt
6	Converter Clutch Spring (Inner)
7	Converter Clutch Spring (Outer)
8	Converter Clutch Valve
9	Valve Stop
10	Snap Ring
11	Pump Slide Spring (Inner)
12	Pump Slide Spring (Outer)
13	Oil Pump Cover Plug
14	Oil Pump Cooler Feed Plug
15	Oil Pump Converter Clutch Signal Plug
16	Retainer & Ball Assembly
17	Auxiliary Accumulator Valve Tube

18	Rotor Guide
19	Pump Vane Ring
20	Seal Support
21	Pump Slide Seal
22	Bushing
23	Seal
24	Seal Retainer
25	Pump Body
26	Seal Ring
27	"O" Ring
28	Pivot Pin Spring
29	Pivot Pin
30	Pump Slide
31	Vane
32	Rotor
33	Stator Shaft
34	T.V. Boost Bushing
35	T.V. Boost Valve
36	Boost Valve Sleeve
37	Reverse Boost Valve
38	Regulator Valve Spring
39	Pressure Regulator Valve
40	Pump Cover
41	Screen
42	Oil Seal Ring
43	Oil Pump Air Bleed Plug

Inspection

1. Inspect all valves, springs, sleeves and bushings for chips, burrs, distortion and freeness in bores. Check pressure relief ball and spring for damage and distortion, especially after metal contamination. Low main line pressure will exist if ball and spring are damaged.

   NOTE: Use compressed air to blow out all passages, especially converter passage between TCC apply valve and stator support shaft. Metal particles commonly get lodged inside passage.

2. Inspect pump cover screen and "O" ring for wear and damage. Clean pump body and cover. Check all bores for obstructions. Inspect mating sides of cover and body for scoring, flatness and damage between channels. Check channels for dirt and damaged passages. Inspect stator shaft and pump body bushings for damage.
3. Inspect rotor and slide for scoring, cracks and damage. Check rotor guide and pump vane rings for excessive wear and damage. Inspect all seals for damage. Measure pump rotor and slide thickness in

undamaged area if replacement is required. Replacement components must be same size as those removed to provide proper end clearance.

Reassembly

1. Lay pump body flat on bench, and install rotor into rotor and slide cavity. Lay straight edge over pump body and rotor. Use feeler gauge to check rotor-to-stator (cover) clearance. Specification is .0010-.0015" (.025-.038 mm). If pump cover is replaced, ensure reverse input feed hole in stator hub is same diameter as in hub removed.
2. Install "O" ring and seal ring in groove on back side of pump slide. Retain seal ring using petroleum jelly. Install pivot pin and spring in pump body. Install pump slide. Notch in pump slide must align with pivot pin hole and with flat oil seal ring facing downward in pump pocket. Install slide seal and support.
3. Install pump vane ring into pump pocket. Coat rotor guide with petroleum jelly. Install rotor guide on rotor. Install rotor and guide into pump pocket with guide toward pump pocket. Install vanes in rotor. Install vane guide ring. Compress pump slide spring and install into pump pocket. All components must be even with pump body surface. Install "O" ring on pump screen, and install screen in pump cover with seal end last.
4. Using Seal Installer (J-25016), install seal in pump body. Install seal retainer. Install pressure relief check ball and spring in pump cover. Install retaining rivet. Install converter clutch valve springs and converter clutch valve. Install valve stop and snap ring. Install pressure regulator valve and spring in pump cover. See **Fig. 46** .
5. Coat T.V. boost valve with petroleum jelly. Install T.V. boost valve in throttle valve bushing. Long area on valve must be positioned in large hole of bushing. Coat reverse boost valve with petroleum jelly. Install reverse boost valve in boost valve sleeve with small end first. Install reverse boost valve sleeve in pump cover.
6. Install T.V. boost valve sleeve in pump cover. Install snap ring. Ensure snap ring is fully seated. Install pump cover on pump body. Install retaining bolts finger tight. Align pump body and cover using Alignment Strap (J-21368). Place bolt through pump-to-case bolt hole. Tighten retaining bolts to specification. See **TORQUE SPECIFICATIONS** . Remove alignment strap.
7. Position NEW pump-to-case gasket on pump, and retain it using petroleum jelly. Install oil seal rings on stator hub. Retain oil seal rings using petroleum jelly. Install NEW pump-to-case oil seal on cover. Ensure seal is not twisted. Coat seal with ATF. Install pump-to-drum thrust washer. Ensure tangs on washer engage with holes in hub.

2-4 SERVO ASSEMBLY

Disassembly

1. Remove 4th apply piston and housing from 2nd apply piston assembly. Remove return spring from apply pin. Install Piston Compressor (J-22269-01) on second apply piston. See **Fig. 33** .
2. Compress 2nd servo apply piston assembly. Remove retainer ring. Separate 2nd apply piston, spring and retainer. Remove retainer ring, washer and spring from apply pin, and remove pin. Remove all oil seal rings. See **Fig. 32** .

Inspection

Inspect all pistons for porosity and damage. Check for ring groove damage and servo bore in case for any wear which may cut servo seals. Check all springs and oil seal rings for distortion and damage.

Reassembly

Different servo piston housings and 2nd apply pistons are used for different applications. If servo piston housing or 2nd apply piston is replaced, inside dimension of components must be checked. Measure inside of piston housing and 2nd apply piston. Dimension must be same as original. To assemble, reverse disassembly procedure. Coat seals with petroleum jelly before assembly.

CLEANING & INSPECTION

TRANSMISSION CASE

Cleaning & Inspection

1. Clean case with solvent, and dry using compressed air. Inspect case assembly for damage, cracks and damaged bolt hole threads. Inspect valve body surface for flatness and land damage. Using compressed air, check case oil passages for restrictions and blockage.
2. Inspect case internal clutch plate lugs for damage and wear. Inspect speedometer, servo and accumulator bores for damage. Inspect all snap ring grooves for damage. Inspect governor support pin for proper length. Measure distance from governor cover surface to end of governor support pin.
3. Governor support pin length should be 3.30" (83.8 mm) measured from governor cover surface to end of support pin. Incorrect pin length may result in damaged governor gear. Replace transmission case if damaged. Ensure replacement case contains a ribbed area in valve body area. Rib area must be present for use with auxiliary valve body.

CASE ATTACHING PARTS

Cleaning & Inspection

1. Clean all components with clean solvent, and dry using compressed air. Inspect 1-2 and 3-4 accumulator components for damage to pistons or housing. Inspect for flatness and condition of accumulator, oil passage plate and gasket.
2. Inspect wiring harness leads and connectors for damage. Inspect coil and all connections for damage. Inspect speedometer gear and clip for tooth damage and distortion.

REACTION & INPUT GEAR SETS, LOW-REVERSE CLUTCH & SUPPORT

Cleaning & Inspection

1. Clean all components with clean solvent, and dry using compressed air. Inspect reaction and input carriers for pinion gear damage, excessive wear and improper staking of pinion pins.
2. Inspect carrier bearings for heat damage, flatness and roller condition by rotating top thrust washer. Check bearing located inside reaction carrier. Place output shaft sleeve inside reaction carrier and input carrier.

3. Rotate sleeve and note smoothness of bearing operation. Replace carrier assembly if roughness is felt. Check pinion gear end play on reaction and input carriers.
4. Pinion gear end play should be .008-.024" (.20-.61 mm). Replace carrier if pinion gear end play is excessive. Inspect internal reaction gear and support for cracks and damaged splines. Inspect low-reverse clutch plates for wear and signs of excessive heat.
5. Inspect low-reverse clutch piston for roughness or damage in seal ring area. Inspect retainer ring and spring assembly for damage. Inspect sun and internal gears and supports for spline and bushing wear and damage. Replace damaged components as necessary.

TRANSMISSION REASSEMBLY

NOTE: To identify seals, bearings and thrust washers locations, see SEALS, BEARINGS & THRUST WASHERS under TRANSMISSION REASSEMBLY.

LOW-REVERSE CLUTCH

1. Place transmission in a vertical position. Ensure piston is same dimension as that removed if replacement is required. Different thickness pistons are used. Install seals on low-reverse clutch piston. Coat seals with petroleum jelly. Install piston into transmission case.
2. Align piston with notch in bottom of transmission case. Ensure piston is fully seated and parking pawl aligns with opening in piston wall. Install spring assembly with flat side of retainer upward. Using Spring Compressor (J-23327), compress springs past ring groove in case hub. Install retainer ring.
3. Remove spring compressor. Coat bearing assembly with petroleum jelly. Install bearing assembly on case hub with outside bearing race toward case hub. Install internal reaction gear and support. Install bearing assembly onto support with outside bearing race toward support. Install oil deflector (if equipped) and reaction carrier assembly in case. See **Fig. 38** . Ensure clutch plates are proper thickness.
4. Install correct number of clutch plates. See **LOW-REVERSE CLUTCH PLATE USAGE** . Ensure clutch plates align with splines of reaction carrier and case and that steel plates are aligned. Place waved plate on work bench. Install 5 composition plates and 4 steel plates alternately, starting with composition plate.

LOW-REVERSE CLUTCH PLATE USAGE

Type	No. Used	Thickness: In. (mm)
Flat Steel	4	.069 (1.75)
Composition	5	.088 (2.24)

5. Install low-reverse support. Apply light pressure to low-reverse support. **DO NOT** apply excessive pressure or waved plate will start to flatten, resulting in inaccurate measurement. Measure height of clutch pack from work bench to top of low-reverse support. Using height dimension, determine proper selective spacer plate to be used. See **SPACER PLATE SELECTION** .

SPACER PLATE SELECTION

Measured Clutch Pack Height In. (mm) (2)	(1) Plate Thickness In. (mm)

1.136-1.164 (28.85-29.57)	.066-.073 (1.67-1.85)
1.107-1.136 (28.12-28.85)	.094-.101 (2.39-2.57)
1.079-1.107 (27.41-28.12)	.122-.129 (3.10-3.28)

(1) Spacer plates are available in select sizes. Plate (8680439) has no identifying marks and is .066-.073" (1.67-1.85 mm) thick. All other plates have same GM part number (8680440) but are different thicknesses and have one of following stamped identifying marks: "0", "4" or "8".

(2) Clutch pack height is measured without spacer plate in position.

6. Place spacer plate between waved plate and first composition clutch plate with identification facing upward. Measure overall height of clutch pack. Overall height should be 1.20-1.24" (30.5-31.5 mm). Install clutch pack assembly in transmission case.
7. Install low-reverse support in case with hub downward. Install inner race by pushing downward while rotating until it is fully engaged. Bottom tangs will be flush with hub when fully installed. Install spring retainer in case between case lug and open notch in support. Install low-reverse retainer ring.

REACTION & INPUT GEAR SETS

1. Install snap ring on reaction sun gear (if removed). Install sun gear into reaction carrier. Install thrust washer on low-reverse clutch race. Install reaction sun gear shell on reaction sun gear.
2. Install thrust washer on reaction sun gear shell. Ensure thrust washer tangs engage on gear shell. Install input internal gear and reaction carrier shaft in sun gear shell. Carrier shaft splines must engage with reaction carrier. See **Fig. 38** .
3. Install thrust washer on reaction carrier shaft. Outer race must face toward reaction carrier shaft. Install output shaft in transmission. Ensure output shaft engages with all components.
4. Install Output Shaft Support (J-29837). Adjust support so output shaft is positioned upward as far as possible. Install input carrier assembly with hub end down on output shaft. Install NEW retainer ring on output shaft. Remove output shaft support. Install input sun gear, indexing gear end with input carrier pinions.

REVERSE INPUT ASSEMBLY & INPUT CLUTCH

Install selective thrust washer on input housing. Install bearing assembly on selective thrust washer. Inner race (Black) must go toward oil pump. Position reverse input assembly on input clutch assembly. Reverse input clutch plates must align with input clutch hub. Ensure all clutch plates are fully engaged.

REVERSE & INPUT CLUTCHES

Install reverse and input clutch assemblies in case as an assembly. Align 3-4 clutch plates of input assembly with input internal gear. Assembly is fully seated when reverse housing is just below oil pump face of case.

2-4 BAND & SERVO ASSEMBLY

1. Install 2-4 band in case. Align band anchor pin end with case pin hole. Install band anchor pin in case. Ensure band anchor pin aligns with end of 2-4 band.

2. Install 2-4 servo assembly into case, and index apply pin on band end. Check for proper engagement of apply pin on band end. Recheck 2-4 servo apply pin selection to ensure correct pin is installed. See **CHECKING SERVO PIN LENGTH** under TRANSMISSION DISASSEMBLY. Different length servo pins are available. See **SERVO PIN SPECIFICATIONS** . Select proper length servo pin.

SERVO PIN SPECIFICATIONS

Pin ID	Pin Length: In. (mm)
2 Rings	2.61-2.62 (66.3-66.5)
3 Rings	2.67-2.68 (67.8-68.1)
Wide Band	2.72-2.73 (69.1-69.3)

3. Install servo cover and "O" ring. Install Servo Cover Compressor (J-29714), and compress cover. Install cover retaining ring, indexing ring ends with slot in case.

SEALS, BEARINGS & THRUST WASHERS

NOTE: To identify seals, bearings and thrust washers locations, see Fig. 47 .

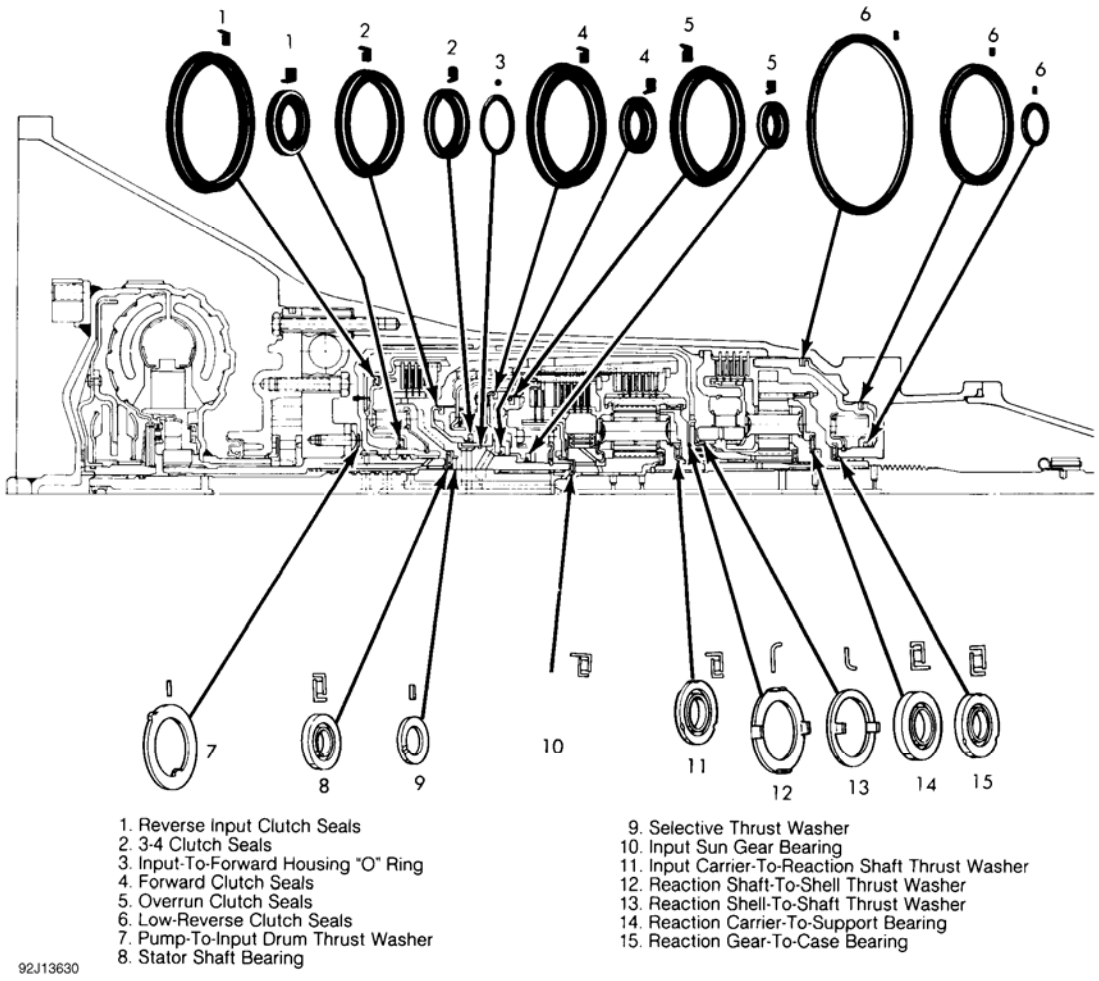


Fig. 47: Exploded View of Seals, Bearings & Thrust Washers
Courtesy of GENERAL MOTORS CORP.

LEGEND FOR FIGURE 47

Item No.	Description
1	Reverse Input Clutch Seals
2	3-4 Clutch Seals
3	Input-To-Forward Housing "O" Ring
4	Forward Clutch Seals
5	Overrun Clutch Seals
6	Low-Reverse Clutch Seals
7	Pump-To-Input Drum Thrust Washer
8	Stator Shaft Bearing
9	Selective Thrust Washer
10	Input Sun Gear Bearing
11	Input Carrier-To-Reaction Shaft Thrust Washer

12	Reaction Shaft-To-Shell Thrust Washer
13	Reaction Shell-To-Shaft Thrust Washer
14	Reaction Carrier-To-Support Bearing
15	Reaction Gear-To-Case Bearing

OIL PUMP ASSEMBLY

1. Turbine shaft seals should be installed just before oil pump installation. Position Seal Installer (J-36418-1) on input shaft. See **Fig. 48** . Adjustment screw in seal installer must be adjusted to obtain correct height for each seal installation. Install 4 turbine shaft seals.

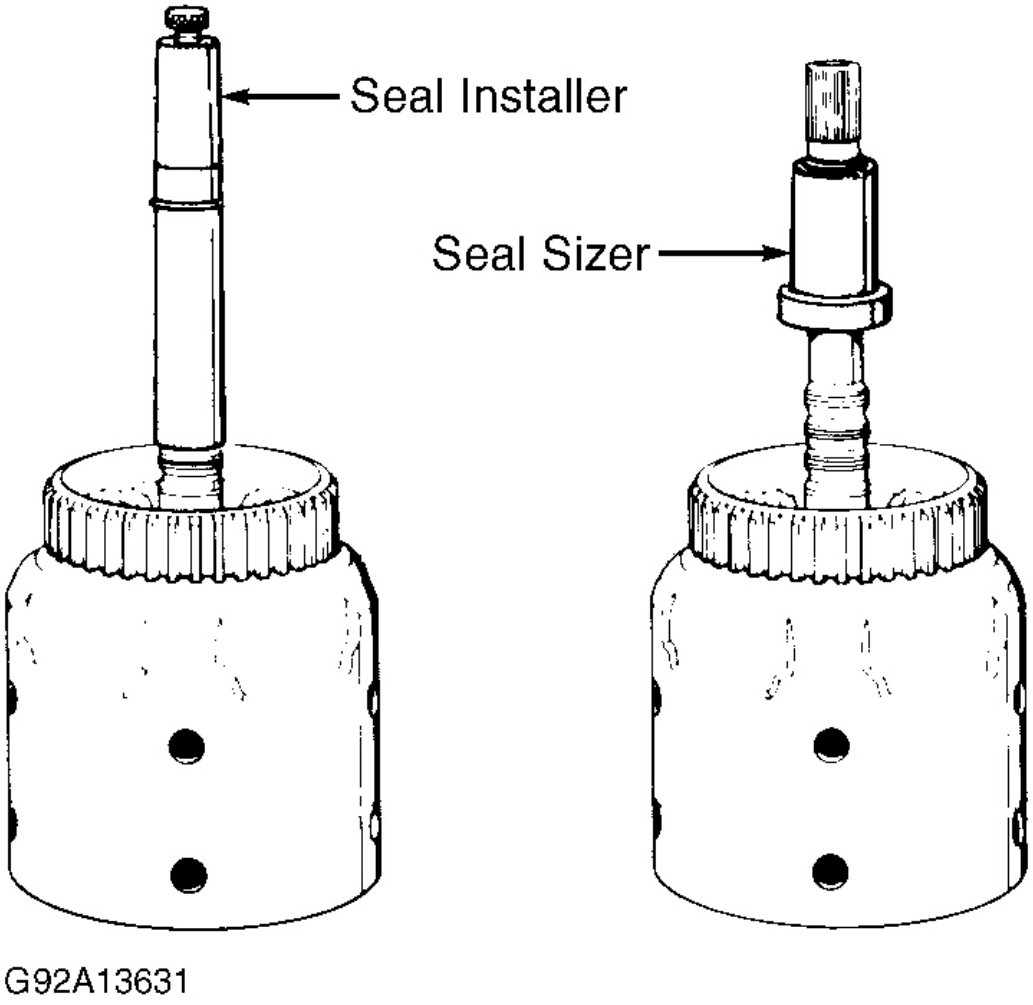


Fig. 48: Installing & Sizing Turbine Shaft Seals
Courtesy of GENERAL MOTORS CORP.

2. Turbine shaft seals must be sized using Seal Sizer (J-36418-2A) after installation. Install aligning pins in 2 opposing pump bolt holes in case. Ensure thrust washer is installed on rear of oil pump. Thrust washer can be retained using petroleum jelly.
3. Install pump into case, aligning filter and pressure regulator holes with holes in case. Install retaining bolts. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** . Place transmission in a horizontal position.
4. Turbine shaft should rotate by hand. If turbine shaft will not rotate, loosen pump retaining bolts and attempt to rotate shaft again. If shaft now turns, reverse and input assemblies have not been indexed properly or some other assembly problem has occurred, such as thrust washer not positioned properly.
5. Transmission end play should be checked. See **TRANSMISSION END PLAY CHECK** under TRANSMISSION DISASSEMBLY. Transmission end play should be .005-.036" (.13-.91 mm). If transmission end play is not within specification, thrust washer must be changed between oil pump and input housing.
6. Select proper thickness thrust washer. See **OIL PUMP THRUST WASHER SPECIFICATIONS** . Install thrust washer, and recheck end play. Install torque converter. Ensure converter hub is aligned with oil pump. Install torque converter retaining strap to hold converter.

OIL PUMP THRUST WASHER SPECIFICATIONS

Identification	Thickness: In. (mm)
67	.074-.078 (1.88-1.98)
68	.080-.084 (2.03-2.13)
69	.087-.091 (2.21-2.31)
70	.094-.098 (2.39-2.49)
71	.100-.104 (2.54-2.64)
72	.107-.111 (2.72-2.82)
73	.113-.118 (2.87-3.00)
74	.120-.124 (3.05-3.15)

1-2 ACCUMULATOR & SPACER PLATES

CAUTION: If spacer plate and gasket replacement is required, ensure NEW spacer plate and gasket are identical as those removed.

1. Install 3-4 accumulator piston pin in case. Install 3-4 piston seal on piston. Install 3-4 accumulator piston on pin. Legs of piston must face valve body.
2. Install 3-4 accumulator spring. Install check balls and oil screens in proper locations. Install special retainer and ball assembly. See **Fig. 35** and **Fig. 36** for check ball and filter installation locations. Install spacer plate gasket and spacer plate.
3. Install 1-2 accumulator spring, oil seal ring and 1-2 accumulator piston. Install accumulator cover and bolts. Tighten bolts to specification. See **TORQUE SPECIFICATIONS** .

VALVE BODY & AUXILIARY VALVE BODY

Install valve body and auxiliary valve body. See **VALVE BODY** and **AUXILIARY VALVE BODY** under

ON-VEHICLE SERVICE.

EXTENSION HOUSING

1. Install speedometer gear and retaining clip on output shaft. If output shaft has 2 locating holes, use hole nearest yoke on Corvette only. Install "O" ring in output shaft sleeve.
2. Using Seal Installer (J-25016), install output sleeve on output shaft. **DO NOT** position output sleeve past machined surface of output shaft. Install seal ring on extension housing.
3. Position extension housing on transmission case with speedometer bore on governor side of case. Install retaining bolts. Tighten bolts to specification. Using Seal Installer (J-21426), install oil seal in extension housing.
4. Install speedometer driven gear and fitting assembly. Install retainer and bolt. Tighten bolt to specification. See **TORQUE SPECIFICATIONS** . Install outside electrical connector and manual shift lever.

SERVICE BULLETINS

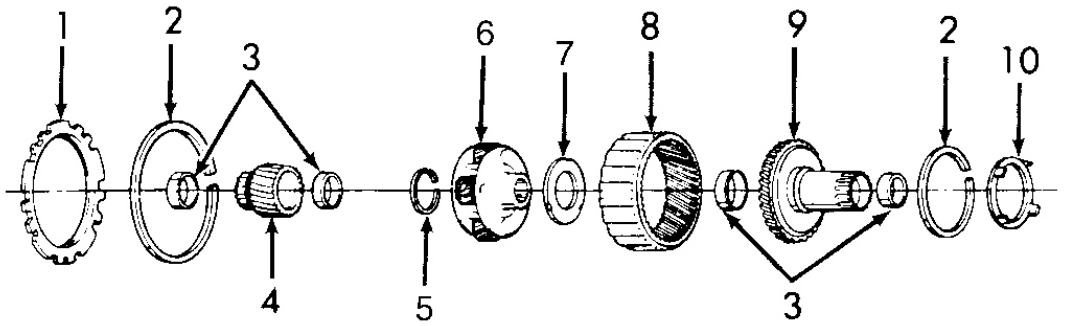
NO UPSHIFT OR STUCK IN 1ST GEAR

1991 Custom Cruiser, 1991 Bravada & 1991-92 Roadmaster (GM TSB 177113R)

Some Hydra-Matic 4L60 transmissions may experience a no upshift or stuck in 1st gear condition. This condition may be caused by input carrier-to-output shaft retaining ring becoming unseated or retaining ring omitted during assembly.

Output shaft is able to move slightly and will cause wear on governor driven gear. Governor driven gear wear may be described as an "apple coring" condition. If governor driven gear is worn, transmission cannot upshift out of 1st gear.

Remove governor, and inspect governor driven gear. If "apple coring" condition exists, disassemble transmission to determine if retaining ring is unseated, broken or missing. See **Fig. 49** . Install NEW retaining ring as necessary. **DO NOT** over expand new retaining ring during installation.



1. 3rd-4th Backing Plate
2. Retaining Ring
3. Bushing
4. Input Sun Gear
5. Output Shaft-To-Input Carrier Retainer Ring
6. Input Carrier Assembly
7. Bearing
8. Input Internal Gear
9. Reaction Carrier Shaft
10. Thrust Washer

92B13632

Fig. 49: Exploded View Of Input Carrier-To-Output Shaft Assembly
Courtesy of GENERAL MOTORS CORP.

LEGEND FOR FIGURE 49

Item No.	Description
1	3rd-4th Backing Plate
2	Retaining Ring
3	Bushing
4	Input Sun Gear
5	Output Shaft-To-Input Carrier Retainer Ring
6	Input Carrier Assembly
7	Bearing
8	Input Internal Gear
9	Reaction Carrier Shaft
10	Thrust Washer

NO 3RD OR 4TH GEAR OR SLIPPING IN 3RD OR 4TH GEAR

1991-92 All Models (GM TSB 177119)

Some Hydra-Matic 4L60 transmissions may experience a no 3rd or 4th gear or slipping in 3rd or 4th gear condition. Ensure T.V. cable is adjusted correctly and fluid level is filled to correct level. Check cooler lines to ensure lines are not restricted. Remove transmission pan, and check transmission filter neck seal for proper fit. If seal does not seal properly around filter, air can enter into oil pump and cause low line pressure or aerated fluid. Replace seal if necessary.

If overhaul is performed, disassemble oil pump and inspect pump body bushing for wear. Replace bushing if necessary. A worn bushing can create a large leak in oil pump and lower line pressure, which can cause oil flow to be cut off. If oil pump bore has excessive wear in one area (out-of-round), replace oil pump body. Inspect 3-4 clutch boost springs for signs of polishing on spring tabs. Polishing is caused by 3-4 clutch friction plates rubbing on boost springs. Replace boost springs as necessary.

Inspect input housing splines on inside of input housing. If splines show drag marks in middle spline, 3-4 clutch steel plates are binding in housing. New plates with smaller outer diameter are available to correct this condition. See **REDESIGNED 3-4 STEEL CLUTCHPLATES** under SERVICE BULLETINS. Check 2-4 band for a lube passage. If lube passage does not exist in 2-4 band, install new design 2-4 band with lube passage.

Inspect 1-2 and 3-4 accumulator piston and bore for scoring caused by metal particles in transmission. Inspect 3rd accumulator exhaust check ball and retainer (located in case servo bore). Check ball may not seat due to metal particles stuck in bore. This will cause 2-4 band to drag or 3-4 clutch to not fully apply on 2-3 upshift.

Ensure 3rd accumulator orifice cup plug (located in case servo bore) is not blocked. If metal particles block orifice, 3rd accumulator will not fill properly due to trapped air in cavity. This can effect 3-4 clutch. Orifice cup plug also lubricates 2-4 band through lube passage.

Check 3-4 clutch exhaust check ball and retainer (located in input housing). Check ball helps exhaust 3-4 clutch. If check ball does not seat, 3-4 clutch cannot fully apply. If check ball is stuck in seated position, 3-4 clutch cannot exhaust fully.

NO 4TH GEAR, LATE OR FALLS OUT OF 4TH GEAR

1991-92 All Models (ATRA TSB 043)

Ensure T.V. cable and manual linkage is adjusted correctly. Check line pressure at 4th gear transmission tap. If pressure does not exist, go to **STEP "A"** . If pressure is low, go to **STEP "B"** . If pressure is normal, go to **STEP "C"** .

STEP "A"

If 4th gear pressure does not exist, check items which could keep transmission from shifting. Check for oversized tires. Oversized tires can reduce governor pressure. Ensure governor is operating correctly. Ensure valve body bolts are tightened to correct specification.

Ensure pressure regulator snap ring is installed in its groove. Air check into exhaust hole at 4-3 sequence valve to check 4th apply servo circuit. Air check into exhaust hole at 3-4 shift valve to check 4th gear switch, 4-3 relay and sequence valve for sticking and binding. Check for missing plug at relay valve.

Air check governor circuit for leaks, and check for sticking 3-4 shift valve. Check for missing cup plug. Remove valve body, and check for stuck valves, relay valve installed backward or plugs missing from upshift and downshift valves. Ensure gaskets are not covering separator plate holes. Check placement of check balls in case and 3-4 spring tension.

STEP "B"

If 4th gear pressure is low, shift occurred but a leak exists in circuit. Remove transmission pan, and air check into exhaust hole at 4-3 sequence valve to check 4th apply servo circuit. Check for valve body leaks. Remove servo, and check for damaged seals, incorrect clearance and assembly errors. Check piston for cracks and pin bore for wear. Check 3-4 accumulator piston for cracks and damaged seal. Check for missing cup plug.

STEP "C"

If 4th gear pressure is normal, a mechanical problem exists in transmission. Remove transmission pan, and check servo exhaust hole for blockage by pan gasket or sealant. Air check into 4th gear pressure tap. Air should come out 4-3 sequence exhaust hole, showing a clear circuit. Block 4-3 sequence exhaust hole, and air check again. Servo should apply. Remove servo, and check for stuck servo pin in second gear piston. Check for stripped sun gear shell. Stripped sun gear shell will cause loss of 2nd gear and Reverse.

LOSS OF WIDE OPEN THROTTLE 3-4 UPSHIFT WHEN HOT

1991 Caprice 5.7L Police (GM TSB 077155)

Some 1991 Hydra-Matic 4L60 transmissions, models BFM, BPM & YNM with 5.7L engine, may exhibit a loss of wide open throttle 3-4 upshift when hot. When servicing this condition, install new T.V. boost valve and spring into oil pump cover. Install new 3-4 throttle valve, sleeve and spring into valve body. See **Fig. 50** . If service is necessary on BFM model transmission, replacement of T.V. boost valve and sleeve in oil pump cover may not be required.

Beginning September 24,1991 (Julian Date 267), transmission contains updated boost valve and sleeve. Beginning October 19, 1990 (Julian Date 292), BFM model transmission was replaced by BJM model transmission. BJM model transmission contains updated components.

BFM, BPM & YNM MODEL TRANSMISSION SERVICE PARTS

Description	Part Number
Throttle Boost Valve & Bushing, 3-4 Throttle Valve, Bushing & Sleeve Service Package	8673948

NOTE: During high speed pursuit, vehicles should be driven in Overdrive for maximum power train performance. DO NOT install 1991 model transmission in earlier model vehicles. 1991 model transmission is not compatible with earlier model vehicles.

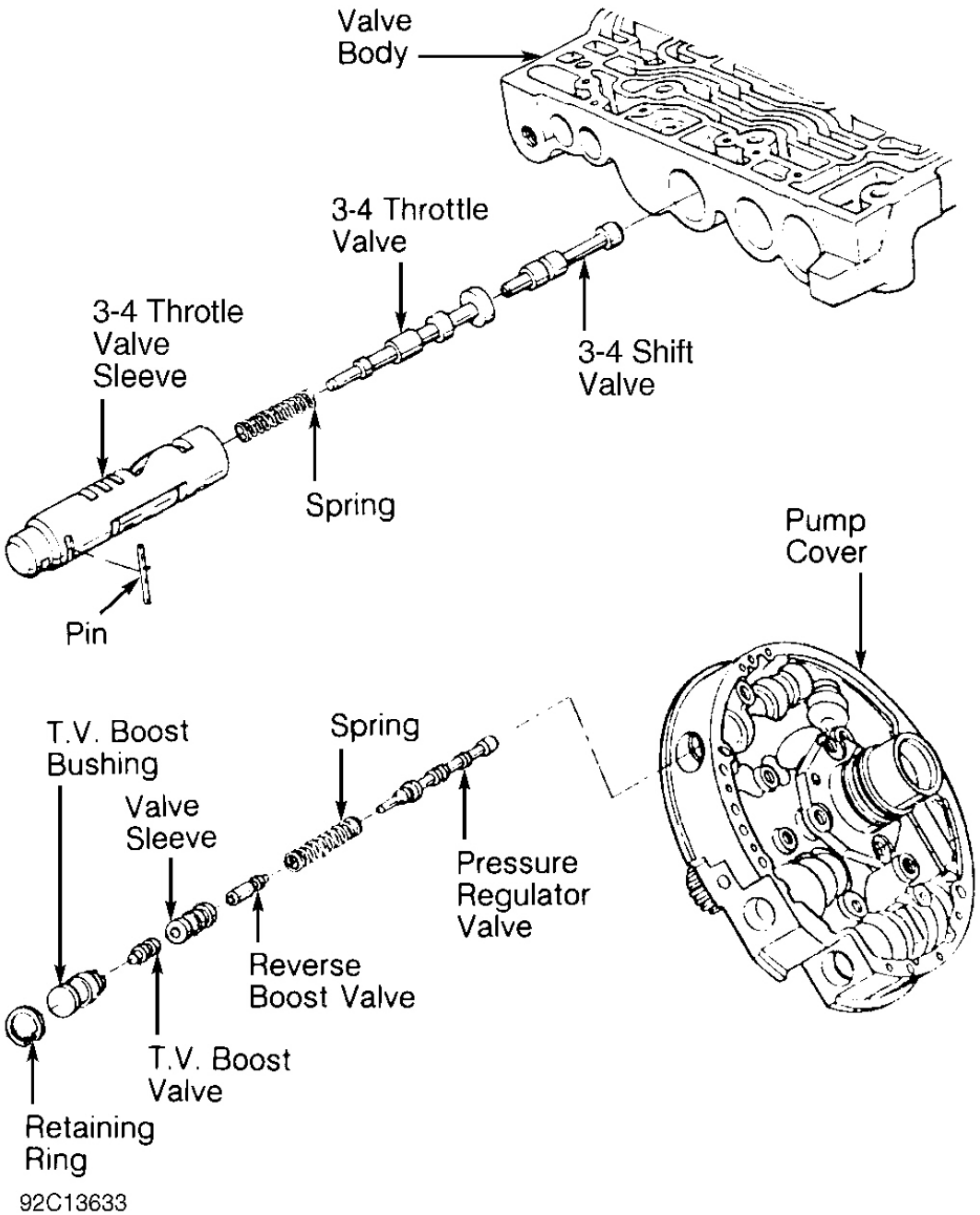


Fig. 50: Installing Throttle Valve & T.V. Boost Valve Assemblies
Courtesy of GENERAL MOTORS CORP.

REDESIGNED OUTPUT SHAFT & INPUT HOUSING-TO-OUTPUT SHAFT SEAL

1991 All Models (GM TSB 177118)

Due to changes in lube passage locations, Hydra-Matic 4L60 transmission output shafts and input housing-to-output shaft seals have been redesigned to provide increased oil flow. Beginning January 28, 1991 (Julian Date 028), all transmissions were built using new output shaft and seal. New seal can only be used on new output shaft. If new seal is used on previous model output shaft, seal will block one lube passage. Previous seal can be used on both shaft designs.

New output shaft and seal can be used as a set in all 4L60 transmissions manufactured. New output shaft can be identified by lube passage location. New shaft has a lube passage on chamfer at front of output shaft. Lube passage was previously located on shank of output shaft.

REDESIGNED 3-4 STEEL CLUTCH PLATES

1991 All Models (GM TSB 077138)

Redesigned 3-4 steel clutch plates have a slightly smaller outer radius. Design lets plates move freely in clutch housing. Beginning July 27,1990 (Julian Date 208), all Hydra-Matic 4L60 transmissions are equipped with new design plates. New clutch plates may be used on any 1989-91 4L60 transmission.

3-4 STEEL CLUTCH PLATES

Description	Part Number
3rd & 4th Plate (Set Of 5 Plates)	8678053
3rd & 4th Plate (Single Plate)	8678054

NEW 3-4 CLUTCH FRICTION MATERIAL

1991-92 All Models (GM TSB 177119)

New friction material on 3-4 clutch plates has been installed on limited applications of Hydra-Matic 4L60 transmission. New friction material has increased heat capacity but cannot be used interchangeably with previous friction material. New material was put into production during 1991 model year. Model codes changed as transmissions received new 3-4 clutch plates.

New plates cannot be used to service any transmissions except those 1991 models listed. See **1991 TRANSMISSION MODEL LIST** . Transmissions used with 5.7L engine were first to contain new plates, beginning in January 1991.

NOTE: DO NOT use new plates in any transmission which is not listed in 1991 TRANSMISSION MODEL LIST . If new plates are used in incorrect application, shift quality will be poor and transmission damage could occur quickly.

1991 TRANSMISSION MODEL LIST

New (1)	Previous
AMM	AKM
APM	DBM
CNM	CHM
CYM	CJM

FYM	FUM
KWM	KRM
LHM	None
RCM	RAM
RDM	WCM
YHM	YDM
(1) New models contain new material. Previous models are early 1991 models which do not contain new material.	

PEENED SPACER PLATE

1991 All Models (GM TSB 177120)

Some valve body spacer plate peening is acceptable and preferred to help seat check balls. Excessive peening will cause uneven seating of check ball. Inspect spacer plate for raised material on opposite side of check ball seat. If material on opposite side is raised, peening is too severe and spacer plate must be replaced. See **Fig. 51** .

To verify spacer plate is peening evenly and check ball is sealing correctly, seat check ball on spacer plate. Shine beam of light on opposite side and inspect for light between spacer plate and check ball. Light should not be present. If light is present, check ball is not seated properly and spacer plate must be replaced.

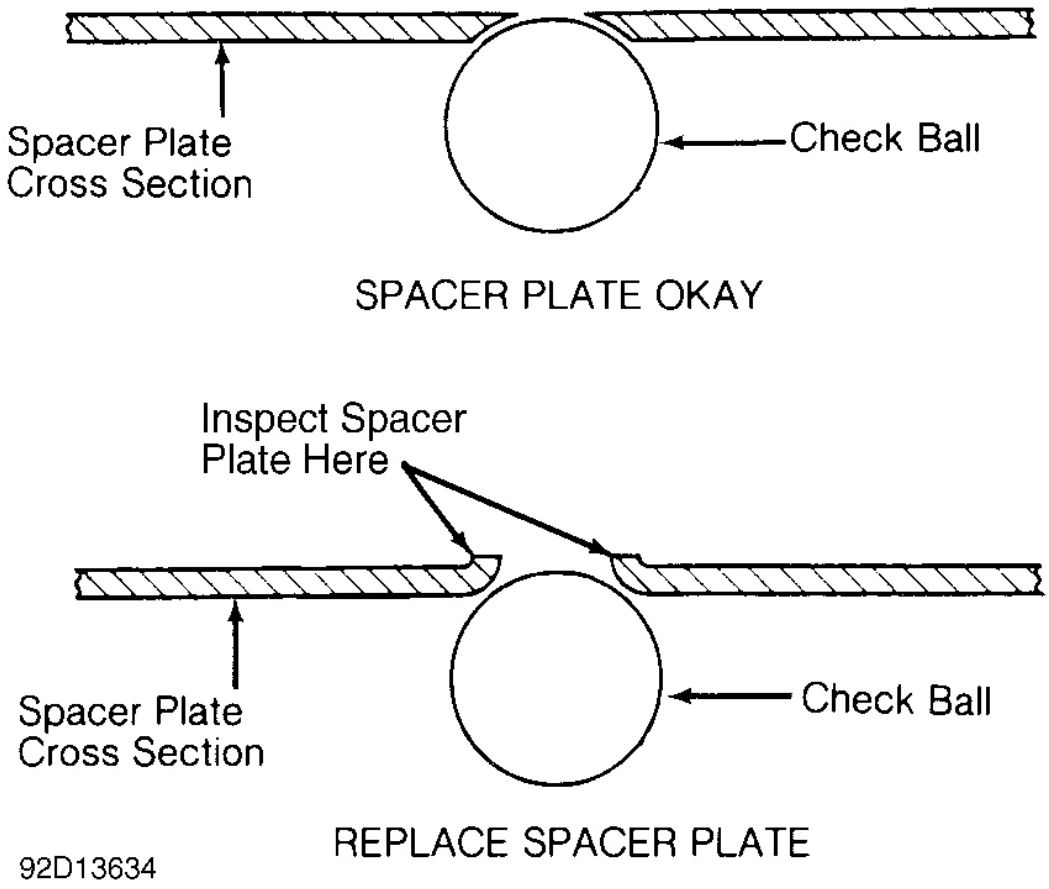


Fig. 51: Checking for Spacer Plate Peening
Courtesy of GENERAL MOTORS CORP.

NOISE IN SHIFT LEVER

1991 Bravada (GM TSB 167103)

When driving vehicle, a squeak or buzz can be heard in shift lever. Possible cause can be found at connection of transmission shift lever and transmission control lever. Check for loose fitting of control lever to shift lever. A loose control lever can generate a vibration induced noise. To correct this condition, a wave washer should be installed on control lever.

A second source of noise is a possible grinding out of shift lever with end of slot in control lever. This condition can be corrected by adding one or 2 flat washers as necessary to end of shift lever that is secured to frame. See **Fig. 52** . Shift lever will center in slot in control lever, preventing grinding out condition. When wave and flat washers have been added to control lever, ensure shift linkage is adjusted correctly. Bravada vehicles built after Vehicle Identification Number (VIN) 1GHDT13Z2M2704746 have had new washers installed.

SHIFT LEVER SERVICE PARTS

Description	Part Number
Wave Washer	4722812
Flat Washer	14074908

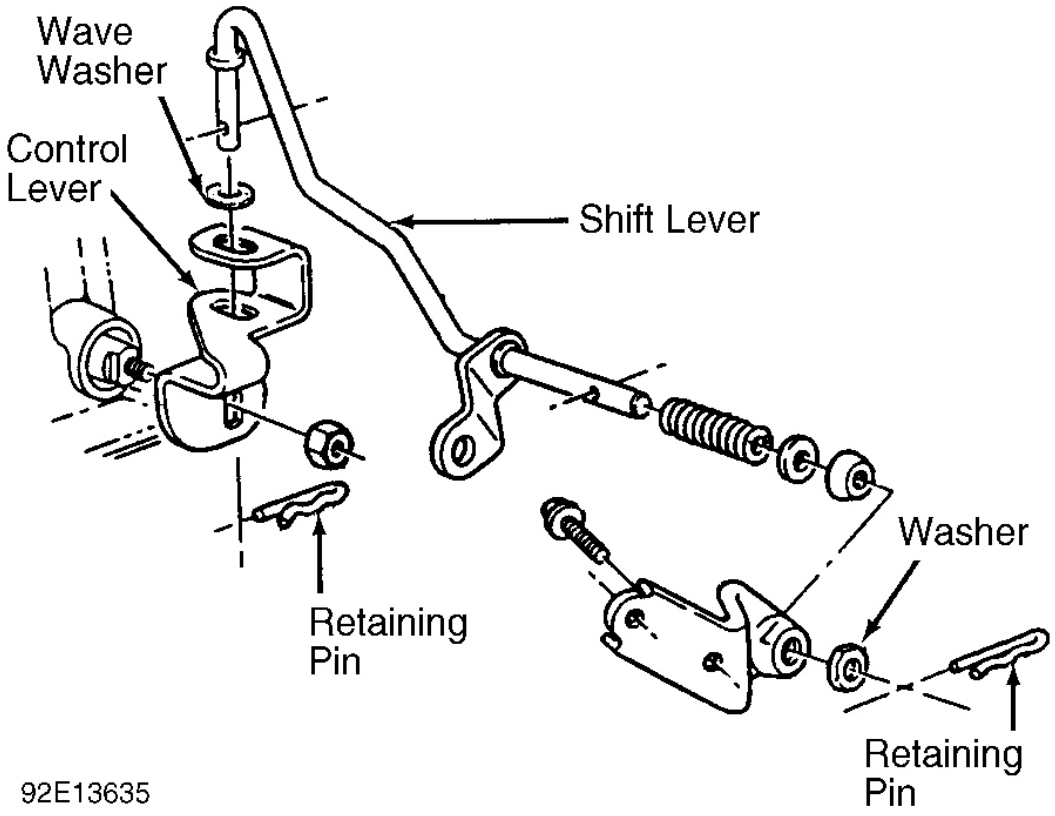


Fig. 52: Exploded View of Shift Lever Assembly
Courtesy of GENERAL MOTORS CORP.

VALVE BODY SLEEVE INSTALLATION

1991-92 All Models (ATRA TSB 058)

Valve body sleeves may be installed incorrectly if casting lines on end of sleeve are not within 10 degrees of vertical. Casting lines are visible without removing valve body. If casting lines are not within 10 degrees of vertical, retaining pin is installed into an oil slot, not into retaining groove. See **Fig. 53** .

NOTE: Sleeves can be installed incorrectly even if casting lines are within vertical position.

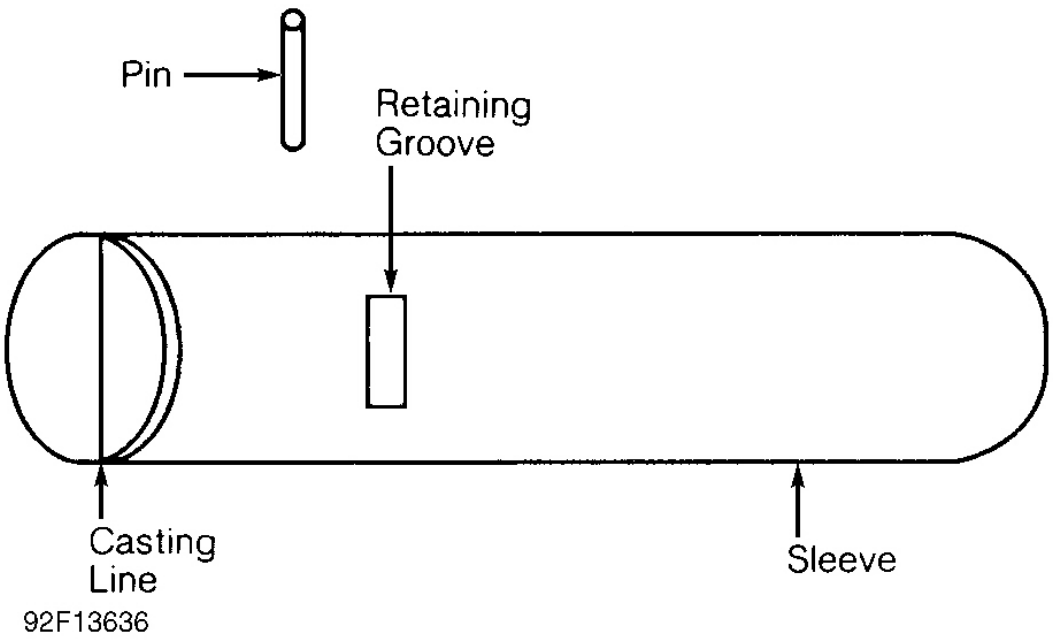


Fig. 53: Locating Valve Sleeve Retaining Groove
Courtesy of ATRA.

OIL PUMP REMOVAL TOOL

1991-92 Bravada, Custom Cruiser & Firebird (GM TSB 277107)

Due to product changes in 4L60 Hydra-Matic transmission stator shaft, a new tool has been developed to remove oil pump assembly. New tool is an adapter for use with current pump puller. Because groove under stator shaft has been removed, previous tool cannot fit onto new shaft.

With transmission removed from vehicle, remove torque converter. Position transmission in an upright position. Remove "O" ring and turbine shaft. Remove oil pump bolts, and install 4L60 adapter by slipping adapter over stator shaft. Install 4L80E pump puller over adapter. Tighten small screw to secure pump puller to adapter. Turn forcing screw to lift oil pump out of case.

POSSIBLE BLOWN FUSES ON CIRCUITS 420, 422 OR 446 DUE TO SHORTED TCC WIRING

1989 B, C, D, F, G, K, M, R, S, T, V, & Y Body Vehicles

A breakdown in Torque Converter Clutch (TCC) wiring insulation may cause a short to ground which may affect vehicle's transmission, electrical system and engine performance. Short circuit may cause blown fuse, loss of A/C, ECM failure or instrument cluster failure.

Die to electrical design differences, each vehicle line may show unique symptoms. A short in TCC wiring will

usually blow the circuit containing the TCC fuse.

The TCC solenoid wiring harness was modified in production as of May 17, 1989 (Julian Date 137) in all 4L60 transmissions.

NOTE: Check vehicle wiring diagram and eliminate any other cause of blown fuses.

Checking Vehicle For Short To Ground

1. Turn off ignition. Unplug TCC wiring harness at transmission. Replace blow fuse.
2. Start engine. Check if short circuit is still present. If so, TCC wiring is probably not the cause. If short circuit is not present, continue with diagnosis.

Check TCC Wiring Harness For Short To Ground

1. Turn off ignition. Unplug wiring harness from transmission case. Using self-powered test light or high impedance ohmmeter, check for short circuit between transmission case and terminal "A", and between terminal "D".
2. If short exists, replace TCC solenoid wiring harness. DO NOT attempt to repair wiring.

Diagnostic Hints

1. If wire "A" (circuit 420) shorts to ground, check for blown fuse in 12-volt feed circuit. See **TCC BATTERY FEED CIRCUIT** .

NOTE: TCC BATTERY FEED CIRCUIT does not include all possible fuses. Check vehicle wiring diagram.

TCC BATTERY FEED CIRCUIT

Vehicle Type & Body Code	Check For Blown Fuse (Circuit 420)
Passenger Cars	
B	Gauges
D	G.A. Trans
F	Gauges
Y	Gauges
Light Trucks & Vans	
C/K	ECM/Ignition
M	Gauges
R/V	Gauges/Idle
G	Gauges
S/T	Ignition/Gauges

2. If wire "D" (circuit 422) shorts to ground, 3 different conditions may occur:
    - TCC may engage if transmission is too hot and there is short in White wire between TCC and TCC switch.
    - Engine may idle rough. If transmission has 4th gear switch and there is short between ECM and switch, ECM always receives signal that transmission is in 4th gear. This may affect engine performance if spark timing depends on gear position.
3. If wire "B" (circuit 446) shorts to ground, TCC will engage after a 1-2 shift (all except S and T truck with 2.5L engine).

DIAGNOSIS INFORMATION FOR POSSIBLE INOPERATIVE TORQUE CONVERTER OR RELATED CONDITION

1985-87 F (2.8L), M, S & T Body Vehicles

1. Causes for possible torque converter failure are as follows:
    - Broken damper plate rivet (inside the converter)
    - Broken or loose spring tips
    - Broken or loose converter pump vanes
    - Broken converter turbine hub
    - Damaged seals causing hydraulic leak
    - Delamination of converter clutch apply plate fiber material
2. Symptoms that a vehicle may exhibit upon or during torque converter operation are as follows:
    - Shudder and/or vibration during torque converter clutch apply
    - No upshift due to fiber material sticking valves and/or fiber material and metal particles in filter
    - No Drive and/or Reverse
    - Converter sprag inoperative (no torque multiplication)
    - Noisy converter bearing or excessive end play
    - Pinging noise (constantly)
    - Vibration, out of balance, loose vanes (noisy)
    - Vehicle may exhibit shudder or no TCC apply. Torque converter clutch lining delaminating due to coolant contamination from transmission cooler
    - Torque converter clutch crowd shudder condition: This condition is caused by a leak in the TCC circuit which could cause excessive slippage and wear away the fiber lining on the TCC apply plate. Possible causes for TCC solenoid "O" ring, valve body gaskets. Worn TCC accumulator piston pin or seal.
    - TCC apply shudder caused by converter dampener plate not parallel.
    - A whine noise when shifted into drive that may increase when brake torqued. Torque converter whine is usually noticed when the vehicle is stopped and when the transmission is in Drive or Reverse. The noise will increase when the vehicle is moving and there is no torque multiplication (both halves of the torque converter are turning at the same speed) or when the torque converter clutch is applied.
3. With foot on brake and Gear Selector in Drive, depress accelerator to approximately 1200 RPM for no

more than 6 seconds (Stall Test). A torque converter noise increases under load.

NOTE: This noise should not be confused with pump whine noise which is usually noticeable in Park, Neutral and all other gear ranges. Pump whine will vary with pressure ranges.

4. The torque converter should be replaced under any of the following conditions:
   - Vehicles have TCC shudder and/or No TCC apply but, only after all Electrical and Hydraulic diagnosis has been made (Converter Clutch material may be glazed)
   - Evidence of damage to the pump assembly or steel particles in converter
   - Steel particles are found after flushing the cooler and cooler lines
   - External leaks in the hub weld area
   - Converter pilot is broken, damaged or poor fit into crankshaft.
   - Converter hub is scored or damaged
   - Internal failure to stator roller clutch
   - Contamination from engine coolant
   - Excess end play found after checking converter for end play
   - Steel particles or clutch lining material found in fluid filter or on magnet when no internal parts in unit are worn or damaged indicating lining material came from converter.
   - Heavy clutch debris due to overheating (Blue Converter)

NEW LOW & REVERSE CLUTCH SUPPORT & SELECTIVE PLATE DIMENSIONS

1990 B, C, D, F, G, K, L, M, R, S, T, V & Y Body Vehicles

1. Dimensional change has been made in low and reverse clutch support and its selective plates. Thickness of low and reverse clutch support has increased while thickness of selective plates has decreased. Three selective plates are available. Productions change was initiated as follows:
   - Low and Reverse Clutch Support November 1, 1989 (Julian Date 305) and Selective Plates February 2, 1990 (Julian Date 033).
2. In most cases, new low and reverse clutch assembly will only require fifth reactions plate instead of selective plate. To identify low and reverse clutch support, measure its thickness with a micrometer.
3. The new low and reverse clutch support and selective plates may be used to service a post model year transmission if:
   - Transmission was built after February 9, 1987 (Julian Date 040)

NOTE: Selective plates are not interchangeable between previous clutch support and new clutch support. If selective plates are installed in the wrong clutch assembly, durability or low and reverse clutch will be reduced.

4. The following is service parts information:

NEW LOW & REVERSE CLUTCH ASSEMBLY

Part Name	Part No.	Dimension: In. (mm)
Selective Plate	8673548	.0459-.0519 (1.168-1.314)
Selective Plate	8673549	.0865-.0922 (2.198-2.344)
Selective Plate	6261120	N/A
Clutch Support	N/A	.3020-.3090 (7.671-7.849)
Low & Reverse Clutch & Support Assembly	8673544	N/A

PREVIOUS LOW & REVERSE CLUTCH ASSEMBLY

Part Name	Part No.	Dimension: In. (mm)
Selective Plate	8667584	.0939-.1007 (2.386-2.557)
Selective Plate	8667585	.1221-.1288 (3.101-3.272)
Clutch Support	N/A	.2620-.2720 (6.655-6.909)
Low & Reverse Clutch & Support Assembly	8663094	N/A

CLUTCH APPLY PLATES-MATERIAL CHANGED TO POWDERED METAL IN FORWARD & 3-4 CLUTCHES

1990 B, C, D, F, G, K, L, M,, S, T, V, & 7 Body Vehicles

The forward and 3-4 clutch apply plates will now be manufactured from powdered metal instead of steel. Production change was as follows:

Forward - January 25, 1990 (Julian Date 025), 3-4 - January 29, 1990 (Julian Date 029)

The new powdered metal plates are interchangeable with current steel plates. Part Numbers have changed as listed in **3-4 CLUTCH APPLY PLATE** .

3-4 CLUTCH APPLY PLATE

Part Number	Description
8663785	Apply Plate - Forward Clutch (steel)
8667423	Apply Plate - 3-4 Clutch (steel)
8676059	Apply Plate - Forward Clutch (powdered metal)
8676379	Apply Plate - 3-4 Clutch (powdered metal)

NOISE/VIBRATION WITH TORQUE CONVERTER CLUTCH APPLIED (REPLACE TORQUE CONVERTER K7020)

1989-91 S/T Trucks, 1989-90 C, G, L & M Body Vehicles (4.3L LB4 Engines Only)

The transmission may produce a noise or vibration with the torque converter clutch (TCC) applied. This may happen if the damper spring stops in the torque converter damper bottom out against the damper plate. This may occur in Hydra-Matic 4L60 models that are used with 4.3L LB4 engines.

Date of Production Change

The following dates show which transmissions contain torque converters with damper springs that may bottom out against the spring stops.

TORQUE CONVERTER WITH DAMPER SPRINGS

Model	Date of Production
9FMM, 9MAM, 9MFM, 9MXM, 9TH, 9TLM	Some after December 9, 1988 Julian Date 343)
0CAM, 0CAM, 0WAM	All before February 20, 1990 Julian Date 051)
0SHM	All before February 20, 1990 Julian Date 051)
0TLM	All before February 14, 1990 Julian Date 045)
0MJM, 0MNM	All before February 2, 1990 Julian Date 033)

Diagnosis

The following information will help you determine if vehicle has a vibration condition caused by damper spring stops bottoming out in the torque converter.

- Gear Range: Drive 4 (overdrive) with TCC engaged
- Vehicle Speed: Approximately 40-50 MPH with TCC engaged - then step into the throttle slightly

Conditions:

1. Noise, vibration or rattle
2. Low frequency noise that builds up until the floorboards rattle
3. Low growl or driveline grumble

Road grades or trailer loads may cause conditions to be more prominent or extended.

The condition should disappear when the TCC is disengaged. To eliminate this condition, a Torque Converter Assembly Package (8678979) containing damper springs with a higher spring rate and improved torque capacity has been released for production and service.

ERRATIC OR NO UPSHIFT

1989 B, C, E, F, K, M, R, S, T, V & Y Body Vehicles

A Hydra-Matic 4L60 transmission with an erratic or no upshift condition may be due to "Applecoring" or the governor driven gear. "Applecoring" may be caused by nicks and burrs on the governor drive gear. Beginning July 6, 1987 all transmissions were produced with the new governor driven gear and pin package (8663995).

REDESIGNED CLUTCH PISTON SEAL

1989 B, C, F, G, K, M, R, S, T & Y Body Vehicles

Beginning February 28, 1989, all 1989 Hydra-Matic 4L60 transmissions have been built using the new short lip

design. Short lip seals are interchangeable with previous seals. All eight seals are available in overhaul kit or in two separate packages. See **NEW PISTON SEAL PACKAGES** .

NEW PISTON SEAL PACKAGES

Part Number	Description
8642919	3-4 Clutch Piston Inner and Outer Seals, Forward Clutch Piston Inner and Outer Seals, Overrun Clutch Piston Inner and Outer Seals
8657922	Reverse Input Clutch Piston Inner and Outer Seals

PROPER SPACER PLATE GASKETS USAGE

1982-89 B, C, F, G, K, M, R, S, T, V & Y Body Vehicles

Two sets of spacer plate gaskets are supplied with each transmission overhaul service kit. One set is for use on model years 1982-86, and the other set for model years 1987-89. The difference between the two sets of gaskets is the addition of holes in 1987 to accommodate an auxiliary valve body.

If the incorrect (1982-86) gasket set is used on a 1987-89 model year transmission, with or without an auxiliary valve body, the third clutch exhaust passage will be blocked. This may cause slipping or flaring during a 3-2 shift, a delayed 3-2 downshift, or a burned 3-4 clutch. See **PROPER SPACER PLATE GASKET SELECTION** .

PROPER SPACER PLATE GASKET SELECTION

Model Year	Part No.: Gasket Set Only	Part No.: Output Kit
1982-86	8642993	8649995
1988-89	8657938	8649995

LOSS OF WIDE OPEN THROTTLE 3-4 UPSHIFT WHEN HOT

1989 B Body (5.7L Police Only)

Some 1989 Hydra-Matic 4L60 YNM Model transmissions, a 5.7L (Police only) may exhibit a loss of wide open throttle 3-4 upshift when hot. Beginning April 24, 1989, all YNM model transmissions were built with a new control valve assembly containing the new 3-4 throttle valve and sleeve. When servicing for a no wide open throttle 3-4 upshift when hot, install the new 3-4 throttle valve and sleeve. The new control valve assembly is also available if it is necessary to replace the control valve assembly complete. See **YNM MODEL SERVICE PARTS** .

YNM MODEL SERVICE PARTS

Part Number	Description
8671953	9YNM - 3-4 Throttle Valve and Sleeve Service Package
8673413	9YNM - Control Valve Assembly Complete

BINDING OR INOPERATIVE IN REVERSE

1982-89 B, C, F, G, K, M, R, S, T, V & Y Body Vehicles

When servicing a transmission for a binding in reverse condition, remove the control valve assembly and inspect the 4-3 sequence valve and the 2-3 shift valve. Either valve, if stuck in the upshifted position, will result in a binding condition. To correct this condition, the valve body must be completely disassembled and reconditioned.

Inspect the transmission bottom pan for clutch material or burned fluid. Evidence of this will require further transmission diagnosis. Repairs may include complete transmission reconditioning, including disassembly and reconditioning of the transmission pump and possible torque converter replacement.

Complete the cleaning of the hydraulic circuit by changing the transmission fluid and filter and flushing the transmission cooler and cooler pipes.

CAUTION: Overtorquing the bolts during unit reassembly can cause valve to bind. This condition may become more apparent as the unit warms to operating temperature. Correct bolt torque specifications for control valve assembly are 72-120 INCH lbs. (8-14 N.m). Torquing bolts to minimum specification, 72 INCH lbs. (8 N.m) is recommended.

DRIVELINE CLUNK DURING GARAGE SHIFT OR HARD ACCELERATION

1990 C Bodies

Vehicles may exhibit a clunking noise during a garage shift or a driveline clunk during hard acceleration. Vehicles may be affected if they were built within the following VIN numbers ranges:

- Chevrolet: 1GCDC14K2LZ100013 - 1GCDC14Z2LZ101290
- GMC: 1GTDC14Z1LZ500000 - 1GTDC14KXLZ500368

This condition can be repaired by installing a reinforcement plate in the tailshaft crossover support. To install, remove the nut and washer from the underside of the transmission crossmember. Install reinforcement plate (15567681) onto the bolt that passes through crossmember and replace the washer and nut. Torque the nut 40 ft.lbs. (54 N.m).

2-4 BAND CHANGES

1989 B, C, D, F, G, K, L, M, S, T, V & Y Body Vehicles

A new transmission 2-4 band has changes to the apply and anchor brackets, locating tabs, and the addition of a "lube window". The lube window was added to direct lubricating transmission fluid to the bank friction material while the band is not applied. Structural changes to the apply and anchor brackets increase their durability and the locating tabs were added to aid in assembly.

The new band is interchangeable with the previous band and should be used for service whenever possible. As soon as the previous bands are used up, the new bands will become available. See **2-4 BAND ASSEMBLY** .

2-4 BAND ASSEMBLY

Part Name	Previous Part Number	New Part Number
Band Assembly-2/4	8654144	8673175

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Cooler Pipe Connector	28 (38)
Detent Spring-To-Valve Body Bolt	18 (24)
Extension Housing Bolt	26 (35)
Manual Shaft-To-Detent Lever Nut	23 (31)
Oil Pump Cover-To-Body Bolt	18 (24)
Oil Pump-To-Case Bolt	18 (24)
Park Bracket-To-Case Bolt	18 (24)
Pressure Plugs 1/4 X 18"	18 (24)
Torque Converter-To-Flexplate Bolt	46 (62)
	INCH Lbs. (N.m)
Accumulator Cover-To-Case Bolt	96 (11.0)
Auxiliary Valve Body Bolt	96 (11.0)
Oil Pan-To-Case Bolt	96 (11.0)
Oil Passage Cover Bolt	96 (11.0)
Pressure Plugs 1/8 X 27"	96 (11.0)
Pressure Switches	96 (11.0)
Solenoid Bolt	96 (11.0)
Speed Sensor Bolt	89 (10.0)
T.V. Cable Bolt	75 (8.5)
Valve Body-To-Case Bolt (1)	96 (11.0)
(1) Tighten valve body bolts in a spiral pattern starting in center of valve body.	

AUTOMATIC TRANSMISSIONS Hydra-

Matic 4L60-E Overhaul

APPLICATION

TRANSMISSION APPLICATIONS

Vehicle Application (Body Code)	Engine Size
Buick	
Roadmaster ("B")	5.7L
Cadillac	
Fleetwood ("D")	5.7L
Chevrolet	
Astro	
2WD ("M")	4.3L
4WD/AWD ("L")	4.3L
Blazer	
2WD ("S")	
4-Cylinder	2.2L
V6	4.3L
4WD ("T")	4.3L
Camaro ("F")	
V6	3.4L & 3.8L
V8	5.7L
Caprice ("B")	
V6	4.3L
V8	5.7L
Corvette ("Y")	5.7L
Impala SS ("B")	5.7L
Pickup & Suburban	
2WD ("C")	
V6	4.3L
V8 (Gas)	5.0L & 5.7L
V8 (Diesel)	6.5L
4WD ("K")	
V6	4.3L
V8 (Gas)	5.0L & 5.7L
V8 (Diesel)	6.5L
S10	
2WD ("S")	
4-Cylinder	2.2L
V6	4.3L

4WD ("T")	4.3L
Tahoe	
2WD ("C")	5.7L
4WD ("K")	5.7L
Van ("G")	
V6	4.3L
V8 (Gas)	5.0L & 5.7L
V8 (Diesel)	6.5L
GMC	
Jimmy	
2WD ("S")	4.3L
4WD ("T")	4.3L
Sierra Pickup & Suburban	
2WD ("C")	
V6	4.3L
V8 (Gas)	5.0L & 5.7L
V8 (Diesel)	6.5L
4WD ("K")	
V6	4.3L
V8 (Gas)	5.0L & 5.7L
V8 (Diesel)	6.5L
Safari	
2WD ("M")	4.3L
4WD/AWD ("L")	4.3L
Sonoma	
2WD ("S")	
4-Cylinder	2.2L
V6	4.3L
4WD ("T")	4.3L
Van ("G")	
V6	4.3L
V8 (Gas)	5.0L & 5.7L
V8 (Diesel)	6.5L
Yukon	
2WD ("C")	5.7L
4WD ("K")	5.7L
Oldsmobile	
Bravada - AWD ("T")	4.3L
Pontiac	
Firebird ("F")	
V6	3.4L & 3.8L
V8	

	5.7L

IDENTIFICATION

The 4L60-E transmission can be identified by a letter code contained in identification number. Identification number is stamped on transmission case above oil pan rail on right rear side. See **Fig. 1**. Identification number contains information which must be used when ordering replacement parts.

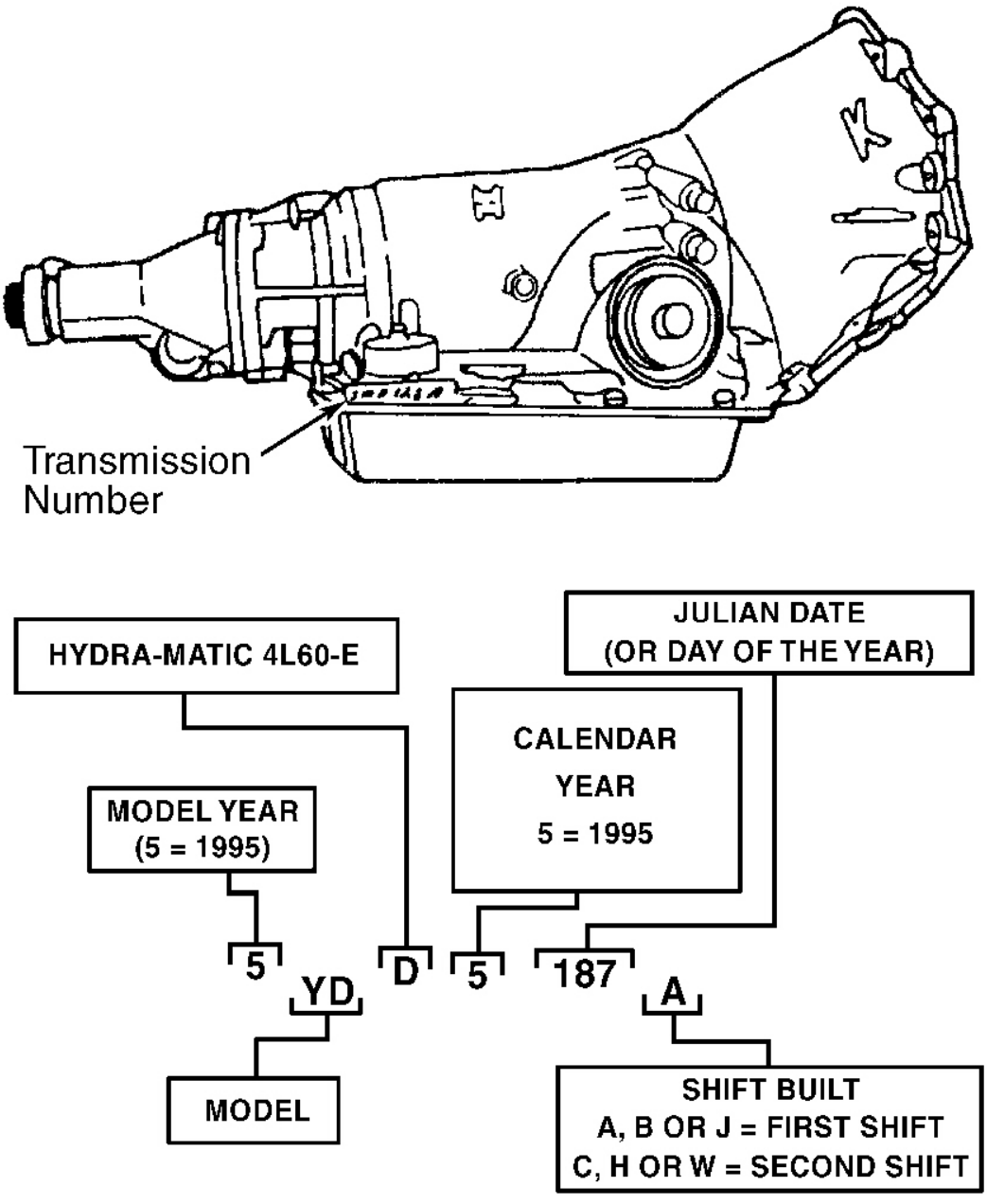


Fig. 1: Locating Transmission Identification Number
Courtesy of GENERAL MOTORS CORP.

DESCRIPTION

The 4L60-E is a fully automatic transmission consisting of a 3-element hydraulic torque converter with a

Torque Converter Clutch (TCC). Two planetary gear sets, 5 multiple-disc clutches, one sprag clutch, one roller clutch and a 2-4 band provide friction elements necessary to produce 4 forward speeds. See **Fig. 2**.

A hydraulic system, pressurized by a variable capacity vane type oil pump, provides pressure required to operate friction elements and automatic controls. The 4L60-E also contains electronic solenoids to control hydraulic operations. A Powertrain Control Module (PCM) receives signals from Vehicle Speed Sensor (VSS), Throttle Position (TP) Sensor, fluid pressure switch assembly, and temperature sensor. These signals help PCM determine when to switch 2 shift solenoids, 3-2 downshift solenoid, and/or TCC solenoid on or off. PCM can also control line pressure via pressure control solenoid (force motor).

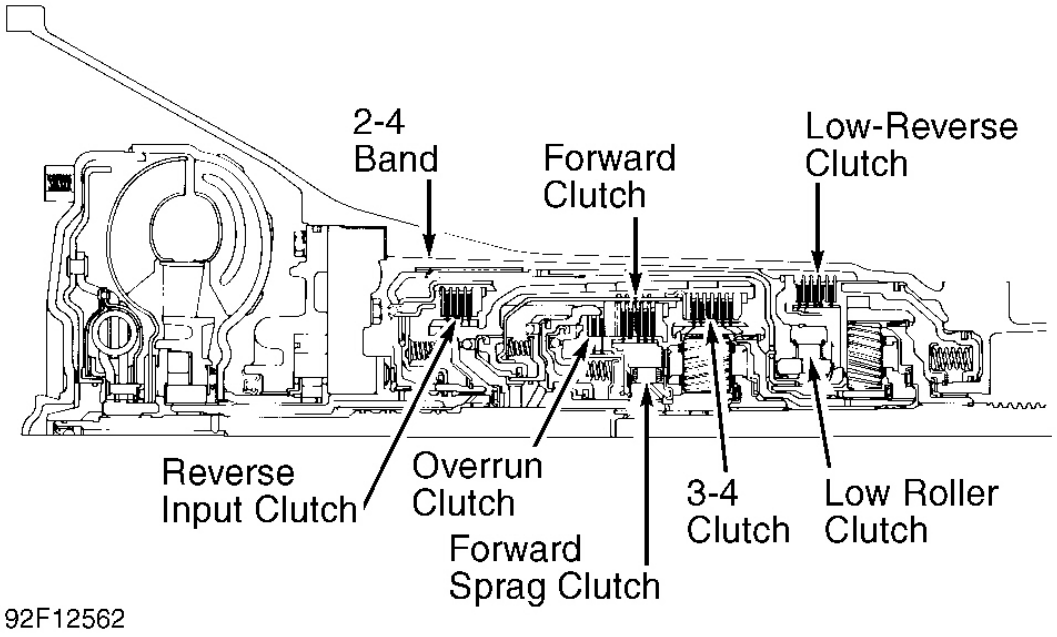


Fig. 2: Cut-Away View Of 4L60-E Transmission
Courtesy of GENERAL MOTORS CORP.

LUBRICATION

See appropriate TRANSMISSION SERVICING - A/T article in the TRANSMISSION SERVICING section.

ADJUSTMENTS

See appropriate TRANSMISSION SERVICING - A/T article in the TRANSMISSION SERVICING section.

ON-VEHICLE SERVICE

REAR OIL SEAL

Removal & Installation

Remove drive shaft. Pry oil seal from extension housing. Coat outside edge of NEW oil seal with non-hardening sealer. Using Seal Installer (J-21426), install oil seal. To complete installation, install drive shaft. Check fluid level.

VALVE BODY

NOTE: Beginning at start of production for all 1996 models, 4L60-E transmissions were built with a NEW design manual valve and a NEW design valve body casting. New design improves exhaust path for low-reverse clutch fluid when selector lever is in Drive. It also improves low-reverse clutch durability. Manual valves and valve bodies for 1995 and 1996 models ARE NOT interchangeable.

CAUTION: Note valve body bolt length and location during removal procedure. Transmission case damage may occur if bolts are incorrectly installed.

Removal

1. Remove transmission oil pan. Remove oil filter and "O" ring. Ensure "O" ring is removed from transmission case. Remove electrical connectors from switches and solenoids, and mark for reassembly reference. Remove pressure switch assembly. Remove accumulator cover. Remove valve body bolts. Note length and location of bolts for installation reference.
2. Note direction of manual valve link. Remove manual valve link from manual valve at valve body. See **Fig. 3**. Remove valve body. Note location of check balls. **DO NOT** lose balls. See **Fig. 4** and **Fig. 5** .

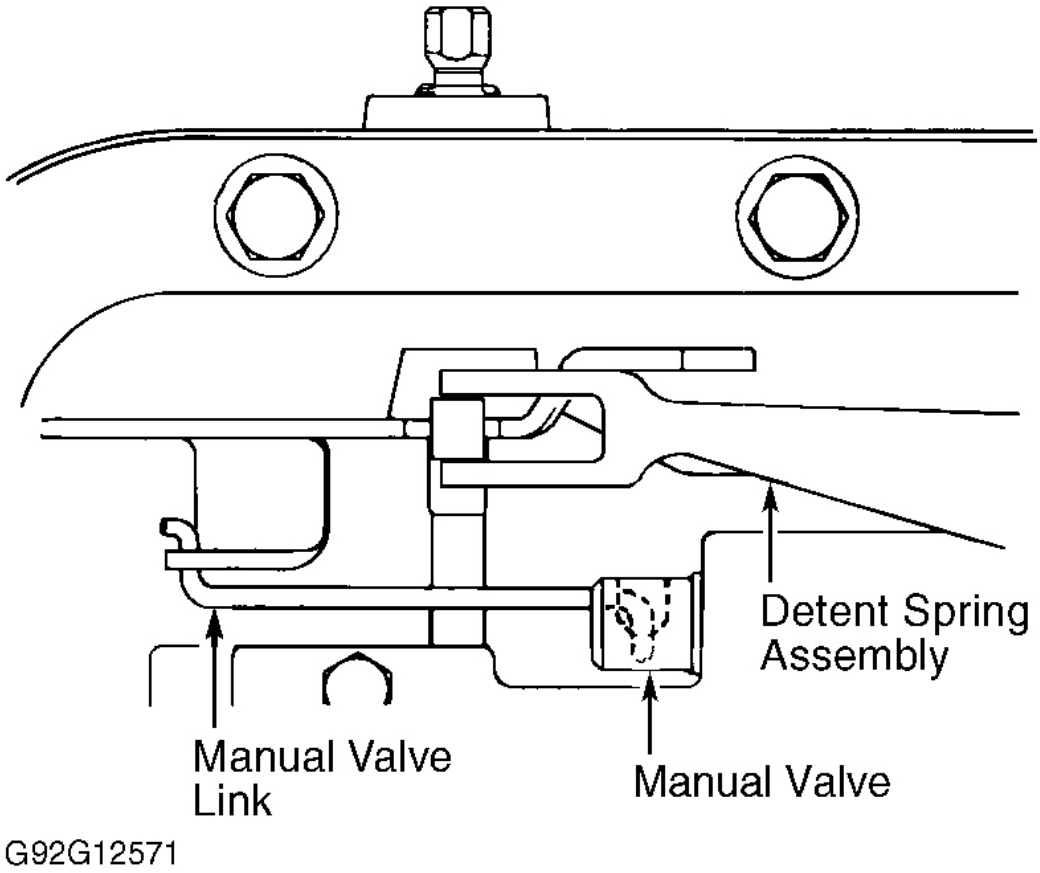


Fig. 3: Installing Manual Valve Link
Courtesy of GENERAL MOTORS CORP.

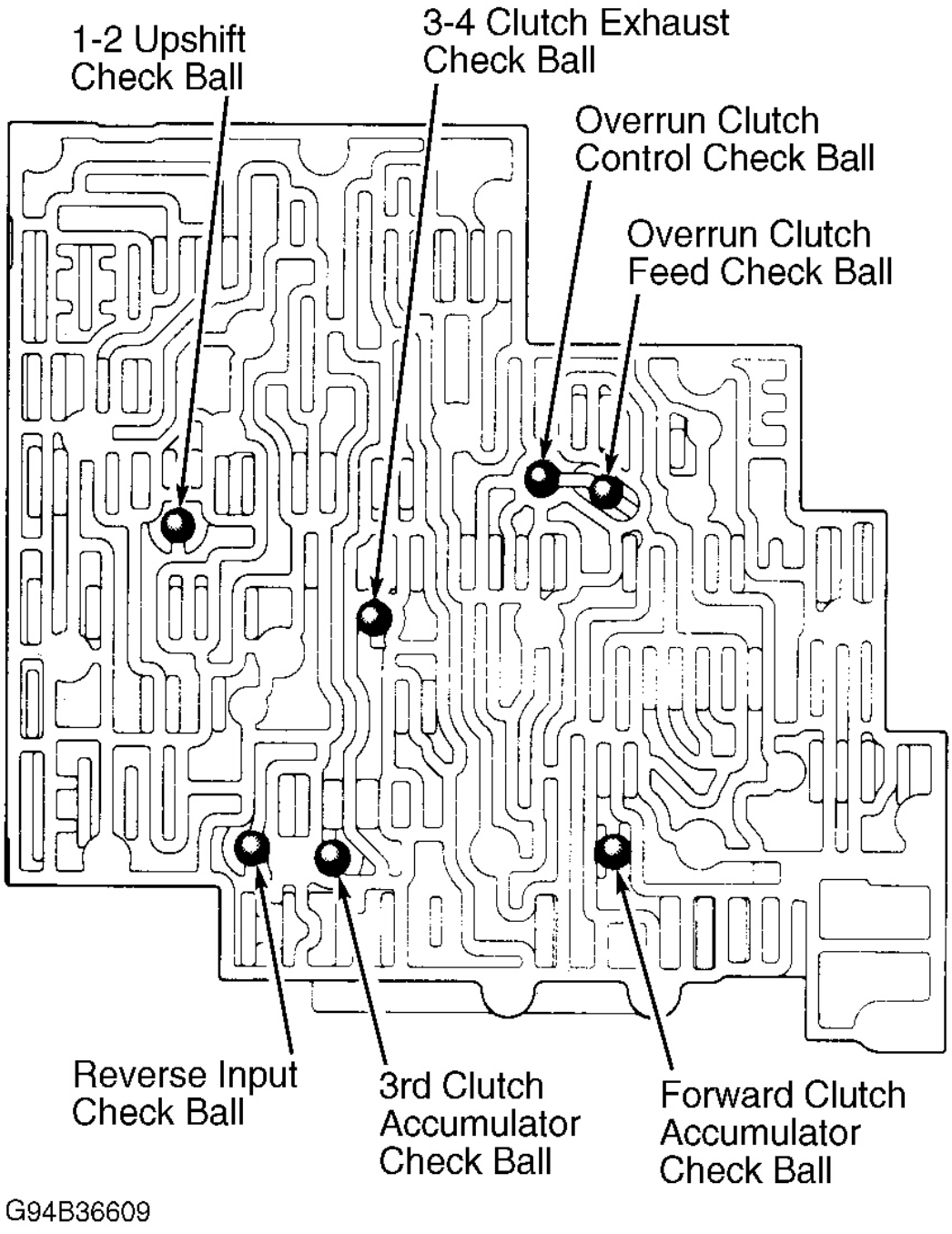


Fig. 4: Locating Valve Body Check Balls
Courtesy of GENERAL MOTORS CORP.

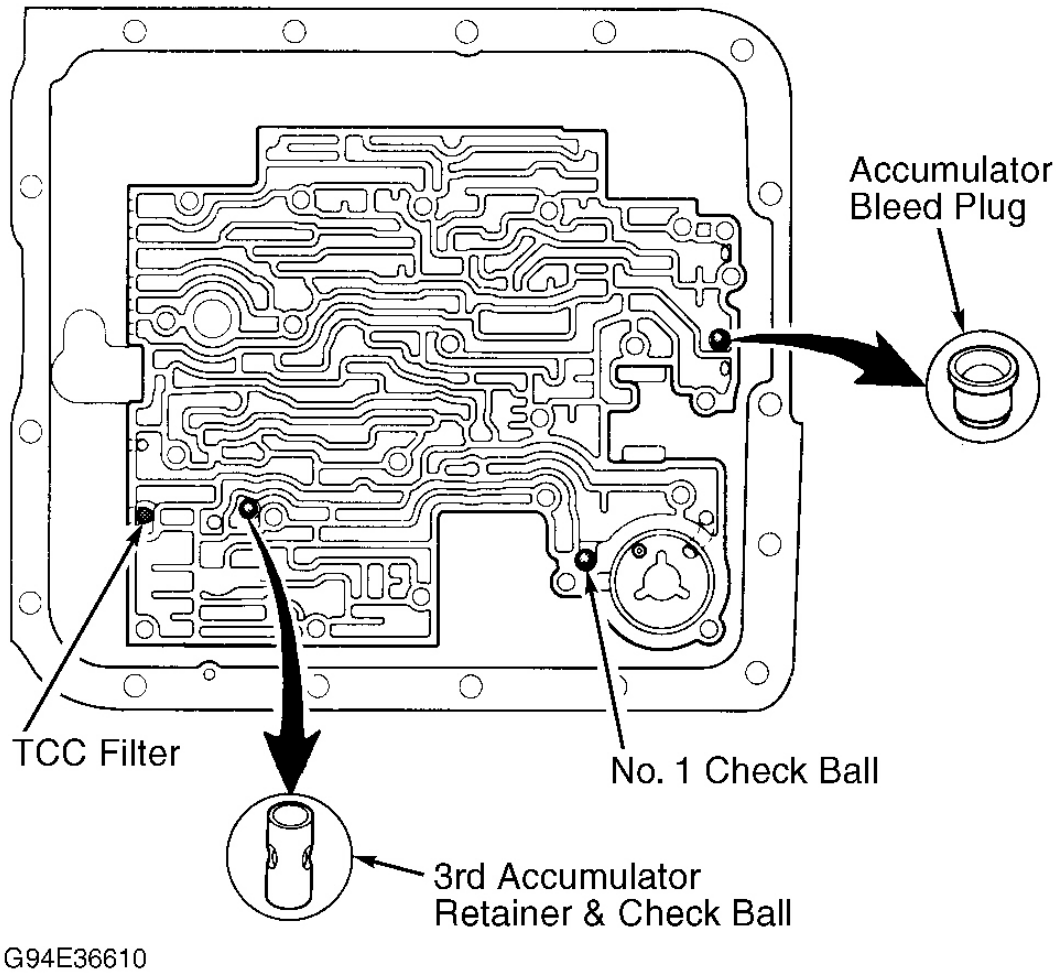


Fig. 5: Locating Check Balls In Case
Courtesy of GENERAL MOTORS CORP.

Installation

1. Coat check balls with petroleum jelly. Install check balls in proper locations on separator plate. See **Fig. 4** and **Fig. 5** . Install manual valve link. Ensure manual valve link is properly seated in manual valve. See **Fig. 3**. Improper positioning may prevent vehicle operation in "D" range.

   NOTE: Improper positioning of throttle valve link will result in erratic shift points or high oil pressure.

2. Install valve body and retaining bolts. Tighten all bolts to specification. See **TORQUE SPECIFICATIONS**. Lubricate oil filter "O" ring with ATF before installation. To complete installation, reverse removal procedure. Fill transmission with fluid.

2-4 SERVO ASSEMBLY

Removal & Installation

Install Piston Compressor (J-29714) on oil pan. Compress servo cover, and remove retaining ring. See **Fig. 6**. Remove servo cover and "O" ring. Remove 2-4 servo assembly. To install, reverse removal procedure. For servo pin length check, see **2-4 SERVO ASSEMBLY** under TRANSMISSION DISASSEMBLY.

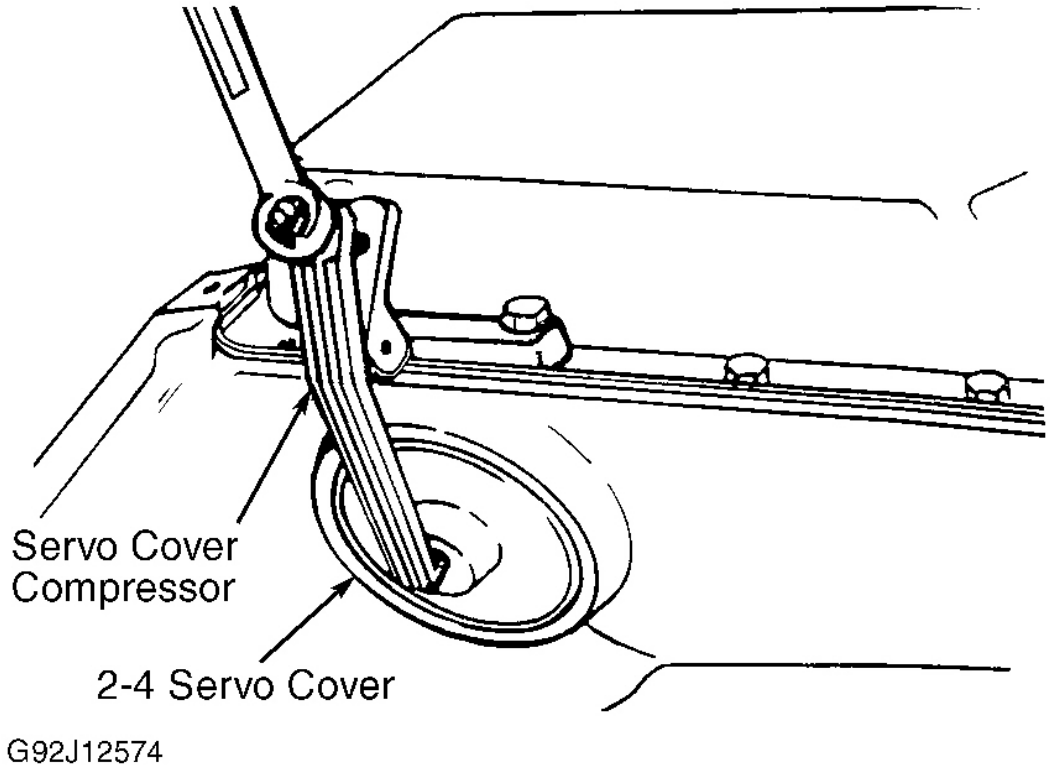


Fig. 6: Compressing Servo Cover
Courtesy of GENERAL MOTORS CORP.

TROUBLE SHOOTING

NOTE: For electrical trouble shooting, see procedures in AUTO TRANS DIAGNOSIS - 4L60-E article. For additional trouble shooting, see TECHNICAL SERVICE BULLETINS. For elements in use at specified selector lever positions, see CLUTCH & BAND APPLICATION CHART under CLUTCH & BAND APPLICATION.

SYMPTOM DIAGNOSIS

1st Gear Only, No Upshift

Check 1-2 shift valve sticking in valve body. Spacer plate or gaskets damaged or not positioned properly. Case-to-valve body face damaged or not flat. Governor screen restricted or damaged. 2-4 servo assembly restricted or blocked case passages. Nicks or burrs on servo pin or case pin bore. Missing or damaged piston or pin seals. 4th servo piston installed backward.2-4 band worn or damaged, or band anchor pin not engaged. Check shift solenoids.

1st Gear Start In 2nd Gear Start Mode (Camaro/Firebird Only)

Check second gear start switch.

Slips In 1st Gear

Defective forward clutch assembly. Clutch plates worn. Piston porous or damaged. Piston seals missing or damaged. Input housing-to-forward clutch housing "O" ring seal missing or damaged. Damaged housing. Housing retainer and ball assembly damaged or not seating. Input shaft and housing assembly turbine shaft seals missing or damaged. Accumulator valve stuck in valve body.

Valve body face not flat, damaged lands, or interconnected passages. Spacer plate or gaskets incorrect, damaged or not positioned properly. Check for defective 1-2 accumulator piston assembly. Porosity in piston or cover and pin assembly. Damaged piston ring grooves. Piston seal missing or damaged. Cover gasket missing or damaged. Broken accumulator spring.

Improper oil pressure. Torque converter stator roller clutch not holding or 4th servo piston in backward. Damage to low roller clutch lugs or inner ramps. Rollers not free moving, inadequate spring tension or damage to inner splines. Oil passage plugged. Forward clutch accumulator piston seal missing or damaged. Piston out of its bore.

Slipping Or Rough 1-2 Shift

Check for defective valve body assembly. 1-2 shift valve train or accumulator valve stuck. Gaskets or spacer plate incorrect, damaged or not installed properly. Valve body face not flat.

Defective 2-4 servo assembly. Apply pin incorrect length. Servo seals or "O" ring seals missing or damaged. Restricted or missing oil passages. Case servo bore damaged. Defective 2nd accumulator. Porosity in 1-2 accumulator housing or piston. Piston seal or groove damaged. Nicks or burrs in 1-2 accumulator housing. Missing or restricted oil passages or 2-4 band worn or not positioned properly. Oil pump assembly or case faces not flat.

Slipping, Rough Or No 2-3 Shift

Internal converter damage. Oil pump stator shaft sleeve scored or not located properly. Valve body 2-3 valve train or accumulator valve stuck. Spacer plate or gaskets incorrect, damaged or not positioned properly. Input housing assembly forward or 3-4 clutch plates worn. Excessive clutch plate travel.

Forward or 3-4 piston seals damaged. Porosity in 3-4 clutch housing or piston, or 3-4 piston check ball stuck, damaged or not sealing. Restricted apply passages. Forward clutch piston or 3rd accumulator retainer and ball assembly not seating. Sealing balls loose or missing. 2-4 servo assembly or 2nd apply piston seals missing or damaged.

1st & 4th Or 2nd & 3rd Gear Only

Check shift solenoids for dirt, damaged seals or electrical connections.

3rd Gear Only

Check 2-3 shift solenoid and 3-2 control solenoid circuits, damaged seals or electrical connections.

3-2 Flare Or Tie Up

Check 3-2 control solenoid for dirt, damaged seals or electrical connections.

Slipping, Rough Or No 3-4 Shift

Check oil pump assembly faces not flat or pump cover retainer and ball assembly omitted or damaged. Valve body assembly 2-3 shift train, accumulator valve, 1-2 shift valve or 3-2 control valve stuck. Manual valve link bent or damaged. Spacer plate or gaskets incorrect, damaged or not positioned properly. Defective 2-4 servo assembly.

Incorrect band apply pin. Servo seals missing or damaged. Porosity in pistons, cover or case. Plugged or missing orifice cup plug. Case 3rd accumulator retainer and ball assembly leaking. Porosity in 3-4 accumulator piston or bore. 3-4 accumulator piston seal or seal grooves damaged. Restricted oil passage. Defective input housing assembly. Forward or 3-4 clutch plates worn, or excessive plate travel.

Forward or 3-4 piston seals damaged. Porosity in 3-4 clutch housing or piston. 3-4 piston check ball stuck, damaged or not sealing. Restricted apply passages. Forward clutch piston retainer and ball assembly not seating. 2-4 band worn or not positioned properly. Sealing balls loose or missing.

No Reverse Or Slips In Reverse

Defective input housing assembly. 3-4 apply ring stuck in applied position. Forward clutch not releasing. Turbine shaft seals missing or damaged. Manual valve link disconnected. Defective oil pump assembly. Retainer and ball assembly missing or damaged. Stator shaft seal rings or ring grooves damaged. Stator shaft sleeve scored or damaged. Reverse boost valve stuck, damaged or not assembled properly. Cup plug missing.

Restricted oil passage. Oil pump faces not flat. Converter clutch valve stuck. Defective valve body assembly. 2-3 shift valve stuck. Manual linkage out of adjustment. Spacer plate and gaskets incorrect, damaged or not positioned properly. Defective reverse input clutch assembly. Clutch plate worn. Housing and drum assembly cracked at weld. Clutch plate or return spring assembly retaining ring out of groove. Piston deformed or dished.

Seals damaged or missing. Retainer and ball assembly not sealing. Restricted apply passage. Defective low-reverse clutch. Clutch plates worn or retaining ring not positioned properly. Porosity in piston. Seals damaged. Return spring assembly retaining ring not positioned properly. Case porosity. Case cover plate not tightened properly or gasket missing or damaged.

No Part-Throttle Or Delayed Downshifts

Check for defective 2-4 servo assembly. Servo cover retaining ring missing or not assembled properly. 4th

apply piston damaged or not assembled properly. Inner housing damaged or not assembled properly. Defective valve body assembly. 3-2 control valve stuck. 4-3 sequence valve body channel blocked. No. 5 check ball missing.

Harsh Garage Shifts

Check valve body for missing check ball, or orifice cup plug.

No Overrun Braking In Manual 3-2-1

Defective valve body assembly. 4-3 sequence valve or throttle valve stuck. No. 3 check ball not positioned properly. Spacer plate and gaskets incorrect, damaged or not positioned properly. Defective input clutch assembly. Turbine shaft oil passages plugged or not drilled. Turbine shaft seal rings damaged. Turbine shaft sealing balls loose or missing. Porosity in forward or overrun clutch piston. Overrun piston seals damaged or cut. Overrun piston check ball not sealing.

Drives (Creeps) In Neutral

Forward clutch not releasing. Manual valve link disconnected. Converter clutch apply valve stuck in oil pump. Face of transmission case not flat or internal leakage in case.

Starts In 2nd In "D"

Forward sprag clutch assembly installed backward.

No Park

Parking linkage binding, loose, missing or not positioned properly.

Oil Pressure High Or Low

Oil pressure regulator valve stuck or valve spring damaged. Rotor guide omitted or not assembled properly. Rotor cracked or reverse boost valve or sleeve stuck, damaged or not assembled properly. Orifice hole in pressure regulator valve plugged. Sticking slide or excessive rotor clearance. Pressure relief ball not seated or damaged. Pump cover or body has porosity. Incorrect pump cover or pump face not flat. Excessive rotor clearance.

Intake pipe restricted by casting flash. Cracks in filter body or intake pipe. "O" ring seal missing, cut or damaged. Incorrect lubricant used during rebuild procedure.

Manual valve scored or damaged. Spacer plate or gaskets incorrect, damaged or not assembled properly. Check for stuck 2-3 shift valve, damaged pressure control solenoid or damaged pressure switch assembly. Check for missing check balls or wrong assembly. Case-to-valve body face not flat. Harsh Shifts

Check PCM input signals from TP sensor, pressure switch assembly, fluid temperature sensor, VSS and engine coolant temperature sensor. Inspect pressure control solenoid for damaged pins or seals, or dirt in oil circuits.

High Or Low Shift Points

Check for stuck pressure regulator valve or pump slide sticking. Spacer plate or gaskets damaged, incorrect or not assembled properly.

Valve body pad porous or damaged. 2-4 accumulator has porosity. Servo piston seals damaged. Apply pin damaged or has improper length. 2-4 band burned or anchor pin not engaged. Throttle Position (TP) sensor, VSS and/or 4WD low switch (if equipped) disconnected or damaged.

No Converter Clutch Apply

Transmission not supplied 12 volts. Outside electrical connector damaged. Inside electrical connector wiring harness or solenoid damaged. Solenoid wire pinched. Solenoid not grounded. Pressure switches incorrect or damaged. Temperature sensor damaged. Engine speed sensor or pressure switch assembly. Converter internal damage.

Converter clutch valve stuck or assembled backward, or retaining ring not positioned properly. Pump-to-case gasket not positioned properly. Orifice cup plug restricted or damaged. Solenoid "O" ring seal cut or damaged. Pump-to-body cover high or uneven bolt torque.Turbine shaft "O" ring seal cut or damaged. Turbine shaft retainer and ball assembly restricted or damaged. TCC shift valve or apply valve stuck. Solenoid "O" ring leaking. Solenoid screen is blocked.

Converter Shudder

Torque converter has internal damage. Converter clutch valve stuck. Restricted oil passages. Crack in filter body. Restriction in filter neck. "O" ring seal cut or damaged. Turbine shaft "O" ring cut or damaged. Turbine shaft retainer and ball assembly restricted or damaged. Low oil pressure. Engine not tuned properly.

No Converter Clutch Release

Solenoid external ground. Converter internal damage. Converter clutch valve stuck. Converter clutch apply valve stuck in apply position. PCM external ground faulty.

Converter Clutch Applies When Cold

Check engine coolant temperature sensor and trouble codes.

Ratcheting Noise

Parking pawl return spring weak, damaged or not assembled properly.

Oil Leaking Out Vent

Chamfer in pump body rotor pocket too large. Fluid level overfilled. Cross leak out of pump body and cover.

Vibration In Reverse & Whining Noise In Park

Broken oil pump vane rings.

Front Oil Leak

Torque converter welded seam leaking. Damaged torque converter hub. Damaged front seal.

Pump Bushing Spins Out, "Walks" Into Seal, Or Seizes To Converter Hub

Transmission and engine center lines do not match. Excessive crankshaft runout. Bent flexplate (drive plate). Excessive converter hub runout. Pump bushing I.D. not centered in pump. Bushing too loose in pump. Not enough hub-to-bushing clearance.

Falls Out Of 4th Gear During Coasting

Low line pressure at idle (weak pressure regulator spring).

Binds Up On 3-4 Shift (Feels Like Brake Drag)

Forward pressure plate installed incorrectly. Too many plates in overrun clutch. Incorrect top steel plate installed in overrun clutch.

No Forward Or Reverse Gears (Line Pressure Reading Okay)

Mismatched converter input shaft or broken turbine hub.

Binds Up In Reverse

Stator sleeve rotated out of position. Stuck2-3 shift valve. Servo pin jammed in case. Stuck 3-4 relay or 4-3 sequence valve.

No Reverse

Reverse input drum cracked at weld or seals damaged.

No Drive In "D" Range

Torque converter stator roller clutch not holding.

No Drive In "OD" Range

Faulty output sprag. Teeth "hammered" out of forward friction plates.

CLUTCH & BAND APPLICATION

CLUTCH & BAND APPLICATION CHART (4L60-E)

Selector Lever Position	Shift Solenoid Position	Elements In Use
"D" (Overdrive)		
First Gear	1-2 ON/2-3 ON	Forward Clutch, Forward Sprag & Low Roller Clutch
Second Gear	1-2 OFF/2-3 ON	Forward Clutch,

		Forward Sprag & 2-4 Band
Third Gear	1-2 OFF/2-3 OFF	Forward Clutch, Forward Sprag & 3-4 Clutch
Overdrive	1-2 ON/2-3 OFF	Forward Clutch 2-4 Band & 3-4 Clutch
"D" (Drive)		
First Gear	1-2 ON/2-3 ON	Forward Clutch, Forward Sprag & Low Roller Clutch
Second Gear	1-2 OFF/2-3 ON	Forward Clutch, Forward Sprag & 2-4 Band
Third Gear	1-2 OFF/2-3 OFF	Forward Clutch, Forward Sprag, Overrun Clutch & 3-4 Clutch
"2" (Intermediate)		
First Gear	1-2 ON/2-3 ON	Forward Clutch, Forward Sprag, Low Roller Clutch & Overrun Clutch
Second Gear	1-2 OFF/2-3 ON	Forward Clutch, Forward Sprag, Overrun Clutch & 2-4 Band
"1" (Low)		
First Gear	1-2 ON/2-3 ON	Forward Clutch, Forward Sprag, Low Reverse Clutch, Low Roller Clutch & Overrun Clutch
Second Gear (1)	1-2 OFF/2-3 ON	Forward Clutch, Forward Sprag, Overrun Clutch & 2-4 Band
"R" (Reverse)	1-2 ON/2-3 ON	Low Reverse Clutch, Reverse Input Clutch
"N" Or "P" (Neutral Or Park)	1-2 ON/2-3 ON	All Clutches & Bands Released Or Ineffective
(1) Gear is only available above 30-35 MPH.		

TORQUE CONVERTER

NOTE: **Torque converter is a sealed unit and must be serviced as a complete assembly.**

STALL SPEED TEST

1. Torque converter whine is usually noticed when vehicle is stopped and transmission is in Reverse or Drive. Whine will increase when engine RPM is increased and will stop when vehicle is moving or when torque converter clutch is applied. Stall test is to ensure whine is coming from torque converter.
2. Start engine, and allow it to reach normal operating temperature. Apply parking and service brakes. Put transmission in Drive. Depress accelerator to approximately 1200 RPM for less than 6 seconds. **DO NOT** depress accelerator for more than 6 seconds or transmission damage may occur. Torque converter noise will increase under this load.

NOTE: **Torque converter whine should not be confused with pump whine, which is usually noticeable in Park, Neutral and all other gear ranges. Pump whine will vary with pressure.**

STATOR CHECK

1. Torque converter stator roller clutch can either remain locked up at all times or freewheel in both directions. If stator is freewheeling at all times, vehicle tends to have poor acceleration from a stop. Vehicle may act normal at speeds above 30-35 MPH.
2. If poor acceleration is noted, ensure exhaust system is not blocked, engine timing is correct and transmission is in 1st gear when starting from a stop. If stator is locked up at all times, performance from a stop appears normal. Engine RPM and acceleration is limited at high speeds. Engine may overheat from this condition.
3. A visual inspection of torque converter may reveal converter is Blues from overheating. If torque converter has been removed from vehicle, stator roller clutch can be checked by inserting a finger into splined inner race of roller clutch and trying to turn race in both directions. Inner race should turn freely clockwise but should not turn or should be difficult to turn counterclockwise.

END PLAY CHECK

1. Inspect torque converter for hub scoring, cracks or weld area cracks before checking end play. Install End Play Checking Tool (J-35138) on torque converter. See **Fig. 7**.
2. Note end play of torque converter. End play must be within specification. See **TORQUE CONVERTER END PLAY SPECIFICATIONS**. Replace torque converter if end play is not within specification or damage to hub area exists.

TORQUE CONVERTER END PLAY SPECIFICATIONS

Converter Diameter In. (mm)	End Play In. (mm)
9.65 (245.0)	.000-.020 (.00-.50)
11.73 (298.0)	.000-.024 (.00-.61)

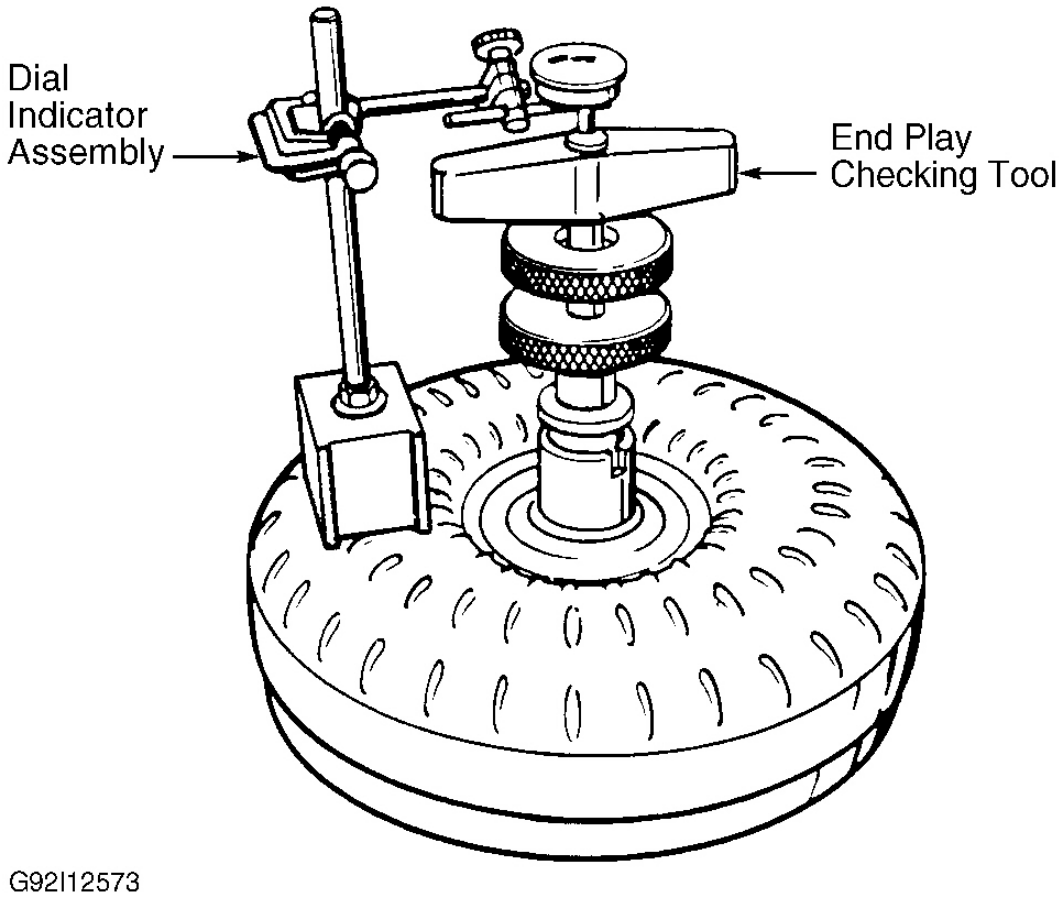


Fig. 7: Checking Torque Converter End Play
Courtesy of GENERAL MOTORS CORP.

CONVERTER FLUSHING

Torque converter flushing is not recommended. Replace torque converter if contamination is found during oil cooler flushing procedure.

NOTE: For additional information on Torque Converter Clutch (TCC), see AUTO TRANS DIAGNOSIS - 4L60-E article in the AUTOMATIC TRANSMISSIONS section.

ELECTRONIC SELF-DIAGNOSTICS

NOTE: See AUTO TRANS DIAGNOSIS - 4L60-E article in the AUTOMATIC TRANSMISSIONS section.

TESTING

ROAD TEST

NOTE: Shift speed charts reference throttle position angle instead of minimum or wide open throttle position. This measurement is more accurate. A scan tool should be used to monitor throttle position angle. For transmission model code, refer to metal identification tag attached to transmission. Shift speed information for 3.8L is not available.

Gear Selector Position "D" (Overdrive)

1. With gear selector in "D" (overdrive) position, choose throttle position angle of 10 or 25 percent. See **Fig. 8** and **Fig. 9** . Set scan tool to monitor throttle position angle and vehicle speed. Accelerate vehicle to chosen throttle position angle and hold throttle steady.
2. Note shift speed engagement points in 2nd gear, 3rd gear and overdrive gear. Use charts as a reference for proper shift speeds. See **Fig. 8** and **Fig. 9** . Also note Torque Converter Clutch (TCC) engagement point while in overdrive. Repeat procedure using different throttle position angle.

NOTE: Shift speeds may vary due to slight hydraulic delays responding to electronic controls. A change from original equipment tire size also affects shift speeds. Ensure TCC engages in 3rd or overdrive. TCC should not apply unless transmission has reached a minimum operating temperature of 64°F (18°C) and engine coolant temperature is 140°F (60°C).

3. At vehicle speeds of 40-50 MPH in overdrive, quickly increase throttle position angle to more than 50 percent. Verify TCC releases, transmission immediately downshifts to 3rd gear and 1-2 shift solenoid turns off.
4. At vehicle speeds of 40-50 MPH in overdrive, quickly depress accelerator to wide open position (full throttle detent downshift). Verify TCC releases, transmission immediately downshifts to 2nd gear, 1-2 solenoid is off and 2-3 solenoid is on.
5. At vehicle speeds of 40-55 MPH in overdrive, release accelerator pedal while moving gear selector to "3" (third gear) position. Verify TCC releases, transmission immediately downshifts into 3rd gear, and engine braking slows vehicle.
6. Move gear selector to "D" (overdrive) position, and accelerate to 40-45 MPH. Release accelerator pedal while moving gear selector to "2" (2nd gear) position. Verify TCC releases, transmission immediately downshifts to 2nd gear, and engine braking slows vehicle.
7. Move gear selector to "D" (overdrive) position, and accelerate to 30 MPH. Release accelerator pedal while moving gear selector to "1" (1st gear) position. Verify TCC releases, transmission immediately downshifts to 1st gear and engine braking slows vehicle. At speeds below 30 MPH, transmission immediately downshifts to 1st gear.
8. With gear selector in the "D" (overdrive) position, accelerate vehicle to overdrive gear with TCC applied. Release accelerator pedal, and lightly apply brakes. Verify TCC releases and downshifts occur at speeds shown in shift speed charts. See **Fig. 8** and **Fig. 9** .

ENGINE & RPO	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM TPS			2-3 SHIFT +/- 200 RPM TPS			3-4 SHIFT +/- 150 RPM TPS			2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			10	25	50	10	25	50	10	25	50			
3.4L (L32)	F	3.23	472	837	1072	815	1523	1994	1373	2016	N/A	1286	1501	2874
4.3L (L99)	B	2.93	376	581	924	650	992	1642	992	1300	N/A	1027	1505	2395
4.3L (L99)	B	2.73	376	615	1026	650	1026	1711	958	1403	N/A	1027	1711	2395

ENGINE & RPO	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM TPS			2-3 SHIFT +/- 200 RPM TPS			3-4 SHIFT +/- 150 RPM TPS			2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			10	25	50	10	25	50	10	25	50			
5.7L (LT1)	B	3.08	457	724	1182	724	1220	2212	1106	1716	N/A	1258	1716	3051
5.7L (LT1)	B/D	2.93	317	570	951	570	951	1680	887	1268	N/A	982	1331	2250
5.7L (LT1)	B/D	2.56	348	602	1046	602	1077	1902	919	1458	N/A	951	1648	2536
5.7L (LT1)	F Normal Mode	2.73	434	543	1375	760	1303	2570	977	1448	N/A	1339	1737	3366
	F Performance Mode (Pontiac Only)	2.73	434	651	1194	760	1267	2280	977	1737	N/A	1339	1520	3004
5.7L (LT1)	F Normal Mode	3.23	481	788	1182	832	1576	2190	1401	1883	N/A	1620	1664	3197
	F Performance Mode (Pontiac Only)	3.23	481	788	1357	876	1357	2934	1401	1883	N/A	1620	1576	3197
5.7L (LT1)	Y	2.59	386	737	1193	751	1333	2211	1053	1860	N/A	1404	1755	3439
5.7L (LT1)	Y	3.07	456	830	1286	871	1618	2407	1203	2241	N/A	1618	1743	3237

1. ALL SPEEDS ARE GIVEN IN TRANSMISSION OUTPUT SHAFT RPM
2. SPEEDS ARE BASED ON PERCENT THROTTLE POSITION SENSOR (TPS) DATA
3. USE A TECH 1 OR OTHER SCAN TOOL TO MONITOR THIS DATA
4. ALL SHIFT SPEEDS ARE APPROXIMATE

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Fig. 8: Hydra-Matic 4L60-E Shift Speed Charts (Cars)
Courtesy of GENERAL MOTORS CORP.

ENGINE & RPO	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM TPS			2-3 SHIFT +/- 200 RPM TPS			3-4 SHIFT +/- 150 RPM TPS			3-2 +/- 100 RPM	2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
2.2L			10	25	50	10	25	50	10	25	50				
(LM2)	S	4.10	596	795	1143	1043	1441	2137	1491	1988	3280	3081	1491	1689	3230

ENGINE & RPO	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM TPS			2-3 SHIFT +/- 200 RPM TPS			3-4 SHIFT +/- 150 RPM TPS			3-2 +/- 100 RPM	2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			10	25	50	10	25	50	10	25	50				
4.3L (L35)	S/T	3.08/3.42	566	828	915	1090	1526	1787	1438	1918	2659	2441	1220	1526	2921
	M/L	3.42/3.73	566	828	915	1090	1526	1787	1438	1918	2659	2441	1220	1526	2921
4.3L (LB4)	G	3.42/3.73	479	654	959	872	1264	1918	1395	1831	2572	2267	1220	1351	2528
	C/K	3.08/3.42	479	654	959	959	1264	1918	1395	1831	2572	2267	1220	1351	2528
	C/K	3.73/4.10	523	697	784	1002	1351	1613	1395	1831	2572	2049	1220	1351	2528
	M	3.23	479	654	959	959	1526	1918	1395	1831	2572	2267	1220	1351	2528
	M	3.42	523	784	1046	915	1438	1962	1395	1918	2659	2049	1220	1351	2528
	S/T	3.08/3.42	479	654	959	915	1526	1918	1395	1831	2572	2267	1220	1351	2528

ENGINE & RPO	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM TPS			2-3 SHIFT +/- 200 RPM TPS			3-4 SHIFT +/- 150 RPM TPS			3-2 +/- 100 RPM	2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			10	25	50	10	25	50	10	25	50				
5.0L (L03)	C10/G10/G20	3.08	481	666	851	777	1184	1591	1184	1665	2479	2035	962	1258	2368
	C20/K10/K20	3.42													
	C10/G10/G20	3.42	529	773	936	814	1302	1750	1221	1668	2482	2035	976	1261	2360
	C20/K10/K20	3.73													
	G20	3.73	536	849	938	894	1385	1788	1251	1698	2503	2011	983	1251	2369
	C20/K10/K20	4.10													

ENGINE & RPO	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM TPS			2-3 SHIFT +/- 200 RPM TPS			3-4 SHIFT +/- 150 RPM TPS			3-2 +/- 100 RPM	2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
			10	25	50	10	25	50	10	25	50				
5.7L (L05)	C10/G10/G20	3.08	444	629	851	777	1184	1591	1184	1628	2479	2035	962	1295	2368
	C20/K10/K20	3.42													
	C10/G10/G20	3.42	447	691	936	814	1302	1709	1221	1668	2482	2035	976	1261	2360
	C20/K10/K20	3.73													
	C10/G20	3.73	491	759	938	894	1385	1788	1251	1698	2503	2011	983	1251	2369
	C20/K20	4.10													

ENGINE	BODY	AXLE RATIO	1-2 SHIFT +/- 250 RPM TPS			2-3 SHIFT +/- 200 RPM TPS			3-4 SHIFT +/- 150 RPM TPS			3-2 +/- 100 RPM	2-1 +/- 100 RPM	1-2 WOT	2-3 WOT
		TPS	10	25	50	10	25	50	10	25	50				
6.5L (DIESEL)	G	3.42	370	534	822	698	1068	1644	1315	1561	2096	1767	945	1191	1931
	G	3.08	370	518	814	703	1073	1665	1295	1554	2109	1776	962	1147	1924
	C10	3.42	370	534	822	698	1068	1644	1315	1561	2096	2013	945	1191	2260
	C20/K	3.73													
	C10	3.08	370	518	814	703	1036	1665	1295	1517	2109	2035	962	1147	2257
	C20/K	3.42													
	G	3.73	358	537	806	716	1075	1657	1299	1568	2105	1792	940	1164	1926

1. ALL SPEEDS ARE GIVEN IN TRANSMISSION OUTPUT SHAFT RPM
2. SPEEDS ARE BASED ON PERCENT THROTTLE POSITION SENSOR (TPS) DATA
3. USE A TECH 1 OR OTHER SCAN TOOL TO MONITOR THIS DATA
4. ALL SHIFT SPEEDS ARE APPROXIMATE

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Fig. 9: Hydra-Matic 4L60-E Shift Speed Charts (Trucks & Vans)
Courtesy of GENERAL MOTORS CORP.

NOTE: Upshifts in manual gear ranges are controlled by shift solenoids. Perform following steps by accelerating vehicle at throttle position angle of 10-15 percent.

Gear Selector Position "3" (3rd Gear)

With vehicle stopped, move gear selector to "3" (3rd gear) position and steadily increase throttle pressure to accelerate vehicle. Note speeds at which vehicle shifts into 2nd and 3rd gears. See **Fig. 8** and **Fig. 9** .

Gear Selector Position "2" (2nd Gear)

With vehicle stopped, move gear selector to "2" (2nd gear) position. Accelerate vehicle and note speed at which vehicle shifts from 1st gear to 2nd gear. Accelerate vehicle to 35 MPH. Verify transmission does not shift into 3rd gear, and TCC does not apply.

Gear Selector Position "1" (1st Gear)

With vehicle stopped, move gear selector to "1" (1st gear) position. Accelerate vehicle to 20 MPH. Verify transmission does not upshift, and TCC does not apply.

Gear Selector Position "R" (Reverse)

With vehicle stopped, move gear selector to "R" (Reverse) position. Verify 1-2 and 2-3 shift solenoids are on.

HYDRAULIC PRESSURE TEST

CAUTION: Parking and service brakes must be applied throughout hydraulic pressure test. Total time for testing with vehicle in any driving gear should not exceed 2 minutes. Transmission damage may occur.

1. Before performing hydraulic pressure test, check fluid level and condition. Check manual control linkages for correct adjustment, and ensure engine is properly tuned.
2. Connect scan tool to Data Link Connector (DLC). Apply parking brake and start engine. Check for stored trouble codes. If trouble codes are present, diagnose as necessary. See **AUTO TRANS DIAGNOSIS - 4L60-E** article. Turn engine off. Connect oil pressure gauge to line pressure test port. See **Fig. 10**.
3. Start engine and warm to normal operating temperature. With vehicle in Reverse, line pressure should be 64-324 psi (441-2234 kPa). With vehicle in Park, Neutral or Drive, line pressure should be 55-189 psi (379-1303 kPa).
4. Shift transaxle into Park. Access Pressure Control Solenoid (PCS) test on scan tool. Increase DESIRED PCS in 0.1 amp increments and read corresponding line pressure on oil pressure gauge. Allow pressure to stabilize for 5 seconds after each current change. Compare readings to **LINE PRESSURE SPECIFICATIONS**. If pressure readings are not as specified, and no trouble codes are present, internal malfunction exists. See **TROUBLE SHOOTING**.

NOTE: Scan tool is only able to control pressure control solenoid in Park and Neutral with vehicle stopped. This protects clutches from extremely high or low pressures in Reverse and Drive.

LINE PRESSURE SPECIFICATIONS

PCS Current (Amp)	Line Pressure psi (kPa)

0.02	170-190 (1172-1310)
0.10	165-185 (1137-1275)
0.20	160-180 (1103-1241)
0.30	155-175 (1068-1207)
0.40	148-168 (1020-1158)
0.50	140-160 (965-1103)
0.60	130-145 (896-1000)
0.70	110-130 (758-896)
0.80	90-115 (621-793)
0.90	65-90 (448-621)
0.98	55-65 (379-448)

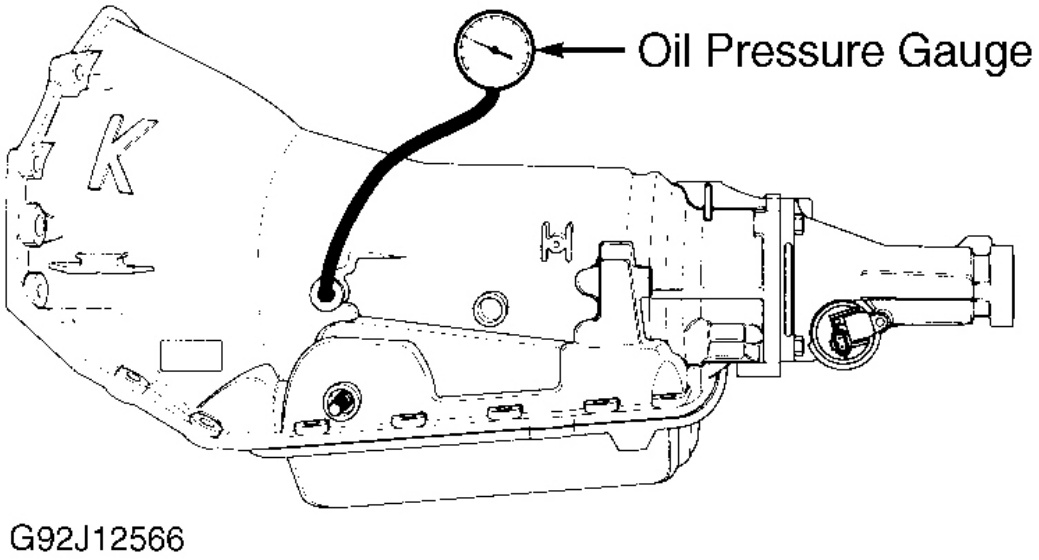


Fig. 10: Installing Oil Pressure Gauge
Courtesy of GENERAL MOTORS CORP.

REMOVAL & INSTALLATION

See appropriate TRANSMISSION REMOVAL & INSTALLATION - A/T article in the TRANSMISSION SERVICING section.

TRANSMISSION DISASSEMBLY

NOTE: Beginning at start of production for all 1996 models, some 4L60-E transmissions were built with a bolt-on bellhousing. This design is used on

models with a 4.3L engine. Design change will make 4L60-E transmission more versatile for a wide variety of engine sizes. Bolts securing bellhousing require a Torx-Plus 50-IP bit for removal. Bolt heads will strip if incorrect tool is used during removal. Transmission case has a totally different casting design for bolt-on bellhousing. Oil pump body has a machined ring added to front of pump body to center bellhousing on installation. Pump body with added machined ring may be found on and can be used in 1995 models, but cannot be used in 1993-94 models.

2-4 SERVO ASSEMBLY

1. Mount transmission on bench using Holding Fixture (J-8763-02). Remove torque converter. Install Servo Cover Compressor (J-29714) on oil pan. See **Fig. 6**. Compress servo cover. Remove servo cover and "O" ring.
2. Remove 2-4 servo assembly. Servo pin length should be checked before disassembling assembly to determine 2-4 band and reverse input drum wear or damage.

CHECKING SERVO PIN LENGTH

1. Remove 4th apply piston and return spring. See **Fig. 11**. Remove retainer ring, washer, apply pin spring and 2nd apply piston pin. Install Piston Compressor (J-22269-01) on 2nd apply piston. See **Fig. 12**.
2. Remove retainer ring, cushion spring and spring retainer. Install Band Apply Pin Tool (J-33037) and apply pin. See **Fig. 13**. Apply 100 INCH lbs. (11 N.m) torque.
3. White line on band apply tool should be within gauge slot if pin length is correct. If White line is not within gauge slot, inspect 2-4 band and reverse input drum for wear and damage during disassembly.
4. Servo pin length must be checked during reassembly. Servo pin is preset and must not be readjusted. See **SERVO PIN SPECIFICATIONS** under 2-4 BAND & SERVO ASSEMBLY under TRANSMISSION REASSEMBLY.

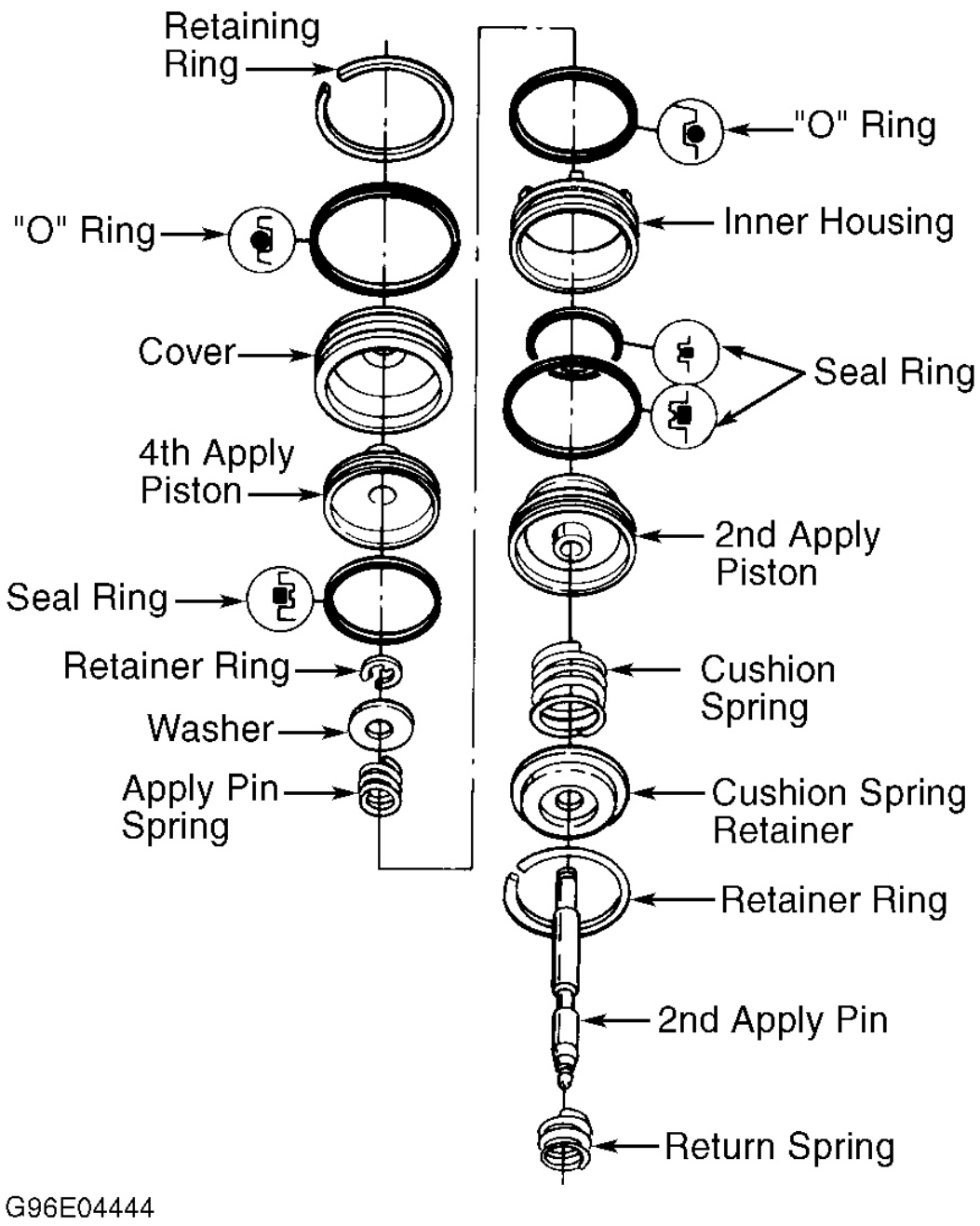


Fig. 11: Exploded View Of 2-4 Servo Assembly
Courtesy of GENERAL MOTORS CORP.

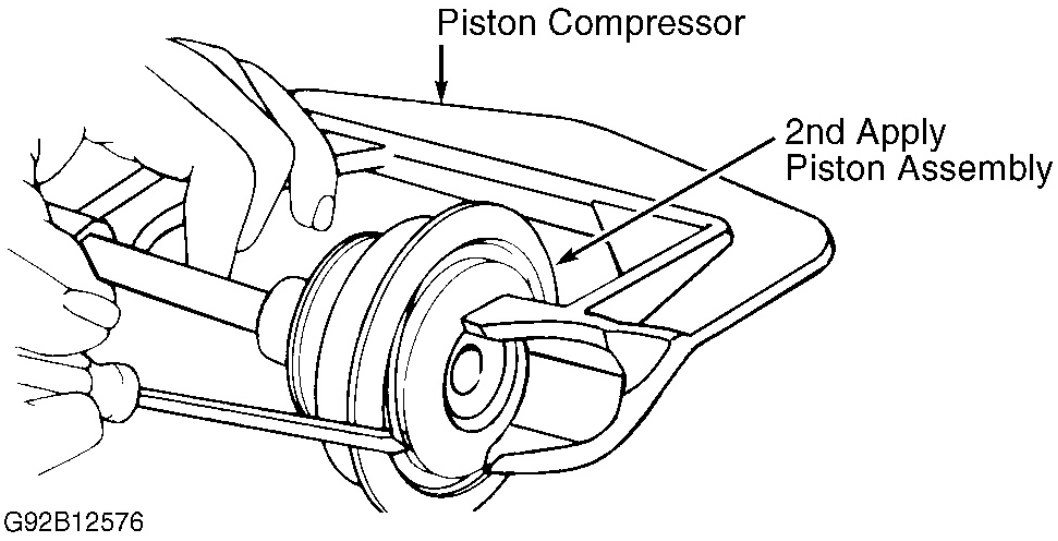


Fig. 12: Compressing 2nd Apply Piston
Courtesy of GENERAL MOTORS CORP.

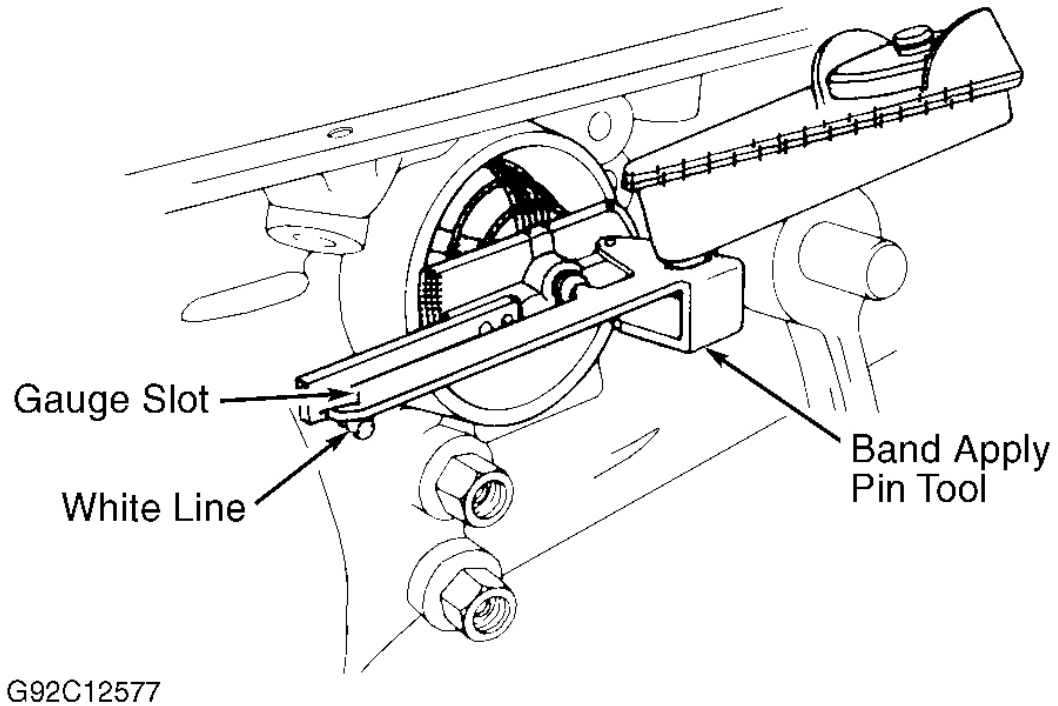


Fig. 13: Measuring Servo Pin Length

Courtesy of GENERAL MOTORS CORP.

EXTENSION HOUSING

Remove speed sensor retaining bolt. Using Puller (J-38417), remove speed sensor assembly and "O" ring. See **Fig. 15**. Remove extension housing and seal. Remove output shaft sleeve and "O" ring (if equipped). Remove speed sensor rotor from output shaft (if necessary). Install Gear Puller (J-21427-01) and Adapter (J-8433) on rotor. Pull rotor from output shaft.

1-2 ACCUMULATOR & SPACER PLATES

1. Remove solenoid retaining bolts. Remove solenoid and "O" ring. Remove wiring harness, and note location for reassembly reference. Carefully remove accumulator cover retaining bolts, 1-2 accumulator cover and pin assembly. See **Fig. 15**.
2. Remove 1-2 accumulator piston, seal and spring. Remove spacer plate, and note check ball and filter locations. Remove spring, 3-4 accumulator piston and pin. Note spacer plate and gasket locations. See **Fig. 5** for check ball and filter locations.

TRANSMISSION END PLAY CHECK

NOTE: Check transmission end play before disassembly. If end play is not within specification, check for damaged parts.

Install Pump Remover/End Play Fixture (J-24773-A) and End Play Adapter (J-25022-A) on end of turbine shaft. See **Fig. 14**. Clamp dial indicator on long bolt with indicator tip on end play fixture. Zero dial indicator. Pull up on end play fixture. Measure transmission end play. Transmission end play should be .005-.036" (.13-.91 mm).

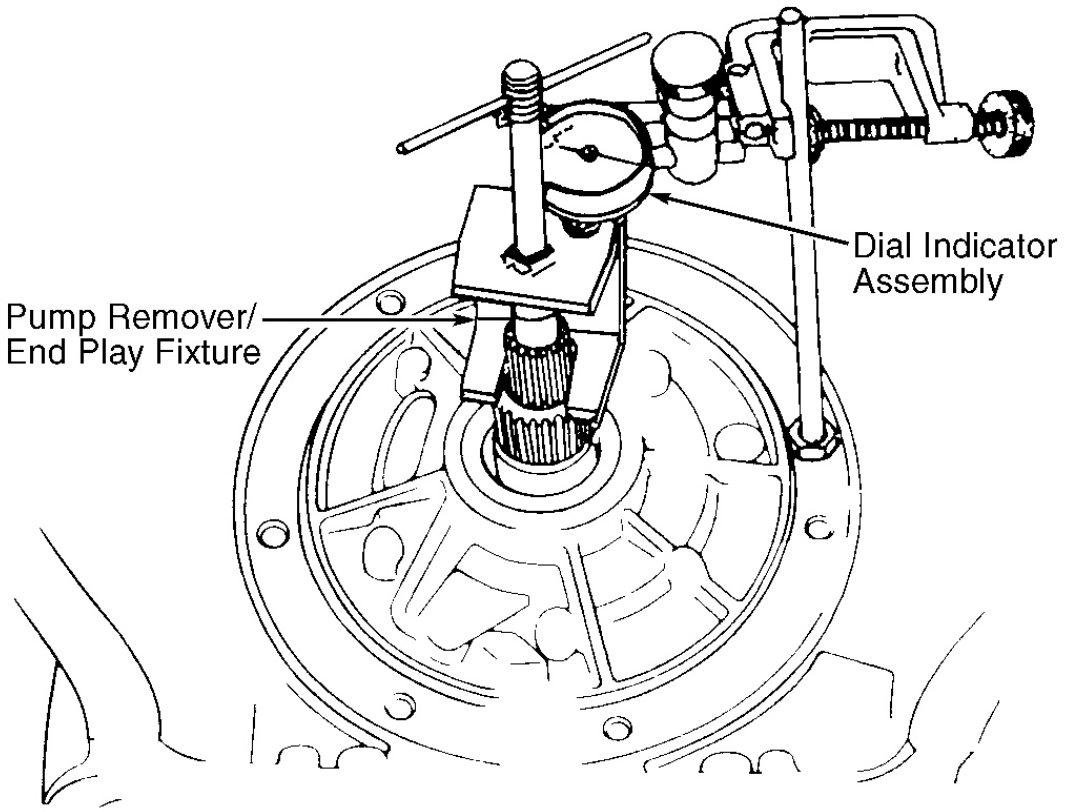


Fig. 14: Checking Transmission End Play
Courtesy of GENERAL MOTORS CORP.

OIL PUMP, INPUT CLUTCH & REVERSE CLUTCH

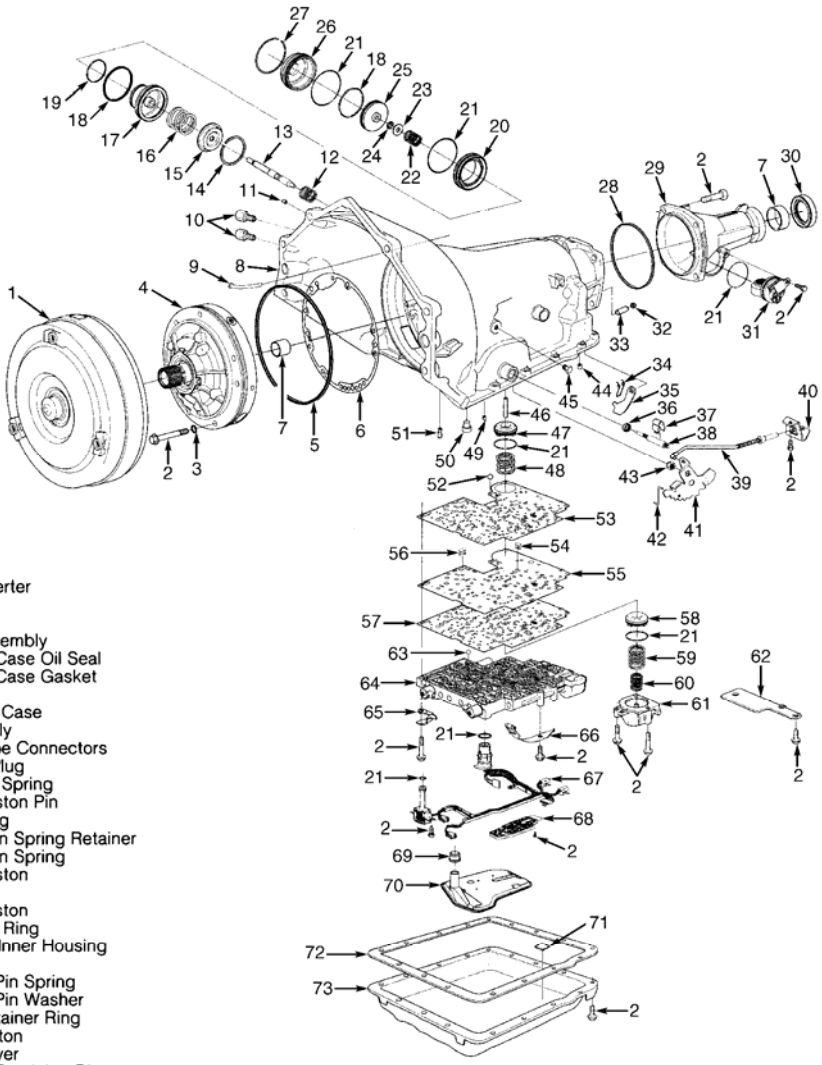
1. Ensure TCC solenoid assembly and oil filter are removed before oil pump removal. Remove oil pump retaining bolts. Using Oil Pump Remover (J-37789-A) and Adapter (J-39119), pull oil pump assembly free from case. See **Fig. 15**.
2. Remove oil pump seal and gasket. Remove reverse input clutch-to-pump thrust washer from pump. Lift out turbine shaft with reverse input clutch assembly.

2-4 BAND & INPUT GEAR SET

1. Remove band anchor pin from case. See **Fig. 15**. Remove 2-4 band assembly from case. Remove input sun gear. See **Fig. 16**.

CAUTION: Output shaft must be held in place when removing input carrier retainer ring.

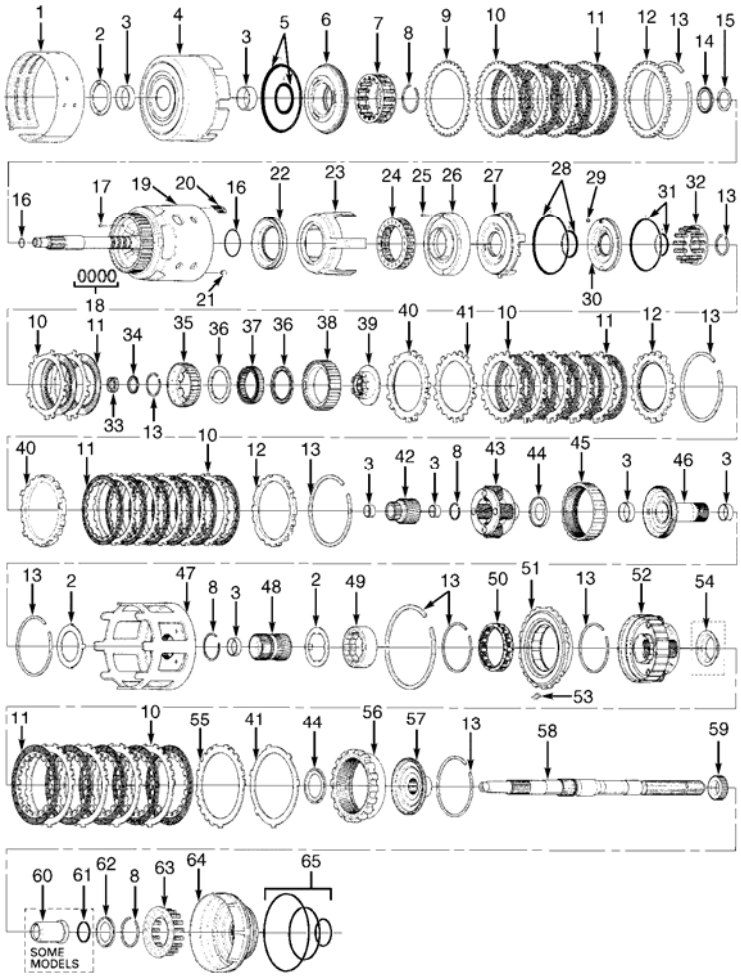
2. Install Output Shaft Support (J-29837) on output shaft. See **Fig. 17**. Remove input carrier to output shaft retainer ring. Remove input carrier. Remove output shaft. Remove input carrier thrust bearing from reaction carrier shaft.



1. Torque Converter
2. Bolt
3. "O" Ring
4. Oil Pump Assembly
5. Oil Pump-To-Case Oil Seal
6. Oil Pump-To-Case Gasket
7. Bushing
8. Transmission Case
9. Vent Assembly
10. Oil Cooler Pipe Connectors
11. Case Servo Plug
12. Servo Return Spring
13. 2nd Apply Piston Pin
14. Retaining Ring
15. Servo Cushion Spring Retainer
16. Servo Cushion Spring
17. 2nd Apply Piston
18. Oil Seal Ring
19. 2nd Apply Piston Inner Oil Seal Ring
20. Servo Piston Inner Housing
21. "O" Ring Seal
22. Servo Apply Pin Spring
23. Servo Apply Pin Washer
24. Apply Pin Retainer Ring
25. 4th Apply Piston
26. 2-4 Servo Cover
27. Servo Cover Retaining Ring
28. Extension-To-Case Seal
29. Case Extension
30. Oil Seal
31. Speed Sensor
32. Steel Cup Plug
33. Parking Pawl Shaft
34. Parking Pawl Return Spring
35. Parking Pawl
36. Manual Shaft Seal
37. Manual Shaft Retainer
38. Manual Shaft
39. Parking Lock Actuator Assembly
40. Parking Lock Bracket
41. Detent Lever
42. Manual Valve Link
43. Nut
44. Transmission Case Plug
45. Pressure Plug
46. Accumulator Piston Pin
47. 3-4 Accumulator Piston
48. 3-4 Accumulator Spring
49. Double Orifice Retainer & Ball Assembly
50. Band Anchor Pin
51. 3rd Accumulator Retainer & Ball Assembly
52. No. 10 Check Ball
53. Spacer Plate-To-Case Gasket
54. Shift Solenoids Screen
55. Valve Body Spacer Plate
56. Pressure Control Solenoid Screen
57. Spacer Plate-To-Valve Body Gasket
58. 1-2 Accumulator Piston
59. 1-2 Accumulator Spring
60. 1-2 Accumulator Inner Spring
61. 1-2 Accumulator Cover & Pin Assembly
62. Spacer Plate Support Plate
63. Check Ball
64. Control Valve Body Assembly
65. Dipstick Stop Bracket
66. Manual Detent Spring Assembly
67. Solenoid Wiring Harness
68. Transmission Pressure Switch Assembly
69. Filter Seal
70. Oil Filter Assembly
71. Magnet
72. Oil Pan Gasket
73. Oil Pan

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Fig. 15: Exploded View Of 4L60-E Transmission External Components
Courtesy of GENERAL MOTORS CORP.



1. 2-4 Band Assembly
2. Thrust Washer
3. Bushing
4. Reverse Input Clutch Housing & Drum Assembly
5. Reverse Input Clutch Seals
6. Clutch Piston
7. Clutch Spring Assembly
8. Retainer Ring
9. Belleville Plate
10. Steel Plate
11. Composition Plate
12. Selective Backing Plate
13. Snap Ring
14. Stator Shaft Bearing Assembly
15. Selective Thrust Washer
16. "O" Ring Seal
17. Orificed Cup Plug
18. Oil Seal Rings
19. Input Shaft & Housing Assembly
20. 3-4 Clutch Boost Spring Assembly
21. Check Ball & Retainer Assembly
22. 3-4 Clutch Piston
23. 3-4 Clutch Apply Ring
24. 3-4 Clutch Spring Assembly
25. Forward Clutch Housing Ball & Retainer Assembly
26. Forward Clutch Housing
27. Forward Clutch Piston
28. Forward Clutch Seals
29. Overrun Clutch Ball
30. Overrun Clutch Piston
31. Overrun Clutch Seals
32. Overrun Clutch Spring Assembly
33. Input Housing-To-Output Shaft Seal
34. Input Sun Gear Bearing Assembly
35. Overrun Clutch Hub
36. Sprag Assembly Retainer Rings
37. Forward Sprag Assembly
38. Forward Clutch Race
39. Sprag Retainer & Race Assembly
40. Apply Plate
41. Waved Plate
42. Input Sun Gear
43. Input Carrier Assembly
44. Thrust Bearing
45. Input Internal Gear
46. Reaction Carrier Shaft
47. Reaction Sun Shell
48. Reaction Sun Gear
49. Low-Reverse Roller Clutch Race
50. Low-Reverse Roller Clutch Assembly
51. Low-Reverse Clutch Support Assembly
52. Reaction Carrier Assembly
53. Support Retainer Spring
54. Oil Deflector (High Output Models)
55. Selective Spacer Plate
56. Internal Reaction Gear
57. Internal Reaction Gear Support
58. Output Shaft
59. Speed Sensor Rotor
60. Output Shaft Sleeve
61. Output Shaft Seal
62. Bearing
63. Low-Reverse Clutch Spring Assembly
64. Low-Reverse Clutch Piston
65. Low-Reverse Clutch Seals

Fig. 16: Exploded View Of 4L60-E Transmission Internal Components
Courtesy of GENERAL MOTORS CORP.

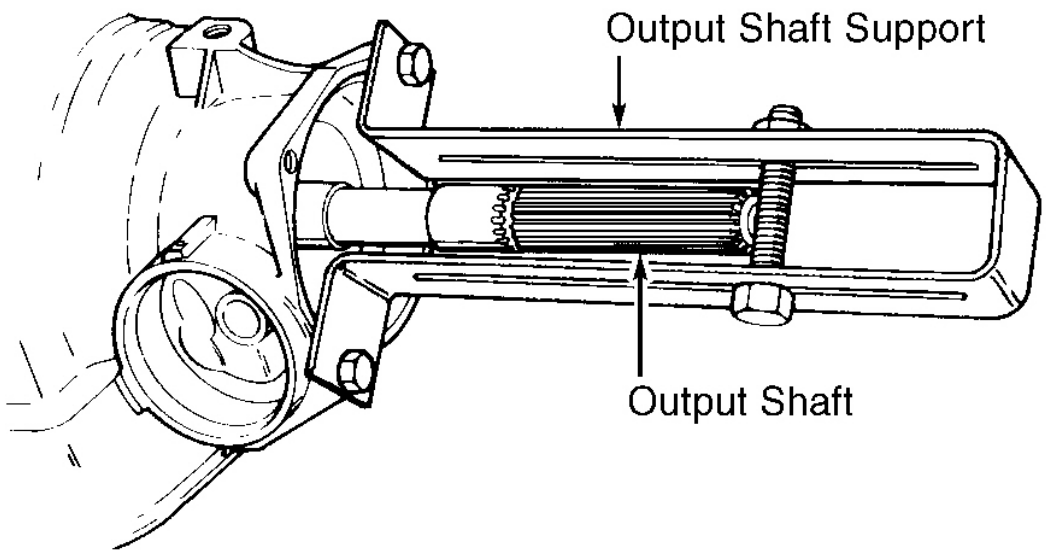


Fig. 17: Installing Output Shaft Support
Courtesy of GENERAL MOTORS CORP.

REACTION GEAR SET

1. Remove input internal gear and reaction carrier shaft Remove reaction sun shell and thrust washer. Remove sun shell-to-clutch race thrust washer. Remove support-to-case retaining ring.
2. Remove spring retainer from low-reverse support. Remove reaction sun gear, low-reverse roller clutch race, roller clutch, support assembly and reaction carrier assembly. See **Fig. 16**.
3. Remove low-reverse clutch assembly. Note locations of parts. Remove internal reaction gear and bearing assembly. Remove internal reaction support-to-case bearing assembly.

LOW-REVERSE CLUTCH

NOTE: Parking pawl may require removal to access low-reverse clutch.

1. Remove parking lock bracket retaining bolts. Remove lock bracket. Using screw extractor, remove shaft plug. Remove parking pawl shaft, parking pawl and return spring if necessary. See **Fig. 15**.
2. Using Clutch Spring Compressor (J-23327), compress low reverse clutch spring retainer. Remove spring retaining ring and low-reverse spring assembly. Remove low-reverse clutch piston by applying air pressure in case apply passage. See **Fig. 18**.

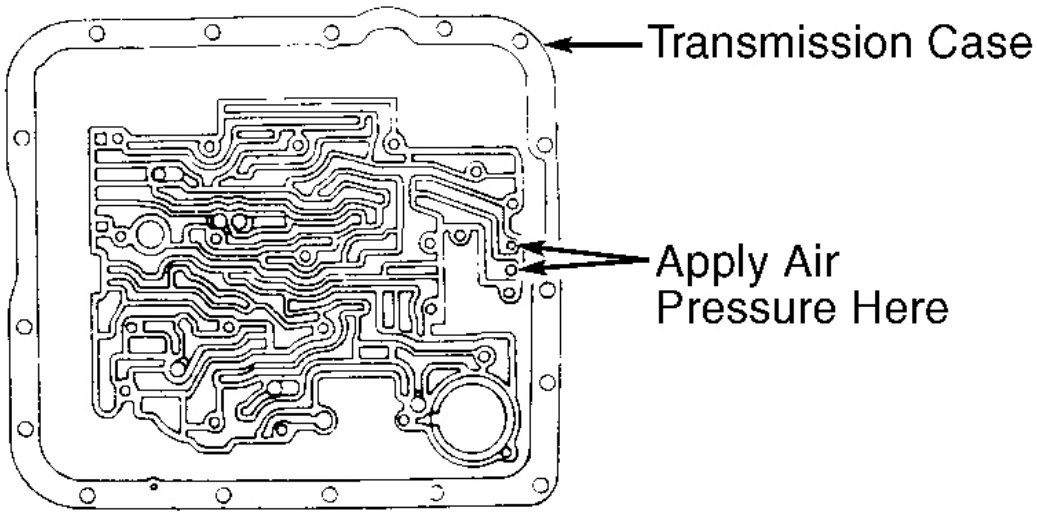


Fig. 18: Removing Low-Reverse Clutch Piston
Courtesy of GENERAL MOTORS CORP.

INNER MANUAL SHAFT LINKAGE

Remove manual shaft nut. Remove manual shaft and retainer. Remove parking lock actuator assembly and inner detent lever. Remove manual shaft seal from transmission case.

3RD ACCUMULATOR CHECK VALVE

1. Check 3rd accumulator check valve before removing it. **DO NOT** remove check valve unless it is leaking. Install servo assembly in bore. Install servo cover and retaining ring. See **Fig. 6**. Pour clean solvent in bore. Inspect for leaks in transmission case. Replace check valve assembly if it leaks. See **Fig. 19**. Remove servo assembly.
2. For check valve removal, install No. 4 screw extractor in check valve assembly. Remove check valve. Ensure bore is free of burrs. Installation tool must be made to ensure proper installation depth is obtained. Using a 3/8" O.D. rod, scribe indicator mark at 1.653" (41.98 mm) from end of rod. Install check valve until scribe mark on rod is flush with case. See **Fig. 19**.

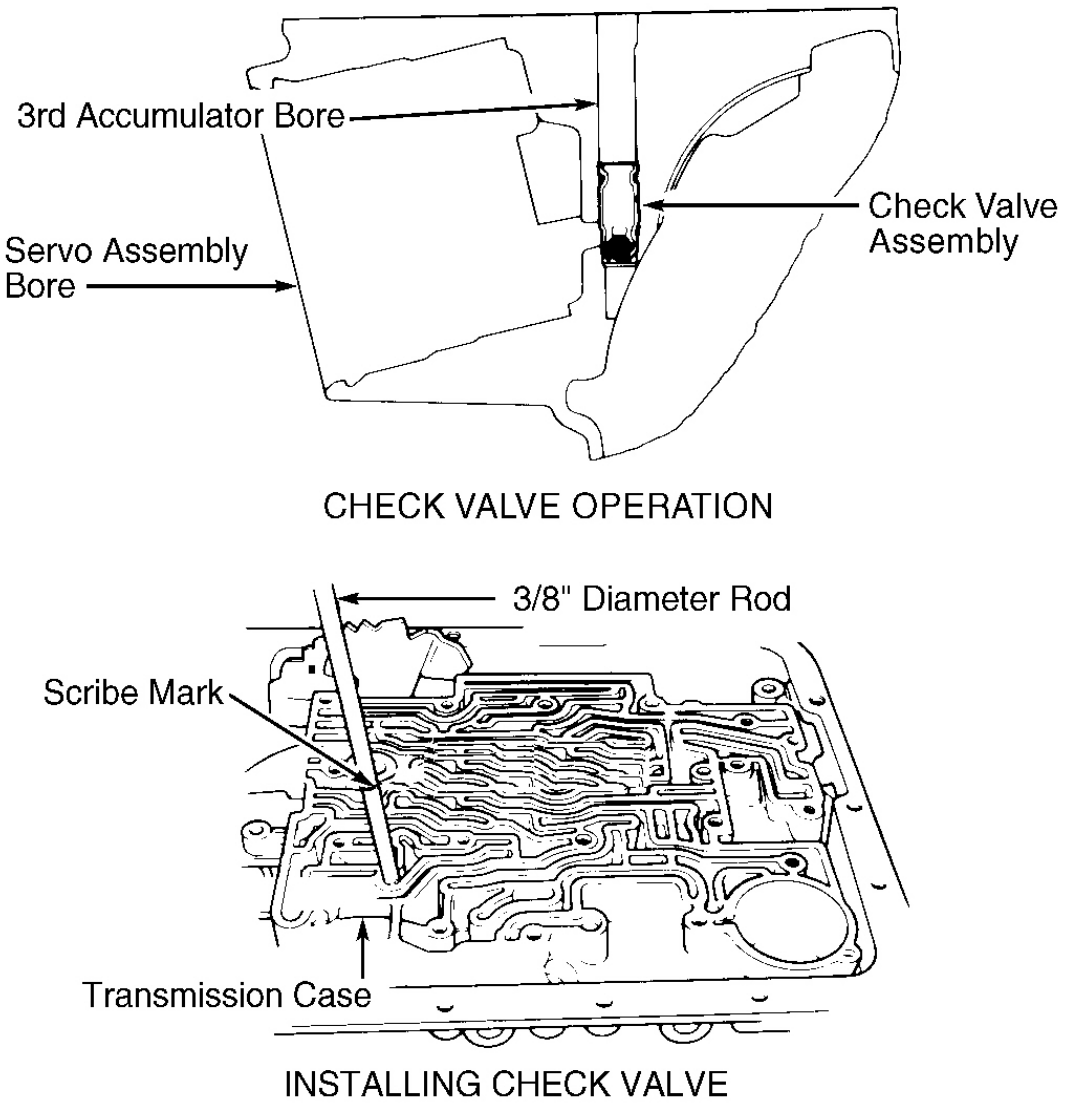


Fig. 19: Installing 3rd Accumulator Check Valve Assembly
Courtesy of GENERAL MOTORS CORP.

CLEANING & INSPECTION

TRANSMISSION CASE

Cleaning & Inspection

Clean transmission case and dry with compressed air. Inspect case assembly for damage, cracks and damaged bolt hole threads. Inspect valve body surface for flatness and land damage. Check case oil passages for

restrictions and blockage. Inspect case internal clutch plate lugs for damage and wear. Inspect servo and accumulator bores for damage. Inspect all snap ring grooves for damage.

CASE ATTACHMENTS

Cleaning & Inspection

Clean all parts and dry with compressed air. Inspect 1-2 and 3-4 accumulator parts for damage to pistons or housing. Inspect for flatness and condition of accumulator, oil passage plate and gasket. Inspect wiring harness leads and connectors for damage. Inspect speed sensor rotor teeth for damage and distortion.

REACTION & INPUT GEAR SETS, LOW-REVERSE CLUTCH & SUPPORT

Cleaning & Inspection

1. Clean all parts and dry with compressed air. Inspect reaction and input carriers for pinion gear damage, excessive wear and improper staking of pinion pins. Inspect carrier bearings for heat damage, flatness and roller condition. Place output shaft sleeve inside reaction carrier and input carrier.
2. Rotate sleeve and note smoothness of bearing operation. Replace carrier assembly if roughness is felt. Check pinion gear end play on reaction and input carriers.
3. Pinion gear end play should be .008-.024" (.20-.61 mm). Inspect internal reaction gear and support for cracks and damaged splines. Inspect low-reverse clutch plates for wear and signs of excessive heat.
4. Inspect low-reverse clutch piston for roughness or damage in seal ring area. Inspect retainer ring and spring assembly for damage. Inspect sun and internal gears and supports for spline and bushing wear and damage. Replace damaged parts as necessary.

COMPONENT DISASSEMBLY & REASSEMBLY

REVERSE INPUT CLUTCH

Disassembly

1. Remove snap ring from reverse input clutch housing. Remove selective backing plate, steel plates, composition plates and Belleville plate. See **Fig. 16**. Note number of clutch plates for reassembly reference. Compress reverse input clutch spring assembly.
2. Remove retainer ring and spring assembly. Remove piston and seals. Thickness of composition plates should be .068-.074" (1.73-1.88 mm). Thickness of steel plates should be .075-.081" (1.90-2.05 mm). Thickness of Belleville plate should be .087-.091" (2.21-2.31 mm).

Inspection

Inspect all plates for damage, distortion, flatness and burred edges. Inspect spring retainer for distortion. Check piston for deformation or damage. Inspect clutch housing bushings for wear. Inspect clutch housing for dishing. Replace worn or damaged parts as necessary.

NOTE: Soak clutch plates in ATF before installation.

Reassembly

1. Apply ATF to piston seals. Install seals on piston with seal lips facing away from plates. Install piston in clutch housing. Install spring assembly with large opening toward piston. Compress spring assembly. Install retainer ring.

CAUTION: Ensure correct retainer ring is used. Ensure reverse input clutch retainer ring is not interchanged with low-reverse retainer ring.

2. Install Belleville plate. Install clutch plates starting with steel plate and alternating with composition plate. Install backing plate with chamfered side upward. Install snap ring. Apply even pressure to backing plate using fingers.
3. **DO NOT** apply too much pressure or Belleville plate will be distorted. Using feeler gauge, measure clearance between snap ring and backing plate. Clearance should be .040-.076" (1.02-1.94 mm). Select backing plate. See **REVERSE INPUT CLUTCH BACKING PLATE SPECIFICATIONS**.

REVERSE INPUT CLUTCH BACKING PLATE SPECIFICATIONS

ID Number	Thickness In. (mm)
2	.285-.292 (7.24-7.42)
3	.257-.263 (6.52-6.68)
4	.228-.234 (5.79-5.94)

LOW-REVERSE SUPPORT ASSEMBLY

CAUTION: Note direction roller clutch is installed in support. Roller clutch must be installed in proper direction to provide lockup of inner race when rotated.

Disassembly & Inspection

Remove inner race and snap ring. Remove roller clutch assembly. Check inner race for damage and surface finish. See **Fig. 20**. Inspect roller and springs for damage and distortion. Inspect support for loose cam, cracks and damaged surface finish. Replace damaged parts as necessary.

Reassembly

1. Install roller clutch assembly in low-reverse support. See **Fig. 20**. Place support in case with hub facing downward. Install inner race. Rotate inner race while pushing downward. Use care not to damage roller and springs during installation.
2. Ensure inner race is fully seated. Bottom tangs will be flush with carrier hub when fully seated. Inner race should rotate clockwise and lock counterclockwise with clutch hub downward. Insert support retainer spring into case between case lug and open notch in support.

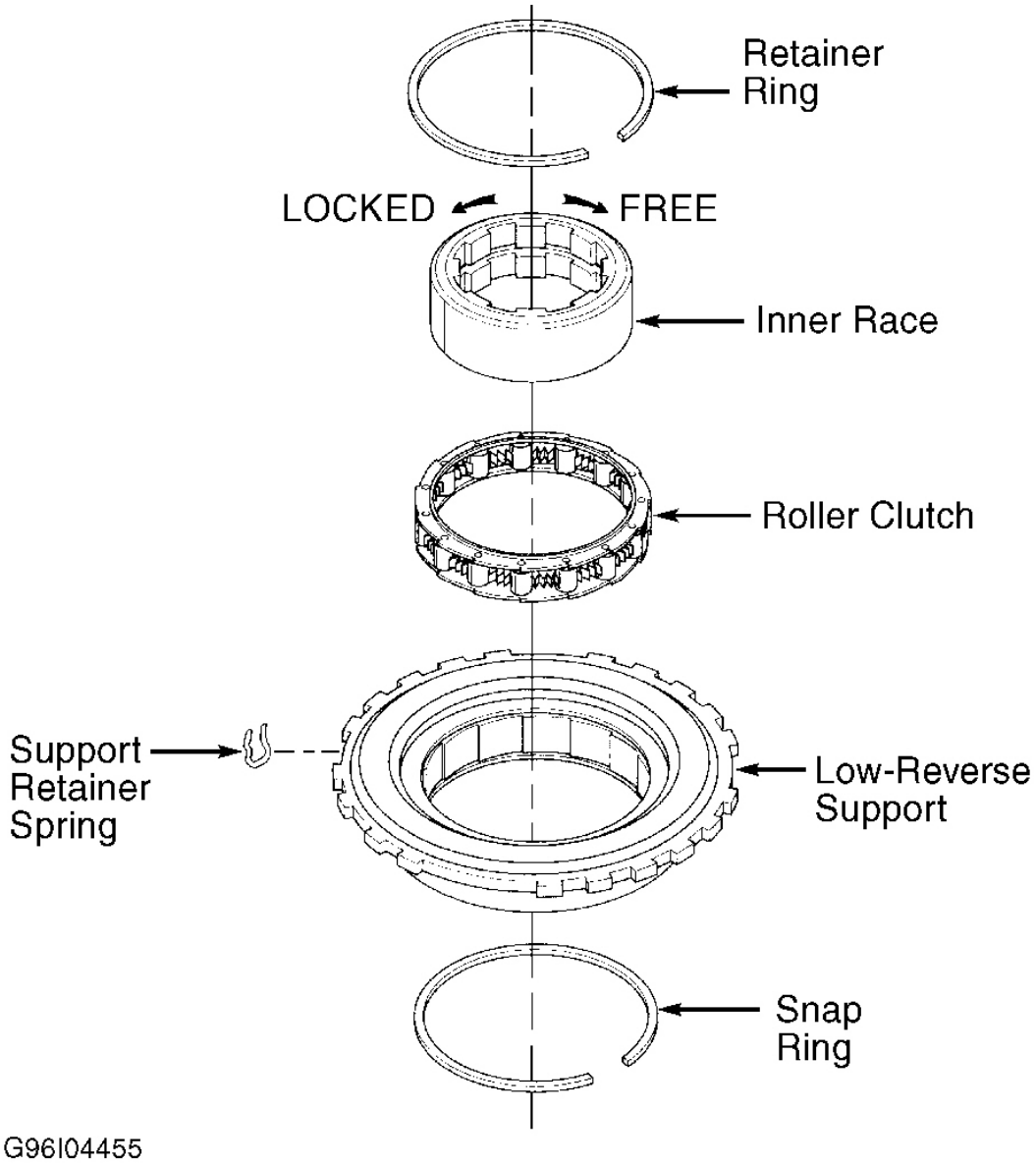


Fig. 20: Exploded View Of Low-Reverse Clutch Assembly
Courtesy of GENERAL MOTORS CORP.

INPUT CLUTCH & FORWARD CLUTCH HUB ASSEMBLY

Disassembly

1. Remove snap ring and backing plate. Remove 3-4 clutch plates. Note number and location of parts for reassembly reference. Remove 3-4 apply plate and clutch ring retainer. See **Fig. 16**.
2. Remove forward clutch snap ring, and remove backing plate. Remove forward clutch sprag assembly and

bearing. Remove input housing seal. Remove forward clutch plates. Note number and location of parts for reassembly reference. Remove waved and apply plates. Remove overrun clutch plates (2 steel and 2 composition). Compress overrun clutch spring retainer.

3. Remove snap ring and spring assembly. Remove overrun piston and forward clutch piston. Remove seals from pistons. Note direction of seals. Remove forward clutch housing. Remove 3-4 clutch spring, 3-4 clutch apply ring and piston. Remove "O" ring from input housing. Remove turbine shaft oil seal rings.
4. Remove forward clutch race. Remove snap ring and overrun clutch hub. Remove sprag retainer and race. Note direction race is installed. Use care not to lose rollers from roller cage.

Inspection

1. Inspect sprag assembly for weak or damaged springs and retainers and worn rollers. Inspect overrun clutch hub for spline damage, excessive wear and open oil passages. Inspect retainer and race for spline damage, surface wear and damaged ring grooves.
2. Replace sprag assembly if damaged. Inspect forward clutch race for spline damage, excessive wear and open oil passages. Inspect input shaft and housing for spline damage, wear and open feed passages.
3. Inspect 3 sealing balls located in rear of turbine shaft for tightness. Turbine shaft contains one open lubrication hole. Ensure orifice plug is installed. Inspect turbine shaft seal areas for roughness and burrs.
4. Inspect check ball located in input housing for free operation. Inspect pistons for wear, damage and porosity. Inspect spring assemblies for damage and distortion.
5. Inspect steel and composition plates for damage. Inspect snap rings for distortion and damage. Check backing plates for flatness and distortion. Inspect clutch apply rings for distortion and damaged tangs.
6. Inspect forward clutch housing check ball for proper operation (if equipped). Inspect housing for cracks and damage in seal areas. Inspect bearings for excessive wear, flatness, damage and flat rollers.

Reassembly

1. For input housing check ball replacement, drive retainer and ball assembly from housing using 1/4" diameter drift. Install NEW check ball assembly using 1/4" drift. Check ball assembly should seat on housing shoulder. Assemble forward clutch sprag assembly.
2. Install sprag assembly in forward clutch race. Notches located in sprag must face upward. See **Fig. 21**. Install snap ring on sprag retainer and race. Snap ring flange must face away from retainer and race.

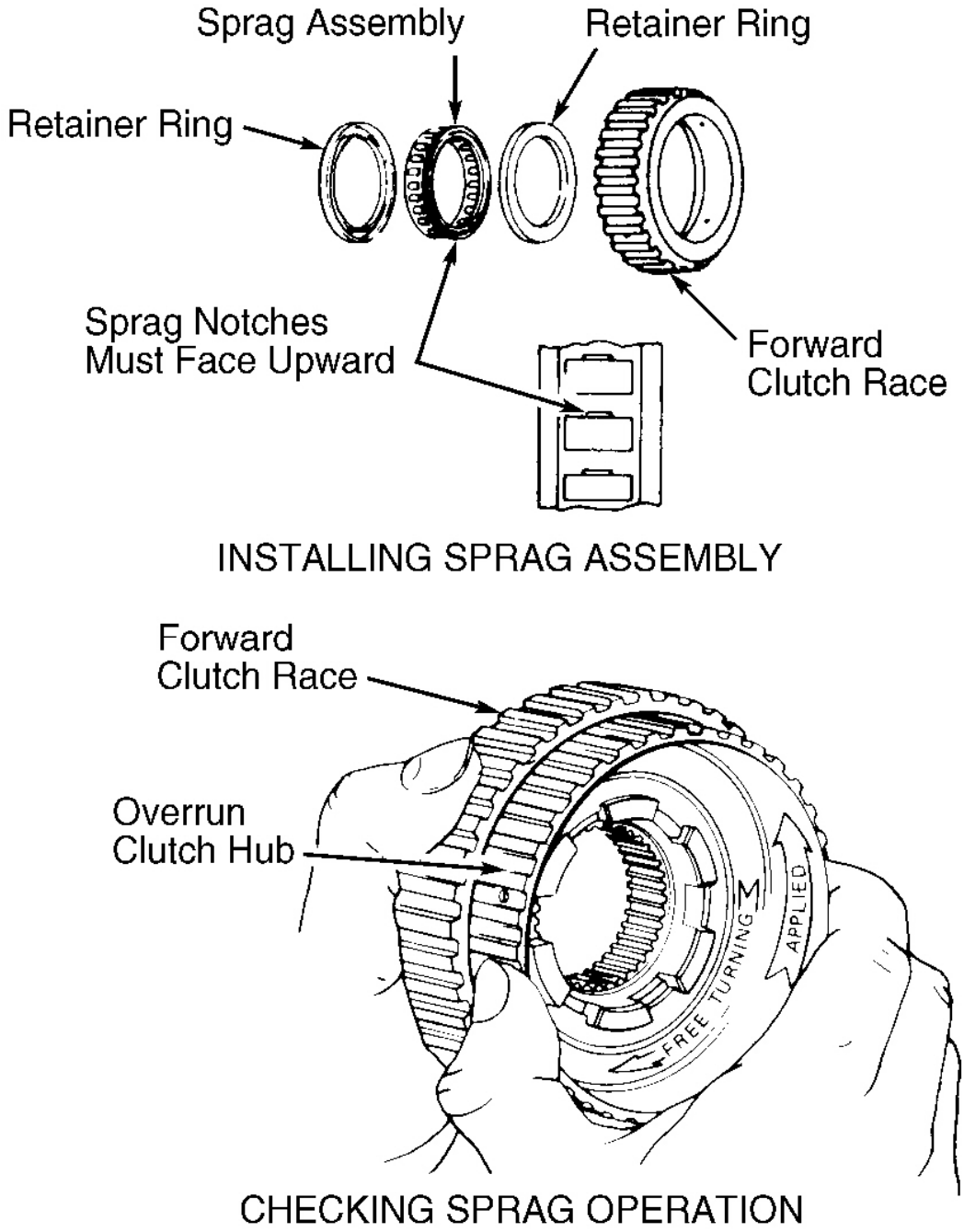


Fig. 21: Installing & Checking Forward Clutch Sprag Assembly
Courtesy of GENERAL MOTORS CORP.

3. Hold forward clutch race in left hand. Support sprag assembly. Install sprag retainer and race assembly in

sprag assembly. See **Fig. 16**. Rotate sprag retainer and race assembly counterclockwise. Install remaining retainer ring. Install overrun clutch hub. Install snap ring.

4. Check sprag operation. Holding forward clutch race, rotate overrun clutch hub. Overrun clutch hub should turn freely clockwise and lock counterclockwise. See **Fig. 21**.

NOTE: If replacing forward sprag or overrun clutch hub, see OE parts department for updated and redesigned parts availability.

5. Place input clutch housing with turbine shaft downward. Install 3-4 piston seals with lips facing away from hub. Install 3-4 piston in input housing.
6. Install 3-4 clutch apply ring. Install "O" ring seal in input clutch housing. Install forward clutch housing. Install seals on forward clutch piston with lips facing away from tangs.
7. Install forward clutch piston in forward clutch housing. Install 3-4 spring on 3-4 clutch apply ring. Install forward clutch assembly on 3-4 spring assembly. Align forward clutch piston legs with tangs of 3-4 apply ring. Install Seal Protector (J-29883) on input housing.
8. Install 3-4 apply ring and forward clutch assembly in input clutch housing. Hold apply ring tangs while installing. **DO NOT** allow forward clutch piston to separate from assembly. Ensure assembly is firmly seated.
9. Install Seal Protector (J-29883) on input housing. Install overrun clutch piston with hub facing upward. If fully seated, overrun piston should be 3/16" below top of snap ring groove in input housing hub. Install spring assembly on overrun piston. Compress springs, and install snap ring. Install input housing seal.

NOTE: Soak clutch plates in ATF before installation. Coat all seals and "O" rings with ATF. Coat thrust washers and bearings with petroleum jelly.

10. Install 4 overrun clutch plates, starting with steel plate. Align wide notches with case lugs. Install remaining clutch plates, alternating steel and composition plates.
11. Install bearing assembly on input clutch hub. Bearing inner race must face input housing hub. Ensure bearing is centered. Align clutch plate tabs. Install forward clutch sprag assembly in input housing. Align overrun clutch hub with clutch plates.
12. Install forward clutch apply plate in input housing. Install waved forward clutch plate. Ensure all plates are aligned with input housing tangs. Starting with steel plate, install clutch plates, alternating steel and composition plates. Install backing plate and snap ring. See **FORWARD CLUTCH PLATE SPECIFICATIONS**.
13. Using 2 feeler gauges, measure clearance between backing plate and snap ring. Clearance should be .030-.063" (.75-1.60 mm). Install proper size backing plate with chamfered side upward. See **FORWARD CLUTCH BACKING PLATE SPECIFICATIONS**. Install snap ring.

FORWARD CLUTCH PLATE SPECIFICATIONS

Plate Type	Quantity	Thickness In. (mm)
Apply	1	.169 (4.29)
Backing	1	Selective
Composition	5	.070 (1.78)

Flat Steel	5	.090 (2.29)
Waved Steel	1	.070 (1.78)

FORWARD CLUTCH BACKING PLATE SPECIFICATIONS

ID Letter	Thickness In. (mm)
A	.274-.278 (6.96-7.06)
B	.251-.255 (6.38-6.48)
C	.228-.232 (5.79-5.89)
D	.205-.208 (5.20-5.28)
E	.180-.185 (4.57-4.70)

14. Install 3-4 clutch plates and backing plate. Install clutch plates and backing plate with chamfered side upward. Install retainer ring. Using feeler gauge, measure clearance between backing plate and first composition plate. Clearance should be .035-.083" (.90-2.10 mm).
15. Select proper backing plate to obtain correct clearance. See **3-4 BACKING PLATE SPECIFICATIONS**. Air check all clutches at feed holes in turbine shaft.
16. During overrun clutch test, air pressure will blow past forward clutch piston seals and exit out forward clutch feed hole in turbine shaft. Turbine shaft seals require sizing and should be installed just before oil pump installation.

3-4 CLUTCH PLATE SPECIFICATIONS

Plate Type	Quantity	Thickness In. (mm)
Backing	1	Selective
Composition	6	.079 (2.01)
Flat Steel (1)	1	.070 (1.78)
Flat Steel	5	.107 (2.71)
Stepped Apply	1	.220 (5.60)
(1) Same spline configuration as apply plate.		

3-4 BACKING PLATE SPECIFICATIONS

Identification	Thickness In. (mm)
A	.224-.231 (5.68-5.88)
B	.187-.196 (4.76-4.99)
C	.153-.161 (3.89-4.09)

OIL PUMP ASSEMBLY

Disassembly

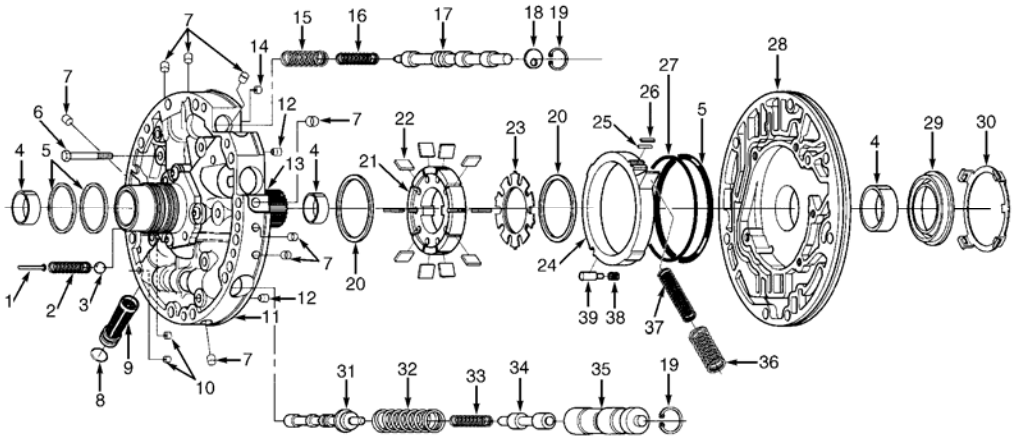
1. Remove reverse input clutch drum-to-oil pump thrust washer, pump-to-case gasket and pump-to-case oil seal ring from pump assembly. Remove pump cover retaining bolts. Separate pump cover from pump body.

CAUTION: Pump slide spring and pressure relief spring rivet are under high pressure. To prevent possible injury, cover springs during removal.

2. Using needle-nose pliers, compress pump slide spring. Remove from pump by pulling straight out. Remove pump vane rings, pump vanes, pump rotor and rotor guide from pump pocket.

CAUTION: Keep pump vanes in installed position. If pump vanes are installed upside-down or backwards, they will quickly wear out.

3. Remove slide from pump pocket. Remove slide seal and seal support from pump slide. See **Fig. 22**. Remove pivot pin and pivot pin spring. Remove seal ring and "O" ring from pump slide. Remove seal retainer and seal from pump body.
4. Check condition of pump bushing. If bushing is in good condition, **DO NOT** remove it. Push inward on converter clutch valve stop to compress spring. Remove snap ring. Remove valve stop, converter clutch apply valve and springs.
5. Using a small punch, remove pressure relief spring retaining rivet. Remove relief spring and ball. Remove oil screen and "O" ring from pump cover. Remove reverse boost valve sleeve. Remove reverse boost valve, pressure regulator valve spring and pressure regulator valve.



1. Rivet
2. Pressure Relief Spring
3. Check Ball
4. Bushing
5. Oil Seal Rings
6. Cover-To-Body Bolt
7. Oil Pump Cover Plugs
8. "O" Ring
9. Screen
10. Orificed Cup Plug
11. Pump Cover
12. Retainer & Ball Assembly
13. Stator Shaft
14. Converter Clutch Signal Orifice Cup Plug
15. Converter Clutch Spring (Outer)
16. Converter Clutch Spring (Inner)
17. Converter Clutch Valve
18. Valve Stop
19. Snap Ring
20. Pump Vane Ring
21. Oil Pump Rotor
22. Pump Vane
23. Rotor Guide
24. Pump Slide
25. Seal Support
26. Pump Slide Seal
27. "O" Ring Seal
28. Pump Body
29. Oil Seal Assembly
30. Seal Retainer
31. Pressure Regulator Valve
32. Pressure Regulator Valve Spring
33. Pressure Regulator Isolator Spring
34. Reverse Boost Valve
35. Reverse Boost Valve Sleeve
36. Pump Slide Spring (Outer)
37. Pump Slide Spring (Inner)
38. Pivot Pin Spring
39. Pivot Pin

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Fig. 22: Exploded View Of Oil Pump Assembly
Courtesy of GENERAL MOTORS CORP.

Inspection

1. Inspect all valves, springs, sleeves and bushings for chips, burrs, distortion and free movement in bores.

Check pressure relief ball and spring for damage and distortion. Low line pressure will exist if ball and spring are damaged.

2. Inspect pump cover screen and "O" ring for wear and damage. Clean pump body and cover. Check all bores for obstructions. Inspect mating sides of cover and body for scoring, flatness and damage between channels. Check channels for dirt and damaged passages. Inspect stator shaft and pump body bushings for damage.
3. Inspect rotor and slide for scoring, cracks and damage. Check rotor guide and pump vane rings for excessive wear and damage. Inspect all seals for damage. Measure pump rotor and slide thickness in undamaged area if replacement is required. Replacement parts must be same size as those removed to provide proper end clearance.

Reassembly

1. Install "O" ring and seal ring in groove on back side of pump slide. Retain seal ring using petroleum jelly. Install pivot pin and spring in pump body. Install pump slide. Notch in pump slide must align with pivot pin hole and with flat oil seal ring facing downward in pump pocket. Install slide seal and support.

CAUTION: Keep pump vanes in installed position. If pump vanes are installed upside-down or backwards, they will quickly wear out.

2. Install pump vane ring into pump pocket. Coat rotor guide with petroleum jelly. Install rotor guide on rotor. Install rotor and guide into pump pocket with guide toward pump pocket. Install vanes in rotor. Install vane guide ring. Compress pump slide spring and install into pump pocket. All parts must be even with pump body surface. Install "O" ring on pump screen, and install screen in pump cover with "O" ring end out.
3. Install oil seal in pump body. Install seal retainer. Install pressure relief check ball and spring in pump cover. Install retaining rivet. Install converter clutch valve springs and converter clutch valve. Install valve stop and snap ring. Install pressure regulator valve and spring in pump cover. See **Fig. 22**.
4. Coat reverse boost valve with petroleum jelly. Install reverse boost valve in boost valve sleeve with small end first. Install reverse boost valve sleeve in pump cover.
5. Install pump cover on pump body. Install retaining bolts finger tight. Align pump body and cover using Alignment Strap (J-21368). Place bolt through pump-to-case bolt hole. Tighten retaining bolts to specification. See **TORQUE SPECIFICATIONS**. Remove alignment strap.
6. Position pump-to-case gasket on pump, and retain it using petroleum jelly. Install oil seal rings on stator hub. Retain oil seal rings using petroleum jelly. Install pump-to-case oil seal on cover. Ensure seal is not twisted. Coat seal with ATF. Install pump-to-drum thrust washer. Ensure tangs on washer engage with holes in hub.

2-4 SERVO ASSEMBLY

Disassembly

1. Remove 4th apply piston and housing from 2nd apply piston assembly. Remove return spring from apply pin. Install Piston Compressor (J-22269-01) on second apply piston. See **Fig. 12**.
2. Compress 2nd servo apply piston assembly. Remove retainer ring. Separate 2nd apply piston, spring and

retainer. Remove retainer ring, washer and spring from apply pin, and remove pin. Remove all oil seal rings. See **Fig. 11**.

Inspection

Inspect all pistons for porosity and damage. Check for ring groove damage and servo bore in case for any wear which may cut servo seals. Check all springs and oil seal rings for distortion and damage.

Reassembly

Different servo piston housings and 2nd apply pistons are used for different applications. If servo piston housing or 2nd apply piston is replaced, inside dimension of parts must be checked. Measure inside diameter of piston housing and 2nd apply piston. Dimension must be same as original. To reassemble, reverse disassembly procedure. Coat seals with petroleum jelly before assembly.

VALVE BODY

NOTE: Valves are held in valve body by pins or retainers. Valves may be under spring pressure. Note location of all parts during disassembly for reassembly reference.

Disassembly

Remove valve train, and note direction of valve installation. See **Fig. 23**. Remove all valve pins, retainers and bore plugs. Remove shift solenoids. Note locations of all parts.

Inspection

Inspect valves and sleeves for scoring and cracks. Ensure valves move freely in bores. Inspect valve body for cracks and scored bores. Inspect machined surfaces for damage. Inspect springs for damaged coils. Replace damaged parts as necessary.

Reassembly

For reassembly, reverse disassembly procedure. Ensure all parts are installed in correct location. See **Fig. 23**. Ensure pins, retainers and bore plugs are fully installed and do not extend into machined areas.

1. Valve Body
2. Pin
3. Forward Accumulator Piston
4. Forward Accumulator Spring
5. Forward Accumulator Cover
6. Low Overrun Valve
7. Spring
8. Forward Abuse Valve
9. 1-2 Shift Solenoid
10. 1-2 Shift Valve
11. Bore Plug
12. 2-3 Shift Solenoid
13. 2-3 Shuttle Valve
14. Retainer
15. 2-3 Shift Valve
16. 1-2 Accumulator Valve Sleeve
17. 1-2 Accumulator Valve
18. 1-2 Accumulator Valve Spring
19. Pressure Control Solenoid
20. Actuator Feed Limit Valve Spring
21. Manual Valve
22. Actuator Feed Limit Valve
23. 3-2 Control Solenoid
24. 3-2 Control Valve Spring
25. 3-2 Control Valve
26. 3-2 Downshift Valve Spring
27. 3-2 Downshift Valve
28. Reverse Abuse Valve Spring
29. Reverse Abuse Valve
30. 3-4 Shift Valve Spring
31. 3-4 Shift Valve
32. 3-4 Relay Valve
33. 4-3 Sequence Valve
34. 4-3 Sequence Valve Spring
35. Isolator Valve
36. Regulator Apply Spring
37. Regulator Apply Valve
38. TCC PWM Solenoid

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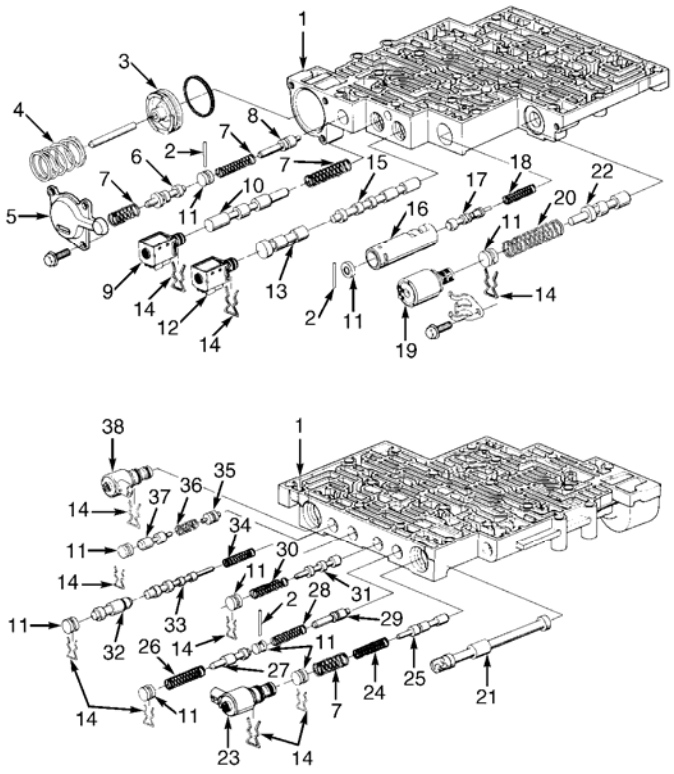


Fig. 23: Exploded View Of Valve Body
Courtesy of GENERAL MOTORS CORP.

TRANSMISSION REASSEMBLY

NOTE: To identify seal, thrust bearing and thrust washer locations and direction, see SEALS, BEARINGS & THRUST WASHERS under TRANSMISSION REASSEMBLY. See Fig. 24 and Fig. 25 .

LOW-REVERSE CLUTCH

1. Place transmission in a vertical position. Install seals on low-reverse clutch piston. Apply petroleum jelly to seals. Align and install piston with notch in bottom of transmission case. Ensure piston is fully seated and parking pawl aligns with opening in piston wall. Install spring assembly with flat side of retainer upward. Compress springs and install retainer ring.
2. Coat bearing assembly with petroleum jelly. Install bearing assembly on case hub with outside bearing race toward case hub. Install internal reaction gear and support. Install bearing assembly onto support with outside bearing race toward support. Install oil deflector (if equipped) and reaction carrier assembly in case. See **Fig. 16**. Ensure clutch plates are proper thickness.
3. Install clutch plates. See **LOW-REVERSE CLUTCH PLATE USAGE**. Ensure clutch plates align with splines of reaction carrier and case and that steel plates are aligned. Place waved plate on work bench.

Install 5 composition plates and 4 steel plates alternately, starting with composition plate.

LOW-REVERSE CLUTCH PLATE USAGE

Type	No. Used	Thickness In. (mm)
Composition	5	.088 (2.24)
Flat Steel	5	.069 (1.75)

4. Install low-reverse support. Apply light pressure to low-reverse support. **DO NOT** flatten waved plate. Measure height of clutch pack from work bench to top of low-reverse support. Using height dimension, determine proper selective spacer plate to be used. See **SPACER PLATE SELECTION** table.

SPACER PLATE SELECTION

Measured Clutch Pack Height In. (mm) (1)	Plate Thickness (2) In. (mm)
1.081-1.102 (27.55-28.06)	.066-.073 (1.67-1.85)
1.102-1.122 (28.06-28.59)	.046-.052 (1.17-1.31)
1.061-1.081 (27.03-27.54)	.087-.092 (2.19-2.34)

(1) Clutch pack height is measured without spacer plate in position.

(2) Spacer plates are available in select sizes. Plate 066-.073" (1.67-1.85 mm) thick has no identifying marks. Other plates are marked "0" or "1".

5. Place spacer plate between waved plate and first composition plate with identification facing upward. Measure overall height of clutch pack. Overall height should be 1.15-1.18" (29.2-29.9 mm). Install clutch pack assembly in transmission case.
6. Install low-reverse support in case with hub downward. Install inner race by pushing downward while rotating until it is fully engaged. Bottom tangs will be flush with hub when fully installed. Install spring retainer in case between case lug and open notch in support. Install low-reverse snap ring.

REACTION & INPUT GEAR SETS

1. Install retainer ring on reaction sun gear (if removed). Install sun gear into reaction carrier. Install thrust washer on low-reverse clutch race. Install reaction sun gear shell on reaction sun gear.
2. Install thrust washer on reaction sun gear shell. Ensure thrust washer tangs engage on gear shell. Install input internal gear and reaction carrier shaft in sun gear shell. Carrier shaft splines must engage with reaction carrier. See **Fig. 16**.
3. Install thrust washer on reaction carrier shaft. Outer race must face toward reaction carrier shaft. Install output shaft in transmission. Ensure output shaft engages with all parts.
4. Install Output Shaft Support (J-29837). Adjust support so output shaft is positioned upward as far as possible. Install input carrier assembly with hub end down on output shaft. Install NEW retainer ring on output shaft. Remove output shaft support. Install input sun gear, indexing gear end with input carrier pinions.

REVERSE INPUT ASSEMBLY & INPUT CLUTCH

Install selective thrust washer on input housing. Install bearing assembly on selective thrust washer. Inner race (Black) must go toward oil pump. Position reverse input assembly on input clutch assembly. Reverse input clutch plates must align with input clutch hub. Ensure all clutch plates are fully engaged.

REVERSE & INPUT CLUTCHES

Install reverse and input clutch assemblies in transmission case as an assembly. Align 3-4 clutch plates of input assembly with input internal gear. Assembly is fully seated when reverse input clutch housing is just below oil pump face of case.

2-4 BAND & SERVO ASSEMBLY

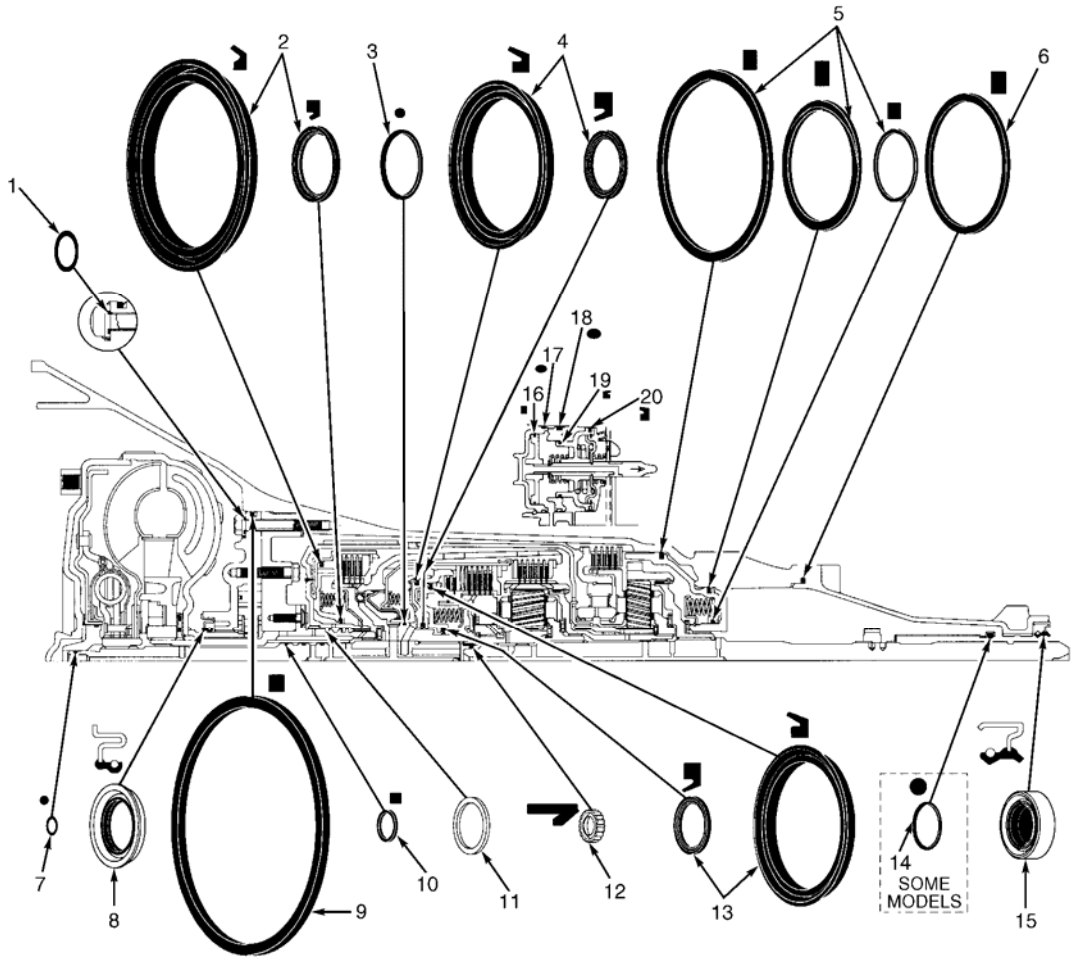
1. Install 2-4 band in case. Align band anchor pin end with case pin hole. Install band anchor pin in case. Ensure band anchor pin aligns with end of 2-4 band.
2. Install 2-4 servo assembly into case, and index apply pin on band end. Check for proper engagement of apply pin on band end. Recheck 2-4 servo apply pin selection to ensure correct pin is installed. See **CHECKING SERVO PIN LENGTH** under TRANSMISSION DISASSEMBLY.
3. Different length servo pins are available. See **SERVO PIN SPECIFICATIONS**. Select proper length servo pin. Install servo cover and "O" ring. Compress cover and install cover retaining ring. Index ring ends with slot in case.

SERVO PIN SPECIFICATIONS

Pin ID	Pin Length In. (mm)
1 Groove	2.59-2.60 (65.8-66.1)
2 Grooves	2.65-2.66 (67.2-67.5)
No Groove	2.70-2.71 (68.6-68.9)

SEALS, BEARINGS & THRUST WASHERS

NOTE: To identify seal, thrust bearing and thrust washer locations and direction, see Fig. 24 and Fig. 25 .



1. Pump-To-Case Bolt "O" Ring
2. Reverse Input Clutch Seals
3. Input-To-Forward Housing "O" Ring Seal
4. Forward Clutch Seals
5. Low-Reverse Clutch Seals
6. Case Seal
7. Turbine Shaft Selective Washer "O" Ring Seal
8. Oil Seal Assembly
9. Pump-To-Case Oil Seal
10. Solid Oil Seal Ring
11. Stator Shaft Oil Seal Ring
12. Input Housing-To-Output Shaft Seal
13. Overrun Clutch Seals
14. Output Shaft Seal
15. Case Extension Oil Seal Assembly
16. 4th Apply Piston Oil Seal Ring
17. 2-4 Servo Cover "O" Ring Seal
18. "O" Ring Seal
19. 2nd Apply Piston Inner Oil Seal Ring
20. 2nd Apply Piston Outer Oil Seal Ring

96F04449

Fig. 24: Location & Direction Of Transmission Seals
Courtesy of GENERAL MOTORS CORP.

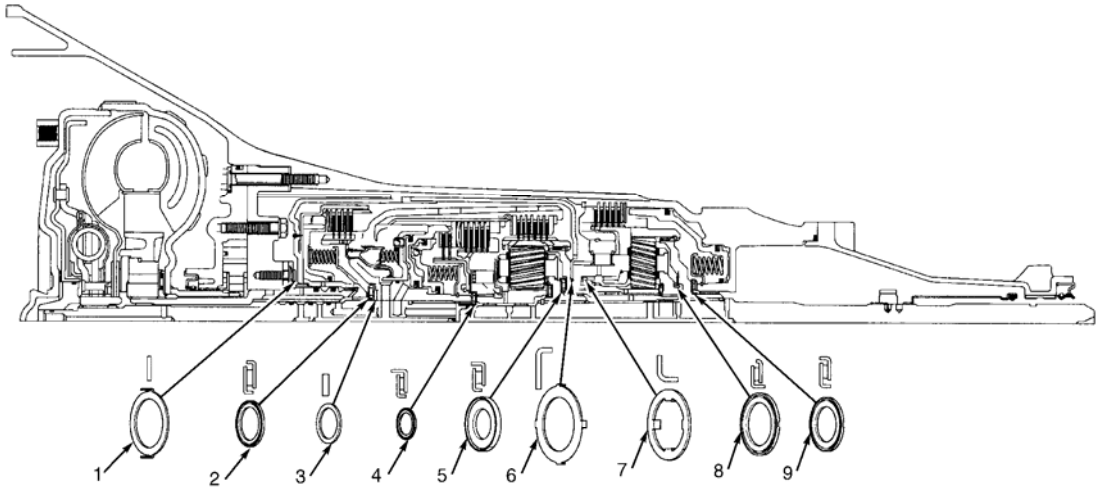


Fig. 25: Location & Direction Of Transmission Thrust Bearings & Thrust Washers
Courtesy of GENERAL MOTORS CORP.

OIL PUMP ASSEMBLY

1. Turbine shaft seals should be installed prior to oil pump installation. Position Seal Installer (J-36418-1) on input shaft. See **Fig. 26**. Adjustment screw in seal installer must be adjusted to obtain correct height for each seal installation. Install 4 turbine shaft seals.

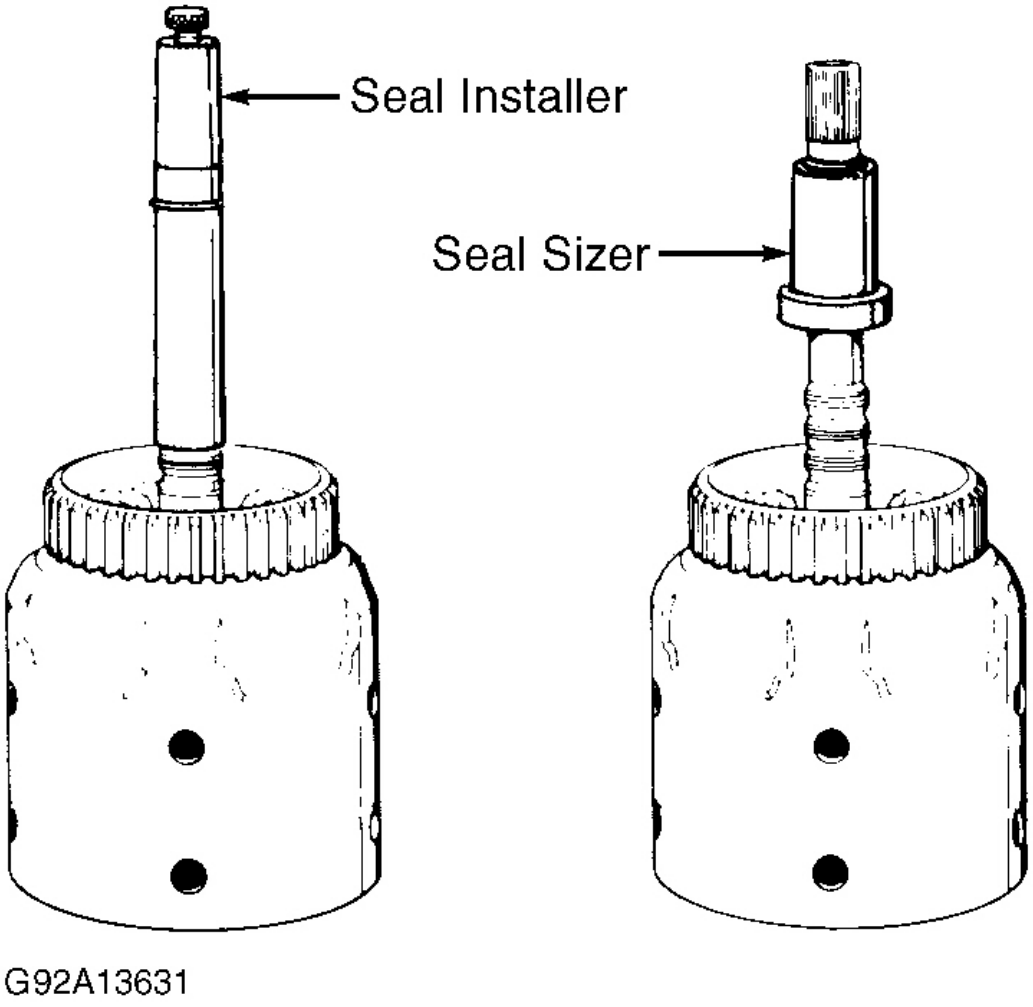


Fig. 26: Installing & Sizing Turbine Shaft Seals
Courtesy of GENERAL MOTORS CORP.

2. Turbine shaft seals must be sized using Seal Sizer (J-36418-2A) after installation. Install aligning pins in 2 opposing pump bolt holes in case. Ensure thrust washer is installed on rear of oil pump. Thrust washer can be retained using petroleum jelly.
3. Install oil pump into case, aligning filter and pressure regulator holes with holes in case. Install retaining bolts. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**. Place transmission in a horizontal position.
4. Turbine shaft should rotate by hand. If turbine shaft will not rotate, loosen pump retaining bolts and attempt to rotate shaft again. If shaft now turns, reverse and input assemblies have not been indexed properly or some other assembly problem has occurred, such as thrust washer not positioned properly.
5. Check transmission end play. See **TRANSMISSION END PLAY CHECK** under TRANSMISSION

DISASSEMBLY. Transmission end play should be .005-.036" (.13-.91 mm). If transmission end play is not within specification, thrust washer must be changed between oil pump and input housing.

6. See **OIL PUMP THRUST WASHER SPECIFICATIONS**. Install thrust washer, and recheck end play. Install torque converter. Ensure converter hub is aligned with oil pump. Install torque converter retaining strap to hold converter.

OIL PUMP THRUST WASHER SPECIFICATIONS

ID Number	Thickness In. (mm)
67	.074-.078 (1.88-1.98)
68	.080-.084 (2.03-2.13)
69	.087-.091 (2.21-2.31)
70	.094-.098 (2.39-2.49)
71	.100-.104 (2.54-2.64)
72	.107-.111 (2.72-2.82)
73	.113-.118 (2.87-3.00)
74	.120-.124 (3.05-3.15)

1-2 ACCUMULATOR & SPACER PLATES

CAUTION: If spacer plate and gasket replacement is required, ensure NEW spacer plate and gasket are identical as those removed.

1. Install 3-4 accumulator piston pin in case. Install 3-4 piston seal on piston. Install 3-4 accumulator piston on pin. Legs of piston must face valve body.
2. Install 3-4 accumulator spring. Install check balls and oil screens in proper locations. Install special retainer and ball assembly. See **Fig. 5** for check ball and filter installation locations. Install spacer plate gasket and spacer plate.
3. Install 1-2 accumulator spring, oil seal ring and 1-2 accumulator piston. Install accumulator cover and bolts. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**.

VALVE BODY

Install valve body. See **VALVE BODY** under ON-VEHICLE SERVICE.

EXTENSION HOUSING

1. Install speed sensor rotor retaining clip on output shaft. Install "O" ring in output shaft sleeve. Install output shaft sleeve on output shaft. **DO NOT** position output sleeve past machined surface of output shaft. Install seal ring on extension housing.
2. Position extension housing on transmission case. Install retaining bolts. Install oil seal in extension housing. Install speed sensor assembly. Install retainer and bolt. Tighten bolt to specification. See **TORQUE SPECIFICATIONS**. Install outside electrical connector and manual shift lever.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Cooler Pipe Connector	28 (38)
Detent Spring-To-Valve Body Bolt	18 (24)
Extension Housing Bolt	26 (35)
Manual Shaft-To-Detent Lever Nut	23 (31)
Oil Pump Cover-To-Body Bolt	18 (24)
Oil Pump-To-Case Bolt	18 (24)
Park Bracket-To-Case Bolt	23 (31)
Torque Converter-To-Flexplate Bolt	46 (62)
	INCH Lbs. (N.m)
Accumulator Cover-To-Case Bolt	96 (11)
Oil Pan-To-Case Bolt	96 (11)
Oil Passage Cover Bolt	96 (11)
Pressure Plugs	96 (11)
Pressure Switch Assembly	96 (11)
Solenoid Bolt	96 (11)
Speed Sensor Bolt	96 (11)
Valve Body-To-Case Bolt (1)	96 (11)
(1) Tighten valve body bolts in a spiral pattern starting in center of valve body.	

TRANSMISSION REMOVAL & INSTALLATION - A/T

TRANSMISSION SERVICING General Motors - Transmission Removal & Installation

BODY CODE IDENTIFICATION

1992 BODY CODE IDENTIFICATION

Body Code	Model
B	Caprice, Custom Cruiser & Roadmaster
D	Brougham
F	Camaro, Firebird

1993 BODY CODE IDENTIFICATION

Body Code	Model
B	Caprice, Roadmaster
D	Fleetwood
F	Camaro, Firebird

WARNING: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

MANUAL

NOTE: For manual transmission/transaxle replacement procedures, see appropriate article in the CLUTCHES Section.

REMOVAL & INSTALLATION

4L60 TRANSMISSION

Removal

1. Disconnect negative battery cable. Remove air cleaner, if necessary. Disconnect transmission throttle valve cable from throttle body. On "B" and "D" bodies, remove transmission dipstick. On "F" body, remove transmission dipstick tube. Raise and support vehicle on hoist.
2. On "F" body, remove torque arm from rear suspension (requires removing rear coil springs). See REAR SUSPENSION article in the SUSPENSION Section. On all vehicles, remove drive shaft. Disconnect shift linkage from transmission. Disconnect electrical connectors as necessary.
3. Remove torque converter cover. Mark position of flexplate in relation to torque converter. Remove torque converter bolts. Remove catalytic converter support bracket (raise transmission slightly, if necessary). Remove transmission mount nut.

4. Remove transmission-to-transmission mount bolts. Remove transmission crossmember-to-frame bolts. Support transmission. Slide transmission crossmember rearward. Partially lower the transmission to gain access to fluid line fittings and transmission throttle valve cable.
5. On "B" and "D" bodies, remove transmission filler tube. Disconnect fluid lines and transmission throttle valve cable from transmission. Support engine. Remove bellhousing bolts. Move transmission rearward far enough to install Torque Converter Holder (J-21366). Remove transmission.

Installation

1. To install, reverse removal procedure. Align index marks made during removal. Tighten torque converter-to-flexplate bolts finger tight, then tighten to specification. Tighten other nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .
2. Rotate torque converter by hand to ensure it rotates freely. Adjust shift linkage and transmission throttle valve cable. See ADJUSTMENTS in AUTOMATIC TRANSMISSION SERVICING article in this Section. Refill transmission to proper fluid level.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Flywheel-To-Converter Bolt	46 (62)
Torque Arm-To Rear Differential Nut	98 (133)
Transmission Crossmember-To-Frame Bolt	25 (34)
Transmission-To-Engine Bolt	35 (47)
Transmission Mount-To-Transmission Bolt	35 (47)
Transmission Mount-To-Transmission Crossmember Nut	30 (41)

TRANSMISSION SERVICING General Motors Corp. Automatic Transmission Servicing

IDENTIFICATION

The following system has been developed by the manufacturer to functionally describe its transmissions and transaxles. The designations indicate the number of speeds, type, series and major features. See **Fig. 1** .

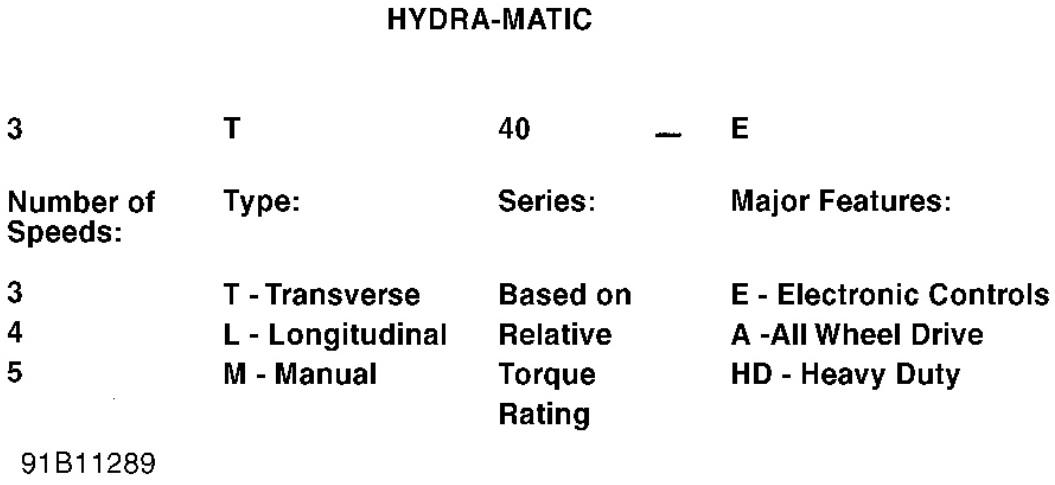


Fig. 1: Identifying Hydra-Matic Products
Courtesy of GENERAL MOTORS CORP.

FWD TRANSAXLE APPLICATION

Model	Body	Transmission(s)
Buick		
Century	"A"	3T40 & 4T60
LeSabre	"H"	4T40
Park Avenue	"C"	4T60-E
Reatta	"E"	4T60
Regal	"W"	4T60
Riviera	"E"	4T60
Skylark	"N"	3T40
Cadillac		
DeVille	"C"	4T60
Eldorado	"E"	4T60-E
Fleetwood	"C"	4T60
Seville	"K"	4T60-E

Chevrolet		
Beretta	"L"	3T40
Cavalier	"J"	3T40
Corsica	"L"	3T40
Lumina	"W"	3T40, 4T60 & 4T60-E
Oldsmobile		
Cutlass Calais	"N"	3T40
Cutlass Ciera	"A"	3T40 & 4T60
Cutlass Cruiser	"A"	4T60
Cutlass Supreme	"W"	3T40, 4T60 & 4T60-E
Eighty-Eight	"H"	4T60
Ninety-Eight	"C"	4T60-E
Toronado	"E"	4T60-E
Trofeo	"E"	4T60-E
Pontiac		
Bonneville	"H"	4T60
Grand Am	"N"	3T40
Grand Prix	"W"	3T40, 4T60 & 4T60-E
Sunbird	"J"	3T40
Touring Sedan	"C"	4T60-E
6000	"A"	3T40 & 4T60

RWD TRANSMISSION APPLICATION

Manufacturer/Model	Body	Transmission(s)
Buick		
Roadmaster	"B"	4L60
Cadillac		
Brougham	"D"	4L60
Chevrolet		
Camaro	"F"	4L60
Caprice	"B"	4L60
Corvette	"Y"	4L60
Oldsmobile		
Custom Cruiser	"B"	4L60
Pontiac		
Firebird	"F"	4L60

LUBRICATION

SERVICE INTERVALS

Check transmission fluid level at every engine oil change. Transmission fluid should be changed and filter

replaced every 100,000 miles under normal operating conditions.

Under continuous extreme operating conditions (trailer towing, heavy city traffic with ambient temperature over 90°F (32°C) or delivery service), fluid and filter should be changed every 15,000 miles.

CHECKING FLUID LEVEL

CAUTION: DO NOT overfill transmission. When transmission is hot, one pint of fluid will raise fluid level from "ADD 1 PT. OR .5L" mark to "FULL HOT" mark on dipstick.

1. Start engine and operate vehicle for at least 15 minutes or until reaching operating temperature. With engine at curb idle and vehicle on level ground, move gear selector lever through all ranges ending in the "P" position.
2. Remove transmission dipstick, wipe clean and fully reinsert into filler tube. Remove again and inspect fluid level. Fluid level should be between the "ADD 1 PT. OR .5L" mark and the "FULL HOT" mark on dipstick.

CAUTION: If vehicle has been driven for an extended period of time at high speeds, in city traffic, hot weather, or if vehicle has been pulling a trailer, an accurate fluid level reading cannot be made until vehicle has been parked and ATF is allowed to cool about 30 minutes.

RECOMMENDED FLUID

Use only Dexron-II Automatic Transmission Fluid (ATF).

FLUID CAPACITY

FLUID CAPACITIES (1)

Application	Drain & Refill (2) Qts. (L)	Overhaul Qts. (L)
3T40		
Achieva, Beretta, Cavalier, Corsica, Grand Am, Skylark & Sunbird	4.0 (3.8)	6.0 (5.7)
Century, Cutlass Ciera, Cutlass Supreme, Grand Prix & Lumina	4.0 (3.8)	7.0 (6.6)
4L60		
Brougham, Camaro (5.0L & 5.7L), Caprice, Corvette, Custom Cruiser, Firebird (5.0L & 5.7L) & Roadmaster	5.0 (4.7)	11.2 (10.6)
Camaro (3.1L) & Firebird (3.1L)	5.0 (4.7)	8.4 (7.9)
4T60	6.0 (5.7)	8.0 (7.6)
4T60-E		

Bonneville, Eighty Eight, LeSabre, Ninety Eight, Park Avenue, Riviera, Toronado & Trofeo	6.0 (5.7)	11.0 (10.4)
Cutlass Supreme, Grand Prix & Lumina	7.4 (7.0)	10.0 (9.5)
Eldorado & Seville	6.0 (5.7)	8.0 (7.6)
(1) Fluid capacities listed are approximate. Always fill to FULL mark.		
(2) Drain and refill capacity does not include torque converter.		

DRAINING & REFILLING

1. With vehicle raised and large drain pan placed under transmission oil pan, remove front and side transmission oil pan bolts only. Loosen rear pan bolts about 4 turns each.
2. Carefully pry pan loose with screwdriver, allowing fluid to drain. Remove remaining bolts and remove oil pan. Discard old pan gasket. Remove filter and "O" ring or sleeve type seal. Remove any remaining gasket material left on transmission case.
3. Thoroughly clean pan, magnet and screen with solvent and dry with compressed air. Paper type filters should be replaced. Install new "O" ring on pick-up tube or new sleeve into pick-up tube recess. Lubricate with clean oil before installation.
4. Install filter assembly into pick-up tube recess. Install oil pan using new gasket and tighten pan bolts to specification. See **TORQUE SPECIFICATIONS (OIL PAN BOLTS)** . Add required amount of fluid to transmission through filler tube.
5. Start engine with gear selector lever in the "P" position and parking brake applied. Engage transmission in each gear ending in the "P" position. Check fluid level with vehicle warm and add fluid if necessary. **DO NOT** overfill.

ADJUSTMENTS

THROTTLE VALVE (T.V.) CABLE

"N" Body (2.3L)

1. Rotate T.V. cable adjuster body (at transaxle) 90 degrees. Pull cable housing until slider mechanism hits stop. See **Fig. 2** .
2. Rotate adjuster body back to original position. Using a torque wrench and socket, rotate T.V. cable adjuster hex nut until 75 INCH lbs. (8.5 N.m) is reached. Road test vehicle.

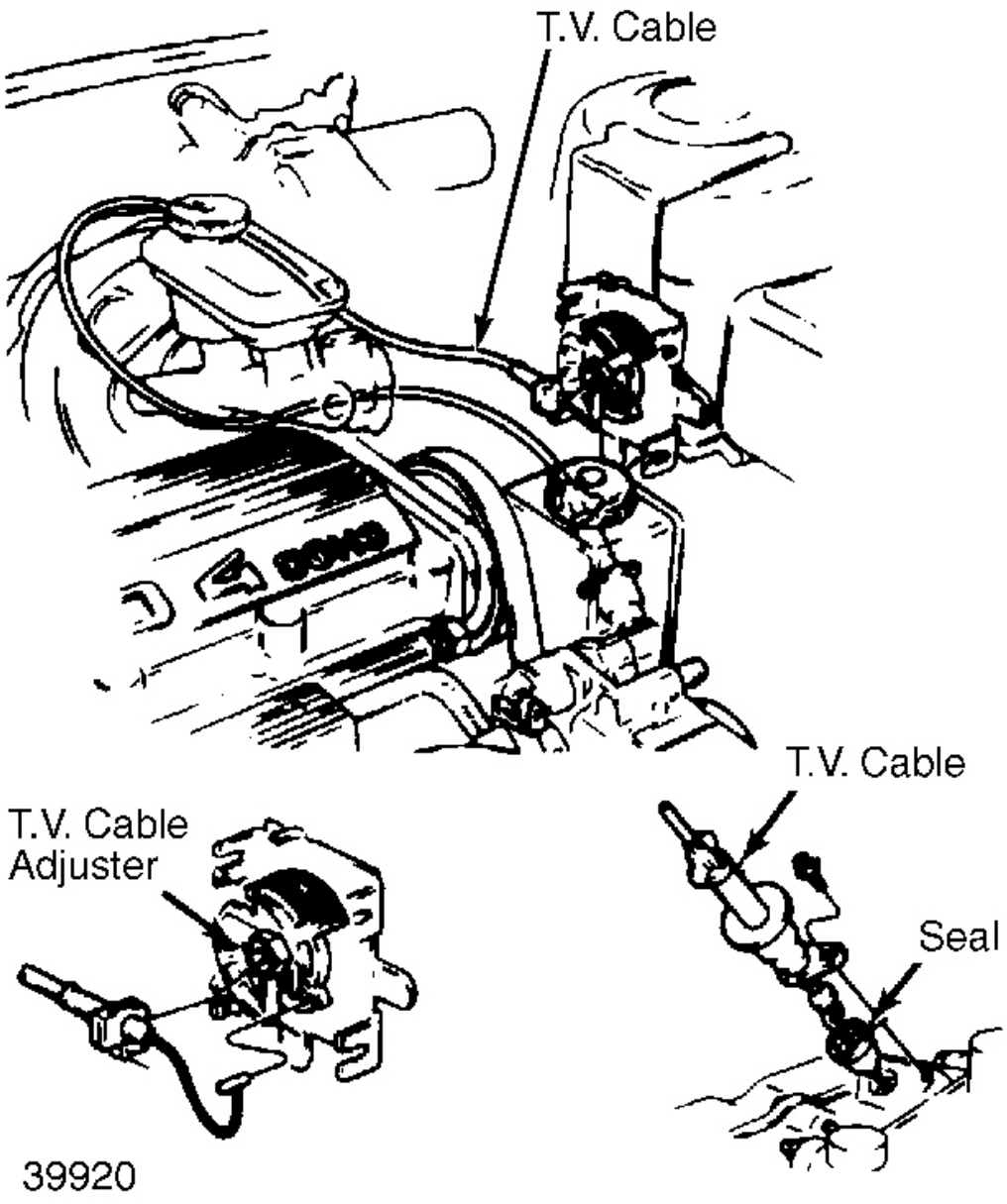


Fig. 2: Adjusting Throttle Valve (T.V.) Cable ("N" Body - 2.3L)
Courtesy of GENERAL MOTORS CORP.

"A" Body (2.5L)

1. Ensure T.V. cable is in full, nonadjusted position. Ensure T.V. cable operates smoothly and connected at transaxle.

2. Accelerator cable must be installed when adjusting T.V. cable. Rotate idler pulley (cam) counterclockwise to 65 INCH lbs. (7 N.m) to place cable in adjusted position. See **Fig. 3** .

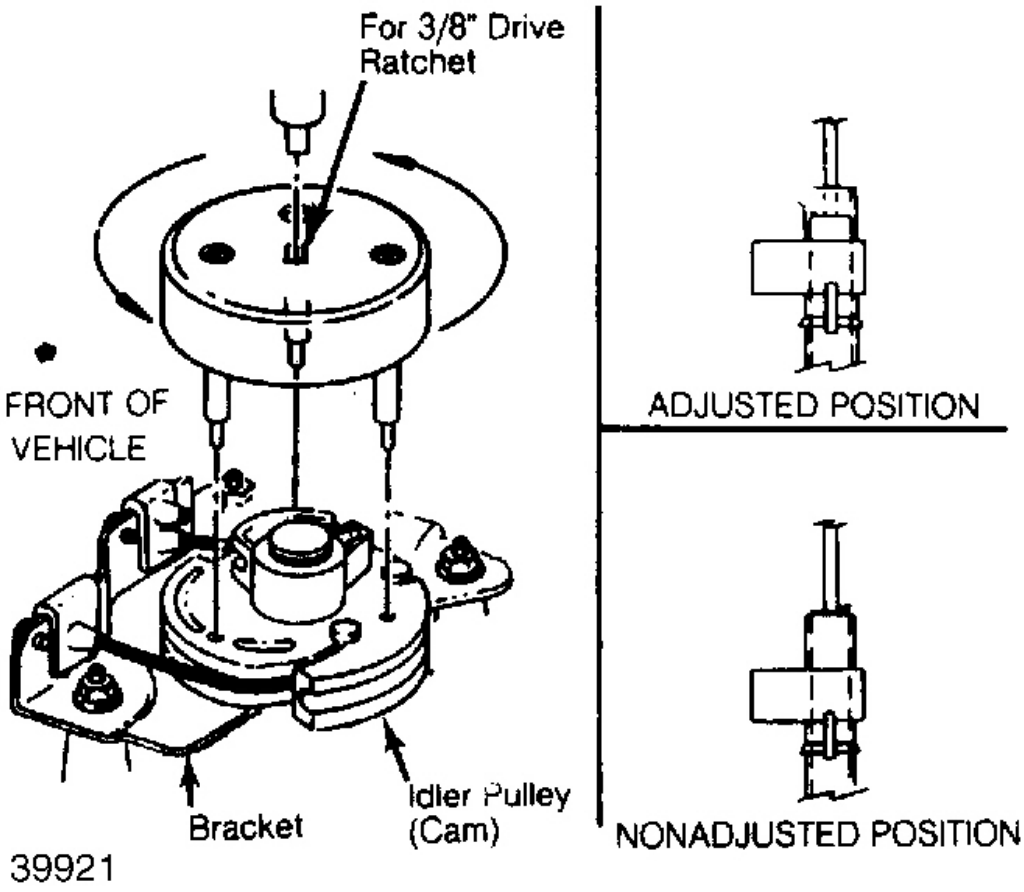


Fig. 3: Adjusting Throttle Cable ("A" Body - 2.5L)
Courtesy of GENERAL MOTORS CORP.

Except "A" & "N" Bodies

1. Engine must be off. Depress metal readjust tab on cable adjuster (located at cable support bracket on engine) and hold it in this position.
2. Move cable housing slider (away from throttle lever) until it stops and is completely against fitting. Release readjust tab. See **Fig. 4** .
3. Rotate throttle lever (by hand) to its full throttle position. Slider must move (ratchet) toward lever when lever is rotated to its full throttle position. Check cable for sticking and binding.

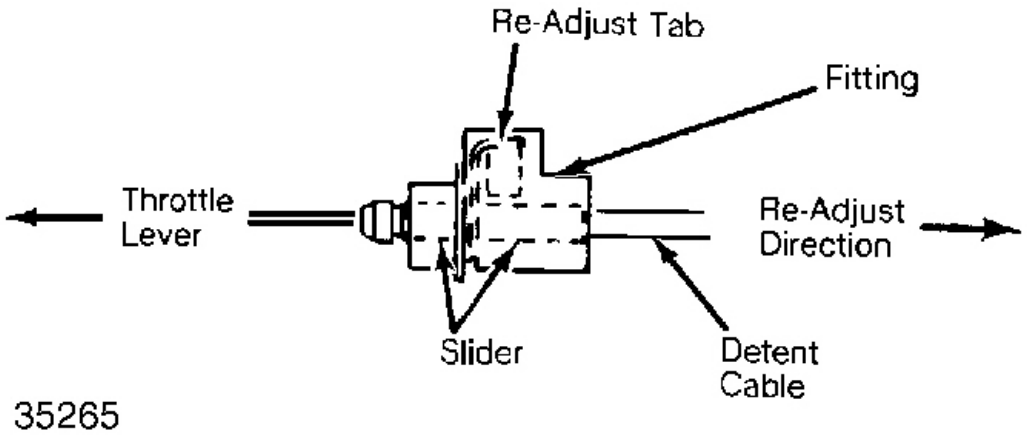


Fig. 4: Adjusting Self-Adjusting Throttle Valve Cable (Except "A" & "N" Bodies)
Courtesy of GENERAL MOTORS CORP.

GEAR SHIFT LINKAGE

1. Linkage should be adjusted so engine cannot be started in any position except Park or Neutral. If linkage is improperly adjusted, an internal hydraulic leak could occur causing internal clutch and/or band failure.
2. With selector lever in the "P" position, transmission parking pawl should engage rear/reaction internal gear lugs or output ring gear lugs. Pointer on indicator quadrant should line up properly with range indicators in all ranges.

RWD Column Shift Rod

1. Position steering column gear selector lever in the Neutral gate notch. Raise and support vehicle. Loosen clamp screw from below vehicle and place transmission lever in Neutral. See **Fig. 5** .
2. Hold clamp flush against equalizer lever. Tighten clamp screw finger tight, then tighten to 21 ft. lbs. (28 N.m) without applying tension on either equalizer lever or selector rod. Ensure there is no tension on either equalizer lever or selector rod after adjustment is complete. See **Fig. 5** .

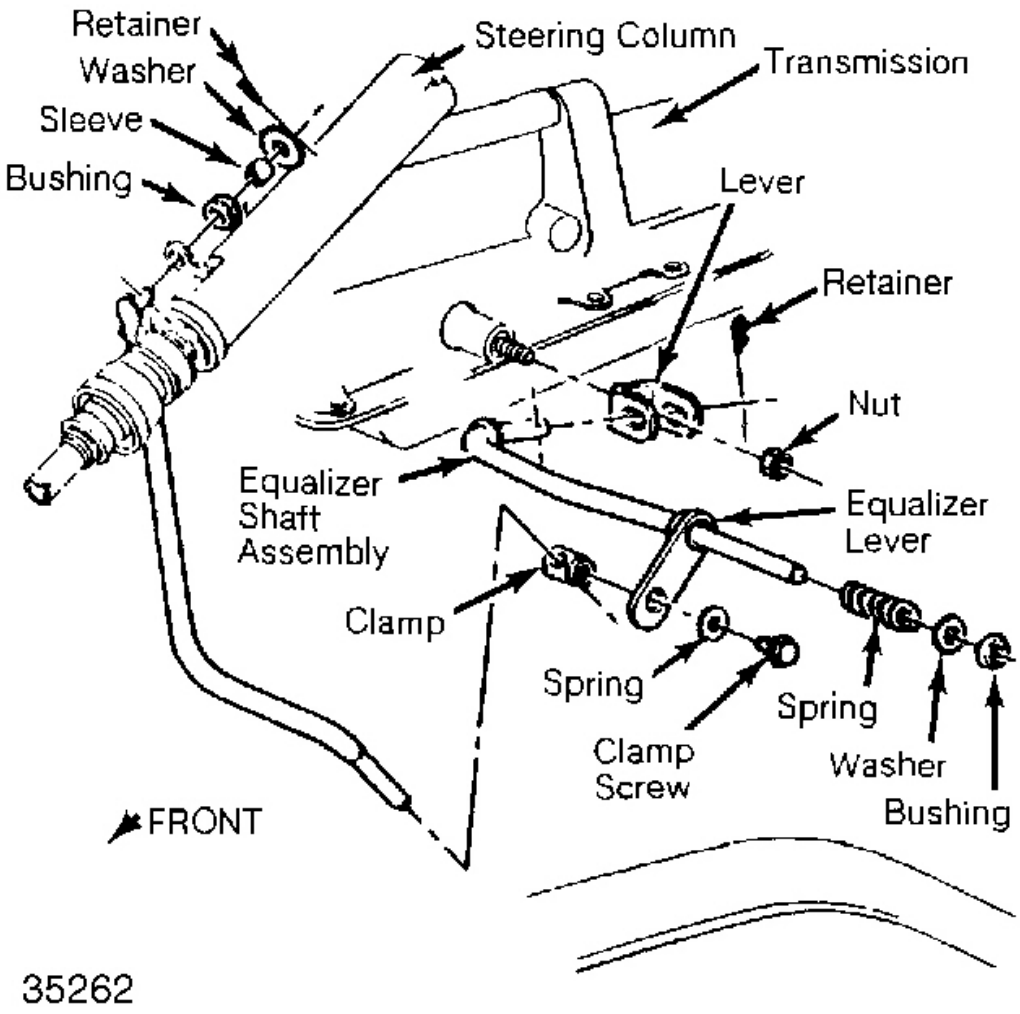


Fig. 5: Adjusting RWD Column Shift Rod
Courtesy of GENERAL MOTORS CORP.

RWD Floor Shift Cable ("B" & "D" Bodies)

1. Place gear selector lever in "P" position. Raise and support vehicle. Ensure transmission is fully engaged in Park by rotating drive shaft until parking pawl engages preventing rotation of shaft.
2. Loosen cable adjusting nut on transmission lever to allow pin to slide freely. With gear selector lever and transmission lever both in Park position, tighten cable adjusting nut to 15 ft. lbs. (20 N.m). See **Fig. 6** .

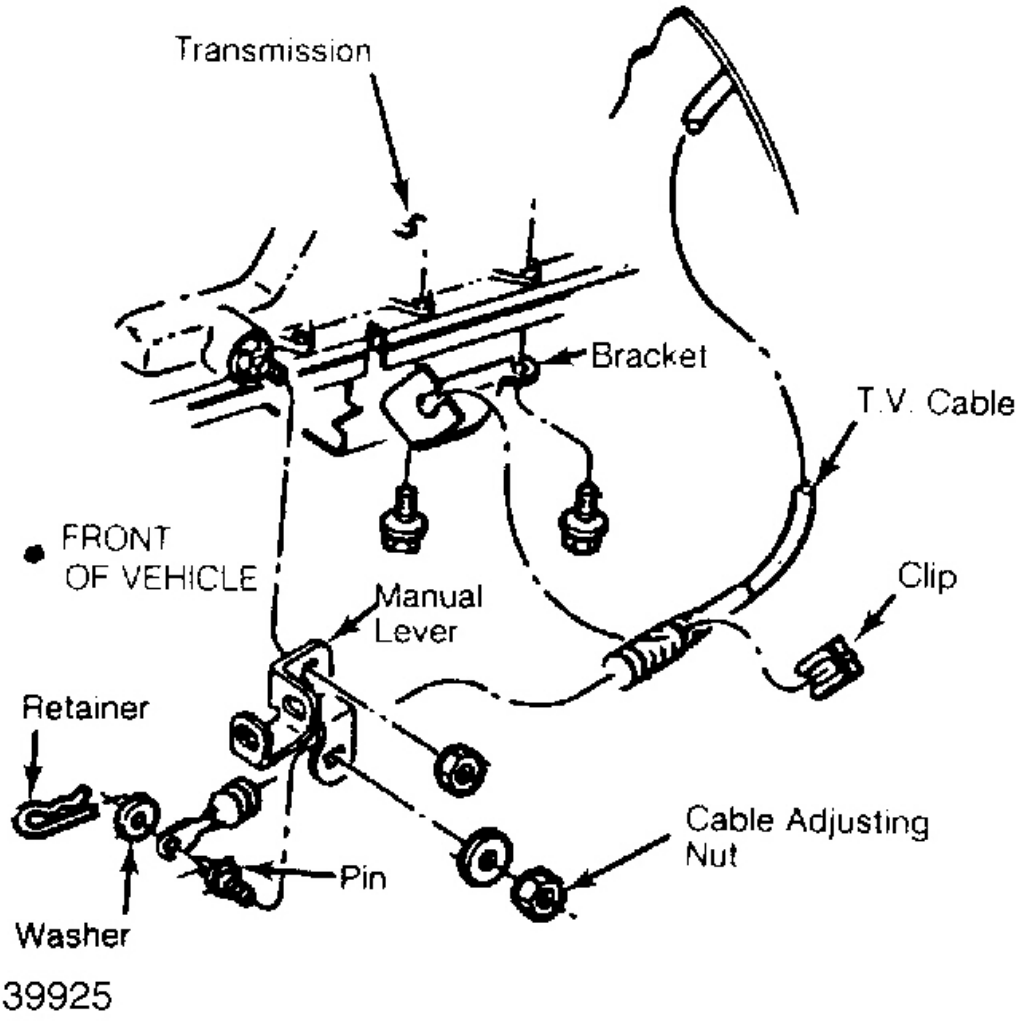


Fig. 6: Adjusting RWD Floor Shift Cable ("B" & "D" Bodies)
Courtesy of GENERAL MOTORS CORP.

RWD Floor Shift Cable ("F" & "Y" Bodies)

Place gear selector lever in the "N" position. Raise and support vehicle. Loosen cable adjusting nut at transmission lever. See **Fig. 7** . Ensure transmission lever is in Neutral position by rotating lever clockwise to Park detent, then back (counterclockwise) 2 detents to Neutral. Tighten cable adjusting nut to 11 ft. lbs. (15 N.m).

NOTE: Lever must be held out of Park when tightening nut.

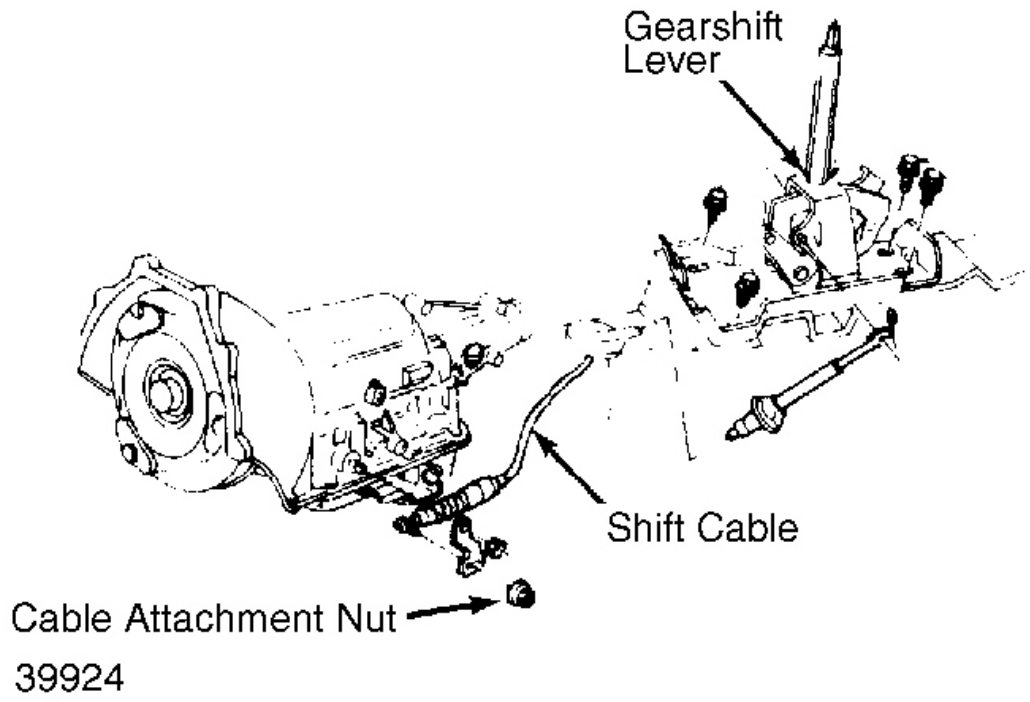


Fig. 7: Adjusting RWD Floor Shift Cable ("F" & "Y" Bodies)
Courtesy of GENERAL MOTORS CORP.

FWD Floor Shift Cable (Except Self-Adjusting Type)

1. Place gear selector lever in the "N" position. Loosen cable adjusting nut at transaxle lever. See **Fig. 8** .
2. Ensure transaxle lever is in Neutral detent. Tighten cable adjusting nut. Lever MUST be held out of Park when tightening nut. **DO NOT** use impact tools on nut.

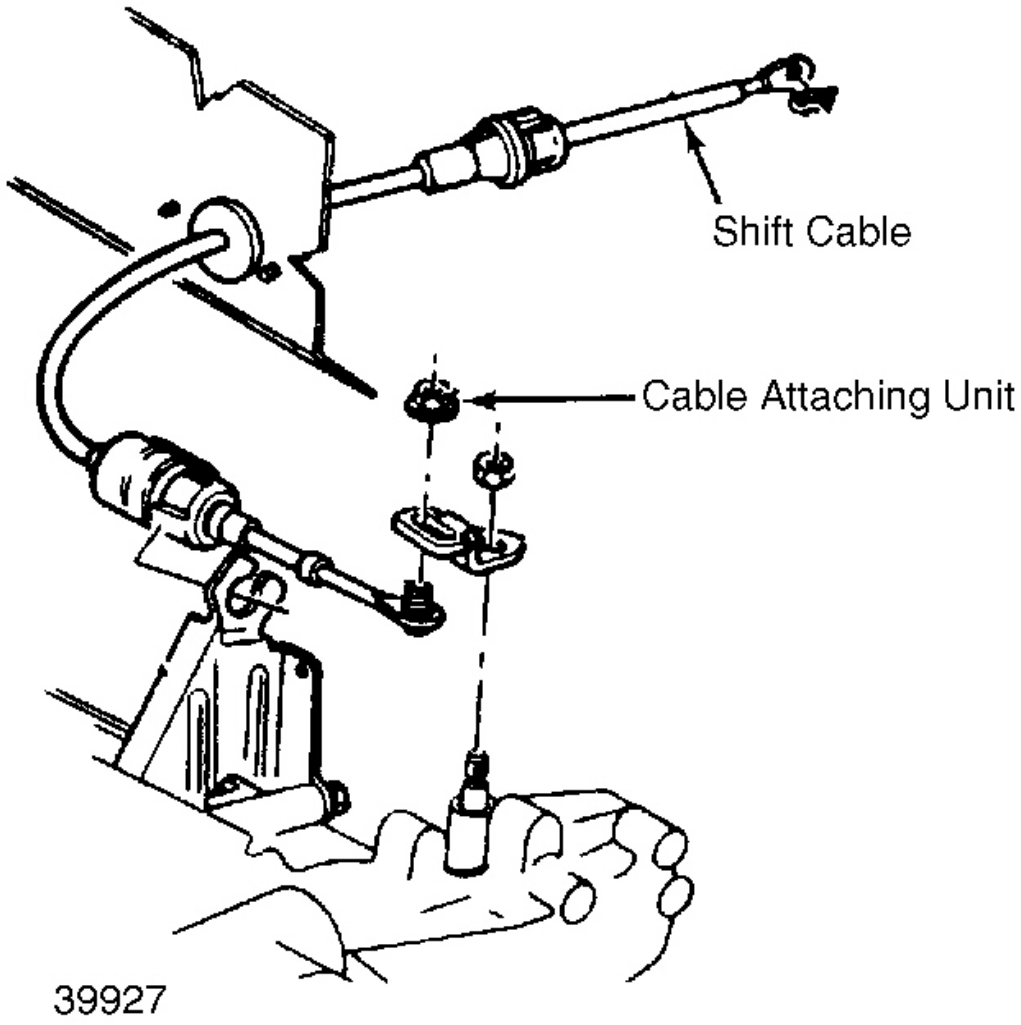


Fig. 8: Adjusting FWD Floor Shift Cable (Typical)
Courtesy of GENERAL MOTORS CORP.

NOTE: Self-adjusting shift cable is commonly used on "A," "C," "H," "N" and "W" body styles.

FWD Floor Shift Cable (Self-Adjusting Type)

Place gear selector lever in the "N" position. Lift up lock button on cable adjuster at transaxle mounting bracket. See **Fig. 9** . Place transaxle lever in Neutral detent. Push down on lock button.

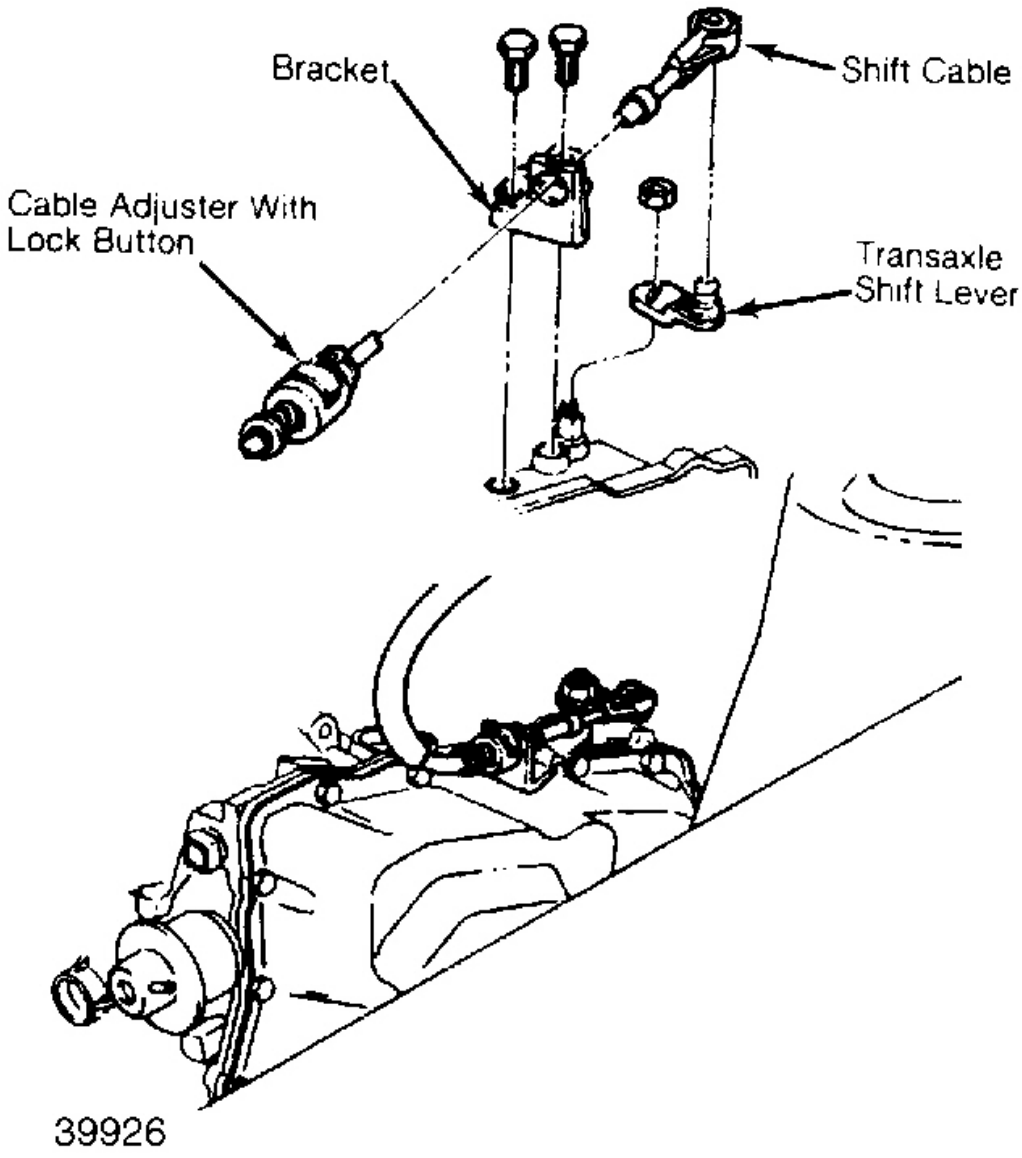


Fig. 9: FWD Self-Adjusting Floor Shift Cable
Courtesy of GENERAL MOTORS CORP.

PARK/LOCK CONTROL CABLE

Floor Shift Models

1. With gear selector lever in the Park position and ignition key in LOCK position, gear selector lever should not be able to be moved to other gear positions. Ignition key should be removable from column.

2. With key in RUN position and gear selector lever in the Neutral position, ensure key cannot be turned to LOCK position. If system does not perform as described in steps 1) and 2), go to step 3) for adjustment procedure.
3. If key cannot be removed in Park position, snap connector lock button to up position. Move cable connector nose rearward until key can be removed from ignition. See **Fig. 10** . Snap lock button down.

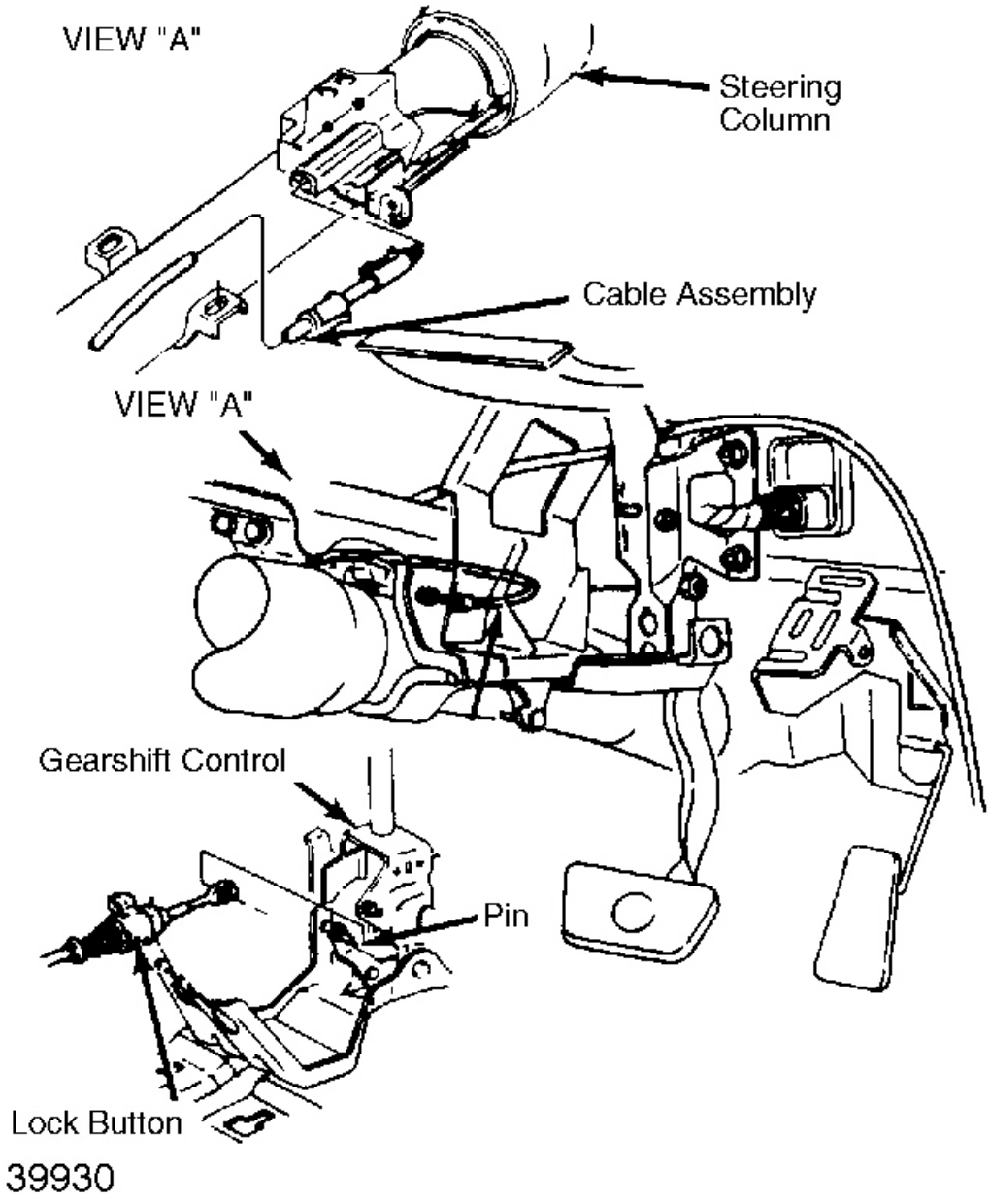


Fig. 10: Adjusting Typical Park/Lock Control Cable
Courtesy of GENERAL MOTORS CORP.

NEUTRAL SAFETY SWITCH

RWD "B" & "D" Bodies

Column shift models use a mechanical interference-type neutral start system. A wedge-shaped finger, attached to the ignition switch actuator rod, blocks movement of ignition switch to the Start position in all gear selector positions except park or neutral.

RWD "F" & "Y" Bodies

1. Disconnect negative battery cable. Remove gear selector knob. Remove center console cover. Place gear selector lever in the "N" position. If old switch is being readjusted, go to step 2). If new switch is being installed, go to step 4).
2. Align tang on switch with tang slot on shift control. See **Fig. 11** . Loosen switch mounting nuts. Rotate switch to align service adjustment hole with carrier tang hole.
3. Insert a .094" (2.34 mm) wire gauge into adjustment hole in top of switch. Rotate switch until pin drops to depth of .59" (15 mm). Tighten mounting nuts to 26 INCH lbs. (3 N.m). Vehicle should only start in Park or Neutral.
4. If new switch if being installed, insert switch tang in slot on shift control. Tighten mounting nuts to 26 INCH lbs. (3 N.m).
5. If holes do not align with shift control, ensure gear selector lever is in the "N" position. **DO NOT** rotate switch. Switch is pinned in Neutral.

   NOTE: If new switch is rotated and pin breaks during installation, use adjustment procedure in step 2).

6. If holes align with shift control, move gear selector lever out of Neutral position to shear plastic pin.

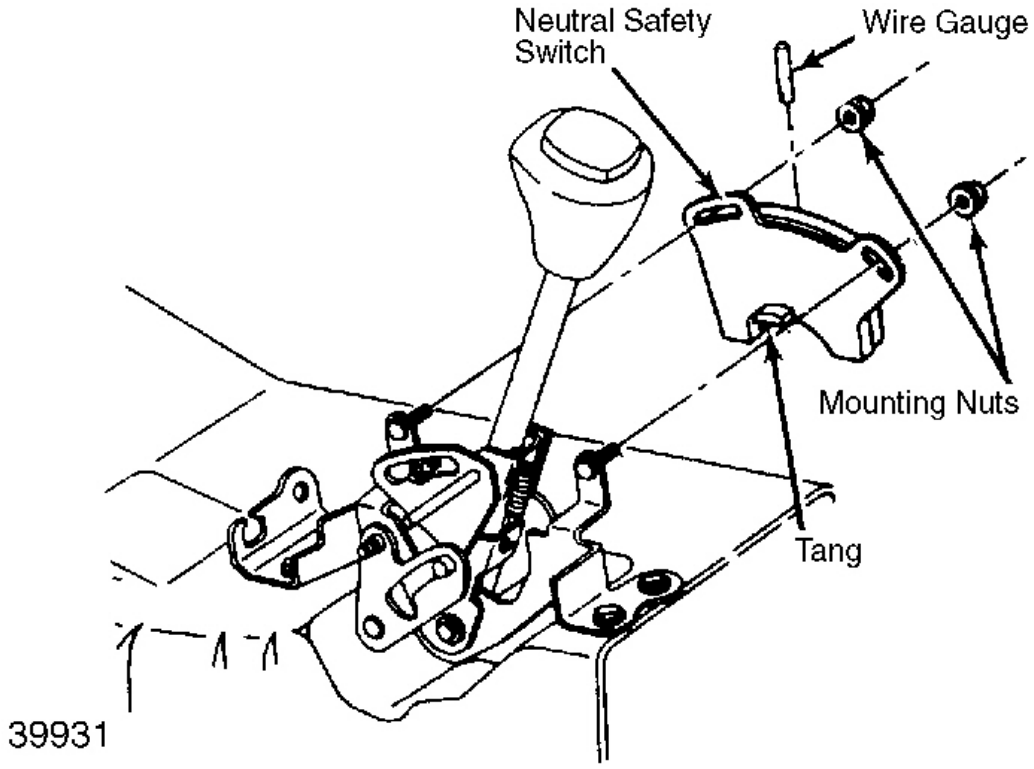


Fig. 11: Adjusting Neutral Safety Switch (RWD "F" & "Y" Bodies)
Courtesy of GENERAL MOTORS CORP.

FWD Models

1. There are 2 different neutral safety switches used on FWD models. See **Fig. 12** . To adjust switch, place gear selector lever in the "N" position.
2. Ensure shift cable is adjusted correctly and transaxle lever is in Neutral position. Loosen switch attaching screws. Rotate switch on shifter assembly to align adjustment hole with carrier tang hole.
3. Insert a 3/32" (2.4 mm) wire gauge about 5/8" into switch holes. Tighten attaching screws. Remove wire gauge. New switches may have plastic pin installed in hole. Plastic pin is designed to shear off during shift lever operation.

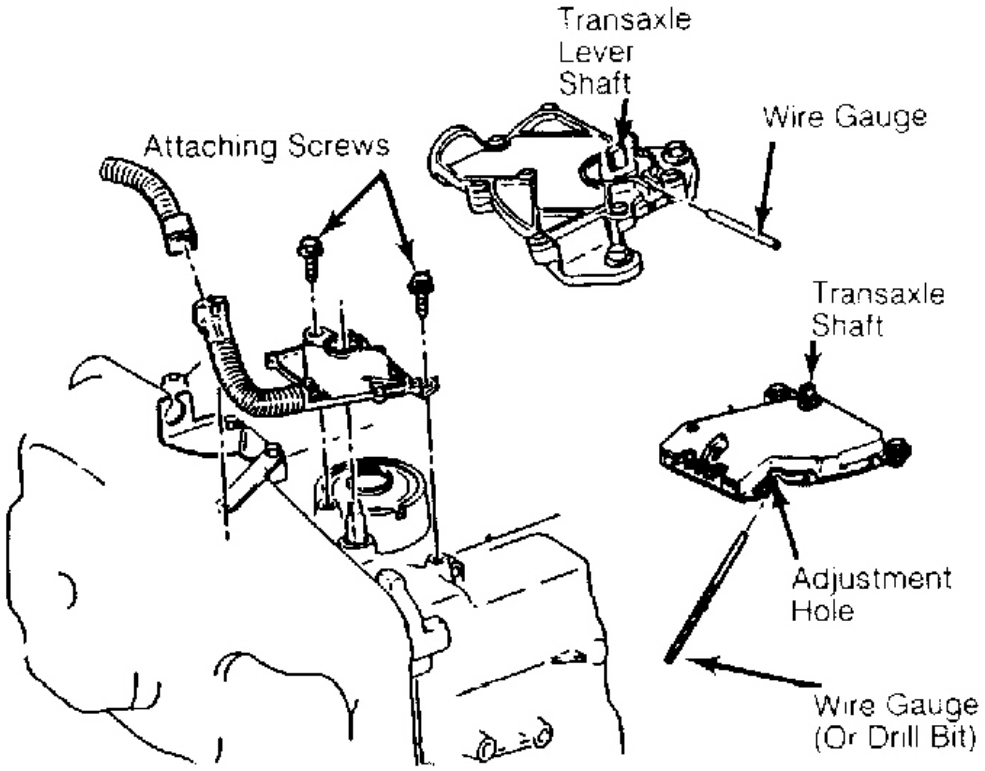


Fig. 12: Adjusting Neutral Safety Switches (FWD)
Courtesy of GENERAL MOTORS CORP.

TORQUE CONVERTER CLUTCH BRAKE SWITCH

The torque converter clutch brake switch must be adjusted to prevent vehicle stalling at idle due to the clutch remaining applied. Ensure brake pedal is fully released. Adjust plunger to just touch brake pedal lever.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS (OIL PAN BOLTS)

Transmission	INCH Lbs. (N.m)
3T40	97 (11)
4T60 & 4T60-E	115 (13)
4L60	144 (16)

TRANSMISSION SERVICING Automatic Transmission Servicing

IDENTIFICATION

The manufacturer has developed a system to functionally describe its transmissions and transaxles. The designations indicate number of speeds, type, series and major features. See **Fig. 1** . Also see appropriate table below.

RWD AUTOMATIC TRANSMISSION APPLICATIONS

Manufacturer/Model	Body	Transmission(s)
Buick		
Roadmaster	"B"	4L60-E
Cadillac		
Fleetwood	"D"	4L60-E
Chevrolet		
Camaro	"F"	4L60-E
Caprice	"B"	4L60-E
Corvette	"Y"	4L60-E
Pontiac		
Firebird	"F"	4L60-E

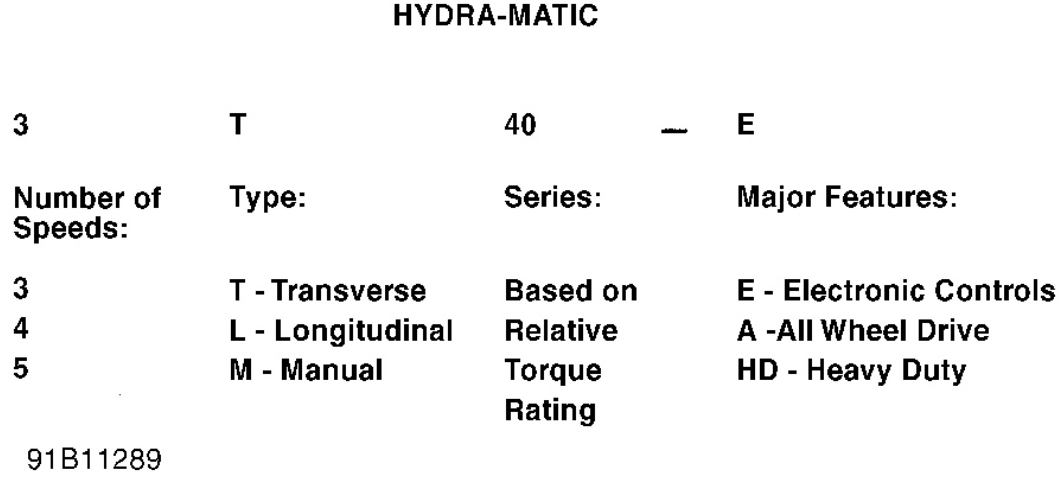


Fig. 1: Identifying Hydra-Matic Products
Courtesy of GENERAL MOTORS CORP.

LUBRICATION

SERVICE INTERVALS

Check transmission fluid level at every engine oil change. Transmission fluid should not be changed under normal operating conditions. Under continuous extreme operating conditions (trailer towing, heavy city traffic with ambient temperature more than 90°F (32°C) or delivery service), fluid and filter should be changed every 50,000 miles.

CHECKING FLUID LEVEL

1. Start engine. Operate vehicle for at least 15 minutes or until operating temperature is reached. With engine at curb idle and vehicle on level ground, move gear selector lever through all ranges, ending in Park.
2. Remove transmission dipstick, wipe clean and fully reinsert into filler tube. Remove dipstick again, and inspect fluid level. Fluid level should be between ADD 1 PT. OR .5L mark and FULL HOT mark on dipstick.

CAUTION: If vehicle has been driven for an extended period of time at high speeds, in city traffic, in hot weather or if vehicle has been pulling a trailer, an accurate fluid level reading cannot be made until vehicle has been parked and ATF is allowed to cool about 30 minutes.

RECOMMENDED FLUID

Use only Dexron-III Automatic Transmission Fluid (ATF).

FLUID CAPACITIES

FLUID CAPACITIES (1)

Application	Drain & Refill (2) Qts. (L)	Overhaul Qts. (L)
4L60-E		
Camaro & Firebird (3.4L)	5.0 (4.7)	8.4 (7.9)
Except Camaro & Firebird (3.4L)	5.0 (4.7)	11.2 (10.6)

(1) Fluid capacities listed are approximate. Always fill to the FULL mark.

(2) Drain and refill capacity does not include the torque converter.

DRAINING & REFILLING

NOTE: If oil pan bolts are equipped with conical washers, DO NOT re-use bolts if conical washers have become reversed. See Fig. 2 .

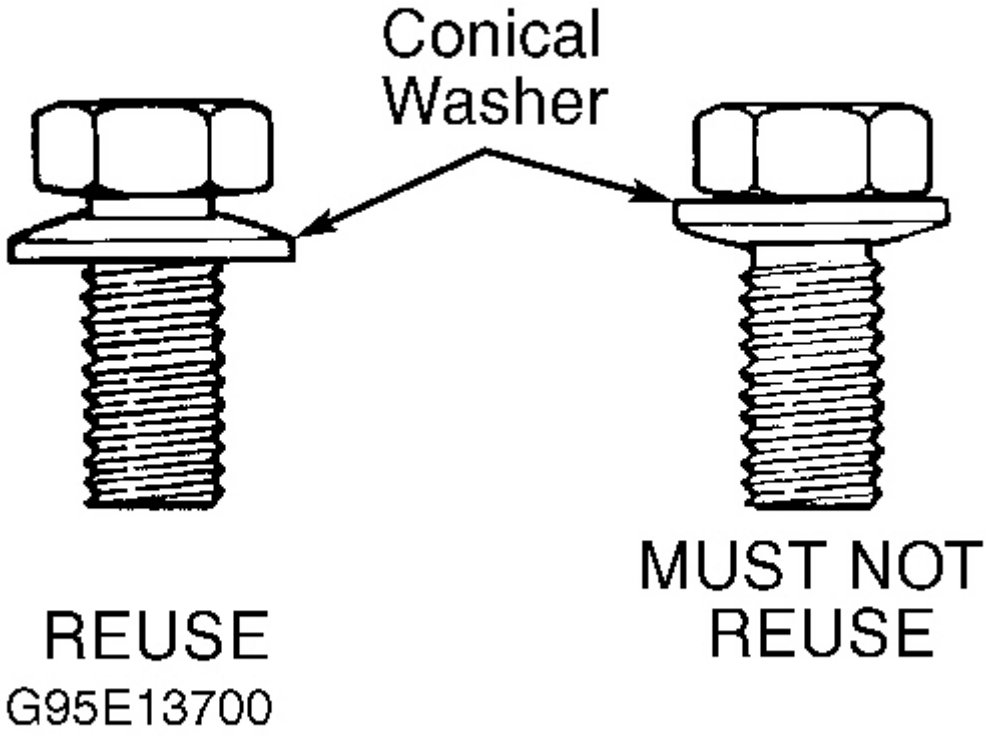


Fig. 2: Identifying Conical Washers
Courtesy of GENERAL MOTORS CORP.

1. Raise vehicle, and place large drain pan under transmission oil pan. Remove transmission oil pan front and side bolts only. Loosen rear bolts about 4 turns each.
2. Carefully pry pan loose using screwdriver. Allow fluid to drain. Remove remaining bolts, and remove oil pan. Discard old pan gasket. Remove filter and "O" ring or sleeve-type seal. Remove any remaining gasket material on transmission case.
3. Thoroughly clean pan, magnet and screen (if metal) with solvent, and then dry using compressed air. Replace paper filter (if equipped). Install NEW "O" ring on pick-up tube or NEW sleeve into pick-up tube recess. Lubricate with clean oil before installation.
4. Install filter assembly into pick-up tube recess. Install oil pan using NEW gasket, and tighten pan bolts to specification. See **TORQUE SPECIFICATIONS (OIL PAN BOLTS)** . Add required amount of fluid to transmission through filler tube.
5. Start engine with gear selector lever in Park and parking brake applied. Engage transmission in each gear, ending in Park. Check fluid level with engine warm. Add fluid if necessary. **DO NOT** overfill.

TORQUE SPECIFICATIONS (OIL PAN BOLTS)

Transmission	INCH Lbs. (N.m)
4L60-E	
Except "Y" Body	144 (16)
"Y" Body	97 (11)

ADJUSTMENTS

SHIFT CABLE (RWD)

WARNING: Adjust shift cable so engine will start in Park or Neutral only. Misadjusted shift linkage could cause clutch and/or band failure in transmission.

CAUTION: To prevent transaxle damage on "F" and "Y" bodies, hold lever out of Park when tightening cable adjusting nut.

"F" & "Y" Bodies

Place gear selector lever in Neutral. Raise and support vehicle. Loosen cable adjusting nut at transmission lever. See **Fig. 3** . Ensure shift shaft lever is in Neutral by rotating lever clockwise to Park detent, and then counterclockwise 2 detents to Neutral. Tighten nut (**DO NOT** tighten nut with lever in Park).

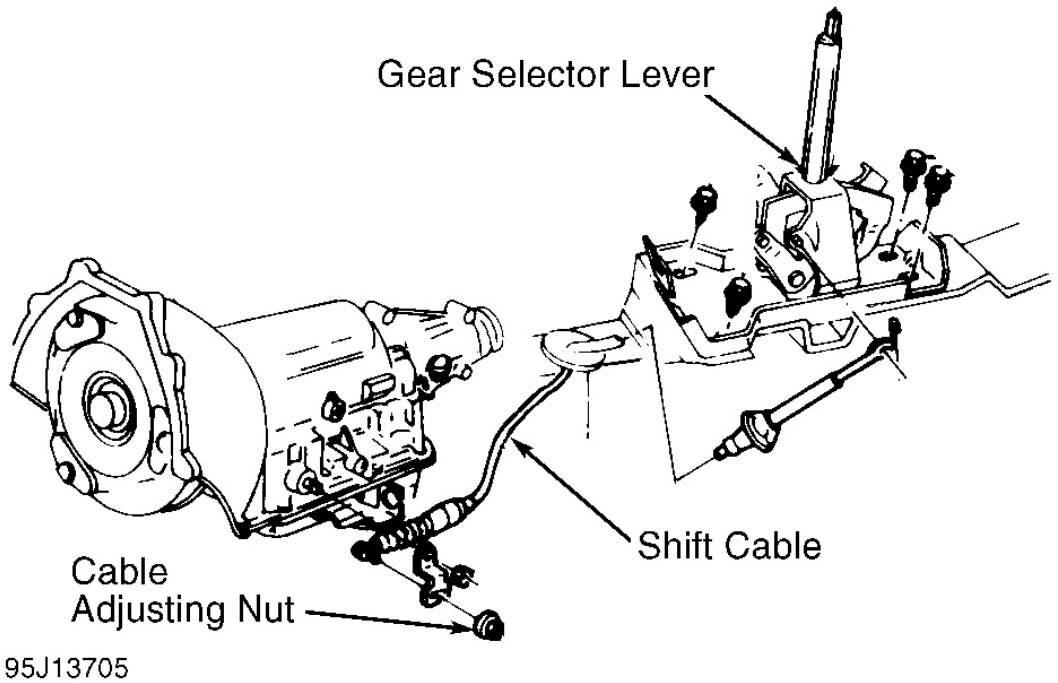


Fig. 3: Adjusting Shift Cable ("F" & "Y" Bodies)
Courtesy of GENERAL MOTORS CORP.

SHIFT LINKAGE ROD (RWD)

> **WARNING: Adjust shift linkage so engine will start in Park or Neutral only. Misadjusted shift linkage could cause clutch and/or band failure in transmission.**

"B" & "D" Bodies

Position steering column shift lever in Neutral. Raise and support vehicle. Loosen clamp and clamp screw where end of selector rod extends through hole in clamp. See **Fig. 4** . Place transmission shift shaft in Neutral. Tighten clamp screw.

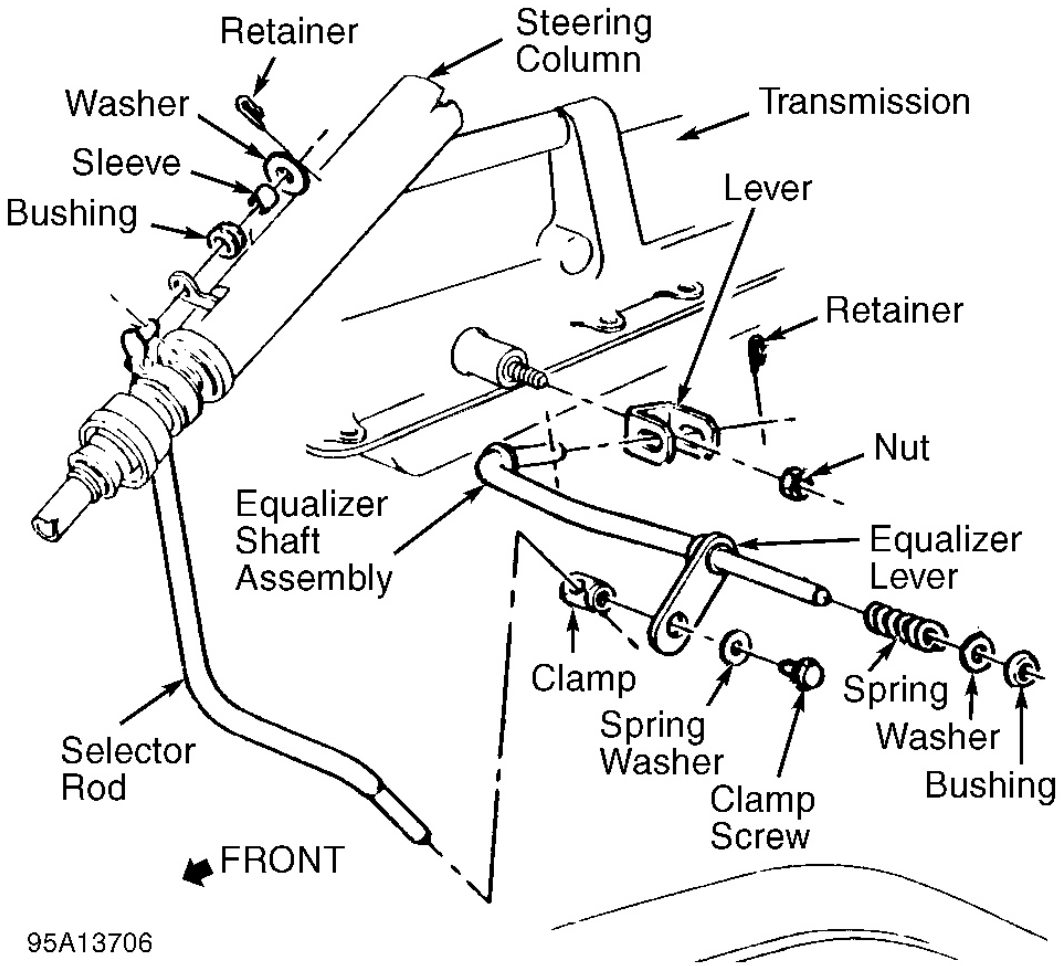


Fig. 4: Adjusting Shift Linkage Rod (RWD)

Courtesy of GENERAL MOTORS CORP.

PARK LOCK CABLE (FLOOR SHIFT)

"F" Body

1. With gear selector lever in Park and ignition switch in LOCK position, gear selector lever should not be able to be moved to other gear positions and ignition key should be removable from lock cylinder.
2. With ignition switch in RUN position and gear selector lever in Neutral, ensure ignition switch cannot be turned to LOCK position. If system does not perform as described, unlock park lock cable adjuster (button up). See **Fig. 5** . Move cable connector nose rearward until key can be removed from ignition. Lock cable adjuster (button down).

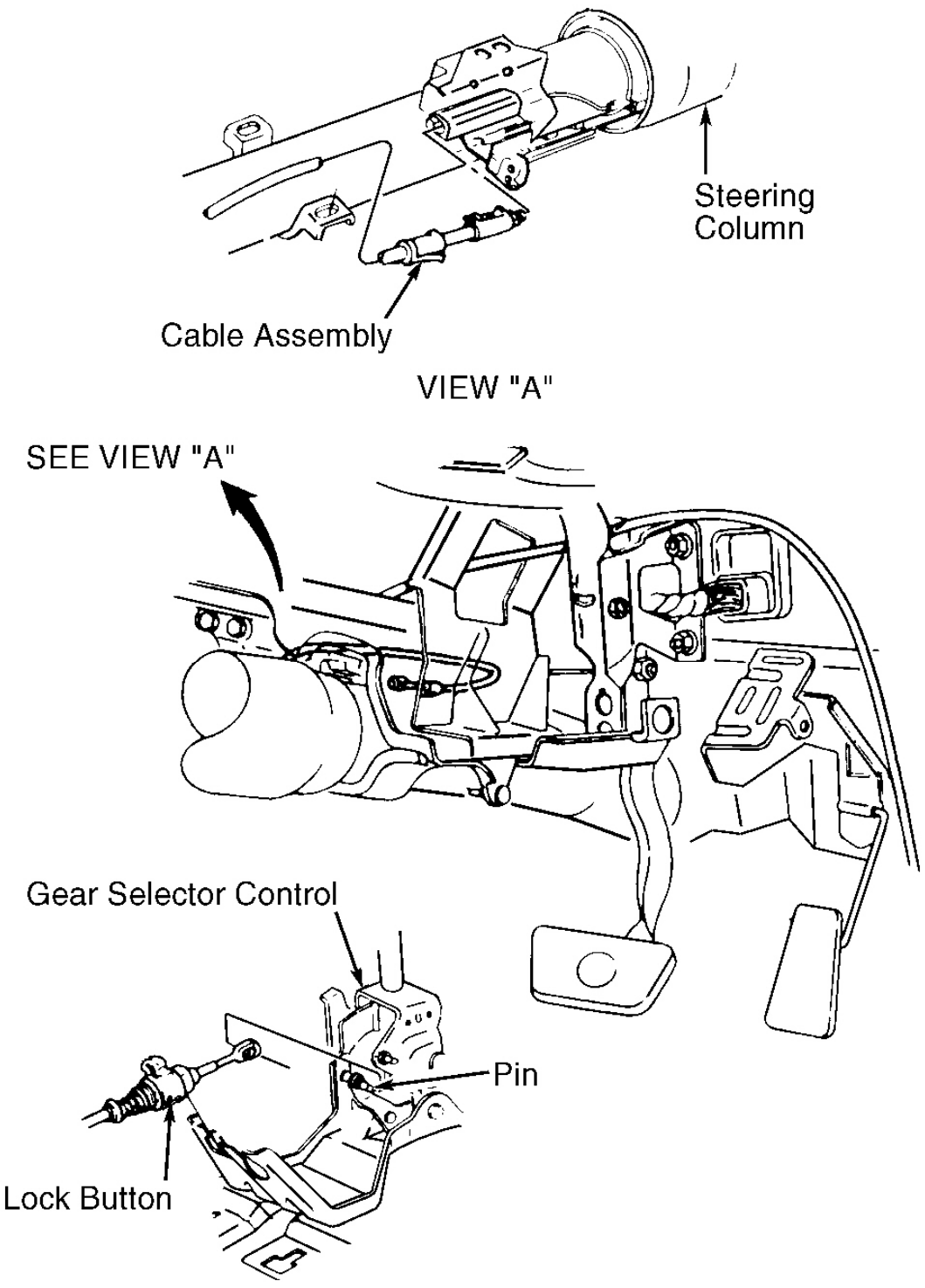


Fig. 5: Adjusting Park Lock Cable ("F" & "N" Bodies - Floor Shift)

Courtesy of GENERAL MOTORS CORP.

NEUTRAL SAFETY SWITCH

NOTE: Adjust switch so engine will start in Park or Neutral only.

RWD ("B" & "D" Bodies)

Vehicles with column shift use a mechanical interference-type neutral start system. With gear selector in any position except Park or Neutral, a wedge-shaped finger, attached to ignition switch actuator rod, prevents ignition switch from being rotated to START position.

RWD ("F" & "Y" Bodies)

1. Disconnect negative battery cable. Remove gear selector knob and center console cover. Place gear selector lever in Neutral. If old switch is being adjusted, go to next step. If NEW switch is being installed, go to step 4).
2. Align the tang on the switch with the tang slot on the shift control. See **Fig. 6** . Loosen switch mounting nuts. Rotate switch to align service adjustment hole with carrier tang hole.
3. Insert a .092" (2.34 mm) wire gauge into adjustment hole in top of switch. Rotate switch until pin drops to depth of .59" (15 mm). Tighten mounting nuts to 27 INCH lbs. (3 N.m). Vehicle should only start in Park or Neutral.
4. If NEW switch if being installed, insert switch tang in slot on shift control. Tighten mounting nuts to 27 INCH lbs. (3 N.m).
5. Ensure gear selector lever is in Neutral if holes **DO NOT** align with shift control. **DO NOT** rotate switch. Switch is pinned in Neutral.

   NOTE: If new switch is rotated and pin breaks during installation, use adjustment procedure in step 2).

6. If holes align with shift control, move gear selector lever out of Neutral to shear plastic pin.

TORQUE CONVERTER CLUTCH BRAKE SWITCH

Ensure torque converter clutch brake switch is adjusted to prevent vehicle from stalling at idle due to clutch remaining applied. Ensure brake pedal is fully released. Adjust switch until switch plunger just touches brake pedal lever.

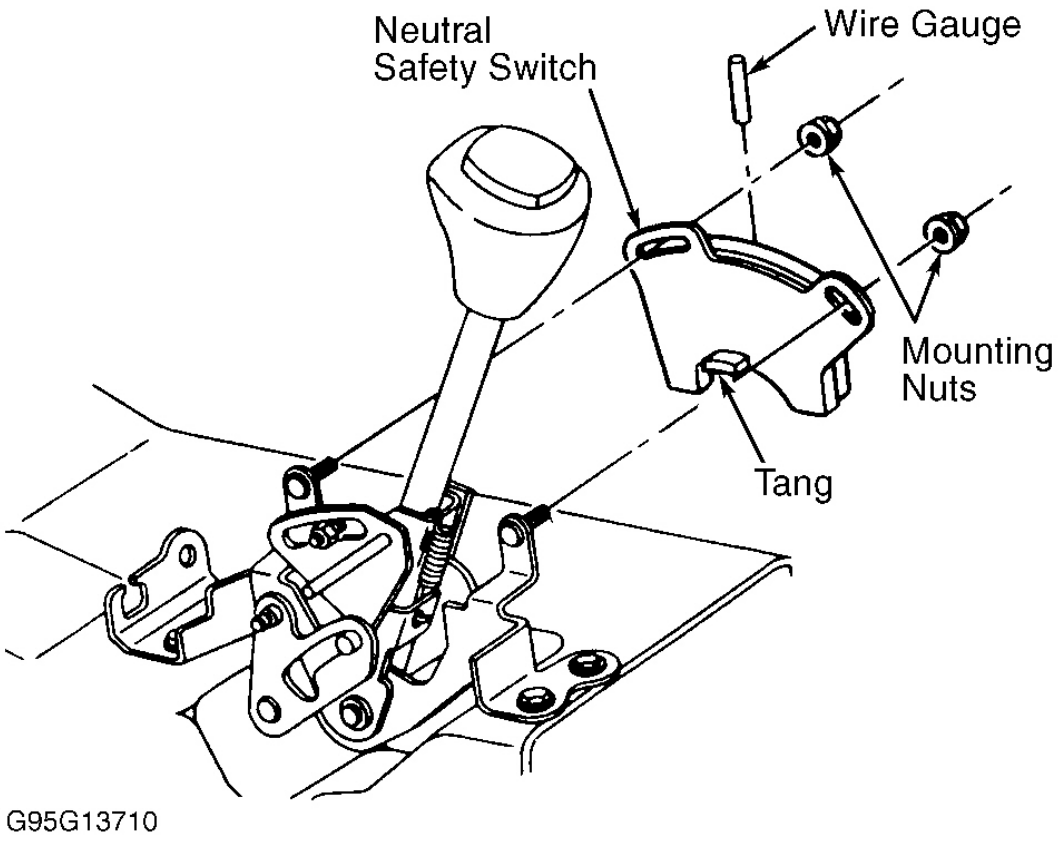


Fig. 6: Neutral Safety Switch ("Y" Body Shown; "F" Body Similar)
Courtesy of GENERAL MOTORS CORP.

F - BASIC TESTING

ENGINE PERFORMANCE General Motors Corp. Basic Diagnostic Procedures

INTRODUCTION

The following diagnostic steps will help prevent overlooking a simple problem. This is also where to begin diagnosis for a no-start condition.

The first step in diagnosing any driveability problem is verifying the customer's complaint with a test drive under the conditions during which the problem reportedly occurred.

Before entering self-diagnostics, perform a careful and complete visual inspection. Most engine control problems result from mechanical breakdowns, poor electrical connections or damaged/misrouted vacuum hoses. Before condemning the computerized system, perform each test listed in this article.

The following table provides the location of commonly used diagnostic information. These former "A" and "C" charts are now written in text and inserted into the appropriate location in the new Engine Performance workflow. To familiarize yourself with the Engine Performance workflow, see AA - USING THIS SECTION (GENERAL HELP INFORMATION) article in the ENGINE PERFORMANCE section.

GENERAL MOTORS A & C CHART REFERENCE

System or Component	Diagnostic Information Location
A-1 & A-2, Malfunction Indicator Light (MIL)	See DIAGNOSTIC CIRCUIT CHECK
A-3, No Start	See NO START - ENGINE CRANKS OKAY
A-5, Fuel Pump Relay	(1) See RELAYS, SOLENOIDS & MOTORS
A-7, Fuel System Diagnosis	See BASIC FUEL SYSTEM CHECKS
C-1, ECM/PCM Replacement Check	See ECM/PCM REPLACEMENT CHECK
C-1, MAP Sensor	(1) See ENGINE SENSORS & SWITCHES
C-1, Power Steering Pressure Switch	(1) See ENGINE SENSORS & SWITCHES
C-1, Park/Neutral Switch	(1) See ENGINE SENSORS & SWITCHES
C-2, Injector Balance Test	(1) See FUEL SYSTEM
C-2, Injector Leak Test	(1) See FUEL SYSTEM
C-2, IAC Motor	(1) See IDLE CONTROL SYSTEM in
C-2, ISC Motor	(1) See IDLE CONTROL SYSTEM in
C-3, Canister Purge System (Fuel Evaporation Control)	(1) See EMISSION SYSTEMS & SUB-SYSTEMS
C-4, EST Ignition Check	See BASIC IGNITION SYSTEM CHECKS
C-5, KS Ignition Check	(1) See IGNITION SYSTEM
C-6, Air Injection System	(1) See EMISSION SYSTEMS & SUB-SYSTEMS
C-7, EGR System	(1) See EMISSION SYSTEMS & SUB-SYSTEMS

C-8, Manual Transmission Shift Lights (Trans.)	(1) (2) See MISCELLANEOUS ECM CONTROLS
C-8, Torque ConverterClutch (Transmission)	(1) See MISCELLANEOUS ECM CONTROLS
C-10, A/C Clutch Control	(1) (3) See MISCELLANEOUS ECM CONTROLS
C-12, Electric Cooling Fan Control	(1) (3) See MISCELLANEOUS ECM CONTROLS
C-16, Engine Coolant Level Switch	See ENGINE SENSORS & SWITCHES
C-16, Fuel Pump/Oil Pressure Switch	See ENGINE SENSORS & SWITCHES
C-16, Oil Level Switch	See ENGINE SENSORS & SWITCHES
(1) Refer to SYSTEM/COMPONENT TESTS article in the ENGINE PERFORMANCE section.	
(2) Covered in entirety in the TRANSMISSION SERVICE & REPAIR section.	
(3) Covered in entirety in the ENGINE COOLING section.	

NOTE: Perform all voltage tests with a Digital Volt-Ohmmeter (DVOM) with a minimum 10-megohm input impedance, unless stated otherwise in test procedure.

PRELIMINARY INSPECTION & ADJUSTMENTS

VISUAL INSPECTION

Visually inspect all electrical wiring, looking for chafed, stretched, cut or pinched wiring. Ensure electrical connectors fit tightly and are not corroded. Ensure vacuum hoses are properly routed and not pinched or cut. See VACUUM DIAGRAMS article in the ENGINE PERFORMANCE section to verify routing and connections (if necessary). Inspect air induction system for possible vacuum leaks.

MECHANICAL INSPECTION

Compression

Check engine mechanical condition with a compression gauge, vacuum gauge, or an engine analyzer. See engine analyzer manual for specific instructions. For compression specifications, see C - SERVICE & ADJUSTMENT SPECIFICATIONS article in the ENGINE PERFORMANCE section.

WARNING: DO NOT use ignition switch during compression tests on fuel injected vehicles. Use a remote starter to crank engine. Fuel injectors on many models are triggered by ignition switch during cranking mode, which can create a fire hazard or contaminate engine oiling system.

Exhaust System Backpressure

Before replacing any components, check exhaust system for restrictions. The exhaust system can be checked with a vacuum gauge or a low pressure (0-5 psi) pressure gauge.

If a vacuum gauge is used, connect vacuum gauge hose to intake manifold vacuum port and start engine. Observe vacuum gauge. Open throttle part way and hold steady. If vacuum gauge reading slowly drops after stabilizing, exhaust system should be checked for a restriction. If using a low pressure gauge, connect gauge in one of the following manners:

- **Check At AIR Pipe**

Remove rubber hose at exhaust manifold AIR pipe check valve and remove check valve. Install pressure gauge to hose and nipple via Propane Enrichment Device(J-26911). Nipple should be inserted into exhaust manifold AIR pipe.

- **Check At Oxygen Sensor**

Remove oxygen sensor. Install backpressure tester in place of oxygen sensor. After test is completed, coat oxygen sensor threads with anti-seize compound.

Diagnosis

1. Start engine and bring to operating temperature. Increase engine speed to 2000-2500 RPM and note gauge. Reading should not exceed 1.25 psi (.09 kg/cm^2). Exhaust system is restricted if specification is exceeded.
2. Check exhaust system for collapsed pipe, heat distress and possible internal muffler failure. If none of these conditions exist, check for restricted catalytic converter. Replace as required.

PCM REPLACEMENT CHECK

Many test procedures and test charts in ENGINE PERFORMANCE lead to conclusion that PCM is faulty. Before replacing PCM, check driven circuits and PCM Quad-Drivers (QDR) using following procedures and accompanying flow chart. See QDR Check Flow Chart below.

1. Using a DVOM, backprobe PCM drive circuit in question and measure pin voltage with ignition on. If system voltage is present, go to next step. If system voltage is not present, turn ignition off. Disconnect PCM connector. Measure voltage on connector terminal for suspect circuit. If low voltage is measured, check circuit for an open or short to ground. Repair as necessary. If system voltage is measured, PCM is defective.
2. With DVOM still backprobing PCM at suspect circuit, ground DLC "test" terminal. Monitor voltage drop on circuit for at least 2 minutes. Voltage drop should not be greater than .5 volt. Some circuits may have low voltage until DLC "test" terminal is grounded. A "switching" operation should occur. Some Torque Converter Clutch (TCC) systems have pressure switches in series with TCC solenoid. On these applications, complete this circuit by disconnecting transmission/transaxle connector and using a test light in series between terminals "A" and "D" of transmission/transaxle connector.
3. If voltage drops and then floats back up, this occurs when QDR circuit is going into current limiting. Check circuit current flow (.75 amp maximum, except as noted in QDR check chart). See QDR Check Flow Chart below.

NOTE: For PCM-equipped vehicles, transmission/transaxle functions can only be

energized through use of TECH 1 scan tester. Shift solenoids on these models will not energize when DLC is grounded.

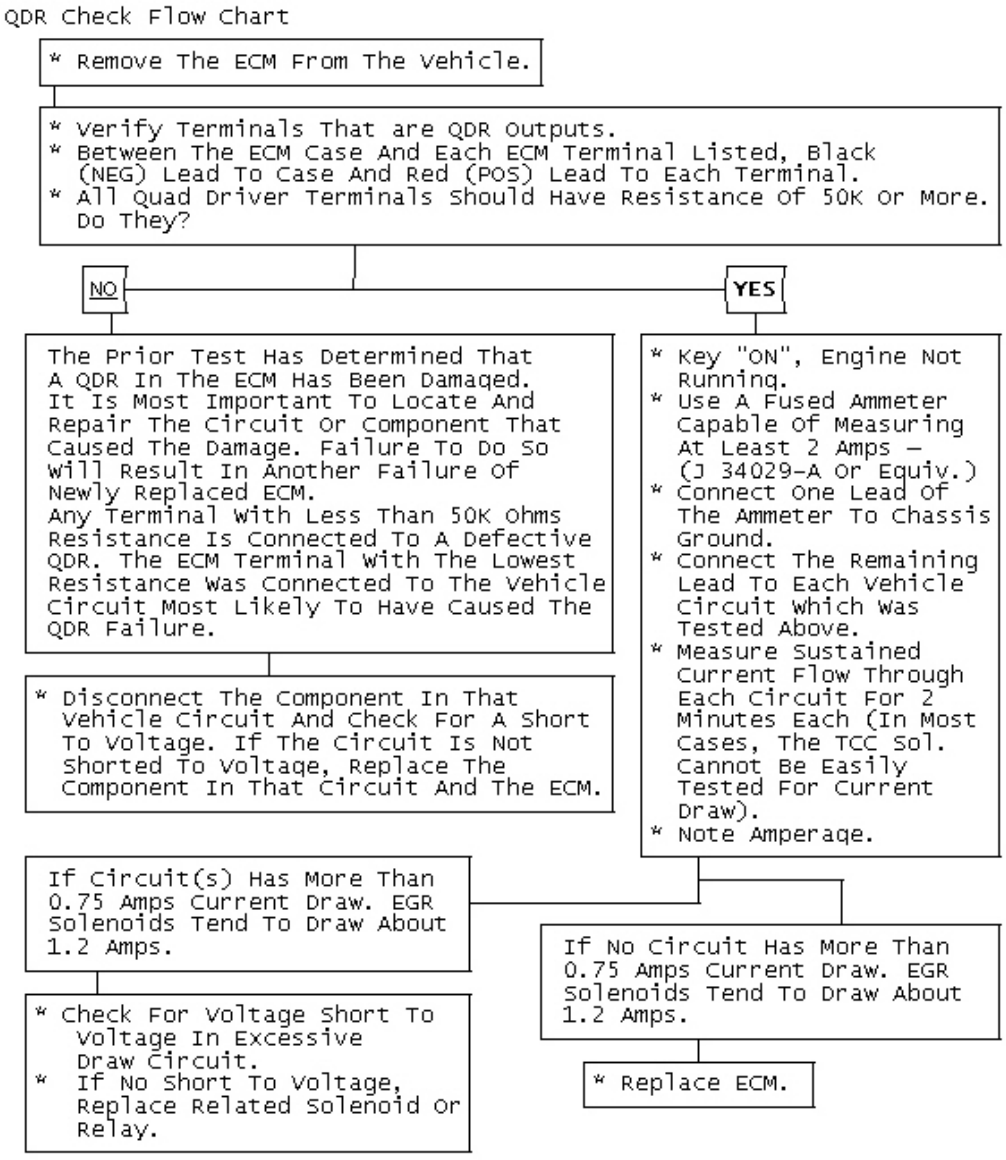


Fig. 1: QDR Check Flow Chart

NO START DIAGNOSIS (A-3)

NOTE: Some vehicles are equipped with anti-theft systems (VATS or PASS-Key(R)) which will not allow vehicle to be started if improper starting procedures or improperly coded ignition keys are used. Both fuel injection and cranking systems will be disabled. Loss of fuel enable signal from anti-theft decoder module should set a trouble code in PCM memory.

DEFINITION

No start is defined as engine cranks properly, but does not start. Engine may fire a few times.

NO START - ENGINE CRANKS OKAY (4.3L & 5.7L WITH OPTI-SPARK)

General Inspection

1. Ensure proper starting procedure is being used. Visually check vacuum hoses for splits, kinks and proper connections, as shown on Vehicle Emission Control Information label. Check ignition wires for cracking, hardness and proper connections at both coil pack and spark plugs.
2. Remove spark plugs. Check and replace as necessary. In very cold temperatures, ensure oil is proper viscosity and not contaminated with gasoline.

Ignition System

1. Check for stored trouble codes. If PCM Codes 16, 18, 41, 42, 46 or 48 are set, use those code charts first. See appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section. If engine has not been started for at least 8 hours, compare scanned ECT sensor temperature with actual coolant temperature.
2. If scanned value are not close, replace Engine Coolant Temperature (ECT) sensor. Ensure TP sensor scan is greater than 2.5 volts at closed throttle. If not, see PCM Code 21 chart in appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section.
3. Using Tech 1 scan tester, scan engine RPM during cranking. If RPM is indicated on scan tester, go to step 6). If RPM is not indicated on scan tester, turn ignition off. Disconnect distributor harness connector.
4. Turn ignition on. Probe terminal "C" (Red wire) of distributor harness connector (PCM side) with test light connected to ground. If test light illuminates, go to next step. If test light does not illuminate, check for faulty PCM connection, open or grounded ignition feed circuit (Pink wire), or a faulty PCM.
5. Turn ignition off. Check for continuity between ground and distributor harness connector terminal "D" (Pink/Black wire). See **Fig. 2** . If continuity exists, problem is faulty distributor connector connection or faulty distributor. If continuity does not exist, problem is faulty PCM connection, open ground circuit (Pink/Black wire) between PCM and distributor harness connector or faulty PCM.
6. Install Spark Tester (ST-125). Crank engine and check for spark on at least 2 spark plug wires. If spark is not present, go to step 8). If spark is present, check injector fuses. If fuses are okay, go to next step. If fuses are faulty, check injector(s) or injector circuits for short to ground.
7. Using scan tester, enable fuel pump. If fuel pump does not operate, go to FUEL SYSTEM test. If fuel pump operates, turn ignition off. Install fuel pressure gauge. Turn ignition on. Fuel pressure should be 41-47 psi (2.9-3.3 kg/cm^2). If fuel pressure is not as specified, go to BASIC FUEL SYSTEM CHECKS. If fuel pressure is as specified, check for sticking EGR valve, faulty MAF or leaks between throttle body and MAF.

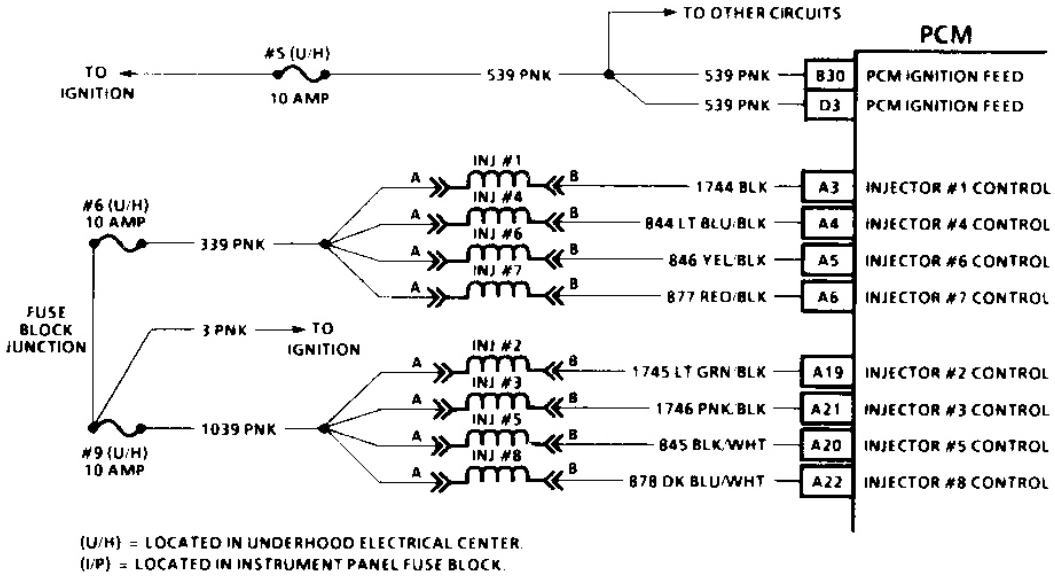
8. Check spark at coil wire using Spark Tester (ST-125). Leave spark tester connected to coil for remaining steps. If spark does not occur, go to next step. If spark occurs, inspect distributor cap for cranks. Inspect secondary wiring (plug wires) for opens, shorts or poor connections. If cap and wires are okay, replace distributor.
9. Remove coil wire. Check coil wire resistance. Coil wire resistance should be less than 5000 ohms. If coil wire resistance is not as specified, replace coil wire. If coil wire is okay, go to next step.
10. Disconnect ignition coil module connector. Turn ignition on. Using DVOM, check voltage between terminals "A" and "D" and ground. If voltage on one terminal is less than 10 volts, check for open or short or faulty coil connection on that circuit. If circuit and connection are okay, coil is faulty.
11. If voltage on both terminals is less than 10 volts, check for faulty power feed circuit to coil or grounded external coil circuit. If external circuits and power feed are okay, coil is faulty.
12. If voltage on both terminals is 10 volts or greater, turn ignition off. Reconnect ignition coil module connector. On "B" and "F" Bodies, go to step 14) On "D" and "Y" Bodies, disconnect ignition coil connectors. Using a fused jumper wire, jumper between Gray connector terminal "B" and Black connector terminal "B". Connect test light between battery voltage and ignition coil Gray connector terminal "A".
13. Crank engine and observe test light. Test light should flash. If test light flashes, ignition coil is faulty. If test light does not flash, check for faulty ignition coil module connection or faulty ignition coil module.
14. Connect DVOM set on AC scale to ground and terminal "B" of coil driver harness. Crank engine. If voltage is not 1-4 volts, go to next step. If voltage is 1-4 volts, probe coil driver connector terminal "C" with a test light connected to battery voltage. If test light does not illuminate, coil driver ground circuit is open. If test light illuminates, coil driver connection or coil driver is faulty.
15. Crank engine and monitor low resolution signal on scan tester. If low resolution signal is present, problem is faulty ignition control connection at PCM or open ignition control circuit, or faulty PCM. If low resolution signal is not present, turn ignition off. Disconnect distributor electrical connector.
16. Turn ignition on. Probe terminal "C" of distributor harness with a test light connected to ground. If test light illuminates, go to next step. If test light does not illuminate, problem is faulty PCM connection, open in ignition feed circuit between PCM and distributor harness connector terminal "C" or faulty PCM.
17. Turn ignition off. Check for continuity between ground and distributor harness connector terminal "D". If continuity exists, go to next step. If continuity does not exist, open ground circuit between PCM and distributor harness connector terminal "D", faulty PCM connection or faulty PCM.
18. Turn ignition on. Using DVOM set on AC scale, measure voltage on terminal "A" of distributor harness connector. If about 5 volts are present, go to next step. If voltage is not as specified, problem is open or short in low resolution circuit between PCM and distributor harness connector terminal "A", faulty PCM connection or faulty PCM.
19. Measure voltage on terminal "B" of distributor harness connector. If about 5 volts are present, distributor connection or distributor is faulty. If about 5 volts are not present, problem is open or short in high resolution circuit between PCM and distributor harness connector terminal "B", faulty PCM connection or faulty PCM.

Fuel System

1. Before checking fuel system for a no-start condition, check ignition for adequate spark. Check for proper fuel pump pressure and capacity. See BASIC FUEL SYSTEM CHECKS.
2. Check fuel pump fuse. If fuel pump fuse is okay, go to step 4). If fuse is faulty, turn ignition off. Remove

fuse. Disconnect fuel pump wiring harness. Using a test light connected to battery voltage, probe fuel pump harness Gray wire connector. If test light illuminates, Gray wire is shorted. If test light does not illuminate, go to next step.

3. Reconnect fuel pump harness connector. Replace fuel pump fuse. Turn ignition on and recheck fuse. If fuse is okay, problem is intermittent short to ground in Gray wire. If fuse blows again, fuel pump harness connector is grounded or fuel pump is faulty.
4. Remove fuel pump relay. Turn ignition on. Using a test light connected to ground, probe fuel pump relay harness battery feed circuit. If test light illuminates, go to next step. If test light does not illuminate, check for open in battery feed circuit.
5. Connect test light to battery voltage. Probe fuel pump relay harness ground circuit. If test light illuminates, go to next step. If test light does not illuminate, check for open in relay ground circuit.
6. Connect DVOM between ground and fuel pump relay harness connector Dark Green/White wire terminal. Using Tech 1 scan tester, enable fuel pump. If battery voltage is present, go to next step. If battery voltage is not present, check for open in Dark Green/White wire, faulty PCM connector or faulty PCM.
7. Using a fused jumper wire, jumper fuel pump relay connector Gray and Orange wire terminals. If fuel pump does not operate, go to next step. If fuel pump operates, check for faulty relay connection of faulty relay.
8. Leave jumper connected. Disconnect fuel pump harness connector. Using a test light, probe fuel pump relay connector Gray wire terminal. If test light illuminates, go to next step. If test light does not illuminate, check for open in circuit from fuel pump relay to fuel pump.
9. Using test light, probe fuel pump harness connector Gray wire terminal. If test light illuminates, check for open in fuel pump harness connector or faulty fuel pump. If test does not illuminate, check for open in fuel pump ground circuit.



94E35000

Fig. 2: 4.3L (VIN W) & 5.7L (VIN P) Fuel Injection & Ignition System Schematic (Caprice, Impala SS & Roadmaster - 1 Of 2)
Courtesy of GENERAL MOTORS CORP.

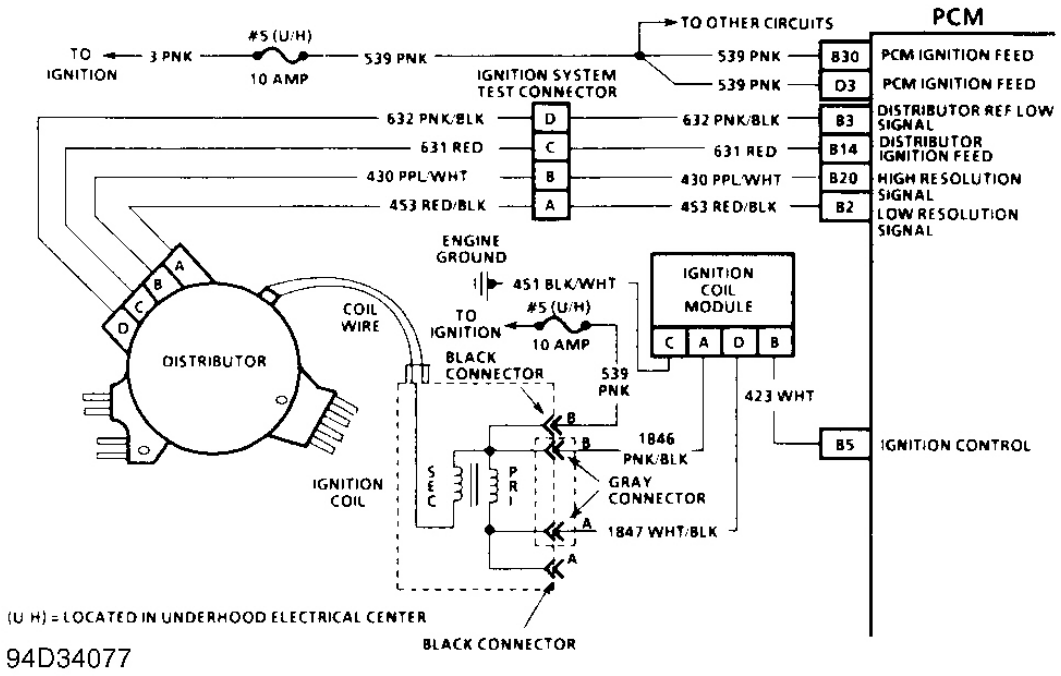


Fig. 3: 4.3L (VIN W) & 5.7L (VIN P) Fuel Injection & Ignition System Schematic (Caprice, Impala SS & Roadmaster - 2 Of 2)
Courtesy of GENERAL MOTORS CORP.

BASIC FUEL SYSTEM CHECKS (A-7)

CAUTION: Fuel system trouble shooting and diagnosis begins with checking fuel injection system pressure. High fuel pressure may be present in fuel lines and component parts. Relieve fuel pressure before disconnecting any fuel system components.

FUEL SYSTEM PRESSURE TEST

Fuel Pressure Relief

Fuel system is under pressure. Pressure must be relieved prior to servicing fuel system. Fuel pressure may be relieved by using one of the following methods.

- On all models, disconnect fuel pump at rear body connector. Start engine and run engine until it stalls. Crank starter for 3 seconds to remove remaining fuel from fuel lines. Turn ignition off. Reconnect rear

body connector.

- Install Fuel Pressure Gauge (J-34730-1) on fuel pressure connector of fuel rail. Wrap shop towel around pressure connection when installing fuel pressure gauge to absorb fuel leakage. Install gauge bleed hose in container. Open bleed valve to bleed fuel pressure.

Fuel Pressure Check

1. Relieve fuel pressure as previously described in FUEL PRESSURE RELIEF. Connect Fuel Pressure Gauge (J-34730-1) to fuel pressure fitting on fuel rail. With gauge installed, turn ignition on. With ignition on and engine off, fuel pressure should read within specification. See **FUEL PRESSURE** table. If no fuel pressure is present, go to step 5).
2. Start engine. Pressure should drop 3-10 psi (.2-.7 kg/cm^2). Turn ignition off. Pressure should hold. If pressure does not hold, check for leaking injectors or fittings. If injectors or fittings are not leaking, replace pressure regulator.
3. If pressure is present but less than specification, check for restricted delivery line or fuel filter. Repair as necessary. If no restriction is evident, apply battery voltage to fuel pump test connector using a 10-amp fused jumper wire. For location of fuel pump test connector, see COMPONENT LOCATIONS in appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section.
4. Gradually pinch off fuel return line between gauge and fuel tank. If fuel pressure increases to within specification, replace fuel pressure regulator. If fuel pressure does not increase with line pinched, check for faulty in-tank fuel pump or partially blocked fuel strainer.
5. Apply battery voltage to fuel pump test connector using a 10-amp fused jumper wire. For location of fuel pump test connector, see COMPONENT LOCATIONS in I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section. Observe fuel pressure reading. If fuel pressure is still not present, check wiring between test connector and fuel pump. If wiring is okay, replace fuel pump.
6. If fuel pressure is present with voltage applied to test connector, test fuel pump relay and voltage supply to relay. See I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section.

FUEL PRESSURE

Application	psi (kg/cm^2)
All Models	41-47 (2.88-3.30)

Fuel Pump Relay

See MOTORS, RELAYS & SOLENOIDS in appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section.

Fuel Pump Relay By-Pass Procedure

See FUEL DELIVERY in I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section.

FIELD SERVICE MODE CHECK

NOTE: Field service mode check can only be performed on vehicles equipped with 12-

pin DLC with a wire present in test terminal "B". See DATA LINK CONNECTOR (DLC) TEST TERMINALS table.

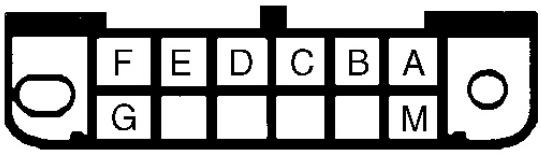
NOTE: Oxygen sensor may cool off while engine is idling. This causes system to go into "open loop". To restore "closed loop" mode, run engine at part throttle several minutes and accelerate from idle to part throttle several times.

Field service mode check confirms proper fuel system operation and verifies "closed loop" operation. Clear codes and perform this test after any repair is completed. When performing this check, always engage parking brake and block DRIVE wheels. Parking brake on FWD models does NOT hold drive wheels.

1. Start engine. With engine running, ground DLC terminal "B". See **Fig. 4** . In "closed loop" mode, Malfunction Indicator Light (MIL) will flash once a second.
2. In "open loop", MIL will flash 2.5 times a second. If MIL is off most of the time, a lean exhaust is indicated. If MIL is on most of the time, a rich exhaust is indicated.

DATA LINK CONNECTOR (DLC) TEST TERMINALS

Application	Ground/Test
12-Pin DLC 4.3L (VIN W)	"A" & "B"
16-Pin DLC 5.7L (VIN P)	(1)
(1) Tech 1 scan tester required to perform On-Board Diagnostic (OBD) system check.	

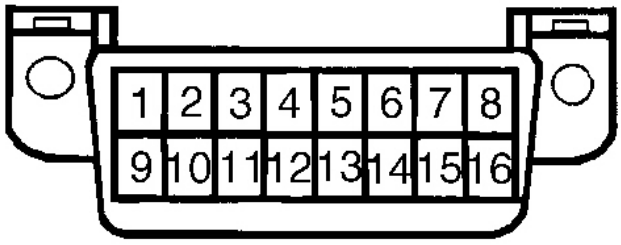


12-PIN DLC

A – Ground
B – Test Terminal
C – Air Injection (If Equipped)
D – Service Engine Soon Light (If Used)
E – Serial Data
F – TCC (If Used)
G – Fuel Pump (If Used)
M – Serial Data (Some Models)

90B01199

Fig. 4: Identifying 12-Pin DLC Connector Terminals
Courtesy of GENERAL MOTORS CORP.



16-PIN DLC

2 - Serial Data (Class 2)
4 - Ground
5 - Ground
6 - Output/Field Service Enable
9 - Serial Data
16 - Battery Power

94J34081

Fig. 5: Identifying 16-Pin DLC Connector Terminals
Courtesy of GENERAL MOTORS CORP.

BASIC IGNITION SYSTEM CHECKS (C-4)

HEI-EST DISTRIBUTOR

NOTE: The only adjustments that can be made to HEI/EST ignition system are basic ignition timing (on distributor-type ignitions) and spark plug gap.

Spark

1. If factory tachometer is connected at coil tachometer terminal, disconnect it before performing tests. When removing spark plug wire from spark plug, twist and pull on boot (not on wire).
2. Using Spark Tester (ST-125), check for spark at coil wire (if applicable) and at each spark plug wire using spark tester. Check spark plug wire resistance on suspect wires. Resistance should be less than 30,000 ohms.

Ignition Coil Power Source

1. Turn ignition on. Using voltmeter, check voltage between terminal "+" of ignition coil and ground on models with remote-mounted coil.
2. On models equipped with integral ignition coil, check voltage between BAT terminal and ground at distributor. Battery voltage should exist. If battery voltage does not exist, check for open circuit, blown ignition fuse or defective ignition switch.

Ignition Coil Resistance

1. Turn ignition off. Remove distributor cap and coil assembly. Invert cap. See **Fig. 6** . Set ohmmeter to low scale. Connect leads to coil BAT and TACH terminals. Resistance should be zero or nearly zero. If resistance is not zero or nearly zero ohms, replace ignition coil.
2. Set ohmmeter on high scale. Connect one lead to coil secondary terminal and other lead to ground terminal. If resistance reading is infinite, replace ignition coil.

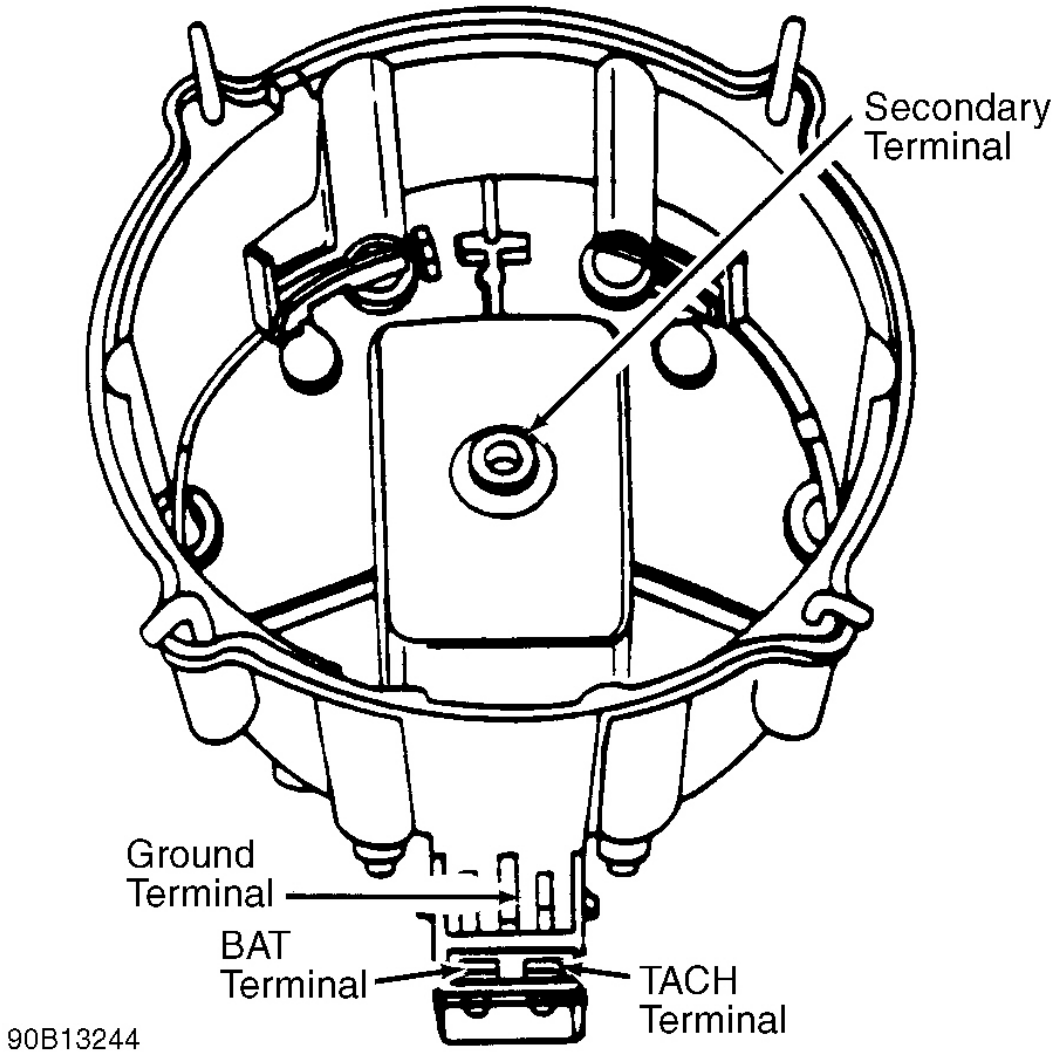


Fig. 6: Testing Ignition Coil Resistance (Internal Coil)
Courtesy of GENERAL MOTORS CORP.

Distributor Pick-Up Coil Short & Resistance Checks

1. Disconnect pick-up coil leads from HEI/EST module terminals "N" and "P". Set ohmmeter to middle scale. Connect one ohmmeter lead to either pick-up coil lead and the other lead to distributor housing.

Flex pick-up coil leads by hand to check for intermittent shorts to ground. Reading should be infinity at all times. If resistance is not infinite, replace pick-up coil.

2. Connect ohmmeter between both pick-up coil leads. Check for intermittent open circuit by flexing wires and connectors. Resistance should be 500-1500 ohms. If resistance is not as specified, replace pick-up coil.

Tach Pulse (RPM) Signal

1. Connect a scan tester to the DLC. RPM should be indicated on tester when engine is cranked or running. If scan tester is not available, tach pulse (RPM reference from ignition module) will be indicated as a voltage signal on a DVOM (with a minimum 10-megohm input impedance) when DVOM is touched to PCM terminal circuit No. 430 with engine cranking.
2. A tach pulse signal may be simulated (to test PCM response) by connecting a test light in series between battery and PCM terminal circuit No. 430. Each time test light is touched to and removed from circuit No. 430, PCM will see this as a tach signal. For circuit and terminal reference, see appropriate schematic under NO START - ENGINE CRANKS OKAY.

Hall Effect Switch (4.9L)

1. Disconnect distributor 4-wire and 6-wire connectors. Apply battery voltage to Red wire of 3-wire distributor connector (distributor side). Connect ground to Black wire of 3-wire distributor connector (distributor side).
2. Connect voltmeter positive lead to terminal "E" (Brown/White wire) of 5-wire distributor connector (distributor side). Connect voltmeter negative lead to terminal "D" (Black/Red wire) of 5-wire distributor connector (distributor side).
3. Bump starter and note voltmeter reading. When distributor blade is in window of Hall Effect switch, voltmeter should read within .5 volt of battery voltage. When distributor blade is not in window of Hall Effect switch, voltmeter should read less than .5 volt. Bump starter several times to cause both conditions to occur.
4. If Hall Effect switch is functioning properly and starter is cranked, voltmeter should show an averaged voltage of about 5-6 volts. If Hall Effect switch does not function as described, replace Hall Effect switch.

OPTI-SPARK

Spark

Disconnect tachometer wire (if equipped). A shorted tachometer will not allow vehicle to start. Check for adequate spark with Spark Tester (ST-125). Check for spark on more than one plug wire. When removing spark plug wire from spark plug, twist and pull on boot. **DO NOT** pull on wire.

Ignition Coil Power Source

Turn ignition on. Check for battery voltage on Pink/Black wire to ignition coil. If battery voltage is not present, check for blown 10-amp COIL fuse. If fuse is okay, check for open between fuse and ignition coil.

Ignition Coil Resistance

Information is not available from manufacturer.

Tach Pulse (RPM Reference) Signal

Connect scan tester to DLC. Scan low and high resolution reference pulses. Both high and low pulses should be present when engine is cranking or running. If low resolution pulse is not present, engine will not start and PCM will set Code 16 in memory. If high resolution pulse is not present, vehicle will still run; however, PCM will set Code 36 in memory. For circuit and terminal reference, see appropriate schematic in NO START - ENGINE CRANKS OKAY.

IDLE SPEED & IGNITION TIMING

Ensure idle speed and ignition timing are set to specification. For adjustment procedures, see appropriate D - ON-VEHICLE ADJUSTMENTS article in the ENGINE PERFORMANCE section.

DIAGNOSTIC CIRCUIT CHECK

The Diagnostic Circuit Check determines:

- If Malfunction Indicator Light (MIL) works.
- If PCM is operating and can recognize a fault.
- If any codes are stored.

After performing procedures in PRELIMINARY INSPECTION & ADJUSTMENTS, BASIC FUEL SYSTEM CHECKS and BASIC IGNITION SYSTEM CHECKS, this is the starting point for utilizing the self-diagnostic system for determining computer-related problems. See **Fig. 7** and **Fig. 8** . After performing necessary tests as described in the diagnostic circuit check, if no codes are indicated and driveability problems still exist, see H - TROUBLE SHOOTING - NO CODES article in the ENGINE PERFORMANCE section and SCAN TESTER USAGE in TESTS W/CODES article in the ENGINE PERFORMANCE section.

NOTE: On vehicles equipped with 16-pin DLC or 12-pin DLC without test terminal "B", use of Tech 1 scan tester is required to perform diagnostic circuit check. See DATA LINK CONNECTOR (DLC) TEST TERMINALS table.

1. Check operation of MIL. Turn ignition on with engine off. MIL should be on steady. If MIL illuminates and stays on steady, go to step 3). If MIL does not illuminate, go to A-1, MIL INOPERATIVE. If MIL flashes, go to step 4).
2. On vehicles equipped with 16-pin DLC or 12-pin DLC without test terminal "B", install Tech 1 scan tester and follow scan tester manufacturer's instructions to proceed with test. If MIL does not come on, go to A-1, MIL INOPERATIVE. If MIL comes on, check for diagnostic trouble codes and diagnose codes using TESTS W/CODES article in the ENGINE PERFORMANCE section. On vehicles equipped with 12-pin DLC with test terminal "B", go to next step.
3. Grounding DLC terminal "B" at this time should cause MIL to flash a Code 12, followed by any codes stored in PCM memory. See **Fig. 4** . MIL going from bright to dim is not considered a code. If MIL dims or remains on and does not flash Code 12, see A-2, MIL ON STEADY OR WON'T FLASH CODE 12.

NOTE: **On some models, as long as a 30-second pause may occur between code flashes. This is normal and does not indicate necessary component replacement.**

4. If MIL begins to flash as soon as ignition is turned on, check for a short to ground on the diagnostic test terminal wire between DLC terminal "B" and PCM terminal No. 5. If circuit is okay, replace PCM.

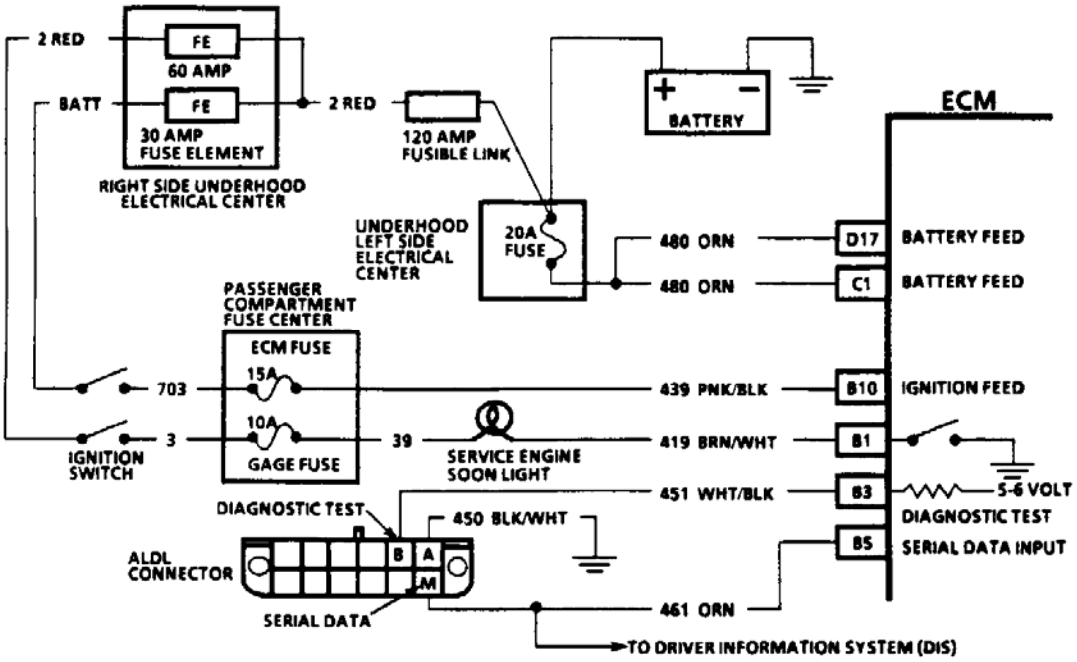


Fig. 7: Fuel Injection Diagnostic Circuit Schematic (Typical)
Courtesy of GENERAL MOTORS CORP.

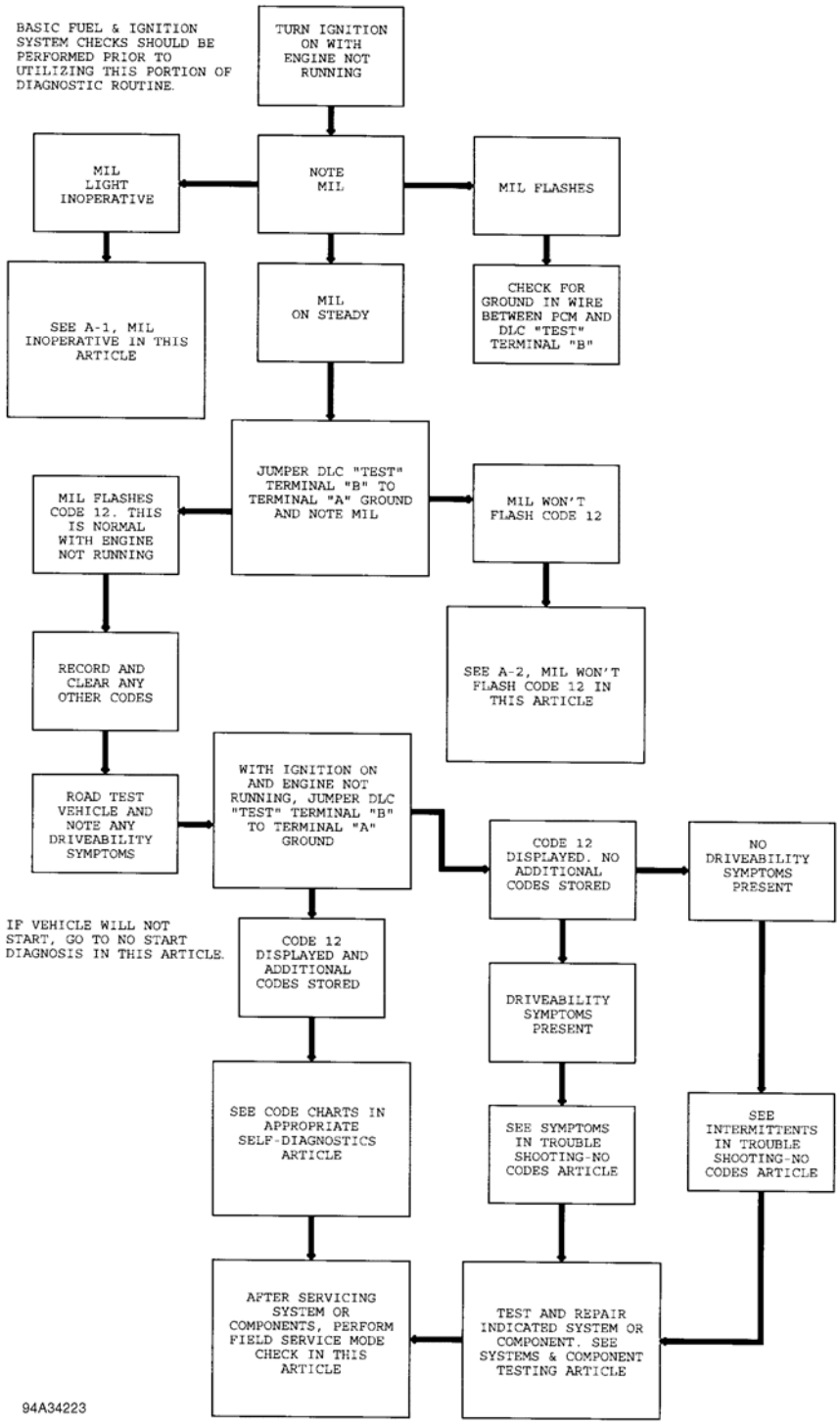


Fig. 8: Diagnostic Circuit Check & Work Flow
Courtesy of GENERAL MOTORS CORP.

A-1, MIL INOPERATIVE

1. If Malfunction Indicator Light (MIL) does not illuminate with ignition on and with engine off, attempt to start engine. If engine starts, go to step 3). If engine does not start, check fusible links at battery and PCM fuse. If fusible links or PCM fuse are blown, repair short to ground.
2. If fusible links and PCM fuse are okay, turn ignition on and check power circuits to PCM, including keep alive memory and ignition feed. See appropriate wiring diagram in WIRING DIAGRAMS section for power terminal identification. If power is not available to power terminals of PCM, check for opens in power circuits. If power is available to PCM power terminals, check for poor PCM ground circuits, or replace faulty PCM.
3. If engine starts and MIL does not illuminate, turn ignition off. Disconnect PCM connectors. Turn ignition on and jumper PCM light driver terminal to ground using a test light. See appropriate wiring diagram in WIRING DIAGRAMS section for power terminal identification.
4. If MIL is now on, repair light driver terminal connections at PCM or replace faulty PCM. If MIL stays off when test light is used to ground light driver terminal, check for blown instrument panel fuse, faulty bulb, open in light driver circuit between PCM and bulb, driver circuit shorted to voltage, or an open in ignition feed to MIL.

A-2, MIL ON STEADY OR WON'T FLASH CODE 12

1. Start engine. Check MIL. If MIL is not flashing, go to next step. If MIL is flashing, turn ignition off. Disconnect PCM connector "D". Using test light connected to battery voltage, probe DLC test terminal "B". If test light illuminates, output/field service enable circuit (12-pin DLC terminal "B") is shorted to ground. If test light does not illuminate, replace faulty PCM.
2. Connect DVOM between ground and DLC output/field service enable terminal (12-pin DLC terminal "B"). DVOM should read 5 volts. If reading is as specified, check for faulty PCM connection or faulty PCM. If reading is not as specified, go to next step.
3. Turn ignition off. Disconnect PCM connector"D". Using jumper wire, ground DLC test terminal "B". With test light connected to battery positive, probe PCM harness connector terminal D20 (White/Black wire). Test light should illuminate. If test light illuminated, check for faulty PCM connection or faulty PCM. If test light did not illuminate, DLC test terminal "B" circuit is open.

SUMMARY

If no faults were found while performing BASIC DIAGNOSTIC PROCEDURES, no trouble codes (or only intermittent ones) were found while performing DIAGNOSTIC CIRCUIT CHECK and driveability problems exist, proceed to H - TROUBLE SHOOTING - NO CODES article in the ENGINE PERFORMANCE section for diagnosis by symptom (i.e., ROUGH IDLE, NO-START, etc.) or intermittent diagnostic procedures.

WIRING DIAGRAMS

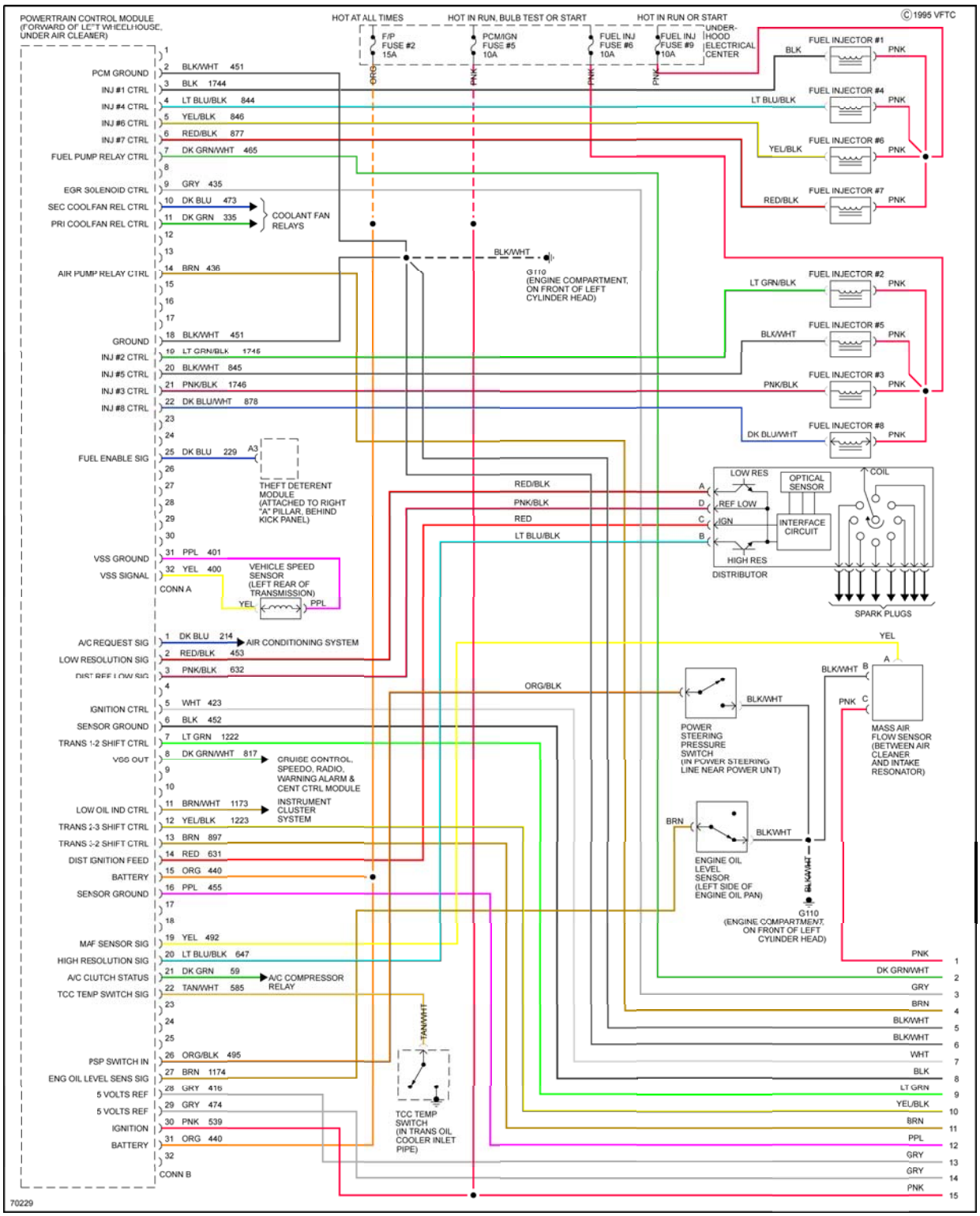


Fig. 9: 4.3L (VIN W) & 5.7L (VIN P) PCM Wiring Diagram (All Models - 1 Of 3)

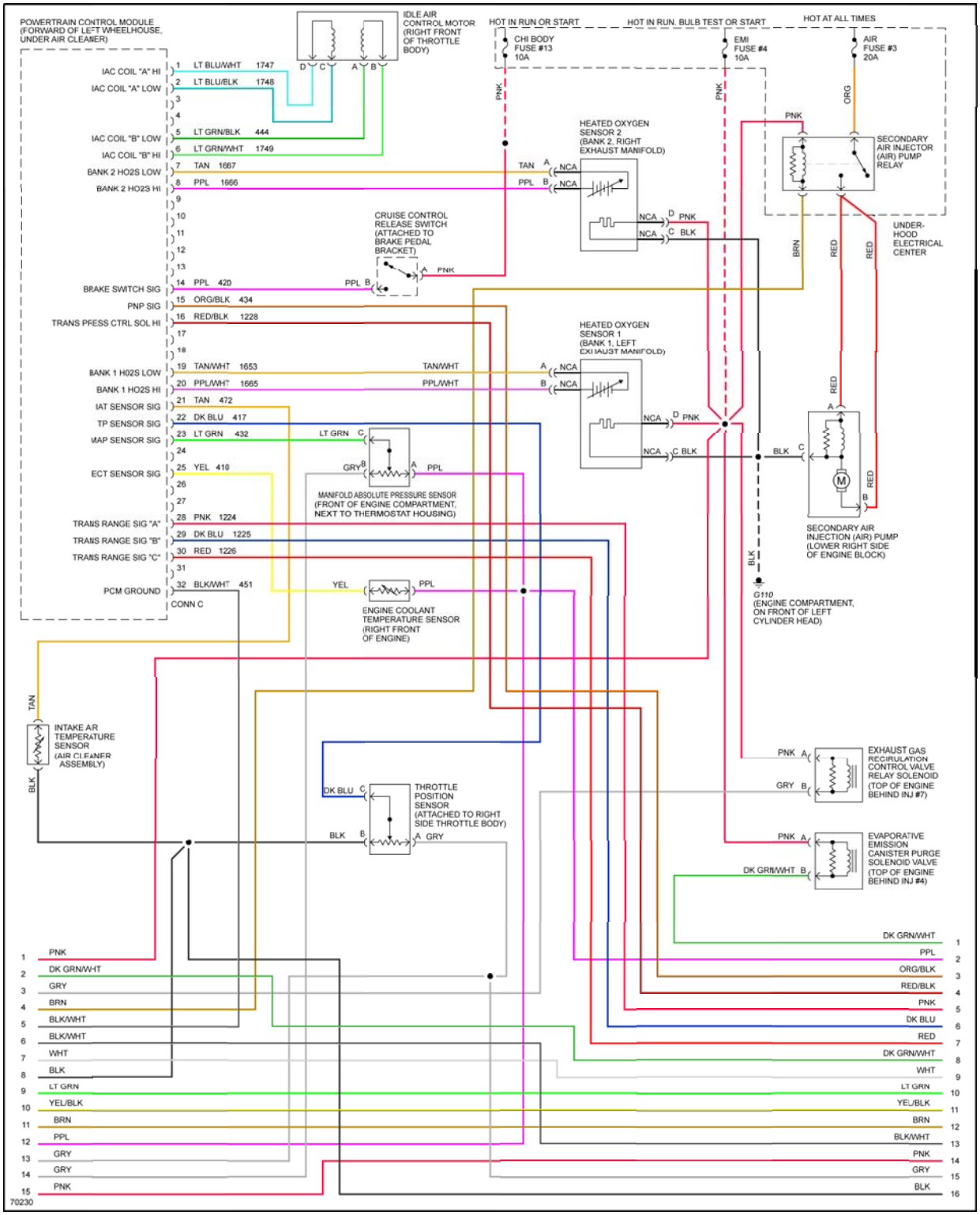


Fig. 10: 4.3L (VIN W) & 5.7L (VIN P) PCM Wiring Diagram (All Models - 2 Of 3)

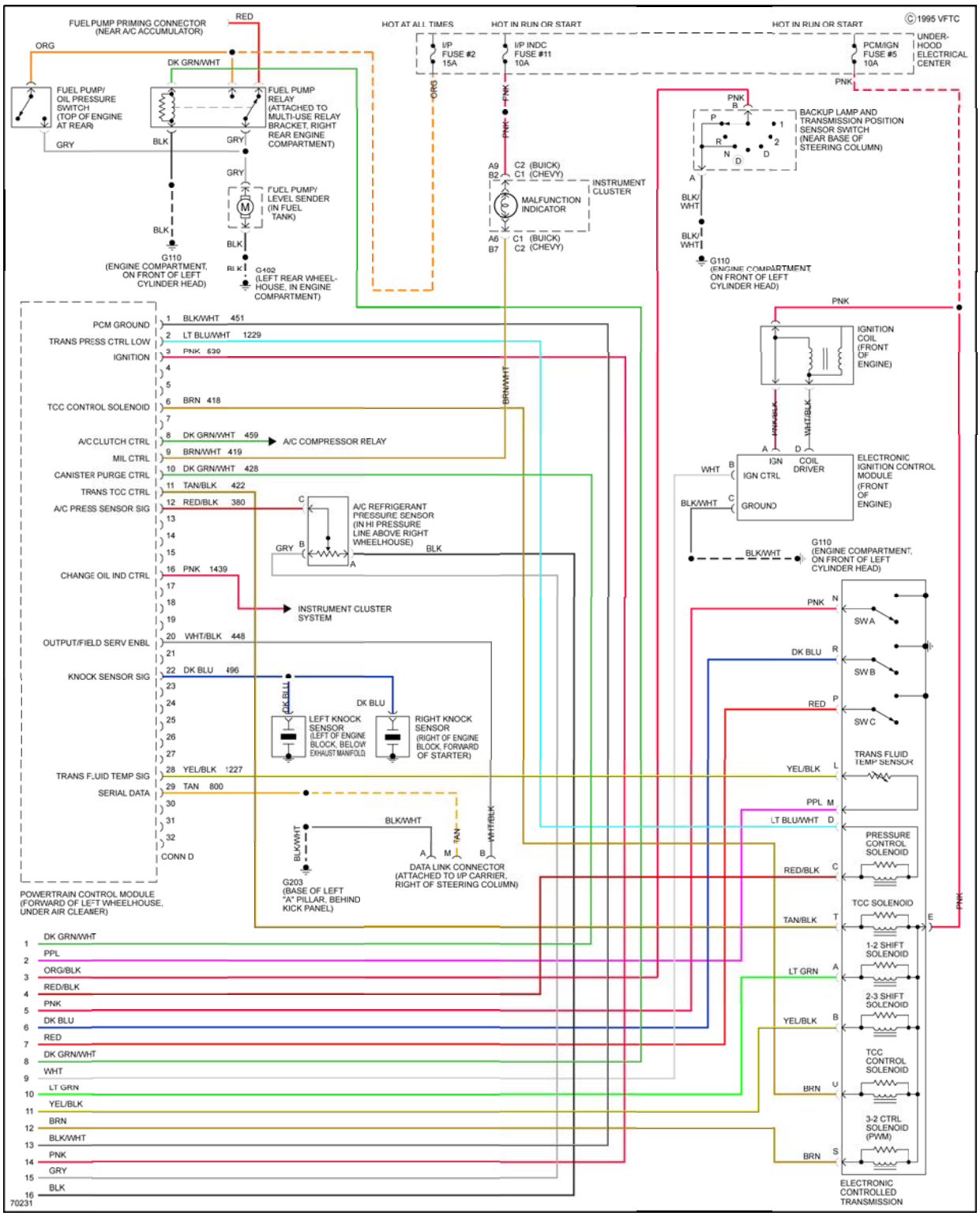


Fig. 11: 4.3L (VIN W) & 5.7L (VIN P) PCM Wiring Diagram (All Models - 3 Of 3)

GENERAL INFORMATION

Trouble Shooting - Basic Procedures

* PLEASE READ THIS FIRST *

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.**

ACCESSORIES & ELECTRICAL

CHARGING SYSTEM TROUBLE SHOOTING

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NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.**

BASIC CHARGING SYSTEM TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Vehicle Will Not Start	
Dead battery	Check battery cells, alternator belt tension and alternator output
Loose or corroded battery connections	Check all charging system connections
Ignition circuit or switch malfunction	Check and replace as necessary
Alternator Light Stays On With Engine Running	
Loose or worn alternator drive belt	Check alternator drive tension and condition, See Belt Adjustment in TUNE-UP article in the TUNE-UP section
Loose alternator wiring connections	Check all charging system connections

Short in alternator light wiring	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Defective alternator stator or diodes	See Bench Tests in ALTERNATOR article
Defective regulator	See Regulator Check in ALTERNATOR article
Alternator Light Stays Off With Ignition Switch ON	
Blown fuse	See WIRING DIAGRAMS
Defective alternator	See Testing in ALTERNATOR article
Defective indicator light bulb or socket	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Alternator Light Stays OFF With Ignition Switch ON	
Short in alternator wiring	See On-Vehicle Tests in ALTERNATOR article
Defective rectifier bridge	See Bench Tests in ALTERNATOR article
Lights or Fuses Burn Out Frequently	
Defective alternator wiring	See On-Vehicle Tests in ALTERNATOR article
Defective regulator	See Regulator Check in ALTERNATOR article
Defective battery	Check and replace as necessary
Ammeter Gauge Shows Discharge	
Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in TUNE-UP article in the TUNE-UP section
Defective wiring	Check all wires and wire connections
Defective alternator or regulator	See Bench Tests and On-Vehicle Tests in ALTERNATOR article
Defective ammeter, or improper ammeter wiring connection	See Testing in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Noisy Alternator	
Loose drive pulley	Tighten drive pulley attaching nut

Loose mounting bolts	Tighten all alternator mounting bolts
Worn or dirty bearings	See Bearing Replacement ALTERNATOR article
Defective diodes or stator	See Bench Test in ALTERNATOR article
Battery Does Stay Charged	
Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in appropriate TUNE-UP article in the TUNE-UP section
Loose or corroded battery connections	Check all charging system connections
Loose alternator connections	Check all charging system connections
Defective alternator or battery	See On-Vehicle Tests and Bench Tests in ALTERNATOR article
Add-on electrical accessories exceeding alternator capacity	Install larger alternator
Battery Overcharged-Uses Too Much Water	
Defective battery	Check alternator output and repair as necessary
Defective alternator	See On-Vehicle Test and Bench Tests in ALTERNATOR article
Excessive alternator voltage	Check alternator output and repair as necessary

IGNITION SYSTEM TROUBLE SHOOTING

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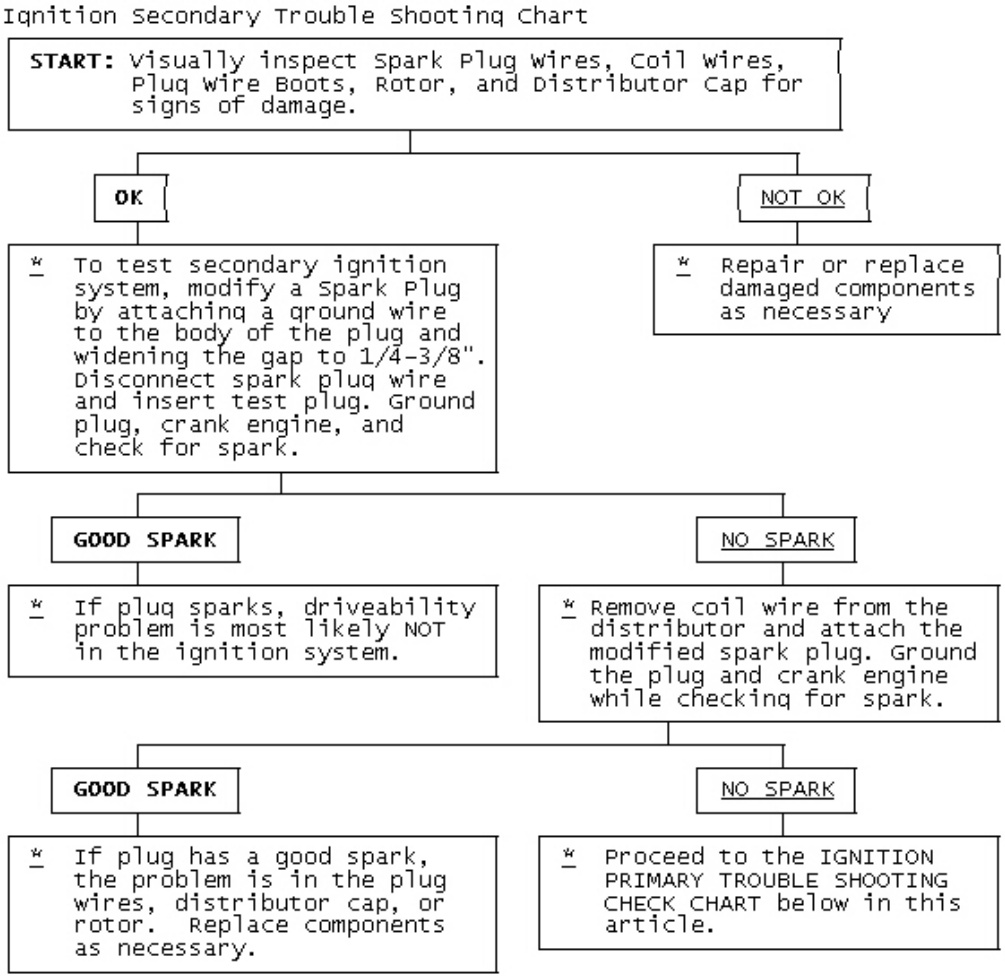


Fig. 1: Ignition Secondary Trouble Shooting Chart

Ignition Primary Trouble Shooting Chart

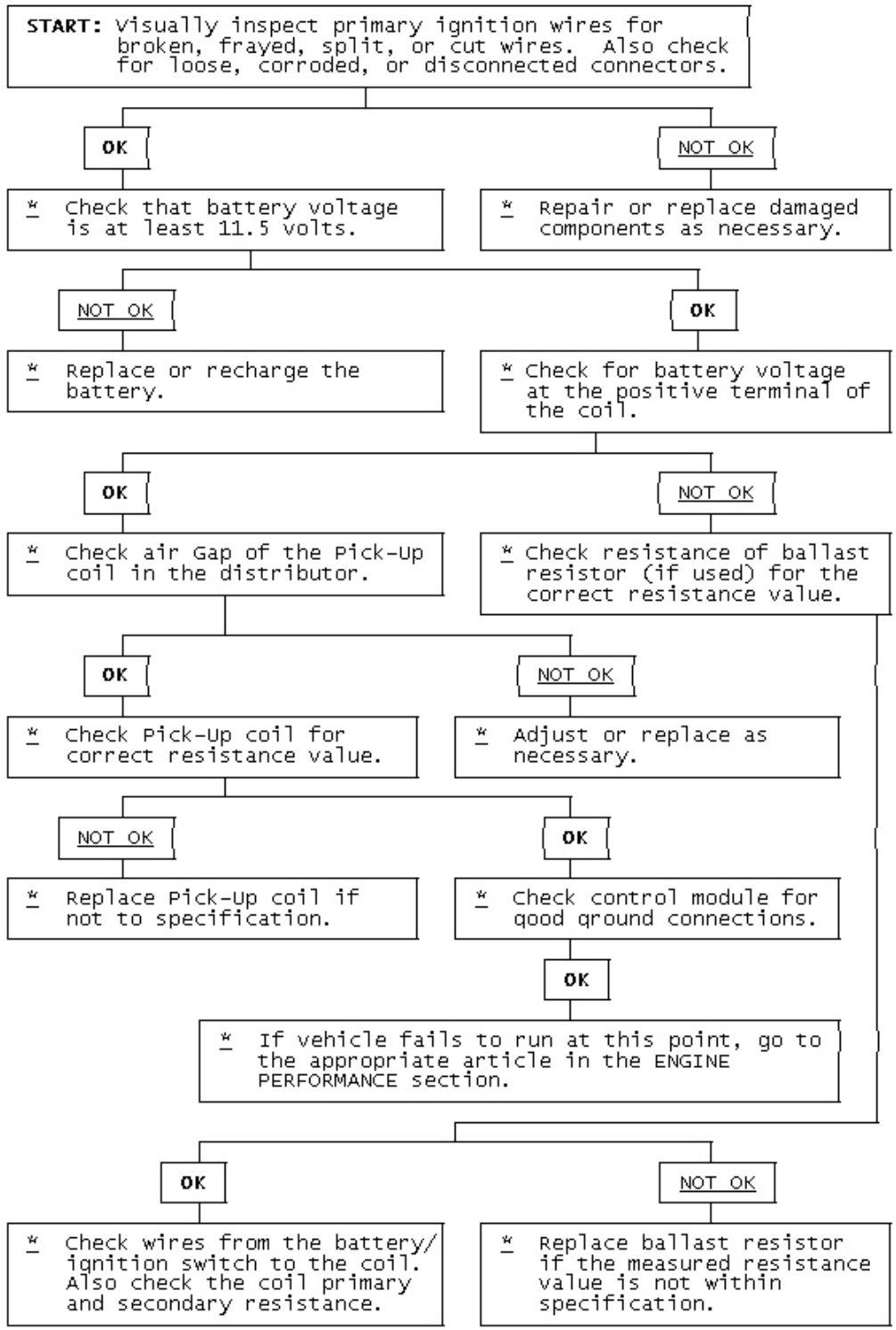


Fig. 2: Ignition Primary Trouble Shooting Chart

STARTER TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC STARTER TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	
Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
Ignition switch faulty or misadjusted	Adjust or replace ignition switch
Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
Starter relay or starter defective	See Testing in STARTER article
Open solenoid pull-in wire	Testing in STARTER article
Starter Does Not Operate and Headlights Dim	
Weak battery or dead cell	Charge or replace battery as necessary
Loose or corroded battery connections	Check that battery connections are clean and tight
Internal ground in starter windings	See Testing in STARTER article
Grounded starter fields	See Testing in STARTERS
Armature rubbing on pole	See STARTER article shoes
Starter Turns but Engine Does Not Rotate	
Starter clutch slipping	See STARTER article
Broken clutch housing	See STARTER article
Pinion shaft rusted or dry	See STARTER article
Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	
Faulty overrunning clutch	See STARTER article
Broken clutch housing	See STARTER article
Broken flywheel teeth	Replace flywheel and check

	for starter pinion gear damage
Armature shaft sheared or reduction gear teeth stripped	See STARTER article
Weak battery	Charge or replace battery as necessary
Faulty solenoid	See On-Vehicle Tests in STARTER article
Poor grounds	Check all ground connections for tight and clean connections
Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	
Battery weak or defective	Charge or replace battery as necessary
Engine overheated	See ENGINE COOLING SYSTEM article
Engine oil too heavy	Check that proper viscosity oil is used
Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
Current draw too low or too high	See Bench Tests in STARTER article
Bent armature, loose pole shoes screws or worn bearing	See STARTER article
Burned solenoid contacts	Replace solenoid
Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	
Engine timing too far advanced	See Ignition Timing in TUNE-UP article
Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
Broken starter clutch	See STARTER article
Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
Weak drive assembly thrust spring	See STARTER article
Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	
Defective point assembly	See Testing in STARTER article
Poor point assembly ground	See Testing in STARTER article
Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	
Dead battery	Charge or replace battery as

	necessary
Faulty wiring	Check all wiring and connections leading to relay
Neutral safety switch faulty	Replace neutral safety switch
Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	
Starter motor loose on mountings	Tighten starter attach bolts
Worn drive end bushing	See STARTER article
Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
Drive yolk return spring broken or missing	Replace return spring
Faulty ignition switch	Replace ignition switch
Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
Starter clutch not disengaging	Replace starter clutch
Ignition starter switch	Replace ignition switch contacts sticking
Starter Relay Operates but Solenoid Does Not	
Faulty solenoid switch, switch connections or relay	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	
Weak battery	Charge or replace battery as necessary
Solenoid contacts corroded	Clean contacts or replace solenoid
Faulty wiring	Check all wiring leading to solenoid
Broken connections inside switch cover	Repair connections or replace solenoid
Open hold-in wire	solenoid
Low Current Draw	
Worn brushes or weak brush springs	Replace brushes or brush springs as necessary
High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	
Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	
Distance too small between starter pinion and flywheel	Flywheel runout contributes to the intermittent nature

AIR CONDITIONING & HEAT

AIR CONDITIONING TROUBLE SHOOTING

WARNING: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC AIR CONDITIONING TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Compressor Not Working	Compressor clutch circuit open.
.....	Compressor clutch coil inoperative.
.....	Poor clutch ground connection.
.....	Fan belts loose.
.....	Thermostatic switch inoperative.
.....	Thermostatic switch not adjusted.
.....	Ambient temperature switch open.
.....	Superheat fuse blown.
Excessive Noise or Vibration	Missing or loose mounting bolts.
.....	Bad idler pulley bearings.
.....	Fan belts not tightened correctly.
.....	Compressor clutch contacting body.
.....	Excessive system pressure.
.....	Compressor oil level low.
.....	Damaged clutch bearings.
.....	Damaged reed valves.
.....	Damaged compressor.
Insufficient or No Cooling; Compressor Working	Expansion valve inoperative.
.....	Heater control valve stuck open.
.....	Low system pressure.
.....	Blocked condenser fins.
.....	Blocked evaporator fins.
.....	Vacuum system leak.
.....	Vacuum motors inoperative.
.....	Control cables improperly adjusted.
.....	Restricted air inlet.
.....	Mode doors binding.
.....	Blower motor inoperative.

.....	Temperature above system capacity.

HEATER SYSTEM TROUBLE SHOOTING

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BASIC HEATER SYSTEM TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Insufficient, Erratic, or No Heat	Low Coolant Level
.....	Incorrect thermostat.
.....	Restricted coolant flow through core.
.....	Heater hoses plugged.
.....	Misadjusted control cable.
.....	Sticking heater control valve.
.....	Vacuum hose leaking.
.....	Vacuum hose blocked.
.....	Vacuum motors inoperative.
.....	Blocked air inlet.
.....	Inoperative heater blower motor.
.....	Oil residue on heater core fins.
.....	Dirt on heater core fins.
Too Much Heat	Improperly adjusted cables.
.....	Sticking heater control valve.
.....	No vacuum to heater control valve.
.....	Temperature door stuck open.
Air Flow Changes During Acceleration	Vacuum system leak.
.....	Bad check valve or reservoir.
Air From Defroster At All Times	Vacuum system leak.
.....	Improperly adjusted control cables.
.....	Inoperative vacuum motor.
Blower Does Not Operate Correctly	Blown fuse.
.....	Blower motor windings open.
.....	Resistors burned out.
.....	Motor ground connection loose.
.....	Wiring harness connections loose.
.....	Blower motor switch inoperative.
.....	Blower relay inoperative.

.....	Fan binding or foreign object in housing.
.....	Fan blades broken or bent.

BRAKES

BRAKE SYSTEM TROUBLE SHOOTING

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BRAKE SYSTEM TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Brakes Pull Left or Right	
Incorrect tire pressure	Inflate tires to proper pressure
Front end out of alignment	See WHEEL ALIGNMENT
Mismatched tires	Check tires sizes
Restricted brake lines or hoses	Check hose routing
Loose or malfunctioning caliper	See DISC BRAKES or BRAKE SYSTEM
Bent shoe or oily linings	See DRUM BRAKES or BRAKE SYSTEM
Malfunctioning rear brakes	See DRUM, DISC BRAKES or BRAKE SYSTEM
Loose suspension parts	See SUSPENSION
Noises Without Brakes Applied	
Front linings worn out	Replace linings
Dust or oil on drums or rotors	See DRUM, DISC BRAKES or BRAKE SYSTEM
Noises With Brakes Applied	
Insulator on outboard shoe damaged	See DISC BRAKES or BRAKE SYSTEM
Incorrect pads or linings	Replace pads or linings
Brake Rough, Chatters or Pulsates	
Excessive lateral runout	Check rotor runout
Parallelism not to specifications	Reface or replace rotor
Wheel bearings not adjusted	See SUSPENSION
Rear drums out-of-round	Reface or replace drums
Disc pad reversed, steel against rotor	Remove and reinstall pad
Excessive Pedal Effort	
Malfunctioning power unit	See POWER BRAKES or

	BRAKE SYSTEM
Partial system failure	Check fluid and pipes
Worn disc pad or lining	Replace pad or lining
Caliper piston stuck or sluggish	See DISC BRAKES or BRAKE SYSTEM
Master cylinder piston stuck	See MASTER CYLINDERS or BRAKE SYSTEM
Brake fade due to incorrect pads for linings	Replace pads or linings
Linings or pads glazed	Replace pads or linings
Worn drums	Reface or replace drums
Excessive Pedal Travel	
Partial brake system failure	Check fluid and pipes
Insufficient fluid in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
Air trapped in system	See BRAKE BLEEDING or BRAKE SYSTEM
Rear brakes not adjusted	See Adjustments in DRUM BRAKES or BRAKE SYSTEM
Bent shoe or lining	See DRUM BRAKES or BRAKE SYSTEM
Plugged master cylinder cap	See MASTER CYLINDERS or BRAKE SYSTEM
Improper brake fluid	Replace brake fluid
Pedal Travel Decreasing	
Compensating port plugged	See MASTER CYLINDERS or BRAKE SYSTEM
Swollen cup in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
Master cylinder piston not returning	See MASTER CYLINDERS or BRAKE SYSTEM
Weak shoe retracting springs	See DRUM BRAKES BRAKE SYSTEM
Wheel cylinder piston sticking	See DRUM BRAKES or BRAKE SYSTEM
Dragging Brakes	
Master cylinder pistons not returning	See MASTER CYLINDERS BRAKE SYSTEM
Restricted brake lines or hoses	Check line routing
Incorrect parking brake adjustment	See DRUM BRAKES BRAKE SYSTEM
Parking Brake cables frozen	See DRUM BRAKES BRAKE SYSTEM

Incorrect installation of inboard disc pad	Remove and replace correctly
Power booster output rod too long	See POWER BRAKE UNITS BRAKE SYSTEM
Brake pedal not returning freely	See DISC, DRUM BRAKES BRAKE SYSTEM
Brakes Grab or Uneven Braking Action	
Malfunction of combination valve	See CONTROL VALVE or BRAKE SYSTEM
Malfunction of power brake unit	See POWER BRAKE UNITS or BRAKE SYSTEM
Binding brake pedal	See DISC, DRUM BRAKES or BRAKE SYSTEM
Pulsation or Roughness	
Uneven pad wear caused by caliper	See DISC BRAKES or BRAKE SYSTEM
Uneven rotor wear	See DISC BRAKES or BRAKE SYSTEM
Drums out-of-round	Reface or replace drums

ENGINE MECHANICAL

COOLING SYSTEM TROUBLE SHOOTING

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COOLING SYSTEM TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Overheating	
Coolant Leak	Fill/Pressure Test System
A/C Condenser Fins Clogged	Remove/Clean Condenser
Radiator Fins Clogged	Remove/Clean Radiator
Thermostat Stuck Closed	Replace Thermostat
Clogged Cooling System Passages	Clean/Flush Cooling System
Water Pump Malfunction	Replace Water Pump
Fan Clutch Malfunction	Replace Fan Clutch
Retarded Ignition Timing	Reset Ignition Timing
Cooling Fan Malfunction	Test Cooling Fan/Circuit
Cooling Fan Motor Malfunction	Test Fan Motor
Cooling Fan Relay Malfunction	Test Fan Relay

Faulty Radiator Cap	Replace Radiator Cap
Broken/Slipping Fan Belt	Replace Fan Belt
Restricted Exhaust	Repair Exhaust System
Corrosion	
Impurities In Coolant	Clean/Flush System
Coolant Leakage	
Damaged hose	Replace Hose
Leaky Water Pump	Replace Water Pump
Damaged Radiator Seam	Replace/Repair Radiator
Leaky Thermostat Cover	Replace Thermostat Cover
Cylinder Head Problem	Check Head/Head Gasket
Leaky Freeze Plugs	Replace Freeze Plugs
Recovery System Inoperative	
Loose and/or Defective Radiator Cap	Replace Radiator Cap
Overflow Tube Clogged and/or Leaking	Repair Tube
Recovery Bottle Vent Restricted	Clean Vent
No Heater Core Flow	
Collapsed Heater Hose	Replace Heater Hose
Plugged Heater Core	Clean/Replace Heater Core
Faulty Heater Valve	Replace Heater Valve

GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING

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BASIC GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Lopes At Idle	
Intake manifold-to-head leaks	Replace manifold gasket, See ENGINES
Blown head gasket	Replace head gasket, See ENGINES
Worn timing gears, chain or sprocket	Replace gears, chain or sprocket
Worn camshaft lobes	Replace camshaft, See ENGINES
Overheated engine	Check cooling system, See COOLING
Blocked crankcase vent valve	Remove restriction

Leaking EGR valve	Repair leak and/or replace valve
Faulty fuel pump	Replace fuel pump
Engine Has Low Power	
Leaking fuel pump	Repair leak and/or replace fuel pump
Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
Sticking valves or weak valve springs	Check valve train components, See ENGINES
Incorrect valve timing	Reset valve timing, See ENGINES
Worn camshaft lobes	Replace camshaft, See ENGINES
Blown head gasket	Replace head gasket. See ENGINES.
Clutch slipping	Adjust pedal and/or replace components, See ENGINES
Engine overheating	Check cooling system, See COOLING
Auto. Trans. pressure regulator valve faulty	Replace pressure regulator valve
Auto. Trans. fluid level too low	Add fluid as necessary
Improper vacuum diverter valve operation	Replace vacuum diverter valve
Vacuum leaks	Inspect vacuum system and repair as required
Leaking piston rings	Replace piston rings, See ENGINES
Faulty High Speed Operation	
Low fuel pump volume	Replace fuel pump
Leaking valves or worn	Replace valves and/or springs, See ENGINES
Incorrect valve timing	Reset valve timing,See ENGINES
Intake manifold restricted	Remove restriction
Worn distributor shaft	Replace distributor
Faulty Acceleration	
Improper fuel pump stroke	Remove pump and reset pump stroke
Incorrect ignition timing	Reset ignition timing, See TUNE-UP
Leaking valves	Replace valves, See ENGINES

Worn fuel pump diaphragm or piston	Replace diaphragm or piston
Intake Backfire	
Improper ignition timing	Reset ignition timing, See TUNE-UP
Faulty accelerator pump discharge	Replace accelerator pump
Improper choke operation	Check choke and adjust as required
Defective EGR valve	Replace EGR valve
Fuel mixture too lean	Reset air/fuel mixture, See TUNE-UP
Choke valve initial clearance too large	Reset choke valve initial clearance
Exhaust Backfire	
Vacuum leak	Inspect and repair vacuum system
Faulty vacuum diverter valve	Replace vacuum diverter valve
Faulty choke operation	Check choke and adjust as required
Exhaust system leak	repair exhaust system leak
Engine Detonation	
Ignition timing too far advanced	Reset ignition timing, See TUNE-UP
Faulty ignition system	Check ignition timing, See TUNE-UP
Spark plugs loose or faulty	Retighten or replace plugs
Fuel delivery system clogged	Inspect lines, pump and filter for clog
EGR valve inoperative	Replace EGR valve
PCV system inoperative	Inspect and/or replace hoses or valve
Vacuum leaks	Check vacuum system and repair leaks
Excessive combustion chamber deposits	Remove built-up deposits
Leaking, sticking or broken valves	Inspect and/or replace valves
External Oil Leakage	
Fuel pump improperly seated or worn gasket	Remove pump, replace gasket and seat properly
Oil pan gasket broken or pan bent	Straighten pan and replace gasket
Timing chain cover gasket broken	Replace timing chain cover gasket
Rear main oil seal worn	Replace rear main oil seal

Oil pan drain plug not seated properly	Remove and reinstall drain plug
Camshaft bearing drain hole blocked	Remove restriction
Oil pressure sending switch leaking	Remove and reinstall sending switch
Excessive Oil Consumption	
Worn valve stems or guides	Replace stems or guides, See ENGINES
Valve "O" ring seals damaged	Replace "O" ring seals, See ENGINES
Plugged oil drain back holes	Remove restrictions
Improper PCV valve operation	Replace PCV valve
Engine oil level too high	Remove excess oil
Engine oil too thin	Replace thicker oil
Valve stem oil deflectors damaged	Replace oil deflectors
Incorrect piston rings	Replace piston rings, See ENGINES
Piston ring gaps not staggered	Reinstall piston rings, See ENGINES
Insufficient piston ring tension	Replace rings, See ENGINES
Piston ring grooves or oil return	slots clogged Replace piston rings, See ENGINES
Piston rings sticking in grooves	Replace piston rings, See ENGINES
Piston ring grooves excessively worn	Replace piston and rings, See ENGINES
Compression rings installed upside down	Replace compression rings correctly, See ENGINES
Worn or scored cylinder walls	Rebore cylinders or replace block
Mismatched oil ring expander and rail	Replace oil ring expander and rail, See ENGINES
Intake gasket dowels too long	Replace intake gasket dowels
Excessive main or connecting rod bearing clearance	Replace main or connecting rod bearings, See ENGINES
No Oil Pressure	
Low oil level	Add oil to proper level
Oil pressure sender or gauge broken	Replace sender or gauge
Oil pump malfunction	Remove and overhaul oil pump, See ENGINES
Oil pressure relief valve sticking	Remove and reinstall valve
Oil pump passages blocked	Overhaul oil pump, See ENGINES

Oil pickup screen or tube blocked	Remove restriction
Loose oil inlet tube	Tighten oil inlet tube
Loose camshaft bearings	Replace camshaft bearings, See ENGINES
Internal leakage at oil passages	Replace block or cylinder head
Low Oil Pressure	
Low engine oil level	Add oil to proper level
Engine oil too thin	Remove and replace with thicker oil
Excessive oil pump clearance	Reduce oil pump clearance, See ENGINES
Oil pickup tube or screen blocked	Remove restrictions
Main, rod or cam bearing clearance excessive	Replace bearing to reduce clearance, See ENGINES
High Oil Pressure	
Improper grade of oil	Replace with proper oil
Oil pressure relief valve stuck closed	Eliminate binding
Oil pressure sender or gauge faulty	Replace sender or gauge
Noisy Main Bearings	
Inadequate oil supply	Check oil delivery to main bearings
Excessive main bearing clearance	Replace main bearings, See ENGINES
Excessive crankshaft end play	Replace crankshaft, See ENGINES
Loose flywheel or torque converter	Tighten attaching bolts
Loose or damaged vibration damper	Tighten or replace vibration damper
Crankshaft journals out-of-round	Re-grind crankshaft journals
Excessive belt tension	Loosen belt tension
Noisy Connecting Rods	
Excessive bearing clearance or missing bearing	Replace bearing, See ENGINES
Crankshaft rod journal out-of-round	Re-grind crankshaft journal
Misaligned connecting rod or cap	Remove rod or cap and realign
Incorrectly tightened rod bolts	Remove and re-tighten rod bolts
Noisy Pistons and Rings	
Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
Bore tapered or out-of-round	Rebore block

Piston ring broken	Replace piston rings, See ENGINES
Piston pin loose or seized	Replace piston pin, See ENGINES
Connecting rods misaligned	Realign connecting rods
Ring side clearance too loose or tight	Replace with larger or smaller rings
Carbon build-up on piston	Remove carbon
Noisy Valve Train	
Worn or bent push rods	Replace push rods, See ENGINES
Worn rocker arms or bridged pivots	Replace push rods, See ENGINES
Dirt or chips in valve lifters	Remove lifters and remove dirt/chips
Excessive valve lifter leak-down	Replace valve lifters, See ENGINES
Valve lifter face worn	Replace valve lifters, See ENGINES
Broken or cocked valve springs	Replace or reposition springs
Too much valve stem-to-guide clearance	Replace valve guides, See ENGINES
Valve bent	Replace valve, See ENGINES
Loose rocker arms	Retighten rocker arms, See ENGINES
Excessive valve seat run-out	Reface valve seats, See ENGINES
Missing valve lock	Install new valve lock
Excessively worn camshaft lobes	Replace camshaft, See ENGINES
Plugged valve lifter oil holes	Eliminate restriction or replace lifter
Faulty valve lifter check ball	Replace lifter check ball, See ENGINES
Rocker arm nut installed upside down	Remove and reinstall correctly
Valve lifter incorrect for engine	Remove and replace valve lifters
Faulty push rod seat or lifter plunger	Replace plunger or push rod
Noisy Valves	
Improper valve lash	Re-adjust valve lash, See ENGINES
Worn or dirty valve lifters	Clean and/or replace lifters
Worn valve guides	Replace valve guides, See ENGINES

Excessive valve seat or face run-out	Reface seats or valve face
Worn camshaft lobes	Replace camshaft, See ENGINES
Loose rocker arm studs	Re-tighten rocker arm studs, See ENGINES
Bent push rods	Replace push rods, See ENGINES
Broken valve springs	Replace valve springs, See ENGINES
Burned,Sticking or Broken Valves	
Weak valve springs or warped valves	Replace valves and/or springs, See ENGINES
Improper lifter clearance	Re-adjust clearance or replace lifters
Worn guides or improper guide clearance	Replace valve guides, See ENGINES
Out-of-round valve seats or improper seat width	Re-grind valve seats
Gum deposits on valve stems, seats or guide	Remove deposits
Improper spark timing	Re-adjust spark timing
Broken Pistons/Rings	
Undersize pistons	Replace with larger pistons, See ENGINES
Wrong piston rings	Replace with correct rings, See ENGINES
Out-of-round cylinder bore	Re-bore cylinder bore
Improper connecting rod alignment	Remove and realign connecting rods
Excessively worn ring grooves	Replace pistons, See ENGINES
Improperly assembled piston pins	Re-assemble pin-to-piston, See ENGINES
Insufficient ring gap clearance	Install new rings, See ENGINES
Engine overheating	Check cooling system
Incorrect ignition timing	Re-adjust ignition timing, See TUNE-UP
Excessive Exhaust Noise	
Leaks at manifold to head, or to pipe	Replace manifold or pipe gasket
Exhaust manifold cracked or broken	Replace exhaust manifold, See ENGINES

ENGINE PERFORMANCE

CARBURETOR TROUBLE SHOOTING:

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BASIC COLD START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Choke not closing	Check choke operation, see FUEL SYSTEMS
Choke linkage bent	Check linkage, see FUEL SYSTEM
Engine Starts, Then Dies	
Choke vacuum kick setting too wide	Check setting and adjust see, FUEL SYSTEMS
Fast idle RPM too low	Reset RPM to specification, see TUNE-UP
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
Vacuum leak	Inspect vacuum system for leaks
Low fuel pump outlet	Repair or replace pump, see FUEL SYSTEMS
Low carburetor fuel level	Check float setting see FUEL SYSTEM
Engine Quits Under Load	
Choke vacuum kick setting incorrect	Reset vacuum kick setting,see FUEL SYSTEMS
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEM
Incorrect hot fast idle speed RPM	Reset fast idle RPM, see TUNE-UP
Engine Starts, Runs Up, Then Idles, Slowly With Black Smoke	
Choke vacuum kick set too narrow	Reset vacuum kick, see FUEL SYSTEMS
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
Hot fast idle RPM too low	Reset fast idle RPM, see TUNE-UP

BASIC HOT START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Engine flooded	Allow fuel to evaporate

BASIC COLD ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Stalls in Gear	
Choke vacuum kick setting incorrect	Reset choke vacuum kick, see FUEL SYSTEMS
Fast idle RPM incorrect	Reset fast idle RPM, see TUNE-UP
Fast idle cam index incorrect	Reset fast idle cam see FUEL SYSTEMS
Acceleration Sag or Stall	
Defective choke control switch	Replace choke control switch
Choke vacuum kick setting incorrect	Reset choke vacuum kick see, FUEL SYSTEMS
Float level incorrect (too low)	Adjust float level, FUEL SYSTEMS
Accelerator pump defective	Repair or replace pump see FUEL SYSTEMS
Secondary throttles not closed	Inspect lockout adjustment, see FUEL SYSTEMS
Sag or Stall After Warmup	
Defective choke control switch	Replace choke control switch, see FUEL SYSTEMS
Defective accelerator pump	Replace pump, see FUEL SYSTEMS
Float level incorrect (too low)	Adjust float level, see FUEL SYSTEMS
Backfiring & Black Smoke	
Plugged heat crossover system	Remove restriction

BASIC WARM ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Hesitation With Small Amount of Gas Pedal Movement	
Vacuum leak	Inspect vacuum lines
Accelerator pump weak or inoperable	Replace pump, see FUEL SYSTEMS
Float level setting too low	Reset float level, see,FUEL SYSTEMS
Metering rods sticking or binding	Inspect and/or replace rods, see FUEL SYSTEMS

Carburetor idle or transfer system plugged	Inspect system and remove restriction
Frozen or binding heated air inlet	Inspect heated air door for binding
Hesitation With Heavy Gas Pedal Movement	
Defective accelerator pump	Replace pump, see FUEL SYSTEMS
Metering rod carrier sticking or binding	Remove restriction
Large vacuum leak	Inspect vacuum system and repair leak
Float level setting too low	Reset float level, see FUEL SYSTEMS
Defective fuel pump, lines or filter	Inspect pump, lines and filter
Air door setting incorrect	Adjust air door setting, see FUEL

DIESEL ENGINE TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

BASIC DIESEL ENGINE TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Crank	
Bad battery connections or dead batteries	Check connections and/or replace batteries
Bad starter connections or bad starter	Check connections and/or replace starter
Engine Cranks Slowly, Won't Start	
Bad battery connections or dead batteries	Check connections and/or replace batteries
Engine oil too heavy	Replace engine oil
Engine Cranks Normally, But Will Not Start	
Glow plugs not functioning	Check glow plug system, see FUEL SYSTEMS
Glow plug control not functioning	Check controller, see FUEL SYSTEMS

Fuel not injected into cylinders	Check fuel injectors, see FUEL SYSTEMS
No fuel to injection pump	Check fuel delivery system
Fuel filter blocked	Replace fuel filter
Fuel tank filter blocked	Replace fuel tank filter
Fuel pump not operating	Check pump operation and/or replace pump
Fuel return system blocked	Inspect system and remove restriction
No voltage to fuel solenoid	Check solenoid and connections
Incorrect or contaminated fuel	Replace fuel
Incorrect injection pump timing	Re-adjust pump timing, see FUEL SYSTEMS
Low compression	Check valves, pistons, rings, see ENGINES
Injection pump malfunction	Inspect and/or replace injection pump
Engine Starts, Won't Idle	
Incorrect slow idle adjustment	Reset idle adjustment, see TUNE-UP
Fast idle solenoid malfunctioning	Check solenoid and connections
Fuel return system blocked	Check system and remove restrictions
Glow plugs go off too soon	See glow plug diagnosis in FUEL SYSTEMS
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
No fuel to injection pump	Check fuel delivery system
Incorrect or contaminated fuel	Replace fuel
Low compression	Check valves, piston, rings, see ENGINES
Injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
Fuel solenoid closes in RUN position	Check solenoid and connections
Engines Starts/Idles Rough W/out Smoke or Noise	
Incorrect slow idle adjustment	Reset slow idle, see TUNE-UP
Injection line fuel leaks	Check lines and connections
Fuel return system blocked	Check lines and connections
Air in fuel system	Bleed air from system
Incorrect or contaminated fuel	Replace fuel

Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS
Engines Starts and Idles Rough W/out Smoke or Noise, But Clears After Warm-Up	
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
Engine not fully broken in	Put more miles on engine
Air in system	Bleed air from system
Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS
Engine Idles Correctly, Misfires Above Idle	
Blocked fuel filter	Replace fuel filter
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
Incorrect or contaminated fuel	Replace fuel
Engine Won't Return To Idle	
Fast idle adjustment incorrect	Reset fast idle, see TUNE-UP
Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
External linkage binding	Check linkage and remove binding
Fuel Leaks On Ground	
Loose or broken fuel line	Check lines and connections
Internal injection pump seal leak	Replace injection pump, see FUEL SYSTEMS
Cylinder Knocking Noise	
Injector nozzles sticking open	Test injectors, see FUEL SYSTEMS
Very low nozzle opening pressure	Test injectors and/or replace
Loss of Engine Power	
Restricted air intake	Remove restriction
EGR valve malfunction	Replace EGR valve
Blocked or damaged exhaust system	Remove restriction and/or replace components
Blocked fuel tank filter	Replace filter
Restricted fuel filter	Remove restriction and/or replace filter
Block vent in gas cap	Remove restriction and/or replace cap
Tank-to-injection pump fuel supply blocked	Check fuel lines and connections
Blocked fuel return system	Remove restriction
Incorrect or contaminated fuel	Replace fuel
Blocked injector nozzles	Check nozzle for blockage, see

	FUEL SYSTEMS
Low compression	Check valves, rings, pistons, see ENGINES
Loud Engine Noise With Black Smoke	
Basic timing incorrect	Reset timing, see FUEL SYSTEMS
EGR valve malfunction	Replace EGR valve
Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
Incorrect injector pump housing pressure	Check pressure, see FUEL SYSTEMS
Engine Overheating	
Cooling system leaks	Check cooling system and repair leaks
Belt slipping or damaged	Check tension and/or replace belt
Thermostat stuck closed	Remove and replace thermostat, see ENGINE COOLING
Head gasket leaking	Replace head gasket
Oil Light on at Idle	
Low oil pump pressure	Check oil pump operation, see ENGINES
Oil cooler or line restricted	Remove restriction and/or replace cooler
Engine Won't Shut Off	
Injector pump fuel solenoid does not return fuel valve to OFF position	Remove and check solenoid and replace if needed

VACUUM PUMP DIAGNOSIS

CONDITION & POSSIBLE CAUSE	CORRECTION
Excessive Noise	
Loose pump-to-drive assembly screws	Tighten screws
Loose tube on pump assembly	Tighten tube
Valves not functioning properly	Replace valves
Oil Leakage	
Loose end plug	Tighten end plug
Bad seal crimp	Remove and re-crimp seal

FUEL INJECTION TROUBLE SHOOTING

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Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC FUEL INJECTION TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start (Cranks Normally)	
Cold start valve inoperative	Test valve and circuit
Poor connection;vacuum or wiring	Check vacuum and electrical connections
Contaminated fuel	Test fuel for water or alcohol
Defective fuel pump relay or circuit	Test relay and wiring
Battery too low	Charge and test battery
Low fuel pressure	Test pressure regulator and fuel pump, check for restricted lines and filters
No distributor reference pulses	Repair ignition system as necessary
Open coolant temperature sensor circuit	Test sensor and wiring
Shorted W.O.T. switch in T.P.S.	Disconnect W.O.T. switch, engine should start
Defective ECM	Replace ECM
Fuel tank residual pressure valve leaks	Test for fuel pressure drop after shut down
Hard Starting	
Disconnected hot air tube to air cleaner	Reconnect tube and test control valve
Defective Idle Air Control (IAC) valve	Test valve operation and circuit
Shorted, open or misadjusted T.P.S.	Test and adjust or replace T.P.S.
EGR valve open	Test EGR valve and control circuit
Poor Oxygen sensor signal	Test for shorted or circuit
Incorrect mixture from PCV system	Test PCV for flow, check sealing of oil filter cap
Poor High Speed Operation	
Low fuel pump volume	Faulty pump or restricted fuel lines or filters
Poor MAP sensor signal	Test MAP sensor, vacuum hose and wiring
Poor Oxygen sensor signal	Test for shorted or open sensor or circuit

Open coolant temperature sensor circuit	Test sensor and wiring
Faulty ignition operation	Check wires for cracks or poor con- nections, test secondary voltage with oscilloscope
Contaminated fuel	Test fuel for water or alcohol
Intermittent ECM ground	Test ECM ground connection for resistance
Restricted air cleaner	Replace air cleaner
Restricted exhaust system	Test for exhaust manifold back pressure
Poor MAF sensor signal	Check leakage between sensor and manifold
Poor VSS signal	If tester for ALCL hook-up is available check that VSS reading matches speedometer
Ping or Knock on Acceleration	
Poor Knock sensor signal	Test for shorted or open sensor or circuit
Poor Baro sensor signal	Test for shorted or open sensor or circuit
Improper ignition timing	See VEHICLE EMISSION CONTROL LABEL (where applicable)
Check for engine overheating problems	Low coolant, loose belts or electric cooling fan inoperative

NOTE: For additional electronic fuel injection trouble shooting information, see the appropriate article in the ENGINE PERFORMANCE section (not all vehicles have Computer Engine Control articles). Information is provided there for diagnosing fuel system problems on vehicles with electronic fuel injection.

IGNITION SYSTEM TROUBLE SHOOTING

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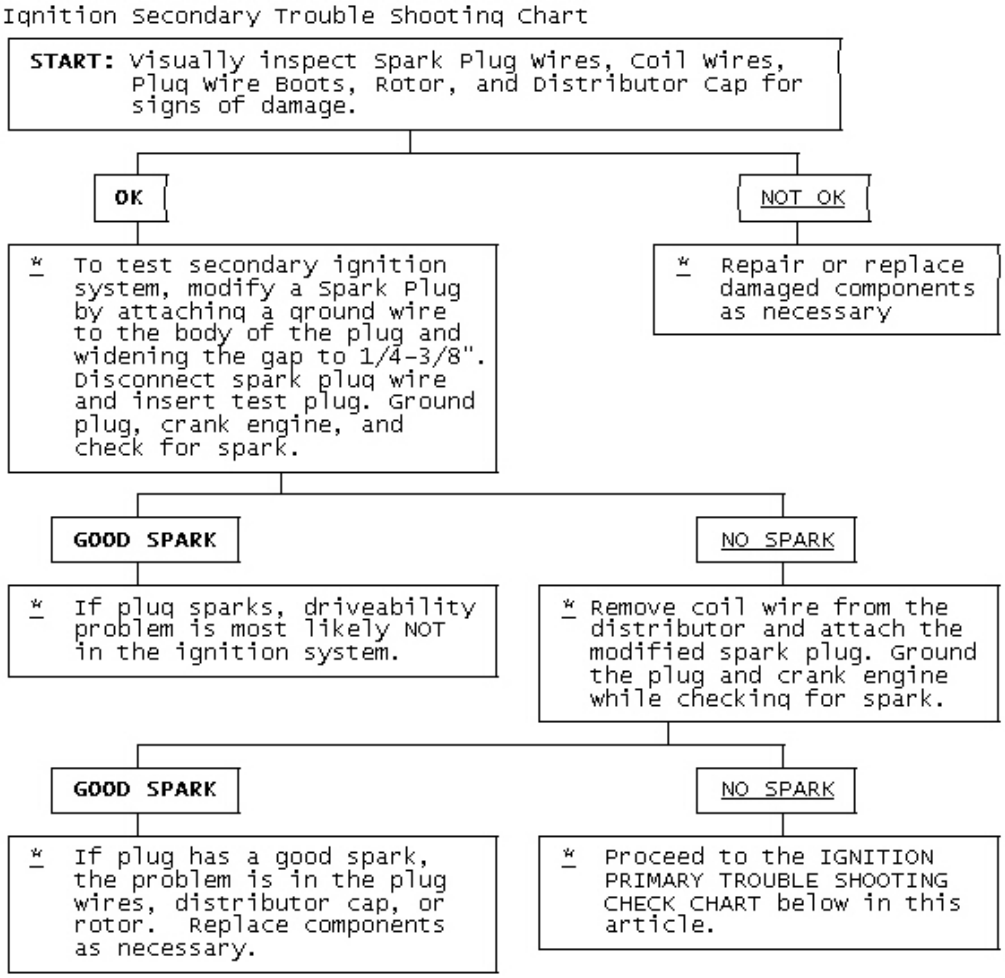


Fig. 3: Ignition Secondary Trouble Shooting Chart

Ignition Primary Trouble Shooting Chart

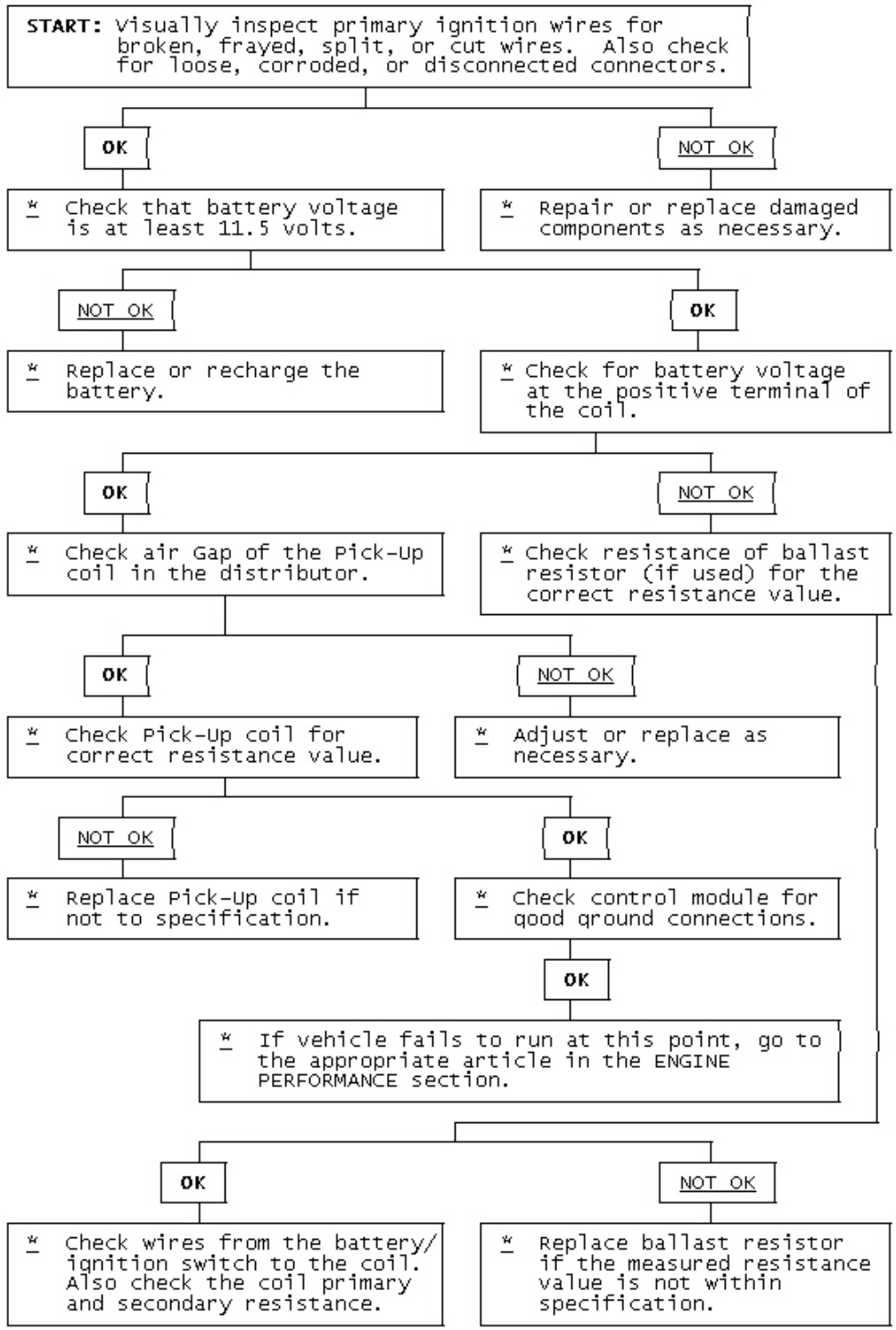


Fig. 4: Ignition Primary Trouble Shooting Chart

STARTER TROUBLE SHOOTING

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BASIC STARTER TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	
Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
Ignition switch faulty or misadjusted	Adjust or replace ignition switch
Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
Starter relay or starter defective	See Testing in STARTER article
Open solenoid pull-in wire	See Testing in STARTER article
Starter Does Not Operate and Headlights Dim	
Weak battery or dead cell	Charge or replace battery as necessary
Loose or corroded battery connections	Check that battery connections are clean and tight
Internal ground in starter windings	See Testing in STARTER article
Grounded starter fields	See Testing in STARTERS
Armature rubbing on pole shoes	See STARTER article
Starter Turns but Engine Does Not Rotate	
Starter clutch slipping	See STARTER article
Broken clutch housing	See STARTER article
Pinion shaft rusted or dry	See STARTER article
Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	

Faulty overrunning clutch	See STARTER article
Broken clutch housing	See STARTER article
Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
Armature shaft sheared or reduction gear teeth stripped	See STARTER article
Weak battery	Charge or replace battery as necessary
Faulty solenoid	See On-Vehicle Tests in STARTER article
Poor grounds	Check all ground connections for tight and clean connections
Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	
Battery weak or defective	Charge or replace battery as necessary
Engine overheated	See ENGINE COOLING SYSTEM article
Engine oil too heavy	Check that proper viscosity oil is used
Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
Current draw too low or too high	See Bench Tests in STARTER article
Bent armature, loose pole shoes screws or worn bearings	See STARTER article
Burned solenoid contacts	Replace solenoid
Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	
Engine timing too far advanced	See Ignition Timing in TUNE-UP article
Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
Broken starter clutch	See STARTER article
Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
Weak drive assembly thrust spring	See STARTER article
Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	
Defective point assembly	See Testing in STARTER

	article
Poor point assembly ground	See Testing in STARTER article
Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	
Dead battery	Charge or replace battery as necessary
Faulty wiring	Check all wiring and connections leading to relay
Neutral safety switch faulty	Replace neutral safety switch
Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	
Starter motor loose on mountings	Tighten starter attach bolts
Worn drive end bushing	See STARTER article
Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
Drive yolk return spring broken or missing	Replace return spring
Faulty ignition switch	Replace ignition switch
Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
Starter clutch not disengaging	Replace starter clutch
Ignition starter switch contacts sticking	Replace ignition switch
Starter Relay Operates but Solenoid Does Not	
Faulty solenoid switch, switch connections or relay	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	
Weak battery	Charge or replace battery as necessary
Solenoid contacts corroded	Clean contacts or replace solenoid
Faulty wiring	Check all wiring leading to solenoid
Broken connections inside switch cover	Repair connections or replace solenoid
Open hold-in wire	Replace solenoid
Low Current Draw	
Worn brushes or weak	Replace brushes or brush springs as necessary
High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	
Distance too great between starter pinion and flywheel	Align starter or check that

	correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	
Distance too small between starter pinion and flywheel	Flywheel runout contributes to the intermittent nature

TUNE-UP TROUBLE SHOOTING - GAS ENGINE VEHICLES

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BASIC SPARK PLUG TROUBLE SHOOTING CHARTS

CONDITION & POSSIBLE CAUSE	CORRECTION
Normal Spark Plug Condition	
Light Tan or Gray deposits	No Action
Electrode not burned or fouled	No Action
Gap tolerance not changed	No Action
Cold Fouling or Carbon Deposits	
Overrich air/fuel mixture	Adjust air/fuel mixture, see ENGINE PERFORMANCE section
Faulty choke	Replace choke assembly, see ENGINE PERFORMANCE section
Clogged air filter	Clean and/or replace air filter
Incorrect idle speed or dirty carburetor	Reset idle speed and/ or clean carburetor
Faulty ignition wires	Replace ignition wiring
Prolonged operation at idle	Shut engine off during long idle
Sticking valves or worn valve guide seals	Check valve train
Wet Fouling or Oil Deposits	
Worn rings and pistons	Install new rings and pistons
Excessive cylinder wear	Rebore or replace block
Excessive valve guide clearance	Worn or loose bearing
Gap Bridged	
Deposits in combustion chamber becoming fused to electrode	Clean combustion chamber of deposits
Blistered Electrode	
Engine overheating	Check cooling system

Wrong type of fuel	Replace with correct fuel
Loose spark plugs	Retighten spark plugs
Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Pre-Ignition or Melted Electrodes	
Incorrect type of fuel	Replace with correct fuel
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Burned valves	Replace valves
Engine Overheating	Check cooling system
Wrong type of spark plug, too hot	Replace with correct spark plug, see ENGINE PERFORMANCE
Chipped Insulators	
Severe detonation	Check for over-advanced timing or combustion
Improper gapping procedure	Re-gap spark plugs
Rust Colored Deposits	
Additives in unleaded fuel	Try different fuel brand
Water In Combustion Chamber	
Blown head gasket or cracked head	Repair or replace head or head gasket

NOTE: **Before diagnosing an electronic ignition system, ensure that all wiring is connected properly between distributor, wiring connector and spark plugs. Ignition problem will show up either as: Engine Will Not Start or Engine Runs Rough.**

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Open circuit between distributor and bulkhead connector	Repair circuit
Open circuit between bulkhead connector and ignition switch	Repair circuit
Open circuit between ignition switch and starter solenoid	Repair circuit
Engine Runs Rough	
Fuel lines leaking or clogged	Tighten fitting, remove restriction
Initial timing incorrect	Reset ignition timing see ENGINE PERFORMANCE
Centrifugal advance malfunction	Repair distributor advance
Defective spark plugs or wiring	Replace plugs or plug wiring
Component Failure	
Spark arc-over on cap, rotor or coil	Replace cap, rotor or or coil

Defective pick-up coil	Replace pick-up coil
Defective ignition coil	Replace ignition coil
Defective vacuum unit	Replace vacuum unit
Defective control module	Replace control module

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS - USING OSCILLOSCOPE PATTERNS

CONDITION & POSSIBLE CAUSE	CORRECTION
Firing Voltage Lines are the Same, but Abnormally High	
Retarded ignition timing	Reset ignition timing, see ENGINE PERFORMANCE section
Fuel mixture too lean	Readjust carburetor, see ENGINE PERFORMANCE
High resistance in coil wire	Replace coil wire
Corrosion in coil tower terminal	Clean and/or replace coil
Corrosion in distributor coil terminal	Clean and/or replace distributor cap
Firing Voltage Lines are the Same but Abnormally Low	
Fuel mixture too rich	Readjust carburetor, see ENGINE PERFORMANCE
Breaks in coil wire causing arcing	Replace coil wire
Cracked coil tower causing arcing	Replace coil
Low coil output	Replace coil
Low engine compression	Determine cause and repair
One or More, But Not All Firing Voltage Lines are Higher Than Others	
Carburetor idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
EGR valve stuck open	Clean and/or replace valve
High resistance in spark plug wires	Replace spark plug wires
Cracked or broken spark plug insulator	Replace spark plugs
Intake vacuum leak	Repair leak
Defective spark plugs	Replace spark plugs
Corroded spark plug terminals	Replace spark plugs
One or More, But Not All Firing Voltage Lines Are Lower Than Others	
Curb idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
Breaks in plug wires	Replace plug wires causing arcing
Cracked coil tower causing arcing	Replace coil
Low compression	Determine cause and repair
Defective spark plugs	Replace spark plugs

Corroded spark plugs	Replace spark plugs
Cylinders Not Firing	
Cracked distributor cap terminals	Replace distributor cap
Shorted spark plug wire	Determine cause and repair
Mechanical problem in engine	Determine cause and repair
Defective spark plugs	Replace spark plugs
Spark plugs fouled	Replace spark plugs

BASIC DRIVEABILITY PROBLEMS TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Hard Starting	
Binding carburetor linkage	Eliminate binding
Binding choke linkage	Eliminate binding
Binding choke piston	Eliminate binding
Restricted choke vacuum	Check vacuum lines for blockage
Worn or dirty needle valve and seat	Clean carburetor, see ENGINE PERFORMANCE
Float sticking	Readjust or replace float see the ENGINE PERFORMANCE section
Incorrect choke adjustment	Reset choke adjustment see ENGINE PERFORMANCE
Defective coil	Replace coil
Improper spark plug gap	Regap spark plugs
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Detonation	
Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Defective spark plugs	Replace spark plugs
Fuel lines clogged	Clean fuel lines
EGR system malfunction	Check and repair EGR system
PCV system malfunction	Repair PCV system
Vacuum leaks	Check and repair vacuum system
Loose fan belts	Tighten or replace fan belts, see ENGINE PERFORMANCE
Restricted airflow	Remove restriction
Vacuum advance malfunction	Check distributor operation
Dieseling	
Binding carburetor linkage	Eliminate binding

Binding throttle linkage	Eliminate blinding
Binding choke linkage or fast idle cam	Eliminate binding
Defective idle solenoid	Replace idle solenoid see ENGINE PERFORMANCE
Improper base idle speed	Reset idle speed, see see ENGINE PERFORMANCE
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Incorrect idle mixture setting	Reset idle mixture, see ENGINE PERFORMANCE
Faulty Acceleration	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Engine cold and choke too lean	Adjust choke and allow engine to warm-up
Defective spark plugs	Replace spark plugs
Defective coil	Replace coil
Faulty Low Speed Operation	
Clogged idle transfer slots	Clean idle transfer slots, see FUEL
Restricted idle air bleeds and passages	Disassemble and clean carburetor, see FUEL
Clogged air cleaner	Replace air filter
Defective spark plugs	Replace spark plugs
Defective ignition wires	Replace ignition wire see ENGINE PERFORMANCE
Defective distributor cap	Replace distributor cap
Faulty High Speed Operation	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Defective distributor centrifugal advance	Replace advance mechanism
Defective distributor vacuum advance	Replace advance unit
Incorrect spark plugs or plug gap	Check gap and/or replace spark plugs
Faulty choke operation	Check choke and repair as required
Clogged vacuum passages	Remove restrictions
Improper size or clogged main jet	Check jet size and clean, see FUEL
Restricted air cleaner	Check filter and replace as necessary
Defective distributor cap, rotor or coil	Replace cap, rotor or coil
Misfire at All Speeds	

Defective spark plugs	Replace spark plugs
Defective spark plug wires	Replace spark plug wires
Defective distributor cap, rotor, or coil	Replace cap, rotor, or coil
Cracked or broken vacuum hoses	Replace vacuum hoses
Vacuum leaks	Repair vacuum leaks
Fuel lines clogged	Remove restriction
Hesitation	
Cracked or broken vacuum	Replace vacuum hoses hoses
Vacuum leaks	Repair Vacuum leaks
Binding carburetor linkage	Eliminate binding
Binding throttle linkage	Eliminate binding
Binding choke linkage or fast idle cam	Eliminate binding
Improper float setting	Readjust float setting, see FUEL
Cracked or broken ignition wires	Replace ignition wires
Rough Idle, Missing or Stalling	
Incorrect curb idle or fast idle speed	Reset idle speed, see see ENGINE PERFORMANCE
Incorrect basic timing	Reset ignition timing see ENGINE PERFORMANCE
Improper idle mixture adjustment	Reset idle mixture, see ENGINE PERFORMANCE
Improper feedback system operation	Check feedback system see ENGINE PERFORMANCE
Incorrect spark plug gap	Reset spark plug gap, see ENGINE PERFORMANCE
Moisture in ignition components	Dry components
Loose or broken ignition wires	Replace ignition wires
Damaged distributor cap or or rotor	Replace distributor cap or rotor
Faulty ignition coil	Replace ignition coil
Fuel filter clogged or worn	Replace fuel filter
Damaged idle mixture screw	Replace idle mixture screw, see FUEL
Improper fast idle cam adjustment	Reset fast idle cam adjustment, see TUNE- see ENGINE PERFORMANCE
Improper EGR valve operation	Replace EGR valve
Faulty PCV valve air flow	Replace PCV valve
Choke binding or improper choke setting	Reset choke or eliminate binding
Vacuum leak	Repair vacuum leak
Improper float bowl fuel level	Reset float adjustment, see

	FUEL
Clogged air bleed or idle passages	Clean carburetor passages, see FUEL
Clogged or worn air cleaner filter	Replace air filter
Faulty choke vacuum diaphragm	Replace diaphragm, see ENGINE PERFORMANCE
Exhaust manifold heat valve inoperative	Replace heat valve
Improper distributor spark advance	Check distributor operation
Leaking valves or valve components	Check and repair valvetrain
Improper carburetor mounting	Remove and remount carburetor
Excessive play in distributor shaft	Replace distributor
Loose or corroded wiring connections	Repair or replace as required
Engine Surges	
Improper PCV valve airflow	Replace PCV valve
Vacuum leaks	Repair vacuum leaks
Clogged air bleeds	Remove restriction
EGR valve malfunction	Replace EGR valve
Restricted air cleaner filter	Replace air filter
Cracked or broken vacuum hoses	Replace vacuum hoses
Cracked or broken ignition wires	Replace ignition wires
Vacuum advance malfunction	Check unit and replace as necessary
Defective or fouled spark plugs	Replace spark plugs
Ping or Spark Knock	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Distributor centrifugal or vacuum advance malfunction	Check operation and replace as necessary
Carburetor setting too lean	Readjust mixture setting, see ENGINE PERFORMANCE
Vacuum leak	Eliminate vacuum leak
EGR valve malfunction	Replace EGR valve
Poor Gasoline Mileage	
Cracked or broken vacuum	Replace vacuum hoses hoses
Vacuum leaks	Repair vacuum leaks
Defective ignition wires	Replace wires
Incorrect choke setting	Readjust setting, see ENGINE PERFORMANCE
Defective vacuum advance	Replace vacuum advance
Defective spark plugs	Replace spark plugs
Binding carburetor power piston	Eliminate binding

Dirt in carburetor jets	Clean and/or replace jets
Incorrect float adjustment	Readjust float setting, see FUEL
Defective power valve	Replace power valve, see ENGINE PERFORMANCE
Incorrect idle speed	Readjust idle speed
Engine Stalls	
Improper float level	Readjust float level
Leaking needle valve and seat	Replace needle valve and seat
Vacuum leaks	Eliminate vacuum leaks

VACUUM PUMP - DIESEL TROUBLE SHOOTING

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NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

VACUUM PUMP (DIESEL) TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Excessive Noise	
Loose pump-to-drive assembly screws	Tighten screws
Loose tube on pump assembly	Tighten tube
Valves not functioning properly	Replace valves
Oil Leakage	
Loose end plug	Tighten end plug
Bad seal crimp	Remove and re-crimp seal

MANUAL TRANSMISSION

MANUAL TRANSMISSION TROUBLE SHOOTING

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MANUAL TRANSMISSION/TRANSAXLE TROUBLE SHOOTING

Condition	Possible Cause
Noisy In Forward Gears	Low gear oil level, Loose bell housing bolts, Worn bearings or gears
Clunk On Deceleration (FWD Only)	Loose engine mounts, Worn inboard CV joints, Worn differential pinion shaft, Side gear hub counterbore in case worn oversize
Gear Clash When Shifting Forward Gears	Clutch Out Of Adjustment, Shift linkage damaged or out of adjustment, Gears or synchronizers damaged, Low gear oil level
Transmission Noisy When Moving (RWD Only) Quiet In Neutral With Clutch Engaged	Worn rear outputshaft bearing
Gear Rattle	Worn bearings, Wrong gear oil, Low gear oil, Worn gears
Steady Ticking At Idle (Increases With RPM)	Broken tooth on gear
Gear Clash When Shifting Forward Gears	Worn or broken synchronizers
Loud Whine In Reverse	Normal condition (1)
Noise When Stepping On Clutch	Bad release bearing, Worn pilot bearing
Ticking Or Screeching As Clutch Is Engaged	Faulty release bearing, Uneven pressure plate fingers
Click Or Snap When Clutch Is Engaged	Worn clutch fork, Worn or broken front bearing retainer
Transmission Shifts Hard	Clutch not releasing, Shift mechanism binding, Clutch installed backwards
Will Not Shift Into One Gear, Shifts Into All Others	Bent shift fork, Worn detent balls
Locked Into Gear, Cannot Shift	Clutch adjustment, Worn detent balls
Transmission Jumps Out Of Gear	Pilot bearing worn, Bent shift fork, Worn gear teeth or face, Excessive gear train end play, Worn synchronizers, Missing detent ball spring, Shift mechanism worn or out of adjustment, Engine or transmission mount bolts loose or out of adjustment, Transmission not aligned
Shift Lever Rattle	Worn shift lever or detents, Worn shift forks, Worn synchronizers sleeve
Shift Lever Hops Under Acceleration	Worn engine or transmission mounts
(1) Most units use spur cut gears in reverse and are noisy	

POWERTRAIN

CLUTCH TROUBLE SHOOTING

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Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC CLUTCH TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Chattering or Grabbing	
Incorrect clutch adjustment	Adjust clutch
Oil, grease or glaze on facings	Disassemble and clean or replace
Loose "U" joint flange	See DRIVE AXLES article
Worn input shaft spline	Replace input shaft
Binding pressure plate	Replace pressure plate
Binding release lever	See CLUTCH article
Binding clutch disc hub	Replace clutch disc
Unequal pressure plate contact	Replace worn/misaligned components
Loose/bent clutch disc	Replace clutch disc
Incorrect transmission alignment	Realign transmission
Worn pressure plate, disc or flywheel	Replace damaged components
Broken or weak pressure springs	Replace pressure plate
Sticking clutch pedal	Lubricate clutch pedal & linkage
Incorrect clutch disc facing	Replace clutch disc
Engine loose in chassis	Tighten all mounting bolts
Failure to Release	
Oil or grease on clutch facings	Clean or replace clutch clutch disc
Incorrect release lever or pedal adjustment	See CLUTCH article
Worn or broken clutch facings	Replace clutch disc
Bent clutch disc or pressure plate	Replace damaged components
Clutch disc hub binding on input shaft	Clean or replace clutch disc and/or input shaft
Binding pilot bearing	Replace pilot bearing
Sticking release bearing sleeve	Replace release bearing and/or sleeve
Binding clutch cable	See CLUTCH article
Defective clutch master	Replace master cylinder
Defective clutch slave	Replace slave cylinder
Air in hydraulic system	Bleed hydraulic system
Rattling	
Weak or broken release lever spring	Replace spring and check alignment
Damaged pressure plate	Replace pressure plate

Broken clutch return spring	Replace return spring
Worn splines on clutch disc or input shaft	Replace clutch disc and/or input shaft
Worn clutch release bearing	Replace release bearing
Dry or worn pilot bearing	Lubricate or replace pilot bearing
Unequal release lever contact	Align or replace release lever
Incorrect pedal free play	Adjust free play
Warped or damaged clutch disc	Replace damaged components
Slipping	
Pressure springs worn or	Release pressure plate
Oily, greasy or worn facings	Clean or replace clutch disc
Incorrect clutch alignment	Realign clutch assembly
Warped clutch disc or pressure plate	Replace damaged components
Binding release levers or clutch pedal	Lubricate and/or replace release components
Squeaking	
Worn or damaged release	Replace release bearing
Dry or worn pilot or release bearing	Lubricate or replace assembly
Pilot bearing turning in crankshaft	Replace pilot bearing and/or crankshaft
Worn input shaft bearing	Replace bearing and seal
Incorrect transmission alignment	Realign transmission
Dry release fork between pivot	Lubricate release fork and pivot
Heavy and/or Stiff Pedal	
Sticking release bearing sleeve	Replace release bearing and/or sleeve
Dry or binding clutch pedal hub	Lubricate and align components
Floor mat interference with pedal	Lay mat flat in proper area
Dry or binding ball/fork pivots	Lubricate and align components
Faulty clutch cable	Replace clutch cable
Noisy Clutch Pedal	
Faulty interlock switch	Replace interlock switch
Self-adjuster ratchet noise	Lubricate or replace self-adjuster
Speed control interlock switch	Lubricate or replace interlock switch
Clutch Pedal Sticks Down	
Binding clutch cable	See CLUTCH article
Springs weak in pressure plate	Replace pressure plate
Binding in clutch linkage	Lubricate and free linkage
Noisy	
Dry release bearing	Lubricate or replace release bearing

Dry or worn pilot bearing	Lubricate or replace bearing
Worn input shaft bearing	Replace bearing
Transmission Click	
Weak springs in pressure	Replace pressure plate plate
Release fork loose on ball stud	Replace release fork and/or ball stud
Oil on clutch disc damper	Replace clutch disc
Broken spring in slave cylinder	Replace slave cylinder

DRIVE AXLE - NOISE DIAGNOSIS

Unrelated Noises

Some driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires, and other parts of the vehicle. Ensure cause of trouble actually is in the drive axle before adjusting, repairing, or replacing any of its parts.

Non-Drive Axle Noises

A few conditions can sound just like drive axle noise and have to be considered in pre-diagnosis. The 4 most common noises are exhaust, tires, CV/universal joints and wheel trim rings.

In certain conditions, the pitch of the exhaust gases may e gear whine. At other times, it may be mistaken for a wheel bearing rumble.

Tires, especially radial and snow, can have a high-pitched tread whine or roar, similar to gear noise. Also, some non-standard tires with an unusual tread construction may emit a roar or whine.

Defective CV/universal joints may cause clicking noises or excessive driveline play that can be improperly diagnosed as drive axle problems.

Trim and moldings also can cause a whistling or whining noise. Ensure none of these components are causing the noise before disassembling the drive axle.

Gear Noise

A "howling" or "whining" noise from the ring and pinion gear can be caused by an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

Before disassembling axle to diagnose and correct gear ke sure that tires, exhaust, and vehicle trim have been checked as possible causes.

Chuckle

This is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 40 MPH and usually can be heard until vehicle comes to a complete stop. The

frequency varies with the speed of the vehicle.

A chuckle that occurs on the driving phase is usually caused ive clearance due to differential gear wear, or by a damaged tooth on the coast side of the pinion or ring gear. Even a very small tooth nick or a ridge on the edge of a gear tooth is enough the cause the noise.

This condition can be corrected simply by cleaning the gear tooth nick or ridge with a small grinding wheel. If either gear is damaged or scored badly, the gear set must be replaced. If metal has broken loose, the carrier and housing must be cleaned to remove particles that could cause damage.

Knock

This is very similar to a chuckle, though it may be louder, and occur on acceleration or deceleration. Knock can be caused by a gear tooth that is damaged on the drive side of the ring and pinion gears. Ring gear bolts that are hitting the carrier casting can cause knock. Knock can also be due to excessive end play in the axle shafts.

Clunk

Clunk is a metallic noise heard when an automatic transmission is engaged in Reverse or Drive, or when throttle is applied or released. It is caused by backlash somewhere in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, check the total axle backlash as follows:

1. Raise vehicle on a frame or twinpost hoist so that drive wheels are free. Clamp a bar between axle companion flange and a part of the frame or body so that flange cannot move.
2. On conventional drive axles, lock the left wheel to keep it from turning. On all models, turn the right wheel slowly until it is felt to be in Drive condition. Hold a chalk marker on side of tire about 12" from center of wheel. Turn wheel in the opposite direction until it is again felt to be in Drive condition.
3. Measure the length of the chalk mark, which is the total axle backlash. If backlash is one inch or less, drive axle is not the source of clunk noise.

Bearing Whine

Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings. Pinion bearings operate at drive shaft speed. Roller wheel bearings may whine in a similar manner if they run completely dry of lubricant. Bearing noise will occur at all driving speeds. This distinguishes it from gear whine, which usually comes and goes as speed changes.

Bearing Rumble

Bearing rumble sounds like marbles being tumbled. It is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of drive shaft speed.

Chatter On Turns

This is a condition where the entire front or rear of vehicle vibrates when vehicle is moving. The vibration is plainly felt as well as heard. Extra differential thrust washers installed during axle repair can cause a condition of partial lock-up that creates this chatter.

Axle Shaft Noise

Axle shaft noise is similar to gear noise and pinion bearing whine. Axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes (Drive, cruise, coast and float), and will persist with transmission in Neutral while vehicle is moving at problem speed.

If vehicle displays this noise condition, remove suspect parts, replace wheel seals and install a new set of bearings. Re-evaluate vehicle for noise before removing any internal components.

Vibration

Vibration is a high-frequency trembling, shaking or grinding condition (felt or heard) that may be constant or variable in level and can occur during the total operating speed range of the vehicle.

The types of vibrations that can be felt in the vehicle can d into 3 main groups:

- Vibrations of various unbalanced rotating parts of the vehicle.
- Resonance vibrations of the body and frame structures caused by rotating of unbalanced parts.
- Tip-in moans of resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

DRIVE AXLE - RWD TROUBLE SHOOTING

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DRIVE AXLE (RWD) TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Knocking or Clunking	
Differential Side Gear Clearance	Check Clearance
Worn Pinion Shaft	Replace Pinion Shaft
Axle Shaft End Play	Check End Play
Missing Gear Teeth	Check Differential/Replace Gear
Wrong Axle Backlash	Check Backlash
Misaligned Driveline	Realign Driveline
Clinking During Engagement	
Side Gear Clearance	Check Clearance
Ring and Pinion Backlash	Check Backlash
Worn/Loose Pinion Shaft	Replace Shaft/Bearing

Bad "U" Joint	Replace "U" Joint
Sticking Slip Yoke	Lube Slip Yoke
Broken Rear Axle Mount	Replace Mount
Loose Drive Shaft Flange	Check Flange
Click/Chatter On Turns	
Differential Side Gear Clearance	Check Clearance
Wrong Turn On Plates (1)	Replace Clutch Plates
Wrong Differential Lubricant (1)	Change Lubricant
Knock Or Click	
Flat Spot on Rear Wheel Bearing	Replace Wheel Bearing
Low Vibration At All Speeds	
Faulty Wheel Bearing	Replace Wheel Bearing
Faulty "U" Joint	Replace "U" Joint
Faulty Drive Shaft	Balance Drive Shaft
Faulty Companion Flange	Replace Flange
Faulty Slip Yoke Flange	Replace Flange
(1) Limited slip differential only.	

FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING

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BASIC FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Grease Leaks	CV boot torn or cracked
Clicking Noise on Cornering	Damaged outer CV
Clunk Noise on Acceleration	Damaged inner CV
Vibration or Shudder on Acceleration	Sticking, damaged or worn CV Misalignment or spring height

STEERING & SUSPENSION

MANUAL STEERING GEAR TROUBLE SHOOTING

NOTE: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT,

DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC MANUAL STEERING GEAR TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise in Rack and Pinion	
Rack and pinion mounting bracket loose	Tighten all mounting bolts
Lack of/or incorrect lubricant	Correct as necessary
Steering gear mounting bolts loose	Tighten all mounting bolts
Excessive Play	
Front wheel bearing improperly adjusted	See FRONT SUSPENSION article
Loose or worn steering linkage	See STEERING LINKAGE article
Loose or worn steering gear shift	See MANUAL STEERING GEAR article
Steering arm loose on gear shaft	See MANUAL STEERING GEAR article
Steering gear housing bolts loose	Tighten all mounting bolts
Steering gear adjustment too loose	See MANUAL STEERING GEAR article
Steering arms loose on knuckles	Tighten and check steering linkage
Rack and pinion mounting loose	Tighten all mounting bolts
Rack and pinion out of adjustment	See adjustment in STEERING article
Tie rod end loose	Tighten and check steering linkage
Excessive Pitman shaft-to-ball nut lash	Repair as necessary
Poor Returnability	
Lack of lubricant in ball joint or linkage	Lubricate and service systems
Binding in linkage or ball joints	See STEERING LINKAGE and SUSPENSION article
Improper front end alignment	See WHEEL ALIGNMENT article
Improper tire pressure	Inflate to proper pressure
Tie rod binding	Inflate to proper pressure
Shaft seal rubbing shaft	See STEERING COLUMN article
Excessive Vertical Motion	
Improper tire pressure	Inflate to proper pressure
Tires, wheels or rotors out of balance	Balance tires then check wheels and rotors
Worn or faulty shock absorbers	Check and replace if necessary

Loose tie rod ends or steering	Tighten or replace if necessary
Loose or worn wheel bearings	See SUSPENSION article
Steering Pulls to One Side	
Improper tire pressure	Inflate to proper pressure
Front tires are different sizes	Rotate or replace if necessary
Wheel bearings not adjusted properly	See FRONT SUSPENSION article
Bent or broken suspension components	See FRONT SUSPENSION article
Improper wheel alignment	See WHEEL ALIGNMENT article
Brakes dragging	See BRAKES article
Instability	
Low or uneven tire pressure	Inflate to proper pressure
Loose or worn wheel bearings	See FRONT SUSPENSION article
Loose or worn idler arm bushing	See FRONT SUSPENSION article
Loose or worn strut bushings	See FRONT SUSPENSION article
Incorrect front wheel alignment	See WHEEL ALIGNMENT article
Steering gear not centered	See MANUAL STEERING GEARS article
Springs or shock	Check and replace if necessary
Improper cross shaft	See MANUAL STEERING GEARS article

POWER STEERING TROUBLE SHOOTING

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BASIC POWER STEERING TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise	
Pressure hoses touching engine parts	Adjust to proper clearance
Loose Pitman shaft	Adjust or replace if necessary
Tie rods ends or Pitman arm loose	Tighten and check system
Rack and pinion mounts loose	Tighten all mounting bolts

Free play in worm gear	See POWER STEERING GEAR article
Loose sector shaft or thrust bearing adjustment	See POWER STEERING GEAR
Free play in pot coupling	See STEERING COLUMN article
Worn shaft serrations	See STEERING COLUMN article
Growl in Steering Pump	
Excessive pressure in hoses	Restricted hoses, see POWER STEERING GEAR article
Scored pressure plates	See POWER STEERING GEAR article
Scored thrust plates or rotor	See POWER STEERING GEAR article
Extreme wear of cam ring	See POWER STEERING GEAR article
Rattle in Steering Pump	
Vanes not installed	See POWER STEERING PUMP article
Vanes sticking in rotor	See POWER STEERING PUMP article
Swish noise in Pump	
Defective flow control valve	See POWER STEERING PUMP article
Groan in Steering Pump	
Air in fluid	See POWER STEERING PUMP article
Poor pressure hose connection	Tighten and check, replace if necessary
Squawk When Turning	
Damper "O" ring on valve spool cut	See POWER STEERING PUMP article
Moan or Whine in Pump	
Pump shaft bearing scored	Replace bearing and fluid
Air in fluid or fluid level low	See POWER STEERING PUMP article
Hose or column grounded	Check and replace if necessary
Cover "O" ring missing or damaged	See POWER STEERING PUMP article
Valve cover baffle missing or damaged	See POWER STEERING PUMP article
Interference of components in pump	See POWER STEERING

	PUMP article
Loose or poor bracket alignment	Correct or replace if necessary
Hissing When Parking	
Internal leakage in steering gear	Check valved assembly first
Chirp in Steering Pump	
Loose or worn power steering belt	Adjust or replace if necessary
Buzzing When Not Steering	
Noisy pump	See POWER STEERING PUMP article
Free play in steering shaft bearing	See STEERING COLUMN article
Bearing loose on shaft serrations	See STEERING COLUMN article
Clicking Noise in Pump	
Pump slippers too long	See POWER STEERING PUMP article
Broken slipper springs	See POWER STEERING PUMP article
Excessive wear or nicked rotors	See POWER STEERING PUMP article
Damaged cam contour	See POWER STEERING PUMP article
Poor Return of Wheel	
Wheel rubbing against turn signal	See STEERING COLUMN SWITCHES article
Flange rubbing steering gear adjuster	See STEERING COLUMN article
Tight or frozen steering shaft bearing	See STEERING COLUMN article
Steering gear out of adjustment	See POWER STEERING GEAR article
Sticking or plugged spool valve	See POWER STEERING PUMP article
Improper front end alignment	See WHEEL ALIGNMENT article
Wheel bearings worn or loose	See FRONT SUSPENSION article
Ties rods or ball joints binding	Check and replace if necessary
Intermediate shaft joints binding	See STEERING COLUMN article
Kinked pressure hoses	Correct or replace if necessary
Loose housing head spanner nut	See POWER STEERING GEAR article

Damaged valve lever	See POWER STEERING GEAR article
Sector shaft adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
Worm thrust bearing adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
Reaction ring sticking in cylinder	See POWER STEERING GEAR article
Reaction ring sticking in housing head	See POWER STEERING GEAR article
Steering pump internal leakage	See POWER STEERING PUMP article
Steering gear-to-column misalignment	See STEERING COLUMN article
Lack of lubrication in linkage	Service front suspension
Lack of lubrication in ball joints	Service front suspension
Increased Effort When Turning Wheel Fast Foaming, Milky Power Steering Fluid, Low Fluid Level or Low Pressure	
High internal pump leakage	See POWER STEERING PUMP article
Power steering pump belt slipping	Adjust or replace if necessary
Low fluid level	Check and fill to proper level
Engine idle speed to low	Adjust to correct setting
Air in pump fluid system	See POWER STEERING PUMP article
Pump output low	See POWER STEERING PUMP article
Steering gear malfunctioning	See POWER STEERING GEAR article
Wheel Surges or Jerks	
Low fluid level	Check and fill to proper level
Loose fan belt	Adjust or replace if necessary
Insufficient pump pressure	See POWER STEERING PUMP article
Sticky flow control valve	See POWER STEERING PUMP article
Linkage hitting oil pan at full turn	Replace bent components
Kick Back or Free Play	
Air in pump fluid system	See POWER STEERING PUMP article
Worn poppet valve in steering gear	See POWER STEERING PUMP article

Excessive over center lash	See POWER STEERING GEAR article
Thrust bearing out of adjustment	See POWER STEERING GEAR article
Free play in pot coupling	See POWER STEERING PUMP article
Steering gear coupling loose on shaft	See POWER STEERING PUMP article
Steering disc mounting bolts loose	Tighten or replace if necessary
Coupling loose on worm shaft	Tighten or replace if necessary
Improper sector shaft adjustment	See POWER STEERING GEAR article
Excessive worm piston side play	See POWER STEERING GEAR article
Damaged valve lever	See POWER STEERING GEAR article
Universal joint loose	Tighten or replace if necessary
Defective rotary valve	See POWER STEERING GEAR article
No Power When Parking	
Sticking flow control valve	See POWER STEERING PUMP article
Insufficient pump pressure output	See POWER STEERING PUMP article
Excessive internal pump leakage	See POWER STEERING PUMP article
Excessive internal gear leakage	See POWER STEERING PUMP article
Flange rubs against gear adjust plug	See STEERING COLUMN article
Loose pump belt	Adjust or replace if necessary
Low fluid level	Check and add proper amount of fluid
Engine idle too low	Adjust to correct setting
Steering gear-to-column misaligned	See STEERING COLUMN article
No Power, Left Turn	
Left turn reaction seal "O" ring worn	See POWER STEERING GEAR article
Left turn reaction seal damaged/missing	See POWER STEERING GEAR article

Cylinder head "O" ring damaged	See POWER STEERING PUMP article
No Power, Right Turns	
Column pot coupling bottomed	See STEERING COLUMN article
Right turn reaction seal "O" ring worn	See POWER STEERING GEAR article
Right turn reaction seal damaged	See POWER STEERING GEAR article
Internal leakage through piston end plug	See POWER STEERING GEAR article
Internal leakage through side plugs	See POWER STEERING GEAR article
Lack of Effort in Turning	
Left and/or right reaction seal sticking in cylinder head	Replace, see POWER STEERING GEAR article
Wanders to One Side	
Front end alignment incorrect	See WHEEL ALIGNMENT article
Unbalanced steering gear valve	See POWER STEERING GEAR article
Low Pressure Due to Steering Pump	
Flow control valve stuck or inoperative	See POWER STEERING PUMP article
Pressure plate not flat against cam ring	See POWER STEERING PUMP article
Extreme wear of cam ring	Replace and check adjustments
Scored plate, thrust plate or rotor	See POWER STEERING PUMP article
Vanes not installed properly	See POWER STEERING PUMP article
Vanes sticking in rotor slots	See POWER STEERING PUMP article
Cracked/broken thrust or pressure plate	See POWER STEERING PUMP article

STEERING COLUMN TROUBLE SHOOTING

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BASIC STEERING COLUMN TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Noise in Steering	
Coupling pulled apart	See STEERING COLUMNS article
Column not correctly aligned	See STEERING COLUMNS article
Broken lower joint	Replace joint
Horn contact ring not	See STEERING COLUMN article
Bearing not lubricated	See STEERING COLUMN article
Shaft snap ring not properly seated	Reseat or replace snap ring
Plastic spherical joint not lubricated	See STEERING COLUMN article
Shroud or housing loose	Tighten holding screws
Lock plate retaining ring not seated	See STEERING COLUMN article
Loose sight shield	Tighten holding screws
High Steering Shaft Effort	
Column assembly misaligned	See STEERING COLUMN article
Improperly installed dust shield	Adjust or replace
Tight steering universal joint	See STEERING COLUMN article
High Shift Effort	
Column is out of alignment	See STEERING COLUMN article
Improperly installed dust shield	Adjust or replace
Seals or bearings not lubricated	See STEERING COLUMNS article
Mounting bracket screws too long	Replace with new shorter screws
Burrs on shift tube	Remove burrs or replace tube
Lower bowl bearing assembled wrong	See STEERING COLUMN article
Shift tube bent or broken	Replace as necessary
Improper adjustment of shift levers	See STEERING COLUMN article
Improper Trans. Shifting	
Sheared shift tube joint	Replace as necessary
Sheared lower shaft lever	Replace as necessary
Improper shift lever adjustment	See STEERING COLUMN

	article
Improper gate plate adjustment	See STEERING COLUMN article
Excess Play in Column	
Instrument panel bracket bolts loose	Tighten bolts and check bracket
Broken weld nut on jacket	See STEERING COLUMN article
Instrument bracket capsule sheared	See STEERING COLUMN article
Column bracket/jacket bolts loose	Tighten bolts and check bracket
Steering Locks in Gear	
Release lever mechanism	See STEERING COLUMN article

SUSPENSION TROUBLE SHOOTING

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BASIC SUSPENSION TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Front End Noise	
Loose or worn wheel	See Wheel Bearing Adjustment in SUSPENSION
Worn shocks or shock mountings	Replace struts or strut mountings
Worn struts or strut mountings	Replace struts or strut mountings
Loose or worn lower control arm	See SUSPENSION
Loose steering gear-to-frame bolts	See STEERING
Worn control arm bushings	See SUSPENSION
Ball joints not lubricated	Lubricate ball joints & see Ball Joint Checking in SUSPENSION
Front Wheel Shake, Shimmy, or Vibration	
Tires or wheels out of balance	Check tire balance
Incorrect wheel alignment	See WHEEL ALIGNMENT
Drive shaft unbalanced	Check drive shaft balance
Loose or worn wheel bearings	See WHEEL ALIGNMENT

Loose or worn tie rod ends	See SUSPENSION
Worn upper ball joints	See Ball Joint Checking in SUSPENSION
Worn shock absorbers	Replace shock absorbers
Worn strut bushings	Replace strut bushings
Car Pulls to One Side	
Mismatched or uneven tires	Check tire condition
Broken or sagging springs	See SUSPENSION
Loose or worn strut bushings	See SUSPENSION
Improper wheel alignment	See WHEEL ALIGNMENT
Improper rear axle alignment	Check rear axle alignment
Power steering gear unbalanced	See STEERING
Front brakes dragging	See BRAKES
Abnormal Tire Wear	
Unbalanced tires	Check tire balance & rotation
Sagging or broken springs	See SUSPENSION
Incorrect front end alignment	See WHEEL ALIGNMENT
Faulty shock absorbers	Replace chock absorbers
Scuffed Tires	
Toe-In incorrect	See WHEEL ALIGNMENT
Suspension arm bent or twisted	See appropriate SUSPENSION article
Springs Bottom or Sag	
Bent or broken springs	See SUSPENSION
Leaking or worn shock absorbers	Replace shock absorbers
Frame misalignment	Check frame for damage
Spring Noises	
Loose "U" Bolts	See SUSPENSION
Loose or worn bushings	See SUSPENSION
Worn or missing interliners	See SUSPENSION
Shock Absorber Noise	
Loose shock mountings	Check & tighten mountings
Worn bushings	Replace bushings
Air in system	Bleed air from system
Undercoating on shocks	Remove undercoating
Car Leans or Sways on Corners	
Loose stabilizer bar	See SUSPENSION
Faulty shocks or mountings	Replace shocks or mountings
Broken or sagging springs	See SUSPENSION
Shock Absorbers Leaking	
Worn seals or reservoir tube crimped	See SUSPENSION

Broken Springs	
Loose "U" bolts	See SUSPENSION
Inoperative shock absorbers	Replace shock absorbers

WHEEL ALIGNMENT TROUBLE SHOOTING

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BASIC WHEEL ALIGNMENT TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Premature Tire Wear	
Improper tire inflation	Check tire pressure
Front alignment out of tolerance	See ALIGNMENT SPECS in WHEEL ALIGNMENT section
Suspension components worn	See SUSPENSION section
Steering system components worn	See STEERING section
Improper standing height	See WHEEL ALIGNMENT
Uneven or sagging springs	See SUSPENSION section
Bent wheel	See WHEEL ALIGNMENT
Improper torsion bar adjustment	See SUSPENSION section
Loose or worn wheel bearings	See WHEEL BEARING ADJ. in SUSPENSION section
Worn or defective shock	Replace shock absorbers
Tires out of balance	Check tire balance
Pulls to One Side	
Improper tire inflation	Check tire pressure
Brake dragging	See BRAKE section
Mismatched tires	See WHEEL ALIGNMENT
Broken or sagging spring	See SUSPENSION section
Broken torsion bar	See SUSPENSION section
Power steering valve not centered	See STEERING section
Front alignment out of tolerance	See WHEEL ALIGNMENT section
Defective wheel bearing	See WHEEL BEARINGS in SUSPENSION section
Uneven sway bar links	See SUSPENSION section
Frame bent	Check for frame damage
Steering system bushing worn	See STEERING section

Hard Steering	
Idler arm bushing too tight	See STEERING LINKAGE in STEERING section
Ball joint tight or seized	See SUSPENSION section
Steering linkage too tight	See STEERING LINKAGE in STEERING section
Power steering fluid low	Add proper amount of fluid
Power steering drive belt loose	See STEERING section
Power steering pump defective	See STEERING section
Steering gear out of adjustment	See STEERING section
Incorrect wheel alignment	See WHEEL ALIGNMENT
Damaged steering gear	See STEERING section
Damaged suspension	See SUSPENSION section
Bent steering knuckle or supports	See SUSPENSION section
Vehicle "Wanders"	
Strut rod or control arm bushing worn	See SUSPENSION section
Loose or worn wheel bearings	See WHEEL BEARINGS in SUSPENSION section
Improper tire inflation	Check tire pressure
Stabilizer bar missing or defective	See SUSPENSION section
Wheel alignment out of tolerance	See Adjustment in WHEEL ALIGNMENT section
Broken spring	See SUSPENSION section
Defective shock absorber	Replace shock absorbers
Worn steering & suspension components	See SUSPENSION section
Front End Shimmy	
Tire out of balance/round	Check tire balance
Excessive wheel runout	See WHEEL ALIGNMENT
Insufficient or improper caster	See WHEEL ALIGNMENT section
Worn suspension or steering components	See SUSPENSION section
Defective shock absorbers	Replace shock absorber
Wheel bearings worn or loose	See WHEEL BEARING ADJ. in SUSPENSION section
Power steering reaction Bracket loose	See STEERING section
Steering gear box (rack) mounting loose	See STEERING section
Steering gear adjustment loose	See STEERING section
Worn spherical joints	See SUSPENSION section
Toe-In Not Adjustable	
Lower control arm bent	See SUSPENSION section
Frame bent	Check frame for damage
Camber Not Adjustable	

Control arm bent	See SUSPENSION section
Frame bent	Check frame for damage
Hub & bearing not seated properly	See SUSPENSION section

BRAKE SYSTEM

BRAKES General Motors - Disc & Drum

DESCRIPTION & OPERATION

Brake system is a dual hydraulic pedal-actuated system with a master cylinder, proportioning valve and pressure differential warning switch, vacuum brake booster, front disc brakes and rear duo-servo drum brakes or optional rear disc brakes. Hydraulic brake line routing is split front and rear for safety reasons.

Master cylinder has dual pressure chambers with a primary piston to supply hydraulic pressure to front brakes and a secondary piston to pressurize rear brakes. There is one outlet for both front brakes and one outlet for both rear brakes. A quick take-up valve is included on master cylinder to provide a large volume of brake fluid during initial brake application.

Hydraulic system pressure differential is controlled and monitored by combination valve, located below master cylinder. Combination valve performs the following functions:

- Limits amount of pressure applied to rear brakes to allow most pressure to be applied to front brakes.
- Transfers hydraulic pressure to front brakes if pressure loss occurs in rear brakes and vice versa.
- Closes contacts in pressure differential switch to turn on BRAKE warning indicator light.
- Metering valve portion of combination valve prevents hydraulic pressure from being applied to front brakes until rear brakeline pressure has overcome rear brake shoe return spring tension, and brake shoe-to-drum clearance has been taken up.

Front disc brakes are continually self-adjusting. Caliper piston seals are designed to retract pistons enough to allow brake lining to lightly brush rotor. Sliding caliper design compensates for lining wear. Replace brake pads in axle sets when lining thickness is .030" (.76 mm) or less.

Rear disc brakes are a single piston caliper assembly. Caliper piston seals are designed to retract pistons enough to allow brake lining to lightly brush rotor. Sliding caliper design compensates for lining wear. Parking brake system uses brake shoes located inside rear brake rotors. Replace brake pads in axle sets when lining thickness is .030" (.76 mm) or less.

Rear drum brake assembly is a duo-servo design. When brakes are applied, wheel cylinder force applied to the primary shoe is multiplied by primary shoe friction against the drum. This multiplied force is applied to the secondary shoe, which stops the drum and rear axle rotation. Adjustments for both rear brake primary and secondary shoes are automatic during reverse brake applications. Replace brake shoes in axle sets when lining thickness is .030" (.76 mm) or less.

BLEEDING BRAKE SYSTEM

CAUTION: Because of brake fluid expansion due to heat absorbed from brakes and engine, DO NOT overfill master cylinder reservoir. DO NOT reuse brake fluid. Use only new, clean DOT 3 brake fluid. DO NOT use DOT 5 silicone brake fluid. Check brake fluid level frequently during bleeding procedure.

MANUAL BLEEDING

Brake System

1. Deplete vacuum reserve from power brake booster by depressing brake pedal several times with engine off. Fill master cylinder and keep at least half full during bleeding procedure. If master cylinder is not known or suspected to have air in bore, go to step 4). If master cylinder is known or suspected to have air in bore, go to next step.
2. Disconnect forward brakeline fitting at master cylinder. Allow fluid to flow from fitting. Tighten fitting to specification. See **TORQUE SPECIFICATIONS**. Have an assistant depress brake pedal slowly and hold. Loosen forward fitting. Tighten fitting while pedal is still at floor. Release brake pedal slowly. Wait 15 seconds.
3. Repeat step 2) until fluid is clear and free of air bubbles. Repeat procedure at other (rearmost) brakeline fitting on master cylinder. Master cylinder is now bled. If wheel cylinders/calipers are not suspected to have air in them, it is not necessary to bleed them.
4. If wheel cylinders/calipers are known or suspected to have air in them, raise and support vehicle. Remove bleeder valve cap from first bleeder valve to be serviced. See **BRAKELINE BLEEDING SEQUENCE** table. Place wrench over bleeder valve.
5. Attach clear vinyl bleeder hose onto bleeder valve. Place other end of hose in clear container partially filled with clean brake fluid. Submerge end of hose in fluid. Slowly depress brake pedal and hold. Open bleeder valve to purge air.
6. Close bleeder valve. Release pedal. Wait 15 seconds and repeat procedure until fluid is clear and free of air bubbles. Repeat procedure on remaining bleeder valves.

BRAKELINE BLEEDING SEQUENCE

Application	Sequence
All Models	RR, LR, RF, LF

PRESSURE BLEEDING

Brake System

1. Clean master cylinder reservoir cap and surrounding area. Remove cap. With pressure bleeder tank at least 1/2 full of brake fluid and charged with 10-30 psi (.70-2.10 kg/cm^2) air pressure, connect tank to master cylinder using proper adapter(s).
2. On vehicles with rear disc brakes, go to next step. On models with rear drum brakes, a manual override is necessary to permit brake fluid flow to front wheels when pressure bleeding. To enable override, attach Combination Valve Pressure Bleeder Adaptor (J-39177) to combination valve.
3. Raise and support vehicle. Attach bleeder hose to first bleeder valve to be serviced. See **BRAKELINE BLEEDING SEQUENCE** table. Place other end of hose in clear container partially filled with clean brake fluid. Submerge end of hose in fluid.
4. Open release valve on pressure bleeder. Open first bleeder valve to be serviced. When fluid flowing into container is clear and free of bubbles, close bleeder valve securely. Open and close each remaining bleeder valve in turn to finish bleeding system. Disconnect pressure tank from master cylinder. Remove adaptor from combination valve. Check brake fluid level. Fill as necessary.

ADJUSTMENTS

BRAKE PEDAL HEIGHT & FREE PLAY

Brake pedal height and free play is not adjustable. See BRAKE PEDAL TRAVEL.

BRAKE PEDAL TRAVEL

NOTE: Brake pedal travel is not adjustable. Most low brake pedal problems are caused by air in hydraulic system and improper rear brake adjustment. Bleed hydraulic system before performing procedure. See BLEEDING BRAKE SYSTEM. Other less frequent causes of excessive pedal travel are incorrect power booster pushrod length, worn linings, rear brake adjusters not operating, misadjusted parking brake, or a leak in hydraulic system. Following procedure determines if brake pedal travel is as specified.

1. With engine off, pump brake pedal until all vacuum reserve is exhausted from power brake booster. A definite change in pedal feel will occur. Install Brake Pedal Effort Gauge (J-28662) onto brake pedal. Hook end of tape measure over top of brake pedal. Measure and record distance to rim of steering wheel.
2. Apply 100 lbs. (45 kg) of force to brake pedal. Measure and record distance to rim of steering wheel again. Difference between measured values is brake pedal travel. See **BRAKE PEDAL TRAVEL SPECIFICATIONS** table.
3. If brake pedal travel exceeds specification, ensure brake power booster piston rod length is correct and rear brakes are adjusted. See **POWER BRAKE BOOSTER PISTON ROD**. See **REAR BRAKE SHOES**. Recheck brake pedal travel. If brake pedal travel still exceeds specification, repair brake system.

BRAKE PEDAL TRAVEL SPECIFICATIONS

Application	In. (mm)
All Models	2.24 (57.0)

REAR BRAKE SHOE ADJUSTMENT

NOTE: Adjustment is only required if shoes have been serviced or length of adjusting screw has been changed.

1. Release parking brake. Raise and support vehicle. Remove wheels and drums. Ensure parking brake cable, linkage and secondary (rear) shoe levers have free movement.
2. If using Brake Drum Gauge (J-21177), go to next step. If not using Brake Drum Gauge (J-21177), turn adjuster wheel until diameter of brake shoes is .050" (1.27 mm) less than inside diameter of brake drum. Go to step 4).
3. Measure inside diameter of brake drum using inside caliper portion of Brake Drum Gauge (J-21177). Turn adjuster wheel until brake shoes contact outside caliper portion of brake drum gauge.
4. Install drums and wheels. Tighten wheel lug nuts to specification. See **TORQUE SPECIFICATIONS**. Lower vehicle. Drive vehicle, making several alternate forward and backward stops, applying brakes firmly.

PARKING BRAKE (DISC)

Preliminary Information

Models equipped with rear disc brakes use parking brake shoes located inside disc brake rotor. These brake shoes are mechanically applied to brake drums cast to inside of rear disc rotors.

Adjustment

1. Ensure parking brake lever/pedal is fully released. Raise and support vehicle. Remove rear caliper mounting bracket with caliper assembly attached and support with a wire hook. Remove rotor. Ensure parking brake shoes are attached to clip at bottom of backing plate. Locate parking brake actuator at top of backing plate.
2. With parking brake actuator at rest, turn adjustment nut and screw until rotor can be installed over parking brake shoes and turned freely. When adjustment is completed, install rotor and rear caliper mounting bracket with caliper assembly attached.
3. Clean and lubricate threads on adjusting rod of parking brake cable equalizer. Press parking brake lever 6 ratchet clicks. Tighten adjuster nut at equalizer until right rear wheel can just be turned rearward with 2 hands but cannot be turned forward. Release parking brake. Ensure rear wheels turn freely.

PARKING BRAKE (DRUM)

1. Raise and support vehicle. Adjust rear brakes. See REAR BRAKE SHOES. Clean and lubricate threads on adjusting rod of parking brake cable equalizer. Press parking brake lever 6 ratchet clicks.
2. Tighten adjuster nut at equalizer until right rear wheel can just be turned rearward with 2 hands but cannot be turned forward. Release parking brake. Ensure rear wheels turn freely.

POWER BRAKE BOOSTER PISTON ROD

NOTE: Use the following procedure to measure how far booster piston rod protrudes from booster when vacuum is applied to booster. Piston rod is not adjustable. If piston rod protrusion is out of limits, replace power brake booster. Power brake booster is now serviced as a complete assemble and is no longer rebuildable.

Booster does not have to be installed to perform procedure. Apply 20-25 in. Hg vacuum or the MAXIMUM available engine vacuum to booster. Position Piston Rod Gauge (J-37839) over piston rod. See **Fig. 1**. One side of gauge measures minimum rod length. Other side measures maximum rod length. If piston rod length does not fall between maximum and minimum dimensions, replace power brake booster.

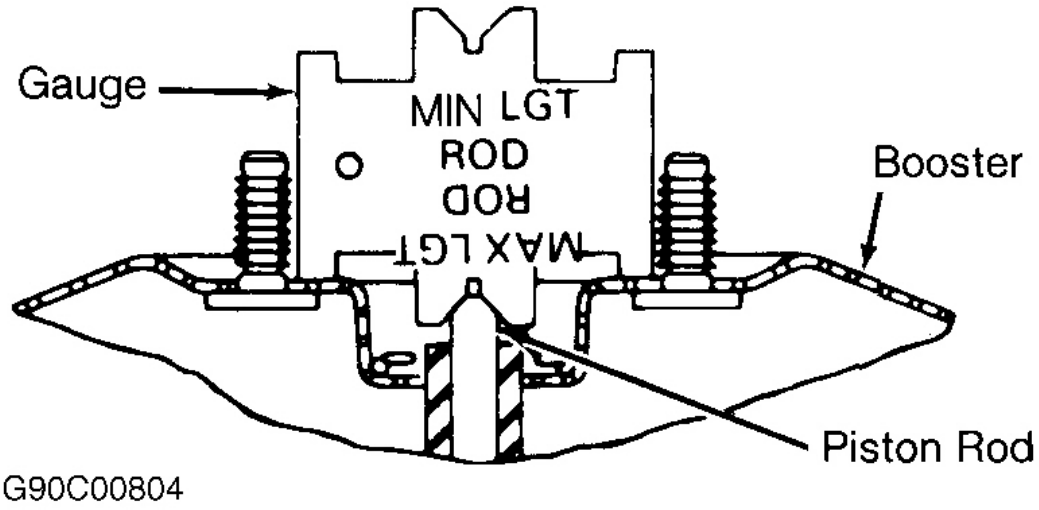


Fig. 1: Gauging Power Brake Booster Piston Rod
Courtesy of GENERAL MOTORS CORP.

BRAKELIGHT SWITCH

Hold brake pedal in applied position. Press switch fully forward until switch body is seated. Pull brake pedal fully rearward against pedal stop with 50 lbs. (22.5 kg) of pressure. DO NOT exceed specified pressure or power brake booster may be damaged. Switch is adjusted when clicking sounds are no longer heard. Ensure brakelights do not stay on with brake pedal at rest (unapplied).

TESTING

BRAKE WARNING INDICATOR INOPERATIVE

NOTE: See appropriate INSTRUMENT PANEL article listed below.

- **INSTRUMENT PANEL** - Roadmaster
- **INSTRUMENT PANEL** - Caprice, Impala SS

REMOVAL & INSTALLATION

FRONT BRAKE CALIPER

Removal

1. Remove and discard 2/3 of brake fluid from master cylinder reservoir to prevent overflow when servicing. Raise and support vehicle. Mark wheel in relation to hub. Remove wheel.

2. If not completely removing caliper (such as for overhaul), go to next step. If completely removing caliper, remove bolt securing brake hose to caliper. Disconnect brake hose from caliper. Plug opening in brake hose and caliper to prevent fluid loss and contamination.
3. Position "C" clamp with stationary end of clamp on caliper housing and threaded end on outboard pad. Tighten "C" clamp until piston is pushed into bore far enough to slide caliper off of rotor. Remove "C" clamp.
4. Remove caliper bolts and bushings. See **Fig. 2**. Remove caliper. If brake hose is still connected to caliper, hang caliper by wire so brake hose will not be damaged. Remove pads from caliper.

Installation

1. Liberally coat inner diameter of bushings with silicone grease. See **Fig. 2**. Install caliper. Install caliper bolts and bushings. If bolts slide through bushings using hand pressure, go to step 3).
2. If bolts do not slide through bushings using hand pressure, remove bolts and bushings. Inspect caliper bores for corrosion. If corrosion is found, replace bushings. Clean bores with clean denatured alcohol. Install and lubricate bushings. Install caliper bolts.
3. Tighten caliper bolts to specification. See **TORQUE SPECIFICATIONS**. If brake hose was not disconnected, go to next step. If brake hose was disconnected, connect brake hose to caliper. Tighten fitting bolt to specification. Bleed brake hydraulic system, and go to next step. See **BLEEDING BRAKE SYSTEM**.
4. Apply brakes several times to seat pads. Install wheel, aligning marks made during removal. Tighten wheel lug nuts to specification. Fill brake fluid reservoir. Road-test vehicle.

FRONT BRAKE PADS

Removal

Remove caliper. See **FRONT BRAKE CALIPER**. Remove outer pad from caliper using a screwdriver to disengage pad retaining buttons. See **Fig. 2**. Remove inner pad.

Installation

1. Clean outside surface of caliper piston boot with denatured alcohol. See **Fig. 2**. Slowly compress piston into bore with a "C" clamp, being careful not to cock piston to one side or damage piston boot. Using small piece of plastic or wood, lift inner edge of boot next to piston and press out any trapped air. Reposition boot so it lays flat with convolutions in proper position.
2. Install inner pad, snapping retainer into place in piston. Ensure pad lays flat against piston. Ensure boot is not touching pad. Install outer pad with wear sensor facing downward. Ensure pad lays flat against caliper. To install remaining components, reverse removal procedure.

FRONT BRAKE ROTOR

Removal

Raise and support vehicle. Remove wheel. Remove ABS wheel speed sensor from steering knuckle. Remove and support caliper. See FRONT BRAKE CALIPER. Remove grease cap, cotter pin, nut and washer. Remove

rotor.

Installation

1. To install, reverse removal procedure. To adjust wheel bearings, tighten spindle nut to 12 ft. lbs. (16 N.m) while spinning rotor forward by hand. Back off nut until just loose, then hand-tighten.
2. Tighten nut until either hole in spindle aligns with a slot in nut. DO NOT move nut more than 1/2 flat. Install NEW cotter pin. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS**.

REAR BRAKE CALIPER

NOTE: Rear caliper does not include parking brake assembly. brackets and guide pins.

Removal

1. Raise and support vehicle. Mark wheel in relation to hub. Remove wheel. Install and finger-tighten 2 lug nuts with flat side toward rotor to hold rotor when caliper is removed.
2. If not completely removing caliper (such as for overhaul), go to next step. If completely removing caliper, remove bolt securing brake hose to caliper. Discard old gaskets. Disconnect brake hose from caliper. Plug opening in brake hose and caliper to prevent fluid loss and contamination.
3. Remove and discard upper and lower caliper guide pin bolts. Remove caliper (suspend with wire if not completely removing).

Installation

1. Replace guide pins or boots if corroded or damaged. See **Fig. 3**. Install caliper housing over rotor. Install new upper and lower guide pin bolts. Tighten to specification. See **TORQUE SPECIFICATIONS**.
2. If brake hose was not disconnected, go to next step. If brake hose was disconnected, connect new gaskets and brake hose to caliper. Tighten fitting bolt to specification. Bleed brake hydraulic system and go to next step. See **BLEEDING BRAKE SYSTEM**.
3. Apply brakes several times to seat pads. Remove 2 wheel lug nuts from rotor and install wheel. Tighten wheel lug nuts to specification. Fill brake fluid reservoir. Road-test vehicle.

REAR BRAKE PADS

Removal

1. Remove 2/3 of brake fluid from master cylinder reservoir. Raise and support vehicle. Mark wheel in relation to wheel studs. Remove wheel. Install 2 wheel lug nuts finger-tight to retain rotor. Position "C" clamp with one end on brake hose fitting bolt and other end on outer pad.
2. Tighten "C" clamp until piston is bottomed in caliper. Remove and discard upper guide pin bolt securing caliper to caliper mounting bracket. See **Fig. 3**. Rotate caliper downward on lower guide pin. Remove pads and pad shim. Discard pad shim.

Installation

1. Clean residue from pad guide surfaces on caliper mounting bracket and caliper housing. Replace guide pins or boots if corroded or damaged. Install new pad shim and pads. Install inner pad with wear sensor on leading edge of inner pad (assuming forward wheel rotation).
2. Rotate caliper housing into position. Ensure springs on outer pad do not stick through inspection hole in caliper housing. Install new upper guide pin bolt. Tighten to specification. See **TORQUE SPECIFICATIONS**. Start engine. Pump brake pedal slowly and firmly to seat pads. Remove 2 wheel lug nuts from rotor and install wheels. Fill master cylinder reservoir. Road test vehicle.

REAR BRAKE ROTOR

Removal & Installation

Raise and support vehicle. Mark wheel in relation to wheel studs. Remove wheel. Remove 2 caliper mounting bracket bolts. Remove caliper mounting bracket with caliper attached and wire aside. See **REAR BRAKE CALIPER**. Mark rotor in relation to hub for installation reference. Slowly turn rotor while pulling away from axle assembly and remove rotor. To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS**.

REAR BRAKE SHOES

NOTE: Observe locations of springs, adjuster assembly and brake shoes for reassembly reference.

Removal & Installation

1. Remove wheels and drums. Remove brake components in order listed in illustration. See **Fig. 4**. Clean brake components and backing plate with denatured alcohol. Lubricate threads of adjuster assembly and shoes lands on backing plate with White grease.
2. To install, reverse removal procedure. Adjust rear brake shoes. See **REAR BRAKE SHOE ADJUSTMENT**. Install wheels. Tighten wheel lug nuts to specification. See **TORQUE SPECIFICATIONS**. Adjust parking brake. See **PARKING BRAKE (DRUM)** under ADJUSTMENTS. Road test vehicle.

MASTER CYLINDER

Removal

Remove brake fluid and discard from master cylinder reservoir. Disconnect brakelines from master cylinder. Plug openings. Disconnect hose from reservoir (if equipped). Plug opening. Remove nuts securing master cylinder to power brake booster. Move combination valve out of way. Remove master cylinder.

Installation

Bench bleed master cylinder. To complete installation, reverse removal procedure. Tighten master cylinder nuts and brakeline fittings to specification. See **TORQUE SPECIFICATIONS**. Bleed brake system. See **BLEEDING BRAKE SYSTEM**.

POWER BRAKE BOOSTER

NOTE: Power brake booster can be removed without completely removing master cylinder, but if both components are to be removed, remove master cylinder first.

Removal

1. Disconnect vacuum hose from check valve on booster. Remove 2 nuts securing master cylinder to booster. Move combination valve bracket and master cylinder forward to clear studs on booster. DO NOT move more than necessary or brake lines may be damaged.
2. Remove left sound insulator from below instrument panel. Working in passenger compartment, remove 4 nuts securing booster to firewall. Separate brake pedal from booster push rod. Remove Daytime Running Lights (DRL) diode assembly (if equipped). Remove booster and gasket.

CAUTION: Ensure accelerator and cruise control cables do not get caught between booster and firewall during installation. If cables become damaged or pinched, they MUST be replaced to prevent accelerator pedal from binding. Failure to do this could result in possible personal injury.

Installation

To install, reverse removal procedure. Tighten nuts to specification. See **TORQUE SPECIFICATIONS**. Adjust brakelight switch. See **BRAKELIGHT SWITCH** under ADJUSTMENTS.

WHEEL CYLINDERS

Removal & Installation

Remove rear brake shoes. See **REAR BRAKE SHOES**. Disconnect inlet tube nut and line. Plug opening in line to prevent fluid loss and contamination. Remove wheel cylinder bolts and wheel cylinder. To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS**. Bleed brake system. See **BLEEDING BRAKE SYSTEM**.

COMBINATION VALVE

Removal

Disconnect electrical connector from brake pressure differential switch on combination valve. Disconnect brakelines from combination valve. Plug brake lines to prevent loss of fluid and contamination. Remove 2 nuts securing combination valve to booster studs. Remove combination valve.

Installation

To install, reverse removal procedure. Tighten nuts and brakeline fittings to specification. See **TORQUE SPECIFICATIONS**. Bleed brake system. See **BLEEDING BRAKE SYSTEM**.

REAR AXLE BEARINGS & OIL SEAL

Removal

1. Raise and support vehicle. Remove wheel. On drum brakes, remove drum and go to next step. On disc brakes, remove caliper mounting bracket with caliper attached, and wire aside. See **REAR BRAKE CALIPER**. Remove rotor. Go to next step.
2. Remove rear axle housing cover. Remove lock bolt securing pinion gear shaft in differential case. Remove pinion gear shaft from differential case.
3. Push outer (flanged) end of axle shaft inward. Remove axle shaft lock from inner end of axle shaft in differential case. Remove axle shaft. Carefully pry axle shaft oil seal from housing. DO NOT damage housing. Position slide hammer into bore so tangs engage bearing outer race. Remove axle shaft bearing.

Installation

Lubricate NEW axle shaft bearing with gear lubricant. Using bearing installer, install axle shaft bearing so bearing installer bottoms against shoulder in housing. Lubricate NEW oil seal lip with gear lubricant. Using oil seal installer, install oil seal into housing bore until even with axle tube. To install remaining components, reverse removal procedure. Apply Loctite (GM 12345382) to threads of pinion shaft lockbolt. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**. Fill rear axle with gear lubricant.

OVERHAUL

NOTE: For overhaul procedures, use exploded views. See Fig. 2-Fig. 5 .

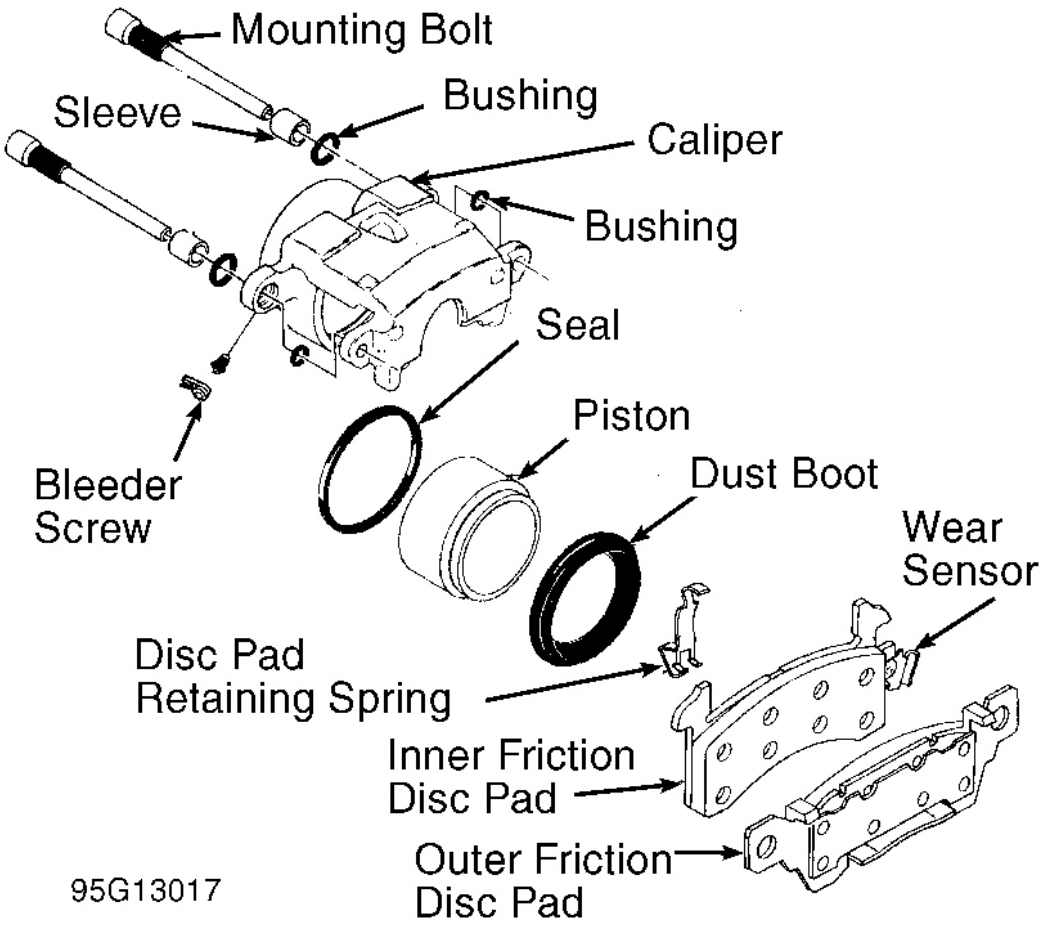
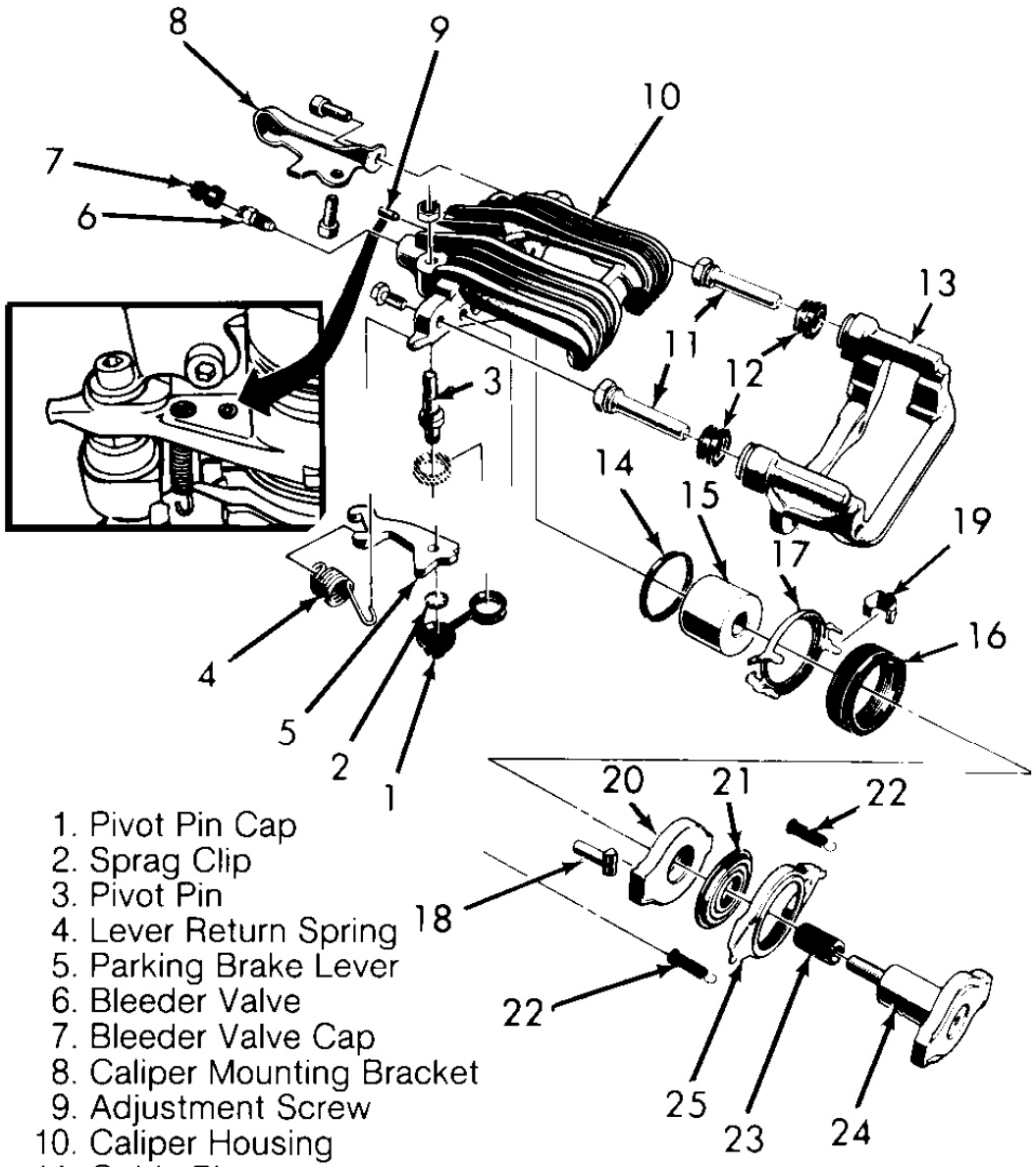


Fig. 2: Exploded View Of Front Brake Caliper
Courtesy of GENERAL MOTORS CORP.

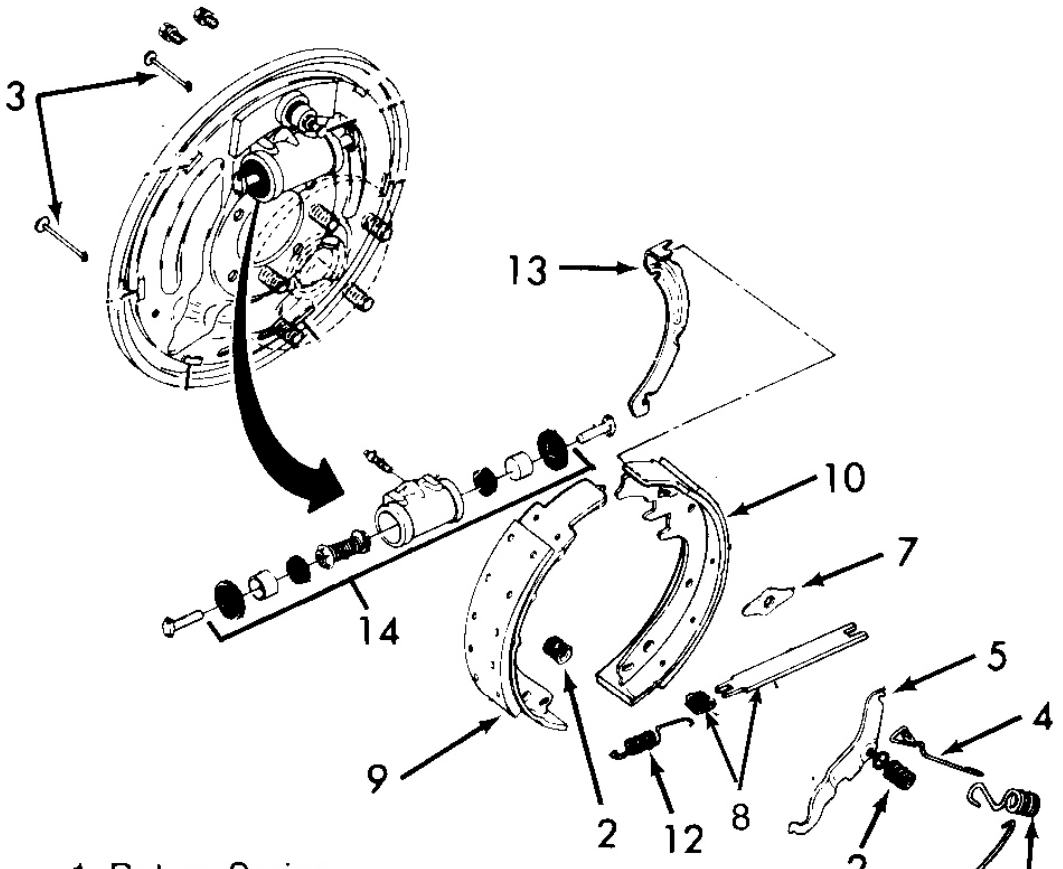


1. Pivot Pin Cap
2. Sprag Clip
3. Pivot Pin
4. Lever Return Spring
5. Parking Brake Lever
6. Bleeder Valve
7. Bleeder Valve Cap
8. Caliper Mounting Bracket
9. Adjustment Screw
10. Caliper Housing
11. Guide Pin
12. Boot
13. Caliper Mounting Bracket
14. Piston Seal
15. Piston
16. Boot
17. Retainer
18. Push Rod
19. Preload Spring
20. Actuating Collar
21. Boot
22. Collar Return Spring
23. Compliance Bushing
24. Clamp Rod
25. Retainer

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Fig. 3: Exploded View Of Rear Brake Caliper (Typical)

Courtesy of GENERAL MOTORS CORP.



1. Return Spring
2. Hold-Down Spring
3. Hold-Down Spring Pin
4. Actuator Link
5. Actuator
6. Adjuster Pawl & Spring
7. Shoe Guide
8. Parking Brake Lever Strut & Spring
9. Primary Shoe
10. Secondary Shoe
11. Adjuster Assembly
12. Adjuster Spring
13. Parking Brake Lever
14. Wheel Cylinder Assembly

NOTE: Left side is shown.

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Fig. 4: Exploded View Of Rear Drum Brake Assembly
Courtesy of GENERAL MOTORS CORP.

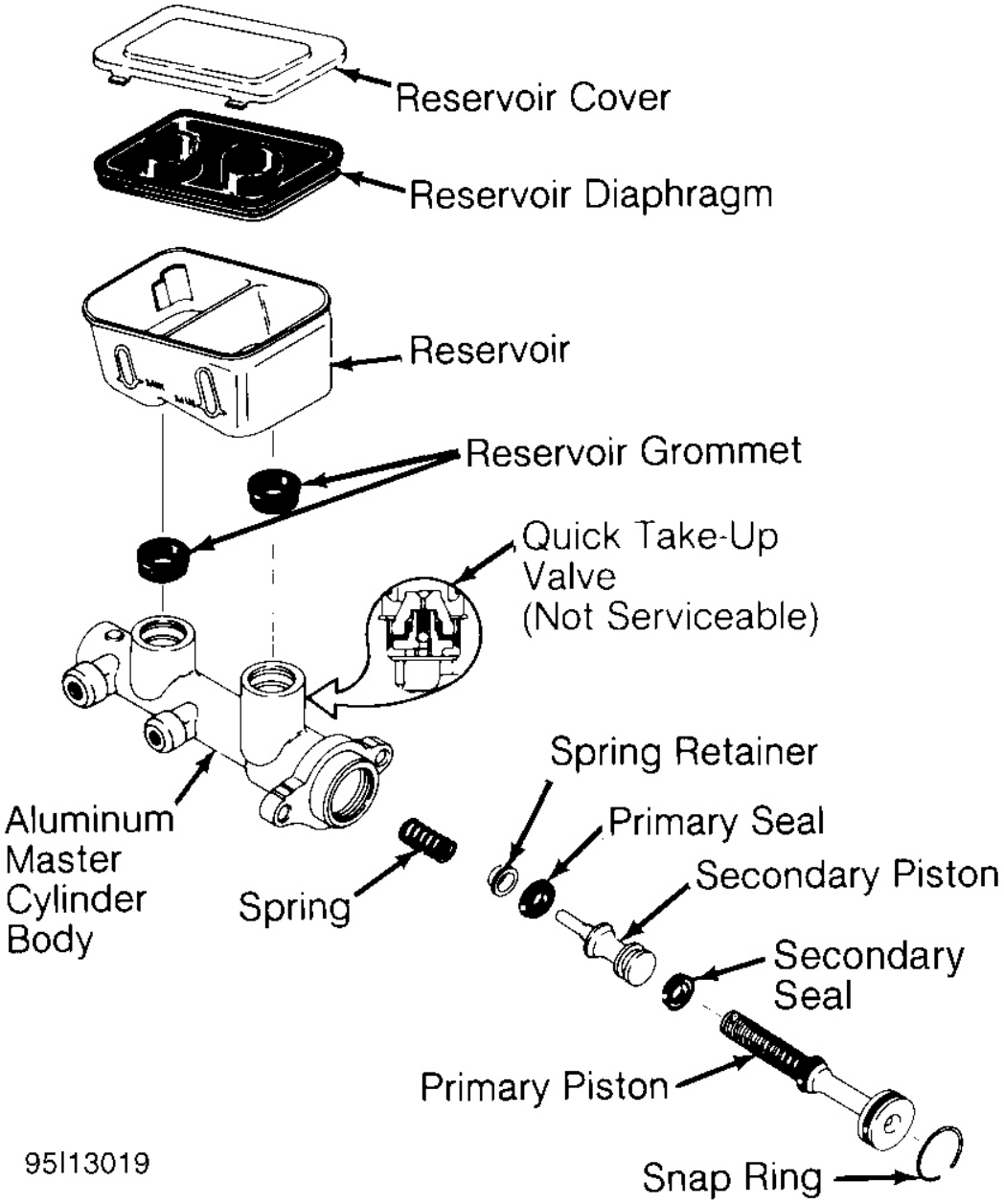


Fig. 5: Exploded View Of Master Cylinder
Courtesy of GENERAL MOTORS CORP.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)

Brakeline/Brake Hose Fitting	
At Caliper	32 (43)
At Combination Valve	11 (15)
At Master Cylinder	24 (33)
At Wheel Cylinder	18 (24)
Caliper Anchor Bracket Bolt	74 (100)
Caliper Bolt/Pin	
Front	38 (52)
Rear	23 (31)
Caliper Mounting Plate Bolt	35 (48)
Combination Valve-To-Booster Nut	20 (27)
Master Cylinder-To-Booster Nut	18 (24)
Pinion Shaft Lock Bolt (1)	37 (50)
Power Brake Booster-To-Firewall Nut	20 (27)
Rear Axle Fill Plug	26 (35)
Rear Axle Housing Cover Bolt	22 (30)
Wheel Cylinder Bolt	13 (18)
Wheel Lug Nut	100 (136)
	INCH lbs. (N.m)
Bleeder Screw	
At Caliper	115 (13)
At Wheel Cylinder	62 (7)
(1) Apply Loctite (GM 12345382) to bolt threads.	

DISC BRAKE SPECIFICATIONS

DISC BRAKE SPECIFICATIONS

Application	**In. (mm)**
Disc Diameter	
Front	12.000 (305.00)
Rear	11.614 (295.00)
Lateral Runout	
Front	.003 (.08)
Rear (On Vehicle)	.004 (.10)
Rear Axle Flange	.002 (.05)
Parallelism	.0005 (.013)
Original Thickness	
Front	1.043 (26.49)
Rear	.787 (20.00)
Minimum Refinish Thickness	
Front	.980 (24.89)

Rear	.735 (18.67)
Discard Thickness (1)	
Front	.965 (24.51)
Rear	.728 (18.49)
(1) Use specification stamped on rotor.	

DRUM BRAKE SPECIFICATIONS

DRUM BRAKE SPECIFICATIONS

Application	In. (mm)
Drum Diameter	
Heavy Duty	11.000 (279.40)
Standard	9.500 (241.30)
Maximum Refinish Diameter	
Heavy Duty	11.060 (280.92)
Standard	9.560 (242.82)
Discard Diameter (1)	
Heavy Duty	11.090 (281.69)
Standard	9.590 (243.59)
Drum Runout	.006 (.15)
(1) Use specification stamped on drum.	

HYDRAULIC COMPONENT SPECIFICATIONS

HYDRAULIC COMPONENT SPECIFICATIONS

Application	In. (mm)
Master Cylinder Bore	
Sedan & Wagon	1.125 (28.58)
Police W/4 Wheel Disc Brakes	1.251 (31.78)
Front Caliper Bore	2.952 (74.98)
Rear Caliper Bore	2.126 (54.00)
Wheel Cylinder Diameter	
Heavy Duty	1.00 (25.40)
Standard	.875 (22.22)

CABIN AIR FILTER

Cabin Air Filter (Special Applications) - General Information

CABIN AIR FILTER APPLICATIONS

NOTE: This article is generic in nature and applies to many different makes and models. We do our best to determine which vehicles do and do not have a cabin air filter.

The vehicle you have selected may not be equipped with a factory-installed cabin air filter or the manufacturer does not provide a removal & installation procedure.

Some vehicles may be equipped with dealer add-on or aftermarket versions. If the vehicle you are working on is equipped with such a filter, check the availability of the replacement filter which may help with the location and replacement information as some include this information in the packaging.

Vehicle manufacturers have many names for these filters including:

- A/C Air Filter
- A/C Filter
- Activated Charcoal Filter
- Air Conditioner Filter
- Air Refiner Filter
- Cabin Air Filter
- Clean Air Filter
- Climate Control Air Filter
- Combination Filter
- Dust & Pollen Filter
- Dust Filter
- Evaporator Air Filter
- HVAC Air Filter
- HVAC Ventilation Filter
- In-Cabin Microfilter
- Microfilter
- Particle Filter
- Particle/Odor Filter
- Particulate Air Filter
- Passenger Compartment Air Cleaner
- Passenger Compartment Air Filter
- Pollen Filter

- Underhood Air Filter
- Ventilation Air Filter

A/C COMPRESSOR REFRIGERANT OIL CHECKING

GENERAL SERVICING General Motors - Compressor Refrigerant Oil Checking

REFRIGERANT OILS

NOTE: For compressor application and specifications, see COMPRESSOR APPLICATIONS & BODY DESIGNATIONS tables and the REFRIGERANT OIL SPECIFICATIONS tables in the A/C COMPRESSOR SERVICING article in the GENERAL SERVICING section. DO NOT exceed A/C system refrigerant oil capacity when servicing system.

NOTE: Use ONLY the specified oil for the appropriate system or A/C compressor. Always check the underhood A/C specification label or A/C compressor label before adding refrigerant oil to A/C compressor/system.

Use only new, pure, moisture-free refrigerant oil in A/C systems. This oil is highly refined with a very low moisture content. Oil container must be tightly closed when not in use, or moisture from air will be absorbed into refrigerant oil.

Refrigerant R-12 based systems use mineral oil, while R-134a systems use synthetic/Polyalkylene Glycol (PAG) refrigerant oil. Using a mineral oil based lubricant with R-134a systems will result in A/C compressor failure due to lack of proper lubrication.

Different compressors have different lubrication requirements and use different specified Polyalkylene Glycol (PAG) refrigerant oils. Use only specified PAG refrigerant oil for the appropriate system and A/C compressor. Always check the underhood A/C specification label or A/C compressor label before adding refrigerant oil to A/C compressor/system. The following types of R-134a refrigerant oil are currently available.

GM

On all models except Saturn, use PAG Refrigerant Oil (Part No. 12345923). On Saturn, use Saturn PAG Refrigerant Oil.

NOTE: Synthetic/PAG oil absorbs moisture very rapidly, 2.3-5.6 percent by weight as compared to a mineral oil absorption rate of .005 percent by weight.

SERVICING PRECAUTIONS

DISCHARGING SYSTEM

If compressor has stem-type service valves, it can be isolated and removed without discharging entire system. Otherwise, discharge A/C system using approved refrigerant recovery/recycling equipment before loosening any fittings.

DISCONNECTING LINES & FITTINGS

After system is discharged, carefully clean area around all fittings to be opened. Always use 2 wrenches when loosening or tightening fittings. Some refrigerant lines are connected with a spring-lock coupling. Special tools may be required to disconnect lines. Cap all openings as soon as lines are removed. DO NOT remove caps until ready to connect lines and fittings.

NOTE: All R-134a based systems use 1/2-16 ACME threaded fittings. Ensure all replacement parts match the connections of the system being worked on.

CONNECTING LINES & FITTINGS

Always use new gasket or "O" ring when connecting lines or fittings. Coat "O" ring with specified refrigerant oil, and ensure it is not twisted during installation. To prevent damage to lines and fittings, always use 2 wrenches. Keep refrigerant oil off fitting threads. Long term contact of oil on threads may cause future damage to threads.

PLACING SYSTEM IN OPERATION

After component service or replacement has been completed, evacuate system thoroughly with a vacuum pump. Charge system with proper amount of refrigerant. See the REFRIGERANT OIL SPECIFICATIONS tables in the **A/C COMPRESSOR SERVICING** article. Perform leak test. After system has been leak tested, check system operation.

NOTE: A/C systems normally will not need additional refrigerant oil unless oil loss has occurred due to ruptured lines, leaking compressor seals, compressor overhaul or component replacement.

CHECKING COMPRESSOR OIL

HARRISON HD6/HR6-HE 6-CYLINDER, HR100T & HR110-MD 4-CYLINDER, & V5 5-CYLINDER

1. Operate system for several minutes to stabilize system, if possible. Turn engine off. Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove compressor. Drain refrigerant oil through compressor drain plug and measure oil.
2. If no oil leaks exist and more than one ounce is drained, add drained amount using new oil. If less than one ounce is drained, add 2 ounces of new oil.
3. If replacing A/C components, add specified amount of refrigerant oil to system. See HD6/HR6-HE, HR100T, HR110-MD & V5 COMPONENT REFRIGERANT OIL CAPACITIES table. Install drain plug and compressor. Evacuate and recharge system. Perform leak test.

NOTE: Approximately 3 ounces of refrigerant oil, suspended in refrigerant, will be lost due to a large, abrupt leak. When replacing faulty component, add required amount of oil for component plus 3 ounces of oil to component. If oil cannot be easily added to component, add to accumulator/receiver-drier.

HD6/HR6-HE, HR100T, HR110-MD & V5 COMPONENT REFRIGERANT OIL CAPACITIES

Component	Ounces
Accumulator/Receiver-Drier	
"G" Body	3.5
Except "G" Body	(1)
Condenser	1.0
Evaporator	3.0
"U" Body	
Rear Evaporator	2.0
Rear Evaporator Lines	1.0
(1) Add one ounce more than was drained from oil accumulator/receiver-drier.	

NIPPONDENSO 10PA17 & 10PA20 10-CYLINDER

1. Operate system for several minutes to stabilize system, if possible. Turn engine off. Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove compressor. Drain refrigerant oil, measure amount of oil removed and discard old oil. Add amount of oil drained from compressor plus one ounce of new refrigerant oil.
2. If replacing A/C components, add specified amount of refrigerant oil to component. See 10PA20 COMPONENT REFRIGERANT OIL CAPACITIES table for component capacities. If oil cannot easily be added to component, add oil to accumulator. Evacuate and recharge system. Perform leak test.

NOTE: Approximately 3 ounces of refrigerant oil, suspended in refrigerant, will be lost due to a large, abrupt leak. When replacing faulty component, add required amount of oil for component plus 3 ounces of oil to component. If oil cannot be easily added to component, add to accumulator.

10PA17 & 10PA20 COMPONENT REFRIGERANT OIL CAPACITIES

Component	Ounces
Accumulator	3.5
Compressor	(1)
Condenser	1.0
Evaporator	3.0
(1) Drain oil from compressor, and then add drained amount plus one ounce.	

SANDEN SD-7H15 7-CYLINDER

1. It is not necessary to check oil level in compressor or to add oil unless there has been an oil loss. Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove compressor. Drain refrigerant oil, measure amount of oil removed and discard old oil.
2. If no oil leaks exist and more than one ounce is drained from compressor, add drained amount using new refrigerant oil specified for compressor. If less than one ounce is drained, add 2 ounces of new refrigerant oil specified for compressor.

3. If replacing A/C components, add specified amount of refrigerant oil to component. See SD-7H15 COMPONENT REFRIGERANT OIL CAPACITIES table for component capacities. If oil cannot easily be added to component, add oil to accumulator. Evacuate and recharge system. Perform leak test.

SD-7H15 COMPONENT REFRIGERANT OIL CAPACITIES

Component	Ounces
"P" Series	
Compressor	(1)
Condenser	1.0
Evaporator	3.0
Accumulator	3.5
(1) If no oil leaks exist and more than one ounce is drained, add drained amount using new oil specified for compressor. If less than one ounce is drained, add 2 ounces of new oil specified for compressor.	

ZEXEL ROTARY VANE

1. Slowly discharge A/C system using approved refrigerant recovery/recycling equipment. Remove old A/C compressor. Install compressor oil drain Adapters (SA9149AC-5 and SA9149AC-6) to service ports. Drain compressor oil. Measure amount drained, and discard oil.
2. Ensure amount of refrigerant oil in replacement compressor is the same as amount removed from old compressor (total system capacity minus amount retained in components that have not been replaced). See ZEXEL COMPONENT REFRIGERANT OIL CAPACITIES table. See the REFRIGERANT OIL SPECIFICATIONS tables in the **A/C COMPRESSOR SERVICING** article for total system capacity. Install compressor. Evacuate and recharge A/C system. Perform leak test.

ZEXEL COMPONENT REFRIGERANT OIL CAPACITIES

Component	Ounces
System Total	6.0
Condenser	0.8
Evaporator	2.3
Receiver-Drier	1.0

A/C COMPRESSOR SERVICING

GENERAL SERVICING General Motors - Compressor Servicing CAPACITIES

NOTE: **Due to late changes, always refer to underhood A/C specification label in engine compartment or A/C compressor label while servicing A/C system. If A/C specification label and specifications listed here differ, use label specifications.**

REFRIGERANT OIL & R-134a REFRIGERANT CAPACITY (CARS)

Application (1)	(2) (3) Oil - Ounces	Refrigerant - Ounces
"A" Body		
2.2L	9.0	28.0
3.1L	9.0	32.0
"B" Body	8.0	28.0
"C" & "H" Bodies	8.0	38.7
"D" Body	8.0	28.0
"E" & "K" Bodies	8.0	32.0
"F" Body	8.0	32.0
"G" Body	8.0	32.0
"J" Body	9.0	24.0
"L" Body	9.0	36.0
"N" Body	9.0	36.0
"W" Body	8.0	32.0
"Y" Body	8.0	32.0
"Z" Body (Saturn)	(4) 6.0	24.0

(1) Body codes are determined by fourth character of VIN code.

(2) Total system capacity, unless otherwise noted.

(3) Use PAG Oil (Part No. 12345923).

(4) Use Saturn PAG oil.

REFRIGERANT OIL & R-134a REFRIGERANT CAPACITY LIGHT TRUCKS & VANS)

Application (1)	Oil Ounces (2)	Refrigerant Ounces
"C" & "K" Series (3)		
Pickup & Sierra	8.0	32.0
Crew Cab & Utility	8.0	36.0
Suburban, Tahoe & Yukon (3)		
With Rear Unit	11.0	64.0

Without Rear Unit	8.0	36.0
"G" Series (3)		
With Rear Unit	11.0	68.0
Without Rear Unit	8.0	48.0
"L" & "M" Series (3)		
With Rear Unit	11.0	48.0
Without Rear Unit	8.0	32.0
"P" Series	8.0 (4)	48.0
"S" & "T" Series (3)		
HR100T & HR110-MD	8.0	32.0
V5	9.0	32.0
"U" Series (3)		
With Rear Unit	11.0	48.0
Without Rear Unit	8.0	36.0

(1) Series codes are determined by fifth character of VIN code.

(2) Total system capacity, unless otherwise noted.

(3) Use PAG Oil (Part No. 12345923).

(4) Use PAG Oil (Part No. 12345923 for 5.7L and 6.5L engines; Part No. 12346075 for 7.4L engines).

COMPRESSOR APPLICATIONS

COMPRESSOR APPLICATIONS (CARS)

Application	Compressor
(1)	
"A" Body	Harrison V5 5-Cyl.
"B" Body	Harrison HD6/HR6-HE 6-Cyl.
"D" Body	Harrison HD6/HR6-HE 6-Cyl.
"C", "E", "H" & "K" Bodies	Harrison HD6/HR6-HE 6-Cyl.
"F" Body	Harrison HD6/HR6-HE 6-Cyl. Or Harrison V5 5-Cyl.
"G" Body	Harrison HD6/HR6-HE 6-Cyl.
"J", "L" & "N" Bodies	Harrison V5 5-Cyl.
"W" Body	Harrison HD6/HR6-HE 6-Cyl. Or V5 5-Cyl.
"Y" Body	Nippondenso 10PA17/10PA20 10-Cyl.
"Z" Body (Saturn)	Zexel Rotary Vane

(1) Body codes are determined by fourth character of VIN code.

COMPRESSOR APPLICATIONS (LIGHT TRUCKS & VANS)

Application (1)	Compressor

"C" & "K" Series	Harrison HR110-MD 4-Cyl.
"G" Series	Harrison HD6 6-Cyl.
"L" & "M" Series	Harrison HR6-HE 6-Cyl.
"P" Series	Harrison HR110-MD 4-Cyl. Or HR6-HE 6-Cyl., Or Sanden SD-7H15 7-Cyl.
"S" & "T" Series	Harrison V5 5-Cyl. Or HR100T/HR110-MD 4-Cyl.
"U" Series	Harrison V5 5-Cyl. Or HD6/HR6-HE 6-Cyl.
(1) Series codes are determined by fifth character of VIN code.	

BODY DESIGNATIONS

BODY DESIGNATIONS (CARS)

Body Designation (1)	**Model**
"A" Body	Century, Cutlass Ciera & Cutlass Cruiser
"B" Body	Caprice, Impala SS & Roadmaster
"C" Body	Ninety Eight & Park Avenue
"D" Body	Fleetwood
"E" Body	Eldorado
"F" Body	Camaro & Firebird
"G" Body	Aurora & Riviera
"H" Body	Bonneville, Eighty Eight & LeSabre
"J" Body	Cavalier & Sunfire
"K" Body	Concours, DeVille & Seville
"L" Body	Beretta & Corsica
"N" Body	Achieva, Grand Am & Skylark
"W" Body	Cutlass Supreme, Grand Prix, Lumina, Monte Carlo & Regal
"Y" Body	Corvette
"Z" Body	Saturn
(1) Body codes are determined by fourth character of VIN code.	

BODY DESIGNATIONS (LIGHT TRUCKS & VANS)

Model	**(1) Body Designation**
Astro & Safari	
2WD	"M" Series
4WD	"L" Series
Blazer, Pickup, Sierra,	
Suburban, Tahoe & Yukon	
2WD	"C" Series
4WD	"K" Series

Lumina APV, Silhouette &	
Trans Sport	"U" Series
Blazer, Jimmy, Pickup & Sonoma	
2WD	"S" Series
4WD	"T" Series
Commercial Van & Chassis	"P" Series
Van	"G" Series
(1) Series codes are determined by fifth character of VIN code.	

HARRISON HD6/HR6-HE 6-CYLINDER & V5 5-CYLINDER

CLUTCH ASSEMBLY

CAUTION: DO NOT hammer on compressor shaft to remove clutch plate, as compressor damage will result.

Removal

1. Remove compressor from vehicle and support using Holding Fixture (J-33026 for HD6/HR6-HE compressor or J-34992 for V5 compressor). Using Clutch Plate Spanner (J-25030 for HD6/HR6-HE compressor or J-33027-A for V5 compressor), hold clutch plate and remove compressor shaft nut.
2. Use Clutch Plate Remover/Installer (J-33013-B) to remove clutch plate. See **Fig. 1** or **Fig. 2**. Remove key from shaft. Remove snap ring. Install Guide (J-33022) on front head. Position Puller (J-33020) in slots on pulley assembly. Tighten puller and remove pulley assembly.
3. Use hammer and Bearing Remover (J-9398-A) to drive bearing from pulley. Disconnect clutch coil lead.
4. Scribe marks on compressor and clutch coil for installation reference. Remove clutch coil using Puller Adapter (J-33023-A) and 2-jaw puller.

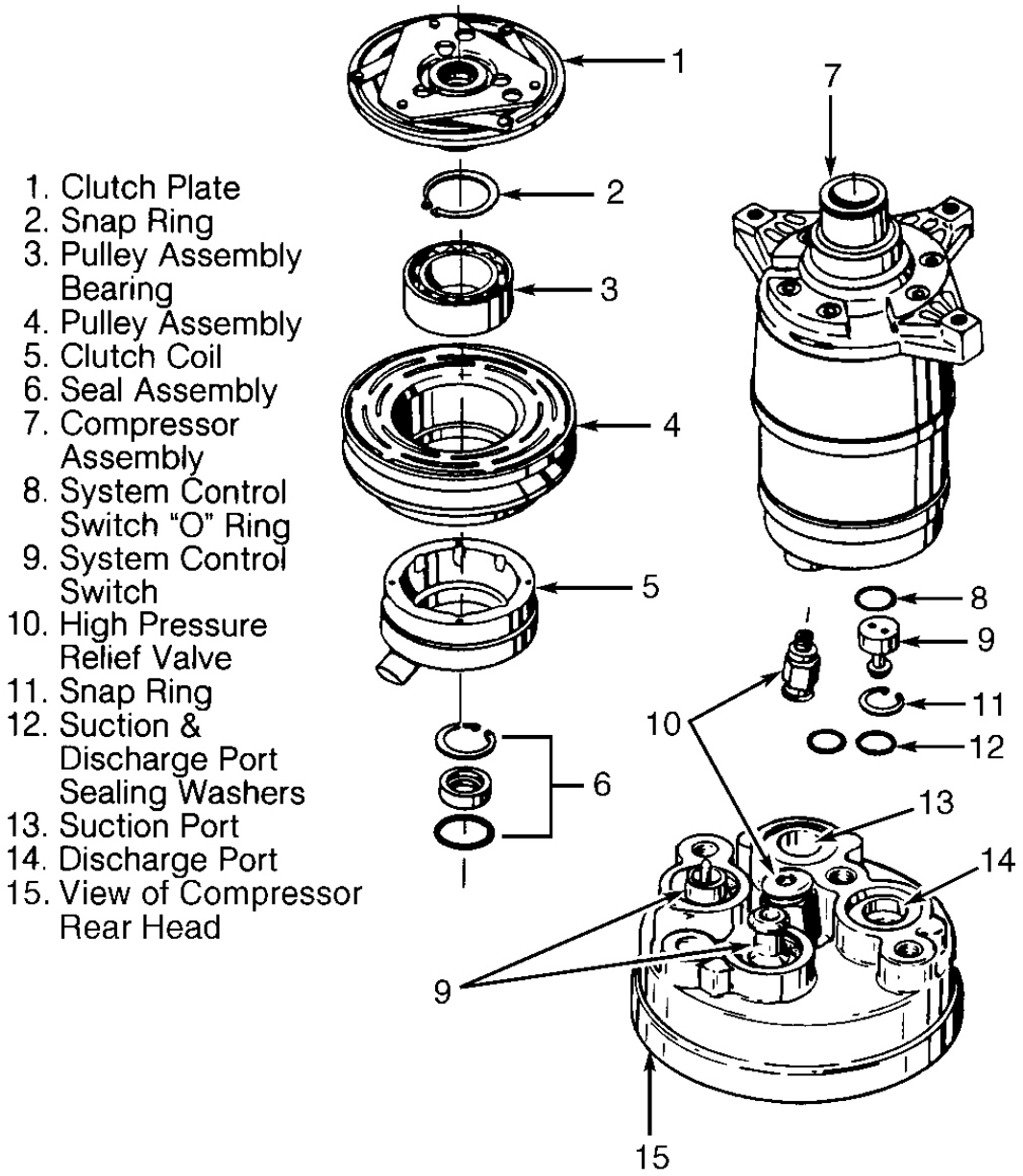


Fig. 1: Compressor Components (Harrison HD6/HR6-HE 6-Cyl.)
Courtesy of GENERAL MOTORS CORP.

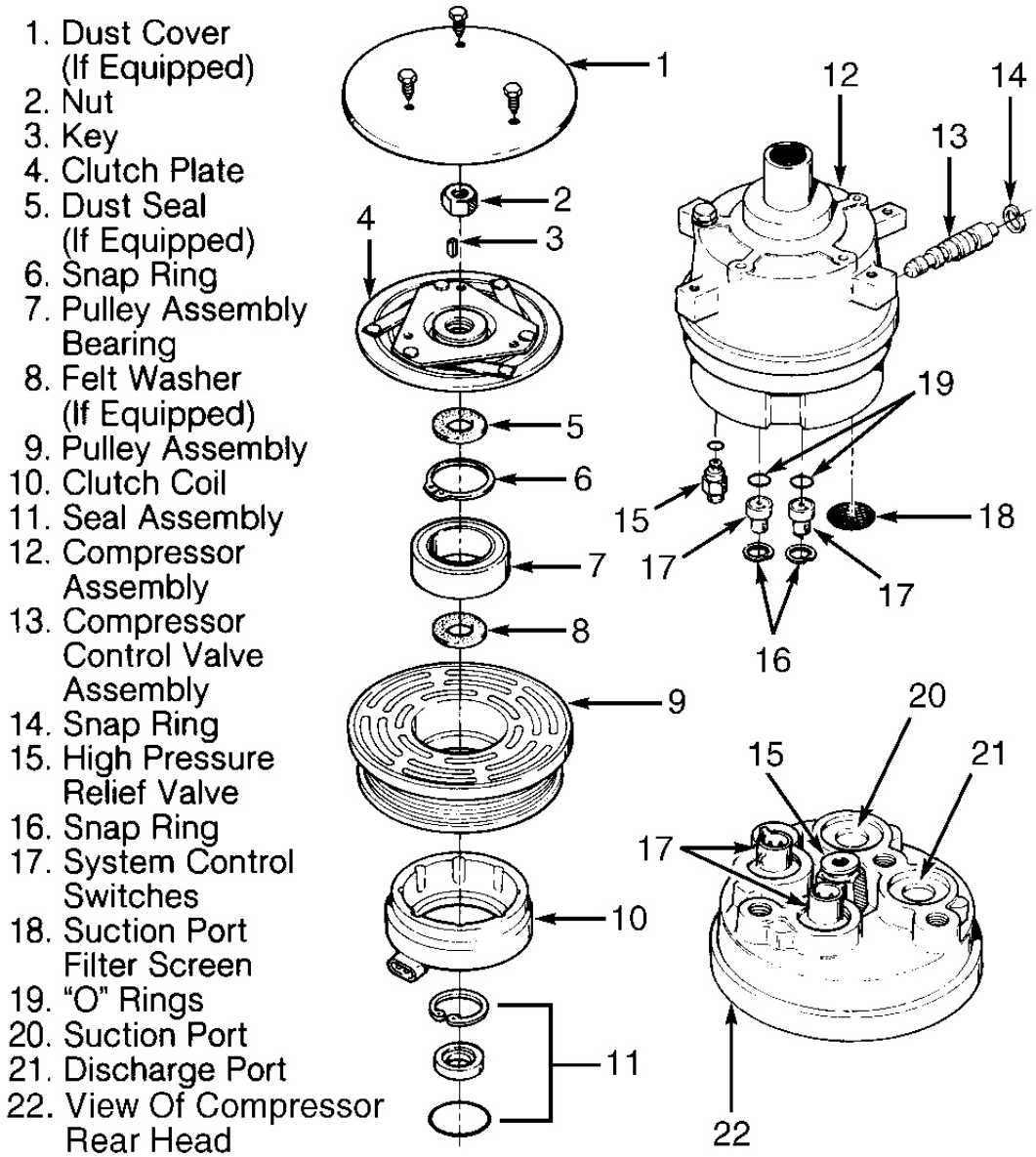


Fig. 2: Compressor Components (Harrison V5 5-Cyl.)
Courtesy of GENERAL MOTORS CORP.

Installation

1. Align reference marks made during removal. Using Puller Adapter (J-33023-A) and Puller Bar (J-8433-1), press clutch coil onto compressor. Stake clutch coil inner ring in 3 places, 120 degrees apart.
2. If bearing was removed from pulley, place pulley on Support(J-21352-A). DO NOT support pulley on flat surface, or pulley will be damaged. Install bearing in pulley using hammer, Handle (J-29886) and Bearing

Installer (J-9481-A).

3. With pulley on support, stake pulley in 3 places, 120 degrees apart. Position pulley on compressor.
4. Place Bearing Installer (J-33017) and Puller Guide (J-33023-A) over inner race of bearing. Using puller, press pulley assembly onto compressor. Install snap ring. Install key in clutch plate, allowing key to protrude about 1/8" from rear of clutch plate.
5. Install clutch plate on compressor shaft. Using clutch plate remover/installer, press clutch plate onto compressor. Clutch assembly clearance for HD6/HR6-HE compressor is .020-.030" (.51-.76 mm) and for V5 compressor is .015-.020" (.38-.51 mm).
6. Using spanner, install compressor shaft nut. Tighten shaft nut to 12.5 ft. lbs. (17 N.m). Check components for proper rotation.

SHAFT SEAL

Removal

1. Discharge A/C system using approved refrigerant recovery/recycling equipment. Using Clutch Plate Spanner (J-25030 for HD6/HR6-HE compressor or J-33027-A for V5 compressor), hold clutch plate and remove compressor shaft nut. Thread Clutch Plate Remover/Installer (J-33013-B) into clutch plate, and remove clutch plate. See **Fig. 1** or **Fig. 2**.
2. Remove shaft seal snap ring. Ensure all surfaces around seal are clean. Install Shaft Seal Protector (J-34614) over compressor shaft. Insert Shaft Seal Remover/Installer (J-23128-A) into shaft seal.
3. Rotate handle clockwise to seat seal remover/installer in seal. Remove shaft seal. Using "O" Ring Remover (J-9553-01), remove "O" ring.

Installation

1. With shaft seal protector in place, lubricate new "O" ring with refrigerant oil and install it on "O" Ring Installer (J-33011).
2. Insert "O" ring installer in compressor until it bottoms. Move slide on "O" ring installer downward until "O" ring is released into groove. Rotate installer to seat "O" ring. Remove "O" ring installer.
3. Lubricate shaft seal with refrigerant oil. Expand seal using shaft seal remover/installer. Install seal on Seal Protector (J-34614). Place seal protector over shaft.
4. Push shaft seal into compressor using a rotary motion until seal bottoms. Install new snap ring with flat side against seal. Install clutch plate on compressor shaft.
5. Using clutch plate remover/installer, press clutch plate onto compressor until a clutch assembly. Clutch assembly clearance for HD6/HR6-HE compressor is .020-.030" (.51-.76 mm) and for V5 compressor is .015-.020" (.38-.51 mm).
6. Using spanner, install compressor shaft nut and tighten it to 12.5 ft. lbs. (17 N.m). Evacuate and recharge system. Check for leaks.

HARRISON HR100T & HR110-MD 4-CYLINDER

CLUTCH PLATE

Removal

1. If compressor is on vehicle, loosen mounting brackets, disconnect drive belt and position compressor for easy access. Using a spanner wrench, remove shaft nut (if equipped). It is not necessary to discharge system. If compressor has been removed from vehicle, use Holding Fixture (J-25008-A) and vise to support compressor.
2. Thread Clutch Plate Remover (J-33013-B) into clutch plate. Hold body of clutch plate remover. Tighten center bolt to remove clutch plate. Remove compressor shaft key. See **Fig. 3**.

Installation

1. Install compressor shaft key, allowing key to protrude about 3/16" from rear of clutch plate. Install clutch plate onto compressor shaft.
2. Using Clutch Plate Installer (J-9401-B), press clutch plate onto compressor until clearance between clutch plate and pulley assembly is .015-.020" (.38-.51 mm). To complete installation, reverse removal procedure.

BELT PULLEY

Removal (Serpentine Belt Pulley)

1. Remove clutch plate. See CLUTCH PLATE. Remove pulley assembly snap ring. Install Pulley Rotor and Puller Guide (J-25031) to pulley assembly. Install Pulley Rotor and Bearing Puller (J-33020) down into inner circle of slots in pulley assembly.
2. Turn puller clockwise to engage puller tangs with segments between pulley assembly slots. Tighten puller center screw against puller guide to remove pulley assembly from compressor.
3. If removing bearing, remove center screw from puller. Do not remove puller from pulley assembly slots. Invert assembly and use puller for support on a solid surface.
4. Using hammer, Handle (J-29886) and Bearing Remover (J-9398-A), drive bearing from pulley assembly hub. Using a file, remove old stake metal from pulley assembly to provide clearance for new bearing.
5. Scribe reference marks on compressor and clutch coil for installation reference. Install puller guide on compressor shaft. Using Puller (J-25287), pull clutch coil from compressor.

CAUTION: Ensure protrusions on rear of clutch coil align with holes in front head.

Installation

1. Using hammer, Handle (J-29886) and Rotor/Bearing Installer (J-26271-A), install clutch coil. Ensure reference marks align.
2. If bearing was removed, use Support Block (J-21352-A) and support pulley assembly. DO NOT support pulley assembly on a flat surface during bearing installation, or assembly will be damaged.
3. Using hammer, Handle (J-29886) and Bearing Installer (J-9481-A), install bearing fully into pulley hub. Using Bearing Staking Guide (J-33019-1) and Bearing Staking Pin (J-33019-2), stake rotor in 3 places, 120 degrees apart. Create metal stake down to, but not touching bearing.
4. Install rotor assembly on front head. Drive rotor on front head using hammer, Handle (J-29886) and Rotor/Bearing Installer (J-26271-A). Install snap ring. Install clutch plate. See CLUTCH PLATE.

5. Check components for proper rotation. If compressor was removed from vehicle, ensure compressor contains proper amount of oil. Install compressor. Evacuate and recharge system. Check for leaks.

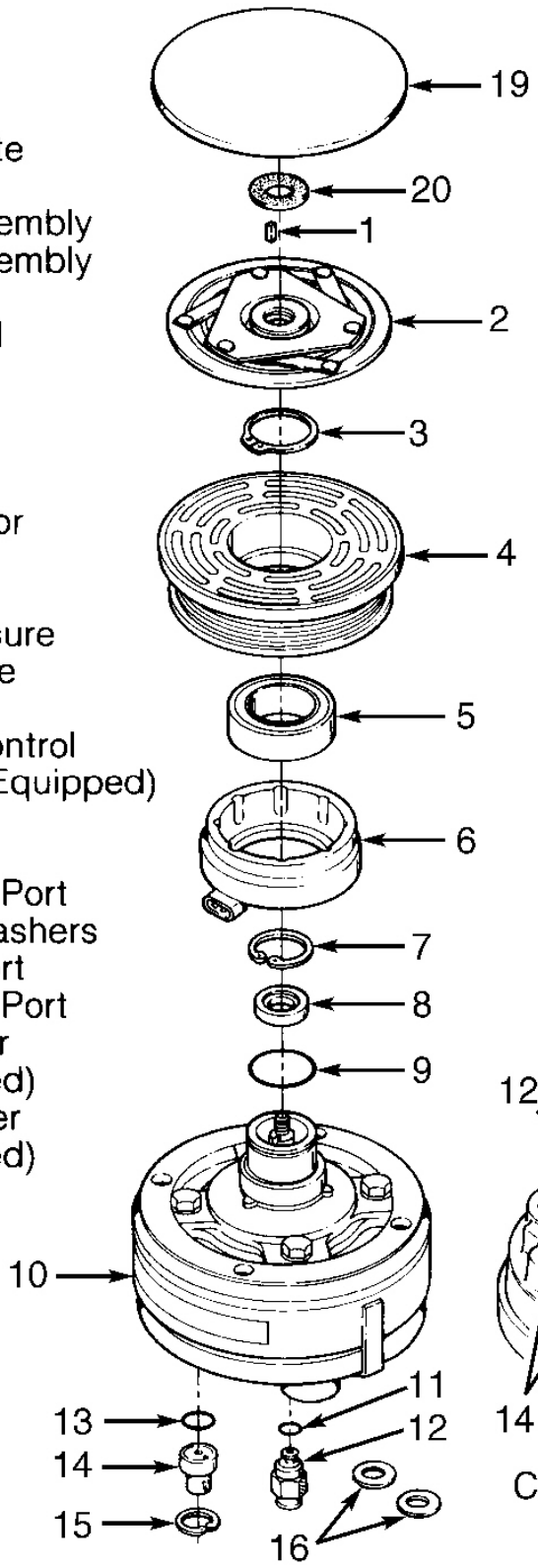
Removal ("V" Groove Belt Pulley)

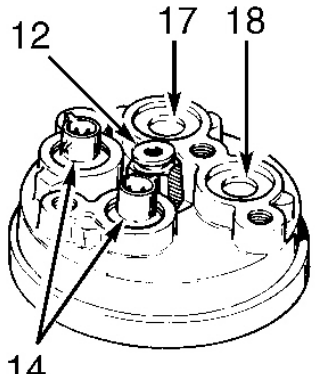
1. Remove clutch plate. See CLUTCH PLATE. Remove pulley assembly snap ring. Install Pulley Rotor and Puller Guide (J-25031) to pulley assembly. Install Pulley Rotor and Bearing Puller (J-33020) down into inner circle of slots in pulley assembly.
2. Turn puller clockwise to engage puller tangs with segments between pulley assembly slots. Tighten puller center screw against puller guide to remove pulley assembly from compressor.
3. Scribe reference marks on compressor and clutch coil for installation reference. Install Pulley Rotor and Puller Guide (J-25031) to pulley assembly. Using a 2-jaw puller, remove clutch coil from front head of compressor.

Installation

1. Install clutch coil on compressor neck. Use reference marks to ensure clutch coil terminals are in correct position. Place pulley assembly on neck of compressor front head. Using a hammer and Rotor And Bearing Installer (J-26271-A), install clutch coil and pulley assembly.
2. Before fully seating clutch coil and pulley assembly, ensure protrusions on rear of clutch coil align with holes in front compressor head. Install snap ring and install clutch plate. See CLUTCH PLATE.
3. Using spanner wrench, install new compressor shaft nut (if equipped) and tighten it to 10 ft. lbs. (14 N.m). Check components for proper rotation. If compressor was removed from vehicle, ensure compressor contains proper amount of oil. Install compressor. Evacuate and recharge system. Check for leaks.

1. Key
2. Clutch Plate
3. Snap Ring
4. Pulley Assembly
5. Pulley Assembly Bearing
6. Clutch Coil
7. Snap Ring
8. Shaft Seal
9. Shaft Seal "O" Ring
10. Compressor Assembly
11. "O" Ring
12. High Pressure Relief Valve
13. "O" Ring
14. System Control Switch (If Equipped)
15. Snap Ring
16. Suction & Discharge Port Sealing Washers
17. Suction Port
18. Discharge Port
19. Dust Cover (If Equipped)
20. Felt Washer (If Equipped)





VIEW OF COMPRESSOR REAR HEAD

95B17633

Fig. 3: Compressor Components (Harrison HR100T & HR110-MD 4-Cyl)
Courtesy of GENERAL MOTORS CORP.

SHAFT SEAL

Removal

1. Discharge A/C system using approved refrigerant recovery/recycling equipment. Use Clutch Plate Spanner (J-33027-A) to remove compressor shaft nut. Thread Clutch Plate Remover (J-33013-B) into clutch plate. Hold body of clutch plate remover. Tighten center bolt to remove clutch plate. Remove compressor shaft key. See **Fig. 3**.
2. Remove shaft seal snap ring. Ensure seal area on compressor is clean. Insert Shaft Seal Remover/Installer (J-23128-A) into shaft seal.
3. Rotate handle clockwise and remove shaft seal. Using "O" Ring Remover (J-9553-01), remove "O" ring.

Installation

1. Lubricate new "O" ring with refrigerant oil, and install it on "O" Ring Installer (J-33011). Insert "O" ring installer in compressor until installer bottoms.
2. Move slide on "O" ring installer downward until "O" ring is released into lower groove. The top groove is for snap ring. Rotate installer to seat "O" ring.
3. Coat shaft seal with refrigerant oil. Install seal on shaft seal remover/installer. Expand seal using shaft seal remover/installer.
4. Install Shaft Seal Protector (J-34614) through seal. Install seal on shaft seal protector so seal lip is toward compressor. Remove shaft seal remover/installer.
5. Install shaft seal protector over end of compressor shaft. Push shaft seal into compressor until it bottoms. Install new shaft seal snap ring with flat side against seal.
6. Install compressor shaft key, allowing key to protrude about 3/16" (4.8 mm) from rear of clutch plate. Install clutch plate on compressor shaft.
7. Using Clutch Plate Installer (J-9401-B), press clutch plate onto compressor until clearance between clutch plate and rotor is .020-.030" (.51-.76 mm).
8. Using spanner, install new compressor shaft nut (if equipped) and tighten it to 10 ft. lbs. (14 N.m). Check components for proper rotation. Install compressor. Evacuate and recharge system. Check for leaks.

NIPPONDENSO 10PA17/10PA20 10-CYLINDER

CLUTCH ASSEMBLY

Removal

1. Hold clutch using Clutch Holder (J-33027-A). Remove compressor shaft bolt. Remove clutch plate and shims.
2. Remove pulley assembly snap ring. Remove pulley assembly and snap ring. Disconnect clutch coil lead. Remove clutch coil. See **Fig. 4**.

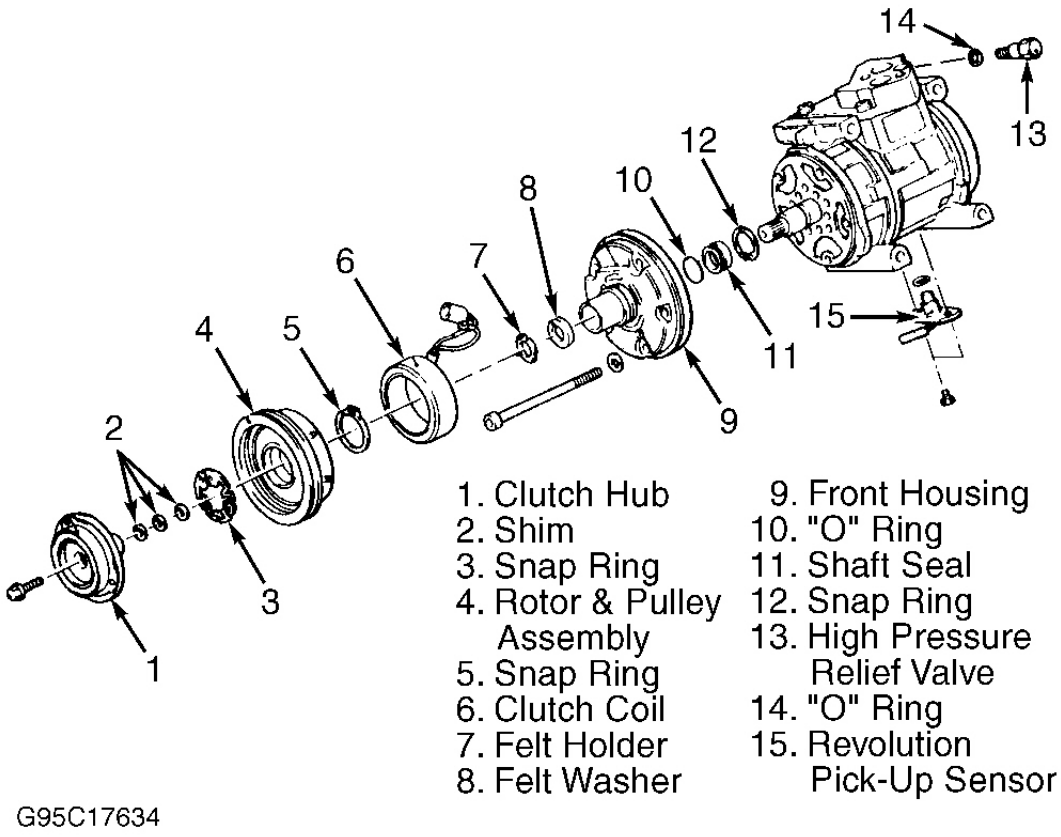


Fig. 4: Compressor Components (Typical)
Courtesy of CHRYSLER CORP.

Installation

1. Install clutch coil so pin in back of coil aligns with hole in front housing. Install snap ring.
2. Install pulley assembly and snap ring. Install clutch plate and shims. Tighten compressor shaft bolt to 10 ft. lbs. (14 N.m). DO NOT use air tools to tighten bolt.
3. Using a feeler gauge, measure air gap between clutch plate and pulley surface in 3 areas. Proper clearance is .014-.026" (.36-.66 mm). Adjust shim thickness to obtain correct clearance.
4. Once compressor shaft bolt is tightened, recheck clearance between clutch plate and pulley surface in 4 places. Readjust clearance if necessary.

SANDEN SD-7H15 7-CYLINDER

CLUTCH ASSEMBLY

Removal

1. Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove compressor. Drain oil from compressor, and measure amount drained.
2. Using Spanner (J-37872), hold clutch and remove compressor shaft nut. Using Puller (J-37825), remove clutch plate. Remove key from compressor shaft.
3. Remove pulley external snap ring. Install jaws of Puller (J-37828) in snap ring groove on pulley.
4. Install puller plate on jaws. Thread 2 bolts through puller plate into jaws finger tight. Tighten pulley center bolt and remove pulley from compressor. Remove clutch coil snap ring and clutch coil.

Installation

1. Install clutch coil and clutch coil snap ring on compressor. Support compressor on rear mounting ears.
2. Use a hammer, Handle (J-29886) and Driver (J-38467), install pulley assembly. Ensure driver rests on inner race of bearing when installing pulley assembly. Install external snap ring.
3. Install original shims. Use a hammer and Shaft Protector (J-29640) to install clutch plate on compressor shaft. Tighten compressor shaft nut to 124 INCH lbs. (14 N.m).
4. Using feeler gauge, measure clearance between clutch plate and pulley assembly in several areas. Clearance should be .016-.031" (.41-.79 mm). If clearance is not within specification, adjust shim thickness to obtain correct clearance.

ZEXEL ROTARY VANE

CLUTCH ASSEMBLY

NOTE: Removing compressor is not necessary to service clutch assembly.

Removal

1. Loosen tensioner and remove drive belt from pulley. Remove coolant/washer reservoir screws. Disconnect electrical harness from coolant reservoir. Release heater return pipe clips. Lift coolant/washer reservoir out of the way.
2. Using Clutch Holder (SA9149AC-4) and 10-mm deep socket, remove clutch drive plate center bolt. Insert drive plate holder sleeve into drive plate. Install remover bolt. While holding clutch remover handle, tighten remover bolt to remove drive plate. DO NOT lose shims.
3. Remove pulley snap ring. Position puller Center Adapter (SA9149AC-2) over end of compressor shaft. Attach 3-jaw puller to back of pulley. Tighten puller bolt against center adapter. Remove pulley. Remove clutch coil screws. Disconnect clutch coil wire. Remove clutch coil.

Installation

1. Install coil in original position. Tighten screws to 35-52 INCH lbs. (3.9-5.9 N.m). Install drive bolt, Drive Plate Installer (SA9149AC-3) and thrust bearing assembly through center of pulley. Finger tighten pulley installation bolt into compressor shaft.
2. Finger tighten nut on installation bolt to align pulley to compressor. Tighten nut until pulley bottoms in compressor. Loosen nut and remove installation bolt. Install snap ring with tapered side out.

3. Install drive plate on holder. Place thrust bearing on installation bolt. Insert installation bolt through drive plate. Place shims on installation bolt. Thread bolt into compressor shaft. Slide drive plate over splines of compressor shaft.
4. While holding end of installation bolt, tighten nut until drive plate bottoms. Loosen nut and remove installation bolt. Install center bolt. Tighten center bolt to 104-130 INCH lbs. (11.8-14.7 N.m).
5. Using a feeler gauge, measure clearance between drive plate and pulley. Clearance should be .01"-.02" (.3-.5 mm). If clearance is not as specified, add or remove shims as necessary.

COOLING SYSTEM SPECIFICATIONS

BELT TENSION SPECIFICATIONS

BELT TENSION SPECIFICATIONS

Application	(1) (2) Lbs. (kg)
2.2L	
Except "A" Body	64-77 (29-35)
"A" Body	51-71 (23-32)
2.3L	51 (23)
3.1L	51-71 (23-32)
All Others	(3)

(1) Specification is for NEW belt.

(2) Serpentine belt is automatically adjusted by the tensioner.

(3) Information is not available from manufacturer.

COOLING SYSTEM SPECIFICATIONS

COOLING SYSTEM SPECIFICATIONS

Application	Specification
Coolant Replacement Interval	30,000 Miles
Coolant Capacity (1)	
2.2L	
"A" Body	8.7 Qts. (8.3L)
"J" Body	13.1 Qts. (12.4L)
"L" Body	9.5 Qts. (9.0L)
2.3L	10.4 Qts. (9.8L)
3.1L	
Except "A" Body	12.7 Qts. (12.0L)
"A" Body	13.1 Qts. (12.4L)
3.4L	12.7 Qts. (12.0L)
3.8L	13.0 Qts. (12.3L)
4.0L	13.0 Qts. (12.3L)
4.3L	
With Heavy Duty Radiator	14.6 Qts. (13.8L)
Without Heavy Duty Radiator	14.3 Qts. (13.5L)
5.7L	

Camaro & Firebird	
Automatic Transmission	15.3 Qts. (14.5L)
Manual Transmission	15.1 Qts. (14.3L)
Corvette	17.8 Qts. (16.9L)
All Others	
With Heavy Duty Radiator	14.6 Qts. (13.8L)
Without Heavy Duty Radiator	14.3 Qts. (13.5L)
Pressure Cap	
"L" Body	18 psi
Saturn	18 psi
All Others	15 psi
Thermostat	
Bonneville, Eighty Eight, LeSabre, Ninety Eight & Park Avenue	
Starts To Open	196°F (91°C)
Fully Opens	223°F (106°C)
Corvette	
Starts To Open	185°F (85°C)
Fully Opens	217°F (103°C)
All Others	
Starts To Open	189°F (87°C)
Fully Opens	207°F (97°C)
(1) Specification is approximate and includes heater capacity.	

CRUISE CONTROL SYSTEM

ACCESSORIES & SAFETY EQUIPMENT General Motors Corp. Cruise Control System

DESCRIPTION & OPERATION

WARNING: To avoid injury from accidental air bag deployment, read and carefully follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in the appropriate AIR BAG RESTRAINT SYSTEM article.

Cruise control system uses a control module to obtain desired vehicle cruise operation. An electronic controller and an electric stepper motor are 2 important components in the cruise control module. Controller monitors vehicle speed and operates electric stepper motor. Stepper motor moves throttle linkage.

Cruise control module contains a low speed limit to prevent cruise engagement below a minimum speed of 25 MPH. System capabilities include cruise, coast, resume speed, accelerate, "tap-up" and "tap-down". Control switches located on multifunction turn signal lever operate controller. Electric brake switches mounted on brake pedal bracket disengage cruise system when brake pedal is depressed.

ENGAGEMENT SWITCH

The engagement switch turns cruise control system on and off. With switch pushed to ON position and SET button pushed in, cruise speed should be maintained. With cruise in RESUME/ACCELERATE (R/A) position, cruise speed can be resumed after slowing down or stopping.

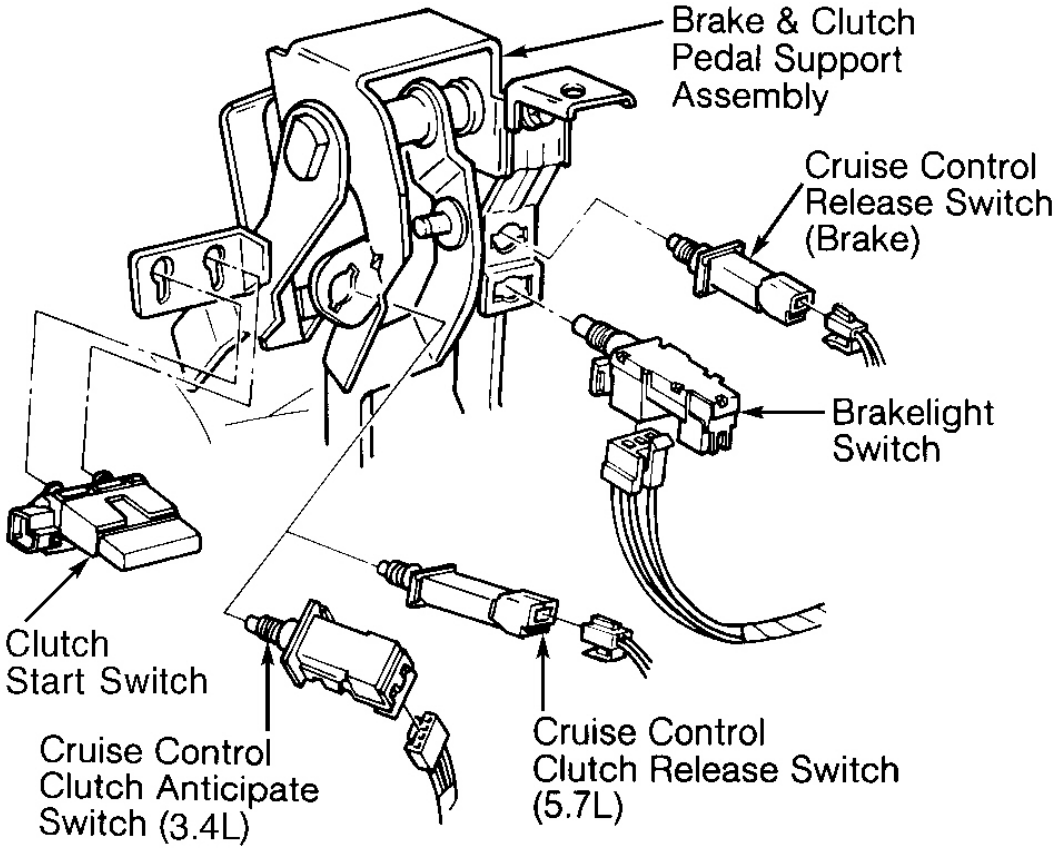
With cruise in R/A position, cruise speed can be raised (tap-up) or lowered (tap-down) in one MPH increments. Cruise control engagement switch is located in multifunction lever, which serves as turn signal lever and wiper switch.

CRUISE CONTROL MODULE

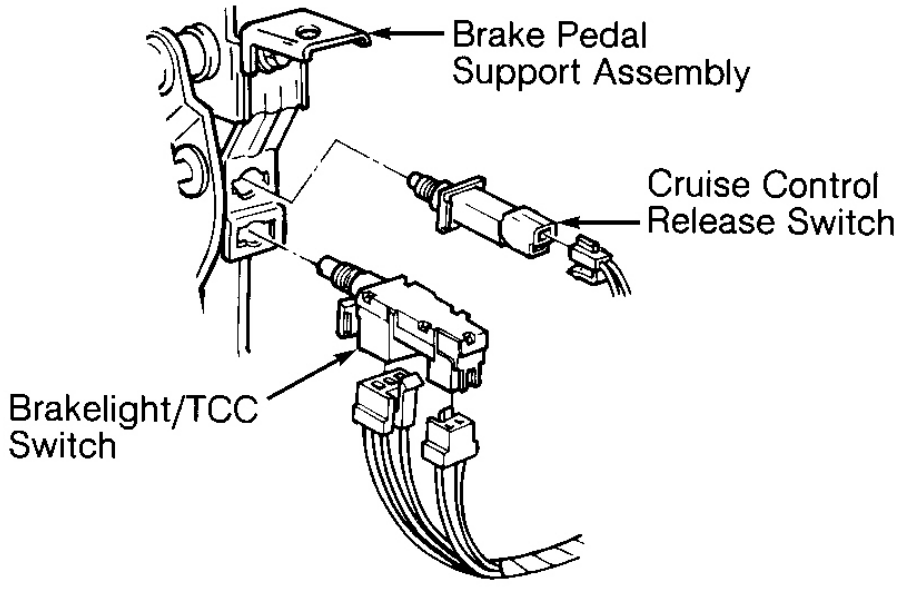
Cruise control module is mounted on left side of engine compartment near master cylinder. Cruise control module uses an internal electronic controller and electric stepper motor to vary throttle with each cruise control mode.

BRAKE & CLUTCH RELEASE SWITCHES

On automatic transmission models, a brakelight/Torque Converter Clutch (TCC) switch and a cruise control release switch mounted on brake pedal bracket are used to disengage cruise system electrically when brake pedal is depressed. Manual transmission models also use a cruise control clutch release switch (5.7L) to stop cruise operation. See **Fig. 1**. Speed of vehicle at brake actuation will be stored in cruise control module memory.



MANUAL TRANSMISSION



93E41032 AUTOMATIC TRANSMISSION

Fig. 1: Identifying Brake & Clutch Release Switches
Courtesy of GENERAL MOTORS CORP.

VEHICLE SPEED SENSOR (VSS)

A Permanent Magnet (PM) generator, driven by transmission, generates an output frequency of vehicle speed information. This frequency is sent to VSS buffer and to ECM, where signal is amplified and sent to cruise control module for cruise control operation.

VEHICLE SPEED SENSOR (VSS) BUFFER

VSS buffer receives a signal from VSS indicating speed of vehicle. This signal is processed by VSS buffer and supplied to ECM, cruise control module and speedometer. VSS buffer is located on convenience center left of steering column.

ADJUSTMENTS

BRAKE & CLUTCH RELEASE SWITCHES

Depress brake pedal and insert brakelight/TCC and cruise control release switches into proper switch receptacles until fully seated. Slowly pull brake pedal back to its fully retracted position (requires 50 lbs. of force). TCC/cruise control and brakelight switch will move within switch retainers to proper adjustment.

CRUISE CONTROL CABLE

Remove air cleaner and resonator. Unlock cable conduit at accelerator cable bracket. Cable adjuster spring will take up slack. See **Fig. 2**. Ensure throttle plate is fully closed. Lock cable conduit at accelerator cable bracket by pressing down on lock tab. Reinstall air cleaner and resonator.

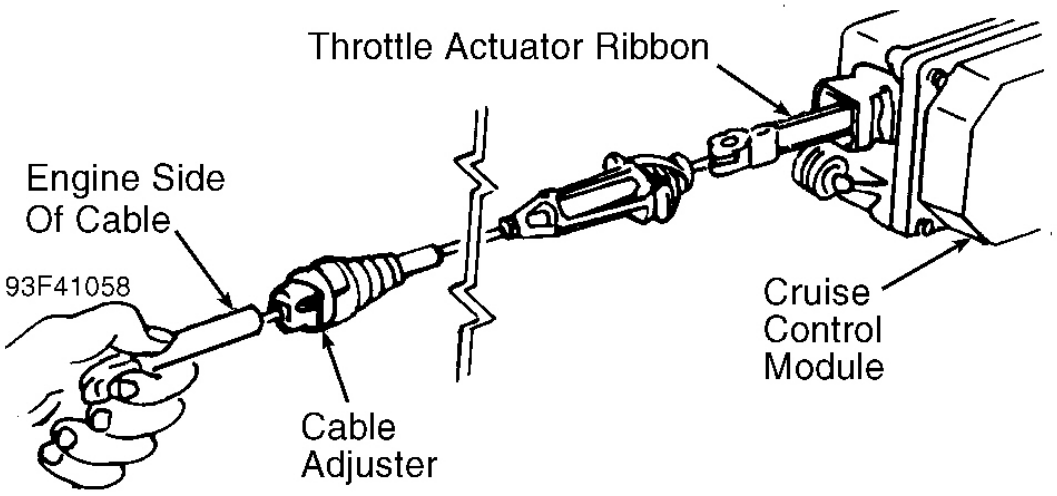


Fig. 2: Adjusting Cruise Control Cable
Courtesy of GENERAL MOTORS CORP.

DIAGNOSIS & TESTING

CRUISE CONTROL WILL NOT ENGAGE

1. Turn ignition off. Disconnect cruise control module connector. Turn ignition switch to RUN. Using a test light, check for battery voltage at terminal "F" of cruise control module harness connector. See **Fig. 3**. If battery voltage is present at terminal "F", go to next step. If battery voltage is not present at terminal "F", check fuses and check wire to terminal "F" for open or poor connection.
2. Connect test light between connector terminals "F" (Brown wire) and "E" (Black/White wire). If test light lights, go to next step. If test light does not light, repair open circuit in Black/White ground circuit.
3. Ensure ignition switch is still in RUN position. Set cruise control slider switch to ON position. Connect test light between cruise control module connector terminals "B" (Dark Blue wire) and "C" (Dark Green wire) and ground. If test light does not light at either terminal, go to next step. If test light lights at either terminal, check Dark Blue and Dark Green wires for a short to voltage. If circuits are okay, replace cruise control switch.
4. Connect test light between module connector terminal "A" (Gray wire) and ground. If test light lights, go to next step. If test light does not light, back probe between terminal "A" (Brown wire) of 4-pin connector at cruise control switch and ground. If test light does not light, repair open or short to ground in Brown wire. If test light lights, check for open circuit in Gray wire. If circuit is okay, replace cruise control switch.
5. Connect test light between module connector terminal "D" (Brown wire) and ground. If test light lights, go to next step. If test light does not light, back probe between cruise control release switch terminal "B" (Brown wire) and ground. If test light does not light, repair open circuit in Brown wire between switch and fuse block. If test light lights, check for open circuit in Brown wire between switch and module.
6. Connect test light between module connector terminal "G" (White wire) and ground. If test light does not light, go to next step. If test light lights, disconnect brakelight switch. Probe between connector terminal "A" (White wire) and ground. If test light lights, repair short to voltage in White wire. If test light does not light, check brakelight switch adjustment. If adjustment is okay, replace switch.
7. Connect test light between module connector terminal "B" (Dark Blue wire) and ground. Press and hold SET switch. If test light lights, go to next step. If test light does not light, backprobe between 4-pin cruise control switch terminal "D" (Brown wire) and ground. Press and hold SET switch. If test light does not light, replace cruise control switch. If test light lights, check for poor circuit at Brown wire.
8. Turn ignition off. Reconnect cruise control module connector. Disconnect Powertrain Control Module (PCM) connector "B". Turn ignition on. Measure voltage between connector "B" terminal No. 8 (Dark Green/White wire) and ground. If voltage is about 7 volts, go to next step. If voltage is not about 7 volts, check for short to ground or open circuit in Dark Green/White wire. If circuit is okay, replace cruise control module.
9. Turn ignition off. Reconnect PCM connector. Set parking brake. Start engine. Move cruise switch to OFF, then ON position. Wait at least 3 seconds, then go to next step.
10. Push cruise switch in and hold. On Roadmaster, CRUISE indicator should light momentarily. On all models, hold cruise switch in R/A position. Fully depress and hold brake pedal. On Roadmaster, CRUISE

indicator should light for 5 seconds. On all models, after 10 seconds, release brake pedal while holding R/A and SET switches. If engine RPM does not momentarily increase, replace cruise control module. If engine RPM does momentarily increase, check for poor connection at PCM connector "B", terminal No. 8 (Dark Green/White wire). If connection is okay, replace PCM.

CRUISE CONTROL WILL NOT RESUME, ACCELERATE, TAP-UP OR

TAP-DOWN

1. Turn ignition switch to RUN position. Set cruise control switch to ON position. Backprobe Dark Green wire of cruise control switch. If test light does not glow, replace cruise control switch/multifunction lever. If test light glows, go to next step.
2. Check Dark Green wire for open, repair wire as necessary. If Dark Green wire is okay, check associated connectors for good connection. If okay, replace cruise control module.

CRUISE INDICATOR INOPERATIVE (ROADMASTER)

1. Disconnect cruise control module connector. Turn ignition on. Measure voltage between cruise control module connector terminal "J" (White wire) and ground.
2. If battery voltage is present, check for poor connection at cruise control module connector terminal "J". If connection is okay, replace cruise control module. If no voltage is present, check for open circuit in White wire between module connector terminal "J" and instrument cluster connector terminal A10.

CRUISE INDICATOR ON AT ALL TIMES (ROADMASTER)

1. Turn ignition on. Turn cruise control off. Disconnect cruise control module connector.
2. If CRUISE indicator is not on, replace cruise control module. If cruise indicator is on, check for short to ground in White wire between module connector terminal "J" and instrument cluster connector terminal A10. If circuit is okay, instrument cluster is defective.

TROUBLE SHOOTING

1. To resolve any cruise control system malfunction, perform a visual inspection of all components. Check system to ensure there are no blown fuses, damaged or disconnected electrical wires or poor connections. Check high mounted brakelight bulbs; if burned out, cruise control system will not function.
2. With ignition switch in RUN position, battery voltage is applied to terminal "F" of cruise control module. See **Fig. 3**. When cruise control switch slider is moved to ON position, battery voltage is applied to terminal "A" of module connector.
3. When brake pedal is released, battery voltage should be present at module terminal "D". When brake pedal is depressed, battery voltage should be present at module terminal "G". When cruise switch slider is moved to R/A position, battery voltage should be present at terminal "C" of module connector.
4. With SET button depressed, battery voltage should be present at module terminal "B". With vehicle moving faster than 25 MPH, voltage at module terminal "K" will oscillate from 0-5 volts. Module ground is at terminal "E".

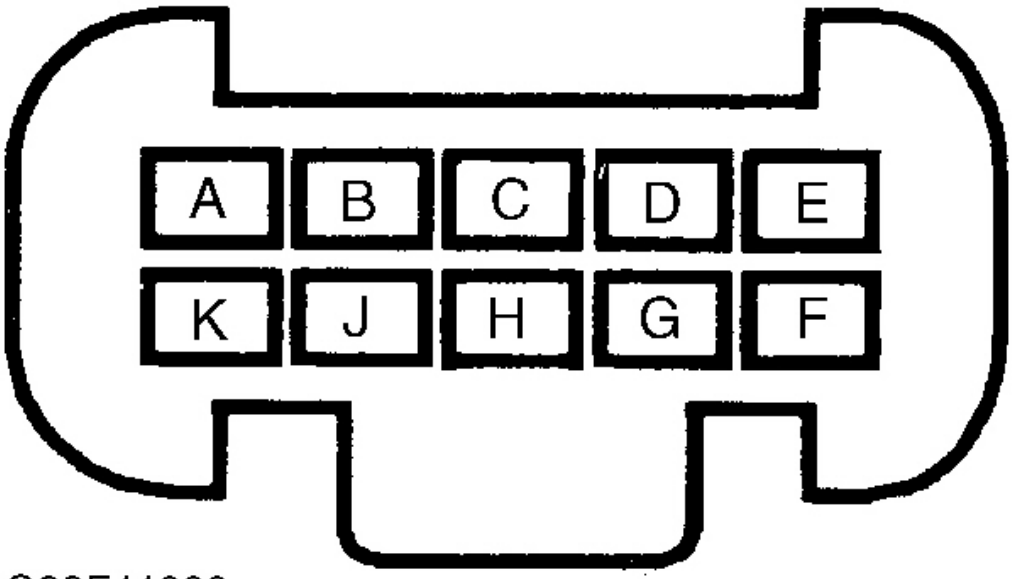


Fig. 3: Identifying Cruise Control Module Connector Terminals
Courtesy of GENERAL MOTORS CORP.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

VEHICLE SPEED SENSOR (VSS)

Removal & Installation

1. Disconnect negative battery cable. Raise vehicle. Disconnect speed sensor electrical connector. Remove speed sensor retainer bolt, retainer and spacer. Remove speed sensor. Remove speed sensor "O" ring and gear from speed sensor.
2. To install, reverse removal procedure. Tighten speed sensor retainer bolt to 89 INCH lbs. (10.1 N.m).

VEHICLE SPEED SENSOR (VSS) BUFFER

Removal & Installation

1. Disconnect VSS buffer harness connector from VSS buffer. Remove 2 convenience center retaining screws. Remove convenience center from cowl. Gently pry retainers and remove VSS buffer.
2. To install, reverse removal procedure. Tighten convenience center retaining screws to 88 INCH lbs. (9.9 N.m).

CRUISE CONTROL CABLE

Removal

1. Remove air cleaner and resonator. Disconnect cruise control cable and clip from throttle body lever stud. Unlock cable conduit at accelerator cable bracket. Remove cable and conduit from accelerator cable bracket.
2. Remove cable from cruise control module. Compress conduit tangs and pull conduit out of cruise control stepper motor ribbon end fitting on module housing. Disconnect cable bead from cruise control motor ribbon end fitting on module. Note routing of cable from vehicle.

Installation

To install, reverse removal procedure. Adjust cruise control cable (if necessary). See CRUISE CONTROL CABLE under ADJUSTMENTS.

BRAKE & CLUTCH SWITCHES

Removal & Installation

1. Disconnect negative battery cable. Remove electrical connectors from switches. Remove switches from retainer. Remove retainer from brake pedal mounting bracket.
2. To install, reverse removal procedure. Adjust brake release switch. See BRAKE & CLUTCH RELEASE SWITCHES under ADJUSTMENTS.

CRUISE CONTROL MODULE

Removal & Installation

1. Disconnect negative battery cable. Disconnect cruise control module electrical connector. Disconnect cruise control cable from module. Remove cruise control module mounting screws. Remove cruise control module and grommet nuts. Remove grommet nuts from cruise control module if new module is used.
2. To install, reverse removal procedure. Tighten cruise control module mounting screws to 18 ft. lbs. (24 N.m).

CRUISE CONTROL SWITCH

NOTE: Cruise control switch is serviced by replacing entire multifunction lever.

Removal & Installation

Disconnect negative battery cable. Remove steering column housing cover end cap by pulling toward front of vehicle. Disconnect electrical connector. Ensure all switches and controls are in OFF position. Pull multifunction lever straight out (toward driver door). Remove multifunction lever. To install, reverse removal procedure.

WIRING DIAGRAM

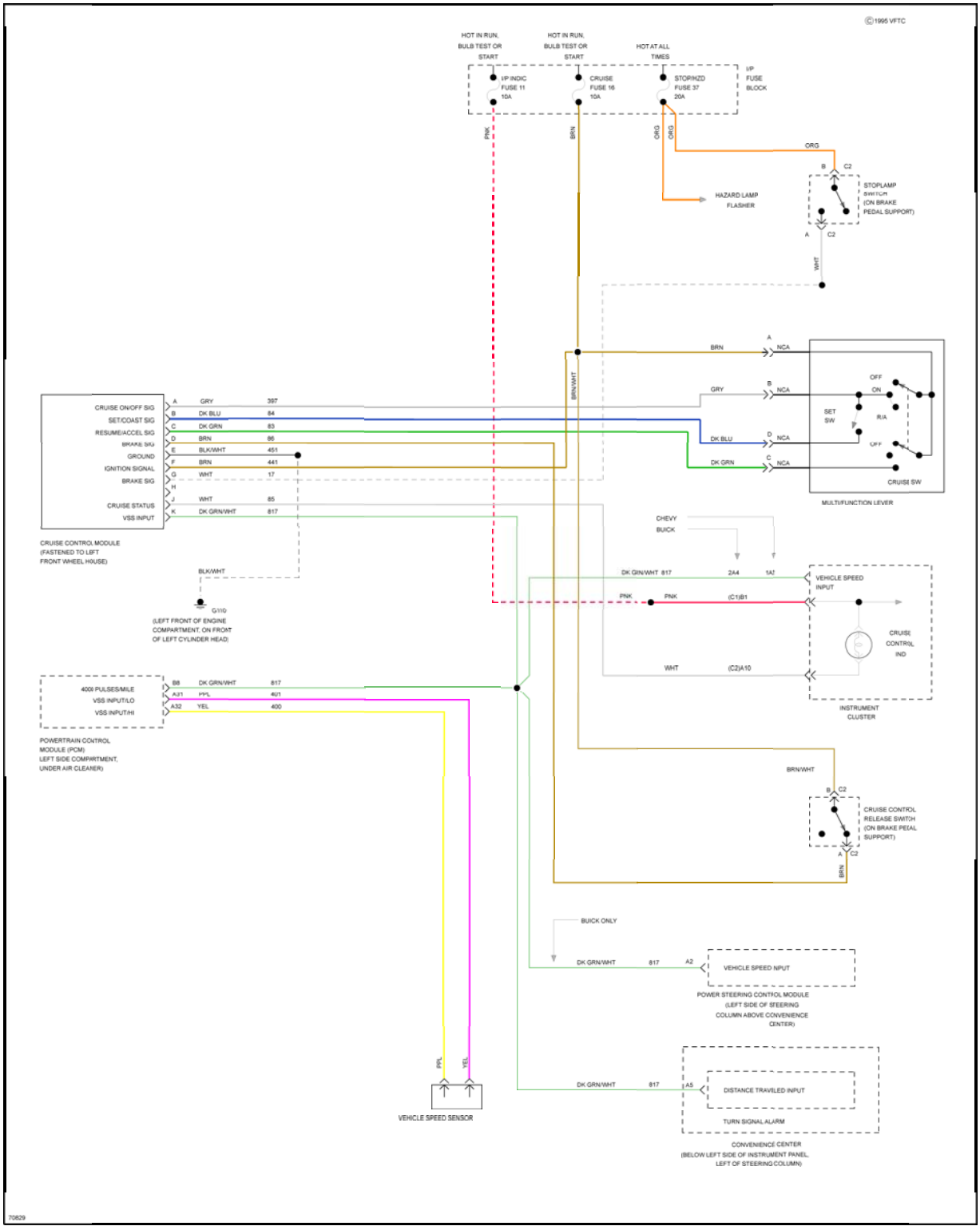


Fig. 4: Cruise Control System Wiring Diagram

DEFOGGER - REAR WINDOW & MIRROR

ACCESSORIES & SAFETY EQUIPMENT General Motors Corp. Defoggers - Rear Window & Mirror

DESCRIPTION & OPERATION

Description

Rear window defogger uses a heating grid on inside of rear window. Vehicles with mirror defoggers use a grid on back of mirror face.

CAUTION: To prevent damaging heating element, DO NOT scrape or apply decals to inside of rear window.

NOTE: For additional information on system operation, see SYSTEM CHECK under appropriate TESTING.

Operation

Rear defogger switch and timer are part of A/C-Heater control panel. Timer directs power to defogger grid (and mirror defoggers, if equipped).

ON-VEHICLE SERVICING

DISABLING & ACTIVATING AIR BAG SYSTEM

WARNING: Before servicing instrument panel components, disable Supplemental Inflatable Restraint (SIR) system. Failure to disable SIR system can result in accidental air bag deployment and possible personal injury.

Disabling

Turn ignition switch to LOCK position. Remove AIRBAG or SIR fuse. Disconnect Yellow SIR connector at base of steering column. On vehicles with passenger side air bag, disconnect Yellow SIR connector under right side of instrument panel or behind glove box.

Activating

Connect Yellow SIR connectors. Reinstall fuse. Turn ignition switch to RUN position. Verify air bag warning light flashes7-9 times and then goes out.

GRID FILAMENT REPAIR

NOTE: To determine operational status, see GRID FILAMENT TEST under TESTING.

CAUTION: To prevent glass fracture, DO NOT allow glass surface to exceed 400°F (204°C). If using heat gun to cure conductive paint, range must be 500-700° F (260-371°C).

1. Clean glass around damaged area of grid line or bus bar with window cleaner. Wipe area with clean dry cloth to remove lint. Put masking tape along both sides of grid line or bus bar at damaged area so conductive paint can be overlapped onto broken grid line or bus bar. See **Fig. 1** .
2. Apply conductive paint to damaged area 3 times in 15-minute intervals, overlapping conductive paint onto existing grid line or bus bar by about 3/4" lengthwise. Carefully remove masking tape. Allow conductive paint to cure for 24 hours at room temperature or hold a heat gun about 10" from glass for 15 minutes. After conductive paint has cured, check operation of rear defogger.

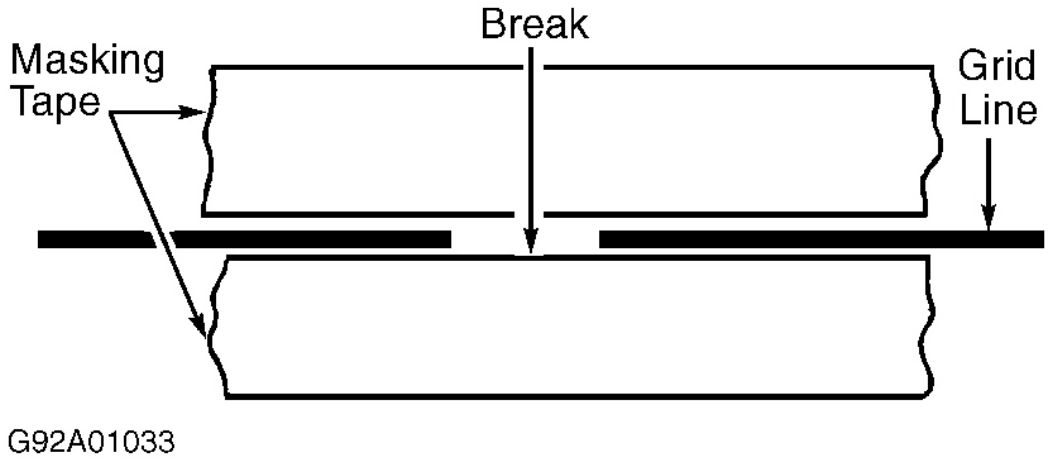


Fig. 1: Repairing Grid Wire
Courtesy of GENERAL MOTORS CORP.

TESTING

NOTE: Before testing, ensure fuses and circuit breakers are okay and ground connections are clean and tight. Leave electrical connectors attached and backprobe terminals unless specified otherwise. For wiring diagram, see WIRING DIAGRAMS .

GRID FILAMENT TEST

1. Start engine. Turn defogger on (press and release rear defogger switch button once). Using grounded test light, lightly touch each grid line. If test light shows full brilliance at both ends of all grid lines, check for loose ground wire. Test light brilliance should gradually change as test light probe is moved from left to right side of grid.

2. Contact each grid line a few inches on either side of glass center line to eliminate possibility of missing a break in grid line. If a problem on a grid line is detected, place test light probe on grid line at left bus bar and move probe toward right bus bar until light goes out, indicating a break in grid line continuity. Refer to Fig. **Fig. 2** . If break exists in grid line, go to **GRID FILAMENT REPAIR** under ON-VEHICLE SERVICING.

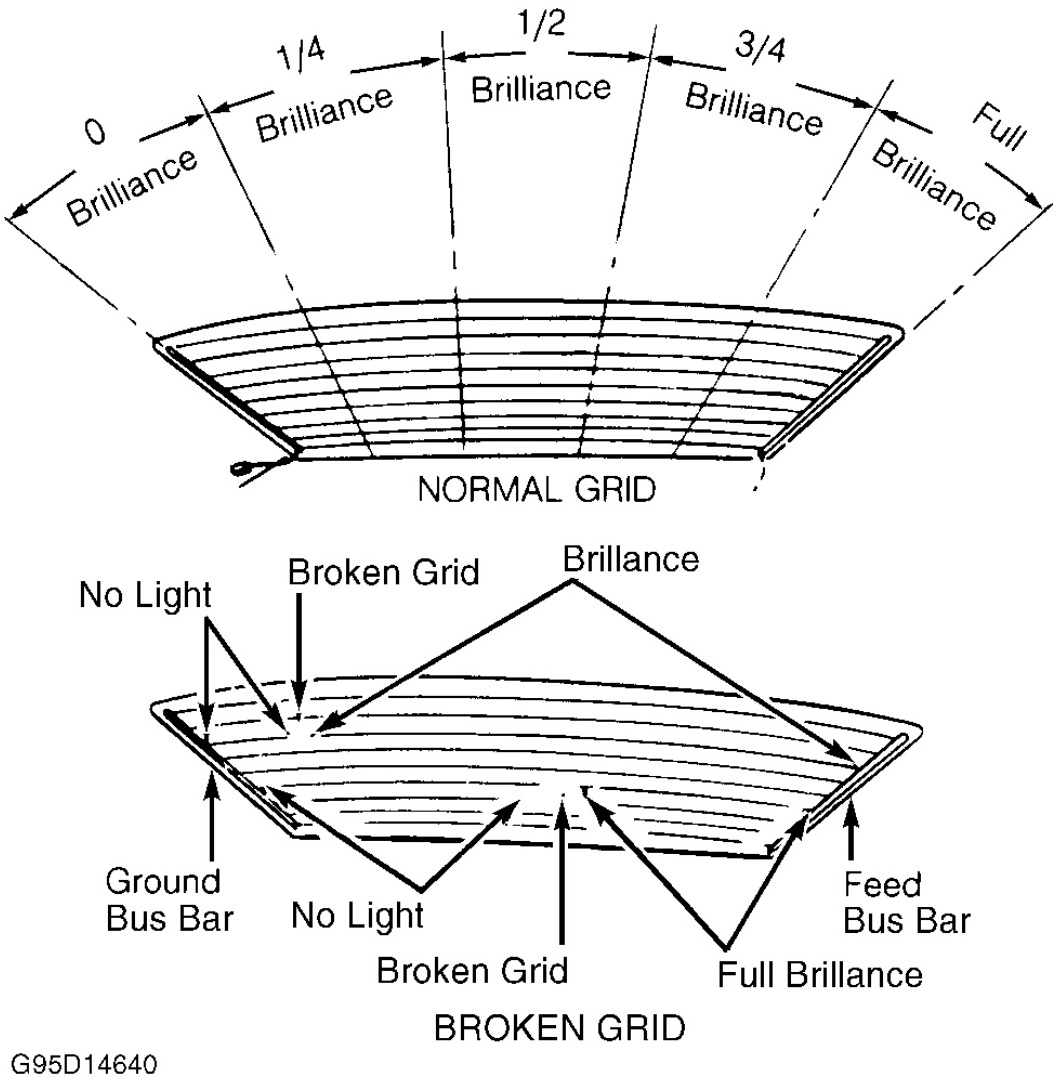


Fig. 2: Examining Grid Brilliance Test Patterns
Courtesy of GENERAL MOTORS CORP.

SYSTEM CHECK

1. Start engine. Turn defogger on (press and release rear defogger switch once). Switch should return to resting position. System should come on. System is on if rear window becomes warm, mirrors become

warm (vehicles with mirror defoggers) and indicator light comes on. If some grid lines do not become warm, go to **GRID FILAMENT TEST** under TESTING.

2. After about 10 minutes, system should automatically turn off. Turn defogger on again. After about 5 minutes, system should automatically turn off. If any of the following conditions exists, replace A/C-heater control panel. For all other conditions, go to appropriate test procedure identified by symptom:
    - Defogger operates, but indicator light does not operate
    - Defogger does not stay on for specified time
    - Switch does not return to rest position.

REAR DEFOGGER DOES NOT OPERATE

Without Defogger Mirrors

1. Connect test light between ground and terminal "A" (Orange wire) of rear defogger switch connector. If test light does not come on, repair Orange wire. If test light comes on, turn ignition switch to RUN position.
2. Connect test light between ground and terminal "C" (Pink wire) of rear defogger switch connector. If test light does not come on, repair Pink wire. If test light comes on, connect test light between terminal "A" (Orange wire) and terminal "D" (Black wire) of rear defogger switch connector.
3. If test light does not come on, repair Black wire. If test light comes on, turn on defogger. Connect test light between ground and terminal "B" (Purple wire) of rear defogger switch connector. If test light does not come on, replace rear defogger switch.
4. If test light comes on, connect test light between ground and positive (feed bus) side of rear defogger grid connector (Purple wire). If test light does not come on, repair Purple wire. If test light comes on, check for poor defogger grid ground, open between grid connector and grid, or open between grid and ground. If none of these conditions exists, go to **GRID FILAMENT TEST** under TESTING.

REAR DEFOGGER & MIRROR DEFOGGERS DO NOT OPERATE

1. Connect test light between ground and terminal "A" (Orange wire) of rear defogger switch connector. If test light does not come on, repair open Orange wire. If test light comes on, turn ignition switch to RUN position.
2. Connect test light between ground and terminal "C" (Pink wire) of rear defogger switch connector. If test light does not come on, repair open Pink wire. If test light comes on, connect test light between terminal "C" (Pink wire) and terminal "D" (Black wire) of rear defogger switch connector.
3. If test light does not come on, repair open Black wire. If test light comes on, turn rear defogger on. Connect test light between ground and terminal "B" (Purple wire) of rear defogger switch connector. If test light does not come on, replace A/C-heater control panel. If test light comes on, repair open Purple wire.

BOTH MIRROR DEFOGGERS DO NOT OPERATE, REAR DEFOGGER OKAY

Turn ignition switch to RUN position. Turn rear defogger on. Connect test light between ground and terminal "K" (Pink/White wire) of connector C302 (10-pin connector located behind left "A" pillar kick panel). If test light comes on, check for:

- Open Pink/White wire between connector C302 and splice. Splice is located about 3" (76 mm) from connector C302.
- Open Black wire between ground and splice. Splice is located behind left "A" pillar kick panel, about 5" (127 mm) from where ground wire is attached to bottom of "A" pillar.

ONE MIRROR DEFOGGER DOES NOT OPERATE

1. Remove door trim panel for access to faulty mirror defogger. Turn ignition switch to RUN position. Turn rear defogger on. Connect test light between ground and Pink/White wire terminal of mirror defogger connector.
2. If test light does not come on, repair open Pink/White wire between mirror defogger connector and splice, located behind left "A" pillar kick panel, about 3" (76 mm) from 10-pin connector. If test light comes on, disconnect mirror defogger connector. Connect test light between Pink/White wire terminal and Black wire terminal of mirror defogger connector.
3. If test light does not come on, repair open Black wire between mirror defogger connector and splice, located behind left "A" pillar kick panel, about 5" (127 mm) from where ground wire is attached to bottom of "A" pillar. If test light comes on, check for poor connection at mirror defogger connector, or open in pigtail wiring to mirror defogger. If connection and wire are okay, replace mirror defogger heater element.

REAR DEFOGGER DOES NOT OPERATE, MIRROR DEFOGGERS OKAY

1. Turn ignition switch to RUN position. Turn rear defogger on. Connect test light between ground and positive (feed bus) side of defogger grid connector. If test light does not come on, repair open Purple wire between defogger grid and splice, located behind left "B" pillar, about 3" (76 mm) from channel opening.
2. If test light comes on, check for open Black wire between defogger grid and ground, or open between defogger grid connector and defogger grid. If circuits are okay, go to **GRID FILAMENT TEST** .

REMOVAL & INSTALLATION

WARNING: To avoid injury from accidental air bag deployment, read and carefully follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in the appropriate AIR BAG RESTRAINT SYSTEM article.

A/C-HEATER CONTROL PANEL

Removal & Installation

1. Disconnect negative battery cable. Remove accessory trim plate. Remove sound insulator from below instrument panel. Remove cigarette lighter for access to screw. Disconnect temperature control cable from door lever on heater case. Remove A/C-heater control panel screws.
2. Pull out control panel far enough to disconnect electrical connectors and vacuum harness. Remove control panel with cable attached, noting routing of cable. To install, reverse removal procedure. Cable does not require adjustment.

WIRING DIAGRAMS

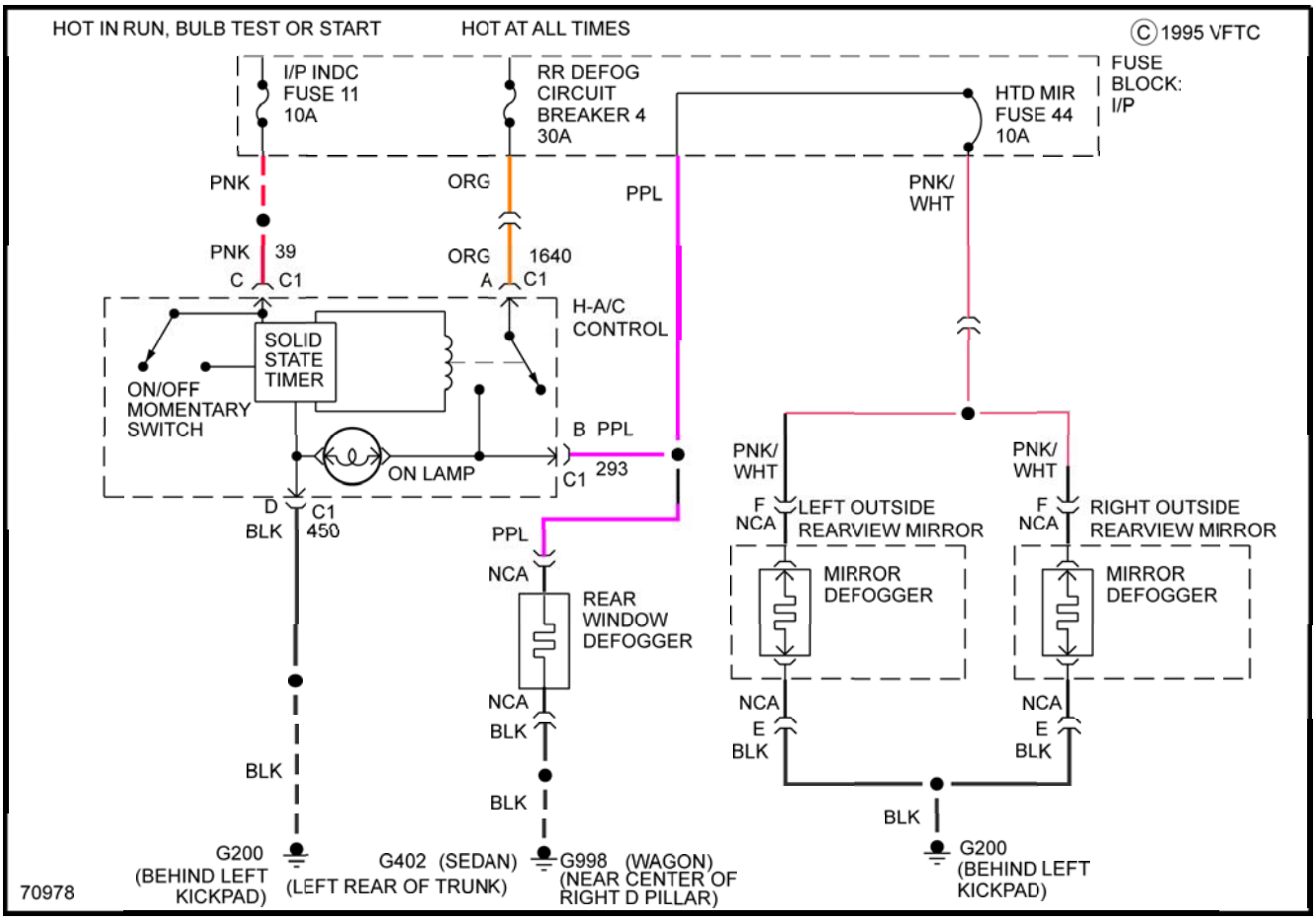


Fig. 3: Defogger System Wiring Diagram

GENERAL INFORMATION

Diagnostic Connector (DLC) Locations

DOMESTIC CARS

CHRYSLER GROUP LLC

NOTE: **This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.**

CHRYSLER GROUP LLC - DOMESTIC CARS

Application	Connector Location
Acclaim	
1989-90	Under Left Side Of Dash
1991-92	On Left Front Fender Panel, Near Shock Tower
1993-94	Near Battery
	Behind Left Side Of Dash, Near Fuse Block
Aries, Caravelle, Dynasty, E Class, Executive Sedan, LeBaron Sedan, New Yorker, Reliant, Town & Country, 400 & 600	
1984-85	On Left Fender Apron, Behind Battery (2.2L Only)
1986-87	On Front Of Right Shock Tower (2.2L & 2.5L Only)
1988-89	On Left Fenderwell
1990	Under Left Side Of Dash
1991-92	On Left Front Fender Panel, Near Shock Tower
1993 (Except New Yorker)	Near Battery
1993 (New Yorker)	On Left Fender Panel Near PCM
Avenger (-00)	Under Center Of Dash, Near Center Console
Breeze, Cirrus & Stratus (1995)	Left Of Steering Column, On BCM
Charger, Horizon, Omni, Rampage, Scamp & Turismo	
1985-89	
2.2L Carbureted	On Left Fender Apron
2.2L Turbo	On Front Of Right Shock Tower
Concorde, Intrepid, LHS, New Yorker, Vision & 300M	
1993-95	Behind Left Side Of Dash
1996-97	Under Left Side Of Dash, Near Center

	Console
Daytona	
1984-87	On Front Of Right Shock Tower
1988-89	On Left Fenderwell
1990-92	On Left Front Fender Panel, Near Shock Tower
1993	On Left Front Inner Fender Or Under Steering Column
Dynasty	
1990	Under Left Side Of Dash
1991-93	On Left Fender Panel, Near SBEC/PCM
Fifth Avenue	
1990	Under Left Side Of Dash
1991-93	On Left Fender Panel Near SBEC/PCM
Horizon & Omni (1989-90)	Under Left Side Of Dash
Imperial	
1981-83	CCC Connector Left Of Air Cleaner
1990	Under Left Side Of Dash
1991-93	On Left Fender Panel Near SBEC/PCM
LeBaron Coupe & Convertible	
1985-87	On Right Front Shock Tower
1988-89	On Left Fenderwell
1990-92	On Left Front Fender Panel, Near Shock Tower
1993	On Left Front Inner Fender Or Under Steering Column
1994	Near Battery
1995	Behind Left Side Of Dash, Near Fuse Block
Lancer	
1985-87	On Right Front Shock Tower
1988-89	On Left Fenderwell
Laser	
1990-94	Above Left Kick Panel, Near Fuse Block
1995	Under Left Side Of Dash, Near Center Console
Monaco & Premier	
1990	On Right Front Fender Panel
1991-92	On Left Fender Panel, Next To SBEC
	Under Headlight Switch, Under Left Side

Neon (1995)	Of Dash
Shadow	
1985-87	On Right Front Shock Tower
1988	On Left Fenderwell
1989	Under Dash, To Right Of Steering Column
1990	On Left Fender Front Panel, Near SBEC
1991-92	On Left Front Fender Panel, Near Shock Tower
1993-94	Near Battery
Spirit & Sundance	
1985-87	On Right Front Shock Tower
1989-90	Under Left Side Of Dash
1991-92	On Left Front Fender Panel, Near Shock Tower
1993-94	Near Battery
1995	Behind Left Side Of Dash, Near Fuse Block
Talon	
1990-94	Above Left Kick Panel, Near Fuse Block
1995-98	Under Left Side Of Dash, Near Center Console

FORD MOTOR CO.

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

FORD MOTOR CO. - DOMESTIC CARS

Application	Connector Location
Bobcat & Pinto	On Center Of Right Fender Apron
Capri	
1980-85	On Center Of Left Front Fender Apron
1986	On Left Rear Corner Of Engine Compartment
Continental	
1984-89	On Right Rear Corner Of Engine Compartment
1990-91	On Right Rear Corner Of Firewall, On Electronic Assembly Cover

1992	On Right Fender Apron
1993-94	VIP Connectors (2) On Right Rear Of Engine Compartment, On PCM Cover
Contour & Mystique	
1995	On Left Rear Corner Of Engine Compartment
Cougar & Thunderbird	
1982-90	On Left Fender Apron
1991	On Rear Of Right Front Fender Panel
1992	Front Of Right Shock Tower
1993	2 Connectors In Right Rear Corner Of Engine Compartment
1994	On Right Side Of Engine Compartment & Below Glove Box
1995	
3.8L	On Right Side Of Engine Compartment & Below Glove Box
4.6L	Behind Right Side Of Dash, Below Glove Box
1996	Lower Right Side Of Dash, Below Glove Box
Crown Victoria, Grand Marquis & Lincoln Town Car	
1983 & 1987	On Right Fender Apron
1985-86 & 1988-90	On Left Fender Apron
1992	On Left Front Fender Panel
1993-94	On Top Of Left Front Wheelwell
Escort, EXP, Lynx & Tracer	
1985-90	On Right Fender Apron Near Firewall
1991	On Left Rear Of Engine Compartment
1992	On Right Rear Of Engine Compartment, Near Cowl
1993-95	On Left Side Of Firewall
LTD & Marquis	
1983	On Left Fender Apron
1984-86	On Left Rear Corner Of Engine Compartment
Mark VII	
1984-87	On Right Rear Corner Of Engine Compartment
1988-90	Front Of Right Fender Apron
1991	On Right Side Of Engine Compartment, Near Thermactor Solenoids

Mark VIII	
1993-96	On Top Of Left Wheelwell
Mustang	
1980-85	On Center Of Left Front Fender Apron
1986-91	On Left Rear Corner Of Engine Compartment
1992	On Left Shock Tower, Near Ignition Coil
1993	2 Connectors On Right Front Strut Tower
1994-95	Behind Right Front Strut Tower & Right Of Steering Column
Probe	
1991-92	On Left Rear Corner Of Engine Compartment
1993	DLC - Behind Left Side Of Dash; STI Connector - On Left Inner Fender Panel
1994-95	On Left Front Inner Fender Panel
Sable & Taurus	
1986-87 (3.0L Only)	Near Alternator
1988-90	
2.5L	On Engine Harness Near PCV Hose
3.0L	On Right Rear Corner Of Engine Compartment
1991	On Right Rear Corner Of Engine Compartment, On ECA Cover
1992	On Right Rear Corner Of Engine Compartment, Below MAP Sensor
1993-95	Right Rear Of Engine Compartment
Tempo & Topaz	
1984-92	On Right Rear Corner Of Engine Compartment
1993-94	In Engine Compartment, On Left Strut Tower

GENERAL MOTORS

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

GENERAL MOTORS - DOMESTIC CARS

Application	Connector Location

Allante	Enter Diagnostic Mode By Pressing OFF & WARM Buttons On Instrument Panel
Bonneville (1980-81)	ECU Connector On Upper Right Kick Panel
Brougham (1987-92)	Bottom Center Of Instrument Panel
Camaro & Firebird (1980)	Diagnostic Ground Lead Connector On Right Shroud Above ECM
Caprice Classic	
1980-81	ECU Connector On Upper Right Kick Panel
1982-88	Under Center Of Instrument Panel
Catalina	ECU Connector On Upper Right Kick Panel
Cavalier (1982-88)	On Side Of Fuse Block
Cimarron	On Side Of Fuse Block
Century	Under Left Of Dash Ashtray
Corvette (1980-83)	In Center Console, Under Ashtray
Custom Cruiser	
1980-81	ECU Connector On Upper Right Kick Panel
1982-88	Under Center Of Instrument Panel
DeVille (1981-88)	Enter Diagnostic Mode By Pressing OFF & WARMER Buttons On Instrument Panel
Delta 88	ECU Connector On Upper Right Kick Panel
Eldorado (1981-88)	Enter Diagnostic Mode By Pressing OFF & WARMER Buttons On Instrument Panel
Electra (1980-81)	ECU Connector On Upper Right Kick Panel
Estate Wagon	ECU Connector On Upper Right Kick Panel
Fiero	Under Ashtray Or Cigar Lighter Panel Within Center Console
Firenza	On Side Of Fuse Block
Fleetwood (1981-88)	Enter Diagnostic Mode By Pressing OFF & WARMER Buttons On Instrument Panel
Fleetwood Brougham	On Bottom Center Of Dash, Near Ashtray
Impala (1982-88)	Under Center Of Instrument Panel
LeMans	ECM Connector On Right Kick Panel

	Or Under Left Side Of Dash
LeSabre (1980-81)	ECU Connector On Upper Right Kick Panel
LeSabre Wagon (1982-88)	Under Center Of Instrument Panel
Monza	Under Right Side Of Dash
Ninety-Eight (1980-81)	ECU Connector On Upper Right Kick Pane
Nova	Behind Right Strut Tower
Parisienne	Under Center Of Instrument Panel
Reatta	
1988-92 (MFI)	Enter Diagnostic Mode By Pressing OFF & WARM Buttons On Instrument Panel
1991-93	Above Parking Brake Pedal
Riviera	
1980-85 (Carbureted)	Under Left Or Center Of Dash
1986-92 (MFI)	Enter Diagnostic Mode By Pressing OFF & WARM Buttons On Instrument Panel
Safari	Under Center Of Instrument Panel
Seville (1981-88)	Enter Diagnostic Mode By Pressing OFF & WARMER Buttons On Instrument Panel
Skyhawk	Under Right Side Of Dash
Starfire	Under Right Side Of Dash
Sunbird	On Side Of Fuse Block, Under Right Side Of Dash
Toronado	
1980-85 (Carbureted)	Under Left Or Center Of Dash
1986-92 (MFI)	Enter Diagnostic Mode By Pressing OFF & WARM Buttons On Instrument Panel
Trofeo	
1988-92 (MFI)	Enter Diagnostic Mode By Pressing OFF & WARM Buttons On Instrument Panel
1991-93	Above Parking Brake Pedal
2000	On Side Of Fuse Block

DOMESTIC LIGHT TRUCKS & VANS

CHRYSLER GROUP LLC

NOTE: **This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.**

CHRYSLER GROUP LLC - DOMESTIC LIGHT TRUCKS & VANS

Application	Connector Location
Caravan, Grand Caravan, Grand Voyager, Mini Ram Van, Town & Country, & Voyager	
1984-92	On Left Side Fender Apron
1993	On Left Fender Front Fender Panel, Near SBEC
1994-95	On Wiring Harness, On Center Of Firewall
Dakota	
1987-88	On Right Side Fender Apron
1989	On Left Side Of Firewall
1990-92	On Right Side Of Firewall
1993-95	On Right Rear Corner Of Engine Compartment
Jeep	
Cherokee (1992-95)	On Left Front Fender Apron, Behind Air Cleaner
Comanche	On Left Front Fender Apron, Behind Air Cleaner
Grand Cherokee & Wagoneer	
1993-95	
PCM	On Right Rear Of Engine Compartment, Near PCM
TCM	Behind Left Side Of Instrument Panel
Wrangler (1992-95)	On Left Side Of Firewall, Near PCM
Pickup & Ramcharger	
1985-90	On Left Side Of Firewall
1991-93	On Left Front Fender Panel, Next To SBEC/PCM
1995 Pickup	On Right Side Of Firewall
Ram Wagon & Van	
1985-90	On Left Side Of Firewall
1991-95	On Center Of Firewall, Near SBEC/PCM

FORD MOTOR CO.

NOTE: **This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side**

of the dash, as mandated in 1996 by the Federal government.

FORD MOTOR CO. - DOMESTIC LIGHT TRUCKS & VANS

Application	Connector Location
Aerostar	
1986-90	On Left Front Fender
1991	Near Starter Relay
1992	On Left Front Inner Fender Panel
1993-95	On Left Side Of Firewall
Bronco	
1982-85	
6-Cylinder	On Left Front Fender
V8	On Right Inner Fender Panel
1986-87	On Right Front Fender, Near Starter Relay
1988-92	On Left Fender Apron
1993-95	2 Connectors In Left Rear Of Engine Compartment, On Bracket
1996-	Below Glove Box
Bronco II	
1983-85	On Right Front Inner Fender Panel (2.3L Only)
1986-90	On Right Front Fender Apron
Excursion	Behind Center Of Dash
Explorer & Mountaineer (1991-94)	On Right Rear Of Engine Compartment, Near A/C-Heater Blower
Pickup	
1982-85	
6-Cylinder	On Left Front Fender
V8	On Right Inner Fender Panel
1986-87	On Right Front Fender, Near Starter Relay
1988-92	On Left Fender Apron
1993-95	2 Connectors In Left Rear Of Engine Compartment, On Bracket
1996-	Below Center Of Instrument Panel
Pickup (F250 Heavy Duty & F350)	Under Right Side Of Dash
Ranger	
1983-85	On Right Front Inner Fender Panel (2.3L Only)
1986-90	On Right Front Fender Apron
1991	Behind Engine Compartment

	Fuse/Relay Block
1992	On Left Front Inner Fender Panel
1993-95	On Rear Of Engine Compartment Fuse/Relay Block
Van	
1986-92	On Right Fender Apron
1993-95	On Left Front Corner Of Engine Compartment
1996	
5.8L (49 State, Over 8600 GVW) & 7.5L (Except Calif.)	On Left Front Corner Of Engine Compartment
All Others	Under Left Side Of Dash
1997-98	
Diesel	Under Left Side Of Dash
All Others	Left Front Corner Of Engine Compartment
Villager (1993)	On Left Side Of Engine Compartment, Below Coolant Reservoir

GENERAL MOTORS

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

GENERAL MOTORS - DOMESTIC LIGHT TRUCKS & VANS

Application	Connector Location
Astro & Safari Van (1986-87)	Under Left Corner Of Cowl
"S" & "T" Series Blazer, Bravada, Envoy, Jimmy, Pickup & Sonoma	
1982-85	
1.9L	Under Left Side Of Dash, Behind ECM
2.0L & 2.8L	Under Ashtray
2.5L	Under Left Side Of Dash
1986-87	Under Ashtray
Van ("G" Series) (1982-87)	Under Driver's Seat

IMPORTED CARS & TRUCKS

ACURA

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side

of the dash, as mandated in 1996 by the Federal government.

ACURA - IMPORTED CARS & TRUCKS

Application	Connector Location
Integra	
1991-93	Behind Right Kick Panel
1994-97	Behind Glove Compartment
1998-02	Behind Right Side Of Center Console
Legend	
1991-93	Under Right Side Of Dash, Above PGM-FI ECU/PCM
1994-95	Behind Glove Compartment
NSX (1997-01)	Under Glove Compartment
SLX	Behind Lower Left Corner Of Dash, Behind Cover
Vigor	
1992-93	Under Right Side Of Dash, Near Center Console
1994	Behind Glove Compartment
2.2CL & 2.3CL	In Front Of Shift Lever, Behind Ashtray
2.5TL	In Front Of Shift Lever, Behind Ashtray
3.0CL	In Front Of Shift Lever, Behind Ashtray
3.2TL & 3.5RL	In Front Of Shift Lever, Behind Ashtray

AUDI

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

AUDI - IMPORTED CARS & TRUCKS

Application	Connector Location
A4	
1996	Next To Rear Ashtray
1997-01 (1.8L Turbo)	Behind Cover, Under Left Side Of Steering Column
1997-99 (2.8L V6)	Under Cover, Next To Rear Ashtray
1997-	Under Left Side Of Dash, Behind Cover
A6	
1995	Under Ashtray, In Front Storage Compartment Of Center Console

1996-97	Under Cover, Next To Parking Brake Handle
Cabriolet	
1994-96	In Fuse/Relay Block, On Left Side Of Dash
1997-98	Under Ashtray, At Rear Of Center Console
Coupe GT, 4000S & 4000S Quattro	In Fuse Socket, On Fuel Pump Relay
80	In Fuse Socket, On Fuel Pump Relay
90	
1988-92	In Fuse Socket, On Fuel Pump Relay
1993	In Main Fuse/Relay Block, On Plenum Tray
1994-95	In Fuse/Relay Block, On Left Side Of Dash
100	
1989-91	Under Left Side Of Dash
1992-94	In Auxiliary Relay Station No. 1, On Left Rear Of Engine Compartment
5000CS Quattro, 5000CS Turbo & 5000S	In Fuse Socket, On Fuel Pump Relay

BENTLEY

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

BENTLEY - IMPORTED CARS & TRUCKS

Application	Connector Location
1996-00	
All Models	In Glove Compartment
2001-04	
Arnage	Below Left Side Of Dash
2001-	
Azure Convertible	In Glove Compartment
Continental	In Glove Compartment

BMW

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

BMW - IMPORTED CARS & TRUCKS

Application	Connector Location
Z3	Behind Cover, On Right Side Of Center Console
Z4 & Z8	Under Left Side Of Dash, Left Of Steering Column, Behind Cover
318 & 325	
1991	On Bracket, Above Thermostat Housing
1992-95	On Right Rear Of Engine Compartment
1996	Under Left Side Of Dash, Behind Panel Labeled OBD
330	Behind Cover, Under Left Side of Dash Above Hood & Trunk Releases
524t	On Top Rear Of Engine
525i & 535i	
1990-91 (Black 20-Pin Connector)	Left Rear Corner Of Engine Compartment
1992-95	Outside Of Engine Compartment Fuse/Relay Block
528e	On Intake Manifold Bracket, Behind Thermostat Housing
635CSi	On Bracket, Next To Fuse/Relay Block
735i	
1986-87	On Bracket, On Top Of Engine
1988-92	On Right Side Of Engine Compartment, On Shock Tower
740 & 750	Under Left Side Of Dash, Behind Panel Labeled OBD
740i & 740iL (1993-01)	Behind Cover On Lower Left Corner Of A/C Control Panel
745Li	In Left Side Kickpanel, Behind Cover Labeled OBD
750iL	Behind Cover On Lower Left Corner Of A/C Control Panel

DAIHATSU

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

DAIHATSU - IMPORTED CARS & TRUCKS

Application	Connector Location
Charade	At Upper Section Of Transmission

Rocky	On Right Front Fender Panel

CHRYSLER GROUP LLC

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

CHRYSLER GROUP LLC - IMPORTED CARS & TRUCKS

Application	Connector Location
Colt & Summit	
1986-87	Above Inside Of Glove Compartment
1988	On Left Rear Corner Of Engine Compartment
1989-98	Under Left Side Of Dash, Near Fuse/Relay Block
Colt Vista	
1987	Behind Glove Compartment
1988-89	Under Left Side Of Dash, Near Hood Release Handle
1990-96	Under Right Side Of Dash
Conquest & Starion	Behind Glove Compartment
Expo	Under Left Side Of Dash, Near Fuse/Relay Block
Medallion	On Left Side Of Firewall
Pickup	Under Left Side Of Dash, Near Fuse/Relay Block
Ram-50	Under Left Side Of Dash, Near Fuse/Relay Block
Sigma	In Glove Compartment
Stealth	
1991-98	Under Left Side Of Dash, On Fuse/Relay Block
1999	Under Left Side Of Dash, Left Of Center Console
Summit Wagon	Under Right Side Of Dash
Vista Wagon	Under Right Side Of Dash

FERRARI

FERRARI - IMPORTED CARS & TRUCKS

Application	Connector Location

All Models	
1996-	Behind Left Side Of Dash

FORD MOTOR CO.

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

FORD MOTOR CO. - IMPORTED CARS & TRUCKS

Application	Connector Location
Aspire	
1994-95	On Left Rear Corner Of Engine Compartment
1996-97	Under Left Side Of Dash
Capri	
1991	Behind Right Side Of Dash, Behind Glove Compartment
1992	
1.3L	On Left Rear Corner Of Engine Compartment
1.6L	On Right Rear Corner Of Engine Compartment
1993-94	On Right Rear Corner Of Engine Compartment
Festiva	
1992-93	
1.3L	On Left Rear Corner Of Engine Compartment
1.6L	On Right Rear Corner Of Engine Compartment
Merkur XR4Ti	On Right Front Fender Apron, Near Battery
Scorpio	On Right Rear Corner Of Engine Compartment
Tracer	On Left Rear Corner Of Engine Compartment

GENERAL MOTORS

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

GENERAL MOTORS & GEO - IMPORTED CARS & TRUCKS

Application	Connector Location
LeMans	Behind Right Kick Panel, Above ECM
Metro	
1989-95	Under Left Side Of Dash, Near Fuse Block
1996	Under Right Side Of Dash, Near Center Console
1997-01	Under Left Side Of Dash
Prizm & Prizm LSi	
1989-95	On Left Front Strut Tower
1996-02	Under Left Side Of Dash
Spectrum	Under Right Side Of Dash, Above A/C-Heater Blower Motor
Sprint	On Left Front Shock Tower, Near Battery
Storm	
1990-91	Behind Right Side Of Dash, Above A/C-Heater Blower Motor
1992-93	Behind Right Kick Panel
Tracker	
1989-95	Under Left Side Of Dash, Near Fuse Block
1996	In Engine Compartment, Near MAP Sensor
1997-	Under Left Side Of Dash

HONDA

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

HONDA - IMPORTED CARS & TRUCKS

Application	Connector Location
Accord	
1990-95	Behind Right Side Of Dash, Above Kick Panel
1996-97	Behind Ashtray In Center Console
Civic (1992-95)	Behind Right Side Of Dash, Near PGM-FI ECM
Civic Del Sol	
1992-95	Behind Right Side Of Dash, Near

	PGM-FI ECM
1996-97	Under Removable Cover On Right Side Of Center Console
CR-V	Behind Passenger Side Of Center Console
Element	
2003-11	Above Gas Pedal, Below Fuse Block
Insight (2010-11)	Below Left-of-Center Of Dash
Odyssey	
1995	Behind Right Side Of Dash, Above Kick Panel
1996-98	Behind Passenger Side Of Center Console
Passport (1995)	Behind Left Kick Panel
Prelude	
1992-95	Behind Center Console
1996	Under Beverage Holder In Center Console
1997-02	Under Removable Cover On Right Side Of Center Console
S2000	Behind Right Side Of Center Console

HYUNDAI

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

HYUNDAI - IMPORTED CARS & TRUCKS

Application	Connector Location
Accent (1995)	In Coin Box
Sonata	
1989	Under Left Side Of Dash, In Fuse Block
1990	
W/Passive Seat Belt Restraints	In Fuse Block
W/O Passive Seat Belt Restraints	On Lower Left Of Steering Column

INFINITI

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side

of the dash, as mandated in 1996 by the Federal government.

INFINITI - IMPORTED CARS & TRUCKS

Application	Connector Location
G20 (1993-95)	In ECCS Control Unit, Behind Center Console
I30 (1995)	Beside Fuse Box
J30	
1993	Under Left Side Of Dash
1994-95	In ECM, Behind Right Kick Panel
1996-98	Under Left Side Of Dash
M30	Under Left Side Of Dash, Near Fuse Block
Q45	
1990-93	Under Left Side Of Dash, Near Fuse Block
1994-95	In ECM, Behind Right Kick Panel

ISUZU

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

ISUZU - IMPORTED CARS & TRUCKS

Application	Connector Location
Amigo & Pickup	
1986-89	Under Left Side Of Dash
1990-95	Behind Left Kick Panel, Near ECM
1998-00	Lower Left Corner Of Dash, Behind Small Cover
Hombre	Under Lower Left Side Of Dash, Behind Cover
Impulse	
1986-89	Under Left Side Of Dash, Above ECU
1990-92	Behind Right Kick Panel
1993-95	Behind Left Kick Panel, Near ECM
I-Mark	Behind Right Side Of Dash, Above A/C-Heater Blower Motor
Oasis	Behind Right Side Of Center Console
Rodeo	
1991-95	Behind Left Kick Panel
1996-	Lower Left Side Of Dash, Behind

	Small Cover
Stylus	Behind Right Kick Panel
Trooper & Trooper II	
1986	Under Left Side Of Dash
1987-91	Under Center Console
1992	
DOHC	Behind Center Of Dash, Right Of Steering Column
SOHC	Under Left Side Of Dash
1993-95	Under Left Side Of Dash, Right Of Steering Column
1996-02	Lower Left Side Of Dash, Behind Small Cover
VehiCROSS	Under Left Side Of Dash

JAGUAR

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

JAGUAR - IMPORTED CARS & TRUCKS

Application	Connector Location
XJR (1995-97)	Near Center Console
XJS	
1992	On Left Rear Trunk Wheel Arch, Behind Trim Panel
1993-94	Under Battery Tray, On Right Front Of Luggage Compartment
1995-96	Near Center Console
XJ6	
1992	On Left Rear Of Engine Compartment
1993-94	Under Battery Tray, On Right Front Of Luggage Compartment
1995-97	Under Left Side Of Dash, Near Center Console
XJ12	Near Center Console

KIA

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side

of the dash, as mandated in 1996 by the Federal government.

KIA - IMPORTED CARS & TRUCKS

Application	Connector Location
Sephia	
1994	On Center Of Firewall
1995 & 1996	
1.6L	Under Center Of Dash, Mounted On Floorboard
2.0L	Under Right Side Of Dash, Near Kick Panel
Sportage	
1994	On Center Of Firewall
1995 & 1996	
1.6L	Under Center Of Dash, Mounted On Floorboard
2.0L	Under Right Side Of Dash, Near Kick Panel

LAND ROVER

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

LAND ROVER - IMPORTED CARS & TRUCKS

Application	Connector Location
Defender 90	Behind Fuse Cover, In Center Of Console
Range Rover	Under Right Side Of Dash, In Footwell

LEXUS

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

LEXUS - IMPORTED CARS & TRUCKS

Application	Connector Location
ES Series	
1990-91	
DLC	Near Left Shock Tower
Total Diagnostic Communication Link Connector	Under Left Side Of Dash
1992-94	

DLC No. 1	On Bracket, Behind Right Front Strut Tower
DLC No. 2 & 3	Under Left Side Of Dash
1995-97	In Fuse Box At Lower Left Of Dash
GS Series	
1990-95	
DLC No. 1	On Bracket, On Top Of Engine
DLC No. 2	Under Left Side Of Dash
1996-00	In Fuse Box At Lower Left Of Dash
LS Series	
1990-94	
DLC No. 1	On Bracket, On Top Of Engine
DLC No. 2	Under Left Side Of Dash
1995-00	In Fuse Box At Lower Left Of Dash
SC Series	
1992-95	
DLC No. 1	On Bracket, Behind Right Front Strut Tower
DLC No. 2 & 3	Under Left Side Of Dash
1996-00	In Fuse Box At Lower Left Of Dash

MAZDA

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

MAZDA - IMPORTED CARS & TRUCKS

Application	Connector Location
B-Series	
1987-88	On Right Front Fender Apron
1989-93	
Engine Control Check Connector (Black 6-Pin)	Near Windshield Washer Motor
Trouble Codes Connector (Green 1-Pin)	Near Black 6-Pin Connector (Engine Control)
1994-95	On Right Front Fender Panel
Miata (1990-95)	On Left Rear Of Engine Compartment, Near Master Cylinder
MPV (1989-95)	
Engine Control Unit (Green 6-Pin & 1-Pin Connectors)	On Left Side Of Engine Compartment, Near Inner Fender Panel
MX-3	Mounted On Bracket, On Left Front Strut Tower

MX-6 & 626	
1988	Behind Left Front Shock Tower
1989	On Left Front Corner Of Engine Compartment
1990-91	At ECU Connector Terminal
1992	On Left Rear Corner Of Engine Compartment
1993	On Side Of Fuse/Relay Block, Near Battery
1994-95	On Left Front Fender Apron
Navajo	
1991-93	On Right Rear Corner Of Engine Compartment
1994-95	On Right Front Fender Panel
Protege	
1987-89	On Passenger's Footwell (Left Foot Area)
1990-95	On Left Side Of Firewall, Near Wiper Motor
RX7	
1986-88 (3 Check Connectors)	At Left & Right Corners Of Engine Compartment
1989-91 (Green 6-Pin Connector)	Behind Ignition Coil
1993-95	On Bracket, On Left Front Strut Tower
323	
1986-88	Front Left Of Engine Compartment, Near Ignition Coil
1989 (Green 6-Pin & Green 1-Pin Connectors)	On Left Side Of Firewall
1990-95	On Left Side Of Firewall, Near Wiper Motor
929	
1989	Near Air Cleaner
1990-91 (Green 6-Pin Connector)	In Left Front Corner Of Engine Compartment
1992-93	Mounted On Air Cleaner Housing
1994-95	On Left Front Strut Tower

MERCEDES-BENZ

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

MERCEDES-BENZ - IMPORTED CARS & TRUCKS

Application	Connector Location
C-Class (1994)	On Right Rear Of Engine Compartment
E-Class	
1994-97	On Right Rear Of Engine Compartment
G-Class	Under Left Side Of Dash, Behind Cover
ML-Class	Under Left Side Of Dash, Behind Cover
S-Class	
140 Platform (1994-99)	On Right Rear Of Engine Compartment
190 Series	
1986-87	On Left Rear Of Engine Compartment
1988-93	
All Models	In Engine Compartment, On Left Front Fender
California (OBD)	On Right Side Of Firewall, Near Battery
1994	On Right Rear Of Engine Compartment
260E	
1987	On Left Front Fender Apron, Next To Ignition Control Module
1988-89	
All Models	In Engine Compartment, On Left Front Fender
California (OBD)	On Right Side Of Firewall, Near Battery
300 Series	
1986-87	On Left Front Fender Apron, Next To Ignition Control Module
1988-92	
All Models	In Engine Compartment, On Left Front Fender
California (OBD)	On Right Side Of Firewall, Near Battery
1993	
Except 300E	Left Fender Apron
300E	Right Rear Corner Of Engine Compartment
1994-95 (All Models)	On Right Rear Of Engine Compartment
400 & 500 Series	

1993	
12-Pin Connector	On Rear Of Left Front Inner Fender Panel
38-Pin (Impulse Readout)	In Module Box, On Right Rear Of Engine Compartment
1994-95	On Right Rear Of Engine Compartment
420SEL & 560 Series (Except 2.2L)	
1986-89	
All Models	In Engine Compartment, On Left Front Fender
California (OBD)	On Right Side Of Firewall, Near Battery
1990-91	In Engine Compartment, On Left Front Fender
560 Series (2.2L)	On Lower Left Side Of Engine Connector

MITSUBISHI

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

MITSUBISHI - IMPORTED CARS & TRUCKS

Application	Connector Location
Diamante (1992-98)	Under Left Side Of Dash, Near Fuse/Relay Block
Expo	Under Left Side Of Dash, Near Fuse/Relay Block
Montero	
1986-88	Left Rear Corner Of Engine Compartment
1989-91	Behind Glove Compartment
Pickup	Under Left Side Of Dash, Near Fuse/Relay Block
Raider	
1987-88	Left Rear Corner Of Engine Compartment
1989	Behind Glove Compartment
3000GT	
1991-98	Under Left Side Of Dash, On Fuse/Relay Block
1999	Under Left Side Of Dash, Left Of Center Console

NISSAN

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

NISSAN - IMPORTED CARS & TRUCKS

Application	Connector Location
Altima	
1993-94	On Driver-Side Of Center Console, Above Accelerator Pedal
1995-96	Below Fuse Box
Maxima	
1989-94	Under Left Side Of Dash
1995-96	Below Fuse Box
NX & Sentra	Under Left Side Of Dash, Near Fuse Block
Pulsar NX	
1986	Above Right Side Of Dash, Below Wiper Motor
1987	Above Steering Column
Quest (1993-95)	
CONSULT Tester Connector	On Driver-Side Of Center Console, Above Accelerator Pedal
Self-Test Connector	Located Near Starter
Stanza	Below Center Of Dash, Near Center Console
Van	On Right Side Of Engine Compartment, Behind Fuel Filter
200SX (1995-96)	Below Fuse Box
240SX	
1991-94	Under Left Side Of Dash, Below Fuse Block
1995-96	In Glove Box
300ZX (1990)	Near Parking Brake

PEUGEOT

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

PEUGEOT - IMPORTED CARS & TRUCKS

Application	Connector Location
505 Series	On Lower Left Side Of Engine Connector

PORSCHE

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

PORSCHE - IMPORTED CARS & TRUCKS

Application	Connector Location
911 Series	
1992-95	In Passenger's Footwell
1996	Left Side Of Center Console
928S	Top Front Of Engine
944 Series	On Left Side Of Engine Compartment

RENAULT

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

RENAULT - IMPORTED CARS & TRUCKS

Application	Connector Location
Sportwagon	
Engine Diagnostic	On Center Of Firewall
Fuel Injection Diagnostic	Right Rear Of Engine Compartment, Behind Airflow Meter

ROLLS-ROYCE

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

ROLLS-ROYCE - IMPORTED CARS & TRUCKS

Application	Connector Location
All Models	
1996-00	In Glove Compartment
2001-	Under Left Side Of Dash

SAAB

NOTE: **This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.**

SAAB - IMPORTED CARS & TRUCKS

Application	Connector Location
900 Series	
1986-90	In Front Of Fuse/Relay Panel
1991-93	Under Back Seat, On Right Side
1994	
Convertible	Under Rear Seat
Hatchback	Under Steering Column
All Others	Under Right Front Seat
9000 Series	
1990	On Left Side Of Engine Compartment
1991-92	Under Passenger's Seat
1993	On Left Of Firewall
1994-95	Under Right Front Seat

SUBARU

NOTE: **This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.**

SUBARU - IMPORTED CARS & TRUCKS

Application	Connector Location
Brat, Coupe, Hatchback, Sedan & Wagon	
1987	
Read Memory Connector	Under Left Side Of Dash, Next To MFI/SMFI Control Unit
Test Mode Connector	
MFI	On Left Side Of Dash, Next To MFI Control Unit
Sequential MFI	On Left Side Of Firewall
1988-89	On Left Side Of Dash, Next To ECU
Forester	Under Left Side of Dash, Behind Cover
Justy	
1987-88	
Read Memory Connector (Factory)	On Right Front Fender, Near Strut Tower
Test Mode Connector	On Driver-Side Kick Panel Or ECU

1989-95	
Read Memory Connector (Factory)	Under Left Side Of Dash
Test Mode Connector	On Driver-Side Kick Panel Or ECU
Legacy	
1990-94	
Check Connector (Black Connector)	Behind Right Side Of Steering Column, Near Heater Case
Diagnostic Connector (Black 4-Pin Connector)	Behind Right Side Of Steering Column, Near Heater Case
Read Memory Connector (Black Connector)	Behind Knee Panel, Right Of Steering Column
Select Monitor Connector (Yellow Connector)	Behind Right Side Of Steering Column, Near Heater Case
Test Mode Connector (Green Connector)	Behind Knee Panel, Right Of Steering Column
1995-	Under Left Side Of Dash, Behind Cover
Loyale	
1990-91	
MFI (5-Pin Connector)	In Front Of ECU
SMFI (Yellow 9-Pin & Black 13-Pin Connectors)	Near Brake Booster
1992-95	
Diagnostic Check Connector (Yellow 9-Pin & Black 13-Pin Connectors)	Behind Brake Booster
Diagnostic Read-Memory Connector (2-Single Wire Connectors)	Behind Left Front Strut Tower
Outback & Outback Sport	Under Center Of Dash
SVX	
1992-96	Under Left Side Of Dash
1997	Right Of Steering Column, On Center Console

SUZUKI

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

SUZUKI - IMPORTED CARS & TRUCKS

Application	Connector Location
Esteem (1995)	Near Battery
Samurai	
1986-90	Under Right Side Of Dash, Behind Glove Compartment

1991-92	On Right Side Of Firewall
1993-95	Under Left Side Of Dash, In Fuse Block
Sidekick & X90	
1989-91	Under Left Side Of Dash, In Fuse Block
1992-93	
ALDL Connector	Under Left Side Of Dash
Engine Connector	Under Left Side Of Dash, Near Fuse Block
1994-96	In Engine Compartment, Near Battery
Swift	
1989-91	Under Left Side Of Dash, In Fuse Block
1992	
ALDL Connector	Under Left Side Of Dash
Diagnostic Test Terminal	In Fuse Block
1993-95	Under Left Side Of Dash, In Fuse Block

TOYOTA

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

TOYOTA - IMPORTED CARS & TRUCKS

Application	Connector Location
Camry	
1983-90	Next To Brake Master Cylinder
1991	Near Left Front Shock Tower
1992-95	
4-Cylinder	Near Wiper Motor
V6	Under Left Side Of Dash
Celica	
1983-84	Next To Battery
1985-95	Behind Left Front Shock Tower
Celica Supra	Rear Of Battery, Near Relay Panel (2-Pin Connector)
Corolla	
Front Wheel Drive	
1987	Side Of Left Front Shock Tower (2-

	Pin Connector)
1988-94	Behind Left Front Shock Tower
Rear Wheel Drive	
1985-86	Side Of Right Front Shock Tower (2-Pin Connector)
1987	Right Rear Corner Of Engine Compartment
Cressida	
1988-93	
Check Connector	On Left Front Shock Tower
Total Diagnostic Communication Link Connector	Under Left Side Of Dash
Land Cruiser (1988-94)	Near Wiper Motor
MR2	
1986-90	Near Airflow Meter
1992-95	On Right Rear Of Engine Compartment, Near MAP Sensor
Paseo (1992-95)	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery
Pickup	
1984-86	Near Ignition Coil, Near Master Cylinder (2-Pin Connector)
1987-90	Right Front Inner Fender Panel, Near Relay Block
1992-94	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery
Previa	
1992-93	Under Front Of Driver's Seat
1994	
Except Supercharged	Under Center Console, Near Parking Brake Lever
Supercharged	Under Cover, On Top Center Of Instrument Panel
1995-97	On Top Center Of Instrument Panel
RAV4	Under Dash, Near Center Console
Starlet	
1981-82	On Instrument Panel Fuse Block, On Top Of Dash
1983-84	Right Rear Of Engine Compartment
Supra	
1986-90	Rear Of Battery, Near Relay Panel
1991-92	On Left Front Shock Tower
1993-94	
DLC No. 1	On Right Side Of Firewall

DLC No. 2	Under Left Side Of Dash, Near Kick Panel
Tacoma & T100	
1993	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery
1994-95	
Except OBD-II DLC	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery
OBD-II DLC	Under Left Side Of Dash
Tercel	
1987-90	In Engine Compartment, Next To Master Cylinder
1991-94	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery
1995-98	Near Steering Column
Van	Near Airflow Meter
4Runner	
1985-86	Near Ignition Coil, Next To Master Cylinder (2-Pin Connector)
1987-95	On Side Of Engine Compartment Fuse/Relay Block No. 2, Near Battery

VOLKSWAGEN

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

VOLKSWAGEN - IMPORTED CARS & TRUCKS

Application	Connector Location
Cabrio	
1996	In Center Console, Below Tachometer
1997-02	On Center Dash, Behind Panel Near Ashtray
Corrado	Under Center Console Trim Plate
Fox	Under Center Console, Near Shift Lever
Golf	
1993	On Center Of Dash, Below A/C-Heater Control Knobs
1994	Under Center Console
1998-03	In Center Console

Golf III 2.0L	
1995-96	Below A/C-Heater Control Panel
1997-98	On Center Dash, Behind Panel Adjacent To Ashtray
GTI	
1993	On Center Of Dash, Below A/C-Heater Control Knobs
1994	Under Center Console
GTI 2.8L	On Center Dash, Behind Panel Adjacent To Ashtray
Jetta	
1993	On Center Of Dash, Below A/C-Heater Control Knobs
1994	Under Center Console
Jetta III 2.0L	
1995-96	Below A/C-Heater Control Panel
1997-98	On Center Dash, Behind Panel Adjacent To Ashtray
Jetta/Jetta III 2.8L	On Center Dash, Behind Panel Adjacent To Ashtray
New Beetle	Lower Part of Dash, In Front Of Shift Lever
Passat	
1992-94	Under Center Console, Forward Of Shift Lever
1995-97	On Center Dash, Behind Panel Near Ashtray
Toureg	
2004-2007	In the cover of the drivers side footwell, to right of engine hood release lever

VOLVO

NOTE: This table provides a quick reference for self-diagnostic connector locations, when available from manufacturer, that ARE NOT located at the lower left side of the dash, as mandated in 1996 by the Federal government.

VOLVO - IMPORTED CARS & TRUCKS

Application	Connector Location
C30	Under Left Center Of Dash
C70	Behind Cover, Below Parking Brake Lever

S40	Under Left Center Of Dash
S70	Behind Cover, Below Parking Brake Lever
S90	Behind Cover, Below Parking Brake Lever
V40	Under Left Center Of Dash
V70 (1997-00)	Behind Cover Below Parking Brake Lever
V90	Behind Cover, Below Parking Brake Lever
240	
1986-92	Left Rear Corner Of Engine Compartment
1993	Behind Left Front Strut Tower
740 & 760	
1986-92	
Ignition System	On Left Front Fender Apron
Fuel Injection (1990-92 Only)	Left Rear Corner Of Engine Compartment
780	On Left Front Fender, Behind Air Cleaner Housing
850	
1993	On Center Console, Forward Of Shift Lever & Near ECM
1994-95	
Non-Turbo	On Right Front Strut Tower
Turbo	Behind Cover, Forward Of Shift Lever
1996-97	Behind Cover, Forward Of Shift Lever
940	
1991-93	
Ignition System	On Left Front Fender Apron
Fuel Injection	Left Rear Corner Of Engine Compartment
1994-95	Behind Left Front Strut Tower
960	
1992-95	On Left Front Strut Tower
1996	In Center Console, To Right Of Parking Brake Lever
1997	Behind Cover, Forward Of Shift Lever

DIFFERENTIAL - LIMITED SLIP

Drive Axles - Differentials - Limited Slip

AXLE RATIO & IDENTIFICATION

Limited slip differential can be identified by raising vehicle and rotating one rear wheel. With transmission in Neutral, both rear wheels will rotate in same direction if vehicle is equipped with limited slip differential.

The axle may also be identified by axle code. Axle code is stamped on front of right rear axle tube and on tag attached by ring gear cover bolt. Axle code contains axle ratio, ring gear diameter and differential type information. See **AXLE RATIO IDENTIFICATION** table.

AXLE RATIO IDENTIFICATION

Application	Teeth Ring Gear/Pinion	RPO Code	Axle Code
Caprice (1)			
Sedan			
2.93:1	41/14	GW9	2LQ
3.08:1	40/13	GU4	2LL, (2) 2LX
3.23:1	42/13	GU5	2GU, 2LS,
3.23:1	42/13	GU5	2LU, (2) 2LZ
Wagon			
2.93:1	41/14	GW9	2YG
Impala SS (1)			
3.08:1	40/13	GU4	2LL
Roadmaster (1)			
Sedan			
2.56:1	41/16	GM8	2GQ
2.93:1	41/14	GW9	2NS
Wagon			
2.93:1	41/14	GW9	2YG

(1) 8 1/2" ring gear.

(2) Police equipment.

DESCRIPTION & OPERATION

Limited slip differential directs a majority of driving force to the wheel with best traction. This is accomplished by 2 spring-loaded thrustplates pressing against differential side gears, seated in tapered brake cones.

Brake cones fit into a tapered recess in each end of differential case. Outward pressure of thrust plate assembly forces brake cones against recesses, providing resistance to normal differential action. Thrust plate spring load is calibrated to permit some slippage under various torque conditions.

All models equipped with limited slip use the Auburn (limited slip) differential units. The Auburn differential is not serviceable and must be replaced as a unit. See **Fig. 1** .

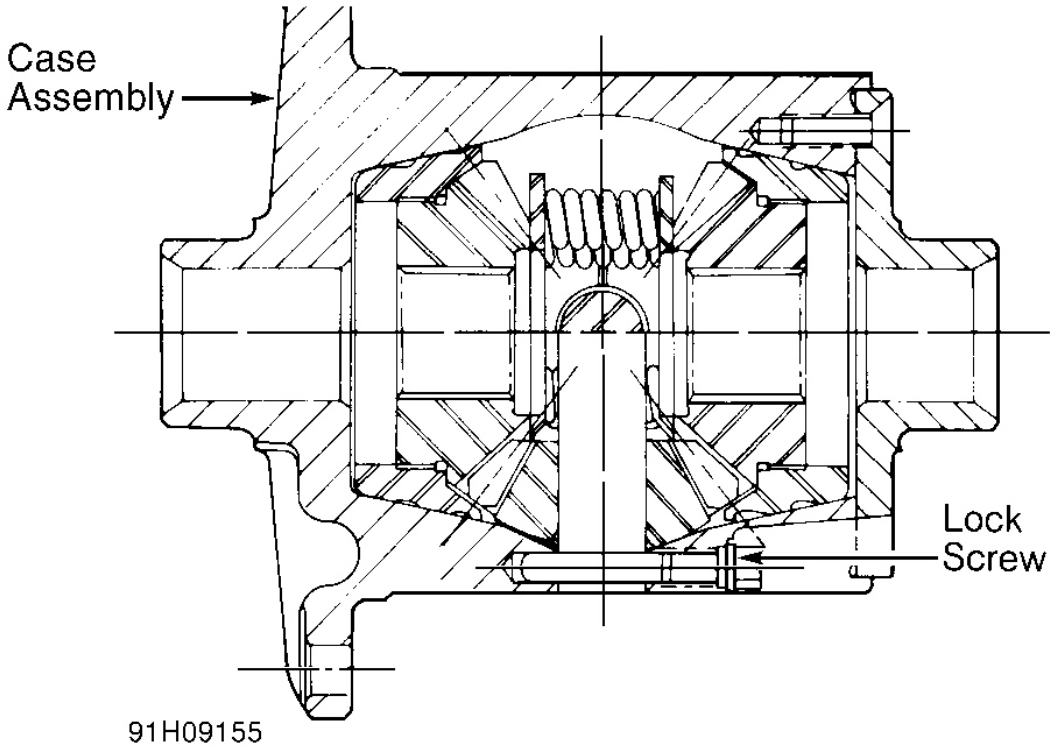


Fig. 1: Cut-Away View Of Auburn (Limited Slip) Differential
Courtesy of GENERAL MOTORS CORP.

LUBRICATION

Fill differential with 4.3 pts. (2.0L) of SAE 80W-90 GL-5 Gear Lubricant (1052271). Add 4 ounces (.12L) of Limited Slip Additive (1052358).

TROUBLE SHOOTING

NOTE: See the TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

TESTING

1. Place transmission in Park. Raise rear of vehicle until both wheels are off ground. Remove rear wheel. Attach Axle Shaft Puller (J-21579) to axle shaft flange. Attach torque wrench to Adapter (J-2619-01). See **Fig. 2** .

2. Measure torque required to rotate wheel assembly. Reading should be 125-225 ft. lbs. (169-305 N.m). Lower vehicle so rear wheel without torque wrench attached is on ground. Place transmission in Neutral.
3. Check torque required to rotate raised wheel. Reading should be 44-100 ft. lbs. (60-136 N.m). Replace differential assembly if not within specifications.

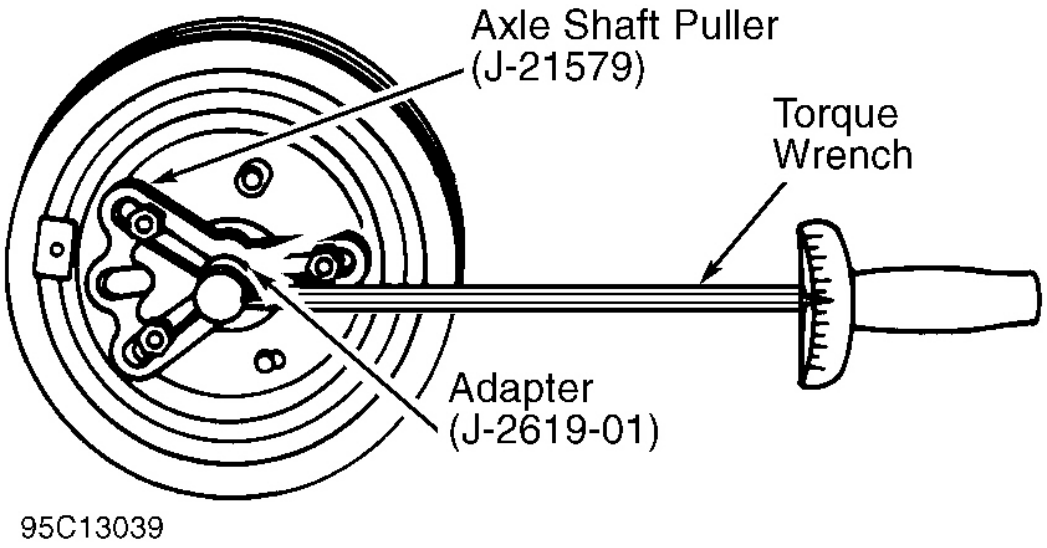


Fig. 2: Testing Differential In Vehicle
Courtesy of GENERAL MOTORS CORP.

REMOVAL & INSTALLATION

DIFFERENTIAL ASSEMBLY

Removal

1. Raise and support vehicle. Remove rear wheels and brake drums. Remove cover, and drain lubricant from differential. Check ring and pinion gear backlash. See **DRIVE AXLE** article. This will indicate gear or bearing wear or an error in backlash or preload setting.
2. Remove pinion shaft lock bolt and pinion shaft. Push axle shafts toward center of vehicle and remove "C" lock from inner end of shafts. On vehicles with Traction Control System (TCS), install ABS Exciter Ring Protector (J-39446) on speed sensor ring. If speed sensor ring is damaged, complete axle shaft assembly must be replaced. Carefully remove axle shafts from housing.
3. Mark differential bearing caps and housing for reassembly reference. Remove caps, and pry differential case from housing. Remove bearing cups and shims. Keep each set with proper bearing cap for installation.

Installation

To install, reverse removal procedure. Use **NEW** cover gasket when installing cover. Refill axle housing with proper lubricant. Bleed and adjust brakes.

NOTE: To prevent misalignment of splines in opposite cone and gear assembly, DO NOT rotate axle after differential and first axle shaft are installed in axle housing.

OVERHAUL

Auburn differentials are not serviceable and must be replaced as an assembly.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Differential Side Bearing Cap Bolt	55 (75)
Pinion Shaft Lock Bolt (1)	27 (36)
Rear Cover Bolt	22 (30)
Ring Gear Bolt (Left-Hand Threads) (2)	89 (121)
Wheel Lug Nut	100 (136)

(1) Threads must be coated with Loctite No. 242 (GM No. 12345382) before installation.

(2) Always use NEW ring gear bolts.

DOOR LOCKS - POWER

ACCESSORIES & SAFETY EQUIPMENT General Motors Corp. Door Locks - Power

DESCRIPTION & OPERATION

WARNING: To avoid injury from accidental air bag deployment, read and carefully follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in the appropriate AIR BAG RESTRAINT SYSTEM article.

NOTE: On some vehicles, the power door lock system is integrated with the Remote Keyless Entry (RKE) system. For information on RKE, see the KEYLESS ENTRY SYSTEM article.

When either door lock switch is activated, all doors lock or unlock.

TROUBLE SHOOTING

Check for blown fuse, open circuit breaker (if equipped), poor grounds, and faulty wiring. Check for mechanical binding in door lock system.

DIAGNOSIS

NOTE: Before diagnosing a problem by its symptom, go to TROUBLE SHOOTING. For a list of symptoms, see TESTING.

TESTING

NOTE: For location of power door lock components, see POWER DOOR LOCK COMPONENT LOCATION table.

Locks Do Not Operate From Either Switch

1. Connect a test light between chassis ground and Orange wire terminal of door lock relay connector. If test light does not glow, repair open Orange wire. If test light glows, connect test light between Orange wire and Black wire terminals of relay connector.
2. If test light does not glow, repair open Black wire. If test light glows, connect test light between chassis ground and Orange wire terminal of connector at either door lock switch. If test light does not glow, repair open Orange wire.
3. If test light glows, connect test light between Gray and Tan wire terminals of relay connector. Hold switch in lock and unlock positions. If test light glows in each case, go to next step. If test light does not glow in each case, check for poor wiring connection at relay. If connection is okay, replace relay.
4. Connect test light between chassis ground and Gray wire terminal of any door lock motor connector.

Hold switch in lock position. If test light does not glow, repair open Gray wire. If test light glows, repair open Tan wire.

Locks Operate From Only One Switch

1. Connect a test light between chassis ground and Orange wire terminal of inoperative door lock switch connector. If test light does not glow, repair open Orange wire. If test light glows, connect test light between chassis ground and Light Blue wire terminal of switch connector.
2. Hold switch in lock position. If test light glows, go to next step. If test light does not glow, check for poor wiring connection at switch. If connection is okay, replace switch.
3. Connect test light between chassis ground and White wire terminal of switch connector. Hold switch in unlock position. If test light glows, repair open White wire. If test light does not glow, check for poor wiring connection at switch. If connection is okay, replace switch.

Doors Do Not Lock From Either Switch (Unlock Okay)

Connect a test light between chassis ground and Light Blue wire terminal of door lock relay connector. Hold switch in lock position. If test light does not glow, repair open Light Blue wire between relay and splice. If test light glows, check for poor wiring connection at relay. If connection is okay, replace relay.

Doors Do Not Unlock From Either Switch (Lock Okay)

Connect a test light between chassis ground and White wire terminal of door lock relay connector. Hold switch in unlock position. If test light does not glow, repair open White wire between relay and splice. If test light glows, check for poor wiring connection at relay. If connection is okay, replace relay.

Doors Do Not Lock From One Switch (Unlock Okay)

Connect a test light between chassis ground and Light Blue wire terminal of inoperative door lock switch connector. Hold switch in lock position. If test light glows, repair open Light Blue wire between switch and splice. If test light does not glow, check for poor wiring connection at switch. If connection is okay, replace switch.

Doors Do Not Unlock From One Switch (Lock Okay)

Connect a test light between chassis ground and White wire terminal of inoperative door lock switch connector. Hold switch in unlock position. If test light glows, repair open White wire between switch and splice. If test light does not glow, check for poor wiring connection at switch. If connection is okay, replace switch.

One Or More Doors Do Not Lock Or Unlock From Either Front

Switch

1. Connect a test light between chassis ground and Gray wire terminal of inoperative door lock motor connector. Hold switch in lock position. If test light does not glow, repair open Gray wire between motor and splice.
2. If test light glows, connect test light between chassis ground and Tan wire terminal of motor connector. Hold switch in unlock position. If test light does not glow, repair open Tan wire between motor and

splice. If test light glows, check for poor wiring connection at motor. If connection is okay, replace motor.

POWER DOOR LOCK COMPONENT LOCATION

Component	Location
Door Lock Relay	At Base Of Left "A" Pillar, Behind Kick Panel

WIRING DIAGRAMS

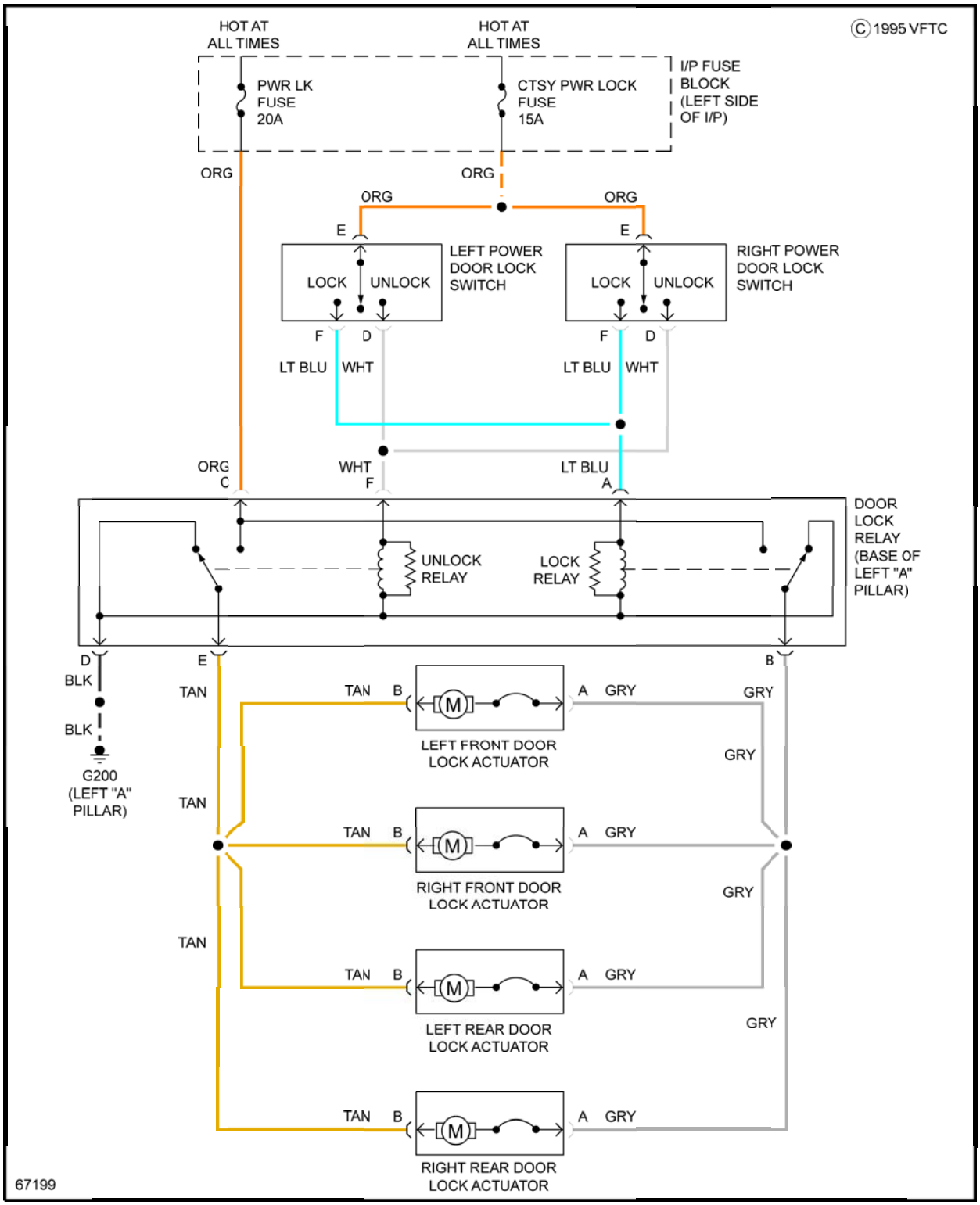


Fig. 1: Power Door Locks Wiring Diagram

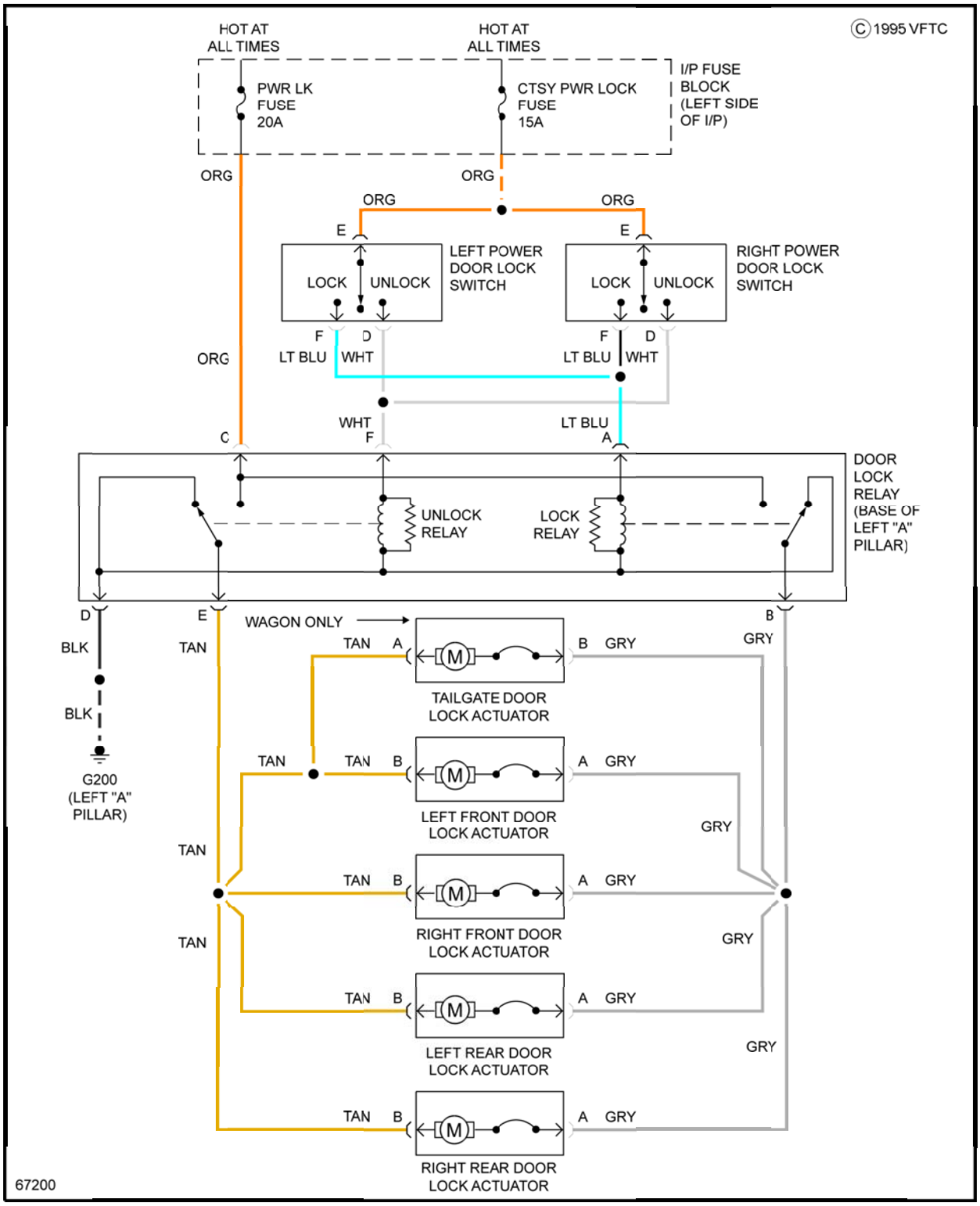


Fig. 2: Power Door Locks Wiring Diagram

IDENTIFICATION

AXLE RATIO & IDENTIFICATION CODE

Rear axle ratio, differential type, manufacturer, and build date information is stamped on forward side of right axle. An RPO code may be stamped on a metal tag attached to differential housing. The service parts identification label will have Regular Production Option (RPO) codes for specific rear axle identification. See **Fig. 1** . Also, refer to the appropriate **AXLE RATIO IDENTIFICATION** table.

NOTE: On Caprice and Roadmaster, 7 1/2" ring and pinion gear has been replaced with 7 5/8" ring and pinion gear. Although axle housing assemblies look alike, internal components are different.

AXLE RATIO IDENTIFICATION

AXLE RATIO IDENTIFICATION (CAPRICE SEDAN, IMPALA SS SEDAN)

Application	Teeth: Ring Gear/Pinion	RPO Code	Axle Code
7 5/8" (2.93:1)	41/14	GW9	2GF, 2GG
8 1/2" Ring Gear			
2.93:1	41/14	GW9	(1) 2LQ, 4ZB
3.08:1	40/13	GU4	(1) 2LL, (2) 2LW, (1) (2) 2LX
3.23:1	42/13	GU5	(1) 2GU, (1) 2LS, 2LT
3.23:1	42/13	GU5	(1) 2LU, (2) 2LY, (1) (2) 2LZ

(1) Limited slip differential.

(2) Police equipment.

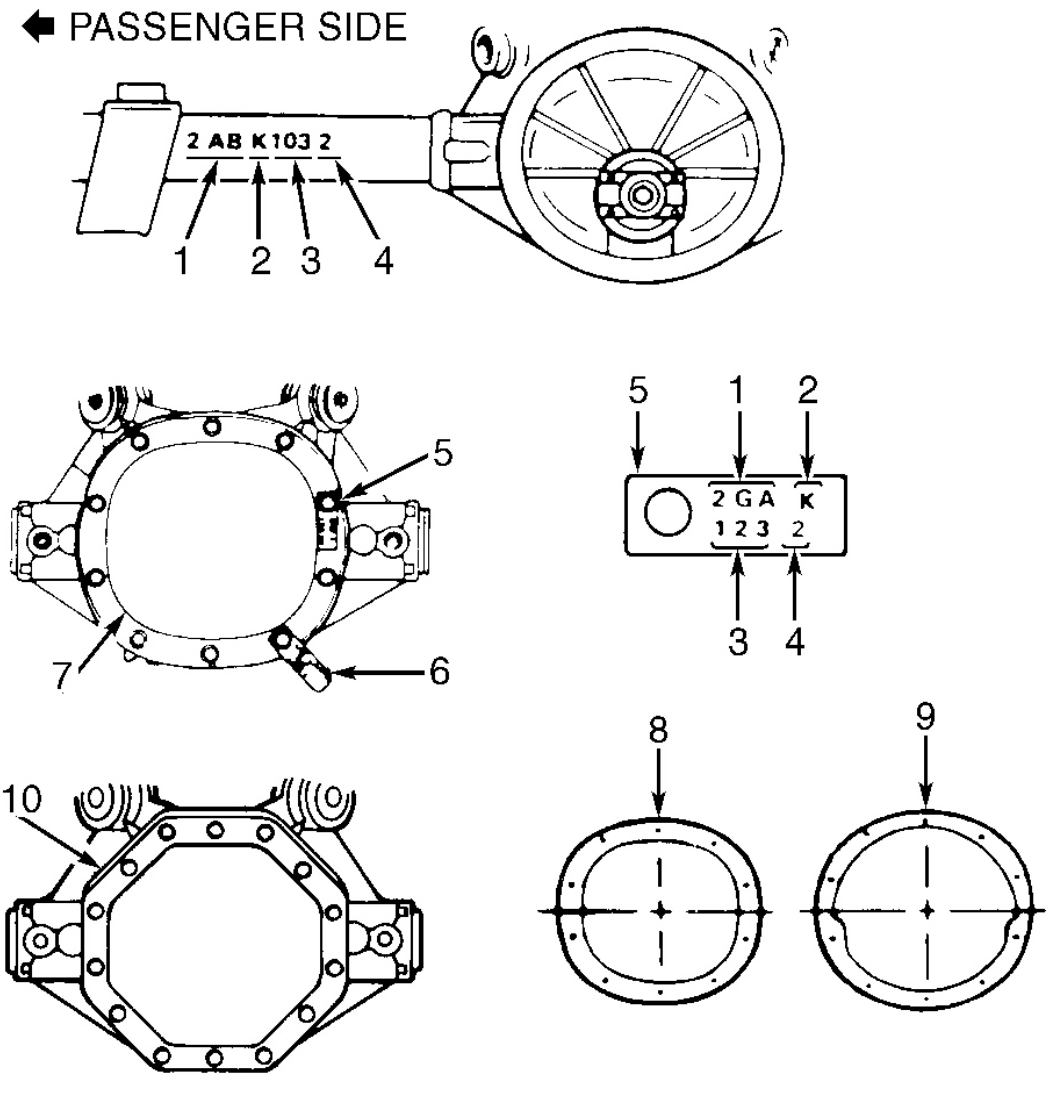
AXLE RATIO IDENTIFICATION (CAPRICE WAGON, ROADMASTER WAGON)

Application	Teeth: Ring Gear/Pinion	RPO Code	Axle Code
8 1/2" Ring Gear			
2.56:1	41/16	GM8	2YN
2.93:1	41/14	GW9	2YF, (1) 2YG

(1) Limited slip differential.

AXLE RATIO IDENTIFICATION (ROADMASTER SEDAN)

Application	Teeth: Ring Gear/Pinion	RPO Code	Axle Code
8 1/2" Ring Gear			
2.56:1	41/16	GM8	2GC, (1) 2GQ
2.93:1	41/14	GW9	(1) 2NS
(1) Limited slip differential.			



1. Axle Code
2. Manufacturer Code
   "K" - GM Of Canada
   "G" - Saginaw Detroit
3. Build Date
4. Shift: 1 - Day; 2 - Night
5. Axle Code Tag
6. Limited Slip Tag
7. Ring Gear Cover
   7 5/8" & 8 1/2"
8. 7 5/8" Ring Gear Cover
9. 8 1/2" Ring Gear Cover
10. 9 1/2" Ring Gear Cover

94H32521

Fig. 1: Locating Rear Axle Identification Codes
Courtesy of GENERAL MOTORS CORP.

DESCRIPTION & OPERATION

Drive axle is a semi-floating, hypoid-gear type with integral housing. Center line of pinion is set below center line of ring gear. A removable steel cover, bolted to rear of housing, permits servicing differential case without removing axle assembly from vehicle.

On Caprice, Impala SS, and Roadmaster with ABS, a sensor is threaded into axle housing just behind drive pinion yoke. Sensor generates a signal from a toothed sensor ring pressed onto the drive pinion gear shaft.

On Traction Control System (TCS) equipped vehicles, speed sensors are located in each backing plate. Speed sensor rings are press fit on axle shafts and are not serviceable.

NOTE: For limited slip differential overhaul procedures, see DIFFERENTIALS - LIMITED SLIP article.

LUBRICATION

Fill differential with 80W-90 GL-5 Gear Lubricant (GM P/N 1052271). See **LUBRICATION CAPACITIES** table. Add 4 ounces (.12L) of limited slip additive (GM P/N 1052358) to all limited slip differentials.

LUBRICATION CAPACITIES (1)

Application	Pts. (L)
7 5/8" Ring Gear	3.5 (1.7)
8 1/2" & 9 1/2" Ring Gear	4.2 (2.0)
(1) Fill no lower than 9/16" (15 mm) below edge of the filler hole.	

TROUBLE SHOOTING

NOTE: See the TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

REMOVAL & INSTALLATION

AXLE SHAFT & BEARING

Removal

1. Raise and support vehicle. Remove rear wheels and brake drums (or disc calipers and rotors). On Caprice, Impala SS, and Roadmaster with disc brakes, remove parking brake lining.
2. Remove cover and drain lubricant from differential. On all models, remove pinion shaft lock bolt and pinion shaft. Push axle shaft toward center of vehicle and remove "C" lock from inner end of shaft. Carefully remove axle shaft from housing.
3. Remove brake backing plate (or caliper mounting bracket). Remove axle shaft seal, using a pry bar behind steel case of seal. Insert Bearing Remover (J-22813-01 on 7 5/8" axles; J-23689 on 8 1/2" axles; J-

29712 on 9 1/2" axles) into bore. Position remover behind bearing so tangs engage bearing outer race. Using a slide hammer, remove bearing. Discard bearing and seal.

Installation

1. Lubricate new bearing with gear oil. Using Bearing Installer (J-23765 on 7 5/8" axles; J-23690 on 8 1/2" axles; J-29709 on 9 1/2" axles) and Handle (J-8092), install bearing. Bearing is properly seated when installer bottoms against bore.
2. Lubricate new seal with gear oil. Position seal on Seal Installer (J-23771 on 7 5/8" axles; J-21128 on 8 1/2" axles; or J-29713 on 9 1/2" axles). Drive seal until flush with axle tube.
3. To complete installation, reverse removal procedure. Pull axle shaft outward after installing "C" lock to seat lock in counterbore of axle side gear. Install pinion shaft and lock screw. Remove ABS Exciter Ring Protector Kit (J-39446) from speed sensor rings, if installed.

COMPANION FLANGE & OIL SEAL

Removal

1. Raise and support vehicle. Mark drive shaft to companion flange for installation reference. Remove drive shaft. Scribe alignment mark on companion flange, pinion and pinion nut so proper drive pinion preload can be maintained.
2. Using an INCH-lb. torque wrench, measure and record pinion bearing preload. Remove pinion nut and washer. Using a puller, remove companion flange. See **Fig. 2** . Using care not to damage housing, with a blunt chisel, drive seal out of housing.

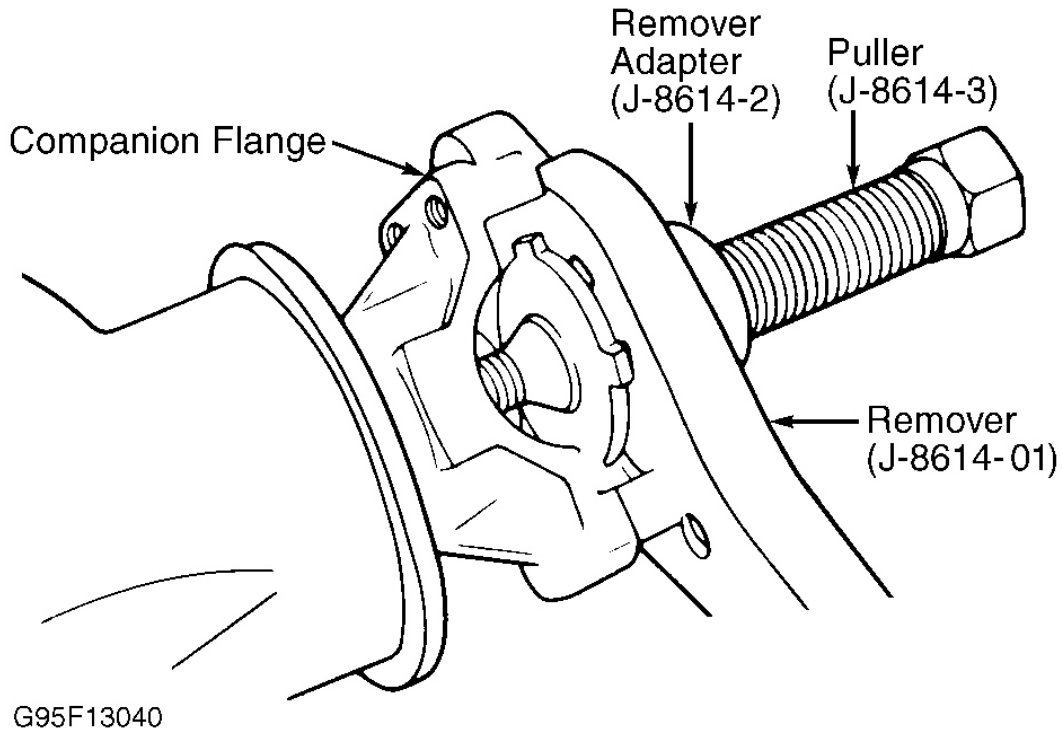


Fig. 2: Removing Companion Flange
Courtesy of GENERAL MOTORS CORP.

Installation

1. Pack seal lip of new seal with lithium-based, extreme-pressure grease. Drive seal into housing until seated against shoulder. Install companion flange, washer and pinion nut.

NOTE: If preload specification is exceeded, a new collapsible spacer must be installed and nut retightened until correct preload is obtained.

2. Gradually tighten pinion nut. Turn drive pinion several times, during tightening to seat bearings. Ensure pinion bearing preload is 3-5 INCH lbs. (.3-.6 N.m) more than reading obtained during removal. Install drive shaft.

REAR AXLE ASSEMBLY

Removal

1. Raise and support vehicle. Remove rear tires. Place supports under rear axle assembly. Disconnect shock absorbers from axle. On Caprice, Impala SS and Roadmaster, disconnect level control switch link and speed sensor (if equipped).

2. On all models, loosen parking brake cable adjuster nut. Remove parking brake cables from adjuster and body clips. Remove stabilizer bar. Scribe alignment mark on companion flange and drive shaft for installation reference. Remove drive shaft.
3. Remove brakeline junction block bolt from axle. Disconnect brakelines from junction block and wheel cylinders/calipers.
4. Disconnect brakeline from axle mounting clips. Remove or clear brakelines away from axle assembly. On Caprice, Impala SS and Roadmaster, disconnect upper control arms from axle assembly.
5. Lower axle and remove springs. Remove brake drums and backing plates (or calipers and rotors), and support out of way. Carefully lower axle and remove from vehicle.

Installation

To install, reverse removal procedure. Use a new cover gasket when installing cover. Refill axle housing with proper lubricant. Bleed and adjust brakes.

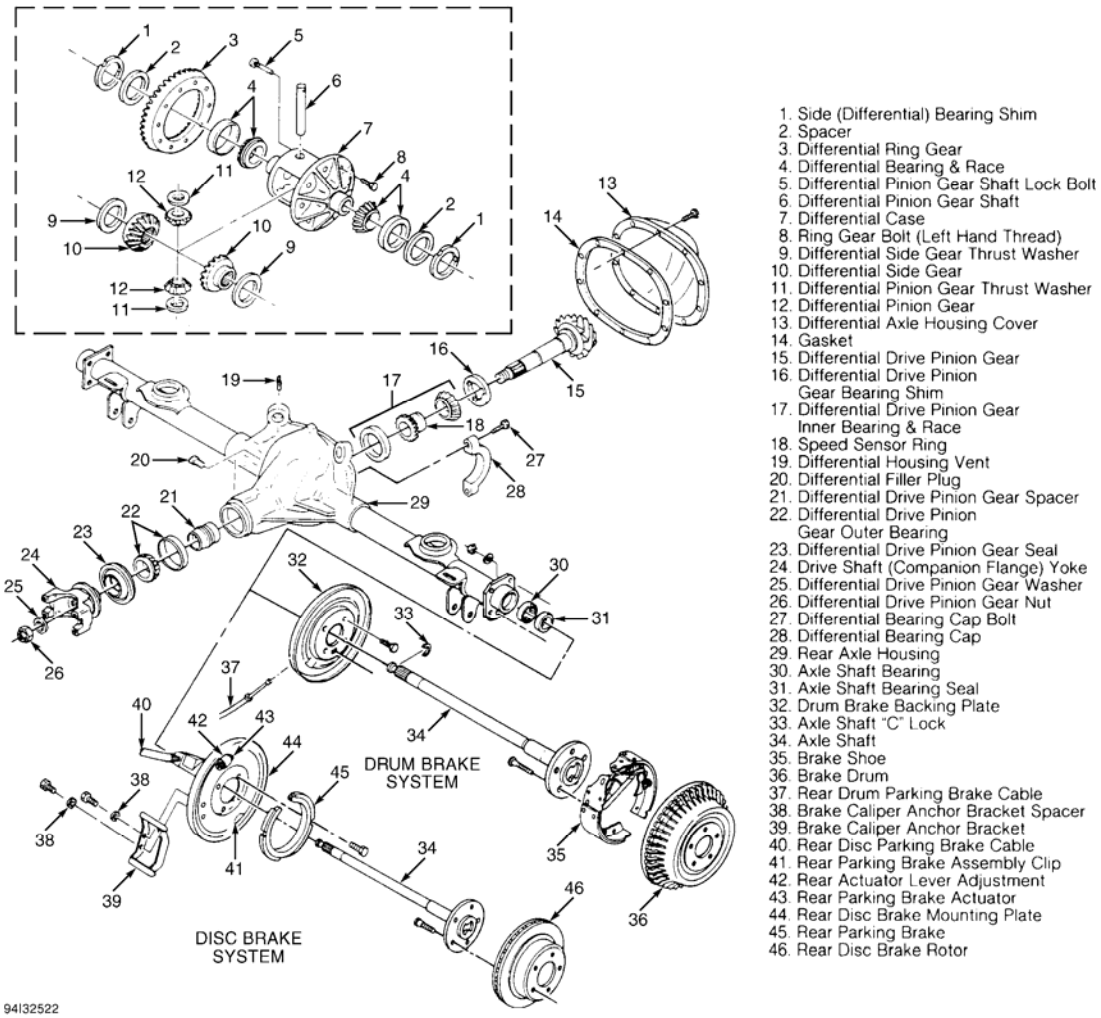


Fig. 3: Exploded View Of Rear Axle Assembly (Caprice, Impala SS & Roadmaster)

Courtesy of GENERAL MOTORS CORP.

OVERHAUL

NOTE: For limited slip differential overhaul procedures, see DIFFERENTIALS - LIMITED SLIP article. The Auburn limited-slip differential case is not serviceable and MUST be replaced as an assembly.

DISASSEMBLY

NOTE: On ABS equipped vehicles, speed sensor ring is located either on pinion shaft or on differential case. If removed, DO NOT reuse speed sensor ring.

Differential Case

1. Remove axle shafts. See **AXLE SHAFT & BEARING** under REMOVAL & INSTALLATION. Check ring and pinion gear backlash and pinion bearing preload. This will indicate gear or bearing wear, or an error in backlash or preload setting. On ABS equipped vehicles, remove speed sensor and install ABS Exciter Ring Protector Kit (J-39446) to speed sensor ring.
2. Mark differential bearing caps and housing for reassembly reference. Remove caps and differential case from housing. Remove bearing cups and shims. Keep each shim set with proper bearing cap for reassembly.
3. Remove differential pinion shaft, gears, and side gears with thrust washers. See **Fig. 3** . Keep components in order for reassembly. Remove ring gear bolts (left-hand threads). Tap ring gear off differential case using soft drift and hammer. On ABS models, **DO NOT** pry between speed sensor ring and ring gear. Using brass hammer, remove speed sensor ring (if necessary).
4. Check pinion bearing preload. Remove pinion nut and companion flange. See **COMPANION FLANGE & OIL SEAL** under REMOVAL & INSTALLATION. Remove drive pinion and front bearing. If necessary, remove pinion bearing cups from housing using a brass drift. Remove and discard collapsible spacer, and speed sensor ring (if equipped). Press drive pinion out of rear bearing and note thickness of pinion depth shim pack.

REASSEMBLY

Pinion Depth Adjustment

1. Thickness of drive pinion rear bearing shim must be determined whenever a new axle housing, ring and pinion set, or pinion bearings and races are installed. Depth of mesh is determined using Pinion Setting Gauge Set (J-21777). See **PINION DEPTH GAUGE SET** table.

   NOTE: Checking procedure for different axle sizes is the same. However, gauge set components vary between axles.

2. If removed, lubricate and install pinion bearings into races. Install lubricated pinion bearings. Position gauge plate and rear pinion bearing pilot on preload stud. Install assembly through rear pinion bearing, front pinion bearing and front pinion bearing pilot. See **Fig. 4** .

3. Install hex nut until snug. Rotate bearings to ensure proper seating. Hold preload stud stationary with a wrench on flats. Tighten hex nut until 20 INCH lbs. (2.3 N.m) is required to rotate bearings.

PINION DEPTH GAUGE SET

Tool Name & Application	**Tool Number**
Arbor	
7 5/8"	J-23597-1
8 1/2" & 9 1/2"	J-21777-1
Dial Indicator	J-8001
Gauge Plate	
7 5/8" Ring Gear	J-23597-11
8 1/2" Ring Gear	J-21777-29
9 1/2" Ring Gear	J-21777-85
Front Pinion Bearing Pilot	J-21777-42
Preload Stud	J-21777-43
Rear Pinion Bearing Pilot	
7 5/8" Ring Gear	J-21777-40
8 1/2" Ring Gear	J-21777-35
9 1/2" Ring Gear	J-21777-8
Side (Differential) Bearing Gauge Discs	
7 5/8" & 8 1/2" Ring Gears	J-21777-45
9 1/2"	J-21777-86

Ring Gear	

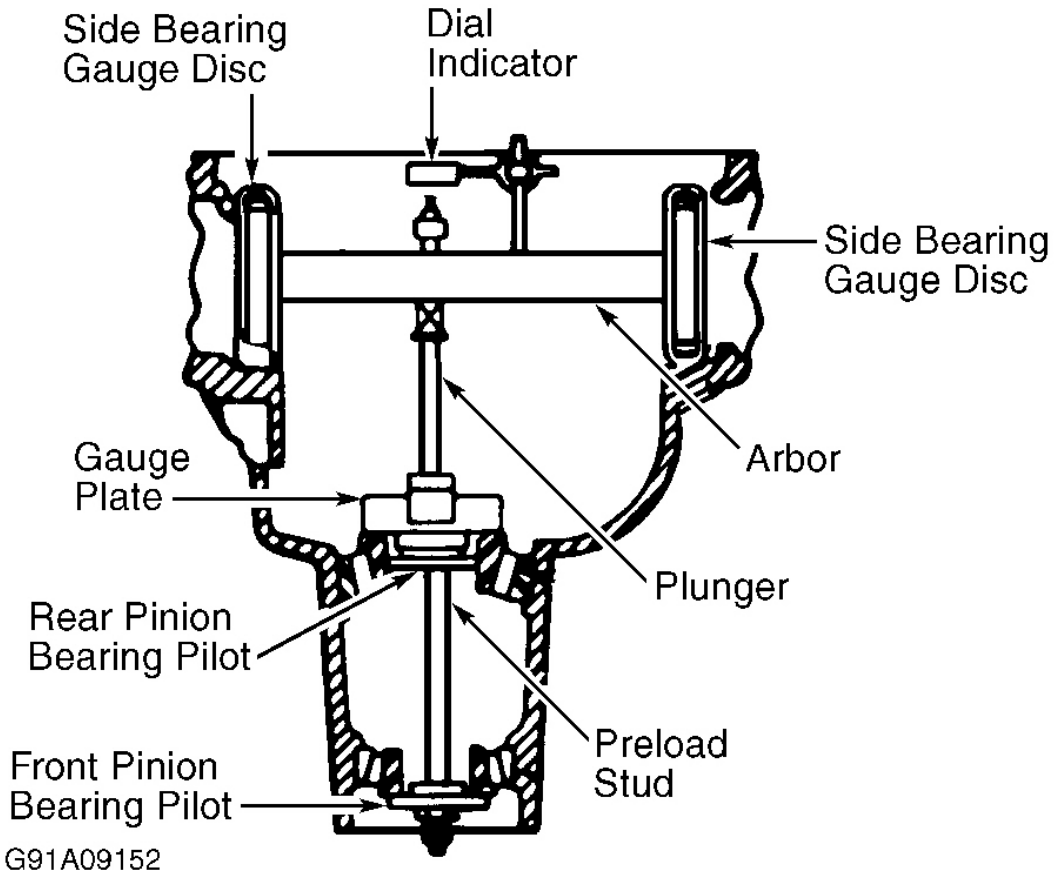


Fig. 4: Installing Pinion Depth Gauge Set
Courtesy of GENERAL MOTORS CORP.

4. Mount side bearing gauging discs on ends of arbor. Place arbor into carrier ensuring discs are properly seated. Install side bearing caps and bolts. Tighten bolts to avoid movement.
5. Position dial indicator on mounting post of arbor with contact button resting on top surface of plunger. Preload dial indicator one-half revolution and tighten. Place plunger onto gauging area of gauge plate.
6. Rock plunger rod slowly back and forth across gauging area until dial indicator reads greatest deflection. Set indicator to zero. Repeat rocking action several times to verify setting. Once zero reading is obtained, remove plunger from gauging area.
7. Dial indicator will now read required pinion shim thickness for a "nominal pinion". Record this reading. Check drive pinion for painted or stamped markings on pinion stem or a stamped code number on small end of pinion gear. See **Fig. 5** .
8. If marking is a positive number, subtract that many thousandths from indicator reading. If marking is a

negative number, add that many thousandths to indicator reading. This will be the thickness of rear pinion bearing shim pack.

9. If no markings are found on pinion, use dial indicator reading as shim thickness. Remove bearing caps and gauging tools from housing. Place selected shim pack on drive pinion. Using a press, install lubricated pinion bearing on pinion shaft. Install NEW speed sensor ring (if equipped).

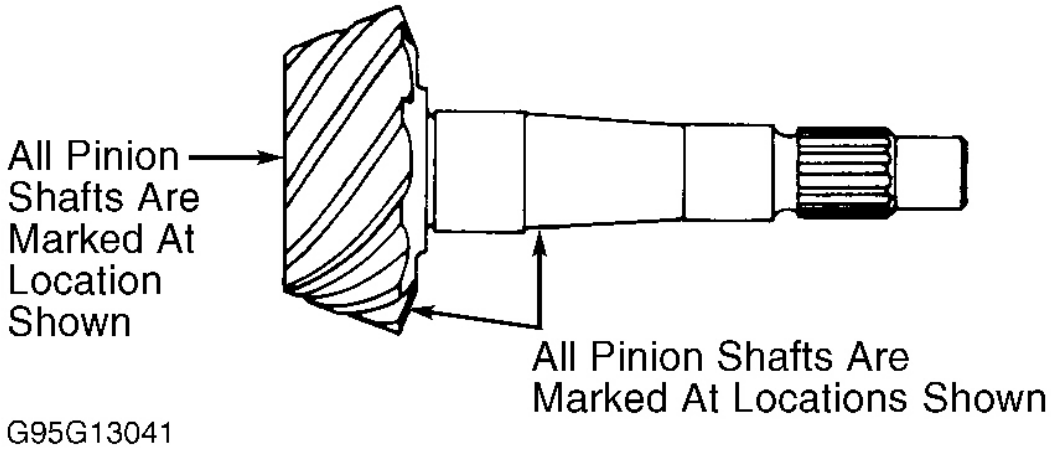


Fig. 5: Locating Pinion Shaft Markings
Courtesy of GENERAL MOTORS CORP.

Differential Case Reassembly

1. Install NEW speed sensor ring (if removed). Install ring gear on case with new bolts. Alternately tighten bolts to pull ring gear into position on case. Place side gear thrust washers over side gear hubs.
2. Install assemblies into case in their original positions. Install pinions and thrust washers into case. Install pinion shaft and lock bolt. Using bearing installer, install side bearings onto differential case.

Differential Shim Selection

1. Measure thickness of original side bearing preload shims. Select a standard .17" (4.3 mm) service spacer and service shims with a total thickness slightly less than original shims. Standard service shims are steel and are available from .040-.082" (1.02-2.08 mm). Production shims are cast iron and available from .210-.272" (5.33-6.91 mm).

NOTE: DO NOT attempt to reuse production shims, because they may break when tapped into position.

2. Install differential case in housing. Install spacer between each bearing cup and housing with chamfered edge of spacer against housing. Install left bearing cap loosely so that differential case is free to move. With left bearing race and spacer against housing, install both left and right service shims between right

bearing race and service spacer.

3. Insert progressively larger feeler gauges between right service spacer and shim pack until a slight drag is felt. Total thickness of required shim pack is equal to feeler gauge thickness plus shim thickness used in step 1). Remove differential case, shims and spacers from axle housing.

Pinion Preload Adjustment

1. Install a new collapsible spacer over pinion stem. Position pinion in housing. While holding pinion forward, carefully drive front pinion bearing onto pinion shaft until a few threads are exposed.
2. Install new oil seal, companion flange, washer and nut. Tighten nut until end play is removed. Rotate pinion several times to seat bearings.
3. Check preload using an INCH-lb. torque wrench. Continue tightening nut and checking preload until correct preload is obtained. **DO NOT** overtighten. See **AXLE ASSEMBLY SPECIFICATIONS** table.

CAUTION: If preload is exceeded, a new collapsible spacer must be installed and nut retightened until proper preload is obtained.

Ring & Pinion Gear Backlash

1. With pinion depth set and pinion installed, place differential case and ring gear assembly into axle housing. Select 2 shims with a combined thickness equal to that of service shims and feeler gauge used in differential shim selection procedure. Install shims and spacers between bearing cups and housing. Install differential bearing caps and tighten cap bolts.
2. Rotate differential case several times to seat bearings. Check backlash using a dial indicator. Increase or decrease shim size where necessary to correct backlash reading. See **Fig. 6** . Recheck backlashat 4 points equally spaced around ring gear. Ensure that variation between points does not exceed .002" (.05 mm).

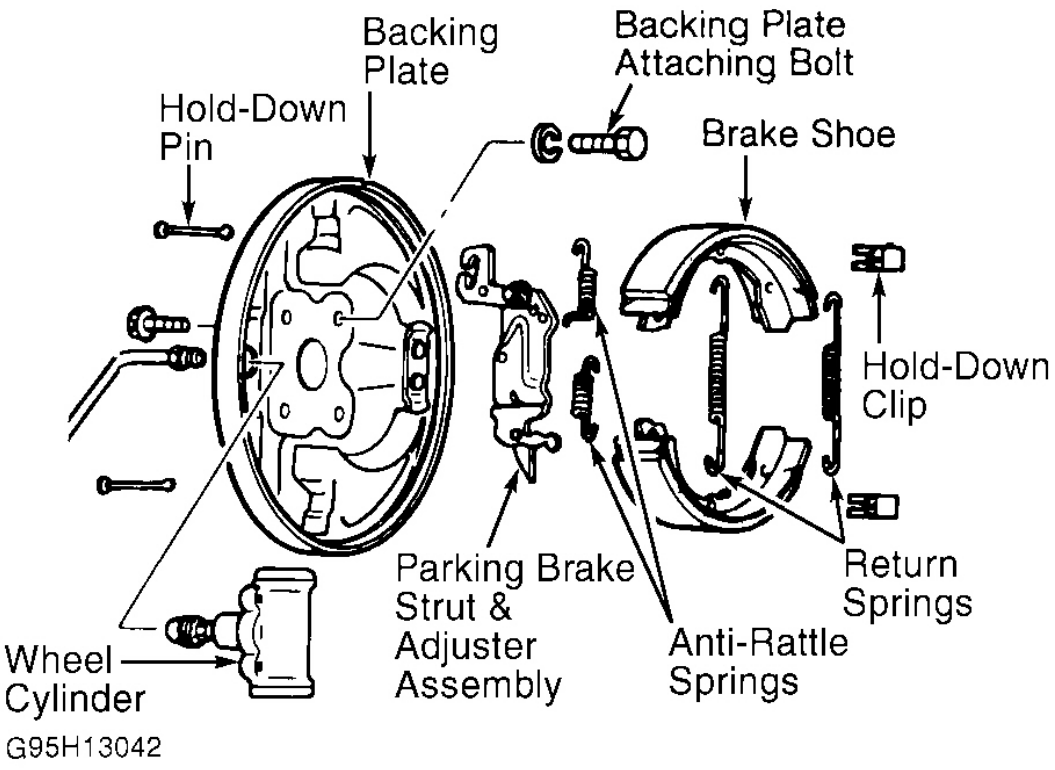


Fig. 6: Adjusting Ring & Pinion Gear Backlash
Courtesy of GENERAL MOTORS CORP.

Differential Bearing Preload

1. Rifferential bearing caps and increase left and right shim sizes .004" (.10 mm). Gentle tapping may be necessary to install second shim. Ensure shims are seated and differential turns freely.
2. On all ring gears, using gear marking compound, check gear tooth contact pattern to verify proper assembly and adjustment. See the **GEAR TOOTH CONTACT PATTERNS** article in GENERAL INFORMATION. Complete necessary settings, and install axle shafts. Install differential cover and fill with lubricant.

CAUTION: Avoid damaging seals when installing axle shafts.

AXLE ASSEMBLY SPECIFICATIONS

AXLE ASSEMBLY SPECIFICATIONS

Application	INCH Lbs. (N.m)
Pinion Bearing Preload (1)	

New Bearing	
7 5/8" Ring Gear	15-30 (1.7-3.4)
8 1/2" Ring Gear	18-36 (2.0-4.1)
Used Bearing	10-15 (1.1-1.7)
Total Assembly Preload (2)	
New Bearing	35-40 (4.0-4.5)
Used Bearing	20-25 (2.3-2.8)
	In. (mm)
Ring Gear Backlash (All Models)	.005-.009 (.13-.23)
Side (Differential) Bearing Preload (3)	Slip Fit Plus .008 (.20)

(1) Measured with new collapsible spacer and seal, without ring gear installed.

(2) Measured at drive pinion gear nut.

(3) Add .004" (.10 mm) to each side to preload bearings.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS (DIFFERENTIAL ASSEMBLY)

TORQUE SPECIFICATIONS (DIFFERENTIAL ASSEMBLY)

Application	**Ft. Lbs. (N.m)**
Differential Bearing Cap Bolt	
9 1/2" Ring Gear	59 (80)
All Others	55 (75)
Differential Bearing Adjusting Nut Lock Bolt (9 1/2")	22 (30)
Differential Filler Plug	26 (35)
Differential Shaft Lock Bolt (1)	
7 5/8" & 8 1/2" Ring Gear	27 (37)
9 1/2" Ring Gear	37 (50)
Housing Cover Bolt	
9 1/2" Ring Gear	30 (41)
All Others	22 (30)
Drive Shaft (Universal Joint) Bolt	16 (22)
Ring Gear Bolt (Left-Hand Threads) (2)	
9 1/2" Ring Gear	107 (145)
All Others	89 (121)
Wheel Lug Nut	100 (136)

(1) Threads must be coated with Loctite No. 242 (GM No. 12345382) before installation.

(2) Always use new ring gear bolts.

TORQUE SPECIFICATIONS (REAR AXLE)

TORQUE SPECS (REAR AXLE)

Application	Ft. Lbs. (N.m)
Drive Shaft "U" Joint Bolt	16 (22)
Height Sensor Control Mounting Bolt	10 (14)
Rear Axle Lower Control Arm	
Bolt	140 (190)
Nut	107 (145)
Rear Axle Upper Control Arm Bolt	
Front	136 (185)
Rear	88 (120)
Rear Axle Upper Control Arm Nut	
Front	107 (145)
Rear	85 (115)
Rear Stabilizer Shaft Bolt	63 (85)
Rear Stabilizer Shaft Bracket Bolt	21 (29)
Shock Absorber Bolt	18 (24)
Shock Absorber Nut	
Upper	16 (22)
Lower	63 (85)
	INCH Lbs. (N.m)
Height Sensor Control Link Nut	27 (3)

DRIVE BELT ROUTING

ENGINE COOLING Fan Belt Routing

DESCRIPTION

NOTE: Description information not available for all vehicles and engines.

4.3L VIN W & 5.7L VIN P

A single serpentine drive belt is used to drive all engine accessories. See **Fig. 13**. On vehicles with the "V08" heavy-duty cooling system, an additional belt is used to drive the mechanical cooling fan. All belt-driven accessories are rigidly mounted to the engine with belt tension maintained by a spring loaded tensioner assembly.

The indicator just behind the tensioner assembly pulley must fall within the acceptable range once the belt is installed. See **Fig. 13**. If the indicator mark on the tensioner assembly does not fall within the acceptable range with the belt is properly installed, replace the belt.

3.8L SUPERCHARGED - VIN 1

Supercharged 3.8L engine uses two accessory drive belts. Outer belt drives generator and poer steering pump. Inner belt drives supercharger, water pump and A/C compressor. Drive belt tension is maintained by individual spring loaded tensioners.

Replace belt when worn or when tensioner indicates that belt has stretched beyond normal limits. See **Fig. 2**.

BELT ADJUSTMENT

NOTE: See Fig. 1 for aligning the drive belt.

NOTE: See Fig. 2 for identifying serpentine belt tension marks (typical illustration).

NOTE: DO NOT allow tensioner to snap against belt.

1. Serpentine belt is automatically adjusted by tensioner. To check for proper tensioning of belt, run engine at normal operating temperature with all accessories on. Turn steering wheel fully left and right several times (vehicles with power steering). Shut engine off.
2. Depress tensioner arm until belt becomes loose on pulleys. Slowly allow tensioner to return to belt. If mark on tensioner arm falls within operating range (2 marks) on tensioner body, go to next step. See **Fig. 2**. If mark is out of range, replace accessory drive belt. Re-check for correct operating range. If mark still does not fall within operating range, replace tensioner.
3. Measure belt tension. If tension is not as specified, replace belt. See **BELT TENSION** table.

BELT TENSION SPECIFICATIONS

Application	(1) (2) Lbs. (kg)
2.2L	
Except "A" Body	64-77 (29-35)
"A" Body	51-71 (23-32)
2.3L	51 (23)
3.1L	51-71 (23-32)
All Others	(3)

(1) Specification is for NEW belt.

(2) Serpentine belt is automatically adjusted by the tensioner.

(3) Information was not released by manufacturer.

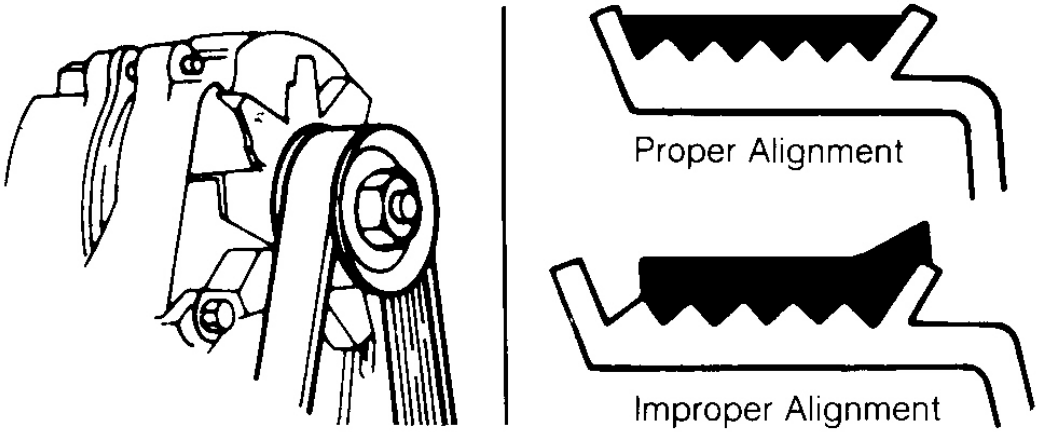


Fig. 1: Aligning Serpentine Belt
Courtesy of GENERAL MOTORS CORP.

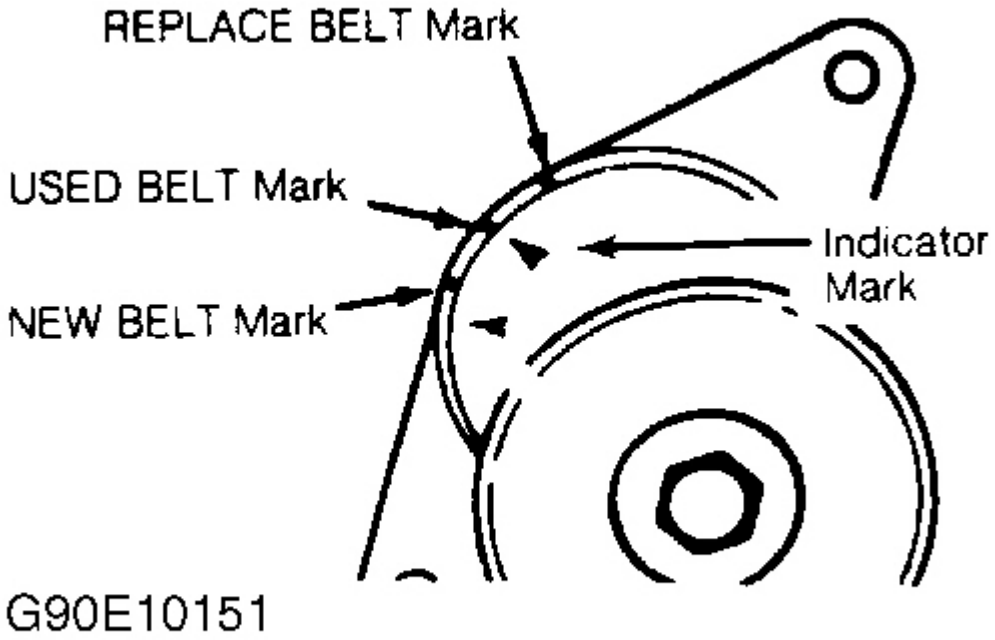


Fig. 2: Identifying Serpentine Belt Tensioner Marks (Typical)
Courtesy of GENERAL MOTORS CORP.

BELT ROUTING

2.2L

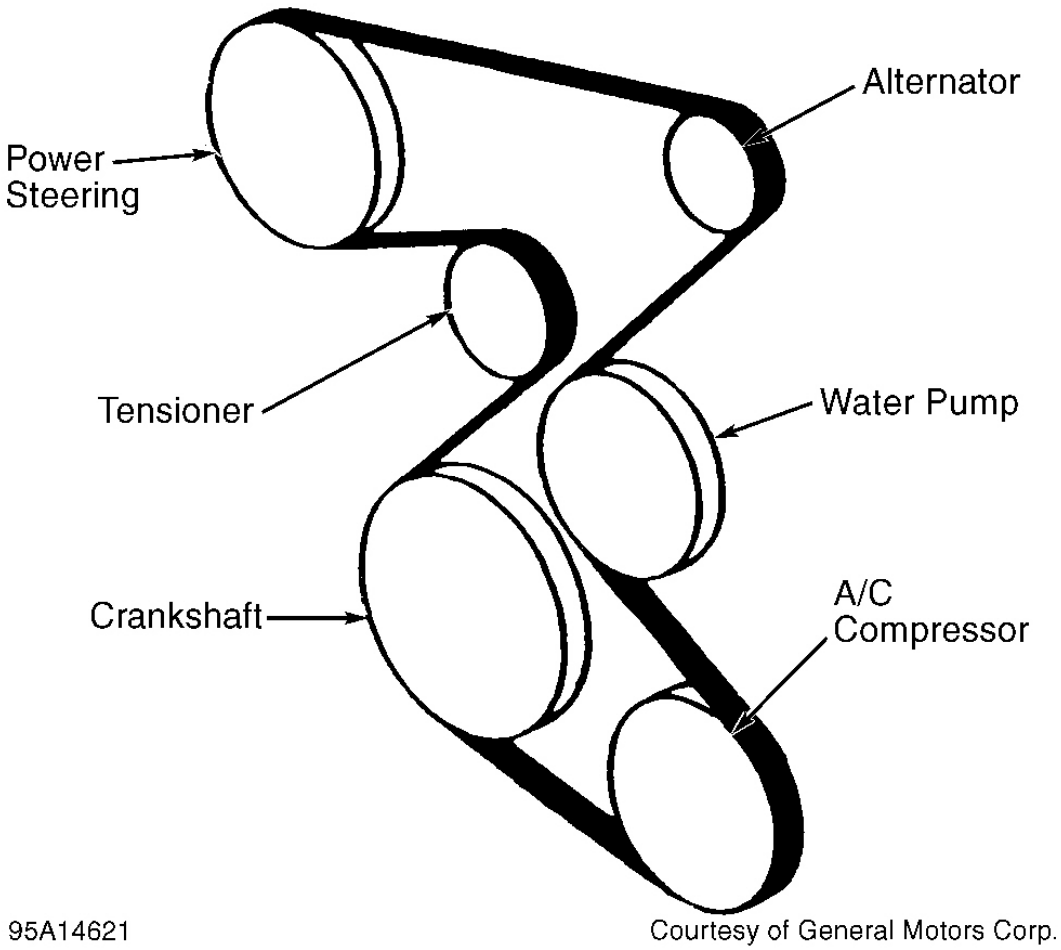


Fig. 3: Routing Serpentine Belt (2.2L With A/C)
Courtesy of GENERAL MOTORS CORP.

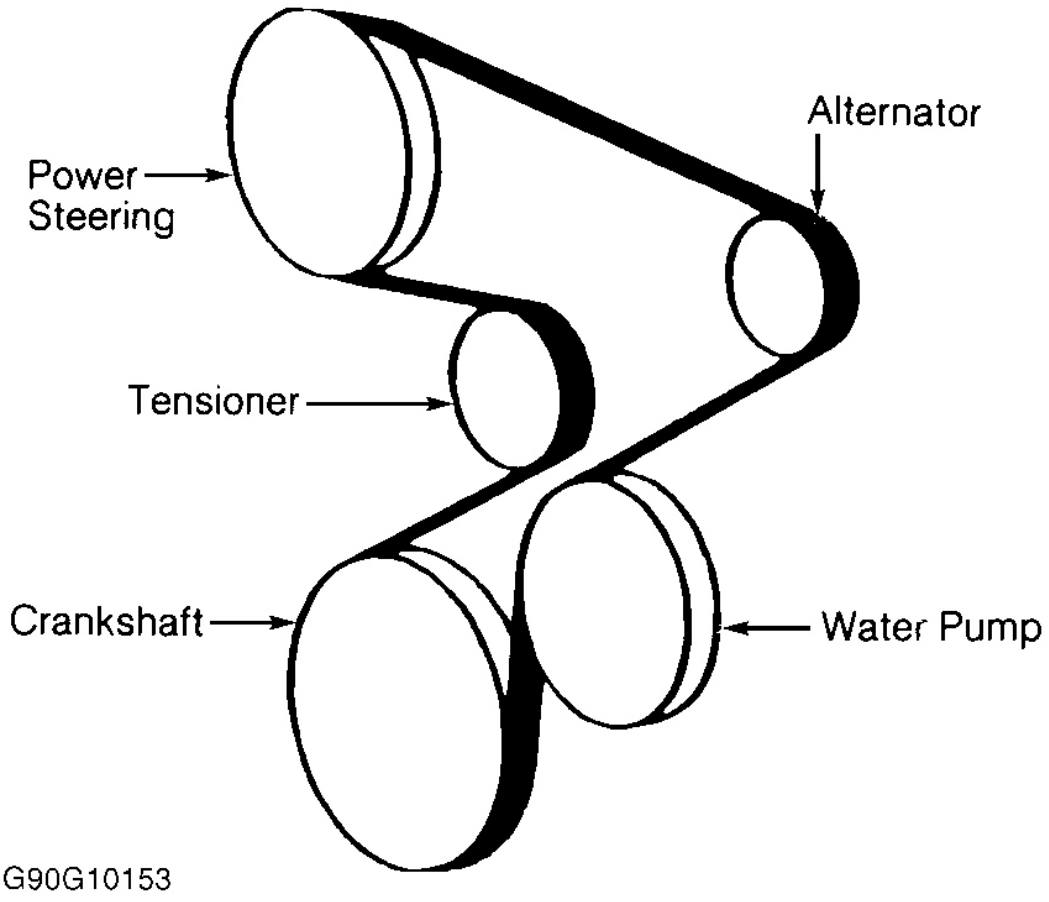


Fig. 4: Routing Serpentine Belt (2.2L Without A/C)
Courtesy of GENERAL MOTORS CORP.

2.3L

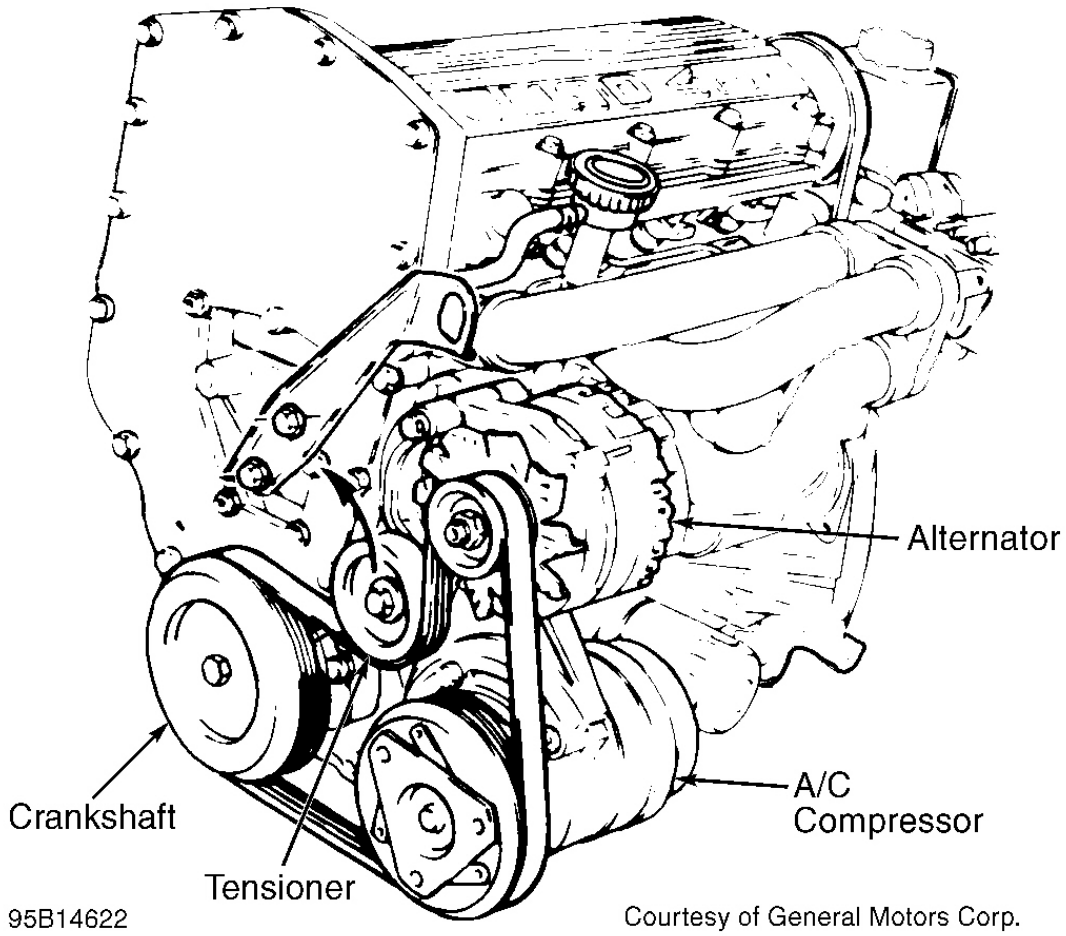


Fig. 5: Routing Serpentine Belt (2.3L)
Courtesy of GENERAL MOTORS CORP.

3.1L

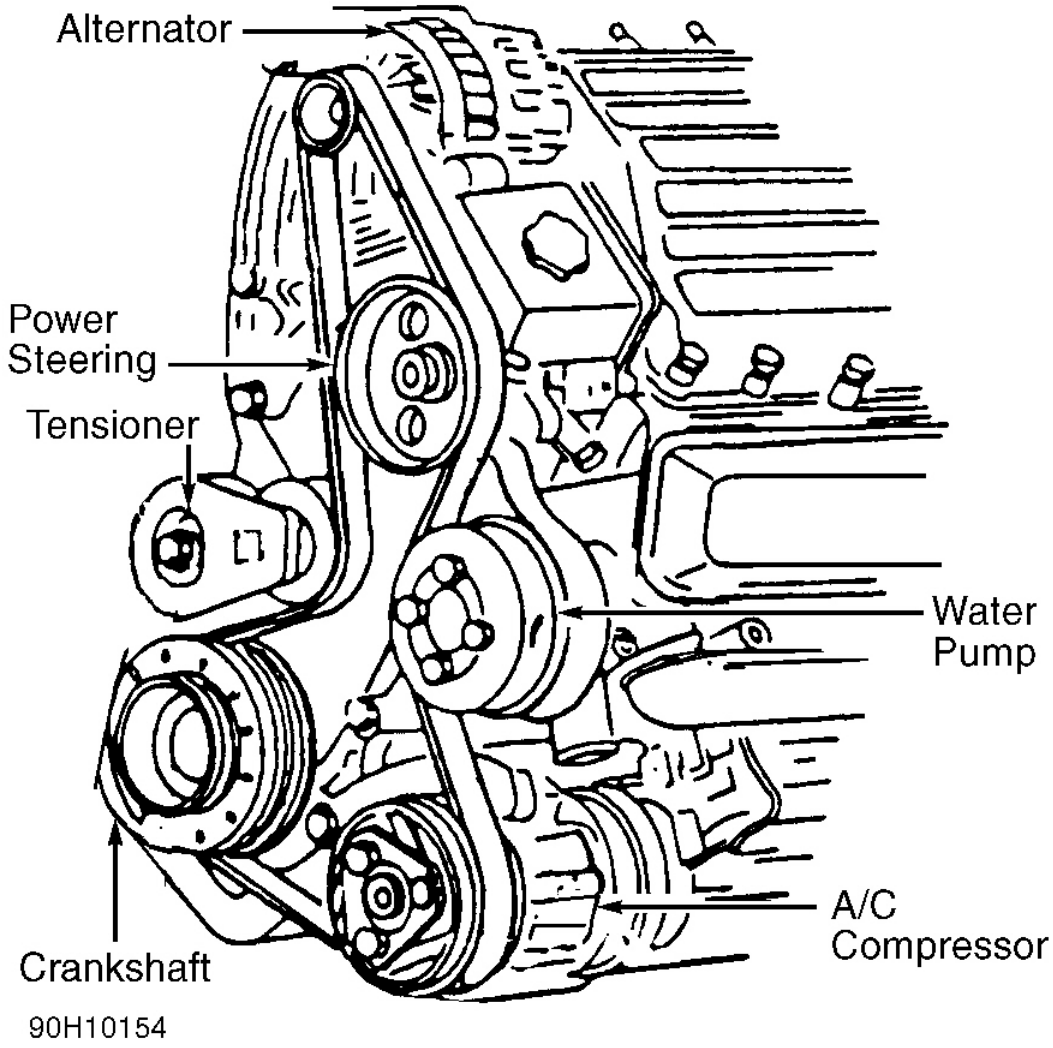


Fig. 6: Routing Serpentine Belt (3.1L)
Courtesy of GENERAL MOTORS CORP.

3.4L

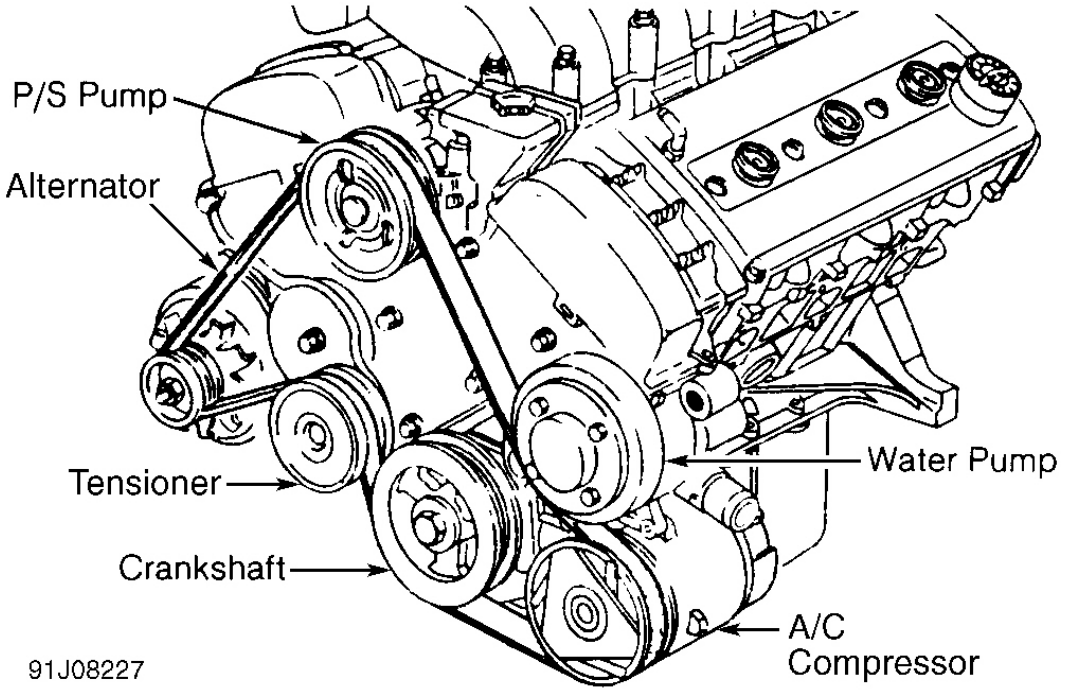


Fig. 7: Routing Serpentine Belt (3.4L Except Camaro & Firebird)
Courtesy of GENERAL MOTORS CORP.

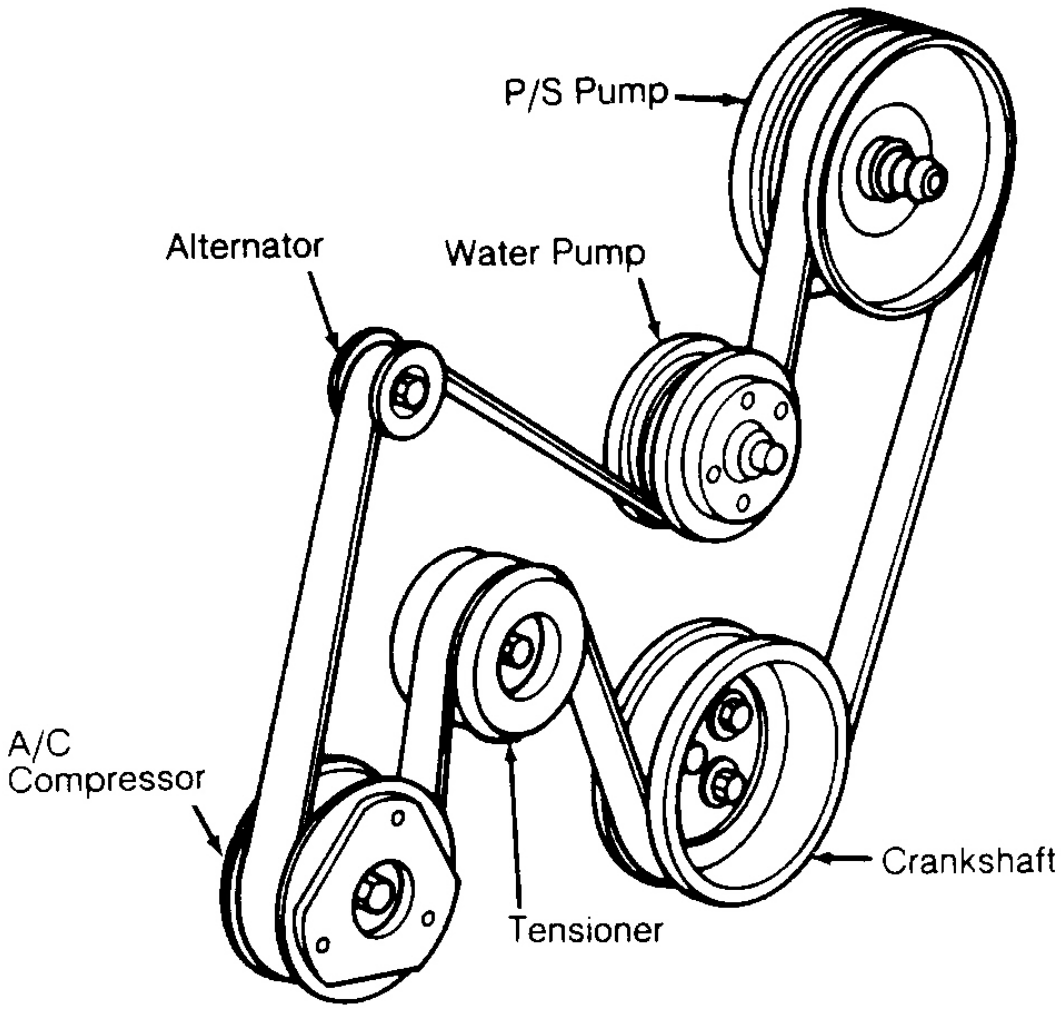


Fig. 8: Routing Serpentine Belt (3.4L Camaro & Firebird)
Courtesy of GENERAL MOTORS CORP.

3.8L

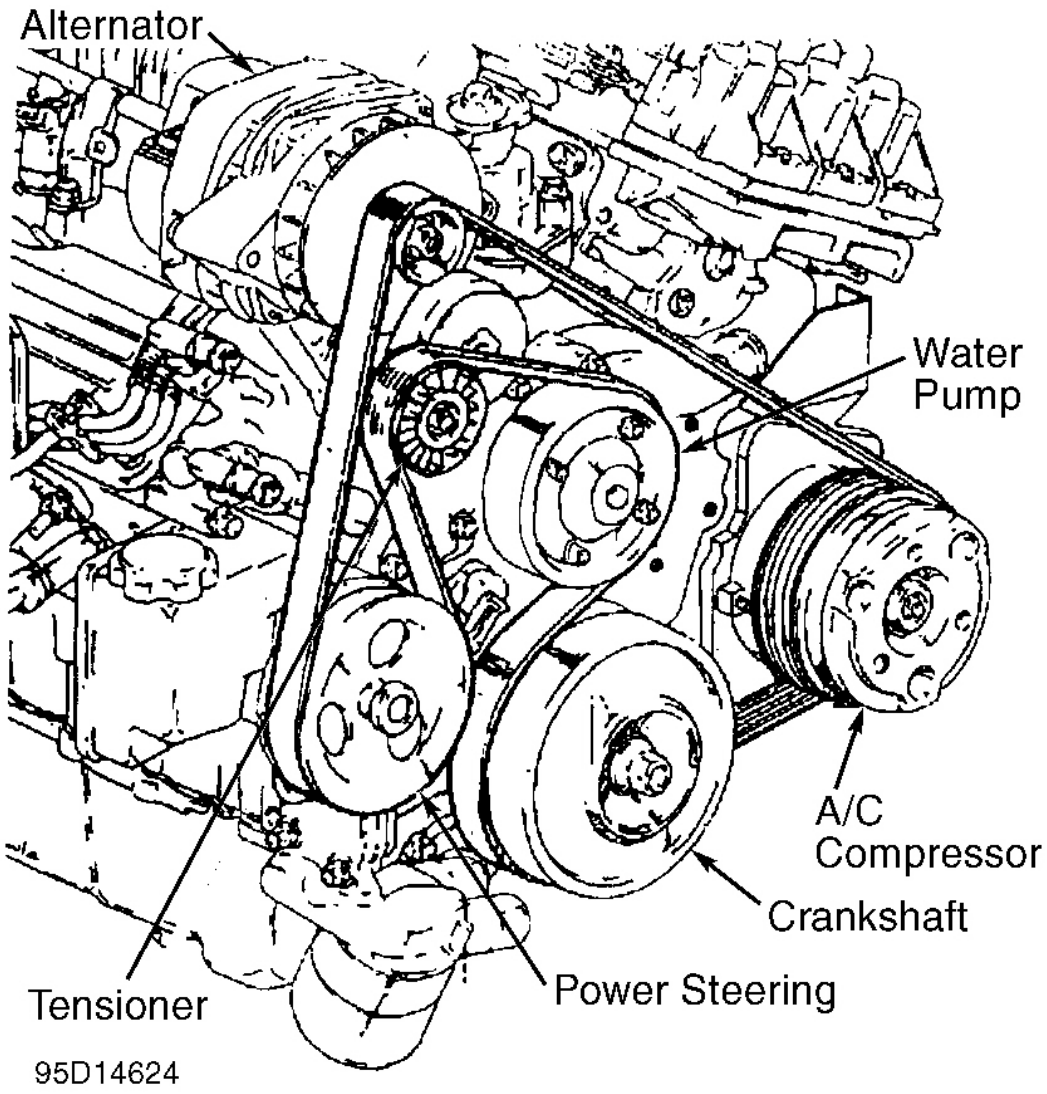


Fig. 9: Routing Serpentine Belt (3.8L VIN K)
Courtesy of GENERAL MOTORS CORP.

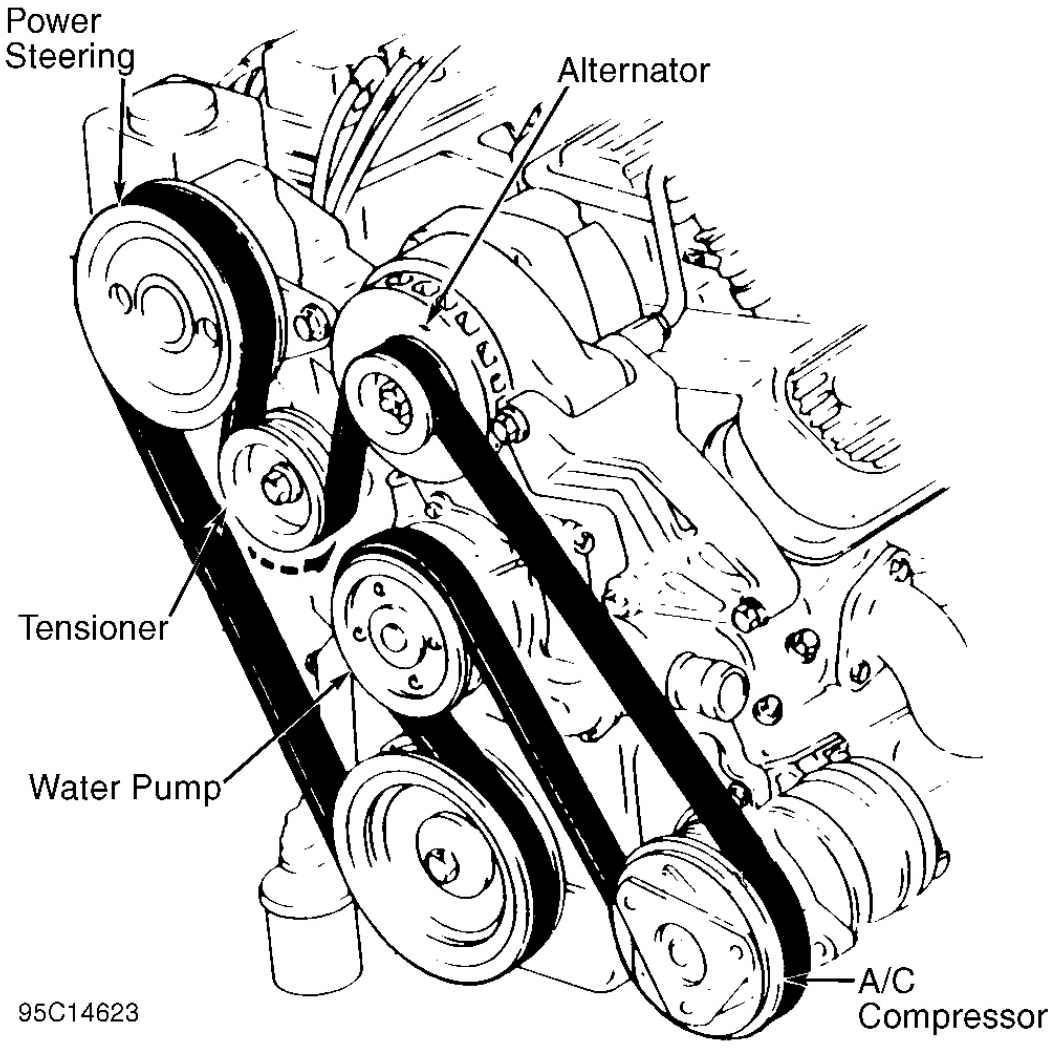


Fig. 10: Routing Serpentine Belt (3.8L VIN L)
Courtesy of GENERAL MOTORS CORP.

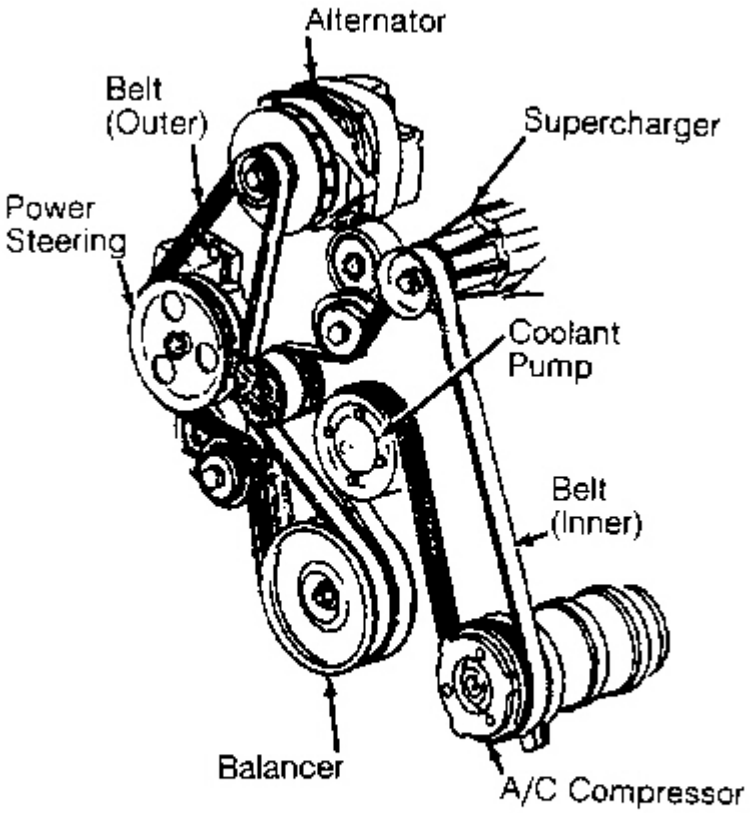


Fig. 11: Routing Serpentine Belt (3.8L VIN 1)
Courtesy of GENERAL MOTORS CORP.

4.0L

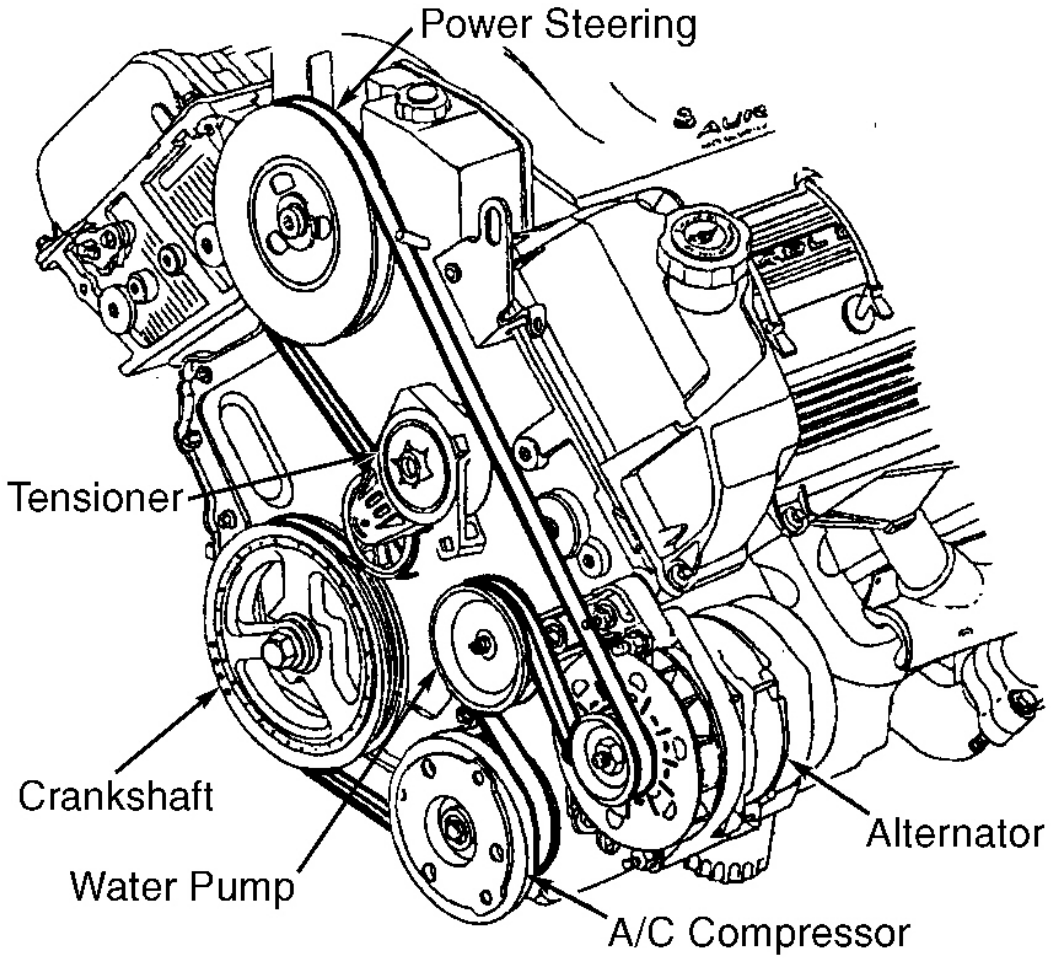
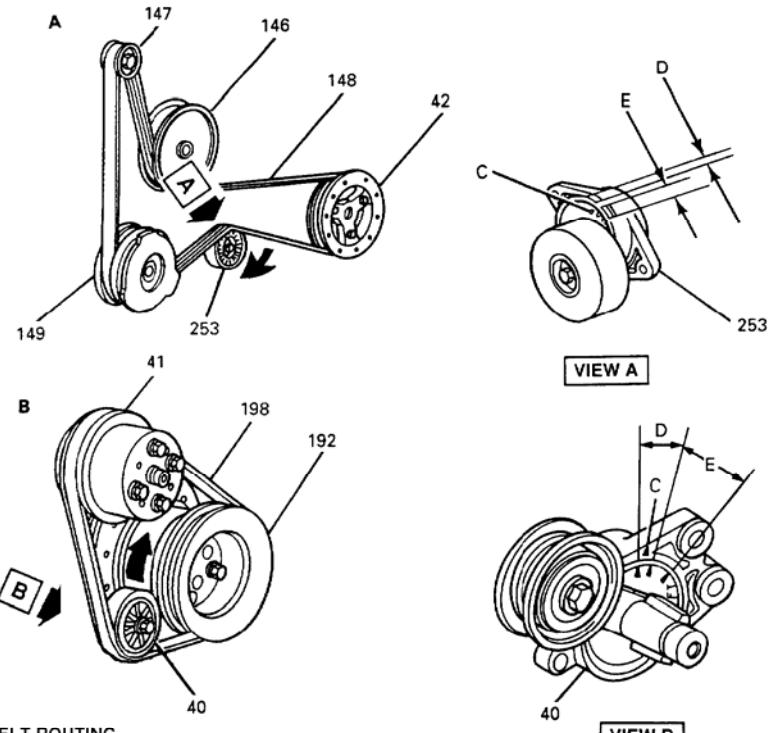


Fig. 12: Routing Serpentine Belt (4.0L)
Courtesy of GENERAL MOTORS CORP.

4.3L & 5.7L (EXCEPT CORVETTE)



A COOLING SYSTEM BELT ROUTING
B ADDITIONAL BELT ROUTING FOR MODELS EQUIPPED WITH "V08" HEAVY DUTY COOLING SYSTEM WITH MECHANICAL FAN
C INDICATOR MARK
D ACCEPTABLE OPERATING RANGE
E UNACCEPTABLE OPERATING RANGE
40 TENSIONER ASSEMBLY, DRIVE BELT (WITH MECHANICAL FAN)
41 PULLEY, FAN
42 BALANCER ASSEMBLY, CRANKSHAFT
146 PUMP ASSEMBLY, POWER STEERING
147 GENERATOR ASSEMBLY
148 BELT, SERPENTINE DRIVE
149 COMPRESSOR ASSEMBLY, AIR CONDITIONING
192 PULLEY, CRANKSHAFT
198 BELT, FAN
253 TENSIONER ASSEMBLY, DRIVE BELT

50D14665

Fig. 13: Belt Routing - Non Corvette (4.3L VIN W & 5.7L VIN P)
Courtesy of GENERAL MOTORS CORP.

5.7L - CORVETTE

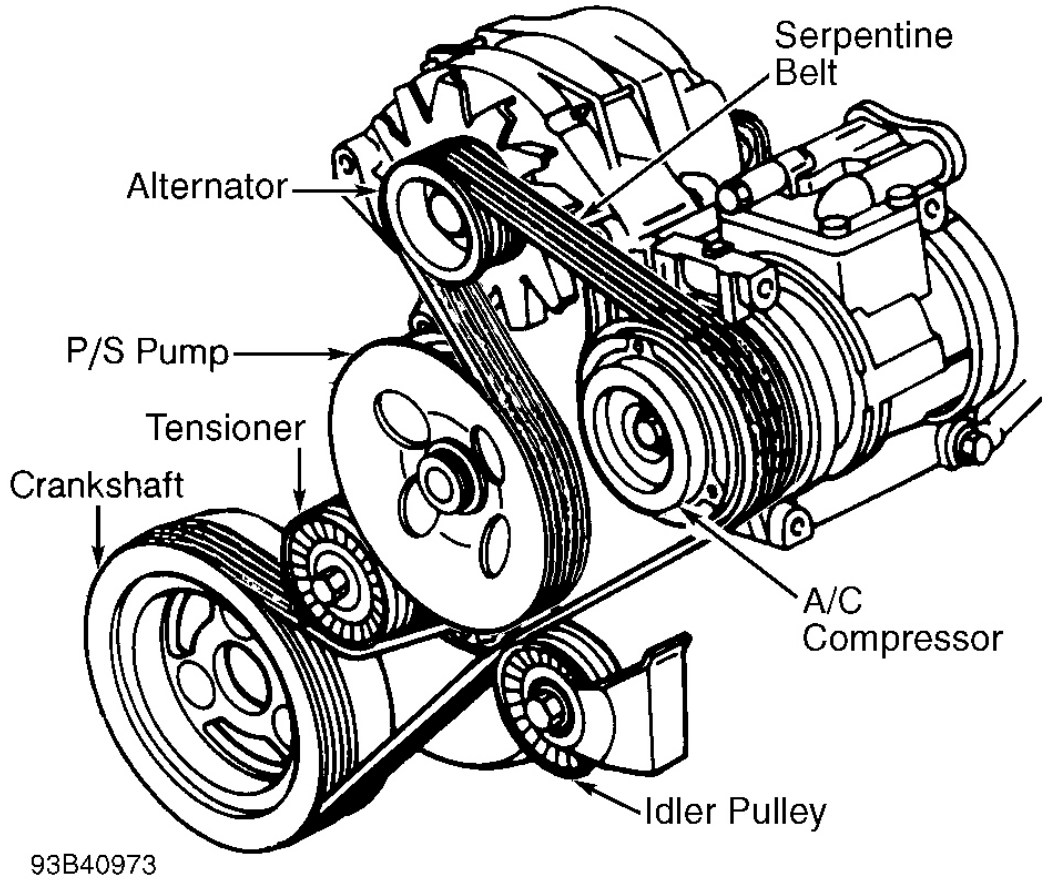


Fig. 14: Routing Serpentine Belt - Corvette (5.7L)
Courtesy of GENERAL MOTORS CORP.

REMOVAL/INSTALLATION

NOTE: Removal and installation information is not provided for all models and engines.

4.0L VIN G

Removal

1. Insert 1/2 inch drive ratchet into drive belt tensioner.
2. Rotate tensioner clockwise and remove belt.

Installation

1. Route the accessory drive belt around the crankshaft, the air conditioning compressor, the idler, the

generator, and the drive belt tensioner pulleys.

2. Insert a 1/2 inch drive ratchet into the drive belt tensioner. Rotate the tensioner clockwise. Route the remainder of the belt around the power steering pulley. Slowly rotate the drive belt tensioner counter clockwise until the drive belt is tight.
3. Remove the 1/2 inch drive ratchet. Check the drive belt for proper seating in all pulleys.

4.3L VIN W & 5.7L VIN P

NOTE: Use Fig. 1-Fig. 14 with this procedure.

Removal

1. Disconnect the battery negative cable.
2. If equipped with a mechanical fan: Remove the fan belt (198) from the tensioner assembly (40). Use 13-mm wrench to rotate tensioner pulley clockwise while sliding belt (198) from tensioner.
3. If equipped with a mechanical fan: Remove the fan belt (198) from pulleys (41 and 192). Remove radiator outlet pipe nuts at air conditioning compressor assembly. Raise and suitably support vehicle.
4. On all, remove serpentine drive belt (148) from tensioner assembly (253): Use 9/16-inch offset wrench to rotate tensioner pulley clockwise while sliding belt (148) from tensioner assembly pulley. Remove serpentine drive belt (148) from accessory pulleys.

Cleaning

Clean the serpentine drive belt surfaces.

Installation

1. Install serpentine drive belt (148) to accessory pulleys. Install serpentine drive belt (148) to tensioner assembly (253), making sure the drive belt (148) is aligned into proper grooves of accessory drive pulleys.
2. If equipped with a mechanical fan: Lower vehicle. Install radiator outlet pipe nuts at air conditioning compressor assembly. Install fan belt (198) to pulleys (41 and 192). Install fan belt (198) to tensioner assembly (40).
3. On all, connect battery negative cable.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

3.8L - VINS 1 & K

Removal & Installation

Remove negative battery cable. Disconnect vacuum reservoir. Disconnect outer and inner accessory drive belts. On supercharged engines, disconnect heater hoses from pipes and pipes from engine. Using appropriate engine support fixture raise engine slightly to take weight off engine mounts. Remove two bottom bolts on front engine mount. Remove through bolt from front engine mount and remove mount. Remove belts from engine compartment. Installation is reverse of removal. See **Fig. 9** and **Fig. 11** . Tighten engine mount bolts to 65 Ft. Lbs. (87 N.m).

INSPECTION OF BELT

Routine inspection of the belt may reveal cracks in the belt ribs. These cracks will not impair belt performance and therefore should not be considered a problem requiring belt replacement. However, the belt should be replaced if the belt causes belt slip to occur or if sections of the belt ribs are missing.

DRIVE SHAFT

Drive Shaft Alignment

DESCRIPTION & OPERATION

Drive shaft is used to transmit power from transmission to rear axle assembly. Use proper universal joint alignment angle to provide smooth operation of drive shaft. Check front and rear universal joint angles with vehicle at proper ride height and a full gas tank. Adjust front universal joint by shimming transmission mount. Adjust rear universal joint angle by shimming transmission mount, repositioning pinion nose or by replacing rear control arms.

INSPECTION

RIDING HEIGHT & UNIVERSAL JOINT ANGLE

1. Ensure vehicle is at proper ride height with a full tank of gasoline. Measure axle tube-to-frame height (ride height) from top of axle tube to bottom of frame. See **Fig. 1**. Bounce vehicle and allow to return to normal ride height before measuring. Ensure ride height is within specification. See **RIDE HEIGHT & UNIVERSAL JOINT ANGLE SPECIFICATIONS** table under ADJUSTMENTS.
2. If ride height is not within specification on models with electronic suspension, adjust height sensor. See **HEIGHT SENSOR** under ADJUSTMENTS. On models without electronic suspension, add weight to trunk to obtain correct ride height.
3. With vehicle level, measure universal joint angles. Clean bearing caps. Install Inclinometer (J-23498-A) on rear drive shaft bearing cap. See **Fig. 2**. Bearing cap must be vertically aligned (straight up and down). Center bubble in sight glass, and record reading.
4. Remove inclinometer, rotate drive shaft 90 degrees, and install inclinometer on drive yoke bearing cap. Measure angle, and subtract smaller reading from larger reading to determine rear universal joint angle.
5. Attach Inclinometer Adapter (J-23498-20) to front drive shaft bearing cap. See **Fig. 3**. Attach inclinometer to adapter, and repeat procedure used on rear universal joint to obtain front universal joint angle.

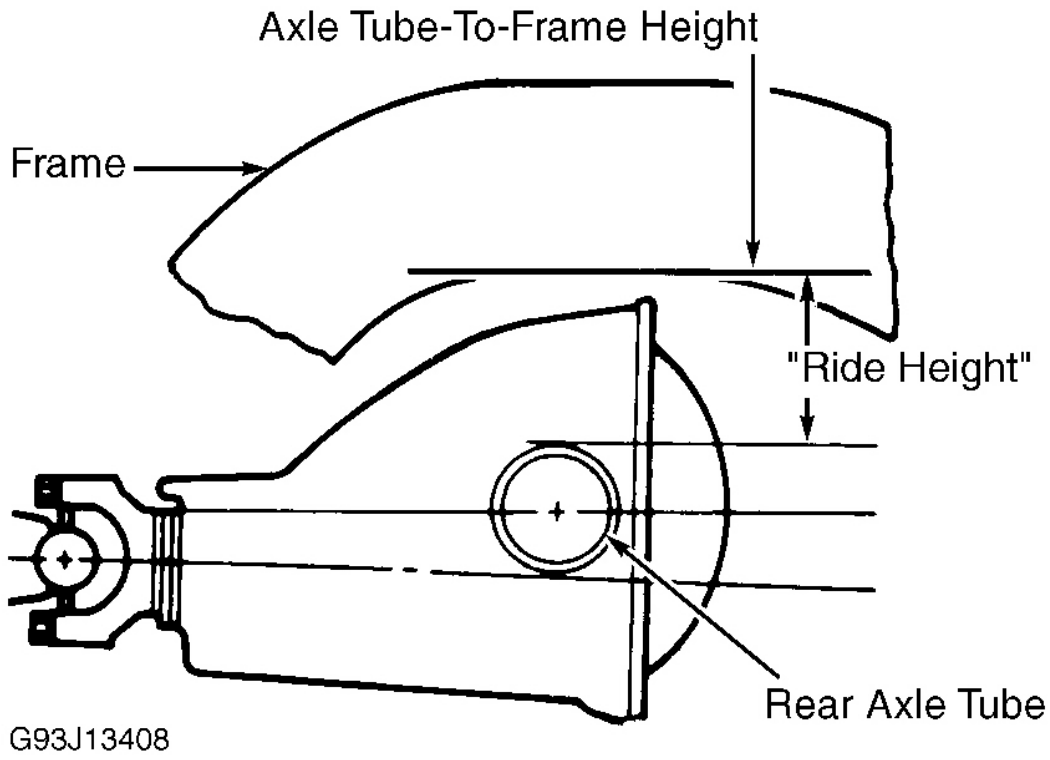


Fig. 1: Checking Axle Tube-To-Frame Height
Courtesy of GENERAL MOTORS CORP.

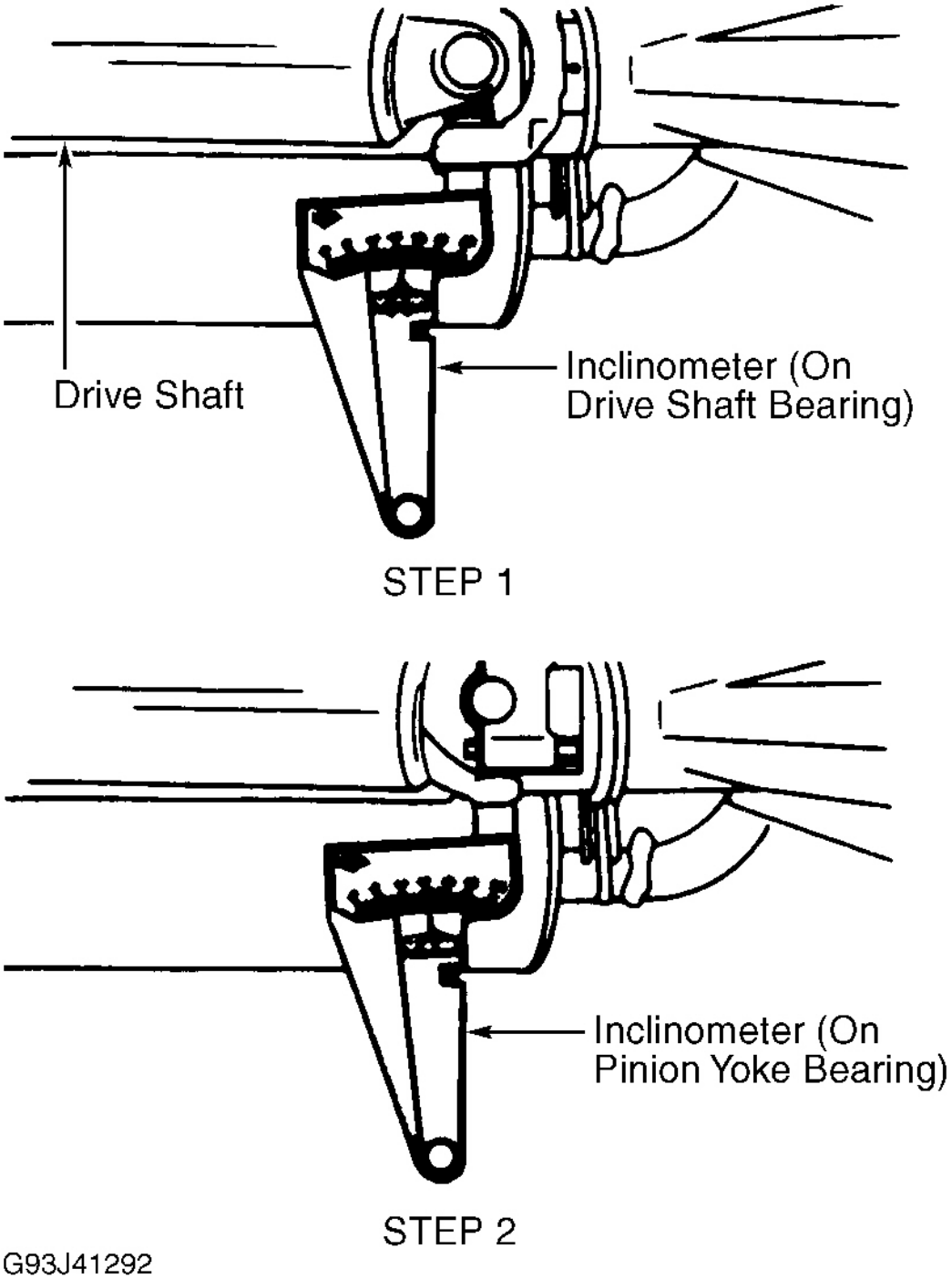


Fig. 2: Measuring Rear Universal Joint Angle
Courtesy of GENERAL MOTORS CORP.

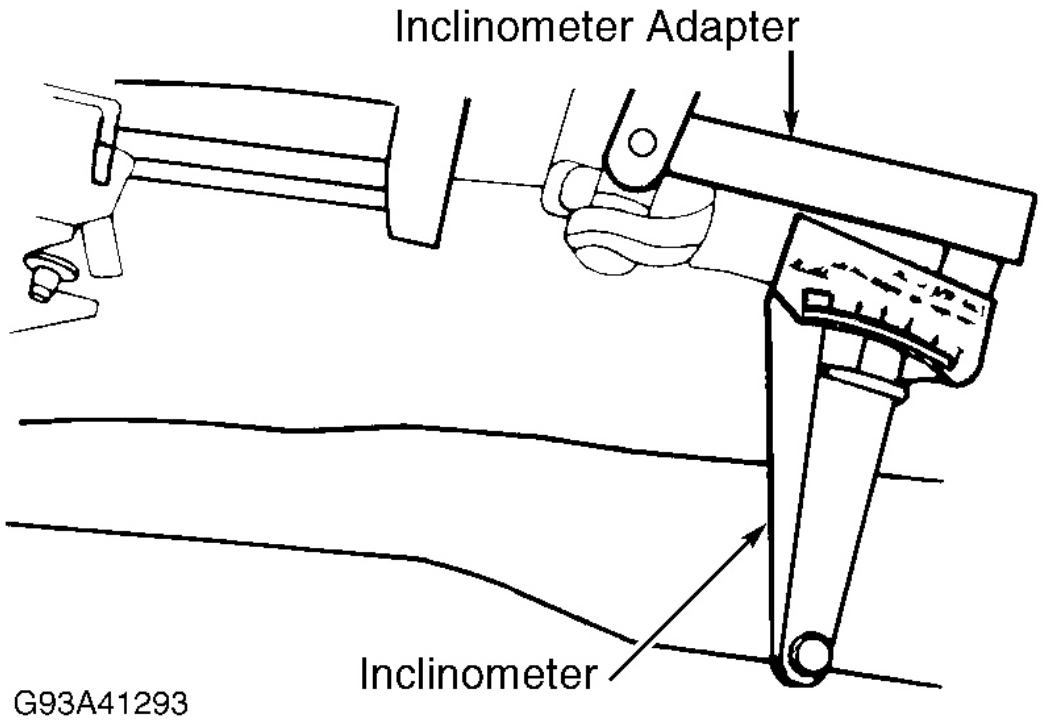


Fig. 3: Measuring Front Universal Joint Angle
Courtesy of GENERAL MOTORS CORP.

ADJUSTMENTS

HEIGHT SENSOR

CAUTION: Control arm-to-sensor arm link must be attached during adjustment.

1. With link attached to metal arm, loosen metal arm-to-height sensor plastic arm lock bolt. See **Fig. 4**. To increase ride height, move plastic arm upward. To decrease ride height, move plastic arm downward. Tighten lock bolt.
2. For every one-degree change in angle arm, the trim (riding) height will change by approximately 1/4" (6 mm). The arm angle may be changed a total of 5 degrees, approximately 1 1/4" (32 mm).

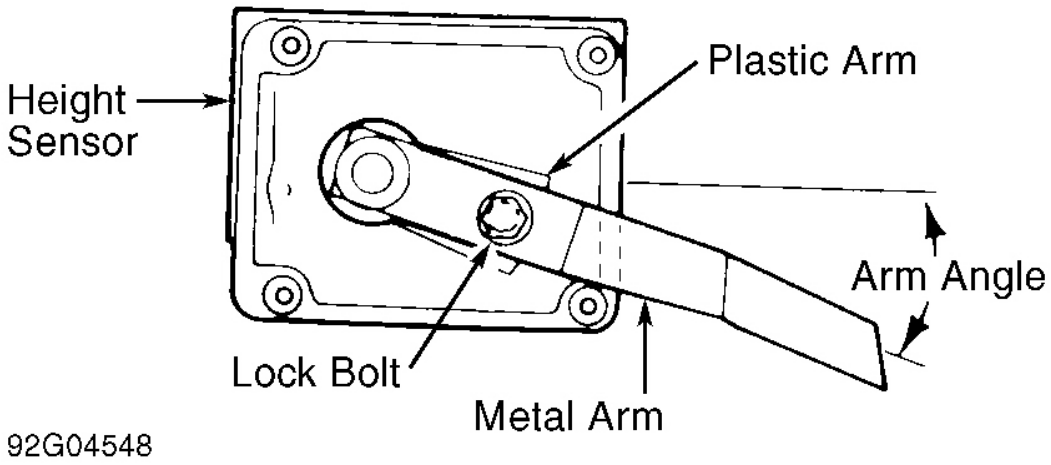


Fig. 4: Adjusting Height Sensor
Courtesy of GENERAL MOTORS CORP.

TRANSMISSION SHIMMING

Adding one shim at transmission mount decreases front universal joint angle 1/2 degree and increases rear angle 1/4 degree. Removing one shim from transmission mount increases front universal joint angle 1/2 degree and decreases rear angle 1/4 degree.

NOTE: Production transmission mount bolt is M10-1.5 x 35 mm. When using 2 or more shims, a M10-1.5 x 50 mm bolt must be used.

REPOSITIONING PINION NOSE

Rear universal joint angle corrections ± 1 degree can be made by loosening all rear suspension control arm bolts. Reposition pinion nose up or down, and tighten all bolts.

CONTROL ARM CHANGE

By using different length control arms available for universal joint angle service, joint angle can be corrected. Rear joint angle can be corrected to within ± 2 degrees. Front joint angle can be corrected to within ± 1/3 degree. See **RIDE HEIGHT & UNIVERSAL JOINT ANGLE SPECIFICATIONS** table.

RIDE HEIGHT & UNIVERSAL JOINT ANGLE SPECIFICATIONS

Application	Ride Height In. (mm)	(1) Front Joint (°)	(2) Rear Joint (°)
Caprice & Impala SS Sedan			
7.6" Axle			
FE1 Suspension	5.59 (142)	1.6	2.6

8.5" Axle			
FE1/FE2 Suspension	5.98 (152)	1.3	2.6
FE2/F41 Suspension	5.51 (140)	1.3	2.6
FE3 Suspension	5.24 (133)	1.3	2.6
7B3 Suspension			
215/75R15	5.91 (150)	1.3	2.6
225/70R15	6.02 (153)	1.3	2.6
235/70R15	5.71 (145)	1.3	2.6
Roadmaster Sedan			
FE1/FE3 Suspension	5.79 (147)	1.3	2.6
FE2/F41 Suspension	6.06 (154)	1.3	2.6
FE2 Suspension	5.98 (152)	1.3	2.6
Caprice & Roadmaster Wagon			
8.5" Axle			
F40 Suspension			
225/75R15	4.84 (123)	1.4	3.0
225/70R15	5.28 (134)	1.4	3.0

(1) Angles may vary within ± 1/3 degree.

(2) Angles may vary within ± 2/3 degree.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Drive Shaft "U" Joint Bolts	16 (22)
Rear Axle Lower Control Arm	
Bolt	140 (190)
Nut	107(145)
Rear Axle Upper Control Arm Bolt	
Front	136 (185)
Rear	88 (120)
Rear Axle Upper Control Arm Nut	
Front	107 (145)
Rear	85 (115)
Rear Stabilizer Shaft Bolt	63 (85)
Rear Stabilizer Shaft Bracket Bolt	21 (29)
Transmission Mount	
Bolts	35 (47)

Nut	30 (41)
	INCH Lbs. (N.m)
Height Sensor Control Arm Lock Bolt	27 (3)

DTC INDEX

Caprice

AIR BAG RESTRAINT SYSTEM DTCS

AIR BAG RESTRAINT SYSTEM DTCS

OEM Code	Description
15	PASSENGER INITIATOR CIRCUIT RESISTANCE HIGH
16	PASSENGER INITIATOR CIRCUIT RESISTANCE LOW
17	PASSENGER INITIATOR CIRCUIT OPEN
21	DRIVER INITIATOR CIRCUIT RESISTANCE HIGH
22	DRIVER INITIATOR CIRCUIT RESISTANCE LOW
24	INITIATOR CIRCUIT VOLTAGE LOW
25	INITIATOR CIRCUIT SHORT TO IGNITION
26	DRIVER INITIATOR CIRCUIT OPEN
35	DISCRIMINATING SENSOR OPEN OR SHORT TO GROUND
36	DISCRIMINATING SENSOR CLOSED OR SHORT TO IGNITION
51	FRONTAL CRASH DETECTED
52	DATA AREA FULL
61	CIRCUIT INDICATOR CIRCUIT FAILURE
62	REDUNDANT SIR INDICATOR CIRCUIT FAILURE
71	INTERNAL SDM FAULT

ANTI-LOCK BRAKE SYSTEM DTCS

ANTI-LOCK BRAKE SYSTEM DTCS

OEM Code	Description
21	FRONT WHEEL SPEED SENSOR CIRCUIT FAULT
23	WHEEL SPEED SENSOR CONTINUITY FAULT
25	FRONT WHEEL SPEED SENSOR CIRCUIT FAULT
27	WHEEL SPEED SENSOR CONTINUITY FAULT
28	WHEEL SPEED SENSOR FREQUENCY ERROR
35	REAR WHEEL SPEED SENSOR CIRCUIT

	FAULT
37	WHEEL SPEED SENSOR CONTINUITY FAULT
41	RIGHT FRONT, LEFT FRONT & REAR INLET VALVE SOLENOID FAULT
42	RIGHT FRONT, LEFT FRONT & REAR OUTLET VALVE SOLENOID FAULT
45	RIGHT FRONT, LEFT FRONT & REAR INLET VALVE SOLENOID FAULT
46	RIGHT FRONT, LEFT FRONT & REAR OUTLET VALVE SOLENOID FAULT
55	RIGHT FRONT, LEFT FRONT & REAR INLET VALVE SOLENOID FAULT
56	RIGHT FRONT, LEFT FRONT & REAR OUTLET VALVE SOLENOID FAULT
61	BPM VALVE PUMP MOTOR FAULT
63	VALVE POWER SUPPLY FAULT
71	EBCM FAULT
85	LOW VOLTAGE

AUTOMATIC TRANSMISSION DTCS

DIAGNOSTIC CHARTS - CARS

OEM Code	Description
14	CTS SIGNAL VOLTAGE LOW (HIGH TEMPERATURE INDICATED)
15	CTS SIGNAL VOLTAGE HIGH (LOW TEMPERATURE INDICATED)
21	THROTTLE POSITION SENSOR SIGNAL VOLTAGE HIGH
22	THROTTLE POSITION SENSOR SIGNAL VOLTAGE LOW
28	TRANS. RANGE PRESSURE SWITCH - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES
37	TCC BRAKE SWITCH ERROR - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES
38	BRAKE SWITCH ERROR - 4.3L & 5.7L "B/D/F/Y" BODIES
53	SYSTEM VOLTAGE HIGH - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES
58	TRANS. TEMP. SENSOR HIGH - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES
59	TRANS. TEMPERATURE SENSOR LOW TEMPERATURE - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES

72	VEHICLE SPEED SENSOR LOSS - 3.4L "F" BODY, 4.3L & 5.7L "B", "D" & "F" BODIES
72	VEHICLE SPEED SENSOR LOSS - 5.7L "Y" BODY
73	PRESSURE CONTROL SOLENOID - 4.3L/5.7L "B/D/F/Y" BODIES
74	TRACTION CONTROL VOLTAGE LOW - 5.7L "D/F/Y" BODIES
75	TRANS. VOLTAGE LOW - 4.3/5.7L "B/D/F/Y" BODIES
79	TRANSMISSION FLUID OVERTEMP - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES
80	TRANSMISSION COMPONENT SLIPPING - 3.4L "F" BODY
81	2-3 SHIFT SOLENOID - 4.3L & 5.7L "B/D/F/Y" BODIES
82	1-2 SHIFT SOLENOID - 4.3L & 5.7L "B/D/F/Y" BODIES
83	TCC PWM SOLENOID - 4.3L & 5.7L "B/D/F/Y" BODIES
84	3-2 CONTROL SOLENOID - 4.3L & 5.7L "B/D/F/Y" BODIES
85	TCC STUCK ON - 4.3L & 5.7L "B", "D", "F" & "Y" BODIES
92	TCC SOLENOID CIRCUIT - 3.4L "F" BODY, 4.3L & 5.7L "B", "D", "F" & "Y" BODIES
93	PRESSURE CONTROL SOLENOID - 3.4L "F" BODY
96	PRESSURE CONTROL SOLENOID - 3.4L "F" BODY

DIAGNOSTIC CHARTS - LIGHT TRUCKS & VANS - GASOLINE EXCEPT "S" & "T" SERIES 4.3L VIN W

OEM Code	Description
14	COOLANT TEMPERATURE SENSOR SIGNAL VOLTAGE LOW
15	COOLANT TEMPERATURE SENSOR SIGNAL VOLTAGE HIGH
21	TPS SIGNAL VOLTAGE HIGH
22	TPS SIGNAL VOLTAGE LOW
24	VEHICLE SPEED SENSOR TRANSMISSION OUTPUT SIGNAL
28	TRANS. RANGE PRESSURE SWITCH
37	TCC BRAKE SWITCH ON/OFF

38	TCC BRAKE SWITCH ON/OFF
52	SYSTEM VOLTAGE HIGH
53	SYSTEM VOLTAGE HIGH
58	TRANS. FLUID TEMP. HIGH
59	TRANS. FLUID TEMP. LOW
66	3-2 CONTROL SOLENOID CIRCUIT FAULT
67	TCC SOLENOID CIRCUIT CHECK
69	TORQUE CONVERTER CLUTCH STUCK ON
72	VSS CIRCUIT LOSS TRANSMISSION OUTPUT SIGNAL
73	PRESSURE CONTROL SOLENOID (CURRENT ERROR)
75	SYSTEM VOLTAGE LOW
79	TRANS. FLUID TEMPERATURE HIGH
81	TRANS. 2-3 ERROR
82	TRANS. 1-2 ERROR
83	TCC SOLENOID CIRCUIT FAULT

DIAGNOSTIC CHARTS - LIGHT TRUCKS & VANS - DIESEL

OEM Code	Description
14	ECT SENSOR CKT LOW (HIGH TEMPERATURE INDICATED)
15	ECT SENSOR CKT HIGH (LOW TEMPERATURE INDICATED)
24	VSS CIRCUIT LOW (TRANS OUTPUT SPEED SIGNAL)
28	TRANS. RANGE PRESSURE SWITCH CIRCUIT FAULT
37	TCC BRAKE SWITCH STUCK ON/OFF
38	TCC BRAKE SWITCH STUCK ON/OFF
52	SYSTEM VOLTAGE HIGH TOO LONG
53	SYSTEM VOLTAGE HIGH TOO LONG
58	TRANS. FLUID TEMP. SENSOR CK LOW HIGH TEMPERATURE INDICATED)
59	TRANS. FLUID TEMP. SENSOR CKT HIGH LOW TEMPERATURE INDICATED)
66	3-2 CONTROL SOLENOID CIRCUIT FAULT
67	TCC SOLENOID CIRCUIT FAULT
69	TCC STUCK ON
72	VEHICLE SPEED SENSOR CIRCUIT LOSS (TRANS OUTPUT SPEED SIGNAL)
73	PRESSURE CONTROL SOLENOID CIRCUIT (CURRENT ERROR)

75	SYSTEM VOLTAGE LOW
79	TRANSMISSION FLUID OVERTEMP
81	2-3 SHIFT SOLENOID CIRCUIT FAULT
82	1-2 SHIFT SOLENOID CIRCUIT FAULT
83	TCC PWM SOLENOID CIRCUIT FAULT

DIAGNOSTIC CHARTS - "S" & "T" SERIES 4.3L VIN W

DTC	Description
P0117	CTS TEMPERATURE LOW - "S" & "T" 4.3L (VIN W)
P0118	CTS TEMPERATURE HIGH - "S" & "T" 4.3L (VIN W)
P0122	TPS SIGNAL LOW - "S" & "T" 4.3L (VIN W)
P0502	VSS CK LOW/HIGH - "S" & "T" 4.3L (VIN W)
P0503	VSS CK LOW/HIGH - "S" & "T" 4.3L (VIN W)
P0560	SYSTEM VOLTAGE MALFUNCTION - "S" & "T" SERIES 4.3L (VIN W)
P0703	TCC BRAKE INPUT CIRCUIT - "S" & "T" SERIES 4.3L (VIN W)
P0712	TRANS. TEMP. SENSOR VOLTAGE LOW "S" & "T" SERIES 4.3L (VIN W)
P0713	TRANS. TEMP. SENSOR VOLTAGE HIGH - "S" & "T" SERIES 4.3L (VIN W)
P0742	TCC STUCK ON - "S" & "T" SERIES 4.3L (VIN W)
P0748	PRESSURE CONTROL SOLENOID - "S" & "T" SERIES 4.3L (VIN W)
P0753	1-2 SHIFT SOLENOID - "S" & "T" 4.3L (VIN W)
P0756	2-3 SHIFT SOLENOID PERFORMANCE - "S" & "T" SERIES 4.3L (VIN W)
P0758	2-3 SHIFT SOLENOID ELECTRICAL - "S" & "T" SERIES 4.3L (VIN W)
P1810	TRANSMISSION RANGE SWITCH ASSEMBLY CIRCUIT S" & "T" SERIES 4.3L (VIN W)
P1812	TRANS. FLUID OVERTEMP - "S" & "T" SERIES 4.3L (VIN W)
P1860	TCC PWM SOLENOID ELECTRICAL CKT - "S" & "T" SERIES 4.3L (VIN W)
P1864	TCC SOLENOID ELECTRICAL CKT - "S" & "T" SERIES 4.3L (VIN W)
P1870	TRANSMISSION COMPONENT SLIPPING - "S" & "T" SERIES 4.3L (VIN W)
P1886	3-2 SOLENOID ELECTRICAL CIRCUIT - "S" &

ENGINE PERFORMANCE DTCS (4.3L)

ENGINE PERFORMANCE DTCS (4.3L)

DTC	OEM Code	Description
P0101	34	MAF Sensor
P0112	23	Air Temperature Sensor
P0113	25	Air Temperature Sensor
P0116	New	Coolant Sensor Range
P0117	15	Coolant Temperature Sensor
P0118	14	Coolant Temperature Sensor
P0122	22	Throttle Position Sensor
P0123	21	Throttle Position Sensor
P0125	New	Coolant Temperature Sensor
P0131	44	Oxygen Sensor
P0132	45	Oxygen Sensor
P0133	New	Oxygen Sensor
P0134	13	Oxygen Sensor
P0135	New	Oxygen Sensor Heater
P0137	New	(Catalyst) Oxygen Sensor
P0138	New	(Catalyst) Oxygen Sensor
P0140	New	(Catalyst) Oxygen Sensor
P0151	44	Oxygen Sensor
P0152	45	Oxygen Sensor
P0153	New	Oxygen Sensor
P0154	13	Oxygen Sensor
P0155	New	Oxygen Sensor Heater
P0158	45	Oxygen Sensor
P0160	13	Oxygen Sensor
P0161	New	Oxygen Sensor Heater
P0171	New	Fuel Lean
P0172	New	Fuel Rich
P0174	New	Fuel Lean
P0175	New	Fuel Rich
P0300	New	Misfire
P0321	17	Spark Reference
P0325	43	Knock Sensor
P0341	18	Cam Signal
P0342	41	Cam Signal
P0401	53/54/55	EGR

P0420	New	Catalyst System
P0501/0502	24	Vehicle Speed Sensor
P0703	38	TCC Brake Switch
P0705	31	Trans. Range Switch
P0712	59	Trans. Fluid Temp. Sensor
P0713	58	Trans. Fluid Temp. Sensor
P0740	39	TCC
P0755	36	Shift Solenoid "B"
P1114	New	Coolant Sensor
P1115	New	Coolant Sensor
P1133	New	Oxygen Sensor
P1153	New	Oxygen Sensor
P1158	New	Oxygen Sensor
P1200	New	Injector Circuit
P1257	57	Supercharger Boost
P1350/1361	42	Ignition
P1403/1404/1405	75/76/77	EGR Solenoid(s)
P1406	32	EGR
P1520	New	Park/Neutral
P1530	69	A/C Pressure Sensor/Switch
P1531	66	A/C Charge Low
P1550	New	Cruise
P1558	63	Cruise
P1561	61	Cruise
P1562	62	Cruise
P1565	65	Cruise
P1567	67	Cruise
P1568	68	Cruise
P1571	New	Traction Control
P1573	New	Traction Control
P1599	99	Cruise
P1619	New	Oil Life Reset
P1623	51	PROM Error
P1626/1629	58	Pass-Key
P1630	16	Voltage High/Low
P1640	26/56	Quad-Driver
P1650	26/56	Quad-Driver
P1670	26/56	Quad-Driver
P1860	New	TCC PWM Solenoid

ENGINE PERFORMANCE DTCS

OEM Code	Description
11	MALFUNCTION INDICATOR LIGHT
13	LEFT HEATED OXYGEN SENSOR CIRCUIT OPEN
14	COOLANT TEMP SENS SGNL VLTGE LOW (HI TEMP INDICATED)
15	COOLANT TEMP SENSOR SIGNAL VOLTAGE LOW
16	OPTI-SPARK IGNITION SYSTEM LOW RESOLUTION PULSE
18	INJECTOR CIRCUIT
21	THROTTLE POSITION SENSOR SIGNAL VOLTAGE HIGH
22	THROTTLE POSITION SENSOR SIGNAL VOLTAGE LOW
23	IAT SENSOR SIGNAL VOLTAGE HIGH (LOW TEMP INDICATED)
24	VEHICLE SPEED SENSOR
25	IAT SENSOR SIGNAL VOLTAGE LOW (HIGH TEMP INDICATED)
26	CANISTER PURGE SOLENOID
27	EGR SOL VALVE
28	TRANS. RANGE PRESSURE SWITCH
29	SECONDARY AIR INJECTION
32	EGR SYSTEM ERROR
33	MAP SENSOR SIGNAL VOLTAGE HIGH
34	MAP SENSOR SIGNAL VOLTAGE LOW
36	OPTI-SPARK HIGH RESOLUTION PULSE
37	TCC BRAKE SWITCH ERROR
38	BRAKE SWITCH ERROR
41	OPTI-SPARK IGNITION SYSTEM OPEN OR SHORTED EST CKT
42	IC CIRCUIT GROUNDED
43	KNOCK SENSOR CIRCUIT (DUAL SENSORS)
44	LEFT HEATED OXYGEN SENSOR LEAN EXHAUST INDICATION
45	LEFT HEATED OXYGEN SENSOR RICH EXHAUST INDICATION
46	PASS-KEY CIRCUIT
47	KNOCK SENSOR MODULE
48	MASS AIRFLOW SENSOR
50	SYSTEM VOLTAGE LOW
52	FAULTY CAL-PAK

53	SYSTEM VOLTAGE HIGH
55	FUEL LEAN MONITOR
55	PCM ERROR
58	TRANS TEMPERATURE SENSOR HIGH TEMPERATURE
59	TRANS. TEMPERATURE SENSOR LOW TEMPERATURE
63	RIGHT HEATED OXYGEN SENSOR CIRCUIT OPEN
64	RIGHT HEATED OXYGEN SENSOR LEAN EXHAUST INDICATION
65	RIGHT HEATED OXYGEN SENSOR RICH EXHAUST INDICATION
66	A/C PRESSURE SENSOR
67	A/C PRESSURE SENSOR
68	A/C RELAY CIRCUIT SHORTED
69	A/C COMPRESSOR RELAY
70	A/C COMPRESSOR RELAY DRIVER
72	VEHICLE SPEED SENSOR LOSS
73	PRESSURE CONTROL SOLENOID
75	TRANSMISSION VOLTAGE LOW
77	PRIMARY COOLING FAN DRIVER
78	SECONDARY COOLING FAN DRIVER
79	TRANSMISSION FLUID OVERTEMP
81	2-3 SHIFT SOLENOID
82	1-2 SHIFT SOLENOID
83	TCC PWM SOLENOID A/T
84	3-2 CONTROL SOLENOID WITH A/T
85	TCC STUCK ON
90	TCC SOLENOID CIRCUIT
95	CHANGE OIL LIGHT
96	LOW OIL LIGHT
97	VSS OUTPUT CIRCUIT

ENGINE PERFORMANCE DTCS (5.7L)

ENGINE PERFORMANCE DTCS (5.7L)

OEM Code	Description
11	MALFUNCTION INDICATOR LIGHT
13	LEFT HEATED OXYGEN SENSOR CIRCUIT OPEN
14	COOLANT TEMP SENS SGNL VLTGE LOW (HI

	TEMP INDICATED)
15	COOLANT TEMP SENSOR SIGNAL VOLTAGE LOW
16	OPTI-SPARK IGNITION SYSTEM LOW RESOLUTION PULSE
18	INJECTOR CIRCUIT
21	THROTTLE POSITION SENSOR SIGNAL VOLTAGE HIGH
22	THROTTLE POSITION SENSOR SIGNAL VOLTAGE LOW
23	IAT SENSOR SIGNAL VOLTAGE HIGH (LOW TEMP INDICATED)
24	VEHICLE SPEED SENSOR
25	IAT SENSOR SIGNAL VOLTAGE LOW (HIGH TEMP INDICATED)
26	CANISTER PURGE SOLENOID
27	EGR SOL VALVE
28	TRANS. RANGE PRESSURE SWITCH
29	SECONDARY AIR INJECTION
32	EGR SYSTEM ERROR
33	MAP SENSOR SIGNAL VOLTAGE HIGH
34	MAP SENSOR SIGNAL VOLTAGE LOW
36	OPTI-SPARK HIGH RESOLUTION PULSE
37	TCC BRAKE SWITCH ERROR
38	BRAKE SWITCH ERROR
41	OPTI-SPARK IGNITION SYSTEM OPEN OR SHORTED EST CKT
42	IC CIRCUIT GROUNDED
43	KNOCK SENSOR CIRCUIT (DUAL SENSORS)
44	LEFT HEATED OXYGEN SENSOR LEAN EXHAUST INDICATION
45	LEFT HEATED OXYGEN SENSOR RICH EXHAUST INDICATION
46	PASS-KEY CIRCUIT
47	KNOCK SENSOR MODULE
48	MASS AIRFLOW SENSOR
50	SYSTEM VOLTAGE LOW
52	FAULTY CAL-PAK
53	SYSTEM VOLTAGE HIGH
55	FUEL LEAN MONITOR
55	PCM ERROR
58	TRANS TEMPERATURE SENSOR HIGH TEMPERATURE

59	TRANS. TEMPERATURE SENSOR LOW TEMPERATURE
63	RIGHT HEATED OXYGEN SENSOR CIRCUIT OPEN
64	RIGHT HEATED OXYGEN SENSOR LEAN EXHAUST INDICATION
65	RIGHT HEATED OXYGEN SENSOR RICH EXHAUST INDICATION
66	A/C PRESSURE SENSOR
67	A/C PRESSURE SENSOR
68	A/C RELAY CIRCUIT SHORTED
69	A/C COMPRESSOR RELAY
70	A/C COMPRESSOR RELAY DRIVER
72	VEHICLE SPEED SENSOR LOSS
73	PRESSURE CONTROL SOLENOID
75	TRANSMISSION VOLTAGE LOW
77	PRIMARY COOLING FAN DRIVER
78	SECONDARY COOLING FAN DRIVER
79	TRANSMISSION FLUID OVERTEMP
81	2-3 SHIFT SOLENOID
82	1-2 SHIFT SOLENOID
83	TCC PWM SOLENOID A/T
84	3-2 CONTROL SOLENOID WITH A/T
85	TCC STUCK ON
90	TCC SOLENOID CIRCUIT
95	CHANGE OIL LIGHT
96	LOW OIL LIGHT
97	VSS OUTPUT CIRCUIT

ELECTRICAL COMPONENT LOCATOR

ELECTRICAL COMPONENT LOCATION General Motors Corp. - Electrical Component Location

BUZZERS, RELAYS & TIMERS

BUZZERS, RELAYS & TIMERS LOCATION

Component	Location
A/C Compressor Relay	On fuse/relay block, in engine compartment.
Blower Relays	Under right side of dash, near blower motor.
Cooling Fan Relays	On fuse/relay block, in engine compartment.
Dome/Courtesy Light Relay	On convenience center. See **Fig. 2**.
Fuel Pump Relay	On to fuse/relay block, in engine compartment.
Hazard Flasher	On convenience center. See **Fig. 2**.
Horn Relay	On convenience center. See **Fig. 2**.
Luggage Compartment Release Relay	On convenience center. See **Fig. 2**.
Power Antenna Relay	On convenience center. See **Fig. 2**.
Power Door Lock Relay	Behind left kick panel.
Rear Defogger Relay	Behind right side of dash, near blower motor.
Rear Glass Release Relay (Wagon)	On convenience center. See **Fig. 2**.
Secondary AIR Pump Relay	On fuse/relay block, in engine compartment.
Tailgate Lock Relay	Behind left kick panel.
Theft Deterrent Relay	Behind right kick panel.
Turn Signal Flasher	On convenience center. See **Fig. 2**.
Warning Alarm	On convenience center. See **Fig. 2**.

CIRCUIT PROTECTION DEVICES

CIRCUIT PROTECTION DEVICES LOCATION

Component	Location
Battery Junction Block	On right inner fender panel, near battery.
Circuit Breaker (Power Seats)	In fuse block.
Circuit Breaker (Power Windows)	In fuse block.
Circuit Breaker (Rear Defogger)	In fuse block.
Convenience Center	Behind left side of dash, on bracket.
I/P Fuse Block	Mounted on left side of dash. See **Fig. 1**.
Fusible Links	Under fuse/relay block.
PCM/Fuel Pump In-Line Fuse	In right rear of engine compartment, on relay bracket.
Seat Lumbar In-Line Fuse	Under each front seat.
Underhood Electrical Center	In engine compartment, on right inner fender panel.

	See **Fig. 1**.

CONTROL UNITS

CONTROL UNITS LOCATION

Component	Location
ABS System Module	In left side of engine compartment, on brake pressure modulator valve.
A/C-Heater Module	Behind center of dash.
Air Bag System (Left Inflator Module)	At center of steering wheel.
Air Bag System (Right Inflator Module)	Behind right side of dash, above glove compartment.
Audio Alarm Module	On convenience center.
Auto. Headlight Control Module	Behind right kick panel.
Blower Motor Control Module	Behind right side of dash, near blower motor.
Cruise Control Module	On left front inner fender panel, near master cylinder.
Daytime Running Lights (DRL) & Twilight Sentinel Module	Behind right kick panel.
Diagnostic Energy Reserve Module (DERM)	Behind left side of dash, above convenience center.
Electronic A/C Power Module	Behind right side of dash, near blower motor.
Keyless Entry Module	In luggage compartment, attached to rear shelf.
Power Steering Control Module	Behind left side of dash, near fuse block.
Powertrain Control Module (PCM)	On left front of engine compartment, under air cleaner. See **Fig. 1**.

MOTORS

MOTORS LOCATION

Component	Location
ABS Modulator	On left front of engine compartment.
A/C-Heater Blower Motor	Under right side of dash.
Automatic Level Control Pump	On left front frame rail.
Power Seat Motors	Under each front seat.
Secondary Air Injection (AIR) Pump	On lower left front of engine. See **Fig. 1**.
Window Washer Pump	In washer fluid reservoir.
Wiper Motor (Front)	On right side of firewall.
Wiper Motor (Rear)	On center of rear header.

SENDING UNITS & SENSORS

SENDING UNITS & SENSORS LOCATION

Component	Location
ABS Wheel Speed Sensor (Front)	Mounted on each front wheel knuckle.
ABS Wheel Speed Sensor (Rear)	Mounted on rear axle differential.
A/C-Heater System Inside Air Temperature Sensor	Behind right side of dash, above glove compartment.
A/C-Heater System Outside Air Temperature Sensor	Attached to hood latch support.
A/C-Heater System Sunload Sensor	On top center of dash, near defroster grille.
A/C Refrigerant Pressure Sensor	On high pressure line, above right inner fender panel. See **Fig. 1**.
Air Bag System Arming Sensor	Behind dash, to right of steering column.
Air Bag System Forward Discriminating Sensors	Center of radiator support assembly, near hood latch.
Automatic Level Control Sensor	On center of rear crossmember.
Engine Coolant Temperature (ECT) Sensor	On front of engine, near thermostat housing. See **Fig. 1**.
Engine Coolant Temperature Gauge Sensor	Lower right side of engine block, below manifold. See **Fig. 3**.
Engine Oil Level Sensor	At left rear of engine. See **Fig. 1**.
Heated Oxygen Sensor (HO2S)	On left and right side of engine. See **Fig. 1**.
Intake Air Temperature (IAT) Sensor	In air cleaner assembly. See **Fig. 1**.
Knock Sensor	On left and right side of engine. See **Fig. 3**.
Low Coolant Level Sensor	In coolant expansion tank.
Manifold Absolute Pressure (MAP) Sensor	In front of engine, above water pump. See **Fig. 1**.
Mass Airflow (MAF) Sensor	In fresh air intake hose, near air cleaner. See **Fig. 1**.
Oil Level Sensor	On left side of oil pan.
Throttle Position (TP) Sensor	On throttle body assembly. See **Fig. 1**.
Twilight Sentinel Photocell Sensor	On top of dash panel, on defrost grille.
Vehicle Speed Sensor (VSS)	On left transmission tail shaft. See **Fig. 1**.

SOLENOIDS & SOLENOID VALVES

SOLENOIDS & SOLENOID VALVES LOCATION

Component	Location
A/C-Heater Vacuum Elect. Solenoid	Behind right side of dash, below blower motor.
Brake/Transmission Shift Interlock (BTSI) Solenoid	On upper left side of steering column.
EGR Vacuum Control Signal Solenoid Valve	On top of engine, behind cylinder No. 7 injector. See **Fig. 1**.
EVAP Canister Purge Solenoid Valve	On top of engine, behind cylinder No. 4 injector. See **Fig. 1**.
Idle Air Control (IAC) Valve	On throttle body assembly. See **Fig. 1**.
Luggage Compartment Release Solenoid	Under top rear of luggage compartment lid.

Rear Glass Release Solenoid	On center of tailgate.
Trunk Lid Release Solenoid	Mounted to trunk lid.

SWITCHES

SWITCHES LOCATION

Component	Location
A/C Cycling Switch	Mounted on A/C accumulator. See **Fig. 1**.
Backup Light/Transmission Position Switch	On base of steering column.
Brake Pressure Switch	Below master cylinder, on brake combination valve.
Engine Oil Pressure Gauge Sensor & Fuel Pump Switch	On top rear of engine. See **Fig. 1**.
Idle Speed Control Power Steering Pressure (PSP) Switch	Near power steering pump, in pressure line. See **Fig. 1**.
Park/Neutral Switch	Near steering column base.
Parking Brake Switch	Attached to top of parking brake assembly.
Seat Belt Switch	Part of driver's seat belt assembly.
Stoplamp/Cruise Release Switch	On brake pedal support bracket. See **Fig. 1**.
Tailgate Ajar Switch	Inside lower right corner of tailgate assembly.
TCC/Cruise Release Switch	On brake pedal support bracket.
TCC Temperature Switch	In transmission cooler pipe, near cooler.
Washer Fluid Level Switch	In windshield washer reservoir, on left front fender.

MISCELLANEOUS

MISCELLANEOUS LOCATION

Component	Location
Blower Motor Resistor	Behind right side of dash, near blower motor.
Crankcase Ventilation Valve	At left side of engine. See **Fig. 1**.
Data Link Connector (DLC)	Under dash, to right of steering column. See **Fig. 1**.
Diode (A/C Compressor Clutch)	Taped inside compressor clutch harness connector.
Diode (Circuit Isolation)	On turn/hazard switch harness connector breakout branch.
Diode (Door Open Warning - SE Models)	Taped 1" from instrument cluster connector breakout branch.
Diode (DRL Dropping Diode)	Attached to brake pedal bracket.
Interior Lights	Taped 1" from instrument cluster connector breakout branch.
Fuel Injectors	At intake manifold. See **Fig. 1**.
Fuel Pump Test Connector	Near A/C accumulator.
Ignition Test Connector	On top right side of engine, near rocker cover. See **Fig. 1**.

Malfunction Indicator Light (MIL)	At left side of dash. See **Fig. 1**.
PCM Ground	At left front side of engine. See **Fig. 1**.
Primary Cooling Fan	At right front side of engine compartment. See **Fig. 1**.
Remote Control Door Lock Receiver	Mounted under center of rear shelf.
Secondary Cooling Fan	At left front side of engine compartment. See **Fig. 1**.
SIR System Components	At front & rear of engine compartment, & left side of dash. See **Fig. 1**.
Transmission Electrical Connector	At right rear side of engine. See **Fig. 1**.

CONNECTORS

CONNECTORS LOCATION

Component	Location
C100 (Black, 10 Pin)	Forward of windshield washer solvent container.
C101 (Gray, 4 Pin)	Behind left front park/turn light.
C103 (5 Pin)	Near underhood electrical center.
C104 (4 Pin)	Near battery.
C200 (Black, 56 Pin)	Above accelerator pedal.
C201 (Black, 6 Pin)	At right side of steering column.
C202 (6 Pin)	At right side of steering column.
C203 (Natural, 10 Pin)	At right side of steering column.
C204 (Black, 37 Pin)	Behind right side of dash.
C205 (Natural, 10 Pin)	At right side of dash compartment.
C206 (4 Pin)	Above accelerator pedal.
C207 (6 Pin)	Body harness to engine harness, near C204.
C207A (3 Pin)	Near base of right "A" pillar.
C207B (3 Pin)	Near base of right "A" pillar.
C210 (Black, 11 Pin)	Under steering column.
C218 (4 Pin)	Above accelerator pedal.
C220 (Natural, 10 Pin)	At right side of steering column.
C300 (Black, 6 Pin)	Under driver's seat.
C301 (Black, 6 Pin)	Under passenger's seat.
C302 (Black, 10 Pin)	At base of left "A" pillar.
C303 (Black, 6 Pin)	At base of left "A" pillar.
C308 (Gray, 6 Pin)	At upper left side of rear compartment.
C309 (6 Pin)	At base of left "A" pillar.
C315 (Blue, 10 Pin)	At base of left "A" pillar.
C316 (Black, 23 Pin)	Under driver's seat.
C317 (Black, 23 Pin)	Under passenger's seat.
C318 (6 Pin)	Under driver's seat.

C319 (6 Pin)	Under driver's seat.
C320 (3 Pin)	Under driver's seat.
C321 (2 Pin)	Under driver's seat.
C322 (2 Pin)	Under driver's seat.
C324 (2 Pin)	Under driver's seat.
C325 (4 Pin)	Under driver's seat.
C326 (2 Pin)	Under driver's seat.
C327 (23 Pin)	Cross-car to passenger power seat jumper.
C328 (2 Pin)	Under passenger's seat.
C329 (2 Pin)	Under passenger's seat.
C330 (3 Pin)	Under passenger's seat.
C331 (2 Pin)	Under passenger's seat.
C332 (4 Pin)	Under passenger's seat.
C334 (2 Pin)	Under driver's seat.
C335 (2 Pin)	Under passenger's seat.
C350 (6 Pin)	Near center of left "D" pillar.
C351 (6 Pin)	At left rear wheelwell.
C400 (Sedan) (Black, 8 Pin)	At left rear fender.
C400 (Wagon) (Black, 6 Pin)	Forward of left taillights.
C402 (1 Pin)	Near fuel pump/level sender.
C403 (2 Pin)	At center of tailgate.
C405 (Green, 6 Pin)	Near center of left "D" pillar.
C406 (Black, 6 Pin)	Forward of taillights.
C500 (Black, 8 Pin)	Inside left front door.
C600 (Black, 8 Pin)	Inside right front door.

GROUNDS

GROUNDS LOCATION

Component	Location
G100	In engine compartment, at front of right cylinder head.
G101	At right front fender, near battery.
G102	Behind left headlight support.
G104	In engine compartment, at front of left cylinder head.
G106	At right headlight support.
G200	At base of left "A" pillar.
G201	At base of left "A" pillar.
G202	At base of right "A" pillar.
G300 (Sedan)	In trunk, at left rear wheelwell.

G300 (Wagon)	Near center of left "D" pillar.
G400	Near center of right "D" pillar.

SPLICES

SPLICES LOCATION

Component	Location
S100	In forward lamp harness, near breakout for right park/turn light.
S101	In forward lamp harness, near breakout for left headlight.
S102	In engine harness, near breakout for right fuel injectors.
S103	In engine harness, near breakout for transmission controller.
S104	In forward lamp harness, near breakout for C100.
S105	In forward lamp harness, near breakout for C100.
S106	In forward lamp harness, near breakout for C100.
S107	In forward lamp harness, near breakout for C100.
S109	In engine harness, near breakout for transmission.
S110	In engine harness, near breakout for brake pressure modulator valve.
S111	In engine harness, near breakout for underhood electrical center.
S112	In engine harness, near breakout for underhood electrical center.
S113	In engine harness, near breakout for fuel injector No. 6.
S114	In engine harness, near breakout for transmission controller.
S115	In engine harness, near breakout for transmission.
S116	In forward lamp harness, near breakout for ignition coil.
S117	In engine harness, near breakout for fuel injector No. 6.
S118	In engine harness, near breakout for transmission controller.
S119	In engine harness, near breakout for G104.
S120	In engine harness, near breakout for fuel injector No. 8.
S121	In engine harness, near breakout for transmission controller.
S122	In engine harness, near breakout for ignition coil.

S132	In engine harness, near breakout for underhood electrical center.
S138	In forward lamp harness, near breakout for left horn.
S140	In forward lamp harness, near breakout for left horn.
S141	In forward lamp harness, near breakout for C103.
S200 (Buick)	In dash harness, near breakout for instrument cluster.
S200 (Chevrolet)	In dash harness, near breakout for heater & A/C control.
S201 (Buick)	In dash harness, near breakout for instrument cluster.
S201 (Chevrolet)	In dash harness, near breakout for C200.
S202	In daytime running light harness, near breakout for ambient light sensor.
S207	In daytime running light harness, near breakout for ambient light sensor.
S211	In dash harness, near breakout for electric actuator.
S212	In engine harness, near breakout for underhood electrical center.
S213	In dash harness, near breakout for heater & A/C control.
S215	In body harness, near breakout for SDM.
S220	In daytime running light harness, near breakout for ambient light sensor.
S221	In dash harness, near breakout for C200.
S223	In dash harness, near breakout for C200.
S224	In dash harness, near breakout for C200.
S226	In body harness, near breakout for convenience center.
S227	In body harness, near breakout for SDM.
S228	In dash harness, near breakout for instrument cluster.
S230	In body harness, near breakout for BTSI solenoid.
S231	In body harness, near breakout for convenience center.
S232	In body harness, near breakout for SDM.
S233	In dash harness, near breakout for instrument cluster.
S234	In body harness, near breakout for C201.
S236	In body harness, near breakout at left front wheelwell.
S237	In body harness, near breakout at left front wheelwell.

S239	In daytime running lights harness, near breakout for ambient light sensor.
S241	In body harness, near breakout for SDM.
S242	In body harness, near breakout for C302.
S245	In body harness, near breakout for dash fuse block.
S247	In body harness, near breakout for theft deterrent relay.
S250	In body harness, near breakout for convenience center.
S251	In body harness, near breakout for SDM.
S252	In body harness, near breakout for SDM.
S253	In body harness, near breakout for convenience center.
S254	In dash harness, behind instrument cluster.
S255	In dash harness, behind instrument cluster.
S256	In body harness, near breakout for convenience center.
S257	In body harness, near breakout for convenience center.
S260	In body harness, near breakout for convenience center.
S265	In body harness, near breakout for SDM.
S266	In body harness, near breakout for rear window defogger relay.
S267	In body harness, near breakout for rear window defogger relay.
S269	In body harness, near breakout for SDM.
S270	In body harness, near breakout for SDM.
S271	In body harness, near breakout for SDM.
S275	In body harness, near breakout for C200.
S276	In body harness, near breakout for SDM.
S277	In body harness, near breakout for SDM.
S278	In body harness, near breakout for convenience center.
S279	In body harness, near breakout for convenience center.
S280	In body harness, near breakout for BTSI solenoid.
S281	In body harness, near breakout for convenience center.
S282	In body harness, near channel opening at left "B" pillar.
S300	In cross-car harness, near breakout for G201.
S303	In cross-car harness, near breakout for G302.

S306	In cross-car harness, near breakout for power seat.
S307	In body harness, near breakout for C309.
S308	In body harness, near breakout for C309.
S309	In deck lid harness, near breakout for rear license light.
S310	In body harness, near breakout for C309.
S311	In body harness, at breakout for C309.
S312	In cross-car harness, near breakout for C309.
S313	In body harness, near breakout for G300.
S314 (Sedan)	In body harness, near breakout for G300.
S316	In roof harness, near breakout for C309.
S325	In cross-car harness, near breakout for power seat.
S328	In cross-car harness, near breakout for power seat.
S330	In cross-car harness, near breakout for door lock relay.
S331	In cross-car harness, near breakout for C303.
S332	In cross-car harness, near breakout for C303.
S333	In cross-car harness, at breakout for C303.
S335	In cross-car harness, at breakout for C303.
S338	In cross-car harness, at breakout between right front door & "A" pillar.
S339	In cross-car harness, near breakout for power seat.
S341	In cross-car harness, near breakout for power seat.
S342	In cross-car harness, near breakout for power seat.
S343	In cross-car harness, near breakout for power seat.
S344	In driver's seat harness, near breakout for seat control switch.
S345	In driver's seat harness, near breakout for seat control switch.
S346	In driver's seat harness, near breakout for driver seat switch.
S348	In passenger's seat harness, near breakout for C301.
S349	In passenger's seat harness, near breakout for C301.
S350	In passenger's seat harness, near breakout for C301.
S349	In passenger's seat harness, near breakout for C301.
S400 (Sedan)	In rear light harness, near breakout for left back-up light.
S400 (Wagon)	In left rear light harness, near breakout for left lower tail/turn/stoplight.
S401 (Sedan)	In rear light harness, near breakout for taillight.
S401 (Wagon)	In right rear light harness, near breakout for right lower tail/turn/stoplight.

S402	In tailgate harness, near breakout for center high mount stoplight.
S403	In rear light harness, near breakout for C405.
S404	In body rear harness, near breakout for C400.
S406	In rear header harness, near breakout for rear window defogger ground.
S407	In tailgate harness, near breakout for C405.
S408	In deck lid harness, near breakout for rear license light.
S409	In license light harness, near breakout for C400.
S410	In rear light harness, near breakout for C400.
S411	In rear light harness, near breakout for C400.
S413	In body rear harness, near breakout for G300.
S414	In body rear harness, near breakout for G300.
S415	In rear body harness, near breakout for C350.
S416	In rear body harness, near breakout for rear defogger grid connector.
S417	In body harness, near breakout for G300.
S418	In body harness, near breakout for high mount stoplight.
S420	In body harness, near breakout for C400.
S501	In cross-body harness, inside left front door.
S503	In cross-body harness, inside left front door.
S505	In cross-body harness, inside left front door.

COMPONENT LOCATION GRAPHICS

NOTE: **Figures may show multiple component locations. Refer to appropriate table for proper figure references.**

COMPUTER HARNESS

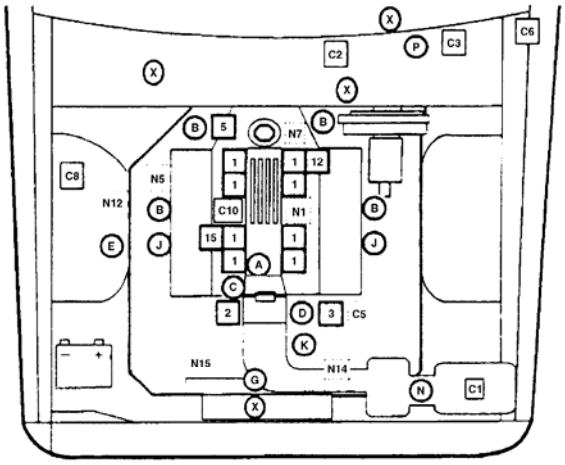
C1. Powertrain Control Module (PCM)
C2. Data Link Connector (DLC)
C3. Malfunction Indicator Light (MIL)
C5. PCM Ground
C6. I/P Fuse Block
C8. Underhood Electrical Center
C10. Ignition Test Connector

CONTROLLED DEVICES

1. Fuel Injectors
2. Idle Air Control (IAC) Valve
5. Transmission Electrical Connector
9. Secondary Air Injection (AIR) Pump
12. EGR Vacuum Control Signal Solenoid Valve
15. EVAP Canister Purge Solenoid Valve

INFORMATION SENSORS

A. Manifold Absolute Pressure (MAP) Sensor
B. Heated Oxygen Sensor (HO2S)
C. Throttle Position (TP) Sensor
D. Engine Coolant Temperature (ECT) Sensor
E. A/C Refrigerant Pressure Sensor
F. Engine Oil Level Sensor
G. Intake Air Temperature (IAT) Sensor
J. Knock Sensor
K. Idle Speed Control Power Steering Pressure (PSP) Switch
M. Vehicle Speed Sensor (VSS)
N. Mass Air Flow (MAF) Sensor
P. Stoplamp/Cruise Release Switch



4.3L (VIN W) & 5.7L (VIN P)

NOT PCM CONTROLLED

N1. Crankcase Ventilation Valve
N7. Engine Oil Pressure Gauge Sensor & Fuel Pump Switch
N12. A/C Cycling Switch
N14. Secondary Cooling Fan
N15. Primary Cooling Fan

MISCELLANEOUS

X. SIR System Components

96E03147

Fig. 1: Engine Compartment

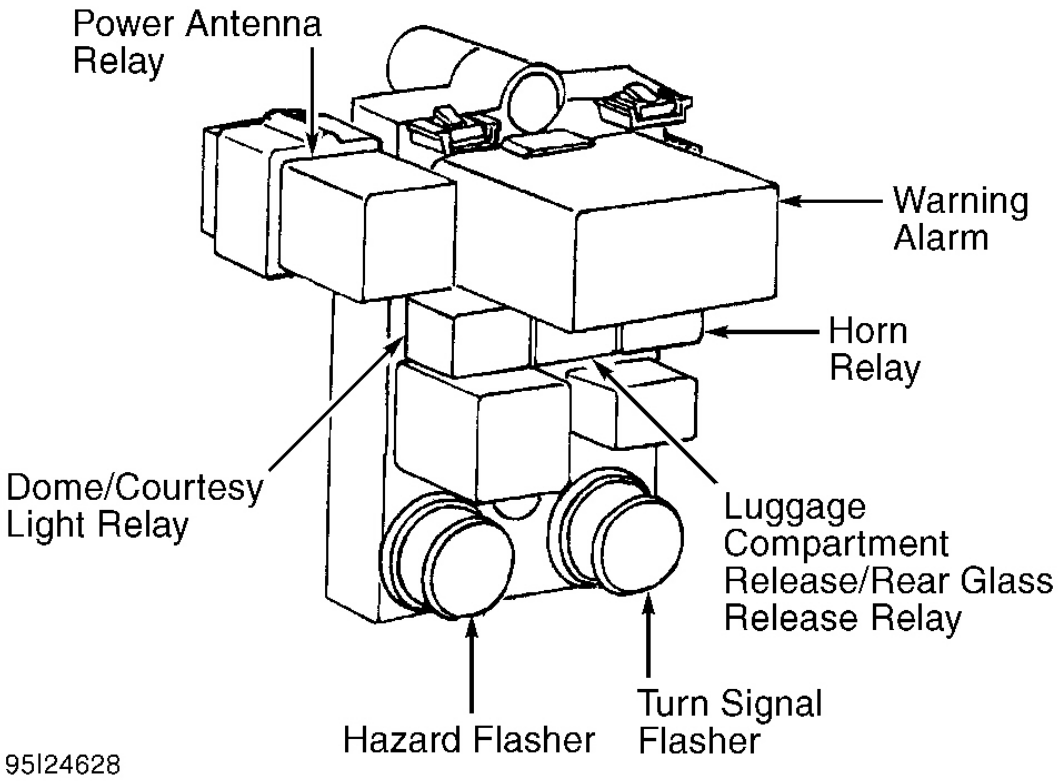


Fig. 2: Convenience Center

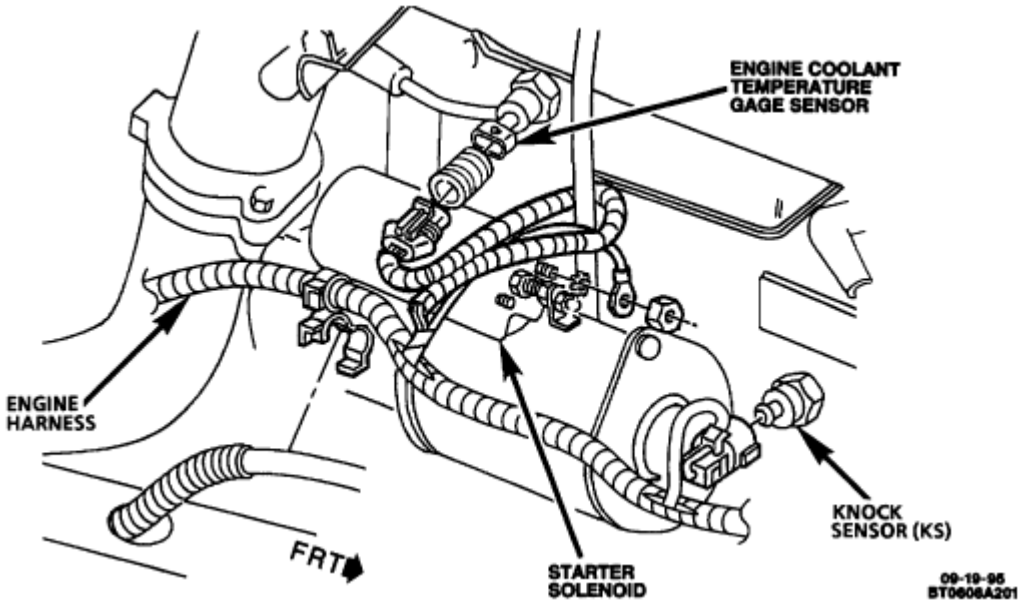


Fig. 3: Locating Coolant Temperature Gauge Sensor, Knock Sensor, Starter
Courtesy of GENERAL MOTORS CORP.

4.3L V8 - VIN [W]

ENGINE General Motors 4.3L V8 - VIN W

ENGINE IDENTIFICATION

NOTE: For repair procedures not covered in this article, see ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION in the GENERAL INFORMATION section.

Engine can be identified by eighth character of Vehicle Identification Number (VIN) which is stamped on a metal pad, located near lower left corner of windshield. See **ENGINE IDENTIFICATION CODES** table. An "S" in tenth character of VIN indicates model year.

Engine can also be identified by a 3-character engine code (RPO code). See **ENGINE IDENTIFICATION CODES** table. This code may be stamped on engine, at flange where engine and transmission meet.

ENGINE IDENTIFICATION CODES

Engine	Code
4.3L PFI V8	
8th Character Of Dash VIN	W
Engine Code (RPO Code)	L99

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

NOTE: Engine is equipped with hydraulic valve lifters. Adjustment is required only if valve train has been disassembled.

Remove rocker arm covers. Rotate crankshaft until cylinder No. 1 is at TDC of compression stroke. Begin by adjusting exhaust valve of cylinder No. 1. See **VALVE CLEARANCE ADJUSTMENT SEQUENCE** table. While trying to rotate push rod with thumb and forefinger, loosen nut on rocker stud until push rod just starts to rotate. This is considered zero lash. Tighten nut 3/4 - 1 1/4 turns (this centers the lifter plunger).

VALVE CLEARANCE ADJUSTMENT SEQUENCE

Condition	Valves	Cylinders No.
Cyl. No. 1 At TDC (1)	Exhaust	1, 3, 4 & 8
Intake		1, 2, 5 & 7
Cyl. No. 6 At TDC (1)	Exhaust	2, 5, 6 & 7
Intake		3, 4, 6 & 8
(1) TDC of compression stroke.		

REMOVAL & INSTALLATION

NOTES

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION before disconnecting battery.

NOTE: For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks onto engine hood and other major assemblies before removal.

FUEL PRESSURE RELEASE

Disconnect negative battery cable. Loosen fuel tank filler cap. Connect Fuel Gauge (J-34730-1) to fuel pressure connection (wrap shop towel around fitting to avoid spillage). Install bleed hose. Turn gauge valve, and drain fuel into an appropriate container.

DRAINING & REFILLING COOLING SYSTEM

The draining procedure is first, followed by the refilling/bleeding procedure. The two procedures can be used independently of each other.

Draining the Cooling System

WARNING: To avoid the danger of being burned, do not remove the coolant recovery reservoir filler cap while the engine and radiator assembly are still hot. Scalding fluid and steam may be blown out under pressure.

1. Park the vehicle on level surface. Remove the coolant recovery reservoir filler cap assembly: Slowly rotate cap counterclockwise about 1/4 turn and then stop. Wait until any remaining pressure (indicated by a hissing sound) is relieved. After all hissing ceases, continue to rotate cap assembly counterclockwise until cap is removed.
2. Open coolant drain valve located in left-hand radiator end tank. Disconnect the battery negative cable assembly. Open heater air bleed valve (36) located just above water pump assembly on the thermostat housing. See **Fig. 1**. Place a shop towel under the bleed valve to prevent coolant from splashing onto distributor assembly.
3. Remove both electronic spark control (ESC) knock sensors located on both sides of engine block assembly. Allow system to drain completely.
4. Store used coolant in a proper fashion, i.e., in a used coolant holding tank.

NOTE: NEVER POUR USED COOLANT DOWN THE DRAIN! Ethylene Glycol antifreeze is a very toxic chemical; disposing of it into the sewer system or

ground water is both illegal and ecologically unsound!

5. Close coolant drain valve on radiator. Install ESC knock sensors. Tighten each knock sensor to 14 ft.lbs (19 N.m).

Refilling/Bleeding the Cooling System

WARNING: Under some conditions, Ethylene Glycol in engine coolant is flammable. To avoid being burned when adding engine coolant, do not spill it on the exhaust system or on hot engine parts.

1. If not already open, open heater air bleed valve (36) located just above the water pump assembly on the thermostat housing. See **Fig. 1** . Place a shop towel under the bleed valve to prevent coolant from splashing onto distributor assembly.
2. Fill cooling system through the coolant recovery reservoir assembly to the "FULL COLD" mark. Use Ethylene Glycol antifreeze meeting GM specification 2025-M to provide required freezing and corrosion protection; at least a 50% solution. For fluid capacity, see the **COOLING SYSTEM APPROXIMATE FLUID CAPACITIES TABLE**.
3. Add two engine coolant supplement sealant pellets (GM P/N 363462) or equivalent.
4. Close heater air bleed valve when bubbles disappear and only coolant is visible. Run engine with the coolant recovery reservoir filler cap off until thermostat assembly opens.
5. Re-open heater air bleed valve. When bubbles disappear and only coolant is visible, close heater air bleed valve. Again, place a shop towel under the bleed valve to prevent coolant from splashing onto distributor assembly.
6. Fill cooling system through the coolant recovery reservoir until the coolant level is approximately 1 inch (25 mm) above the "FULL COLD" mark.
7. Install the coolant recovery reservoir filler cap assembly. Inspect for leaks after running engine until normal operating temperature is reached.

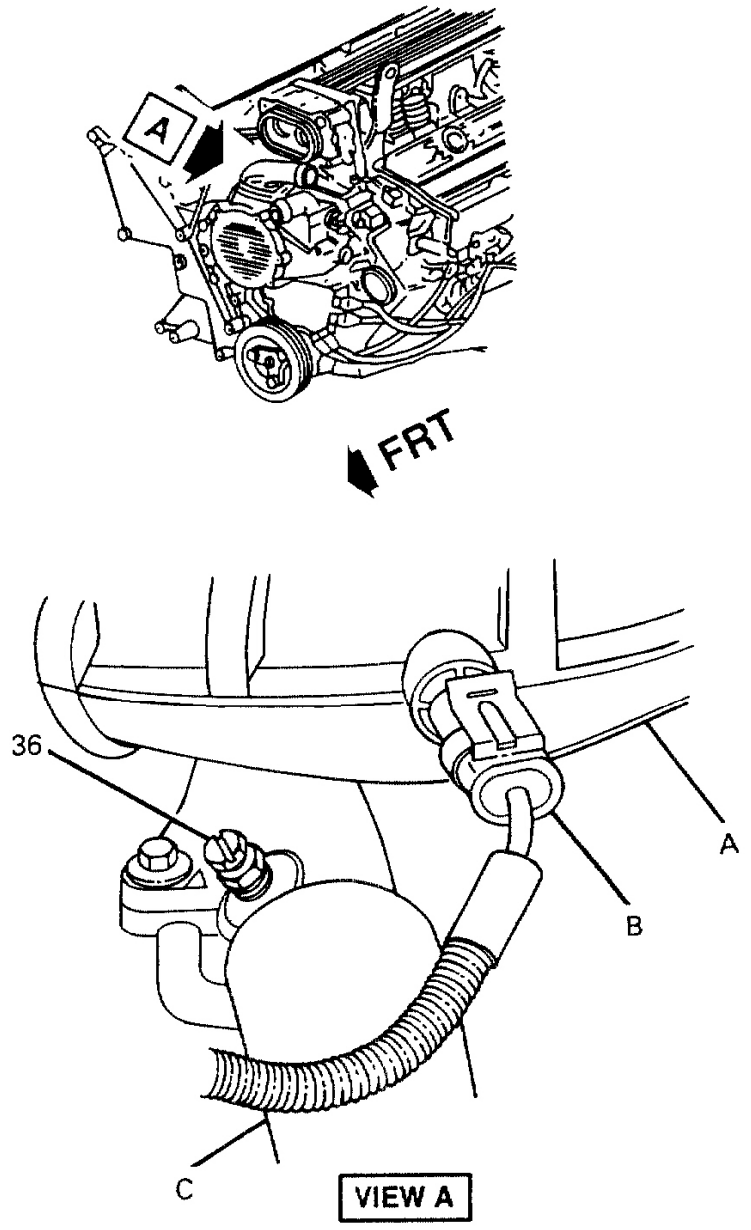
NOTE: The "LOW COOLANT" warning/indicator lamp may come on after this procedure. It can take up to THREE engine heat up/cool down cycles before the light goes out! If the "LOW COOLANT" warning/indicator lamp still does not go out and coolant is above "FULL COLD" mark in reservoir assembly, there is a fault with the circuit. Troubleshoot and repair as necessary.

NOTE: If at any time the "TEMP" warning/indicator lamp comes on, immediate action is required. Turn off engine and allow vehicle to cool. Do not remove coolant recovery cap at this time.

COOLING SYSTEM APPROXIMATE FLUID CAPACITIES

Application	Quarts (Liters)
Without Heavy-Duty Cooling System (1)	14.3 (13.5)
With Heavy-Duty Cooling System (1)	14.6 (13.8)

(1) Non Heavy-Duty Cooling systems have two electric cooling fans. The Heavy-Duty Cooling system has one electric fan and one mechanical belt-driven fan.



A DUCT, REAR AIR INTAKE
B ELECTRICAL CONNECTOR, INTAKE AIR TEMPERATURE SENSOR
C HOSE, RADIATOR OUTLET
36 VALVE, HEATER AIR BLEED

50J14661

Fig. 1: Heater Air Bleed Valve Location

Courtesy of GENERAL MOTORS CORP.

ENGINE

Removal

1. This procedure involves removing engine without transmission. Release fuel pressure. See **FUEL PRESSURE RELEASE**. Disconnect negative battery cable. Discharge A/C system using approved refrigerant recovery/recycling equipment.
2. Drain coolant. Remove air cleaner resonator and air intake duct. Disconnect fuel lines from fuel rail assembly. On vehicles with mechanically driven fan, remove radiator fan upper shroud, fan, and fan pulley.
3. On all vehicles, disconnect heater hose from water pump. Disconnect control cables from throttle body. Disconnect radiator hoses from engine. Disconnect coolant hose from throttle body. Raise and support vehicle. Disconnect oil filter adapter hoses. Drain crankcase.
4. Disconnect exhaust pipes from manifolds. Remove cover and torque converter bolts (A/T). Remove serpentine drive belt. Disconnect A/C hoses from compressor. Plug openings. Disconnect transmission fluid cooler lines from clips (A/T).
5. Remove radiator fan lower shroud (or electric cooling fans, if equipped). Disconnect electrical connectors from starter, knock sensor, oxygen sensor, oil level sensor, and oil pressure sensor. Lower vehicle. Disconnect power steering hoses from pump.
6. Disconnect brake booster vacuum hose. Disconnect wiring from alternator and remaining components as necessary. Raise and support vehicle. Remove bolts securing transmission to engine. Remove transmission filler tube bolt. Remove engine mount through-bolts. Lower vehicle. Support transmission. Attach lifting device to engine. Remove engine.

Installation

To install, reverse removal procedure. Fill crankcase. Fill and bleed cooling system. See the Refilling/Bleeding the Cooling System section under the **DRAINING & REFILLING COOLING SYSTEM** subhead. Fill and bleed power steering system. Evacuate and charge A/C system.

INTAKE MANIFOLD

Removal

1. Disconnect negative battery cable, and drain cooling system. Relieve fuel pressure. See **FUEL PRESSURE RELEASE**. Remove air intake duct assembly and fuel rail covers. Disconnect throttle and cruise control cables. Mark and disconnect necessary electrical connectors and vacuum hoses.
2. Remove heater hoses. Remove AIR diverter valve hoses. Disconnect fuel pressure regulator vacuum hose. Remove fuel injectors and fuel rail from intake manifold, and position aside.
3. Remove PCV valve and hose. Remove EGR solenoid bracket and EGR valve. Remove fuel vapor canister purge solenoid bracket and solenoid. Remove AIR pipe from intake manifold and right exhaust manifold.
4. Remove alternator brace. Remove throttle body and gasket. Remove intake manifold and gaskets.

Installation

Clean gasket surfaces. Apply 3/16" bead of RTV Sealer (1052289) to front and rear of cylinder block, and run the same bead 1/2" onto each cylinder head. Install gaskets and intake manifold. Tighten bolts and studs to specification in sequence. See **Fig. 2**. Refer to **TORQUE SPECIFICATIONS**. To complete installation, reverse removal procedure. Adjust timing (if necessary) and check for leaks.

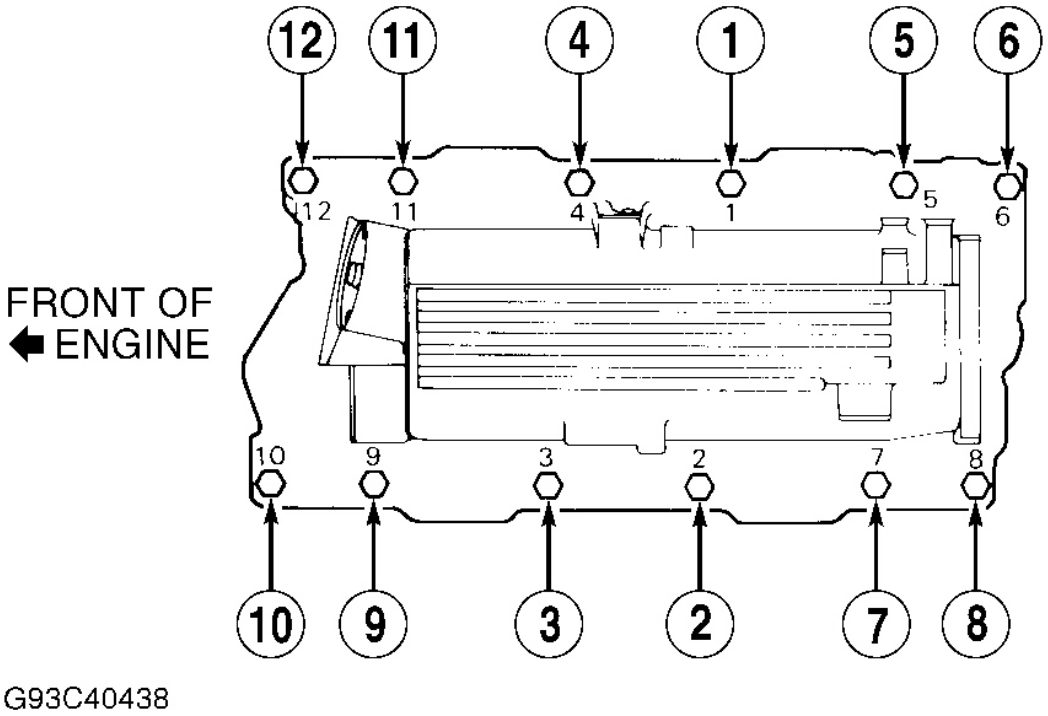


Fig. 2: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

EXHAUST MANIFOLD

Removal (Left)

1. Disconnect negative battery cable. Raise and support vehicle. Remove catalytic converter from exhaust manifold. Remove exhaust system from vehicle. Lower vehicle. Remove air intake duct. Remove serpentine belt. Remove left wheelwell center panel. Remove A/C compressor and alternator and position aside.
2. Remove exhaust crossover pipe at exhaust manifold. Lower vehicle. Remove air cleaner. Remove spark plug wires and clips. Remove air injection pipe and check valve as an assembly. Remove exhaust manifold heat shields, exhaust manifold and gasket.

Removal (Right)

1. Disconnect negative battery cable. Raise and support vehicle. Remove catalytic converter from exhaust manifold. Remove exhaust system from vehicle. Lower vehicle. Remove fuel rail covers. Remove fuel injector electrical connectors. Remove fuel pressure regulator vacuum hose. Remove fuel injectors and fuel rail from intake manifold.
2. Lower vehicle. Remove air cleaner. Remove air injection hoses. Mark and disconnect spark plug wires at spark plugs. Remove necessary accessory brackets.
3. Remove oil indicator and tube. Remove exhaust manifold and gasket (if equipped).

Installation (Left & Right)

To install, reverse removal procedure. Tighten studs/bolts to specification. See **TORQUE SPECIFICATIONS**.

CYLINDER HEAD

CAUTION: Remove cylinder head when engine is cold.

Removal

1. Disconnect negative battery cable. Remove intake manifold, exhaust manifold and valve covers. See the following:
   - **INTAKE MANIFOLD**
   - **EXHAUST MANIFOLD**
   - **VALVE COVERS**
2. Remove serpentine belt. Drain cooling system. Remove rocker arms and push rods (mark components for installation reference). Remove cylinder head bolts in 3 steps in reverse order of tightening sequence. See **Fig. 3**. Remove cylinder head and gasket.

Inspection

See **CYLINDER HEAD** under OVERHAUL.

Installation

1. Clean cylinder head bolt holes and threads. Coat steel-type head gaskets with sealer. DO NOT coat composition-type head gaskets with sealer. Install head gasket onto cylinder block. Install cylinder head. Coat head bolts with Sealing Compound (1052080).
2. Tighten bolts in 3 steps in sequence. See **Fig. 3**. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**. To complete installation, reverse removal procedure.

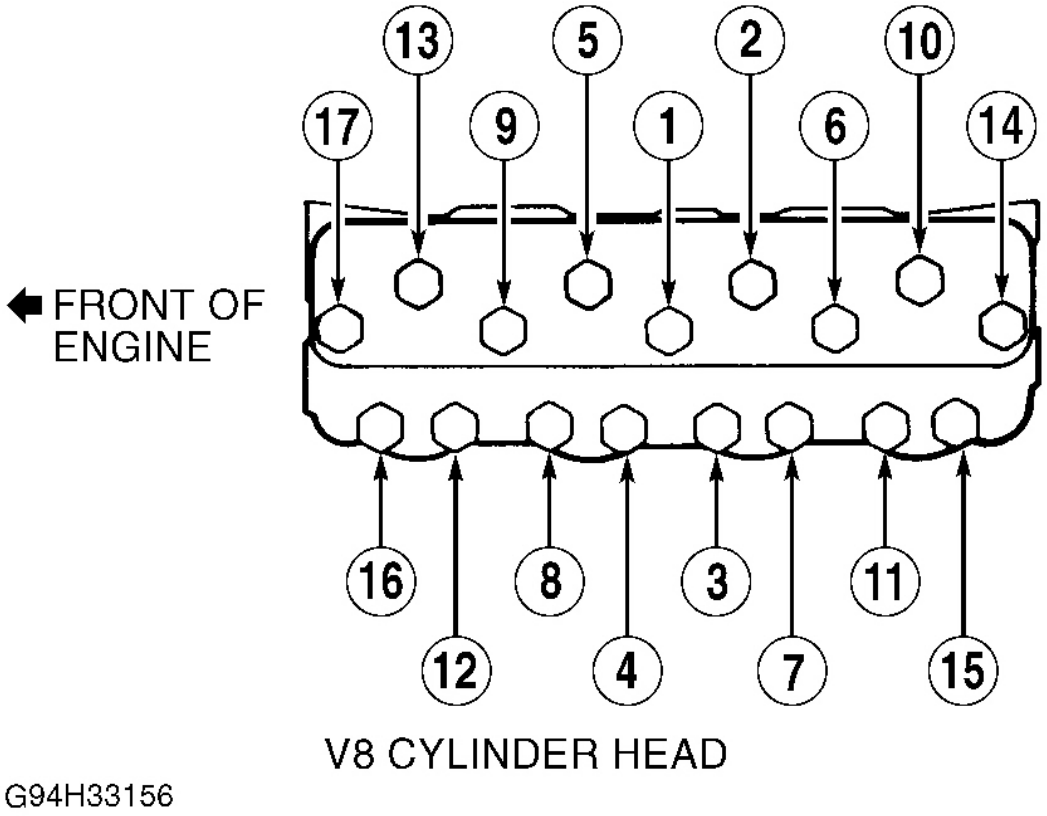


Fig. 3: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

FRONT COVER & OIL SEAL

Removal

1. Disconnect negative battery cable and serpentine drive belt. Remove crankshaft pulley. Loosen or remove motor mount nuts as necessary for harmonic balancer removal. Remove harmonic balancer-to-crankshaft bolt. Mark position, and remove harmonic balancer using Harmonic Balancer Remover/Installer (J-39046).
2. Remove the oil pan. See **OIL PAN**. Remove the water pump. See **WATER PUMP**. Remove throttle body air duct and distributor. Remove front cover and gasket. Carefully pry seal from timing cover using a large screwdriver.

Installation

1. Using Seal Aligner/Installer (J-35468), install NEW oil seal in timing cover. Coat timing cover gasket with sealant, and position onto timing cover. Install timing cover.
2. Alternately tighten all bolts to specification. Refer to **TORQUE SPECIFICATIONS**. Apply sealant to

oil pan, cylinder block and timing cover joint. To complete installation, reverse removal procedure.

TIMING CHAIN

Removal

1. Disconnect the negative battery cable. Remove front cover. See **FRONT COVER & OIL SEAL**. Rotate crankshaft until the camshaft sprocket and crankshaft sprocket timing marks line up with the shaft centers. See **Fig. 5**.
2. Remove camshaft sprocket and chain as an assembly. See **Fig. 4**. If replacing crankshaft sprocket, use Sprocket Remover (J-5825-A) to pull sprocket off crankshaft. If replacing water pump drive gear, use Gear Remover (J-39243) to remove gear.

Installation

Drive crankshaft sprocket onto crankshaft, with timing mark facing out. Ensure timing marks on crankshaft sprocket and camshaft sprocket are as close together as possible and lined up with shaft centers. See **Fig. 5**. Install camshaft sprocket and chain as an assembly. To complete installation, reverse removal procedure.

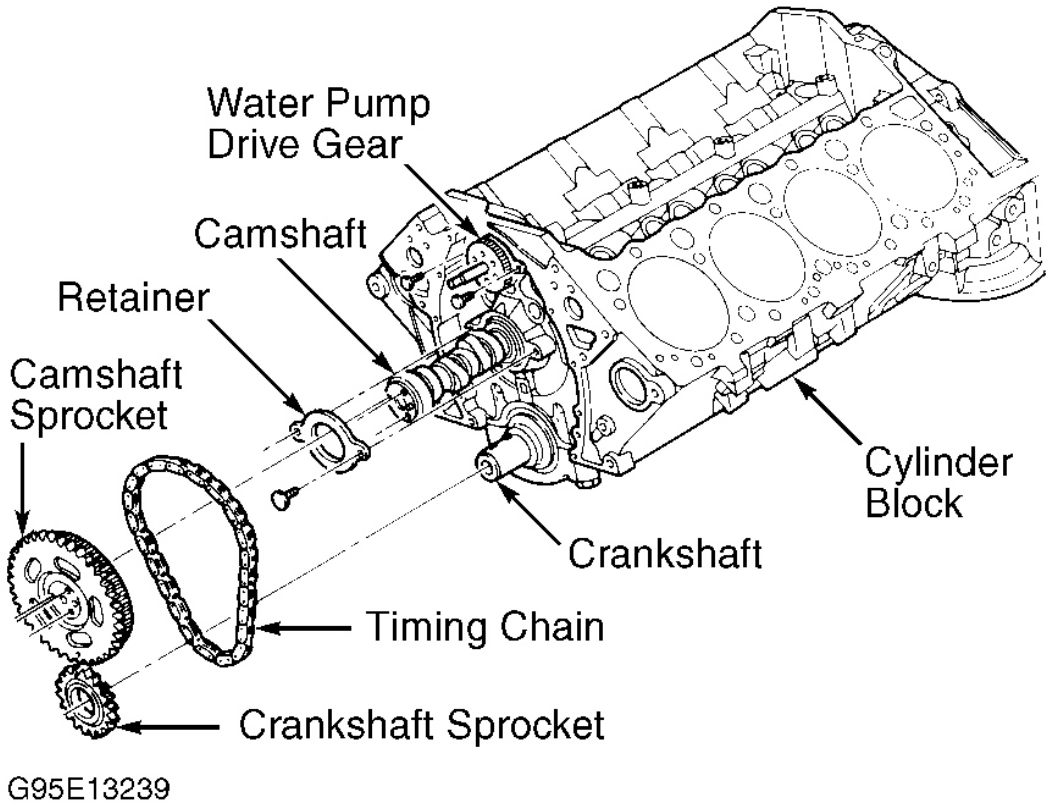


Fig. 4: View Of Timing Chain & Components

Courtesy of GENERAL MOTORS CORP.

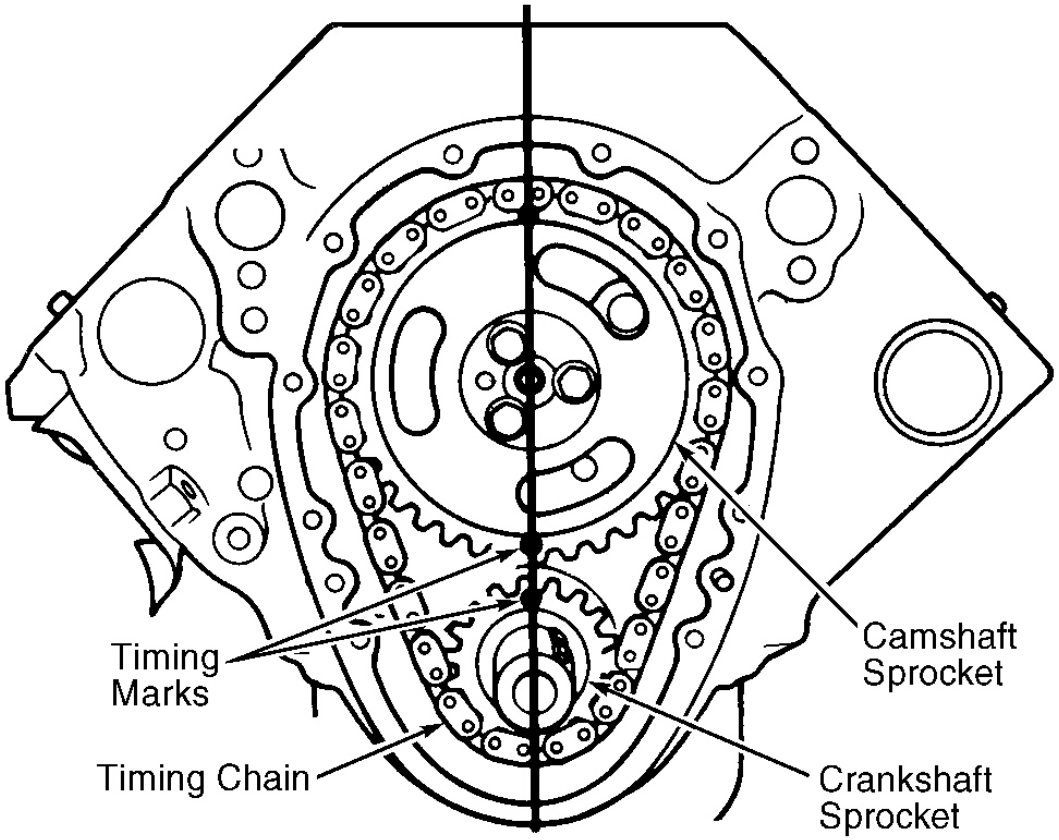


Fig. 5: Aligning Timing Marks
Courtesy of GENERAL MOTORS CORP.

VALVE COVERS

Removal (Left)

Disconnect negative battery cable. Remove alternator brace. Remove alternator and position aside. Disconnect AIR diverter valve hose from check valve. Remove fuel rail cover and studs, and position wiring harness aside. Remove fuel lines and brackets. Remove valve cover bolts, washers, valve cover and gasket.

Removal (Right)

1. Disconnect negative battery cable. Remove fuel rail cover and fuel rail bolts. Disconnect fuel pressure regulator vacuum hose. Remove fuel injectors and fuel rail from intake manifold. Remove fuel rail cover studs, and position wiring harness aside. Remove AIR pipe and check valve from intake and exhaust manifolds.

2. Disconnect ECM harness connectors and position harness aside. Remove AIR diverter valve and hoses. Remove spark plug wires at distributor. Remove EGR solenoid bracket. Disconnect PCV hose and connector. Remove valve cover and gasket.

Installation (Left & Right)

To install, reverse removal procedure. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS**.

ROCKER ARMS & PUSH RODS

Removal & Installation

Remove valve covers. See **VALVE COVERS**. Mark components for installation in original locations. Remove rocker arm nuts, balls, rocker arms and push rods. To install, reverse removal procedure. Apply Prelube (1052365) to rocker arm and ball mating surface.

ROCKER ARM STUD

Removal & Installation

1. Remove the rocker arms and push rods as necessary. Refer to **ROCKER ARMS & PUSH RODS**. Remove rocker arm stud(s) using Stud Remover (J-5802-01). Ream stud bore to replacement size of oversize stud. Oversize studs are available in .003" (.08 mm) and .013" (.33 mm).
2. Coat press-fit area of stud with hypoid axle lubricant. Install rocker arm stud using Stud Installer (J-6880) until installer bottoms out on cylinder head. To complete installation, reverse removal procedure.

CAMSHAFT

NOTE: Rotate crankshaft in direction of normal operation only. Keep components in order for installation reference.

Removal

1. Remove valve covers and rocker arms. See **VALVE COVERS**. DO NOT remove push rods. See **ROCKER ARMS & PUSH RODS**. Measure lobe lift of camshaft with push rods installed.
2. To measure lobe lift, attach dial indicator to cylinder head. Position indicator pointer onto tip of a push rod. Rotate crankshaft until push rod is at lowest point. Zero indicator, and rotate crankshaft until push rod is at highest point. Record reading, and repeat procedure for remaining lobes.
3. After lobe lift is measured, remove push rods. Remove intake manifold and timing sprockets. See **INTAKE MANIFOLD**. Also refer to **TIMING CHAIN**. Remove air cleaner, coolant reservoir hose from radiator, and relay bracket from left side of radiator support. Remove AIR pump and hoses, and position aside. Disconnect cooling fan electrical connectors. Remove upper radiator support.
4. Remove upper radiator fan shroud. Remove radiator and hoses. Discharge A/C system and remove condenser (if equipped). Remove valve lifters and camshaft retaining plate. Using three 5/16" x 18 tpi x 4" bolts as a handle, carefully pull camshaft from engine. Remove camshaft rear plug and bearings as

necessary.

Inspection

Check camshaft for scratches, pits and loose fit in bearings. Check camshaft journal diameter and lobe lift (recorded earlier). Replace camshaft if damaged or not to specification. See **CAMSHAFT** table under ENGINE SPECIFICATIONS.

Installation

1. Install front and rear bearings. Position camshaft bearing No. 1 oil holes at 1 o'clock and 5 o'clock positions.
2. Position oil hole of rear bearing at 12 o'clock position. Position oil holes of middle bearings at 5 o'clock position, toward left side of engine and even with bottom of cylinder bore.
3. Install camshaft rear plug flush to .031" (.79 mm) deep in block. Use Sealant (1052080) on camshaft plug. If replacing camshaft, replace lifters, engine oil and filter.
4. Apply Camshaft Prelube (1052365) to camshaft lobes. Apply engine oil to bearings and camshaft bearing journals. To complete installation, reverse removal procedure.

CRANKSHAFT REAR OIL SEAL

Removal

Remove transmission. Remove flywheel/flexplate. Pry out seal using screwdriver at notches in seal retainer. See **Fig. 6**.

Installation

1. Coat entire seal with engine oil. Install seal using Seal Installer (J-35621) until installer bottoms. See **Fig. 6**. Align crankshaft dowel to flywheel hole.
2. Install flywheel/flexplate-to-crankshaft bolts. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**. To complete installation, reverse removal procedure.

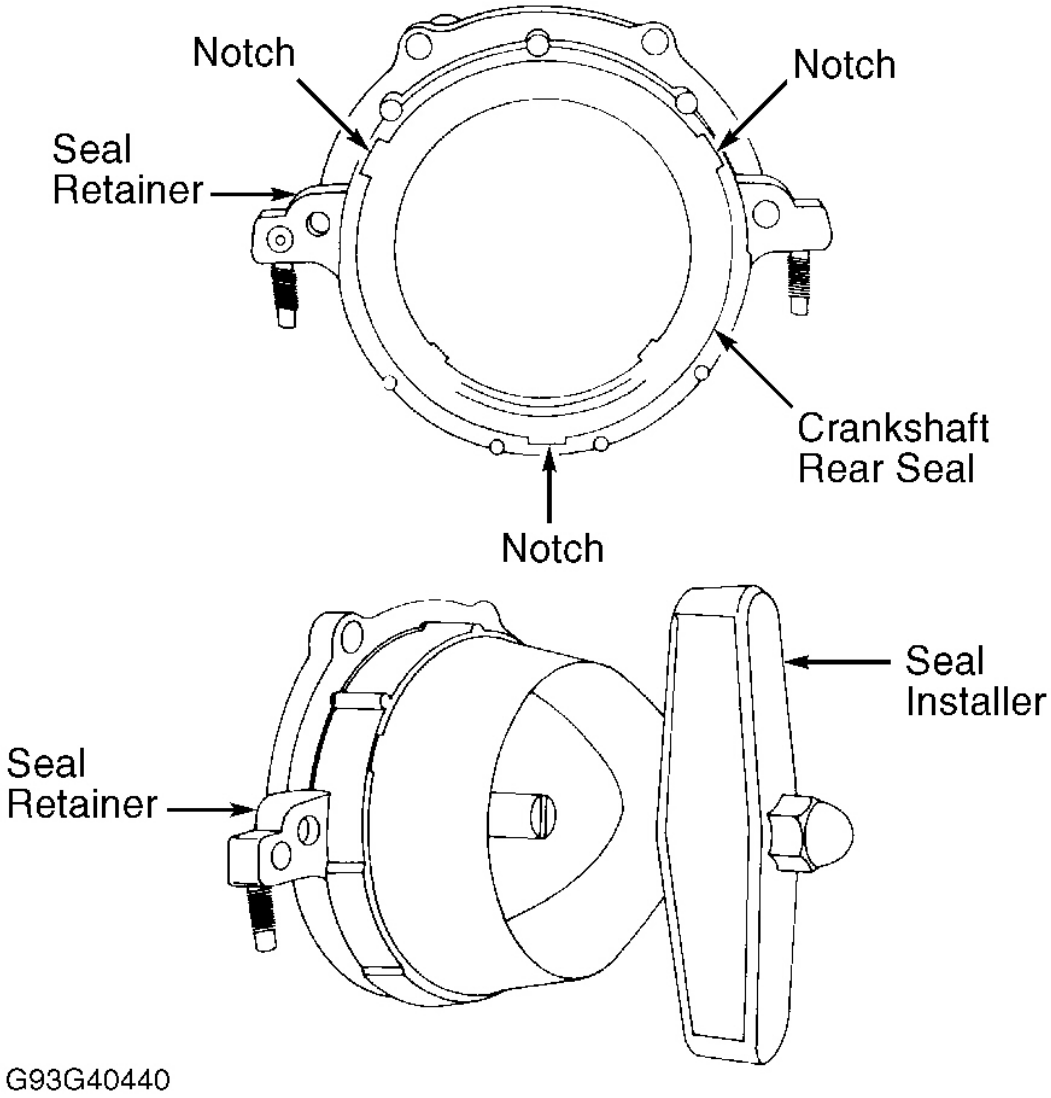


Fig. 6: Removing & Installing Crankshaft Rear Seal
Courtesy of GENERAL MOTORS CORP.

WATER PUMP

The layout of this section is:

- Brief description of the water pump
- Removal of the water pump; all cooling system types are addressed
- Cleaning after removal
- Installation of the water pump

Description

The water pump assembly is gear driven by the camshaft sprocket using a driveshaft and coupling. Keep the ignition wires connected to the distributor assembly until the water pump assembly is removed and all coolant has been drained.

Removal

NOTE: See Fig. 7 for exploded view of water pump assembly. This illustration is referred in these procedures.

1. Drain engine coolant. See the **DRAINING & REFILLING COOLING SYSTEM** section in this article
2. If equipped with a mechanical fan: Remove air cleaner resonator bracket nuts. Remove air cleaner resonator assembly; loosen clamp and slide resonator assembly off studs. Remove the air intake duct.
3. If equipped with a mechanical fan: remove radiator fan upper shroud. See **Fig. 8**. Remove bolts and screws (25 and 26) from upper shroud assembly (27). Remove upper shroud assembly (27) from lower shroud assembly (28) and radiator support assembly.
4. If equipped with a mechanical fan: Remove fan belt from tensioner assembly. See **Fig. 9** Remove the fan blade clutch nuts (247) and fan blade assembly (249) with clutch assembly attached.
5. For all, remove engine coolant and heater hose assemblies from water pump assembly (37).
6. If equipped with a mechanical fan: Remove fan pulley. Remove coolant fan pulley bracket nuts (132). Remove coolant fan pulley bracket (130)
7. For all, remove the electrical connect from coolant sensor. Remove the secondary air injection pump assembly by removing the electrical connector from AIR pump, outlet and inlet hoses, and finally, the air pump mounting bolts (3) from bracket. See **Fig. 10**.
8. Remove the water pump bolts/screw (127 and 129) and stud (128). Remove water pump assembly (37) and gaskets (38). Remove water pump driveshaft coupling (39) and seals (156). Discard the seals (156).

Cleaning

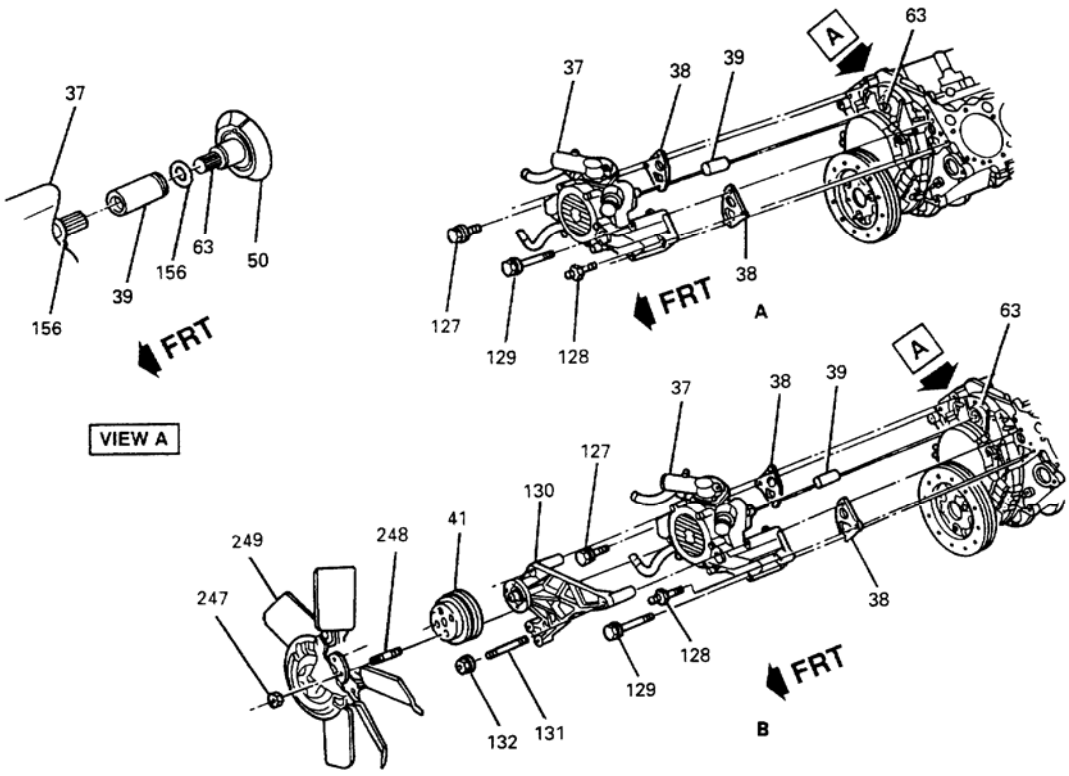
Clean the water pump gasket surfaces, the water pump bolts/screws (127 and 129). Clean coolant fan pulley bracket studs (131), if removed.

Installation

NOTE: See Fig. 7 for exploded view of water pump assembly. This illustration is referred to here.

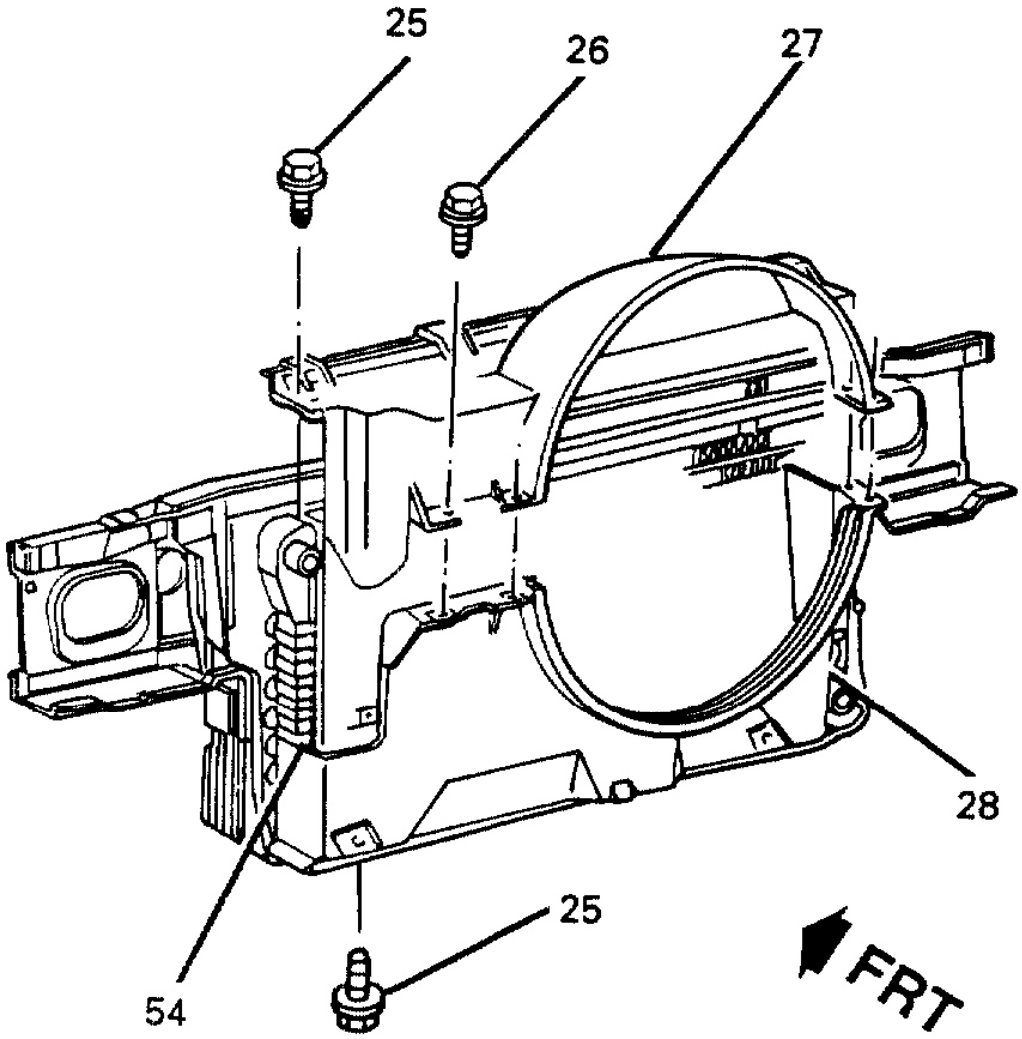
1. Install the water pump driveshaft coupling (39) and new seals (156). Install water pump assembly (37) and gaskets (38). Install the water pump bolts/screws (127 and 129) and stud (128). Tighten all to 30 lb.ft. (41 N.m).
2. Install the secondary air injection pump assembly: Install the AIR pump to bracket. See **Fig. 10**. Connect the mounting bolts (3), tightening them to 50 lb.in. (5.6 N.m). Connect outlet and inlet hoses to pump. Connect electrical connector to AIR pump.
3. Install the electrical connector to coolant sensor.

4. If equipped with a mechanical fan: Install the coolant fan pulley bracket (130). Install the coolant fan pulley bracket nuts (132), tightening them to 22 lb.ft. (30 N.m). Install the fan pulley. Install the fan blade assembly (249) with clutch assembly attached and nuts (247). Tighten the nuts to 19 lb.ft. (26 N.m).
5. On all, install the engine coolant and heater hose assemblies to water pump assembly (37).
6. If equipped with a mechanical fan: Install the fan belt to tensioner assembly. See **Fig. 9**. Install the radiator fan upper shroud: Install upper shroud assembly (27) to lower shroud assembly (28) and radiator support assembly. See **Fig. 8**. Install the bolts/screws (25 and 26), tightening them to 53 lb.ft. (6 N.m).
7. If equipped with a mechanical fan: Install the air intake duct. Install air cleaner resonator assembly; slide resonator assembly over studs and tighten clamp until snug. Install the air cleaner resonator bracket nuts, tightening them to 89 lb.in. (10 N.m).
8. For all, refill and bleed the cooling system. See the **DRAINING & REFILLING COOLING SYSTEM** section in this article



A WITHOUT MECHANICAL FAN
B WITH MECHANICAL FAN
37 PUMP ASSEMBLY, WATER
38 GASKET, WATER PUMP
39 COUPLING, WATER PUMP DRIVESHAFT
41 PULLEY, FAN
50 COVER ASSEMBLY, ENGINE FRONT
63 DRIVESHAFT ASSEMBLY, WATER PUMP
127 BOLT/SCREW, WATER PUMP
128 STUD, WATER PUMP
129 BOLT/SCREW, WATER PUMP
130 BRACKET, COOLANT FAN PULLEY
131 STUD, COOLANT FAN PULLEY BRACKET
132 NUT, COOLANT FAN PULLEY BRACKET
156 SEAL, WATER PUMP DRIVESHAFT
247 NUT, FAN BLADE CLUTCH
248 STUD, FAN BLADE CLUTCH
249 BLADE ASSEMBLY, FAN
50C14664

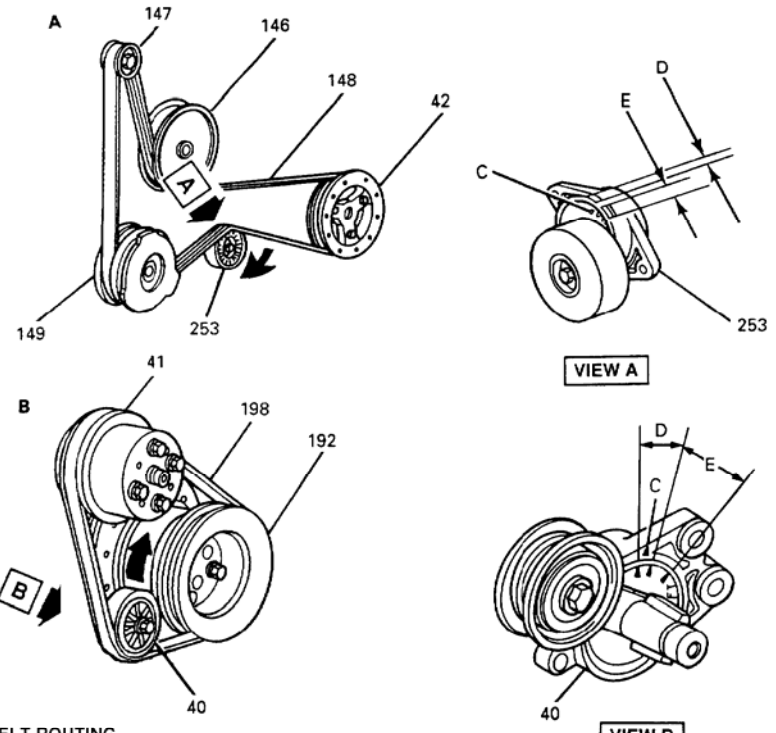
Fig. 7: Exploded View of Water Pump Assembly
Courtesy of GENERAL MOTORS CORP.



25 BOLT/SCREW, RADIATOR FAN SHROUD, 6 N•m (53 LB. IN.)
26 BOLT/SCREW, RADIATOR FAN UPPER SHROUD, 6 N•m (53 LB. IN.)
27 SHROUD ASSEMBLY, RADIATOR FAN UPPER
28 SHROUD ASSEMBLY, RADIATOR FAN LOWER
54 RADIATOR ASSEMBLY

50A14662

Fig. 8: Exploded View of Fan Shroud - For Mechanical Fan Only
Courtesy of GENERAL MOTORS CORP.



A COOLING SYSTEM BELT ROUTING
B ADDITIONAL BELT ROUTING FOR MODELS EQUIPPED WITH "V08" HEAVY DUTY COOLING SYSTEM WITH MECHANICAL FAN
C INDICATOR MARK
D ACCEPTABLE OPERATING RANGE
E UNACCEPTABLE OPERATING RANGE
40 TENSIONER ASSEMBLY, DRIVE BELT (WITH MECHANICAL FAN)
41 PULLEY, FAN
42 BALANCER ASSEMBLY, CRANKSHAFT
146 PUMP ASSEMBLY, POWER STEERING
147 GENERATOR ASSEMBLY
148 BELT, SERPENTINE DRIVE
149 COMPRESSOR ASSEMBLY, AIR CONDITIONING
192 PULLEY, CRANKSHAFT
198 BELT, FAN
253 TENSIONER ASSEMBLY, DRIVE BELT

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Fig. 9: Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

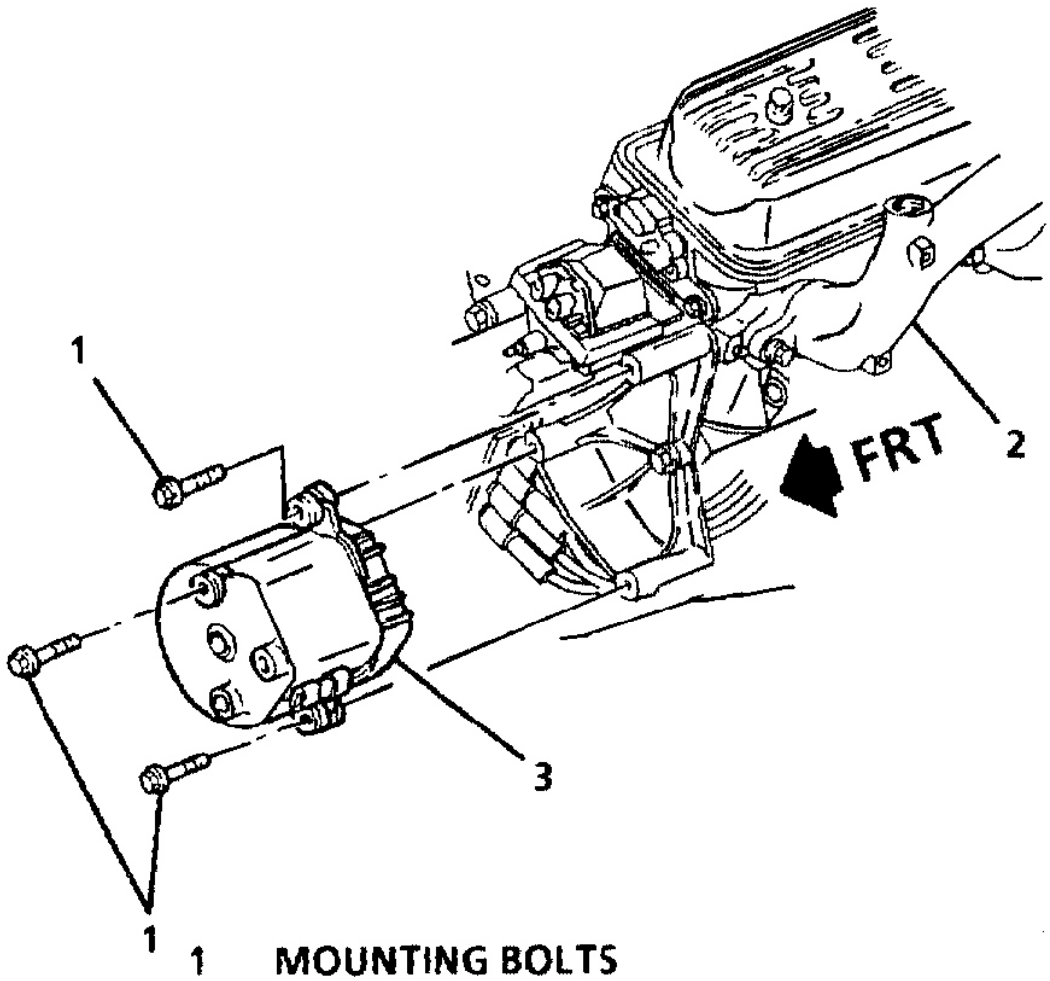


Fig. 10: Exploded View of Smog Pump Assembly
Courtesy of GENERAL MOTORS CORP.

OIL PAN

Removal

1. Disconnect negative battery cable. Remove air cleaner resonator and air intake duct. Remove radiator fan

upper shroud (vehicles with mechanically driven fan). Disconnect windshield wiper motor electrical connector. Raise and support vehicle. Drain crankcase. Remove oil level sensor.

2. Disconnect exhaust pipes from manifolds. Disconnect catalytic converter support from transmission. Remove oil filter and adapter. Disengage transmission fluid cooler lines from clips at oil pan (A/T). Remove starter. Remove flywheel cover.
3. Rotate crankshaft until arrow on crankshaft balancer is pointing straight down (6 o'clock position). Remove engine mount through-bolts. Lift engine from above. Remove oil pan.

Installation

To install, reverse removal procedure. Apply Sealant (1052914) to front cover, cylinder block, rear seal retainer and cylinder block junction. Install NEW oil pan gasket. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS**.

OVERHAUL

CYLINDER HEAD OVERHAUL

Valve Guides

Check and service guides before servicing valve and seat. Guide replacement information is not available from manufacturer. Valve guides may be reamed for installation of .003" (.08 mm), .015" (.38 mm) or .030" (.76 mm) oversize valves.

Valve Seat

Valve seat replacement information is not available from manufacturer. Follow instructions of tool manufacturer for servicing valve seats. If seats are serviced, service or replace valves.

Valves

Check valves before servicing. Replace valves as necessary. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS. Valve face may be machined.

Valve Seat Correction Angles

If seat is too wide after grinding, use a 20-degree stone to lower or a 70-degree stone to raise seat.

CYLINDER BLOCK ASSEMBLY

Piston & Rod Assembly

1. Mark rod and rod cap with matching cylinder number. Before disassembling, mark piston-to-rod position for reassembly reference. Notch or dot on piston top should face front of engine. Piston pin is a press fit.
2. When measuring, ensure pin bore and piston pin are free of varnish and scuffing. If clearance between the piston and pin exceeds specification, replace the piston and pin as an assembly. See **PISTONS, PINS & RINGS** table under ENGINE SPECIFICATIONS.

Fitting Pistons

Ensure notch or dot on piston top faces front of engine. Check pistons for wear and damage. Replace pistons as necessary. Check piston-to-cylinder bore clearance. If one cylinder needs to be bored, bore all cylinders to same oversize.

Piston Rings

Install marked side of ring toward top of piston. Top compression ring is chrome or molybdenum face. Second compression ring has a tapered face. Oil ring is a 3-piece type. Ensure end gaps are evenly spaced on piston. See **Fig. 11**.

NOTE: Rod and main bearings are available in .001" (.03 mm) and .002" (.05) undersize for oil clearance adjustment.

Rod Bearings

Ensure bearing cap bolt holes and mating surfaces are clean and dry. Use connecting rod stud protectors on rod cap bolts. Install inserts in connecting rod and cap. Lubricate bearings and crank pin. Install bearing cap. Tighten rod bearing cap bolts to specification. See **TORQUE SPECIFICATIONS**.

Crankshaft & Main Bearings

1. If bearing clearance is greater than specification, replace with undersized bearings and recheck bearing clearance using Plastigage. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.
2. Tighten the main bearing caps finger tight. Pry the crankshaft rearward and then forward to align the rear main bearing thrust surfaces. Retighten the main bearing caps to specification. See **TORQUE SPECIFICATIONS**.

Thrust Bearing

Check crankshaft end play by forcing the crankshaft to the extreme forward position. Measure end play at the front of the rear main bearing using a feeler gauge. If end play is not within specification, replace thrust bearing and/or crankshaft. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

Cylinder Block

Check cylinder bore for wear, taper, out-of-round and piston fit. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS. Cylinders with less than .005" (.13 mm) wear or taper can be honed. Cylinders with more than .005" (.13 mm) wear or taper should be bored to smallest oversize piston which will permit complete resurfacing of all cylinders.

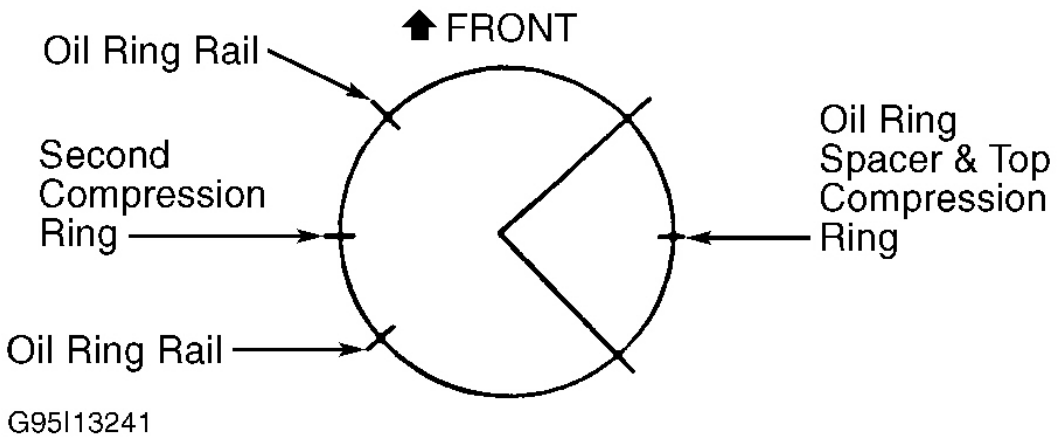


Fig. 11: Positioning Piston Ring End Gaps
Courtesy of GENERAL MOTORS CORP.

LUBRICATION

ENGINE OILING SYSTEM

A gear-type oil pump provides pressurized lubrication through the full-flow oil filter. Oil pump is bolted to bottom of cylinder block, inside oil pan. Oil pump is driven (through intermediate shaft) by a gear on rear end of camshaft.

Crankcase Capacity

Crankcase capacity is 4 qts. (3.8L) without oil filter change or 5 qts. (4.7L) with oil filter change.

Oil Pressure

With engine at normal operating temperature, oil pressure should be at least 6 psi (0.4 kg/cm^2) at 1000 RPM, 18 psi (1.3 kg/cm^2) at 2000 RPM and 24 psi (1.7 kg/cm^2) at 4000 RPM.

OIL PUMP

Removal & Disassembly

Remove oil pan. See **OIL PAN** under REMOVAL & INSTALLATION. Remove oil pan baffle (if equipped). Remove oil pump assembly and intermediate shaft. Remove oil pump cover screws, and remove cover. Mark gear teeth for reassembly reference. Remove gears. Remove pressure regulator pin, spring and valve from cover. Remove pick-up screen and pipe from cover only if replacing.

Inspection

Check oil pump body and gears for cracks, wear and damage. Check oil pump shaft for looseness in housing. Check inside of cover for wear or oil leakage. If excess wear or damage is found, replace oil pump as an assembly. Oil pump specifications are not available from manufacturer.

Reassembly & Installation

Clean parts in solvent. Dry parts using compressed air. To assemble, reverse disassembly procedure. To install, reverse removal procedure.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Camshaft Sprocket Bolt	18 (25)
Coolant Fan Pulley Bracket Nut	22 (30)
Connecting Rod Cap Nut	
Step 1	20 (27)
Step 2	Additional 55 Degrees
Crankshaft Balancer & Hub-To-Crankshaft Bolt	74 (100)
Crankshaft Balancer-To-Hub Bolt	63 (85)
Crankshaft Rear Oil Seal Housing Bolt	11 (15)
Cylinder Head Bolt (1)	65 (88)
Exhaust Manifold Bolt	26 (35)
Flexplate/Flywheel-To-Crankshaft Bolt (2)	74 (100)
Intake Manifold Bolt (3)	35 (48)
Main Bearing Cap Bolt	77 (105)
Oil Filter Adapter	17 (23)
Oil Pan Baffle Nut	30 (40)
Oil Pan Bolt/Nut (Corners)	15 (20)
Oil Pump-To-Main Bearing Bolt	66 (90)
Rocker Arm Stud	50 (68)
Throttle Body Bolt	18 (25)
Torque Converter-To-Flexplate Bolt	46 (62)
Valve Lifter Guide Bolt	18 (25)
Water Pump	
Bolt/Screw and Stud	30 (41)
Drivesahft Bearing Retainer Bolt/Screw	30 (41)
	INCH Lbs. (N.m)
Front Cover Bolt	97 (11)
Oil Pan Bolt/Nut (Except Corners)	97 (11)
Valve Cover Bolt	106 (12)

(1) Tighten in sequence (in 3 passes). See **Fig. 3**.

(2) Tighten bolts evenly using a crisscross sequence.

(3) Tighten bolts in several phases and in sequence. See **Fig. 2**.

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS

Application	Specification
Displacement	265 Cu. In. (4.3L)
Bore	3.736" (94.89 mm)
Stroke	3.000" (76.20 mm)
Compression Ratio	9.9:1
Fuel System	SFI
Horsepower @ RPM	200 @ 5200
Torque Ft. Lbs. @ RPM	235 @ 2400

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

Application	In. (mm)
Crankshaft	
End Play	.001-.007 (.03-.17)
Runout At Rear Flange (Maximum)	.0015 (.038)
Main Bearings	
Journal Diameter	2.4485-2.4491 (62.191-62.207)
Journal Out-Of-Round	
Standard	.0002 (.005)
Wear Limit	.0010 (.025)
Journal Taper	
Standard	.0002 (.005)
Wear Limit	.0010 (.025)
Oil Clearance	
Journal No. 1	
Standard	.0008 (.020)
Wear Limit	.0020 (.051)
Journals No. 2, 3 & 4	
Standard	.0011 (.028)
Wear Limit	.0025 (.064)
Journal No. 5	
Standard	.0017 (.043)

Wear Limit	.0035 (.089)
Connecting Rod Bearings	
Journal Diameter	2.0978-2.0998 (53.284-53.334)
Journal Out-Of-Round	
Standard	.0003 (.007)
Wear Limit	.0010 (.025)
Journal Taper	
Standard	.0003 (.007)
Wear Limit	.0010 (.025)
Oil Clearance	.0013-.0035 (.033-.088)

CONNECTING RODS

CONNECTING RODS

Application	**In. (mm)**
Maximum Bend	(1)
Maximum Twist	(1)
Side Play	.006-.014 (.16-.35)
(1) Replace rod if any bend or twist exists.	

PISTONS, PINS & RINGS

PISTONS, PINS & RINGS

Application	**In. (mm)**
Piston Clearance	.0010-.0027 (.025-.068)
Pins	
Diameter	.9270-.9271 (23.546-23.548)
Piston Fit	.0004-.0008 (.010-.020)
Rod Fit (Interference)	.0008-.0016 (.021-.040)
Rings	
No. 1	
End Gap	
Standard	.010-.020 (.25-.50)
Wear Limit	.035 (.88)
Side Clearance	
Standard	.0012-.0029 (.030-.073)
Wear Limit	.0043 (.110)
No. 2	
End Gap	
Standard	.018-.026 (.46-.66)
Wear Limit	.035 (.88)

Side Clearance	
Standard	.0012-.0029 (.029-.073)
Wear Limit	.0043 (.110)
No. 3 (Oil)	
End Gap	
Standard	.010-.030 (.25-.76)
Wear Limit	.065 (1.65)
Side Clearance	
Standard	.002-.007 (.05-.17)
Wear Limit	.008 (.20)

CYLINDER BLOCK

CYLINDER BLOCK

Application	In. (mm)
Cylinder Bore	
Diameter	3.7355-3.7385 (94.881-94.957)
Taper	
Standard	.0005 (.012)
Wear Limit	.0010 (.025)
Out-Of-Round	
Standard	.001 (.02)
Wear Limit	.002 (.05)

VALVES & VALVE SPRINGS

VALVES & VALVE SPRINGS

Application	Specification
Valves	
Face Angle	45°
Margin (Minimum)	.031" (.80 mm)
Valve Springs	
Free Length	2.0" (51 mm)
Installed Height	1.70" (43.2 mm)
Pressure (1)	
Valve Closed	76-84 @ 1.70 (34-37 @ 43.2)
Valve Open	187-203 @ 1.27 (83-90 @ 32.3)
(1) Lbs. @ In. (Kg @ mm).	

CYLINDER HEAD

CYLINDER HEAD

Application	Specification
Valve Seats	
Intake Valve	
Seat Angle	46°
Seat Width	.045-.070" (1.14-1.77 mm)
Exhaust Valve	
Seat Angle	46°
Seat Width	.065-.098" (1.65-2.49 mm)
Valve Guides	
Stem-To-Guide Oil Clearance	
Standard	.0011-.0027" (.028-.069 mm)
Wear Limit	
Intake	.0037" (.093 mm)
Exhaust	.0047" (.119 mm)

CAMSHAFT

CAMSHAFT

Application	In. (mm)
End Play	.004-.012 (.11-.30)
Journal Diameter	1.8677-1.8697 (47.440-47.490)
Lobe Lift	
Intake	.279 (7.09)
Exhaust	.286 (7.26)

5.0L (305") V8 - VIN [E]

GENERAL MOTORS ENGINES 5.0L (305") V8

ENGINE IDENTIFICATION

NOTE: For engine repair procedures not covered in this article, see ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION article in the GENERAL INFORMATION section.

Engine may be identified using Vehicle Identification Number (VIN) stamped on a metal pad, located near lower left corner of windshield. The eighth character identifies the engine model. See ENGINE IDENTIFICATION CODES table.

Engine identification code, located on cylinder block below cylinder head, may be required when ordering replacement parts. See ENGINE IDENTIFICATION CODES table.

ENGINE IDENTIFICATION CODES

Application	Engine Code	VIN Code
5.0L (305") V8 TBI	L03	E

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

Hydraulic valve lifters are used. Under normal use, valve adjustment is not required.

TROUBLE SHOOTING

To trouble shoot mechanical engine components, see appropriate table in TROUBLE SHOOTING article in GENERAL INFORMATION.

REMOVAL & INSTALLATION

GENERAL NOTES

WARNING: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

NOTE: For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks on engine hood and other major assemblies before removal.

FUEL PRESSURE RELEASE

A constant bleed unit relieves fuel pressure when ignition is turned off. To release fuel tank pressure, remove gas cap.

ENGINE ASSEMBLY

Removal

1. Release fuel pressure. See FUEL PRESSURE RELEASE under REMOVAL & INSTALLATION. Disconnect negative battery cable. Remove hood and air cleaner. Drain coolant from radiator. Disconnect radiator hoses, and remove upper fan shroud. Remove fan assembly. Disconnect heater hoses at engine.
2. Remove serpentine belt. Remove power steering pump, and set it aside. Remove A/C compressor, and set it aside. Disconnect accelerator and throttle valve cable. Disconnect cooler lines (if equipped) at radiator. Remove radiator.
3. Disconnect vacuum hoses. Disconnect engine wiring harness (including ground strap) at engine bulkhead. Remove windshield wiper motor. Disconnect ECM wiring harness.
4. Disconnect Air Injection Reactor (AIR) hose at pipe from converter. Remove MAP sensor (if equipped).
5. Remove distributor cap and distributor. Disconnect cruise control cable. Disconnect positive battery cable at starter. Disconnect negative battery cable at engine block. Raise and support vehicle.
6. Remove crossover pipe and catalytic converter as an assembly. Remove flexplate cover. Remove torque converter-to-flywheel bolts. Remove motor mount bolts. Disconnect fuel hose from front fuel pipes. Disconnect torque converter clutch wiring at transmission.
7. Disconnect transmission cooler lines at clip on engine oil pan. Remove transmission-to-engine bolts. Remove ground wires from rear of cylinder head. Lower vehicle. Support transmission. Install lifting device, and remove engine.

Installation

To install, reverse removal procedure. With engine off, fill radiator until level is even with base of filler neck. Fill coolant recovery reservoir to COLD FILL mark. Install coolant recovery reservoir cap. Run engine until radiator inlet hose is hot. With engine at idle, add coolant to radiator until level is even with base of filler neck. Install cap.

INTAKE MANIFOLD

1. Disconnect negative battery cable, and drain cooling system. Remove air cleaner and throttle body assembly. Disconnect ECM wiring harness, and set it aside. Remove upper radiator hose at thermostat and heater hose at intake manifold.
2. Remove thermostat housing and gasket. Mark and remove necessary electrical connectors and vacuum hoses. Mark and remove necessary fuel line clips and lines. Remove throttle cable bracket. Mark and remove spark plug wires at distributor cap. Remove EGR valve and solenoid. Remove distributor cap.
3. Mark distributor rotor position for installation reference. Remove distributor. Remove ignition coil and coolant temperature sensor. Remove A/C compressor brace. Remove intake manifold bolts and studs. Remove intake manifold and gasket.

Installation

Clean all gasket surfaces. Apply 3/16" bead of RTV Sealer (1052289) on front and rear of cylinder block and 1/2" onto each cylinder head. See **Fig. 1** . Install gaskets and intake manifold. Tighten bolts and studs to specification in sequence. See **Fig. 1** . See TORQUE SPECIFICATIONS table at end of article. To complete installation, reverse removal procedure.

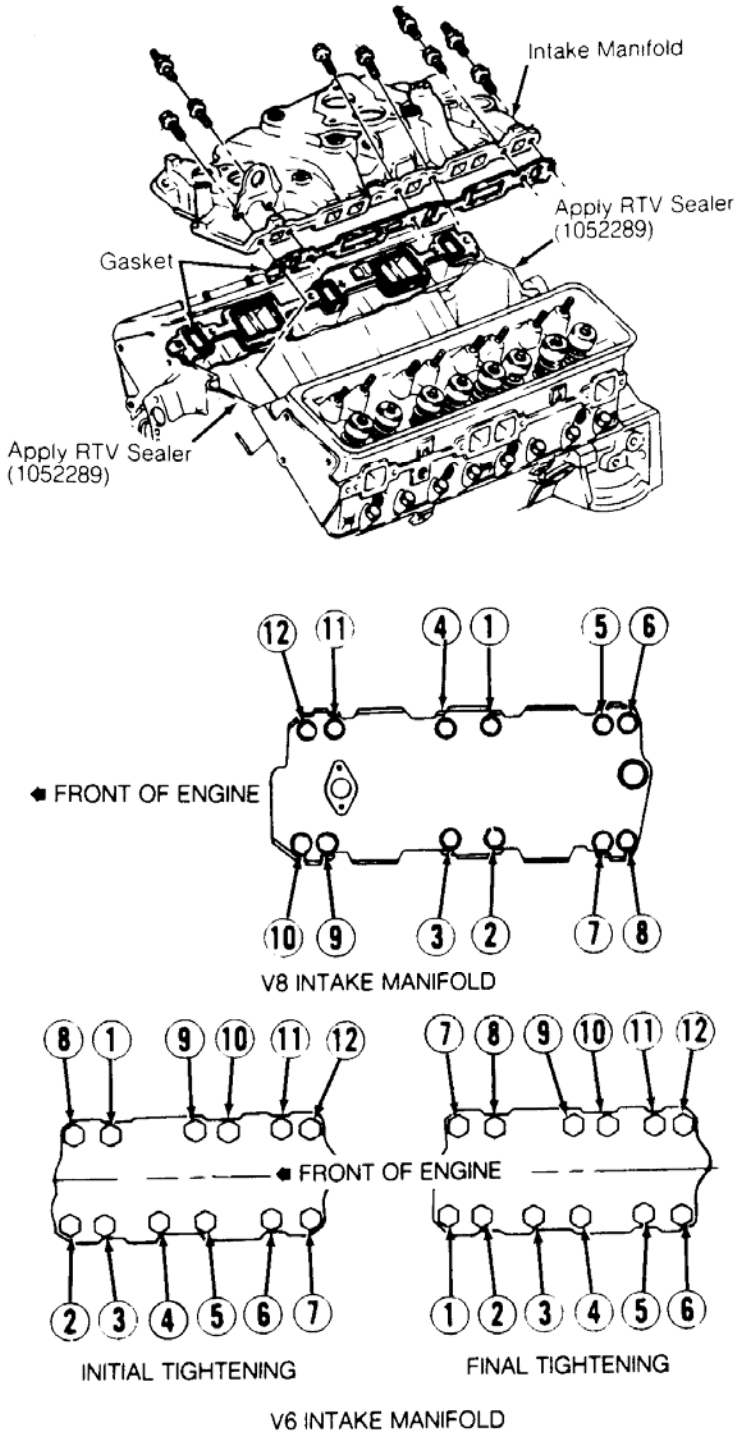


Fig. 1: Exploded View of Intake Manifold & Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

EXHAUST MANIFOLD

Removal (Left)

1. Disconnect negative battery cable. Raise and support vehicle.
2. Disconnect oxygen sensor electrical connector. Remove exhaust crossover pipe at exhaust manifold. Lower vehicle. Remove air cleaner. Remove spark plug wires and clips. Remove AIR pipe and check valve as an assembly.
3. Remove the exhaust manifold studs, heat shields, exhaust manifold and gasket.

Removal (Right)

1. Disconnect negative battery cable. Raise and support vehicle.
2. Remove exhaust crossover pipe at exhaust manifold. Lower vehicle. Remove air cleaner.
3. Remove Air Injection Reactor (AIR) hoses. Mark and disconnect spark plug wires at spark plugs. Remove necessary accessory brackets. Remove exhaust manifold bolts. Remove exhaust manifold and gaskets.

Installation (Left & Right)

To install, reverse removal procedure. Tighten bolts and nuts to specification. See TORQUE SPECIFICATIONS table at end of article.

CYLINDER HEAD

NOTE: Check and record compression before removing cylinder head. Remove cylinder head when engine is cold.

Removal

1. Disconnect negative battery cable. Remove intake manifold, exhaust manifold and valve covers. See INTAKE MANIFOLD, EXHAUST MANIFOLD and VALVE COVERS.
2. Remove serpentine belt. Drain cooling system. Ensure components are kept in order for installation reference. Remove cylinder head bolts in 3 steps in reverse order of tightening sequence. See **Fig. 2** . Remove cylinder head and gasket.

Inspection

Clean all carbon and gasket material from mating surfaces. Check cylinder head for warpage and cracks. Clean and tap cylinder head bolt holes and threads.

Installation

1. Coat steel-type head gaskets with sealer. DO NOT coat composition-type head gaskets with sealer. Install head gasket on cylinder block. Install cylinder head. Coat head bolts with Sealing Compound (1052080).
2. Install head bolts finger tight. Tighten bolts to specification in 3 steps in proper sequence. See **Fig. 2** . To complete installation, reverse removal procedure.

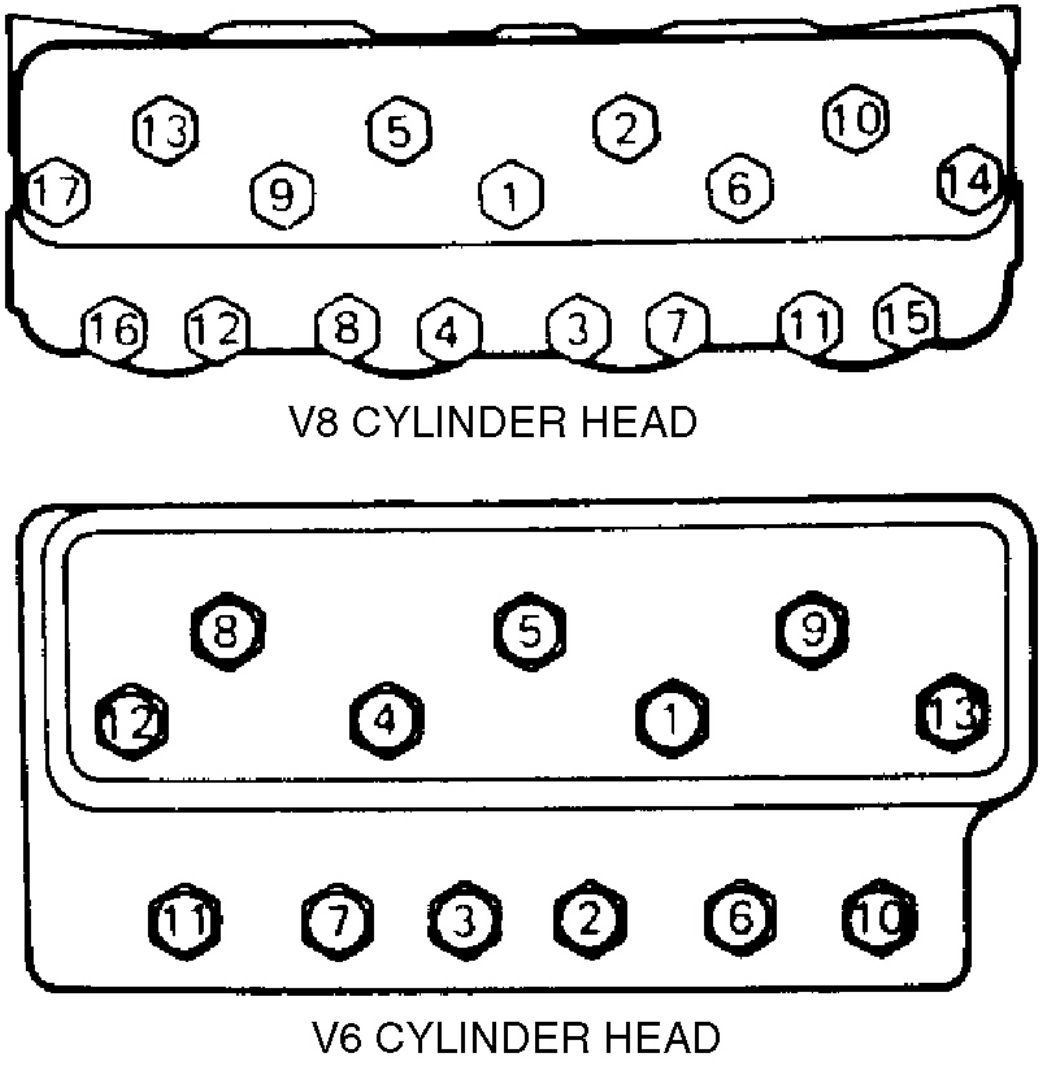


Fig. 2: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

FRONT COVER & OIL SEAL

NOTE: Removing timing cover is not necessary to replace timing cover seal.

Removal

1. Disconnect negative battery cable and serpentine drive belt. Remove crankshaft pulley bolts, and remove pulley. Remove harmonic balancer-to-crankshaft bolt. Remove harmonic balancer using Harmonic

Balancer Remover/Installer (J-23523-E).

2. Remove oil pan. See OIL PAN under REMOVAL & INSTALLATION. Remove water pump. See WATER PUMP under REMOVAL & INSTALLATION. On Corvette, remove throttle body air duct and distributor.
3. On all models, remove front cover-to-engine bolts. Remove cover and gasket. Carefully pry seal from timing cover using a large screwdriver.

Installation

1. Install new oil seal in timing cover. Coat timing cover gasket with sealant, and position it on timing cover. Install timing cover and bolts. Tighten bolts finger tight.
2. Tighten bolts alternately and evenly to specification. See TORQUE SPECIFICATIONS table at end of article. Apply sealant to area where oil pan, cylinder block and timing cover join. To complete installation, reverse removal procedure.

TIMING CHAIN

Removal

1. Disconnect negative battery cable. Remove front timing cover. See FRONT COVER & OIL SEAL. Rotate crankshaft until camshaft gear and crankshaft gear timing marks line up with shaft centers. See **Fig. 3** -4.
2. Remove 3 camshaft gear retaining bolts. Remove camshaft gear and chain as an assembly. See **Fig. 3** . If replacing crankshaft gear, use Gear Remover (J-5825-A) to pull gear off crankshaft.

Installation

Drive crankshaft gear on crankshaft, with timing mark facing out. Ensure timing marks on crankshaft sprocket and camshaft sprocket are as close together as possible and lined up with shaft centers. See **Fig. 4** . Install camshaft gear and chain as an assembly. To complete installation, reverse removal procedure.

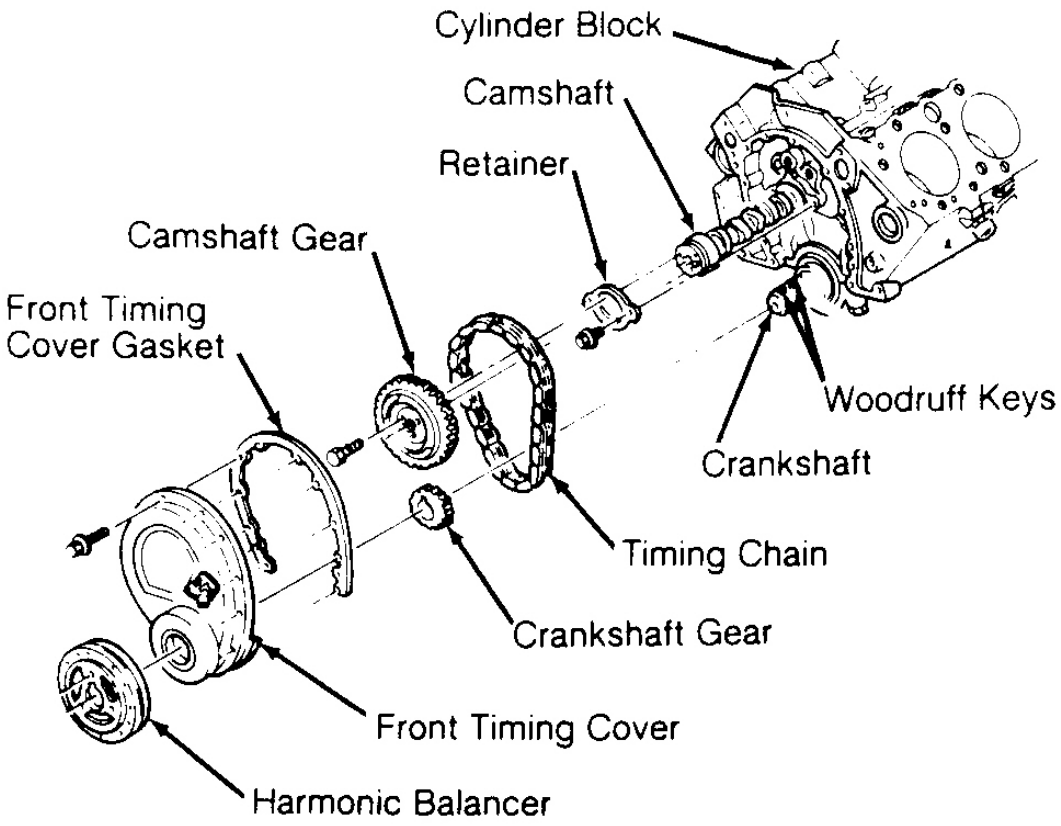


Fig. 3: Exploded View of Engine Front
Courtesy of GENERAL MOTORS CORP.

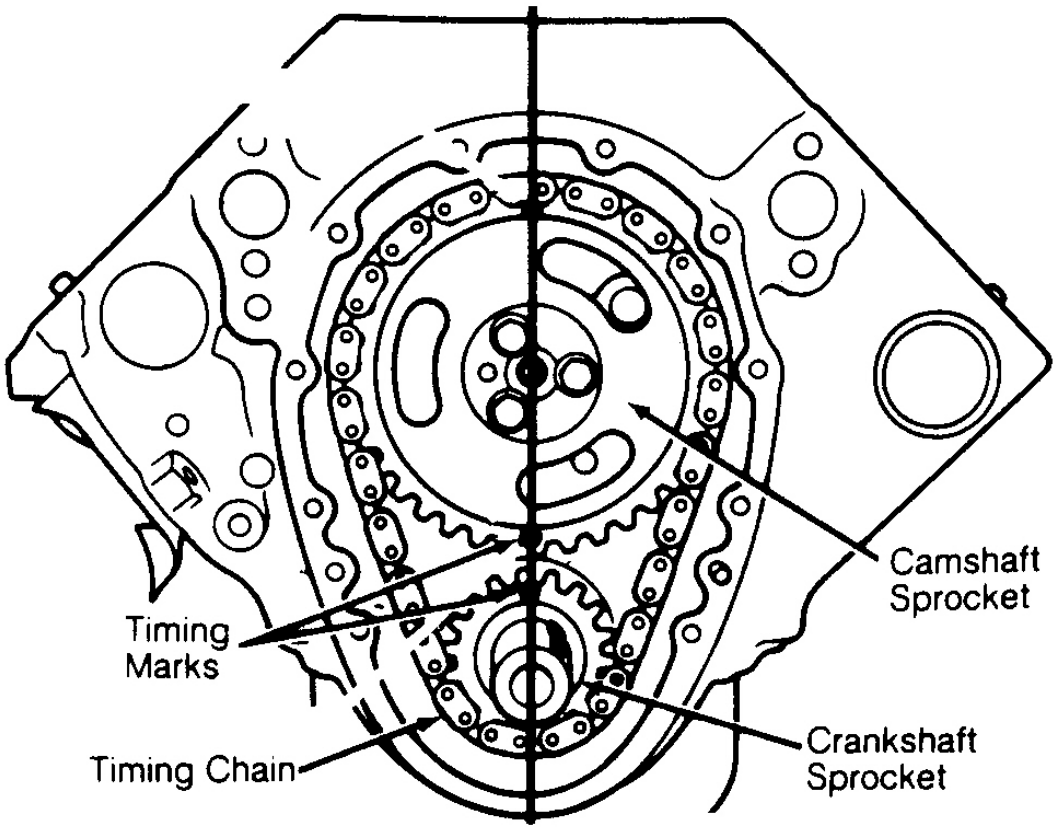


Fig. 4: Aligning Timing Marks
Courtesy of GENERAL MOTORS CORP.

VALVE COVERS

Removal (Left)

1. Disconnect negative battery cable.
2. Remove air cleaner, power brake pipe, PCV valve and hose at valve cover. Remove fuel lines and brackets. Remove valve cover bolts, washers, valve cover and gasket.

Removal (Right)

1. Disconnect negative battery cable.
2. Remove air cleaner. Disconnect ECM harness connectors, and position aside. Remove AIR diverter valve and hoses. Remove spark plug wires at distributor. Remove EGR solenoid bracket.
3. Disconnect PCV hose and connector. Remove valve cover bolts, washers, valve cover and gasket.

Installation (Left & Right)

To install, reverse removal procedure. Tighten bolts and nuts to specification. See TORQUE SPECIFICATIONS table at end of article.

ROCKER ARMS & PUSH RODS

Removal & Installation

1. Remove valve covers. See VALVE COVERS. Keep components in order for installation in original location and position.
2. Remove rocker arm nuts, balls, rocker arms and push rods. To install, reverse removal procedure. Apply Prelube (1052365) to rocker arm and ball mating surface.

ROCKER ARM STUD

Removal & Installation

1. Remove rocker arm studs using Stud Remover (J-5802-01). Ream stud bore to replacement size of oversize stud. Oversize studs are available in .003" (.08 mm) and .013" (.33 mm).
2. Coat press-fit area of stud with hypoid axle lubricant. Install rocker arm stud using Stud Installer (J-6880) until it bottoms out on cylinder head. To complete installation, reverse removal procedure.

CAMSHAFT

NOTE: Rotate crankshaft in direction of normal operation only. Keep components in order for installation reference.

Removal

1. Remove valve covers and rocker arms. DO NOT remove push rods. See VALVE COVERS and ROCKER ARMS & PUSH RODS. Measure lobe lift of camshaft with push rods installed.
2. To measure lobe lift, attach dial indicator to cylinder head. Position indicator pointer on tip of a push rod. Rotate crankshaft until push rod is at lowest point. Zero indicator, and rotate crankshaft until push rod is at highest point. Record reading, and repeat procedure for remaining lobes.
3. After lobe lift is measured, remove push rods. Remove intake manifold and timing gears. See INTAKE MANIFOLD and TIMING CHAIN under REMOVAL & INSTALLATION.
4. Remove upper radiator fan shroud. Remove radiator and hoses.
5. Discharge A/C system and remove condenser (if equipped). Remove grille assembly. Remove valve lifters and camshaft retaining plate. Using three 5/16" x 18" x 4" bolts, pull camshaft from engine.
6. Carefully remove camshaft without damaging camshaft bearings. Remove rear camshaft plug. Remove bearings using standard bearing remover.

Inspection

Check camshaft for scratches, pits and loose fitting in bearings. Check camshaft journal diameter and lobe lift. See CAMSHAFT table under ENGINE SPECIFICATIONS at end of article. Replace camshaft if damaged or not to specification.

Installation

1. Install front and rear bearings. Position camshaft bearing No. 1 oil holes at 1 o'clock and 5 o'clock positions.
2. Position oil holes of bearings No. 2-4 at 5 o'clock position toward left side of engine and even with bottom of cylinder bore. Position oil hole of bearing No. 5 at 12 o'clock position.
3. Install rear camshaft plug flush to .031" (.79 mm) deep in block. Use Sealant (1052080) on camshaft plug. If replacing camshaft, replace lifters, engine oil and filter.
4. Apply Camshaft Prelube (1052365) to camshaft lobes. Apply engine oil to bearings and camshaft bearing journals. To complete installation, reverse removal procedure.

REAR CRANKSHAFT OIL SEAL

Removal

Remove transmission. Remove flywheel/flexplate. Pry out seal using screwdriver and notches in seal retainer. See **Fig. 5** .

Installation

1. Coat entire seal with engine oil. Install seal using Seal Installer (J-35621) until installer bottoms. See **Fig. 5** . Align crankshaft dowel to proper flywheel hole.
2. Install flywheel/flexplate-to-crankshaft bolts, and tighten bolts to specification. See TORQUE SPECIFICATIONS table at end of article. To complete installation, reverse removal procedure.

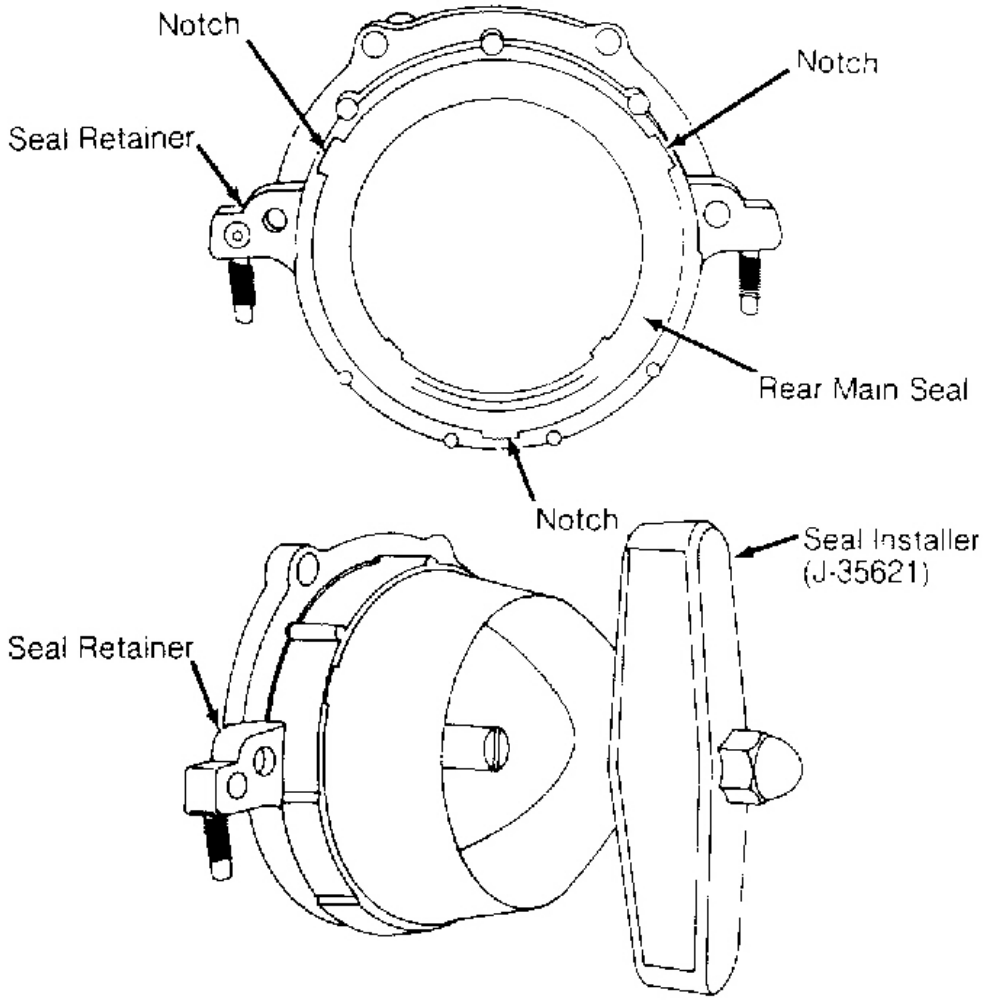


Fig. 5: Removing & Installing Rear Seal
Courtesy of GENERAL MOTORS CORP.

WATER PUMP

Removal

1. Disconnect negative battery cable, and drain cooling system. Remove air cleaner and intake duct assembly. Disconnect MAF sensor electrical connector. Remove cooling fans if necessary.
2. Remove accessory drive belt(s), fan, pulley and accessories as necessary. Remove coolant hoses from water pump. Remove water pump bolts, water pump and gasket.

Installation

To install, reverse removal procedure. Fill and bleed cooling system. To bleed system, leave radiator cap off. Start and run engine until upper hose is hot. With engine at idle, add coolant until level is at bottom of neck.

NOTE: For more cooling system information, see appropriate article in ENGINE COOLING.

OIL PAN

Removal

1. Disconnect negative battery cable. Remove air cleaner and fan shroud. Remove spark plug wires and distributor cap.
2. Raise and support vehicle. Drain crankcase oil. Disconnect oil level sensor electrical connector, and remove sensor (if equipped).
3. Disconnect exhaust pipe at manifold, Air Injection Reactor (AIR) pipe clamp and catalytic converter hanger bolts. Remove exhaust crossover pipe at manifold and converter (if equipped).
4. Remove starter and flexplate access cover. Disconnect transmission line bracket at oil pan. Remove engine mount through bolts. Remove oil pan bolts. Lower pan.
5. Position front crankshaft throw and/or counterweight on horizontal plane so it does not hinder oil pan removal. Turn crankshaft to 6 o'clock position on timing mark. Raise engine, reinstall through bolts and remove oil pan.

OIL PUMP

Removal & Disassembly

1. Remove oil pan. See OIL PAN under REMOVAL & INSTALLATION. On Corvette, remove oil pan baffle nuts. On all models, remove oil pump retaining bolts, and remove pick-up screen. Remove oil pump and intermediate shaft.
2. Remove oil pump cover screws, and remove cover. Mark gear teeth for reassembly reference. Remove idler gear, drive gear and shaft. Remove pressure regulator pin, spring and valve from cover. Remove pick-up screen and pipe from cover only if replacing.

Inspection

Check oil pump body and gears for cracks, wear and damage. Check oil pump shaft for looseness in housing. Check inside of cover for wear which would permit oil leakage. Replace oil pump assembly as necessary. Oil pump specifications are not available from manufacturer.

Installation

To install, reverse removal procedure. Apply Sealant (1052914) to front cover, cylinder block, rear seal retainer and cylinder block junction. Install new oil pan gasket. Tighten bolts and nuts to specification. See TORQUE SPECIFICATIONS table at end of article.

OVERHAUL

VALVE GUIDES

NOTE: Mark components to ensure installation in original location and position.

Check and service guides before servicing valve and seat. Guide replacement information is not available from manufacturer. Valve guides may be reamed to .003" (.08 mm), .015" (.38 mm)or .030" (.76 mm) oversize for installation of oversize valve.

VALVE SEAT

Valve seat replacement information is not available from manufacturer. Follow instructions of tool manufacturer for servicing valve seats. If seats are serviced, valves must be serviced or replaced.

VALVES

Check valves before servicing. Replace valves as necessary. See VALVES & VALVE SPRINGS table under ENGINE SPECIFICATIONS at end of article. Valves may be machined to specification.

VALVE SEAT CORRECTION ANGLES

If seat is too wide after grinding, use a 20-degree stone to lower or a 70-degree stone to raise seat.

PISTON & ROD ASSEMBLY

1. Mark rod and rod cap with matching cylinder number. Before disassembling, mark piston to rod for reassembly reference. Notch or dot on piston top should face front of engine. Piston pin is a press fit.
2. When measuring, pin bore and piston pin must be free of varnish and scuffing. If piston-to-pin clearance exceeds .001" (.03 mm), replace piston and pin as an assembly.

FITTING PISTONS

Ensure notch or dot on piston top faces front of engine. Check pistons for wear and damage. Replace pistons as necessary. Check piston-to-cylinder bore clearance. If one cylinder must be bored, all cylinders must be bored to same oversize.

PISTON RINGS

Rings are marked and must be installed properly. Marked side of ring must face toward top of piston. Top compression ring is chrome or molybdenum faced. Second compression ring has a tapered face. Oil ring is a 3-piece type. Ensure end gaps are positioned properly on piston. See **Fig. 6** .

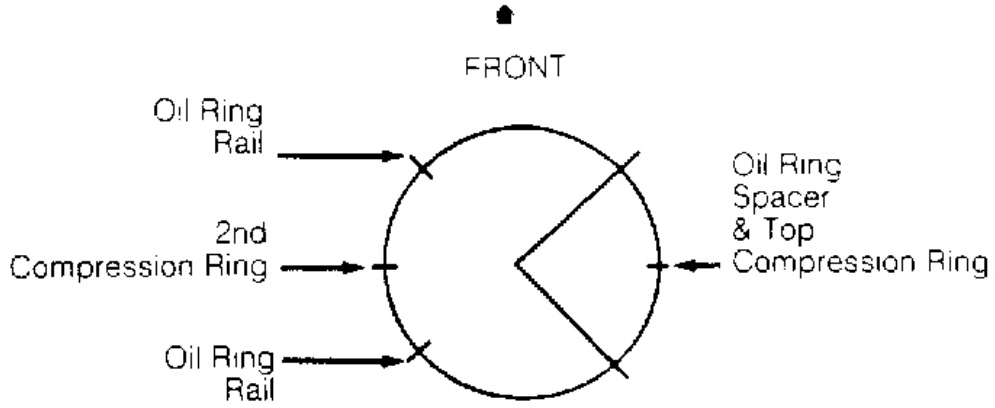


Fig. 6: Positioning Piston Ring End Gaps
Courtesy of GENERAL MOTORS CORP.

ROD BEARINGS

Ensure bearing cap bolt holes and mating surfaces are clean and dry. Use connecting rod stud protectors on all rod cap bolts. Install inserts in connecting rod and cap. Lubricate bearings and crank pin. Install bearing cap. Tighten rod bearing cap bolts.

CRANKSHAFT & MAIN BEARINGS

1. If bearing clearance is greater than specification, replace with undersized upper and lower bearings. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table under ENGINE SPECIFICATIONS at end of article. Recheck bearing clearance using Plastigage.
2. Tighten main bearing caps, except rear main cap, to specification. Tighten rear main cap to specification. Tap crankshaft rearward and then forward using lead hammer. This will align rear main bearing with crankshaft and thrust surfaces. Retighten all main bearing caps to specification. See TORQUE SPECIFICATIONS table at end of article.

THRUST BEARING

Check crankshaft end play by forcing crankshaft to extreme front position. Measure end play at front end of rear main bearing using a feeler gauge. If end play is not within specification, replace thrust bearing. See CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS table under ENGINE SPECIFICATIONS at end of article.

CYLINDER BLOCK

Check cylinder bore for wear, taper, out-of-round and piston fit. See CYLINDER BLOCK table under ENGINE SPECIFICATIONS at end of article. Cylinders with less than .005" (.13 mm) wear or taper may be honed.

Cylinders with greater than .005" (.13 mm) wear or taper must be bored to smallest oversize piston which will permit complete resurfacing of all cylinders. Machine or replace cylinder as necessary.

LUBRICATION

ENGINE OILING SYSTEM

A gear-type oil pump provides full pressure lubrication through full-flow oil filter. Oil pump is bolted to bottom of cylinder block, inside oil pan. Intermediate (drive) shaft is splined into distributor and oil pump. Distributor is camshaft-driven.

CRANKCASE CAPACITY

Crankcase capacity is 4 qts. (3.8L) without oil filter and 5 qts. (4.7L) with oil filter.

OIL PRESSURE

With engine at normal operating temperature, oil pressure should be at least 6 psi (0.4 kg/cm^2) at 1000 RPM, 18 psi (1.3 kg/cm^2) at 2000 RPM and 24 psi (1.7 kg/cm^2) at 4000 RPM.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Camshaft Gear Bolt	21 (28)
Clutch Pressure Plate Bolt	30 (41)
Connecting Rod Cap Nut	44 (60)
Crankshaft Pulley Bolt	43 (58)
Cylinder Head Bolt (1)	
Step 1	22 (30)
Step 2	45 (61)
Step 3	68 (92)
Exhaust Manifold Bolt	
Center Bolt/Stud	26 (35)
Outer Bolt/Stud	20 (27)
Flexplate/Flywheel-To-Crankshaft Bolt	(2) 74 (100)
Harmonic Balancer (Damper) Bolt	70 (95)
Intake Manifold (3)	35 (47)
Main Bearing Cap Bolt	76 (103)
Oil Pump Bolt	75 (102)
Torque Converter-To-Flexplate Bolt	46 (62)
Water Pump Pulley Bolt	22 (30)
Water Pump-To-Block Bolt	30 (41)

	INCH Lbs. (N.m)
Front Timing Cover Bolt	97 (11)
Oil Pan Bolt & Nut	97 (11)
Valve Cover Bolt	97 (11)

(1) Coat threads with Sealing Compound (1052080). Tighten in 3 steps, evenly and in sequence. See **Fig. 2** .

(2) Tighten flywheel bolts evenly using crisscross sequence.

(3) Tighten intake manifold-to-cylinder head bolts evenly and in sequence. See **Fig. 1** .

ENGINE SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

Application	Specification
Displacement	305 Cu. In. (5.0L)
Bore	3.74" (95.0 mm)
Stroke	3.48" (88.4 mm)
Compression Ratio	9.1:1
Fuel System	TBI
Horsepower @ RPM	170 @ 4000
Torque Ft. Lbs. @ RPM	255 @ 2400

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS SPECIFICATIONS

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS SPECIFICATIONS

Application	In. (mm)
Crankshaft	
End Play	.001-.007 (.03-.17)
Runout (Maximum)	.001 (.03)
Main Bearings	
Journal Diameter	
Journal No. 1	2.4488-2.4493 (62.199-62.212)
Journals No. 2, 3 & 4	2.4481-2.4490 (62.182-62.205)
Journal No. 5	2.4481-2.4488 (62.182-62.199)
Journal Out-Of-Round (Maximum)	.001 (.03)
Journal Taper (Maximum)	.0002 (.005)
Oil Clearance	

Journal No. 1	.0010-.0015 (.025-.038)
Journals No. 2, 3 & 4	.0010-.0025 (.025-.064)
Journal No. 5	.0025-.0035 (.064-.089)
Connecting Rod Bearings	
Journal Diameter	2.0893-2.0998 (53.068-53.334)
Journal Out-Of-Round (Maximum)	.001 (.03)
Journal Taper (Maximum)	.001 (.03)
Oil Clearance	.0013-.0035 (.033-.089)

CONNECTING RODS SPECIFICATIONS

CONNECTING RODS SPECIFICATIONS

Application	**In. (mm)**
Maximum Bend	(1)
Maximum Twist	(1)
Side Play	.006-.014 (.15-.36)
(1) Replace rod if any bend or twist exists.	

PISTONS, PINS & RINGS SPECIFICATIONS

PISTONS, PINS & RINGS SPECIFICATIONS

Application	**In. (mm)**
Piston	
Clearance	.0007-.0021 (.018-.053)
Pins	
Diameter	.9270-.9271 (23.546-23.548)
Piston Fit	.0003-.0010 (.076-.025)
Rod Fit	.0008-.0016 (.020-.041)
Rings	
No. 1	
End Gap	.010-.020 (.25-.51)
Side Clearance	.0012-.0032 (.030-.081)

No. 2	
End Gap	.018-.026 (.46-.66)
Side Clearance	.0012-.0032 (.030-.081)
No. 3 (Oil)	
End Gap	.015-.055 (.38-1.40)
Side Clearance	.002-.007 (.05-.20)

CYLINDER BLOCK SPECIFICATIONS

CYLINDER BLOCK SPECIFICATIONS

Application	In. (mm)
Cylinder Bore	
Diameter	3.735-3.739 (94.87-94.96)
Maximum Taper	.001 (.03)
Maximum Out-Of-Round	.002 (.05)

VALVES & VALVE SPRINGS SPECIFICATIONS

VALVES & VALVE SPRINGS SPECIFICATIONS

Application	Specification
Valves	
Face Angle	45°
Minimum Margin	.031" (.80 mm)
Valve Springs	
Installed Height	1.70" (43.2 mm)
Pressure (1)	
Valve Closed	76-84 @ 1.70 (34-37 @ 43.0)
Valve Open	194-206 @ 1.25 (86-92 @ 32.0)
(1) Lbs. @ In. (Kg @ mm).	

CYLINDER HEAD SPECIFICATIONS

CYLINDER HEAD SPECIFICATIONS

Application	Specification
Valve Seats	
Intake Valve	
Seat Angle	46°
Seat Width	.035-.060" (.88-1.52

	mm)
Exhaust Valve	
Seat Angle	46°
Seat Width	.060-.094" (1.52-2.38 mm)
Valve Stem-To-Guide Oil Clearance	.0011-.0027" (.028-.069 mm)

CAMSHAFT SPECIFICATIONS

CAMSHAFT SPECIFICATIONS

Application	**In. (mm)**
End Play	.004-.012 (.10-.30)
Journal Diameter	1.868-1.869 (47.45-47.48)
Lobe Lift	
Exhaust	.257 (6.53)
Intake	.234 (5.94)

ENGINES

5.7L V8 - VIN 7

ENGINE IDENTIFICATION

NOTE: For engine repair procedures not covered in this article, see ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION article in the GENERAL INFORMATION section.

Engine may be identified using Vehicle Identification Number (VIN) stamped on a metal pad, located near lower left corner of windshield. The eighth character identifies the engine model. See ENGINE IDENTIFICATION CODES table.

Engine identification code, located on cylinder block below cylinder head, may be required when ordering replacement parts. See ENGINE IDENTIFICATION CODES table.

ENGINE IDENTIFICATION CODES

Application	Engine Code	VIN Code
5.7L (350") V8 TBI	LO5	7

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

NOTE: Normally, valve adjustment is not required. If valve train components are disassembled or replaced, use adjustment procedure.

1. Bring No. 1 cylinder to firing position and align timing marks on front cover and harmonic balancer. Adjust exhaust valves on cylinders No. 1, 3, 4 and 8 by backing off adjusting nut until valve lash is felt at push rod.
2. Tighten adjusting nut (while rotating push rod) until valve lash is eliminated. Tighten adjusting nut an additional 3/4 - 1 1/4 turns. Repeat adjustment on intake valves for cylinders No. 1, 2, 5, and 7.
3. Turn engine one revolution to firing position for cylinder No. 6. Adjust exhaust valves on cylinders No. 2, 5, 6 and 7. Adjust intake valves on cylinders No. 3, 4, 6 and 8.

TROUBLE SHOOTING

To trouble shoot mechanical engine components, see appropriate table in TROUBLE SHOOTING article in GENERAL INFORMATION.

REMOVAL & INSTALLATION

GENERAL PRECAUTION

WARNING: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

NOTE: For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks on engine hood and other major assemblies before removal.

FUEL PRESSURE RELEASE

A constant bleed unit relieves fuel pressure when ignition is turned off. To release fuel tank pressure, remove gas cap.

COOLING SYSTEM BLEEDING

With engine off, fill radiator until level is even with base of filler neck. Fill coolant recovery reservoir to COLD FILL mark. Install coolant recovery reservoir cap. Run engine until radiator inlet hose is hot. With engine at idle, add coolant to radiator until level is even with base of filler neck. Install cap.

ENGINE ASSEMBLY

Removal

1. Release fuel pressure. See **FUEL PRESSURE RELEASE** . Disconnect negative battery cable. Remove hood and air cleaner. Drain coolant from radiator. Disconnect radiator hoses, and remove upper fan shroud. Remove fan assembly. Disconnect heater hoses at engine.
2. Remove serpentine belt. Remove power steering pump, and set it aside. Remove A/C compressor, and set it aside. Disconnect accelerator and throttle valve cable. Disconnect cooler lines (if equipped) at radiator. Remove radiator.
3. Disconnect vacuum hoses. Disconnect engine wiring harness (including ground strap) at engine bulkhead. Remove windshield wiper motor. Disconnect ECM wiring harness.
4. Disconnect Air Injection Reactor (AIR) hose at pipe from converter. Remove MAP sensor (if equipped).
5. Remove distributor cap and distributor. Disconnect cruise control cable. Disconnect positive battery cable at starter. Disconnect negative battery cable at engine block. Raise and support vehicle.
6. Remove crossover pipe and catalytic converter as an assembly. Remove flexplate cover. Remove torque converter-to-flywheel bolts. Remove motor mount bolts. Disconnect fuel hose from front fuel pipes. Disconnect torque converter clutch wiring at transmission.
7. Disconnect transmission cooler lines at clip on engine oil pan. Remove transmission-to-engine bolts. Remove ground wires from rear of cylinder head. Lower vehicle. Support transmission. Install lifting device, and remove engine.

Installation

To install, reverse removal procedure. Tighten fasteners to specification. See **TORQUE SPECIFICATIONS** .

Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING** .

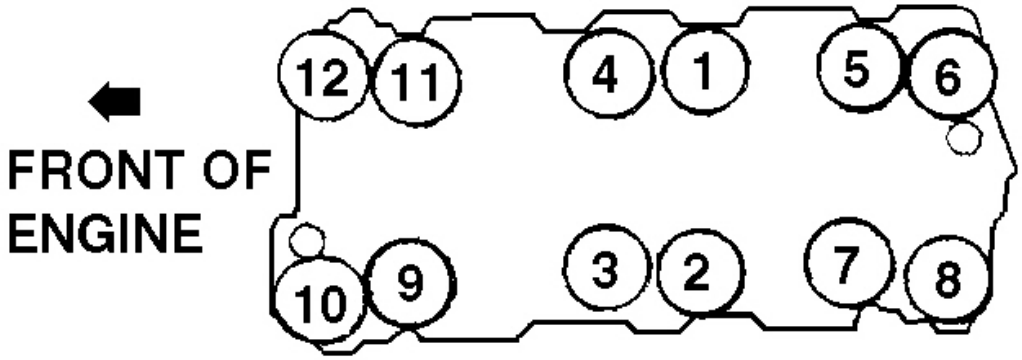
INTAKE MANIFOLD

Removal

1. Disconnect negative battery cable, and drain cooling system. Remove air cleaner and throttle body assembly. Disconnect ECM wiring harness, and set it aside. Remove upper radiator hose at thermostat and heater hose at intake manifold.
2. Remove thermostat housing and gasket. Mark and remove necessary electrical connectors and vacuum hoses. Mark and remove necessary fuel line clips and lines. Remove throttle cable bracket. Mark and remove spark plug wires at distributor cap. Remove EGR valve and solenoid. Remove distributor cap.
3. Mark distributor rotor position for installation reference. Remove distributor. Remove ignition coil and coolant temperature sensor. Remove A/C compressor brace. Remove intake manifold bolts and studs. Remove intake manifold and gasket.

Installation

Clean all gasket surfaces. Apply 3/16" bead of RTV Sealer (1052289) on front and rear of cylinder block and 1/2" onto each cylinder head. See **Fig. 1** . Install NEW gaskets and intake manifold. Tighten bolts and studs to specification in sequence. See **Fig. 1** . See **TORQUE SPECIFICATIONS** . To complete installation, reverse removal procedure.



5.0L & 5.7L

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Fig. 1: Exploded View of Intake Manifold & Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

EXHAUST MANIFOLD

Removal (Left)

1. Disconnect negative battery cable. Raise and support vehicle.
2. Disconnect oxygen sensor electrical connector. Remove exhaust crossover pipe at exhaust manifold. Lower vehicle. Remove air cleaner. Remove spark plug wires and clips. Remove AIR pipe and check valve as an assembly.
3. Remove the exhaust manifold studs, heat shields, exhaust manifold and gasket.

Removal (Right)

1. Disconnect negative battery cable. Raise and support vehicle.
2. Remove exhaust crossover pipe at exhaust manifold. Lower vehicle. Remove air cleaner.
3. Remove Air Injection Reactor (AIR) hoses. Mark and disconnect spark plug wires at spark plugs. Remove necessary accessory brackets. Remove exhaust manifold bolts. Remove exhaust manifold and gaskets.

Installation

To install, reverse removal procedure. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS** .

CYLINDER HEAD

NOTE: Check and record compression before removing cylinder head. Remove cylinder head when engine is cold.

Removal

1. Disconnect negative battery cable. Remove intake manifold, exhaust manifold and valve covers. See **INTAKE MANIFOLD** , **EXHAUST MANIFOLD** and **VALVE COVERS** .
2. Remove serpentine belt. Drain cooling system. Ensure components are kept in order for installation reference. Remove cylinder head bolts in 3 steps in reverse order of tightening sequence. See **Fig. 2** . Remove cylinder head and gasket.

Inspection

Clean all carbon and gasket material from mating surfaces. Check cylinder head for warpage and cracks. Clean and tap cylinder head bolt holes and threads.

Installation

1. Coat steel-type head gaskets with sealer. DO NOT coat composition-type head gaskets with sealer. Install head gasket on cylinder block. Install cylinder head. Coat head bolts with Sealing Compound (1052080).
2. Install head bolts finger tight. Tighten bolts to specification in 3 steps in proper sequence. See **Fig. 2** . See **TORQUE SPECIFICATIONS** . To complete installation, reverse removal procedure.

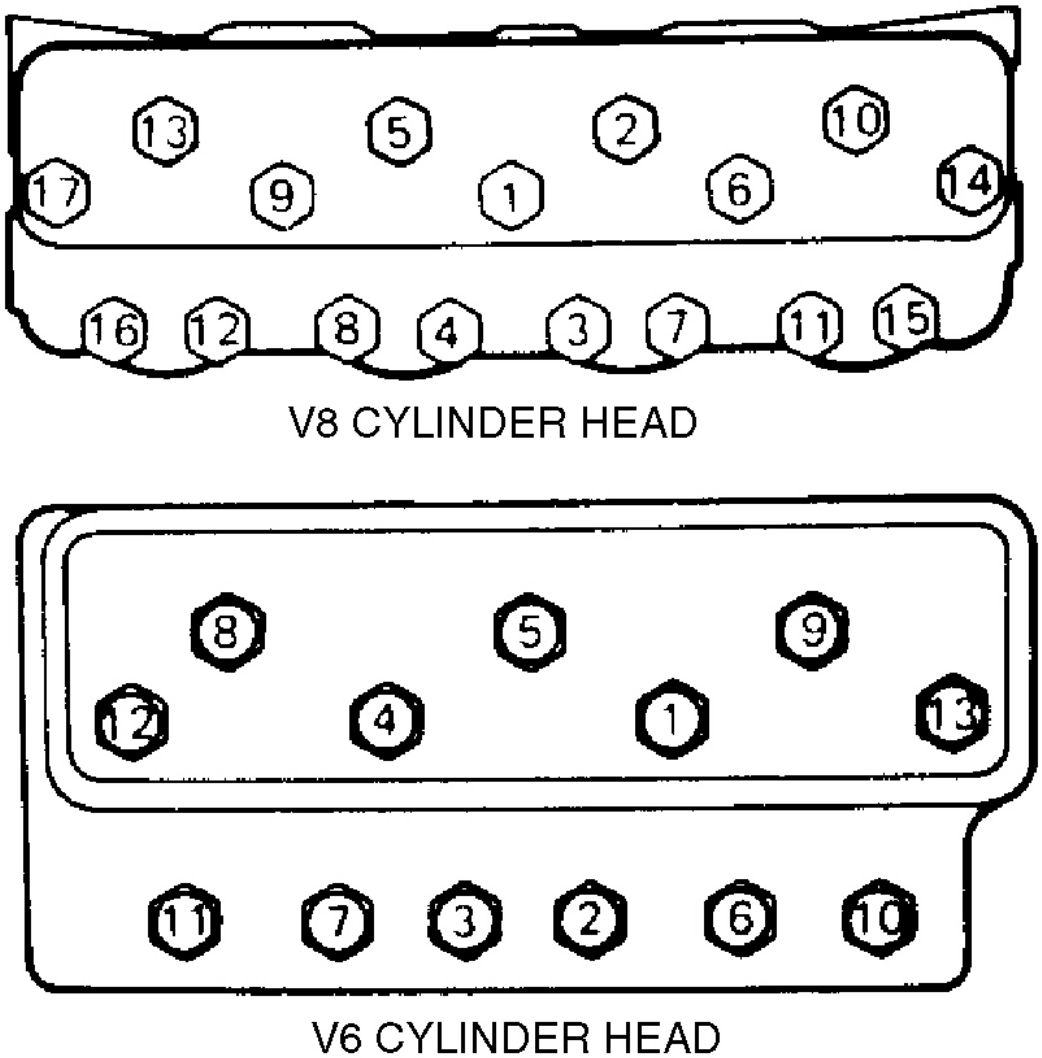


Fig. 2: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

FRONT COVER & OIL SEAL

NOTE: Removing timing cover is not necessary to replace timing cover seal.

Removal

1. Disconnect negative battery cable and serpentine drive belt. Remove crankshaft pulley bolts, and remove pulley. Remove harmonic balancer-to-crankshaft bolt. Remove harmonic balancer using Harmonic Balancer Remover/Installer (J-23523-E).
2. Remove water pump. See **WATER PUMP** . Loosen or remove oil pan as necessary. See **OIL PAN** .
3. Remove front cover-to-engine bolts. Remove cover and gasket. Carefully pry seal from timing cover using a large screwdriver.

Installation

1. Install new oil seal in timing cover. Coat timing cover gasket with sealant, and position it on timing cover. Install timing cover and bolts. Tighten bolts finger tight.
2. Tighten bolts alternately and evenly to specification. See **TORQUE SPECIFICATIONS** . Apply sealant to area where oil pan, cylinder block and timing cover join. To complete installation, reverse removal procedure.

TIMING CHAIN

Removal

1. Disconnect negative battery cable. Remove front timing cover. See **FRONT COVER & OIL SEAL** . Rotate crankshaft until camshaft gear and crankshaft gear timing marks line up with shaft centers. See **Fig. 4** .
2. Remove 3 camshaft gear retaining bolts. Remove camshaft gear and chain as an assembly. See **Fig. 3** . If replacing crankshaft gear, use Gear Remover (J-5825-A) to pull gear off crankshaft.

Installation

Drive crankshaft gear on crankshaft, with timing mark facing out. Ensure timing marks on crankshaft sprocket and camshaft sprocket are as close together as possible and lined up with shaft centers. See **Fig. 4** . Install camshaft gear and chain as an assembly. Tighten fasteners to specification. See **TORQUE SPECIFICATIONS** . To complete installation, reverse removal procedure.

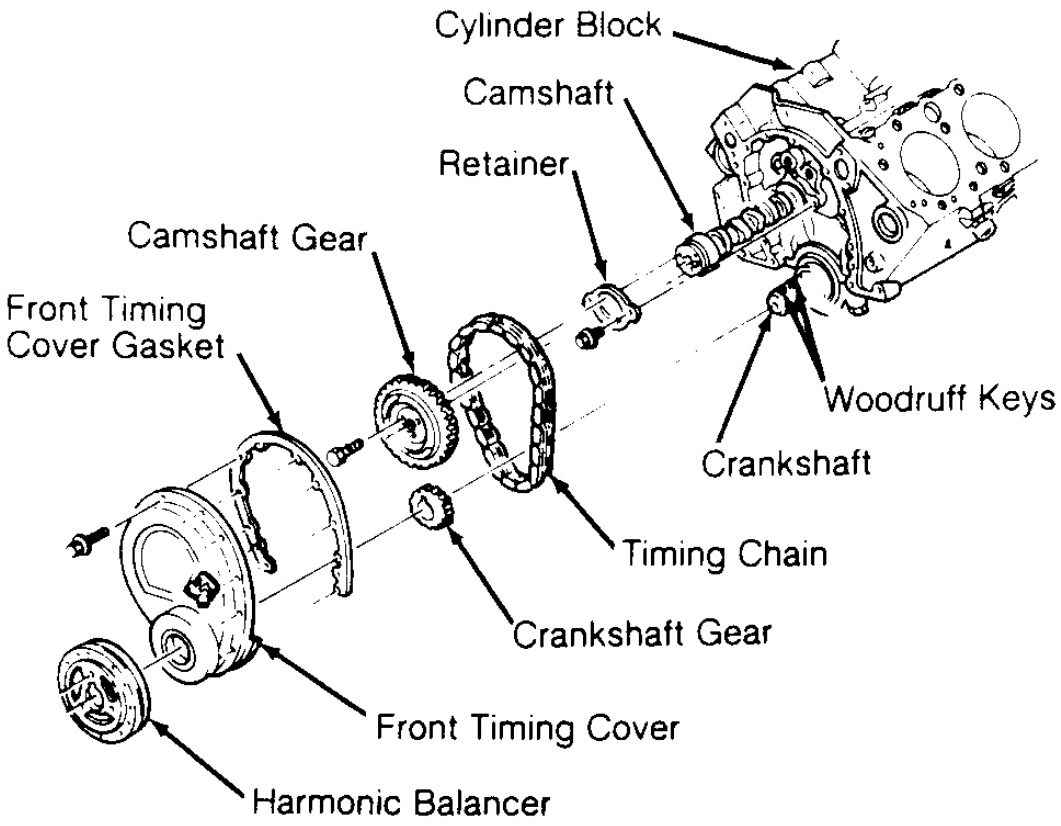


Fig. 3: Exploded View of Engine Front
Courtesy of GENERAL MOTORS CORP.

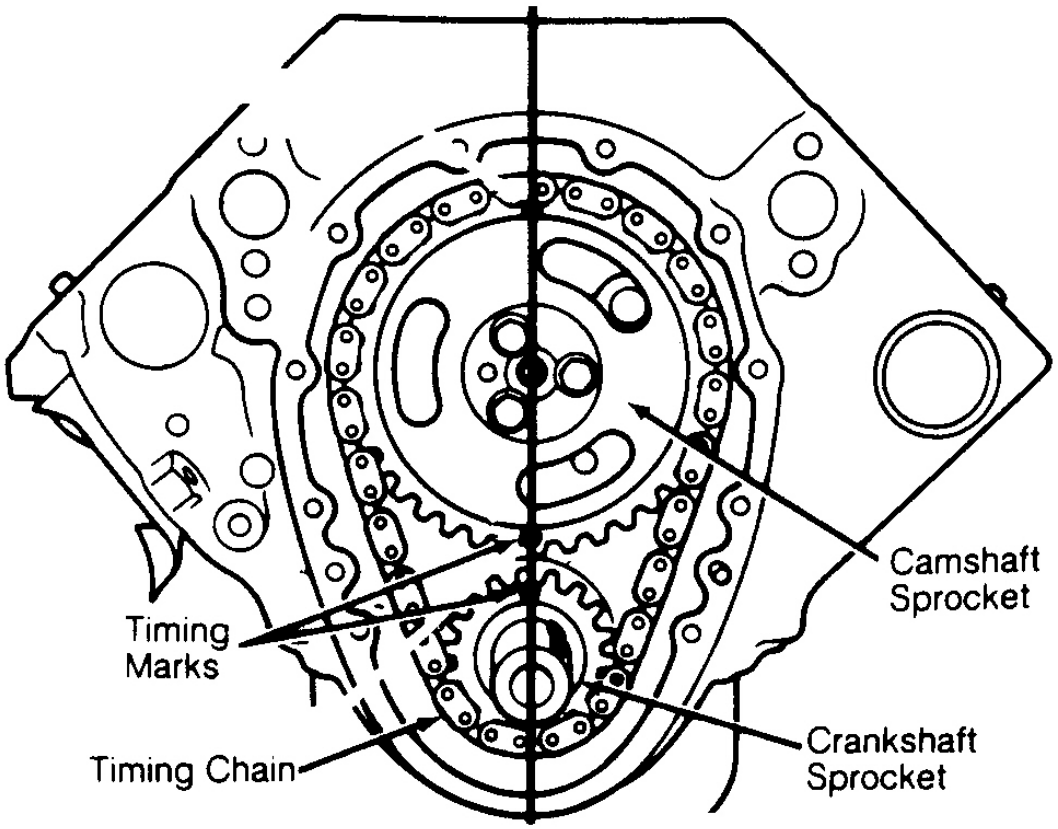


Fig. 4: Aligning Timing Marks
Courtesy of GENERAL MOTORS CORP.

VALVE COVERS

Removal (Left)

1. Disconnect negative battery cable.
2. Remove air cleaner, power brake pipe, PCV valve and hose at valve cover. Remove fuel lines and brackets. Remove valve cover bolts, washers, valve cover and gasket.

Removal (Right)

1. Disconnect negative battery cable.
2. Remove air cleaner. Disconnect ECM harness connectors, and position aside. Remove AIR diverter valve and hoses. Remove spark plug wires at distributor. Remove EGR solenoid bracket.
3. Disconnect PCV hose and connector. Remove valve cover bolts, washers, valve cover and gasket.

Installation

To install, reverse removal procedure. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS** .

ROCKER ARMS & PUSH RODS

Removal & Installation

1. Remove valve covers. See **VALVE COVERS** . Keep components in order for installation in original location and position.
2. Remove rocker arm nuts, balls, rocker arms and push rods. To install, reverse removal procedure. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS** . Apply Prelube (1052365) to rocker arm and ball mating surface. Adjust valves as necessary. See **VALVE CLEARANCE ADJUSTMENT** under ADJUSTMENTS.

ROCKER ARM STUD

Removal & Installation

1. Remove rocker arm studs using Stud Remover (J-5802-01). Ream stud bore to replacement size of oversize stud. Oversize studs are available in .003" (.08 mm) and .013" (.33 mm).
2. Coat press-fit area of stud with hypoid axle lubricant. Install rocker arm stud using Stud Installer (J-6880) until it bottoms out on cylinder head. To complete installation, reverse removal procedure.

CAMSHAFT

NOTE: Rotate crankshaft in direction of normal operation only. Keep components in order for installation reference.

Removal

1. Remove valve covers. See **VALVE COVERS** . Remove rocker arms but DO NOT remove push rods at this time. See **ROCKER ARMS & PUSH RODS** . Measure lobe lift of camshaft with push rods installed.
2. To measure lobe lift, attach dial indicator to cylinder head. Position indicator pointer on tip of a push rod. Rotate crankshaft until push rod is at lowest point. Zero indicator, and rotate crankshaft until push rod is at highest point. Record reading, and repeat procedure for remaining lobes.
3. After lobe lift is measured, remove push rods. See **ROCKER ARMS & PUSH RODS** . Remove intake manifold. See **INTAKE MANIFOLD** . Remove timing gears and chain. See **TIMING CHAIN** .
4. Remove upper radiator fan shroud. Remove radiator and hoses.
5. Using approved refrigerant recovery/recycling equipment, discharge A/C system and remove condenser (if equipped). Remove grille assembly. Remove valve lifters and camshaft retaining plate. Using three 5/16" x 18" x 4" bolts, pull camshaft from engine.
6. Carefully remove camshaft without damaging camshaft bearings. Remove rear camshaft plug. Remove bearings using standard bearing remover.

Inspection

Check camshaft for scratches, pits and loose fitting in bearings. Check camshaft journal diameter and lobe lift. See **CAMSHAFT** under ENGINE SPECIFICATIONS. Replace camshaft if damaged or not to specification.

Installation

1. Install front and rear bearings. Position camshaft bearing No. 1 oil holes at 1 o'clock and 5 o'clock positions.
2. Position oil holes of bearings No. 2-4 at 5 o'clock position toward left side of engine and even with bottom of cylinder bore. Position oil hole of bearing No. 5 at 12 o'clock position.
3. Install rear camshaft plug flush to .031" (.79 mm) deep in block. Use Sealant (1052080) on camshaft plug. If replacing camshaft, replace lifters, engine oil and filter.
4. Apply Camshaft Prelube (1052365) to camshaft lobes. Apply engine oil to bearings and camshaft bearing journals. To complete installation, reverse removal procedure.

REAR CRANKSHAFT OIL SEAL

Removal

Remove transmission. See **REMOVAL & INSTALLATION - A/T** article in AUTOMATIC TRANSMISSIONS. Remove flexplate. Pry out seal using screwdriver and notches in seal retainer. See **Fig. 5** .

Installation

1. Coat entire seal with engine oil. Install seal using Seal Installer (J-35621) until installer bottoms. See **Fig. 5** . Align crankshaft dowel to proper flexplate hole (if equipped).
2. Install flexplate-to-crankshaft bolts, and tighten bolts to specification. See **TORQUE SPECIFICATIONS** . To complete installation, reverse removal procedure.

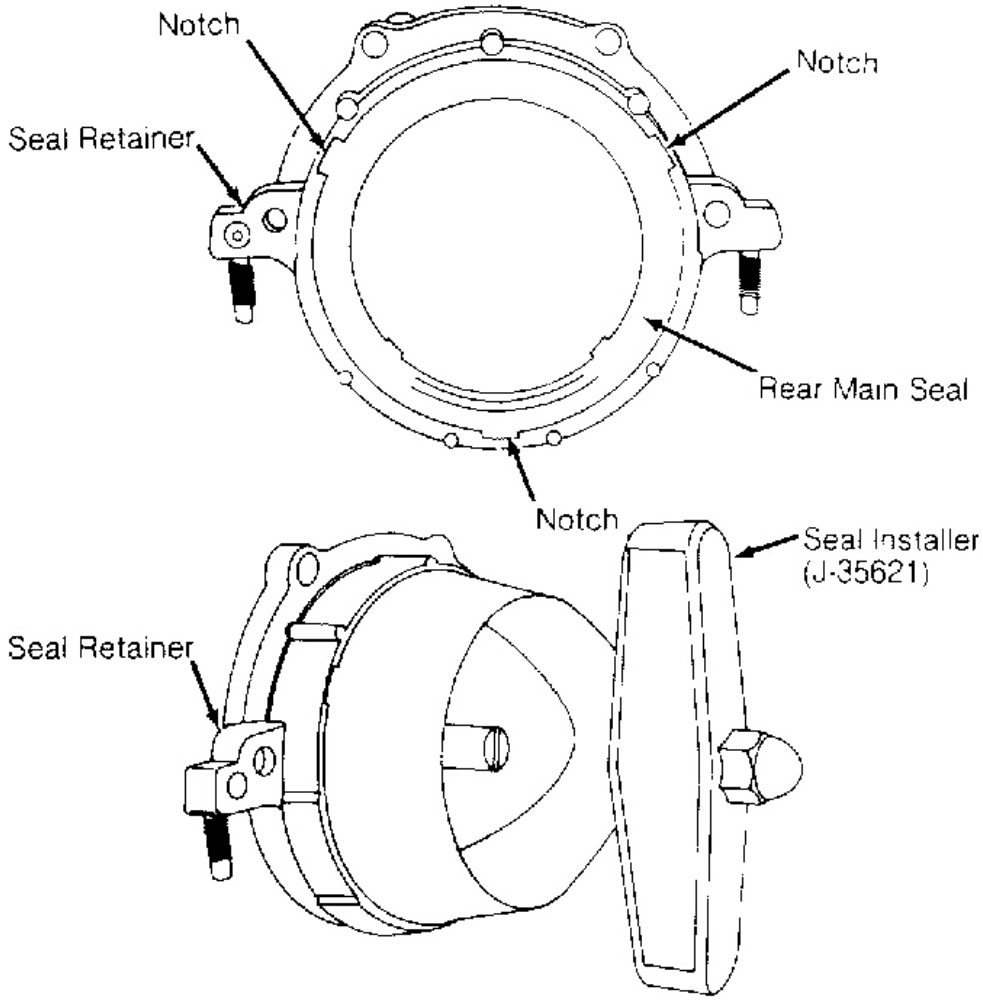


Fig. 5: Removing & Installing Rear Seal
Courtesy of GENERAL MOTORS CORP.

WATER PUMP

Removal

1. Disconnect negative battery cable, and drain cooling system. Remove air cleaner and intake duct assembly.
2. Remove accessory drive belt(s), fan, pulley and accessories as necessary. Remove coolant hoses from water pump. Remove water pump bolts, water pump and gasket.

Installation

To install, reverse removal procedure. Tighten fasteners to specification. See **TORQUE SPECIFICATIONS** . Fill and bleed cooling system. See **COOLING SYSTEM BLEEDING** .

NOTE: For more cooling system information, see appropriate article in ENGINE COOLING.

OIL PAN

Removal

1. Disconnect negative battery cable. Remove air cleaner and fan shroud. Remove spark plug wires and distributor cap.
2. Raise and support vehicle. Drain crankcase oil. Disconnect oil level sensor electrical connector, and remove sensor (if equipped).
3. Disconnect exhaust pipe at manifold, Air Injection Reactor (AIR) pipe clamp and catalytic converter hanger bolts. Remove exhaust crossover pipe at manifold and converter (if equipped).
4. Remove starter and flexplate access cover. Disconnect transmission line bracket at oil pan. Remove engine mount through bolts. Remove oil pan bolts. Lower pan.
5. Position front crankshaft throw and/or counterweight on horizontal plane so it does not hinder oil pan removal. Turn crankshaft to 6 o'clock position on timing mark. Raise engine, reinstall through bolts and remove oil pan.

Installation

To install, reverse removal procedure. Apply Sealant (1052914) to front cover, cylinder block, rear seal retainer and cylinder block junction. Install NEW oil pan gasket. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS** .

OIL PUMP

Removal & Disassembly

1. Remove oil pan. See **OIL PAN** . Remove oil pump retaining bolts, and remove pick-up screen. Remove oil pump and intermediate shaft.
2. Remove oil pump cover screws, and remove cover. Mark gear teeth for reassembly reference. Remove idler gear, drive gear and shaft. Remove pressure regulator pin, spring and valve from cover. Remove pick-up screen and pipe from cover only if replacing.

Inspection

Check oil pump body and gears for cracks, wear and damage. Check oil pump shaft for looseness in housing. Check inside of cover for wear which would permit oil leakage. Replace oil pump assembly as necessary. Oil pump specifications are not available from manufacturer.

Installation

To install, reverse removal procedure. Apply Sealant (1052914) to front cover, cylinder block, rear seal retainer and cylinder block junction. Install new oil pan gasket. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS** .

OVERHAUL

GENERAL NOTE

NOTE: Mark components to ensure installation in original location and position.

VALVE GUIDES

Check and service guides before servicing valve and seat. Guide replacement information is not available from manufacturer. Valve guides may be reamed to .003" (.08 mm), .015" (.38 mm) or .030" (.76 mm) oversize for installation of oversize valve.

VALVE SEAT

Valve seat replacement information is not available from manufacturer. Follow instructions of tool manufacturer for servicing valve seats. If seats are serviced, valves must be serviced or replaced.

VALVES

Check valves before servicing. Replace valves as necessary. See **VALVES & VALVE SPRINGS** under ENGINE SPECIFICATIONS. Valves may be machined to specification.

VALVE SEAT CORRECTION ANGLES

If seat is too wide after grinding, use a 20-degree stone to lower or a 70-degree stone to raise seat.

PISTON & ROD ASSEMBLY

1. Mark rod and rod cap with matching cylinder number. Before disassembling, mark piston to rod for reassembly reference. Notch or dot on piston top should face front of engine. Piston pin is a press fit.
2. When measuring, pin bore and piston pin must be free of varnish and scuffing. If piston-to-pin clearance exceeds .001" (.03 mm), replace piston and pin as an assembly.

FITTING PISTONS

Ensure notch or dot on piston top faces front of engine. Check pistons for wear and damage. Replace pistons as necessary. Check piston-to-cylinder bore clearance. If one cylinder must be bored, all cylinders must be bored to same oversize.

PISTON RINGS

Rings are marked and must be installed properly. Marked side of ring must face toward top of piston. Top

compression ring is chrome or molybdenum faced. Second compression ring has a tapered face. Oil ring is a 3-piece type. Ensure end gaps are positioned properly on piston. See **Fig. 6** .

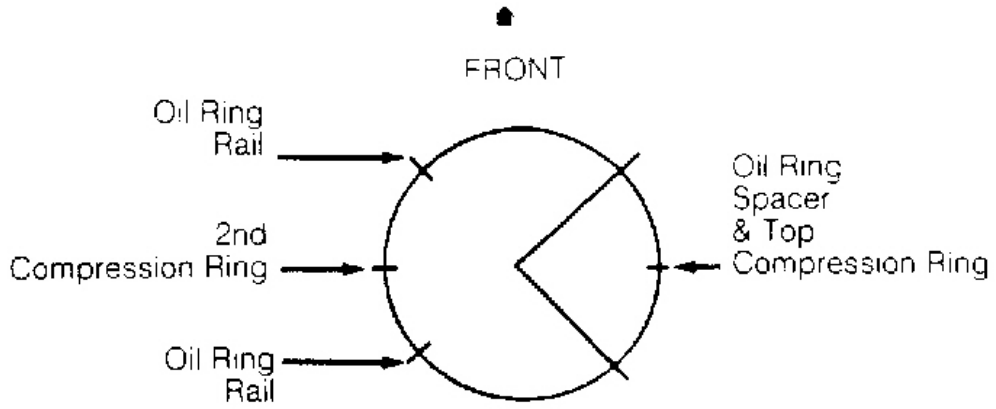


Fig. 6: Positioning Piston Ring End Gaps
Courtesy of GENERAL MOTORS CORP.

ROD BEARINGS

Ensure bearing cap bolt holes and mating surfaces are clean and dry. Use connecting rod stud protectors on all rod cap bolts. Install inserts in connecting rod and cap. Lubricate bearings and crank pin. Install bearing cap. Tighten rod bearing cap bolts.

CRANKSHAFT & MAIN BEARINGS

1. If bearing clearance is greater than specification, replace with undersized upper and lower bearings. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** under ENGINE SPECIFICATIONS. Recheck bearing clearance using Plastigage.
2. Tighten main bearing caps, except rear main cap, to specification. Tighten rear main cap to specification. Tap crankshaft rearward and then forward using lead hammer. This will align rear main bearing with crankshaft and thrust surfaces. Retighten all main bearing caps to specification. See **TORQUE SPECIFICATIONS** .

THRUST BEARING

Check crankshaft end play by forcing crankshaft to extreme front position. Measure end play at front end of rear main bearing using a feeler gauge. If end play is not within specification, replace thrust bearing. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** under ENGINE SPECIFICATIONS.

CYLINDER BLOCK

Check cylinder bore for wear, taper, out-of-round and piston fit. See **CYLINDER BLOCK** under ENGINE SPECIFICATIONS. Cylinders with less than .005" (.13 mm) wear or taper may be honed. Cylinders with greater than .005" (.13 mm) wear or taper must be bored to smallest oversize piston which will permit complete resurfacing of all cylinders. Machine or replace cylinder as necessary.

LUBRICATION

ENGINE OILING SYSTEM

A gear-type oil pump provides full pressure lubrication through full-flow oil filter. Oil pump is bolted to bottom of cylinder block, inside oil pan. Intermediate (drive) shaft is splined into distributor and oil pump. Distributor is camshaft-driven.

CRANKCASE CAPACITY

Crankcase capacity is 4 qts. (3.8L) without oil filter and 5 qts. (4.7L) with oil filter.

OIL PRESSURE

With engine at normal operating temperature, oil pressure should be at least 6 psi (0.4 kg/cm^2) at 1000 RPM, 18 psi (1.3 kg/cm^2) at 2000 RPM and 24 psi (1.7 kg/cm^2) at 4000 RPM.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Camshaft Gear Bolt	21 (28)
Clutch Pressure Plate Bolt	30 (41)
Connecting Rod Cap Nut	44 (60)
Crankshaft Pulley Bolt	43 (58)
Cylinder Head Bolt (1)	
Step 1	22 (30)
Step 2	45 (61)
Step 3	68 (92)
Exhaust Manifold Bolt	
Center Bolt/Stud	26 (35)
Outer Bolt/Stud	20 (27)
Flexplate/Flywheel-To-Crankshaft Bolt	(2) 74 (100)
Harmonic Balancer (Damper) Bolt	70 (95)
Intake Manifold (3)	35 (47)
Main Bearing Cap Bolt	76 (103)
Oil Pump Bolt	75 (102)
Torque Converter-To-Flexplate Bolt	46 (62)

Water Pump Pulley Bolt	22 (30)
Water Pump-To-Block Bolt	30 (41)
	INCH Lbs. (N.m)
Front Timing Cover Bolt	97 (11)
Oil Pan Bolt & Nut	97 (11)
Valve Cover Bolt	97 (11)

(1) Coat threads with Sealing Compound (1052080). Tighten in 3 steps, evenly and in sequence. See **Fig. 2** .

(2) Tighten flywheel bolts evenly using crisscross sequence.

(3) Tighten intake manifold-to-cylinder head bolts evenly and in sequence. See **Fig. 1** .

ENGINE SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS

Application	Specification
Displacement	350 Cu. In. (5.7L)
Fuel System	TBI
Bore	4.00" (101.6 mm)
Stroke	3.48" (88.4 mm)
Compression Ratio	9.75:1
Horsepower @ RPM	185 @ 3800
Torque Ft. Lbs. @ RPM	290 @ 2400

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS SPECS

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS SPECS

Application	In. (mm)
Crankshaft	
End Play	.001-.007 (.03-.17)
Runout (Maximum)	.001 (.03)
Main Bearings	
Journal Diameter	
No. 1	2.4488-2.4493 (62.199-62.212)
No. 2, 3 & 4	2.4481-2.4490 (62.182-62.205)
No. 5	2.4481-2.4488 (62.182-62.199)
Journal Out-Of-Round (Maximum)	.001 (.03)

Journal Taper (Maximum)	.0002 (.005)
Oil Clearance	
Journal No. 1	.0010-.0015 (.025-.038)
Journals No. 2, 3 & 4	.0010-.0025 (.025-.064)
Journal No. 5	.0025-.0035 (.064-.089)
Connecting Rod Bearings	
Journal Diameter	2.0893-2.0998 (53.068-53.334)
Journal Out-Of-Round (Maximum)	.001 (.03)
Journal Taper (Maximum)	.001 (.03)
Oil Clearance	.0013-.0035 (.033-.089)

CONNECTING RODS SPECIFICATIONS

CONNECTING RODS SPECIFICATIONS

Application	**In. (mm)**
Maximum Bend	(1)
Maximum Twist	(1)
Side Play	.006-.014 (.15-.36)
(1) Replace rod if any bend or twist exists.	

PISTONS, PINS & RINGS SPECIFICATIONS

PISTONS, PINS & RINGS SPECIFICATIONS

Application	**In. (mm)**
Piston Clearance	.0005-.0022 (.013-.056)
Pins	
Diameter	.9270-.9273 (23.546-23.553)
Piston Fit	.0003-.0010 (.076-.025)
Rod Fit	.0008-.0016 (.020-.041)
Rings	
No. 1	
End Gap	.010-.020 (.25-.51)
Side Clearance	.0012-.0032 (.030-.081)

No. 2	
End Gap	.018-.026 (.46-.66)
Side Clearance	.0012-.0032 (.030-.081)
No. 3 (Oil)	
End Gap	.015-.055 (.38-1.40)
Side Clearance	.002-.007 (.05-.20)

CYLINDER BLOCK SPECIFICATIONS

CYLINDER BLOCK SPECIFICATIONS

Application	In. (mm)
Cylinder Bore	
Diameter	4.001-4.002 (101.62-101.65)
Maximum Taper	.001 (.03)
Maximum Out-Of-Round	.002 (.05)

VALVES & VALVE SPRINGS SPECIFICATIONS

VALVES & VALVE SPRINGS SPECIFICATIONS

Application	Specification
Valves	
Face Angle	45°
Minimum Margin	.031" (.80 mm)
Valve Springs	
Installed Height	1.70" (43.2 mm)
Pressure (1)	
Valve Closed	76-84 @ 1.70 (34-37 @ 43.0)
Valve Open	194-206 @ 1.25 (86-92 @ 32.0)
(1) Lbs. @ In. (Kg @ mm).	

CYLINDER HEAD SPECIFICATIONS

CYLINDER HEAD SPECIFICATIONS

Application	Specification
Valve Seats	
Intake Valve	
Seat Angle	46°
Seat Width	.035-.060" (.88-1.52

	mm)
Exhaust Valve	
Seat Angle	46°
Seat Width	.060-.094" (1.52-2.38 mm)
Valve Stem-To-Guide Oil Clearance	.0011-.0027" (.028-.069 mm)

CAMSHAFT SPECIFICATIONS

CAMSHAFT SPECIFICATIONS

Application	**In. (mm)**
End Play	.004-.012 (.10-.30)
Journal Diameter	1.868-1.869 (47.45-47.48)
Lobe Lift	
Exhaust	.256 (6.50)
Intake	.233 (5.92)

ENGINE IDENTIFICATION

NOTE: For repair procedures not covered in this article, see ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION in the GENERAL INFORMATION section.

Engine can be identified by eighth character of Vehicle Identification Number (VIN) which is stamped on a metal pad, located near lower left corner of windshield. See **ENGINE IDENTIFICATION CODES** table. An "S" in tenth character of VIN indicates model year.

Engine can also be identified by a 3-character engine code (RPO code). See **ENGINE IDENTIFICATION CODES** table. This code may be stamped on engine, at flange where engine and transmission meet.

ENGINE IDENTIFICATION CODES

Engine	Code
5.7L PFI V8	
8th Character Of Dash VIN	P
Engine Code (RPO Code)	LT1

ADJUSTMENTS

VALVE CLEARANCE ADJUSTMENT

NOTE: Engine is equipped with hydraulic valve lifters. Adjustment is required only if valve train has been disassembled.

Remove rocker arm covers. Rotate crankshaft until cylinder No. 1 is at TDC of compression stroke. Begin by adjusting exhaust valve of cylinder No. 1. See **VALVE CLEARANCE ADJUSTMENT SEQUENCE** table. While trying to rotate push rod with thumb and forefinger, loosen nut on rocker stud until push rod just starts to rotate. This is considered zero lash. Tighten nut 3/4 - 1 1/4 turns (this centers the lifter plunger).

VALVE CLEARANCE ADJUSTMENT SEQUENCE

Condition	Valves	Cylinders No.
Cyl. No. 1 At TDC (1)	Exhaust	1, 3, 4 & 8
Intake		1, 2, 5 & 7
Cyl. No. 6 At TDC (1)	Exhaust	2, 5, 6 & 7
Intake		3, 4, 6 & 8
(1) TDC of compression stroke.		

REMOVAL & INSTALLATION

NOTES

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION before disconnecting battery.

NOTE: For reassembly reference, label all electrical connectors, vacuum hoses and fuel lines before removal. Also place mating marks onto engine hood and other major assemblies before removal.

DRAINING & REFILLING COOLING SYSTEM

The draining procedure is first, followed by the refilling/bleeding procedure. The two procedures can be used independantly of each other.

WARNING: To avoid the danger of being burned, do not remove the coolant recovery reservoir filler cap while the engine and radiator assembly are still hot. Scalding fluid and steam may be blown out under pressure.

Draining the Cooling System

1. Park the vehicle on level surface. Remove the coolant recovery reservoir filler cap assembly: Slowly rotate cap counterclockwise about 1/4 turn and then stop. Wait until any remaining pressure (indicated by a hissing sound) is relieved. After all hissing ceases, continue to rotate cap assembly counterclockwise until cap is removed.
2. Open coolant drain valve located in left-hand radiator end tank. Disconnect the battery negative cable assembly. Open heater air bleed valve (36) located just above water pump assembly on the thermostat housing. See **Fig. 1**. Place a shop towel under the bleed valve to prevent coolant from splashing onto distributor assembly.
3. Remove both electronic spark control (ESC) knock sensors located on both sides of engine block assembly. Allow system to drain completely.
4. Store used coolant in a proper fashion, i.e., in a used coolant holding tank.

NOTE: NEVER POUR USED COOLANT DOWN THE DRAIN! Ethylene Glycol antifreeze is a very toxic chemical; disposing of it into the sewer system or ground water is both illegal and ecologically unsound!

5. Close coolant drain valve on radiator. Install ESC knock sensors. Tighten each knock sensor to 14 ft.lbs (19 N.m).

Refilling/Bleeding the Cooling System

WARNING: Under some conditions, Ethylene Glycol in engine coolant is flammable. To avoid being burned when adding engine coolant, do not spill it on the exhaust system or on hot engine parts.

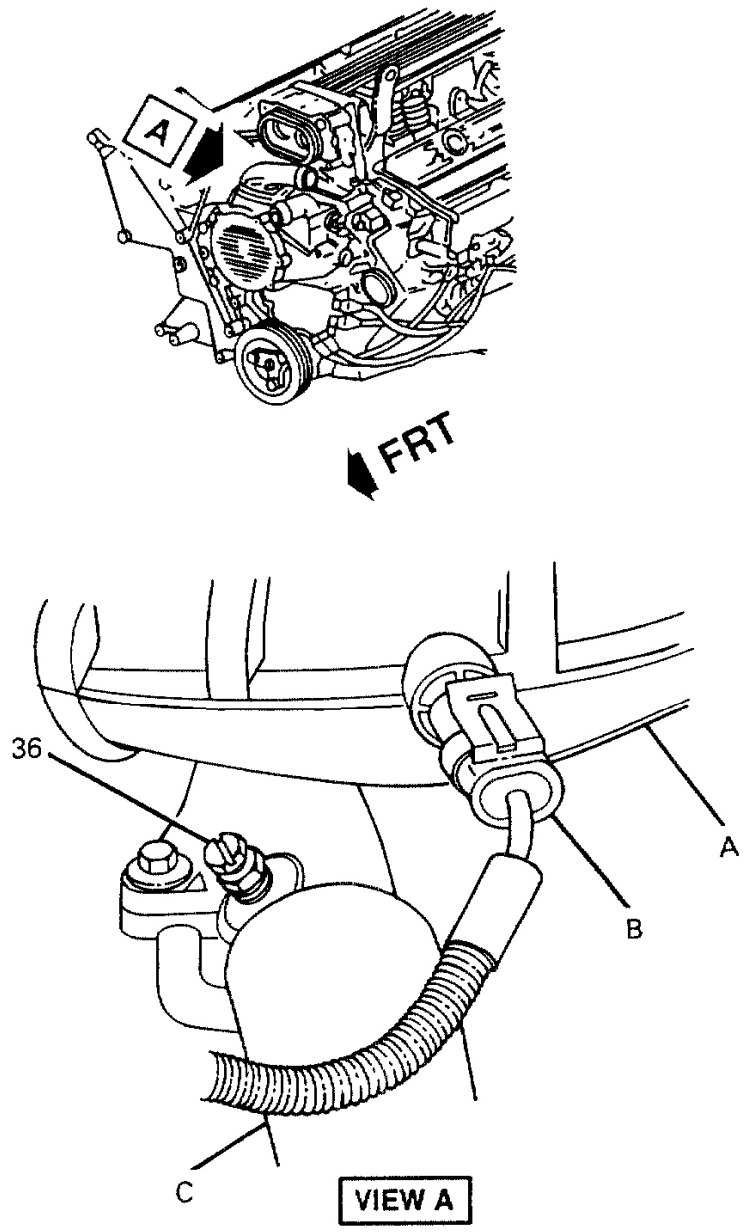
1. If not already open, open heater air bleed valve (36) located just above the water pump assembly on the thermostat housing. See **Fig. 1** . Place a shop towel under the bleed valve to prevent coolant from splashing onto distributor assembly.
2. Fill cooling system through the coolant recovery reservoir assembly to the "FULL COLD" mark. Use Ethylene Glycol antifreeze meeting GM specification 2025-M to provide required freezing and corrosion protection; at least a 50% solution. For fluid capacity, see the **COOLING SYSTEM APPROXIMATE FLUID CAPACITIES TABLE**.
3. Add two engine coolant supplement sealant pellets (GM P/N 363462) or equivalent.
4. Close heater air bleed valve when bubbles disappear and only coolant is visible. Run engine with the coolant recovery reservoir filler cap off until thermostat assembly opens.
5. Re-open heater air bleed valve. When bubbles disappear and only coolant is visible, close heater air bleed valve. Again, place a shop towel under the bleed valve to prevent coolant from splashing onto distributor assembly.
6. Fill cooling system through the coolant recovery reservoir until the coolant level is approximately 1 inch (25 mm) above the "FULL COLD" mark.
7. Install the coolant recovery reservoir filler cap assembly. Inspect for leaks after running engine until normal operating temperature is reached.

NOTE: The "LOW COOLANT" warning/indicator lamp may come on after this procedure. It can take up to THREE engine heat up/cool down cycles before the light goes out! If the "LOW COOLANT" warning/indicator lamp still does not go out and coolant is above "FULL COLD" mark in reservoir assembly, there is a fault with the circuit. Troubleshoot and repair as necessary.

NOTE: If at any time the "TEMP" warning/indicator lamp comes on, immediate action is required. Turn off engine and allow vehicle to cool. Do not remove coolant recovery cap at this time.

COOLING SYSTEM APPROXIMATE FLUID CAPACITIES

Application	Quarts (liters)
Without Heavy-Duty Cooling System (1)	14.3 (13.5)
With Heavy-Duty Cooling System (1)	14.6 (13.8)
X5/	
(1) Non Heavy-Duty Cooling systems have two electric cooling fans. The Heavy-Duty Cooling system has one electric fan and one mechanical belt-driven fan.	



A DUCT, REAR AIR INTAKE
B ELECTRICAL CONNECTOR, INTAKE AIR TEMPERATURE SENSOR
C HOSE, RADIATOR OUTLET
36 VALVE, HEATER AIR BLEED

50J14661

Fig. 1: Heater Air Bleed Valve Location
Courtesy of GENERAL MOTORS CORP.

FUEL PRESSURE RELEASE

Disconnect negative battery cable. Loosen fuel tank filler cap. Connect Fuel Gauge (J-34730-1) to fuel pressure connection (wrap shop towel around fitting to avoid spillage). Install bleed hose. Turn gauge valve, and drain fuel into an appropriate container.

ENGINE

Removal (Caprice, Fleetwood, Impala SS & Roadmaster)

1. This procedure involves removing engine without transmission. Release fuel pressure. See **FUEL PRESSURE RELEASE**. Disconnect negative battery cable. Discharge A/C system using approved refrigerant recovery/recycling equipment.
2. Drain coolant. Remove air cleaner resonator and air intake duct. Disconnect fuel lines from fuel rail assembly. On vehicles with mechanically driven fan, remove radiator fan upper shroud, fan, and fan pulley.
3. On all vehicles, disconnect heater hose from water pump. Disconnect control cables from throttle body. Disconnect radiator hoses from engine. Disconnect coolant hose from throttle body. Raise and support vehicle. Disconnect oil filter adapter hoses. Drain crankcase.
4. Disconnect exhaust pipes from manifolds. Remove cover and torque converter bolts (A/T). Remove serpentine drive belt. Disconnect A/C hoses from compressor. Plug openings. Disconnect transmission fluid cooler lines from clips (A/T).
5. Remove radiator fan lower shroud (or electric cooling fans, if equipped). Disconnect electrical connectors from starter, knock sensor, oxygen sensor, oil level sensor, and oil pressure sensor. Lower vehicle. Disconnect power steering hoses from pump.
6. Disconnect brake booster vacuum hose. Disconnect wiring from alternator and remaining components as necessary. Raise and support vehicle. Remove bolts securing transmission to engine. Remove transmission filler tube bolt. Remove engine mount through-bolts. Lower vehicle. Support transmission. Attach lifting device to engine. Remove engine.

Installation

To install, reverse removal procedure. Fill crankcase. Fill and bleed cooling system. See REFILLING/BLEEDING THE COOLING SYSTEM under **DRAINING & REFILLING COOLING SYSTEM**. Fill and bleed power steering system. Evacuate and charge A/C system.

INTAKE MANIFOLD

Removal

1. Disconnect negative battery cable, and drain cooling system. Relieve fuel pressure. See **FUEL PRESSURE RELEASE**. Remove air intake duct assembly and fuel rail covers. Disconnect throttle and cruise control cables. Mark and disconnect necessary electrical connectors and vacuum hoses.
2. Remove heater hoses. Remove AIR diverter valve hoses. Disconnect fuel pressure regulator vacuum hose. Remove fuel injectors and fuel rail from intake manifold, and position aside.
3. Remove PCV valve and hose. Remove EGR solenoid bracket and EGR valve. Remove fuel vapor canister purge solenoid bracket and solenoid. Remove AIR pipe from intake manifold and right exhaust manifold.

4. Remove alternator brace. Remove throttle body and gasket. Remove intake manifold and gaskets.

Installation

Clean gasket surfaces. Apply 3/16" bead of RTV Sealer (1052289) to front and rear of cylinder block, and run the same bead 1/2" onto each cylinder head. Install gaskets and intake manifold. Tighten bolts and studs to specification in sequence. See **Fig. 2**. Refer to **TORQUE SPECIFICATIONS**. To complete installation, reverse removal procedure. Adjust timing (if necessary) and check for leaks.

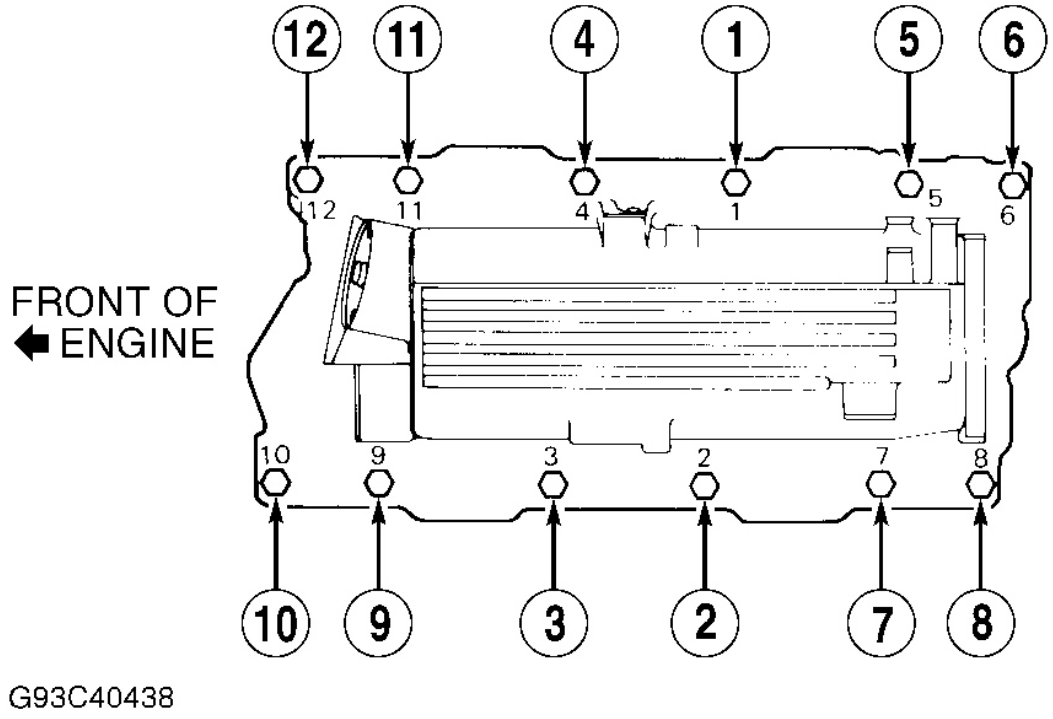


Fig. 2: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

EXHAUST MANIFOLD

Removal (Left)

1. Disconnect negative battery cable. Raise and support vehicle. Remove catalytic converter from exhaust manifold. Remove exhaust system from vehicle. Lower vehicle. Remove air intake duct. Remove serpentine belt. Remove left wheelwell center panel. Remove A/C compressor and alternator and position aside.
2. Remove exhaust crossover pipe at exhaust manifold. Lower vehicle. Remove air cleaner. Remove spark plug wires and clips. Remove air injection pipe and check valve as an assembly. Remove exhaust

manifold heat shields, exhaust manifold and gasket.

Removal (Right)

1. Disconnect negative battery cable. Raise and support vehicle. Remove catalytic converter from exhaust manifold. Remove exhaust system from vehicle. Lower vehicle. Remove fuel rail covers. Remove fuel injector electrical connectors. Remove fuel pressure regulator vacuum hose. Remove fuel injectors and fuel rail from intake manifold.
2. Lower vehicle. Remove air cleaner. Remove air injection hoses. Mark and disconnect spark plug wires at spark plugs. Remove necessary accessory brackets.
3. Remove oil indicator and tube. Remove exhaust manifold and gasket (if equipped).

Installation (Left & Right)

To install, reverse removal procedure. Tighten studs/bolts to specification. See **TORQUE SPECIFICATIONS**.

CYLINDER HEAD

CAUTION: Remove cylinder head when engine is cold.

Removal

1. Disconnect negative battery cable. Remove intake manifold, exhaust manifold and valve covers. See the following:
   - **INTAKE MANIFOLD**
   - **EXHAUST MANIFOLD**
   - **VALVE COVERS**
2. Remove serpentine belt. Drain cooling system. Remove rocker arms and push rods (mark components for installation reference). Remove cylinder head bolts in 3 steps in reverse order of tightening sequence. See **Fig. 3**. Remove cylinder head and gasket.

Inspection

See **CYLINDER HEAD** under OVERHAUL.

Installation

1. Clean cylinder head bolt holes and threads. Coat steel-type head gaskets with sealer. DO NOT coat composition-type head gaskets with sealer. Install head gasket onto cylinder block. Install cylinder head. Coat head bolts with Sealing Compound (1052080).
2. Tighten bolts in 3 steps in sequence. See **Fig. 3**. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**. To complete installation, reverse removal procedure.

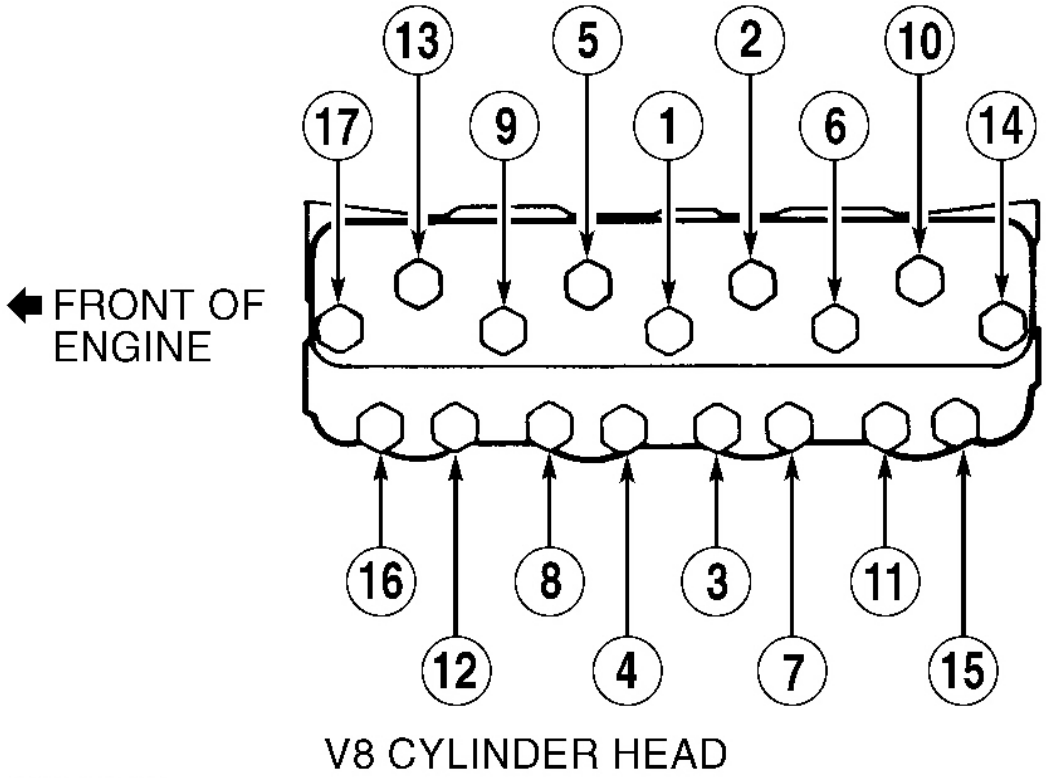


Fig. 3: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CRANKSHAFT BALANCER PULLEY ASSEMBLY & HUB

NOTE: For component identification in removal and installation procedures. Refer to illustrations. See Fig. 4-Fig. 7 .

Removal

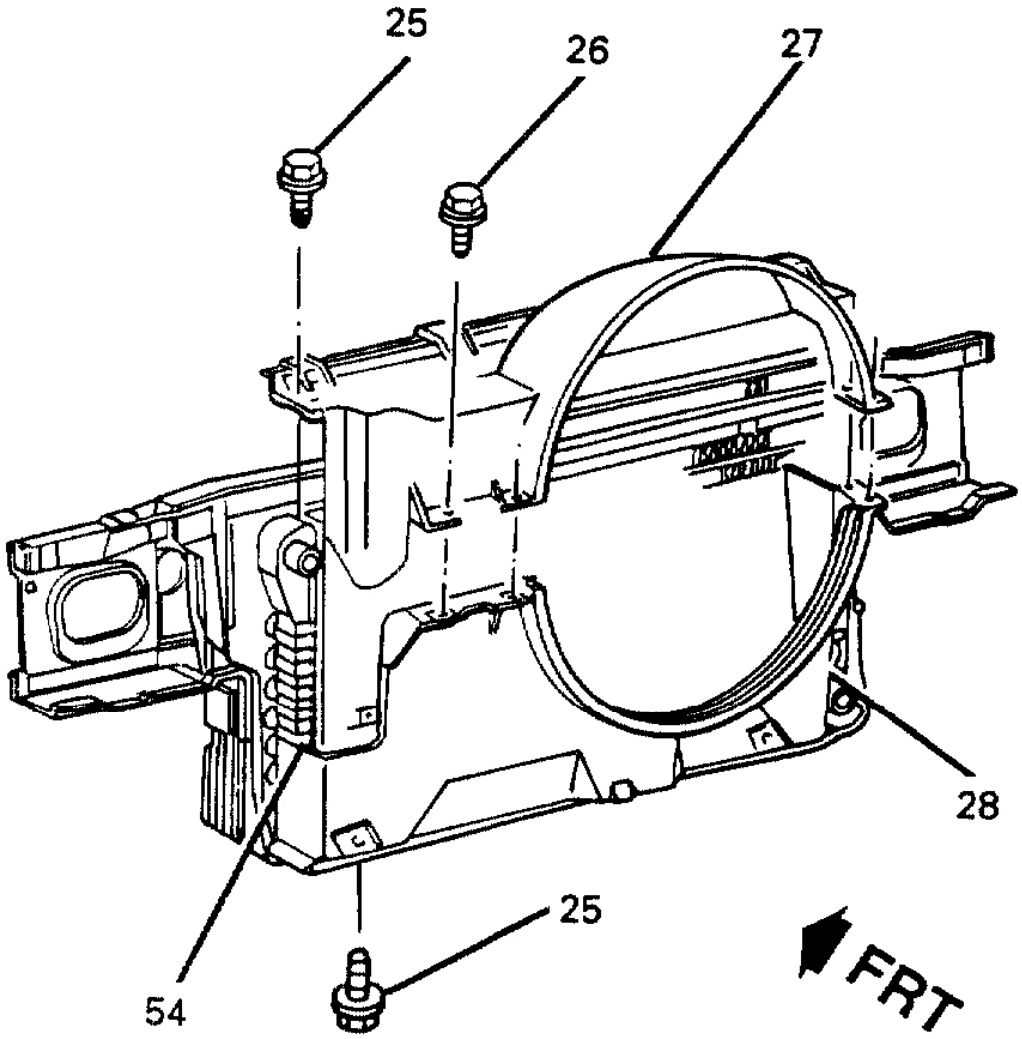
1. Raise and suitably support vehicle.
2. Remove serpentine drive belt.
3. If equipped with a mechanical fan: remove radiator fan upper shroud. See **Fig. 4**. Remove bolts and screws (25 and 26) from upper shroud assembly (27). Remove upper shroud assembly (27) from lower shroud assembly (28) and radiator support assembly. Remove fan.

NOTE: Remove only the balancer pulley.

4. Mark fan belt drive pulley to crankshaft balancer pulley, remove pulley. Mark crankshaft pulley to the

hub. Remove crankshaft balancer pulley bolts/screws (46) and remove the balancer assembly (42). See **Fig. 5**.

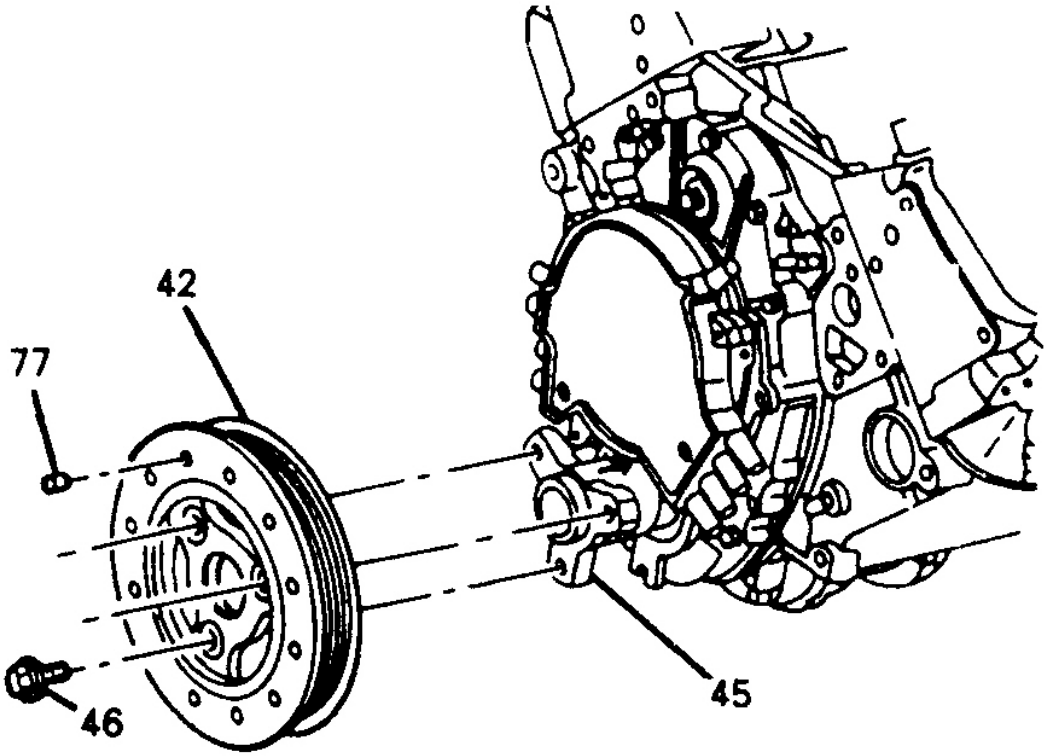
5. Remove hub only if necessary. Mark crankshaft hub (45) to engine front cover assembly. DO NOT crank engine over after match-marking crankshaft hub and engine front cover assembly. Rotating crankshaft assembly will misalign installation of balancer assembly to crankshaft assembly possibly resulting in engine imbalance.
6. Remove crankshaft hub bolt/screw and washer. Pull crankshaft hub (45) using Crankshaft Hub Remover/Installer (J 39046).



25 BOLT/SCREW, RADIATOR FAN SHROUD, 6 N•m (53 LB. IN.)
26 BOLT/SCREW, RADIATOR FAN UPPER SHROUD, 6 N•m (53 LB. IN.)
27 SHROUD ASSEMBLY, RADIATOR FAN UPPER
28 SHROUD ASSEMBLY, RADIATOR FAN LOWER
54 RADIATOR ASSEMBLY

50A14662

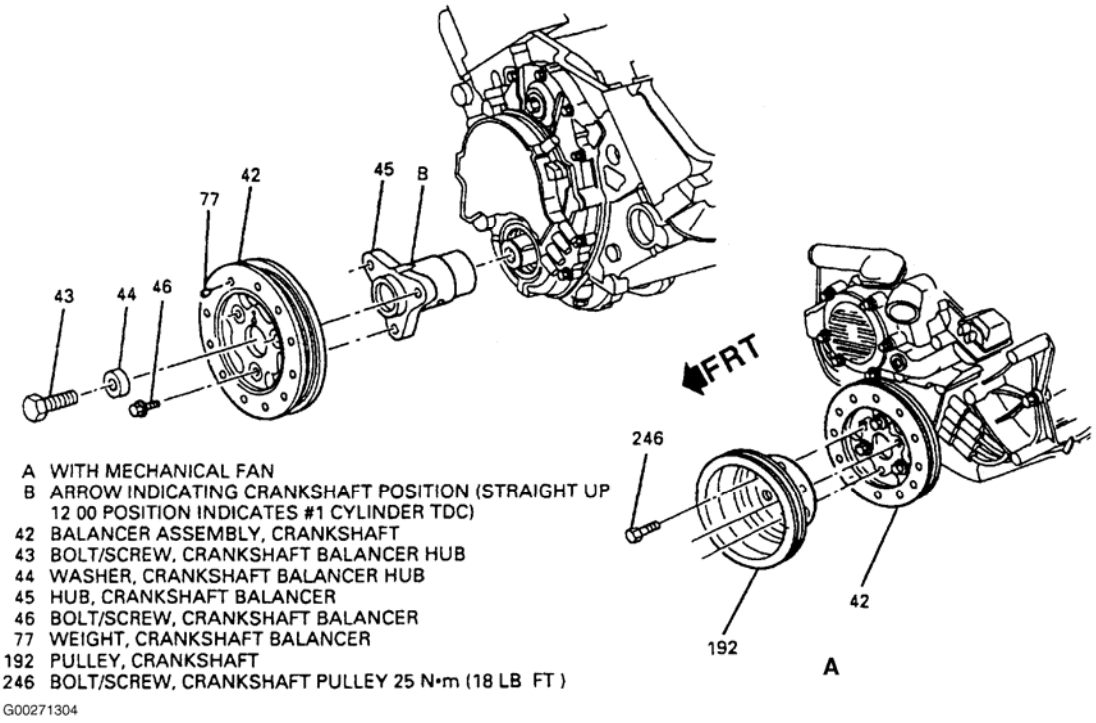
Fig. 4: Exploded View of Fan Shroud (For Mechanical Fan Only)
Courtesy of GENERAL MOTORS CORP.



42 BALANCER ASSEMBLY, CRANKSHAFT
45 HUB, CRANKSHAFT BALANCER
46 BOLT/SCREW, CRANKSHAFT BALANCER
77 WEIGHT, CRANKSHAFT BALANCER

G00249533

Fig. 5: Identifying Crankshaft Balancer Assembly & Hub
Courtesy of GENERAL MOTORS CORP.



A WITH MECHANICAL FAN
B ARROW INDICATING CRANKSHAFT POSITION (STRAIGHT UP 12 00 POSITION INDICATES #1 CYLINDER TDC)
42 BALANCER ASSEMBLY, CRANKSHAFT
43 BOLT/SCREW, CRANKSHAFT BALANCER HUB
44 WASHER, CRANKSHAFT BALANCER HUB
45 HUB, CRANKSHAFT BALANCER
46 BOLT/SCREW, CRANKSHAFT BALANCER
77 WEIGHT, CRANKSHAFT BALANCER
192 PULLEY, CRANKSHAFT
246 BOLT/SCREW, CRANKSHAFT PULLEY 25 N•m (18 LB FT)

G00271304

Fig. 6: Identifying Crankshaft Balancer Assembly & Hub (With Fan Belt Pulley)
Courtesy of GENERAL MOTORS CORP.

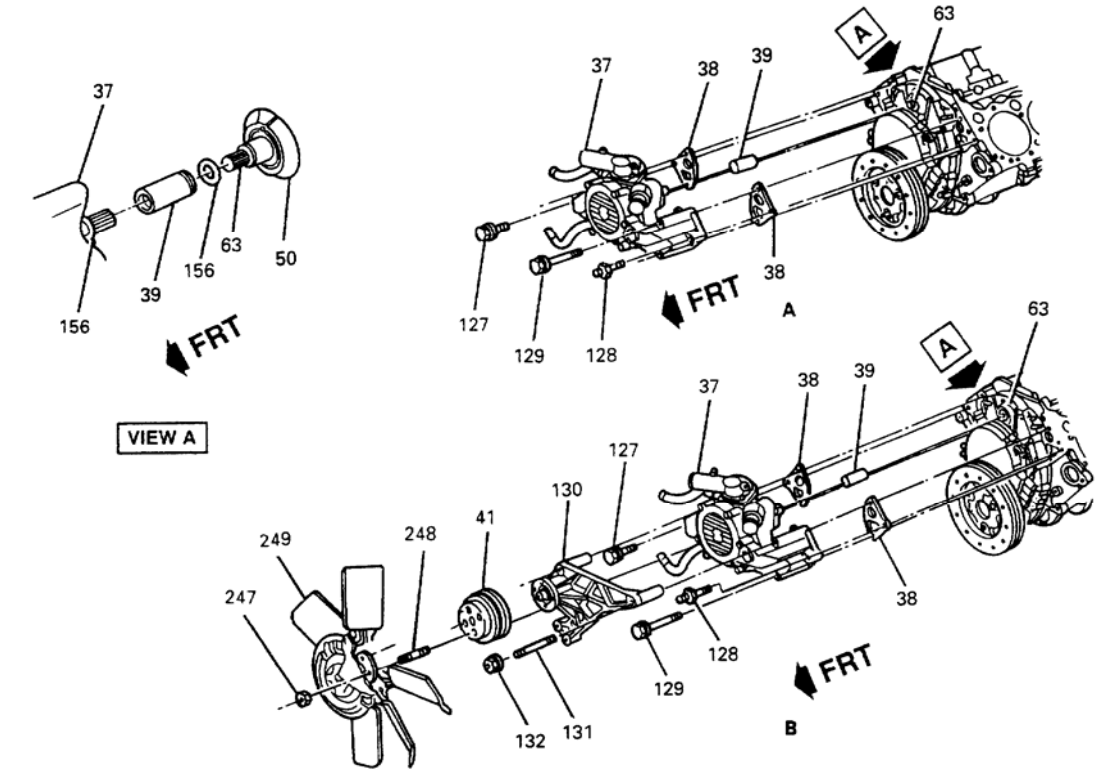


Fig. 7: Exploded View of Water Pump Assembly
Courtesy of GENERAL MOTORS CORP.

Installation

NOTE: If balancer assembly is replaced, new balance weights of the same size must be installed on the new balancer assembly in the same hole locations as the old balancer assembly.

The crankshaft hub (45) can be installed by a different procedure if the engine should accidentally be cranked over after match marking the hub and engine front cover assembly.:

- Set number 1 piston assembly to top dead center.
- Install crankshaft hub (45) with cast arrow on hub in the 12 o'clock position.

Install crankshaft hub (45) using Installer (J 39046). Install crankshaft hub washer and bolt/screw. Install crankshaft balancer assembly (42) and bolts/screws (46). Install fan belt pulley. See **Fig. 5**. Tighten fasteners to

specification. See **TORQUE SPECIFICATIONS**.

FRONT COVER & OIL SEAL

Removal

1. Disconnect negative battery cable and serpentine drive belt. Remove crankshaft pulley. Loosen or remove motor mount nuts as necessary for harmonic balancer removal. Remove harmonic balancer-to-crankshaft bolt. Mark position, and remove harmonic balancer using Harmonic Balancer Remover/Installer (J-39046).
2. Remove the oil pan. See **OIL PAN**. Remove the water pump. See **WATER PUMP**. Remove throttle body air duct and distributor. Remove front cover and gasket. Carefully pry seal from timing cover using a large screwdriver.

Installation

1. Using Seal Aligner/Installer (J-35468), install NEW oil seal in timing cover. Coat timing cover gasket with sealant, and position onto timing cover. Install timing cover.
2. Alternately tighten all bolts to specification. Refer to **TORQUE SPECIFICATIONS**. Apply sealant to oil pan, cylinder block and timing cover joint. To complete installation, reverse removal procedure.

TIMING CHAIN

Removal

1. Disconnect the negative battery cable. Remove front cover. See **FRONT COVER & OIL SEAL**. Rotate crankshaft until the camshaft sprocket and crankshaft sprocket timing marks line up with the shaft centers. See **Fig. 9**.
2. Remove camshaft sprocket and chain as an assembly. See **Fig. 8**. If replacing crankshaft sprocket, use Sprocket Remover (J-5825-A) to pull sprocket off crankshaft. If replacing water pump drive gear, use Gear Remover (J-39243) to remove gear.

Installation

Drive crankshaft sprocket onto crankshaft, with timing mark facing out. Ensure timing marks on crankshaft sprocket and camshaft sprocket are as close together as possible and lined up with shaft centers. See **Fig. 9**. Install camshaft sprocket and chain as an assembly. To complete installation, reverse removal procedure.

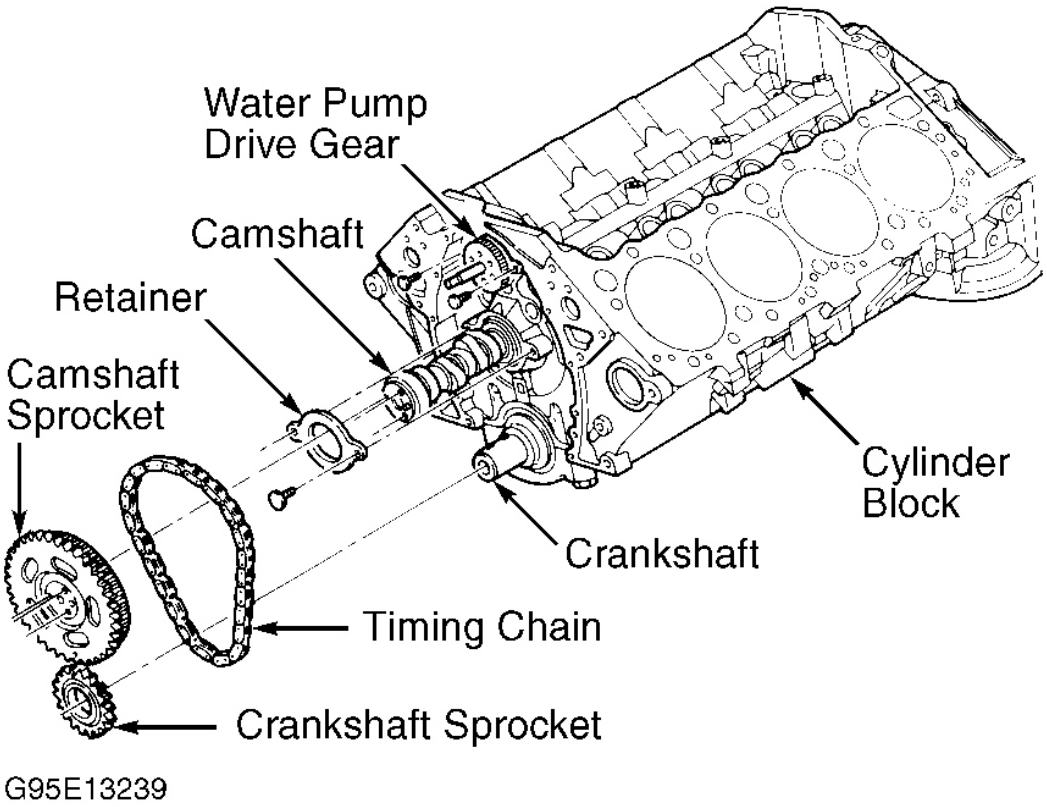


Fig. 8: View Of Timing Chain & Components
Courtesy of GENERAL MOTORS CORP.

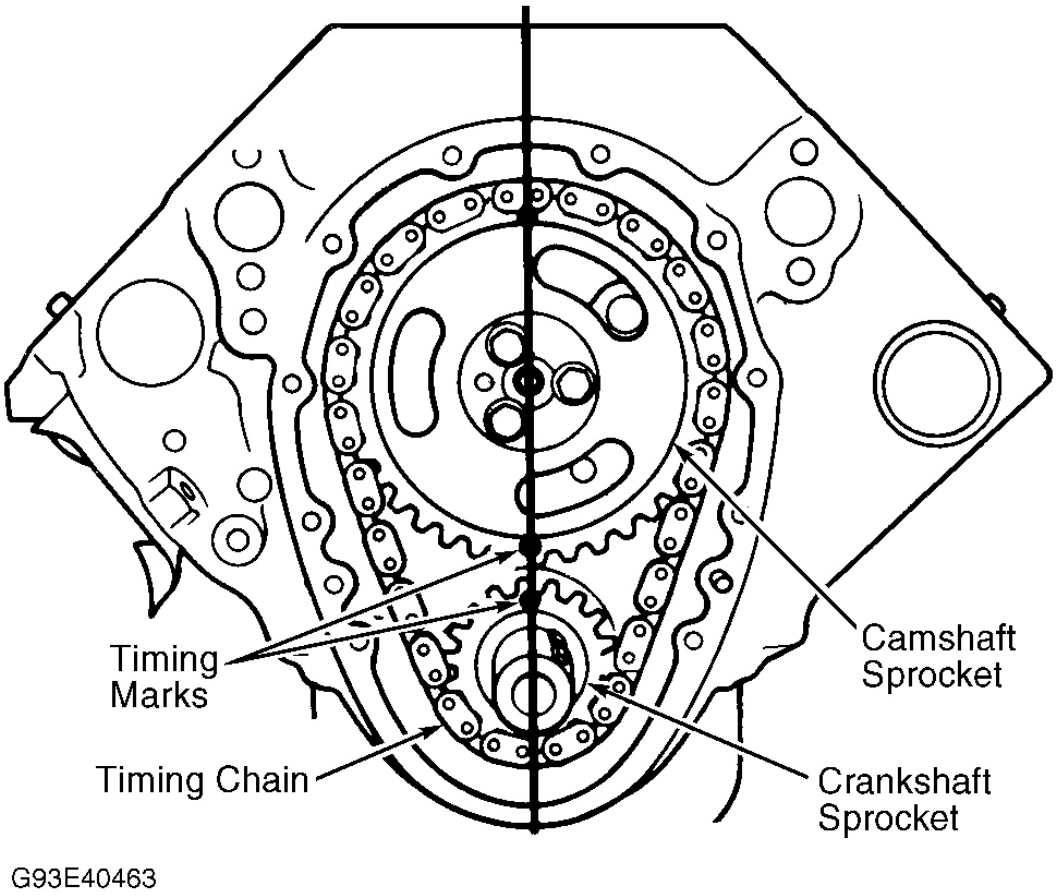


Fig. 9: Aligning Timing Marks
Courtesy of GENERAL MOTORS CORP.

VALVE COVERS

Removal (Left)

Disconnect negative battery cable. Remove alternator brace. Remove alternator and position aside. Disconnect AIR diverter valve hose from check valve. Remove fuel rail cover and studs, and position wiring harness aside. Remove fuel lines and brackets. Remove valve cover bolts, washers, valve cover and gasket.

Removal (Right)

1. Disconnect negative battery cable. Remove fuel rail cover and fuel rail bolts. Disconnect fuel pressure regulator vacuum hose. Remove fuel injectors and fuel rail from intake manifold. Remove fuel rail cover studs, and position wiring harness aside. Remove AIR pipe and check valve from intake and exhaust manifolds.
2. Disconnect ECM harness connectors and position harness aside. Remove AIR diverter valve and hoses.

Remove spark plug wires at distributor. Remove EGR solenoid bracket. Disconnect PCV hose and connector. Remove valve cover and gasket.

Installation (Left & Right)

To install, reverse removal procedure. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS**.

ROCKER ARMS & PUSH RODS

Removal & Installation

Remove valve covers. See **VALVE COVERS**. Mark components for installation in original locations. Remove rocker arm nuts, balls, rocker arms and push rods. To install, reverse removal procedure. Apply Prelube (1052365) to rocker arm and ball mating surface.

ROCKER ARM STUD

Removal & Installation

1. Remove the rocker arms and push rods as necessary. Refer to **ROCKER ARMS & PUSH RODS**. Remove rocker arm stud(s) using Stud Remover (J-5802-01). Ream stud bore to replacement size of oversize stud. Oversize studs are available in .003" (.08 mm) and .013" (.33 mm).
2. Coat press-fit area of stud with hypoid axle lubricant. Install rocker arm stud using Stud Installer (J-6880) until installer bottoms out on cylinder head. To complete installation, reverse removal procedure.

CAMSHAFT

NOTE: Rotate crankshaft in direction of normal operation only. Keep components in order for installation reference.

Removal

1. Remove valve covers and rocker arms. See **VALVE COVERS**. DO NOT remove push rods. See **ROCKER ARMS & PUSH RODS**. Measure lobe lift of camshaft with push rods installed.
2. To measure lobe lift, attach dial indicator to cylinder head. Position indicator pointer onto tip of a push rod. Rotate crankshaft until push rod is at lowest point. Zero indicator, and rotate crankshaft until push rod is at highest point. Record reading, and repeat procedure for remaining lobes.
3. After lobe lift is measured, remove push rods. Remove intake manifold and timing sprockets. See **INTAKE MANIFOLD**. Also refer to **TIMING CHAIN**. Remove air cleaner, coolant reservoir hose from radiator, and relay bracket from left side of radiator support. Remove AIR pump and hoses, and position aside. Disconnect cooling fan electrical connectors. Remove upper radiator support.
4. Remove upper radiator fan shroud. Remove radiator and hoses. Discharge A/C system and remove condenser (if equipped). Remove valve lifters and camshaft retaining plate. Using three 5/16" x 18 tpi x 4" bolts as a handle, carefully pull camshaft from engine. Remove camshaft rear plug and bearings as necessary.

Inspection

Check camshaft for scratches, pits and loose fit in bearings. Check camshaft journal diameter and lobe lift (recorded earlier). Replace camshaft if damaged or not to specification. See CAMSHAFT table under ENGINE SPECIFICATIONS.

Installation

1. Install front and rear bearings. Position camshaft bearing No. 1 oil holes at 1 o'clock and 5 o'clock positions.
2. Position oil hole of rear bearing at 12 o'clock position. Position oil holes of middle bearings at 5 o'clock position, toward left side of engine and even with bottom of cylinder bore.
3. Install camshaft rear plug flush to .031" (.79 mm) deep in block. Use Sealant (1052080) on camshaft plug. If replacing camshaft, replace lifters, engine oil and filter.
4. Apply Camshaft Prelube (1052365) to camshaft lobes. Apply engine oil to bearings and camshaft bearing journals. To complete installation, reverse removal procedure.

CRANKSHAFT REAR OIL SEAL

Removal

Remove transmission. Remove flywheel/flexplate. Pry out seal using screwdriver at notches in seal retainer. See **Fig. 10**.

Installation

1. Coat entire seal with engine oil. Install seal using Seal Installer (J-35621) until installer bottoms. See **Fig. 10**. Align crankshaft dowel to flywheel hole.
2. Install flywheel/flexplate-to-crankshaft bolts. Tighten bolts to specification. See **TORQUE SPECIFICATIONS**. To complete installation, reverse removal procedure.

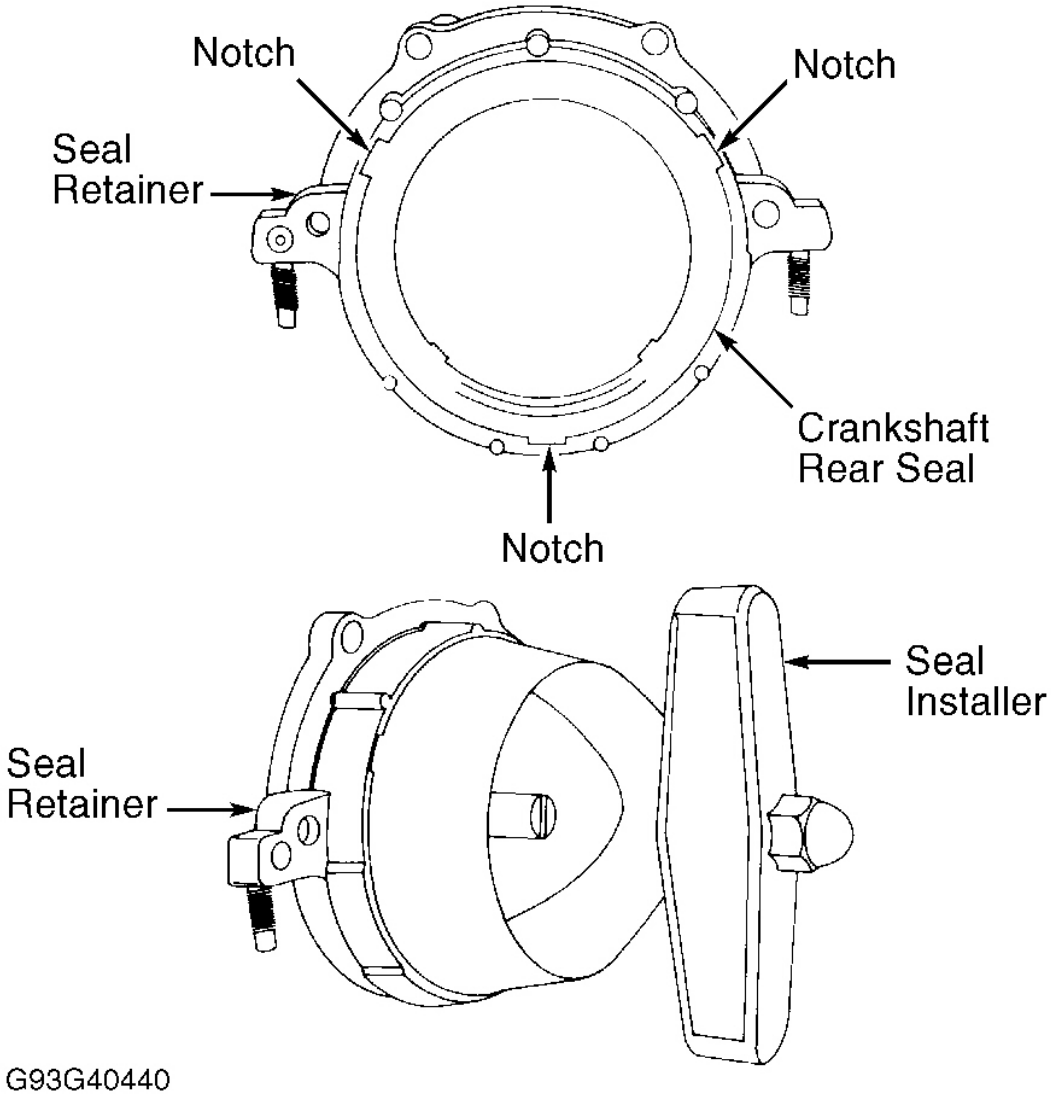


Fig. 10: Removing & Installing Crankshaft Rear Seal
Courtesy of GENERAL MOTORS CORP.

WATER PUMP

The layout of this section is:

- Brief description of the water pump
- Removal of the water pump; all cooling system types are addressed
- Cleaning after removal
- Installation of the water pump

Description

The water pump assembly is gear driven by the camshaft sprocket using a driveshaft and coupling. Keep the ignition wires connected to the distributor assembly until the water pump assembly is removed and all coolant has been drained.

Removal

NOTE: See Fig. 11 for exploded view of water pump assembly. This illustration is referred to here.

1. Drain engine coolant. See the **DRAINING & REFILLING COOLING SYSTEM** section in this article
2. If equipped with a mechanical fan: Remove air cleaner resonator bracket nuts. Remove air cleaner resonator assembly; loosen clamp and slide resonator assembly off studs. Remove the air intake duct.
3. If equipped with a mechanical fan: remove radiator fan upper shroud. See **Fig. 12**. Remove bolts and screws (25 and 26) from upper shroud assembly (27). Remove upper shroud assembly (27) from lower shroud assembly (28) and radiator support assembly.
4. If equipped with a mechanical fan: Remove fan belt from tensioner assembly. See **Fig. 13** Remove the fan blade clutch nuts (247) and fan blade assembly (249) with clutch assembly attached.
5. For all, remove engine coolant and heater hose assemblies from water pump assembly (37).
6. If equipped with a mechanical fan: Remove fan pulley. Remove coolant fan pulley bracket nuts (132). Remove coolant fan pulley bracket (130)
7. For all, remove the electrical connect from coolant sensor. Remove the secondary air injection pump assembly by removing the electrical connector from AIR pump, outlet and inlet hoses, and finally, the air pump mounting bolts (3) from bracket. See **Fig. 14**.
8. Remove the water pump bolts/screw (127 and 129) and stud (128). Remove water pump assembly (37) and gaskets (38). Remove water pump driveshaft coupling (39) and seals (156). Discard the seals (156).

Cleaning

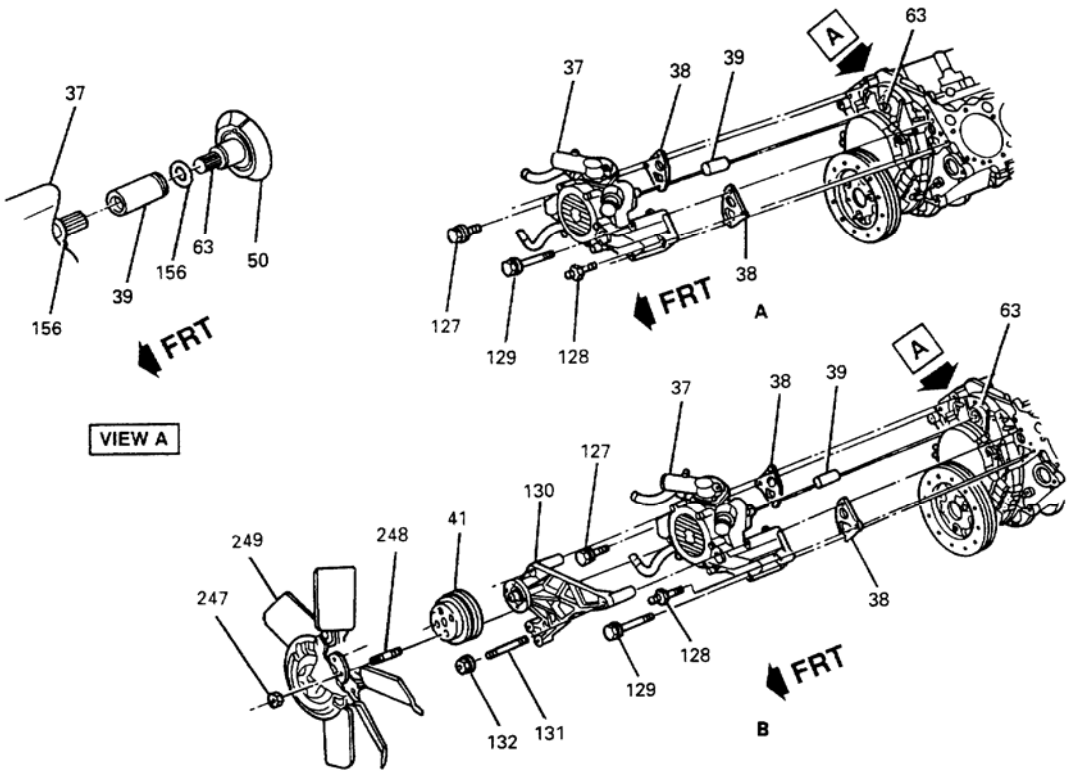
Clean the water pump gasket surfaces, the water pump bolts/screws (127 and 129). Clean coolant fan pulley bracket studs (131), if removed.

NOTE: See Fig. 11 for exploded view of water pump assembly. This illustration is referred to here.

Installation

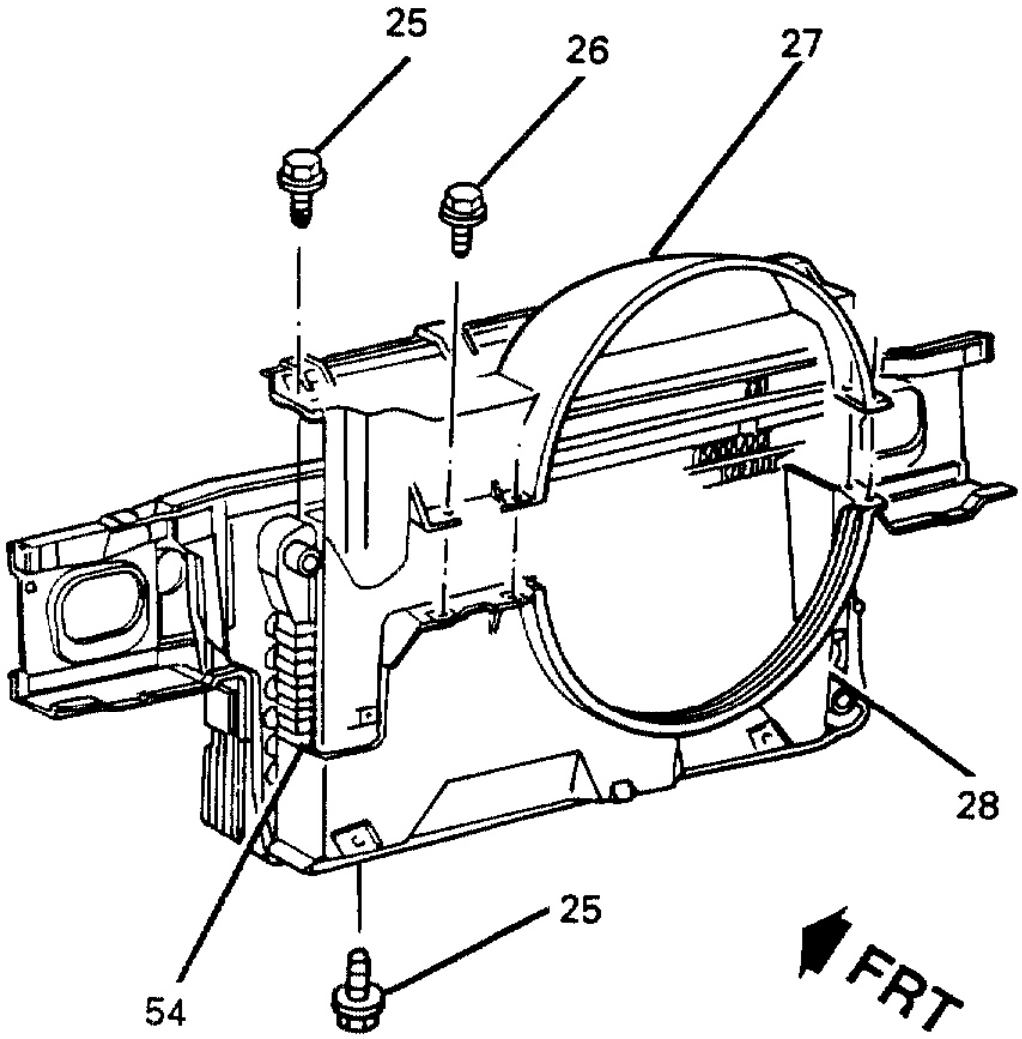
1. Install the water pump driveshaft coupling (39) and new seals (156). Install water pump assembly (37) and gaskets (38). Install the water pump bolts/screws (127 and 129) and stud (128). Tighten all to 30 lb.ft. (41 N.m).
2. Install the secondary air injection pump assembly: Install the AIR pump to bracket. See **Fig. 14**. Connect the mounting bolts (3), tightening them to 50 lb.in. (5.6 N.m). Connect outlet and inlet hoses to pump. Connect electrical connector to AIR pump.
3. Install the electrical connector to coolant sensor.

4. If equipped with a mechanical fan: Install the coolant fan pulley bracket (130). Install the coolant fan pulley bracket nuts (132), tightening them to 22 lb.ft. (30 N.m). Install the fan pulley. Install the fan blade assembly (249) with clutch assembly attached and nuts (247). Tighten the nuts to 19 lb.ft. (26 N.m).
5. On all, install the engine coolant and heater hose assemblies to water pump assembly (37).
6. If equipped with a mechanical fan: Install the fan belt to tensioner assembly. See **Fig. 13**. Install the radiator fan upper shroud: Install upper shroud assembly (27) to lower shroud assembly (28) and radiator support assembly. See **Fig. 12**. Install the bolts/screws (25 and 26), tightening them to 53 lb.ft. (6 N.m).
7. If equipped with a mechanical fan: Install the air intake duct. Install air cleaner resonator assembly; slide resonator assembly over studs and tighten clamp until snug. Install the air cleaner resonator bracket nuts, tightening them to 89 lb.in. (10 N.m).
8. For all, refill and bleed the cooling system. See the **DRAINING & REFILLING COOLING SYSTEM** section in this article



A WITHOUT MECHANICAL FAN
B WITH MECHANICAL FAN
37 PUMP ASSEMBLY, WATER
38 GASKET, WATER PUMP
39 COUPLING, WATER PUMP DRIVESHAFT
41 PULLEY, FAN
50 COVER ASSEMBLY, ENGINE FRONT
63 DRIVESHAFT ASSEMBLY, WATER PUMP
127 BOLT/SCREW, WATER PUMP
128 STUD, WATER PUMP
129 BOLT/SCREW, WATER PUMP
130 BRACKET, COOLANT FAN PULLEY
131 STUD, COOLANT FAN PULLEY BRACKET
132 NUT, COOLANT FAN PULLEY BRACKET
156 SEAL, WATER PUMP DRIVESHAFT
247 NUT, FAN BLADE CLUTCH
248 STUD, FAN BLADE CLUTCH
249 BLADE ASSEMBLY, FAN
50C14664

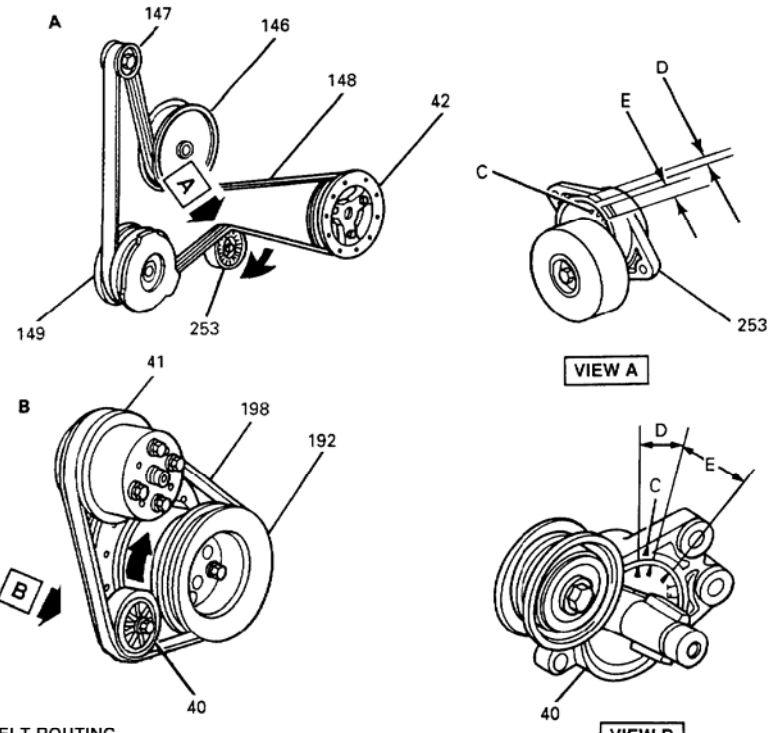
Fig. 11: Exploded View of Water Pump Assembly
Courtesy of GENERAL MOTORS CORP.



25 BOLT/SCREW, RADIATOR FAN SHROUD, 6 N•m (53 LB. IN.)
26 BOLT/SCREW, RADIATOR FAN UPPER SHROUD, 6 N•m (53 LB. IN.)
27 SHROUD ASSEMBLY, RADIATOR FAN UPPER
28 SHROUD ASSEMBLY, RADIATOR FAN LOWER
54 RADIATOR ASSEMBLY

50A14662

Fig. 12: Exploded View of Fan Shroud - For Mechanical Fan Only
Courtesy of GENERAL MOTORS CORP.



A COOLING SYSTEM BELT ROUTING
B ADDITIONAL BELT ROUTING FOR MODELS EQUIPPED WITH "V08" HEAVY DUTY COOLING SYSTEM WITH MECHANICAL FAN
C INDICATOR MARK
D ACCEPTABLE OPERATING RANGE
E UNACCEPTABLE OPERATING RANGE
40 TENSIONER ASSEMBLY, DRIVE BELT (WITH MECHANICAL FAN)
41 PULLEY, FAN
42 BALANCER ASSEMBLY, CRANKSHAFT
146 PUMP ASSEMBLY, POWER STEERING
147 GENERATOR ASSEMBLY
148 BELT, SERPENTINE DRIVE
149 COMPRESSOR ASSEMBLY, AIR CONDITIONING
192 PULLEY, CRANKSHAFT
198 BELT, FAN
253 TENSIONER ASSEMBLY, DRIVE BELT

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Fig. 13: Drive Belt Routing
Courtesy of GENERAL MOTORS CORP.

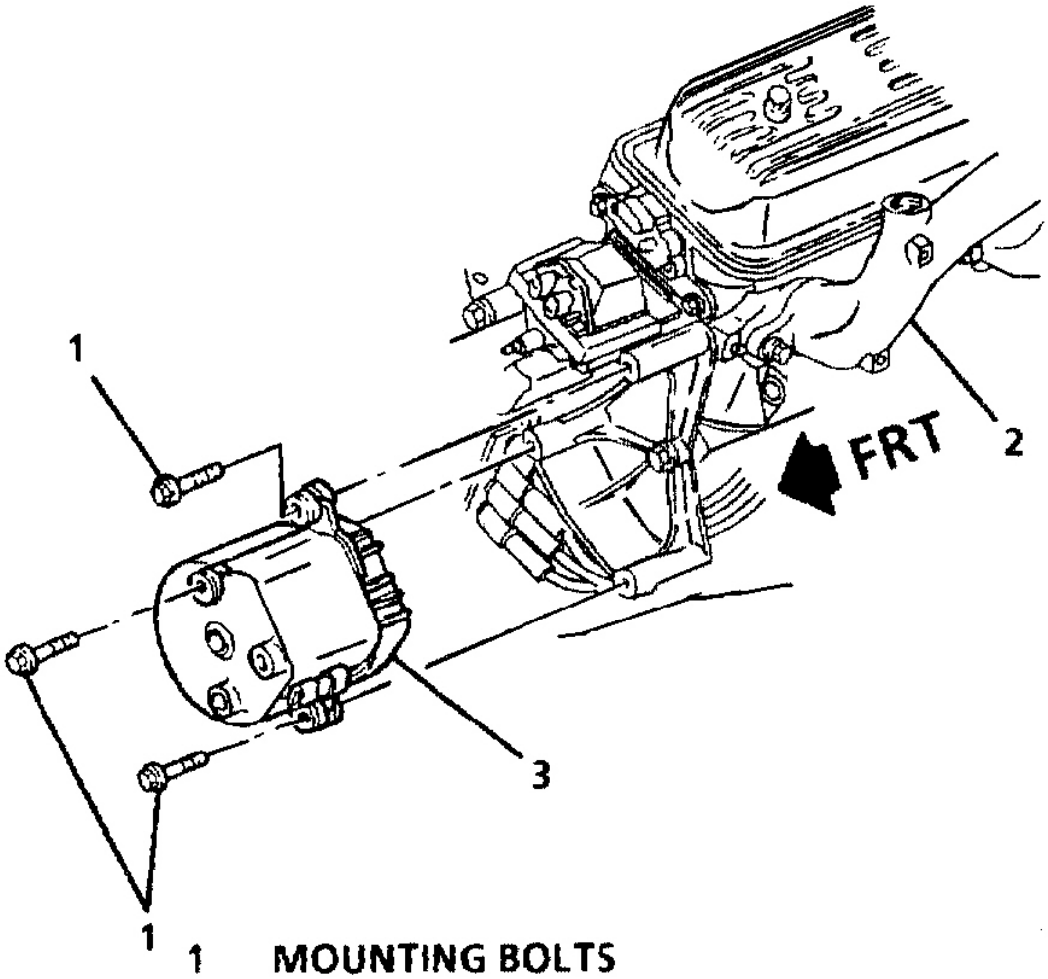


Fig. 14: Exploded View of Smog Pump Assembly
Courtesy of GENERAL MOTORS CORP.

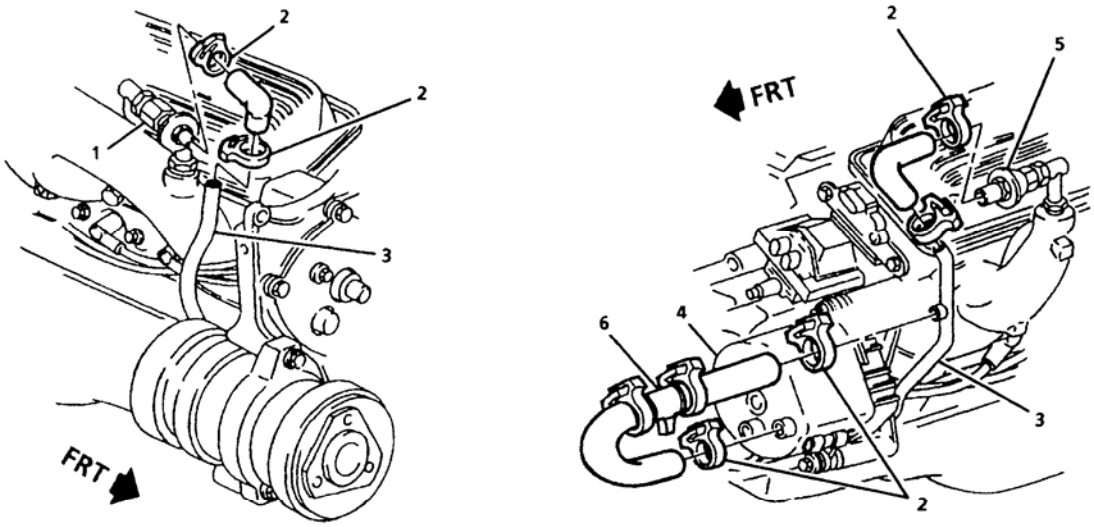
SECONDARY AIR INJECTION PUMP

Removal & Installation

NOTE: For component identification in removal and installation procedures. Refer to

illustrations. See Fig. 15-Fig. 17 .

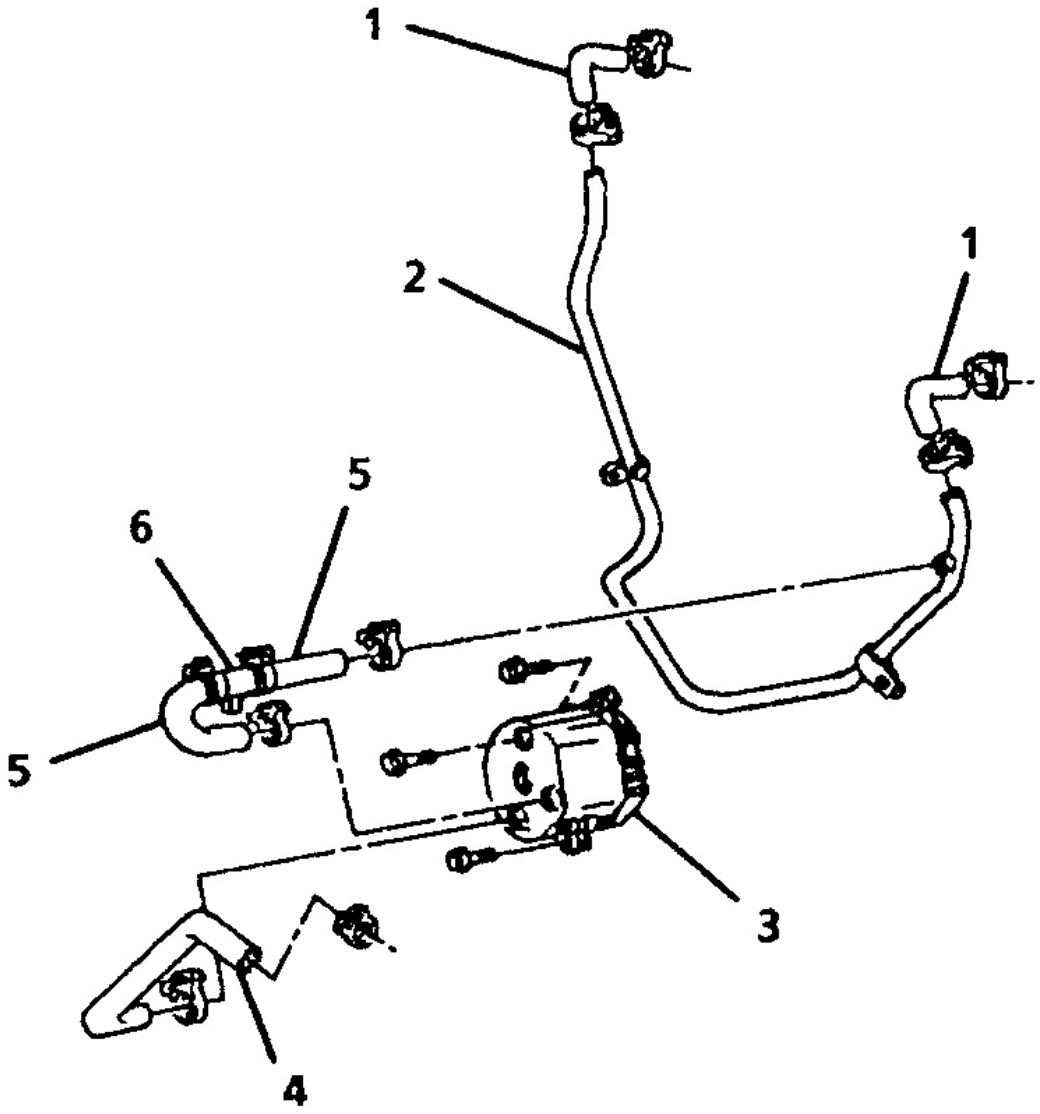
1. Remove negative battery terminal. Disconnect harness connector from air pump.
2. Remove outlet and inlet hoses from air pump. Remove air pump mounting bolts, remove air pump.
3. Remove air pump bracket to block mounting bolt(s). Remove bracket. To install, reverse removal procedure. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS**.



1 SECONDARY AIR INJECTION (AIR) RIGHT SIDE PIPE AND CHECK VALVE
2 CLAMP
3 SECONDARY AIR INJECTION (AIR) CROSS UNDER PIPE
4 SECONDARY AIR INJECTION (AIR) PIPE
5 SECONDARY AIR INJECTION (AIR) LEFT SIDE PIPE AND CHECK VALVE
6 VACUUM BLEED VALVE

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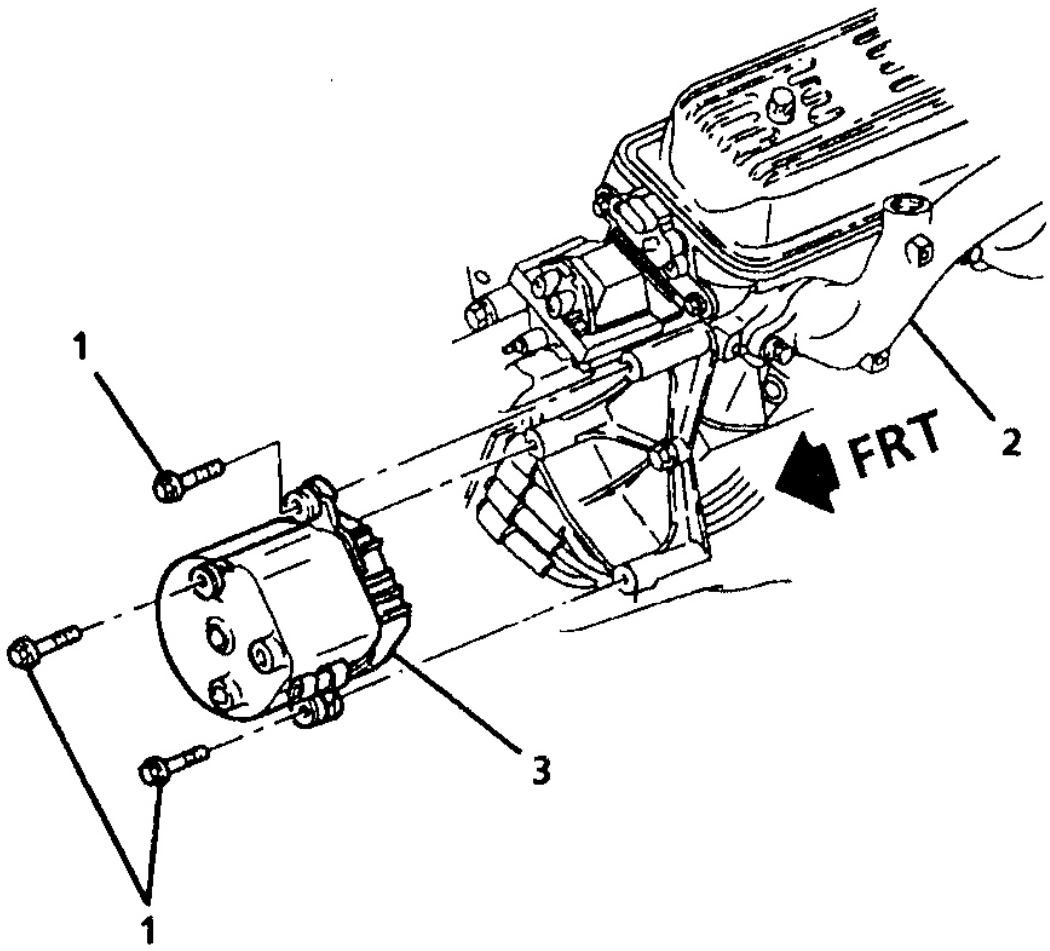
Fig. 15: Identifying Secondary Air Injection Pump Components (1 Of 3)
Courtesy of GENERAL MOTORS CORP.



1 AIR HOSE TO CHECK VALVE
2 AIR CROSSUNDER PIPE
3 AIR PUMP
4 AIR HOSE TO AIR CLEANER ASSEMBLY
5 AIR HOSE TO CROSSUNDER PIPE
6 VACUUM BLEED VALVE

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Fig. 16: Identifying Secondary Air Injection Pump Components (2 Of 3)
Courtesy of GENERAL MOTORS CORP.



1 MOUNTING BOLTS
2 EXHAUST MANIFOLD
3 SECONDARY AIR INJECTION (AIR) PUMP

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Fig. 17: Identifying Secondary Air Injection Pump Components (3 Of 3)
Courtesy of GENERAL MOTORS CORP.

OIL PAN

Removal (Caprice, Fleetwood, Impala SS & Roadmaster)

1. Disconnect negative battery cable. Remove air cleaner resonator and air intake duct. Remove radiator fan upper shroud (vehicles with mechanically driven fan). Disconnect windshield wiper motor electrical connector. Raise and support vehicle. Drain crankcase. Remove oil level sensor.
2. Disconnect exhaust pipes from manifolds. Disconnect catalytic converter support from transmission. Remove oil filter and adapter. Disengage transmission fluid cooler lines from clips at oil pan (A/T). Remove starter. Remove flywheel cover.
3. Rotate crankshaft until arrow on crankshaft balancer is pointing straight down (6 o'clock position). Remove engine mount through-bolts. Lift engine from above. Remove oil pan.

Installation (All Models)

To install, reverse removal procedure. Apply Sealant (1052914) to front cover, cylinder block, rear seal retainer and cylinder block junction. Install NEW oil pan gasket. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS**.

OVERHAUL

CYLINDER HEAD OVERHAUL

Valve Guides

Check and service guides before servicing valve and seat. Guide replacement information is not available from manufacturer. Valve guides may be reamed for installation of .003" (.08 mm), .015" (.38 mm) or .030" (.76 mm) oversize valves.

Valve Seat

Valve seat replacement information is not available from manufacturer. Follow instructions of tool manufacturer for servicing valve seats. If seats are serviced, service or replace valves.

Valves

Check valves before servicing. Replace valves as necessary. See **VALVES & VALVE SPRINGS** table under ENGINE SPECIFICATIONS. Valve face may be machined.

Valve Seat Correction Angles

If seat is too wide after grinding, use a 20-degree stone to lower or a 70-degree stone to raise seat.

CYLINDER BLOCK ASSEMBLY

Piston & Rod Assembly

1. Mark rod and rod cap with matching cylinder number. Before disassembling, mark piston-to-rod position for reassembly reference. Notch or dot on piston top should face front of engine. Piston pin is a press fit.
2. When measuring, ensure pin bore and piston pin are free of varnish and scuffing. If clearance between the piston and pin exceeds specification, replace the piston and pin as an assembly. See **PISTONS, PINS &**

RINGS table under ENGINE SPECIFICATIONS.

Fitting Pistons

Ensure notch or dot on piston top faces front of engine. Check pistons for wear and damage. Replace pistons as necessary. Check piston-to-cylinder bore clearance. If one cylinder needs to be bored, bore all cylinders to same oversize.

Piston Rings

Install marked side of ring toward top of piston. Top compression ring is chrome or molybdenum face. Second compression ring has a tapered face. Oil ring is a 3-piece type. Ensure end gaps are evenly spaced on piston. See **Fig. 18**.

NOTE: Rod and main bearings are available in .001" (.03 mm) and .002" (.05) undersize for oil clearance adjustment.

Rod Bearings

Ensure bearing cap bolt holes and mating surfaces are clean and dry. Use connecting rod stud protectors on rod cap bolts. Install inserts in connecting rod and cap. Lubricate bearings and crank pin. Install bearing cap. Tighten rod bearing cap bolts to specification. See **TORQUE SPECIFICATIONS**.

Crankshaft & Main Bearings

1. If bearing clearance is greater than specification, replace with undersized bearings and recheck bearing clearance using Plastigage. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.
2. Tighten the main bearing caps finger tight. Pry the crankshaft rearward and then forward to align the rear main bearing thrust surfaces. Retighten the main bearing caps to specification. See **TORQUE SPECIFICATIONS**.

Thrust Bearing

Check crankshaft end play by forcing the crankshaft to the extreme forward position. Measure end play at the front of the rear main bearing using a feeler gauge. If end play is not within specification, replace thrust bearing and/or crankshaft. See **CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS** table under ENGINE SPECIFICATIONS.

Cylinder Block

Check cylinder bore for wear, taper, out-of-round and piston fit. See **CYLINDER BLOCK** table under ENGINE SPECIFICATIONS. Cylinders with less than .005" (.13 mm) wear or taper can be honed. Cylinders with more than .005" (.13 mm) wear or taper should be bored to smallest oversize piston which will permit complete resurfacing of all cylinders.

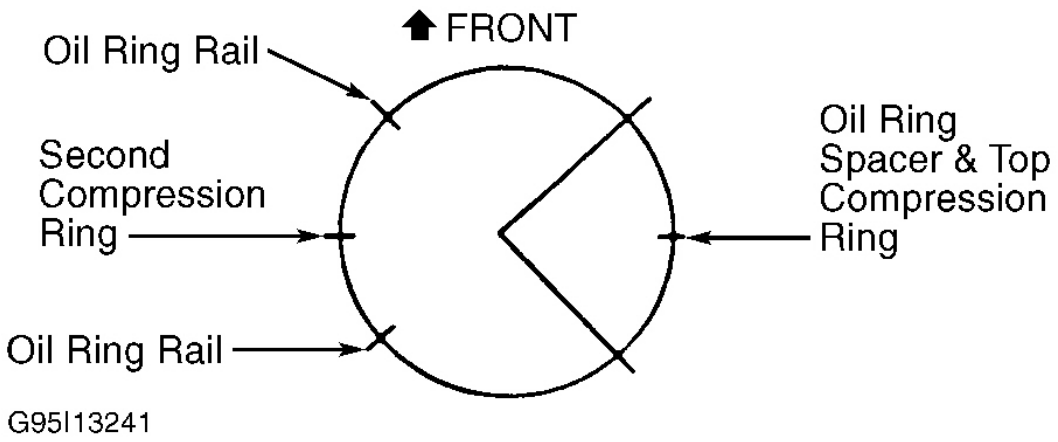


Fig. 18: Positioning Piston Ring End Gaps
Courtesy of GENERAL MOTORS CORP.

LUBRICATION

ENGINE OILING SYSTEM

A gear-type oil pump provides pressurized lubrication through the full-flow oil filter. Oil pump is bolted to bottom of cylinder block, inside oil pan. Oil pump is driven (through intermediate shaft) by a gear on rear end of camshaft.

Crankcase Capacity

Crankcase capacity is 4 qts. (3.8L) without oil filter change or 5 qts. (4.7L) with oil filter change.

Oil Pressure

With engine at normal operating temperature, oil pressure should be at least 6 psi (0.4 kg/cm^2) at 1000 RPM, 18 psi (1.3 kg/cm^2) at 2000 RPM and 24 psi (1.7 kg/cm^2) at 4000 RPM.

OIL PUMP

Removal & Disassembly

Remove oil pan. See **OIL PAN** under REMOVAL & INSTALLATION. Remove oil pan baffle (if equipped). Remove oil pump assembly and intermediate shaft. Remove oil pump cover screws, and remove cover. Mark gear teeth for reassembly reference. Remove gears. Remove pressure regulator pin, spring and valve from cover. Remove pick-up screen and pipe from cover only if replacing.

Inspection

Check oil pump body and gears for cracks, wear and damage. Check oil pump shaft for looseness in housing. Check inside of cover for wear or oil leakage. If excess wear or damage is found, replace oil pump as an assembly. Oil pump specifications are not available from manufacturer.

Reassembly & Installation

Clean parts in solvent. Dry parts using compressed air. To assemble, reverse disassembly procedure. To install, reverse removal procedure.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Camshaft Sprocket Bolt	18 (25)
Connecting Rod Cap Nut	
Step 1	20 (27)
Step 2	Additional 55 Degrees
Cooling Fan Pulley Bracket Nut	37 (50)
Cooling Fan Belt Pulley -To-Crankshaft Balancer Bolt	18 (25)
Crankshaft Hub-To-Crankshaft Bolt	74 (100)
Crankshaft Balancer-To-Hub Bolt	63 (85)
Crankshaft Rear Oil Seal Housing Bolt	11 (15)
Cylinder Head Bolt (1)	65 (88)
Exhaust Manifold Bolt	26 (35)
Flexplate/Flywheel-To-Crankshaft Bolt (2)	74 (100)
Intake Manifold Bolt	(3)
Main Bearing Cap Bolt	77 (105)
Oil Filter Adapter	17 (23)
Oil Pan Baffle Nut	30 (40)
Oil Pan Bolt/Nut (Corners)	15 (20)
Oil Pump-To-Main Bearing Bolt	66 (90)
Rocker Arm Stud	50 (68)
Secondary Air Injection	
Air Pump Bracket-To-Block	30 (40)
Air Check Valve	17 (23)
Right Side Air Pipe-To-Exhaust Manifold	18 (24)
Left Side Air Pipe-To-Exhaust Manifold	18 (24)
Throttle Body Bolt	18 (25)
Torque Converter-To-Flexplate Bolt	46 (62)
Valve Lifter Guide Bolt	18 (25)
Water Pump	
Bolt/Screw and Stud	30 (41)

Drvshft Bearing Retainer Bolt/Screw	30 (41)
	INCH Lbs. (N.m)
Front Cover Bolt	97 (11)
Oil Pan Bolt/Nut (Except Corners)	97 (11)
Secondary Air Injection	
Air Pump-To-Bracket Bolt	50 (5.6)
Cross Air Pipe Mounting Bolt	50 (5.6)
Valve Cover Bolt	106 (12)
Valve Cover Bolt	106 (12)

(1) Tighten in sequence (in 3 passes). See **Fig. 3**.

(2) Tighten bolts evenly using a crisscross sequence.

(3) Tighten bolts/studs in sequence to specification in 2 steps. See **Fig. 2**. On first sequence, tighten bolts/studs to 71 INCH lbs. (8 N.m). On second sequence, tighten bolts/studs to 35 Ft. lbs. (48 N.m).

ENGINE SPECIFICATIONS

GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS

Application	Specification
Displacement	350 Cu. In. (5.7L)
Bore	4.00" (101.6 mm)
Stroke	3.48" (88.4 mm)
Compression Ratio	10.0:1
Fuel System	SFI
Horsepower @ RPM	260 @ 5000
Torque Ft. Lbs. @ RPM	
Caprice, Impala SS & Roadmaster	330 @ 3200
Fleetwood	335 @ 2400

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

CRANKSHAFT, MAIN & CONNECTING ROD BEARINGS

Application	In. (mm)
Crankshaft	
End Play	.001-.007 (.03-.17)
Runout At Rear Flange (Maximum)	.0015 (.038)
Main Bearings	
Journal Diameter	
Journal No. 1	2.4484-2.4493 (62.189-62.212)
Journals No. 2, 3 & 4	2.4481-2.4490 (62.182-62.205)

Journal No. 5	2.4479-2.4488 (62.177-62.200)
Journal Out-Of-Round	
Standard	.0002 (.005)
Wear Limit	.0010 (.025)
Journal Taper	
Standard	.0002 (.005)
Wear Limit	.0010 (.025)
Oil Clearance	
Journal No. 1	
Standard	.0008 (.020)
Wear Limit	.0020 (.051)
Journals No. 2, 3 & 4	
Standard	.0011 (.028)
Wear Limit	.0025 (.064)
Journal No. 5	
Standard	.0017 (.043)
Wear Limit	.0035 (.089)
Connecting Rod Bearings	
Journal Diameter	2.0978-2.0998 (53.284-53.334)
Journal Out-Of-Round	
Standard	.0003 (.007)
Wear Limit	.0010 (.025)
Journal Taper	
Standard	.0003 (.007)
Wear Limit	.0010 (.025)
Oil Clearance	.0013-.0035 (.033-.088)

CONNECTING RODS

CONNECTING RODS

Application	**In. (mm)**
Maximum Bend	(1)
Maximum Twist	(1)
Side Play	.006-.014 (.16-.35)
(1) Replace rod if any bend or twist exists.	

PISTONS, PINS & RINGS

PISTONS, PINS & RINGS

Application	**In. (mm)**
Piston Clearance	.0010-.0027 (.025-.068)

Pins	
Diameter	.9270-.9271 (23.546-23.548)
Piston Fit	.0004-.0008 (.010-.020)
Rod Fit (Interference)	.0008-.0016 (.021-.040)
Rings	
No. 1	
End Gap	
Standard	.010-.020 (.25-.50)
Wear Limit	.035 (.88)
Side Clearance	
Standard	.0012-.0029 (.030-.073)
Wear Limit	.0043 (.110)
No. 2	
End Gap	
Standard	.018-.026 (.46-.66)
Wear Limit	.035 (.88)
Side Clearance	
Standard	.0012-.0029 (.029-.073)
Wear Limit	.0043 (.110)
No. 3 (Oil)	
End Gap	
Standard	.010-.030 (.25-.76)
Wear Limit	.065 (1.65)
Side Clearance	
Standard	.002-.007 (.05-.17)
Wear Limit	.008 (.20)

CYLINDER BLOCK

CYLINDER BLOCK

Application	**In. (mm)**
Cylinder Bore	
Diameter	4.0007-4.0017 (101.618-101.643)
Taper	
Standard	.0005 (.012)
Wear Limit	.0010 (.025)
Out-Of-Round	
Standard	.001 (.02)
Wear Limit	.002 (.05)

VALVES & VALVE SPRINGS

VALVES & VALVE SPRINGS

Application	Specification
Valves	
Face Angle	45°
Margin (Minimum)	.031" (.80 mm)
Valve Springs	
Free Length	2.0" (51 mm)
Installed Height	1.78" (45.2 mm)
Pressure (1)	
Valve Closed	76-84 @ 1.70 (34-37 @ 43.2)
Valve Open	187-203 @ 1.27 (83-90 @ 32.3)
(1) Lbs. @ In. (Kg @ mm).	

CYLINDER HEAD

CYLINDER HEAD

Application	Specification
Valve Seats	
Intake Valve	
Seat Angle	46°
Seat Width	.040-.065" (1.02-1.65 mm)
Exhaust Valve	
Seat Angle	46°
Seat Width	.065-.098" (1.65-2.49 mm)
Valve Guides	
Stem-To-Guide Oil Clearance	
Standard	.0011-.0027" (.028-.069 mm)
Wear Limit	
Intake	.0037" (.093 mm)
Exhaust	.0047" (.119 mm)

CAMSHAFT

CAMSHAFT

Application	In. (mm)
End Play	.004-.012 (.11-.30)
Journal Diameter	1.8677-1.8697 (47.440-47.490)
Lobe Lift	
Intake	.279 (7.09)
Exhaust	.286 (7.26)

On-Vehicle Adjustments - 4.3L

ENGINE MECHANICAL

NOTE: The Assembly Line Data Link (ALDL) connector may also be referred to as the Data Link Connector (DLC). The SERVICE ENGINE SOON (SES) light may also be referred to as the Malfunction Indicator Light (MIL).

Before performing any on-vehicle adjustments to fuel or ignition systems, ensure engine mechanical condition is okay.

VALVE CLEARANCE

NOTE: All models use hydraulic lifters. No adjustments are required.

IGNITION TIMING

4.3L WITH DISTRIBUTOR

1. Set parking brake, block drive wheels and place transmission in Neutral or Park. Warm engine to normal operating temperature. Turn A/C off (if equipped). Ensure Malfunction Indicator Light (MIL) is off.
2. Disconnect Tan/Black Electronic Spark Timing (EST) by-pass connector wire. DO NOT disconnect 4-wire connector at distributor.
3. On models where engine computer is located underhood, on right fenderwell, by-pass connector which is a single Tan/Black wire, breaks out of wiring harness near engine computer harness connectors.
4. On models where engine computer is located in passenger compartment under right side of instrument panel, by-pass connector which is a single Tan/Black wire, breaks out of wiring harness where heater box and carpet meet on passenger side floor. Pull back carpet to expose single Tan/Black wire and connector on outside of control module harness.
5. On all models, connect timing light to No. 1 spark plug wire. Check timing and adjust if necessary. See **IGNITION TIMING**. Reconnect EST by-pass connector. Clear Diagnostic Trouble Code (DTC).

4.3L WITH DIS

Ignition timing is not adjustable.

IGNITION TIMING (DEGREES BTDC @ RPM)

Application	Man. Trans.	Auto. Trans.
With Distributor	0 @ Idle	0 @ Idle
Distributorless	(1)	(1)

(1) Ignition timing is not adjustable.

IDLE SPEED & MIXTURE

CONTROLLED IDLE SPEED CHECK

NOTE: DO NOT attempt to adjust idle mixture and idle speed. Both are controlled by Electronic Control Module (ECM). Incorrect idle speeds are normally caused by dirty throttle plate or vacuum leaks. Ensure all vacuum components are functioning properly.

NOTE: Controlled idle speed and IAC count can be checked using scan tester. See CONTROLLED IDLE SPEED & IAC COUNT.

1. Ensure no trouble code(s) are present, IAC system is okay, and ignition timing is correct. Block drive wheels. Apply parking brake. Connect Tech 1 scan tester to Data Link Connector (DLC). Put scan tester into OPEN mode.
2. Start engine and bring to normal operating temperature. Check for correct state of Park/Neutral switch on scan tester. Check if idle speed and IAC valve pintle position (counts) are as specified. See **CONTROLLED IDLE SPEED & IAC COUNT**.
3. If idle speed is not within specification, refer to **TESTS W/O CODES - GASOLINE** article in this section.

CONTROLLED IDLE SPEED & IAC COUNT

Application	Idle RPM	(1) IAC Counts
CPI		
"L" Series (A/T) (2)	625	15-50
"M", "S" & "T" Series (A/T) (2)	550	5-40
TBI		
"C" & "K" Series		
Auto. Trans. (2) (4)	537	5-30
Auto. Trans. (2) (4)	650	20-35
Man. Trans. (3)	550	2-20
"G" Series		
Auto. Trans. (2)	538	5-30
Man. Trans. (3)	650	5-30
"L" Series		
Auto. Trans. (2)	625	5-50
Man. Trans. (3)	700	3-30
"M" Series (A/T) (2)	538	5-30
"P" Series		
Auto. Trans. (2)	650	5-30
	700	5-30

Man. Trans. (2)		
"S" & "T" Series		
Auto. Trans. (2)	650	5-30
Manual Trans.		
Pickup	725	3-30
Utility	700	5-30

(1) Add 2 counts for engines with less than 500 miles. On 4.3L engines, add 2 counts for every 1000 ft. above sea level.

(2) Automatic transmission in Drive.

(3) Manual transmission in Neutral. Tech 1 scan tester will display "RDL" with transmission in Neutral.

(4) Calibration identification is not given by manufacturer. IAC count and actual RPM should correspond to one of these calibrations.

THROTTLE POSITION (TP) SENSOR

TP sensor output voltage should be .85 volt or less at idle (closed throttle).

D - ADJUSTMENTS

ENGINE PERFORMANCE General Motors Corp. On-Vehicle Adjustments

ENGINE MECHANICAL

Before performing any on-vehicle adjustments to fuel or ignition systems, ensure engine mechanical condition is okay.

VALVE CLEARANCE

NOTE: All models use hydraulic lifters. Adjustments are not required.

IGNITION TIMING

NOTE: Procedures for timing adjustment are for engines equipped with HEI-EST distributors only. Other engines are equipped with C(3)I, DIS, IDI or Opti-Spark ignition system. Timing on these systems is not adjustable.

IDLE SPEED & MIXTURE

NOTE: Idle mixture is controlled by Powertrain Control Module (PCM). Adjustment is not possible.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

IDLE SPEED

NOTE: On 4.3L and 5.7L, idle speed is controlled by PCM. Slight fluctuations in idle speed are considered normal. Adjustment is not required. Refer to IAC VALVE RESET procedure below.

IAC Valve Reset

Idle speed is PCM-controlled. Resetting of IAC valve pintle is the only adjustment that can be performed. To reset IAC valve pintle position, depress accelerator pedal slightly. Start engine, and release accelerator pedal. Run engine for 5 seconds. Turn engine off for 10 seconds. Restart engine, and check for proper idle operation.

IDLE MIXTURE

NOTE: **Idle mixture is controlled by Powertrain Control Module (PCM). Adjustment is not required or possible.**

THROTTLE POSITION (TP) SENSOR

THROTTLE POSITION SENSOR

NOTE: **V8 engine TP sensor is not adjustable. For further testing procedures, refer to TESTS W/CODES or SYSTEM/COMPONENT TESTING article in this section.**

- **TESTS W/CODES - 4.3L** (Caprice Only)
- **TESTS W/CODES - 5.7L** (All Models)
- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

TP SENSOR ADJUSTMENT VOLTAGE

Application	(1) Volts
4.3L & 5.7L	(2) .60-5.00

(1) Voltage range is from idle position to wide open throttle position.

(2) TP sensor is not adjustable.

ENGINE PERFORMANCE Basic

Diagnostic Procedures - 4.3L

MODEL IDENTIFICATION

MODEL IDENTIFICATION

Series (1)	Model
"C"	2WD Pickup, Sierra
"G"	(2) Van
"K"	4WD Pickup, Sierra
"L"	AWD Astro & Safari
"M"	2WD Astro & Safari
"P"	Commercial Van
"S"	2WD Blazer, Jimmy, S10 Pickup & Sonoma
"T"	4WD Blazer, Jimmy, S10 Pickup & Sonoma

(1) Vehicle series is fifth character of VIN.

(2) Includes Rally Van and Vandura.

INTRODUCTION

The following diagnostic steps help prevent overlooking simple problems. This is also where to begin diagnosis for no-start condition.

The first step in diagnosing any driveability problem is verifying the customer's complaint by test driving vehicle under the conditions in which the problem reportedly occurred.

Before entering self-diagnostics, perform a careful and complete visual inspection. Most engine control problems result from mechanical breakdowns, poor electrical connections or damaged/misrouted vacuum hoses. Before condemning the computerized system, perform each test listed in this article.

NOTE: Unless otherwise instructed in test procedures, perform all voltage tests using a Digital Volt-Ohmmeter (DVOM) with a minimum 10-megohm input impedance.

NOTE: Following table provides location of commonly used diagnostic information. These former "A" and "C" charts are now written in text and inserted into appropriate location of engine performance workflow. To learn about engine performance workflow, see HOW TO USE THE ENGINE PERFORMANCE SECTION in this section.

"A" & "C" CHART REFERENCE

System Or Component	Diagnostic Information Location
DIAGNOSTIC CIRCUIT CHECK	See appropriate DIAGNOSTIC CIRCUIT CHECK

A-1 & A-2, MIL	See appropriate DIAGNOSTIC CIRCUIT CHECK
A-3, No-Start	See A-3, NO-START DIAGNOSIS
A-4, Injector Circuit	See **INJECTOR CIRCUIT DIAGNOSIS**
A-5, Fuel Pump Relay	(1) See RELAYS, SOLENOIDS, MOTORS & MODULES
A-6 & A-7, Fuel System Diagnosis	See appropriate BASIC FUEL SYSTEM CHECKS
A-8, Injector Coil	See **INJECTOR COIL TEST**
C-1, MAP Sensor	(1) See ENGINE SENSORS & SWITCHES
C-1, Power Steering Pressure Switch	(1) See ENGINE SENSORS & SWITCHES
C-1, Park/Neutral Switch	(1) See ENGINE SENSORS & SWITCHES
C-2, Injector Balance Test (4.3L)	(1) See FUEL CONTROL under FUEL SYSTEM
C-2, IAC Motor	(1) See IDLE CONTROL SYSTEM under FUEL SYSTEM
C-3, Canister Purge System	(1) See appropriate EMISSION SYSTEMS & SUB-SYSTEMS
C-4, EST Ignition Check	See C-4, BASIC IGNITION SYSTEM CHECKS
C-5, ESC Ignition Check	(1) See IGNITION SYSTEM
C-6, Air Injection System	(1) See appropriate EMISSION SYSTEMS & SUB-SYSTEMS
C-7, EGR System	(1) See appropriate EMISSION SYSTEMS & SUB-SYSTEMS
C-8, Torque Converter Clutch	(1) See MISCELLANEOUS ECM CONTROLS
C-8, M/T Shift Lights	(1) See MISCELLANEOUS ECM CONTROLS
C-10, A/C Clutch Control	(1) See MISCELLANEOUS ECM CONTROLS
C-12, Electric Cooling Fan Control	(1) See MISCELLANEOUS ECM CONTROLS
(1) See **SYSTEM/COMPONENT TESTS - 4.3L** article in this section.	

PRELIMINARY INSPECTION & ADJUSTMENTS

VISUAL INSPECTION

Visually inspect all electrical wiring. Look for chafed, stretched, cut or pinched wiring. Ensure electrical connectors fit tightly and are not corroded. Ensure vacuum hoses are properly routed and not pinched or cut. If necessary, see **VACUUM DIAGRAMS - 4.3L** article to verify routing and connections. Inspect air induction system for possible vacuum leaks.

MECHANICAL INSPECTION

Compression

Check engine mechanical condition using a compression gauge, vacuum gauge or engine analyzer capable of performing a relative compression test. If using engine analyzer, see engine analyzer instruction manual for availability and description of relative compression feature.

WARNING: Because fuel injectors on many models are triggered by ignition switch during cranking mode, DO NOT use ignition switch during compression tests. Use a remote starter to crank engine to prevent fire hazard or engine's oiling system contamination.

Exhaust System Backpressure

Before replacing any components, check exhaust system for restrictions. Use a vacuum gauge or a low-pressure (1-5 psi) pressure gauge to check exhaust system.

If using a vacuum gauge, connect gauge to intake manifold vacuum, and start engine. Observe gauge while holding throttle steady at 2000-2500 RPM. If vacuum gauge reading slowly drops after stabilizing, exhaust system may be restricted.

Check At Oxygen Sensor

Remove oxygen sensor. Install backpressure tester in place of oxygen sensor. After test is completed, coat oxygen sensor threads with anti-seize compound before installation.

Diagnosis

1. Start engine and bring to operating temperature. Increase engine speed to 2000-2500 RPM. Note gauge. Exhaust system is restricted if reading exceeds 1.25 psi (.09 kg/cm^2).
2. Check exhaust system for collapsed pipe, heat distress and possible internal muffler failure. If none of these conditions exists, check for restricted catalytic converter. Replace as required.

A-3, NO-START DIAGNOSIS

DEFINITION

No-start is defined as engine cranks okay but does not start. Engine may fire a few times.

NOTE: Before performing following tests, check battery condition, engine cranking speed and fuel supply.

NO START - ENGINE CRANKS OKAY (HEI-EST)

General Inspection

1. Ensure proper starting procedure is being used.
2. Visually check vacuum hoses for splits, kinks and improper connections. See underhood emission control information label. Check ignition wires for cracks, hardness, and improper connections at distributor cap and spark plugs.
3. Remove spark plugs. Check and replace if necessary.
4. Remove distributor cap and check for moisture, dust, cracks, burns, and arcing to ground through coil mounting screws or rotor.

5. Try to turn distributor shaft by hand. Drive gear pin may be broken.
6. If vehicle has been exposed to very cold temperatures, ensure oil is of proper viscosity and not contaminated with gasoline.

Ignition System

1. Disconnect tachometer wire at distributor tachometer terminal (if equipped). A shorted tachometer or tachometer circuit prevents vehicle from starting. Ensure TP sensor and coolant sensor codes are not present, and sensors are not out of calibration.
2. Check for battery voltage at "+" terminal of ignition coil with ignition on. See **Fig. 1** - **Fig. 4** . Repair as necessary.
3. Connect Spark Tester (ST-125) to end of one plug wire. Crank engine. If spark is present, check fuel delivery.
4. If spark does not occur, disconnect 4-wire EST connector at distributor and check for spark at ignition coil tower using Spark Tester (ST-125). If spark now occurs, check cap and rotor for damage or wear. Check for open in coil wires.
5. If spark does not occur, reconnect EST connector. Leave spark tester connected to coil tower for remainder of test. Disconnect ignition coil Black 2-wire connector, and check voltage on "C" and "+" terminals with ignition on.
6. If voltage on both terminals is 10 volts or greater, go to next step. If voltage on both terminals is less than 10 volts, repair wire from module "+" terminal to "B" terminal on coil Black 2-wire connector. If voltage is less than 10 volts on "C" terminal only, check for open or short to ground in circuit from "C" terminal of ignition module to ignition coil. If circuit is okay, problem is faulty coil or coil connections.
7. Connect voltmeter between ground and tachometer terminal at coil with ignition on. Tachometer terminal may be taped back against harness. If voltage is greater than 10 volts, go to step 9).
8. If voltage is 1-10 volts, replace ignition module and check for spark at coil tower using Spark Tester (ST-125). If voltage is less than one volt, repair open in tachometer lead or tachometer connector. After repairs, recheck voltage at tachometer terminal.
9. Connect test light between ground and tachometer terminal. Crank engine. If test light remains on (steady), go to next step. If test light flashes, replace ignition coil with a known-good unit and recheck for spark. If spark does not occur, reinstall original ignition coil and replace ignition module.
10. Remove distributor cap. Unplug ignition module pick-up coil connector. Connect voltmeter between ground and tachometer terminal. Turn ignition on. Using jumper wires, connect positive end of a known-good 1.5-volt battery to terminal "P" of module. Observe voltmeter at tachometer terminal as negative end of test battery is momentarily grounded to distributor housing.
11. If voltage at tachometer terminal does not drop, check ignition module ground. Check for open in wires from ignition coil to module. If all is okay, replace ignition module.
12. If voltage at tachometer terminal drops, check for spark at spark tester as jumper is removed from terminal "P". If spark does not occur, go to next step. If spark occurs, check pick-up coil connections. Check for 500-1500 ohms resistance at pick-up coil leads. Ensure leads are not shorted to ground. Repair as necessary.
13. Test ignition module with module tester. If module tests okay, check ignition coil wire. If module tester is not available, replace ignition coil, and touch terminal "P" again. If spark occurs, system is okay. If spark does not occur, reinstall original ignition coil, and check coil wire from distributor cap. If no problem is

found, replace ignition module.

Fuel System (TBI)

1. Before checking fuel system for a no-start condition, check ignition for adequate spark. Check for proper fuel pump pressure (9-13 psi) and capacity (one pint in 30 seconds).
2. Crank engine, and watch for injector spray. If injector spray occurs, go to step 5). If no spray occurs, disconnect injector harness. Check for battery voltage at harness with ignition on. Battery voltage should be present on one injector terminal. If battery voltage is not present, check for blown injector power fuse. If battery voltage is present on both terminals, check for wires shorted together.
3. If battery voltage is present on only one terminal, connect injector test light to injector harness. Crank engine, and note light. If light flashes, check for stored PCM codes. See **DIAGNOSTIC CIRCUIT CHECK**. If no codes are present, refer to HARD START symptom in **TESTS W/O CODES - GASOLINE** article in this section. If light does not flash, momentarily touch test light from battery voltage to PCM RPM reference terminal (circuit No. 430 - Purple/White wire).
4. Each time test light is removed from PCM RPM reference terminal, injector test light should flash. If test light does not flash, check for open in RPM reference wire or injector drive (ground) circuit. If wiring is okay, replace faulty PCM. Before replacing PCM, check PCM power and ground circuits.
5. Disconnect injector harness, and crank engine. If injector spray or leakage occurs, a no-start condition may be caused by excessive fuel being delivered during cranking. Repair faulty injector or injector seal. If no spray or leakage occurs, refer to HARD START symptom in **TESTS W/O CODES - GASOLINE** article in this section.

Fuel System (CPI 4.3L VIN W)

Before checking fuel system for a no-start condition, check ignition for adequate spark. For fuel system testing, see **FUEL SYSTEM PRESSURE TEST** under A-7, BASIC FUEL SYSTEM CHECKS.

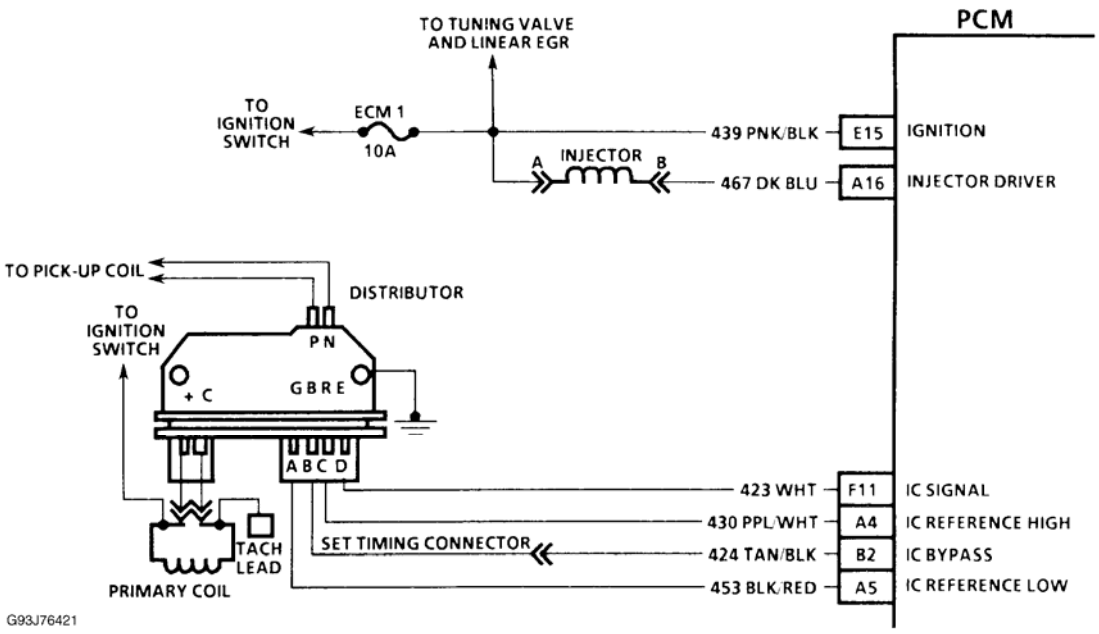


Fig. 1: HEI Ignition & Injector Circuits (4.3L CPI "M", "L", "S" & "T" Series With A/T)
Courtesy of GENERAL MOTORS CORP.

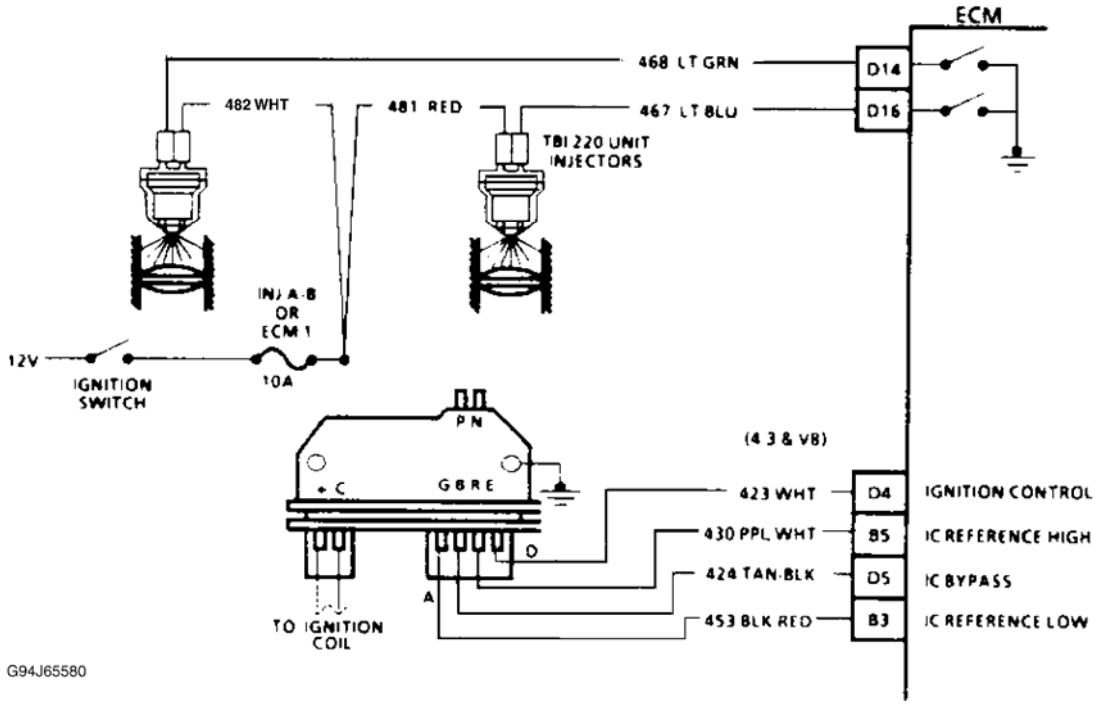


Fig. 2: HEI Ignition & Injector Circuits (4.3L TBIL "P3" & "P/G3" Series With M/T)
Courtesy of GENERAL MOTORS CORP.

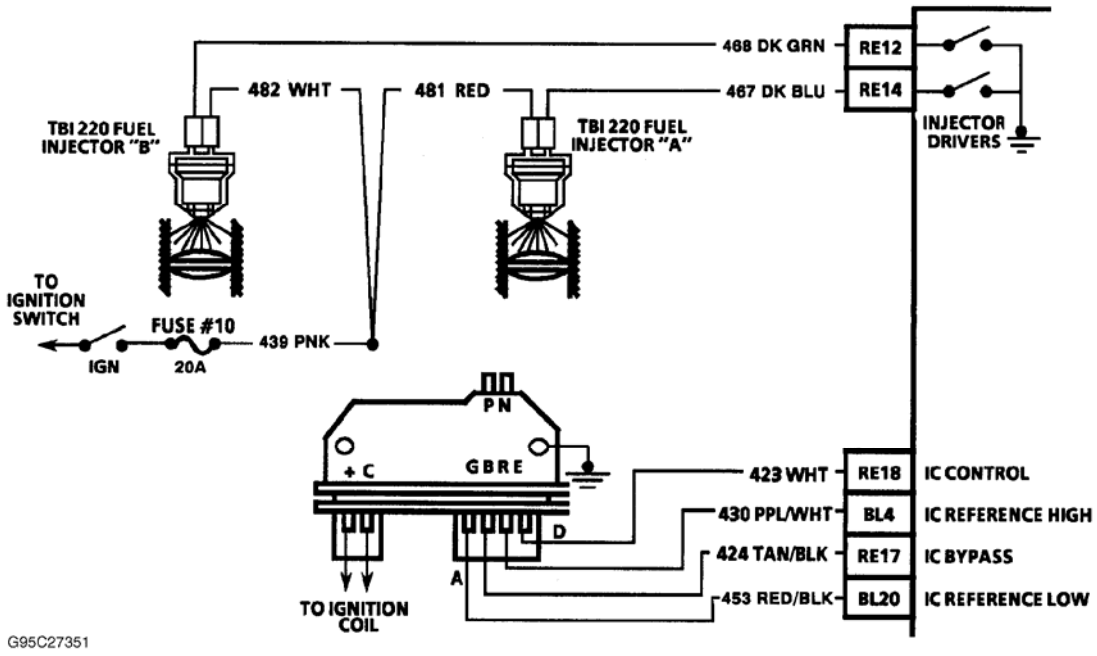


Fig. 3: HEI Ignition & Injector Circuits (4.3L TBI "S" & "T" Series With M/T)
Courtesy of GENERAL MOTORS CORP.

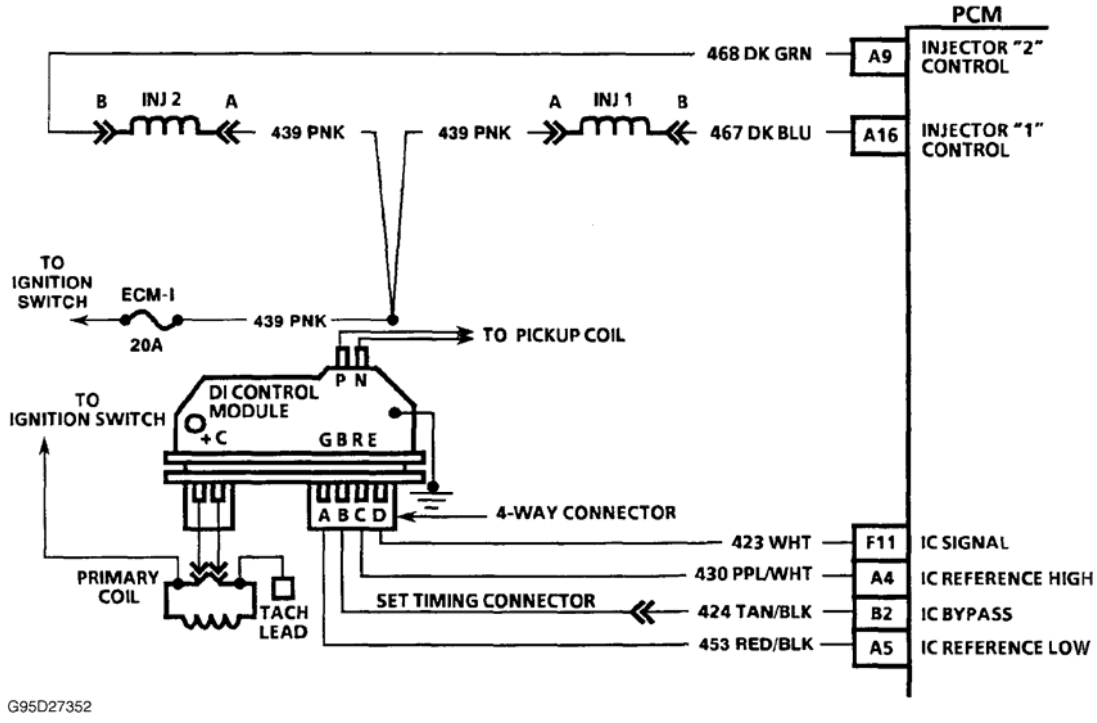


Fig. 4: HEI Ignition & Injector Ckts. (4.3L A/T & M/T "C", "G" & "K")
Courtesy of GENERAL MOTORS CORP.

NO START - ENGINE CRANKS OKAY (ENHANCED/HIGH VALUE IGNITION SYSTEM)

General Inspection

1. Ensure proper starting procedure is being used.
2. Visually check vacuum hoses for splits, kinks and improper connections. See underhood emission control information label. Check ignition wires for cracks, hardness, and improper connections at distributor cap and spark plugs.
3. Remove spark plugs. Check and replace if necessary.
4. Remove distributor cap and check for moisture, dust, cracks or burns. Try to turn distributor shaft by hand. Drive gear pin may be broken.
5. If vehicle has been exposed to very cold temperatures, ensure oil is of proper viscosity and not contaminated with gasoline.

Ignition System

1. Check if Code P1221 is stored. If code is present, diagnose code first. Check TP sensor voltage. If TP sensor voltage is greater than 2.5 volts at closed throttle, see Code P0118. Check ECT sensor reading. If ECT sensor reading is -30°C, see Code P0118. See **TESTS W/CODES - 4.3L** article.
2. Turn ignition off for 10 seconds. Turn ignition on. Listen for fuel pump operation. Fuel pump should operate for 2 seconds. If fuel pump operates, go to next step. If fuel pump does not operate, check fuel pump relay and circuit. See the appropriate **SYSTEM/COMPONENT TESTS - 4.3L** article.
3. Disconnect injector connector at intake manifold. Connect Injector Test Light (J 34730) to wiring harness connector. Crank engine. If injector test light flashes, go to next step. If injector test light does not flash or stays on steady, go to step 6).
4. Disconnect one spark plug wire. Install Spark Tester (ST-125). Crank engine and check for spark. If spark is present, go to next step. If spark is not present, proceed to the **C-4, BASIC IGNITION SYSTEM CHECKS**.
5. Reconnect spark plug wire. Turn ignition off. Relieve fuel pressure. See **FUEL SYSTEM PRESSURE RELIEF**. Connect Fuel Pressure Gauge (J 34730-1). Turn ignition on. Fuel pressure should be 55-61 psi (3.9-4.3 kg/cm^2) when fuel pump stops. Pressure should hold steady. If fuel pressure is as specified and holds steady, check injectors. See **SYSTEM/COMPONENT TESTS - 4.3L** article. If fuel pressure is not as specified, go to **A-7, BASIC FUEL SYSTEM CHECKS**.
6. If injector test light does not illuminate, go to next step. If injector test light stayed on steady, check for short to ground in injector circuit. See **Fig. 5**. If circuit is okay, check injector resistance. Injector resistance should be greater than 1.3 ohms. If resistance is as specified, replace VCM-A. If resistance is not as specified, replace faulty injector.

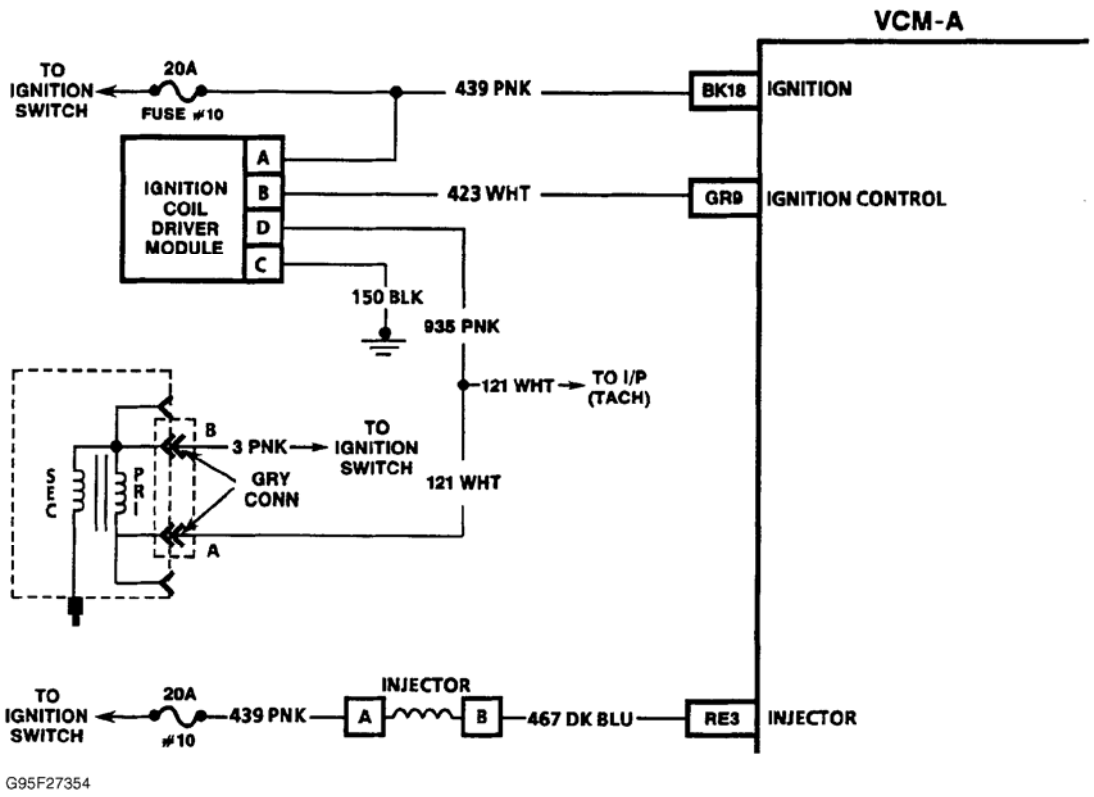


Fig. 5: Enhanced/High Value Ignition & Injector Circuits (4.3L CPI "S" & "T" Series A/T & M/T With VCM-A)
Courtesy of GENERAL MOTORS CORP.

7. Turn ignition off. Disconnect coil high voltage wire. Disconnect3-pin crank sensor harness connector. Turn ignition on. Using test light connected to battery, momentarily touch test light to Yellow wire crank sensor harness connector terminal. If injector test light flashed, check for faulty crank sensor harness connection or faulty crank sensor. If injector test light does not flash, go to next step.
8. Turn ignition off. Check for open or grounded Yellow wire to crank sensor or faulty VCM-A connector. If wire or connector is okay, remove injector test light.
9. Turn ignition on. Using test light connected to ground, probe engine harness connector. If test light illuminates on one of the terminals, go to next step. If test light illuminates on both terminals, repair short to voltage in Dark Blue wire between injector and VCM-A. If test light does not illuminate on either terminal, repair open between ignition coil (Driver module) Pink wire to VCM-A.
10. Turn ignition off. Reconnect injector connector. Disconnect Red VCM-A connector. Turn ignition on. Using test light connected to ground, probe VCM-A terminal No. RE3. If test light illuminates, check for faulty VCM-A connector or faulty VCM-A. If test light does not illuminate, check for faulty VCM-A connector or open in circuit.

Fuel System (CPI)

Before checking fuel system for a no-start condition, check ignition for adequate spark. For fuel system testing, see the **FUEL SYSTEM PRESSURE TEST** under A-7, BASIC FUEL SYSTEM CHECKS.

A-4 INJECTOR CIRCUIT DIAGNOSIS

NOTE: This test only applies to vehicles equipped with a VCM.

1. **ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK**. After performing OBD system check, go to next step.
2. Disconnect injector connector at intake manifold. Turn ignition on. Using test light connected to ground, probe ignition feed circuits. See WIRING DIAGRAMS article. If test light illuminates, go to next step. If test light does not illuminate, go to step 7).
3. Install injector test light to each injector circuit, one at a time. Crank engine. If injector test light flashes on each injector, check fuel injector(s). See FUEL SYSTEM in I -SYSTEM/COMPONENT TESTS article. If injector test light did not flash on an injector circuit, go to next step.
4. If injector test light was on steady on an injector circuit, go to next step. If injector test light did not illuminate on an injector circuit, go to step 6).
5. Install injector test to affected injector. Turn ignition off. Disconnect Blue and Red VCM connectors. Turn ignition on, with engine off. If injector test light turns off, go to step 11). If injector test light stays on, go to step 8).
6. Check for open or short in battery circuit to affected injector. If circuit is open or shorted, go to next step. If circuit is okay, go to step 9).
7. Repair circuit as necessary. After repairs, go to step 12).
8. Repair short to ground in injector control circuit. After repairs, go to step 12).
9. Check terminal contact at VCM connector. If terminal contact is faulty, go to next step. If terminal contact is okay, go to step 11).
10. Repair terminal contact. After repairs, go to step 12).
11. Replace VCM. Reprogram replacement VCM. After replacing VCM, go to next step.
12. Using scan tool, select DTC, CLEAR INFO mode. Attempt to start engine. If engine starts and continues to run, go to next step. If engine does not start or starts and stalls/dies, go to step 14).
13. Warm engine to normal operating temperature. Using scan tool, select DTC, FAILED THIS IGN mode. If other DTC(s) are present, diagnose affected DTC(s). If no other DTC(s) are present, go to next step.
14. Using scan tool, select CAPTURE INFO, REVIEW INFO. If additional undiagnosed DTC(s) are present, diagnose affected DTC(s). If DTC(s) are not present, system is okay.

A-7, BASIC FUEL SYSTEM CHECKS

FUEL SYSTEM PRESSURE RELIEF

CAUTION: Begin fuel system trouble shooting and diagnosis with fuel system pressure test. Relieve fuel system pressure before disconnecting any components or installing fuel pressure gauge.

CPI (4.3L VIN W)

Fuel system is under pressure, which must be relieved before servicing fuel system. Fuel pressure may be

relieved by one of the following methods.

- Disconnect fuel pump at rear body connector. Start and allow engine to run until it stalls. Crank starter 3 seconds to remove remaining fuel from fuel lines. Reconnect rear body connector.
- Install Fuel Pressure Gauge (J-34730-1) on fuel pressure connector of fuel rail. Wrap shop towel around pressure connection when installing fuel pressure gauge to absorb fuel leakage. Place gauge bleed hose in container. Open bleed valve to relieve fuel pressure.

TBI Unit

Fuel pressure is relieved and drops to zero when ignition is turned off. To minimize risk of fire and personal injury, cover area to be disconnected with a shop rag.

FUEL SYSTEM PRESSURE TEST

> **WARNING: Begin fuel system trouble shooting and diagnosis with fuel system pressure test. Relieve fuel system pressure before disconnecting any components or installing fuel pressure gauge.**

CPI (4.3L VIN W)

1. Relieve fuel pressure. See **FUEL SYSTEM PRESSURE RELIEF**. Connect Fuel Pressure Gauge (J-34730-1) to fuel pressure connector. Turn ignition on. With ignition on and engine off, pressure should be 54-64 psi (3.8-4.5 kg/cm^2) and should hold steady.
2. If pressure is within specification and holds, go to next step. If pressure is within specification but does not hold, go to step 4). If fuel pressure is not present, go to step 7). If pressure is greater than specification, go to step 9). If pressure is less than specification, go to step 5).
3. Start engine. With engine at operating temperature, open throttle quickly and note fuel pressure. If fuel pressure is not close to64 psi (4.5 kg/cm^2), replace CPI assembly. If fuel pressure is close to 64 psi (4.5 kg/cm^2), problem does not exist.
4. Check for leaking injectors or fittings by pinching off fuel return line. If pressure does not hold, replace CPI assembly. If pressure holds, check for faulty in-tank fuel pump or pump connections.
5. Check for restricted delivery line or fuel filter. Repair as necessary. If no restriction is evident, apply battery voltage to fuel pump test connector using a 10-amp fused jumper wire. For location of fuel pump test connector, see COMPONENT LOCATIONS in **SYSTEM/COMPONENT TESTS - 4.3L** article.
6. Gradually pinch off flexible fuel return line between CPI assembly and fuel tank. If fuel pressure increases to within specification, pressure regulator is faulty. Replace CPI assembly. If fuel pressure does not increase with line pinched, check for faulty in-tank fuel pump, loose pump connections or partially blocked fuel strainer.
7. Use a 10-amp fused jumper wire to apply battery voltage to fuel pump test connector. For location of fuel pump test connector, see COMPONENT LOCATIONS in **SYSTEM/COMPONENT TESTS - 4.3L** article. Observe fuel pressure reading. If fuel pressure is still not present, check wiring between test connector and fuel pump. If wiring is okay, replace fuel pump.
8. If fuel pressure is present with voltage applied to test connector, test fuel pump relay and voltage supply to relay. See **SYSTEM/COMPONENT TESTS - 4.3L** article.

9. Relieve fuel pressure. Disconnect fuel return line. Attach a 5/16" flexible fuel line to CPI side of fuel line. Route hose into appropriate container. Turn ignition on, and note fuel pressure. If fuel pressure is within specification, locate and repair restriction in fuel return line. If fuel pressure is still greater than specification, replace CPI assembly.

TBI

1. Turn ignition off for 10 seconds. Turn ignition on, and listen at fuel tank for fuel pump operation. Pump should run 2 seconds (20 seconds on models with fuel module). If fuel pump runs, go to next step. If fuel pump does not run, go to step 7).
2. If fuel pump runs, turn ignition off. Verify fuel tank has fuel. Relieve fuel pressure. See **FUEL SYSTEM PRESSURE RELIEF**. Remove air cleaner, and plug air cleaner vacuum ports (if equipped). Disconnect fuel line between throttle body and fuel filter. Install Fuel Pressure Gauge (J-29658-D) and Adapter (J-2968A-85) between steel fuel line and flexible hose, on outlet side of fuel filter.
3. Turn ignition on, and note reading on pressure gauge. If fuel pressure is 9-13 psi (.63-.91 kg/cm^2) or 26-32 psi (1.8-2.4 kg/cm^2) on 7.4L engines, no problem exists. If pressure is less than either of the low readings, go to step 5). If pressure is greater than either of the higher readings, turn ignition off, and bleed fuel pressure. Disconnect fuel return line downstream of pressure gauge. Insert return line into a gasoline container.
4. Turn ignition on. If pressure is now as specified, correct restriction in fuel return line between disconnected point and fuel tank. If fuel pressure is greater than either of the higher readings, check for restricted return line (including fuel filter) downstream of pressure gauge. If no restrictions are present, replace fuel pressure regulator assembly.
5. Check for restricted fuel line between in-tank fuel pump and pressure regulator. If fuel line is okay, disconnect injector connector. Turn ignition on. Gradually pinch fuel pressure gauge outlet hose. Note pressure.

   CAUTION: DO NOT pinch off fuel return line completely. DO NOT allow fuel pressure build-up to exceed specification, as damage to fuel pressure regulator may occur.

6. If pressure is greater than 13 psi (.91 kg/cm^2) or 32 psi (2.2 kg/cm^2) on 7.4L engines, replace fuel pressure regulator. If pressure is less than 9 psi (.63 kg/cm^2) or 26 psi (1.8L kg/cm^2) on 7.4L engines, check for faulty fuel pump or incorrect part. Check fuel pump coupling hose and pump inlet filter in fuel tank. On models with dual fuel tanks, check for faulty fuel tank selector valve and meter switch.
7. Apply 12 volts to fuel pump test connector. For fuel pump test connector location, see underhood engine component views under COMPONENT LOCATIONS in **SYSTEM/COMPONENT TESTS - 4.3L** article. If fuel pump now runs, repair open in fuel pump relay drive or power circuit or repair faulty fuel pump relay. To test relay, see **SYSTEM/COMPONENT TESTS - 4.3L** article.
8. If fuel pump does not run with 12 volts applied to fuel pump test connector, repair open in fuel pump power or ground circuit, or repair faulty fuel pump.

FIELD SERVICE MODE CHECK

NOTE: Assembly Line Data Link (ALDL) connector may also be referred to as Data Link

Connector (DLC). SERVICE ENGINE SOON (SES) light may also be referred to as Malfunction Indicator Light (MIL).

NOTE: Oxygen sensor may cool off while engine idles, causing system to enter open loop. To restore closed loop mode, run engine at part throttle several minutes and accelerate from idle to part throttle several times.

This test confirms proper fuel system operation and verifies closed loop operation. Clear codes and perform this test after any repair is completed. When performing this test, always engage parking brake and block drive wheels. Parking brake on FWD models does not hold drive wheels.

1. Start engine. With engine running, ground diagnostic test terminal "B" of DLC. See **Fig. 9** - **Fig. 12** . In closed loop mode, Malfunction Indicator Light (MIL) flashes once per second.
2. In open loop, light flashes 2.5 times per second. A lean exhaust is indicated if light is usually off. A rich exhaust is indicated if light is usually on.

A-8, INJECTOR COIL TEST

1. Perform on-board diagnostic test. Diagnose any Diagnostic Trouble Code (DTC) present. If DTC is not present, go to next step.
2. Turn ignition off. Relieve fuel pressure. Connect Fuel Injector Tester (J-39021) to battery positive. Connect Injector Switch Box (J-39021-210). Set amperage on fuel injector tester to 2.5-amp. Connect DVOM to fuel injector tester. Connect Tech 1 scan tool and monitor engine coolant temperature. If coolant temperature is 50-95°F (10-35°C), go to step 4). If coolant temperature is not as specified, go to next step.
3. Allow engine to warm or cool as necessary. If engine coolant temperature is now 50-95°F (10-35°C), go to next step.
4. Using fuel injector tester, press PUSH TO START TEST button and monitor DVOM reading. Perform this test to each injector. Voltage reading should be 5.44-7.53 volts. If voltage reading is as specified, go to next step. If voltage reading is not as specified, perform injector balance test. See A-7, CENTRAL SEQUENTIAL PORT INJECTOR BALANCE TEST (CSI).
5. Replace faulty injector nozzle and poppet assembly and then proceed to next step.
6. Using Tech 1 scan tool, select DTC, CLEAR INFO. Start engine. If engine starts and continues to run, go to next step. If engine does not start or starts and dies, repeat step 2).
7. Warm engine to normal operating temperature. Using scan tool, select DTC, FAILED THIS IGN. If DTC (s) are present, diagnose DTC(s). If DTC(s) are not present, go to next step.
8. Using scan tool, select CAPTURE INFO, REVIEW INFO. If additional DTC(s) are present, diagnose DTC(s). If DTC(s) are not present, system is okay.

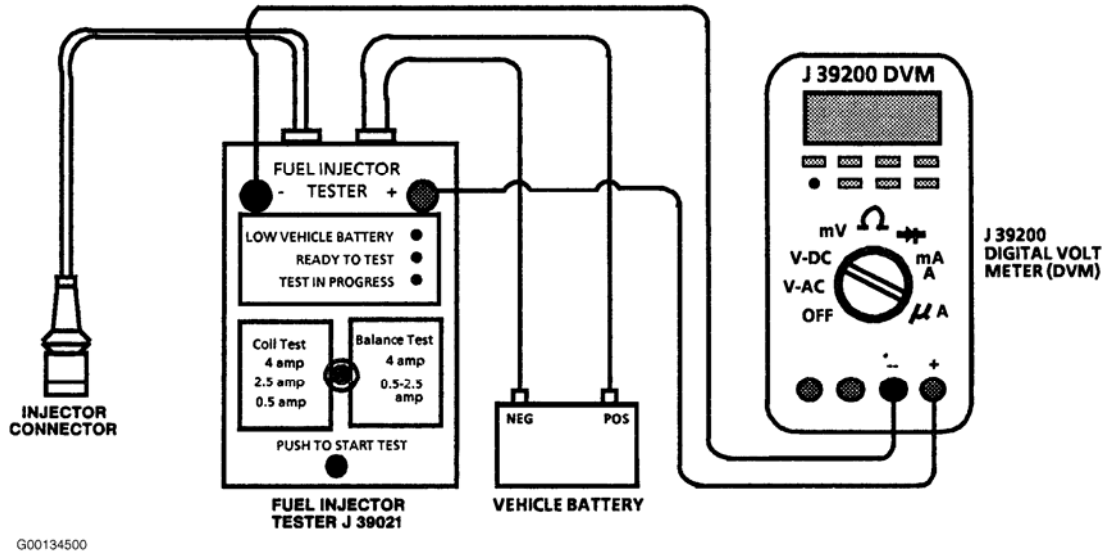


Fig. 6: Identifying Injector Coil Test
Courtesy of GENERAL MOTORS CORP.

C-4, BASIC IGNITION SYSTEM CHECKS

ENHANCED/HIGH VALUE IGNITION SYSTEM (OBD-II)

NOTE: This system is used on "S" and "T" Series with 4.3L engine equipped with VCM-A controller. Timing is not adjustable on this system.

Spark

1. If equipped with factory tachometer, disconnect tachometer terminal before performing tests. To disconnect tachometer lead, it is necessary to disconnect the Gray ignition coil connector from ignition coil. Using a fused jumper wire, jumper connector terminal "B" of ignition coil and Terminal Test Adapter Kit (J 35616-A).
2. Using Spark Tester (ST-125), crank engine and check for spark at coil wire and at each spark plug wire. If spark is not present or intermittent, go to next step. If spark is present, check spark plugs and fuel system.
3. Check coil wire or spark plug wire resistance on suspect wire. Resistance should be about 1000 ohms per inch.

Ignition Coil Power Source

1. Turn ignition off. Disconnect ignition coil driver module connector. Turn ignition on. Using DVOM, check voltage at ignition coil driver module terminals "A" and "D". See **Fig. 5**. Both terminals should read 10 volts or greater. If voltage is as specified on both terminals, go to next step. If voltage is 10 volts or less on either or both terminals, go to step 6).
2. Place DVOM on AC scale. Connect DVOM to ignition coil module terminal "B" and ground. Crank

engine. Voltage reading should be 1-4 volts. If voltage reading is as specified, go to next step. If voltage reading is not as specified, go to step 4).

3. Connect test light to battery voltage and probe coil driver module connector terminal "C". See **Fig. 5**. If test light illuminates, check for faulty ignition coil driver module connection or faulty ignition coil module. If test light does not illuminate, check for open ignition coil driver module ground.
4. Turn ignition off. Disconnect Gray VCM-A harness connector. Check for continuity between VCM-A ignition control connector terminal and ignition driver module connector terminal "B". If continuity is present, go to next step. If continuity is not present, check for open IC circuit between VCM-A and ignition coil driver module.
5. Connect test light to battery voltage and probe VCM-A ignition control harness terminal. If test light illuminates, check for grounded IC circuit between VCM-A and ignition coil driver module. If test light does not illuminate, check for faulty VCM-A connection or VCM-A.
6. If voltage is less than 10 volts on both terminals, check for faulty ignition feed circuit to ignition coil, grounded external coil circuit or faulty ignition coil. If voltage is less than 10 volts on only one of the terminals, check circuit from affected terminal or check for faulty coil connection or faulty coil.

HEI-EST DISTRIBUTOR

NOTE: Only basic ignition timing is adjustable in HEI/EST ignition system.

Spark

1. If factory tachometer is connected to ignition coil tachometer terminal, disconnect it before performing tests. When removing spark plug wire from spark plug, twist and pull on boot. **DO NOT** pull on wire.
2. Using Spark Tester (ST-125), check for spark at coil wire (if applicable) and at each spark plug wire. Check spark plug wire resistance on suspect wires. Resistance should not be greater than 30,000 ohms.

Ignition Coil Power Source

Turn ignition on. Use voltmeter to check voltage between terminal "B" of ignition coil and ground. If battery voltage does not exist, check for open circuit, blown ignition fuse or defective ignition switch.

Ignition Coil Resistance

1. Remove coil connectors and secondary coil wire. In test "A", use high ohmmeter scale. See **Fig. 7**. Resistance value should be very high (infinite). If reading is not infinite, replace coil.
2. In test "B", use low ohmmeter scale. Reading should be very low (near zero ohms). If reading is not near zero ohms, replace coil. In test "C", use high ohmmeter scale. Continuity should exist. If no continuity exists, replace coil.

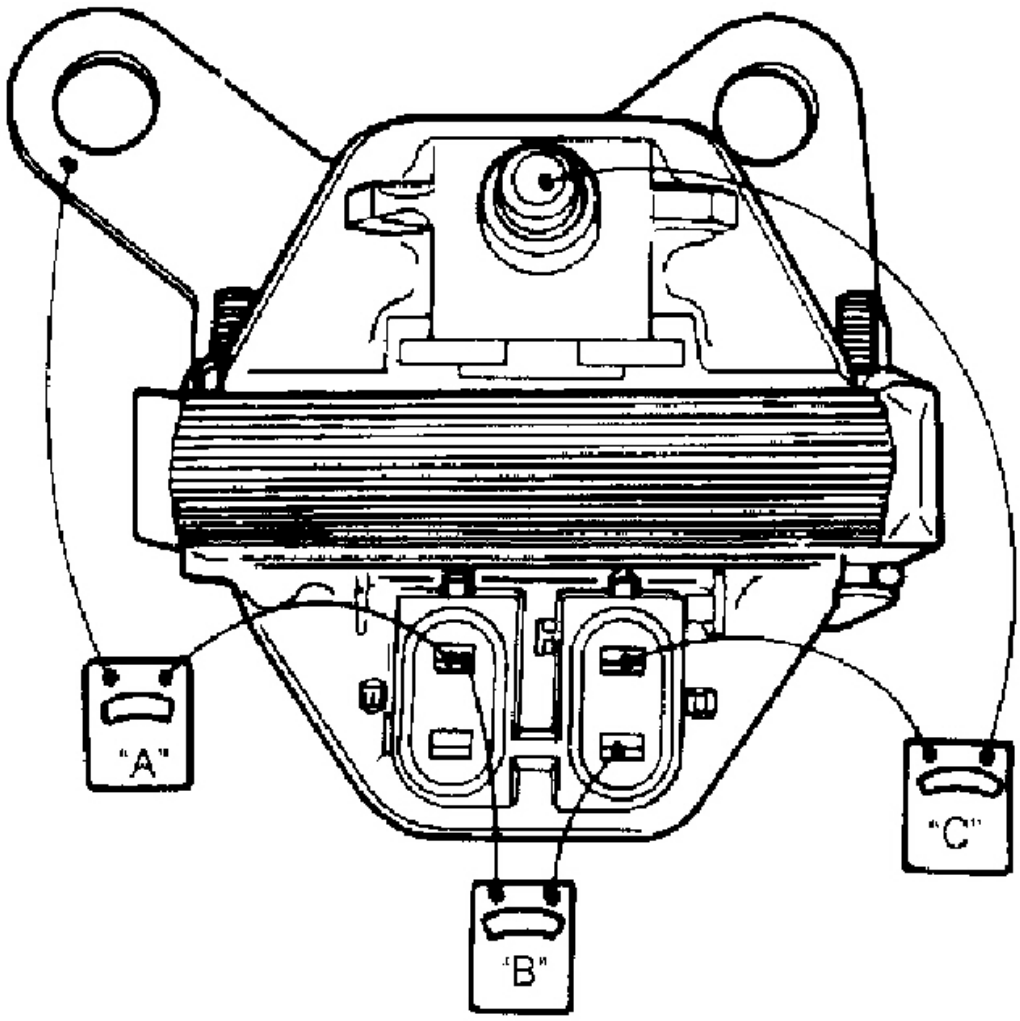


Fig. 7: Testing HEI-EST Ignition Coil Resistance
Courtesy of GENERAL MOTORS CORP.

Distributor Pick-Up Coil Short & Resistance Checks

1. Disconnect pick-up coil leads from module. Using ohmmeter, check pick-up coil resistance. Connect ohmmeter to distributor housing and either pick-up coil lead (step 1 in illustration). See **Fig. 8**. Flex pick-up coil leads by hand to check fo r intermittent short to ground. If reading is not always infinite, replace pick-up coil.
2. Connect ohmmeter between pick-up coil leads (step 2 in illustration). See **Fig. 8**. Check for intermittent open by flexing wire s and connectors. If resistance is not 500-1500 ohms, replace pick-up coil.

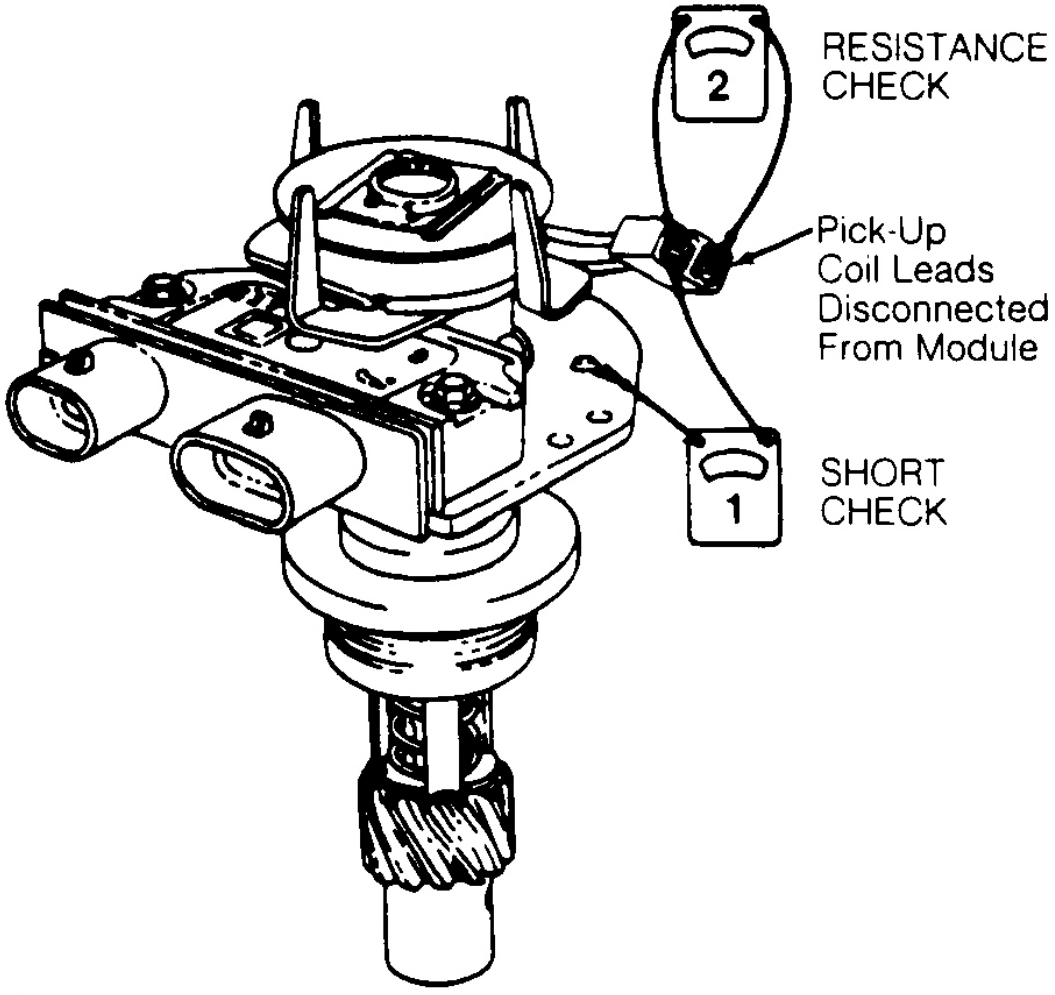


Fig. 8: Checking HEI-EST Distributor Pick-Up Coil
Courtesy of GENERAL MOTORS CORP.

Tach Pulse (RPM) Signal

Connect scan tester to DLC. RPM should be indicated on tester when engine is cranked or running. Tach pulse (RPM reference) will be indicated as a voltage signal when a DVOM connected to battery voltage is used to backprobe circuit No. 430, PCM terminal. See **Fig. 3**-5. If tach pulse signal is not present, vehicle will not run.

IDLE SPEED & IGNITION TIMING

Ensure idle speed and ignition timing are set to specifications. For specifications, see **SPECIFICATIONS - 4.3L** article. For adjustment procedures, see **ADJUSTMENTS - 4.3L** article.

DIAGNOSTIC CIRCUIT CHECK

DIAGNOSTIC CIRCUIT CHECK DETERMINES THE FOLLOWING:

- Whether Malfunction Indicator Light (MIL) works.
- Whether ECM/PCM/VCM/VCM-A is operating and can recognize a fault.
- Whether any codes are stored.

After performing basic diagnostic procedures listed under PRELIMINARY INSPECTION & ADJUSTMENTS; A-7, BASIC FUEL SYSTEM CHECKS and C-4, BASIC IGNITION SYSTEM CHECKS, use self-diagnostic system for determining computer-related problems. See **Fig. 16**.

If codes are NOT indicated and driveability problems still exist after performing necessary tests in diagnostic circuit check, see **TESTS W/O CODES - GASOLINE** article and SCAN TESTER USAGE under SELF-DIAGNOSTIC SYSTEM in **TESTS W/CODES - 4.3L** article.

1. Check MIL operation. Turn ignition on with scan tester not connected, DLC terminal not grounded and engine not running. MIL should be on steadily. If light glows and stays on steadily, go to next step. If light does not glow, go to A-1, MALFUNCTION INDICATOR LIGHT (MIL) INOPERATIVE. If light flashes, go to step 3).
2. Ground DLC test terminal "B". MIL should flash Code 12, followed by any codes stored in PCM memory. If light goes from bright to dim or if light remains on and does not flash Code 12, see A-2, MALFUNCTION INDICATOR LIGHT (MIL) ALWAYS ON OR WON'T FLASH CODE 12.
3. Check for short to ground in diagnostic test terminal wire between DLC terminal "B" and PCM terminal. See **Fig. 9** - **Fig. 12** . If circuit is okay, replace PCM.

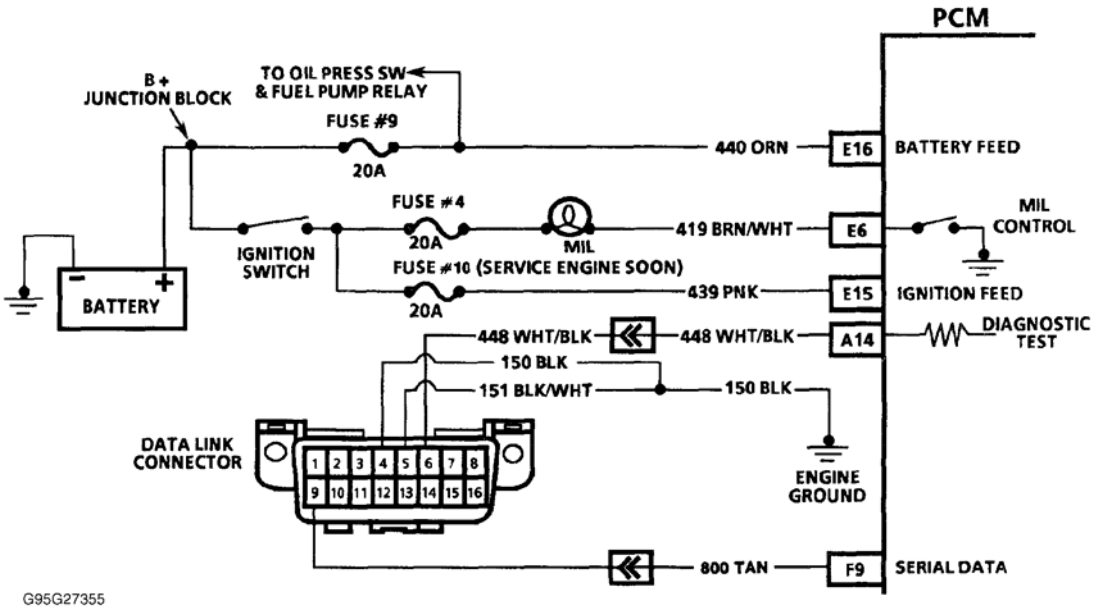


Fig. 9: Fuel Injection Diag. Ckt. Schematic (4.3L A/T "S" & "T" Series With PCM)

Courtesy of GENERAL MOTORS CORP.

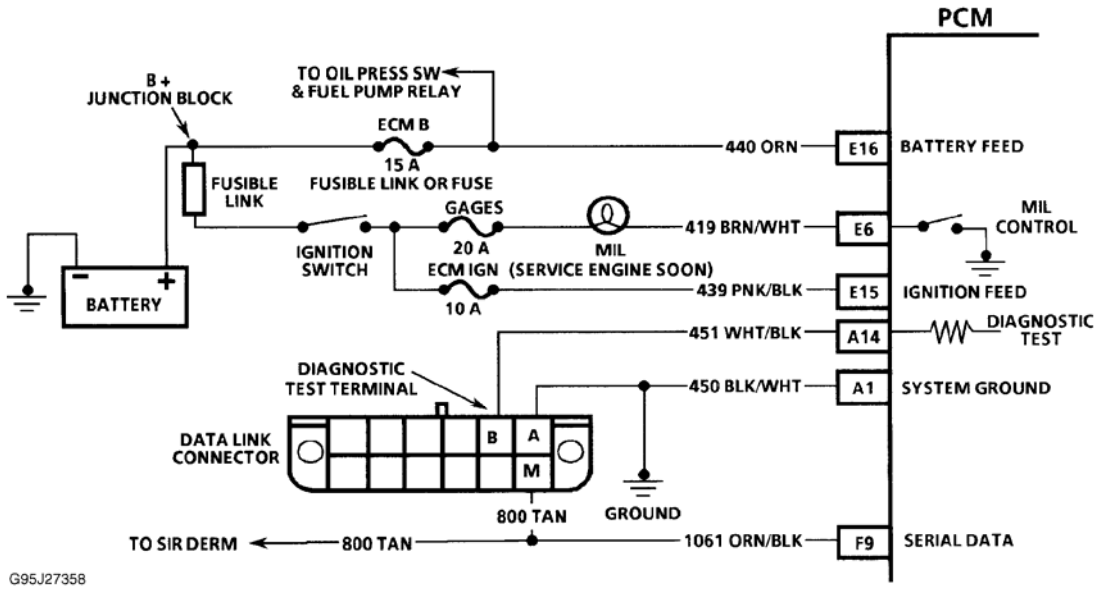


Fig. 10: Fuel Injection Diagnostic Circuit Schematic (4.3L "C", "G", "K", "L", "M" & "P" Series)
Courtesy of GENERAL MOTORS CORP.

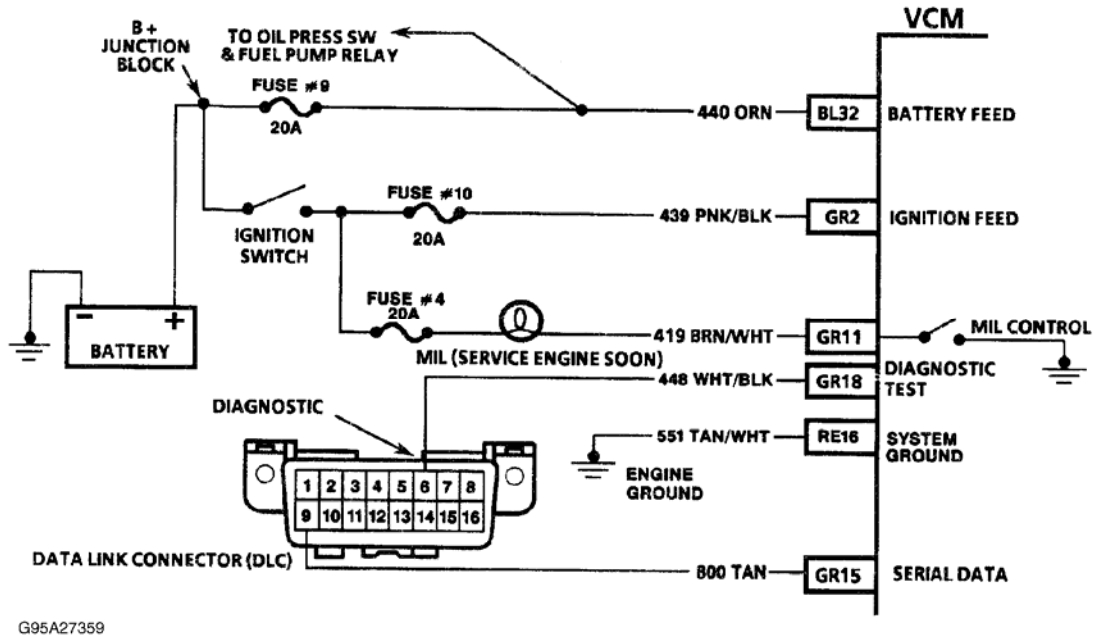


Fig. 11: Fuel Injection Diagnostic Circuit Schematic (4.3L VIN Z M/T "S" & "T" Series With VCM)
Courtesy of GENERAL MOTORS CORP.

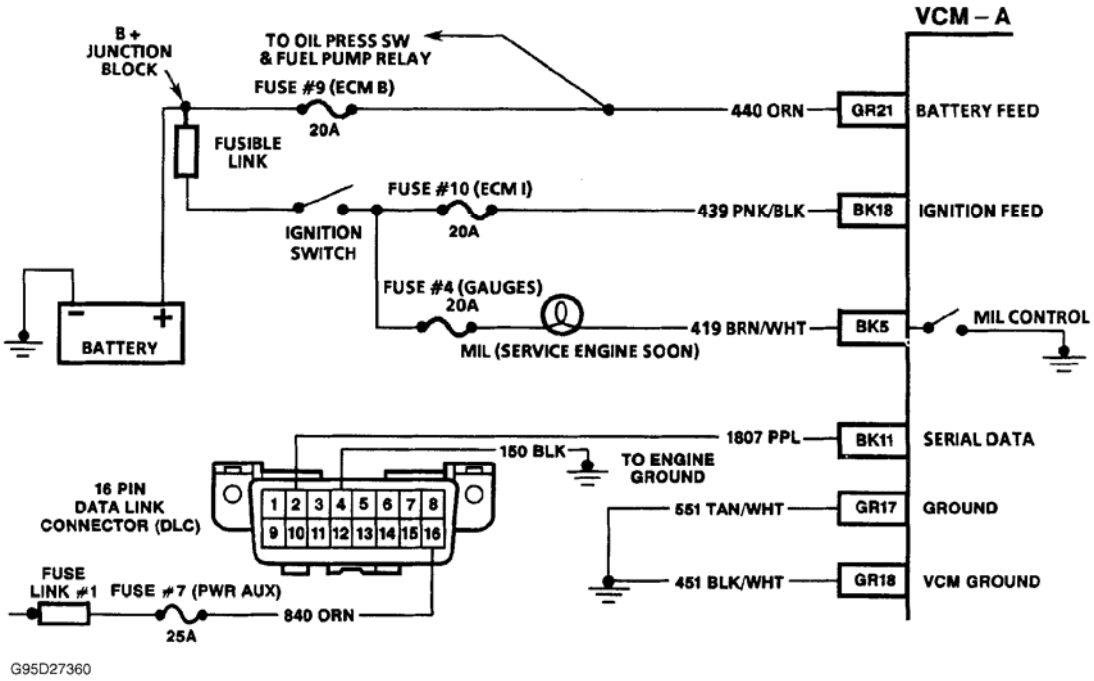


Fig. 12: Fuel Injection Diagnostic Circuit Schematic (4.3L VIN W "S" & "T" Series With VCM-A) Courtesy of GENERAL MOTORS CORP.

A-1, MALFUNCTION INDICATOR LIGHT (MIL) INOPERATIVE

1. If MIL does not illuminate with ignition on and engine off, attempt to start engine. If engine starts, go to step 3). If engine does not start, check fusible links at battery. Also check PCM fuse. If fusible links or PCM fuse are blown, repair short to ground.
2. If fusible links and PCM fuse are okay, turn ignition on and check power circuits to PCM, including keep-alive memory and ignition feed. See appropriate WIRING DIAGRAM in the **WIRING DIAGRAMS** section at the end of this article for power terminal identification. If power to PCM power terminals is not available, check for open in power circuits. If power to PCM power terminals is available, check for poor PCM ground circuits. If circuits are okay, replace faulty PCM.
3. Turn ignition off. Disconnect PCM connectors. Turn ignition on, and connect PCM MIL driver terminal to ground using a test light. See See appropriate WIRING DIAGRAM in the **WIRING DIAGRAMS** section at the end of this article for power terminal identification.
4. If MIL is now on, repair MIL driver terminal connections at PCM, or replace faulty PCM. If MIL stays off when test light is used to ground MIL driver terminal, check for blown instrument panel fuse, faulty bulb, open in MIL driver circuit between PCM and bulb, short in driver circuit to voltage or open in ignition feed to MIL.

A-2, MIL ALWAYS ON OR WON'T FLASH CODE 12

1. Turn ignition on, engine off. If MIL does not illuminate, see A-1, MALFUNCTION INDICATOR LIGHT (MIL) INOPERATIVE. If MIL is on, ground DLC test terminals "A" and "B". Code 12 should flash. If Code 12 does not flash, go to next step. If Code 12 now flashes, problem is no serial data. Check

serial data circuit for open or short to ground, or short to voltage between PCM and DLC terminal. If circuits are okay, replace faulty PCM or PROM (MEM-CAL).

2. Turn ignition off. Disconnect PCM connectors. Turn ignition on. If MIL is on, check for short to ground in MIL driver circuit between MIL and PCM driver terminal. See **Fig. 9** - **Fig. 12** . Also, see See appropriate WIRING DIAGRAM in the **WIRING DIAGRAMS** section at the end of this article for terminal identification.
3. If light is off with PCM connectors disconnected, turn ignition off. Reconnect PCM connectors. Turn ignition on with engine off and diagnostic terminal not grounded. Using a test light connected to ground, backprobe PCM terminal circuit to DLC terminal "B". See **Fig. 9** - **Fig. 12** . If MIL does not flash Code 12, go to next step. If MIL flashes Code 12, check for open in DLC test terminal "B" circuit to PCM. If circuit is okay, check for open in DLC terminal "A" circuit to PCM and PCM ground. See **Fig. 9** - **Fig. 12** .
4. Check PROM (MEM-CAL) for proper installation. If installation is okay, replace PCM using original PROM (MEM-CAL). Recheck for Code 12. If Code 12 is not present, replace PROM (MEM-CAL). If Code 12 is present, system is okay.

ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK

NOTE: Use of Tech 1 scan tool is required to perform ON-BOARD DIAGNOSTIC (OBD) SYSTEM CHECK.

THE OBD SYSTEM CHECK DETERMINES:

- If Malfunction Indicator Light (MIL) works.
- If PCM/VCM is operating and can recognize a fault.
- If any Diagnostic Trouble Codes (DTCs) are stored.

After performing procedures in PRELIMINARY INSPECTION & ADJUSTMENTS, BASIC FUEL SYSTEM CHECKS and BASIC IGNITION SYSTEM CHECKS, this is the starting point for utilizing the self-diagnostic system for determining computer-related problems. After performing necessary tests as described in the OBD system circuit check, if no codes are indicated and driveability problems still exist, see TESTS W/O CODES article and SCAN TESTER usage in TESTS W/CODES article.

1. Turn ignition on with engine off. Observe Malfunction Indicator Light (MIL). If MIL illuminates, go to next step. If MIL does not illuminate, go to **A-1, MALFUNCTION INDICATOR LIGHT (MIL)**.
2. Turn ignition off. Install Tech 1 scan tool and follow scan tool manufacturer's instructions to proceed with test. Turn ignition on. If scan tool displays PCM data, go to next step. If scan tool does not display PCM data, go to **A-2, NO SCAN TOOL DATA**.
3. Attempt to start engine. If engine starts and runs, go to next step. If engine does not start or starts and dies, see A-3, NO-START DIAGNOSIS. Repair as necessary.
4. Using scan tool, observe DTC status LAST TST FAIL function. If any DTC is stored, save freeze frame and fail record information using CAPTURE INFO feature. If a DTC is indicated as last test failed, diagnose affected DTC. See TESTS W/CODES article. If DTC is not indicated, go to next step.
5. Using scan tool, display DTC fail records. If a DTC fail record is stored, save freeze frame and fail record information using scan tool CAPTURE INFO feature. If a fail record is stored, diagnose affected DTC.

See TESTS W/CODES article.

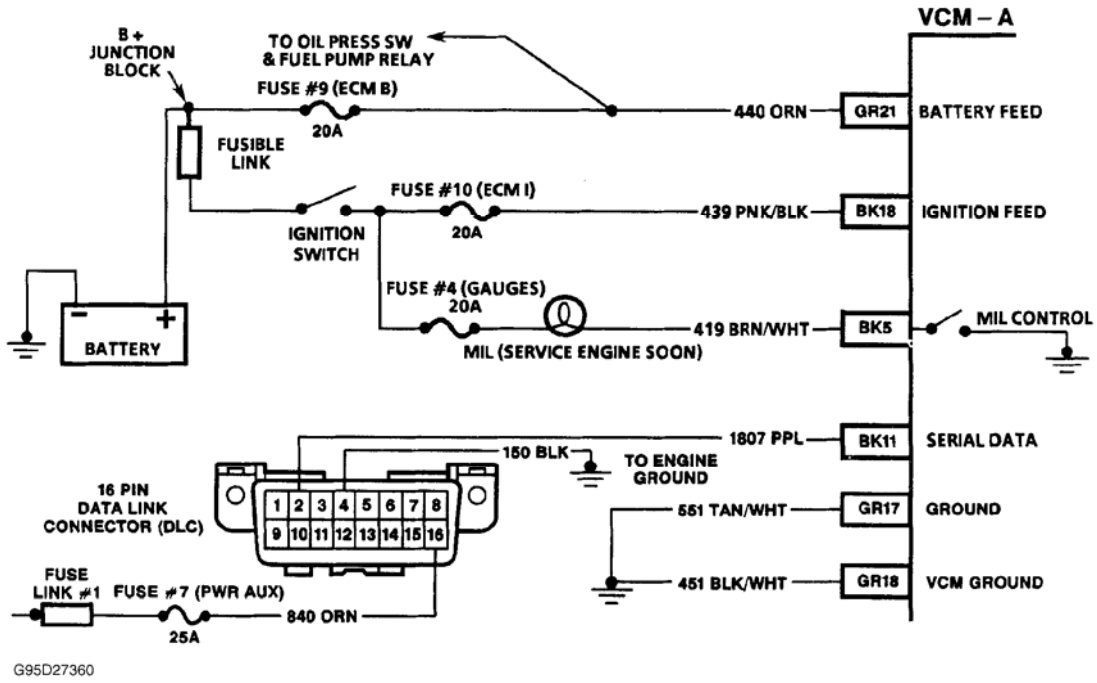


Fig. 13: Data Link Connector Circuit Schematic (OBD)
Courtesy of GENERAL MOTORS CORP.

A-1, MALFUNCTION INDICATOR LIGHT (MIL)

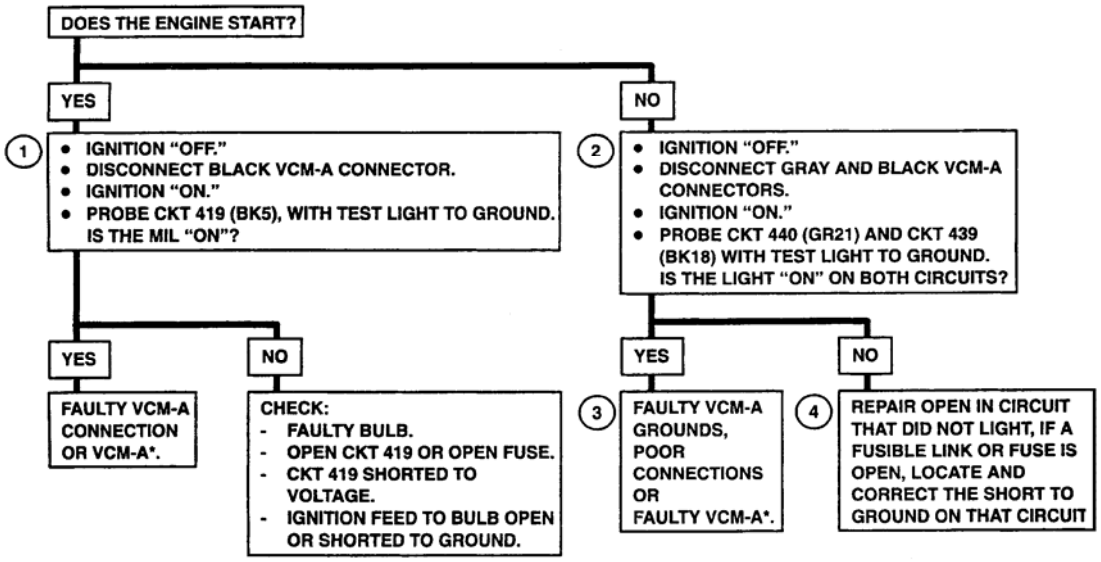


Fig. 14: Flow Chart A-1, Malfunction Indicator Light (MIL) (OBD)
Courtesy of GENERAL MOTORS CORP.

A-2, NO SCAN TOOL DATA

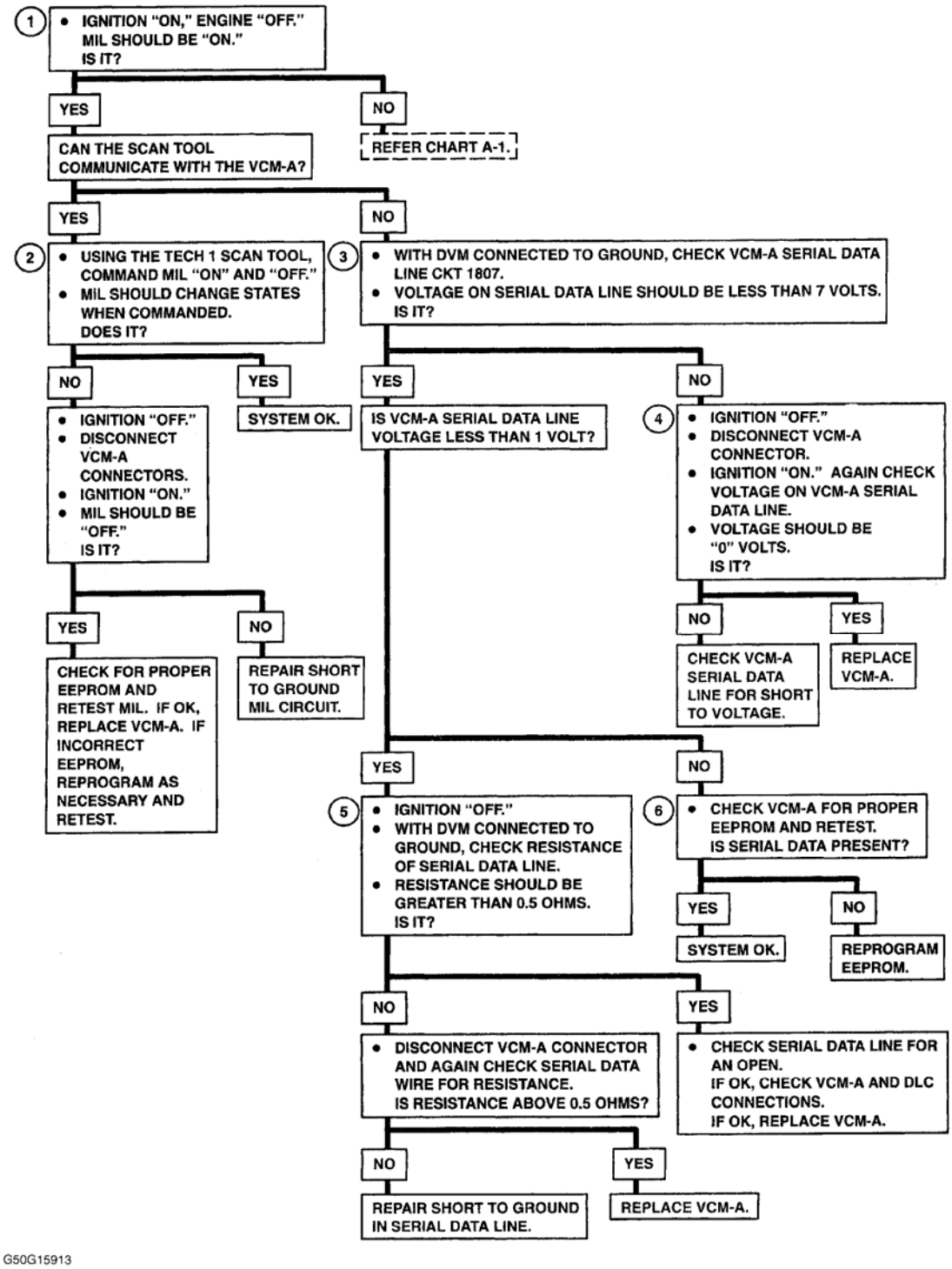


Fig. 15: Flow Chart A-2, No Scan Tool Data (OBD)
Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC CIRCUIT CHECK & WORK FLOW CHART

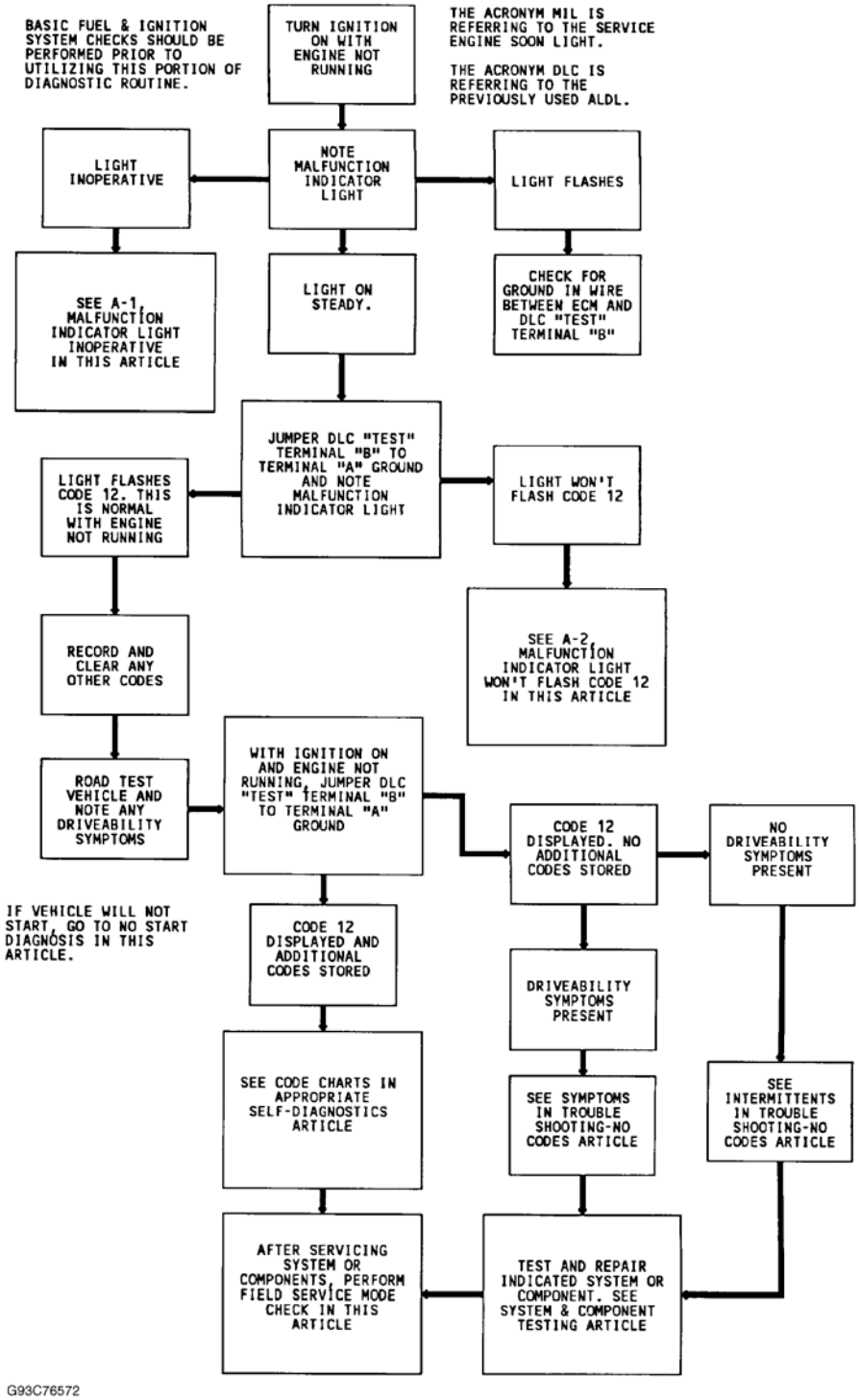


Fig. 16: Diagnostic Circuit Check & Work Flow Chart

SUMMARY

If faults were not found while performing BASIC DIAGNOSTIC PROCEDURES, proceed to **TESTS W/CODES - 4.3L** article. If no hard codes are found in self-diagnostics, or vehicle does not have a self-diagnostic system, proceed to **TESTS W/O CODES - GASOLINE** article for diagnosis by symptom (i.e., ROUGH IDLE, NO START, etc.) or intermittent diagnostic procedures.

WIRING DIAGRAMS

ASTRO & SAFARI

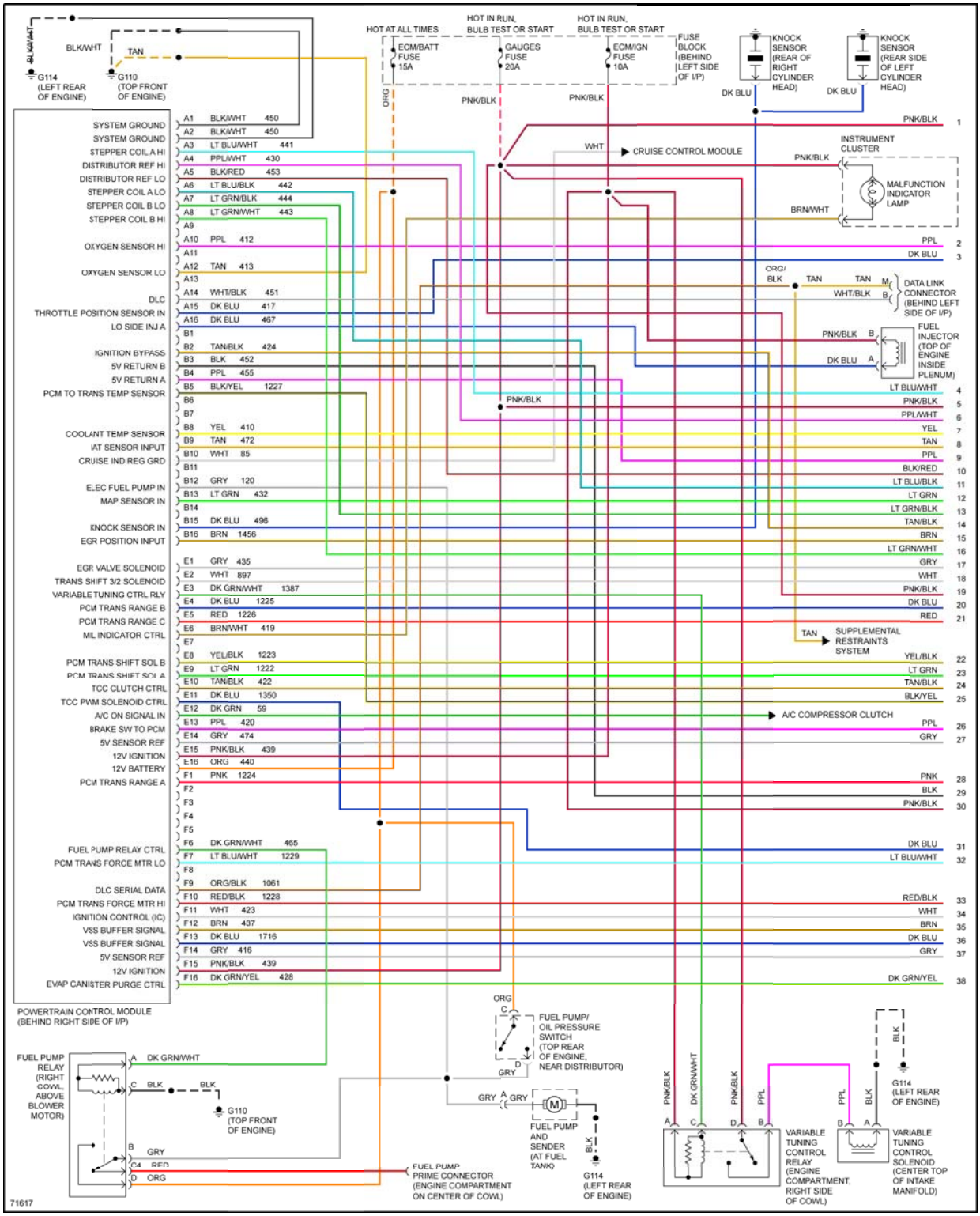


Fig. 17: Wiring Diagram (Astro & Safari 4.3L - 1 Of 2)

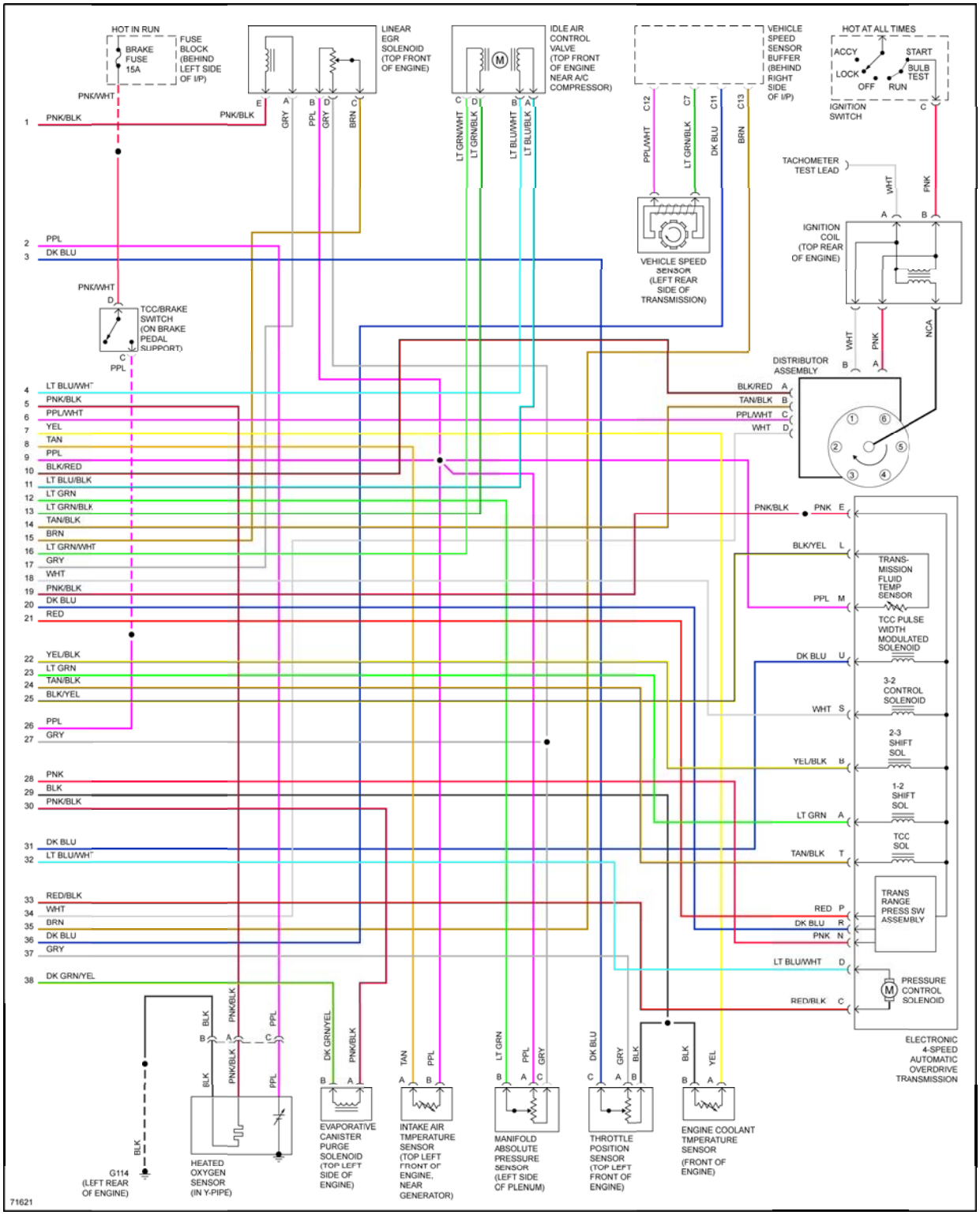


Fig. 18: Wiring Diagram (Astro & Safari 4.3L - 2 Of 2)

"C" & "K" SERIES WITH A/T

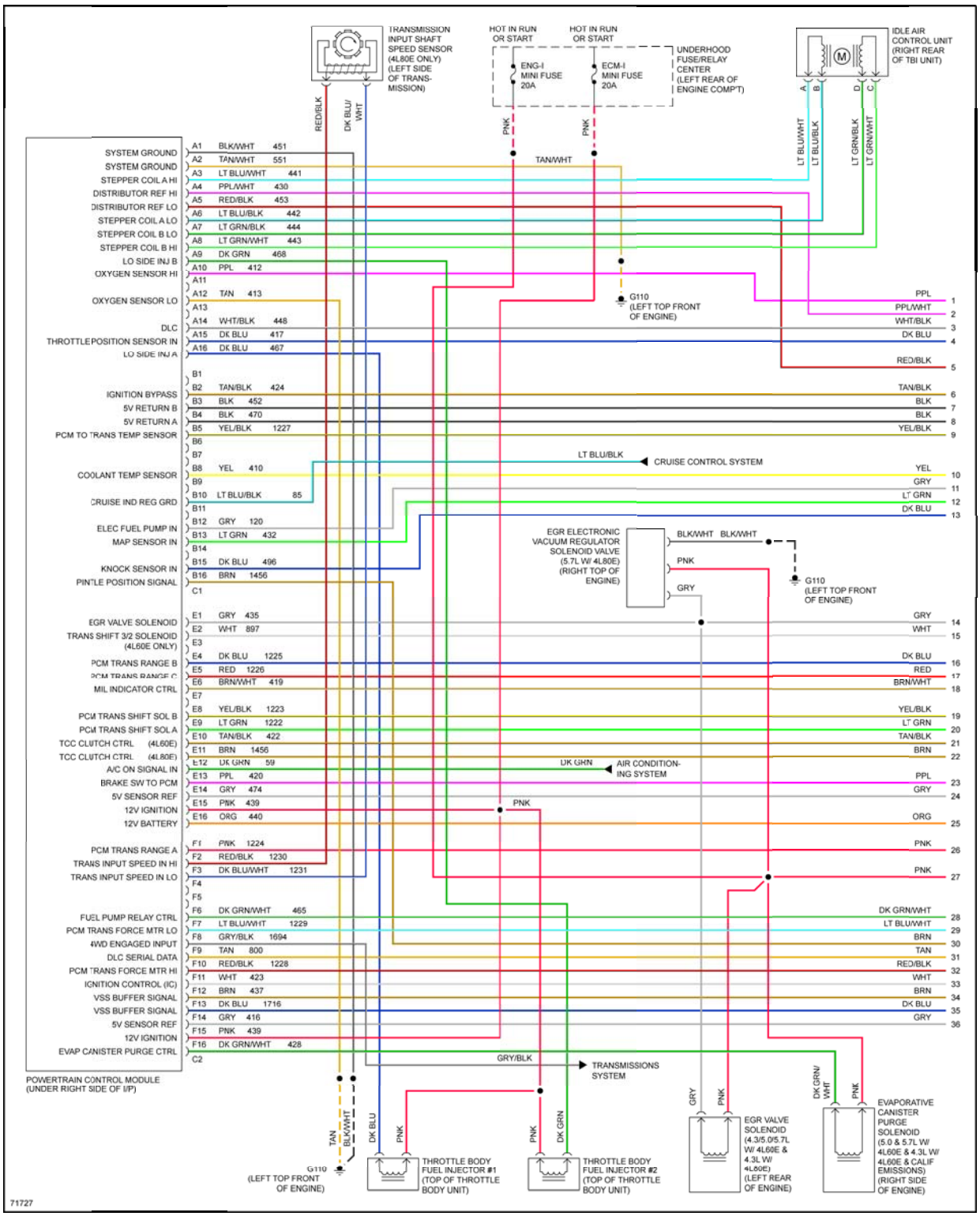


Fig. 19: Wiring Diagram ("C" & "K" Series Pickup, Sierra, Suburban, Tahoe & Yukon - 4.3L With A/T

- 1 Of 3)

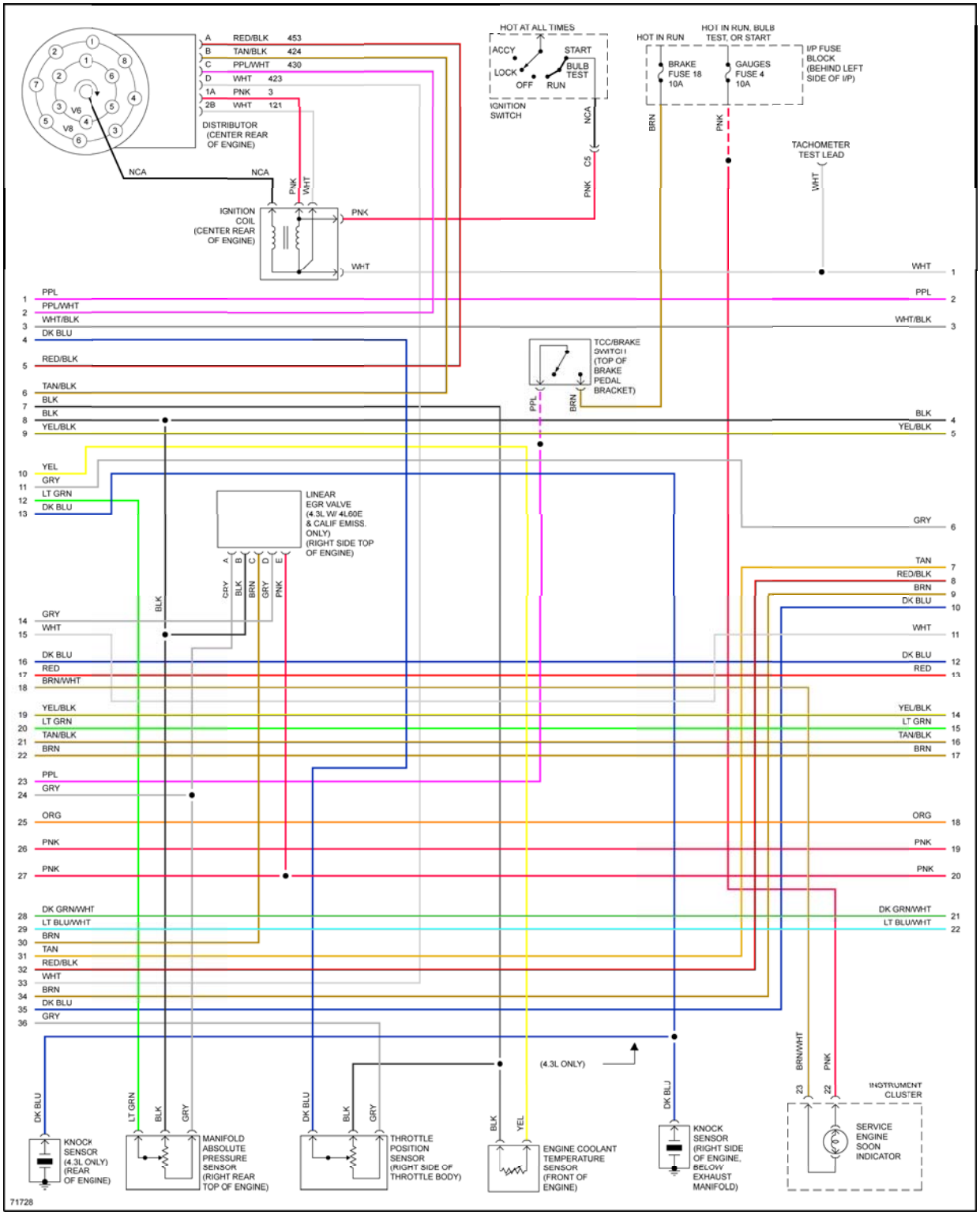


Fig. 20: Wiring Diagram ("C" & "K" Series Pickup, Sierra, Suburban, Tahoe & Yukon - 4.3L With A/T

- 2 Of 3)

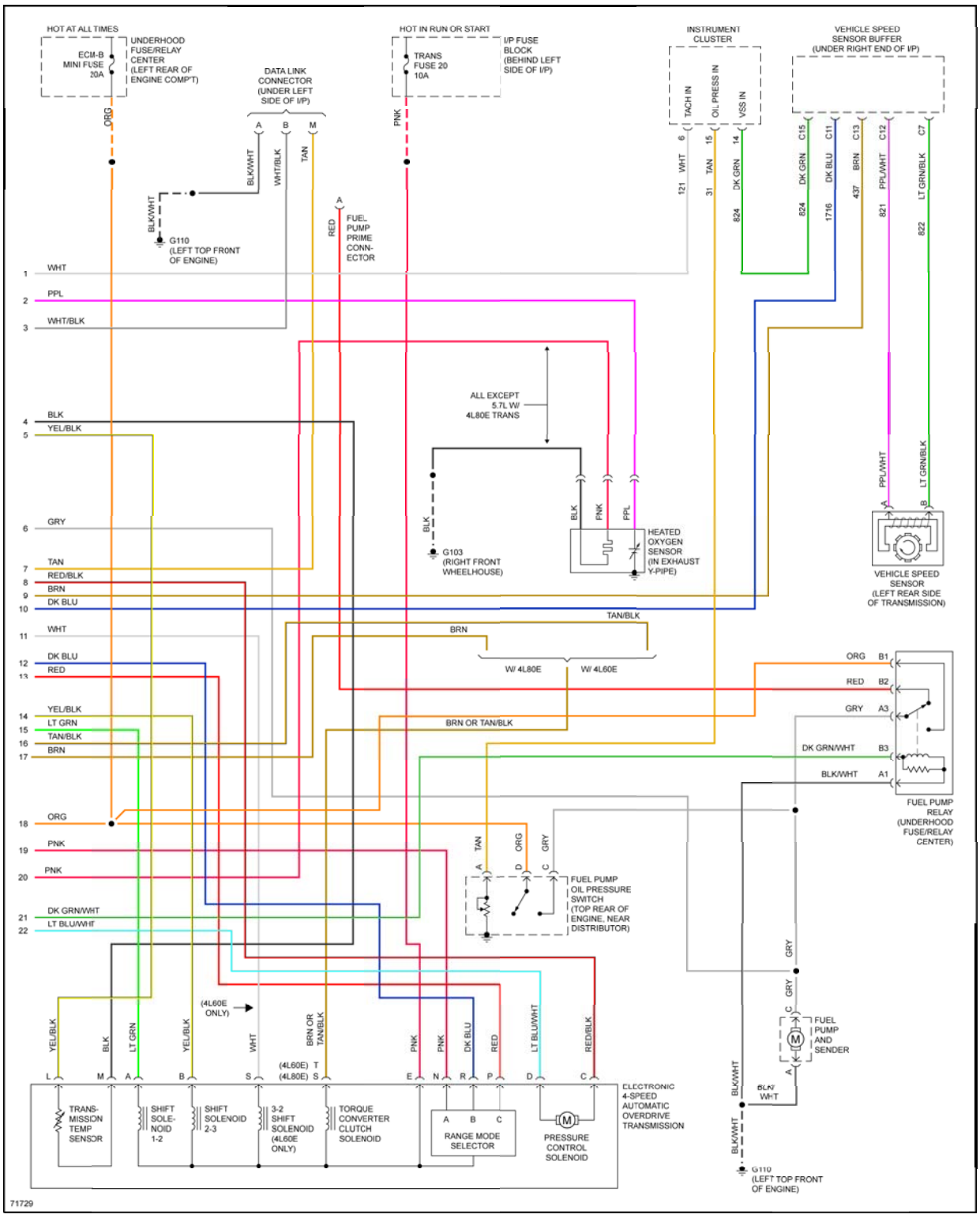


Fig. 21: Wiring Diagram ("C" & "K" Series Pickup, Sierra, Suburban, Tahoe & Yukon - 4.3L With A/T

- 3 Of 3)

"C" & "K" SERIES WITH M/T

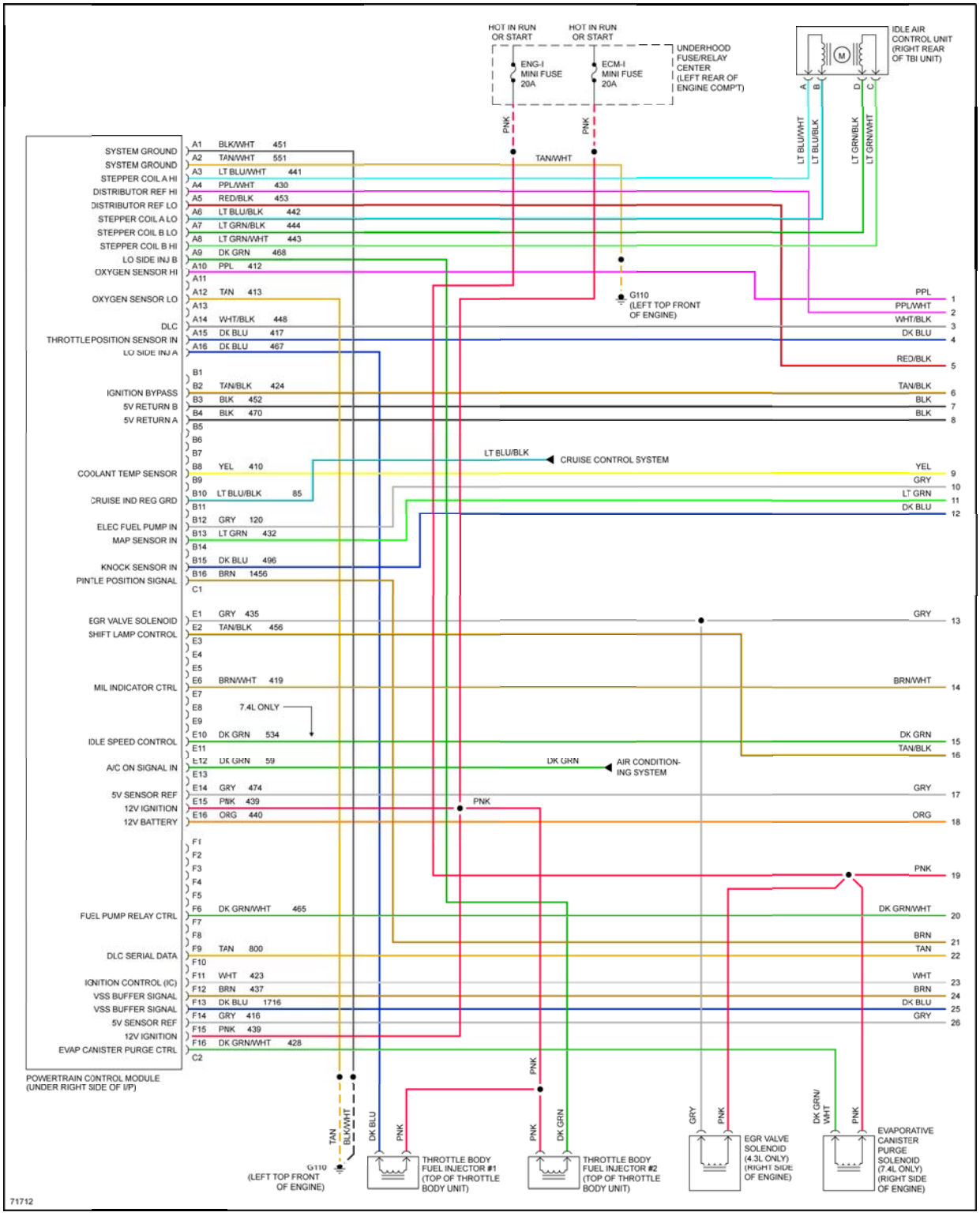


Fig. 22: Wiring Diagram ("C" & "K" Series Pickup & Sierra - 4.3L With M/T - 1 Of 3)

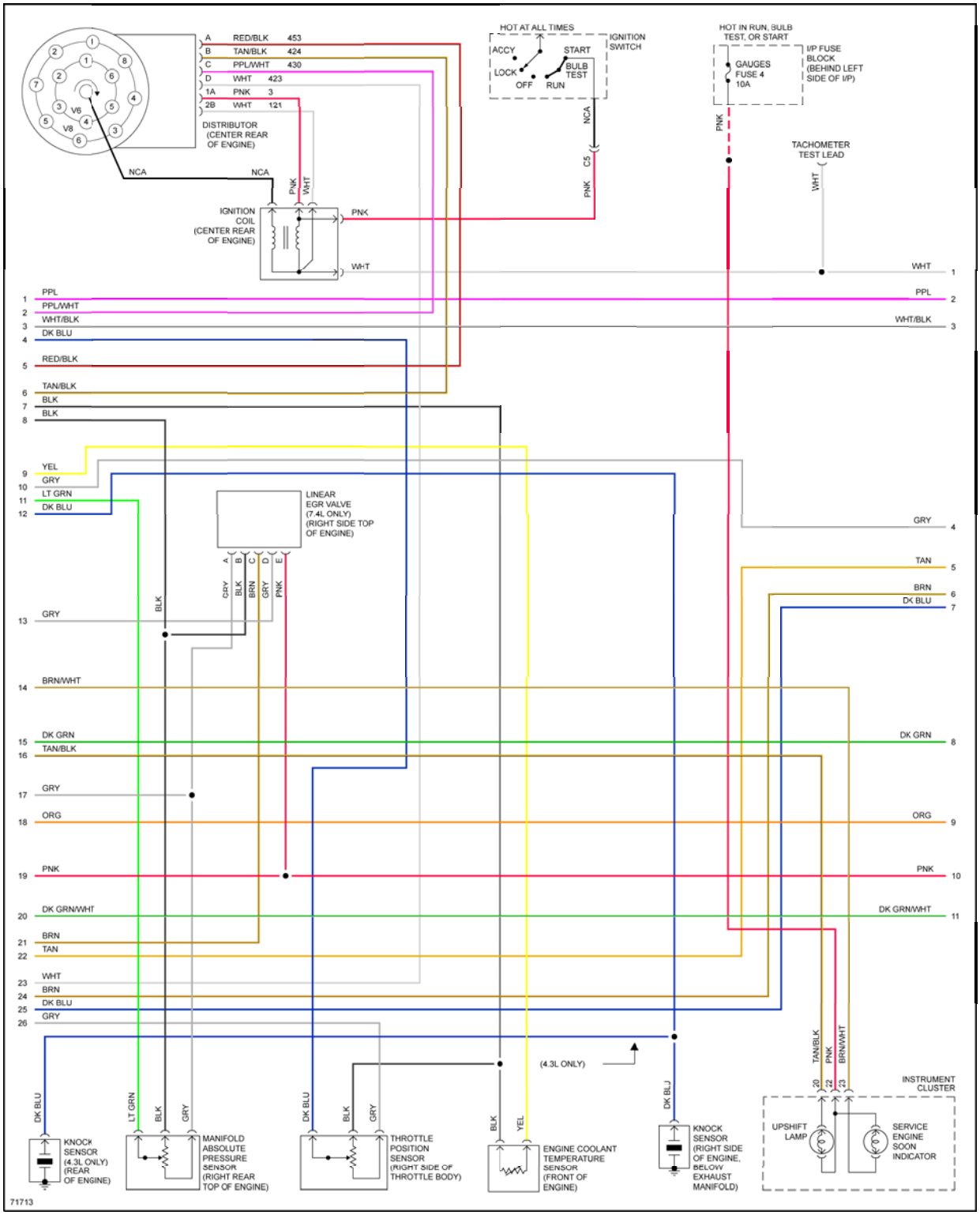


Fig. 23: Wiring Diagram ("C" & "K" Series Pickup & Sierra - 4.3L With M/T - 2 Of 3)

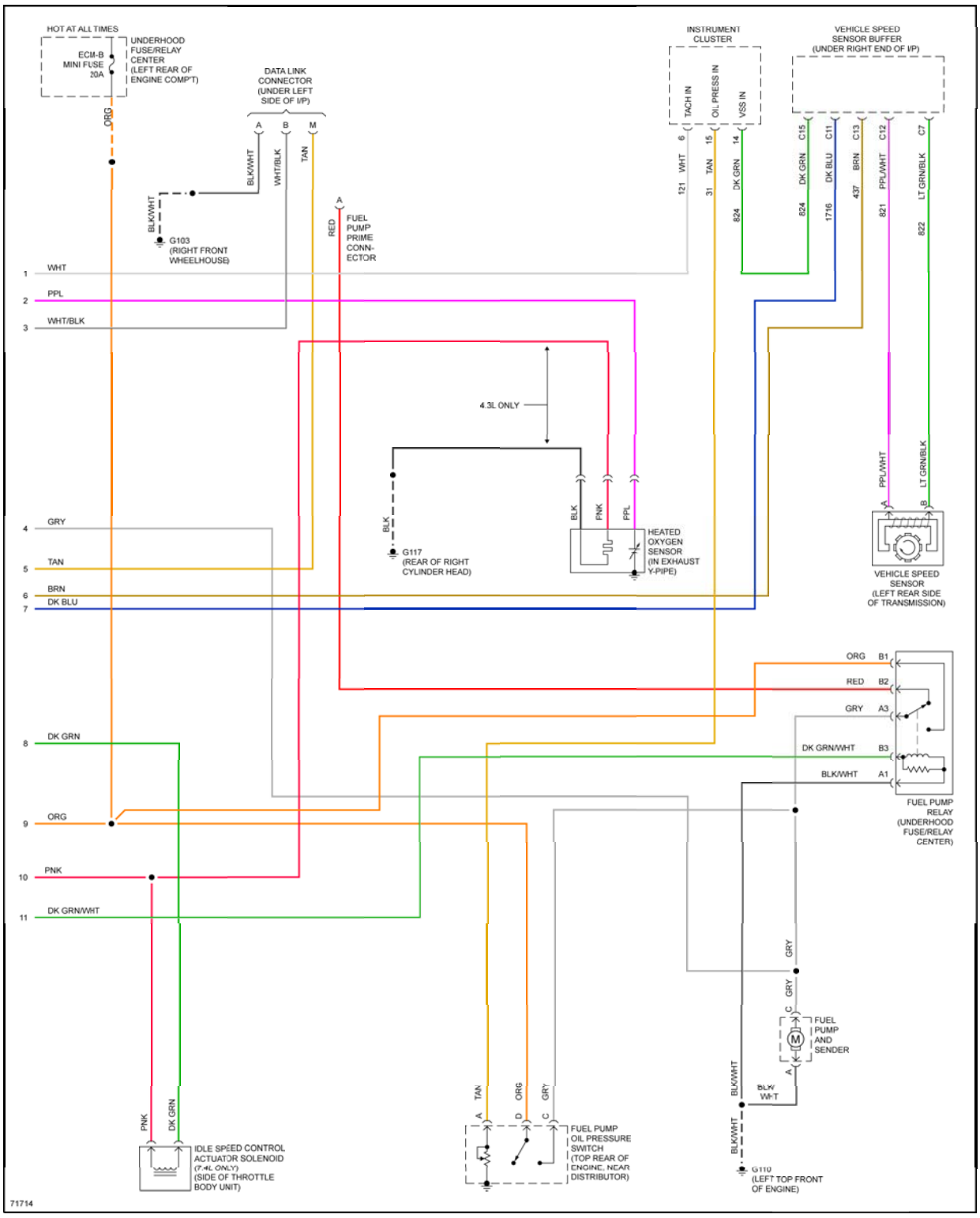


Fig. 24: Wiring Diagram ("C" & "K" Series Pickup & Sierra - 4.3L With M/T - 3 Of 3)

"P" SERIES WITH M/T

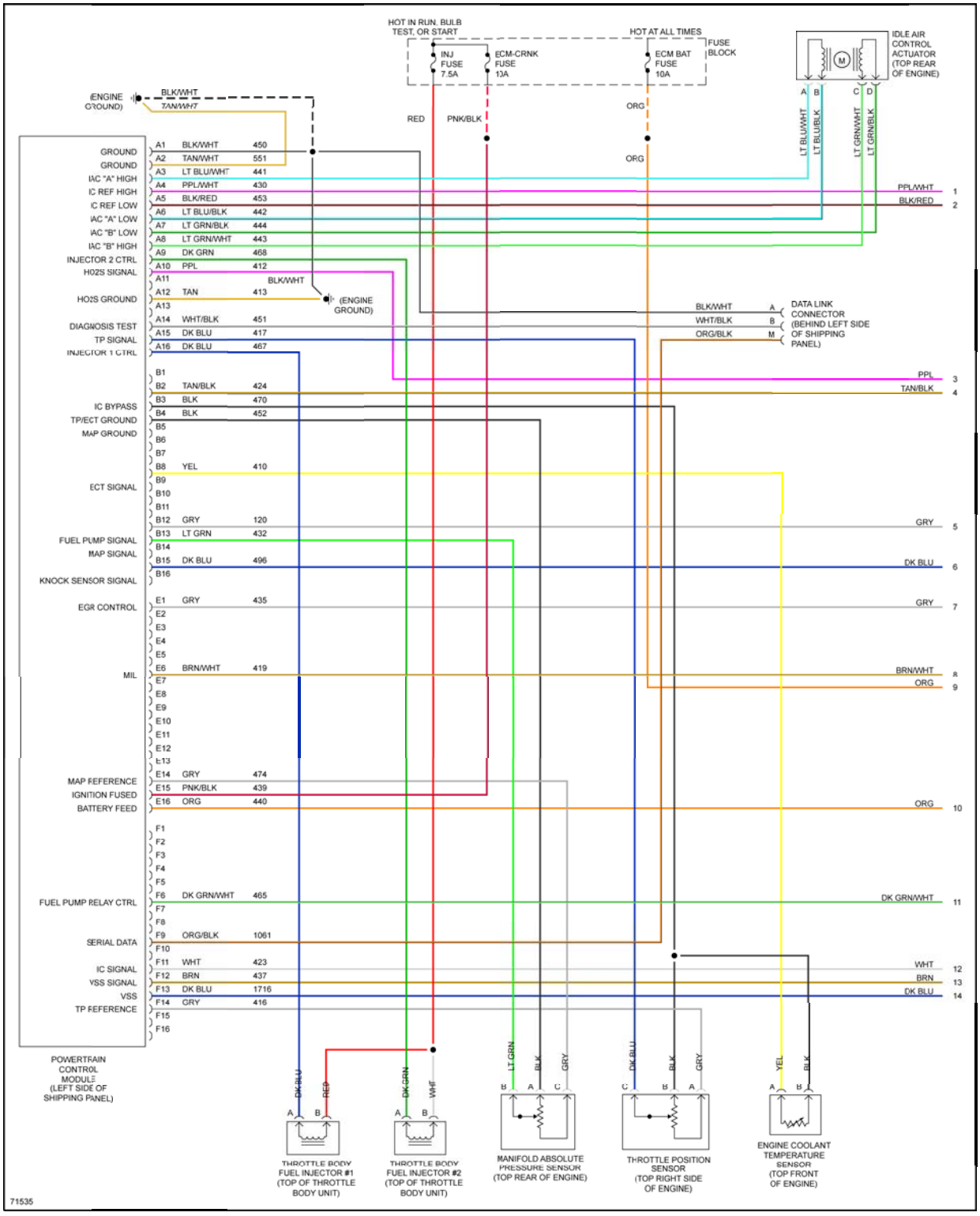


Fig. 25: Wiring Diagram ("P" Series - 4.3L With M/T - 1 Of 2)

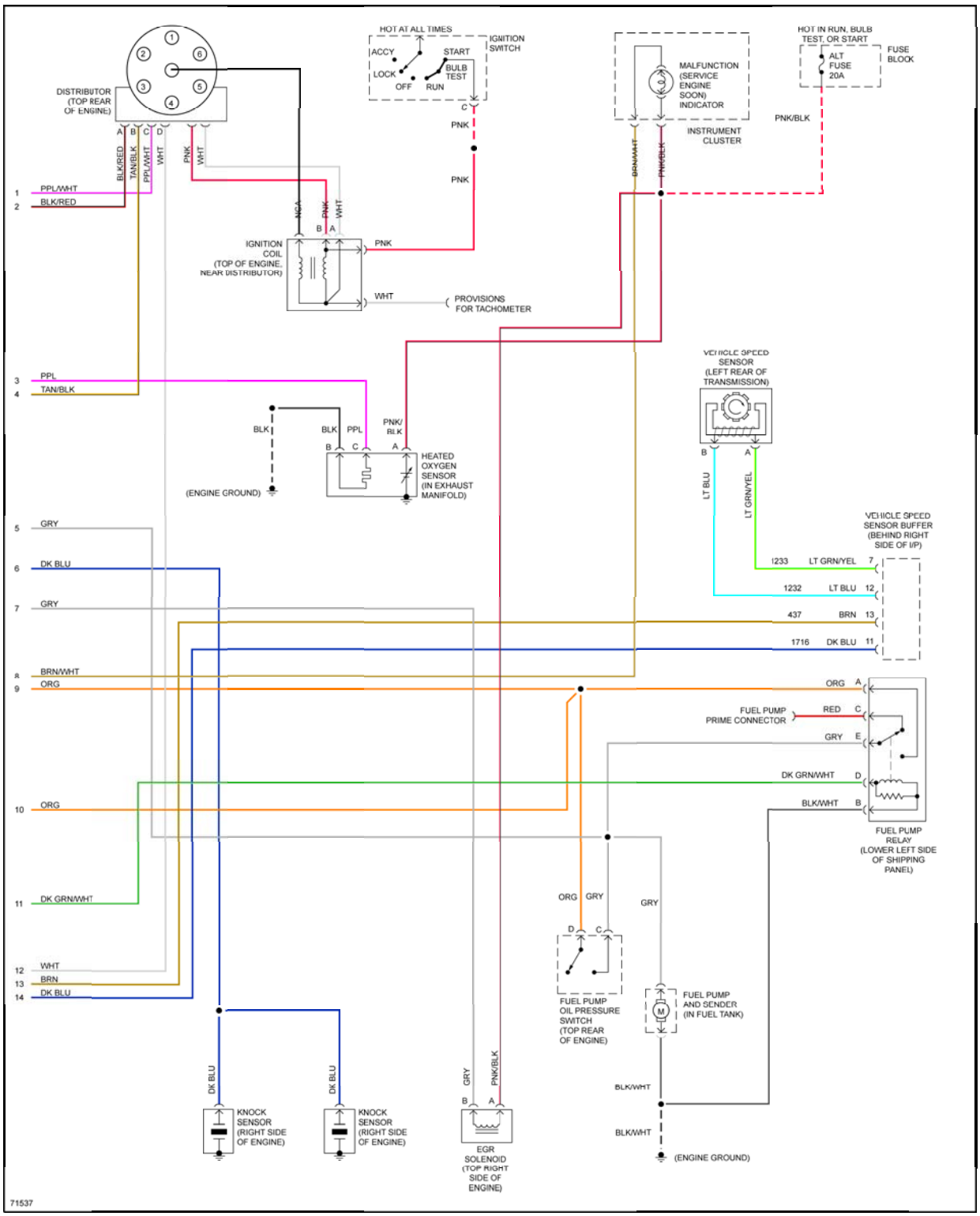


Fig. 26: Wiring Diagram ("P" Series - 4.3L With M/T - 2 Of 2)

"P" SERIES COMMERCIAL & MOTORHOME - WITH 4L80-E

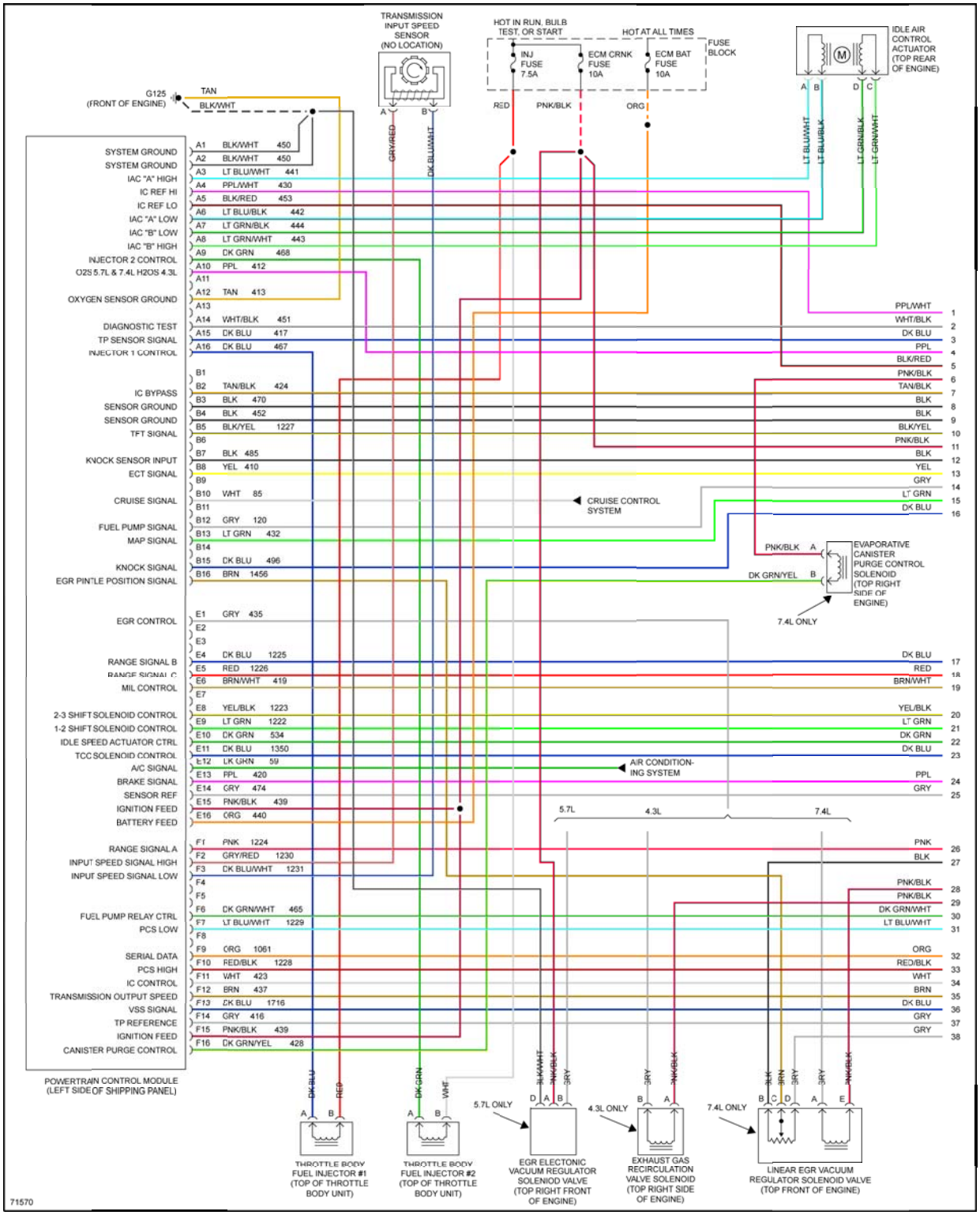


Fig. 27: Wiring Diagram ("P" Series - Commercial & Motorhome - 4.3L With 4L80-E - 1 Of 3)

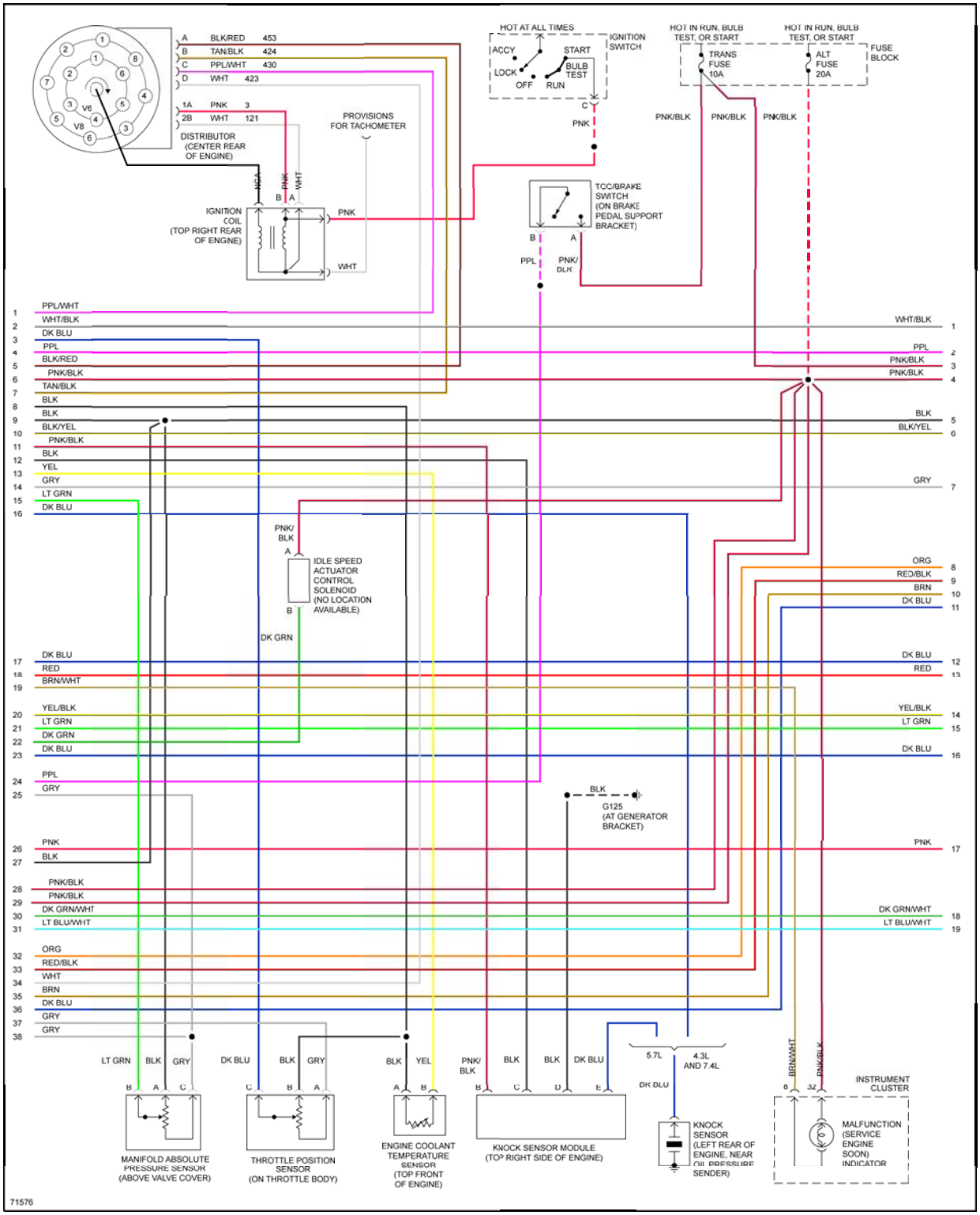


Fig. 28: Wiring Diagram ("P" Series - Commercial & Motorhome - 4.3L With 4L80-E - 2 Of 3)

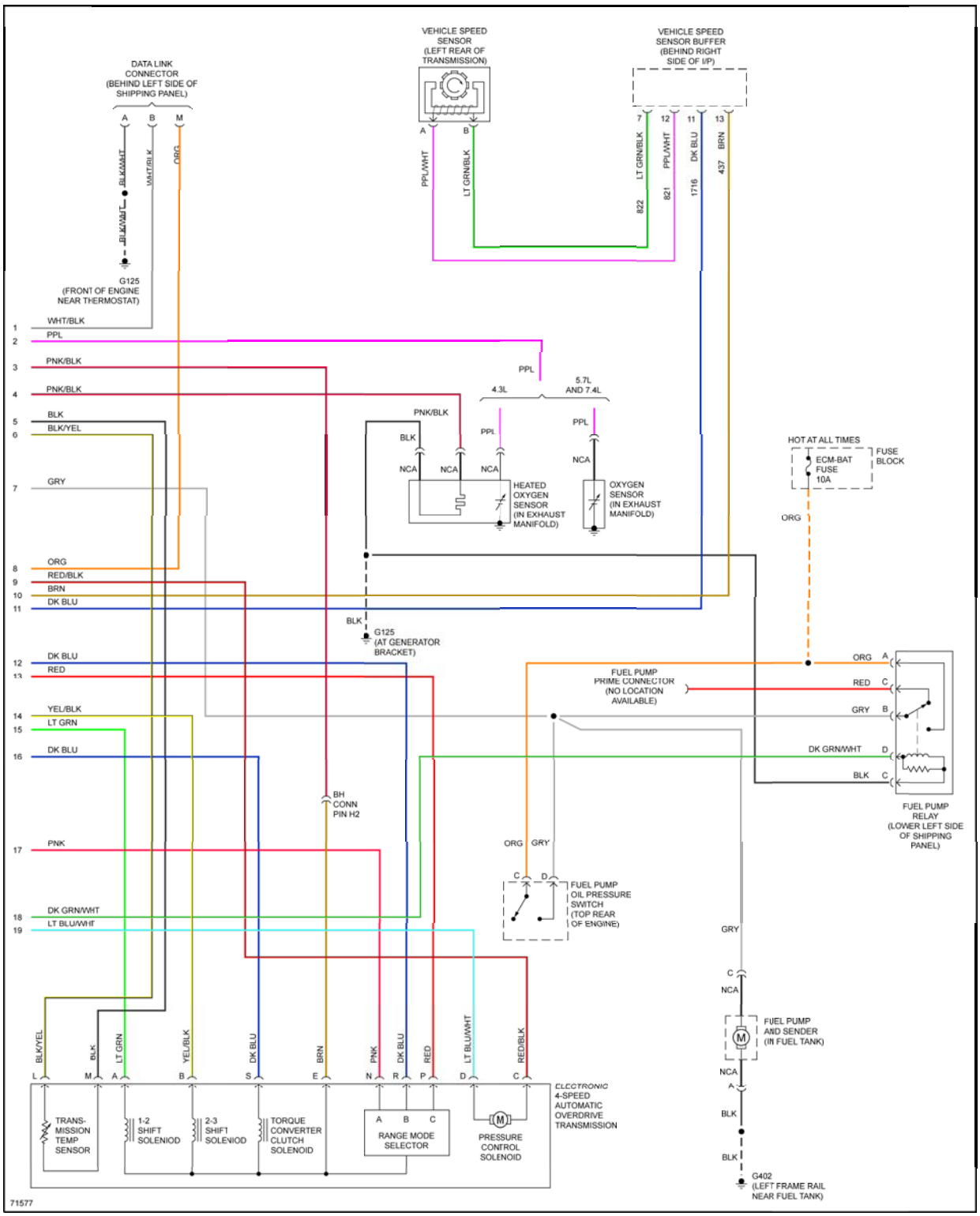


Fig. 29: Wiring Diagram ("P" Series - Commercial & Motorhome - 4.3L With 4L80-E - 3 Of 3)

"S" & "T" SERIES - WITH PCM

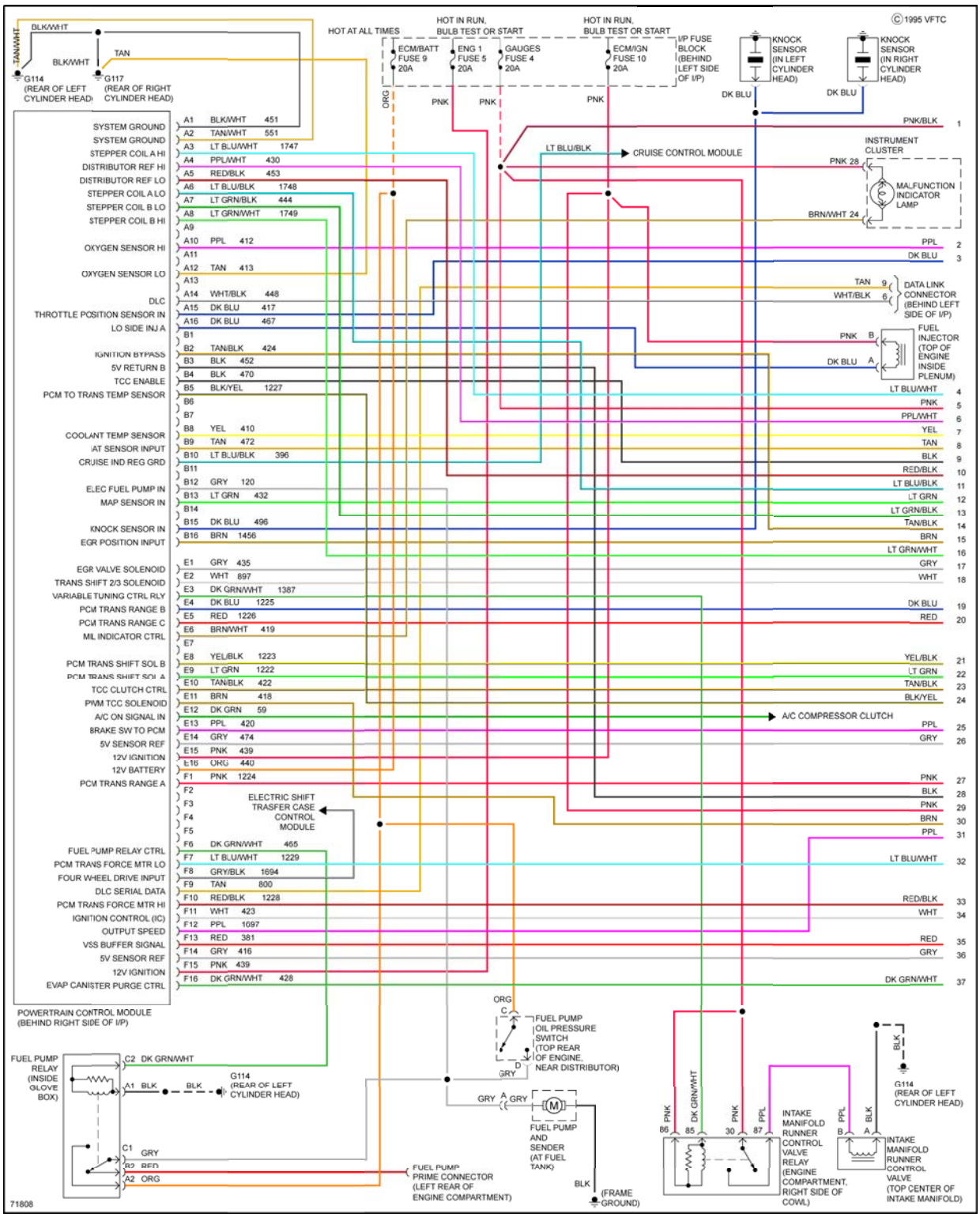


Fig. 30: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN W W/PCM - 1 Of 2)

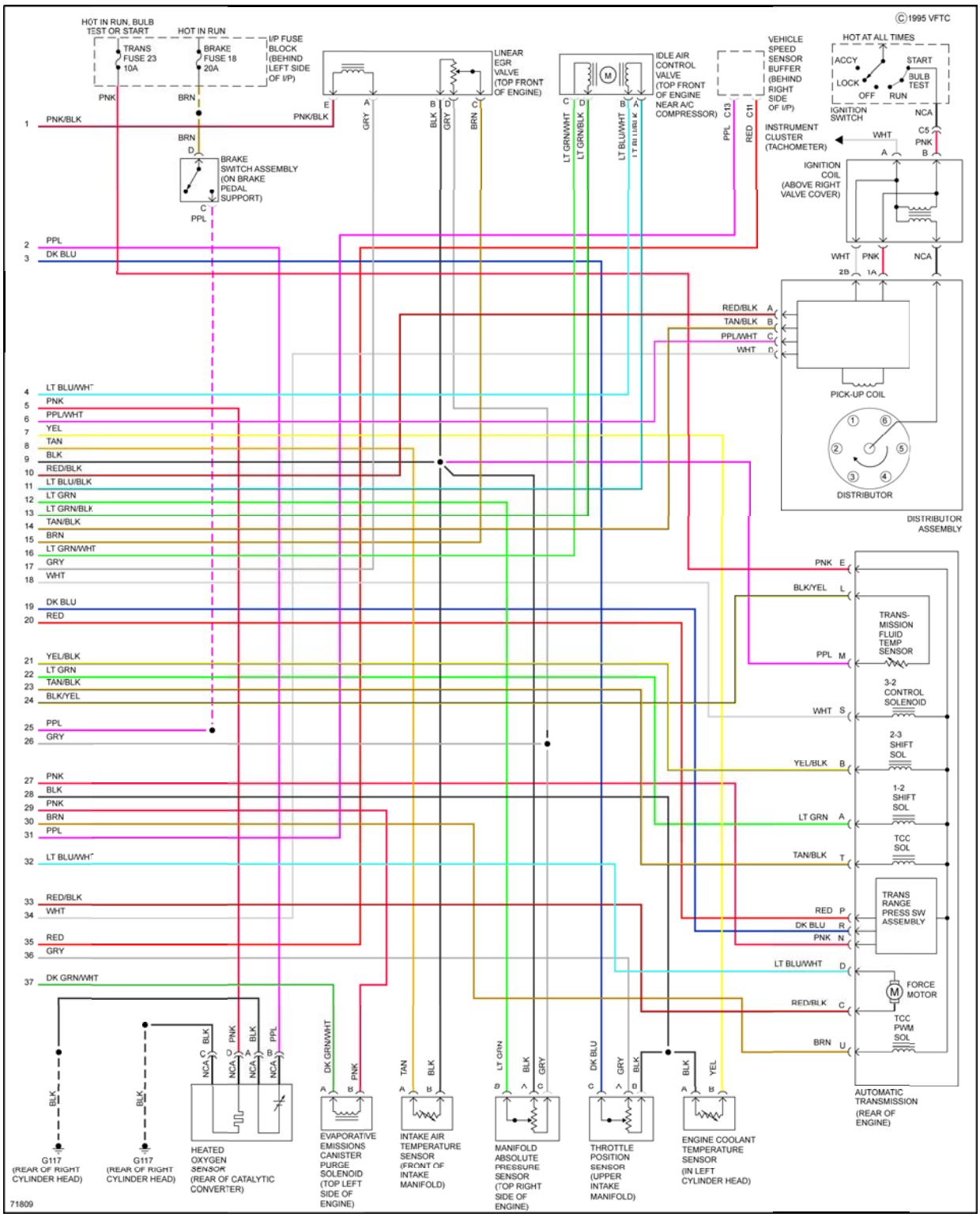


Fig. 31: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN W W/PCM - 2 Of 2)

"S" & "T" SERIES - WITH VCM

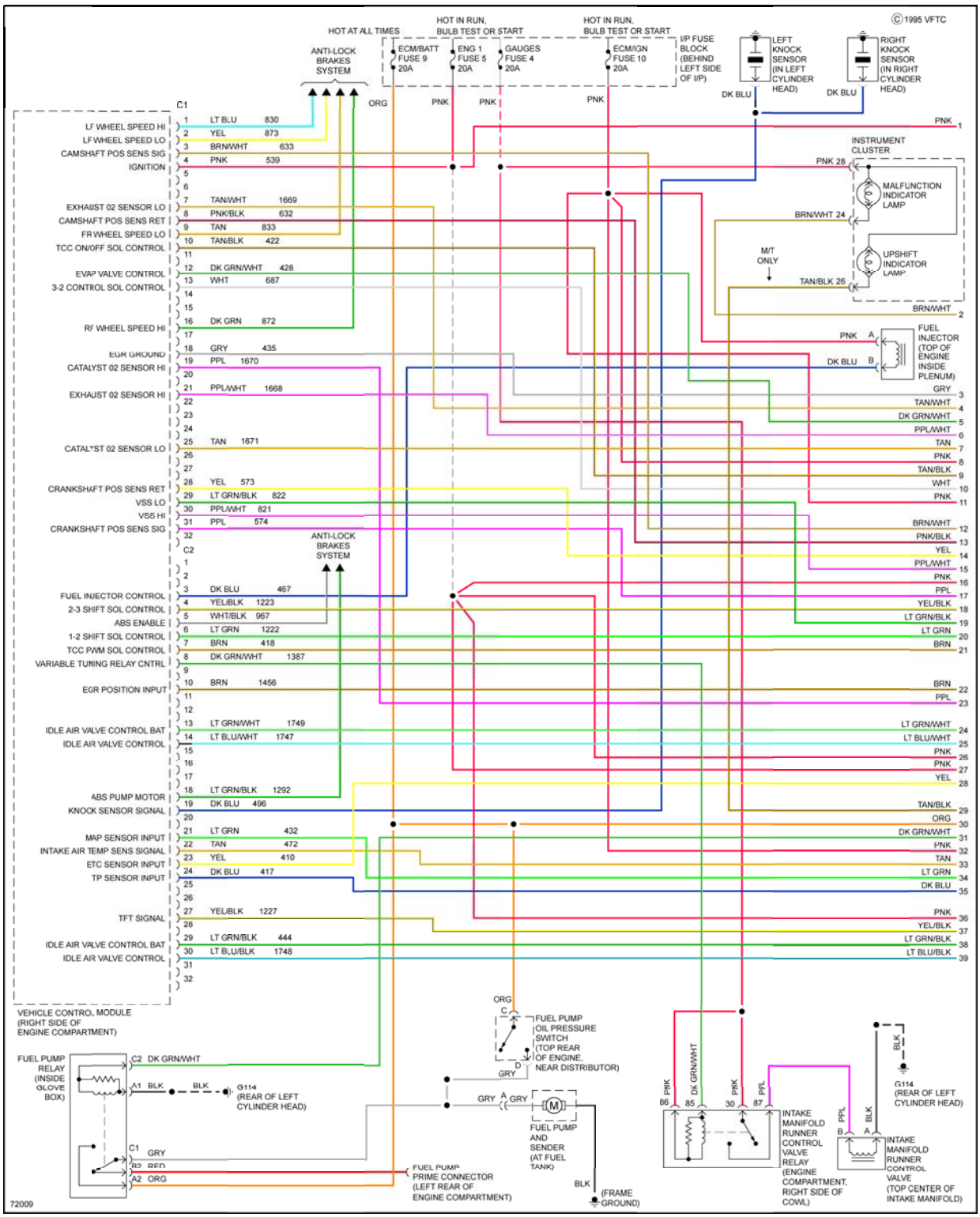


Fig. 32: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN W W/VCM-A - 1 Of

3)

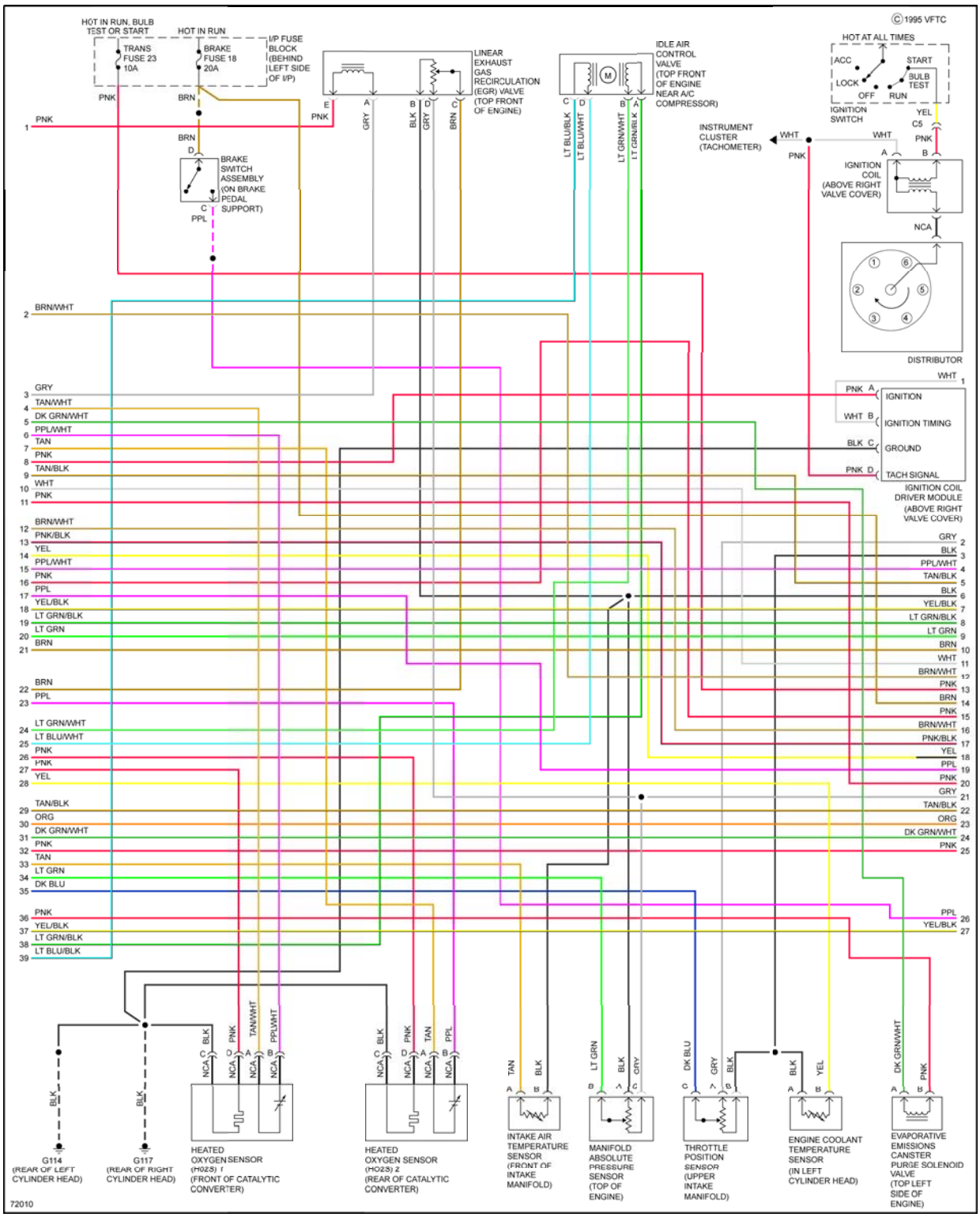


Fig. 33: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN W W/VCM-A - 2 Of

3)

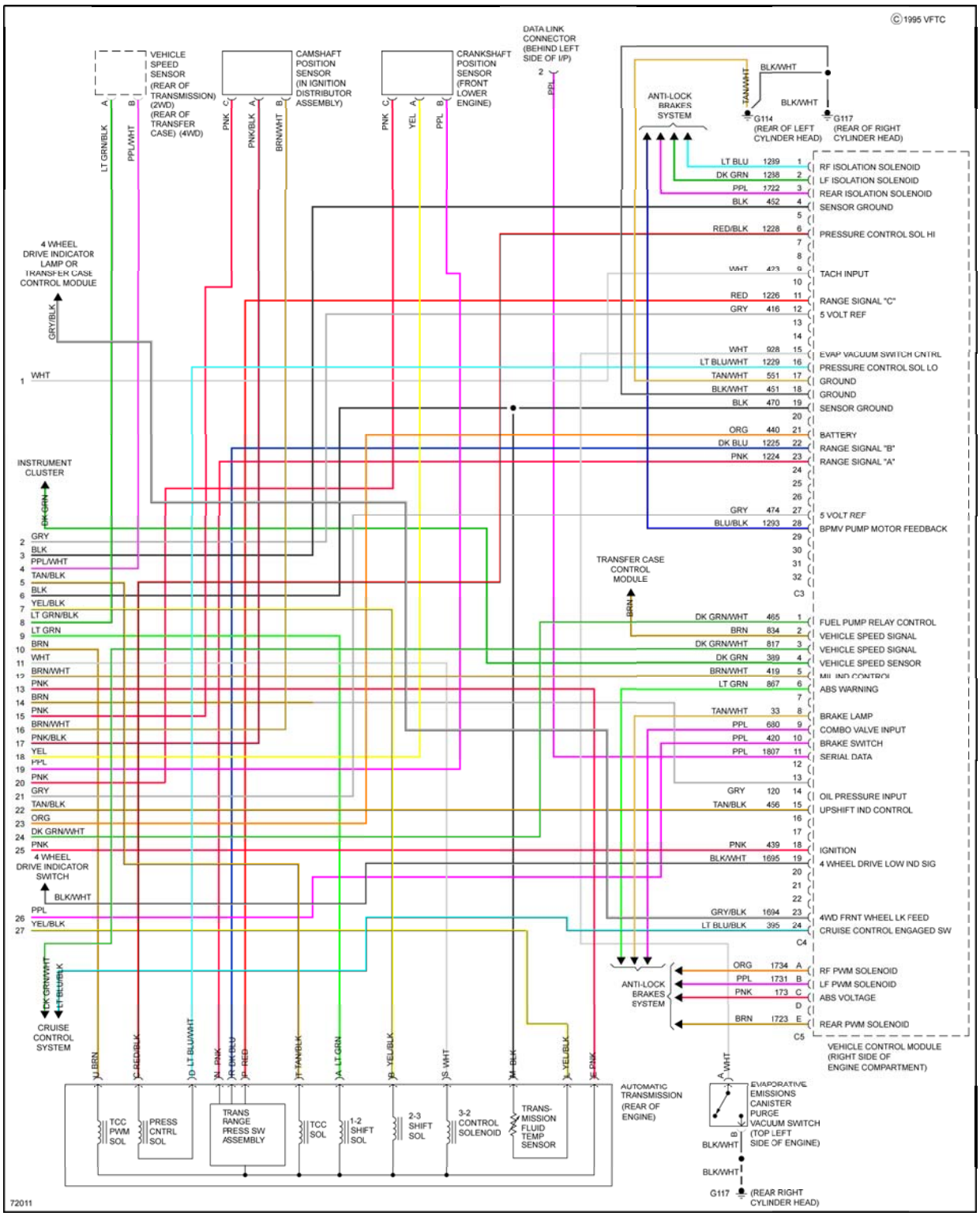


Fig. 34: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN W W/VCM-A - 3 Of

3)

"S" & "T" SERIES WITH PCM

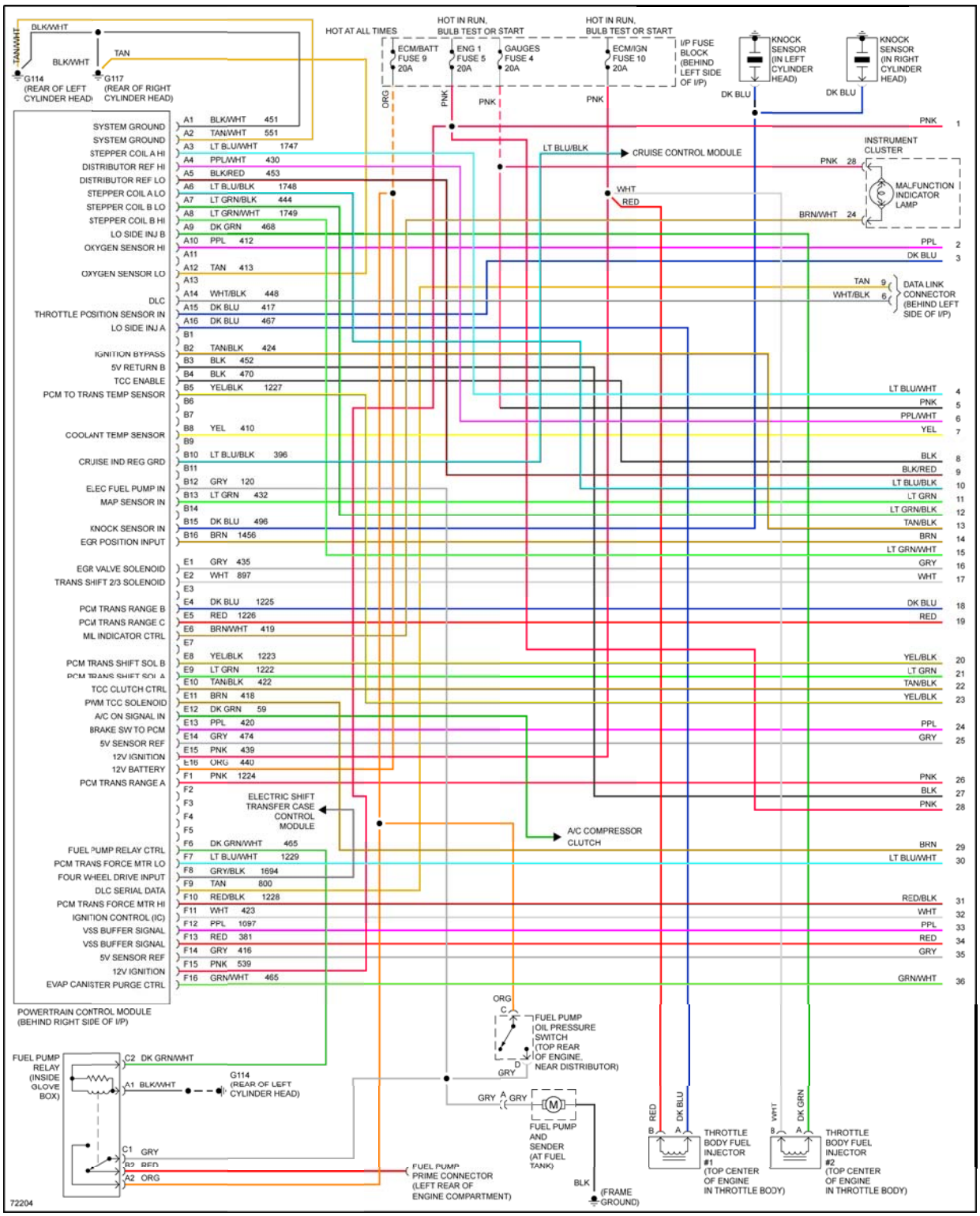


Fig. 35: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN Z W/PCM - 1 Of 2)

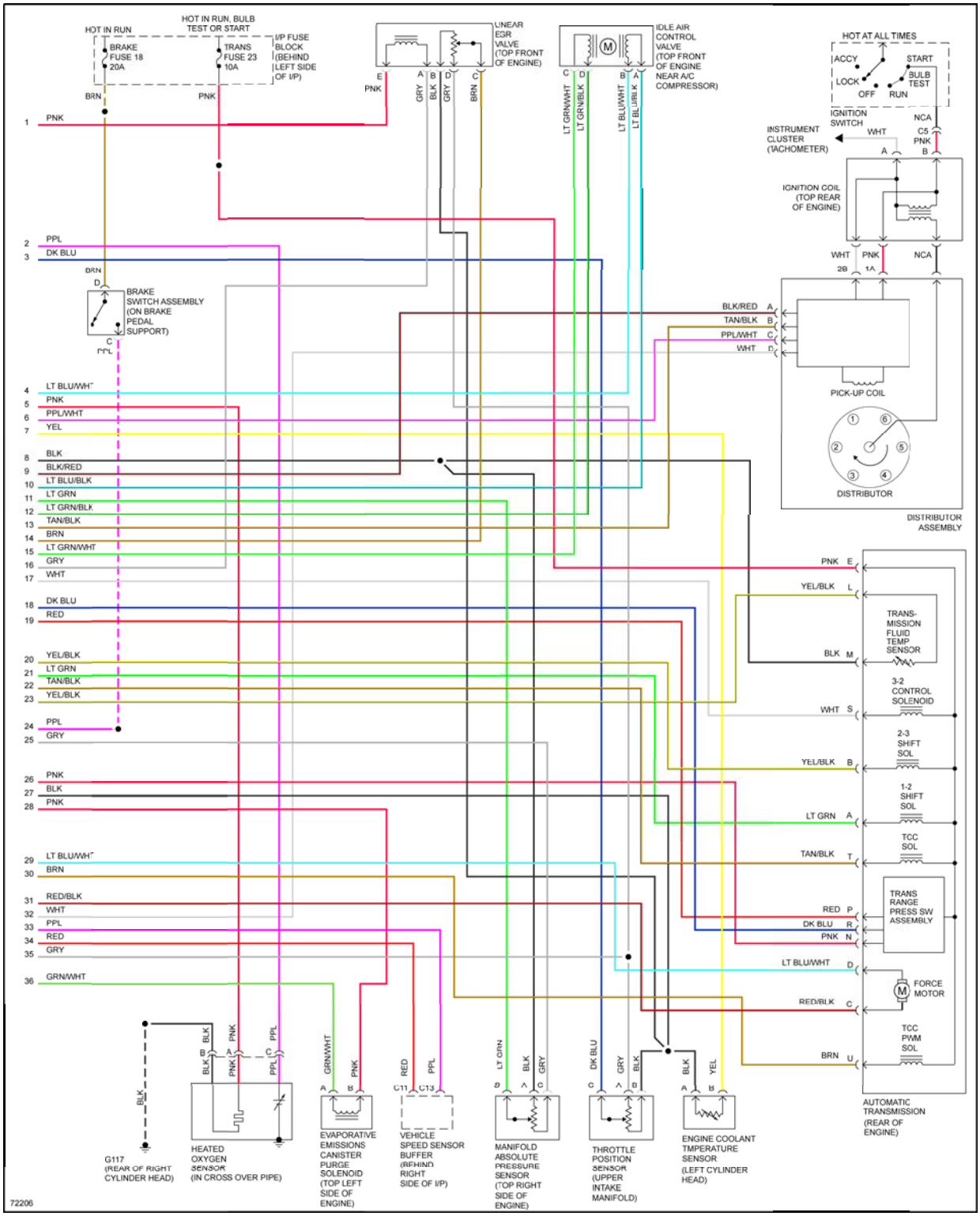


Fig. 36: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN Z W/PCM - 2 Of 2)

"S" & "T" SERIES WITH VCM

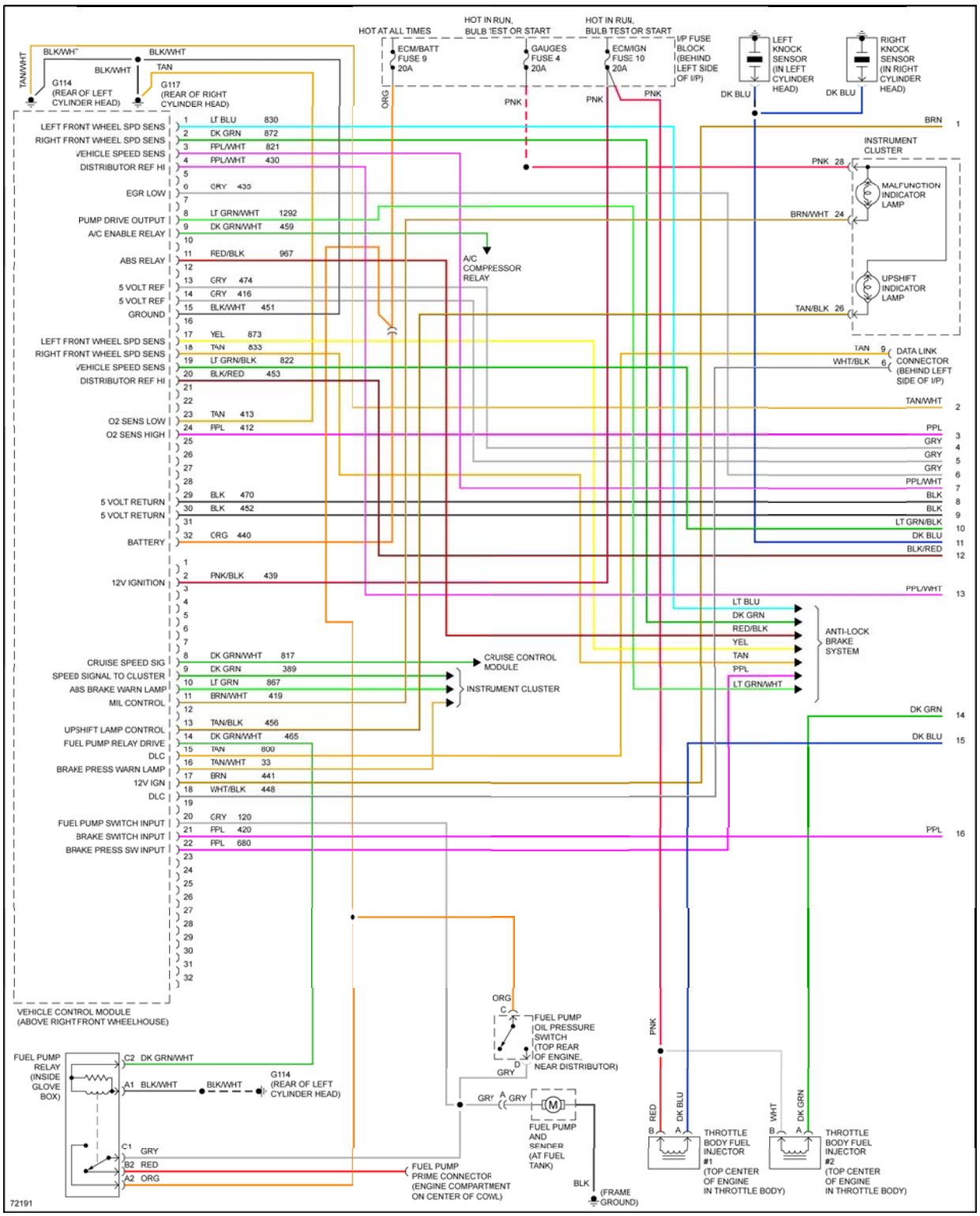


Fig. 37: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN Z W/VCM - 1 Of 2)

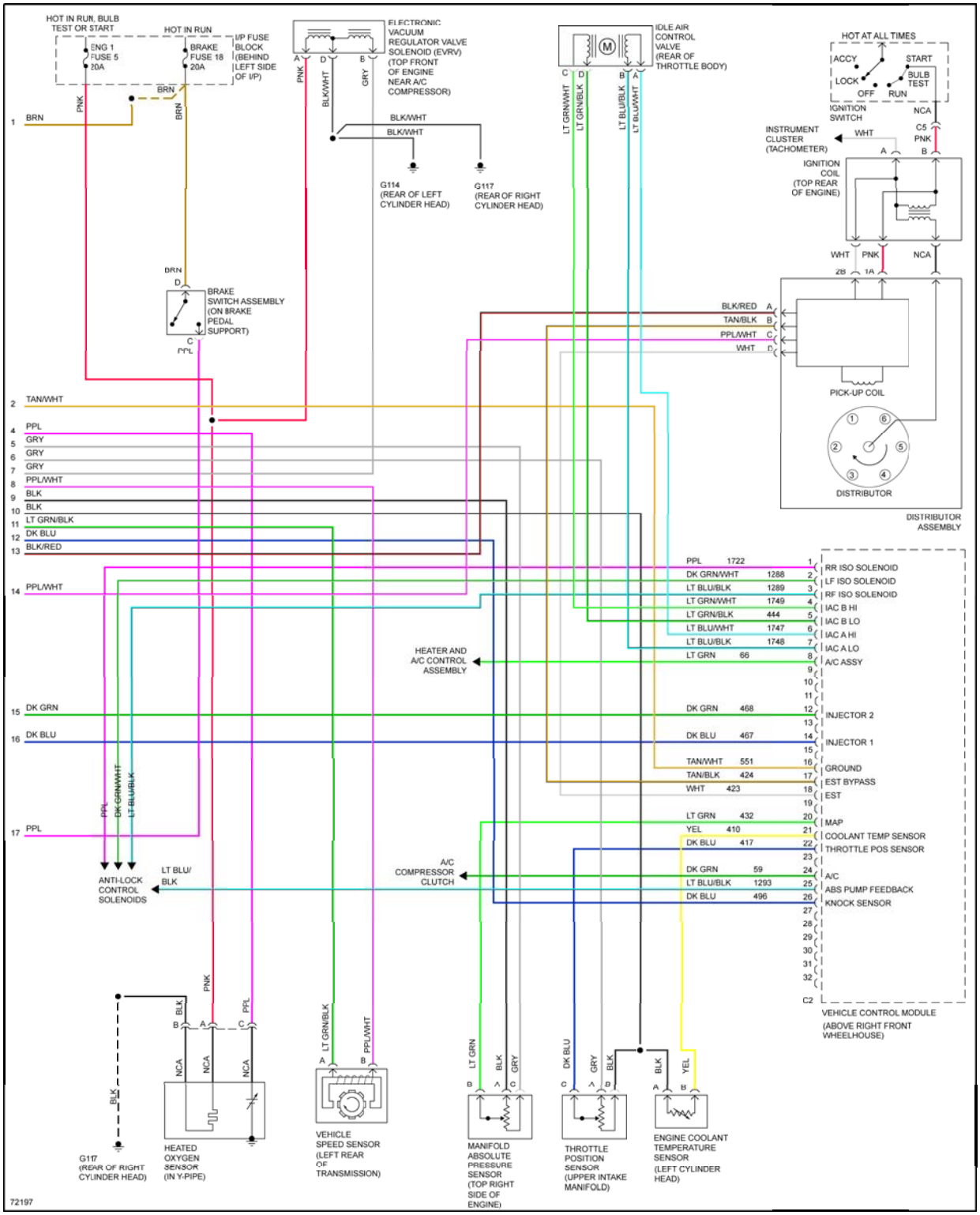


Fig. 38: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN Z W/VCM - 2 Of 2)

VAN WITH 4L60-E

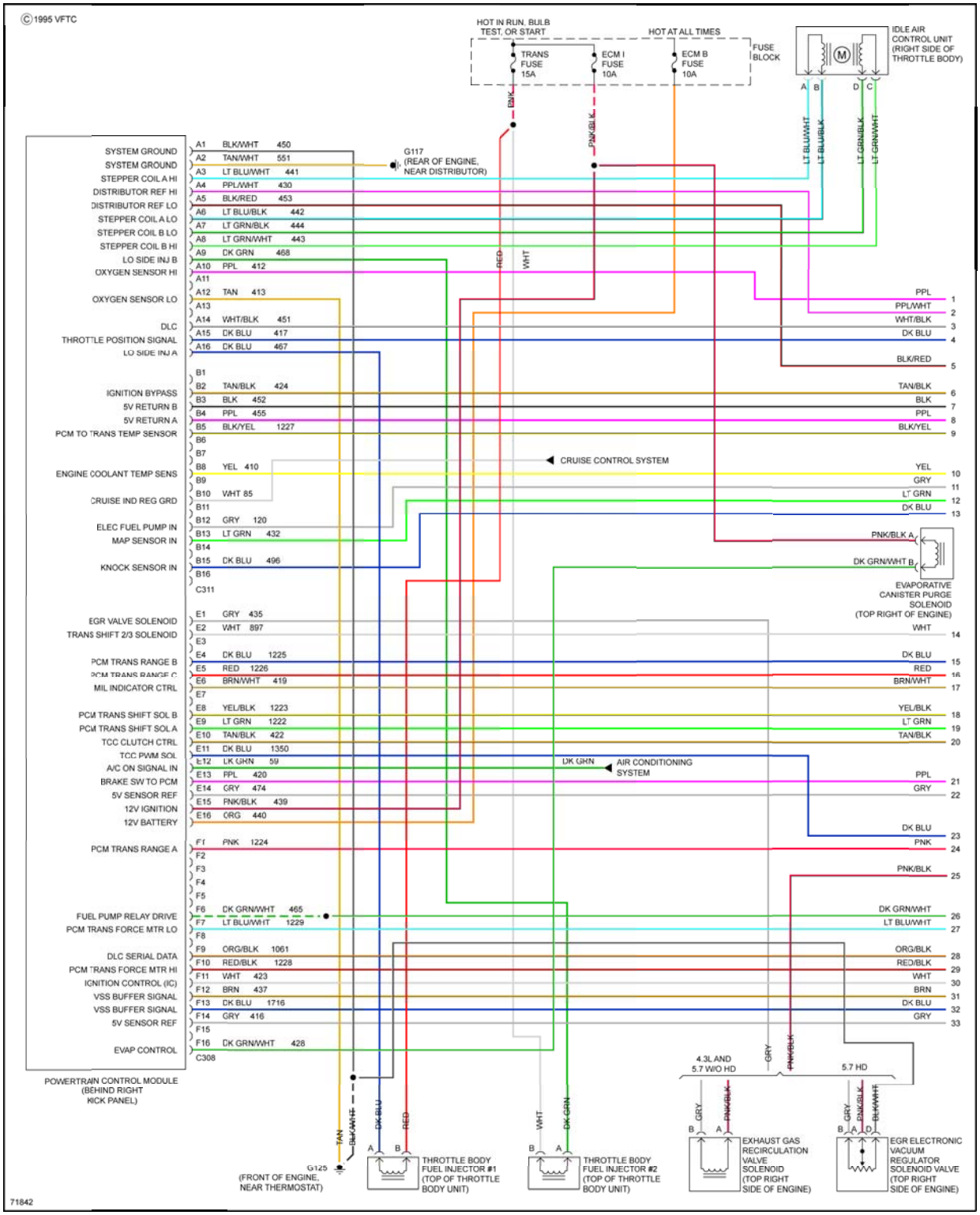


Fig. 39: Wiring Diagram (Van - 4.3L With 4L60-E - 1 Of 3)

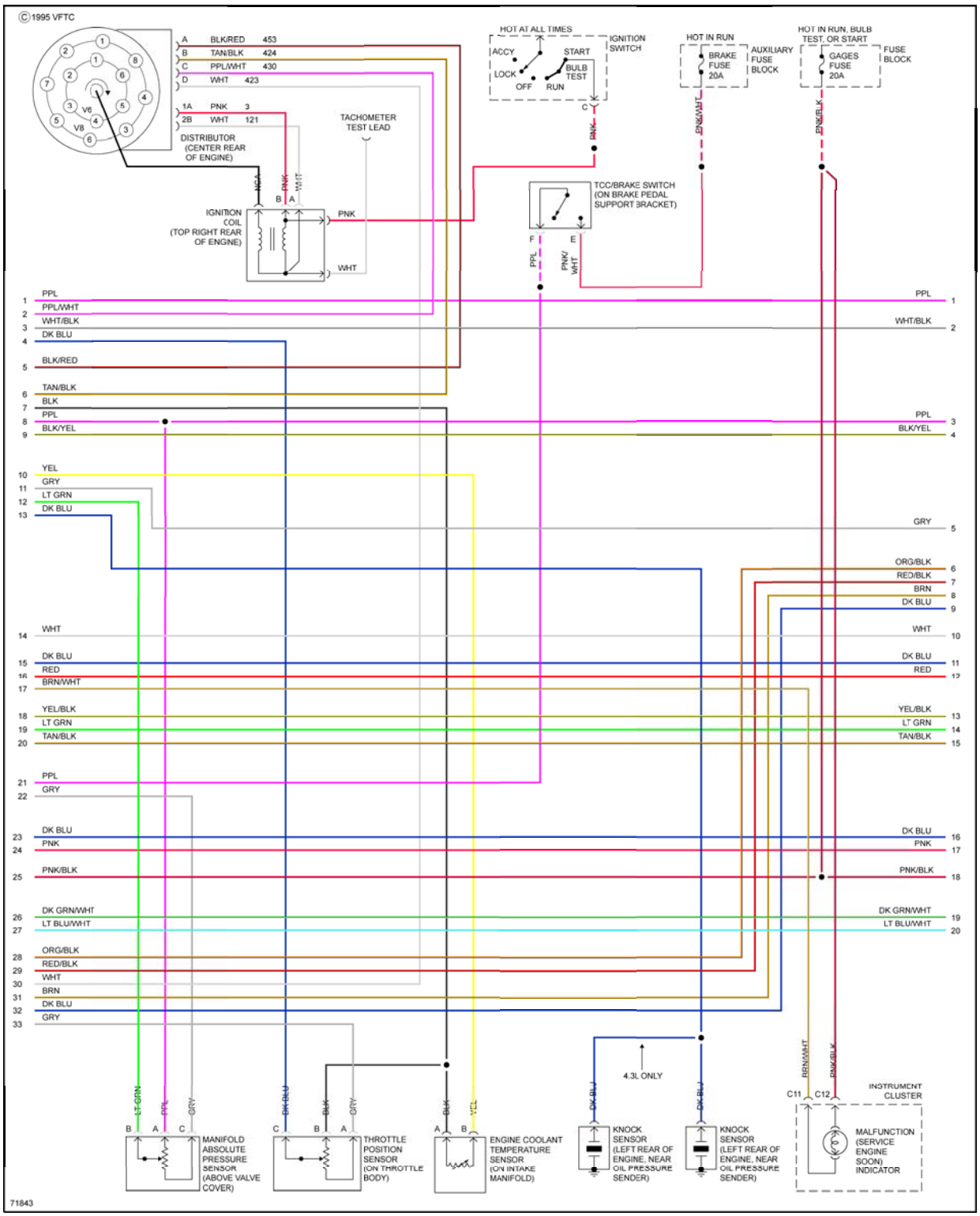


Fig. 40: Wiring Diagram (Van - 4.3L With 4L60-E - 2 Of 3)

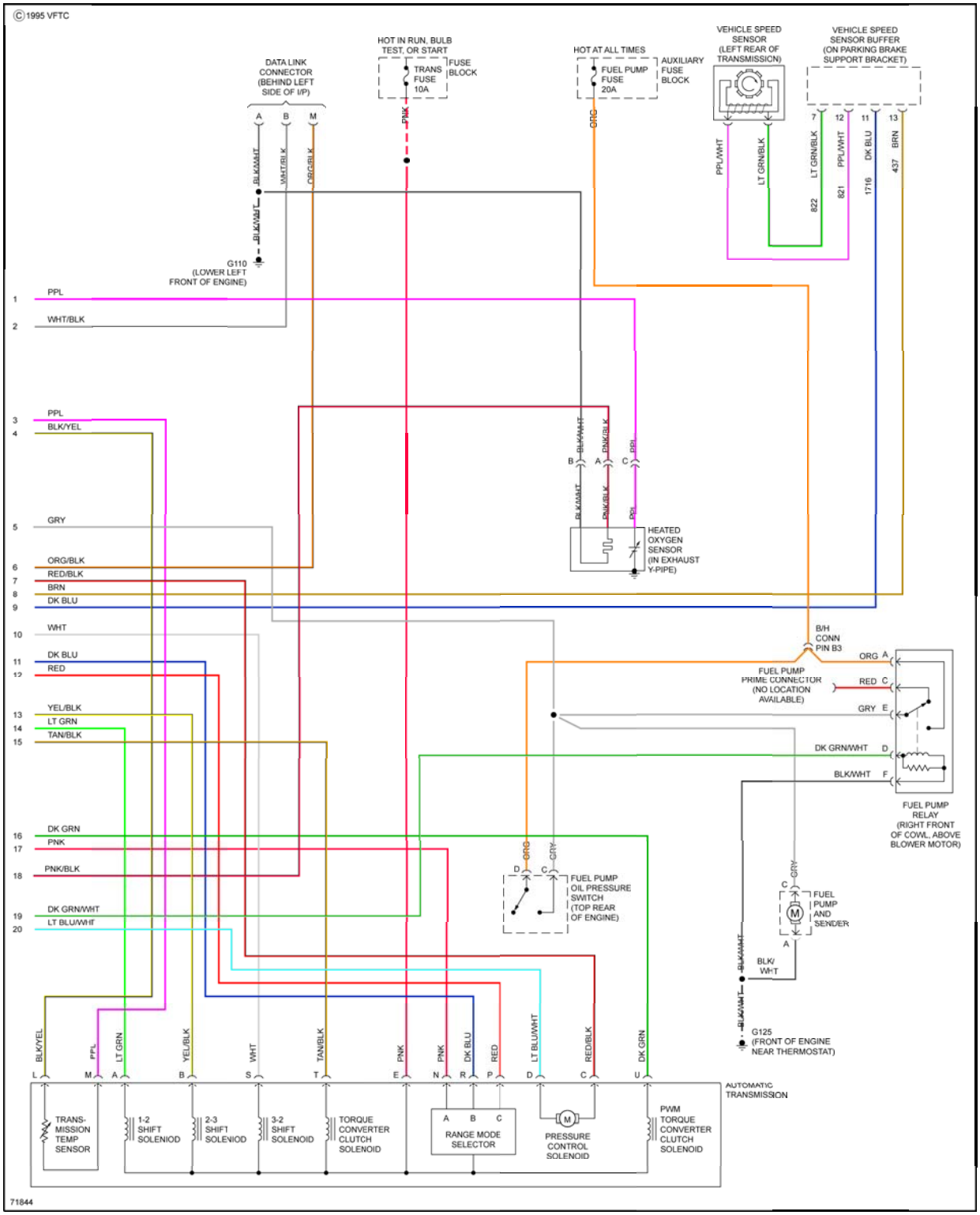


Fig. 41: Wiring Diagram (Van - 4.3L With 4L60-E - 3 Of 3)

VAN WITH 4L80-E

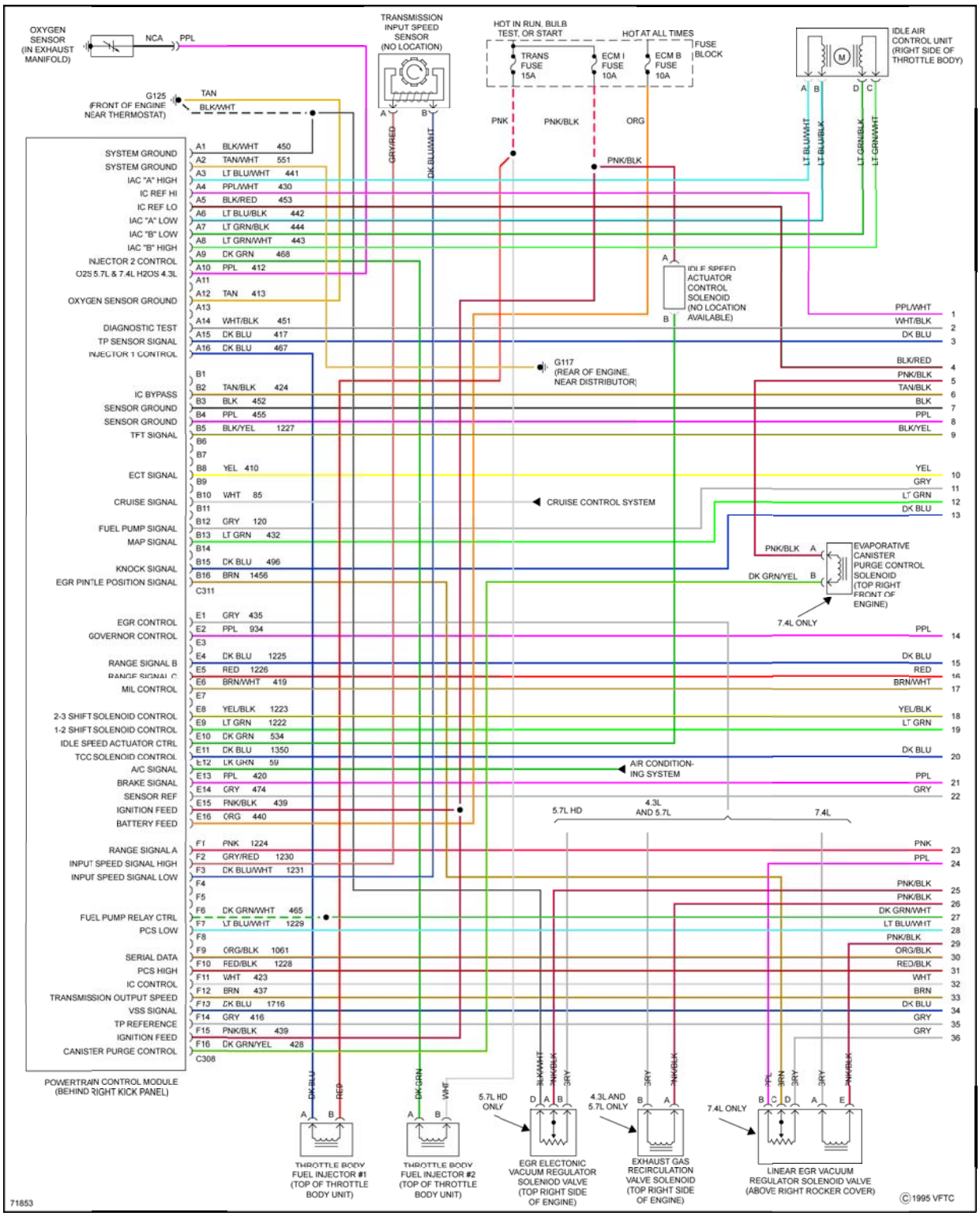


Fig. 42: Wiring Diagram (Van - 4.3L With 4L80-E - 1 Of 3)

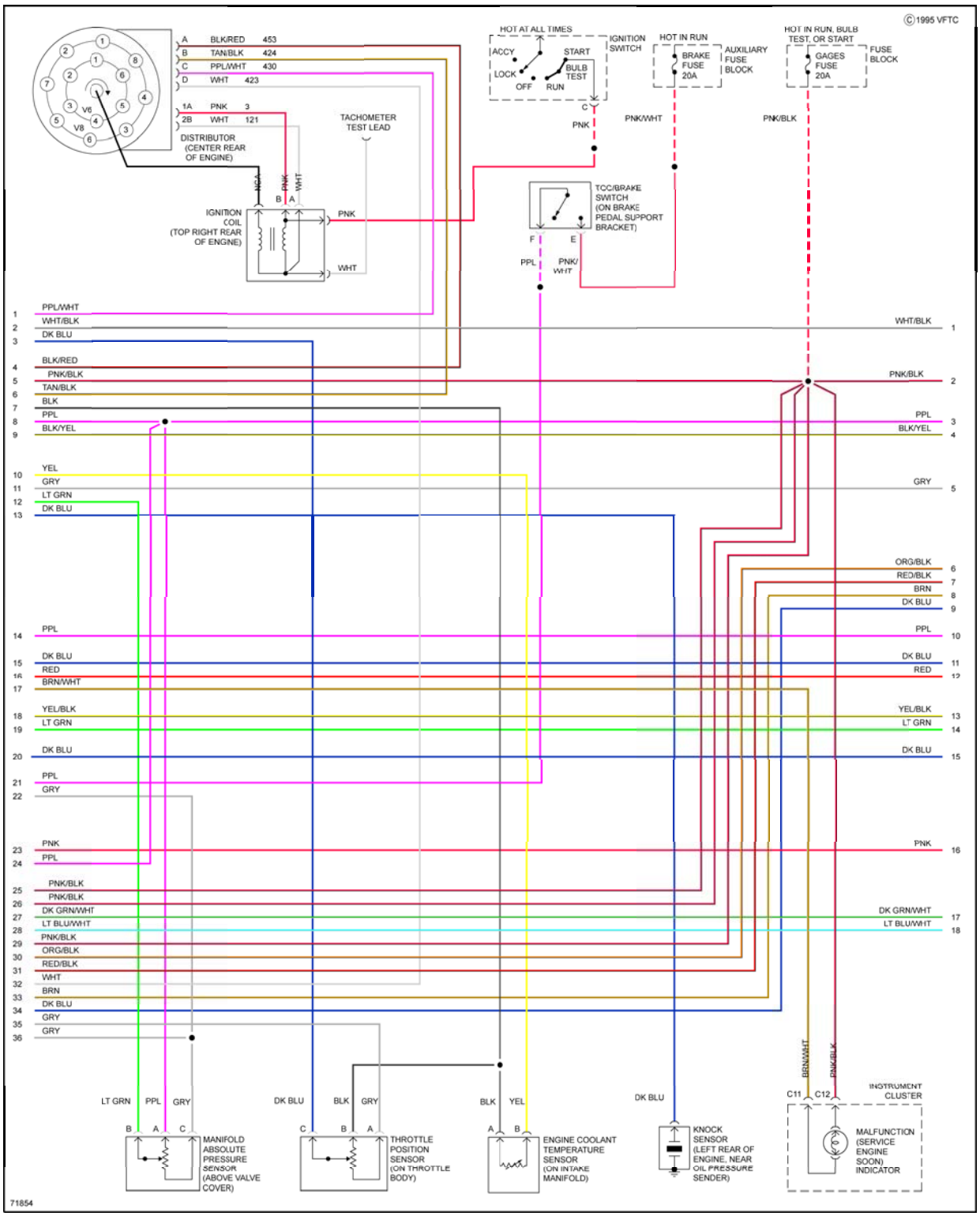


Fig. 43: Wiring Diagram (Van - 4.3L With 4L80-E - 2 Of 3)

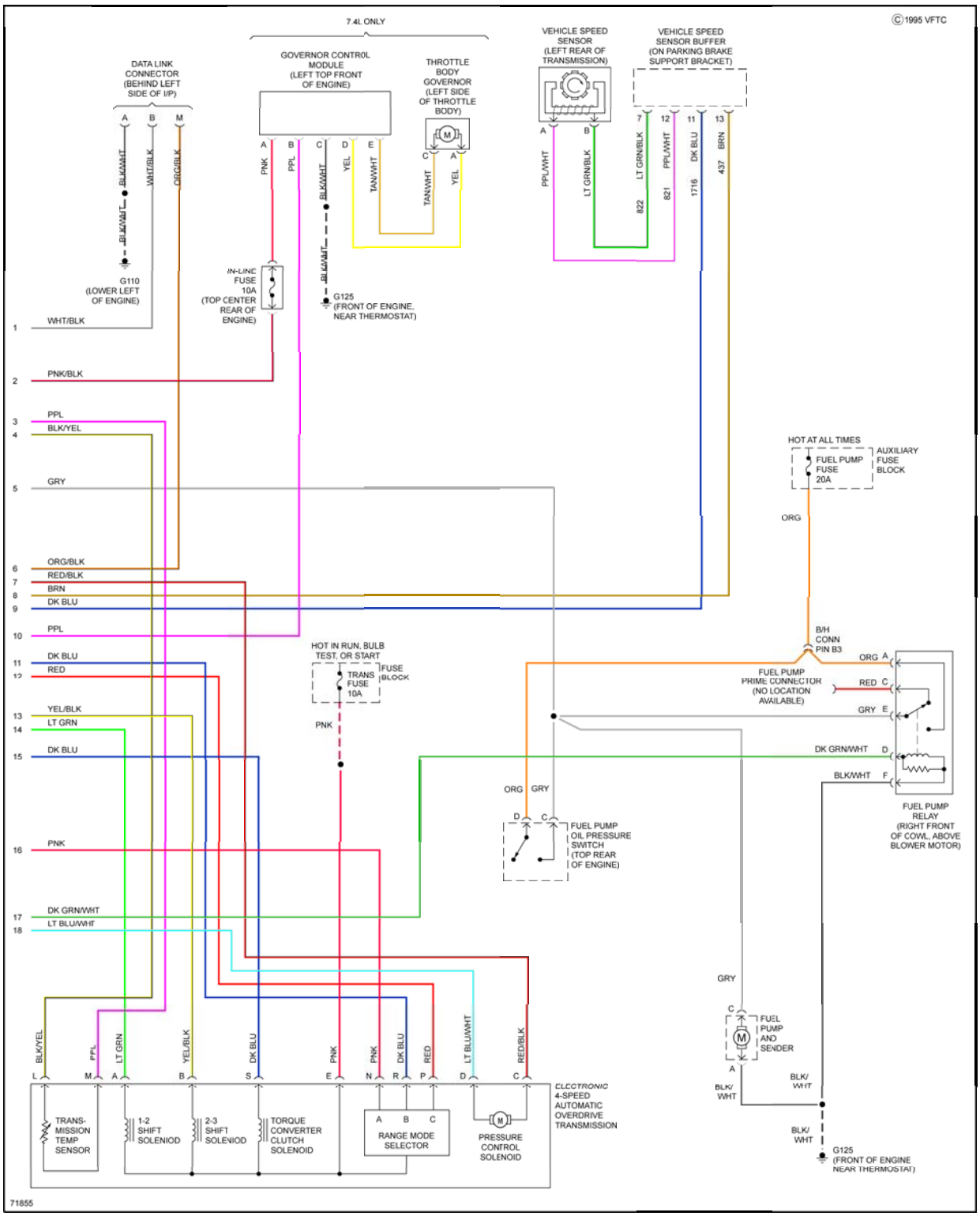


Fig. 44: Wiring Diagram (Van - 4.3L With 4L80-E - 3 Of 3)

Removal, Overhaul & Installation - 4.3L

INTRODUCTION

Removal, overhaul and installation procedures are covered in this article. If component removal and installation is primarily an unbolt and bolt-on procedure, only a torque specification may be furnished.

ON-VEHICLE ADJUSTMENTS

NOTE: For adjustments, see ADJUSTMENTS - 4.3L article in the ENGINE PERFORMANCE section.

POWERTRAIN CONTROL MODULE (PCM)

NOTE: All vehicles are equipped with either an Engine Control Module (ECM), Powertrain Control Module (PCM) or Vehicle Control Module (VCM) for engine control. Unless specifically stated, references to PCM also apply to ECM and VCM equipped vehicles. Some vehicles equipped with an electronically-controlled transmission also use a Transmission Control Module (TCM) for transmission control.

CONTROL MODULE

CAUTION: When certain materials rub together, a transfer of electrons from one material to another may occur under special conditions. This causes electrostatic charge (static electricity) build-up in one of the materials. When any conducting material comes in contact with the charged material, electrostatic discharge occurs, transferring electrons to the third material. Electronic components used in control systems are designed to carry very low voltages; a 30-volt charge created by static electricity can cause a total or degrading failure in PCM or other electronic components containing integrated circuits. Before servicing PCM, ground yourself, and ground the work area to discharge stored electricity.

STATIC CHARGE

Movement	Relative Humidity 10-20%	Relative Humidity 65-90%
Walking Across Carpet	35,000	1500
Handling Clear Plastic Bag	20,000	1200
Sliding Across Velour Seat	15,000	400
Walking Across Tile/Vinyl	12,000	50
Handling Vinyl Tote Bag	7000	600

CAUTION: DO NOT remove PCM from packaging until ready to install. Ground static-proof package BEFORE opening. DO NOT touch electrical terminals of components unless properly grounded. DO NOT lay electrical components on car seat, carpeting or dashboard. Use electrostatic protection mat and ground strap whenever possible. See Fig. 1.

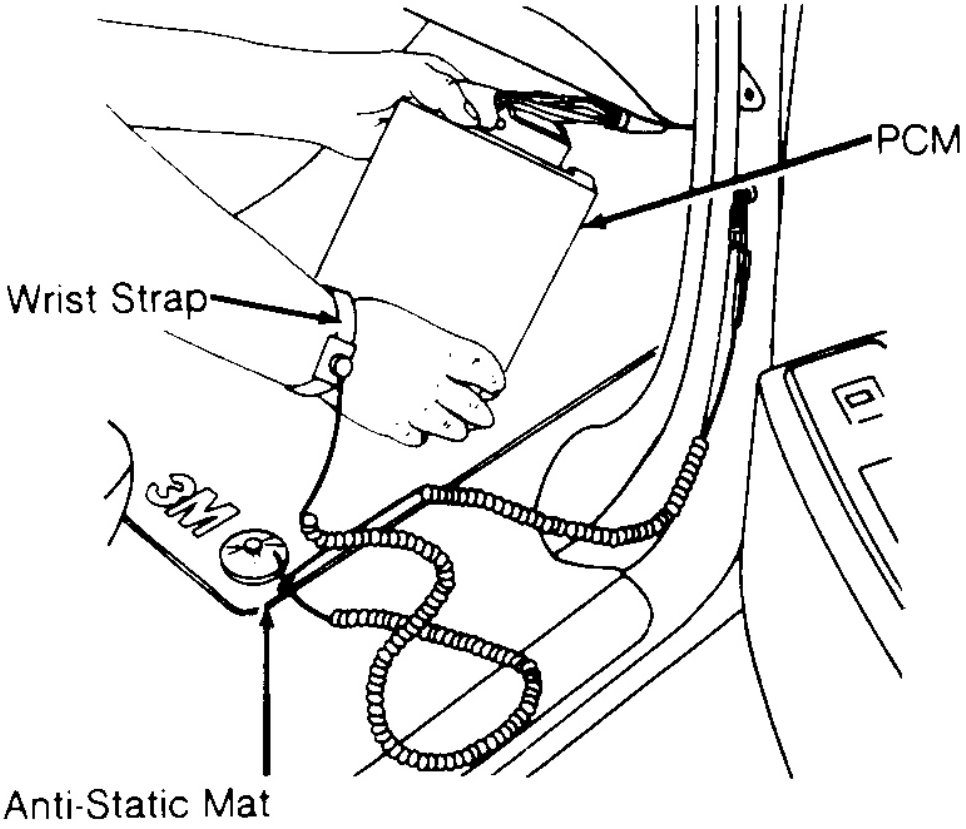


Fig. 1: Servicing PCM While Using 3M Anti-Static Mat

NOTE: Before replacing PCM, carefully inspect all wiring and control components. Ensure ignition switch is in OFF position when connecting or disconnecting PCM connector.

Removal

Disconnect negative battery cable. Unplug electrical connectors from PCM. See **Fig. 1**. Remove PCM from vehicle. Remove PROM and CALPAK (if equipped) or MEM-CAL from PCM. See CALPAK, MEM-CAL, or

PROGRAMMABLE READ-ONLY MEMORY (PROM).

Installation

Install PROM and CALPAK (if equipped) or MEM-CAL in NEW PCM. See CALPAK, MEM-CAL, or PROGRAMMABLE READ-ONLY MEMORY (PROM). Install PCM into vehicle. Connect electrical connectors to PCM. Install access panels. Reconnect negative battery cable.

MEM-CAL

Removal

Disconnect negative battery cable. Remove PCM from vehicle. See REMOVAL under **CONTROL MODULE**. Using 2 fingers, push retaining clips back from MEM-CAL. At the same time, grasp it at both ends and lift out of socket. DO NOT remove MEM-CAL cover.

Installation

1. Carefully align MEM-CAL pins with PCM pin holes. DO NOT press in middle of MEM-CAL. Push downward evenly on ends of MEM-CAL until retaining clips on ends of MEM-CAL snap into place.
2. Install PCM. Reconnect negative battery cable. Turn ignition on and ground DLC terminal "B". DTC 12 should be flashed at least 4 times. If DTC 12 is not flashed at least 4 times, other codes are present. If DTC 51 is present, or if MIL stays on constantly with code(s) present, MEM-CAL is not fully seated, or is defective.

PROGRAMMABLE READ-ONLY MEMORY (PROM)

Removal

1. Remove PCM from vehicle. See REMOVAL under **CONTROL MODULE**. Position PCM so bottom cover is facing upward. Remove slide-off PROM access cover by depressing locking tab.
2. Using PROM removal tool, grasp PROM at narrow ends. Gently rock PROM from end to end while pulling up. If installing new PROM, remove old PROM from PROM carrier.

NOTE: Note reference notch locations in PROM, carrier and PCM for reassembly reference.

Installation

1. Ensure new PROM has same service number as old one or correct factory upgrade. Place NEW PROM in PROM carrier, and position squarely over PCM PROM socket. Press on PROM carrier until PROM is firmly seated in PCM.

   NOTE: Ensure reference notches in PCM and PROM are properly aligned. If PROM is installed backwards and ignition is turned on, PROM will be destroyed.

2. Install PROM access cover on PCM. Install PCM in vehicle. See INSTALLATION under **CONTROL**

MODULE. Turn ignition on and ground DLC terminal "B". Check for DTC 51.

3. If DTC 51 is present, PROM is not fully seated in PCM, installed backwards, has bent pins, or is defective. If bent pins are cracked while straightening, replace PROM. If PROM is installed backwards or is defective, replace PROM.

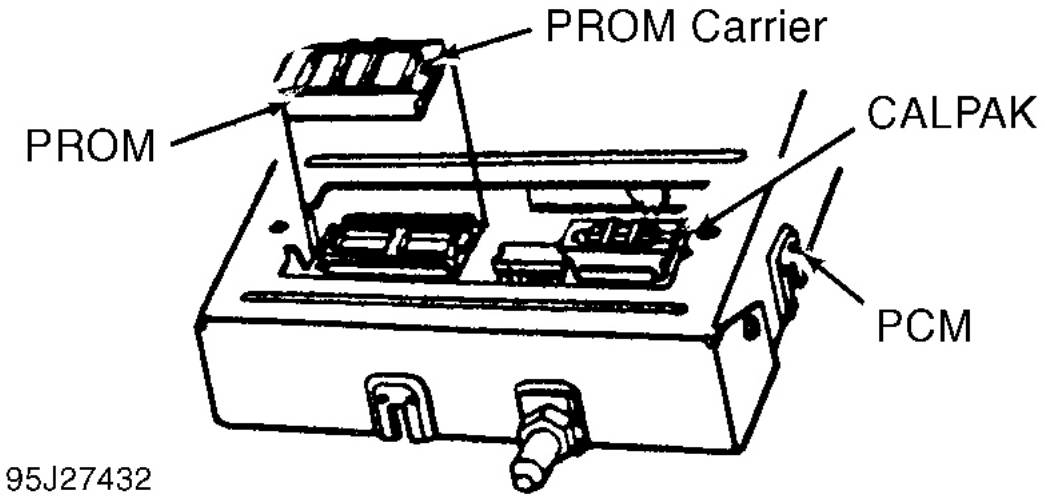


Fig. 2: Locating PROM On PCM
Courtesy of GENERAL MOTORS CORP.

FUEL SYSTEM

FUEL SYSTEM PRESSURE RELIEF (CPI)

1. Disconnect negative battery cable. Loosen fuel filler cap to relieve fuel tank pressure. Install Fuel Pressure Gauge (J-34730-1) to fuel pressure connection.
2. Wrap shop towel around pressure connection when installing fuel pressure gauge to absorb fuel leakage. Place gauge bleed hose in container. Open bleed valve to bleed fuel pressure.

FUEL SYSTEM PRESSURE RELIEF (TBI)

Disconnect negative battery cable. Loosen fuel filler cap to relieve fuel tank pressure. Fuel pressure is relieved and drops to zero when ignition is turned off. However, to minimize risk of fire and personal injury, cover area to be disconnected with a shop rag.

IN-LINE FILTER

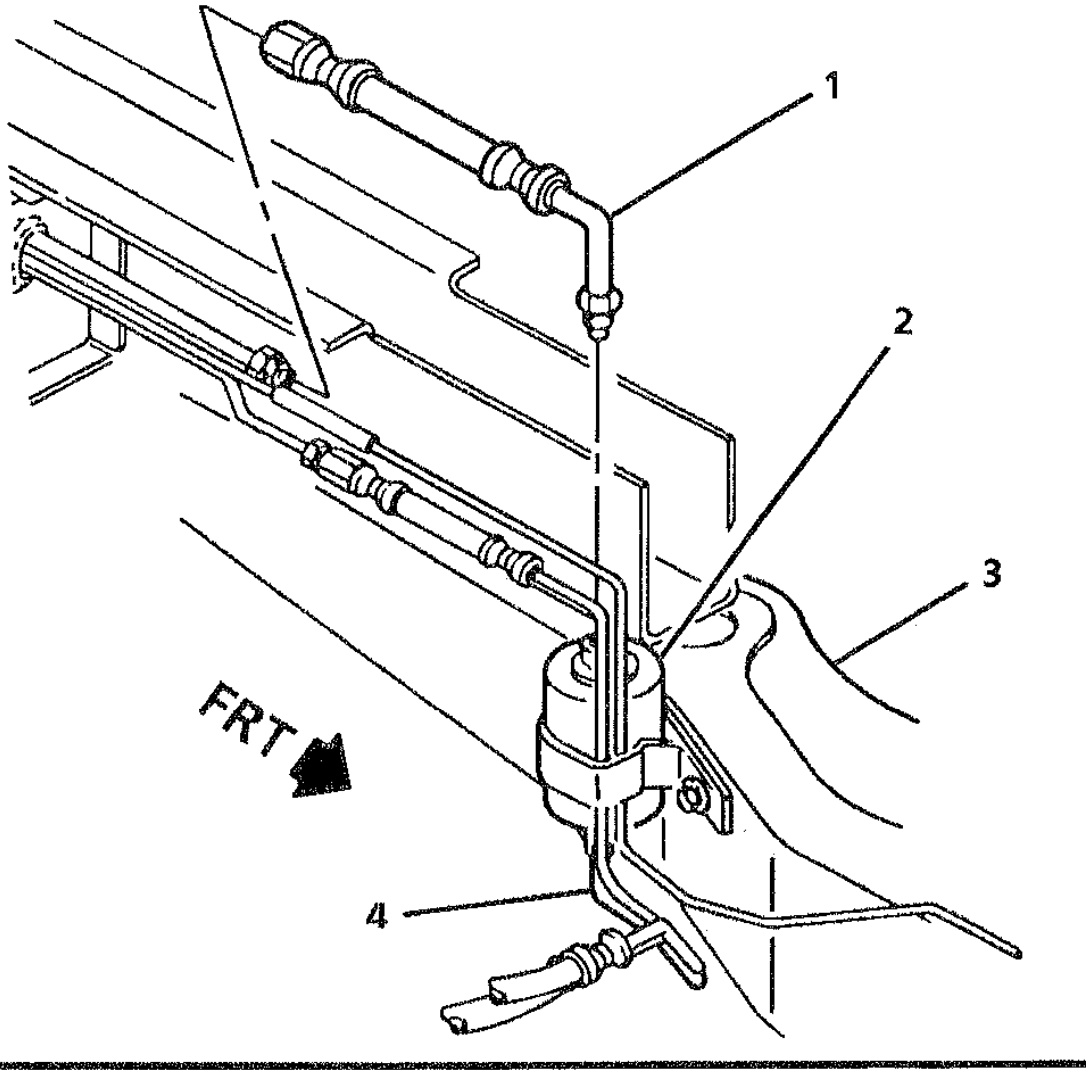


Fig. 3: Identifying In-Line Fuel Filter Components With Torque Specifications
Courtesy of GENERAL MOTORS CORP.

Removal

1. Remove fuel filler cap.

2. Remove fuel feed lines.
3. Remove clamp bolt.
4. Remove Filter and clamp.
5. Remove clamp from filter.

Installation

1. Install clamp to filter.
2. Install clamp bolt.
3. Install fuel feed nuts.
4. Install fuel filler cap.
5. Check for leaks.

IN-TANK FILTER

Refer to "Fuel Pump Replacement" if the in-tank filter requires service.

FUEL PUMP

NOTE: When installing sending unit, DO NOT fold or twist strainer. This will restrict fuel flow.

Removal & Installation (All Models)

1. Relieve fuel system pressure. See FUEL SYSTEM PRESSURE RELIEF (CPI or TBI) under **FUEL SYSTEM**. Disconnect negative battery cable. Raise vehicle and remove fuel tank. Remove sender unit and pump by turning cam lock counterclockwise using Tool (J-36608 or J-24187).
2. Remove fuel pump from sending unit by pulling pump up into attaching hose while pulling outward from the bottom support. DO NOT damage rubber insulator or strainer. To install, reverse removal procedure.

IDLE AIR CONTROL (IAC) VALVE

Removal (CPI)

Disconnect IAC valve harness connector. Remove IAC valve retaining screws and remove IAC valve from upper intake manifold assembly.

Installation

1. Inspect "O" ring for damage. Replace if necessary. If reusing IAC valve, DO NOT push or pull on pintle. Threads on worm gear will be damaged.
2. If replacing IAC valve, measure distance between tip of new IAC valve pintle and mounting flange. Distance should not exceed 1 1/8" (28 mm). If distance is greater than specified, use finger pressure to slowly retract pintle. Lubricate "O" ring with clean engine oil.
3. Apply thread locking compound (Loctite 262) to IAC valve retaining screw threads. Install IAC valve to

throttle body. Tighten IAC valve retaining screws to 27 INCH lbs. (3 N.m). Connect IAC valve harness connector.

4. To reset IAC valve pintle position, turn ignition on for 5 seconds. Turn ignition off for 10 seconds. Start engine and check for proper idle operation. Repeat IAC valve resetting procedure if proper idle operation cannot be obtained.

Removal (TBI)

Remove air cleaner and related ducting. Disconnect Idle Air Control (IAC) electrical connector. Unscrew IAC valve. Replace if necessary.

Installation

1. Inspect gasket for damage. Replace if necessary. Measure distance between tip of IAC valve pintle and mounting flange. Distance should not exceed 1 1/8" (28 mm). If valve is extended too far, damage to valve will result during installation.
2. To set IAC valve pintle length on new IAC valve, use finger pressure to slowly retract pintle. Install NEW gasket. Install IAC valve on throttle body. Tighten IAC valve to specification. See **TORQUE SPECIFICATIONS**.

CAUTION: DO NOT manually extend or retract pintle if IAC valve has been in service, or damage to worm gear will result.

3. Connect IAC valve harness connector and install air cleaner. Start engine and allow it to reach normal operating temperature. Drive vehicle. It may be necessary to reset idle speed. To reset, disconnect negative battery cable for 10 seconds and reconnect. Cycle ignition on with engine off for 5 seconds. Turn ignition off for 10 seconds and restart vehicle. Proper idle will be initialized.

INTAKE MANIFOLD TUNING VALVE (CPI)

Removal & Installation

1. Disconnect intake manifold tuning valve electrical harness connector. Remove intake manifold tuning valve retaining screws. Discard "O" ring. Use carburetor cleaner to remove carbon deposits. DO NOT soak tuning valve assembly in solvent.
2. To install, reverse removal procedure. Lubricate NEW "O" ring with clean engine oil. Apply thread locking compound (Loctite 262) to intake manifold tuning valve retaining screw threads. Tighten retaining screws to 18 INCH lbs. (2 N.m). Reconnect electrical harness connector.

THROTTLE BODY (CPI)

NOTE: Throttle body on CPI is part of upper intake manifold. To remove throttle body, see UPPER INTAKE MANIFOLD & CPI ASSEMBLY under FUEL SYSTEM.

THROTTLE BODY (TBI)

NOTE: Identification number is stamped on throttle body near TP sensor. Identification number must be used for ordering replacement components.

Identification

An 8-digit unit identification number is stamped on throttle body assembly. Number is stamped vertically on front of throttle body, at Throttle Position (TP) sensor side.

Removal

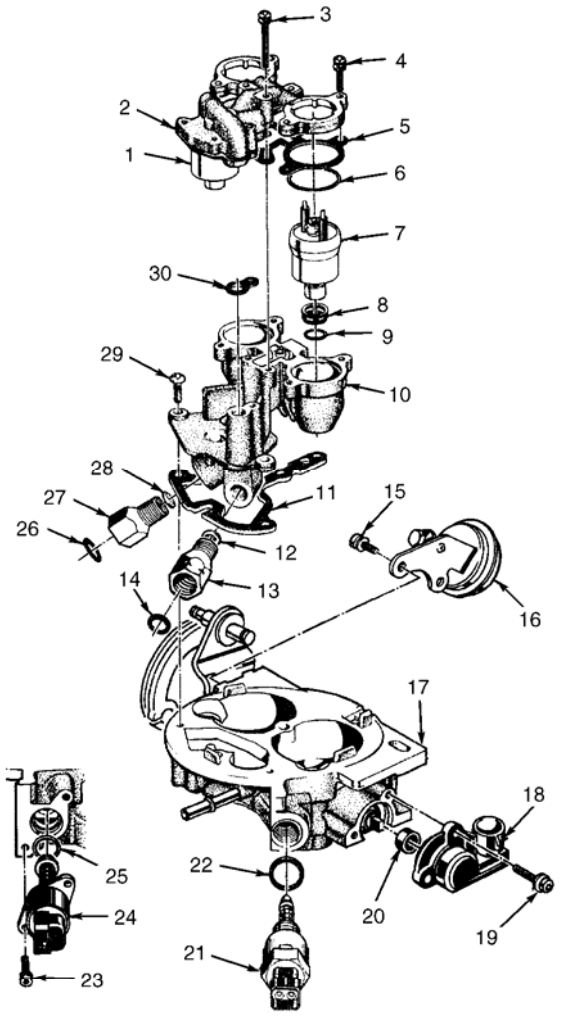
1. Remove air cleaner, adapter and gasket. Relieve fuel pressure. See **FUEL SYSTEM PRESSURE RELIEF (TBI)** under FUEL SYSTEM.
2. Disconnect electrical harness connectors from IAC valve, TP sensor and fuel injectors. Disconnect fuel lines from throttle body. Discard fuel line "O" rings. Disconnect grommet with wires from throttle body.
3. Disconnect throttle linkage, return spring and cruise control linkage (if equipped). Label and disconnect all vacuum hoses from throttle body. Remove throttle body mounting bolts/nut. Remove throttle body.

NOTE: Disassembling throttle body unit for immersion in cleaning solvent requires removal of fuel meter assembly, TP sensor, IAC valve and governor assembly (if equipped). Throttle valve screws are staked in position and should NOT be removed.

WARNING: On throttle bodies without governor assembly, pressure regulator spring is under heavy tension and may cause personal injury if released. DO NOT immerse cover in any type of cleaning solvent.

Disassembly (Fuel Meter Assembly Model 220)

1. Place throttle body on Holding Fixture (J-9789-118 or BT-30-15) to prevent damage to throttle valve. Remove fuel meter cover assembly-to-fuel meter body screws (note location of short screw). See **Fig. 2**. Remove fuel meter cover assembly. Remove and discard pressure regulator dust seal. Fuel meter cover assembly and pressure regulator are serviced as an assembly. DO NOT remove pressure regulator from cover assembly.
2. Remove fuel injectors. Note location of fuel inlet and outlet nuts and remove. Discard gaskets. Remove fuel meter body assembly-to-throttle body screws. See **Fig. 2**. Remove fuel meter body assembly. Remove and discard fuel meter body assembly gasket and fuel meter outlet gasket.
3. Remove TP sensor, IAC valve, ISC actuator, rubber components and gaskets. Clean all remaining (metal) parts in a cold immersion-type cleaner such as Carbon X (X-55). Blow dry with compressed air. Inspect mating surfaces for damage which may prevent gasket sealing. Repair or replace faulty components.



1. Pressure Regulator
2. Fuel Meter Cover Assembly
3. Long Screw
4. Short Screw
5. Fuel Meter Cover Assembly Gasket
6. "O" Ring (Upper)
7. Fuel Injector
8. Injector Filter
9. "O" Ring (Lower)
10. Fuel Meter Body Assembly
11. Fuel Meter Body Assembly Gasket
12. Fuel Outlet Nut Gasket
13. Fuel Outlet Nut
14. "O" Ring
15. ISC Actuator Screw
16. ISC Actuator
17. Throttle Body Assembly
18. Throttle Position (TP) Sensor
19. TP Sensor Screw
20. TP Sensor Seal
21. Idle Air Control (IAC) Valve (Threaded)
22. IAC Valve Gasket
23. IAC Valve Screw
24. Idle Air Control (IAC) Valve (Flange Mounted)
25. "O" Ring
26. "O" Ring
27. Fuel Inlet Nut
28. Fuel Inlet Nut Gasket
29. Fuel Meter Body Assembly Screw
30. Fuel Meter Outlet Gasket

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Fig. 4: Exploded View Of Throttle Body (TBI 220)
Courtesy of GENERAL MOTORS CORP.

Disassembly (Fuel Meter Assembly Model 295)

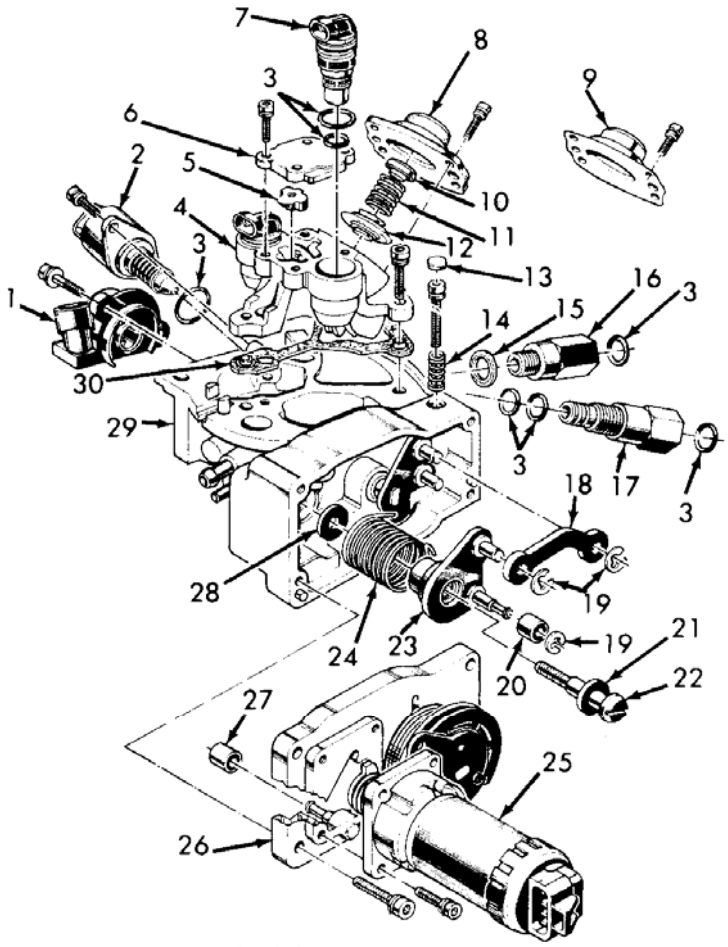
1. Place throttle body on Holding Fixture (J-9789-118 or BT-30-15) to prevent damage to throttle valve. Remove fuel meter body cover screws and remove fuel meter body cover. See **Fig. 5**. If fuel pres sure regulator cover is removed, regulator diaphragm must be replaced to prevent fuel leaks.
2. Remove fuel injectors. Note location of fuel inlet and outlet nuts and remove. Discard gaskets and "O" rings. Remove fuel meter body assembly-to-throttle body screws. See **Fig. 5**. Remove fuel meter body assembly. Remove and discard fuel meter body assembly gasket.
3. Remove TP sensor, IAC valve, fuel pressure regulator, governor drive motor and governor throttle drive assembly, lever and bearing assembly, rubber components, gaskets and diaphragms. Clean all remaining (metal) parts in a cold immersion-type cleaner such as Carbon X (X-55). Blow dry with compressed air. Inspect mating surfaces for damage which may prevent gasket sealing. Repair or replace faulty components.

Reassembly (Fuel Meter Assembly)

1. On TBI 220, install NEW pressure regulator dust seal into recess of throttle body. Install NEW fuel meter outlet gasket on fuel meter body assembly. On all models, install NEW fuel meter body gasket on throttle body. Install TP sensor, IAC valve, rubber components, gaskets and diaphragms (if equipped).
2. On TBI 220, install ISC actuator. On TBI 295, install governor drive motor and governor throttle drive assembly, lever and bearing assembly, and fuel pressure regulator. On all models, install fuel meter body assembly onto throttle body. Apply thread locking compound (Loctite 262) to fuel meter body assembly screws and tighten to specification. See **TORQUE SPECIFICATIONS**.
3. Lubricate fuel inlet and outlet "O" rings with clean engine oil. Install fuel inlet and outlet "O" rings, gaskets and nuts. Install fuel injectors. On TBI 220, install fuel meter cover assembly. On TBI 295, install fuel meter body cover. On all models, apply thread locking compound (Loctite 262) to cover attaching screws. Tighten screws.

Installation

To install, reverse removal procedure. Ensure throttle body and intake manifold sealing surfaces are clean. Use NEW throttle body gasket and fuel line "O" rings. Check fuel system for leaks by turning ignition on, but DO NOT start engine.



1. Throttle Position (TP) Sensor
2. Idle Air Control (IAC) Valve
3. "O" Ring
4. Fuel Meter Body Assembly
5. Fuel Vapor Block
6. Fuel Meter Body Cover
7. Fuel Injector
8. Fuel Pressure Regulator Cover
9. Fuel Pressure Regulator Cover
10. Spring Seat
11. Spring
12. Diaphragm
13. Idle Stop Plug
14. Idle Stop Screw Spring
15. Fuel Outlet Nut Gasket
16. Fuel Outlet Nut
17. Fuel Inlet Nut
18. Throttle-To-Motor Link
19. Retaining Ring
20. Shock Absorber
21. Washer
22. Screw Stud
23. Lever & Bearing
24. Governor Spring
25. Governor Drive Motor
26. Governor Throttle Drive Assembly
27. Shock Absorber
28. Lever Washer
29. Throttle Body Assembly
30. Fuel Meter Body Assembly Gasket

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Fig. 5: Exploded View Of Throttle Body (TBI 295)
Courtesy of GENERAL MOTORS CORP.

THROTTLE BODY INJECTOR (TBI)

Removal

1. Relieve fuel pressure. See FUEL SYSTEM PRESSURE RELIEF (TBI) under **FUEL SYSTEM**. Disconnect fuel injector electrical connector. Remove fuel meter cover assembly (TBI 220, or fuel meter body cover (TBI 295), leaving cover gasket in place. Using screwdriver and fulcrum, pry injector out. See **Fig. 6**. Remove small "O" ring from nozzle end of injector.
2. Carefully rotate injector fuel filter back and forth to remove fuel filter from base of injector. Remove and discard fuel meter cover gasket. Remove large "O" ring and steel back-up washer (if equipped) from top counterbore of throttle body injector cavity.

Installation

1. Install fuel filter on nozzle end of fuel injector. Ensure large end of filter faces injector so filter covers raised rib at base of injector. Lubricate small "O" ring with Automatic Transmission Fluid (ATF), and push "O" ring on nozzle end of injector until it presses against injector filter.
2. Install steel back-up washer (if equipped) in top counterbore of throttle body injector cavity. Lubricate large "O" ring with ATF, and install "O" ring directly over back-up washer. Ensure "O" ring is seated properly in cavity, and is flush with top of throttle body casting.

CAUTION: Install back-up washer and large "O" ring before installing injector. Improper seating of "O" ring will cause fuel leak.

3. Install "O" ring on injector. Install injector into cavity by aligning raised lug on injector base with cast-in notch of throttle body cavity. Push down on injector until fully seated. Install fuel meter cover.

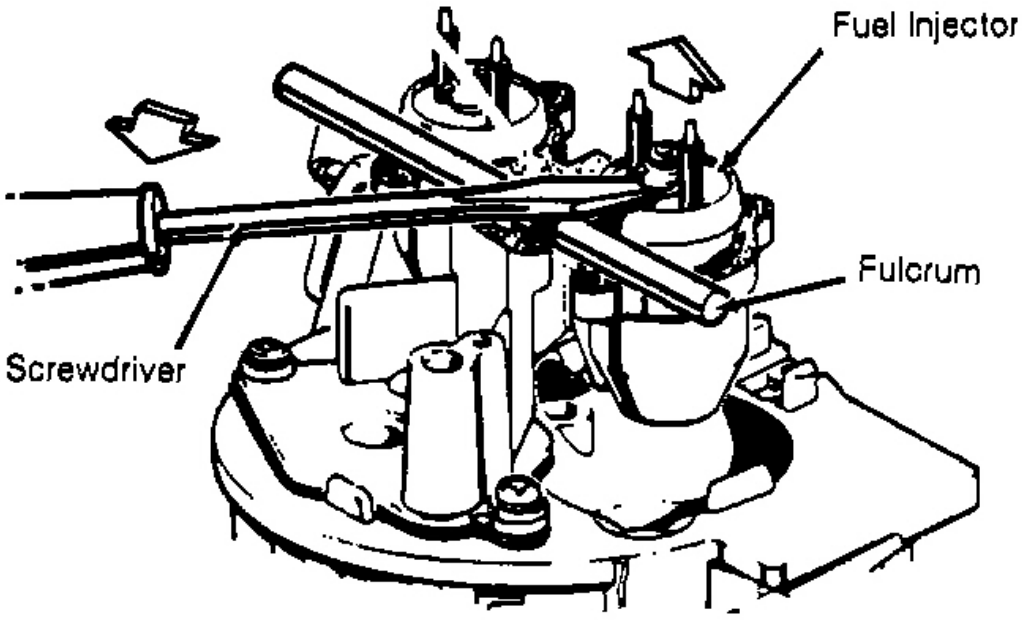


Fig. 6: Removing Throttle Body Injector
Courtesy of GENERAL MOTORS CORP.

UPPER INTAKE MANIFOLD & CPI ASSEMBLY

NOTE: Identification number is stamped on base of upper intake manifold or on fuel pressure regulator. Identification number must be used for ordering replacement components.

Removal

1. Relieve fuel pressure. See FUEL SYSTEM PRESSURE RELIEF (CPI) under **FUEL SYSTEM**. Disconnect negative battery cable. Remove plastic cover on upper intake manifold. Disconnect electrical harness connectors from TP sensor, IAC valve, MAP sensor and intake manifold tuning valve assembly.
2. Disconnect throttle and cruise control cables from upper intake manifold. Remove ignition coil, PCV hose and related vacuum hoses. Remove air cleaner snorkel.
3. Mark location of all studs for proper reassembly. Remove upper intake manifold bolts and stud nuts. Remove upper intake manifold assembly. See **Fig. 7**.

NOTE: DO NOT attempt to disassemble CPI assembly. CPI unit is not serviceable and should be replaced as an assembly.

4. Remove injector wiring harness connector at CPI unit. Remove and discard fuel fitting clip. Disconnect

fuel inlet and return lines, and fitting assembly. Discard "O" ring seal.

5. To remove CPI assembly from intake manifold, squeeze poppet nozzle locking tabs together while lifting nozzle out of casing socket from each cylinder. After removing all the poppet nozzles (6), lift CPI assembly out of casing. See **Fig. 7**.

Installation

1. To install, reverse removal procedure. Align CPI assembly grommet with casting grommet slots and push down on CPI until it is seated in bottom of guide hole. See **Fig. 7**.
2. Push poppet nozzles into casting sockets. Ensure poppet nozzles are firmly seated and locked in casting socket. Install fuel inlet and return lines. Lubricate NEW "O" rings with clean engine oil.
3. Pressurize fuel system and check for fuel leak. Install upper intake manifold assembly. Tighten upper intake manifold bolts and nuts in sequence to 88 INCH lbs. (10 N.m). See **Fig. 8**.

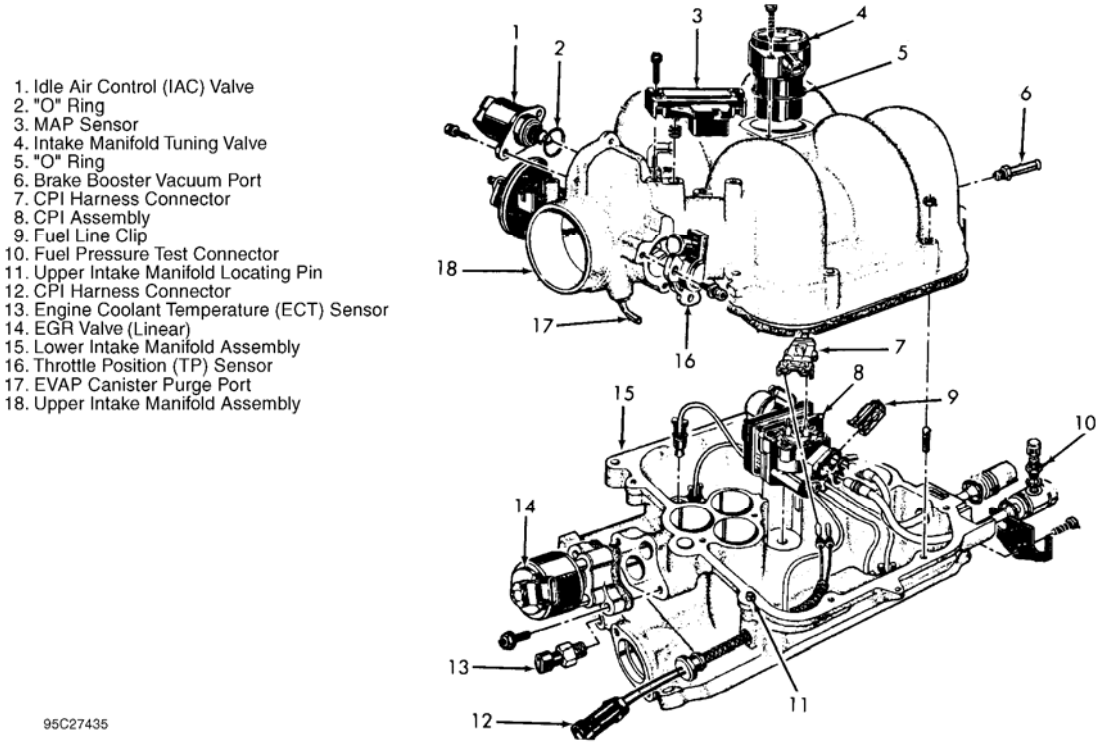


Fig. 7: Exploded View Of Central Port Injection (CPI) Assembly
Courtesy of GENERAL MOTORS CORP.

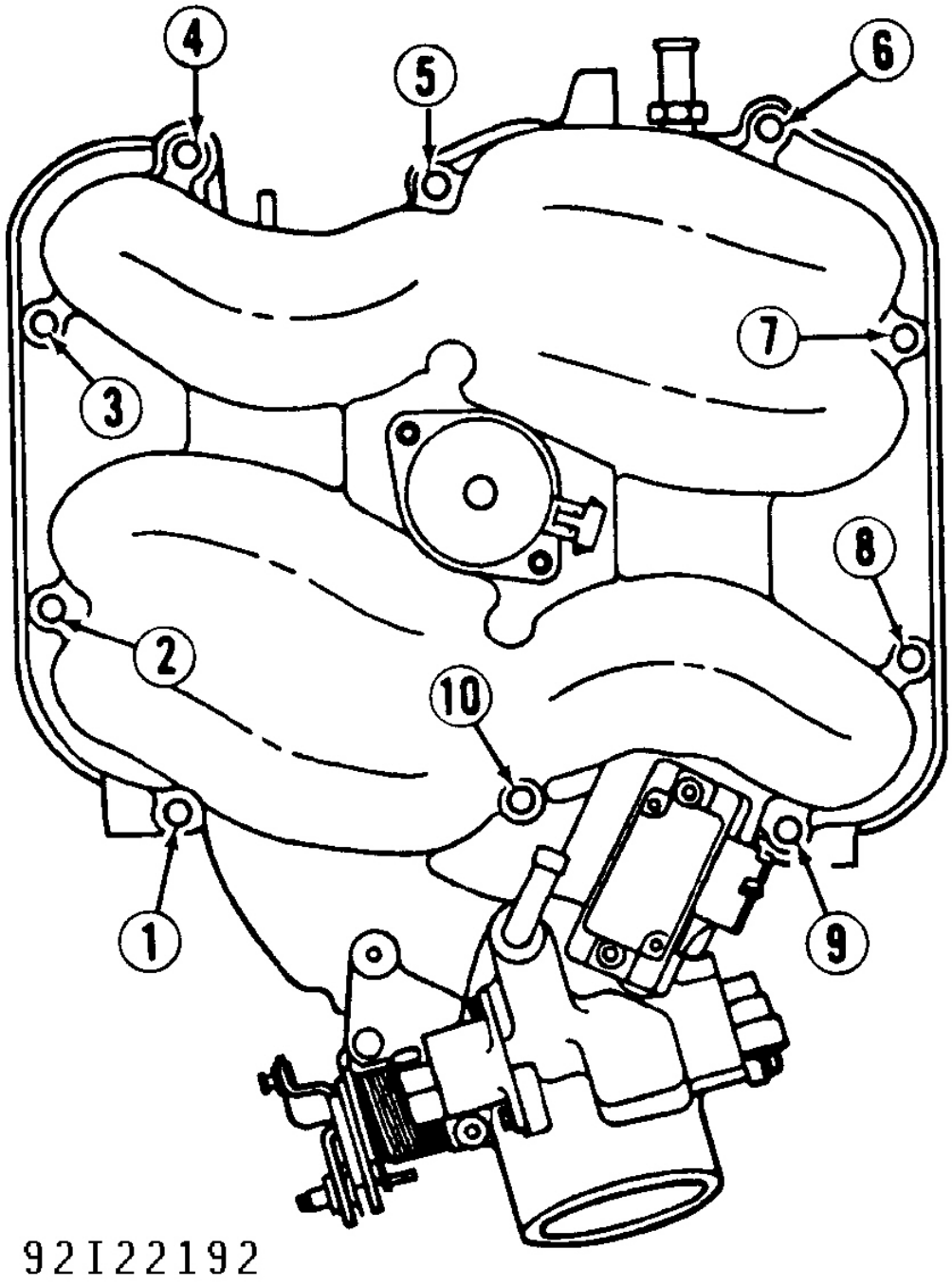


Fig. 8: CPI Upper Intake Manifold Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

GOVERNOR ASSEMBLY (TBI 295)

Removal & Installation

1. Remove air cleaner assembly, extension (spacer) and gasket. Disconnect electrical harness connector from governor assembly. Rotate the throttle cam lever to 11 o'clock position. Install a 14 mm socket between governor drive motor and throttle cam lever to block throttle cam lever. See **Fig. 9**.
2. Remove mounting screws. Hold throttle valve closed. Remove governor assembly. See **Fig. 9**.
3. To install, make sure throttle cam lever is blocked open (11 o'clock position). Install governor assembly. See **Fig. 9**. Remove 14 mm socket. Ensure throttle cam lever and throttle valves rotate freely. To complete installation, install remaining parts.

Disassembly & Reassembly

1. Hold throttle cam lever open at 11 o'clock position. See **Fig. 10**. Remove mounting screws and remove governor drive motor. Release spring tension from governor drive lever. No other disassembly is possible.
2. If necessary, apply Special Grease (available in repair kit only) to governor mechanism. Align governor drive motor with cover plate. See **Fig. 11**. Reattach spring to governor drive lever.
3. Hold throttle cam lever open at 11 o'clock position. See **Fig. 10**. Tilt governor drive motor slightly. Ensure governor drive lever clears cover and align mounting holes. Apply Loctite to threads and tighten mounting screws to 27 INCH lbs. (3 N.m).
4. Rotate governor drive lever clockwise. Spring tension should be felt. Release lever. Governor drive lever should return to park position. If governor drive lever does not operate as described, recheck assembly procedure.

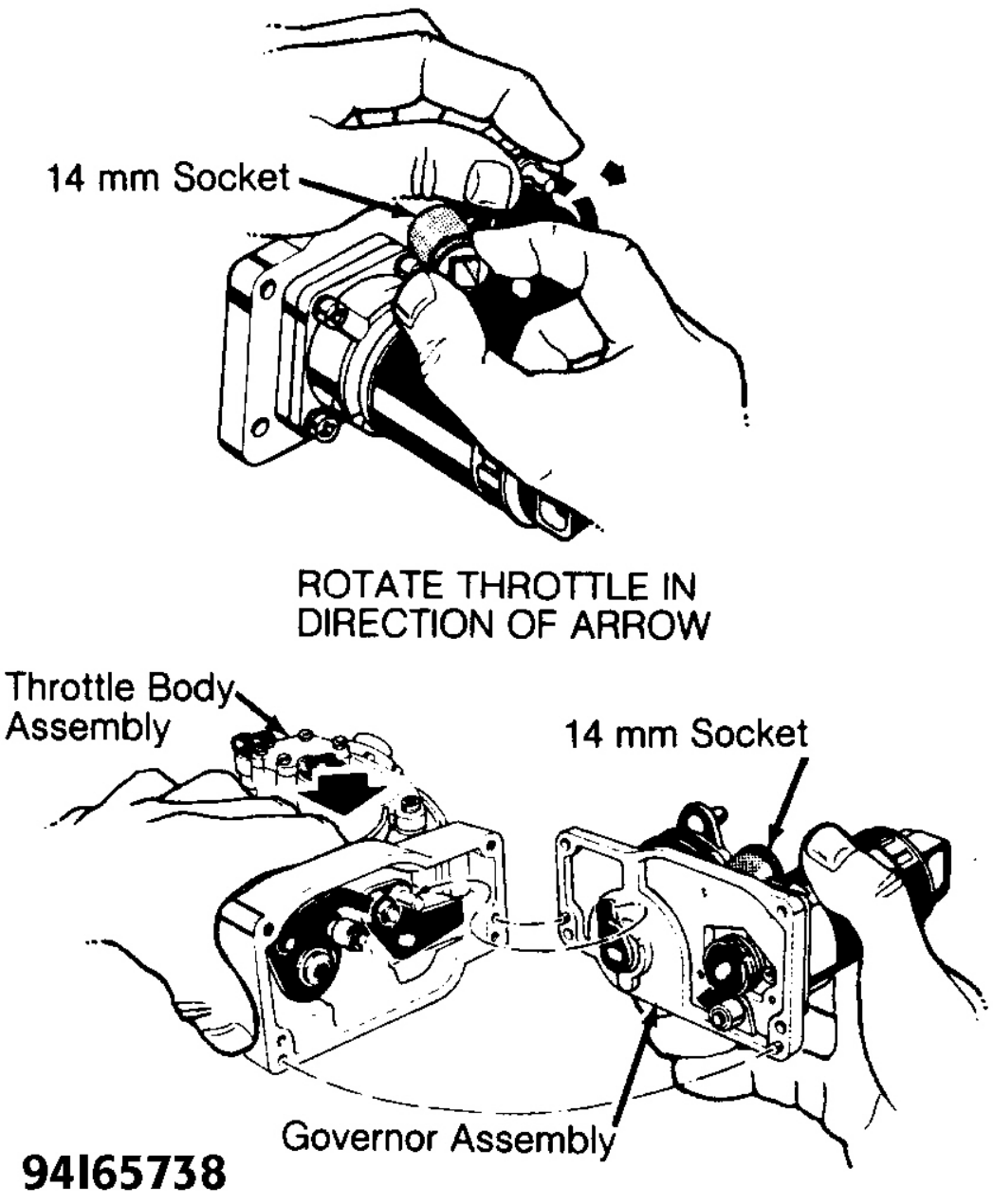


Fig. 9: Removing & Installing Governor Assembly
Courtesy of GENERAL MOTORS CORP.

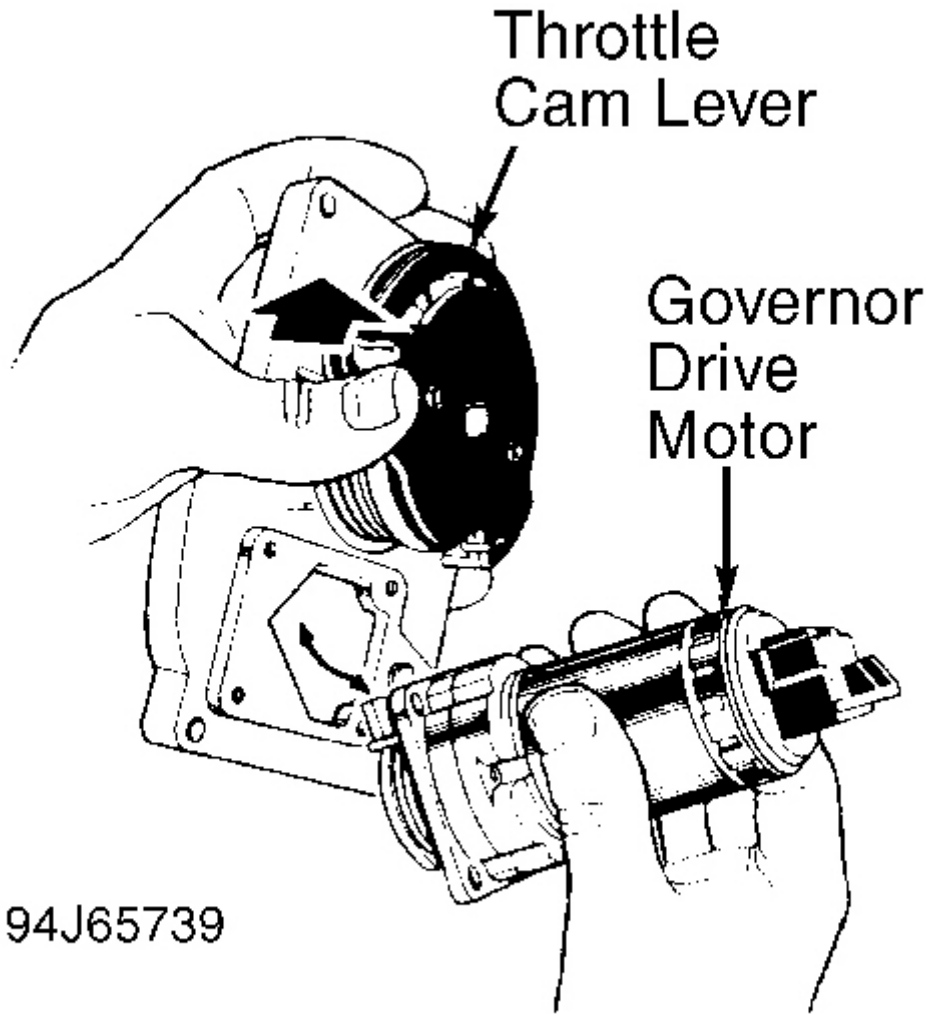
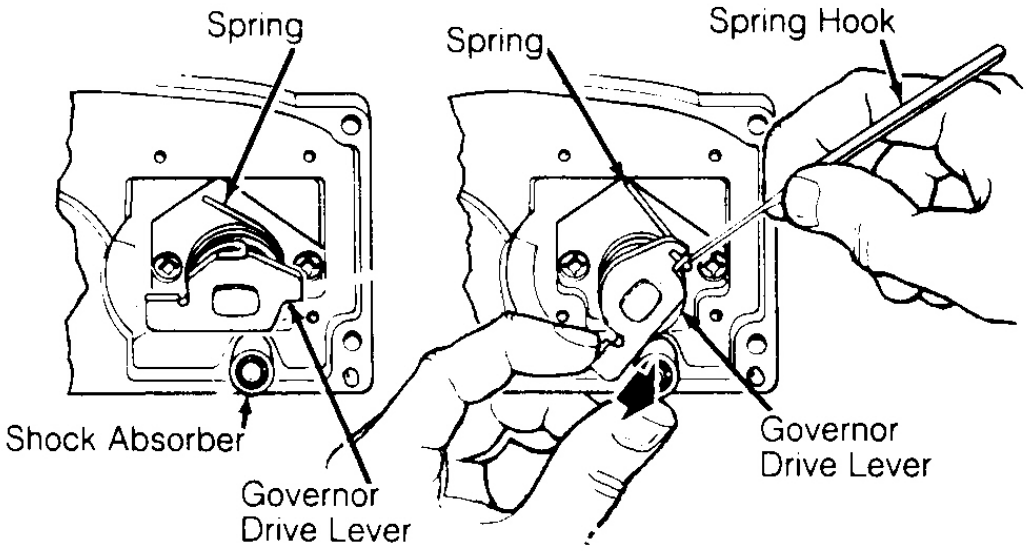


Fig. 10: Removing & Installing Governor Drive Motor
Courtesy of GENERAL MOTORS CORP.



94C65740

Fig. 11: Attaching Governor Drive Lever Spring
Courtesy of GENERAL MOTORS CORP.

IGNITION SYSTEM

DISTRIBUTOR (HEI-EST SYSTEM)

Removal

1. Disconnect negative battery cable. On TBI models, remove air cleaner assembly. Remove upper intake manifold assembly.
2. On all models, disconnect electrical connectors to distributor. Remove distributor cap and move aside. Remove distributor hold-down bolt and hold-down clamp. Note position of rotor. Pull up slightly on distributor until rotor stops turning counterclockwise and again note position of rotor. Remove distributor from engine.

CAUTION: Although similar in appearance, components of HEI/EST distributors are NOT interchangeable. See Fig. 12.

Disassembly & Reassembly

1. Disassembly procedure is not available from manufacturer. For disassembly, use exploded views of distributors. See **Fig. 12**.
2. When reassembling, ensure pick-up assembly arm is correctly installed on pin. If not, arm can float and

cause ignition timing to vary. To prevent corrosion, lubricate terminals with petroleum jelly before installation.

3. To prevent heat damage, coat bottom of module and module rest pad in distributor housing with silicone grease. Before installing roll pin in driven gear, ensure timing mark on roll pin and rotor tip align. See **Fig. 12**.

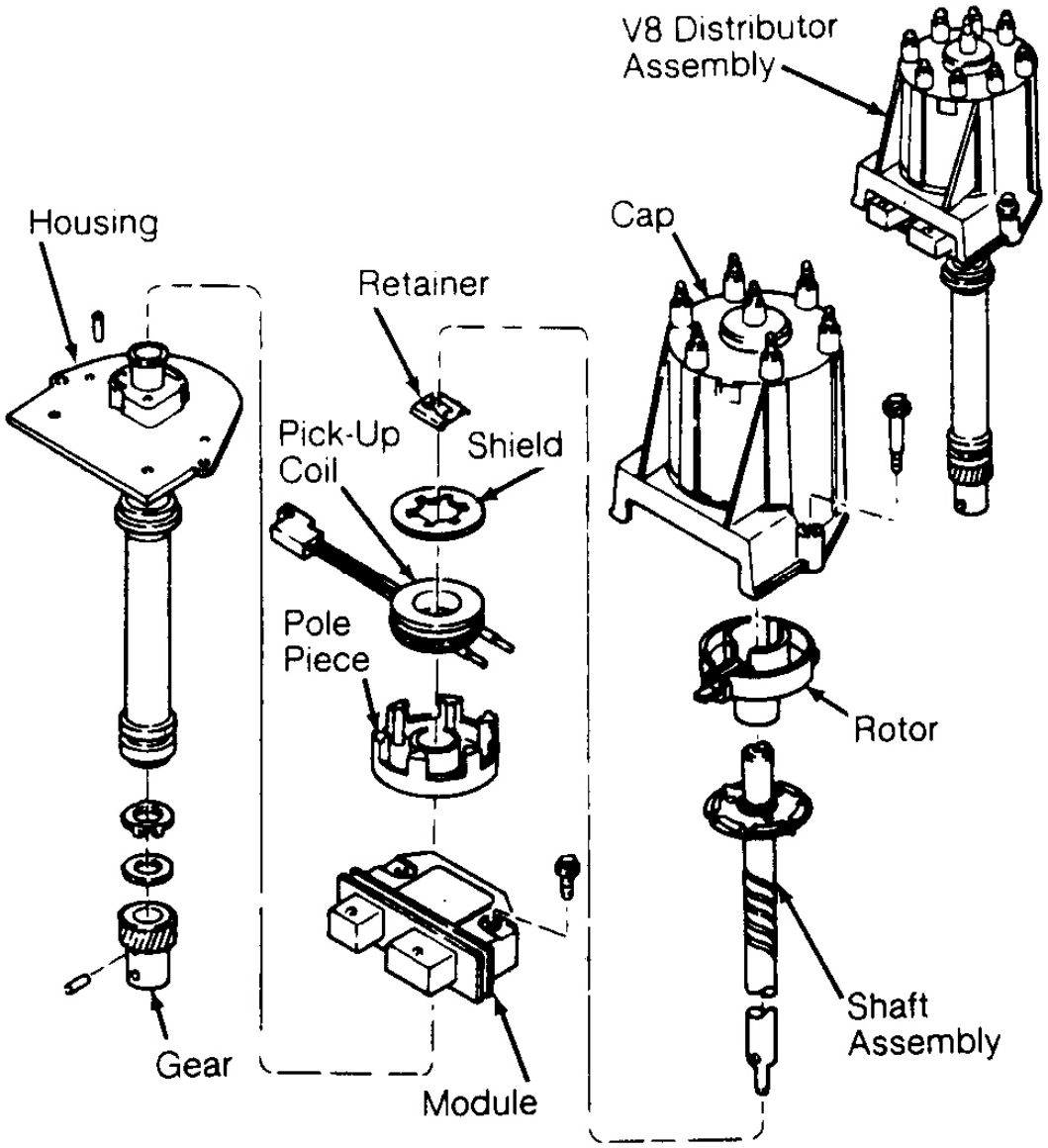


Fig. 12: Exploded View Of HEI-EST Distributor (4.3L & V8)
Courtesy of GENERAL MOTORS CORP.

Installation

1. To install, reverse removal procedure. To ensure correct timing of distributor, install with rotor correctly positioned as it was before distributor was removed.
2. If engine was cranked after distributor was removed, remove No. 1 spark plug. Place finger over No. 1 cylinder spark plug hole. Crank engine slowly until compression is felt. Align timing mark on pulley to "0" on engine timing indicator. Turn rotor to point to cylinder No. 1 spark plug tower on distributor cap. Complete distributor installation. Start engine and check ignition timing.

DISTRIBUTOR (HVI - HIGH VALUE IGNITION SYSTEM)

The M/L model vehicles equipped with 4.3L (VIN W) engine use the HVI system. The "distributor" is called the High Voltage Switch (HVS). System is also referred to as the HVI/HVS system. The HVS includes a camshaft position sensor.

CAUTION: HVS ("distributor") is installed in a fixed, nonadjustable position. Base timing is computer controlled and cannot be adjusted by rotating HVS. Attempting to do so may result in crossfire and misfire conditions. If HVS is installed incorrectly a DTC 1345 may be set.

Removal

1. Ensure ignition is off. Disconnect spark plugs and coil leads from HVS cap. Disconnect 3-wire camshaft position sensor plug from base of HVS. Remove 2 screws holding cap to HVS housing.
2. Mark HVS cap with a grease pencil to indicate position of rotor to housing. Loosen mounting clamp hold-down bolt and slide clamp back.
3. Remove HVS. See **Fig. 13**. When HVS is being removed rotor will rotate approximately 42 degrees. Place a second mark at this position for reassembly reference. If the original HVS is being replaced, transfer marks made during removal to replacement component.

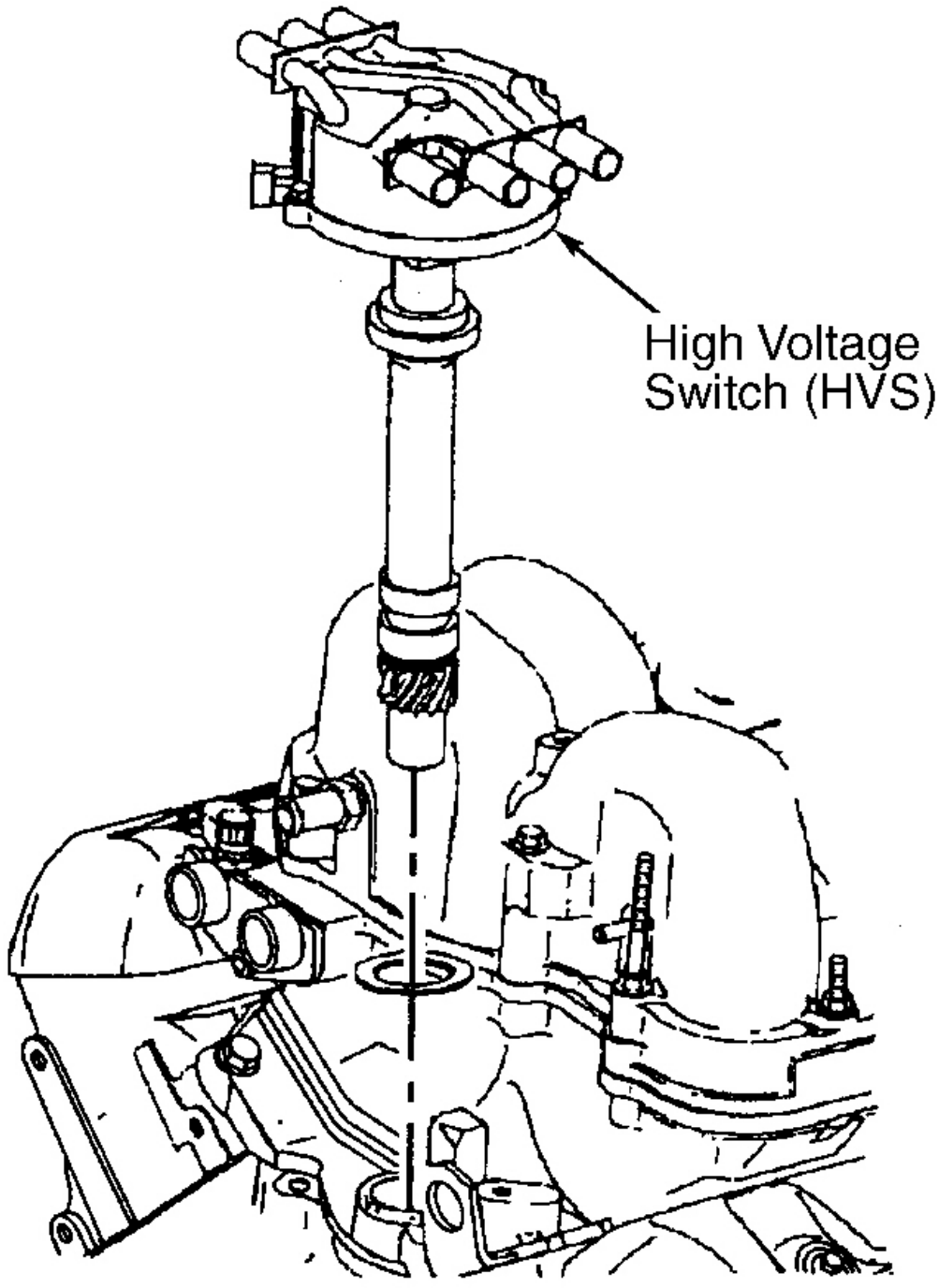
Installation

NOTE: If engine crankshaft has been rotated since HVS was removed, marks made during removal to aide installation are no longer valid. If this condition exists, start installation procedure at Step 4).

1. Align rotor to second mark made during removal. Guide HVS into engine. Ensure rotor rotates approximately 42 degrees during installation. When HVS is completely seated in position ensure rotor aligns with initial mark made during removal.
2. If rotor and mark are not aligned, HVS and camshaft have meshed one or more teeth out of time. Remove HVS and reinstall. Once marks are aligned and HVS is in correct position, position mounting clamp and tighten to 20 ft. lbs. (27 N.m).
3. Install cap and 3-wire camshaft position sensor connector. Connect spark plug and coil wires. Start engine. If CHECK ENGINE LIGHT is on or DTC 1345 is set, go to next step to check or reset distributor position. If not, installation is correct.
4. Position engine crankshaft at TDC position for No. 1 cylinder. Ensure piston is on compression stroke. Align pre-drilled indent hole in HVS driven gear with arrow cast into upper portion of shaft housing. The

rotor should point to the cap hold down mount nearest the flat side of the housing. See **Fig. 14**.

5. Use a long screwdriver to align oil pump drive shaft position, in engine, with position of HVS drive tab. Guide HVS into place. Ensure locating slot in HVS base is over dowel pin.
6. With HVS fully seated, ensure rotor tip is now aligned with pointer cast into HVS base. See **Fig. 14**. Pointer has a "6" cast into it (to indicate unit is for a 6-cylinder engine). If rotor and pointer are not closely aligned (within a few degrees), HVS may be out of time by a tooth. Repeat installation procedure.
7. Once marks are aligned and HVS is in correct position, position mounting clamp and tighten to 20 ft. lbs. (27 N.m). Install cap and 3-wire camshaft position sensor connector. Connect spark plug and coil wires.
8. Start engine. If CHECK ENGINE LIGHT is on or DTC 1345 is set, check distributor position and installation procedure.



HVI/HVS IGNITION

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Fig. 13: HVI/HVS Ignition (M & L Models W/4.3L)
Courtesy of GENERAL MOTORS CORP.

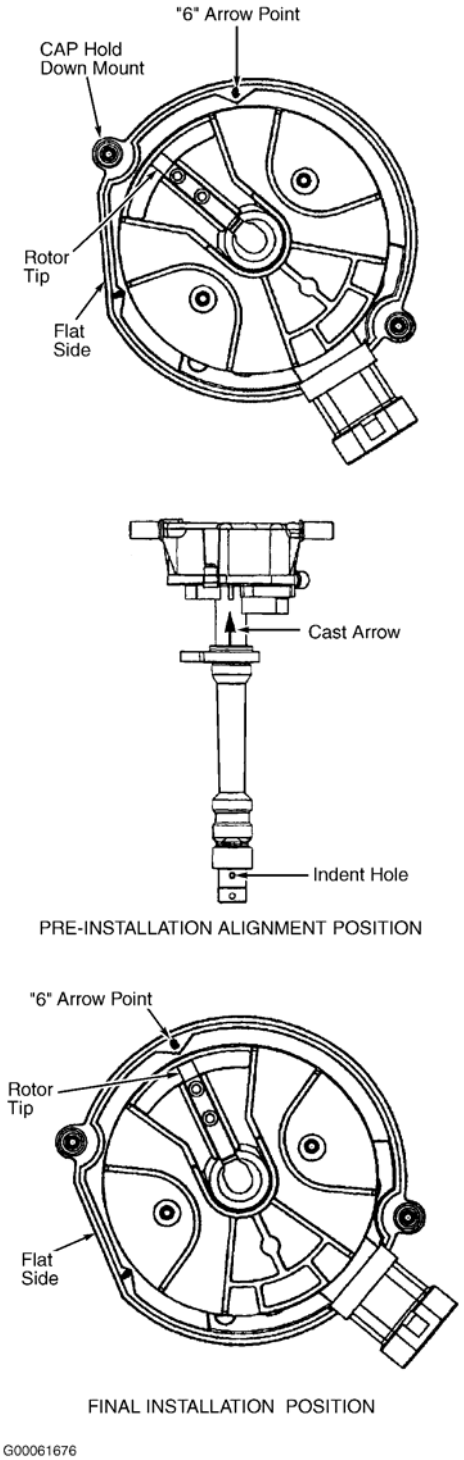


Fig. 14: Aligning HVS For Installation
Courtesy of GENERAL MOTORS CORP.

THROTTLE POSITION (TP) SENSOR

REMOVAL & INSTALLATION

1. Remove air cleaner assembly. Disconnect electrical connector from TP sensor. Remove attaching screws, lock washers, retainers, and TP sensor.
2. To install, reverse removal procedure. Adjust TP sensor to specification. See **ADJUSTMENTS - 4.3L** article in the ENGINE PERFORMANCE section. When replacing a TP sensor, ensure correct part number is used. Use Loctite on TP sensor attaching screws.

OXYGEN SENSOR

CAUTION: Oxygen sensor is equipped with a permanent pigtail, which must be protected to prevent damage when removing sensor.

REMOVAL

1. Oxygen sensor is mounted in the exhaust pipe, below exhaust manifold. Ensure sensor is free of contaminants. DO NOT use cleaning solvents of any type. Sensor may be difficult to remove when engine temperature is less than 120°F (48°C). Excessive removal force may damage threads in exhaust manifold or pipe.
2. Disconnect negative battery cable. Disconnect electrical connector from oxygen sensor. Carefully remove oxygen sensor from exhaust pipe.

CAUTION: Correct torque of oxygen sensor is critical to prevent crushing glass beads in graphite anti-seize compound. Crushing glass beads will cause sensor to seize in exhaust manifold. This may require replacement of exhaust manifold upon next removal.

INSTALLATION

1. Whenever oxygen sensor is removed, coat threads with anti-seize compound before reinstalling. New oxygen sensors already have this compound applied to threads.
2. Install oxygen sensor in exhaust pipe and tighten sensor to 30 ft. lbs. (41 N.m). Reconnect electrical connector to oxygen sensor. Reconnect negative battery cable.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Fuel Line Nut	17 (23)
Idle Air Control Valve (Threaded)	13 (18)
HVS (Distributor) Hold Down Bolt	20 (27)
Oxygen Sensor	30 (41)

Throttle Body-To-Manifold Bolts	12 (16)
	INCH Lbs. (N.m)
Fuel Meter Body Cover Screws	
TBI Model 295	28 (3.2)
Fuel Meter Body Screws	
TBI Model 220	30 (4)
TBI Model 295	40 (4.5)
Fuel Meter Cover Assembly Screws	
TBI Model 220	27 (3)
Fuel Pressure Regulator Cover Screws	
TBI Model 295	21 (2.4)
Idle Air Control Valve Screws (Flange Mounted)	27 (3)
Intake Manifold Tuning Valve (CPI)	18 (2)
Upper Intake Manifold Bolts & Nuts (CPI)	88 (10)

N - REMOVE/INSTALL/OVERHAUL

ENGINE PERFORMANCE General Motors Corp. Removal, Overhaul & Installation

INTRODUCTION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION section before disconnecting battery.

Removal, overhaul and installation procedures (when given by manufacturer) are covered in this article. If component removal and installation is primarily an unbolt and bolt-on procedure, only a simple torque specification may be supplied.

IGNITION SYSTEM

POWERTRAIN CONTROL MODULE (PCM)

CAUTION: Electronic components used in control systems are designed to carry very low voltages. As little as a 30-volt charge created by static electricity can cause a total or degrading failure in PCM or other electronic components containing integrated circuits. Before servicing PCM, ground yourself and ground work area to discharge stored electricity.

STATIC CHARGE (VOLTS)

Movement	Relative Humidity 10-20%	Relative Humidity 65-90%
Handling Clear Plastic Bag	20,000	1200
Handling Vinyl Envelope	7000	600
Sliding On Velour Seat	15,000	400
Walking On Carpet	35,000	1500
Walking On Tile/Vinyl	12,000	50

CAUTION: DO NOT remove part from packaging until ready to install. Ground any static-proof package before opening. DO NOT touch electrical terminals of components unless properly grounded. DO NOT lay electrical components on car seat, carpeting or dashboard. Use electrostatic protection mat and ground strap whenever possible. See Fig. 1.

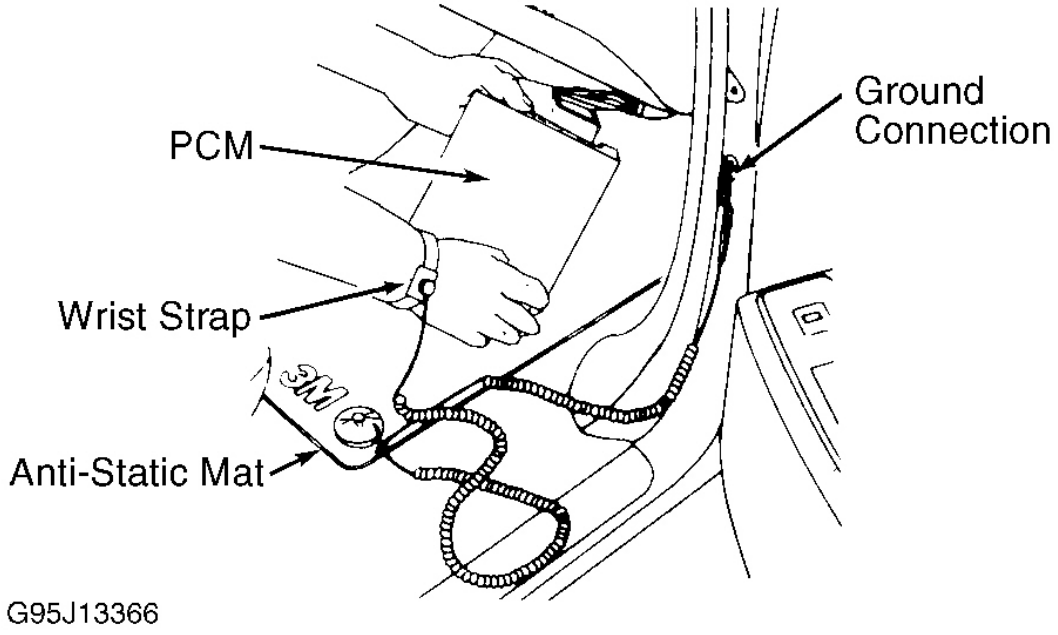


Fig. 1: Servicing PCM Using 3M Anti-Static Mat
Courtesy of GENERAL MOTORS CORP.

NOTE: Before replacing PCM, carefully inspect all wiring and control components. Failure to test for short circuits may result in repeated PCM failure due to grounds and Quad-Driver failure. To prevent internal damage to PCM, ensure ignition switch is in OFF position when disconnecting or reconnecting PCM connectors or 12-volt components.

NOTE: When replacing defective PCM, remove knock sensor module or PROM from defective PCM. New PCM does not come equipped with knock sensor module or PROM (if applicable). Install knock sensor module or PROM into new PCM.

Removal

Ensure ignition switch is in OFF position. Disconnect negative battery cable. Remove electrical connectors from PCM. Remove PCM from vehicle. Remove access cover and remove knock sensor module or PROM (if applicable) from PCM.

Installation

Install knock sensor module or PROM (if applicable) in new PCM. Install access cover. Install PCM into vehicle. Connect electrical connectors to PCM. Reconnect negative battery cable to battery.

PROGRAMMABLE READ-ONLY MEMORY (PROM)

Removal

Disconnect negative battery cable. Remove PCM from vehicle. See **POWERTRAIN CONTROL MODULE (PCM)**. Position PCM so access cover faces upward. Remove access cover from PCM. Using thumb and forefinger, squeeze both ends of PROM inward (outward on some models) and pull PROM up from access hole.

NOTE: Note reference notch locations in PROM and PCM for reassembly reference.

Installation

1. Ensure new PROM has same service number as old one. Position PROM squarely over PCM PROM access hole. Press on outer edges of PROM until PROM is firmly seated in PCM.

   NOTE: Ensure reference notches in both PCM and PROM are properly aligned. If PROM is installed backward, PROM will be destroyed when ignition is turned on.

2. Install PROM access cover on PCM. Install PCM in vehicle. See **POWERTRAIN CONTROL MODULE (PCM)**. Start engine and enter diagnostics. See appropriate TESTS W/CODES article in this section below. Check for diagnostic trouble codes. See appropriate TESTS W/CODES article in this section for code identification.
   - **TESTS W/CODES - 4.3L** (for Caprice Only)
   - **TESTS W/CODES - 5.7L** (for All Models)
3. If code(s) sets, PROM is either not fully seated in PCM or installed backward, has bent pins or is defective. If bent pins crack when trying to straighten, replace PROM. If PROM is installed backward or is defective, replace PROM.

KNOCK SENSOR MODULE

Removal & Installation

1. Disconnect negative battery cable. Remove PCM from vehicle. See **POWERTRAIN CONTROL MODULE (PCM)**. Position PCM so access cover faces upward. Remove access cover from PCM.
2. Using thumb and forefinger, squeeze both ends of knock sensor module inward and pull module up from access hole. To install, reverse removal procedure. Ensure module latches into holder in PCM.

OPTI-SPARK DISTRIBUTOR

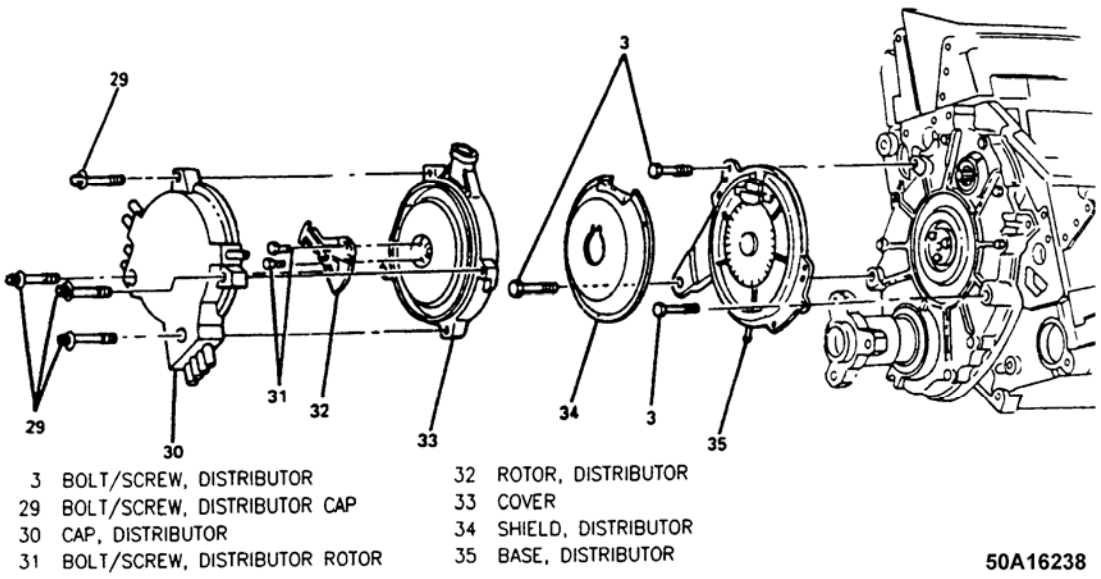


Fig. 2: Exploded View of Distributor

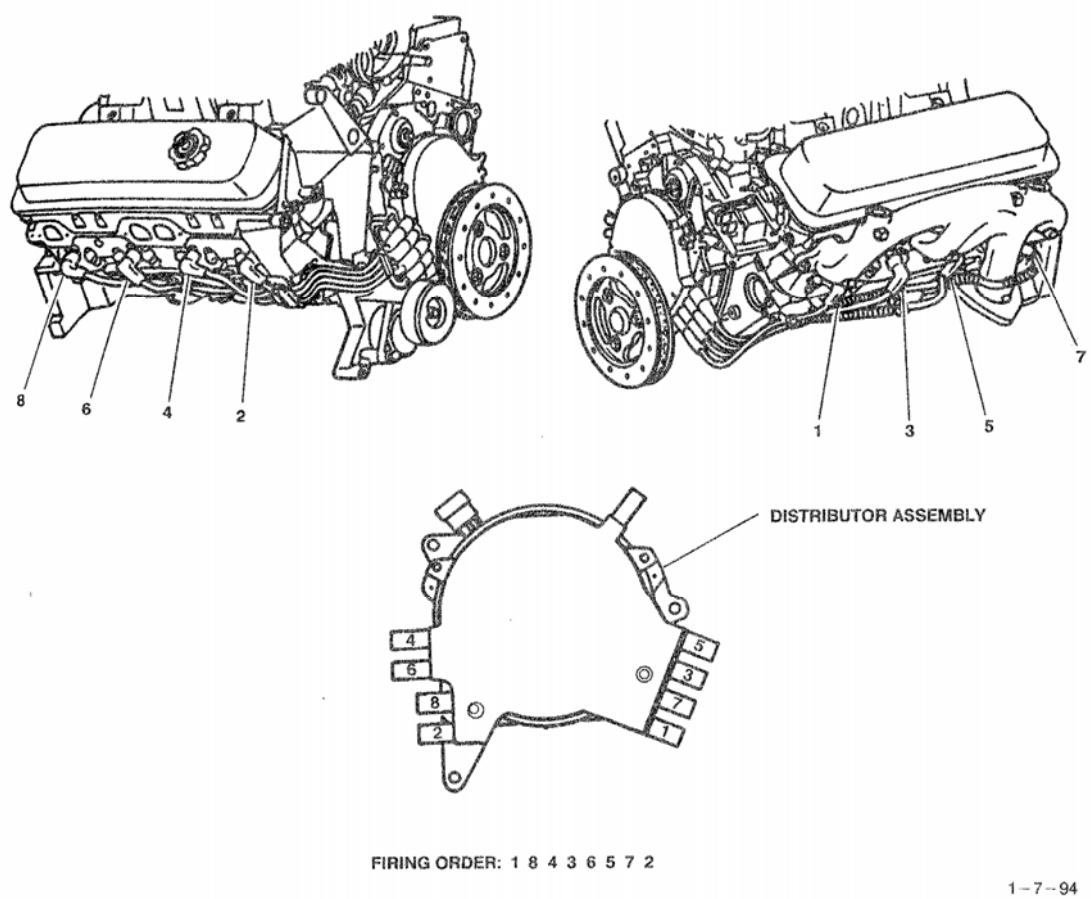


Fig. 3: Identifying Spark Plug Wire Harness Routing
Courtesy of GENERAL MOTORS CORP.

Removal & Installation

1. Disconnect negative battery cable. Drain cooling system. Disconnect Intake Air Temperature (IAT) sensor harness connector. Remove knock sensor. Remove air intake duct. Remove serpentine belt. Remove coolant hoses to water pump assembly.
2. Disconnect coolant temperature sensor harness connector. Remove water pump-to-engine block mounting bolts. Remove water pump assembly. Remove crankshaft harmonic balancer. Remove belt tensioner. Remove spark plug wires from distributor.
3. Disconnect 4-terminal PCM connector from distributor. Remove 3 distributor mounting bolts. Pull distributor forward until distributor shaft disengages from engine. Mark top surface of distributor shaft for reassembly purposes.
4. To install, ensure mark made on distributor shaft during removal is on top or facing up. To complete installation, reverse removal procedure. Refill coolant and check for leaks. Tighten distributor hold-down bolts to 106 INCH lbs. (12 N.m).

FUEL SYSTEM

FUEL PRESSURE RELIEF

WARNING: Always relieve fuel pressure before disconnecting any fuel injection-related component. DO NOT allow fuel to contact engine or electrical components.

1. Fuel system is under pressure. Relieve pressure before servicing fuel system. Fuel pressure may be relieved using one of 2 different methods.
2. One method is to disconnect fuel pump connector. Start engine and allow to run until it stops. Operate starter for 3 seconds to remove remaining fuel from fuel lines. Reconnect fuel pump once repair is complete.
3. The other method is to install Fuel Pressure Gauge (J-34730-1) on fuel pressure test port. When installing fuel pressure gauge, wrap shop towel around pressure connection to absorb fuel leakage. Place gauge bleed hose in container. Open bleed valve to bleed fuel pressure.

THROTTLE BODY

NOTE: Ensure residual fuel pressure is relieved before working on throttle body.

Removal

1. Relieve fuel pressure. See **FUEL PRESSURE RELIEF**. Disconnect negative battery cable. Remove air intake ducts. Disconnect and mark electrical connections and vacuum hoses from throttle body. Disconnect control cables from throttle body.
2. Drain cooling system and remove coolant hoses to throttle body (if applicable). Remove throttle body retaining bolts. Remove throttle body and gasket.

NOTE: Identification number is stamped on throttle body. Use identification number to

order replacement components.

Installation

1. To install, reverse removal procedure using NEW gasket. Tighten retaining bolts to specification. See **TORQUE SPECIFICATIONS**. Refill cooling system (if drained).
2. If installing new Idle Air Control (IAC) valve, ensure IAC pintle length setting is adjusted before installation. See **IDLE AIR CONTROL (IAC) VALVE**. Adjust idle speed and TP sensor (if removed, and if adjustable). See **ADJUSTMENTS** article in this section.

FUEL PRESSURE REGULATOR

NOTE: On 3.4L (VIN S), 4.0L and 4.6L, fuel pressure regulator and fuel rail are serviced as an assembly only. DO NOT remove pressure regulator or pressure regulator cover from fuel rail.

Removal

1. Relieve fuel pressure. See **FUEL PRESSURE RELIEF**. Disconnect negative battery cable. Remove resonator and resonator bracket. Disconnect pressure regulator vacuum hose. Remove fuel return line bracket and retainer clip. Remove fuel return line and "O" ring from pressure regulator. Remove fuel rail. See **FUEL RAIL & INJECTORS**.
2. Remove pressure regulator screws. Remove pressure regulator from fuel rail. Remove pressure regulator retainer and spacer assembly from fuel rail. Remove fuel inlet "O" ring from pressure regulator. Remove and discard filter screen if dirty.

Installation

To install, reverse removal procedure. **DO NOT** reuse "O" rings. Lubricate fuel inlet "O" ring with oil and install in regulator. Replace filter screen as necessary. Tighten screws to specification. See **TORQUE SPECIFICATIONS**.

FUEL RAIL & INJECTORS

Removal

1. Relieve fuel pressure. See **FUEL PRESSURE RELIEF**. Disconnect negative battery cable. Remove resonator and resonator bracket.
2. Disconnect quick-connect fitting at fuel rail inlet and return lines. Disconnect vacuum hose at pressure regulator. Remove any vacuum lines as necessary to gain access to fuel rail and fuel lines. Remove electrical harness from routing clips on fuel rail.
3. Remove fuel line retaining bolt. Disconnect electrical connectors from injectors. Remove fuel rail retaining bolts. Remove fuel rail from intake manifold using equal force on both sides of fuel rail. See **Fig. 4**. Remove injector-to-fuel rail retaining clip. Remove injector from fuel rail. Remove injector "O" rings and discard.

Installation

To install, reverse removal procedure. Lubricate NEW injector "O" rings with clean engine oil. Install injector-to-fuel rail retaining clip on right side of injector electrical connection. Position fuel rail on intake manifold. Push down on rail to seat injectors in manifold. Tighten fuel rail retaining bolts. See **TORQUE SPECIFICATIONS**. To complete installation, reverse removal procedure.

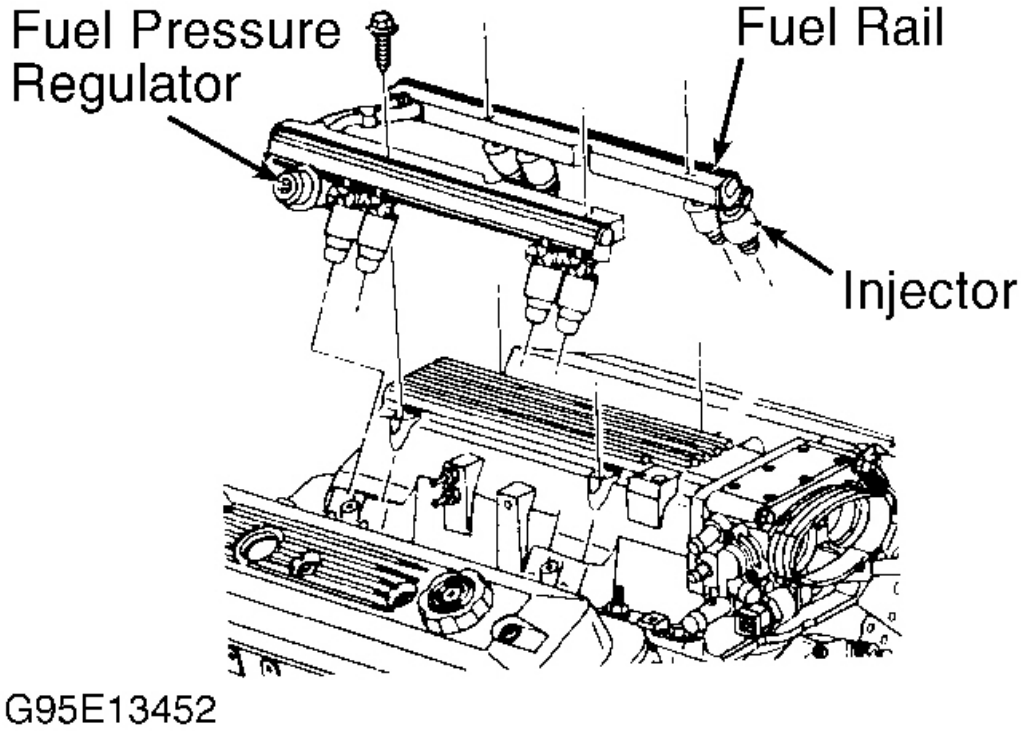


Fig. 4: Locating Fuel Rail Assembly Components (4.3L & 5.7L)

IDLE AIR CONTROL (IAC) VALVE

CAUTION: For calibration purposes, several different style IAC valves are used. Ensure replacement valve has the same part number as original valve.

Removal

Remove electrical connector from IAC valve. Remove IAC valve, gasket and "O" ring from throttle body assembly.

CAUTION: DO NOT extend or retract pintle if IAC valve has been in service, or

damage to worm gear will result.

Installation

1. Inspect gasket or "O" ring for damage. Replace as necessary. Check the extended distance of IAC pintle before installing. Damage will occur if measurement is incorrect. Distance must not exceed 1 1/8" (28 mm). Measurement should be taken from valve housing flange to end of pintle cone.
2. To retract NEW IAC valve pintle, slowly exert finger pressure on valve. Install NEW "O" ring or gasket on valve. Coat "O" ring with clean engine oil. Install IAC valve. Tighten IAC valve to specification. See **TORQUE SPECIFICATIONS**. Install electrical connector. To reset IAC valve, refer to **ADJUSTMENTS** article in this section.

IN-LINE FUEL FILTER

IMPORTANT: There is no service interval for fuel filter replacement. Only replace fuel filter if it is restricted. If it is restricted, the fuel tank should be inspected internally and cleaned if necessary.

Removal

1. Remove negative battery cable.
2. Relieve fuel system pressure. Refer to **FUEL PRESSURE RELIEF**.
3. Raise vehicle.
4. Remove fuel filter bracket attaching bolt.
5. Remove quick-connect fittings.
6. Remove fuel filter.

Installation

1. Remove protective caps from new filter.
2. Install new plastic connector retainers on filter inlet and outlet tubes. Install in same positions as on old filter noting direction of fuel flow arrow.
3. Install quick-connect fittings.
4. Trap in-line fuel filter over return pipe and install to frame with attaching bolt.

   Tighten

   In-line fuel filter attaching bolt: 89 lb. in. (10 N.m)

5. Lower vehicle.
6. Tighten fuel filler cap.
7. Install negative battery cable.
8. Turn ignition switch ON for 2 seconds. Turn to OFF for 10 seconds. Turn to ON and check for fuel leaks.

FUEL PUMP

Removal & Installation

1. Disconnect negative battery cable. Relieve fuel pressure. See **FUEL PRESSURE RELIEF**. Remove filler neck. Lower fuel tank. Disconnect fuel lines and electrical connection.
2. Remove fuel level sending unit and fuel pump retaining bolts or cam lock ring. Lift assembly from fuel tank and remove fuel pump from sending unit.
3. Pull fuel pump upward while pulling away from bottom support. Use care not to damage rubber insulator and strainer. To install, reverse removal procedure using NEW "O" ring and gasket.

THROTTLE POSITION (TP) SENSOR

Removal

Turn ignition switch to OFF position. Disconnect electrical connector from TP sensor. Remove TP sensor retaining screws. Remove TP sensor from throttle body.

Installation

1. With throttle valve in closed position, install TP sensor on throttle body. Ensure TP sensor lever engages with drive lever on throttle shaft. Install retaining screws and electrical connection.
2. TP sensor is self-zeroing and is not adjustable. See **ADJUSTMENTS** article in this section.

OXYGEN SENSOR

Oxygen sensor is mounted in exhaust pipe, below exhaust manifold. It is equipped with a permanent pigtail which must remain intact when removing sensor.

Removal

1. Ensure sensor is free of contaminants. **DO NOT** use cleaning solvents of any type. Sensor may be difficult to remove when engine temperature is less than 120°F (48°C). Excessive removal force may damage threads in exhaust manifold or pipe.
2. Disconnect negative battery cable. Disconnect electrical connector from oxygen sensor. Carefully remove oxygen sensor from exhaust pipe.

CAUTION: Correct torque of oxygen sensor is critical to prevent crushing glass beads in graphite anti-seize compound. Crushing glass beads will cause sensor to seize in exhaust manifold. This may necessitate replacement of exhaust manifold at the next removal.

Installation

1. Whenever an oxygen sensor is removed, coat threads with anti-seize compound before it is reinstalled. New oxygen sensors already have this compound applied to threads.

2. Install oxygen sensor in exhaust pipe. Tighten sensor to 30 ft. lbs. (41 N.m). Reconnect electrical connector to oxygen sensor. Reconnect negative battery cable.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Oxygen Sensor	30 (41)
Throttle Body Bolts	18 (24)
	INCH Lbs. (N.m)
Crossover Tube Retainer Bolt	44 (4.9)
Fuel Pressure Regulator Screws	89 (10)
Fuel Rail Retaining Bolts	89 (10)
Idle Air Control (IAC) Valve Housing	28 (3.2)
Idle Air Control (IAC) Valve Screw	26 (3.0)
Throttle Position Sensor Screw	18 (2.0)

C - SPECIFICATIONS

ENGINE PERFORMANCE General Motors Corp. Service & Adjustment Specifications

INTRODUCTION

Use this article to quickly find specifications related to servicing and on-vehicle adjustments. This is a quick-reference article to use when you are familiar with proper adjustment procedures and only need a specification.

CAPACITIES

BATTERY SPECIFICATIONS

Engine	Cold Crank Amps @ 0°F (-18°C)	Reserve Minutes
4.3L	525	90
5.7L	525	90

FLUID CAPACITIES

Application	(1) Quantity: Qts. (L)
Crankcase (2)	4.0 (3.8)
Cooling System (Includes Heater)	
4.3L	
With Heavy-Duty Cooling	14.6 (13.8)
Without Heavy-Duty Cooling	14.3 (13.5)
5.7L	
With Heavy-Duty Cooling	14.6 (13.8)
Without Heavy-Duty Cooling	14.3 (13.5)
Automatic Transmission (3) (4)	5.0 (4.7)

(1) Fluid capacities listed are approximate. Always fill to FULL mark.

(2) Does not include oil filter capacity.

(3) Drain and refill capacity only. Does not include torque converter.

(4) Dexron-III or Dexron-IIE.

QUICK-SERVICE

SERVICE INTERVALS & SPECIFICATIONS

REPLACEMENT INTERVALS

Component	Miles
Air Filter	30,000
Camshaft Timing Belt	(1)

Coolant	30,000
Fuel Filter	(1)
Oil & Filter	7500
Spark Plugs	30,000
(1) No scheduled replacement interval is given by manufacturer. Check and replace as necessary.	

BELT ADJUSTMENT

Application	**(1) Tension: Lbs. (kg)**
Serpentine Belt (2)	(3)
(1) Specifications are for new belts only. Measure tension using belt tension gauge.	
(2) Engines with serpentine belts have automatic tensioner. If tension is not as specified, check belt operating length and tensioner operating range. Replace belt or tensioner as necessary.	
(3) Adjustment of serpentine belt is not necessary. Belt tension is maintained by spring-tensioned idler pulley (some equipped with belt wear indicator).	

MECHANICAL CHECKS

ENGINE COMPRESSION

Check engine compression with engine at normal operating temperature, all spark plugs removed and throttle wide open.

COMPRESSION SPECIFICATIONS

Application	**Specification**
Compression Ratio	
4.3L	9.9:1
5.7L	10.5:1
Normal Compression Pressure	(1)
Minimum Compression Pressure	(1)
(1) Lowest compression reading should not be less than 70 percent of highest compression reading. No cylinder compression reading should be less than 100 psi	

VALVE CLEARANCE

NOTE: All models are equipped with hydraulic lifters. Adjustment is not required.

IGNITION SYSTEM

HIGH TENSION WIRE RESISTANCE

HIGH TENSION WIRE RESISTANCE

Application	Ohms
All Models	30,000 Maximum

SPARK PLUGS

SPARK PLUG TYPE

Application	AC Spark Plug
4.3L	41-906
5.7L	41-906

SPARK PLUG SPECIFICATIONS

Application	Gap: In. (mm)	Torque: Ft. Lbs. (N.m)
4.3L	.050 (1.27)	20 (27)
5.7L	.050 (1.27)	20 (27)

FIRING ORDER & TIMING MARKS

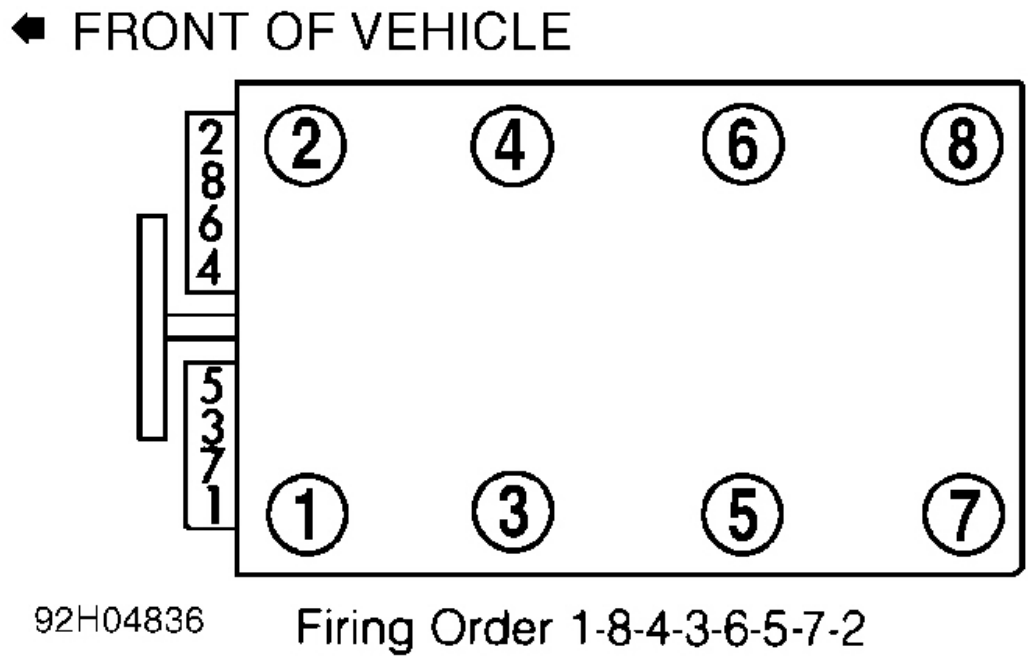


Fig. 1: Firing Order (4.3L & 5.7L)

IGNITION TIMING

NOTE: **For timing procedures, see ADJUSTMENTS article in this section.**

IGNITION TIMING (Degrees BTDC @ RPM)

Application	Specification
All Models	(1)
(1) Not adjustable.	

FUEL SYSTEM

FUEL PUMP

FUEL PUMP PERFORMANCE

Application	Pressure psi (kg/cm^2)
4.3L & 5.7L	41-47 (2.88-3.30)

INJECTOR RESISTANCE

INJECTOR RESISTANCE SPECIFICATIONS

Application	Ohms
4.3L & 5.7L	(1) 11.8-12.6
(1) Injector resistance specification is at 140°F (60°C).	

IDLE SPEED & MIXTURE

NOTE: **Idle mixture is controlled by Powertrain Control Module (PCM). Idle mixture adjustment is neither required nor possible.**

THROTTLE POSITION (TP) SENSOR

NOTE: **For further testing, see appropriate TESTS W/CODES article in this section below.**

- **TESTS W/CODES - 4.3L** (for Caprice Only)
- **TESTS W/CODES - 5.7L** (for All Models)

TP SENSOR ADJUSTMENT VOLTAGE

Application	(1) Volts
4.3L & 5.7L	(2) .60-5.00
(1) Voltage range is from idle position to wide open throttle Position.	
(2) TP sensor is not adjustable.	

MODEL IDENTIFICATION

Vehicle model is identified by fifth character of Vehicle Identification Number (VIN), stamped on metal pad on top of left end of instrument panel, near windshield. See **MODEL IDENTIFICATION**.

MODEL IDENTIFICATION

Series (1)	Model
"C"	2WD Pickup, Sierra Pickup
"G"	(2) Van
"K"	4WD Pickup, Sierra Pickup
"L"	AWD Astro & Safari
"M"	2WD Astro & Safari
"S"	2WD Blazer, Jimmy, Pickup & Sonoma
"T"	4WD Blazer, Jimmy, Pickup & Sonoma

(1) Vehicle series is fifth character of VIN.

(2) Includes Rally Van and Vandura.

TERMINOLOGY

Due to Federal government requirements, manufacturers may use names and acronyms for systems and components different than those used in previous years. The following table will help eliminate confusion when dealing with these components and systems. Only relevant components and systems whose names have changed from current General Motors Corp. terminology have been listed.

SAE TERMINOLOGY

Former Name Or Acronym	New Name Or Acronym
ALDL	Data Link Connector (DLC)
CHECK ENGINE Light	Malfunction Indicator Light (MIL)
CTS	Engine Coolant Temp. (ECT) Sensor
Diagnostic Circuit Check	On-Board Diagnostic (OBD) System Check
ESC System	Knock Sensor (KS) System
EST System	Ignition Control (IC) System
MAT Sensor	Intake Air Temperature (IAT) Sensor
Park/Neutral (P/N) Switch	Park/Neutral Position (PNP) Switch
Port Fuel Injection	Multi-Port Fuel Injection
Scan Data	Scan Tester (ST) Data
SERVICE ENGINE SOON Light	Malfunction Indicator Light (MIL)
Thermostatic Air Cleaner (TAC)	Air Cleaner (ACL)

Throttle Position Sensor (TPS)	Throttle Position (TP) Sensor
Throttle Position Switch	Closed Throttle Position (CTP) Switch
Throttle Position Switch	Wide Open Throttle (WOT) Switch
Viscous Converter Clutch (VCC)	Torque Converter Clutch (TCC)

INTRODUCTION

Before testing separate components or systems, perform procedures in **BASIC TESTING - 4.3L** article. Since many computer-controlled and monitored components set a trouble code if they malfunction, also perform procedures in **TESTS W/CODES - 4.3L** article.

NOTE: Testing individual components does not isolate shorts or opens. Perform all voltage tests with a Digital Volt-Ohmmeter (DVOM) with a minimum 10-megohm input impedance, unless stated otherwise in test procedure. Use ohmmeter and refer to WIRING DIAGRAMS at the end of this article to isolate wiring harness shorts or opens.

NOTE: The following table provides the location of commonly used diagnostic information. These former "A" and "C" charts are now written in text and inserted into the appropriate location in the new Engine Performance workflow. To familiarize yourself with the Engine Performance workflow, see HOW TO USE THE ENGINE PERFORMANCE SECTION in GENERAL INFORMATION section.

GENERAL MOTORS "A" & "C" CHART REFERENCE

System or Component	Diagnostic Information Location
DIAGNOSTIC CIRCUIT CHECK	(1) See DIAGNOSTIC CKT CHECK
A-1 & A-2, Malfunction Indicator Light (MIL)	(1) See DIAGNOSTIC CKT CHECK
A-3, No-Start	(1) See NO-START DIAGNOSIS
A-5, Fuel Pump Relay	See RELAYS, SOLENOIDS, MOTORS & MODULES
A-6 & A-7, Fuel System Diagnosis	(1) See BASIC FUEL SYSTEM CHECKS
C-1, MAP Sensor	See ENGINE SENSORS & SWITCHES
C-1, Power Steering Pressure Switch	See ENGINE SENSORS & SWITCHES
C-1, Park/Neutral Switch	See ENGINE SENSORS & SWITCHES
Injector Balance Test (PFI)	See FUEL CONTROL
C-2, IAC Valve	See IDLE CONTROL SYSTEM
C-3, Canister Purge System	See EMISSION SYSTEMS & SUB-SYSTEMS
C-4, EST Ignition Check	(1) See BASIC IGNITION SYSTEM CHECKS
C-5, ESC Ignition Check	See IGNITION SYSTEM
C-6, Air Injection System	See EMISSION SYSTEMS & SUB-SYSTEMS
C-7, EGR System	See EMISSION SYSTEMS & SUB-SYSTEMS

C-8, Torque Converter Clutch	See MISCELLANEOUS ECM CONTROLS
C-8, Manual Trans. Shift Lights	See MISCELLANEOUS ECM CONTROLS
C-10, A/C Clutch Control	See MISCELLANEOUS ECM CONTROLS
C-12, Electric Cooling Fan Control	See MISCELLANEOUS ECM CONTROLS
(1) See **BASIC TESTING - 4.3L** article in this section.	

COMPUTERIZED ENGINE CONTROLS

CONTROL UNIT

NOTE: To perform the following ground and power tests, use appropriate wiring diagram in WIRING DIAGRAMS section at the end of this article.

Ground Circuits

1. Using an ohmmeter, check for continuity to ground on ECM/PCM/VCM ground terminals. Resistance should be zero ohms. If not, repair open to ground.
2. Using a DVOM, touch negative lead of voltmeter to a good ground. Touch positive lead of voltmeter to each ground terminal. With vehicle running, voltmeter should indicate less than one volt. If voltmeter reading is greater than one volt, check for open, corrosion or loose connection on ground circuit.

Power Circuits

1. Using a voltmeter, check for battery voltage between ECM/PCM/VCM continuous power terminal(s) and ground. If battery voltage is not present, check for blown fuse or open fusible link. If okay, check for open in wire between ECM/PCM/VCM terminal and power source.
2. Turn ignition on. Using a voltmeter, check for battery voltage between ECM/PCM/VCM ignition power terminals and ground. If battery voltage is not present, check IGN fuse. If fuse is okay, check for an open in wire between battery and ignition switch, and between ignition switch and ECM/PCM/VCM terminal. If okay, check for a defective ignition switch.
3. Connect voltmeter between ground and ECM/PCM/VCM starter (crank) signal terminal. On vehicles with manual transmission/transaxle, depress clutch pedal. Turn ignition switch to START position. Battery voltage should be present ONLY when ignition switch is in START position.
4. If voltage is not present, check CRANK fuse or fusible link between ignition switch and ECM/PCM/VCM terminal. If fuse or fusible link is okay, check for an open in wire between ignition switch and ECM/PCM/VCM terminal, or check for a defective ignition switch.

ENGINE SENSORS & SWITCHES

A/C ON SWITCH/SYSTEM TEST

1. Turn ignition switch to RUN position. Move mode selector switch to OFF position. With A/C control assembly connected, measure voltage between mode selector switch Dark Green wire (Dark Green/White on "S" & "T" Series) and ground. For wiring schematics, see mini-schematics in **A/C CLUTCH** under

MISCELLANEOUS ECM/PCM/VCM CONTROLS.

2. Battery voltage should be present. If battery voltage is present, mode selector switch is operating normally. If battery voltage is not present, check wire from selector switch to fuse for an open circuit. Also check A/C high and low pressure switches for open.
3. Check voltage between mode selector Dark Green or Dark Green/White wire and ground. Voltage should not be present. If voltage is present, replace mode selector switch.

BRAKE SWITCH

Disconnect brake switch harness connector. Using an ohmmeter, check continuity between brake switch terminals. Continuity should be present. Depress brake pedal or activate brake switch, continuity should not be present.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

If a coolant sensor-related code is present, see appropriate **TESTS W/CODES - 4.3L** article. An out-of-calibration sensor may not set a trouble code. Use following procedure to test sensor calibration. Disconnect ECT sensor connector. Measure resistance between sensor terminals. Resistance should be high when engine is cold and drop as engine warms. See **ECT SENSOR RESISTANCE VALUES**.

ECT SENSOR RESISTANCE VALUES

Temperature °F (°C)	Resistance (Ohms)
212 (100)	177
158 (70)	467
100 (38)	1800
68 (20)	3520
23 (-5)	12,300
0 (-18)	25,000
-40 (-40)	100,700

NOTE: Intake Air Temperature (IAT) sensor is also referred to as Manifold Air Temperature (MAT) sensor.

INTAKE AIR TEMPERATURE (IAT) SENSOR

If an IAT sensor-related code is present, see appropriate **TESTS W/CODES - 4.3L** article. An out-of-calibration sensor may not set a trouble code. Use following procedure to test calibration. Disconnect IAT sensor harness connector. Connect ohmmeter between sensor terminals. Sensor resistance should be as specified. See **IAT SENSOR RESISTANCE**. With vehicle sitting overnight, IAT sensor and coolant sensor should have close to the same resistance reading.

IAT SENSOR RESISTANCE

Temperature °F (°C)	Resistance (Ohms)
210 (100)	185
160 (70)	450

100 (38)	1800
70 (20)	3400
40 (4)	7500
20 (-7)	13,500
0 (-18)	25,000
-40 (-40)	100,700

KNOCK SENSOR

1. Disconnect knock sensor harness connector. Using an ohmmeter, measure knock sensor resistance between sensor terminal and engine block. Resistance should be 3300-4500 ohms. Connect voltmeter between sensor terminal and ground. Set voltmeter to 2-volt AC scale.
2. Start and idle engine. Tap on engine block near sensor. A signal should be indicated on voltmeter. If no signal is indicated, replace knock sensor. Also see **TIMING CONTROL SYSTEMS** under IGNITION SYSTEM and **TESTS W/CODES - 4.3L** article.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

1. MAP sensor circuit malfunction should set a related code in ECM/PCM/VCM memory. If a code is present, proceed to the **TESTS W/CODES - 4.3L** article. An out-of-calibration sensor may not set a trouble code. Use following procedure to test sensor calibration. If driveability problems exist, MAP sensor failure is suspected and no MAP code is present, disconnect MAP sensor connector. If driveability condition improves, check MAP vacuum hose for splits, kinks, proper routing and blockage. If no problems are found, replace MAP sensor.
2. With ignition on and engine off, check MAP sensor parameter using a scan tester connected to Data Link Connector (DLC). Voltage should be as specified in **MAP SENSOR VOLTAGE RANGE**.
3. If MAP sensor voltage is as specified, go to next step. If voltage is not as specified, check for 5-volt reference supplied to sensor. Check harness integrity. If no problems are evident, replace MAP sensor.
4. Using a hand-held vacuum pump, apply 10 in. Hg to MAP sensor and note voltage change. Voltage should drop to about 1.0-2.5 volts less than specified in table. If voltage is not as specified or voltage reading does not immediately follow vacuum change, MAP sensor is faulty.

MAP SENSOR VOLTAGE RANGE

Altitude (Ft.)	**Range (Volts)**
Below 1000	3.8-5.5
1000-2000	3.6-5.3
2000-3000	3.5-5.1
3000-4000	3.3-5.0
4000-5000	3.2-4.8
5000-6000	3.0-4.6
6000-7000	2.9-4.5
7000-8000	2.8-4.3
8000-9000	2.6-4.2
9000-10,000	2.5-4.0

OXYGEN SENSOR (O2S)

1. Start engine and warm to operating temperature. Disconnect oxygen sensor. Connect DVOM between Purple lead of oxygen sensor and ground. Place DVOM on 2-volt scale.
2. Using another DVOM on 20-volt scale, connect DVOM in series between Purple wire from ECM/PCM/VCM and positive post of battery. This will simulate a rich condition, causing ECM/PCM/VCM to respond by leaning mixture. Reading on DVOM connected to oxygen sensor should decrease to less than .3 volt.
3. Move DVOM lead from positive battery post to negative battery post. This will simulate a lean condition, causing ECM/PCM/VCM to respond by richening mixture. Reading on DVOM connected to oxygen sensor should increase to greater than .8 volt. If reading does not change as specified, replace oxygen sensor.
4. If a second DVOM is not available, connect a jumper in Purple wire from ECM/PCM/VCM. Hold jumper in one hand and touch positive post of battery with other hand to simulate a rich condition. Touch negative post of battery to simulate a lean condition. For additional testing procedures, see **TESTS W/CODES - 4.3L** article.

OXYGEN SENSOR HEATING ELEMENT

On models with oxygen sensor heating elements, disconnect 3-wire connector at oxygen sensor. Measure resistance between White wire terminals on sensor side of connector. Resistance should be 3.5-14 ohms at 68°F (20°C). If resistance is not 3.5-14 ohms, replace oxygen sensor.

THROTTLE POSITION (TP) SENSOR

1. Install jumper wires to enable connection of a DVOM in parallel between TP sensor harness connectors. Connect DVOM positive lead to Dark Blue wire terminal. Connect negative lead to Black wire terminal. See **Fig. 1**.
2. Turn ignition on, engine off. Slowly depress accelerator pedal. Signal voltage should gradually change from less than one volt at closed throttle to about 5.0 volts at wide open throttle position. If reading is not as specified, replace TP sensor.
3. TP sensor circuit malfunction should set a related trouble code. For further information, see **TESTS W/CODES - 4.3L** article. Also see TP Sensor ADJUSTMENT in **ADJUSTMENTS - 4.3L** article.

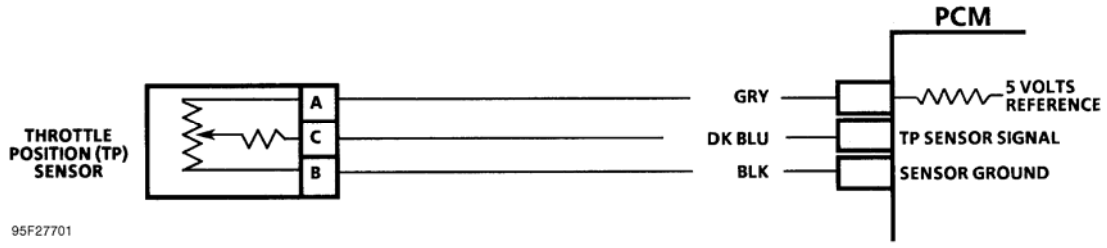


Fig. 1: Typical Throttle Position (TP) Sensor Circuit
Courtesy of GENERAL MOTORS CORP.

TRANSMISSION RANGE SWITCH

A problem in transmission range switch circuit will set related diagnostic trouble code. See **TESTS W/CODES - 4.3L** article.

VEHICLE SPEED SENSOR (PM GENERATOR)

Disconnect vehicle speed sensor harness connector (located in transmission/transaxle). Place gear selector in Neutral. Raise vehicle drive wheels off the ground. Turn drive wheels by hand (greater than 3 MPH). Measure AC signal voltage between sensor terminals. Voltage reading should vary from 0.1 to 0.5 volt AC as wheel is turned. If reading is not as specified, replace vehicle speed sensor. If a code is set, refer to **TESTS W/CODES - 4.3L** article.

RELAYS, SOLENOIDS, MOTORS & MODULES

RELAYS

A/C Relays

See **MISCELLANEOUS ECM/PCM/VCM CONTROLS**.

Fuel Pump Relay

1. If a prolonged crank is required to start vehicle, fuel pump relay may be faulty. To verify, start engine. With engine running, disconnect oil pressure switch (fuel pump back-up circuit). If engine stalls, fuel pump relay is faulty. If vehicle continues to run, relay is okay. Check for other causes of prolonged crank.
2. To test fuel pump relay, disconnect fuel pump relay. Refer to **COMPONENT LOCATIONS**. Apply battery voltage and ground to fuel pump relay winding terminals (control and ground). See **Fig. 2**-7.
3. Using an ohmmeter, check continuity between fuel pump relay control and ground terminals. Continuity should exist. If continuity does not exist, fuel pump relay is defective.
4. To by-pass fuel pump relay on vehicle (fuel pump not operating), turn ignition off. Disconnect fuel pump relay connector. Using a fused jumper wire, connect fuel pump test connector to positive side of battery. Fuel pump should run.
5. If fuel pump runs, check for faulty connections to relay or replace defective relay. To locate fuel pump test connector, refer to **COMPONENT LOCATIONS**.

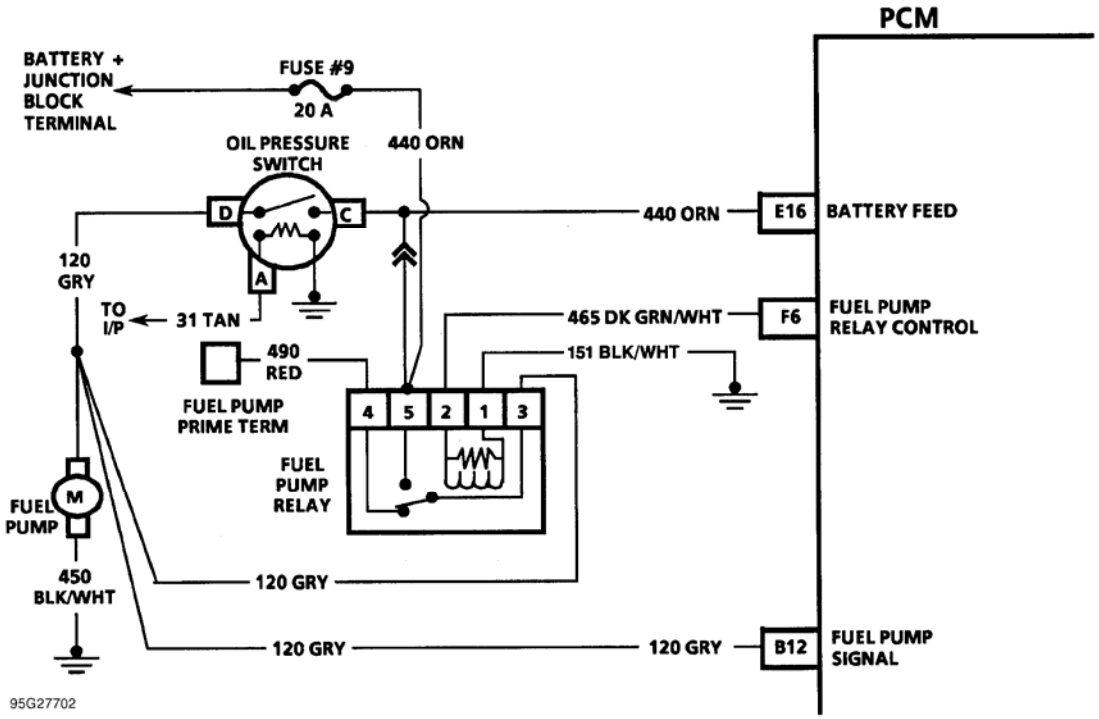


Fig. 2: Fuel Pump Relay Schematic (4.3L "S" & "T" Pickup & Utility With A/T)
Courtesy of GENERAL MOTORS CORP.

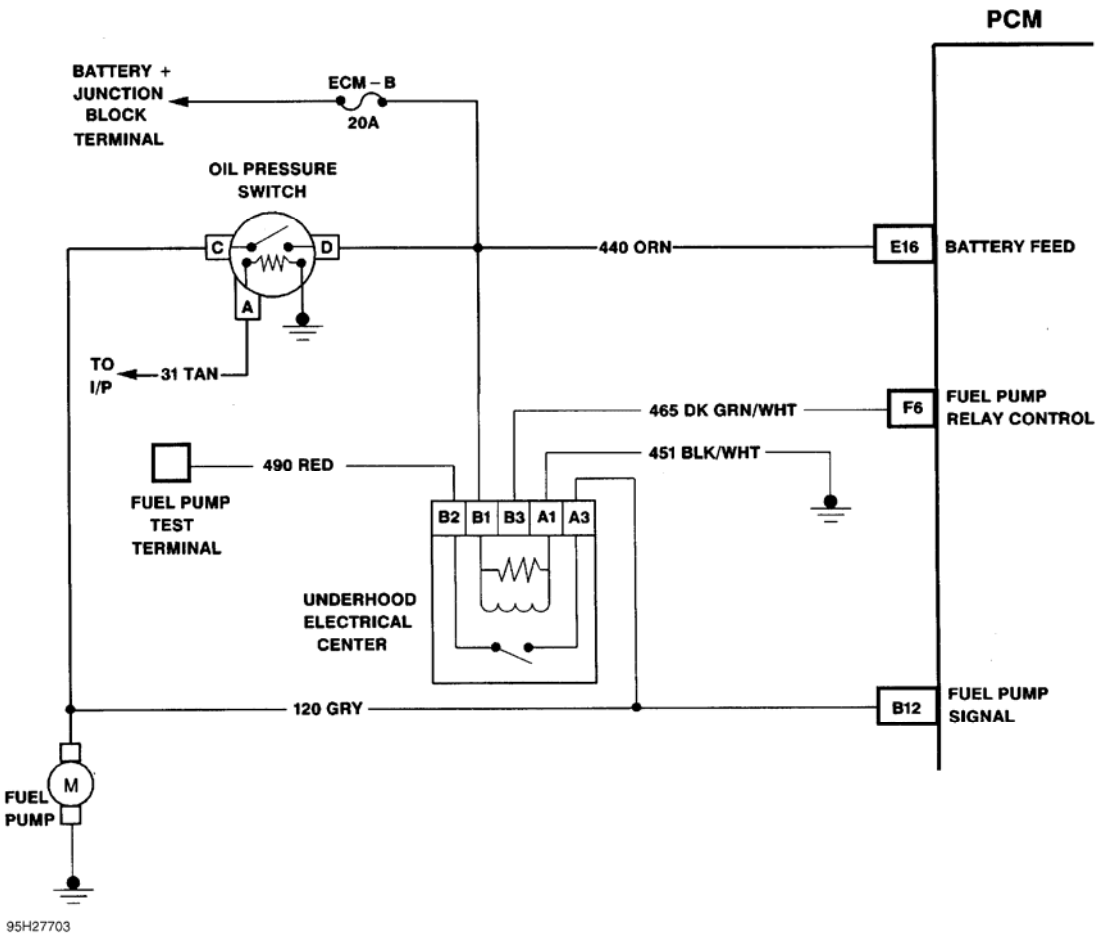


Fig. 3: Fuel Pump Relay Schematic (4.3L A/T "C" & "K" Series)
Courtesy of GENERAL MOTORS CORP.

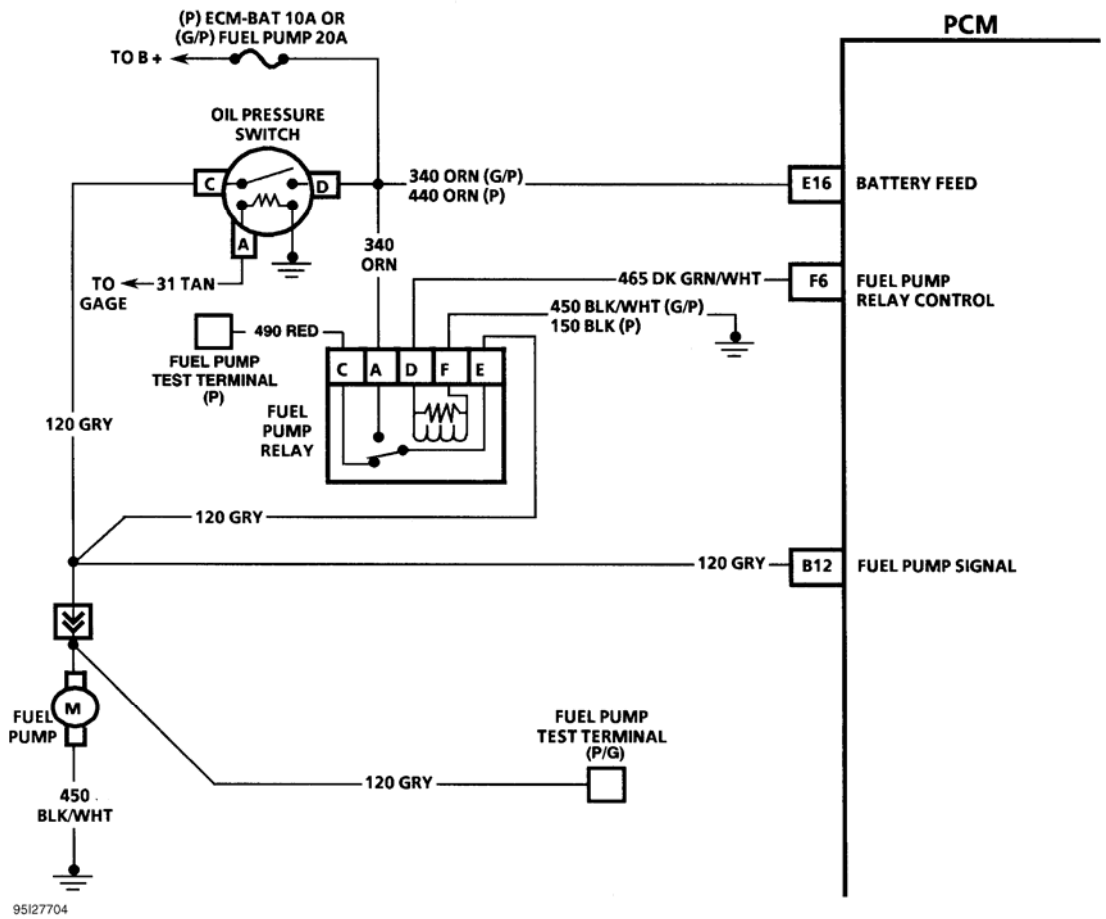


Fig. 4: Fuel Pump Relay Schematic (4.3L "G" & "P" Series)
Courtesy of GENERAL MOTORS CORP.

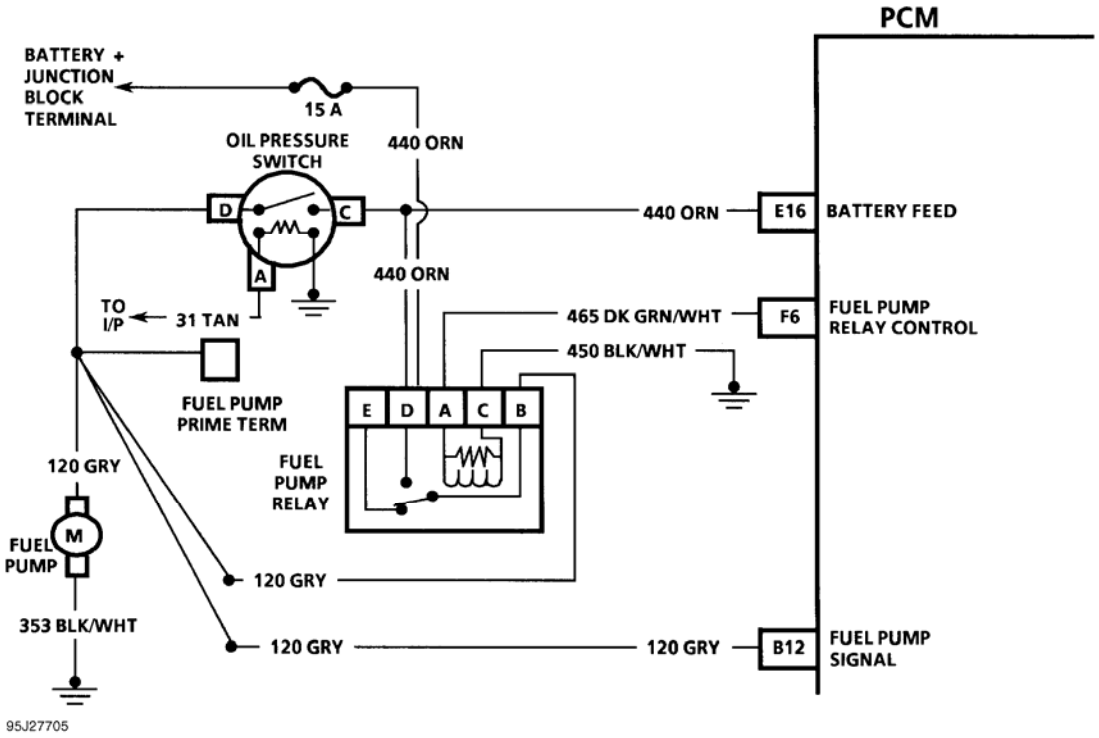


Fig. 5: Fuel Pump Relay Schematic (4.3L "L" & "M" Series)
Courtesy of GENERAL MOTORS CORP.

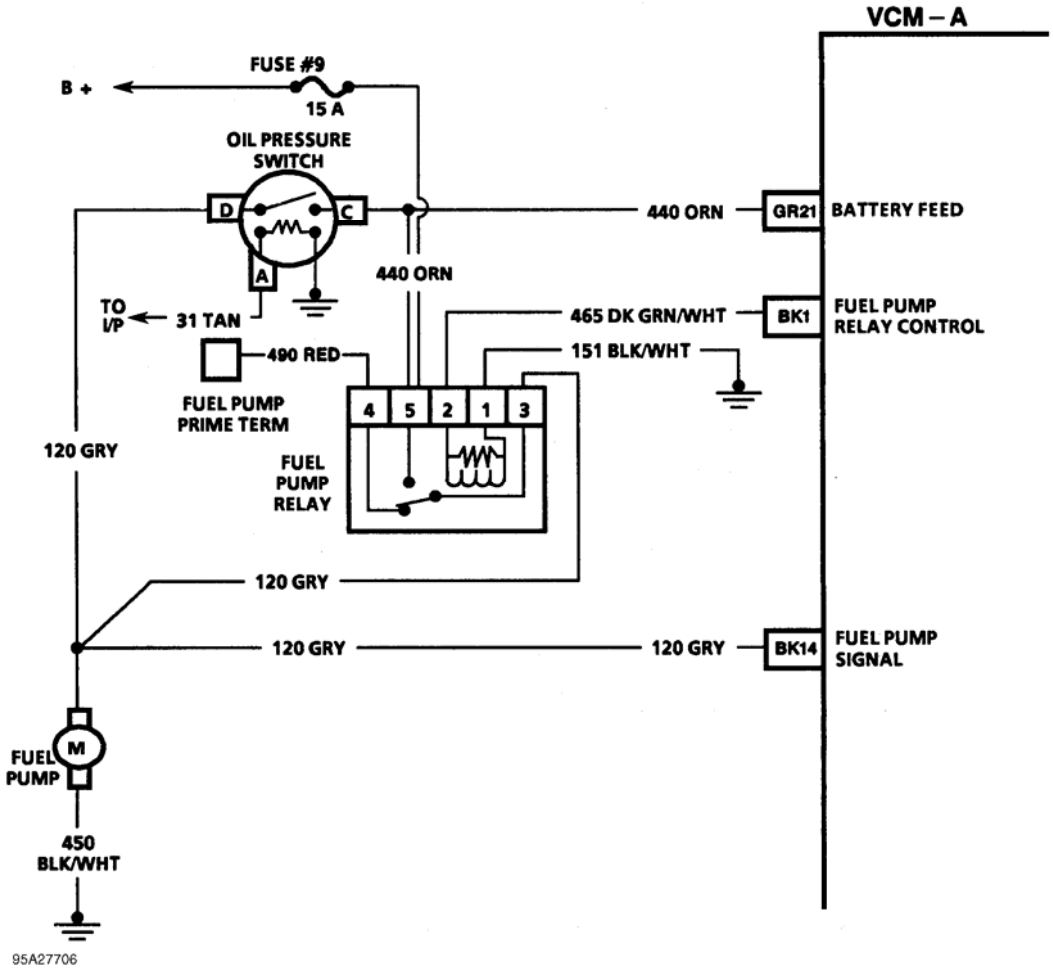


Fig. 6: Fuel Pump Relay Schematic (4.3L VIN W "S" & "T" Pickup & Utility)
Courtesy of GENERAL MOTORS CORP.

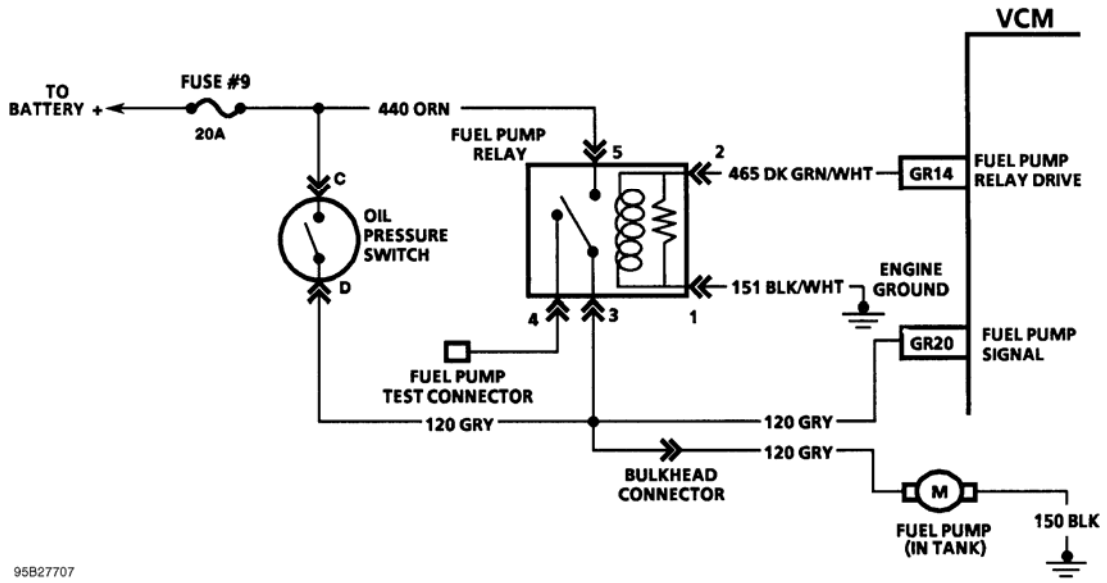


Fig. 7: Fuel Pump Relay Schematic (4.3L VIN Z "S" & "T" M/T)
Courtesy of GENERAL MOTORS CORP.

SOLENOIDS

NOTE: All ECM/PCM/VCM-controlled solenoids should have at least 20 ohms of resistance (except fuel injectors).

Electronic Air Control (EAC) Solenoid

See **EMISSION SYSTEMS & SUB-SYSTEMS**.

EGR Control Solenoid

See **EMISSION SYSTEMS & SUB-SYSTEMS**.

Idle Air Control (IAC) Valve

See **IDLE CONTROL SYSTEM** under FUEL SYSTEM.

Torque Converter Clutch (TCC) Solenoid

See **MISCELLANEOUS ECM/PCM/VCM CONTROLS**.

FUEL SYSTEM

FUEL DELIVERY

NOTE: For fuel system pressure testing, see the BASIC TESTING - 4.3L article.

Fuel Pressure Regulator (Port Fuel Injection)

Fuel pressure regulator is a vacuum-controlled diaphragm type, which uses manifold vacuum to modify fuel pressure to compensate for engine load fuel requirements. Connect fuel pressure gauge to fuel pressure service port. Start engine and note fuel pressure. Disconnect vacuum hose from fuel pressure regulator. Fuel pressure should increase 4-10 psi (.28-.70 kg/cm^2). If pressure does not increase 4-10 psi (.28-.70 kg/cm^2), check for presence of manifold vacuum at signal line. If vacuum is not present, check for kinked, cut or split vacuum hose or plugged throttle body vacuum port. If vacuum is present and no pressure change occurs, replace fuel pressure regulator.

Fuel Pressure Regulator (Central & Throttle Body Injection)

Fuel pressure regulator is mechanically controlled by internal spring pressure. Regulator is adjusted at factory and is not serviceable. If fuel pressure is too low, check for restricted delivery line. Also, check fuel pump pressure and volume. If fuel pressure is too high, check for restricted fuel tank return line or fuel filter. If no faults are found and pressure is too high or too low, replace fuel pressure regulator.

Fuel Pump Oil Pressure Switch (Back-Up Circuit)

To test fuel pump oil pressure switch back-up circuit, start engine. With engine running, disconnect fuel pump relay. If engine stalls, fuel pump oil pressure switch is faulty. If vehicle continues to run, switch is okay.

Fuel Pump Relay

See **RELAYS, SOLENOIDS, MOTORS & MODULES**.

Fuel Pump Relay By-Pass Procedure

If fuel pump will not energize, relay may be by-passed to test fuel pump. Turn ignition off. Using a fused jumper wire, apply battery voltage to fuel pump test connector. Fuel pump should turn on. For fuel pump test connector location, refer to **COMPONENT LOCATIONS**.

FUEL CONTROL

Fuel Injector(s)

Disconnect fuel injector harness connector. Measure resistance across injector terminals. Resistance should be as specified. See **FUEL INJECTOR RESISTANCE**.

FUEL INJECTOR RESISTANCE

Application	(1) Resistance (Ohms)
4.3L	1.3
(1) Injector resistance specification is at 140°F (60°C).	

Oxygen Sensor (O2S)

See **ENGINE SENSORS & SWITCHES**.

NOTE: If injectors are dirty, they should be cleaned using approved injector cleaning procedure before performing port fuel INJECTOR BALANCE TEST.

C-2, Port Fuel Injector Balance Test

The injector balance test is used to pulse the injector for a precise amount of time, spraying a measured amount of fuel in the intake manifold. As each injector is pulsed, a drop in fuel rail pressure occurs. This pressure drop can be recorded and compared to other injectors. An injector with a pressure drop of 1.5 psi (.11 kg/cm^2) or more, greater than or less than other injectors, should be considered faulty.

NOTE: Allow engine to cool to avoid irregular readings due to "hot soak" fuel boiling. To prevent flooding, INJECTOR BALANCE TEST should not be repeated more than once without starting and running engine.

CAUTION: To avoid possible vehicle fire, wrap a shop towel around fitting to avoid fuel spillage.

1. With ignition off, connect Fuel Pressure Gauge (J-34730-1) to pressure tap. Unplug harness connector at all injectors. Connect Injector Tester (J-34730-3) to one of the injectors.
2. Follow manufacturer's instructions when installing adapter harness. Ignition should be turned off at least 10 seconds to complete ECM/PCM/VCM shutdown cycle.
3. Turn ignition on. Fuel pump should run at least 2 seconds after ignition is turned on. Bleed air from gauge and hose to ensure accurate gauge reading. Repeat this procedure until all air is bled from system. Turn ignition off for at least 10 seconds.
4. Turn ignition on again to bring fuel pressure to maximum. Record initial pressure reading. Energize tester one time and note pressure drop at lowest point.
5. Disregard any slight pressure drop after low point is reached. Subtracting second pressure reading from initial reading indicates amount of injector pressure drop.
6. Repeat step 4) on each injector and compare pressure drop. Recheck injectors not within pressure drop range. Replace injector(s) failing second check. If injectors are all okay, plug in harness connectors and review SYMPTOMS in **TESTS W/O CODES - GASOLINE** article.

IDLE CONTROL SYSTEM

Idle Air Control (IAC) Valve

1. Disconnect harness connector to motor. Check resistance across IAC coil terminals "A" to "B" and "C" to "D". See **Fig. 8**. Resistance should be 40-80 ohms. If okay, go to next step. If resistance is not as specified, replace IAC valve.
2. Check resistance between IAC terminals "B" to "C" and "A" to "D". Resistance should be infinite. If resistance is not as specified, replace IAC valve.

NOTE: **Functional testing of Idle Air Control (IAC) valve requires a scan tester capable of cycling ECM/PCM/VCM output devices (bidirectional) or a special IAC Driver and Noid Light Set (222L or J-37027). Flow charts in TESTS W/CODES - 4.3L article may refer to Tech 1 tester, General Motors' bidirectional tester.**

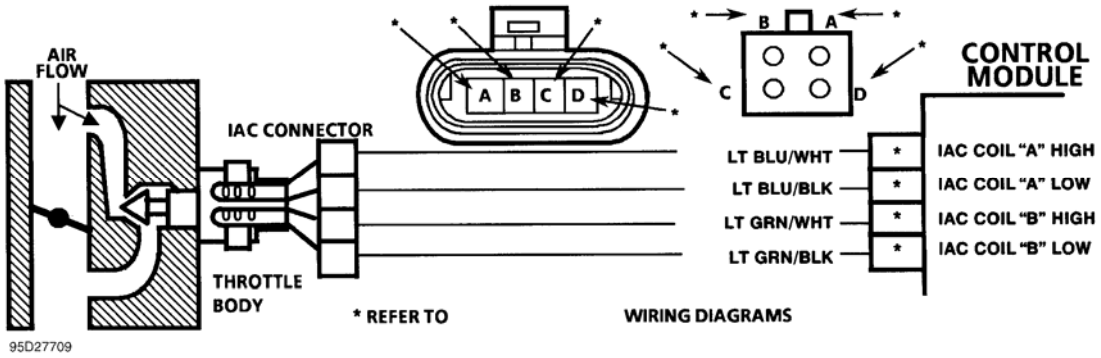


Fig. 8: Identifying IAC Valve Circuits (All Models)
Courtesy of GENERAL MOTORS CORP.

IGNITION SYSTEM

NOTE: **For basic ignition system checks, see the BASIC TESTING - 4.3L article.**

TIMING CONTROL SYSTEMS (C-4 & C-5)

C-4, Ignition Control Circuit

An open or short to ground in Ignition Control (IC) or by-pass circuit will cause ECM/PCM/VCM to turn on Malfunction Indicator Light (MIL) and confirm fault by setting a related trouble code. Refer to the **TESTS W/CODES - 4.3L** article.

C-5, Knock Sensor Circuit (Models Using External Spark Controller Module)

1. An open or short circuit on ESC wire to ECM/PCM/VCM will cause a loss of 12-volt ESC controller signal. This will cause ECM/PCM/VCM to fully retard ignition timing.
2. If a scan tester is available, connect tester to Data Link Connector (DLC). Using a metal object, tap on engine next to knock sensor and note knock parameter. Knock should be indicated on scan tester.
3. If a scan tester is not available, backprobe ECM/PCM/VCM knock sensor signal terminal with a DVOM. With engine idling, 8-12 volts should be present at this terminal. Using a metal object, tap on engine close to knock sensor. Voltage signal at ECM/PCM/VCM terminal should drop to zero volts, and return when knock signal ceases.
4. If signal does not respond as described, check knock sensor-to-controller-signal. On vehicles equipped with automatic transmission, it may be necessary to place transmission in Drive for timing change to occur. See **KNOCK SENSOR** under ENGINE SENSORS & SWITCHES.

C-5, Knock Sensor Circuit (Models Using Knock Sensor With Internal Spark Controller Module)

1. An open or short circuit on knock sensor wire to ECM/PCM/VCM will set a related trouble code. A false detonation signal will not cause ECM/PCM/VCM to set a code.
2. If a scan tester is available, connect it to Data Link Connector (DLC). Tap on engine next to knock sensor and note "knock" parameter. Knock should be indicated on scan tester.
3. If a scan tester is not available, connect tachometer to engine. Start engine and hold RPM above idle. Using a metal object, tap on engine close to knock sensor. A noticeable decrease in engine RPM should occur. If no RPM decrease occurred, check knock sensor to ECM/PCM/VCM circuit.
4. On vehicles equipped with automatic transmission, it may be necessary to place transmission in Drive for timing change to occur. See **KNOCK SENSOR** under ENGINE SENSORS & SWITCHES.

EMISSION SYSTEMS & SUB-SYSTEMS

EXHAUST GAS RECIRCULATION (C-7)

System Test (Vacuum-Controlled Valve)

Start and run engine to normal operating temperature. With engine at idle, RPM should drop as EGR valve is opened by pushing up on underside of EGR diaphragm.

CAUTION: Wear gloves when handling hot EGR valve.

EGR Control Solenoid

1. Disconnect EGR solenoid electrical harness connector and vacuum hoses. Connect a hand-held vacuum pump to solenoid vacuum source port. Connect vacuum gauge to solenoid EGR port. Pump up vacuum pump. Vacuum should not be present at port to EGR valve.
2. Activate EGR solenoid with a remote ground and 12-volt power supply. Vacuum should now be present at vacuum gauge. Solenoid should have at least 20 ohms of resistance.

Negative Backpressure EGR Valve

With engine off, disconnect vacuum hose to EGR valve. Connect vacuum pump to EGR and apply 10 in. Hg. If EGR diaphragm does not move up and stay up for 20 seconds, replace EGR valve.

Linear EGR Valve (Digital Valve)

1. Install scan tester. Ensure P/N switch is operating properly. See **ENGINE SENSORS & SWITCHES**. With engine at normal operating temperature, command EGR pintle position to zero percent. Increase engine speed to 2000 RPM. If scan tester reads actual EGR pintle position at greater than 3 percent, EGR valve is stuck open. Replace EGR valve.
2. If scan tester reads actual EGR pintle position at 3 percent or less, command a 25 percent position step increase (i.e. 0-25 percent, 25-50 percent, 50-75 percent, etc.). Observe MAP reading and actual EGR pintle position for 3 seconds. EGR should increase by about 25 percent position and MAP reading should

also increase.

3. If actual EGR pintle position is stable and within 10 percent of desired EGR pintle position command after 2 seconds, go to next step. If actual EGR pintle position is not as specified, go to step 5).
4. MAP reading should have increased when EGR pintle responded. If MAP did not respond, check EGR passages and EGR valve for blockage. If MAP responded, set desired EGR pintle position to 100 percent. If EGR pintle position sets to 100%, EGR is okay. If not, replace EGR valve.
5. Turn engine off. Check EGR electrical circuit and connecting components. Turn ignition on, check for 5-volt reference voltage on harness connector terminal "D" (Gray wire). If 5-volt reference voltage is not present, check ECM/PCM/VCM. See **CONTROL UNIT** under COMPUTERIZED ENGINE CONTROLS. If circuits are okay, replace EGR valve.

FUEL EVAPORATION CONTROL (C-3)

Vapor Canister Purge Valve ("P" Series & 4.3L CPI)

1. Install a short length of hose to lower port of purge valve. Blow into hose. Little or no air should pass into canister (a small amount of air will pass if the canister has a constant purge hole).
2. Using a hand-held vacuum pump, apply 15 in. Hg to vacuum control (upper) port. If vacuum does not hold for 20 seconds, replace canister.
3. With vacuum still applied, again try to blow through hose connected to lower port. An increased flow of air should be observed. If airflow does not increase, replace canister.

Fuel Tank Pressure Control Valve ("C", "G", "K" & "M" Series -High-Altitude)

1. Connect a hand-held vacuum pump to "control vac" port of tank pressure control valve. Apply approximately 15 in. Hg. to "control vac" port.
2. Attach a short piece of hose to fuel tank side of valve. Blow through hose. Air must pass through fuel tank pressure control valve. If air does not pass through fuel tank pressure control valve, replace defective valve.

Thermostatic Vacuum Switch

1. With engine coolant temperature less than 100°F (38°C), apply vacuum to manifold side of thermostatic vacuum switch. Switch should hold vacuum.
2. With engine coolant temperature greater than 122°F (50°C), vacuum should drop off. If thermostatic vacuum switch fails either test, replace switch.

POSITIVE CRANKCASE VENTILATION

Required Service

The PCV system may require service for obstructions if any of the following conditions exist:

- Rough Idle
- Stalling or Slow Idle Speed
- Oil Leaks

- Oil in Air Cleaner
- Sludge in Engine

A leaking PCV valve or hose could cause:

- Rough Idle
- Stalling
- High Idle Speed

If engine idles roughly, check for clogged PCV valve and for plugged or broken PCV hoses BEFORE adjusting idle. Check correct PCV valve application to ensure the correct valve is fitted. Replace PCV valve if required.

Checking PCV Valve Function

1. Remove PCV valve from rocker cover. Run engine at idle. Place thumb over open end of valve to check for vacuum. If there is no vacuum at valve, check for obstruction in manifold port, hoses or PCV valve. Repair or replace as necessary.
2. Turn engine off. Remove PCV valve. Shake valve and listen for rattle of check valve inside PCV valve. If a clear rattle is not heard, replace PCV valve.
3. Visually inspect valve for varnish or deposits that may make PCV valve sticky, restricted or incompletely seated. Replace if necessary.
4. Engine must be sealed for PCV system to function as designed. If leakage, sludging or dilution of oil is noted and PCV system is functioning properly, check engine for cause and repair as required to ensure PCV system will continue to function properly.
5. Since an engine operating without any crankcase ventilation can be damaged, it is important to replace PCV valve and air cleaner breather at regular intervals (at least every 30,000 miles). Check all hoses and clamps for failure or deterioration.

THERMOSTATIC AIR CLEANER

Damper Door - Wax Pellet Check

1. Remove air cleaner assembly from vehicle and allow to cool to less than 40°F (4°C). Damper door should be closed to outside (cold) air.
2. Reinstall air cleaner assembly. Start engine and observe damper door. As air cleaner assembly warms up, wax pellet should expand, closing off hot air delivery and opening cold air delivery.
3. If door does not respond as indicated, ensure door is not binding and calibrated damper spring is installed properly.

MISCELLANEOUS ECM/PCM/VCM CONTROLS

NOTE: Although not considered true engine performance-related systems, some controlled devices may affect driveability if they malfunction.

TRANSMISSION (C-8)

Torque Converter Clutch (TCC) Solenoid

Disconnect harness connector to TCC solenoid. Measure resistance between TCC solenoid terminals. See **Fig. 9** - **Fig. 11** . Solenoid resistance should be greater than 20 ohms.

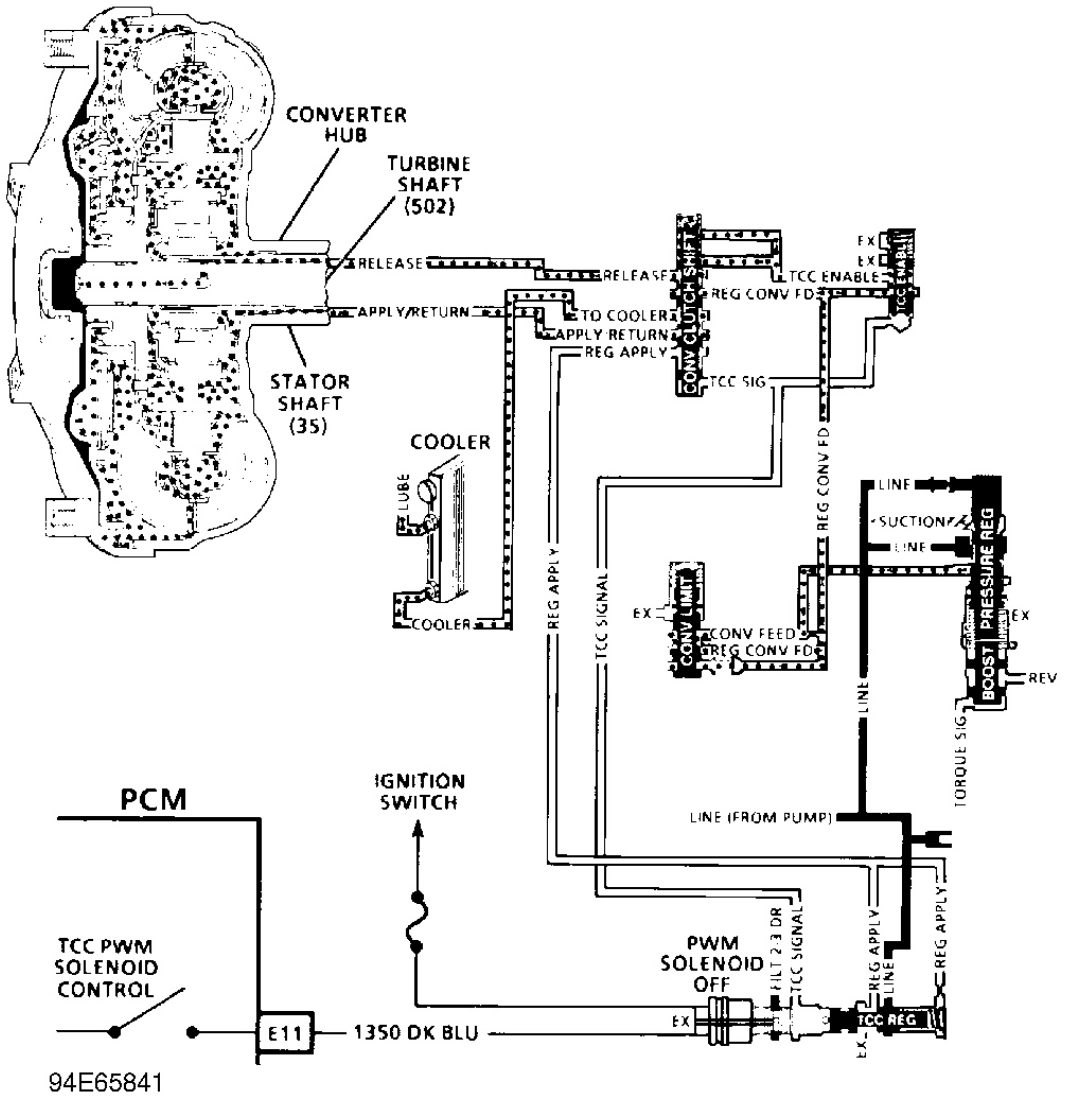


Fig. 9: Torque Converter Clutch Schematic ("G" Series)
Courtesy of GENERAL MOTORS CORP.

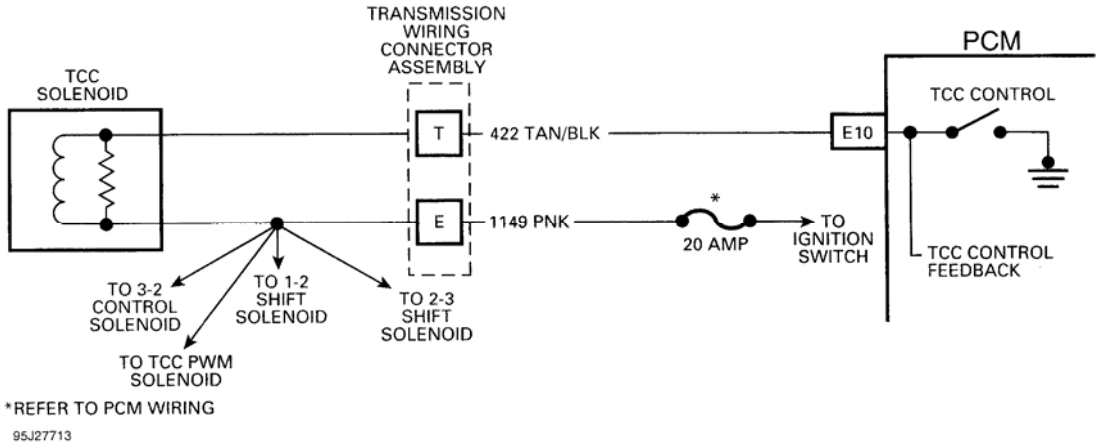


Fig. 10: Torque Converter Clutch Schematic ("L" & "M" Series)
Courtesy of GENERAL MOTORS CORP.

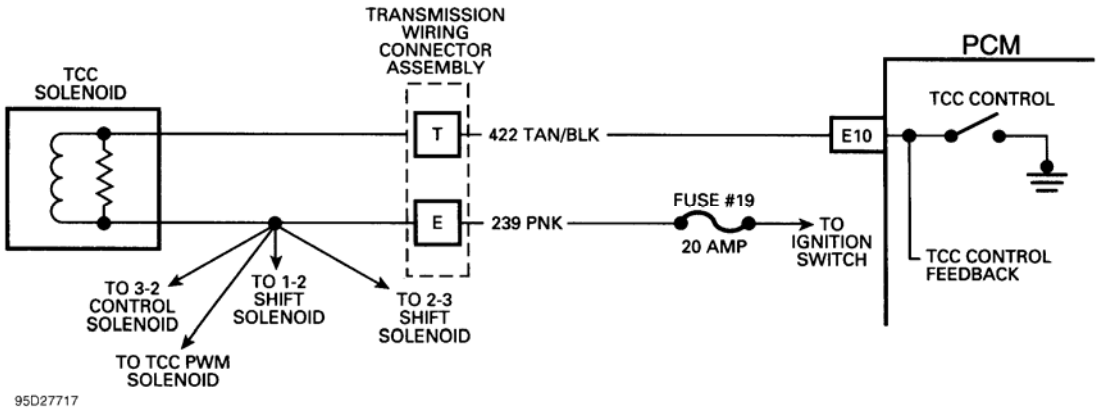


Fig. 11: Torque Converter Clutch Schematic ("S" & "T" Series)
Courtesy of GENERAL MOTORS CORP.

NOTE: Some solenoids have an internal pressure switch in series with solenoid winding and will not show continuity until transmission hydraulic pressure is applied.

Converter Lock-Up Signal At Transmission

1. Warm engine to operating temperature. Raise vehicle and support drive wheels. Support suspension where necessary to prevent damage to drive axles.
2. Disconnect converter clutch connector at transmission. Connect a test light across converter clutch harness terminals. See **Fig. 9** - **Fig. 11** . Start engine and place transmission in Drive. Accelerate vehicle to 45 MPH and note test light.
3. If test light is not on, check solenoid power supply wire of harness for open or short to ground. Check ground circuit for open between harness connector and ECM/PCM/VCM. If harness is okay, see

CONVERTER LOCK-UP SIGNAL FROM ECM/PCM/VCM below.

Converter Lock-Up Signal From ECM/PCM/VCM

1. Warm engine to operating temperature. Raise vehicle and support drive wheels. Support suspension where necessary to prevent damage to drive axles.
2. Connect a test light to battery voltage. Touch TCC control driver terminal with test light. See **Fig. 9** - **Fig. 11** . Accelerate vehicle to 45 MPH and note test light. If test light does not illuminate, problem is a faulty ECM/PCM/VCM connector or ECM/PCM/VCM. On some models, lock-up signal may be checked at Data Link Connector (DLC) terminal "F" instead of at ECM/PCM/VCM terminal.

Shift Light (Manual Transmission)

1. These tests assume a shift light problem exists. Use this procedure only if the light will not illuminate, or illuminates all the time.
2. Turn ignition on, with engine off. Note shift light. Shift light should not be on. If shift light is on, check for a short to ground between bulb and ECM/PCM/VCM or for bad ECM/PCM/VCM.
3. With ignition on and engine off, ground test terminal "B" of Data Link Connector (DLC). Malfunction Indicator Light (MIL) should start to flash and shift light should come on. If MIL comes on, go to next step. If MIL does not flash, perform DIAGNOSTIC CIRCUIT CHECK as described in **BASIC TESTING - 4.3L** article.
4. If shift light does not come on, ground Tan/Black light driver wire at ECM/PCM/VCM terminal using a jumper wire. For circuit identification, see **SHIFT LIGHT CIRCUIT IDENTIFICATION** below, and **Fig. 12**.
5. If shift light still does not come on, check for blown GAGES fuse, blown bulb or open circuit between fuse and ECM/PCM/VCM. If shift light comes on when grounding ECM/PCM/VCM terminal with a jumper wire, problem is a bad ECM/PCM/VCM connection or bad ECM/PCM/VCM.

SHIFT LIGHT CIRCUIT IDENTIFICATION

Application	Terminal
"C" & "K" Series	
ECM	E7
PCM	E2
"S" & "T" Series	
PCM	E2
VCM	GR13
VCM-A	BK15

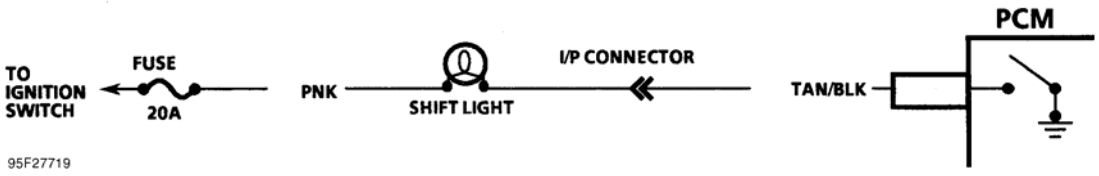


Fig. 12: Typical Shift Light Circuit (All Models)
Courtesy of GENERAL MOTORS CORP.

A/C CLUTCH (C-10) & ELECTRIC COOLING FAN (C-12)

NOTE: For additional information on electric cooling fans, see appropriate COOLING SYSTEM SPECIFICATIONS article in ENGINE COOLING section below.

- **COOLING SYSTEM SPECIFICATIONS** (for Astro & Safari)
- **COOLING SYSTEM SPECIFICATIONS** (for all others)

A/C CLUTCH (C-10)

A/C Clutch Relay

1. Disconnect A/C clutch relay harness connector. Using proper mini-schematic and an ohmmeter, check continuity between A/C clutch relay winding terminals. See **Fig. 19**. Continuity should exist. Check continuity between clutch drive circuit terminals of relay. Continuity should not exist.
2. Using jumper wires, apply ground and battery voltage to relay winding. Continuity should now exist between clutch drive circuit terminals of relay. Replace A/C clutch relay if continuity does not exist.

COOLING FAN (C-12)

NOTE: For additional information on electric cooling fans, see COOLING SYSTEM SPECIFICATIONS article in ENGINE COOLING.

Cooling Fan Relay

1. Disconnect cooling fan relay harness connector. Using an ohmmeter, check continuity of relay winding. See **Fig. 23**. Continuity should exist. Check continuity across power delivery terminals of relay. With relay not energized, continuity should not exist.
2. With ohmmeter still attached to power delivery terminals of relay, apply battery voltage and ground to energize relay winding. Continuity should now exist between cooling fan relay power delivery terminals. Replace cooling fan relay if continuity does not exist.

Cooling Fan Motor

Disconnect cooling fan motor harness connector. Apply battery voltage to one of the fan motor terminals and jumper the other terminal to ground. Fan motor should activate. If fan motor does not activate, replace faulty fan motor.

NOTE: For a more specific system testing, refer to the following C-10 or C-12 diagnostic charts. If any chart other than a C-10 or C-12 chart is referenced, see appropriate TESTS W/CODES - 4.3L article.

DIAGNOSTIC CHARTS

NOTE: In the following diagnostic tests, illustrations, schematics and flow charts are courtesy of General Motors Corp.

CHART C-10, A/C COMPRESSOR CLUTCH CIRCUIT DIAGNOSIS - 4.3L (VIN W & Z) S" & "T" SERIES A/T & 4.3L (VIN W) "T" SERIES M/T

A/C delay relay is used to delay operation of A/C compressor clutch for about 18 seconds after ignition is turned on. Regardless of A/C control position, delay relay is energized and starts its timer sequence when ignition is turned on.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Check for power to relay terminal No. 30 on circuit No. 901.
2. If A/C compressor clutch engages, compressor cycling switch is stuck open. Before replacing switch, check A/C refrigerant charge.
3. If voltage is present on circuit No. 66, circuit to relay terminal is okay.

Diagnostic Aids

A solid state relay is used to delay A/C compressor clutch engagement. If vehicle is started with A/C control on and compressor clutch engages immediately, A/C delay relay may be stuck closed or incorrect relay may have been installed.

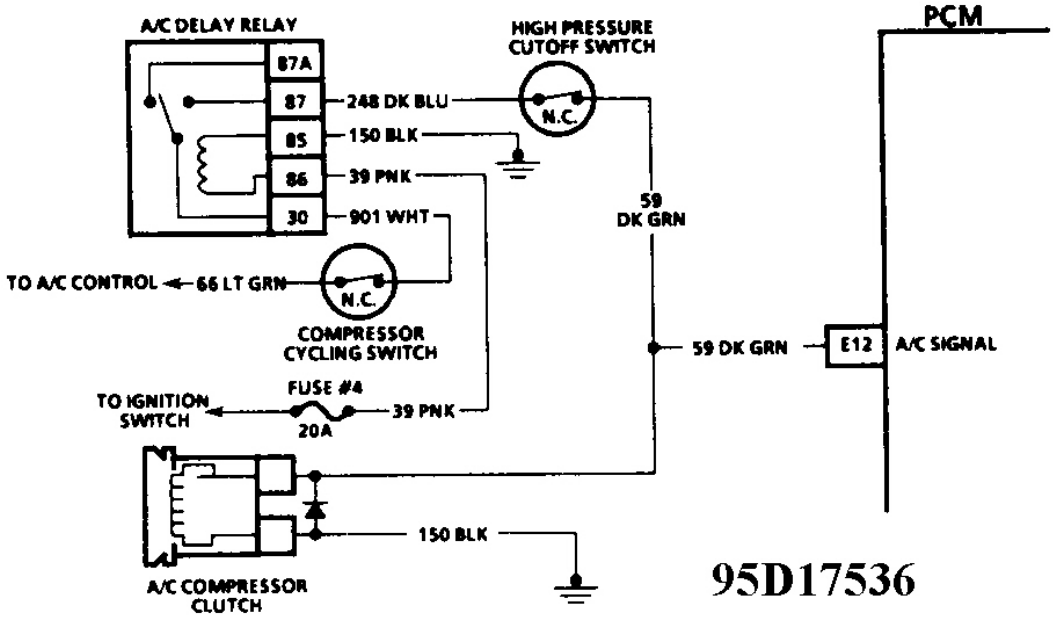


Fig. 13: Chart C-10 Schematic (4.3L (VIN W & Z) "S" & "T" Series A/T & 4.3L (VIN W) "T" Series

M/T A/C Compressor Clutch Circuit Diagnosis

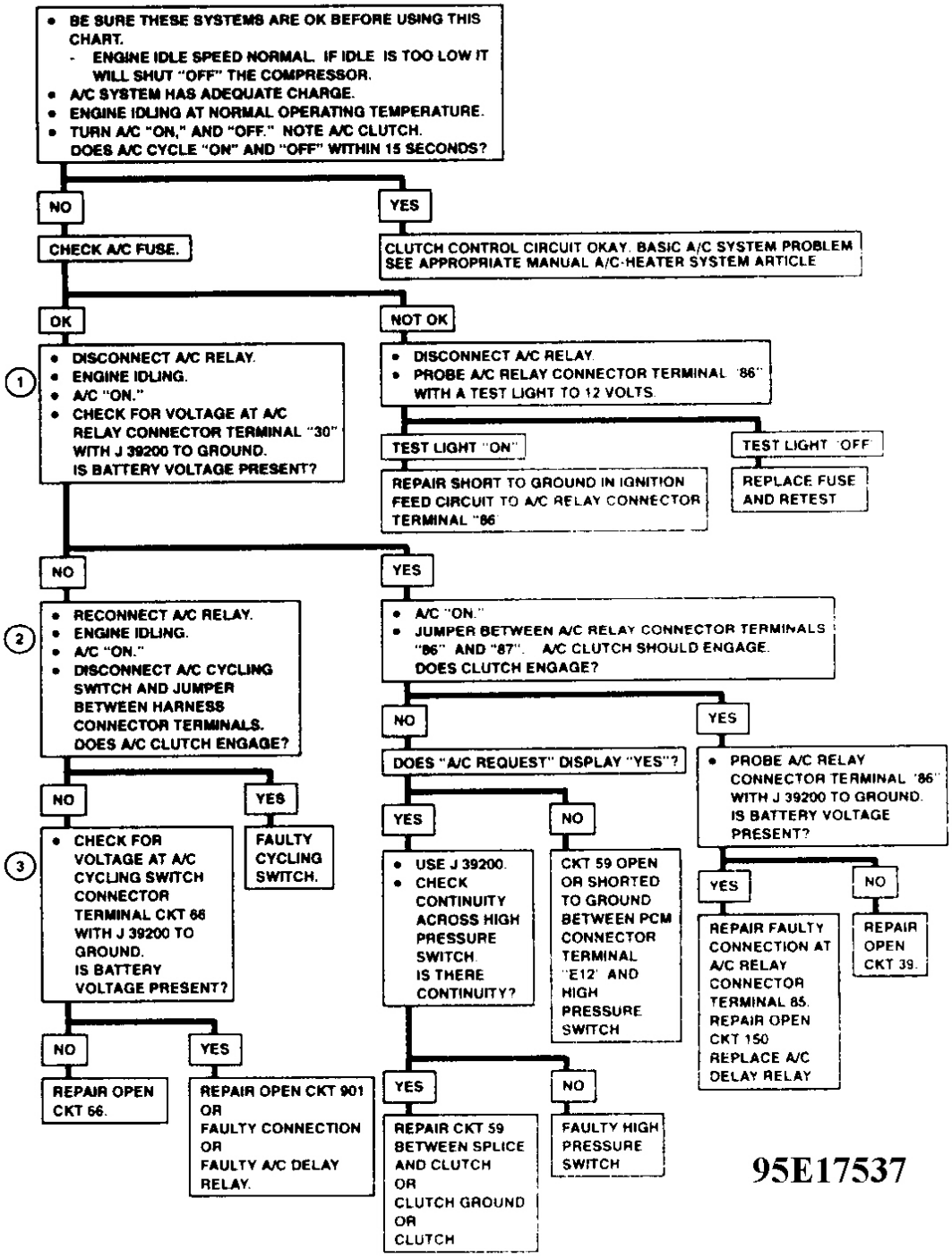


Fig. 14: Chart C-10 Diagnostic Flow Chart (4.3L (VIN W & Z) "S" & "T" Series A/T & 4.3L (VIN W) "T" Series M/T A/C Compressor Clutch Circuit Diagnosis

CHART C-10, A/C COMPRESSOR CLUTCH CIRCUIT DIAGNOSIS 4.3L (VIN Z) "S" & "T" SERIES M/T (1 OF 2)

When A/C control switch is turned on, voltage is supplied to Vehicle Control Module (VCM) circuit No. 66. If A/C pressure is okay and/or ambient temperature is not too cold, A/C pressure switch will close and supply voltage to switch side of A/C relay circuit No. 901. After a calibrated delay of 20 seconds, VCM will ground circuit No. 459, enabling relay and applying voltage to circuit No. 248. Normally closed A/C high pressure cut-off switch will provide voltage to circuit No. 59 and enable A/C compressor clutch. Voltage is also supplied to VCM on circuit No. 59. This voltage signal allows VCM to make idle, timing and fuel corrections for smoother clutch engagement.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks A/C request signal to VCM.
2. Checks compressor clutch and connections.
3. Checks circuit No. 150.
4. Determines which diagnostic path to take.
5. Checks circuit No. 39 at relay.
6. Checks relay, circuit No. 459, VCM connections or VCM.

Diagnostic Aids

Ensure correct A/C relay is installed on vehicle.

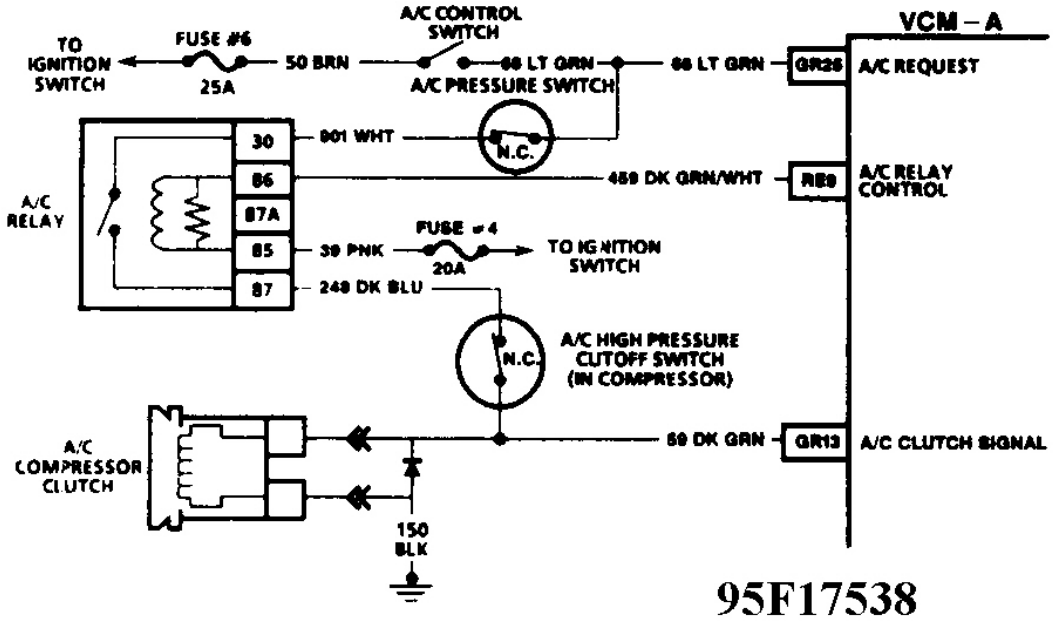


Fig. 15: Chart C-10 Schematic (4.3L (VIN Z) "S" & "T" Series M/T) A/C Compressor Clutch Circuit Diagnosis

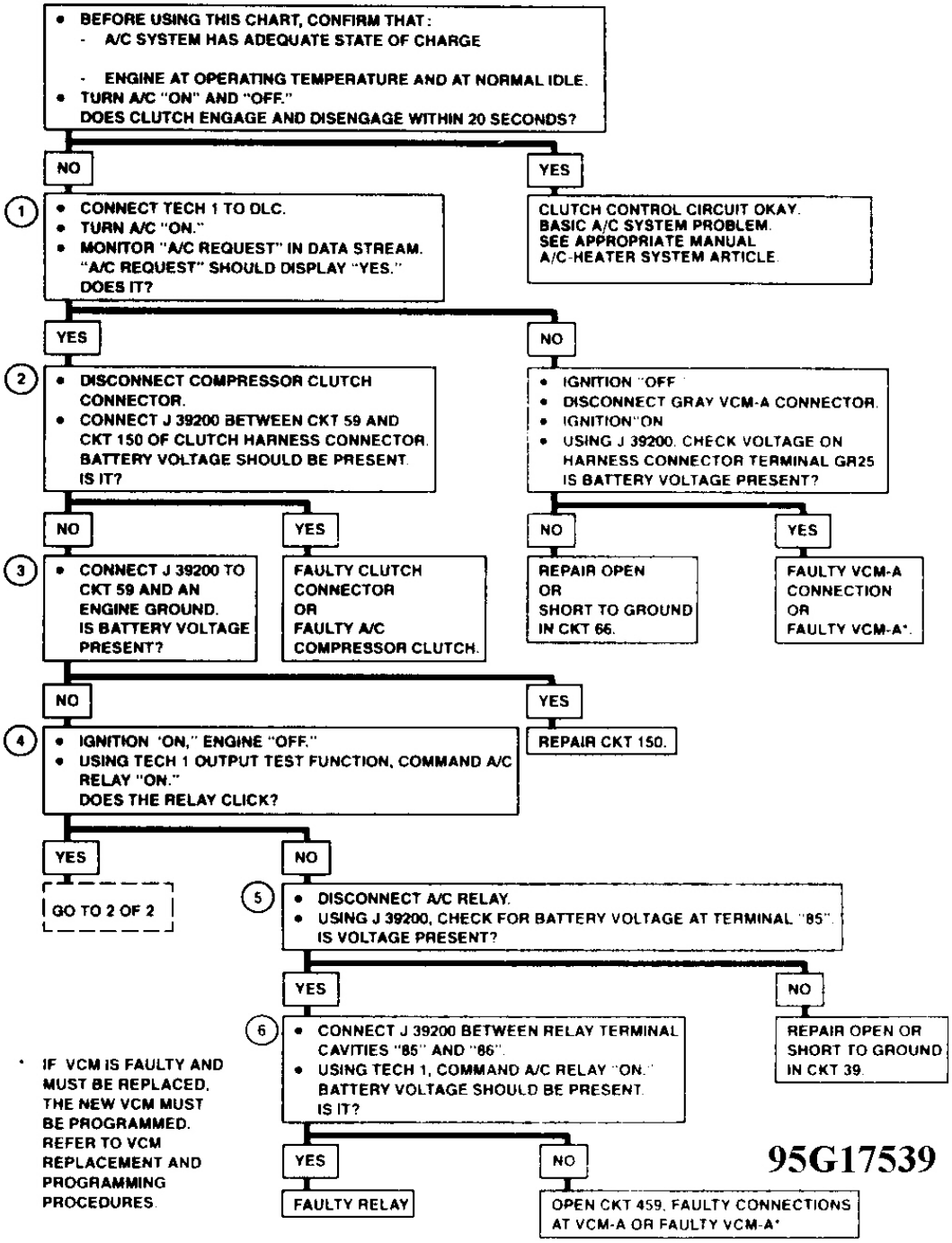


Fig. 16: Chart C-10 Diagnostic Flow Chart - 1 Of 2 (4.3L (VIN Z) "S" & "T" Series M/T) A/C Compressor Clutch Circuit Diagnosis

CHART C-10, A/C COMPRESSOR CLUTCH CIRCUIT DIAGNOSIS 4.3L (VIN Z) "S" & "T" SERIES M/T (2 OF 2)

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for voltage at relay.
2. Checks circuit No. 248 and relay.
3. Checks circuit No. 66.
4. Checks circuit No. 59 and high pressure switch.
5. Checks state of charge circuit No. 901 and low pressure switch.

Diagnostic Aids

Ensure correct A/C relay is installed on vehicle.

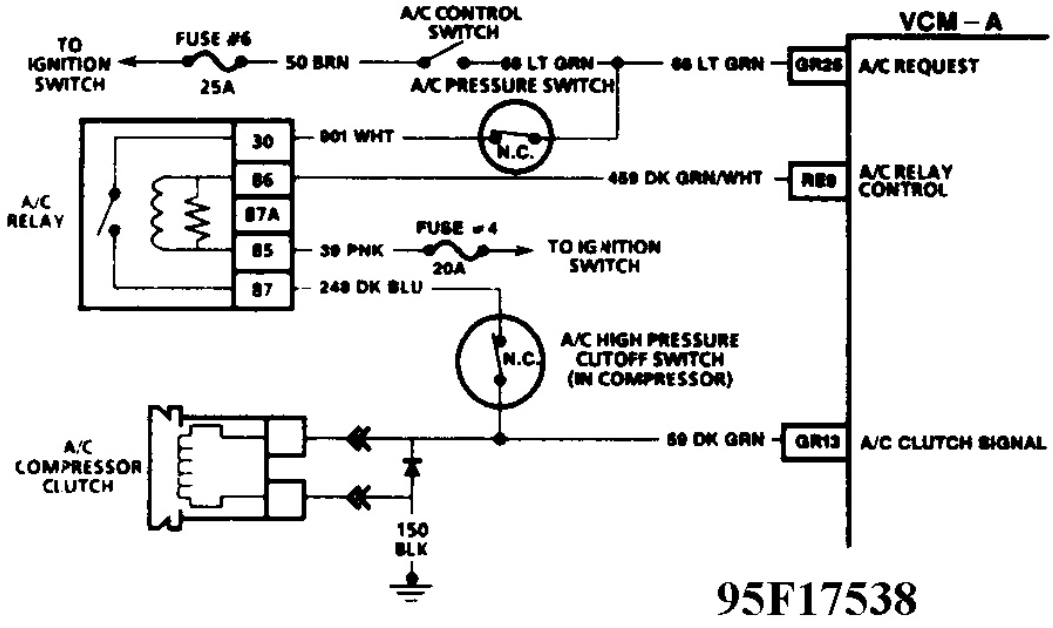


Fig. 17: Chart C-10 Schematic (4.3L (VIN Z) "S" & "T" Series M/T) A/C Compressor Clutch Circuit Diagnosis

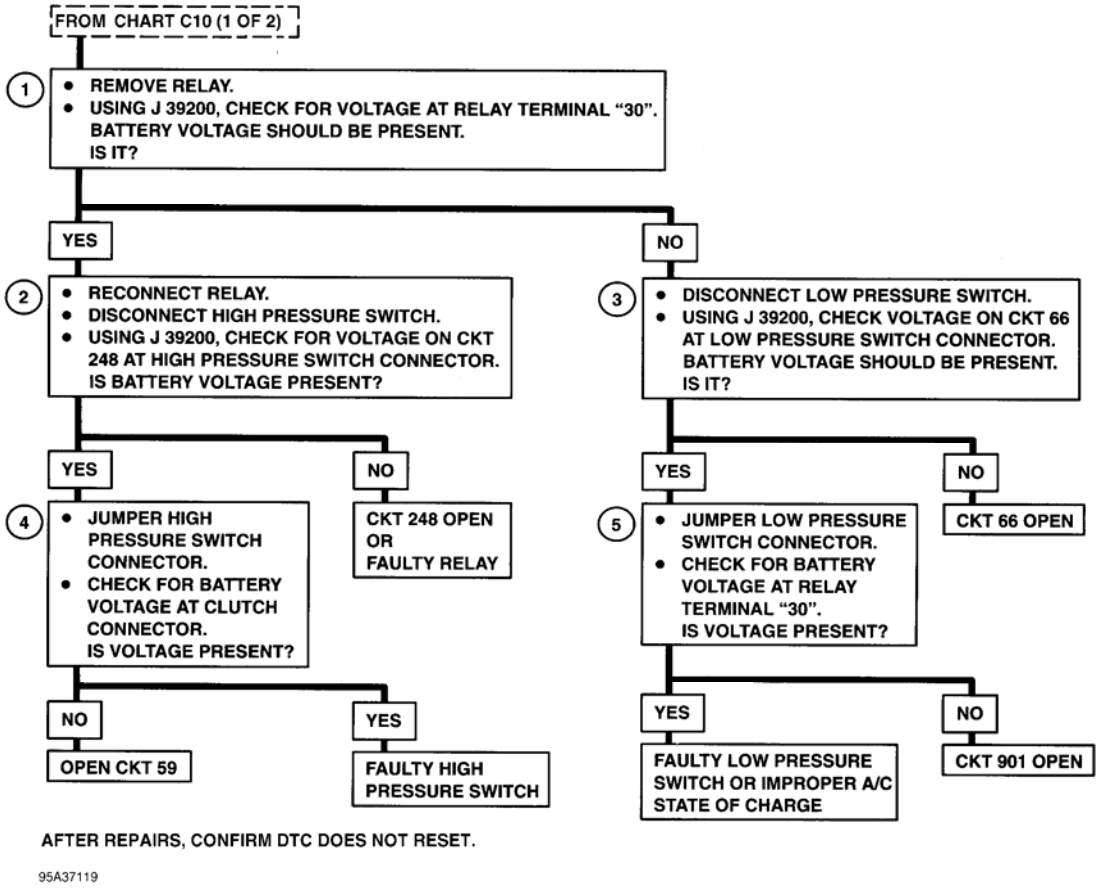


Fig. 18: Chart C-10 Diagnostic Flow Chart - 2 Of 2 (4.3L (VIN Z) "S" & "T" Series M/T) A/C Compressor Clutch Circuit Diagnosis

A/C REQUEST SIGNAL CIRCUIT DIAGNOSIS - 4.3L VIN W & Z ("C", "G", "K", "L", "M" & "P" SERIES)

Turning on A/C system supplies battery voltage to A/C compressor clutch and Powertrain Control Module (PCM) terminal E12 through circuit No. 59, increasing idle speed. PCM does not control A/C compressor clutch. If A/C compressor clutch is malfunctioning, repair basic A/C system problem. If A/C system is operating properly and idle speed drops too low when A/C compressor turns on or flares too high when A/C compressor turns off, check for an open circuit No. 59 to PCM. If circuit is okay, repair faulty PCM connection (terminal E12) or replace faulty PCM.

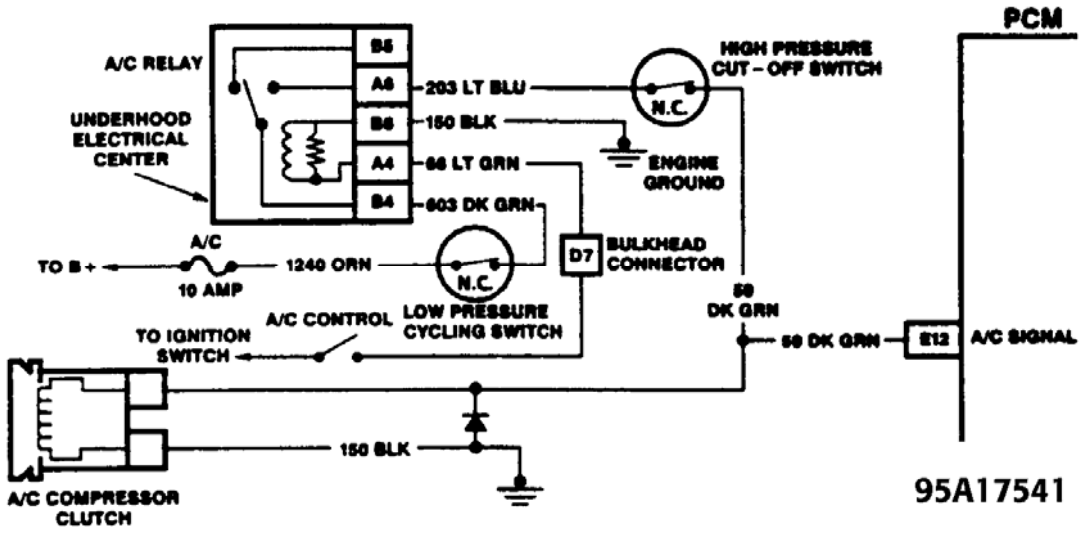


Fig. 19: A/C Clutch Circuit Schematic - 4.3L VIN W & Z ("C" & "K" Series) A/C Request Signal Circuit Diagnosis

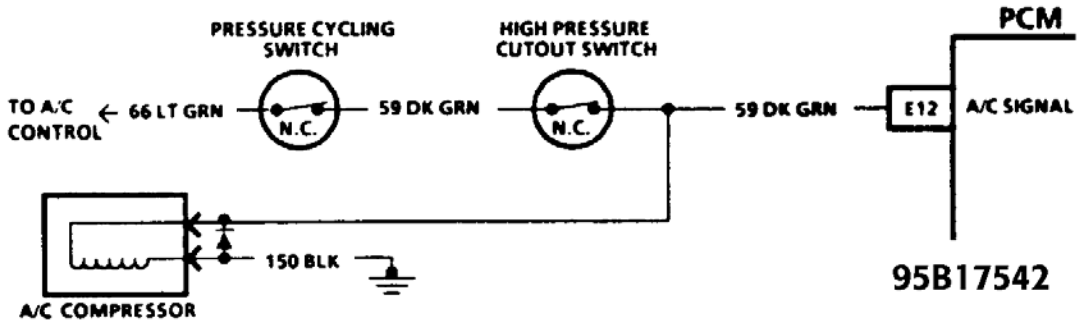


Fig. 20: A/C Clutch Circuit Schematic - 4.3L VIN W & Z ("G" Series) A/C Request Signal Circuit Diagnosis

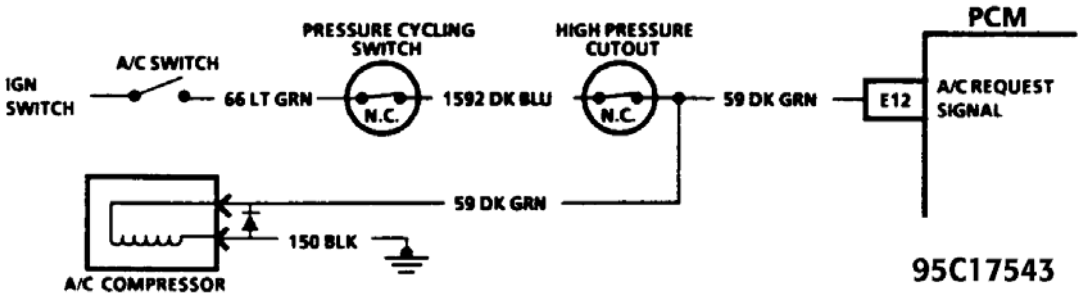


Fig. 21: A/C Clutch Circuit Schematic - 4.3L VIN W & Z ("L" & "M" Series) A/C Request Signal Circuit Diagnosis

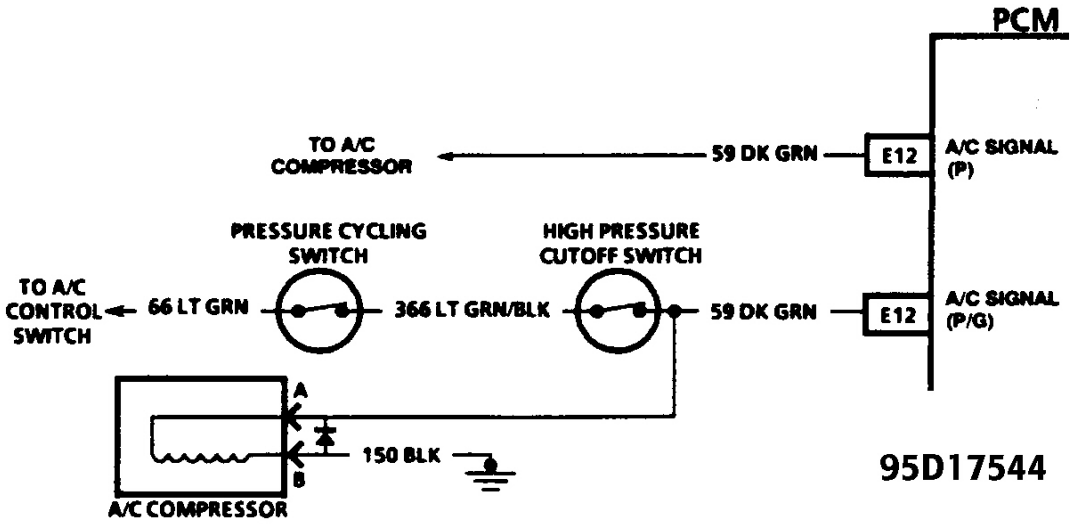


Fig. 22: A/C Clutch Circuit Schematic - 4.3L VIN W & Z ("P" Series) A/C Request Signal Circuit Diagnosis

AUXILIARY COOLING FAN CIRCUIT DIAGNOSIS

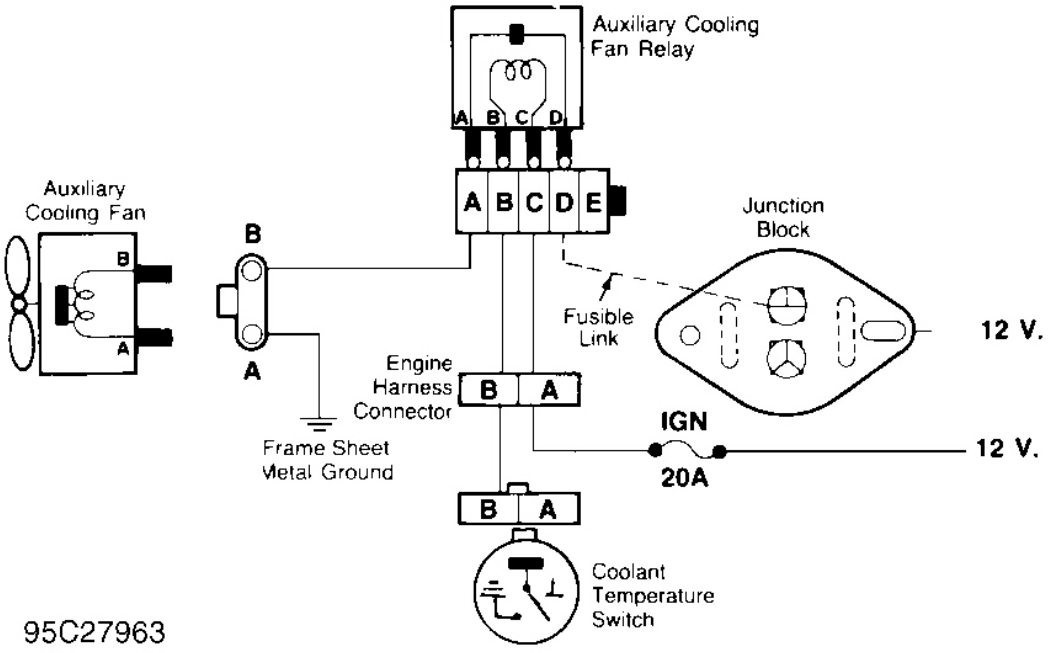


Fig. 23: Auxiliary Cooling Fan Schematic ("C", "G", "K" & "P" Series With A/C) Auxiliary Cooling Fan Circuit Diagnosis

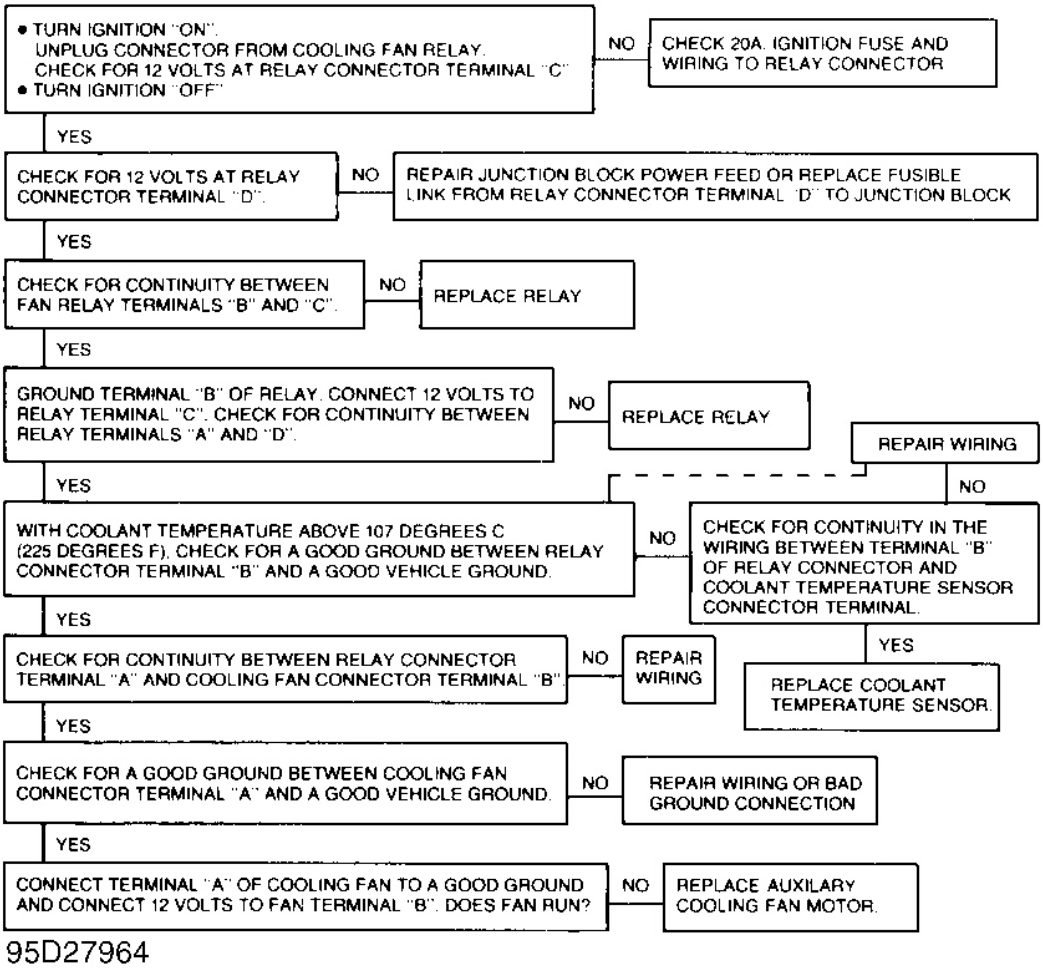


Fig. 24: Auxiliary Cooling Fan Diagnostic Flow Chart ("C", "G", "K" & "P" Series With A/C)
Auxiliary Cooling Fan Circuit Diagnosis

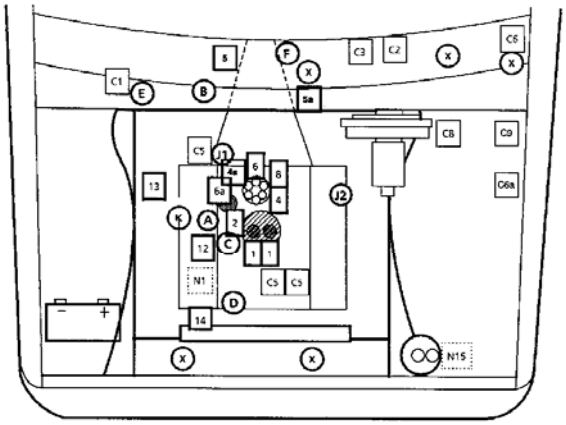
COMPONENT LOCATIONS

COMPUTER HARNESS
C1. Powertrain Control Module (PCM)
C2. Data Link Connector (DLC)
C3. Malfunction Indicator Light (MIL)
C5. PCM Harness Ground
C6. Fuse Block
C6a. Underhood Electrical Center
C8. Fuel Pump Test Connector
C9. Underhood Electrical Center

CONTROLLED DEVICES
1. Fuel Injector
2. Idle Air Control (IAC) Valve
4. EGR Valve (Fed.)
4a. Linear EGR Valve (Calif.)
5. Trans. Harness Connector (4L60-E)
5a. Trans. Harness Connector (4L80-E)
6. Ignition Distributor
6a. Remote Ignition Coil
8. Oil Pressure Switch
12. EGR Vacuum Solenoid
13. A/C Low Pressure Cycling Switch
14. A/C High Pressure Cut-Out Switch

INFORMATION SENSORS
A. Manifold Absolute Pressure (MAP) Sensor
B. Heated Oxygen Sensor (HO2S)
C. Throttle Position (TP) Sensor
D. Engine Coolant Temp. (ECT) Sensor
E. Vehicle Speed Sensor (VSS) Buffer Module
F. Vehicle Speed Sensor (VSS)
J1. Knock Sensor No. 1
J2. Knock Sensor No. 2
K. Canister Purge Solenoid (Calif.)

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4.3L (VIN Z) "C" & "K" SERIES

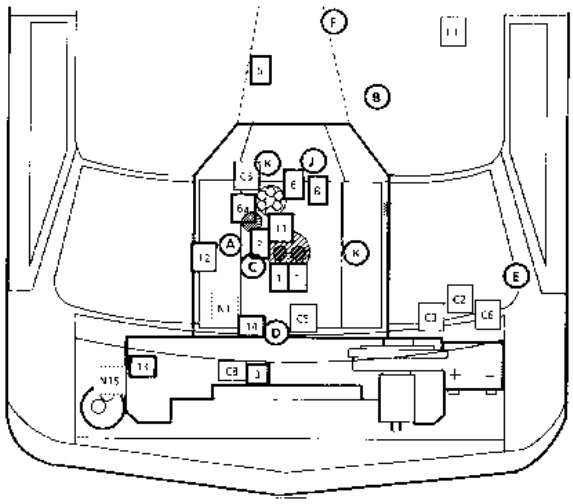
EMISSIONS SYSTEMS
(Not PCM Controlled)
N1. PCV Valve
N15. EVAP Canister

Fig. 25: Component Location For 4.3L (VIN Z) "C" & "K" Series
Courtesy of GENERAL MOTORS CORP.

COMPUTER HARNESS
C1. Powertrain Control Module (PCM)
C2. Data Link Connector (DLC)
C3. Malfunction Indicator Light
C5. PCM Harness Ground
C6. Fuse Block
C8. Fuel Pump Test Connector

CONTROLLED DEVICES
1. Fuel Injector
2. Idle Air Control (IAC) Valve
3. Fuel Pump Relay
5. Transmission Harness Connector
6. Ignition Distributor
6a. Remote Ignition Coil
8. Fuel Pump/Oil Pressure Switch
11. EGR Valve
12. EGR Solenoid
13. A/C Low Pressure Switch
14. A/C High Pressure Switch

INFORMATION SENSORS
A. Manifold Absolute Pressure (MAP) Sensor
B. Heated Oxygen Sensor (HO2S)
C. Throttle Position (TP) Sensor
D. Engine Coolant Temp. (ECT) Sensor
E. Vehicle Speed Sensor (VSS) Buffer
F. Vehicle Speed Sensor (VSS)
J. Knock Sensor (1994)
K. Knock Sensor (1995)



"G" SERIES 4.3L (VIN Z – 4L60E A/T)

NOT PCM CONTROLLED
N1. PCV Valve
N15. Fuel Vapor Canister

94A43489

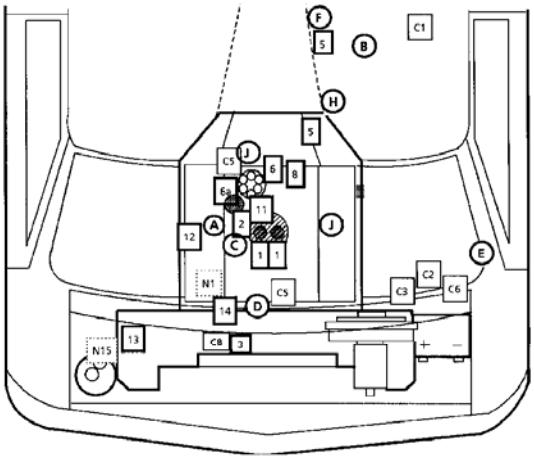
Fig. 26: Component Location For 4.3L (VIN Z) "G" Series W/ 4L60E A/T
Courtesy of GENERAL MOTORS CORP.

COMPUTER HARNESS
C1. Powertrain Control Module (PCM)
C2. Data Link Connector (DLC)
C3. Malfunction Indicator Light (MIL)
C5. PCM Harness Ground
C6. Fuse Block
C8. Fuel Pump Test Connector

CONTROLLED DEVICES
1. Fuel Injector
2. Idle Air Control (IAC) Valve
3. Fuel Pump Relay
5. Transmission Harness Connector
6. Ignition Distributor
6a. Remote Ignition Coil
8. Oil Pressure Switch
11. EGR Valve
12. EGR Vacuum Solenoid
13. A/C Low Pressure Switch
14. A/C High Pressure Cut-Out Switch

INFORMATION SENSORS
A. Manifold Absolute Pressure (MAP) Sensor
B. Heated Oxygen Sensor (HO2S)
C. Throttle Position (TP) Sensor
D. Engine Coolant Temp. (ECT) Sensor
E. Vehicle Speed Sensor (VSS) Buffer
F. VSS Output Sensor
H. VSS Input Sensor
J. Knock Sensor

95D27725



4.3L (VIN Z) "G" SERIES WITH 4L80E A/T

EMISSIONS SYSTEMS
(Not PCM Controlled)
N1. PCV Valve
N15. Fuel Vapor Canister

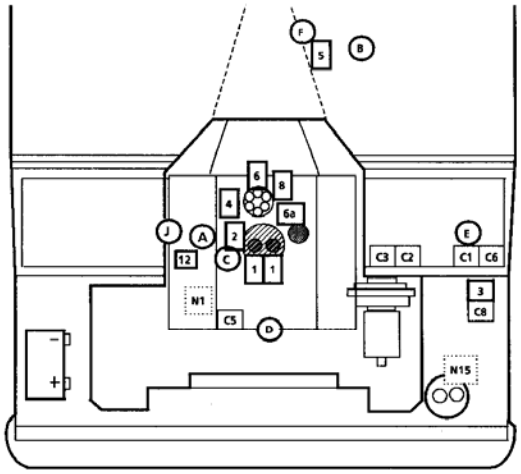
Fig. 27: Component Location For 4.3L (VIN Z) "G" Series W/ 4L80E A/T
Courtesy of GENERAL MOTORS CORP.

COMPUTER HARNESS
C1. Powertrain Control Module (PCM)
C2. Data Link Connector (DLC)
C3. Malfunction Indicator Light (MIL)
C5. PCM Harness Ground
C6. Fuse Block
C8. Fuel Pump Test Connector

CONTROLLED DEVICES
1. Fuel Injector
2. Idle Air Control (IAC) Valve
3. Fuel Pump Relay
4. EGR Valve
5. Trans. Harness Connector
6. Ignition Distributor
6a. Remote Ignition Coil
8. Oil Pressure Switch
12. EGR Vacuum Solenoid

INFORMATION SENSORS
A. Manifold Absolute Pressure (MAP) Sensor
B. Heated Oxygen Sensor (HO2S)
C. Throttle Position (TP) Sensor
D. Engine Coolant Temp. (ECT) Sensor
E. Vehicle Speed Sensor (VSS) Buffer
F. VSS Output Sensor
H. VSS Input Sensor
J. Knock Sensor

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4.3L (VIN Z) "P" SERIES WITH A/T

EMISSIONS SYSTEMS
(Not PCM Controlled)
N1. PCV Valve
N15. EVAP Canister

Fig. 28: Component Location For 4.3L (VIN Z) "P" Series With A/T

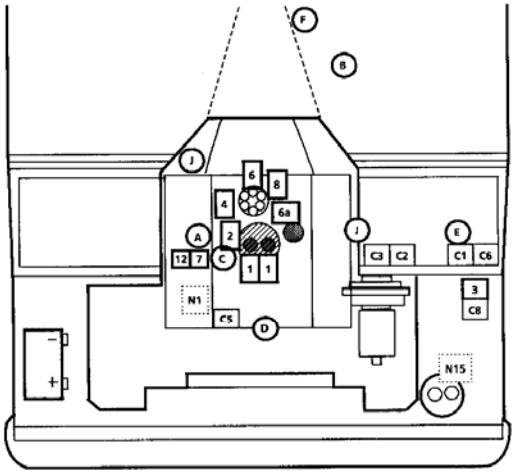
Courtesy of GENERAL MOTORS CORP.

COMPUTER HARNESS
C1. Powertrain Control Module (PCM)
C2. Data Link Connector (DLC)
C3. Malfunction Indicator Light (MIL)
C5. PCM Harness Ground
C6. Fuse Block
C8. Fuel Pump Test Connector

CONTROLLED DEVICES
1. Fuel Injector
2. Idle Air Control (IAC) Valve
3. Fuel Pump Relay
4. EGR Valve
6. Ignition Distributor
6a. Remote Ignition Coil
7. Knock Sensor Module
8. Oil Pressure Switch
12. EGR Vacuum Solenoid

INFORMATION SENSORS
A. Manifold Absolute Pressure (MAP) Sensor
B. Heated Oxygen Sensor (HO2S)
C. Throttle Position (TP) Sensor
D. Engine Coolant Temp. (ECT) Sensor
E. Vehicle Speed Sensor (VSS) Buffer Module
F. Vehicle Speed Sensor (VSS)
J. Knock Sensor

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4.3L (VIN Z) "P" SERIES WITH M/T

EMISSIONS SYSTEMS
(Not PCM Controlled)
N1. PCV Valve
N15. EVAP Vapor Canister

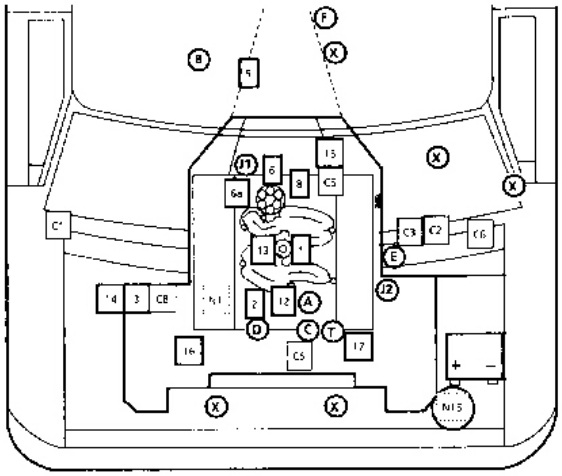
Fig. 29: Component Location For 4.3L (VIN Z) "P" Series With M/T
Courtesy of GENERAL MOTORS CORP.

COMPUTER HARNESS
C1. Powertrain Control Module (PCM)
C2. Data Link Connector (DLC)
C3. Malfunction Indicator Light (MIL)
C5. PCM Harness Ground
C6. Fuse Block
C8. Fuel Pump Test Connector

CONTROLLED DEVICES
1. Intake Manifold Tuning Valve (IMTV)
2. Idle Air Control (IAC) Valve
3. Fuel Pump Relay
5. Transmission Harness Connector
6. Ignition Distributor
6a. Remote Ignition Coil
8. Fuel Pump/Oil Pressure Switch
12. EGR Valve (Linear)
13. Central Port Injection (CPI) Assembly
14. IMTV Relay
15. Canister Purge Solenoid
16. A/C Low Pressure Cut-Out Switch
17. A/C High Pressure Cut-Out Switch

INFORMATION SENSORS
A. Manifold Absolute Pressure (MAP) Sensor
B. Heated Oxygen Sensor (HO2S)
C. Throttle Position (TP) Sensor
D. Engine Coolant Temp. (ECT) Sensor
E. Vehicle Speed Sensor (VSS) Buffer
F. Vehicle Speed Sensor (VSS)
J1. Knock Sensor No. 1
J2. Knock Sensor No. 2
T. Intake Air Temperature (IAT) Sensor

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"L" & "M" SERIES 4.3L (VIN W)

NOT PCM CONTROLLED
N1. PCV Valve
N15. Fuel Vapor Canister

MISCELLANEOUS
X. Air Bag Components

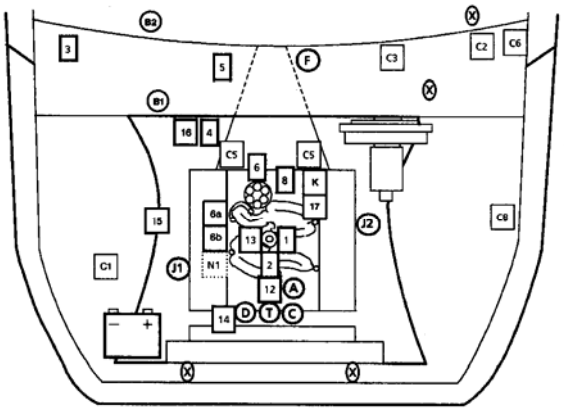
Fig. 30: Component Location For 4.3L (VIN W) "L" & "M" Series
Courtesy of GENERAL MOTORS CORP.

COMPUTER HARNESS
C1. Vehicle Control Module (VCM-A)
C2. Data Link Connector (DLC)
C3. Malfunction Indicator Light (MIL)
C5. VCM-A Harness Ground
C6. Fuse Block
C8. Fuel Pump Test Connector

CONTROLLED DEVICES
1. Intake Manifold Tuning Valve (IMTV)
2. Idle Air Control (IAC) Valve
3. Fuel Pump Relay (In Glove Box)
4. IMTV Relay
5. Trans. Harness Conenctor
6. Ignition Distributor
6a. Remote Ignition Coil
6b. Coil Driver Module
8. Oil Pressure Switch
12. EGR Valve (Linear)
13. Central Port Injection (CPI)
14. A/C High Pressure Cut-Out Switch
15. A/C Low Pressure Cut-Out Switch
16. A/C Relay
17. EVAP Purge Solenoid

INFORMATION SENSORS
A. Manifold Absolute Pressure (MAP) Sensor
B1. Heated Oxygen Sensor (HO2S) No. 1
B2. Heated Oxygen Sensor (HO2S) No. 2
C. Throttle Position (TP) Sensor
D. Engine Coolant Temp. (ECT) Sensor
F. Vehicle Speed Sensor (VSS)
J1. Knock Sensor No. 1
J2. Knock Sensor No. 2
K. EVAP Canister Vacuum Switch
T. Intake Air Temp. (IAT) Sensor

95A27730



4.3L (VIN W) "S" & "T" SERIES
(PICKUP & UTILITY MODELS)

EMISSIONS SYSTEMS
(Not VCM-A Controlled)
N1. PCV Valve
MISCELLAENOUS
X. Air Bag System Components

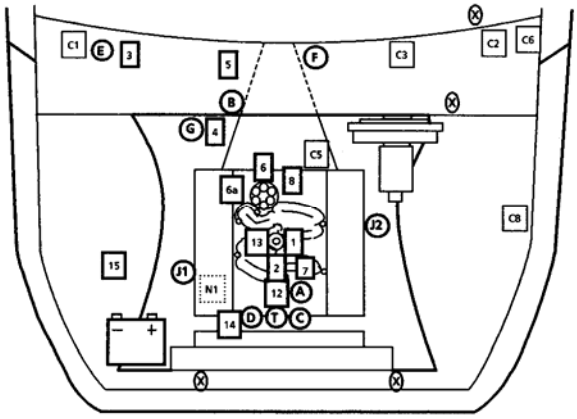
Fig. 31: Component Location For 4.3L (VIN W) "S" & "T" Series (Pickup & Utility Models)
Courtesy of GENERAL MOTORS CORP.

COMPUTER HARNESS
C1. Powertrain Control Module (PCM)
C2. Data Link Connector (DLC)
C3. Malfunction Indicator Light (MIL)
C5. PCM Harness Ground
C6. Fuse Block
C8. Fuel Pump Test Connector

CONTROLLED DEVICES
1. Intake Manifold Tuning Valve (IMTV)
2. Idle Air Control (IAC) Valve
3. Fuel Pump Relay (In Glove Box)
4. IMTV Relay
5. Trans. Harness Connector
6. Ignition Distributor
6a. Remote Ignition Coil
7. Canister Purge Solenoid
8. Oil Pressure Switch
12. EGR Valve (Linear)
13. Central Port Injection (CPI)
14. A/C High Pressure Cut-Out Switch
15. A/C Low Pressure Cut-Out Switch

INFORMATION SENSORS
A. Manifold Absolute Pressure (MAP) Sensor
B. Heated Oxygen Sensor (HO2S)
C. Throttle Position (TP) Sensor
D. Engine Coolant Temp. (ECT) Sensor
E. Vehicle Speed Sensor (VSS) Buffer
F. Vehicle Speed Sensor (VSS)
G. A/C Delay Relay
J1. Knock Sensor No. 1
J2. Knock Sensor No. 2
T. Intake Air Temp. (IAT) Sensor

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4.3L (VIN W) "S" & "T" SERIES WITH A/T (PICKUP & UTILITY MODELS)

EMISSIONS SYSTEMS
(Not PCM Controlled)
N1. PCV Valve

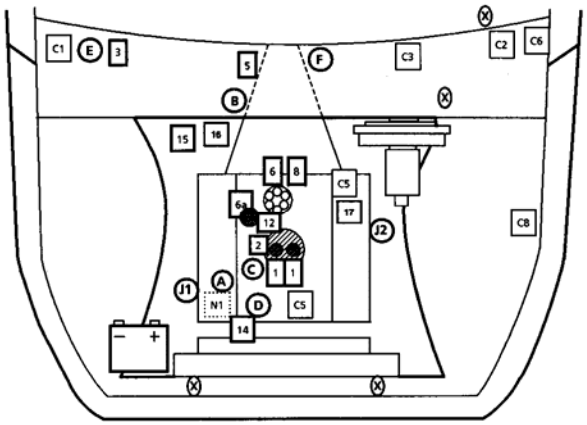
Fig. 32: Component Location For 4.3L (VIN W) "S" & "T" Series W/ A/T (Pickup & Utility Models)
Courtesy of GENERAL MOTORS CORP.

COMPUTER HARNESS
C1. Powertrain Control Module (PCM)
C2. Data Link Connector (DLC)
C3. Malfunction Indicator Light (MIL)
C5. PCM Harness Ground
C6. Fuse Block
C8. Fuel Pump Test Connector

CONTROLLED DEVICES
1. Fuel Injectors
2. Idle Air Control (IAC) Valve
3. Fuel Pump Relay (In Glove Box)
5. Trans. Harness Connector
6. Ignition Distributor
6a. Remote Ignition Coil
8. Oil Pressure Switch
12. EGR Valve (Linear)
14. A/C High Pressure Cut-Out Switch
15. A/C Low Pressure Cut-Out Switch
16. A/C Delay Relay
17. EVAP Canister Purge Solenoid

INFORMATION SENSORS
A. Manifold Absolute Pressure (MAP) Sensor
B. Heated Oxygen Sensor (HO2S)
C. Throttle Position (TP) Sensor
D. Engine Coolant Temp. (ECT) Sensor
E. Vehicle Speed Sensor (VSS) Buffer
F. Vehicle Speed Sensor (VSS)
J1. Knock Sensor No. 1
J2. Knock Sensor No. 2

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4.3L (VIN Z) "S" & "T" SERIES WITH A/T (PICKUP MODEL)

EMISSIONS SYSTEMS
(Not PCM Controlled)
N1. PCV Valve

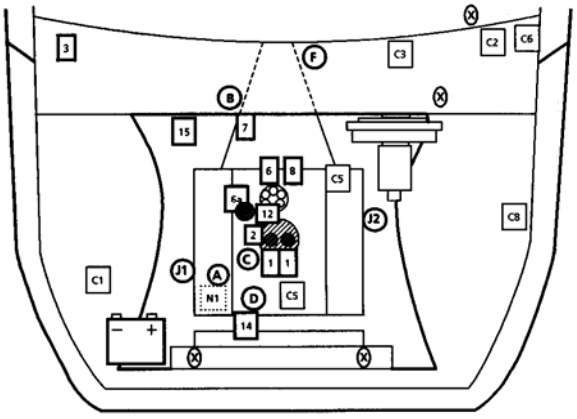
Fig. 33: Component Location For 4.3L (VIN Z) "S" & "T" Series W/ A/T (Pickup)
Courtesy of GENERAL MOTORS CORP.

COMPUTER HARNESS
C1. Vehicle Control Module (VCM)
C2. Data Link Connector (DLC)
C3. Malfunction Indicator Light (MIL)
C5. VCM Harness Ground
C6. Fuse Block
C8. Fuel Pump Test Connector

CONTROLLED DEVICES
1. Fuel Injectors
2. Idle Air Control (IAC) Valve
3. Fuel Pump Relay (In Glove Box)
6. Ignition Distributor
6a. Remote Ignition Coil
7. A/C Relay
8. Oil Pressure Switch
12. EGR Valve (Linear)
14. A/C High Pressure Cut-Out Switch
15. A/C Low Pressure Cut-Out Switch

INFORMATION SENSORS
A. Manifold Absolute Pressure (MAP) Sensor
B. Heated Oxygen Sensor (HO2S)
C. Throttle Position (TP) Sensor
D. Engine Coolant Temp. (ECT) Sensor
F. Vehicle Speed Sensor (VSS)
J1. Knock Sensor No. 1
J2. Knock Sensor No. 2

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4.3L (VIN Z) "S" & "T" SERIES WITH M/T (PICKUP)

EMISSIONS SYSTEMS
(Not VCM Controlled)
N1. PCV Valve

MISCELLANEOUS
X. Air Bag System Components

Fig. 34: Component Location For 4.3L (VIN Z) "S" & "T" Series W/ M/T (Pickup)
Courtesy of GENERAL MOTORS CORP.

WIRING DIAGRAMS

ASTRO & SAFARI - VIN W

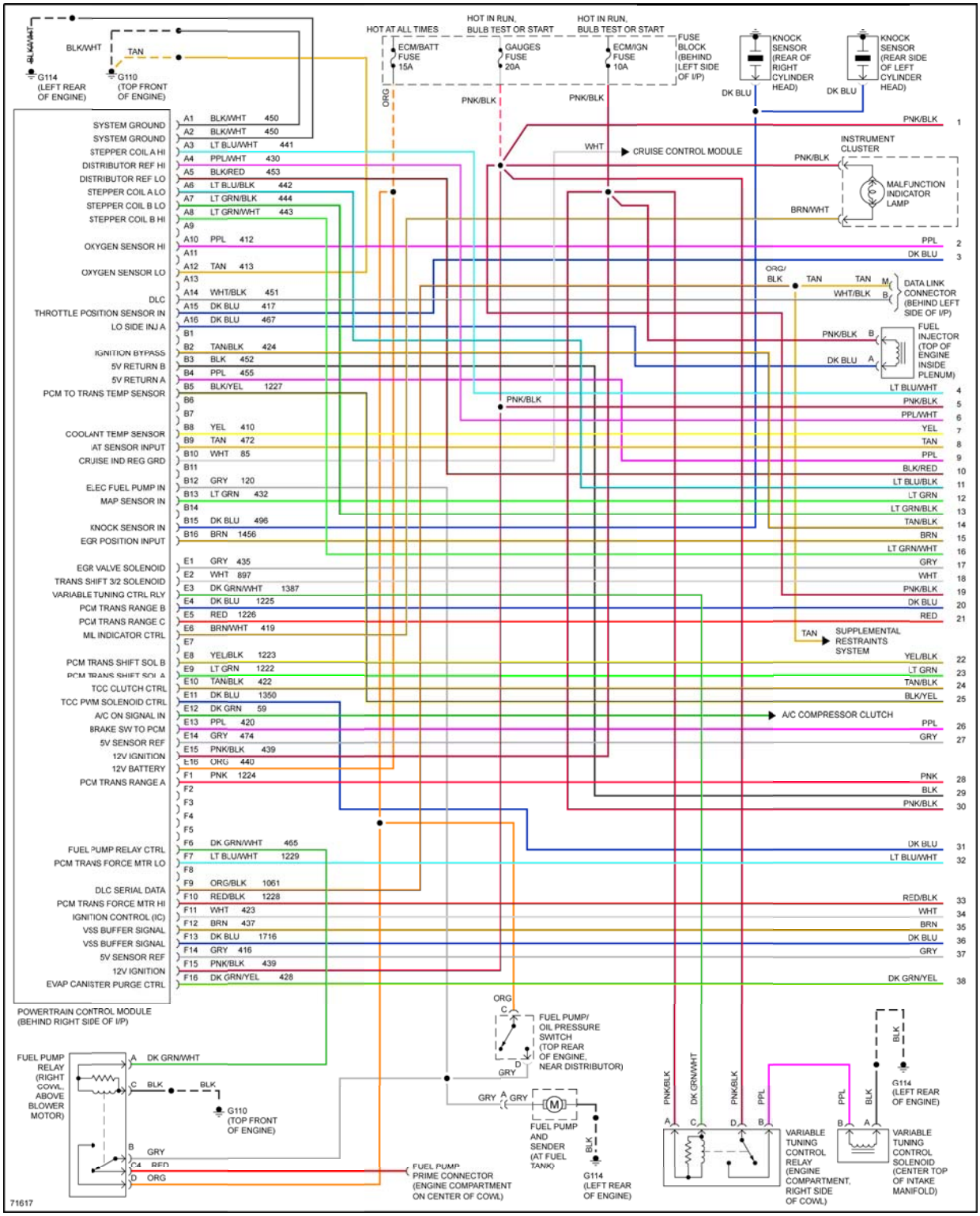


Fig. 35: Wiring Diagram (Astro & Safari 4.3L VIN W - 1 Of 2)

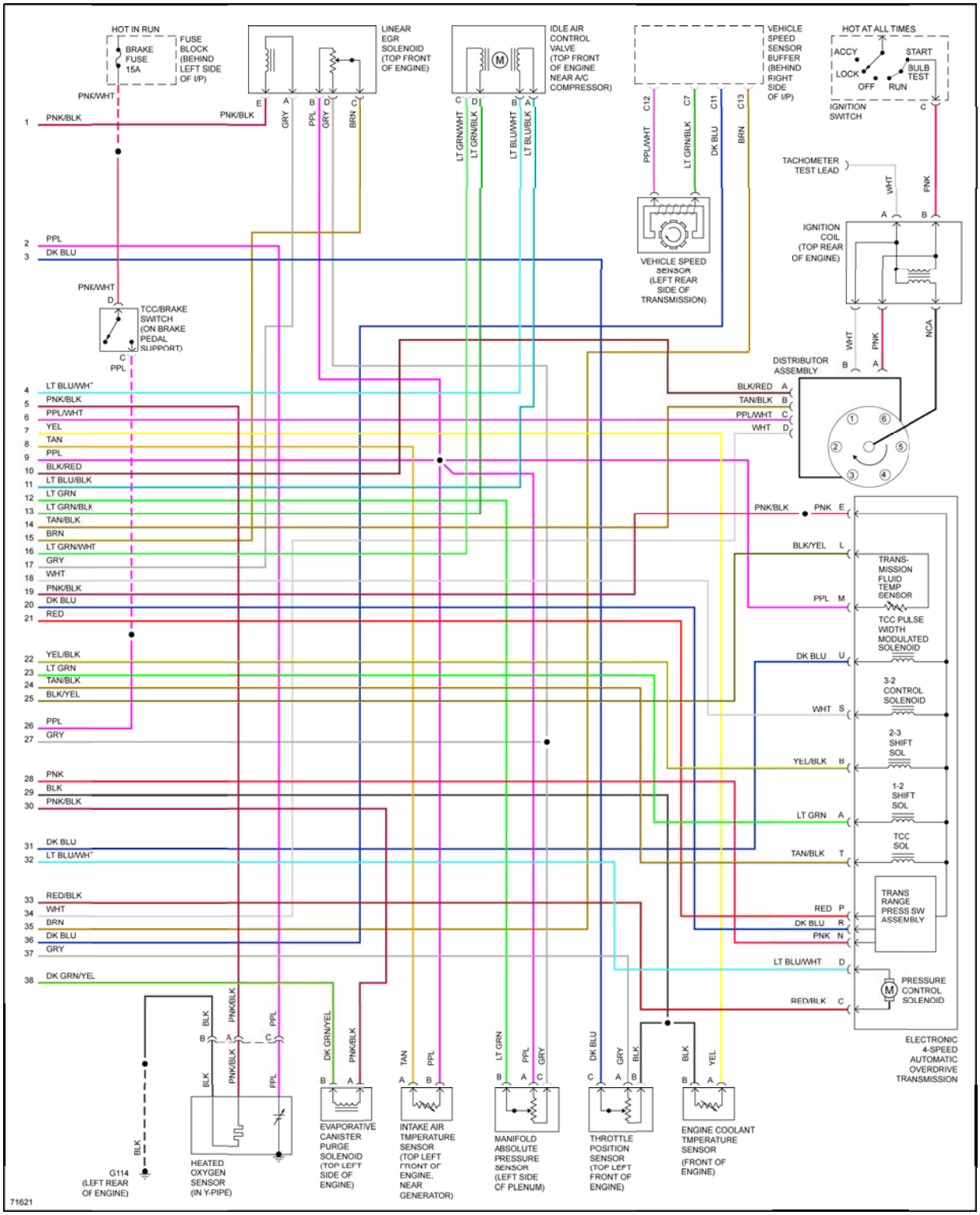


Fig. 36: Wiring Diagram (Astro & Safari 4.3L VIN W - 2 Of 2)

"C" & "K" SERIES - WITH A/T

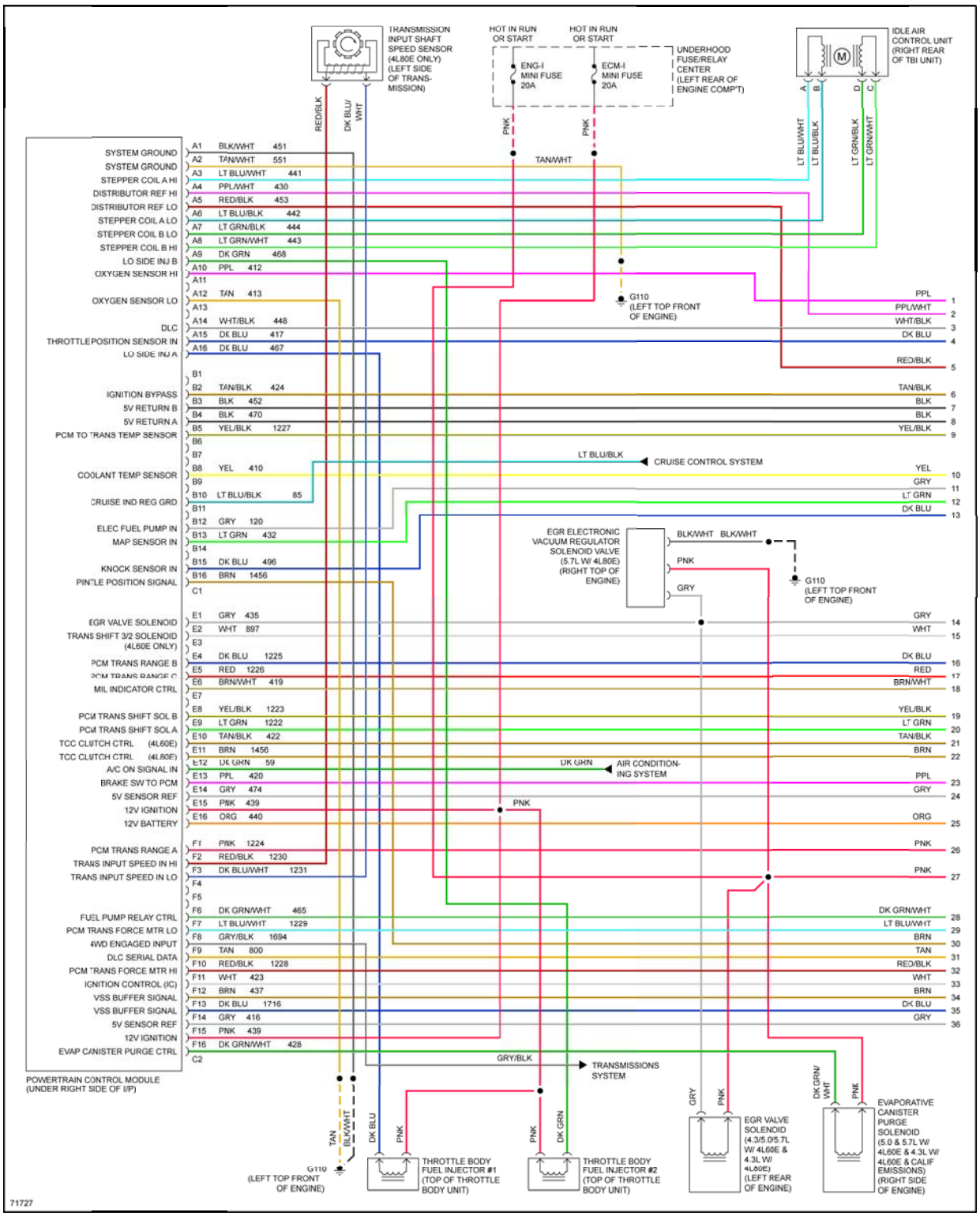


Fig. 37: Wiring Diagram ("C" & "K" Series Pickup, Sierra, Suburban, Tahoe & Yukon - 4.3L With A/T

- 1 Of 3)

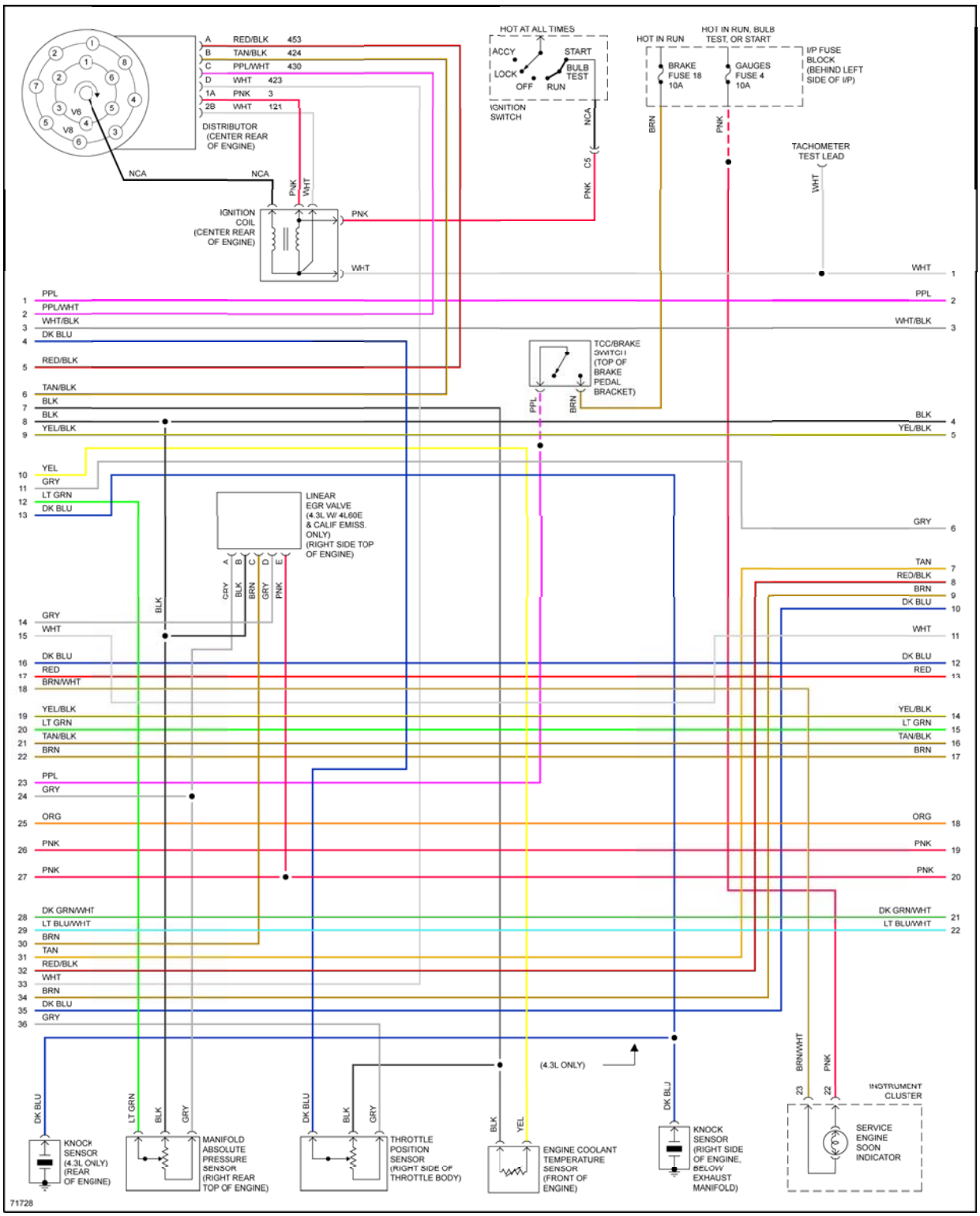


Fig. 38: Wiring Diagram ("C" & "K" Series Pickup, Sierra, Suburban, Tahoe & Yukon - 4.3L With A/T

- 2 Of 3)

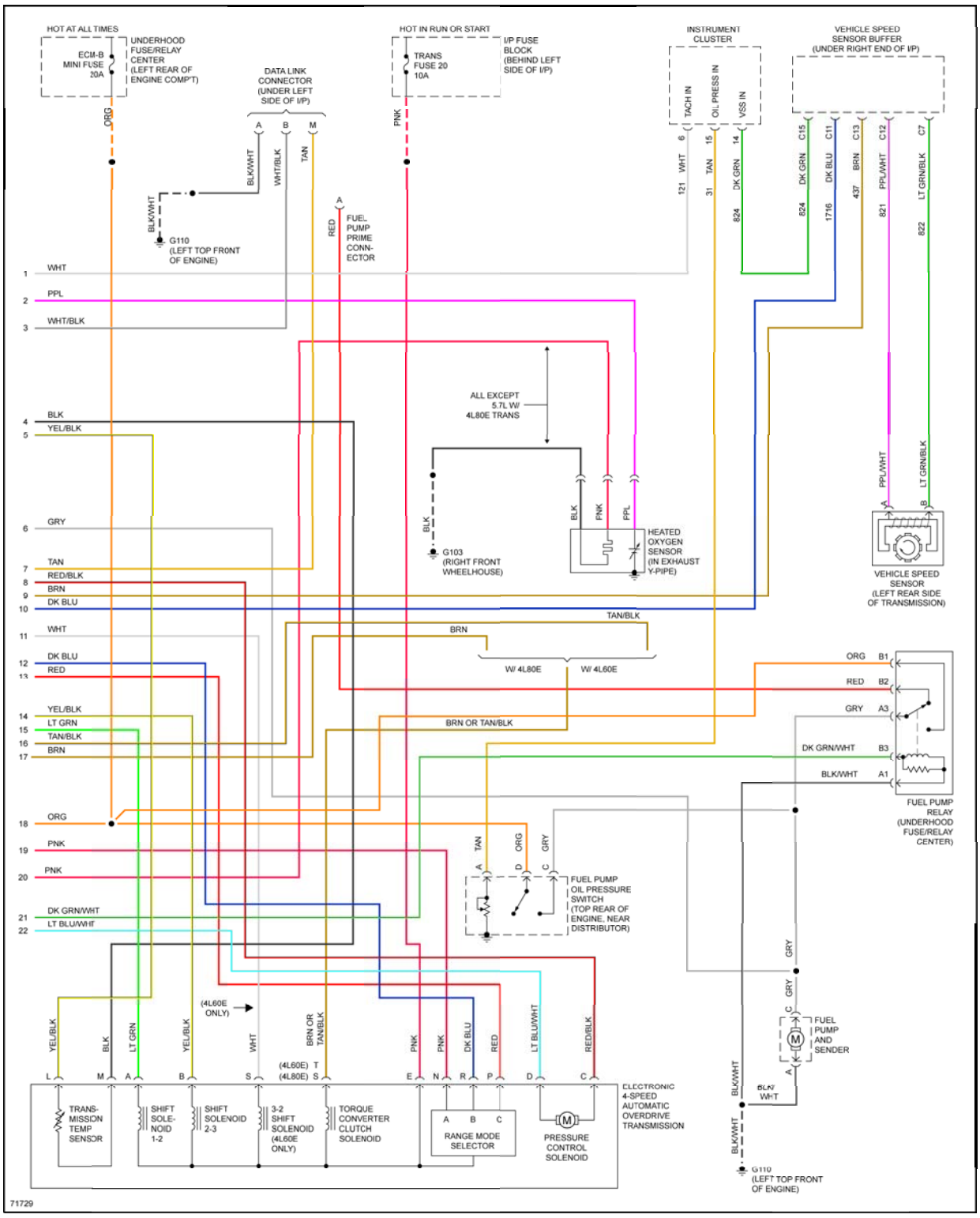


Fig. 39: Wiring Diagram ("C" & "K" Series Pickup, Sierra, Suburban, Tahoe & Yukon - 4.3L With A/T

- 3 Of 3)

"C" & "K" SERIES PICKUP & SIERRA - WITH M/T

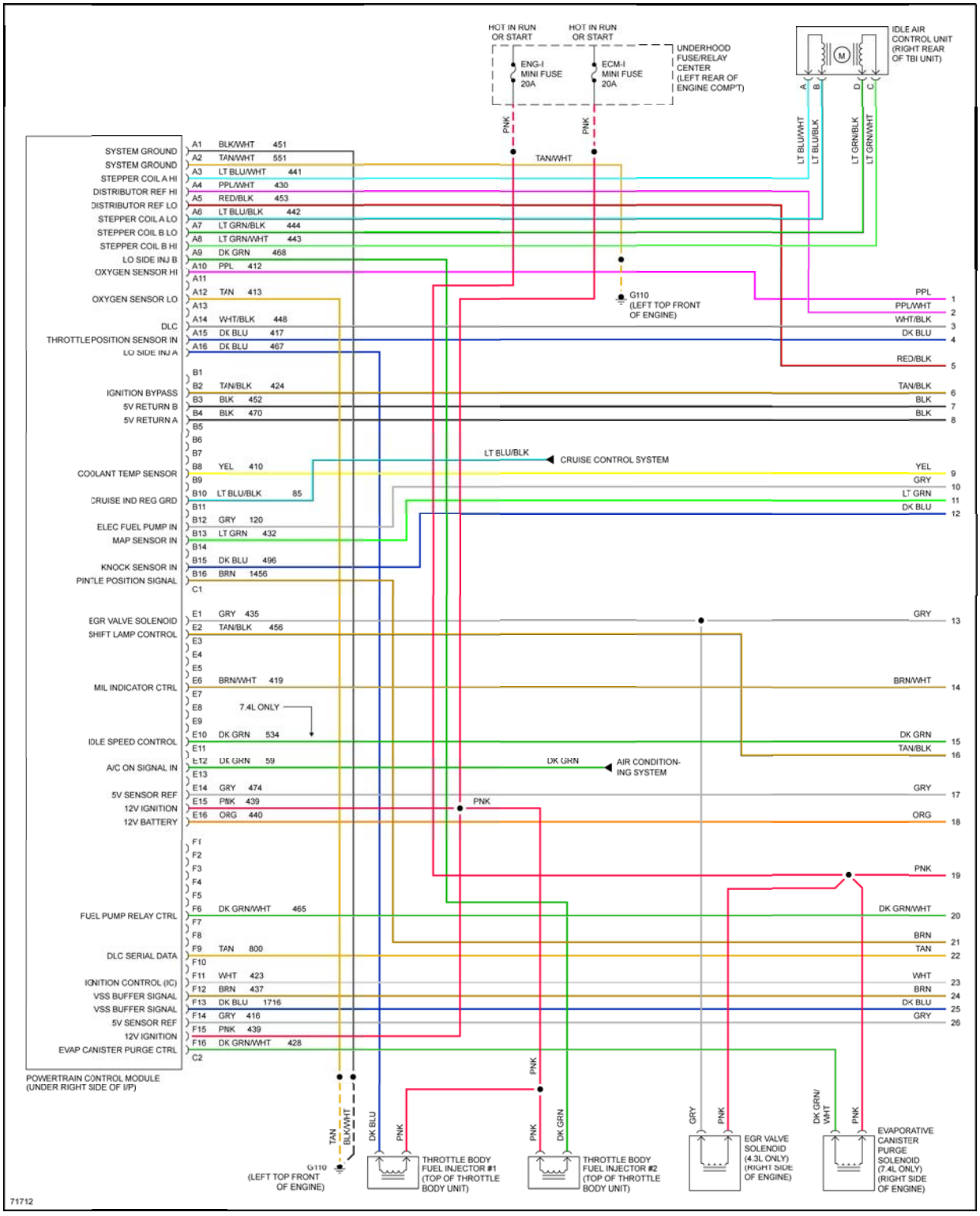


Fig. 40: Wiring Diagram ("C" & "K" Series Pickup & Sierra - 4.3L With M/T - 1 Of 3)

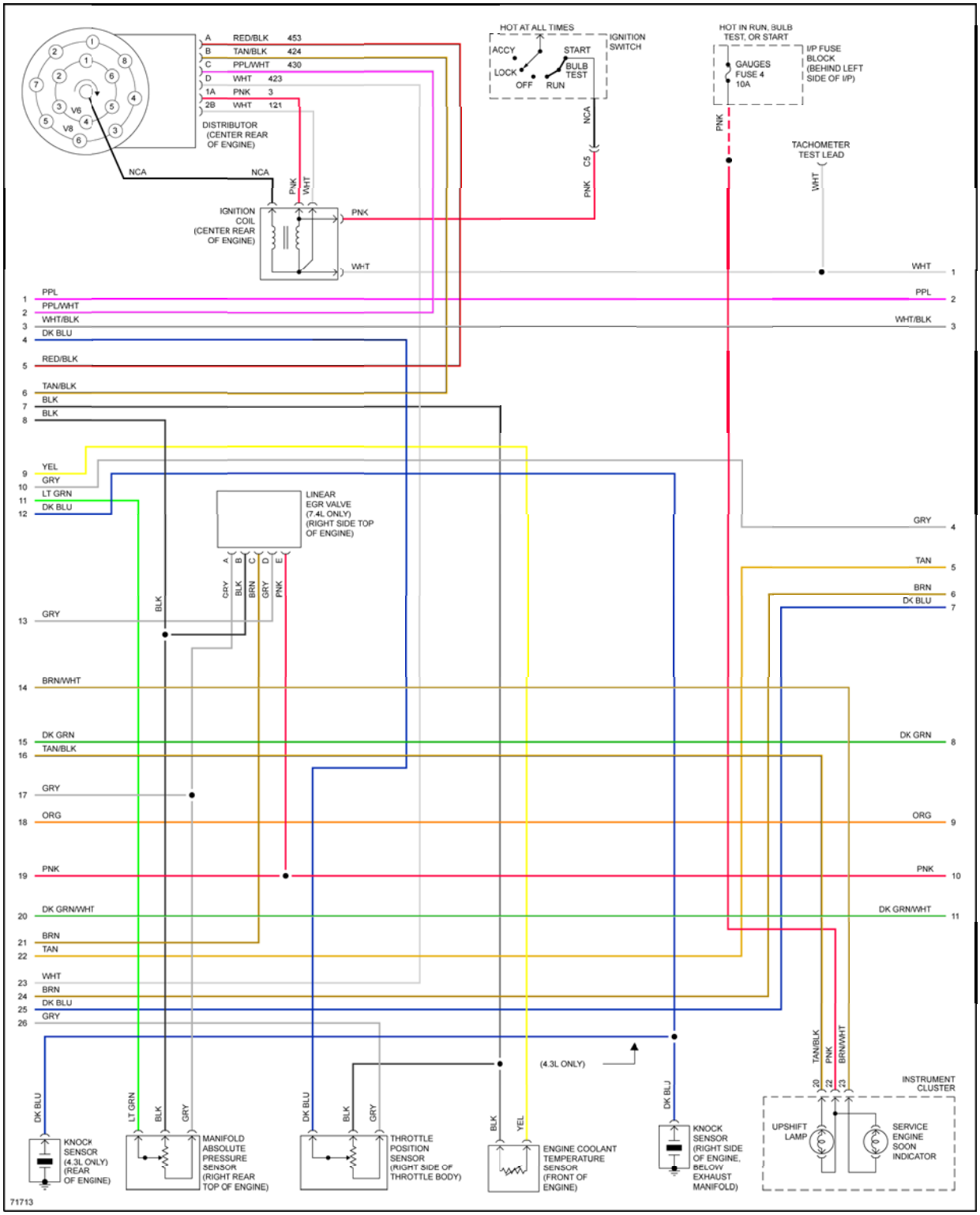


Fig. 41: Wiring Diagram ("C" & "K" Series Pickup & Sierra - 4.3L With M/T - 2 Of 3)

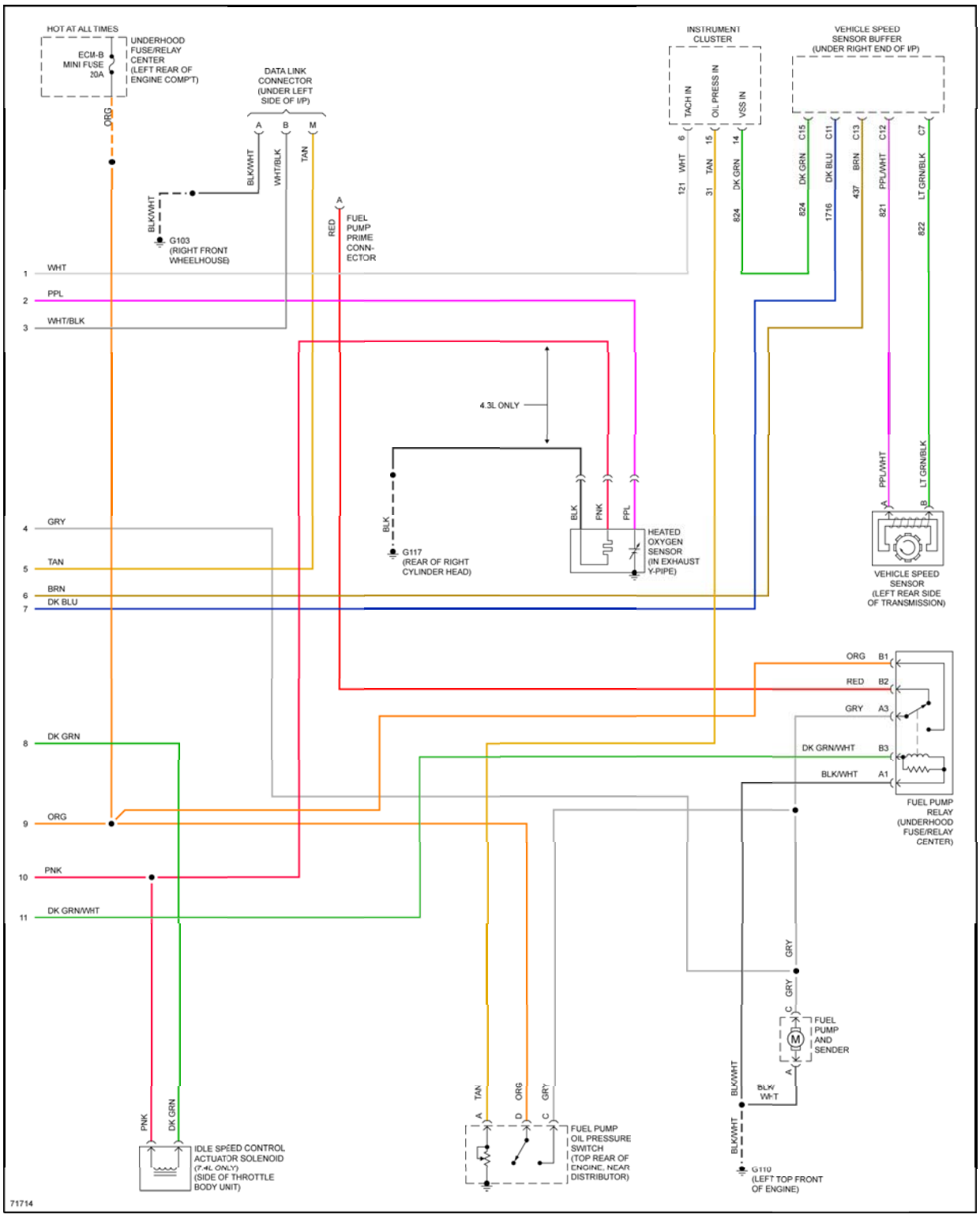


Fig. 42: Wiring Diagram ("C" & "K" Series Pickup & Sierra - 4.3L With M/T - 3 Of 3)

"P" SERIES - WITH M/T

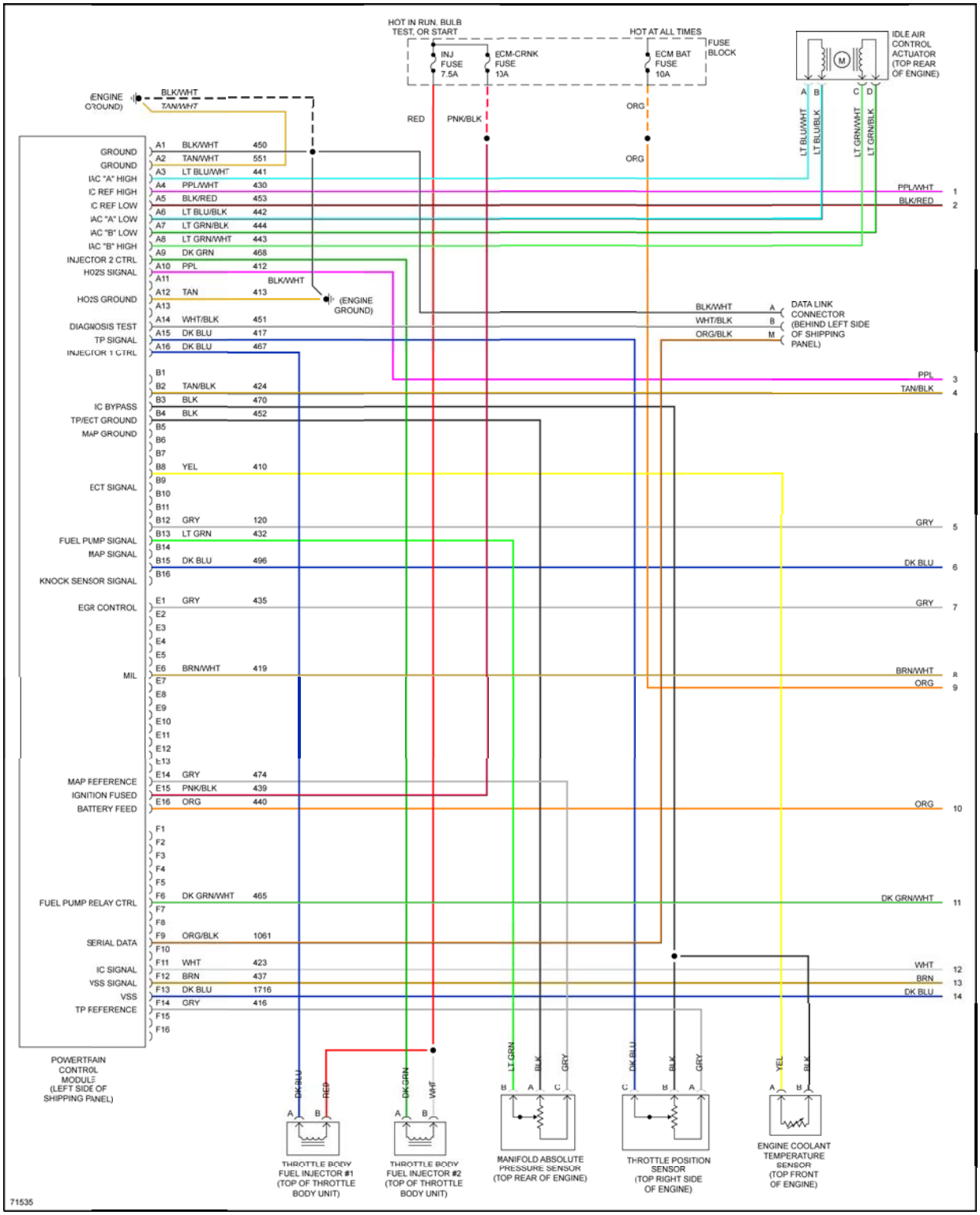


Fig. 43: Wiring Diagram ("P" Series - 4.3L With M/T - 1 Of 2)

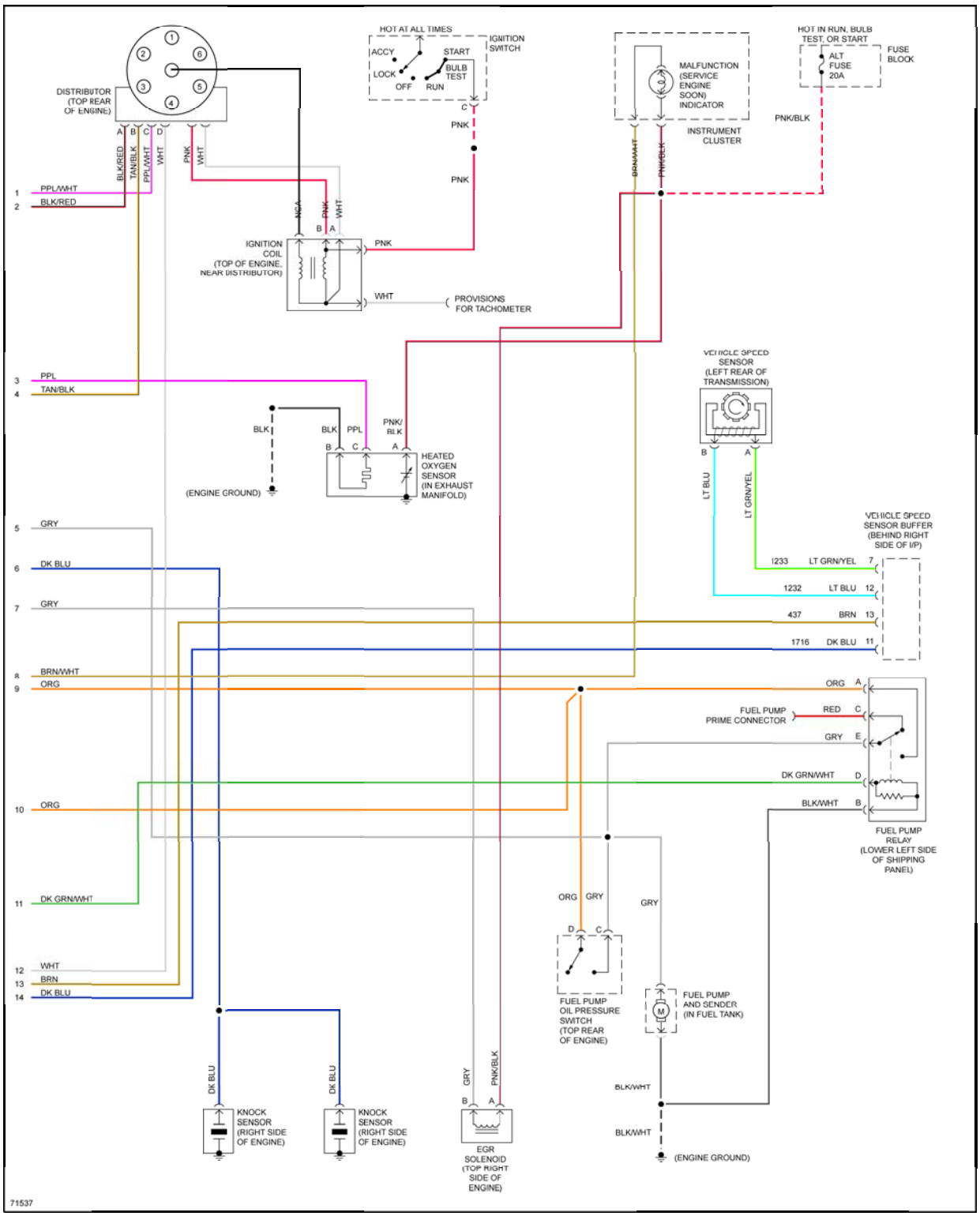


Fig. 44: Wiring Diagram ("P" Series - 4.3L With M/T - 2 Of 2)

"P" SERIES - COMMERCIAL VAN/MOTORHOME - WITH 4L80-E

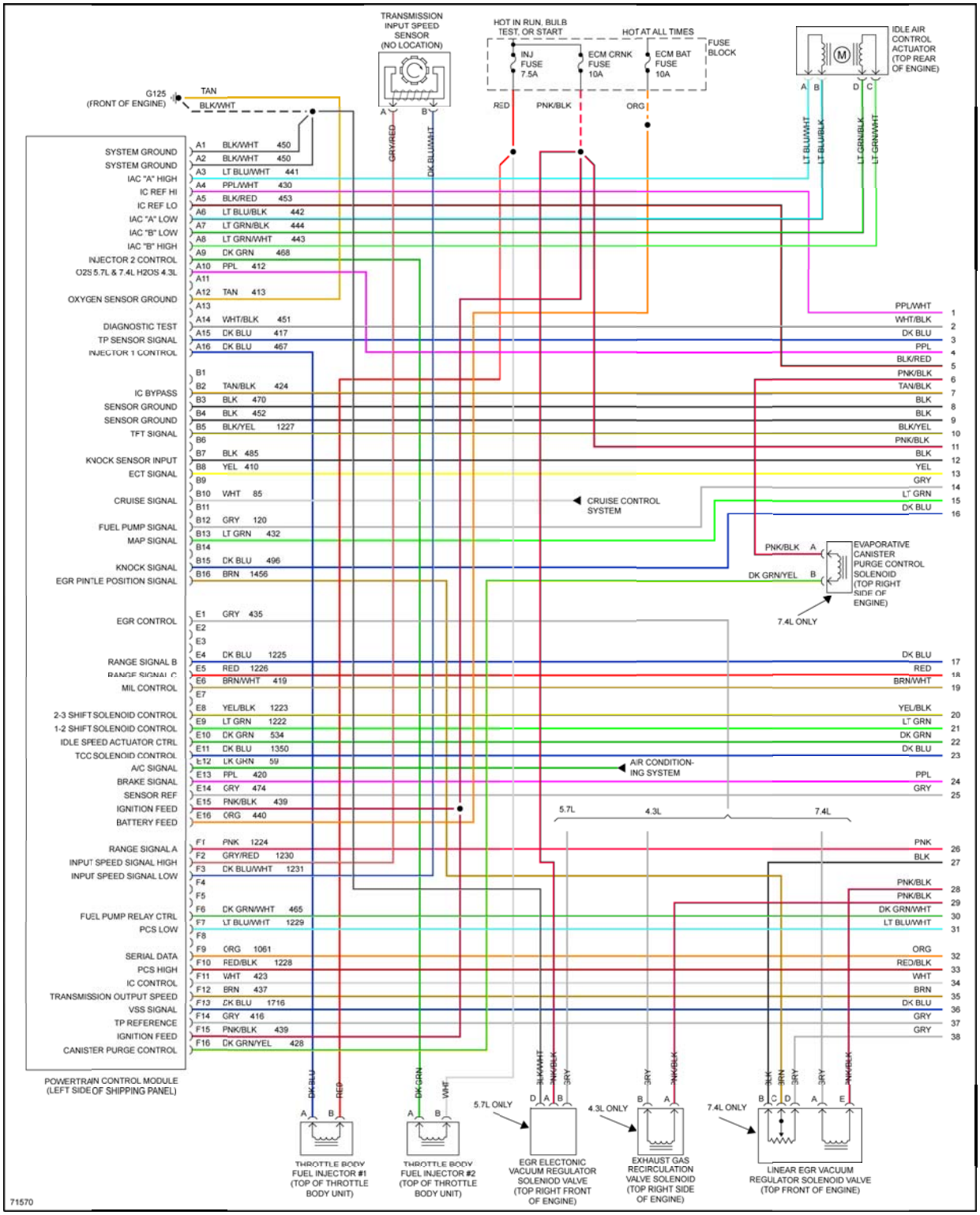


Fig. 45: Wiring Diagram ("P" Series - Commercial Van/Motorhome - 4.3L With 4L80-E - 1 Of 3)

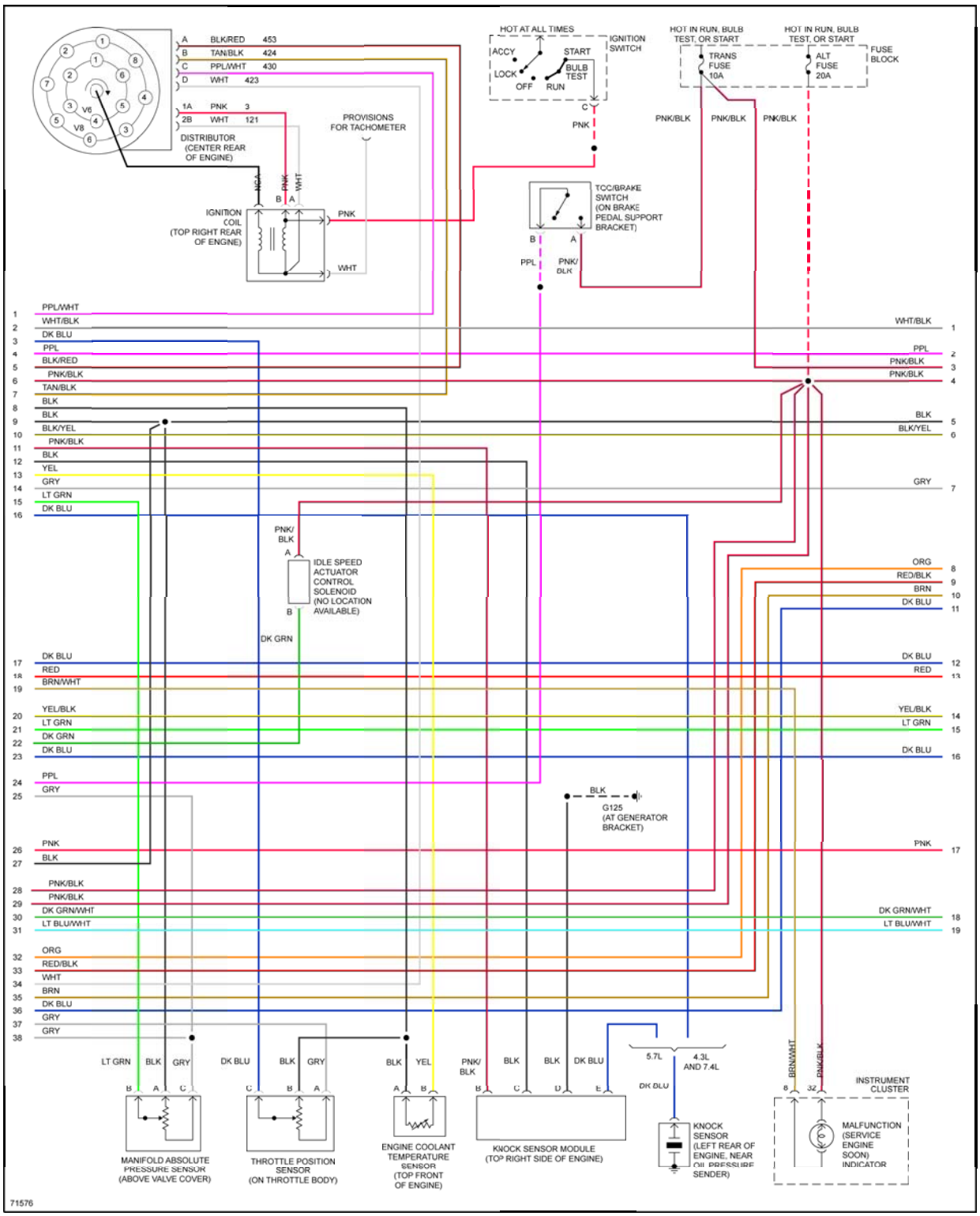


Fig. 46: Wiring Diagram ("P" Series - Commercial Van/Motorhome - 4.3L With 4L80-E - 2 Of 3)

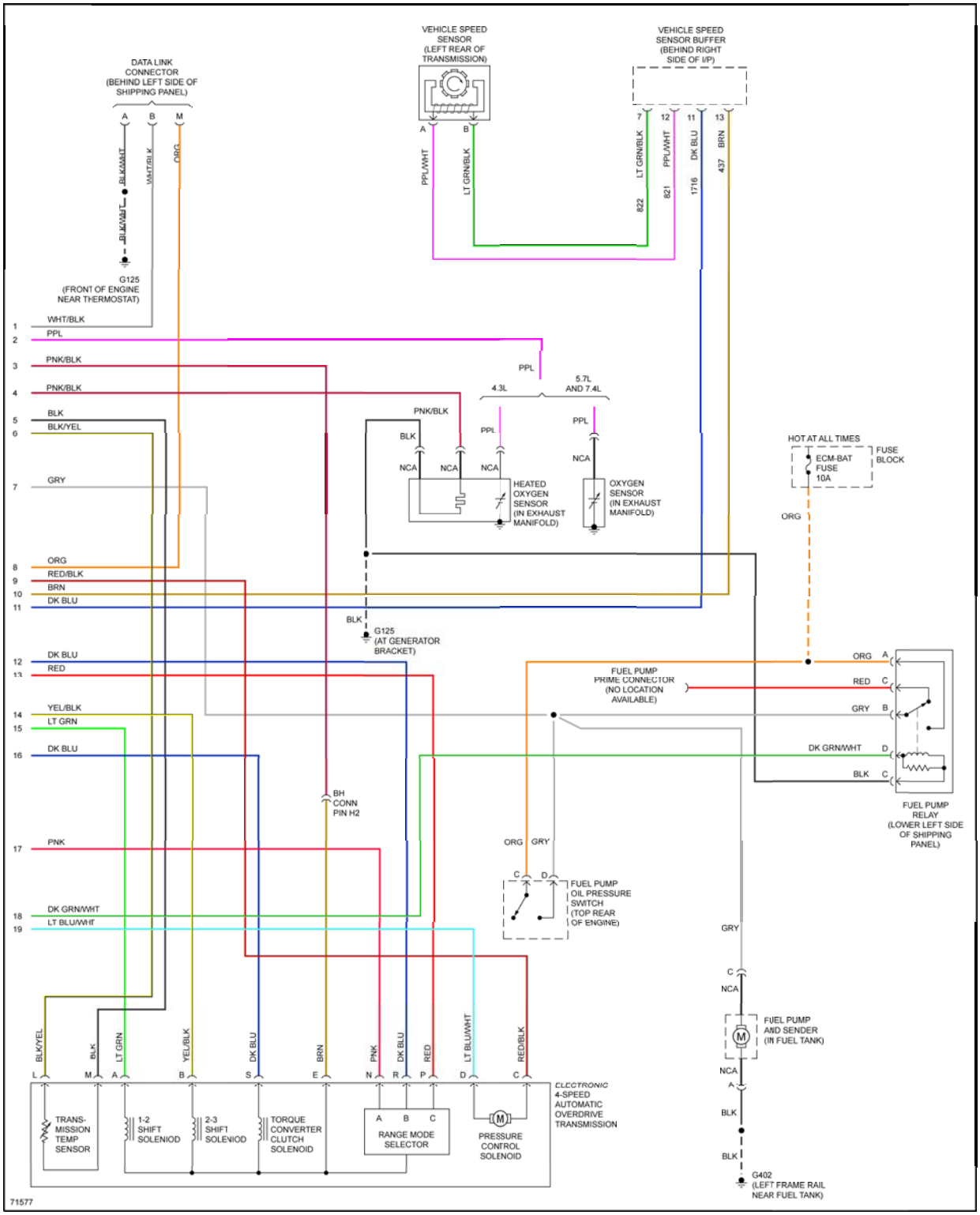


Fig. 47: Wiring Diagram ("P" Series - Commercial Van/Motorhome - 4.3L With 4L80-E - 3 Of 3)

"S" & "T" BLAZER, JIMMY, PICKUP & SONOMA - VIN W W/PCM

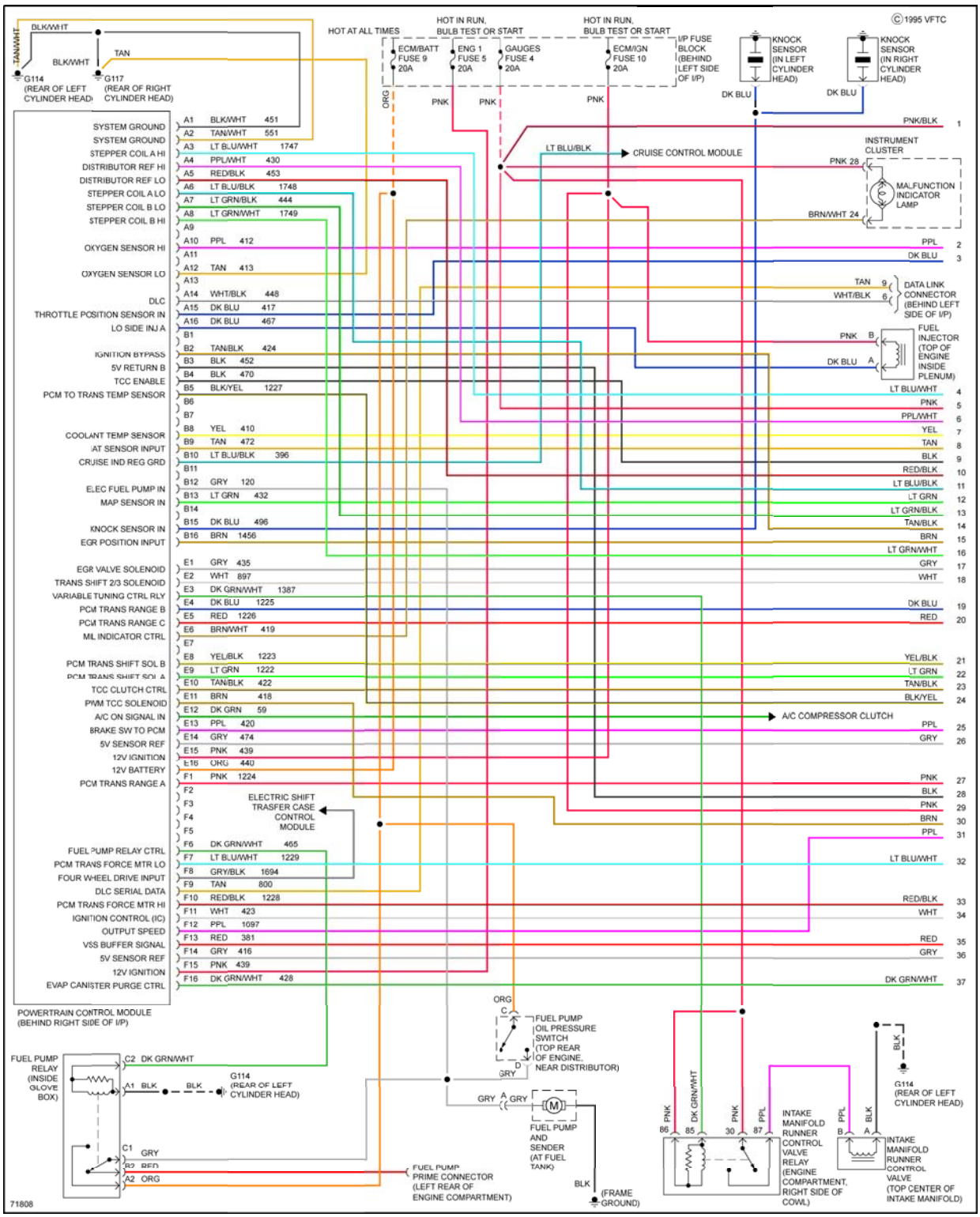


Fig. 48: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN W W/PCM - 1 Of 2)

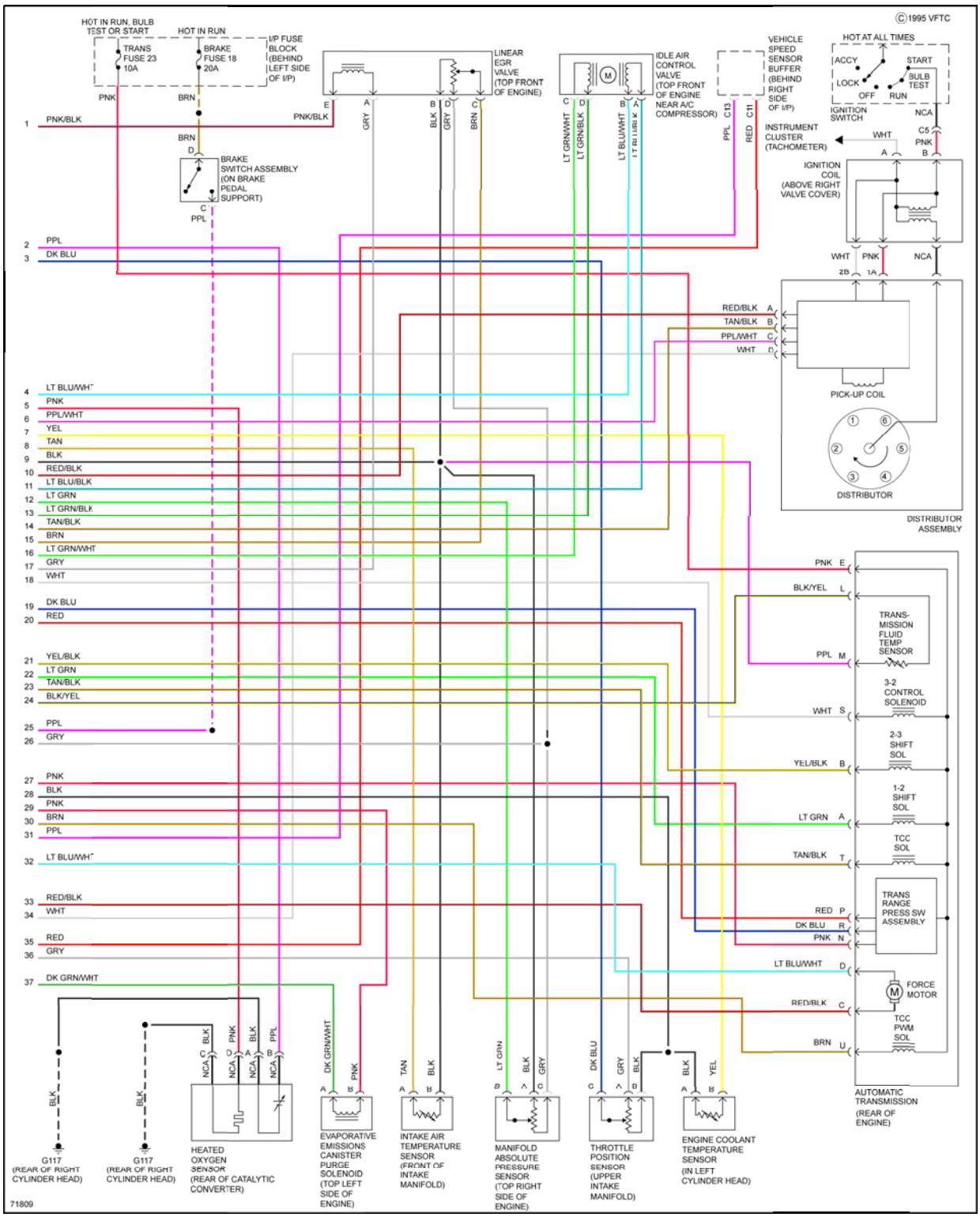


Fig. 49: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN W W/PCM - 2 Of 2)

"S" & "T" BLAZER, JIMMY, PICKUP & SONOMA - VIN W W/VCM

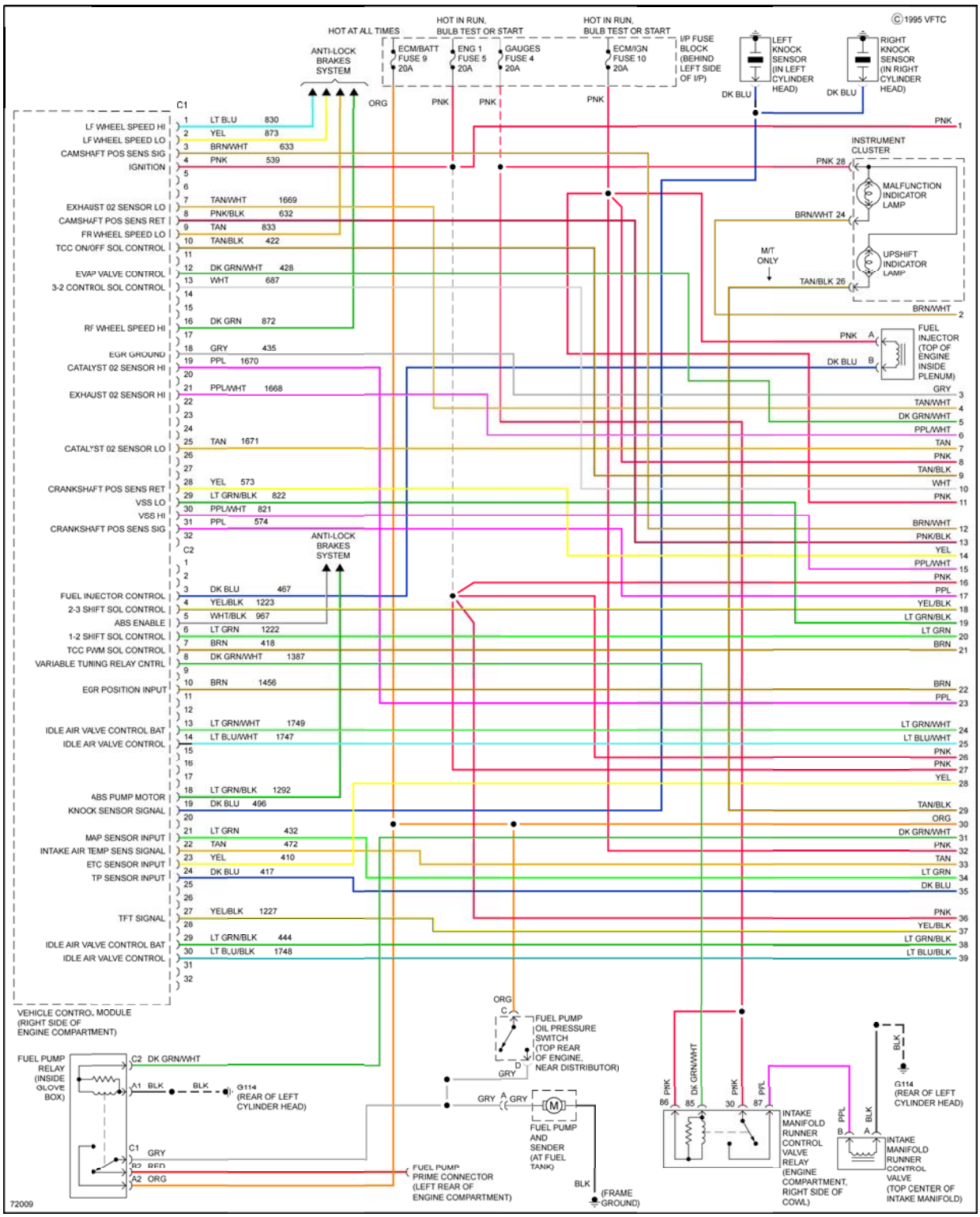


Fig. 50: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN W W/VCM - 1 Of 3)

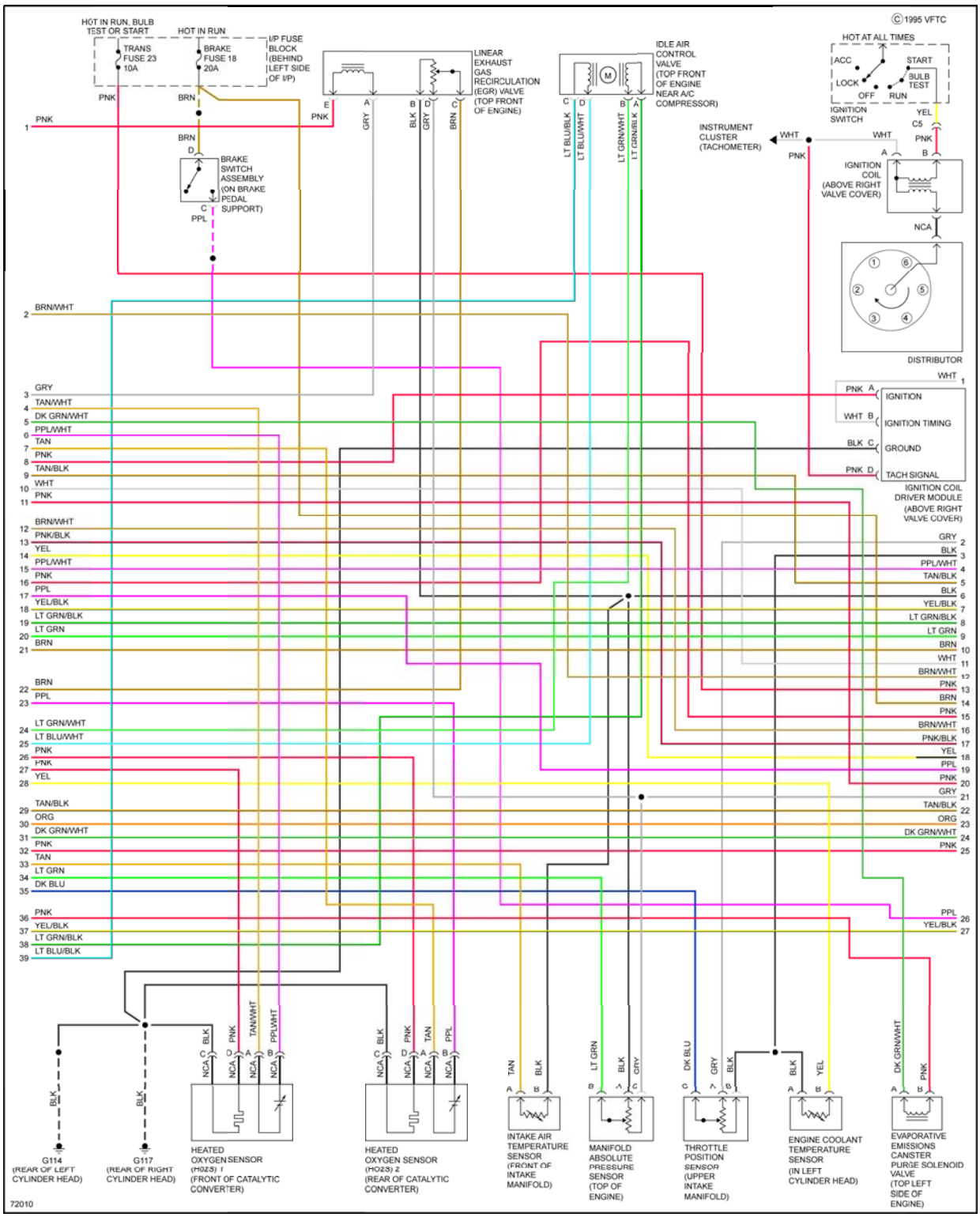


Fig. 51: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN W W/VCM - 2 Of 3)

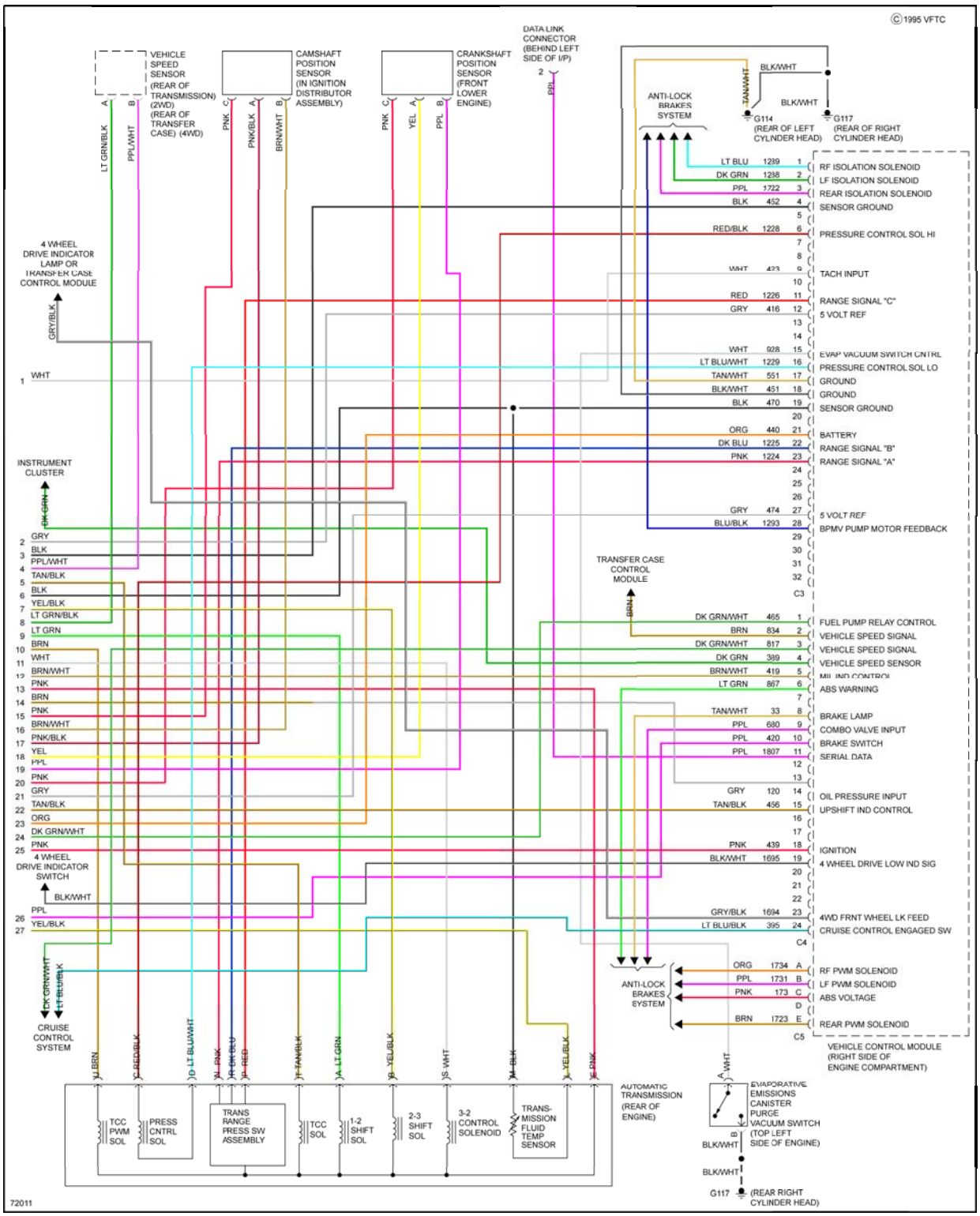


Fig. 52: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN W W/VCM - 3 Of 3)

"S" & "T" BLAZER, JIMMY, PICKUP & SONOMA - VIN Z W/PCM

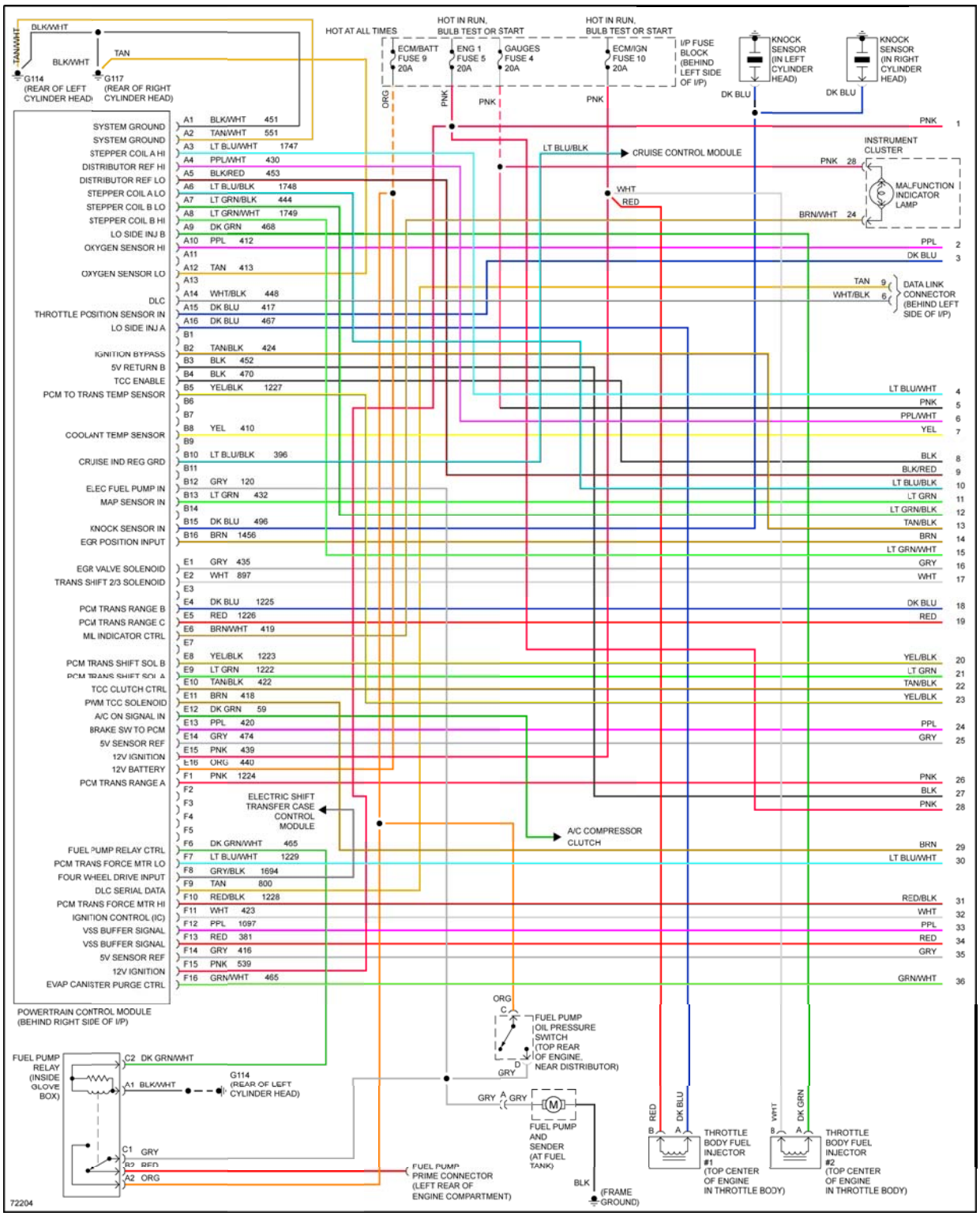


Fig. 53: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN Z W/PCM - 1 Of 2)

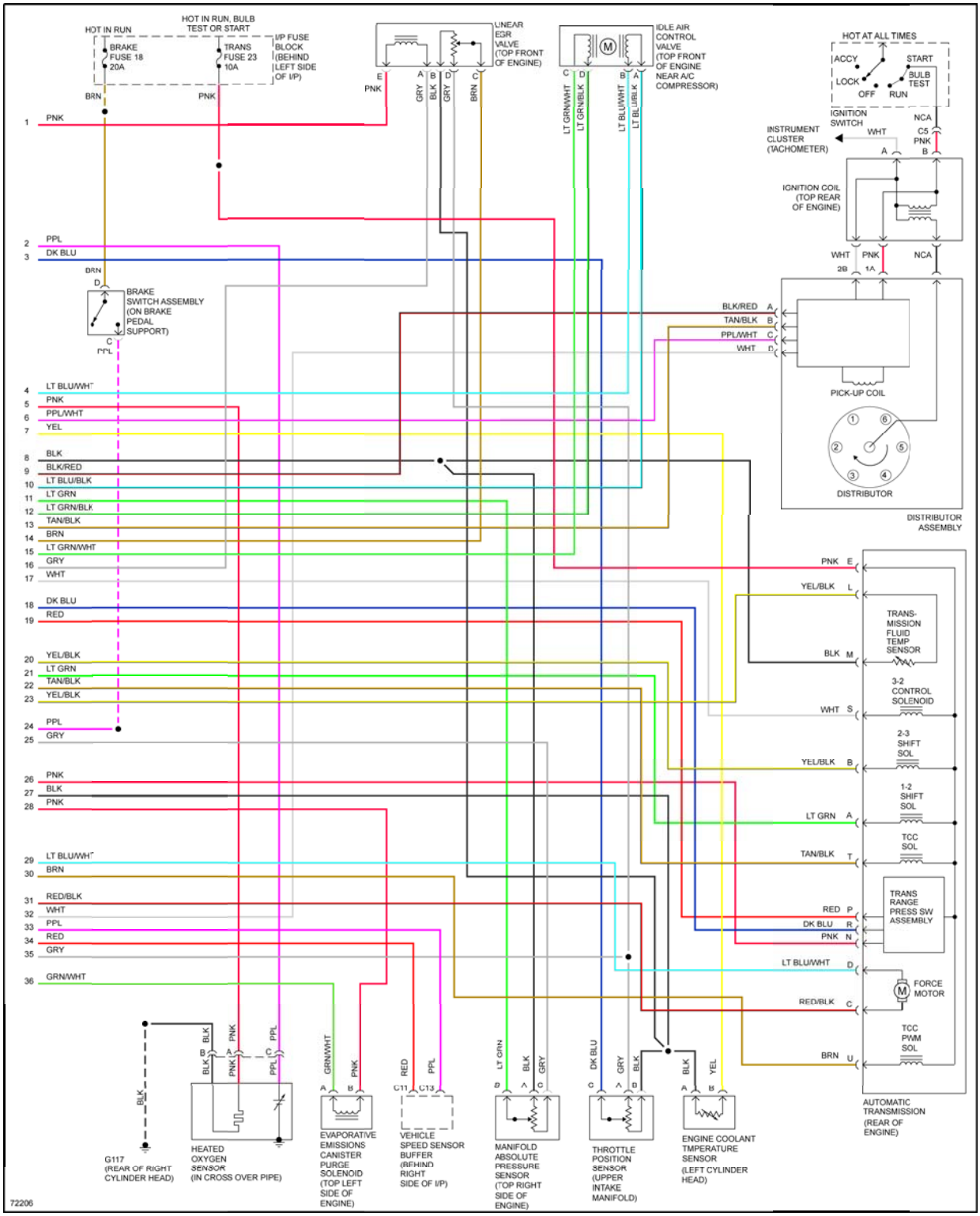


Fig. 54: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN Z W/PCM - 2 Of 2)

"S" & "T" BLAZER, JIMMY, PICKUP & SONOMA - VIN Z W/VCM

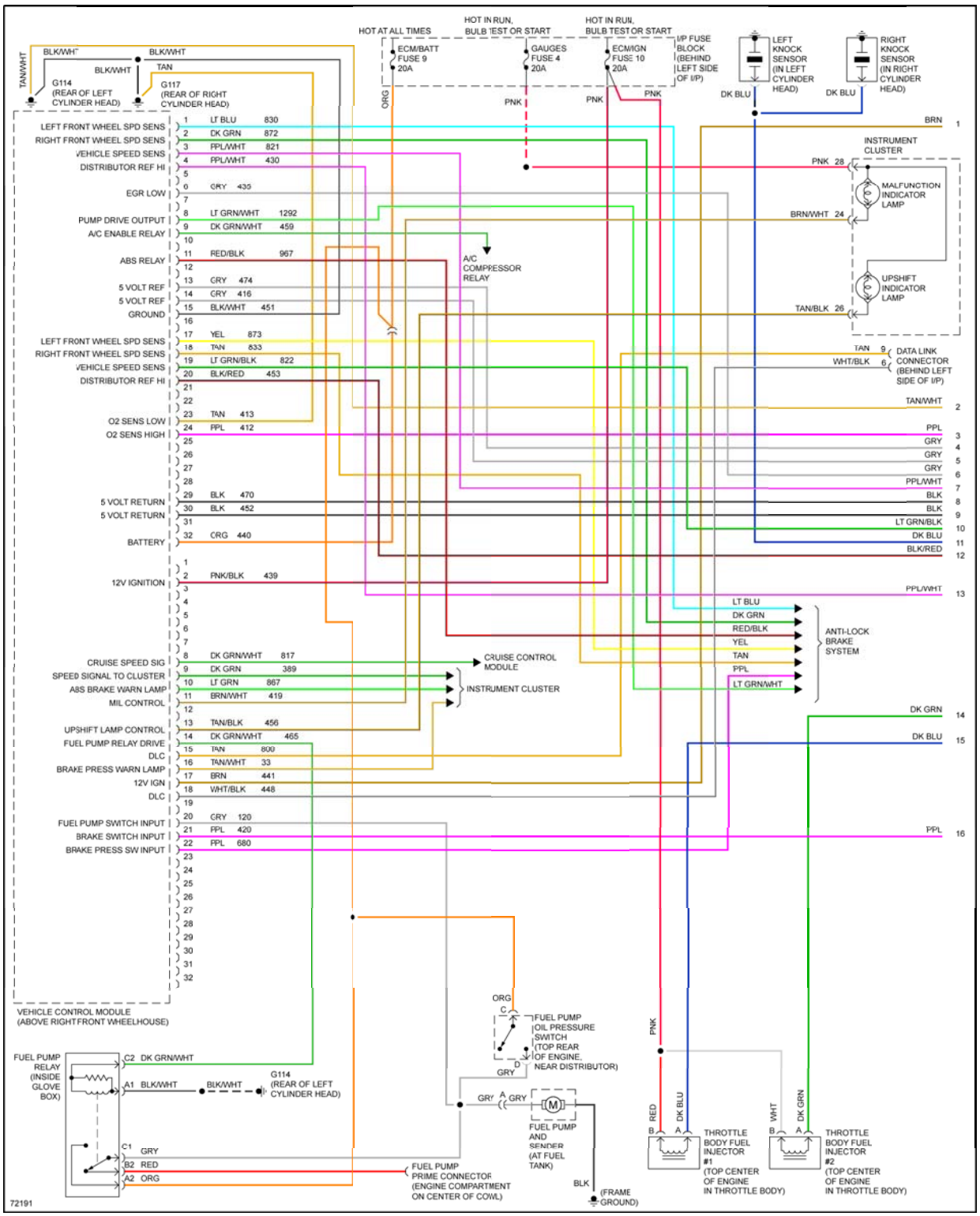


Fig. 55: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN Z W/VCM - 1 Of 2)

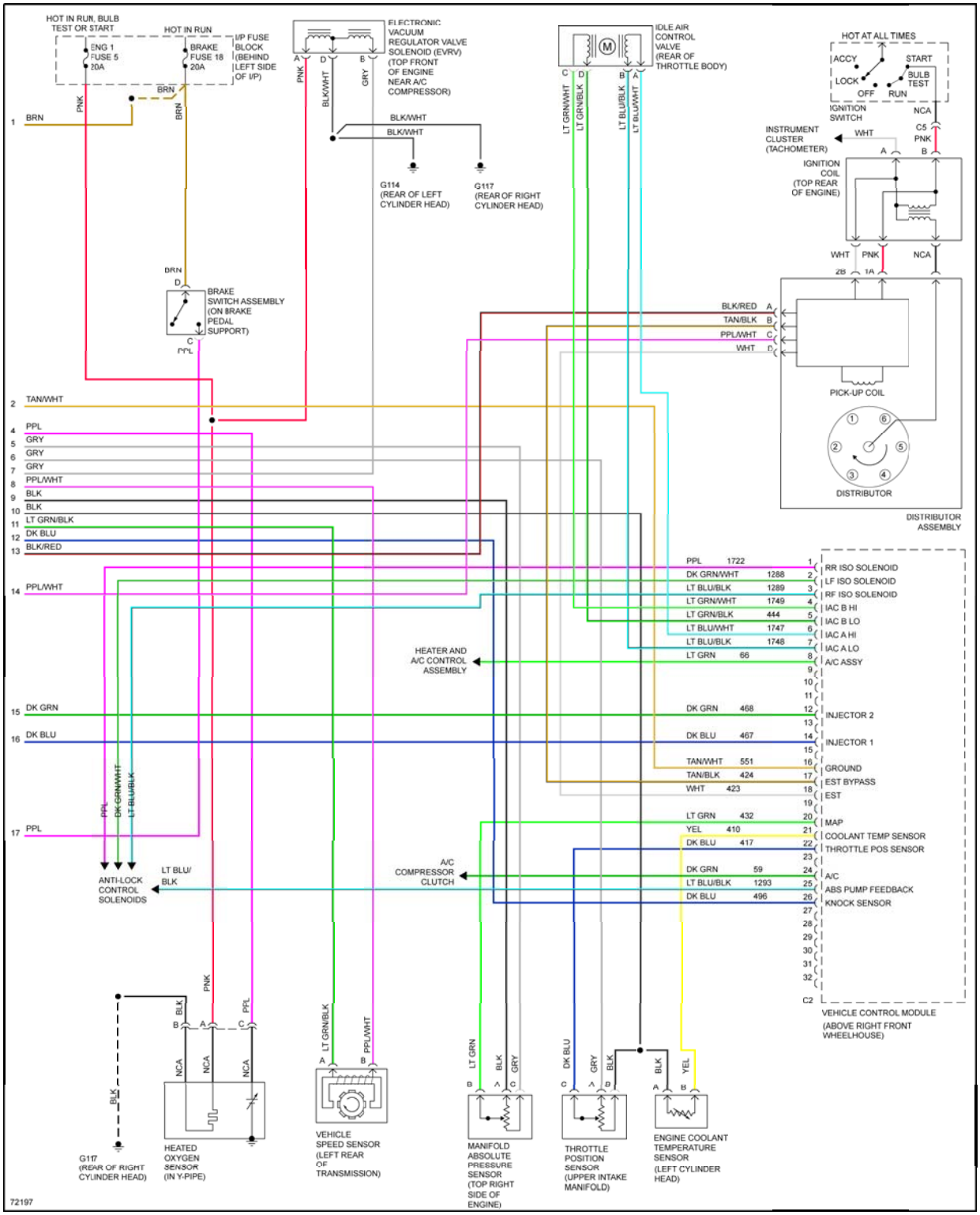


Fig. 56: Wiring Diagram ("S" & "T" Blazer, Jimmy, Pickup & Sonoma - 4.3L VIN Z W/VCM - 2 Of 2)

VAN - WITH 4L60-E

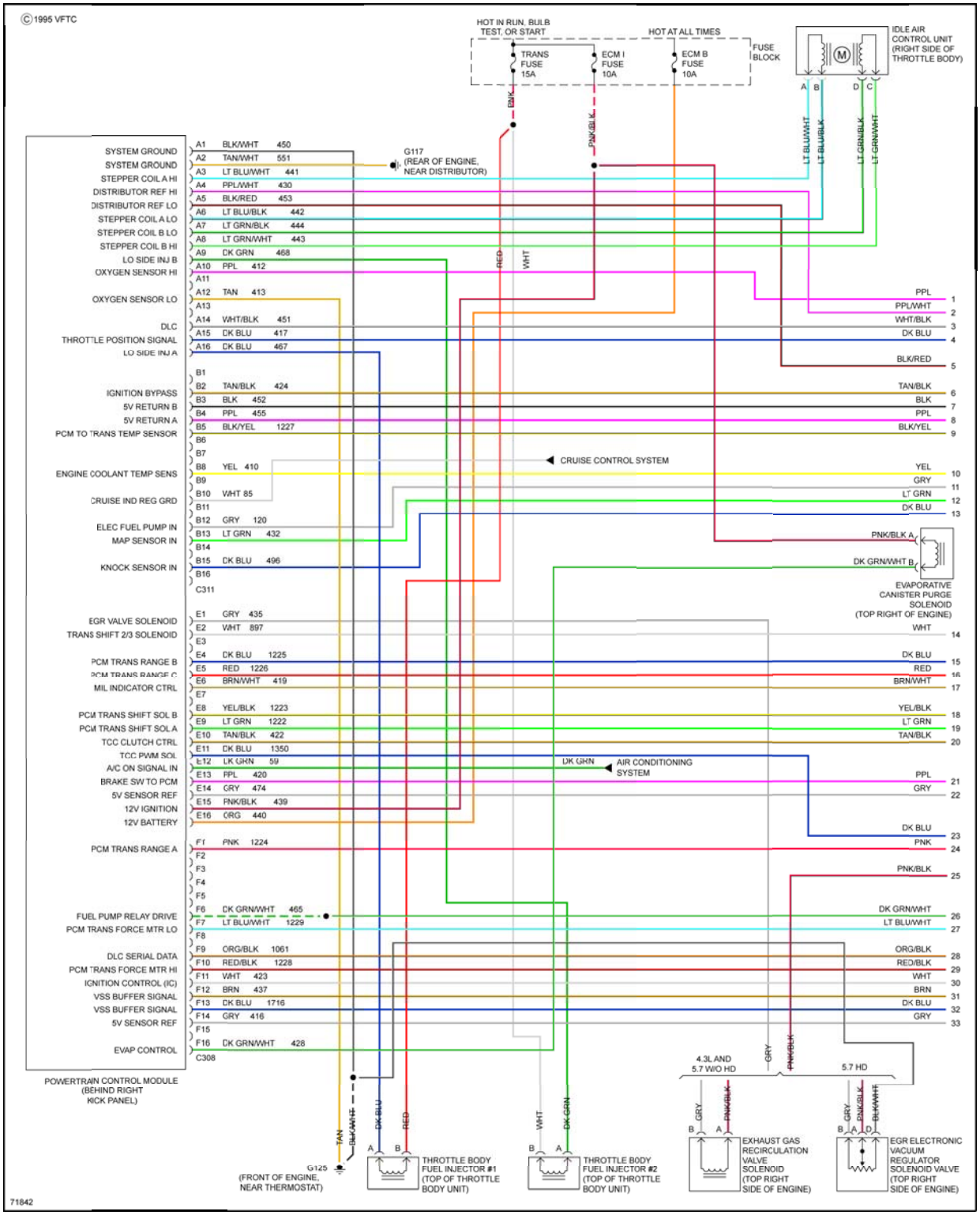


Fig. 57: Wiring Diagram (Van - 4.3L With 4L60-E - 1 Of 3)

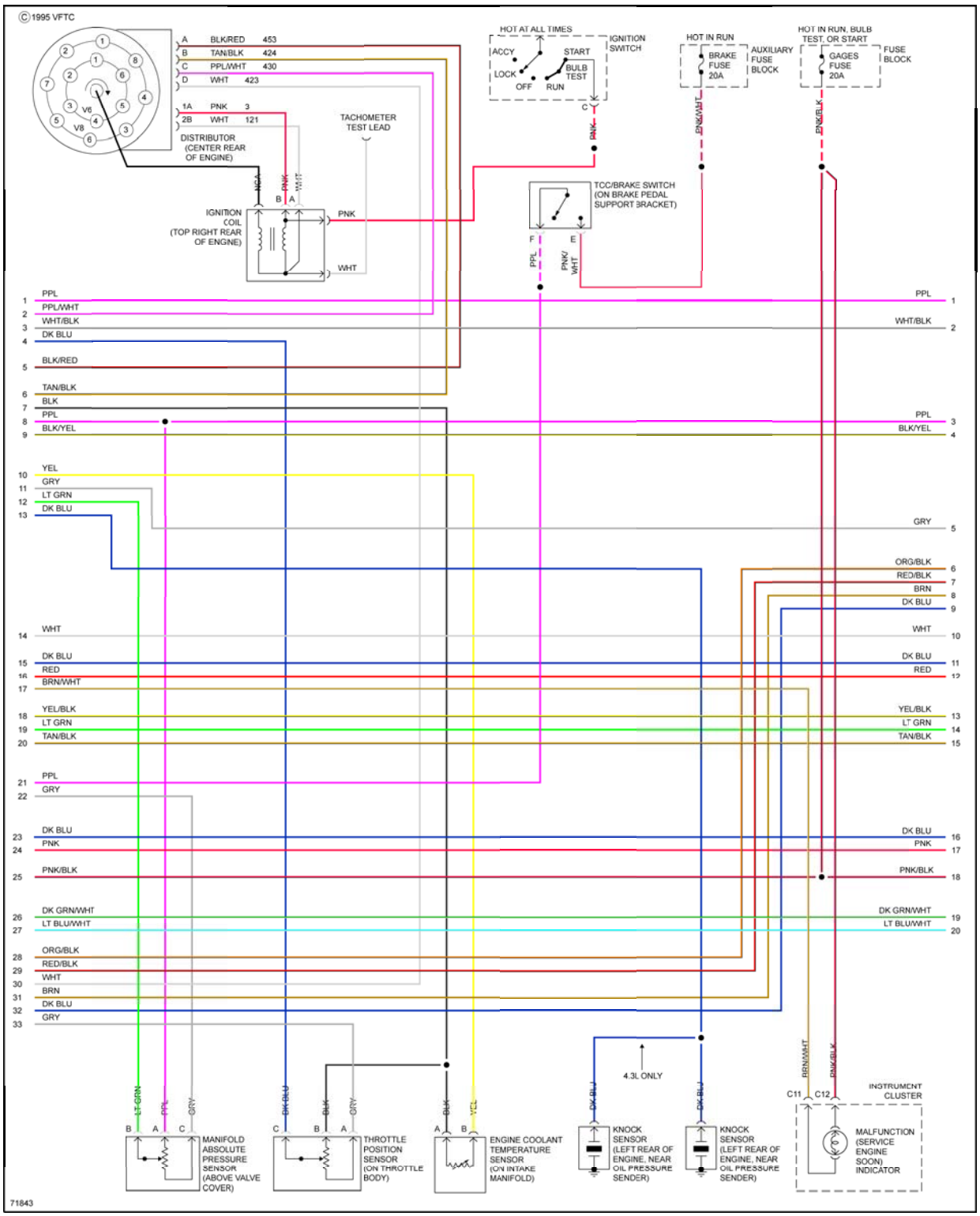


Fig. 58: Wiring Diagram (Van - 4.3L With 4L60-E - 2 Of 3)

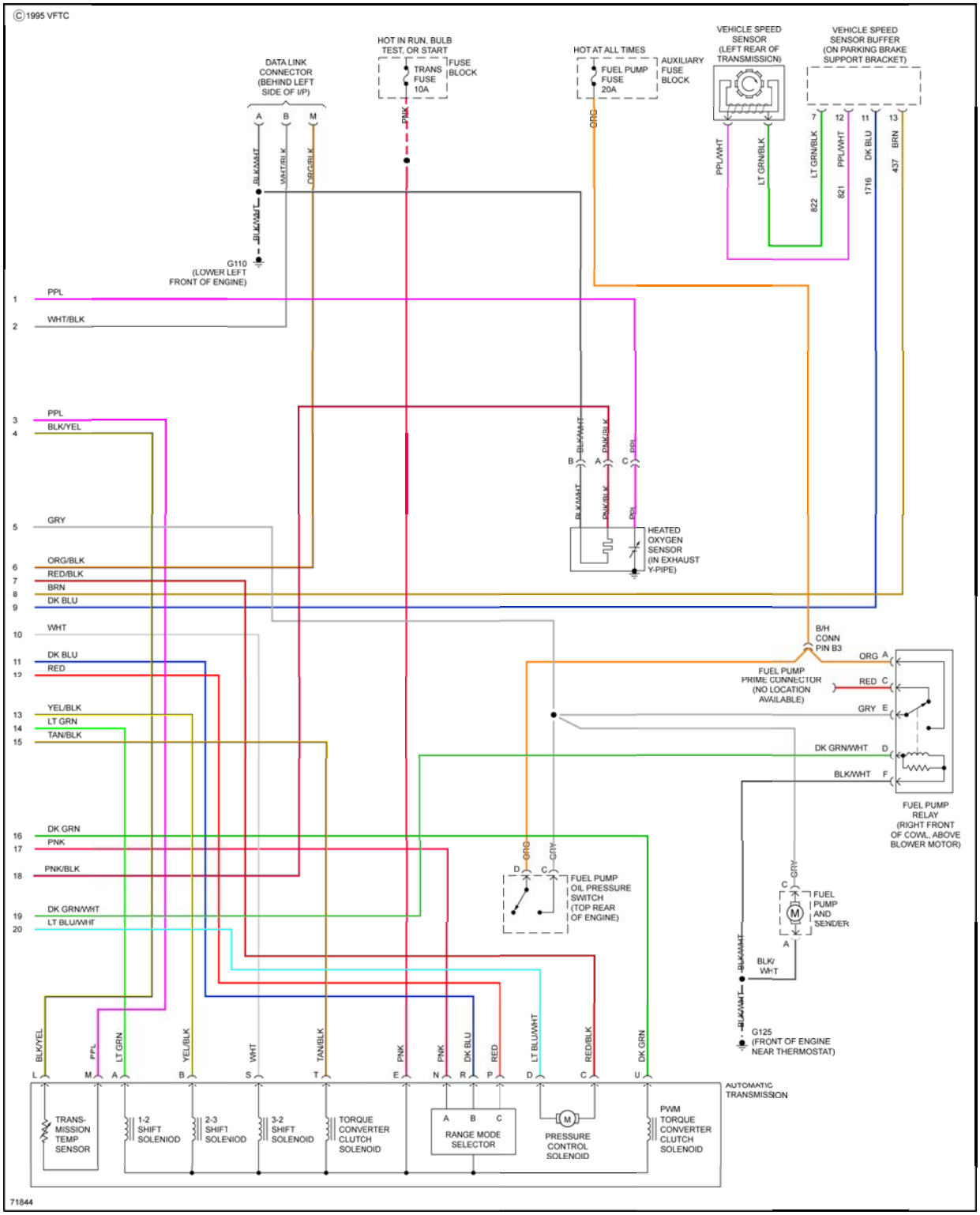


Fig. 59: Wiring Diagram (Van - 4.3L With 4L60-E - 3 Of 3)

VAN - WITH 4L80-E

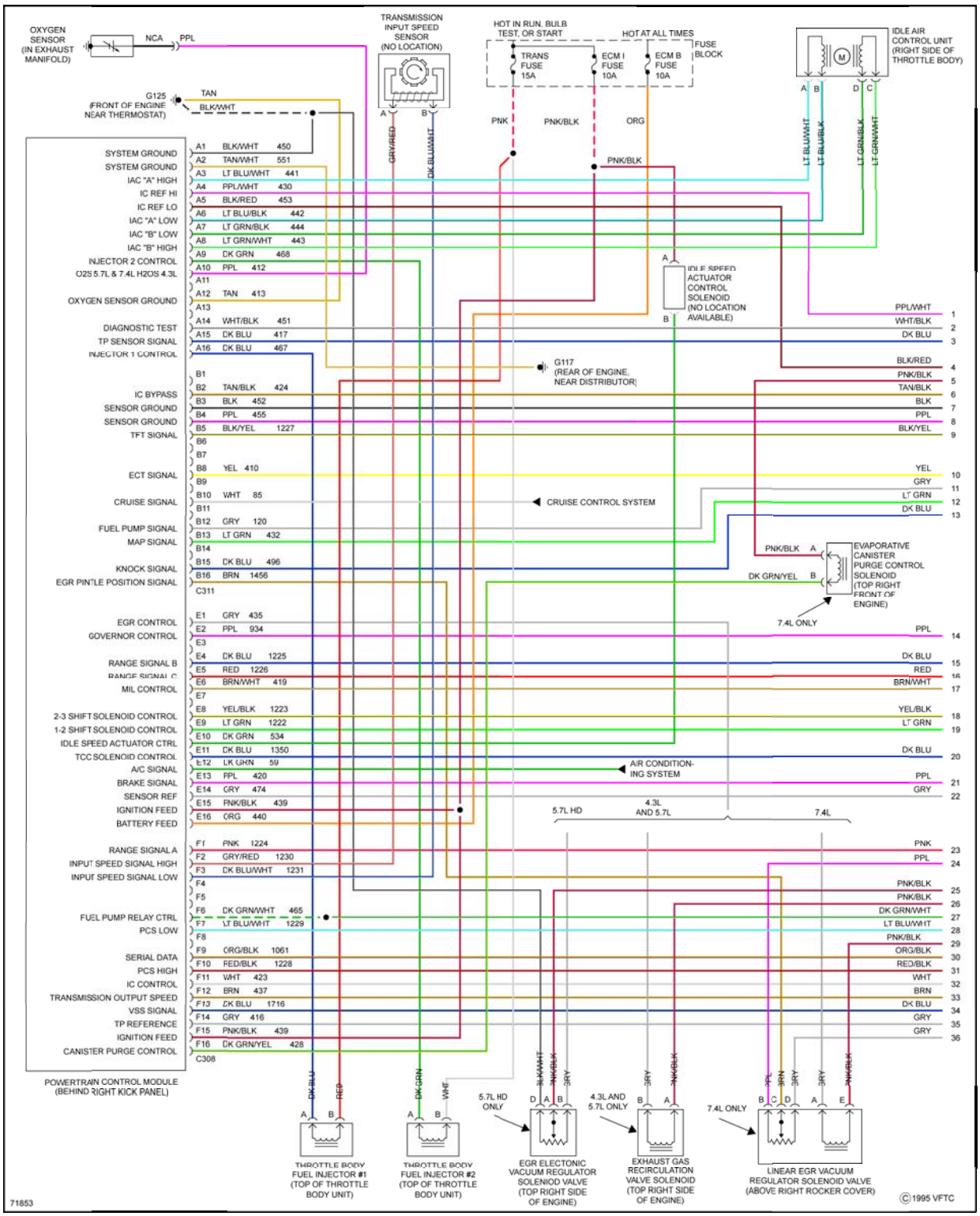


Fig. 60: Wiring Diagram (Van - 4.3L With 4L80-E - 1 Of 3)

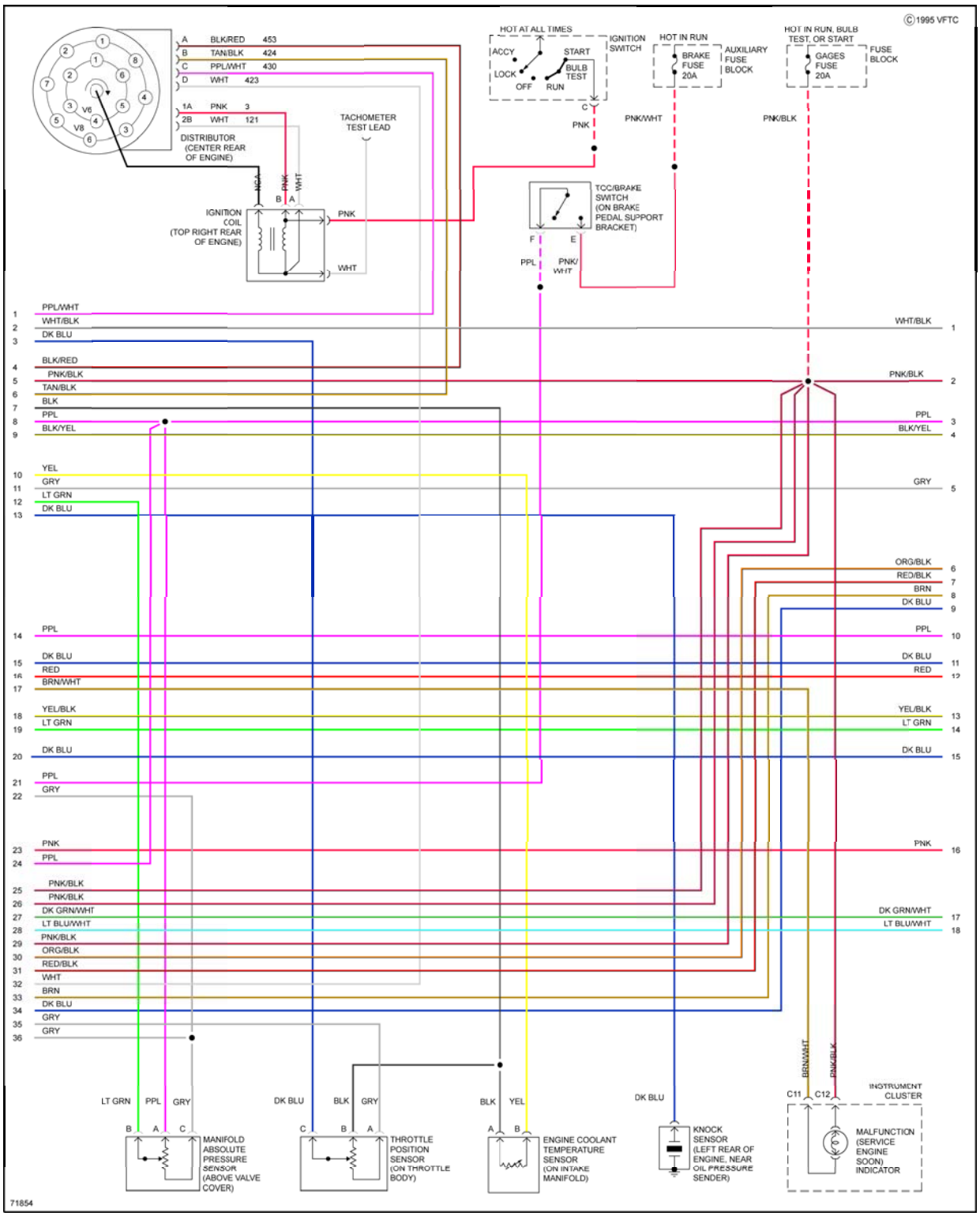


Fig. 61: Wiring Diagram (Van - 4.3L With 4L80-E - 2 Of 3)

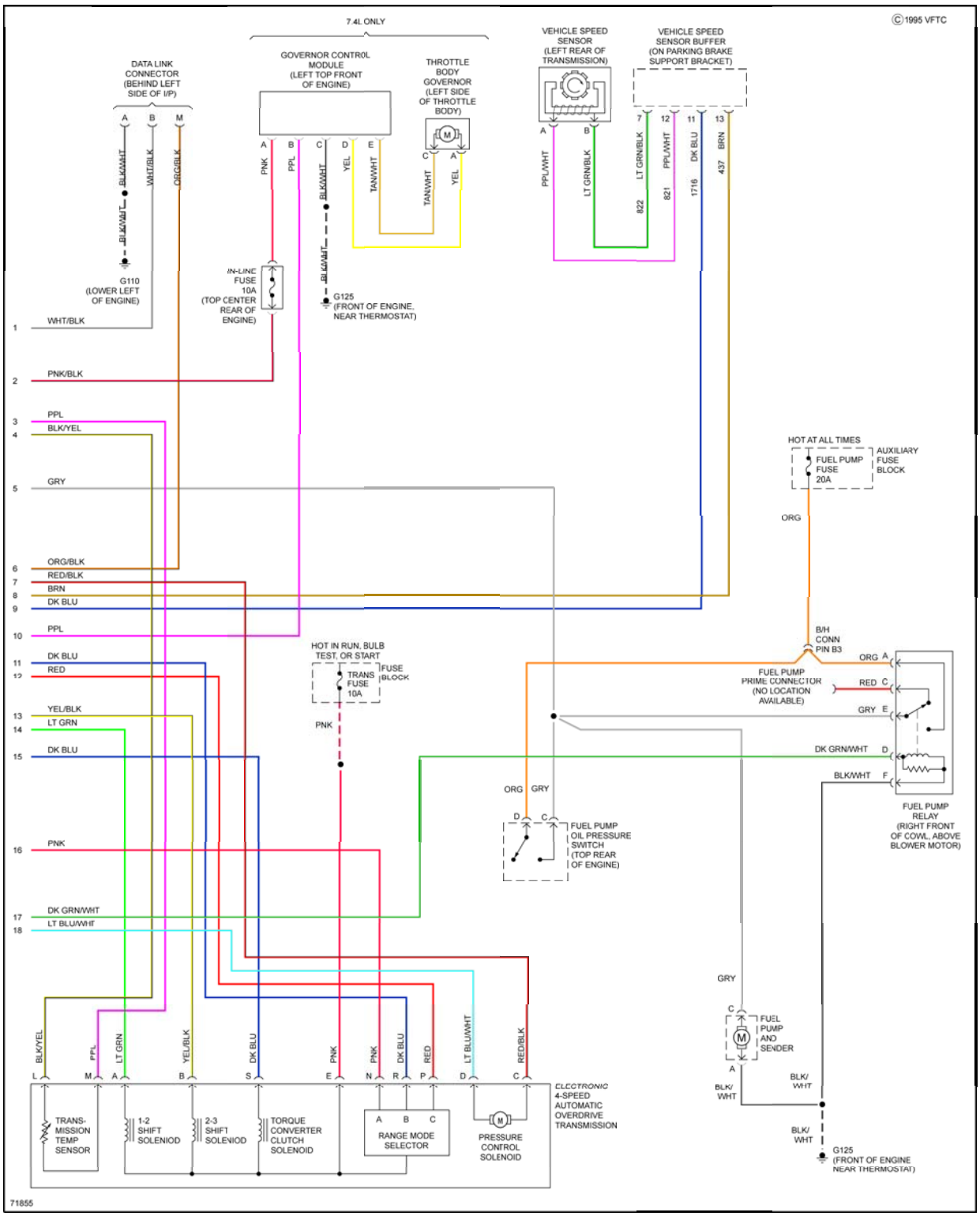


Fig. 62: Wiring Diagram (Van - 4.3L With 4L80-E - 3 Of 3)

I - SYSTEM/COMPONENT TESTS - 5.7L

ENGINE PERFORMANCE General Motors Corp. System & Component Testing - 5.7L

INTRODUCTION

Before testing separate components or systems, perform all procedures listed in **BASIC TESTING** article in the ENGINE PERFORMANCE section. Since many computer-controlled and monitored components will set a diagnostic trouble code if they malfunction, it is also recommended that self-diagnosis be performed. See appropriate **TESTS W/CODES - 5.7L** article in the ENGINE PERFORMANCE section.

NOTE: Testing individual components does not isolate shorts or opens. Perform all voltage tests with a Digital Volt-Ohmmeter (DVOM) with a minimum 10-megohm input impedance, unless stated otherwise in test procedure. Use ohmmeter to isolate wiring harness shorts or opens. The following table provides the location of commonly used diagnostic information. These former "A" and "C" charts are now written in text and inserted into the appropriate location in the new Engine Performance workflow. To familiarize yourself with the Engine Performance workflow, see AA - HOW TO USE THE ENGINE PERFORMANCE SECTION article in GENERAL INFORMATION section.

GENERAL MOTORS A & C CHART REFERENCE

System Or Component	Diagnostic Information Location
A-1 & A-2, MALFUNCTION INDICATOR LIGHT (MIL)	(1) See DIAGNOSTIC CIRCUIT CHECK
A-3, No Start	(1) See NO START - ENGINE CRANKS OKAY
A-5, Fuel Pump Relay	See FUEL SYSTEM in this article
A-7, Fuel System Diagnosis	(1) See BASIC FUEL SYSTEM CHECKS
C-1, ECM/PCM Replacement Check	(1) See ECM/PCM REPLACEMENT CHECK
C-1, MAP Sensor	See ENGINE SENSORS & SWITCHES in this article
C-1, Power Steering Pressure Switch	See ENGINE SENSORS & SWITCHES in this article
C-1, Park/Neutral Position Switch	See ENGINE SENSORS & SWITCHES in this article
C-2, Injector Balance Test	See FUEL SYSTEM in this article
C-2, Injector Coil Test	See FUEL SYSTEM in this article
C-2, Injector Leak Test	See FUEL SYSTEM in this article
C-2, IAC Motor	See IDLE CONTROL SYSTEM in this article
C-2, ISC Motor	See IDLE CONTROL SYSTEM in this article
C-3, Canister Purge System (Fuel Evaporation Control)	See EMISSION SYSTEMS & SUB-SYSTEMS in this article
C-4, EST Ignition Check	See BASIC IGNITION SYSTEM CHECKS in this article
C-5, KS Ignition Check	See IGNITION SYSTEM in this article
C-6, Air Injection System	See EMISSION SYSTEMS & SUB-SYSTEMS in this article
C-7, EGR System	See EMISSION SYSTEMS & SUB-SYSTEMS in this article

C-8, Manual Transmission Shift Lights (Transmission)	See MISCELLANEOUS CONTROLS in this article
C-8, Torque Converter Clutch (Transmission)	(2) See MISCELLANEOUS CONTROLS in this article
C-10, A/C Clutch Control	See MISCELLANEOUS CONTROLS in this article
C-12, Electric Cooling Fan Control	See MISCELLANEOUS CONTROLS in this article
C-16, Engine Coolant Level Switch	See ENGINE SENSORS & SWITCHES in this article
C-16, Fuel Pump/Oil Pressure Switch	See ENGINE SENSORS & SWITCHES in this article
C-16, Oil Level Switch	See ENGINE SENSORS & SWITCHES in this article
C-18, Supercharger Boost Control	See AIR INDUCTION SYSTEMS in this article
(1) See **BASIC TESTING** article in the ENGINE PERFORMANCE section. (2) Covered in entirety in appropriate TRANSMISSION SERVICING & REPAIR manual.	

COMPUTERIZED ENGINE CONTROLS

CONTROL UNIT

Ground Circuits

1. Using an ohmmeter, check for continuity to ground on control unit ground terminals. Use appropriate wiring diagram in WIRING DIAGRAMS section to determine PCM ground terminals. Resistance to ground should be zero ohms. If reading is other than zero ohms, repair open to circuit ground.
2. Using a DVOM, touch negative lead of voltmeter to a good ground. Touch positive lead of voltmeter to each ground terminal. With vehicle running, voltmeter should indicate less than one volt. If voltmeter reading is one volt or more, check for open, corroded or loose connection on ground lead.

Power Circuits

1. Using a voltmeter, check for battery voltage between control unit constant battery power terminals and ground. If battery voltage is not present, check control unit power supply fuse. If fuse is okay, check for open in power supply or control unit wiring.
2. Turn ignition switch to the ON position. Using a voltmeter, check for battery voltage between control unit ignition power terminals and ground. If battery voltage is not present, check power supply fuse(s). If fuse is okay, check for an open in wiring between fuse and control unit, or check for a defective ignition switch.
3. Connect voltmeter between ground and control unit start (crank) signal terminal. Turn ignition switch to the START position. Battery voltage should be present between control unit start terminal and ground ONLY when ignition switch is in the START position.
4. If voltage is not present, check fuse(s). If fuse is okay, check for an open in wiring between fuse and control unit, or check for a defective ignition switch.

ENGINE SENSORS & SWITCHES

NOTE: For additional sensor testing specifications, see SENSOR RANGE CHARTS article in the ENGINE PERFORMANCE section.

A/C ON (A/C REQUEST) SWITCH TEST

1. Start engine and allow to idle. If a scan tester is available, scan A/C request parameter. Move A/C mode selector back and forth between ON and OFF positions. Scan status should change.
2. If scan tester is not available or scan status does not change, measure voltage between ground and PCM A/C request terminal. For wiring schematics, see mini-schematics under A/C CLUTCH (C-10) & ELECTRIC COOLING FAN (C-12) under MISCELLANEOUS CONTROLS.
3. With A/C mode selector in the ON position, battery voltage should be present. If battery voltage is not present, check for open between A/C mode select switch and PCM A/C request terminal, low A/C refrigerant level causing low pressure switch to open, bad A/C fuse or bad A/C mode select switch.

A/C PRESSURE SENSOR

A malfunction in A/C pressure sensor circuit will set a related diagnostic trouble code. For testing procedures, see **TESTS W/CODES - 5.7L** article in the ENGINE PERFORMANCE section. For wiring schematics, see mini-schematics under A/C CLUTCH (C-10) & ELECTRIC COOLING FAN (C-12) under MISCELLANEOUS CONTROLS.

A/C PRESSURE SWITCH

1. Connect A/C pressure gauges to system and start engine. Note high and low pressure readings. If pressures are normal, go to next step. If pressures are less than normal, check system for leaks. Evacuate and recharge as necessary. If pressures are high, check for system overcharge, overheating or mechanical failure in refrigerant delivery system.
2. Disconnect high and low pressure switches. Install jumper across each switch harness connector to allow A/C system to function normally. Using an ohmmeter, check continuity between pressure switch terminals.
3. Continuity should be present on both high and low switches (if equipped). If continuity is not present, replace A/C pressure switch. For wiring schematics, see mini-schematics under A/C CLUTCH (C-10) & ELECTRIC COOLING FAN (C-12) under MISCELLANEOUS CONTROLS.

BRAKE SWITCH

Disconnect brake switch harness connector. Using an ohmmeter, check continuity between brake switch terminals. Continuity should be present. Depress brake pedal to activate brake switch. Continuity should not be present.

CRANKSHAFT POSITION SENSOR

A malfunction in the crankshaft position sensor circuit will set a related diagnostic trouble code. For testing procedures, see **TESTS W/CODES - 5.7L** article in the ENGINE PERFORMANCE section. To diagnose position crankshaft sensor, the following procedures can be used:

1. If a scan tester is available, scan RPM parameter while cranking engine. If RPM is indicated, crankshaft position sensor is operating properly.
2. If scan tester is not available, disconnect crankshaft position sensor harness connector. Set ohmmeter to 2-k/ohm position, and measure resistance across sensor terminals. Resistance should be 800-1200 ohms.
3. Set voltmeter on the 2-volt AC scale. Crank engine and measure output voltage across sensor terminals. Voltmeter reading should be .8-1.4 volts. If resistance reading is not as specified or sensor does not produce the specified output voltage reading, repair faulty wiring or faulty crankshaft position sensor.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

If a coolant sensor-related diagnostic trouble code is present, see **TESTS W/CODES - 5.7L** article in the ENGINE PERFORMANCE section. An out-of-calibration sensor may not set a diagnostic trouble code. Use following procedure to test sensor calibration. Disconnect ECT sensor connector. Measure resistance between sensor terminals. Resistance should be high when engine is cold and drop as engine warms. See ECT SENSOR RESISTANCE VALUES table.

ECT SENSOR RESISTANCE VALUES

°F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

INTAKE AIR TEMPERATURE (IAT) SENSOR

IAT sensor may also be referred to as a Manifold Air Temperature (MAT) sensor. If a IAT sensor related code is present, see **TESTS W/CODES - 5.7L** article in the ENGINE PERFORMANCE section. An out-of-calibration sensor may not set a diagnostic trouble code. Use following procedure to test calibration. Disconnect IAT sensor harness connector. Connect ohmmeter between sensor terminals. Sensor resistance should be as specified. See IAT SENSOR RESISTANCE VALUES table. After vehicle has sat overnight, MAT sensor and coolant sensor should have close to the same resistance reading.

IAT SENSOR RESISTANCE VALUES

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467

104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

KNOCK SENSOR (KS)

Disconnect knock sensor harness connector. Using an ohmmeter, measure knock sensor resistance between sensor terminal and engine block. Resistance should be 3300-4500 ohms. Connect DVOM between sensor terminal and ground. Set voltmeter to 2-volt AC scale. Start and idle engine. Tap on engine block near sensor. A signal should be indicated on voltmeter. If no signal is indicated, replace knock sensor. Also, see TIMING CONTROL SYSTEMS under IGNITION SYSTEM. If a code is present, see **TESTS W/CODES - 5.7L** article in the ENGINE PERFORMANCE section.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR (C-1)

1. A malfunction in the MAP sensor circuit should set a related diagnostic trouble code in PCM memory. If a code is present, see **TESTS W/CODES - 5.7L** article in the ENGINE PERFORMANCE section. An out-of-calibration sensor may not set a diagnostic trouble code. Use following procedure to test sensor calibration. If driveability problems exist, MAP sensor failure is suspected and no MAP code is present, disconnect MAP sensor connector. See **Fig. 1** . If driveability condition improves, replace MAP sensor.
2. With ignition on and engine off, check MAP sensor parameter using a scan tester connected to Data Link Connector (DLC). Voltage should be as specified. See MAP SENSOR VOLTAGE RANGE table. If MAP sensor voltage is as specified, go to step 3). If voltage is not as specified, check for 5-volt reference supplied to sensor. Check harness integrity. If no problems are evident, replace MAP sensor.
3. Using a hand-held vacuum pump, apply 10 in. Hg to MAP sensor, and note voltage change. Voltage should drop about 1.2-2.3 volts less than as specified in table. If voltage is not as specified or voltage reading does not immediately follow vacuum change, MAP sensor is faulty.

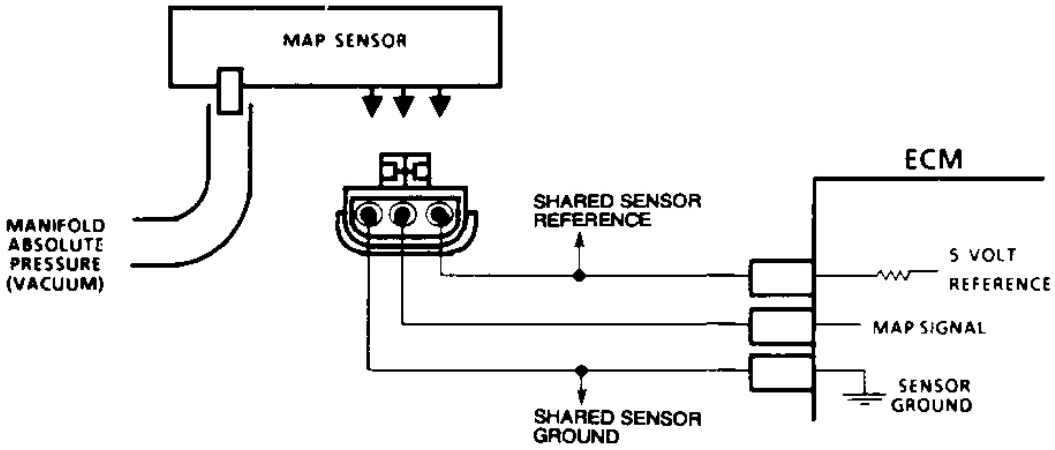


Fig. 1: MAP Sensor Circuit (5.7L)
Courtesy of GENERAL MOTORS CORP.

MAP SENSOR VOLTAGE RANGE

Altitude (Ft.)	Volts
Below 1000	3.8-5.5
1000-2000	3.6-5.3
2000-3000	3.5-5.1
3000-4000	3.3-5.0
4000-5000	3.2-4.8
5000-6000	3.0-4.6
6000-7000	2.9-4.5
7000-8000	2.8-4.3
8000-9000	2.6-4.2
9000-10,000	2.5-4.0

MANIFOLD AIR TEMPERATURE (MAT) SENSOR

MAT sensor may also be referred to as an Intake Air Temperature (IAT) sensor. See INTAKE AIR TEMPERATURE (IAT) SENSOR. A malfunction in the MAT sensor will set a related diagnostic trouble code. For testing procedures, see **TESTS W/CODES - 5.7L** article in the ENGINE PERFORMANCE section.

OXYGEN SENSOR (O2S)

1. Start engine and warm to operating temperature. Disconnect oxygen sensor. Connect a DVOM between lead of oxygen sensor and ground. Place DVOM on the 2-volt scale. Voltmeter reading should increase to greater than .8 volt.

2. Using another DVOM on the 20-volt scale, connect voltmeter in series between the oxygen sensor wire from PCM and positive post of battery. Reading on voltmeter connected to oxygen sensor should decrease to a low voltage (less than .3 volt).
3. If a second DVOM is not available, install short jumper in oxygen sensor wire from PCM. Hold jumper in one hand and touch positive post of battery with other hand. This should cause oxygen sensor to produce less than .3 volt. For additional testing procedures, see **TESTS W/CODES - 5.7L** article in the ENGINE PERFORMANCE section.

PARK/NEUTRAL POSITION (PNP) SWITCH (C-1)

1. Disconnect PNP switch harness connector. Connect ohmmeter between the PNP switch terminals. See **Fig. 2** . Continuity should be present only when gear shift selector is in Park or Neutral. If continuity is present, go to next step. If continuity is not present, check PNP switch adjustment or replace defective PNP switch.
2. With PNP switch connector disconnected, turn ignition on. Check for 12 volts on the Orange/Black wire of PNP switch harness. If 12 volts are not present, check for open or short to ground between switch harness connector and PCM.

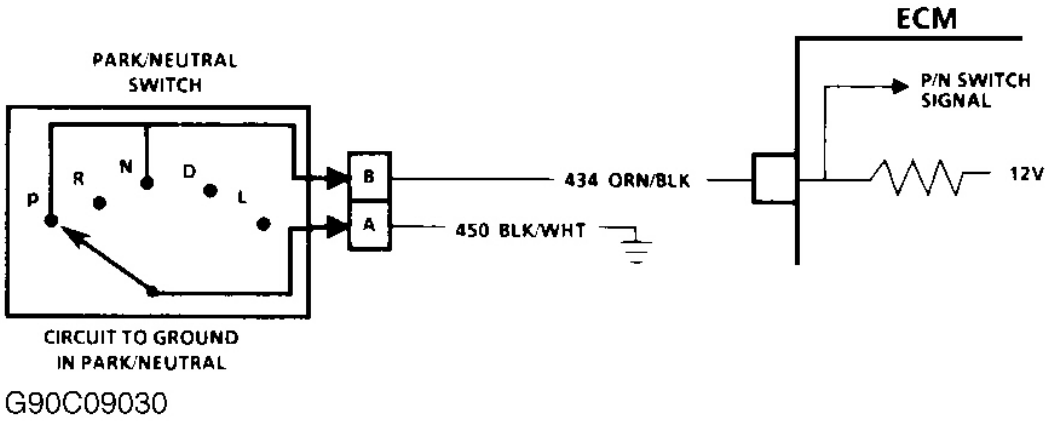


Fig. 2: Park/Neutral Position (PNP) Switch Circuit (5.7L)
Courtesy of GENERAL MOTORS CORP.

POWER STEERING PRESSURE (PSP) SWITCH

1. If scan tester is available, scan power steering pressure switch status. Note status with engine running and wheels in straight-ahead position. Turn steering wheel to full left or right position and again note status. If status changed, power steering pressure switch is okay. If status did not change or scan tester is not available, go to next step.
2. Turn ignition off. Disconnect PSP switch harness connector. Connect ohmmeter between PSP switch terminals. Start engine. With no-load on power steering, continuity should not be present. Turn steering wheel to full left or right position. Continuity should now be present. If readings are not as specified,

replace PSP switch.

3. With PSP switch connector disconnected and ignition on, check for battery voltage on PSP switch harness from PCM. If battery voltage is not present, check for open or short to ground in harness between PSP switch connector and PCM.

THROTTLE POSITION (TP) SENSOR

Install jumper wires to enable connection of a DVOM in parallel between TP sensor harness connectors. Connect DVOM positive lead to Dark Blue TP sensor signal wire terminal. Connect negative lead to Black, Black/Orange or Purple sensor ground wire terminal. See **Fig. 3** . Turn ignition on, with engine off. Signal voltage should gradually change from less than one volt at closed throttle to about 5.0 volts at wide open throttle position. If reading is not as specified, adjust or replace TP sensor. See **ADJUSTMENTS** article in the ENGINE PERFORMANCE section.

A malfunction in the TP sensor circuit should set a related diagnostic trouble code. For further information, see **TESTS W/CODES - 5.7L** article in the ENGINE PERFORMANCE section.

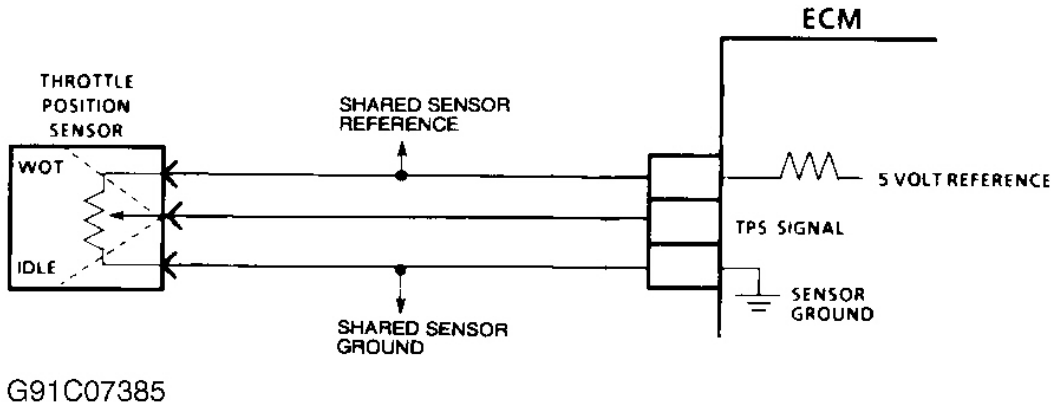


Fig. 3: Throttle Position (TP) Sensor Circuit (5.7L)
Courtesy of GENERAL MOTORS CORP.

VEHICLE SPEED SENSOR (PM GENERATOR TYPE)

Disconnect vehicle speed sensor harness connector (located in transaxle). Place gear selector in Neutral. Raise vehicle drive wheels off the ground. Turn drive wheels by hand (greater than 3 MPH). Measure AC signal voltage between sensor terminals. Voltage reading should vary from 0.1-0.5 volt AC as the wheel is turned. If reading is not as specified, replace vehicle speed sensor.

VEHICLE SPEED SENSOR (LED TYPE)

A speed sensor or buffer malfunction should set a related diagnostic trouble code in PCM memory. If a code is set, refer to **TESTS W/CODES - 5.7L** article for diagnosis in the ENGINE PERFORMANCE section.

MOTORS, RELAYS & SOLENOIDS

MOTORS

Secondary AIR Elec. Air Pump

Locate secondary AIR electric air pump on left front of engine compartment. Disconnect 3-wire connector from electric air pump. Apply ground to terminal "C" (Black wire) of pump. Apply battery voltage with a fused jumper wire to terminal "A" (Red wire) of pump. Pump should run. If pump does not operate, replace pump.

Idle Air Control (IAC) Motor & Idle Speed Control (ISC) Motor

See IDLE CONTROL SYSTEM.

RELAYS

A/C Clutch Relay

See MISCELLANEOUS CONTROLS.

Electric AIR Pump Relay

See EMISSION SYSTEMS & SUB-SYSTEMS.

Fuel Pump Relay

See FUEL SYSTEM.

SOLENOIDS

NOTE: All PCM-controlled solenoids should have at least 20 ohms of resistance when checked with positive ohmmeter lead connected to power supply terminal of solenoid and negative ohmmeter lead connected to ground terminal of solenoid. Some solenoids are equipped with internal diodes. On these solenoids, resistance values will differ if ohmmeter test leads are reversed.

AIR By-Pass Valve Solenoid

See EMISSION SYSTEMS & SUB-SYSTEMS.

Canister Purge Solenoid

See EMISSION SYSTEMS & SUB-SYSTEMS.

EGR Control Solenoid

See EMISSION SYSTEMS & SUB-SYSTEMS.

FUEL SYSTEM

FUEL DELIVERY

NOTE: For fuel system pressure testing, see BASIC TESTING article in the ENGINE PERFORMANCE section.

Fuel Pressure Regulator

1. Install fuel pressure gauge to fuel rail fuel pressure test fitting. Remove vacuum hose from fuel pressure regulator. Turn ignition on and note fuel pressure on gauge.
2. Start engine. Check for manifold vacuum at pressure regulator vacuum hose. If vacuum is not present, repair as necessary. Reconnect vacuum hose to pressure regulator and note fuel pressure on gauge. Compare first and second reading.
3. Fuel pressure reading should be 4-7 psi (.28-.49 kg/cm^2) less with vacuum hose installed. Fuel pressure should decrease as vacuum increases. If results are not as specified, replace fuel pressure regulator.

NOTE: For further fuel pump circuit diagnosis, refer to appropriate FUEL SYSTEM test under NO-START DIAGNOSIS (A-3) in BASIC TESTING article in the ENGINE PERFORMANCE section.

Fuel Pump Relay (A-5)

1. Disconnect fuel pump relay connector. See COMPONENT LOCATIONS at end of article to locate fuel pump relay. Apply battery voltage and ground to fuel pump relay winding terminals. To identify fuel pump relay terminals, see appropriate wiring diagram in WIRING DIAGRAMS section.
2. Using an ohmmeter, check for continuity between fuel pump relay power supply terminal and fuel pump drive terminal. Continuity should exist ONLY with relay energized. If relay does not test as indicated, replace relay.
3. To by-pass fuel pump relay (to test fuel pump and wiring when fuel pump is not energizing), see FUEL PUMP RELAY BY-PASS PROCEDURE.

Fuel Pump Relay By-Pass Procedure

1. If fuel pump will not energize, relay may be by-passed to test fuel pump and related wiring. See **Fig. 4** . Turn ignition off. Disconnect fuel pump relay connector.
2. Using a fused jumper wire, apply battery voltage to fuel pump test connector (located in engine compartment). For fuel pump test connector location, see COMPONENT LOCATIONS at end of this article. See **Fig. 6** - **Fig. 12** .
3. If fuel pump runs and relay tests okay, check for faulty connections at relay. If fuel pump does not run, check for faulty wiring between relay and fuel pump or replace defective fuel pump.

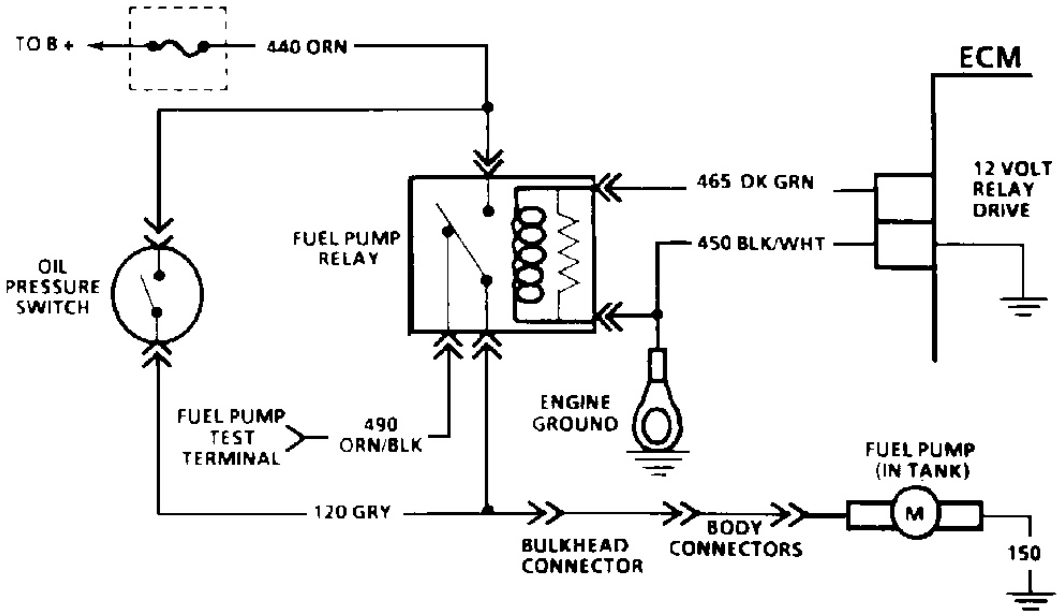


Fig. 4: Fuel Pump Relay Schematic (5.7L)
Courtesy of GENERAL MOTORS CORP.

Oil Pressure Switch Fuel Pump Back-Up

With engine idling, disconnect fuel pump relay. Engine should continue to run through oil pressure switch back-up circuit. If engine stalls, check oil pressure switch and related wiring.

FUEL CONTROL

Fuel Injector(s)

Disconnect fuel injector harness connector. Measure resistance across injector terminals at each injector. Resistance should be as specified. See INJECTOR RESISTANCE SPECIFICATIONS table.

INJECTOR RESISTANCE SPECIFICATIONS

Application	Ohms
5.7L	11.8-12.6

NOTE: If injectors are dirty, they should be cleaned using approved injector cleaning procedure before performing INJECTOR BALANCE TEST.

Injector Balance Test (C-2)

The injector balance test is used to pulse the injector for a precise amount of time, spraying a measured amount of fuel in the intake manifold. As each injector is pulsed, a drop in fuel rail pressure occurs. This pressure drop can be recorded and compared to other injectors. An injector with a pressure drop of 1.5 psi (.11 kg/cm^2) or more, greater than or less than other injectors, should be considered faulty.

NOTE: Allow engine to cool down to avoid irregular readings due to "hot soak" fuel boiling. To prevent flooding, the INJECTOR BALANCE TEST should not be repeated more than once without starting and running engine.

CAUTION: To avoid possible vehicle fire, wrap a shop towel around fitting to absorb fuel spillage.

1. Ensure engine is at normal operating temperature. Connect Fuel Pressure Gauge (J-34730-1) to pressure test port. Energize fuel pump using fuel pump test connector or Tech 1 scan tester.
2. Bleed air from fuel gauge and hose to ensure accurate gauge reading. Repeat this procedure until all air is bled from system. Run fuel pump and note fuel pressure. Fuel pressure should be as specified. See FUEL PRESSURE RANGE chart. If fuel pressure range is not as specified, see BASIC FUEL SYSTEM CHECKS in **BASIC TESTING** article in the ENGINE PERFORMANCE section.
3. Turn fuel pump off. When fuel pump stops, pressure may slightly drop then should hold steady. If fuel pressure does not hold steady, refer to BASIC FUEL SYSTEM CHECKS in **BASIC TESTING** article in the ENGINE PERFORMANCE section.
4. Install Fuel Injector Tester (J-39021) to an injector. Set amperage supply selector switch to "Balance Test, 0.5-2.5 amp." position. Cycle fuel pump on and off to pressurize fuel system. Record stabilized fuel pressure.
5. Depress "Push To Start Test" button on fuel injector tester to energize injector. Note fuel pressure the instant fuel gauge needle stops. Record fuel pressure reading. Perform the same test to all injectors.
6. To obtain pressure drop values, subtract second pressure reading from first pressure reading on each injector. Add all pressure drop values and divide by number of injectors to obtain an average pressure drop.
7. Retest an injector that appears faulty. Replace any injector with a 1.5 psi (.11 kg/cm^2) difference, either greater than or less than the average pressure drop. If injectors are all okay, remove test equipment, plug in disconnected harness connectors and review SYMPTOMS in **TESTS W/O CODES** article in the ENGINE PERFORMANCE section.

FUEL PRESSURE RANGE CHART

Application	psi (kg/cm^2)
5.7L	41-47 (2.9-3.3)

CAUTION: To avoid possible vehicle fire, wrap shop towel around fitting to absorb fuel spillage.

Fuel Injector Leak Test

1. Turn engine off. Relieve fuel pressure. Access fuel injectors. Connect Fuel Injector Tester (J-39021) to vehicle battery and to a fuel injector. If coolant temperature is 50-95°F (10-35°C), go to next step. If coolant temperature is not 50-95°F (10-35°C), go to step 5).
2. Set fuel injector tester's amperage supply selector switch to "Coil Test 0.5 amp" position. Connect a Digital Volt-Ohmmeter (DVOM) to fuel injector tester. Set DVOM to tenths scale (0.0).
3. Ensure engine coolant temperature is 50-95°F (10-35°C). Press "Push To Start" tester button. Observe DVOM. Voltage reading may climb during test. Record lowest voltage displayed immediately after activation.
4. Perform voltage reading on all injectors. If voltage reading is erratic or falls out of specified range, perform injector balance test or replace faulty injector. See INJECTOR TEST VOLTAGE RANGE table or INJECTOR BALANCE TEST (C2).
5. Press "Push To Start" button on fuel injector tester. Observe DVOM. Voltage reading may climb during test. Record lowest voltage displayed immediately after activation. Perform voltage reading at least twice on all injectors.
6. If voltage reading is erratic or is greater than 9.5 volts, replace affected fuel injector. If voltage reading is not erratic or not greater than 9.5 volts, go to next step.
7. From recorded voltages (except readings greater than 9.5 volts), identify highest voltage reading and subtract from the other recorded voltages. If subtracted value is greater than 0.6 volts, replace affected fuel injector. If subtracted value is less than 0.6 volts, perform injector balance test. See INJECTOR BALANCE TEST (C2).

INJECTOR TEST VOLTAGE RANGE

Application	Volts
5.7L	5.7-6.6

Oxygen Sensor

See ENGINE SENSORS & SWITCHES.

IDLE CONTROL SYSTEM (C-2)

IDLE AIR CONTROL (IAC) MOTOR

1. Disconnect harness connector to motor. Check resistance across IAC coil terminals "A" and "B" (coil "B") and "C" and "D" (coil "A"). See **Fig. 5** . Resistance should be 40-80 ohms. If resistance is as specified, go to next step. If resistance is not as specified, replace IAC motor.
2. Check resistance between IAC terminals "B" to "C" and "A" to "D". Resistance should be infinite. If resistance is not as specified, replace IAC motor.

NOTE: Additional testing of Idle Air Control (IAC) motor requires an IAC motor actuator and node light, or a scan tester capable of cycling PCM output devices (General Motors Tech 1).

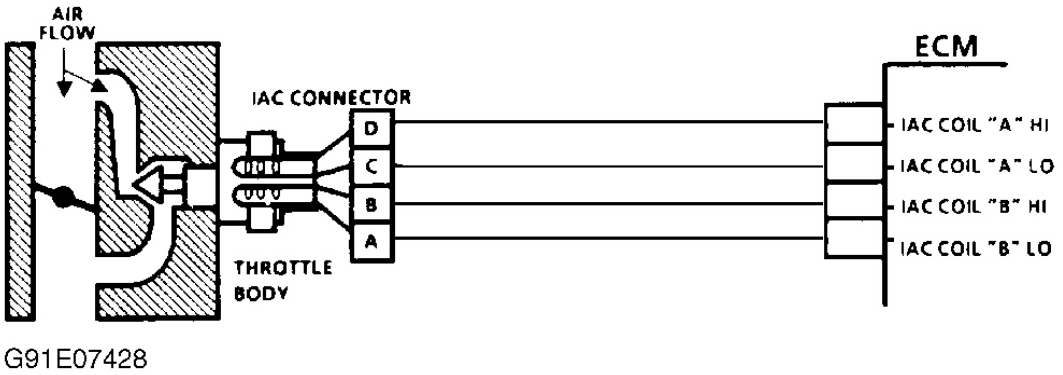


Fig. 5: IAC Motor Circuit (5.7L)
Courtesy of GENERAL MOTORS CORP.

IGNITION SYSTEM

NOTE: For basic ignition system checks, see BASIC TESTING article in the ENGINE PERFORMANCE section.

TIMING CONTROL SYSTEMS

Ignition Control (IC) Timing Advance System

1. A malfunction in the IC circuit (formerly referred to as the EST circuit) should set a related diagnostic trouble code. Start engine and warm to operating temperature. On vehicles equipped with a manual transmission, increase engine speed to about 2000 RPM. On vehicle equipped with an automatic transmission, slightly increase idle speed.
2. Ground DLC "test" terminal "B" (not applicable to all models). A noticeable change in engine speed should occur. If no change occurs, see DIAGNOSTIC CIRCUIT CHECK in **BASIC TESTING** article in the ENGINE PERFORMANCE section.

Knock Sensor (KS) System Without KS Controller (C-5)

1. An open or short circuit on the KS wire to the PCM will set a related diagnostic trouble code. A false detonation signal will not cause PCM to set a code.
2. If a scan tester is available, connect it to the DLC. Tap on engine next to knock sensor and note "knock" parameter. Knock should be indicated on scan tester.
3. If a scan tester is not available, connect tachometer to engine. Start engine and hold RPM above idle. Using a metal object, tap on engine close to knock sensor. A noticeable decrease in engine RPM should occur. If no RPM decrease occurred, check knock sensor-to-PCM circuit.
4. On vehicles equipped with automatic transmission, it may be necessary to place transmission in Drive for timing change to occur. Also, see KNOCK SENSOR (KS) under ENGINE SENSORS & SWITCHES.

Knock Sensor (KS) System With KS Controller (C-5)

1. An open or short circuit on KS wire to PCM will cause a loss of 12-volt KS controller signal. This will cause PCM to fully retard ignition timing.
2. If scan tester is available, connect it to the DLC. Tap on engine next to knock sensor and note "knock" parameter. Knock should be indicated on scan tester.
3. If scan tester is not available, connect a DVOM to PCM ESC signal terminal. With engine idling, 12 volts should be present at this terminal. Using a metal object, tap on engine close to knock sensor. Voltage signal at PCM terminal should drop to zero volts, and return when knock signal ceases.
4. If signal does not respond as described, check knock sensor signal to KS controller. On vehicles equipped with automatic transmission, it may be necessary to place transmission in Drive for timing change to occur. Also, see KNOCK SENSOR (KS) under ENGINE SENSORS & SWITCHES.

EMISSION SYSTEMS & SUB-SYSTEMS

AIR INJECTION (C-6)

AIR Pump (Belt-Driven)

Accelerate engine to approximately 1500 RPM and observe airflow from hoses. If airflow increases as engine is accelerated, pump is working properly. If airflow does not increase, check hoses, pump belt tension, leaky valves or defective air injection pump.

Check Valve

Detach check valve and blow through valve in direction of check valve flow (to cylinder head). Attempt to suck air back. Replace valve if airflow is allowed against the direction of flow.

Electric AIR Pump Relay

1. Start engine. With engine operating in open loop, electric air pump should run and air should be coming out of electric air pump exhaust port.
2. If electric air pump is operating, allow engine to idle for at least 3 minutes. With vehicle in closed loop (or about 3 minutes after start), PCM should de-energize electric air pump relay and electric air pump should stop. If this does not occur, go to next step. If air pump operates as described, relay is functioning properly.
3. Remove air pump relay from fuse/relay block. Air pump should stop. If air pump stops, check or replace faulty relay. If air pump does not stop, check circuit to air pump for a short to battery voltage.

EXHAUST GAS RECIRCULATION (C-7)

There are 3 types of EGR systems used: pulse width modulated backpressure (positive and negative) EGR with a control solenoid, pulse width modulated backpressure (positive and negative) EGR without a control solenoid, digital and linear EGR. See EGR SYSTEM IDENTIFICATION table.

EGR SYSTEM IDENTIFICATION

Application	System Type	Solenoid Type
5.7L	BP/EGR	Normally Closed

System Test (Vacuum Operated)

Start and run engine to normal operating temperature. With engine at idle, push up on underside of EGR diaphragm. RPM should drop as EGR valve is opened. If RPM does not drop, remove EGR valve and check for blocked EGR passages. If RPM drops as diaphragm is lifted and EGR vacuum supply is regulated by an PCM-controlled solenoid, verify vacuum is available to solenoid at 2000 RPM and check solenoid using appropriate procedure. See appropriate EGR CONTROL SOLENOID procedure.

CAUTION: Wear gloves if handling EGR valve when it is hot.

EGR Control Solenoid (Normally Closed)

1. Disconnect EGR solenoid electrical harness connector and vacuum hoses. Connect a hand-held vacuum pump to solenoid vacuum source port. Connect vacuum gauge to solenoid EGR port. Pump up vacuum pump. Vacuum should not be present at port to EGR valve.
2. Activate EGR solenoid with a 12-volt power supply. Vacuum should now be present or registered at vacuum gauge. If vacuum is not present, check EGR solenoid resistance. Solenoid should have at least 20 ohms of resistance.

EGR Control Solenoid (Normally Open)

1. Disconnect solenoid harness connector. Install vacuum pump to vacuum source side of solenoid. Apply vacuum to solenoid. Vacuum should pass through when solenoid connector is disconnected.
2. Apply battery voltage and ground to solenoid terminals. With solenoid energized, apply vacuum to solenoid. Vacuum should not pass through solenoid. If results are not as specified, check EGR solenoid resistance. Solenoid should have at least 20 ohms of resistance.

Negative Backpressure EGR Valve

With engine off, disconnect vacuum hose to EGR valve. Connect vacuum pump to EGR and apply 10 in. Hg. EGR diaphragm should move up and stay up for 20 seconds. If valve does not operate as indicated, replace EGR valve.

Positive Backpressure EGR Valve

1. Place transmission in Park or Neutral. Set parking brake and block drive wheels. Connect tachometer. With engine running at normal operating temperature, run engine at 2000 RPM.
2. Disconnect vacuum hose from EGR valve and plug hose. EGR valve diaphragm should move down and engine RPM should increase.

NOTE: On some engines with PCM-controlled solenoid, EGR vacuum is locked out in Park/Neutral and solenoid must be by-passed with vacuum supply

hose.

3. Reconnect vacuum hose. EGR diaphragm should move up and engine RPM should decrease. A slight vibration of diaphragm plate may be noticed in backpressure EGR valves.
4. If engine RPM did not change and EGR diaphragm moved, the EGR valve is functioning properly. If engine RPM did not change and diaphragm did not move, remove EGR valve and apply 10 in. Hg to EGR vacuum signal port. EGR valve should not open.
5. If EGR valve opens, replace EGR valve. With vacuum still applied, direct a stream of air (15 psi maximum) into valve seat. EGR valve should open completely.
6. If air is not available, connect a short piece of hose over EGR valve seat. Connect vacuum pump to signal port. With thumb plugging intake port of EGR valve, operate vacuum pump while alternately blowing through hose and pausing.
7. With vacuum present at signal port, EGR valve should open while pressure is applied and should close when no vacuum is present.

FUEL EVAPORATION CONTROL (C-3)

NOTE: One of 2 types of solenoid is used: normally open or normally closed. See CANISTER PURGE SOLENOID IDENTIFICATION table.

CANISTER PURGE SOLENOID IDENTIFICATION

Application	Solenoid Type
5.7L	Normally Closed

Canister Purge Solenoid (Normally Closed)

1. Disconnect canister purge solenoid harness connector and vacuum hose. Apply 10 in. Hg to ported intake manifold vacuum side of solenoid valve. If vacuum holds, go to next step. If vacuum does not hold, replace canister purge solenoid.
2. Using a 12-volt power source, energize canister purge solenoid. Vacuum should release. If vacuum does not release, replace canister purge solenoid. Solenoid resistance should be at least 20 ohms.

Canister Purge Solenoid (Normally Open)

1. Disconnect canister purge solenoid harness connector and vacuum hose. Apply vacuum to ported intake manifold vacuum side of solenoid valve. If vacuum holds, go to next step. If vacuum does not hold, replace canister purge solenoid.
2. Using a 12-volt power source, energize canister purge solenoid. Vacuum should release. If vacuum does not release, replace canister purge solenoid. Solenoid resistance should be at least 20 ohms.

Fuel Tank Pressure Control Valve

Apply approximately 15 in. Hg to fuel tank pressure control valve. The diaphragm should hold vacuum for at least 20 seconds. If fuel tank pressure control valve does not hold vacuum, replace tank pressure control valve.

POSITIVE CRANKCASE VENTILATION (PCV)

Required Service

The PCV system may require service for obstructions if any of the following conditions exist:

- Rough idle.
- Stalling or slow idle speed.
- Oil leaks.
- Oil in air cleaner.
- Sludge in engine.

A leaking PCV valve or hose could cause:

- Rough idle.
- Stalling.
- High idle speed.

If engine idles roughly, check for clogged PCV valve or plugged or broken hoses BEFORE adjusting idle. Check PCV valve application to ensure the correct valve is fitted. Replace PCV valve if required.

Checking PCV Valve Function

1. Remove PCV valve from rocker cover. Run engine at idle. Place thumb over open end of valve to check for vacuum. If there is no vacuum at valve, check for obstruction in manifold port, hoses or PCV valve. Repair or replace as necessary.
2. Turn engine off. Remove PCV valve. Shake valve and listen for rattle of check valve inside. If a clear rattle is not heard, replace PCV valve.
3. Visually inspect valve for varnish or deposits which may make PCV valve operation sticky or restricted, or cause incomplete seating of valve. Replace if necessary.
4. An engine must be sealed for the PCV system to function as designed. If leakage, sludging or dilution of oil is noted and the PCV system is functioning properly, check engine for cause and repair as required to ensure PCV system will continue to function properly.
5. An engine operating without any crankcase ventilation can be damaged, so it is important to replace PCV valve and air cleaner breather (if equipped) at regular intervals (at least every 30,000 miles). Check all hoses and clamps for failure or deterioration.

MISCELLANEOUS CONTROLS

NOTE: Although some of the controlled devices listed here are not technically engine performance components, they can affect driveability if they malfunction.

HOT LIGHT OR COOLANT TEMPERATURE LIGHT

NOTE: **These checks assume vehicle is not overheating. Verify proper operation of cooling system prior to diagnosing hot light. The coolant temperature sensor, in rare cases, may fail to indicate correct coolant temperature without setting a diagnostic trouble code (Code 14 or 15). This could result in hot light turning on without having an overheating condition. It could also result in engine overheating without hot light turning on. Check coolant sensor temperature-to-resistance values in SENSOR RANGE CHARTS article in the ENGINE PERFORMANCE section.**

Hot light is powered by the 10-amp INDIC or GAGES fuse. Light will turn on when PCM provides a ground for the circuit. If circuit grounds between light and PCM, light will illuminate any time the ignition is turned on.

1. Turn ignition on with engine off (bulb test position). If hot light illuminates, go to step 3). If hot light does not illuminate, check the following and proceed to next step:
   - 10-amp INDIC or GAGES fuse.
   - Faulty instrument cluster bulb.
   - Open circuit between fuse and hot light.
2. Backprobe PCM hot light driver terminal with a test light to battery voltage. Turn ignition on. If test light does not illuminate, PCM terminal connection is bad or PCM is faulty. If test light illuminates, turn ignition off. Disconnect PCM connectors. Jumper PCM hot light driver harness terminal to ground. Turn ignition on. If hot light does not illuminate, check for open circuit between hot light and PCM. If all circuits are okay and power is available to light, instrument cluster must be replaced.
3. Start engine. If hot light goes off, no problem is evident. If hot light is on, turn ignition off. Disconnect PCM connector. Probe PCM hot light driver harness terminal with a test light to battery voltage. If test light does not illuminate, replace PCM. If test light illuminates, repair short to ground in hot light driver circuit. If circuit is okay, replace instrument cluster.

TRANSMISSION (C-8)

NOTE: **Computerized transmission controls are also covered in greater detail in appropriate TRANSMISSION SERVICING & REPAIR manual.**

Converter Clutch Solenoid

Disconnect harness connector to Torque Converter Clutch (TCC) solenoid. Measure resistance between TCC solenoid terminals "A" and "D". See **Fig. 5** . Solenoid resistance should be greater than 20 ohms.

NOTE: **Some solenoids have an internal pressure switch in series with the solenoid winding and will not show continuity until that pressure switch is applied by transmission hydraulic pressure. See Fig. 5 .**

Converter Lock-Up Signal At Transmission

1. Warm engine to operating temperature. Raise vehicle and support drive wheels. Support suspension where necessary to prevent damage to drive axles.

2. Disconnect converter clutch connector at transmission. Connect a test light across terminals "A" and "D" of converter clutch harness. Start engine and place transmission in Drive. Accelerate vehicle to 45 MPH and note test light.
3. If test light is not on, check solenoid power supply wire of harness for open or short to ground. Check ground circuit for open between harness connector and PCM. If harness is okay, see CONVERTER LOCK-UP SIGNAL FROM PCM.

Converter Lock-Up Signal From PCM

1. Warm engine to operating temperature. Raise vehicle and support drive wheels. Support suspension where necessary to prevent damage to drive axles.
2. Connect a test light to battery voltage. Touch TCC control driver terminal with test light. On some vehicles, this is terminal "F" of Data Link Connector (DLC). See **Fig. 5** . Accelerate vehicle to 45 MPH and note test light. If test light does not illuminate, problem is a faulty PCM connector or PCM.

A/C CLUTCH (C-10) & ELECTRIC COOLING FAN (C-12)

NOTE: For additional information on electric cooling fans, see appropriate ENGINE COOLING FANS article in ENGINE COOLING section.

A/C Clutch Relay

1. Disconnect A/C clutch relay harness connector. Using proper mini-schematic and an ohmmeter, check continuity between A/C clutch relay winding terminals. See **Fig. 6** - **Fig. 11** . Continuity should exist. Check continuity between clutch drive circuit terminals of relay. Continuity should not exist.
2. Using jumper wires, apply ground and battery voltage to relay winding of relay. Continuity should now exist between clutch drive circuit terminals of relay. Replace A/C clutch relay if readings are not as specified.

Cooling Fan System & Quad-Driver Check

1. Connect a test light to battery voltage. Touch the test light probe to the cooling fan control driver terminal of the PCM. See **Fig. 6** - **Fig. 11** . Disconnect coolant temperature sensor. This should set a code, causing PCM to engage cooling fan through relay. On some models, it may be necessary to jumper the coolant temperature sensor harness connectors. On some models, grounding the DLC with the ignition on and engine off will cause the PCM to activate the cooling fan control driver (ground circuit).
2. If test light illuminates and cooling fan does not come on, check cooling fan relay, power circuits, cooling fan motor, and relay and fan motor ground circuits. If test light does not illuminate, problem is a faulty PCM connector or PCM. Clear diagnostic trouble code(s) from PCM memory after testing.
3. If cooling fan functions normally during testing but fails to operate under normal conditions, check PCM monitored inputs which affect cooling fan operation. These include the following: coolant temperature sensor, A/C request signal from A/C control switch and A/C pressure sensor, or pressure/temperature switch signals (if equipped).

Cooling Fan Relay

1. Disconnect cooling fan relay harness connector. Using an ohmmeter, check continuity of relay winding. See **Fig. 6** - **Fig. 11** . Continuity should exist. Check continuity across power delivery terminals of relay. With relay not energized, no continuity should exist.
2. With ohmmeter still attached to power delivery terminals of relay, apply battery voltage and ground to energize relay winding. Continuity should now be present between cooling fan relay power delivery terminals. Replace cooling fan relay if readings are not as specified.

Cooling Fan Motor

Disconnect cooling fan motor harness connector. Apply battery voltage to one of the fan motor terminals and jumper the other terminal to ground. Fan motor should activate. If fan motor does not activate, replace faulty fan motor.

NOTE: For a more specific system testing, refer to the following C-10 or C-12 diagnostic charts. If any chart other than a C-10 or C-12 chart is referenced, see appropriate TESTS W/CODES - 5.7L article in the ENGINE PERFORMANCE section.

DIAGNOSTIC CHARTS

NOTE: In following charts, the terms ECM and PCM can be used interchangeably.

CHART C-12A, COOLING FAN CKT DIAGNOSIS

Cooling fans are controlled by Powertrain Control Module (PCM) based on various inputs. Battery voltage is supplied to terminal C4 of primary fan relay and terminal C1 of secondary fan relay. Ignition voltage is supplied to terminal B4 of primary fan relay and terminal B1 of secondary fan relay. Grounding circuit No. 335 will energize primary cooling fan relay and supply battery voltage to primary cooling fan motor. Grounding circuit No. 473 will energize secondary cooling fan relay and supply battery to secondary cooling fan motor. When certain Diagnostic Trouble Codes (DTC) are set, PCM will energize cooling fans.

NOTE: Test numbers refer to numbers on diagnostic charts.

1. With output/field service enable terminal grounded at DLC, cooling fan control driver(s) will close, energizing fan control relay(s).
2. Cooling fans should come on anytime A/C system is operating. Engine coolant temperature must be less than 212°F (100°C) when performing this step.
3. Comparing Tech 1 scan tester pressure and manifold gauge set pressure will determine if A/C refrigerant pressure sensor is out of range. An out-of-range A/C pressure sensor can cause cooling fans to operate at the wrong times.

Diagnostic Aids

If an overheating condition is suspected, check if it is caused by an actual boilover. If gauge or light indicates an overheat condition and boilover is not evident, inspect gauge circuit for malfunction.

If vehicle is overheating and gauge or light indicates so but cooling fan is not coming on, check Engine Coolant Temperature (ECT) sensor temperature using a scan tester. ECT sensor may have shifted out of calibration and should be replaced. If engine is overheating and cooling fan is on, check cooling system. PCM will command primary cooling fan on at 225°F (107°C) and off at 217°F (103°C). PCM will command secondary cooling fan on at 232°F (111°C) and off at 224°F (107°C).

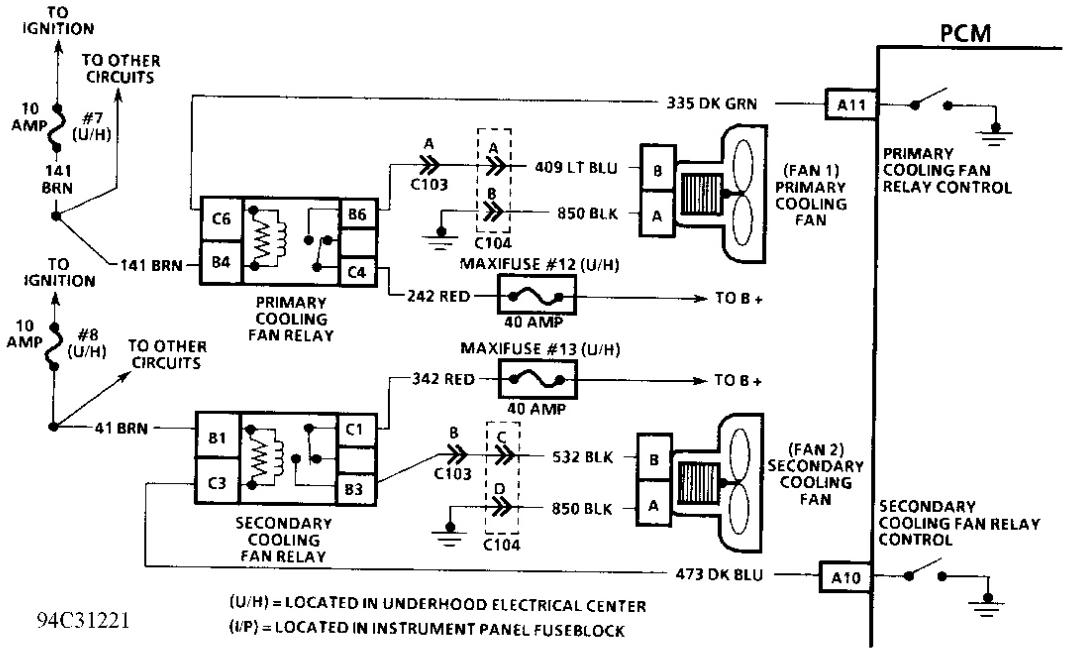


Fig. 6: Cooling Fan Ckt. Schematic (5.7L)
Courtesy of GENERAL MOTORS CORP.

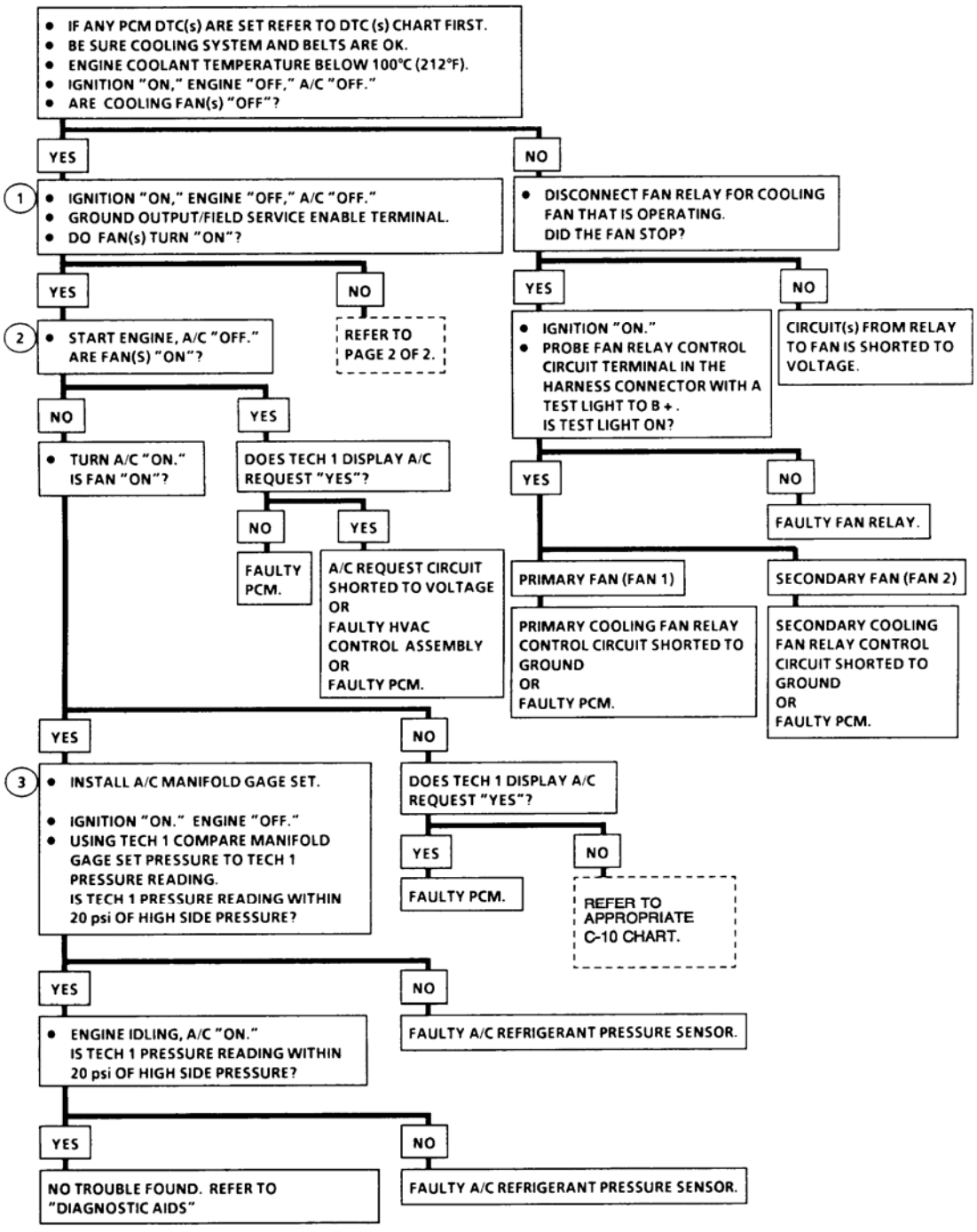


Fig. 7: Cooling Fan Circuit Diagnostic Flow Chart (5.7L - 1 Of 2)
Courtesy of GENERAL MOTORS CORP.

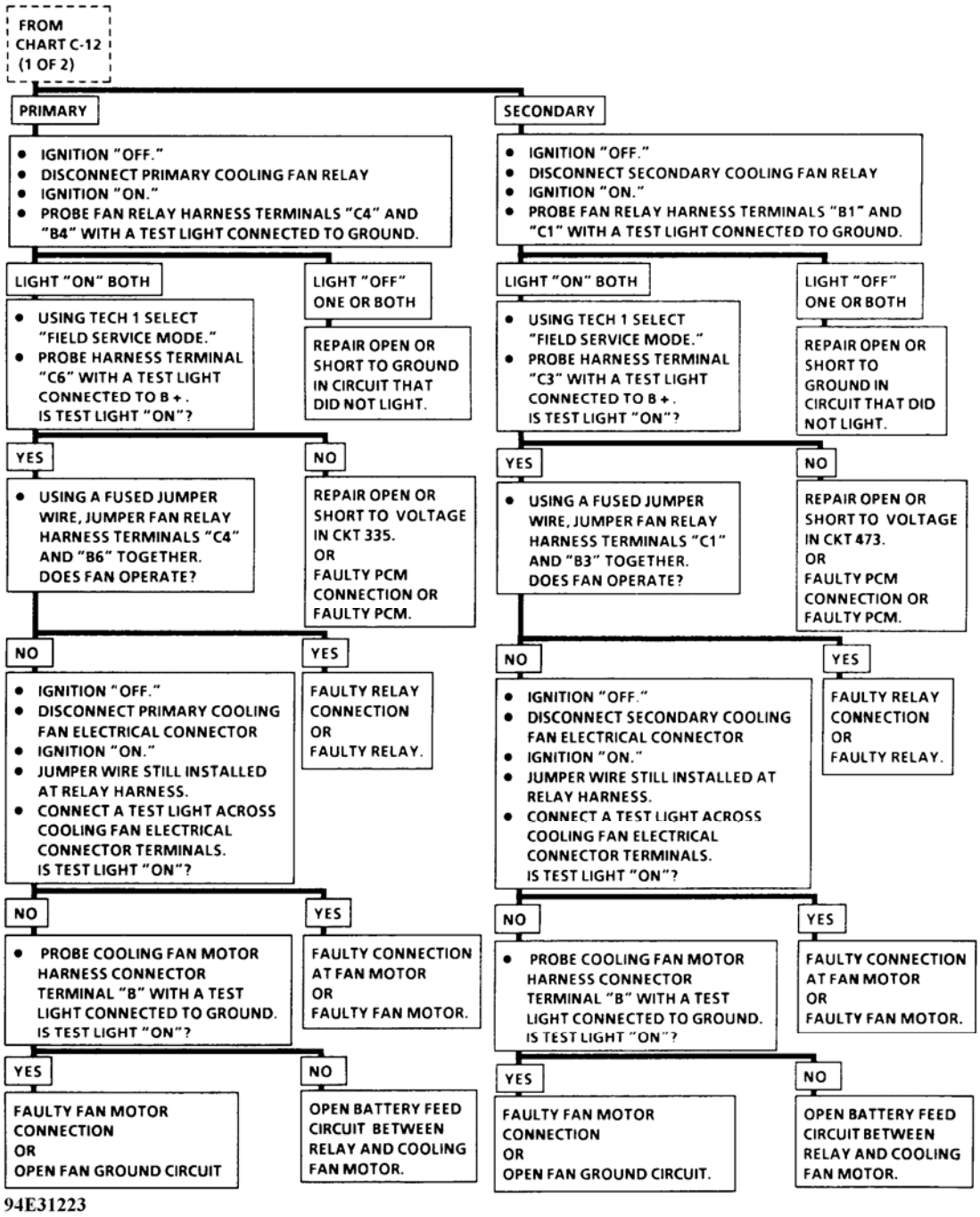


Fig. 8: Cooling Fan Circuit Diagnostic Flow Chart (5.7L - 2 Of 2)
Courtesy of GENERAL MOTORS CORP.

CHART C-10, A/C COMPRESSOR CLUTCH CIRCUIT DIAGNOSIS (1 OF 2)

Powertrain Control Module (PCM) delays A/C compressor clutch engagement momentarily after A/C is turned on. This delay allows PCM time to adjust engine RPM before A/C compressor clutch engages.

PCM will temporarily disengage A/C compressor clutch for a precalibrated time during one or more of the following conditions: Wide Open Throttle (WOT), high engine RPM, high engine coolant temperature or A/C refrigerant pressure too high or too low.

An A/C refrigerant pressure sensor is used to monitor A/C system pressure. If A/C refrigerant pressure is greater than 429 psi (30.2 kg/cm^2) or less than zero, A/C compressor clutch will not engage. If A/C refrigerant pressure sensor signal wire becomes open, shorted to ground or shorted to voltage, a Diagnostic Trouble Code (DTC) 66 will set.

If A/C compressor clutch engages and no refrigerant pressure change is detected, DTC 67 will set. When A/C request is detected by PCM, cooling fan(s) will be turned on unless vehicle speed is too high.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks PCM's ability to control A/C compressor clutch relay.
2. Before replacing A/C system control components, check basic A/C-heater system.
3. Checks for a grounded circuit No. 459 to PCM.

Diagnostic Aids

Before diagnosing vehicle using C-10 chart, ensure no DTCs are stored. PCM will not activate A/C compressor clutch if any DTC is stored.

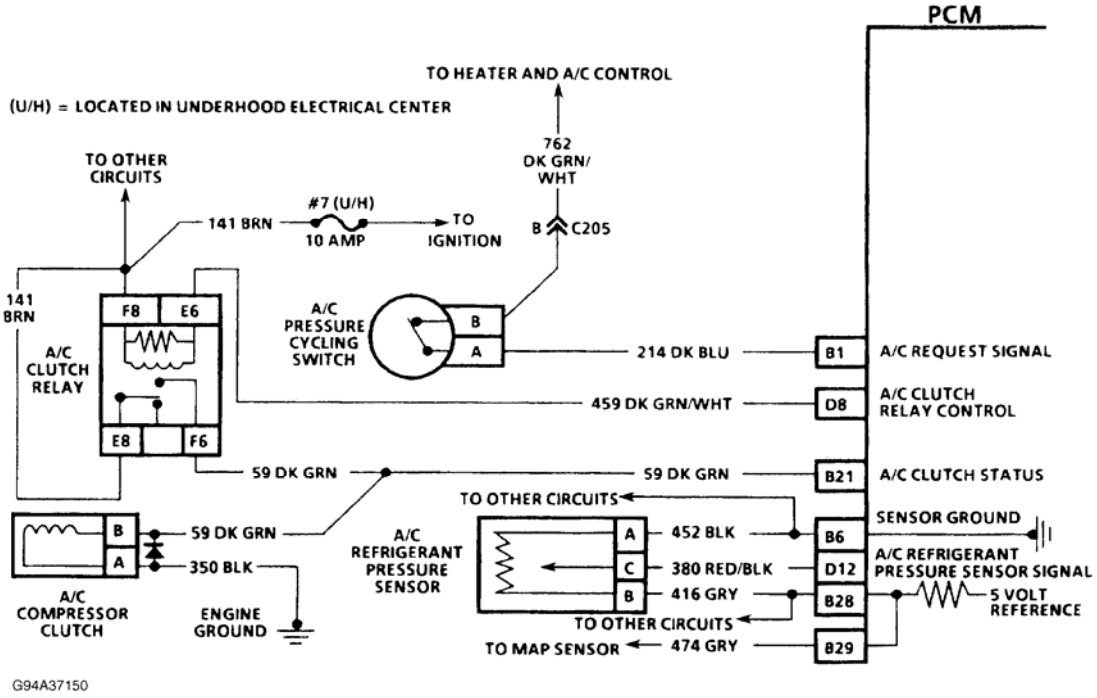


Fig. 9: A/C Clutch Control Circuit Schematic (5.7L)
Courtesy of GENERAL MOTORS CORP.

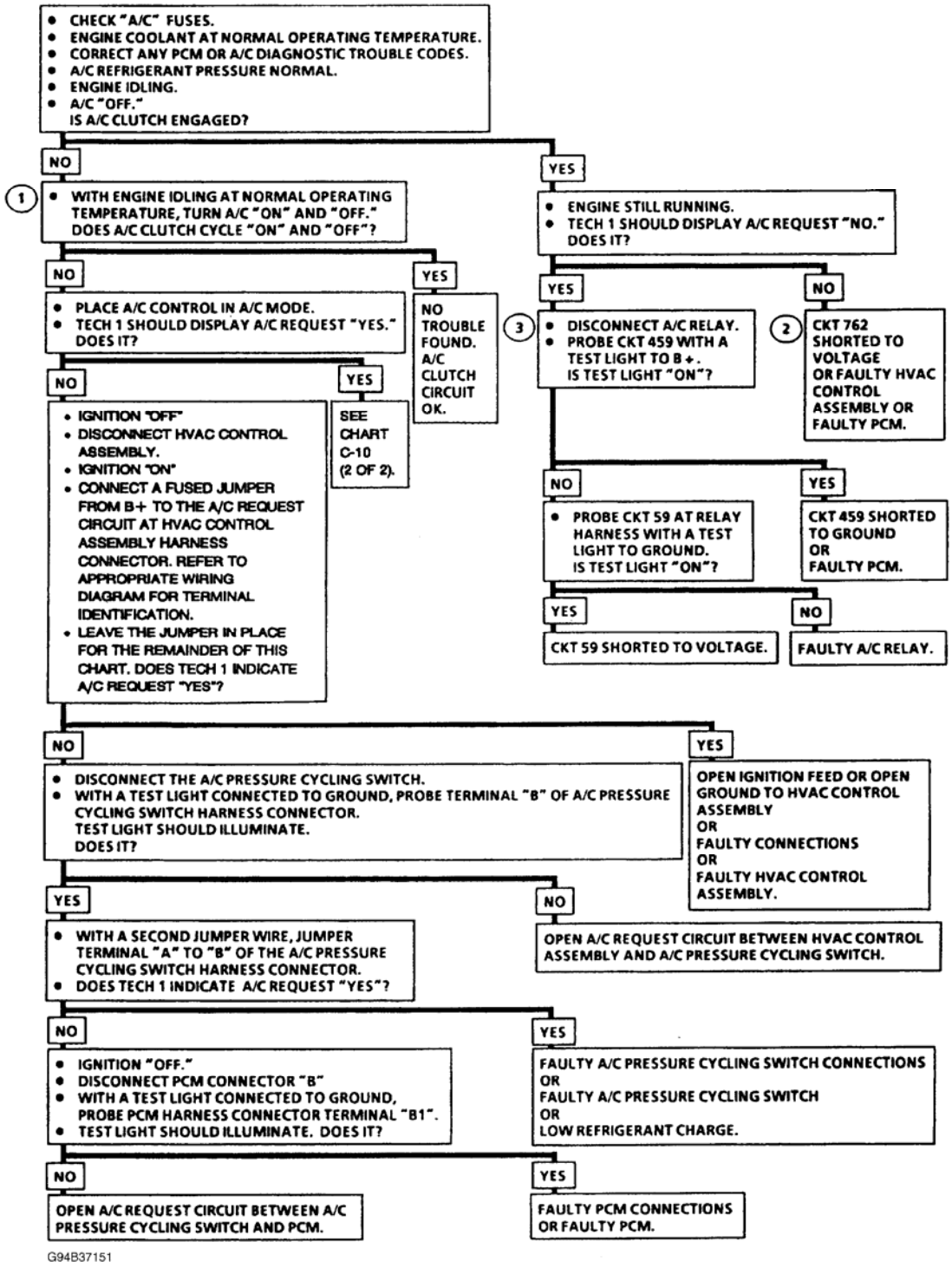


Fig. 10: A/C Clutch Control Circuit Diagnostic Flow Chart (5.7L - 1 Of 2)
Courtesy of GENERAL MOTORS CORP.

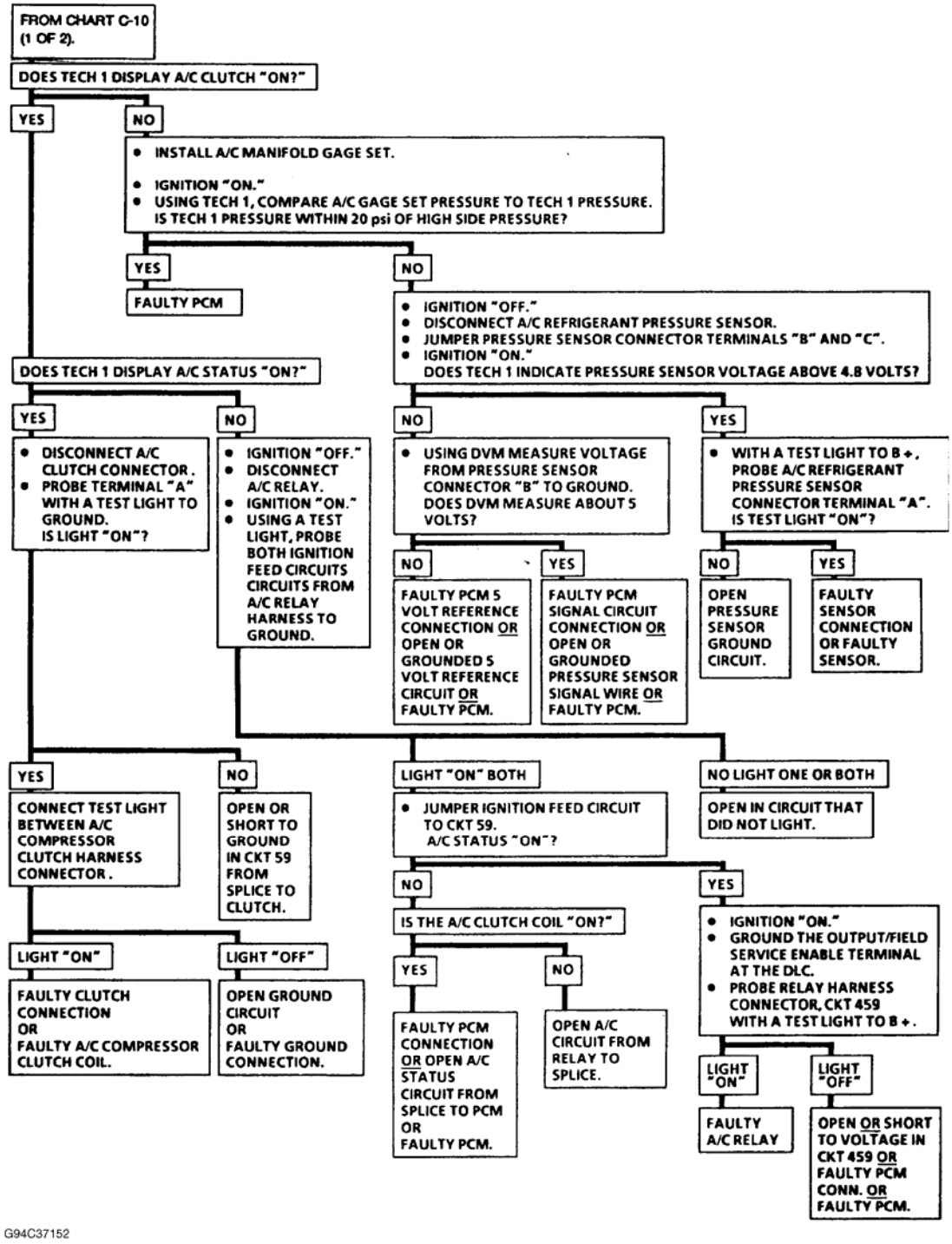


Fig. 11: A/C Clutch Control Circuit Diagnostic Flow Chart (5.7L - 2 Of 2)
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATIONS

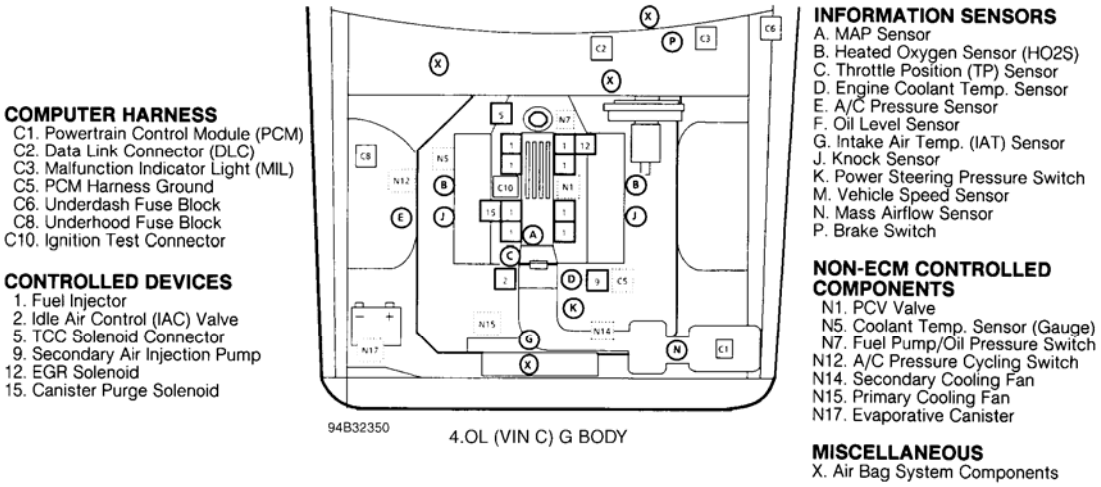


Fig. 12: Component Locations (5.7L VIN P)
Courtesy of GENERAL MOTORS CORP.

WIRING DIAGRAMS

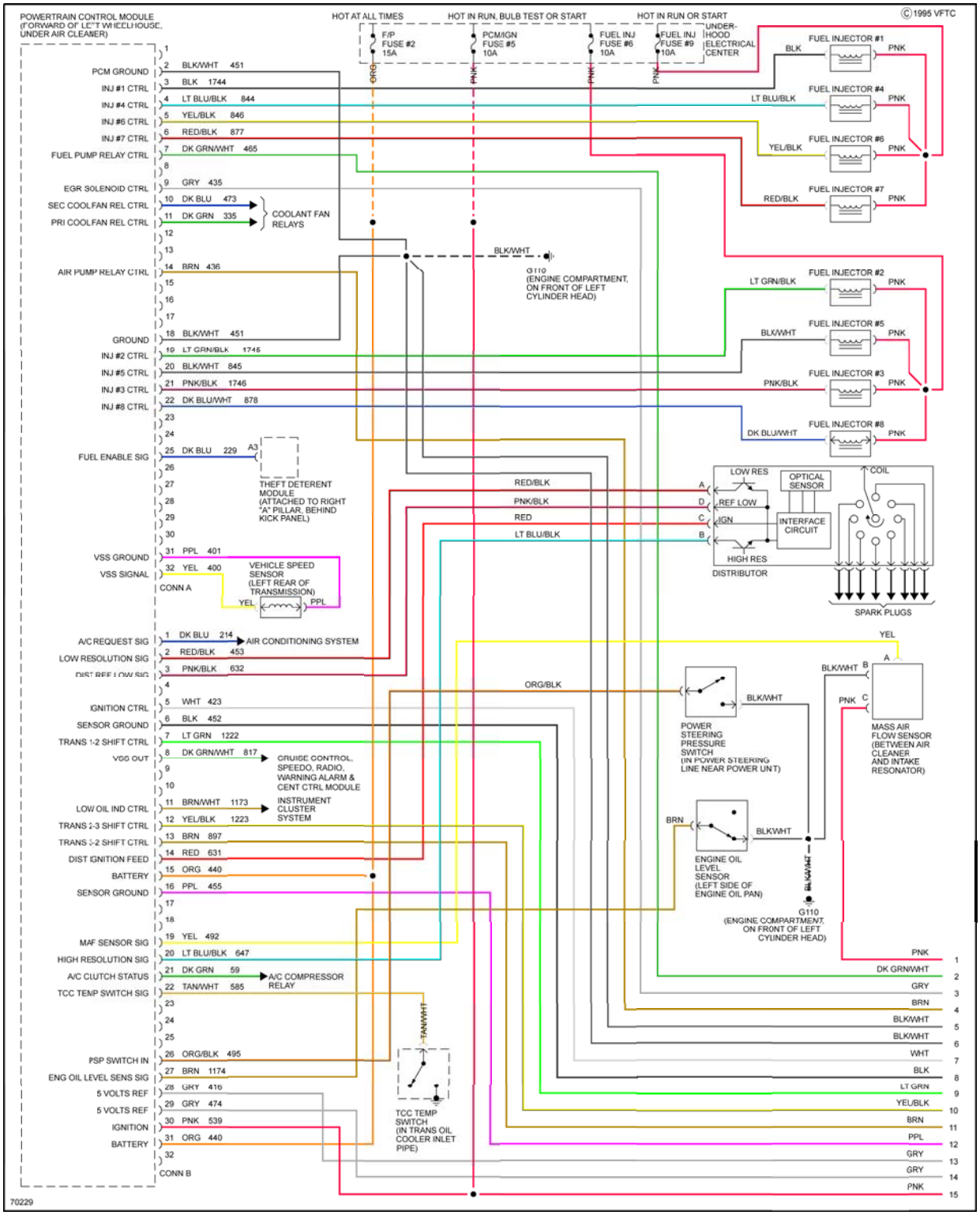


Fig. 13: 5.7L (VIN P) PCM Wiring Diagram (1 Of 3)

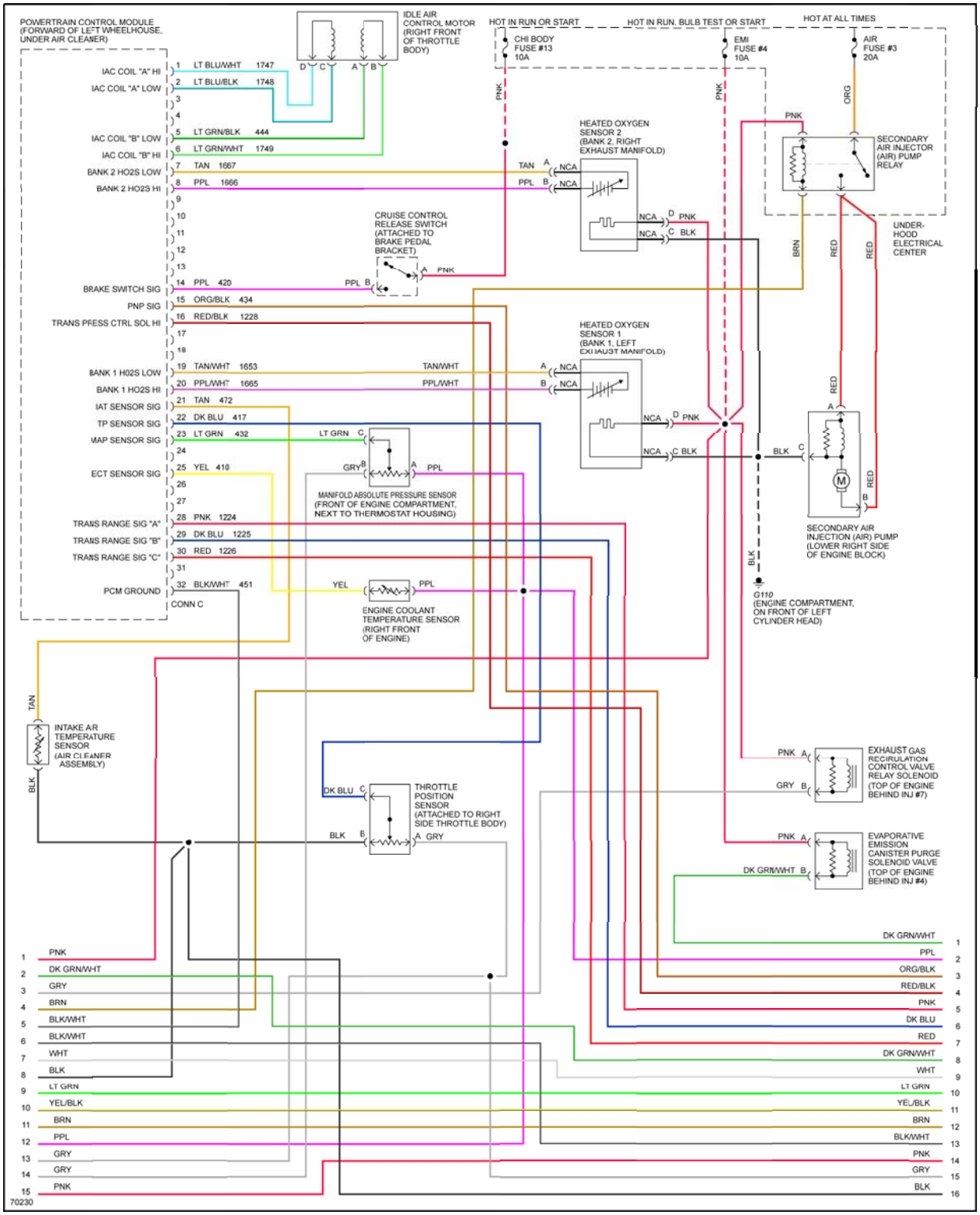


Fig. 14: 5.7L (VIN P) PCM Wiring Diagram (2 Of 3)

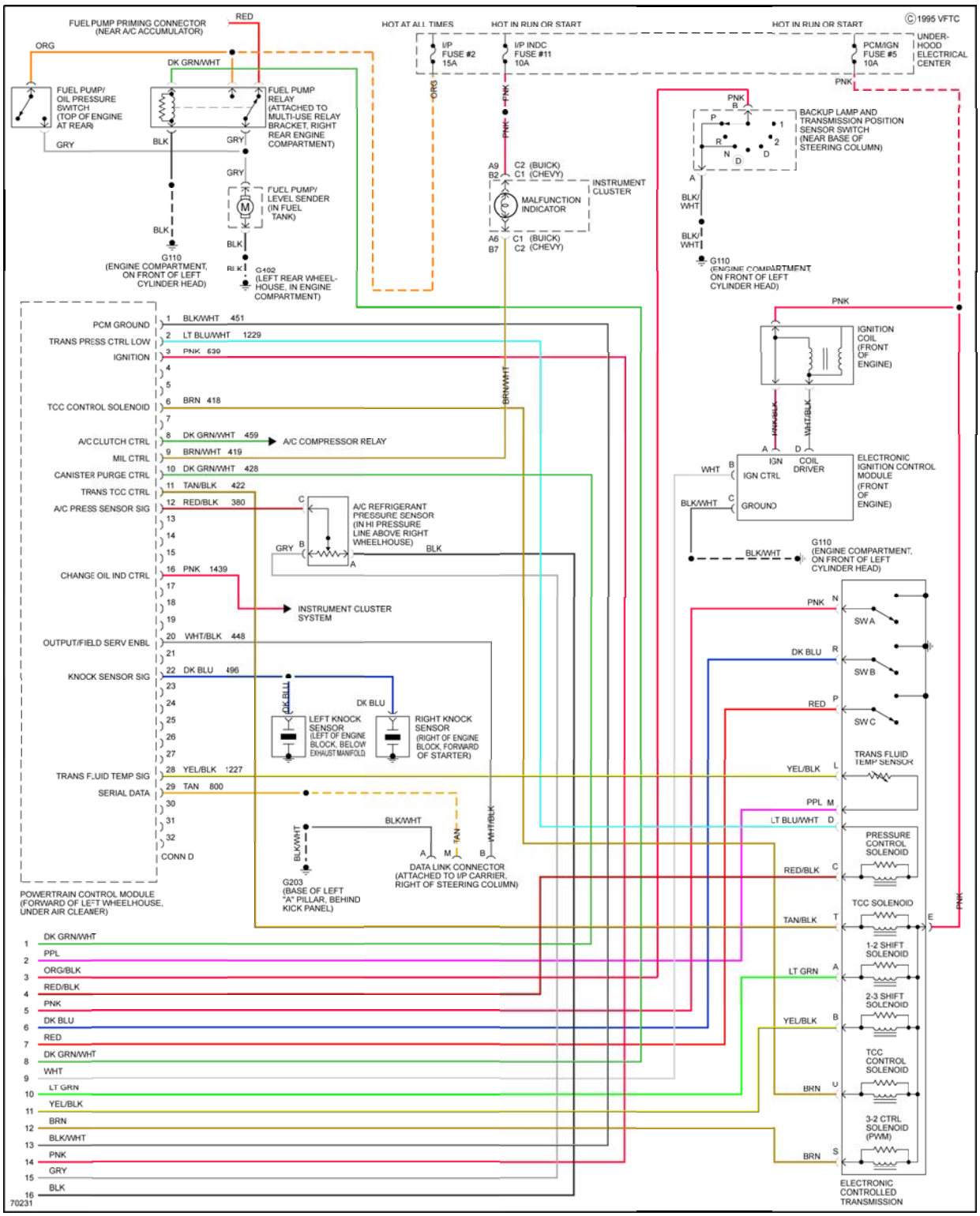


Fig. 15: 5.7L (VIN P) PCM Wiring Diagram (3 Of 3)

ENGINE PERFORMANCE General Motors Corp. Theory & Operation

INTRODUCTION

This article covers basic description and operation of engine performance-related systems and components. Read this article before diagnosing vehicles or systems with which you are not completely familiar.

TERMINOLOGY

Due to Federal government requirements, manufacturers may use names and acronyms for systems and components different than those used in previous years. The following table will help eliminate confusion when dealing with these components and systems. Only relevant components and systems whose names have changed from current General Motors Corp. terminology have been listed.

SAE TERMINOLOGY

Former Name Or Acronym	New Name Or Acronym
ALDL	Data Link Connector (DLC)
CHECK ENGINE Light	Malfunction Indicator Light (MIL)
CTS	Engine Coolant Temperature Sensor
Diagnostic Circuit Check	On-Board Diagnostic (OBD) System Check
ESC System	Knock Sensor (KS) System
EST System	Ignition Control (IC) System
MAT Sensor	Intake Air Temperature (IAT) Sensor
Park/Neutral (P/N) Switch	Park/Neutral Position (PNP) Switch
Port Fuel Injection	Multiport Fuel Injection
Scan Data	Scan Tester (ST) Data
SERVICE ENGINE SOON Light	Malfunction Indicator Light (MIL)
Thermostatic Air Cleaner (TAC)	Air Cleaner (ACL)
Throttle Position Sensor (TPS)	Throttle Position (TP) Sensor
Throttle Position Switch	Closed Throttle Position (CTP) Switch
Throttle Position Switch	Wide Open Throttle (WOT) Switch
Viscous Converter Clutch (VCC)	Torque Converter Clutch (TCC)

AIR INDUCTION SYSTEM

AIRFLOW SENSING

Mass Airflow (MAF)

MAF sensor measures flow of air entering the engine in grams per second. This measurement of airflow is a reflection of engine load (throttle opening and air volume), similar to the relationship of engine load to MAP or vacuum sensor signal. Mass Airflow (MAF) signal should remain relatively constant at cruise, gradually

changing with throttle angle and rapidly changing on sudden acceleration. The PCM uses MAF information to control fuel delivery. Sensor produces a frequency signal which cannot be easily measured in testing (32-150 Hertz). This varying signal is proportional to airflow.

Speed Density

On models equipped with MAP and IAT sensors, the speed density method is used to compute the airflow rate. Manifold pressure and temperature are used to calculate the airflow rate to the PCM. The MAP sensor responds to manifold vacuum changes due to engine load and speed changes.

The PCM sends a voltage signal to MAP sensor. Manifold pressure changes result in resistance changes in MAP sensor. By monitoring MAP sensor output voltage, PCM determines manifold pressure. If MAP sensor fails, PCM will supply a fixed MAP value and use the TP sensor to control fuel.

COMPUTERIZED ENGINE CONTROLS

The computerized engine control system monitors and controls a variety of engine/vehicle functions. The computerized engine control system is primarily an emission control system which is designed to maintain a 14.7:1 air/fuel ratio under most operating conditions. When the ideal air/fuel ratio is maintained, the 3-way catalytic converter can control oxides of nitrogen (NOx), hydrocarbon (HC) and carbon monoxide (CO) emissions.

The computerized engine control system consists of the master controller (PCM), input devices (sensors and switches) and output signals.

POWERTRAIN CONTROL MODULE (PCM)

On most vehicles, PCM is located in passenger compartment. For exact location of PCM, see PCM LOCATION in appropriate TESTS W/CODES article or COMPONENT LOCATIONS in appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below. The PCM contains the Arithmetic Logic Unit (ALU), Central Processing Unit (CPU), power supply and system memories.

- **TESTS W/CODES - 4.3L** (for Caprice Only)
- **TESTS W/CODES - 5.7L** (for All Models)
- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

The PCM has a "learning" ability which allows it to make minor corrections for fuel system variations. If battery power to PCM is interrupted, a vehicle performance change may be noticed. This will correct itself and normal performance will return if vehicle is allowed to "relearn" optimum control conditions. This is accomplished by driving vehicle at normal operating temperature, under part throttle, moderate acceleration and idle conditions.

Arithmetic Logic Unit (ALU)

This internal component of the PCM converts electrical signals, received by PCM from various engine sensors, into digital signals for use by the CPU.

Central Processing Unit (CPU)

Digital signals received by CPU are used to perform all mathematical computations and logic functions necessary to deliver proper air/fuel mixture. CPU also calculates spark timing and idle speed. The CPU commands operation of emission control, "closed loop" fuel control and diagnostic system.

Power Supply

Power for PCM reference output signals (5 volts) and control devices (12 volts) is received from the battery (through ignition circuit when ignition switch is in ON position). Keep alive memory power is received directly from the battery.

Memories

PCM uses 3 types of memories: Read Only Memory (ROM), Random Access Memory (RAM) and Programmable Read Only Memory (PROM).

- **Read Only Memory (ROM)**

ROM is programmed information that can only be read by PCM. The ROM program cannot be changed. If battery voltage is removed, ROM information will be retained.

- **Random Access Memory (RAM)**

RAM is the scratch pad for the CPU. Data input, diagnostic codes and results of calculations are constantly updated and temporarily stored in RAM. If battery voltage is removed from PCM, all information stored in RAM is lost.

- **Programmable Read Only Memory (PROM)**

PROM is factory programmed engine calibration data which "tailors" PCM for specific transmission, engine, emission, vehicle weight and rear axle ratio applications. The PROM can be removed from PCM. If battery voltage is removed, PROM information will be retained. An Electronically Erasable Programmable Read Only Memory (EEPROM) is used on some models. This is the same as a PROM except it can be electronically reprogrammed by the manufacturer using special equipment.

- **Electronically Erasable Programmable Read Only Memory (EEPROM)**

Some models may use an EEPROM. This is the same as a PROM except it can be electronically reprogrammed by the manufacturer using special equipment.

NOTE: Components are grouped into 2 categories. The first category covers INPUT DEVICES, which control or produce voltage signals monitored by the control unit. The second category covers OUTPUT SIGNALS, which are components controlled by the control unit.

INPUT DEVICES

Vehicles are equipped with different combinations of input devices. Not all devices are used on all models. To determine the input devices used on a specific model, see appropriate wiring diagram in WIRING DIAGRAMS section. The available input signals include the following:

A/C Request Signal

The air conditioner mode selector is mounted on instrument panel. This mode selector provides a simple "A/C request" signal which is monitored by the PCM. PCM uses this signal to determine control of A/C clutch relay (if equipped) and to adjust idle speed when A/C compressor clutch is engaged. On some models, PCM may also activate electric cooling fan when this signal is present. If this signal is not present on A/C-equipped vehicles, vehicle may idle rough when A/C compressor cycles. To check function of the A/C mode selector, perform functional check of A/C mode selector. See appropriate appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

A/C Pressure Sensor

Some models are equipped with an air conditioner pressure sensor which is used to inform PCM of A/C system pressure. PCM uses this signal to determine A/C compressor load on the engine to control idle speed with IAC valve. Failure in A/C pressure sensor circuit or with A/C pressure sensor should set a related diagnostic trouble code and A/C compressor clutch will become inoperative. A fixed high pressure value will exist if the ground circuit to sensor is faulty. For testing procedures, see appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section below.

- **TESTS W/CODES - 4.3L** (for Caprice Only)
- **TESTS W/CODES - 5.7L** (for All Models)

A/C Pressure Switches

A/C high and low pressure switches may be used in the PCM-monitored A/C request signal circuit. Switches are normally closed, completing the circuit between ignition and PCM. PCM will engage or disengage A/C clutch relay based upon status of this circuit. When system refrigerant pressure increases beyond a certain point, high side switch will open, causing A/C request line voltage to drop. If system refrigerant level decreases, causing refrigerant pressure to drop below normal, low side pressure switch will open, once again causing A/C request line voltage to drop. Switches may be used as normal clutch cycling devices or as safety devices which prevent compressor damage in the event of excessively high or low refrigerant pressure.

A/C Temperature Sensors

Air conditioner high side and low side temperature sensors inform PCM of A/C system temperature levels. Low temperature signal will cause A/C compressor to disengage. High temperature levels help PCM determine control of A/C compressor relative to cooling fans and idle speed.

Battery Voltage

Battery voltage is monitored by PCM. If battery voltage swings low, a weak spark or improper fuel control may

result. To compensate for low battery voltage, PCM may increase idle speed, advance ignition timing, increase ignition dwell or enrich the air/fuel mixture. If voltage swings excessively high or low, PCM may set a charging system diagnostic trouble code and illuminate the Malfunction Indicator Light (MIL).

Brake Switch Feedback

Models equipped with cruise control systems may monitor the brake switch circuit to determine when to engage and disengage cruise control. On vehicles equipped with a Torque Converter Clutch (TCC), one circuit of brake switch is in series with the power supply for the TCC solenoid located in the transmission/transaxle.

Engine Coolant Temperature (ECT) Sensor

The ECT sensor is a thermistor (temperature sensitive resistor) located in an engine coolant passage. The PCM supplies and monitors a 5-volt signal to ECT sensor through a resistor in PCM. This monitored 5-volt signal is then reduced by resistance of the engine coolant temperature. When coolant temperatures are low, ECT sensor resistance is high, and a high monitored voltage signal is seen by the PCM. When coolant temperatures are high, ECT sensor resistance is low, and a low monitored voltage is seen by the PCM. After engine startup, temperature should rise steadily to proximately 194°F (90°C), then stabilize when thermostat opens.

Engine coolant temperature signal is used in the control of most systems the PCM controls (i.e. fuel delivery, ignition timing, idle speed, emission control devices). After a vehicle has been parked overnight, ECT and IAT sensor signals (resistance and temperature) should be close to same reading. An ECT sensor which is out of calibration will not set a diagnostic trouble code but will cause fuel delivery and driveability problems. Failure in ECT sensor circuit (open or short to ground) will cause monitored voltage to swing high or low and should set a related diagnostic trouble code.

Fuel Pump Feedback

On some models, the fuel pump circuit between the fuel pump relay and fuel pump is monitored by PCM. This enables PCM to determine when the fuel pump relay is energized and voltage is being delivered to fuel pump. Voltage monitored on this circuit is also used in calculations to determine changes in idle speed, air/fuel ratio and ignition dwell. Failure in this monitored circuit should set a related diagnostic trouble code.

Gear Switches

Gear switches are located inside automatic transmission. Switches may be normally open or closed and change status depending upon internal hydraulic pressures. High gear switch information is used by PCM in controlling emission components and engagement of Torque Converter Clutch (TCC).

Ignition/Crank Signal

The PCM monitors initial cranking (RPM) signal to determine when the engine is being started. This information is used for starting enrichment. If this signal is intermittent or not available, hard starting or a no-start condition will result.

Intake Air Temperature (IAT) Sensor

The IAT sensor is a thermistor (temperature sensitive resistor) mounted in the intake manifold. The PCM

supplies and monitors a 5-volt signal to IAT sensor through a resistor in PCM. This monitored 5-volt signal is then reduced by resistance of the intake air temperature. Low intake air temperature produces high resistance, while high intake air temperature produces low resistance. By monitoring this voltage, PCM determines manifold air temperature. IAT sensor signal is used to adjust spark timing according to incoming air density.

Intake air temperature should read close to ambient temperature with engine cold, and rise as underhood temperature increases. After a vehicle has been parked overnight, IAT and ECT sensor signals (resistance and temperature) should be close to same reading. An IAT sensor which is out of calibration will not set a diagnostic trouble code but will cause fuel delivery and driveability problems. Failure in IAT sensor circuit (open or short to ground) will cause monitored voltage to swing high or low and should set a related diagnostic trouble code.

Knock Sensor

The knock sensor is a piezoelectric device which detects abnormal engine vibrations (spark knock) in the engine. This vibration results in the production of a very low AC signal which is sent from the knock sensor back to knock sensor module, if equipped (mounted on PCM), or to the EEPROM/PROM portion of PCM on models not equipped with a knock senor module. The PCM will then retard spark timing until engine knock ceases. Some models use 2 knock sensors.

For additional information on knock sensor operation, see KNOCK SENSOR OPERATION under IGNITION TIMING SYSTEMS under IGNITION SYSTEM. Failure in knock sensor circuit should set a related diagnostic trouble code. If a related diagnostic trouble code is not present and the knock sensor system is suspected as the cause of a driveability problem, perform a functional check of the knock sensor. See appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

Manifold Absolute Pressure (MAP) Sensor

The MAP sensor measures changes in manifold pressure. Changes in manifold pressure result from engine load and speed changes. The MAP sensor converts these changes in manifold pressure into a voltage output signal to PCM (about 1.5 volts at idle to about 4.5 volts at WOT). The PCM can monitor these signals and adjust air/fuel ratio and ignition timing under various operating conditions.

If MAP sensor fails, the PCM will substitute a fixed MAP value and will use the TP sensor to control fuel delivery. Failure in MAP sensor circuit should set a related diagnostic trouble code. If a related diagnostic trouble code is not present and MAP sensor is suspected of causing a driveability problem, perform a functional check of MAP sensor. See appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

Mass Airflow (MAF) Sensor

The MAF sensor measures flow of air entering the engine in grams per second. This measurement of airflow is a reflection of engine load (throttle opening and air volume), similar to the relationship of engine load to MAP or vacuum sensor signal. Mass Airflow (MAF) signal should remain relatively constant at cruise, gradually changing with throttle angle and rapidly changing on sudden acceleration. The PCM uses MAF information to control fuel delivery. Sensor produces a frequency signal which cannot be easily measured in testing (32-150 Hertz). This varying signal is proportional to airflow. Failure in MAF sensor circuit should set a related diagnostic trouble code.

CAUTION: DO NOT attempt to measure oxygen sensor output voltage using a conventional voltmeter. Current drain of voltmeter could damage sensor. Oxygen sensor voltage signal can be measured using a 10-megohm (minimum input impedance) digital voltmeter.

Oxygen Sensor (O2S)

The oxygen sensor is mounted in the exhaust system where it monitors oxygen content of exhaust gases. Two oxygen sensors are used on some models. The oxygen content causes the Zirconia/Platinum-tipped oxygen sensor to produce a voltage signal which is proportional to exhaust gas oxygen concentration (0-3%) compared to outside oxygen (20-21%). This voltage signal is low (about .1 volt) when a lean mixture is present and high (about 1.0 volt) when a rich mixture is present. As PCM compensates for a lean or rich condition, this voltage signal constantly fluctuates between high and low, crossing a .45-volt reference voltage supplied by PCM on the oxygen sensor signal line. This is referred to as "cross counts."

The oxygen sensor will not function properly (produce voltage) until its temperature reaches approximately 600°F (316°C). On some models, oxygen sensor is equipped with a sensor heating element. This allows the sensor to reach operating temperature sooner and prevents fuel system from re-entering "open loop" mode due to a cooled sensor (which is a normal occurrence during prolonged idle).

At temperatures less than the normal operating range of the sensor, vehicle will function in "open loop" mode and PCM will not make air/fuel adjustments based upon oxygen sensor signals but will use TP sensor and MAP or MAF values to determine air/fuel ratio from a table built into memory. When PCM reads a voltage signal greater than .45 volt from the oxygen sensor, PCM will begin to alter commands to injector to produce either a leaner or richer mixture.

Once vehicle has entered "closed loop", a cooled-down sensor or a fault in the oxygen sensor circuit (open or shorted circuit) is the only thing which can return it to "open loop". Failure in oxygen sensor circuit should set a related diagnostic trouble code.

Park/Neutral Position (PNP) Switch

PNP switch is connected to transmission gear selector. PNP switch signals PCM when transmission is in Park, Neutral or Drive. Information from PNP switch is used by PCM for determining control of IAC valve, TCC and EGR. To check PNP switch, perform functional check of switch. See appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below. If vehicle is driven with PNP switch disconnected, idle quality will be affected and a possible false related diagnostic trouble code may be set.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)

- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

Power Steering Pressure (PSP) Switch

The PSP switch informs PCM of engine load conditions that exist when steering wheel is turned from center to full lock position. PCM uses information to help control idle speed, and on some models, A/C clutch. To check PSP switch, perform functional check of switch. See appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

RPM Reference Signal

The RPM is monitored by PCM through tach/pulse signals (circuit No. 430) produced by either the ignition control module or crankshaft position sensor (PM generator signal). These signals are used by PCM for determining control of timing, fuel delivery, EGR function and idle speed.

Throttle Position (TP) Sensor

The TP sensor is a variable mechanical resistor connected directly to the throttle shaft linkage. The TP sensor has 3 wires connected to it. One is connected to a 5-volt reference voltage supply from PCM, the second is connected to PCM ground and the third is the signal return which is monitored by PCM. The voltage signal from the TP sensor varies from closed throttle (.5-1.0 volt) to wide open throttle (4.5-5.0 volts). This signal is used by PCM for determining control of fuel, idle speed, spark timing and converter clutch. Failure in TP sensor circuit should set a related diagnostic trouble code.

Transmission Fluid Temperature Sensor

Transmission fluid temperature sensor is a thermistor (temperature sensitive resistor) and is located in valve body. High sensor resistance produces high signal input voltage which corresponds to low fluid temperature. Low sensor resistance produces low signal input voltage which corresponds to high fluid temperature. PCM uses transmission fluid temperature sensor signal to determine TCC apply and release schedules, hot mode determination and shift quality. Failure in transmission fluid temperature sensor circuit should set a related diagnostic trouble code.

Transmission Range Switch

Transmission range switch is mounted on transaxle assembly. Transmission range switch inputs to PCM indicate which gear is selected. Information from transmission range switch is used by PCM for determining control of IAC valve, timing and canister purge operation. To check transmission range switch, perform functional check of switch. See appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below. If vehicle is driven with transmission range switch disconnected, idle quality will be affected and a possible false related diagnostic trouble code may be set.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

Vehicle Speed Sensor (VSS)

VSS is a Permanent Magnet (PM) generator mounted in transaxle/transmission. The VSS sends a pulsing AC voltage signal to PCM, which PCM converts into miles per hour (MPH). VSS signal is used by PCM in controlling TCC and shift solenoids. Signal may also be used for instrument cluster speedometer and cruise control system. Failure in VSS circuit should set a related diagnostic trouble code.

OUTPUT SIGNALS

NOTE: Vehicles are equipped with different combinations of PCM-controlled components. Not all components listed below are used on every vehicle. For theory and operation on each output component, refer to system indicated after component.

A/C Compressor Clutch

See MISCELLANEOUS CONTROLS.

Air Injection System

See EMISSION SYSTEMS.

Canister Purge Control Solenoid

See EMISSION SYSTEMS.

Cooling Fan Relay

See MISCELLANEOUS CONTROLS.

Digital EGR Valve

See EMISSION SYSTEMS.

Direct Ignition System (DIS)

See IGNITION SYSTEM.

EGR Control Solenoid

See EMISSION SYSTEMS.

Electronic Variable Orifice (EVO) Actuator

See MISCELLANEOUS CONTROLS.

Fuel Injectors

See FUEL CONTROL.

Fuel Pump & Fuel Pump Relay

See FUEL DELIVERY.

High Energy Ignition Electronic Spark Timing (HEI-EST)

See IGNITION SYSTEM.

HOT Light Or Coolant Temperature (TEMP) Light

See MISCELLANEOUS CONTROLS.

Idle Air Control (IAC) Valve

See IDLE SPEED.

Linear EGR Valve

See EMISSION SYSTEMS.

Knock Sensor Operation

See IGNITION SYSTEM.

Malfunction Indicator Light (MIL)

See SELF-DIAGNOSTIC SYSTEM.

Opti-Spark

See IGNITION SYSTEM.

Self-Diagnostics

See SELF-DIAGNOSTIC SYSTEM.

Serial Data

See SELF-DIAGNOSTIC SYSTEM.

Shift Light

See MISCELLANEOUS CONTROLS.

Shift Solenoids (Electronically-Controlled Auto Transmission)

See MISCELLANEOUS CONTROLS.

Torque Converter Clutch

See MISCELLANEOUS CONTROLS.

FUEL SYSTEM

FUEL DELIVERY

Fuel Pump

An in-tank electric fuel pump delivers fuel to injectors through an in-line fuel filter. The pump is designed to supply fuel pressure in excess of vehicle requirements. The pressure relief valve in the fuel pump controls maximum fuel pump pressure.

A pressure regulator, mounted in fuel rail keeps fuel available to injectors at a constant pressure. Excess fuel is returned to fuel tank through pressure regulator return line. For fuel pressure specifications, see **SPECIFICATIONS** article in the ENGINE PERFORMANCE section.

When the ignition switch is turned to ON position, PCM will turn on the electric fuel pump by energizing the fuel pump relay. The PCM will continue to energize relay if the engine is running or cranking (PCM is receiving reference pulses from the ignition control module). If no reference pulses exist, PCM de-energizes fuel pump relay within 2 seconds after ignition is turned on. For additional information, see FUEL PUMP RELAY.

Fuel Pump Relay

When ignition switch is turned to the ON position, PCM will turn on the electric fuel pump by energizing the fuel pump relay. PCM will keep relay energized if engine is running or cranking (PCM is receiving reference pulses from ignition control module). If no reference pulses exist, PCM turns pump off within 2 seconds after key on.

As a back-up system to fuel pump relay, fuel pump is also activated by the oil pressure switch. The oil pressure switch is normally open until oil pressure reaches approximately 4 psi (.28 kg/cm^2). If fuel pump relay fails, the oil pressure switch closes when oil pressure is obtained, operating the fuel pump. An inoperative fuel pump relay may result in extended cranking times due to the time required to build up oil pressure. Oil pressure switch may be combined into a single unit with an oil pressure gauge sender or sensor.

For additional information on fuel pump activation, see **BASIC TESTING** and I - SYSTEM & COMPONENT TESTING TESTING articles in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

Fuel Pressure Regulator

Fuel pressure regulator is a diaphragm-operated relief valve with injector pressure on one side and manifold pressure (vacuum) on the other. Pressure regulator compensates for engine load by increasing fuel pressure when low manifold vacuum is experienced.

During periods of high manifold vacuum, regulator-to-fuel tank return orifice is fully open, keeping fuel pressure on the low side of its regulated range. As throttle valve opens, vacuum to regulator diaphragm decreases, allowing spring tension to gradually close off return passage. At wide open throttle, when vacuum is at its lowest, return orifice is restricted, providing maximum fuel volume and maintaining constant fuel pressure to injectors.

FUEL CONTROL

The PCM, using input signals, determines adjustments to the air/fuel mixture in order to provide the optimum ratio for proper combustion under all operating conditions. One type of fuel control system is used: port fuel injection. This system can operate in "open loop" or "closed loop" mode. Description of these modes is as follows:

Open Loop

When engine is cold and engine speed is greater than 400 RPM, PCM operates in "open loop" mode. In "open loop", PCM calculates air/fuel ratio based upon inputs from Engine Coolant Temperature (ECT), Intake Air Temperature (IAT) and Manifold Absolute Pressure (MAP) sensors. Engine will remain in "open loop" operation until oxygen sensor reaches operating temperature, engine coolant temperature reaches preset temperature, and a specific period of time has elapsed after engine start-up.

Closed Loop

When oxygen sensor has reached operating temperature, engine coolant temperature has reached a preset temperature and a specific period of time has passed since engine start-up, PCM operates in "closed loop". In "closed loop", PCM controls air/fuel ratio based upon oxygen sensor signals (in addition to other input parameters) to maintain as close to a 14.7:1 air/fuel mixture as possible. If oxygen sensor cools off (due to excessive idling) or a fault occurs in the oxygen sensor circuit, vehicle will once again enter "open loop" mode.

Battery Voltage Correction

PCM compensates for low battery voltage by increasing injector pulse width, increasing idle RPM and increasing ignition dwell time. PCM is able to perform these commands because of a built-in memory/learning function.

Fuel Cut-Off

Injectors are de-energized when ignition is turned off to prevent dieseling. Injectors will not be energized if RPM reference pulses are not received by the PCM, even with ignition on. This prevents flooding before starting. Fuel cut-off will also occur at high engine RPM to prevent internal damage to engine. On some models, fuel injector signals may also be cut off during periods of high speed, closed throttle deceleration (when fuel is not needed).

Multiport Fuel Injection (MFI)

Individual, electrically pulsed injectors (one per cylinder) are located in intake manifold fuel rails. These injectors are next to intake valves in cylinder head.

Standard MFI systems feature simultaneous double-fire injection. Fuel injectors are pulsed once for each engine revolution, each spray providing 1/2 the fuel required for the combustion process. Thus, 2 injections of fuel (2 rotations of crankshaft) are mixed with incoming air to produce the fuel charge for each combustion cycle.

Some models use Sequential Fuel Injection (SFI). Injectors on these models are pulsed sequentially in spark plug firing order. The main differences between sequential and simultaneous systems are injectors, wiring and the PCM.

In all systems, constant fuel pressure is maintained to the injectors. Air/fuel mixture is regulated by amount of time injector stays open (pulse width). Various sensors provide information to the PCM to control pulse width.

IDLE SPEED

PCM controls engine idle speed based upon engine operating conditions. The PCM senses engine operating conditions and determines the best idle speed.

Idle Air Control Valve

The Idle Air Control (IAC) valve controls engine idle speed during engine load changes to prevent stalling. The IAC valve is mounted on throttle body or on upper manifold assembly, and controls the amount of air by-passed around the throttle plate. To control engine idle speed, the IAC valve moves its pintle in and out in steps referred to as "counts" (zero counts, fully seated; 255 counts, fully retracted). Counts can be measured using a scan tester plugged into the Data Link Connector (DLC).

Normal counts on an idling engine should be 4-60. When engine is idling, PCM determines proper positioning of IAC valve based on battery voltage, engine coolant temperature, engine load and engine RPM. If engine RPM is too low, pintle is retracted and more air is by-passed around the throttle plate to increase engine RPM. If engine RPM is too high, pintle is extended and less air is by-passed around the throttle plate to decrease engine RPM.

If IAC valve is disconnected or connected with engine running, IAC loses its reference point and has to be reset. Resetting of IAC is accomplished on some models by turning ignition on and off. On other models, driving vehicle at normal operating temperature and speed greater than 35 MPH with circuit properly connected may be necessary. Problems in IAC circuit should set a related diagnostic trouble code.

The IAC valve affects only the idle system. If valve is stuck fully open, excessive airflow into the manifold creates a high idle speed. Valve stuck closed allows insufficient airflow, resulting in low idle speed. For calibration purposes, several different design IAC valves are used. Ensure proper design valve is used during replacement.

IGNITION SYSTEM

All vehicles are equipped with a high energy ignition system capable of producing in excess of 50,000 volts.

OPTI-SPARK

The PCM supplies and monitors two 5-volt reference signals to the Opti-Spark ignition control module inside of the sealed distributor, one on high resolution signal line (360 pulses per camshaft revolution) and one on low resolution signal line (8 pulses per camshaft revolution). Ignition control module will toggle these signals between zero and 5 volts as the camshaft turns. Camshaft-driven distributor is mounted behind water pump.

PCM uses these monitored reference signals in calculations used to control ignition timing. After computing necessary changes to ignition timing, PCM triggers ignition coil through the ignition coil driver. Unlike other type ignition systems, Opti-Spark does not use a by-pass circuit. Timing is always in EST mode.

By comparing the high and low resolution inputs, PCM can determine the position of cylinder No. 1 and TDC position. If either signal is missing, a diagnostic trouble code will set in PCM memory.

IGNITION TIMING SYSTEMS

NOTE: Unlike other type ignition systems, 4.3L and 5.7L with Opti-Spark do not use a by-pass circuit. Ignition timing on this system is constantly in EST mode.

Ignition Timing Advance

At engine speeds less than 400 RPM, the ignition control module controls spark advance by triggering coils at a predetermined interval based only on engine speed. At engine speeds greater than 400 RPM (EST mode), the PCM takes over control of the ignition timing.

PCM controls ignition timing based upon input signals from the engine RPM reference line (ignition control module), engine coolant temperature sensor, intake air temperature sensor, throttle position sensor, knock sensor, vehicle speed sensor, and the MAF or MAP sensor.

The PROM portion of the PCM has a programmed spark advance curve based on engine speed. Spark timing is calculated by PCM whenever an ignition pulse is present. Spark advance is controlled only when engine is running (not during cranking). Input signal values are used by PCM to modify PROM information, increasing or decreasing spark advance to achieve maximum performance with minimum emissions. To check ignition system operation, see **BASIC TESTING** or I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

All models use a an Opti-Spark system. See IGNITION SYSTEM.

- **By-Pass**

When an engine speed signal of approximately 400 RPM is received by the PCM, PCM considers engine to be running and applies 5 volts to the ignition control module on the by-pass wire. This causes ignition control module to switch timing control over to the variable timing control circuit in the PCM. An open or grounded by-pass circuit will set a related diagnostic trouble code in PCM memory. The engine will run at base timing

plus a small amount of advance.

- **EST**

When 5 volts is present on the by-pass circuit and ignition control module has turned control of engine timing over to PCM, the PCM advances or retards spark on this circuit based on calculations involving the reference signal and other sensor input signals. If base timing is incorrectly set, entire advance curve will be incorrect.

- **Ground**

This is the reference ground circuit. It is grounded at distributor and PCM, ensuring no voltage drop occurs in the EST circuit which could affect ignition operation.

- **Reference (RPM)**

Alternating current signals from the pick-up coil (HEI distributor), PM generator (DIS) is converted by the ignition control module converter to digital signals for use by PCM. This supplies RPM data and crankshaft position reference to PCM. Because signal on this circuit is used as an injector trigger reference, engine will not run if circuit is open or grounded.

Knock Sensor Operation

In conjunction with the ignition system, a knock sensor retard system is used. System consists of a knock sensor, knock sensor module (if equipped) and PCM. When detonation (engine knock) occurs, knock sensor produces a low voltage AC signal. This signal inputs to the PROM or knock sensor module (if equipped) located internal of PCM.

PCM supplies a 5-volt DC reference signal on the knock sensor signal line. Internal circuitry of the knock sensor will pull this voltage down to about 2.5 volts. When detonation (engine knock) occurs, the knock sensor produces an AC voltage signal which rides on the 2.5-volt DC signal back to the knock sensor module or PCM. The voltage and frequency of this signal depend upon knock signals received by the knock sensor. The PCM will retard ignition control timing until signals from knock sensor cease.

Failure in knock sensor circuit should set a related diagnostic trouble code. If a related diagnostic trouble code is not present and the knock sensor system is suspected as the cause of a driveability problem, perform a functional check of the knock sensor. See appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

EMISSION SYSTEMS

NOTE: To determine emission systems usage, see appropriate EMISSION APPLICATIONS article in the ENGINE PERFORMANCE.

AIR INJECTION SYSTEM

Air injection system helps reduce hydrocarbon (HC), carbon monoxide (CO) and oxides of nitrogen (NOx) exhaust emissions by injecting air into the exhaust system. The induction of additional air promotes further oxidation (combustion) of unburned and partially burned exhaust gases. During cold engine operation, air is injected into exhaust manifold. This quickly warms up catalytic converter and oxygen sensor. When vehicle warms up, air is diverted to atmosphere or to the catalytic converter. See CATALYTIC CONVERTER.

Air Pump (Electric)

Air pump is a sealed, non-serviceable, electric-motor type. Pump is energized by an PCM-controlled air pump relay, which is activated when fuel system is functioning in "open loop" mode and/or less than a predetermined amount of time has passed since relay was energized. See ELECTRIC AIR PUMP RELAY.

Check Valve

The check valve prevents the backflow of exhaust gases into the air injection system. The check valve closes when exhaust gas pressure in exhaust manifold exceeds pressure delivered by pump. This occurs when air pump by-passes at high speeds, air delivery is switched to catalytic converter, air is diverted to atmosphere or air cleaner, or air pump malfunctions.

Electric Air Pump Relay

When vehicle is cold ("open loop" mode), PCM provides a ground for the electric air pump relay. When relay is energized, power is supplied to the electric air pump. When fuel system goes into "closed loop" or electric air pump has been on for more than a precalibrated period, the PCM opens the ground circuit. When relay is de-energized on, air is diverted to the atmosphere until air pump stops spinning, or an internal stop valve closes when relay is de-energized.

CATALYTIC CONVERTER

A 3-way catalytic (TWC) converter is used on all vehicles to reduce exhaust emissions. This type of converter reduces hydrocarbon (HC), carbon monoxide (CO) and oxides of nitrogen (NOx) levels.

TWC

Converter contains a reducing agent (Rhodium and Platinum) to reduce NOx and an oxidizing agent (Palladium and Platinum) to oxidize HC and CO. This causes HC and CO to oxidize (break down with the addition of oxygen and heat) into the harmless base elements: water (H2O) and carbon dioxide (CO2). Oxygen is removed from NOx, causing it to reduce to the harmless base elements nitrogen (N) and oxygen (O2).

EXHAUST GAS RECIRCULATION (EGR)

The Exhaust Gas Recirculation (EGR) system is designed to reduce oxides of nitrogen (NOx) emissions by lowering combustion temperatures. This is accomplished when a metered amount of exhaust gas is recirculated into the intake manifold and mixed with the air/fuel mixture.

The 2 types of EGR systems used are pulse width modulated negative backpressure EGR using an EGR solenoid and either ported or manifold vacuum, and digital or linear EGR.

On PCM-controlled EGR systems using a solenoid, PCM controls ported or manifold vacuum to EGR valve through solenoid valve. Solenoid may be normally open or normally closed, depending upon application.

PCM uses engine coolant temperature, throttle position and manifold pressure signals to determine vacuum solenoid operation. During cold engine operation and idle, EGR is not desired; PCM causes solenoid to block vacuum to EGR valve. During warm engine operation and at speeds greater than idle, vacuum is allowed through solenoid, opening EGR valve. To check EGR system, perform functional check of EGR system. See appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

Digital EGR System

The digital EGR valve is designed to accurately supply EGR to engine, independent of intake manifold vacuum. The valve controls EGR flow from exhaust to intake manifold through 3 internally-mounted solenoids. When each solenoid is energized, a pintle is lifted to allow exhaust gas to flow through valve. Solenoids are energized individually, in pairs or together to provide 7 different EGR flow ratios. This enables PCM to tailor EGR flow to specific engine requirements.

Linear EGR System

The linear EGR valve is designed to accurately supply EGR to engine, independent of intake manifold vacuum. The valve controls EGR flow from exhaust to intake manifold through an orifice with a PCM-controlled pintle. PCM controls pintle position by monitoring the pintle position feedback signal.

Negative Backpressure EGR Valve

EGR uses negative backpressure EGR valve. Backpressure EGR also use an PCM-controlled solenoid to regulate vacuum signal to EGR valve. Vacuum is applied to upper EGR diaphragm via a hose connected to intake manifold vacuum. Manifold vacuum is also applied to lower EGR diaphragm (through intake port at base of EGR valve). When manifold vacuum in lower chamber is insufficient to overcome spring tension on lower diaphragm, bleed valve will be closed, allowing vacuum in upper chamber to open EGR valve. With engine at idle or under light load, high manifold vacuum applied to lower chamber opens air bleed valve in lower diaphragm. This bleeds off vacuum in upper chamber, keeping the EGR valve closed.

EVAPORATIVE EMISSION CONTROL

Carbon canister storage is used for evaporative fuel control on all vehicles. The function of evaporative emission control system is to store gasoline fumes from fuel tank in a carbon canister until fumes can be drawn into engine for burning during combustion process.

Evaporative emission system uses 4 basic components:

- Activated carbon canister (may be sealed or open at top or bottom for fresh air intake).
- Tank pressure control valve (mounted internally or externally to fuel tank).
- PCM-controlled canister purge control solenoid (mounted in -line or on canister).

- Canister purge control valve (mounted in-line or on canister).

For specific emission component application, see EMISSION APPLICATIONS article. For vacuum hose routing, see **VACUUM DIAGRAMS** article in the ENGINE PERFORMANCE.

Carbon Canister

Evaporative fumes from the fuel tank are vented through hoses into a canister containing activated carbon. The activated carbon absorbs and holds fuel vapors when the engine is not operating. When the engine is started and engine speed is greater than idle (purge at idle would cause too rich a mixture), engine vacuum draws fuel vapors from the canister into the engine. Regulation of vapors through this purge line is controlled by a PCM-controlled canister purge control solenoid.

Carbon canisters are either open or closed design. When the engine is started on open canister models, engine vacuum draws outside air into canister either through the top or through a filter in bottom of canister. This helps to purge vapors from the activated carbon.

NOTE: Models without fuel tank pressure control valves may use a special pressure/vacuum relief fuel tank filler cap or other external relief device.

Canister Purge Control Solenoid

Canister purge control solenoid is controlled by the PCM. Current is supplied to solenoid when the ignition is on. Solenoid is energized when PCM provides a ground circuit for solenoid. Solenoid may be normally closed or normally open. When solenoid is open, charcoal canister is purged using manifold or ported vacuum. When solenoid is closed, purge vacuum to canister is blocked.

The PCM will allow vacuum to pass through solenoid when engine has been running for more than one minute, coolant temperature is greater than 176°F (80°C), vehicle speed is greater than 5 MPH and throttle is off idle. This solenoid (if used) is located in the purge line between charcoal canister and vacuum purge port, or on top of canister.

Canister Purge Control Valve

Canister purge control valve is a vacuum regulated/purge control valve located in vapor delivery hose between fuel tank and carbon canister, or on top of canister. When engine is not running and tank pressure is less than .7 psi (.49 kg/cm^2), internal spring pressure holds valve in the closed position.

This causes fuel tank low-pressure vapors to be vented through a restriction in valve. This restriction will retain most fuel tank vapors in fuel tank. When tank pressure rises and overrides spring tension, fumes are vented to the carbon canister. When engine is running, vacuum is applied to upper port of valve, opening passage between fuel tank and carbon canister, which is purged by engine vacuum.

Tank Pressure Control Valve

Tank pressure control valve is a vacuum regulated/pressure control valve located in fuel tank or in vapor delivery hose between fuel tank and carbon canister. When engine is not running and tank pressure is less

than .9 psi (.63 kg/cm^2), internal spring pressure holds valve in the closed position.

This causes fuel tank low-pressure vapors to be vented through a restriction in valve. This restriction will retain most fuel tank vapors in fuel tank. When tank pressure rises and overrides spring tension, fumes are vented to the carbon canister. When engine is running, vacuum is applied to upper port of valve, opening passage between fuel tank and carbon canister, which is purged by engine vacuum.

POSITIVE CRANKCASE VENTILATION (PCV)

The PCV system is used to provide more effective elimination of crankcase vapors. Fresh air from the air filter housing or throttle body is supplied to the crankcase where it is mixed with blow-by gases and passed through a PCV valve into the intake manifold. This mixture is then passed into the combustion chamber and burned.

The PCV valve provides primary control in this system by metering the flow of the blow-by vapors, according to manifold vacuum. When manifold vacuum is high (at idle), the PCV restricts the flow to maintain a smooth idle condition.

Under conditions in which abnormal amounts of blow-by gases are produced (such as worn cylinders or rings), the system is designed to allow the excess gases to flow back through crankcase vent hose into the intake or throttle body to be consumed during normal combustion.

SELF-DIAGNOSTIC SYSTEM

The PCM is equipped with a self-diagnostic system which detects system failures or abnormalities. When a malfunction occurs, PCM will illuminate the Malfunction Indicator Light (MIL) located on instrument cluster. When malfunction is detected and MIL is turned on, a corresponding diagnostic trouble code will be stored in PCM memory. Malfunctions are designated as either "hard failures" or as "intermittent failures". To retrieve stored codes, see appropriate appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section below.

- **TESTS W/CODES - 4.3L** (for Caprice Only)
- **TESTS W/CODES - 5.7L** (for All Models)

"Hard Failures"

Hard failures cause MIL to illuminate and remain on until the malfunction is repaired. On models using digital display on dash to indicate codes, codes may be accompanied by a "current" or "history" indication for intermittent and hard codes. If light comes on and remains on during vehicle operation, cause of malfunction must be determined using diagnostic trouble code charts located in appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section below. If a sensor fails, PCM will use a substitute value in its calculations to continue engine operation. In this condition, vehicle is functional but loss of good driveability is likely.

- **TESTS W/CODES - 4.3L** (for Caprice Only)
- **TESTS W/CODES - 5.7L** (for All Models)

"Intermittent Failures"

Intermittent failures cause MIL to flicker or glow and go out about 10 seconds after the intermittent fault goes away. The corresponding diagnostic trouble code, however, will be retained in PCM memory. On models using digital display on dash to indicate codes, codes may be accompanied by a "current" or "history" indication for intermittent and hard codes. If related fault does not reoccur within 50 engine restarts, related diagnostic trouble code will be erased from PCM memory. Intermittent failures may be caused by sensor, connector or wiring related problems. See **TESTS W/O CODES** article in the ENGINE PERFORMANCE section.

MALFUNCTION INDICATOR LIGHT (MIL)

As a bulb and system check, MIL will illuminate when ignition switch is turned to ON position and engine is not running. When engine is started, light should go out. If light does not go out, a malfunction has been detected in the computerized engine control system or MIL circuit is faulty. Light may be used on some models to display stored diagnostic trouble codes. To access codes using "scan" or "non-scan" methods, see appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section below.

SERIAL DATA

PCM is equipped with a serial data line. Serial data is a stream of electrical impulses which can be interpreted by special testers of other control modules. On some models, serial data and codes must be accessed using special "scan" testers connected to the Data Link Connector (DLC). Update intervals and information contained within the data stream vary with model application.

On some models, serial data may be accessed using the Driver Information Center (DIC) and Climate Control Panel (CCP). On these models, serial data may be shared with A/C controller, supplemental restraint controller, anti-lock brake controller and even cruise control unit.

MISCELLANEOUS CONTROLS

NOTE: Although not considered true engine performance-related systems, some controlled devices may affect driveability if they malfunction.

A/C COMPRESSOR CLUTCH

On many models, PCM regulates operation of the A/C compressor clutch through a PCM-controlled A/C compressor clutch relay. This allows the PCM to disengage the A/C compressor when compressor load on engine may cause driveability problems (i.e., during hot restart, idle, low speed steering maneuvers and wide open throttle operation), or if A/C refrigerant pressure drops below or rises above normal operating levels.

Refrigerant pressure sensing may be accomplished by monitoring high and low pressure switches or a pressure sensor which will register either high or low pressure levels. Power steering load is monitored through a power steering pressure switch. Hot restart is monitored through the coolant temperature sensor. For component application and related wiring, see A/C wiring schematics under MISCELLANEOUS CONTROLS in appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section below.

- **TESTS W/CODES - 4.3L** (for Caprice Only)
- **TESTS W/CODES - 5.7L** (for All Models)

A/C Pressure Sensor

Some models are equipped with an air conditioner pressure sensor which is used to inform PCM of A/C system pressure levels. Low pressure signal will cause A/C compressor to disengage to prevent system damage. High pressure levels cause PCM to engage high speed fans while A/C compressor clutch is engaged. Extremely high pressure levels will cause PCM to disengage A/C compressor clutch to prevent system damage.

A/C Pressure Switches

A/C high and low pressure switches may be used in the PCM-monitored A/C request circuit. Switches are normally closed, completing the circuit between ignition and PCM. PCM will engage or disengage A/C compressor clutch relay based upon status of this circuit. When system refrigerant pressure increases beyond a certain point, high side switch will open, causing A/C request circuit voltage to drop.

If system refrigerant level decreases, causing refrigerant pressure to drop below normal, low side pressure switch will open, causing A/C request circuit voltage to drop. Switches may be used as normal clutch cycling devices or as safety devices which prevent compressor damage in the event of excessively high or low refrigerant pressure.

ELECTRIC COOLING FAN

On many models, PCM regulates operation of electric cooling fan through a PCM-controlled cooling fan relay which controls the ground circuit or power circuit for the cooling fan. This allows PCM to operate cooling fan based upon engine coolant temperature. Most systems will engage electric cooling fan whenever A/C clutch is engaged, regardless of engine temperature. A malfunction of the cooling fan will cause engine overheating and possible detonation.

Some models use more than one cooling fan. The second fan may function as an auxiliary cooling device when A/C is engaged or (on models using A/C high and low pressure switches) during periods of engine overheating, or high A/C refrigerant pressures.

For component application and related wiring, see wiring schematics under MISCELLANEOUS CONTROLS in appropriate appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

HOT LIGHT OR COOLANT TEMPERATURE LIGHT

When engine coolant temperature sensor input indicates temperature exceeds specified range, PCM will turn on the TEMP or HOT light by providing a ground for the light circuit. As a bulb check, PCM also supplies a ground to turn on light when ignition is first turned on.

TRANSMISSION

Torque Converter Clutch (Non-Electronic Transmission)

The purpose of the transmission/transaxle converter clutch feature is to eliminate power loss of torque converter stage when vehicle is in a cruise condition. This allows convenience of automatic transmission/transaxle and fuel economy of a manual transmission.

Fused battery ignition is supplied to TCC solenoid through a brake switch. On some models, gear hydraulic apply switches (located within the transmission) may also be in series with solenoid power or ground circuit. For wiring reference, see wiring schematics under MISCELLANEOUS CONTROLS in appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

Converter clutch will engage when vehicle is moving faster than a precalibrated speed, engine is at normal operating temperature, throttle position sensor output is not changing (indicating a steady vehicle speed), transmission 3rd gear switch is closed (if equipped), and brake switch is closed.

When vehicle speed is great enough (about 20-45 MPH as indicated by the vehicle speed sensor), PCM energizes TCC solenoid mounted in transmission. This allows torque converter to directly connect engine to the transmission. When operating conditions indicate transmission should operate as normal, TCC solenoid is de-energized.

This allows transmission to return to normal automatic operation. Since power for the TCC solenoid is delivered through the brake switch, transmission will also return to normal automatic operation when brake pedal is depressed. To check TCC system, perform functional check of TCC system. See MISCELLANEOUS CONTROLS in appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

Torque Converter Clutch (Electronic Transmission)

The torque converter clutch functions similarly to the non-electronic type except instead of a single internal TCC solenoid, 2 solenoids are used. A standard TCC solenoid is used in conjunction with a Pulse Width Modulated (PWM) solenoid that regulates hydraulic pressure to make locking and unlocking of the TCC smoother.

Electronic Transmission

On vehicles equipped with electronic transmission, transmission is controlled by the Powertrain Control Module (PCM). PCM controls other vehicle functions as well as the transmission. The PCM monitors a number of engine/vehicle functions and uses the data to control shift solenoid "A", shift solenoid "B", TCC and, on some models, transaxle pressure control solenoid to regulate TCC engagement, upshift pattern, downshift pattern and line pressure (shift quality).

- **Shift Solenoid "A"**

Shift solenoid "A" is attached to the valve body and is a normally open exhaust valve. PCM activates solenoid by grounding it through an internal quad-driver. Solenoid "A" is on in 1st and 4th gears but off in 2nd and 3rd gears. When on, solenoid redirects fluid to act on the shift valves.

- **Shift Solenoid "B"**

Shift solenoid "B" is attached to the valve body and is a normally open exhaust valve. PCM activates solenoid by grounding it through an internal quad-driver. Solenoid "B" is on in 3rd and 4th gears but off in 1st and 2nd gears. When on, solenoid redirects fluid to act on the shift valves.

- **Transaxle Pressure Control Solenoid**

Transaxle pressure control solenoid is attached to the valve body and controls line pressure by moving a pressure regulator valve against spring pressure. Transaxle pressure control solenoid takes the place of the force motor used on past model transmissions. PCM varies line pressure based upon engine load. Engine load is calculated from various inputs, especially the TP sensor.

Line pressure is actually varied by changing the amperage applied to the transaxle pressure control solenoid from zero (high pressure) to 1.1 amps (low pressure). The transaxle pressure control solenoid is periodically pulsed to prevent the pressure regulator valve from sticking due to fluid contamination.

Shift Light

The shift light is used on M/T models. Light indicates the best transmission shift point for maximum fuel economy based on engine speed and load. Power for light is supplied through the GAUGES fuse. Light illuminates when PCM supplies a ground circuit for bulb. For wiring reference, see MISCELLANEOUS CONTROLS in appropriate I - SYSTEM & COMPONENT TESTING article in the ENGINE PERFORMANCE section below.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

WIRING DIAGRAMS

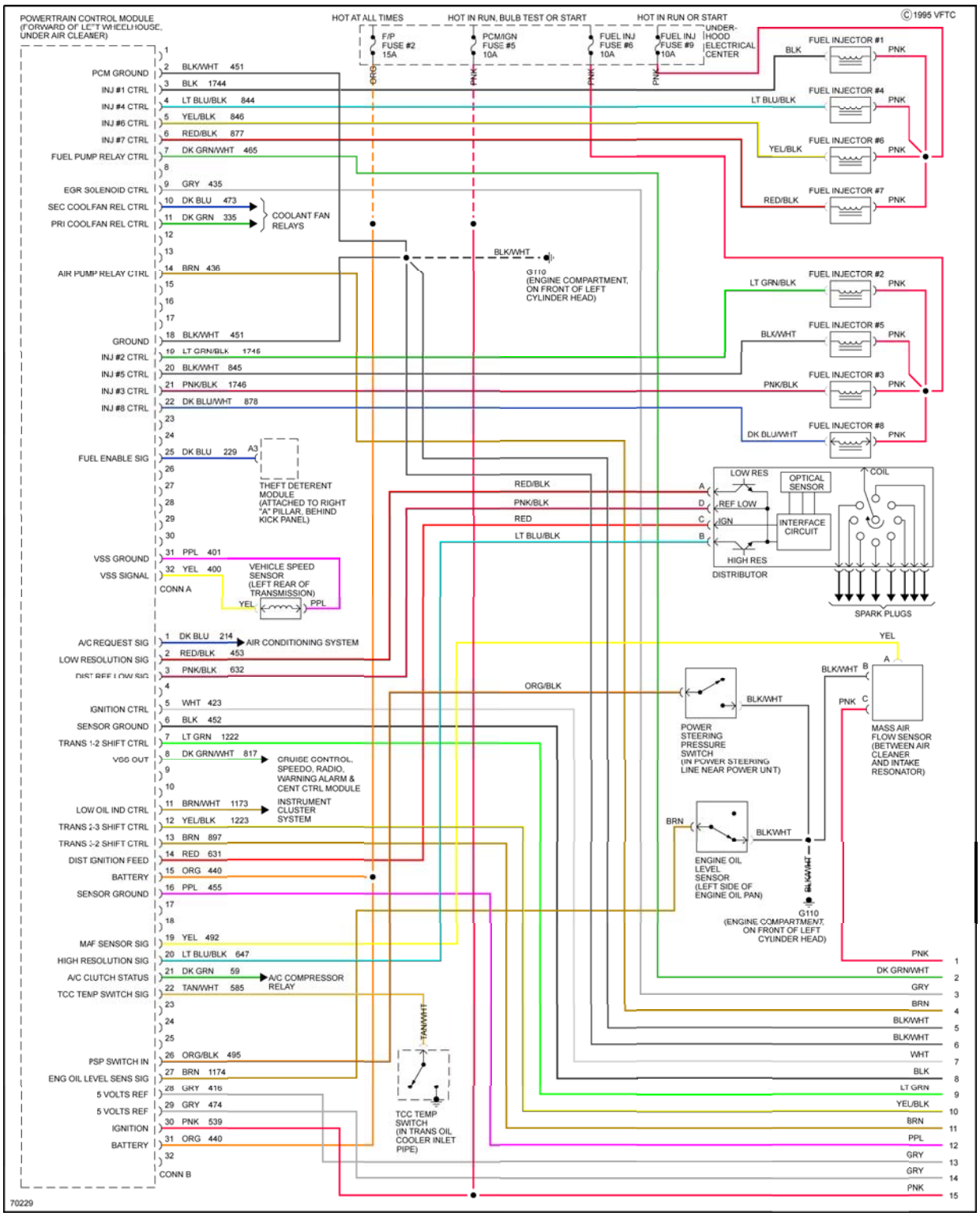


Fig. 1: 4.3L (VIN W) & 5.7L (VIN P) PCM Wiring Diagram (All Models - 1 Of 3)

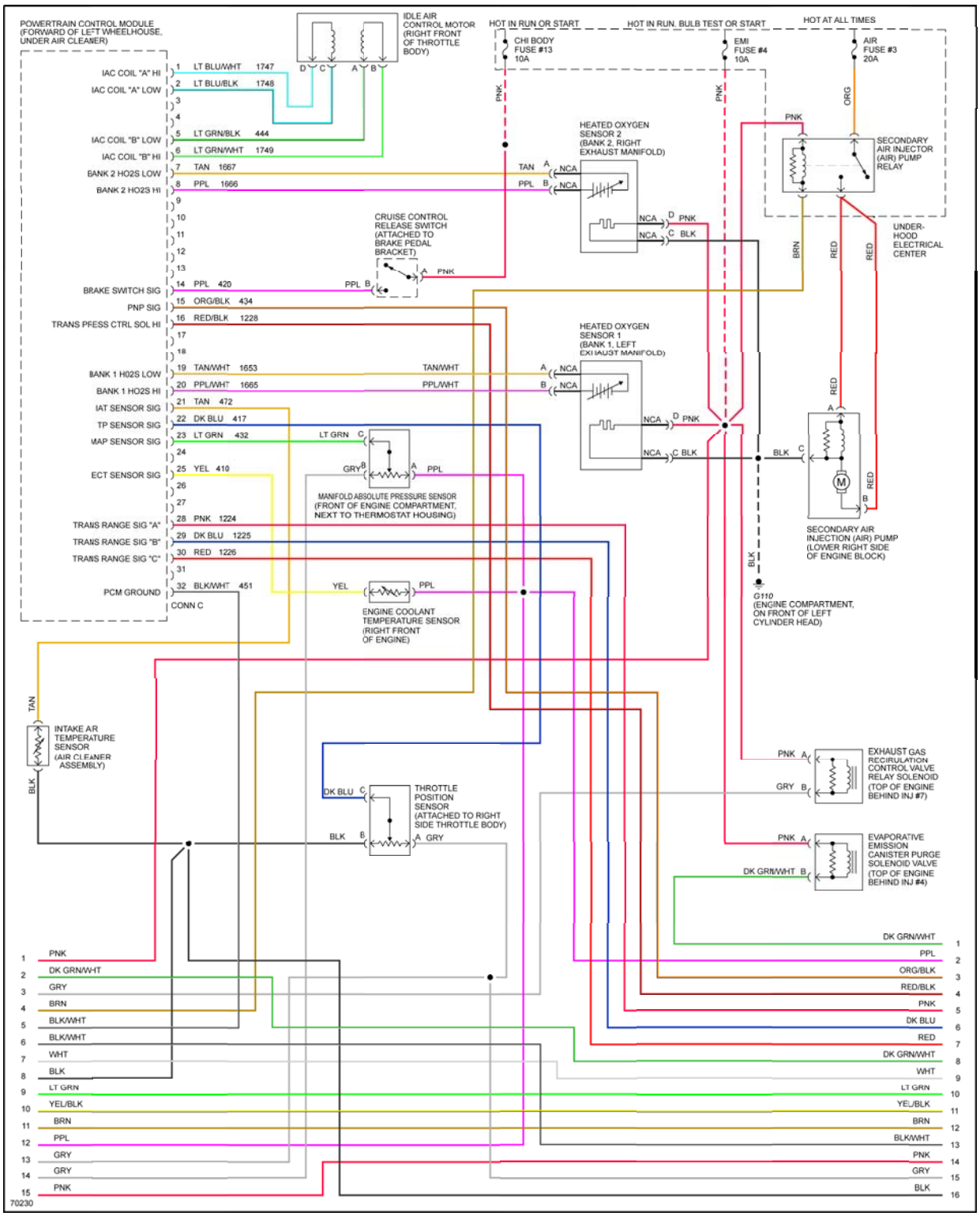


Fig. 2: 4.3L (VIN W) & 5.7L (VIN P) PCM Wiring Diagram (All Models - 2 Of 3)

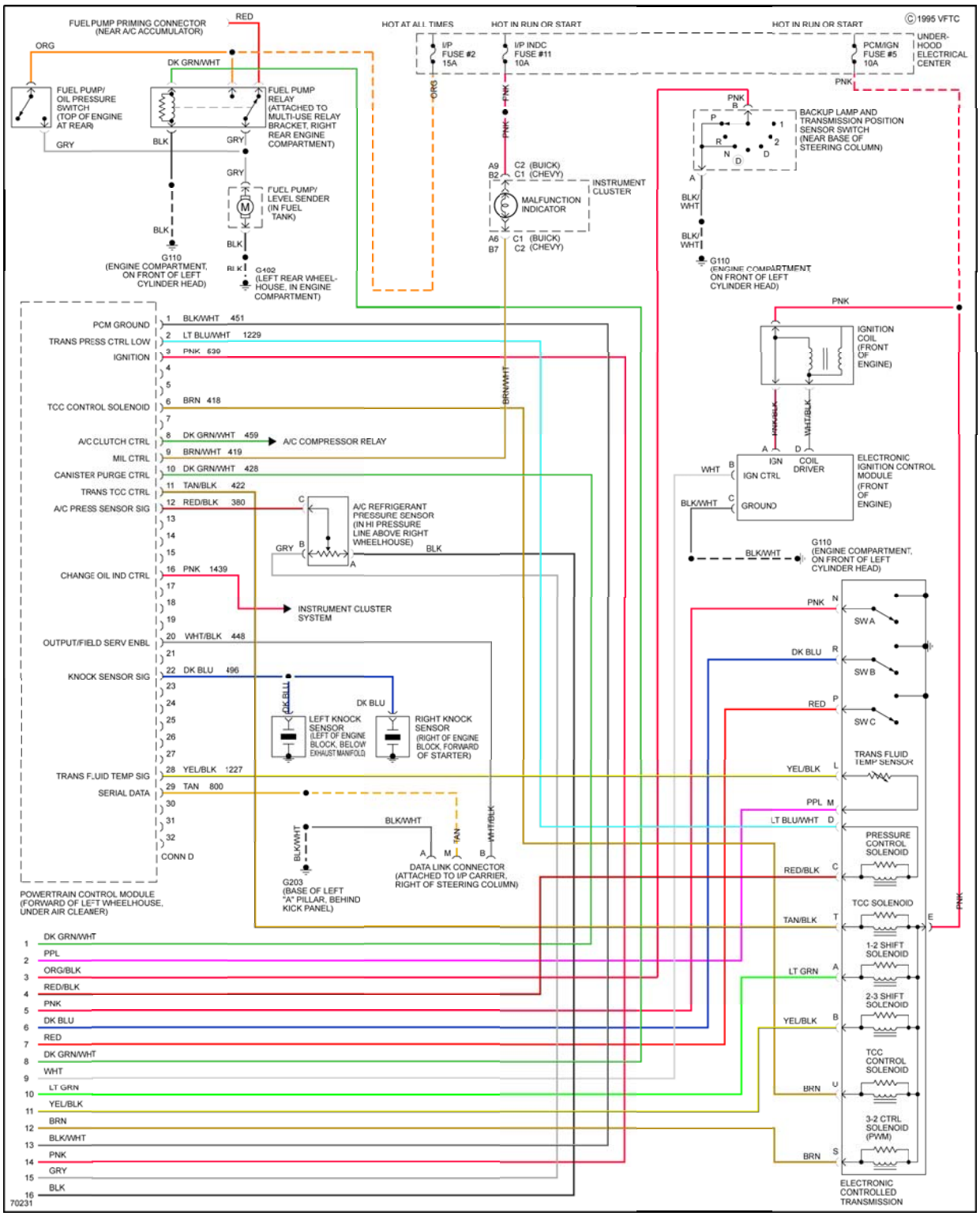


Fig. 3: 4.3L (VIN W) & 5.7L (VIN P) PCM Wiring Diagram (All Models - 3 Of 3)

ENGINE COOLING FAN

ELECTRIC COOLING FANS General Motors Corp.

DESCRIPTION & OPERATION

DESCRIPTION

Several descriptions of the cooling system and fans follow.

Overview

Three different cooling system options are available:

- Base cooling system
- Extra-capacity cooling system ("V03")
- Heavy-duty cooling system ("V08")

Each system has a different cooling fan arrangement. See **COOLING FAN OPTIONS** table for a summary of all the fan configurations. See **Fig. 1** for a view of the different fan configuration.

The following text provides a high-level overview of each type of available cooling system.

Base Cooling System

The base version consists of an aluminum core with plastic end tanks radiator, a pressurized coolant recovery reservoir, an engine water pump driven by the camshaft gear (not by the drive belt), thermostat, and two-electric motor-driven fans. The right-hand end tank of the radiator contains a transmission oil cooler.

Extra-Capacity Cooling System

The extra-capacity cooling system ("V03") has the same components except that the left-hand electric motor-driven fan has a larger size motor and the left-hand end tank of the radiator is larger to allow for an engine oil cooler provided within that end tank.

Heavy-Duty Cooling System

The heavy-duty cooling system ("V08") has the same components as the extra-capacity cooling system except that the right-hand electric motor-driven cooling fan is replaced by a belt-driven hydraulic clutch-controlled fan. The coolant hoses connecting the engine to the radiator on the heavy duty cooling system have metal sections for protection from the belt-driven fan blades.

OPERATION

The operation of several subsystems are described below.

Overview

The electric cooling fan(s) are controlled by the PCM. The PCM controls the ground path for the cooling fan relay(s).

The relay(s) are used to control the high current flow to power the cooling fan motors. The PCM determines operation of the independent fans base on various sensor inputs.

Primary Cooling Fan

The primary cooling fan is controlled by the PCM based on inputs from the A/C system, Engine Coolant Temperature (ECT) sensor, Vehicle Speed Sensor (VSS).

The PCM will turn the primary cooling fan ON when any of the following conditions exist at idle:

- Certain PCM Diagnostic Trouble Codes (DTCs) set.
- ECT above 225°F (107°C)
- A/C head pressure above 189 PSI.

Once the primary fan has been turned ON by the Engine Coolant Temperature (ECT) sensor, the PCM will turn the fan OFF when that temperature has dropped about 7°F (4°C). If the primary cooling fan has been turned ON by high A/C head pressure, the PCM will turn the fan OFF when the pressure has dropped to 150 PSI. The minimum ON time for the primary cooling fan is 50 seconds.

Secondary Cooling Fan

The secondary cooling fan is controlled by the PCM based on inputs from the A/C system, Engine Coolant Temperature (ECT) sensor, Vehicle Speed Sensor (VSS).

The PCM will turn the secondary cooling fan ON when any of the following conditions exist at idle:

- Certain PCM Diagnostic Trouble Codes (DTCs) set.
- ECT above 232°F (111°C)
- A/C head pressure above 240 PSI.

Once the secondary fan has been turned ON by the Engine Coolant Temperature (ECT) sensor, the PCM will turn the fan OFF when that temperature has dropped about 7°F (4°C). If the primary cooling fan has been turned ON by high A/C head pressure, the PCM will turn the fan OFF when the pressure has dropped to 210 PSI. The minimum ON time for the primary cooling fan is 26 seconds.

NOTE: Vehicles equipped with the heavy-duty cooling system ("V08"), will have one mechanical fan (primary) and one electric fan (secondary).

COOLING FAN OPTIONS (1)

Coolant System	Left-Hand Fan	Right-Hand Fan
Base	Electric 100 Watt Motor	Electric 150 Watt Motor
Extra Capacity (V03)	Electric 240 Watt Motor	Electric 150 Watt Motor

Heavy-Duty (V08)	Electric 240 Watt Motor options.	Mechanical Belt-Driven
(1) See **Fig. 1** for a view of the different cooling fan.		

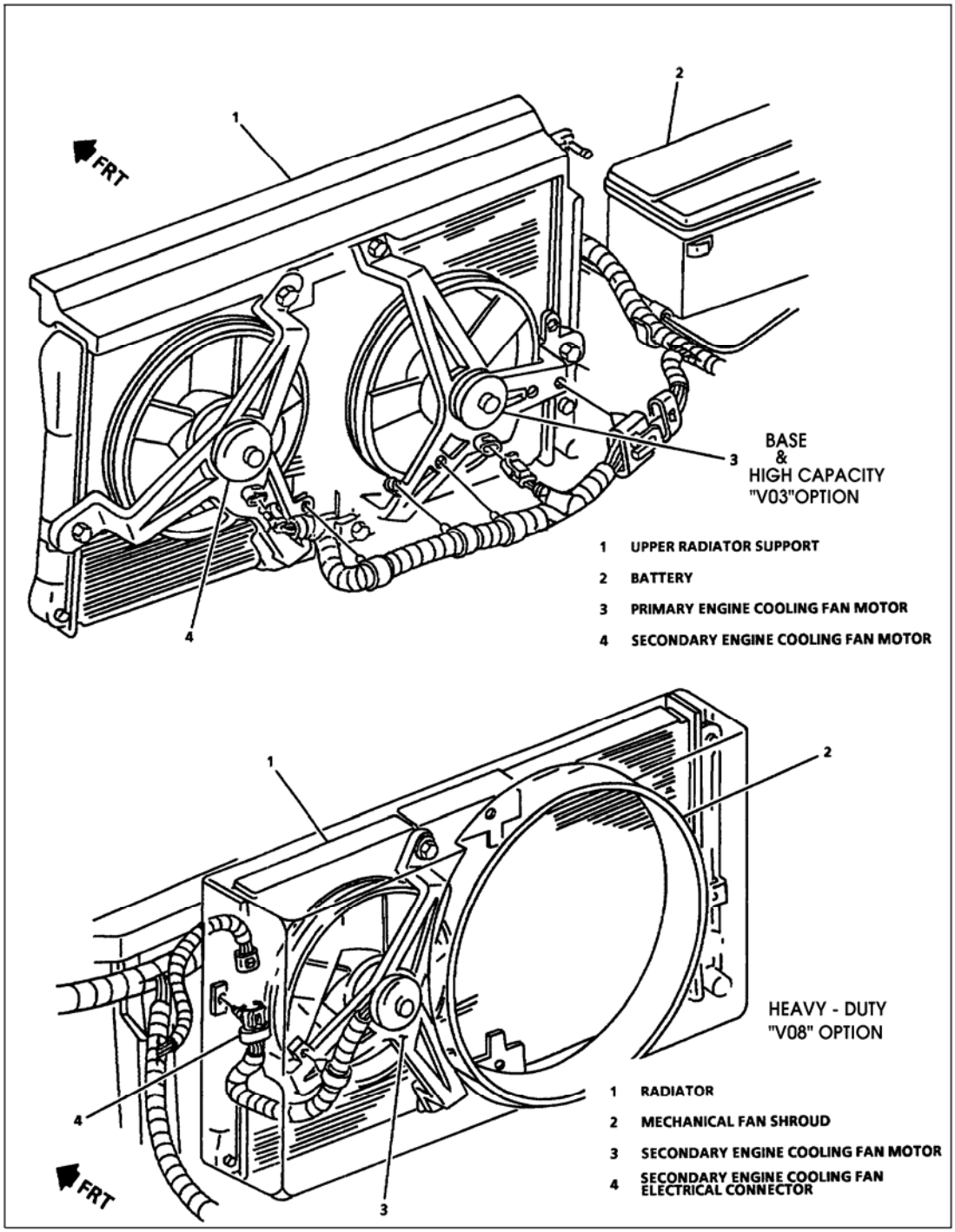


Fig. 1: Cooling Fan Configuration
Courtesy of GENERAL MOTORS CORP.

FUNCTIONAL CHECK & TESTING

To check for proper functioning of the cooling fan(s), proceed to the following C-12 Chart. This chart will also lead you through any diagnosis necessary to troubleshoot faults found with the system.

Chart C-12, Electric Cooling Fan Circuit Diagnosis

Cooling fans are controlled by Powertrain Control Module (PCM) based on various inputs. Battery voltage is supplied to terminal C4 of primary fan relay and terminal C1 of secondary fan relay. Ignition voltage is supplied to terminal B4 of primary fan relay and terminal B1 of secondary fan relay. Grounding circuit No. 335 will energize primary cooling fan relay and supply battery voltage to primary cooling fan motor. Grounding circuit No. 473 will energize secondary cooling fan relay and supply battery to secondary cooling fan motor. See **Fig. 2** for wiring diagram. When certain Diagnostic Trouble Codes (DTC) are set, PCM will energize cooling fans.

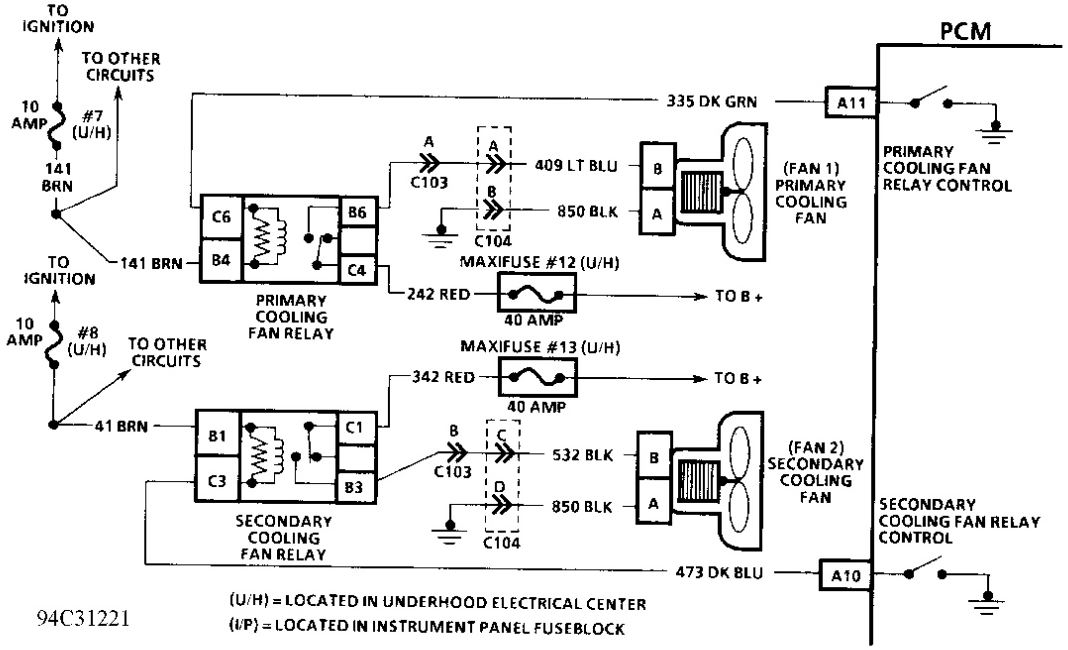


Fig. 2: Chart C-12 - Supplemental Wiring Diagram
Courtesy of GENERAL MOTORS CORP.

NOTE: Test numbers refer to numbers on diagnostic charts. See Fig. 3 and Fig. 4 .

1. With output/field service enable terminal grounded at DLC, cooling fan control driver(s) will close, energizing fan control relay(s).
2. Cooling fans should come on anytime A/C system is operating. Engine coolant temperature must be less

than 212°F (100°C) when performing this step.

3. Comparing Tech 1 scan tester pressure and manifold gauge set pressure will determine if A/C refrigerant pressure sensor is out of range. An out-of-range A/C pressure sensor can cause cooling fans to operate at the wrong times.

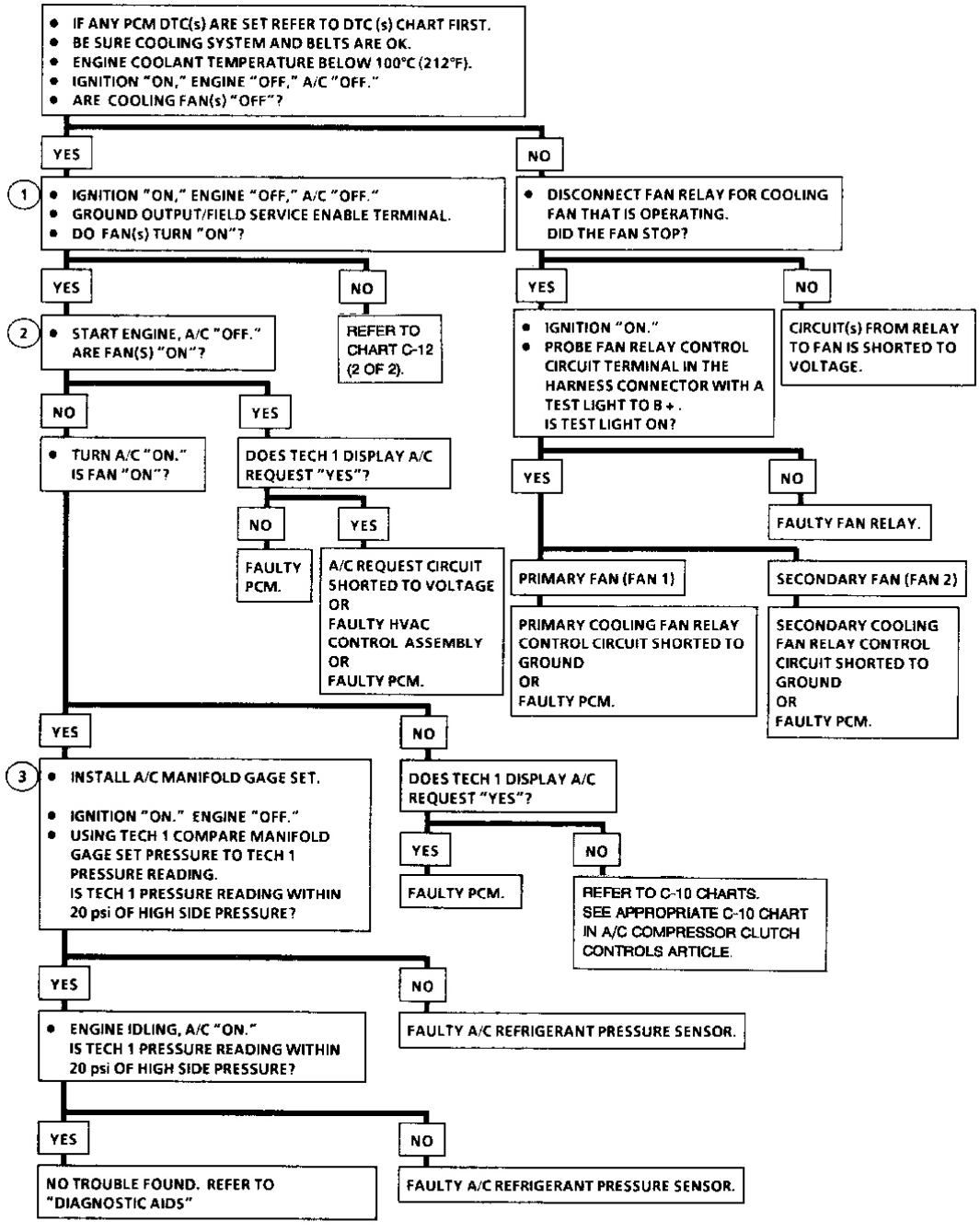


Fig. 3: Chart C-12 - Electric Cooling Fan Circuit Diagnosis (1 of 2)
Courtesy of GENERAL MOTORS CORP.

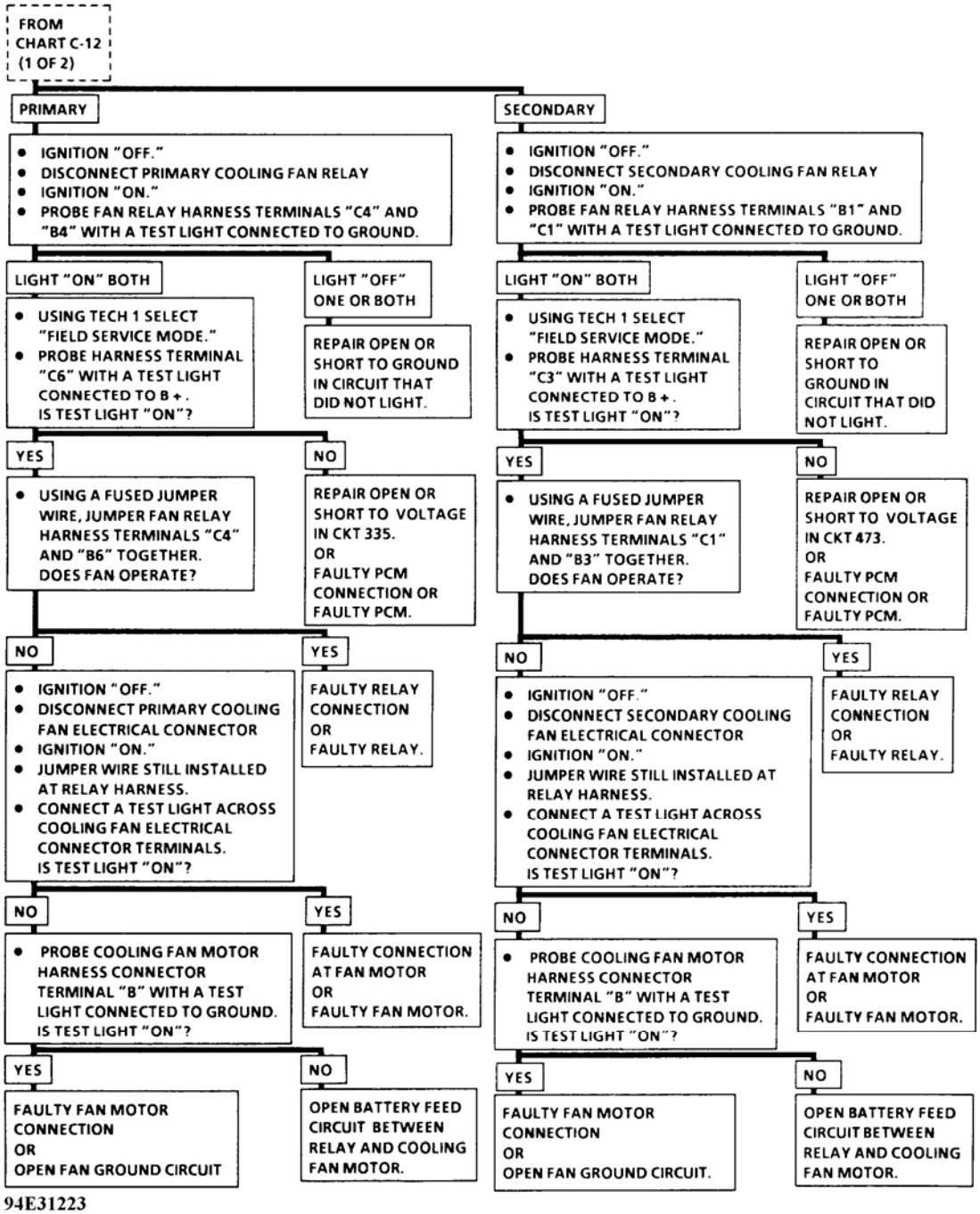


Fig. 4: Chart C-12 - Electric Cooling Fan Circuit Diagnosis (2 of 2)
Courtesy of GENERAL MOTORS CORP.

Diagnostic Aids for Chart C-12

1. Determine whether problem is an actual boilover, warning light or coolant temperature gauge malfunction. Using Tech 1 scan tester, check gauge accuracy by comparing Engine Coolant Temperature (ECT) sensor with gauge indication.
2. If engine is actually overheating and gauge indicates overheating, but cooling fans are off, ECT sensor has probably shifted out of calibration and should be replaced. If engine is overheating and cooling fans are on, check cooling system.
3. Primary cooling fan should come on at 225°F (107°C) and go off at 217°F (103°C). Secondary cooling fan should come on at 232°F (111°C) and go off at 224°F (107°C).

ELECTRICAL COMPONENT LOCATION

NOTE: For locations of components not listed and for terminal identification, see the wiring diagram, Fig. Fig. 5 .

COOLING FAN RELAY LOCATION

Application	Location
Cooling Fan Relay	Inside Electrical Center, On Right Rear Of Engine Compartment

WIRING DIAGRAM

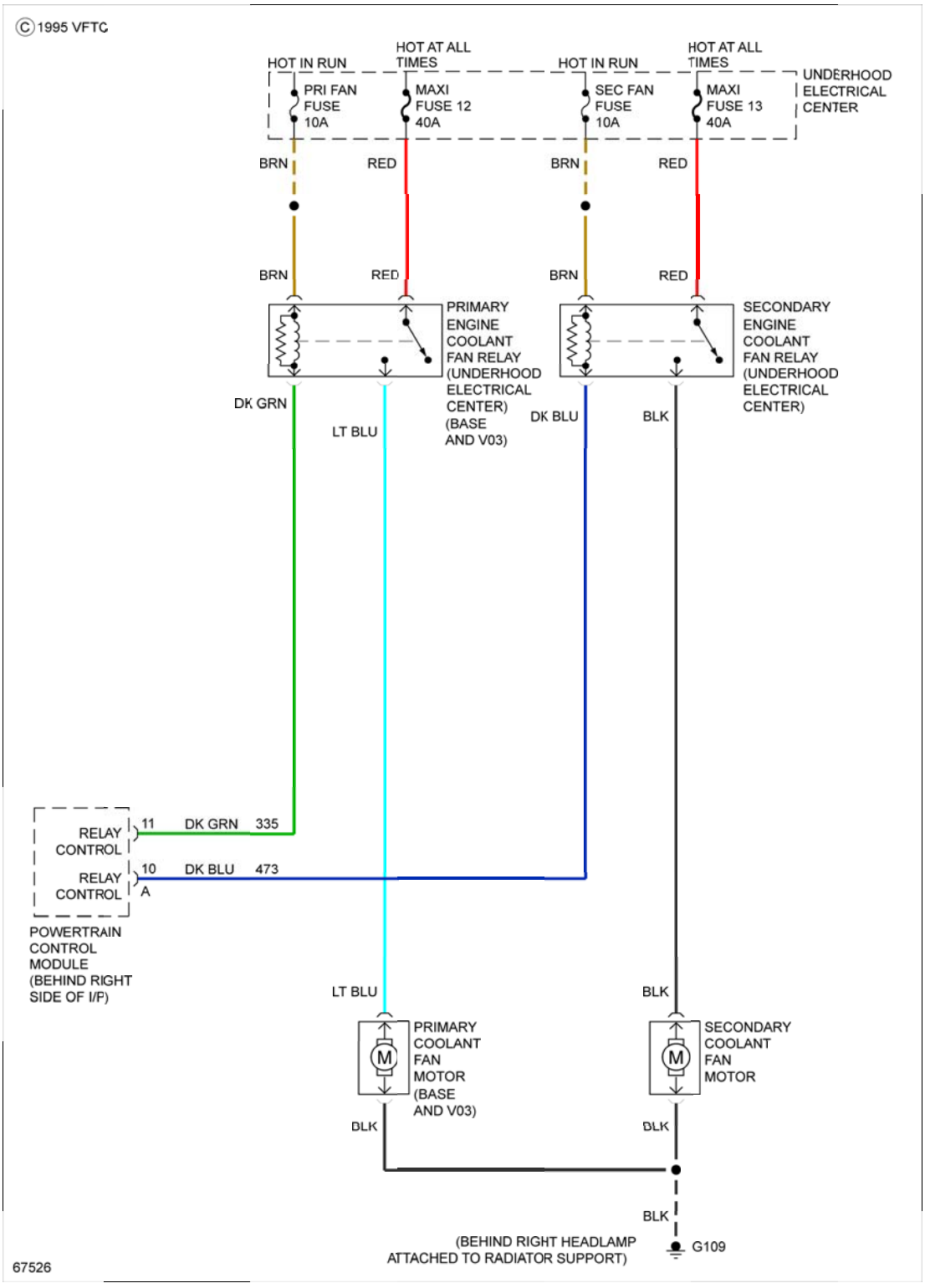


Fig. 5: Cooling Fan Circuit Wiring Diagram

GENERAL INFORMATION

Engine Overhaul Procedures

* PLEASE READ THIS FIRST *

NOTE: **Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.**

Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

DESCRIPTION

Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of cleaning, inspection, and assembly processes are included.

ENGINE IDENTIFICATION

Engine may be identified from Vehicle Identification Number (VIN) stamped on a metal tab. Metal tab may be located in different locations depending on manufacturer. Engine identification number or serial number is located on cylinder block. Location varies with each manufacturer.

INSPECTION PROCEDURES

*** PLEASE READ THIS FIRST ***

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GENERAL

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Engine components must be inspected to meet manufacturer's specifications and tolerances during overhaul. Proper dimensions and tolerances must be met to obtain proper performance and maximum engine life.

Micrometers, depth gauges and dial indicator are used for checking tolerances during engine overhaul. Magnaflux, Magnaglo, dye-check, ultrasonic and x-ray inspection procedures are used for parts inspection.

MAGNETIC PARTICLE INSPECTION

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Magnaflux & Magnaglo

Magnaflux is an inspection technique used to locate material flaws and stress cracks. Component is subjected to a strong magnetic field. Entire component or a localized area can be magnetized. Component is coated with either a wet or dry material that contains fine magnetic particles.

Cracks which are outlined by the particles cause an interruption of magnetic field. Dry powder method of Magnaflux can be used in normal lighting and crack appears as a bright line.

Fluorescent liquid is used along with a Black light in the Magnaglo Magnaflux system. Darkened room is required for this procedure. The crack will appear as a glowing line. Complete demagnetizing of component upon completion is required on both procedures. Magnetic particle inspection applies to ferrous materials only.

PENETRANT INSPECTION

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Zyglo

The Zyglo process coats material with a fluorescent dye penetrant. Component is often warmed to expand cracks that will be penetrated by the dye. Using darkened room and Black light, component is inspected for cracks. Crack will glow brightly.

Developing solution is often used to enhance results. Parts made of any material, such as aluminum cylinder heads or plastics, may be tested using this process.

Dye Check

Penetrating dye is sprayed on the previously cleaned component. Dye is left on component for 5-45 minutes, depending upon material density. Component is then wiped clean and sprayed with a developing solution. Surface cracks will show up as a bright line.

ULTRASONIC INSPECTION

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If an expensive part is suspected of internal cracking, ultrasonic testing is used. Sound waves are used for component inspection.

X-RAY INSPECTION

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This form of inspection is used on highly stressed components. X-ray inspection may be used to detect internal and external flaws in any material.

PRESSURE TESTING

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Cylinder heads can be tested for cracks using a pressure tester. Pressure testing is performed by plugging all but one of the holes of cylinder head and injecting air or water into the open passage.

Leaks are indicated by the appearance of wet or damp areas when using water. When air is used, it is necessary to spray the head surface with a soap solution. Bubbles will indicate a leak. Cylinder head may also be submerged in water heated to specified temperature to check for cracks created during heat expansion.

CLEANING PROCEDURES

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GENERAL

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All components of an engine do not have the same cleaning requirements. Physical methods include bead blasting and manual removal. Chemical methods include solvent blast, solvent tank, hot tank, cold tank and steam cleaning of components.

BEAD BLASTING

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Manual removal of deposits may be required prior to bead blasting, followed by some other cleaning method. Carbon, paint and rust may be removed using bead blasting method. Components must be free of oil and grease prior to bead blasting. Beads will stick to grease or oil soaked areas causing area not to be cleaned.

Use air pressure to remove all trapped residual beads from component after cleaning. After cleaning internal engine parts made of aluminum, wash thoroughly with hot soapy water. Component must be thoroughly cleaned as glass beads will enter engine oil resulting in bearing damage.

CHEMICAL CLEANING

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Solvent tank is used for cleaning oily residue from components. Solvent blasting sprays solvent through a siphon gun using compressed air.

The hot tank, using heated caustic solvents, is used for cleaning ferrous materials only. DO NOT clean aluminum parts such as cylinder heads, bearings or other soft metals using the hot tank. After cleaning, flush parts with hot water.

A non-ferrous part will be ruined and caustic solution will be diluted if placed in the hot tank. Always use eye protection and gloves when using the hot tank.

Use of a cold tank is for cleaning aluminum cylinder heads, carburetors and other soft metals. A less caustic and unheated solution is used. Parts may be left in the tank for several hours without damage. After cleaning, flush parts with hot water.

Steam cleaning, with boiling hot water sprayed at high pressure, is recommended as the final cleaning process when using either hot or cold tank cleaning.

COMPONENT CLEANING

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SHEET METAL PARTS

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Examples of sheet metal parts are rocker covers, front and side covers, oil pan and bellhousing dust cover. Glass bead blasting or hot tank may be used for cleaning.

Ensure all mating surfaces are flat. Deformed surfaces should be straightened. Check all sheet metal parts for cracks and dents.

INTAKE & EXHAUST MANIFOLDS

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Using solvent cleaning or bead blasting, clean manifolds for inspection. If intake manifold has an exhaust crossover, all carbon deposits must be removed. Inspect manifolds for cracks, burned or eroded areas, corrosion and damage to fasteners.

Exhaust heat and products of combustion cause threads of fasteners to corrode. Replace studs and bolts as necessary. On "V" type intake manifolds, sheet metal oil shield must be removed for proper cleaning and inspection. Ensure all manifold parting surfaces are flat and free of burrs.

CYLINDER HEAD REPLACEMENT

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REMOVAL

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Remove intake and exhaust manifolds and valve cover. Cylinder head and camshaft carrier bolts (if equipped) should be removed only when engine is cold. On many aluminum cylinder heads, removal while hot will cause cylinder head warpage. Mark rocker arm or overhead cam components for location.

Remove rocker arm components or overhead cam components. Components must be installed in original location. Individual design rocker arms may utilize shafts, ball-type pedestal mounts or no rocker arms. For all design types, wire components together and identify according to corresponding valve. Remove cylinder head bolts. Note length and location. Some applications require cylinder head bolts be removed in proper sequence to prevent cylinder head damage. See **Fig. 1**. Remove cylinder head.

INSTALLATION

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Ensure all surfaces and head bolts are clean. Check that head bolt holes of cylinder block are clean and dry to prevent block damage when bolts are tightened. Clean threads with tap to ensure accurate bolt torque.

Install head gasket on cylinder block. Some manufacturers may recommend sealant be applied to head gasket prior to installation. Note that all holes are aligned. Some gasket applications may be marked so that certain area faces upward. Install cylinder head using care not to damage head gasket. Ensure cylinder head is fully seated on cylinder block.

Some applications require head bolts be coated with sealant prior to installation. This is done if head bolts are exposed to coolant passages. Some applications require head bolts be coated with light coat of engine oil.

Install head bolts. Head bolts should be tightened in proper steps and sequence to specification. See **Fig. 1**. Install remaining components. Tighten all bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT.

NOTE: Some manufacturers require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.

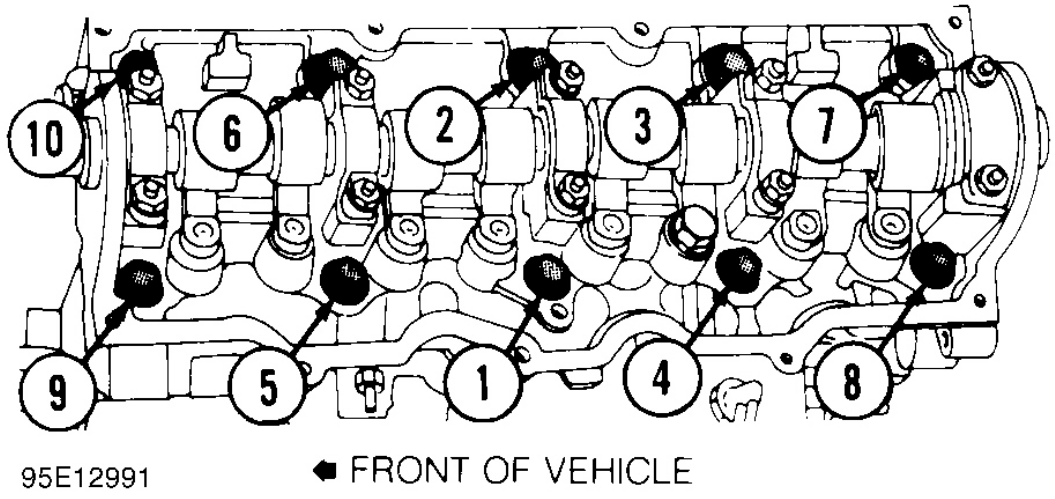


Fig. 1: Typical Cylinder Head Tightening or Loosening Sequence

VALVE ADJUSTMENT

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Engine specifications will indicate valve train clearance and temperature at which adjustment is to be made on most models. In most cases, adjustment will be made with a cold engine. In some cases, both a cold and a hot clearance will be given for maintenance convenience.

On some models, adjustment is not required. Rocker arms are tightened to specification and valve lash is automatically set. On some models with push rod actuated valve train, adjustment is made at push rod end of rocker arm while other models do not require adjustment.

Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer's specifications.

Some models require hydraulic lifter to be bled down and clearance measured. Push rods of different length can be used to obtain proper clearance. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge.

Overhead cam engines designed without rocker arms actuate valves directly on a cam follower. A hardened, removable disc is installed between the cam lobe and lifter. Clearance will be checked between cam heel and adjusting disc in proper sequence using a feeler gauge. Engine will be rotated to obtain all valve adjustments.

On overhead cam engines designed with rocker arms, adjustment is made at valve end of rocker arm. Ensure valve to be adjusted is riding on heel of cam on all engines. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer's specifications.

CYLINDER HEAD OVERHAUL

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CYLINDER HEAD DISASSEMBLY

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section for complete overhaul procedures and specifications for the vehicle being repaired.

Mark valves for location. Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator, valve spring, spring seat and valve. See **Fig. 2**.

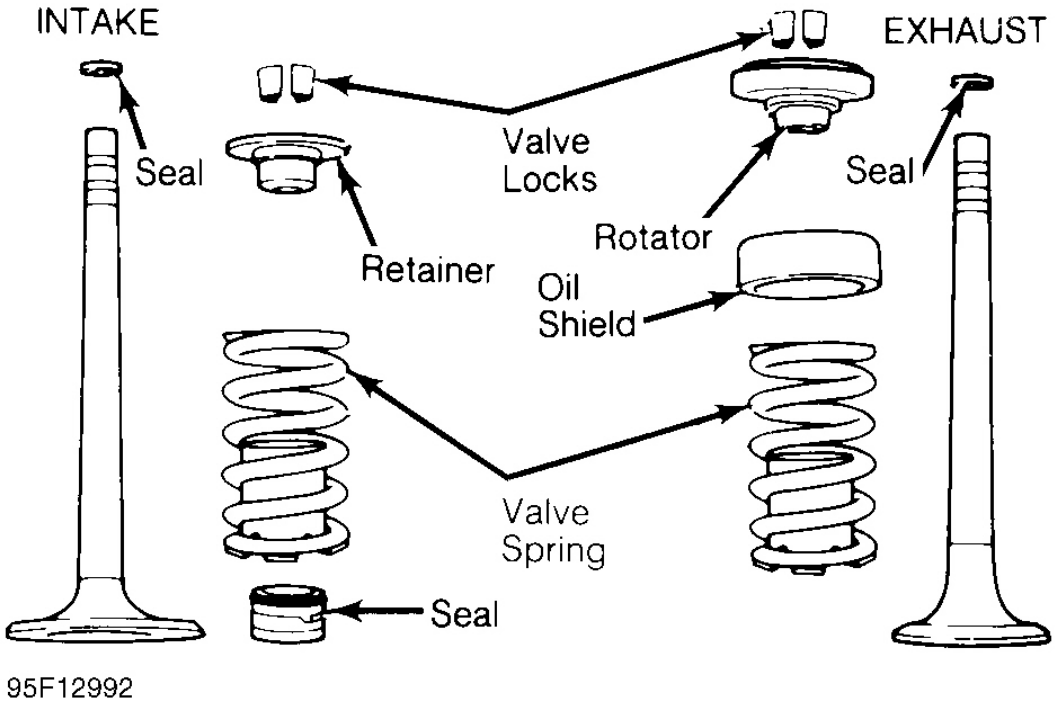


Fig. 2: Exploded View of Valve Assemblies

CYLINDER HEAD CLEANING & INSPECTION

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Clean cylinder head and valve components using approved cleaning methods. Inspect cylinder head for cracks, damage or warped gasket surface. Place straightedge across gasket surface. Determine clearance at center of straightedge. Measure across both diagonals, longitudinal center line and across cylinder head at several points. See **Fig. 3**.

On cast iron cylinder heads, if warpage exceeds .003" (.08 mm) in a 6" span, or .006" (.15 mm) over total length, cylinder head must be resurfaced. On most aluminum cylinder heads, if warpage exceeds .002" (.05 mm) in any area, cylinder head must be resurfaced. Warpage specification may vary by manufacturer. If warpage exceeds specification on some cylinder heads, cylinder head must be replaced.

Cylinder head thickness should be measured to determine amount of material which can be removed before replacement is required. Cylinder head thickness must not be less than the manufacturer's specification.

If cylinder head required resurfacing, it may not align properly with intake manifold. On "V" type engines, misalignment is corrected by machining intake manifold surface that contacts cylinder head. Cylinder head may be machined on surface that contacts intake manifold. Using oil stone, remove burrs or scratches from all sealing surfaces.

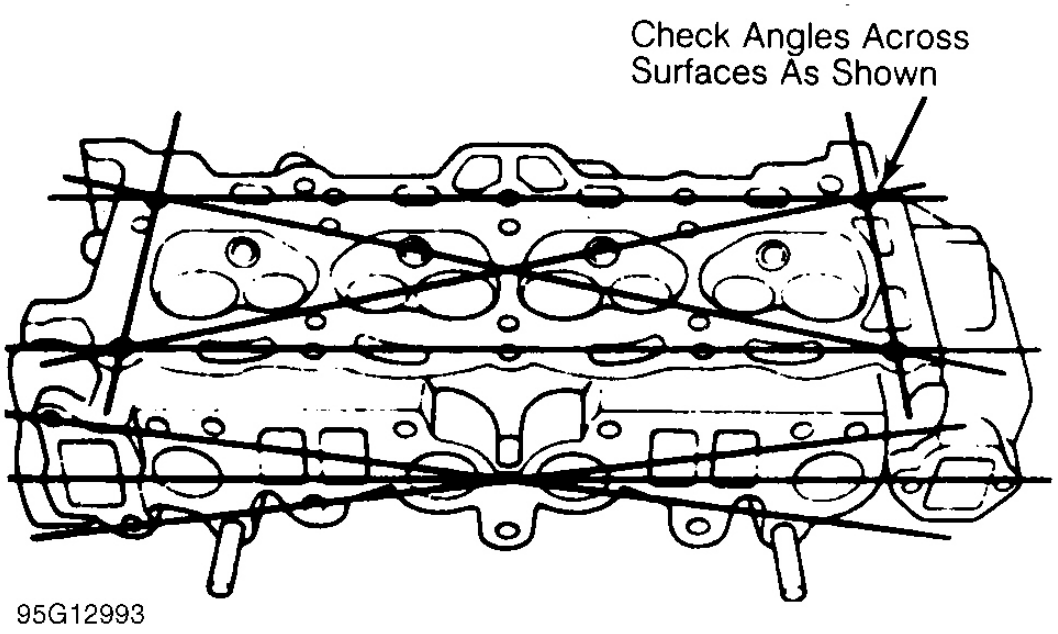


Fig. 3: Checking Cylinder Head for Warpage

VALVE SPRINGS

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Inspect valve springs for corroded or pitted valve spring surfaces which may lead to breakage. Polished spring ends caused by a rotating spring indicate that spring surge has occurred. Replace springs showing evidence of these conditions.

Inspect valve springs for squareness using a 90-degree straightedge. See **Fig. 4**. Replace valve spring if out-of-square exceeds manufacturer's specification.

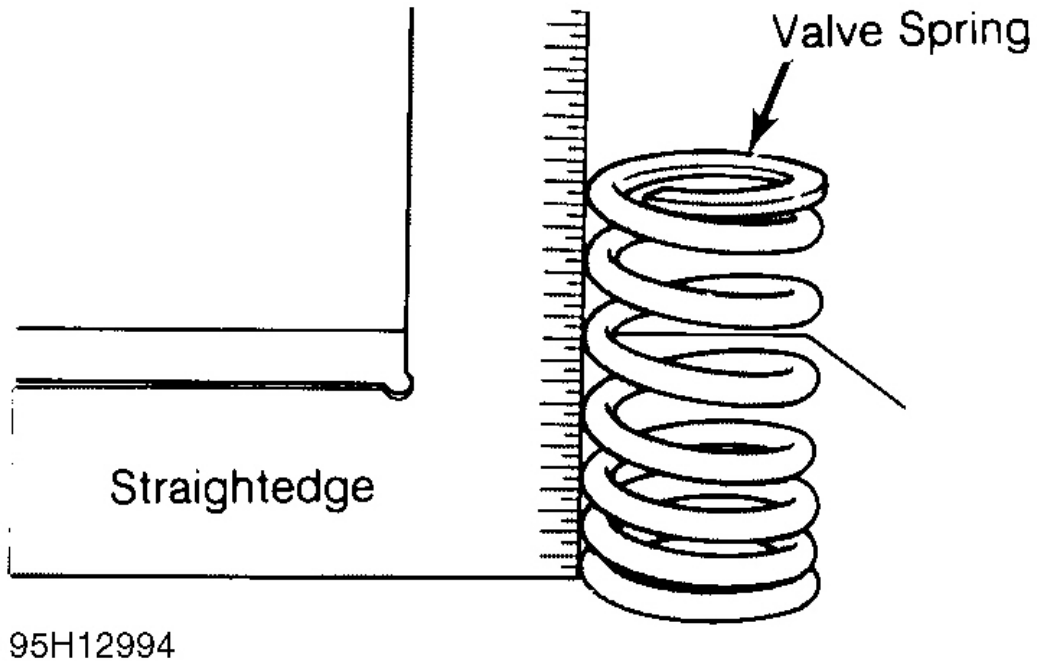


Fig. 4: Checking Valve Spring Squareness

Using vernier caliper, measure free length of all valve springs. Replace springs if not within specification. Using valve spring tester, test valve spring pressure at installed and compressed heights. See **Fig. 5**.

Usually compressed height is installed height minus valve lift. Replace valve spring if not within specification. It is recommended to replace all valve springs when overhauling cylinder head. Valve springs may need to be installed with color coded end or small coils at specified area according to manufacturer.

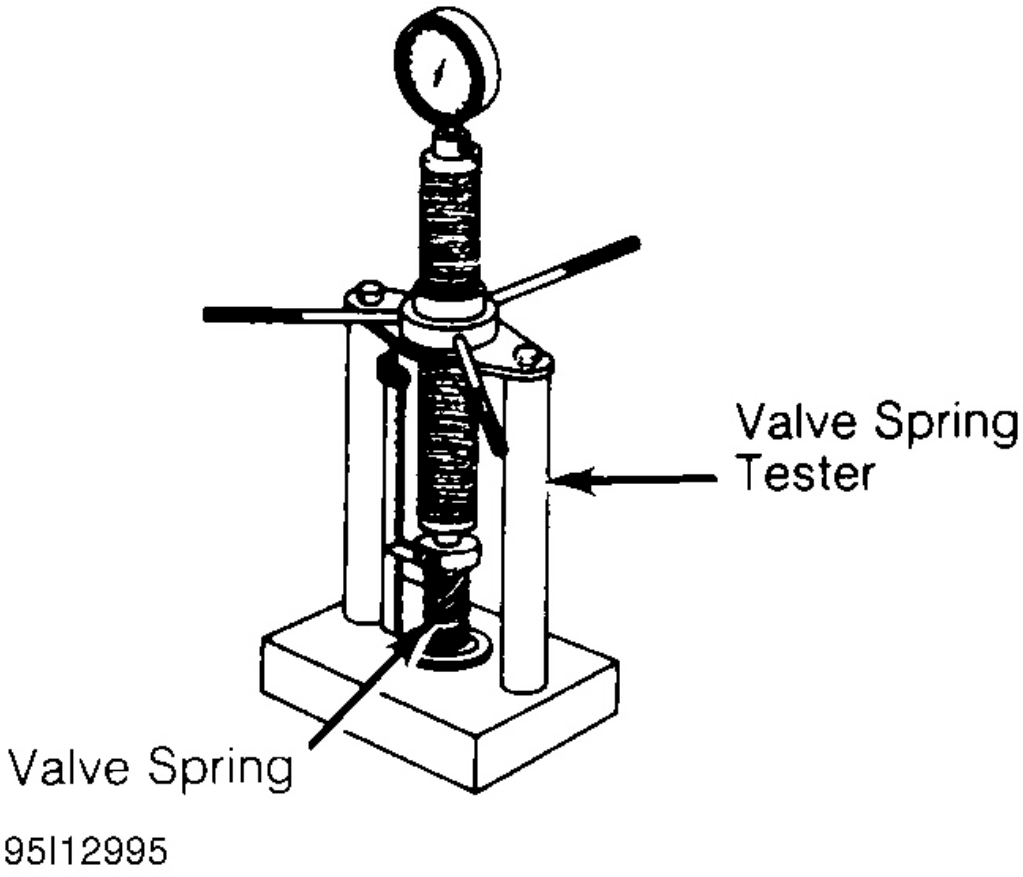


Fig. 5: Checking Valve Spring Pressure

VALVE GUIDE

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Measuring Valve Guide Clearance

Check valve stem-to-guide clearance. Ensure valve stem diameter is within specification. Install valve in valve guide. Install dial indicator assembly on cylinder head with tip resting against valve stem just above valve

guide. See **Fig. 6**.

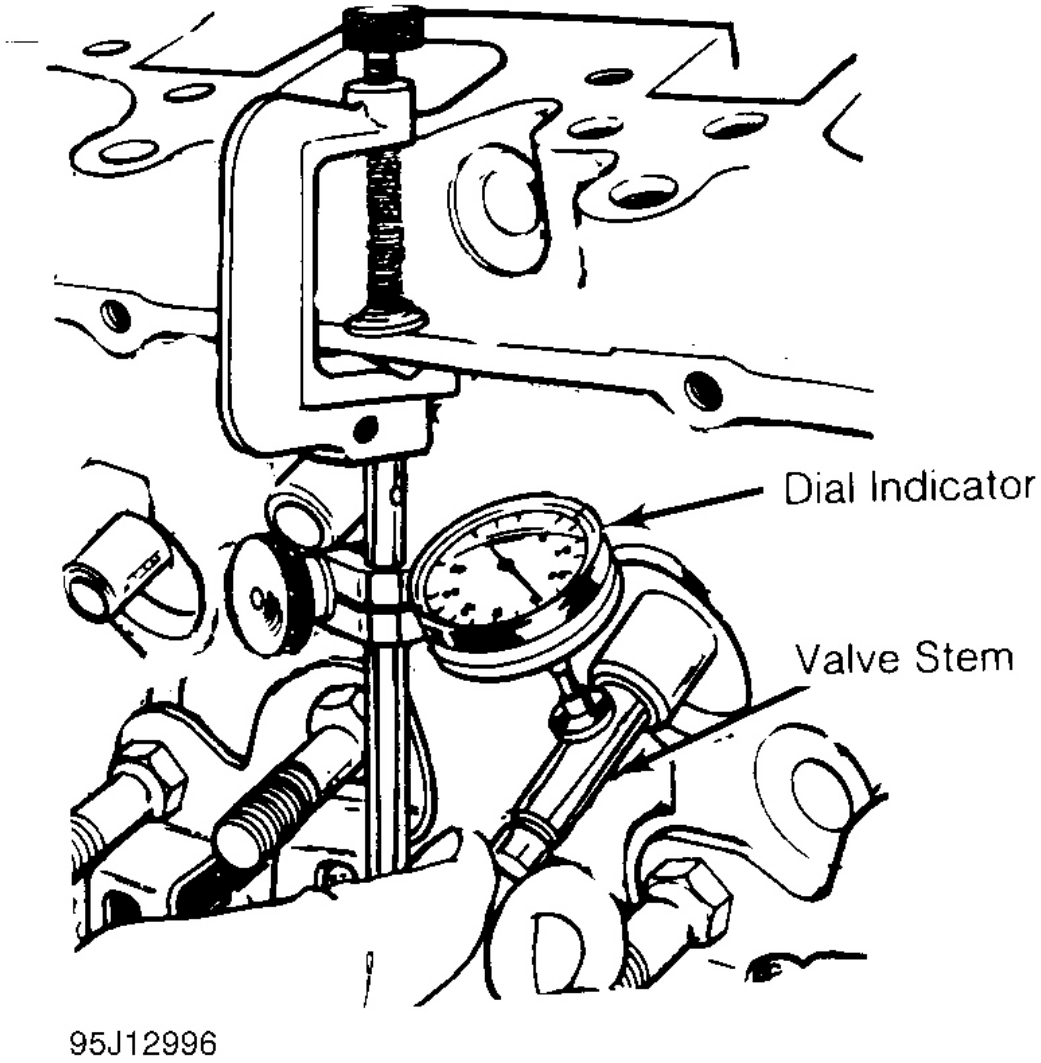


Fig. 6: Measuring Valve Stem-to-Guide Clearance

Lower valve approximately 1/16" below valve seat. Push valve stem against valve guide as far as possible. Adjust dial indicator to zero. Push valve stem in opposite direction and note reading. Clearance must be within specification.

If valve guide clearance exceeds specification, valves with oversize stems may be used and valve guides are reamed to larger size or valve guide must be replaced. On some applications, a false guide is installed, then reamed to proper specification. Valve guide reamer set is used to ream valve guide to obtain proper clearance for new valve.

Reaming Valve Guide

Select proper reamer for size of valve stem. Reamer must be of proper length to provide clean cut through entire length of valve guide. Install reamer in valve guide and rotate to cut valve guide. See **Fig. 7**.

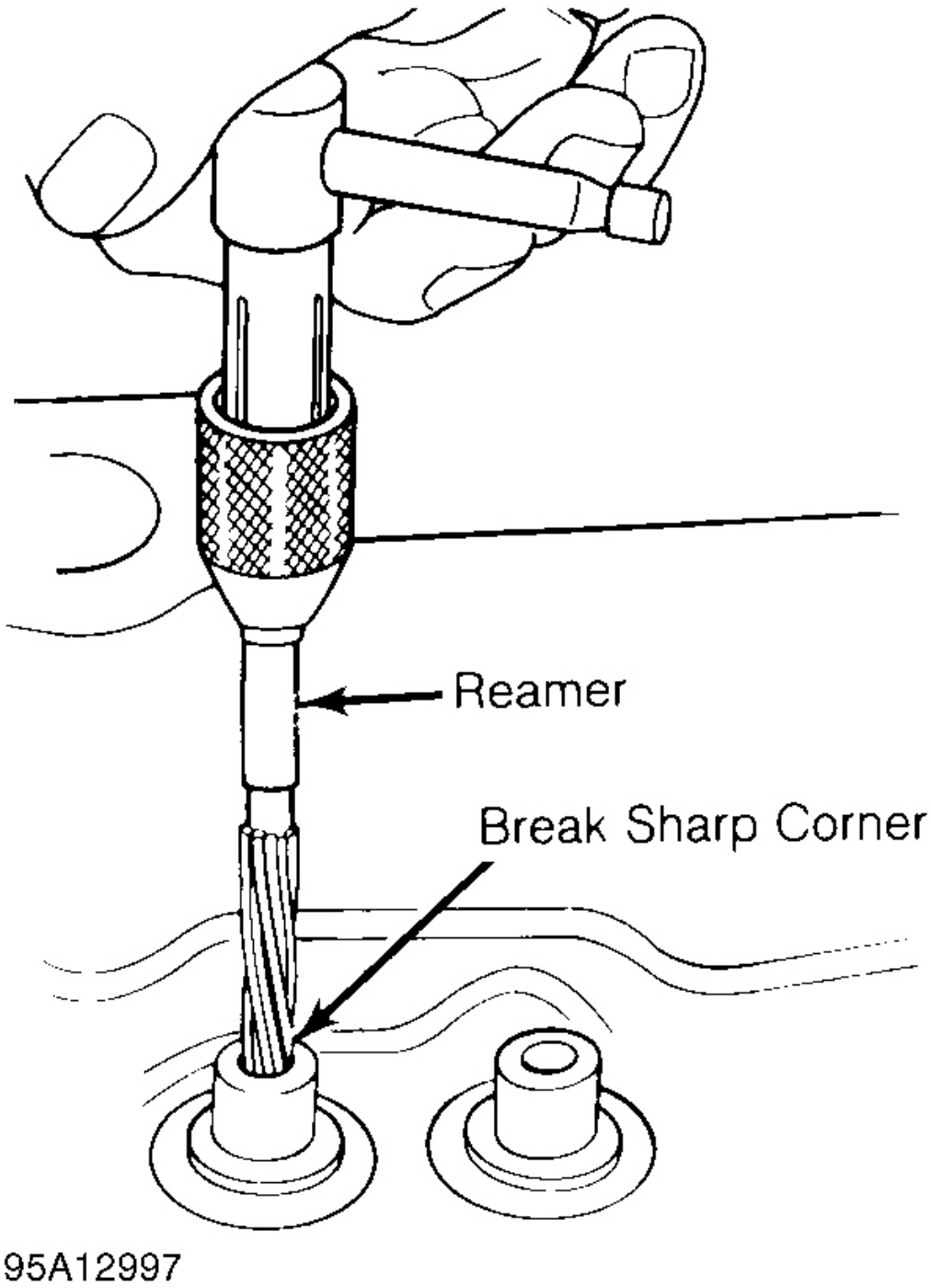


Fig. 7: Reaming Valve Guides

Replacing Valve Guide

Replace valve guide if clearance exceeds specification. Valve guides are either pressed, hammered or shrunk in place, depending upon cylinder head design and type of metal used.

Remove valve guide from cylinder head by pressing or tapping on a stepped drift. See **Fig. 8**. Once valve guide is installed, distance from cylinder head to top of valve guide must be checked. This distance must be within specification.

Aluminum heads are often heated before installing valve guide. Valve guide is sometimes cooled in dry ice prior to installation. Combination of a heated cylinder head and cooled valve guide ensures a tight guide fit upon assembly. The new guide must be reamed to specification.

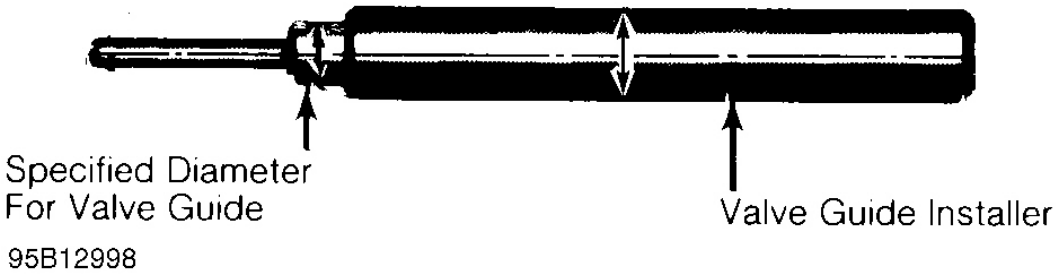


Fig. 8: Typical Valve Guide Remover & Installer

VALVES & VALVE SEATS

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Valve Grinding

Valve stem O.D. should be measured in several areas to indicate amount of wear. Replace valve if not within specification. Valve margin area should be measured to ensure that valve can be ground. See **Fig. 9**.

If valve margin is less than specification, the valves will be burned. Valve must be replaced. Due to minimum margin dimensions during manufacture, some new type valves cannot be reground. Some manufacturers use stellite coated valves that must NOT be machined. Valves can only be lapped into valve seat.

CAUTION: Some valves are sodium filled. Extreme care must be used when disposing of damaged or worn sodium-filled valves.

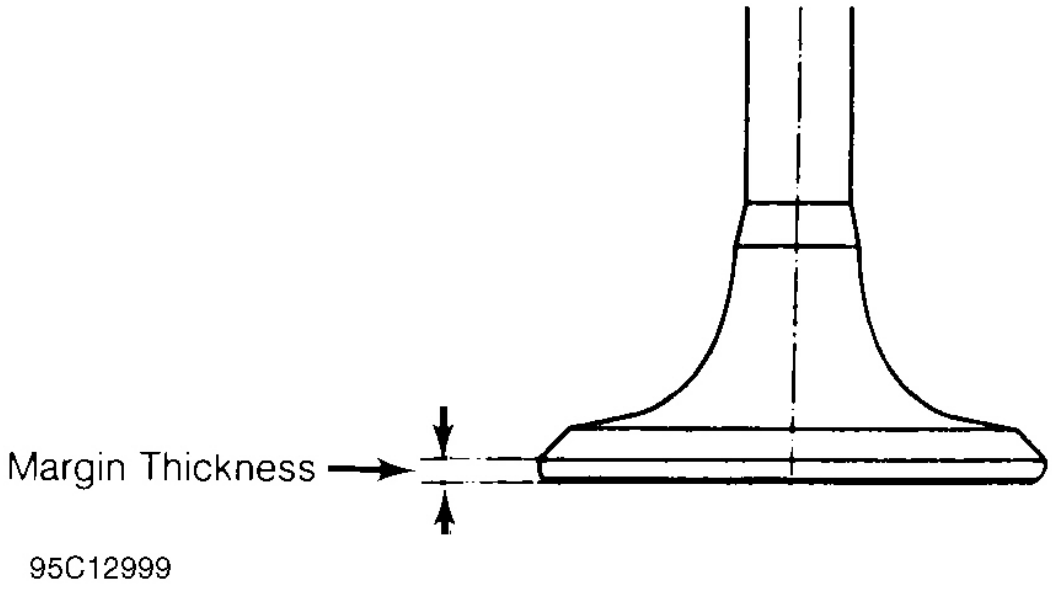


Fig. 9: Measuring Valve Head Margin

Resurface valve to proper angle specification using valve grinding machine. Follow manufacturer's instructions for valve grinding machine. Specifications may indicate a different valve face angle than seat angle. Measure valve margin after grinding. Replace valve if not within specification. Valve stem tip can be refinished using valve grinding machine.

Valve Lapping

During valve lapping of recently designed valves, be sure to follow manufacturer's recommendations. Surface hardening and materials used with some valves do not permit lapping. Lapping process will remove excessive amounts of the hardened surface.

Valve lapping is done to ensure adequate sealing between valve face and seat. Use either a hand drill or lapping stick with suction cup attached.

Moisten and attach suction cup to valve. Lubricate valve stem and guide. Apply a thin coat of fine valve grinding compound between valve and seat. Rotate lapping tool between the palms or with hand drill.

Lift valve upward off the seat and change position often. This is done to prevent grooving of valve seat. Lap valve until a smooth polished seat is obtained. Thoroughly clean grinding compound from components. Valve-to-valve seat concentricity should be checked. See **VALVE SEAT CONCENTRICITY**.

CAUTION: Valve guides must be in good condition and free of carbon deposits prior to valve seat grinding. Some engines contain an induction hardened valve seat. Excessive material removal will damage valve seats.

Valve Seat Grinding

Select coarse stone of correct size and angle for seat to be ground. Ensure stone is true and has a smooth surface. Select correct size pilot for valve guide dimension. Install pilot in valve guide. Lightly lubricate pilot shaft. Install stone on pilot. Move stone off and on the seat approximately 2 times per second during grinding operation.

Select a fine stone to finish grinding operation. Various angle grinding stones are used to center and narrow the valve seat as required. See **Fig. 10**.

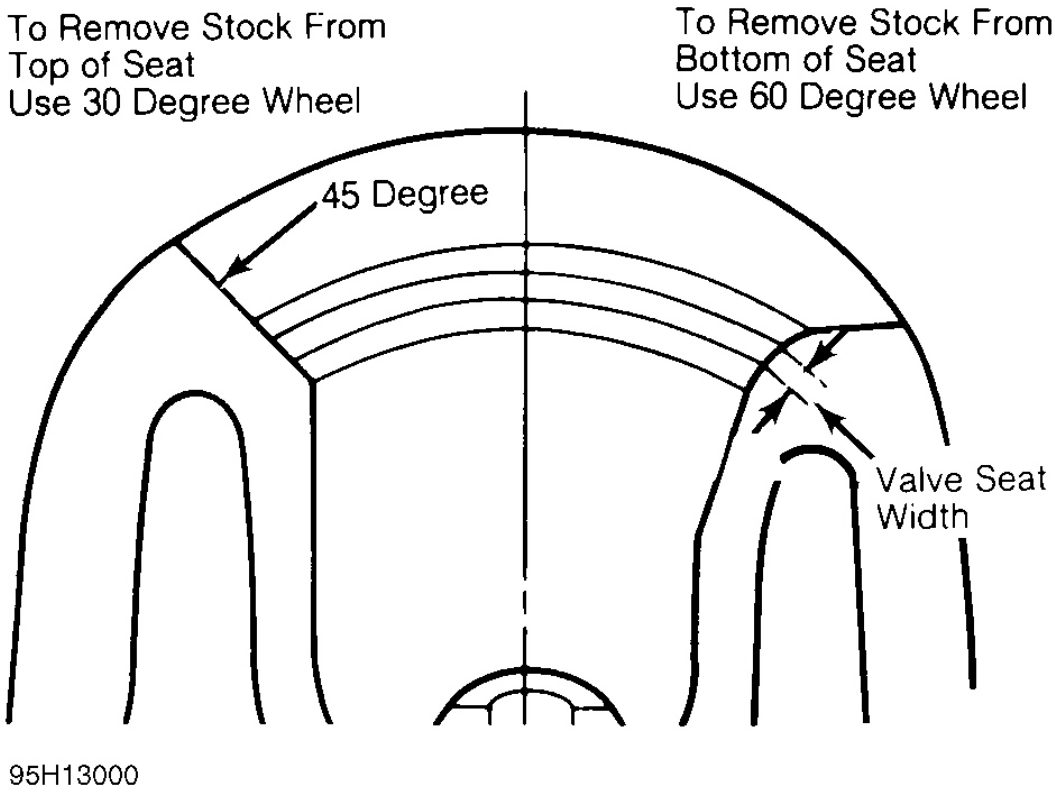


Fig. 10: Adjusting Valve Seat Width

Valve Seat Replacement

Replacement of valve seat inserts is done by cutting out the old insert and machining an oversize insert bore. Replacement oversize insert is usually cooled and the cylinder head is sometimes warmed. Valve seat is pressed into the head. This operation requires specialized machine shop equipment.

Valve Seat Concentricity

Using dial gauge, install gauge pilot in valve guide. Position gauge arm on the valve seat. Adjust dial indicator to zero. Rotate arm 360 degrees and note reading. Runout should not exceed specification.

To check valve-to-valve seat concentricity, coat valve face lightly with Prussian Blue dye. Install valve and rotate it on valve seat. If pattern is even and entire seat is coated at valve contact point, valve is concentric with the valve seat.

CYLINDER HEAD REASSEMBLY

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Valve Stem Installed Height

Valve stem installed height must be checked when new valves are installed or when valves or valve seats have been ground. Install valve in valve guide. Measure distance from tip of valve stem to spring seat. See **Fig. 11**. Distance must be within specification to allow sufficient clearance for valve operation.

Remove valve and grind valve stem tip if height exceeds specification. Valve tips are surface hardened. DO NOT remove more than .010" (.25 mm) from tip. Chamfer sharp edge of reground valve tip. Recheck valve stem installed height.

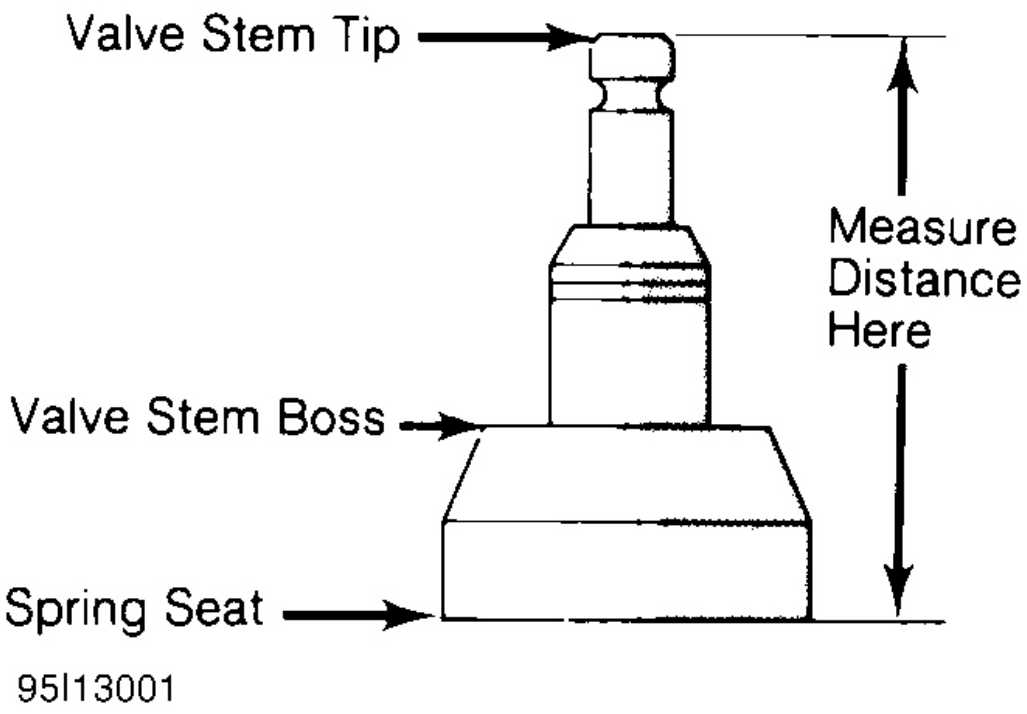


Fig. 11: Measuring Valve Stem Installed Height

VALVE STEM OIL SEALS

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Valve stem oil seals must be installed on valve stem. See **Fig. 2**. Seals are needed due to pressure differential at the ends of valve guides. Atmospheric pressure above intake guide, combined with manifold vacuum below guide, causes oil to be drawn into the cylinder.

Exhaust guides also have pressure differential created by exhaust gas flowing past the guide, creating a low pressure area. This low pressure area draws oil into the exhaust system.

Some manufacturers require that special color code or specified height valve stem oil seal be installed in

designated area.

Replacement (On-Vehicle)

Mark rocker arm or overhead cam components for location. Remove rocker arm components or overhead cam components. Components must be installed in original location. Remove spark plugs. Valve stem oil seals may be replaced by holding valves against seats using air pressure.

Air pressure must be installed in cylinder using an adapter for spark plug hole. An adapter can be constructed by welding air hose connection to spark plug body with porcelain removed.

Rotate engine until piston is at top of stroke. Install adapter in spark plug hole. Apply a minimum of 140 psi (9.8 kg/cm^2) line pressure to adapter. Air pressure should hold valve closed. If air pressure does not hold valve closed, check for damaged or bent valve. Cylinder head must be removed for service.

Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator and valve spring. Remove valve stem oil seal.

If oversize valves have been installed, oversize oil seals must be used. Coat valve stem with engine oil. Install protective sleeve over end of valve stem. Install new oil seal over valve stem and seat on valve guide. Remove protective sleeve. Install spring seat, valve spring and retainer or rotator. Compress spring and install valve locks. Remove spring compressor. Ensure valve locks are fully seated.

Install rocker arms or overhead cam components. Tighten all bolts to specification. Adjust valves if required. Remove adapter. Install spark plugs, valve cover and gasket.

VALVE SPRING INSTALLED HEIGHT

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Valve spring installed height should be checked during reassembly. Measure height from lower edge of valve spring to the upper edge. DO NOT include valve spring seat or retainer. Distance must be within specification. If valves and/or seats have been ground, a valve spring shim may be required to correct spring height. See **Fig. 12**.

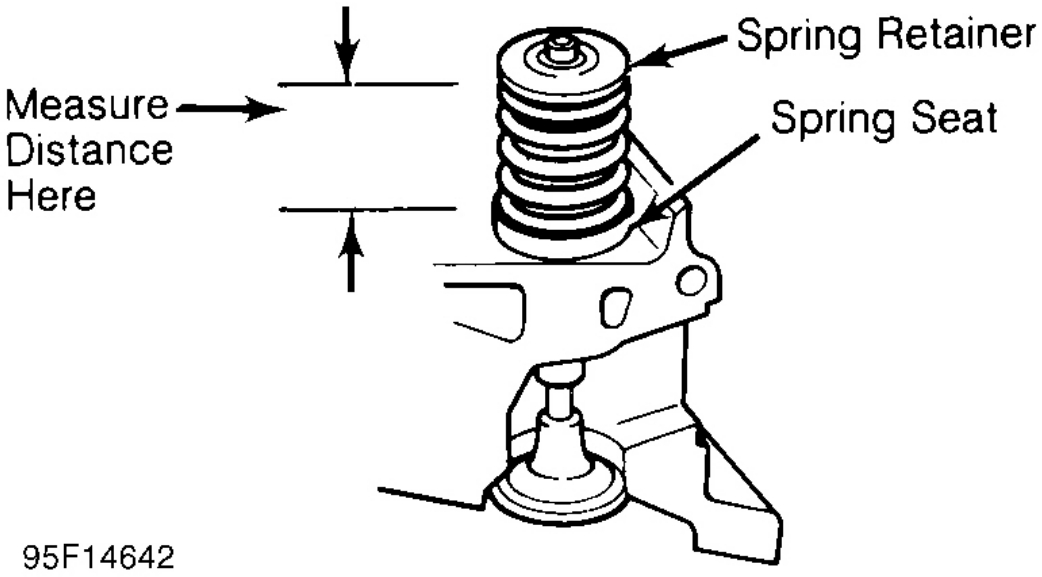


Fig. 12: Measuring Valve Spring Installed Height

ROCKER ARMS & ASSEMBLIES

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Rocker Studs

Rocker studs are either threaded or pressed in place. Threaded studs are removed by locking 2 nuts on the stud. Unscrew the stud by turning the jam nut. Coat new stud threads with Loctite and install. Tighten to specification.

Pressed-in stud can be removed using a stud puller. Ream stud bore to proper specification and press in a new oversize stud. Pressed-in studs are often replaced by cutting threads in the stud bore to accept a threaded stud.

Rocker Arms & Shafts

Mark rocker arms for location. Remove rocker arm retaining bolts. Remove rocker arms. Inspect rocker arms, shafts, bushings and pivot balls (if equipped) for excessive wear. Inspect rocker arms for wear in valve stem

contact area. Measure rocker arm bushing I.D. Replace bushings if excessively worn.

The rocker arm valve stem contact point may be reground, using special fixture for valve grinding machine. Remove minimum amount of material as possible. Ensure all oil passages are clear. Install rocker arm components in original location. Ensure rocker arm is properly seated in push rod. Tighten bolts to specification. Adjust valves if required. See **VALVE ADJUSTMENT**.

PUSH RODS

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Remove rocker arms. Mark push rods for location. Remove push rods. Push rods can be steel or aluminum, solid or hollow. Hollow push rods must be internally cleaned to ensure oil passage to rocker arms is cleaned. Check push rods for damage, such as loose ends on steel tipped aluminum types.

Check push rod for straightness. Roll push rod on a flat surface. Using feeler gauge, check clearance at center. Replace push rod if bent. The push rod can also be supported at each end and rotated. A dial indicator is used to detect a bent area in the push rod.

Lubricate ends of push rod and install push rod in original location. Ensure push rod is properly seated in lifter. Install rocker arm. Tighten bolts to specification. Adjust valves if required. See **VALVE ADJUSTMENT**.

LIFTERS

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Hydraulic Lifters

Before replacing a hydraulic lifter for noisy operation, ensure noise is not caused by worn rocker arms or valve tips. Also ensure sufficient oil pressure exists. Hydraulic lifters must be installed in original location. Remove rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold, cylinder head or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use a hydraulic lifter remover or magnet. Different type lifters are used. See **Fig. 13**.

On sticking lifters, disassemble and clean lifter. DO NOT mix lifter components or positions. Parts are select-fitted and are not interchangeable. Inspect all components for wear. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore for damage and lack of lubrication. On roller type lifters, inspect roller for flaking, pitting, loss of needle bearings and roughness during rotation.

Measure lifter body O.D. in several areas. Measure lifter bore I.D. Ensure components or oil clearance is within specification. Some models offer oversize lifters. Replace lifter if damaged.

If lifter check valve is not operating, obstructions may be preventing it from closing or valve spring may be broken. Clean or replace components as necessary.

Check plunger operation. Plunger should drop to bottom of the body by its own weight when assembled dry. If plunger is not free, soak lifter in solvent to dissolve deposits.

Lifter leak-down test can be performed on lifter. Lifter must be filled with special test oil. New lifters contain special test oil. Using lifter leak-down tester, perform leak-down test following manufacturer's instructions. If leak-down time is not within specifications, replace lifter assembly.

Lifters should be soaked in clean engine oil several hours prior to installation. Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. See **Fig. 13**. Install lifter in original location. Install remaining components. Valve lash adjustment is not required on most hydraulic lifters. Preload of hydraulic lifter is automatic. Some models may require adjustment.

NOTE: Some manufacturers require that a crankcase conditioner be added to engine oil and engine operated for specified amount of time to aid in lifter break-in procedure if new lifters or camshaft are installed.

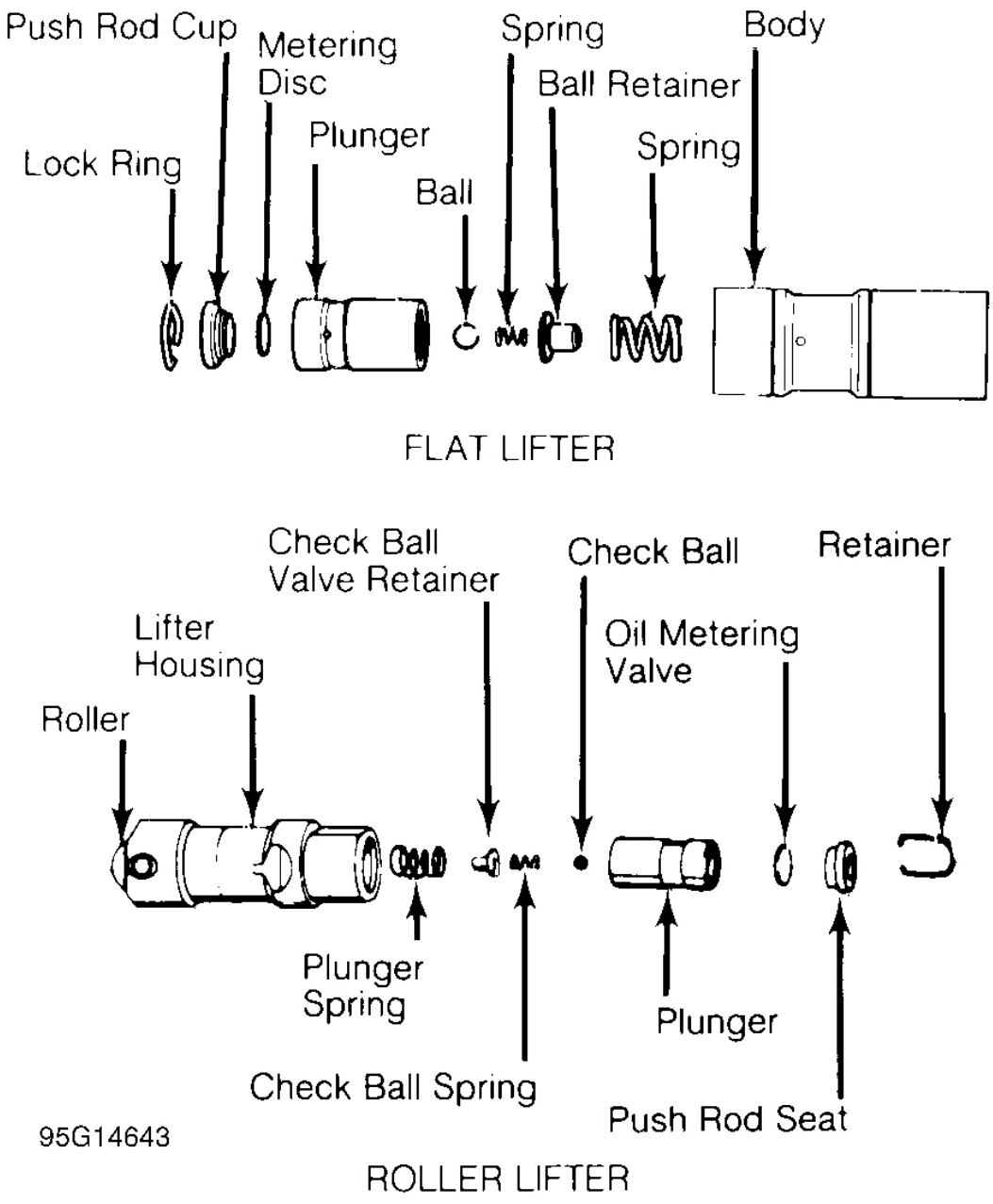


Fig. 13: Typical Hydraulic Valve Lifter Assemblies

Mechanical Lifters

Lifter assemblies must be installed in original locations. Remove rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use lifter remover or magnet.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore for damage and lack of lubrication. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. Install lifter in original location. Install remaining components. Tighten bolts to specification. Adjust valves. See **VALVE ADJUSTMENT**.

PISTONS, CONNECTING RODS & BEARINGS

*** PLEASE READ THIS FIRST ***

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RIDGE REMOVAL

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Ridge in cylinder wall must be removed prior to piston removal. Failure to remove ridge prior to removing pistons will cause piston damage in piston ring lands or grooves.

With piston at bottom dead center, place rag in bore to trap metal chips. Install ridge reamer in cylinder bore. Adjust ridge reamer using manufacturer's instructions. Remove ridge using ridge reamer. DO NOT remove an excessive amount of material. Ensure ridge is completely removed.

PISTON & CONNECTING ROD REMOVAL

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Note top of piston. Some pistons may contain a notch, arrow or be marked FRONT. Piston must be installed in proper direction to prevent damage with valve operation.

Check that connecting rod and cap are numbered for cylinder location and which side of cylinder block the number faces. Proper cap and connecting rod must be installed together. Connecting rod cap must be installed on connecting rod in proper direction to ensure bearing lock procedure. Mark connecting rod and cap if necessary. Pistons must be installed in original location.

Remove cap retaining nuts or bolts. Remove bearing cap. Install tubing protectors on connecting rod bolts. This protects cylinder walls from scoring during removal. Ensure proper removal of ridge. Push piston and connecting rod from cylinder. Connecting rod boss can be tapped with a wooden dowel or hammer handle to aid in removal.

PISTON & CONNECTING ROD

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Disassembly

Using ring expander, remove piston rings. Remove piston pin retaining rings (if equipped). Note direction of piston installation on connecting rod. On pressed type piston pins, special fixtures and procedures according to manufacturer must be used to remove piston pins. Follow manufacturer's recommendations to avoid piston distortion or breakage.

Cleaning

Remove all carbon and varnish from piston. Pistons and connecting rods may be cleaned in cold type chemical tank. Using ring groove cleaner, clean all deposits from ring grooves. Ensure all deposits are cleaned from ring grooves to prevent ring breakage or sticking. DO NOT attempt to clean pistons with wire brush.

Inspection

Inspect pistons for nicks, scoring, cracks or damage in ring areas. Connecting rod should be checked for cracks using Magnaflux procedure. Piston diameter must be measured in manufacturer's specified area.

Using telescopic gauge and micrometer, measure piston pin bore of piston in 2 areas, 90 degrees apart. This is

done to check diameter and out-of-round.

Install proper bearing cap on connecting rod. Ensure bearing cap is installed in proper location. Tighten bolts or nuts to specification. Using inside micrometer, measure inside diameter in 2 areas, 90 degrees apart.

Connecting rod I.D. and out-of-round must be within specification. Measure piston pin bore I.D. and piston pin O.D. All components must be within specification. Subtract piston pin diameter from piston pin bore in piston and connecting rod to determine proper fit.

Connecting rod length must be measured from center of crankshaft journal inside diameter to center of piston pin bushing using proper caliper. Connecting rods must be the same length. Connecting rods should be checked on an alignment fixture for bent or twisted condition. Replace all components which are damaged or not within specification.

PISTON & CYLINDER BORE FIT

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Ensure cylinder is checked for taper, out-of-round and properly honed prior to checking piston and cylinder bore fit. See **CYLINDER BLOCK**. Using dial bore gauge, measure cylinder bore.

Measure piston skirt diameter at 90 degree angle to piston pin at specified area by manufacturer. Subtract piston diameter from cylinder bore diameter to determine piston-to-cylinder clearance. Clearance must be within specification. Mark piston for proper cylinder location.

ASSEMBLING PISTON & CONNECTING ROD

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Install piston on connecting rod for corresponding cylinder. Ensure reference marking on top of piston corresponds with connecting rod and cap number. See **Fig. 14**.

Lubricate piston pin and install in connecting rod. Ensure piston pin retainers are fully seated (if equipped). On

pressed type piston pins, follow manufacturer's recommended procedure to avoid distortion or breakage.

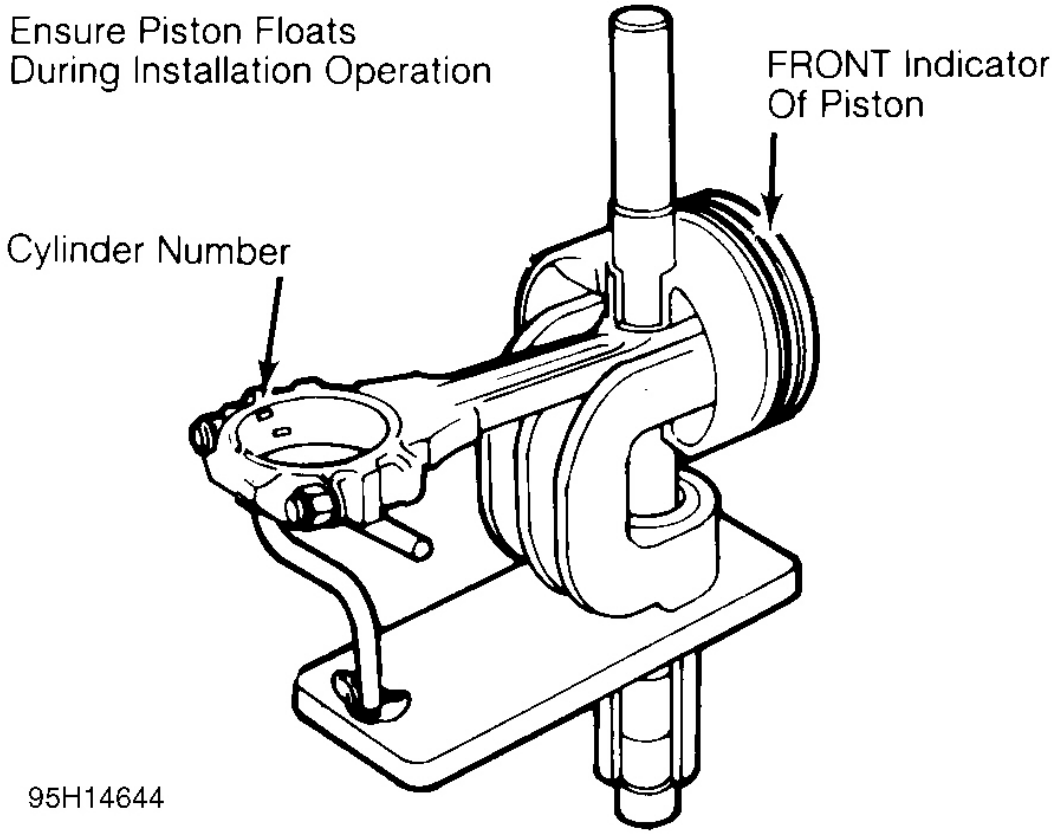


Fig. 14: Installing Typical Piston Pin

CHECKING PISTON RING CLEARANCES

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Piston rings must be checked for side clearance and end gap. To check end gap, install piston ring in cylinder in which it is to be installed. Using an inverted piston, push ring to bottom of cylinder in smallest cylinder diameter.

Using feeler gauge, check ring end gap. See **Fig. 15**. Piston ring end gap must be within specification. Ring breakage will occur if insufficient ring end gap exists.

Some manufacturers permit correcting insufficient ring end gap by using a fine file while other manufacturers recommend using another ring set. Mark rings for proper cylinder installation after checking end gap.

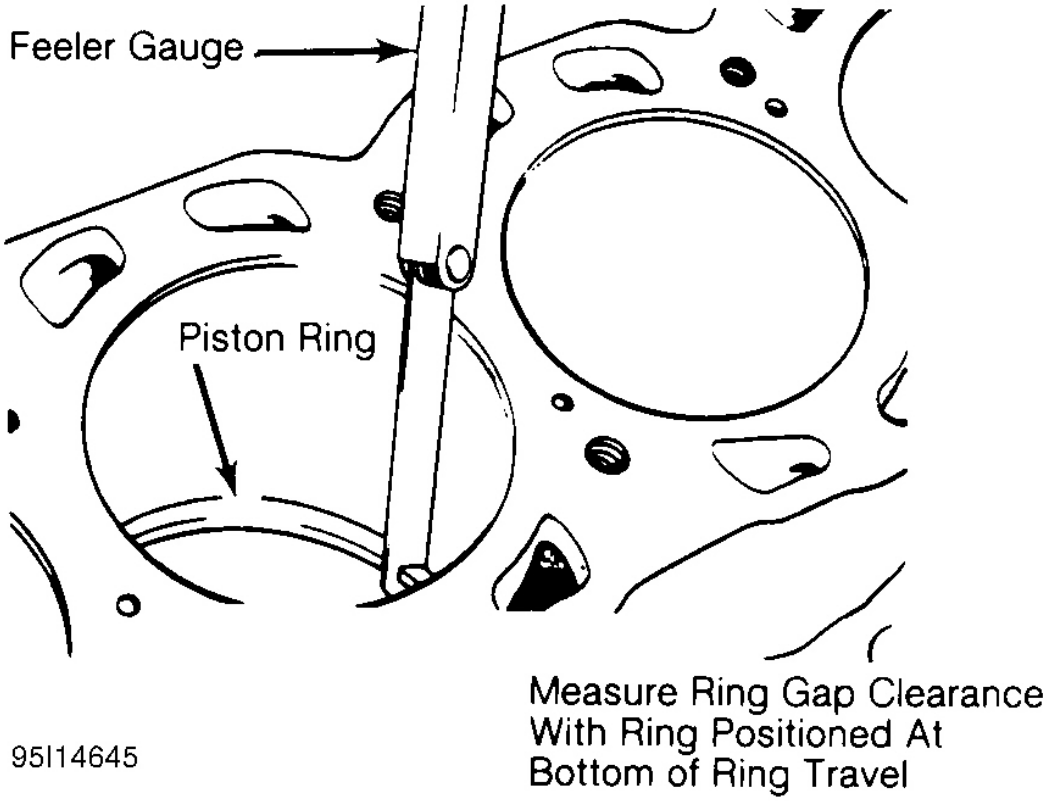


Fig. 15: Checking Piston Ring End Gap

For checking side clearance, install rings on piston. Using feeler gauge, measure clearance between piston ring and piston ring land. Check side clearance in several areas around piston. Side clearance must be within specification.

If side clearance is excessive, piston ring grooves can be machined to accept oversize piston rings (if available). Normal practice is to replace piston.

PISTON & CONNECTING ROD INSTALLATION

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Cylinders must be honed prior to piston installation. See **CYLINDER HONING** under CYLINDER BLOCK.

Install upper connecting rod bearings. Lubricate upper bearings with engine oil. Install lower bearings in rod caps. Ensure bearing tabs are properly seated. Position piston ring gaps according to manufacturer's recommendations. See **Fig. 16**. Lubricate pistons, rings and cylinder walls.

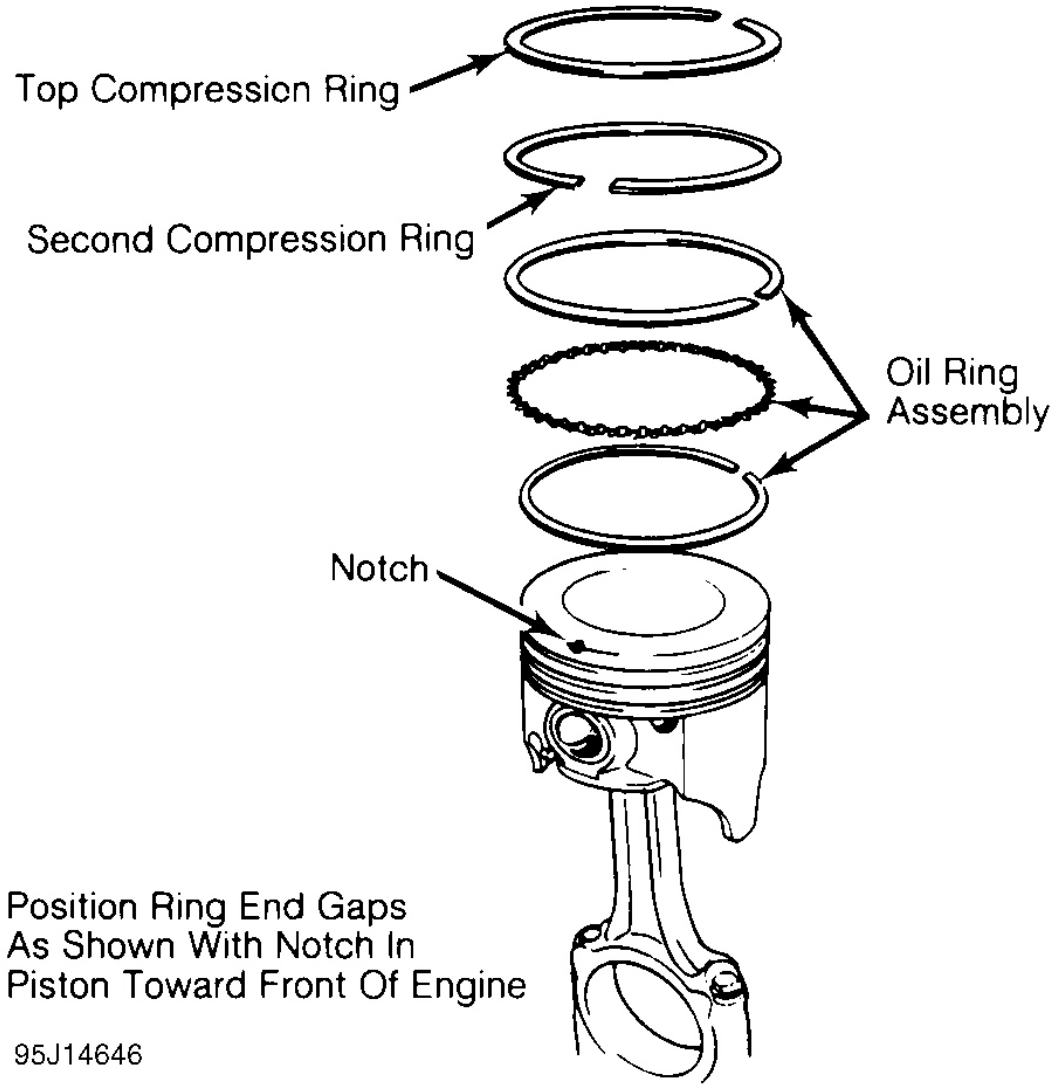


Fig. 16: Positioning Typical Piston Ring End Gap

Install ring compressor. Use care not to rotate piston rings. Compress rings with ring compressor. Install plastic tubing protectors over connecting rod bolts. Install piston and connecting rod assembly. Ensure piston notch, arrow or FRONT mark is toward front of engine. See **Fig. 17**.

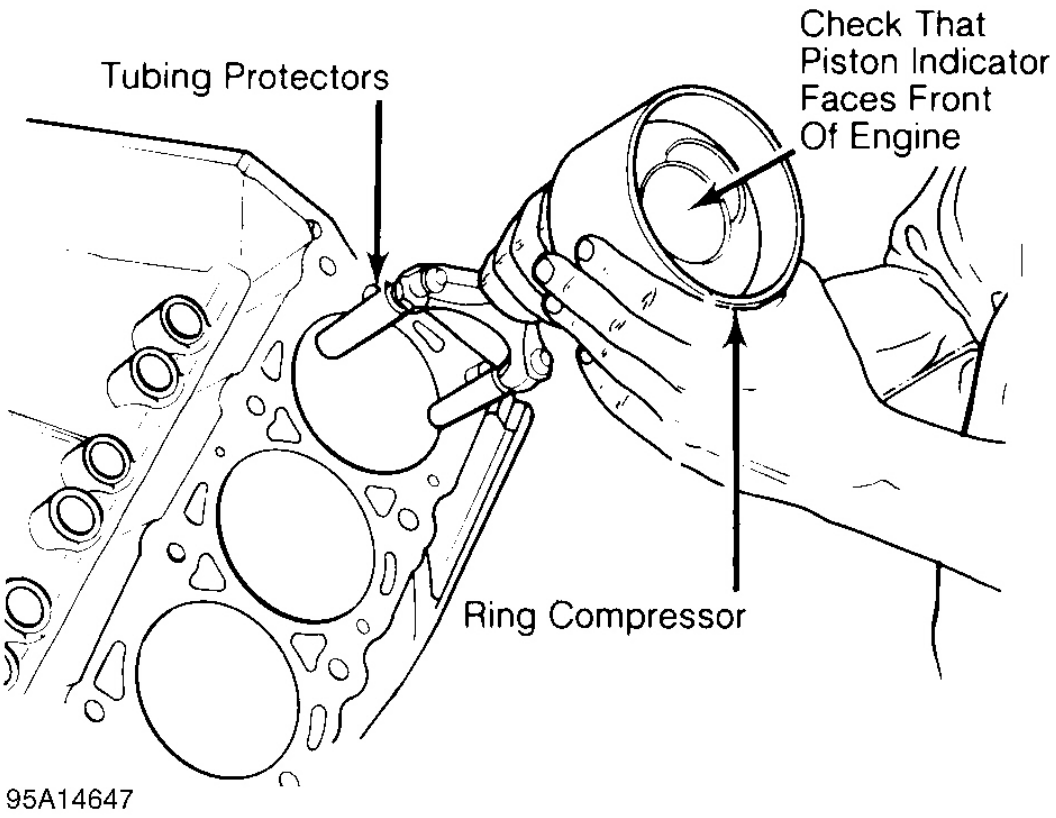


Fig. 17: Installing Piston & Connecting Rod Assembly

Carefully tap piston into cylinder until rod bearing is seated on crankshaft journal. Remove protectors. Install rod cap and bearing. Lightly tighten connecting rod bolts. Repeat procedure for remaining cylinders. Check bearing clearance. See **MAIN & CONNECTING ROD BEARING CLEARANCE**.

Once clearance is checked, lubricate journals and bearings. Install bearing caps. Ensure marks are aligned on connecting rod and cap. Tighten rod nuts or bolts to specification. Ensure rod moves freely on crankshaft. Check connecting rod side clearance. See **CONNECTING ROD SIDE CLEARANCE**.

CONNECTING ROD SIDE CLEARANCE

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to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

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Position connecting rod toward one side of crankshaft as far as possible. Using feeler gauge, measure clearance between side of connecting rod and crankshaft. See **Fig. 18**. Clearance must be within specification.

Check for improper bearing installation, wrong bearing cap or insufficient bearing clearance if side clearance is insufficient. Connecting rod may require machining to obtain proper clearance. Excessive clearance usually indicates excessive wear at crankshaft. Crankshaft must be repaired or replaced.

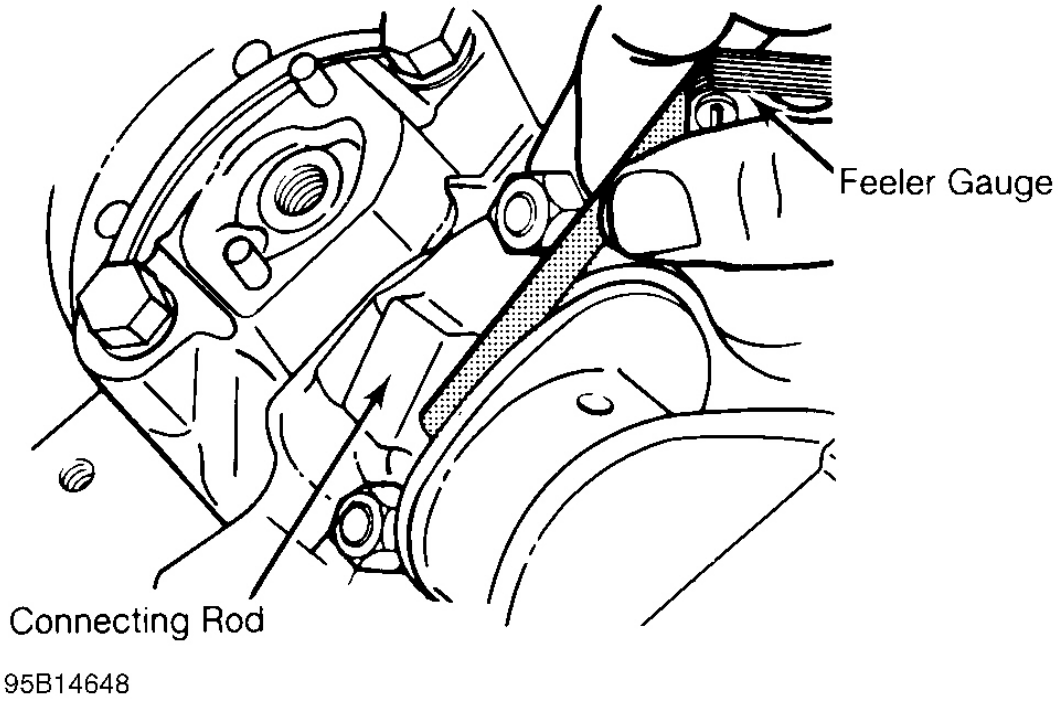


Fig. 18: Measuring Connecting Rod Side Clearance

MAIN & CONNECTING ROD BEARING CLEARANCE

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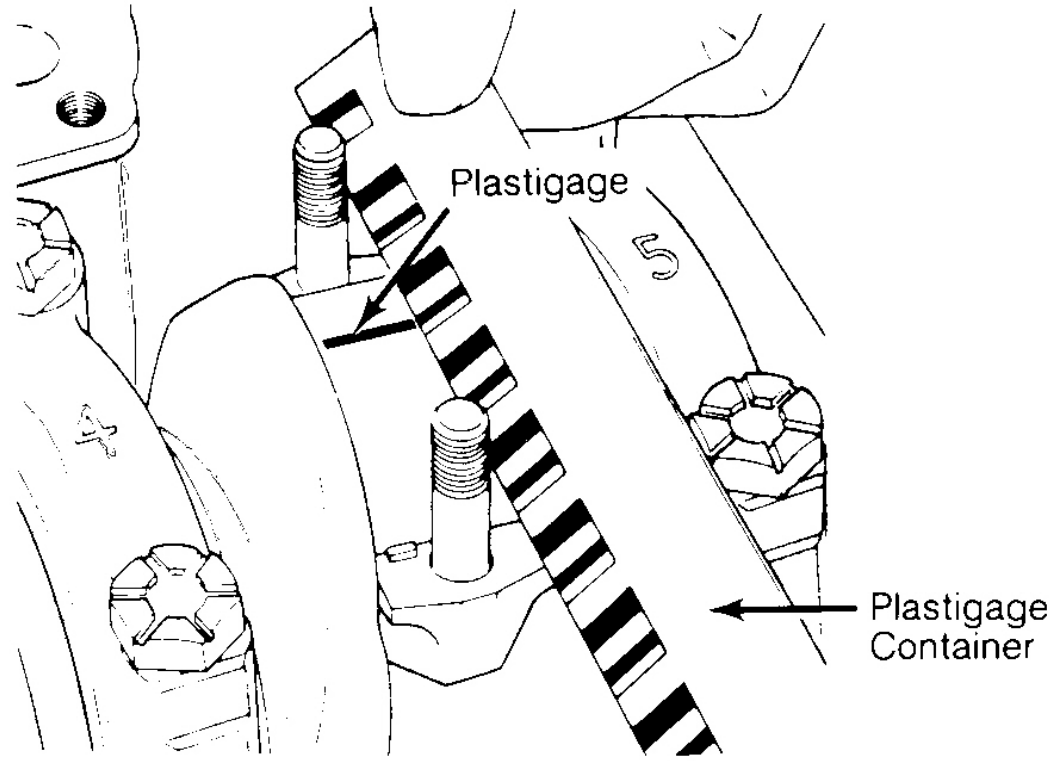
Plastigage Method

Plastigage method may be used to determine bearing clearance. Plastigage can be used with an engine in service or during reassembly. Plastigage material is oil soluble.

Ensure journals and bearings are free of oil or solvent. Oil or solvent will dissolve material and false reading will be obtained. Install small piece of Plastigage along full length of bearing journal. Install bearing cap in original location. Tighten bolts to specification.

CAUTION: DO NOT rotate crankshaft while Plastigage is installed. Bearing clearance will not be obtained if crankshaft is rotated.

Remove bearing cap. Compare Plastigage width with scale on Plastigage container to determine bearing clearance. See **Fig. 19**. Rotate crankshaft 90 degrees. Repeat procedure. This is done to check journal eccentricity. This procedure can be used to check oil clearance on both connecting rod and main bearings.



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Fig. 19: Measuring Bearing Clearance

Micrometer & Telescopic Gauge Method

A micrometer is used to determine journal diameter, taper and out-of-round dimensions of the crankshaft. See **CLEANING & INSPECTION** under CRANKSHAFT & MAIN BEARINGS in this article.

With crankshaft removed, install bearings and caps in original location on cylinder block. Tighten bolts to specification. On connecting rods, install bearings and caps on connecting rods. Install proper connecting rod cap on corresponding rod. Ensure bearing cap is installed in original location. Tighten bolts to specification.

Using a telescopic gauge and micrometer or inside micrometer, measure inside diameter of connecting rod and main bearings bores. Subtract each crankshaft journal diameter from the corresponding inside bearing bore diameter. This is the bearing clearance.

CRANKSHAFT & MAIN BEARINGS

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REMOVAL

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Ensure all main bearing caps are marked for location on cylinder block. Some main bearing caps have an arrow stamped on them. The arrow must face timing belt or timing chain end of engine. Remove main bearing cap bolts. Remove main bearing caps. Carefully remove crankshaft. Use care not to bind crankshaft in cylinder block during removal.

CLEANING & INSPECTION

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Thoroughly clean crankshaft using solvent. Dry with compressed air. Ensure all oil passages are clear and free of sludge, rust, dirt and metal chips.

Inspect crankshaft for scoring and nicks. Inspect crankshaft for cracks using Magnaflux procedure. Inspect rear seal area for grooving or damage. Inspect bolt hole threads for damage. If pilot bearing or bushing is used, check pilot bearing or bushing fit in crankshaft. Inspect crankshaft gear for damaged or cracked teeth. Replace gear if damaged. Ensure oil passage plugs are tight (if equipped).

Using micrometer, measure all journals in 4 areas to determine journal taper, out-of-round and undersize. See **Fig. 20**. Some crankshafts can be reground to the next largest undersize, depending on the amount of wear or damage. Crankshafts with rolled fillet cannot be reground and must be replaced.

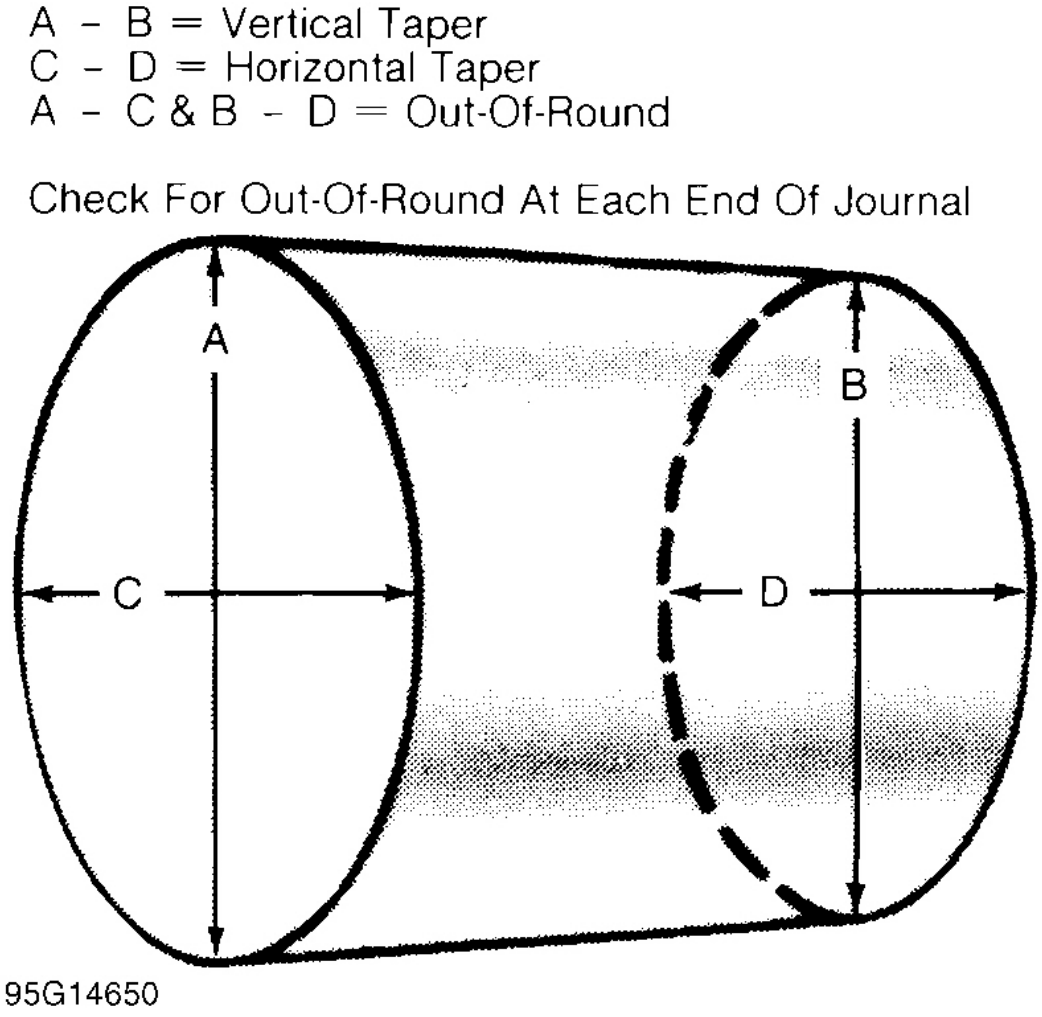


Fig. 20: Measuring Crankshaft Journals

Crankshaft journal runout should be checked. Install crankshaft in "V" blocks or bench center. Position dial indicator with tip resting on the main bearing journal area. See **Fig. 21**. Rotate crankshaft and note reading. Journal runout must not exceed specification. Repeat procedure on all main bearing journals. Crankshaft must be replaced if runout exceeds specification.

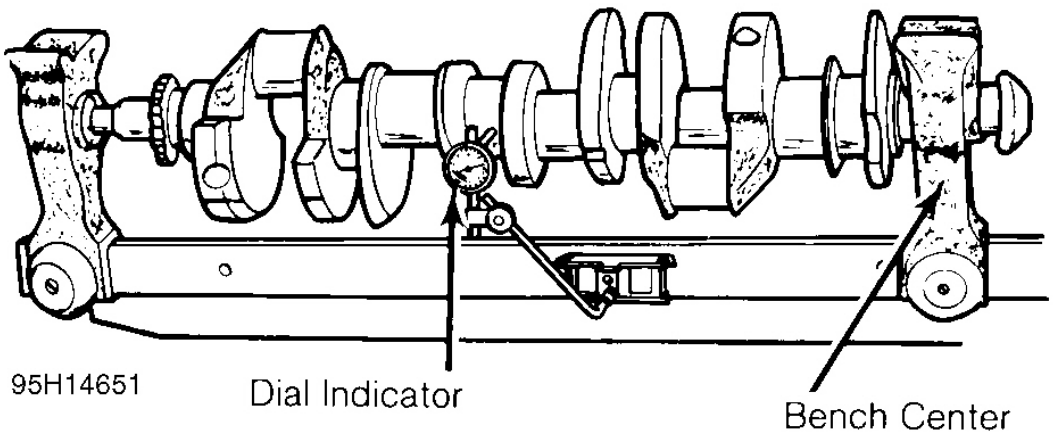


Fig. 21: Measuring Crankshaft Main Bearing Journal Runout

INSTALLATION

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Install upper main bearing in cylinder block. Ensure lock tab is properly located in cylinder block. Install bearings in main bearing caps. Ensure all oil passages are aligned. Install rear seal (if removed).

Ensure crankshaft journals are clean. Lubricate upper main bearings with clean engine oil. Carefully install crankshaft. Check each main bearing clearance using Plastigage method. See **MAIN & CONNECTING ROD BEARING CLEARANCE**.

Once clearance is checked, lubricate lower main bearing and journals. Install main bearing caps in original location. Install rear seal in rear main bearing cap (if removed). Some rear main bearing caps require sealant to be applied in corners to prevent oil leakage.

Install and tighten all bolts except thrust bearing cap to specification. Tighten thrust bearing cap bolts finger tight only. Some models require that thrust bearing be aligned. On most applications, crankshaft must be moved rearward then forward. Procedure may vary with manufacturer. Thrust bearing cap is then tightened to specification. Ensure crankshaft rotates freely. Crankshaft end play should be checked. See **CRANKSHAFT END PLAY**.

CRANKSHAFT END PLAY

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Dial Indicator Method

Crankshaft end play can be checked using dial indicator. Mount dial indicator on rear of cylinder block. Position dial indicator tip against rear of crankshaft. Ensure tip is resting against flat surface.

Pry crankshaft rearward. Adjust dial indicator to zero. Pry crankshaft forward and note reading. Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversize thrust bearings.

Feeler Gauge Method

Crankshaft end play can be checked using feeler gauge. Pry crankshaft rearward. Pry crankshaft forward. Using feeler gauge, measure clearance between crankshaft and thrust bearing surface. See **Fig. 22**.

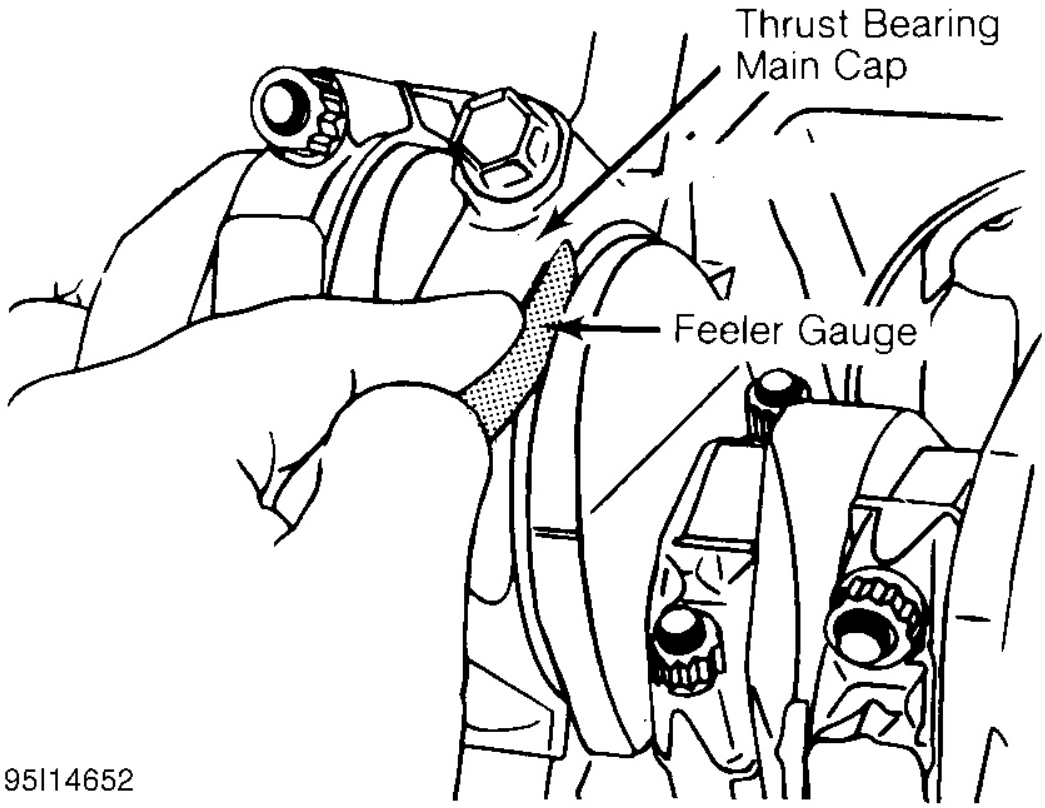


Fig. 22: Checking Crankshaft End Play

Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversize thrust bearings.

CYLINDER BLOCK

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Block Cleaning

Only cast cylinder blocks should be hot tank cleaned. Aluminum cylinder blocks should be cleaned using cold tank method. Cylinder block is cleaned in order to remove carbon deposits, gasket residue and water jacket

scale. Remove oil gallery plugs, freeze plugs and cam bearings before cleaning block.

Block Inspection

Visually inspect the block. Check suspected areas for cracks using the Dye Penetrant inspection method. Block may be checked for cracks using the Magnaflux method.

Cracks are most commonly found at the bottom of cylinders, main bearing saddles, near expansion plugs and between cylinders and water jackets. Inspect lifter bores for damage. Inspect all head bolt holes for damaged threads. Threads should be cleaned using tap to ensure proper head bolt torque. Consult machine shop concerning possible welding and machining (if required).

Cylinder Bore Inspection

Inspect bore for scoring or roughness. Cylinder bore is dimensionally checked for out-of-round and taper using dial bore gauge. For determining out-of-round, measure cylinder parallel and perpendicular to the block center line. Difference in the 2 readings is the bore out-of-round. Cylinder bore must be checked at top, middle and bottom of piston travel area.

Bore taper is obtained by measuring bore at the top and bottom. If wear has exceeded allowable limits, block must be honed or bored to next available oversize piston dimension.

Cylinder Honing

Cylinder must be properly honed to allow new piston rings to properly seat. Cross-hatching at correct angle and depth is critical to lubrication of cylinder walls and pistons.

A flexible drive hone and power drill are commonly used. Drive hone must be lubricated during operation. Mix equal parts of kerosene and SAE 20W engine oil for lubrication.

Apply lubrication to cylinder wall. Operate cylinder hone from top to bottom of cylinder using even strokes to produce 45 degree cross-hatch pattern on the cylinder wall. DO NOT allow cylinder hone to extend below cylinder during operation.

Recheck bore dimension after final honing. Wash cylinder wall with hot soapy water to remove abrasive particles. Blow dry with compressed air. Coat cleaned cylinder walls with lubricating oil.

Deck Warpage

Check deck for damage or warped gasket surface. Place a straightedge across gasket surface of the deck. Using feeler gauge, measure clearance at center of straightedge. Measure across width and length of cylinder block at several points.

If warpage exceeds specifications, deck must be resurfaced. If warpage exceeds manufacturer's maximum tolerance for material removal, replace block.

NOTE: Some manufacturers recommend that a total amount of material (cylinder head and cylinder block) can only be removed before components must be replaced.

Deck Height

Distance from crankshaft center line to block deck is called the deck height. Measure and record front and rear main journals of crankshaft. To compute this distance, install crankshaft and retain with center main bearing and cap only. Measure distance from crankshaft journal to block deck, parallel to cylinder center line.

Add one half of main bearing journal diameter to distance from crankshaft journal to block deck. This dimension should be checked at front and rear of cylinder block. Both readings should be the same.

If difference exceeds specification, cylinder block must be repaired or replaced. Deck height and warpage should be corrected at the same time.

Main Bearing Bore & Alignment

For checking main bearing bore, remove all bearings from cylinder block and main bearing caps. Install main bearing caps in original location. Tighten bolts to specification. Using inside micrometer, measure main bearing bore in 2 areas 90 degrees apart. Determine bore size and out-of-round. If diameter is not within specification, block must be align-bored.

For checking alignment, place a straightedge along center line of main bearing saddles. Check for clearance between straightedge and main bearing saddles. Block must be align-bored if clearance exists.

Expansion Plug Removal

Drill hole in center of expansion plug. Remove with screwdriver or punch. Use care not to damage sealing surface.

Expansion Plug Installation

Ensure sealing surface is free of burrs. Coat expansion plug with sealer. Using wooden dowel or pipe of slightly smaller diameter, install expansion plug. Ensure expansion plug is evenly located.

Oil Gallery Plug Removal

Remove threaded oil gallery plugs using appropriate wrench. Soft press-in plugs are removed by drilling into plug and installing a sheet metal screw. Remove plug with slide hammer or pliers.

Oil Gallery Plug Installation

Ensure threads or sealing surface is clean. Coat threaded oil gallery plugs with sealer and install. Replacement soft press-in plugs are installed with a hammer and drift.

CAMSHAFT

*** PLEASE READ THIS FIRST ***

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to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

CLEANING & INSPECTION

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Clean camshaft with solvent. Ensure all oil passages are clear. Inspect cam lobes and bearing journals for pitting, flaking or scoring. Using micrometer, measure bearing journal O.D.

Support camshaft at each end with "V" blocks. Position dial indicator with tip resting on center bearing journal. Rotate camshaft and note camshaft runout reading. If reading exceeds specification, replace camshaft.

Check cam lobe lift by measuring base circle of camshaft using micrometer. Measure again at 90-degree angle to tip of cam lobe. Cam lift can be determined by subtracting base circle diameter from tip of cam lobe measurement.

Different lift dimensions are given for intake and exhaust cam lobes. Reading must be within specification. Replace camshaft if cam lobes or bearing journals are not within specification.

Inspect camshaft gear for chipped, eroded or damaged teeth. Replace gear if damaged. On camshafts using thrust plate, measure distance between thrust plate and camshaft shoulder. Replace thrust plate if not within specification.

CAMSHAFT BEARINGS

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Removal & Installation

Remove camshaft rear plug. Camshaft bearing remover is assembled with shoulder resting against bearing to be removed according to manufacturer's instructions. Tighten puller nut until bearing is removed. Remove remaining bearings, leaving front and rear bearings until last. These bearings act as a guide for camshaft bearing remover.

To install new bearings, puller is rearranged to pull bearings toward the center of block. Ensure all lubrication passages of bearing are aligned with cylinder block. Coat new camshaft rear plug with sealant. Install camshaft rear plug. Ensure plug is even in cylinder block.

CAMSHAFT INSTALLATION

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Lubricate bearing surfaces and cam lobes with ample amount of Molykote or camshaft lubricant. Carefully install camshaft. Use care not to damage bearing journals during installation. Install thrust plate retaining bolts (if equipped). Tighten bolts to specification. On overhead camshafts, install bearing caps in original location. Tighten bolts to specification. On all applications, check camshaft end play.

CAMSHAFT END PLAY

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Using dial indicator, check camshaft end play. Position dial indicator on front of engine block or cylinder head. Position indicator tip against camshaft. Push camshaft toward rear of cylinder head or engine and adjust indicator to zero.

Move camshaft forward and note reading. Camshaft end play must be within specification. End play may be adjusted by relocating gear, shimming thrust plate or replacing thrust plate depending on each manufacturer.

TIMING CHAINS & BELTS

*** PLEASE READ THIS FIRST ***

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TIMING CHAINS

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Timing chains will stretch during operation. Limits are placed upon amount of stretch before replacement is required. Timing chain stretch will alter ignition timing and valve timing.

To check timing chain stretch, rotate crankshaft to eliminate slack from one side of timing chain. Mark reference point on cylinder block. Rotate crankshaft in opposite direction to eliminate slack from remaining side of timing chain. Force other side of chain outward and measure distance between reference point and timing chain. See **Fig. 23**. Replace timing chain and gears if not within specification.

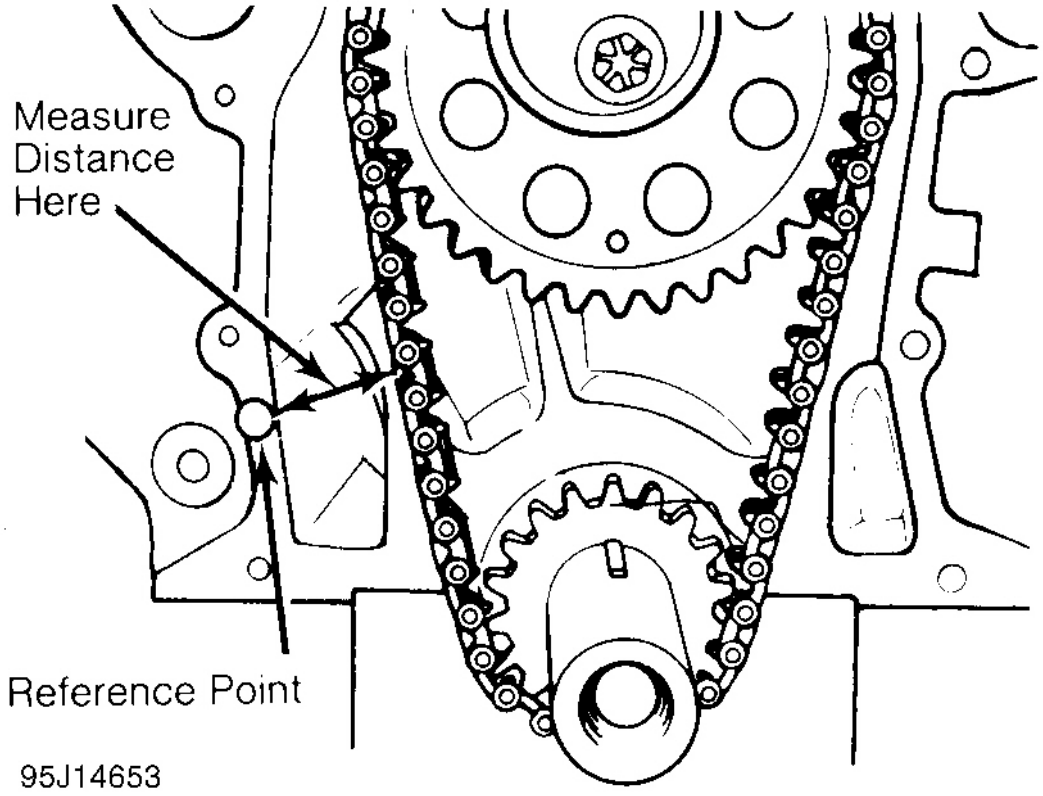


Fig. 23: Measuring Timing Chain Stretch

Timing chains must be installed so timing marks on camshaft gear and crankshaft gear are aligned according to manufacturer. See **Fig. 24**.

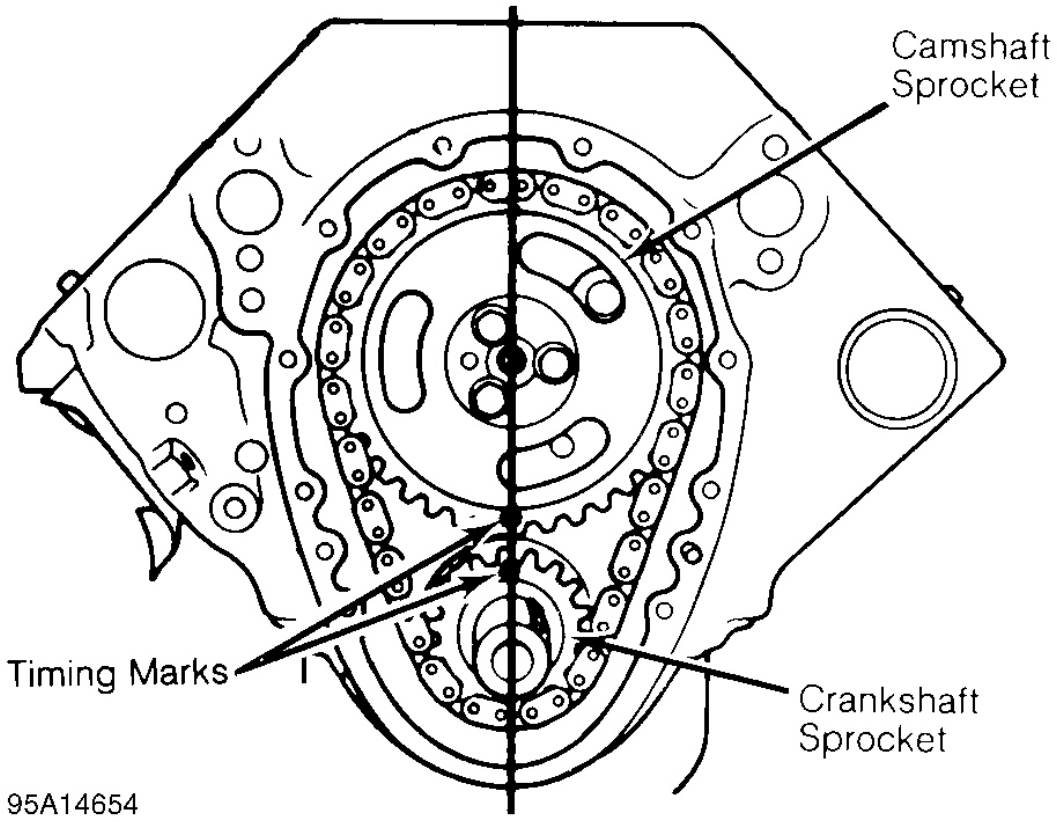


Fig. 24: Typical Gear Timing Mark Alignment

TIMING BELTS

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Cogged tooth belts are commonly used on overhead cam engines. Inspect belt teeth for rounded corners or cracking. Replace belt if it is cracked, damaged, missing teeth or oil soaked.

Used timing belt must be installed in original direction of rotation. Inspect all sprocket teeth for wear. Replace all worn sprockets. Sprockets are marked for timing purposes. Engine is positioned so that crankshaft sprocket mark will be upward. Camshaft sprocket is aligned with reference mark on cylinder head or timing belt cover and then timing belt can be installed. See **Fig. 25**.

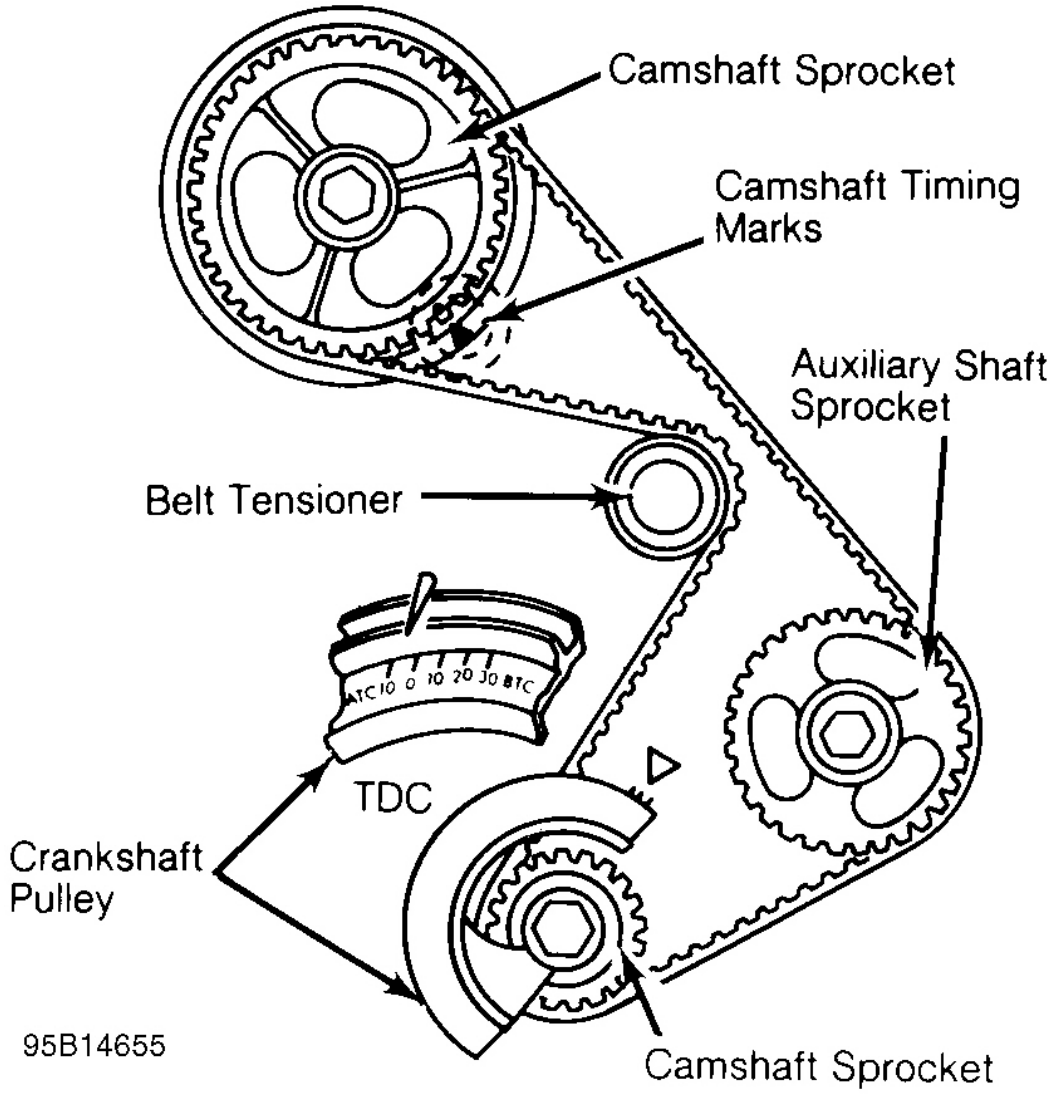


Fig. 25: Typical Camshaft Belt Sprocket Alignment

TENSION ADJUSTMENT

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If guide rails are used with spring loaded tensioners, ensure at least half of original rail thickness remains. Spring loaded tensioner should be inspected for damage.

Ensure all timing marks are aligned. Adjust belt tension using manufacturer's recommendations. Belt tension may require checking using tension gauge. See **Fig. 26**.

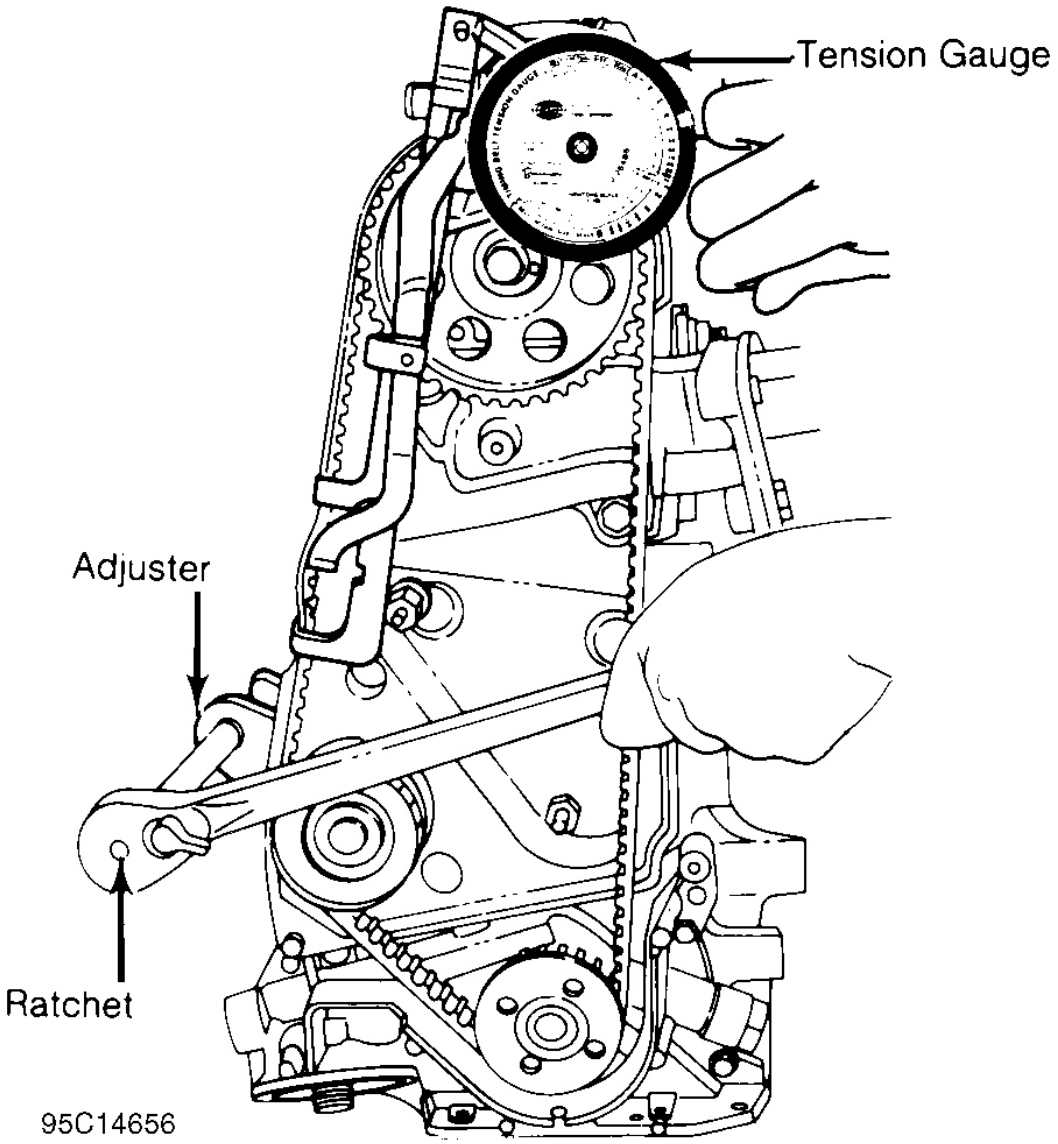


Fig. 26: Adjusting Typical Timing Belt Tension

TIMING GEARS

*** PLEASE READ THIS FIRST ***

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TIMING GEAR BACKLASH & RUNOUT

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On engines where camshaft gear operates directly on crankshaft gear, gear backlash and runout must be checked. To check backlash, install dial indicator with tip resting on tooth of camshaft gear. Rotate camshaft gear as far as possible. Adjust indicator to zero. Rotate camshaft gear in opposite direction as far as possible and note reading.

To determine timing gear runout, mount dial indicator with tip resting on face edge of camshaft gear. Adjust indicator to zero. Rotate camshaft gear 360 degrees and note reading. If backlash or runout exceeds specification, replace camshaft and/or crankshaft gear.

REAR MAIN OIL SEAL INSTALLATION

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One-Piece Type Seal

For one-piece type oil seal installation, coat block contact surface of seal with sealer if seal is not factory coated. Ensure seal surface is free of burrs. Lubricate seal lip with engine oil and press seal into place using proper oil seal installer. See **Fig. 27**.

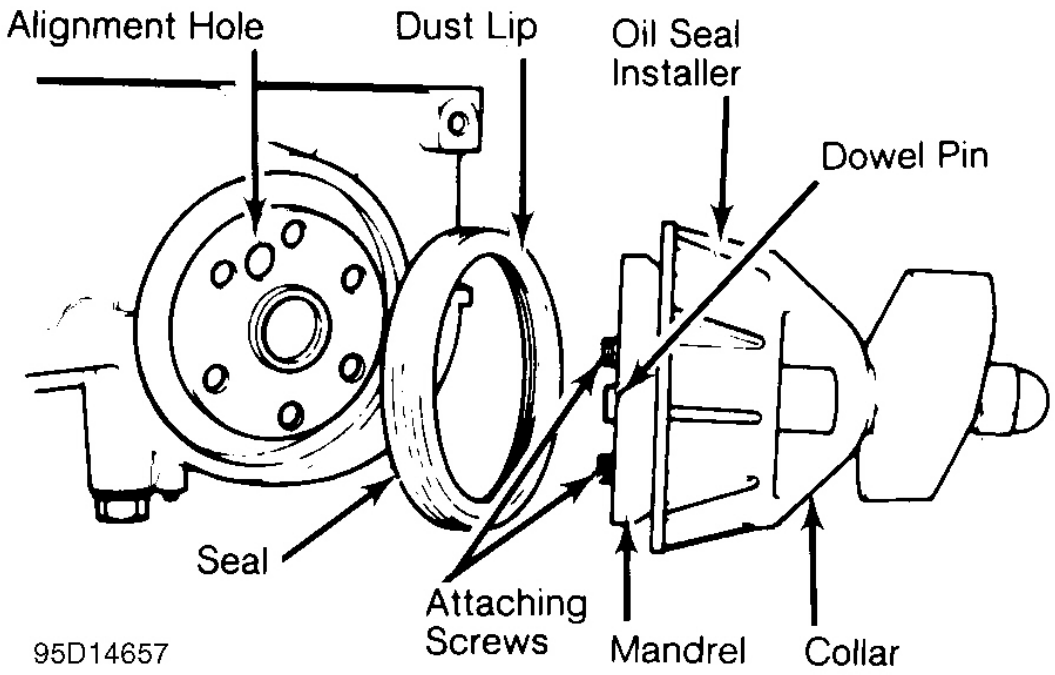


Fig. 27: Installing Typical One-Piece Oil Seal

Rope Type Seal

For rope type rear main oil seal installation, press seal lightly into seat area. Using seal installer, fully seat seal in bearing cap or cylinder block.

Trim seal ends even with cylinder block parting surface. Some applications require sealer to be applied on main bearing cap before installing. See **Fig. 28**.

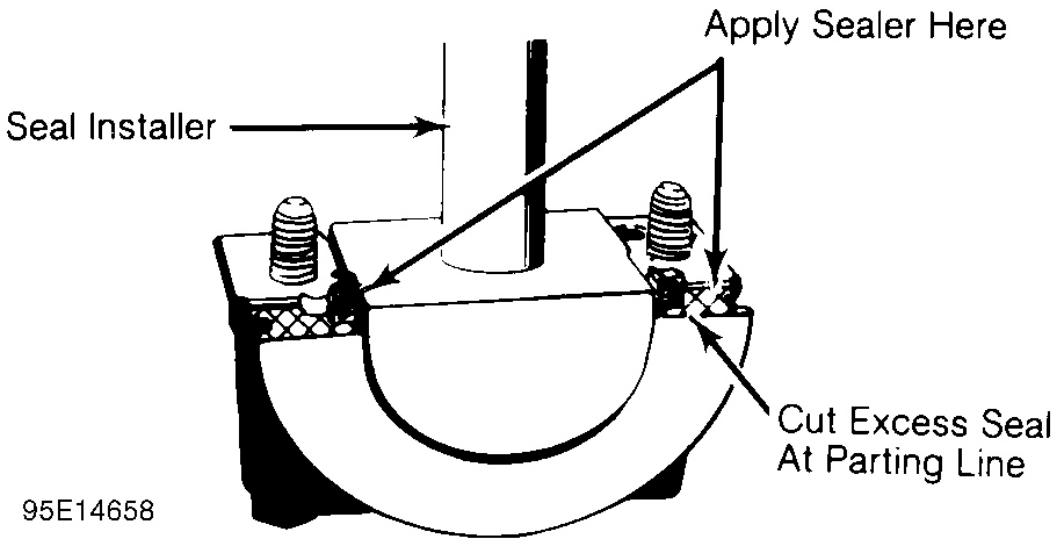


Fig. 28: Installing Typical Rope Seal

Split-Rubber Type Seal

Follow manufacturer's procedures when installing split-rubber type rear main oil seals. Installation procedures vary with manufacturer and engine type. See **Fig. 29**.

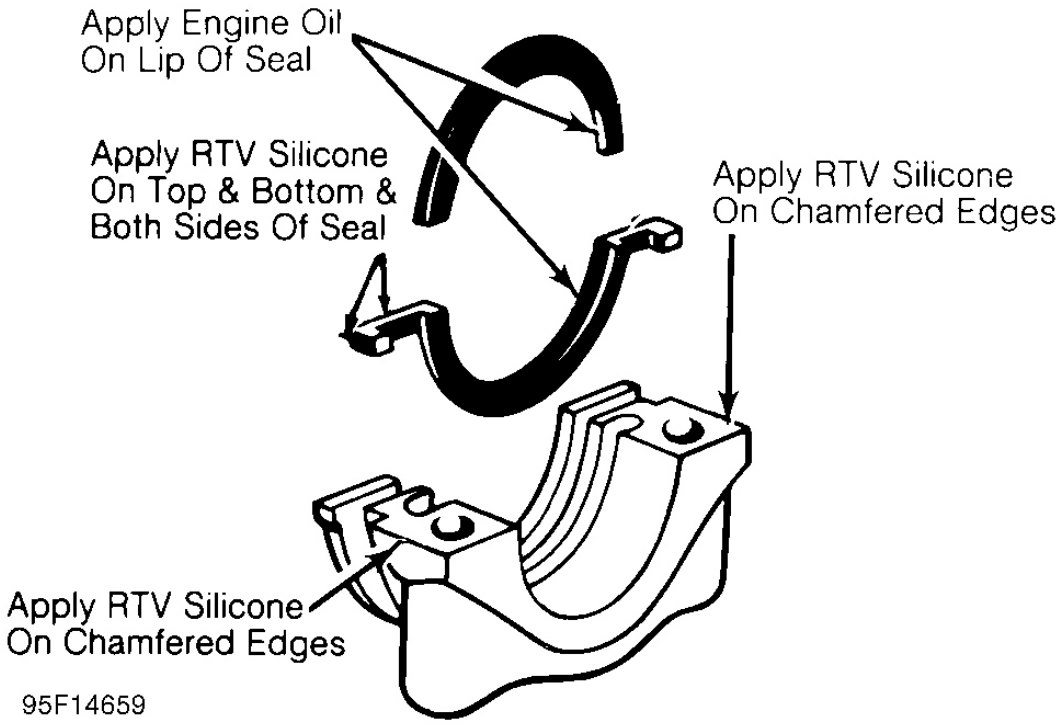


Fig. 29: Installing Typical Split-Rubber Seal

OIL PUMP

*** PLEASE READ THIS FIRST ***

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ROTOR TYPE

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Mark oil pump rotor locations before removing. See **Fig. 30**. Remove outer rotor and measure thickness and diameter. Measure inner rotor thickness. Inspect shaft for scoring or wear. Inspect rotors for pitting or damage. Inspect cover for grooving or wear. Replace worn or damaged components.

Measure outer rotor-to-body clearance. Replace pump assembly if clearance exceeds specification. Measure clearance between rotors. See **Fig. 31**. Replace shaft and both rotors if clearance exceeds specification.

Install rotors in pump body. Position straightedge across pump body. Using feeler gauge, measure clearance between rotors and straightedge. Pump cover wear is measured using a straightedge and feeler gauge. Replace pump if clearance exceeds specification.

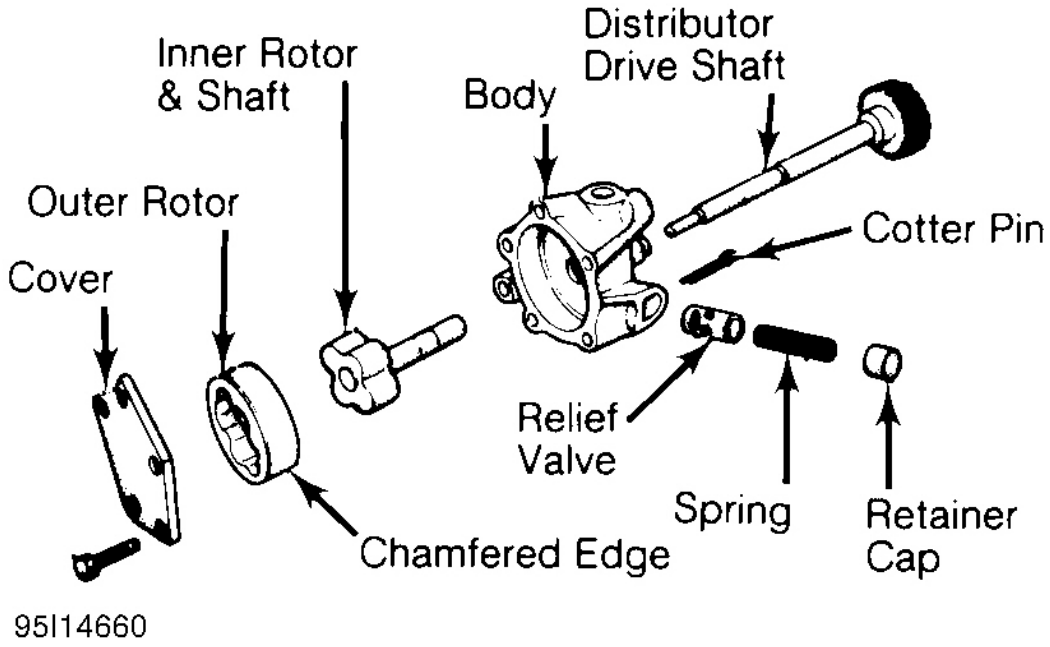


Fig. 30: Typical Rotor Type Oil Pump

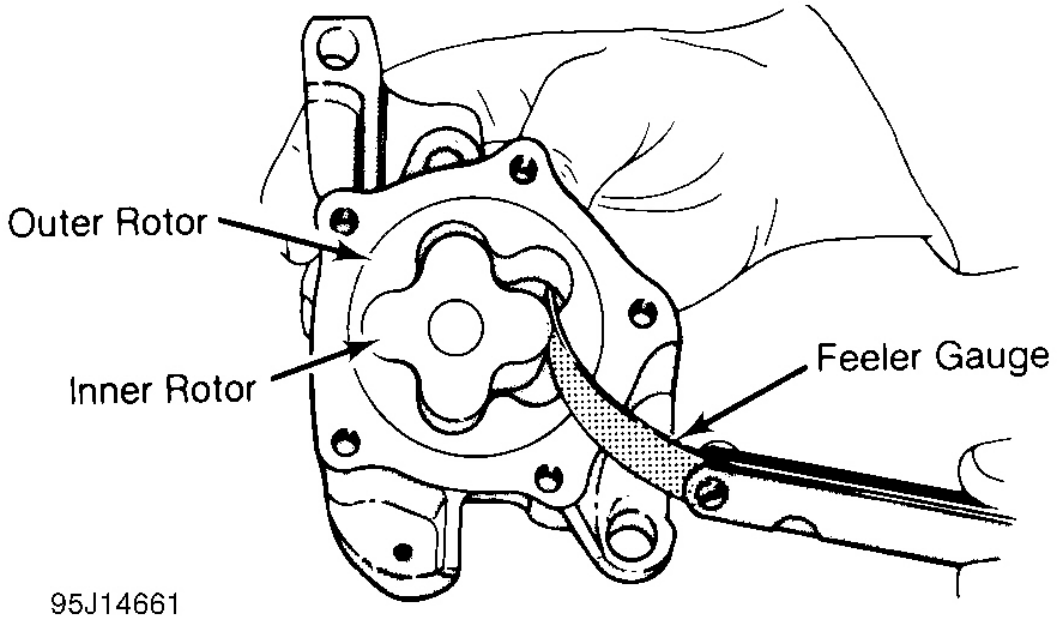


Fig. 31: Measuring Rotor Clearance

GEAR TYPE

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Mark oil pump gear location before removing. See **Fig. 32**. Remove gears from pump body. Inspect gears for pitting or damage. Inspect cover for grooving or wear. Measure gear diameter and length. Measure gear housing cavity depth and diameter. See **Fig. 33**. Replace worn or damaged components.

Pump cover wear is measured using a straightedge and feeler gauge. Replace pump or components if warpage or wear exceeds specification, or mating surface of pump cover is scratched or grooved.

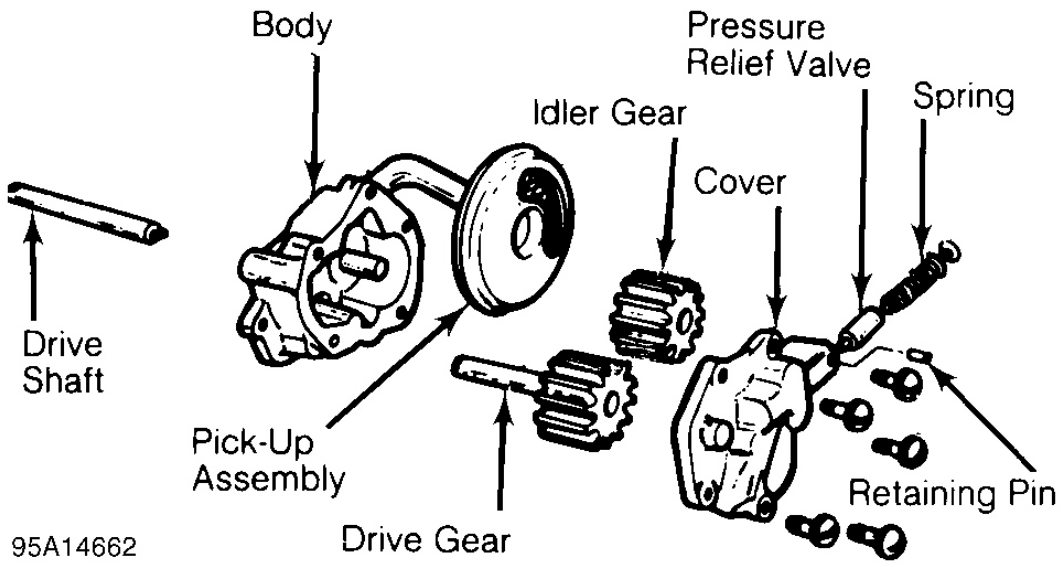


Fig. 32: Typical Gear Type Oil Pump

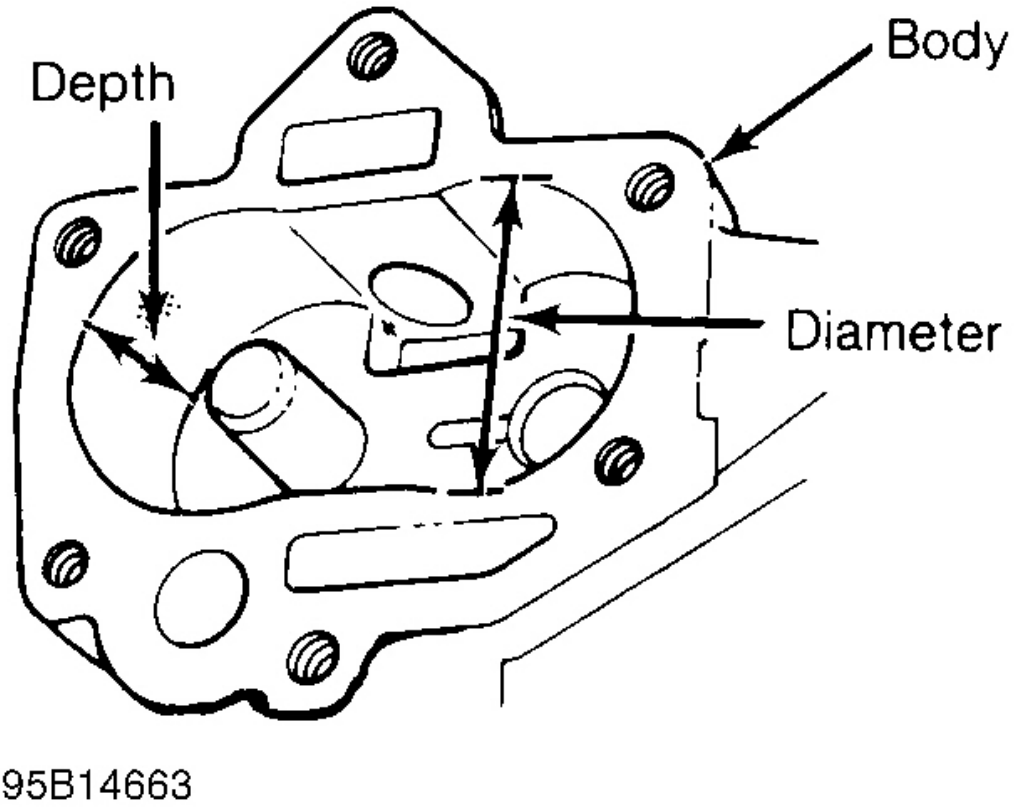


Fig. 33: Measuring Oil Pump Gear Cavity

BREAK-IN PROCEDURE

*** PLEASE READ THIS FIRST ***

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ENGINE PRE-OILING

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Pre-oil engine prior to operation to prevent engine damage. Lightly oiled oil pump will cavitate unless oil pump cavities are filled with engine oil or petroleum jelly.

Engine pre-oiling can be done using pressure oiler (if available). Connect pressure oiler to cylinder block oil passage such as oil pressure sending unit. Operate pressure oiler long enough to ensure correct amount of oil has filled crankcase. Check oil level while pre-oiling.

If pressure oiler is not available, disconnect ignition system. Remove oil pressure sending unit and replace with oil pressure test gauge. Using starter motor, rotate engine starter until gauge shows normal oil pressure for several seconds. DO NOT crank engine for more than 30 seconds to avoid starter motor damage. Ensure oil pressure has reached the most distant point from the oil pump.

NOTE: **If new lifters or camshaft are installed, some manufacturers require that a crankcase conditioner be added to engine oil. The engine should be operated for specified amount of time to aid in lifter break-in procedure.**

INITIAL START-UP

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Start engine and operate engine at low speed while checking for coolant, fuel and oil leaks. Stop engine. Recheck coolant and oil level. Adjust if necessary.

CAMSHAFT

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Break-in procedure is required when new or reground camshaft has been installed. Operate and maintain engine speed between 1500-2500 RPM for approximately 30 minutes. Procedure may vary due to manufacturer's recommendations.

PISTON RINGS

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Piston rings require a break-in procedure to ensure seating of rings to cylinder walls. Serious damage may occur to rings if correct procedures are not followed.

Extremely high piston ring temperatures are obtained during break-in process. If rings are exposed to excessively high RPM or high cylinder pressures, ring damage can occur. Follow piston ring manufacturer's recommended break-in procedure.

FINAL ADJUSTMENTS

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Check or adjust ignition timing and dwell (if applicable). Adjust valves (if necessary). Adjust idle speed and mixture. Retighten cylinder heads (if required). If cylinder head or block is aluminum, retighten bolts when engine is cold. Follow the engine manufacturer's recommended break-in procedure and maintenance schedule for new engines.

NOTE: Some manufacturers require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.

WIPER/WASHER SYSTEM - FRONT

ACCESSORIES & EQUIPMENT General Motors Corp. - Front Wiper/Washer Systems

DESCRIPTION & OPERATION

CAUTION: To prevent scratches, wet windshield before operating wipers.

This is a depressed park system (the wipers park below the bottom of the windshield). The system uses a 2-speed wiper motor. A washer motor is attached to the washer fluid reservoir. A circuit board on the wiper motor cover controls power to the washer motor. See **Fig. 1** and **Fig. 2** .

On vehicles with pulse (intermittent) system, if wiper switch is in DELAY position, a time delay occurs between wiping sweeps (on vehicles with variable delay, you can vary the time delay). The circuit board on the wiper motor cover controls the delay function.

ADJUSTMENTS

WIPER ARMS ADJUSTMENT

1. In park position, distance between upper edge of each wiper arm and bottom of parking ramp should be 1" (25.4 mm). Move wipers to outer wipe position (top of sweep). Distance between left wiper arm and vertical edge of windshield should be as follows: 3/4-3 1/2" (21.3-92.3 mm).
2. While wipers are operating, wiping pattern of right blade should overlap wiping pattern of left blade. If wiper arms are not positioned as specified, remove and reposition wiper arms.

TESTING

NOTE: Before testing, ensure wiper motor is securely mounted. Ensure washer hoses are not kinked, disconnected or broken. Ensure fuses are okay.

WIPERS DO NOT OPERATE IN ANY MODE

1. Disconnect wiper switch connector. Turn ignition switch to RUN position. Connect test light between chassis ground and Yellow wire terminal of wiper switch connector. If test light does not come on, replace fuse and/or repair open wire.
2. If test light is on, disconnect 3-pin connector from wiper motor. Connect test light between battery voltage and Black wire terminal of 3-pin connector. If test light does not come on, repair open Black wire.
3. If test light is on, reconnect wiper switch connector. Disconnect 6-pin connector from wiper motor. Connect test light between chassis ground and Dark Green wire terminal of wiper motor 6-pin connector. If test light is on, go to next step. If test light is off, check for open Dark Green wire. If Dark Green wire is okay, replace wiper switch.
4. Turn wiper switch to LO position. Connect test light between chassis ground and Gray wire terminal of

wiper motor 6-pin connector. If test light is on, go to next step. If test light is off, check for open Gray wire. If Gray wire is okay, replace wiper switch.

5. Check for continuity in Yellow wire between 3-pin and 6-pin wiper motor connectors. If there is no continuity, repair open Yellow wire. If there is continuity, check for poor wiring connection at wiper motor. If connection is okay, replace wiper motor cover (circuit board). See **Fig. 1** and **Fig. 2** . If problem still exists, replace wiper motor.

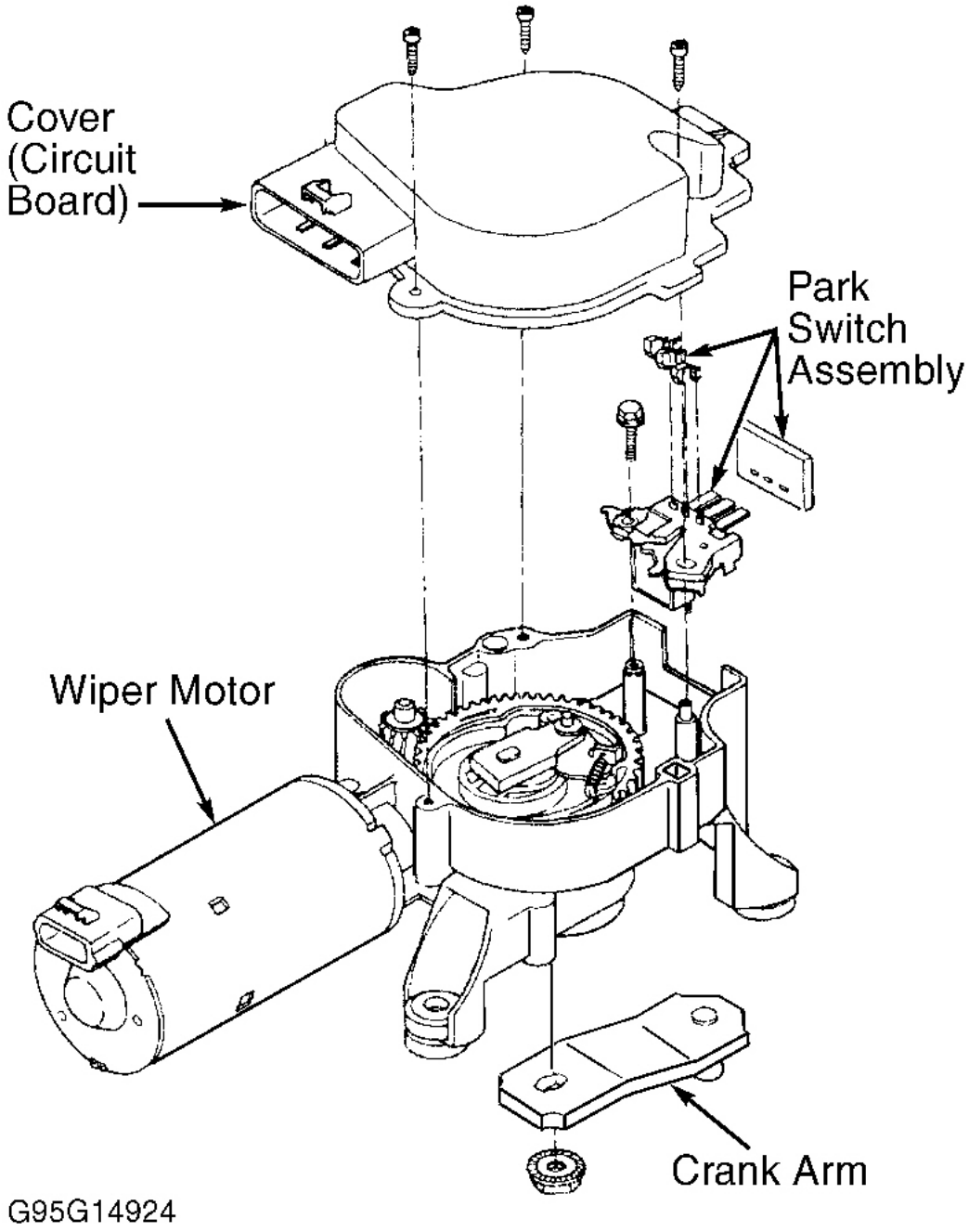


Fig. 1: Locating Wiper Motor Components
Courtesy of GENERAL MOTORS CORP.

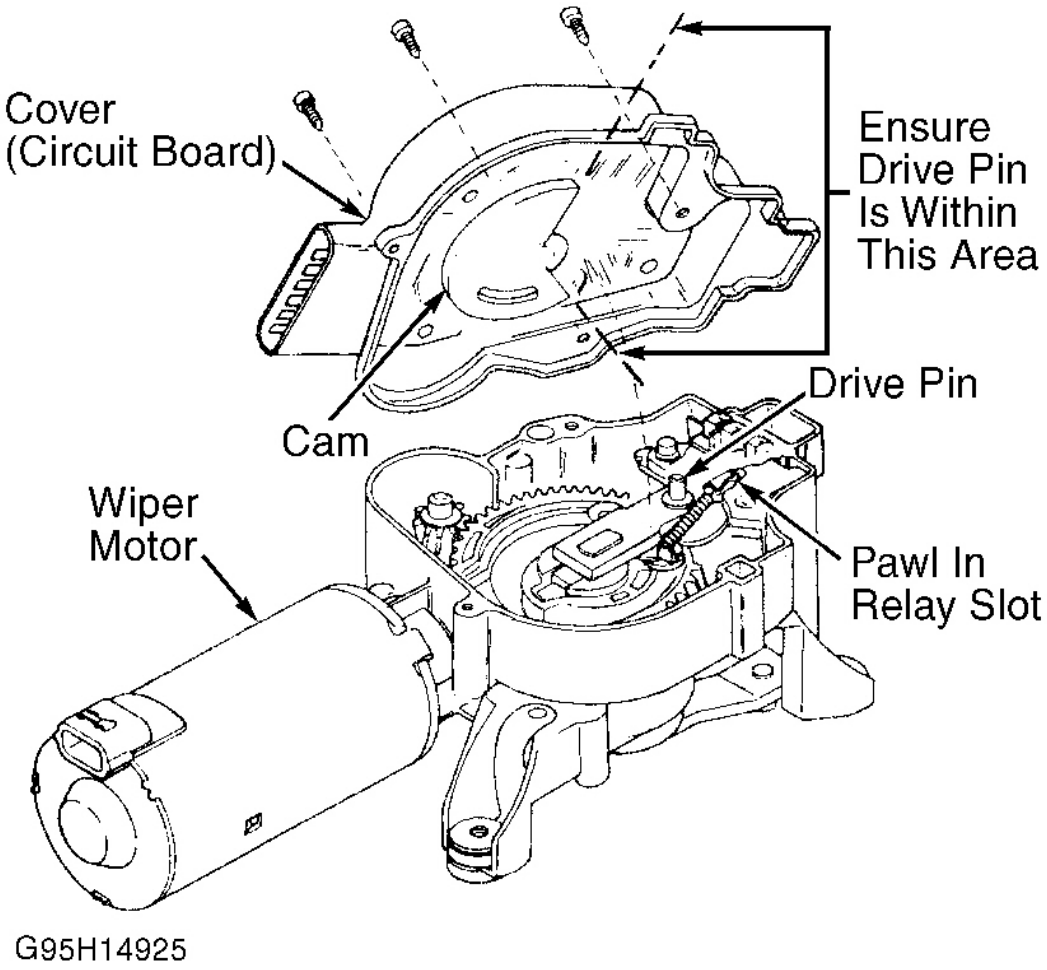


Fig. 2: Positioning Drive Pin Before Installing Wiper Motor Cover
Courtesy of GENERAL MOTORS CORP.

WIPERS RUN AT HIGH SPEED ONLY (LOW SPEED INOPERATIVE)

1. Disconnect 6-pin connector from wiper motor. Turn ignition switch to RUN position. Turn wiper switch to LO position. Connect test light between chassis ground and Gray wire terminal of wiper motor 6-pin connector. If test light is on, go to next step. If test light is off, check for open Gray wire. If Gray wire is okay, replace wiper switch.
2. Connect test light between chassis ground and Dark Green wire terminal of wiper motor 6-pin connector. If light is on, go to next step. If test light is off, check for open Dark Green wire. If Dark Green wire is okay, replace wiper switch.
3. Check for continuity in Yellow wire between 3-pin and 6-pin wiper motor connectors. If there is no continuity, repair open Yellow wire. If there is continuity, check for poor wiring connection at wiper motor. If connection is okay, replace wiper motor cover (circuit board). See **Fig. 1** and **Fig. 2** . If problem

still exists, replace wiper motor.

WIPERS RUN AT LOW SPEED ONLY (HIGH SPEED INOPERATIVE)

1. Disconnect 3-pin connector from wiper motor. Turn ignition switch to RUN position. Turn wiper switch to HI position. Connect test light between chassis ground and Purple wire terminal of wiper motor 3-pin connector.
2. If test light is on, go to next step. If test light is off, check for open Purple wire. If Purple wire is okay, replace wiper switch.
3. Check for poor wiring connection at wiper motor. If connection is okay, replace wiper motor.

WIPERS RUN INTERMITTENTLY IN LOW OR HIGH SPEED SETTINGS

1. Remove wiper system fuse. Connect an ammeter (0-30 amp) across fuse block terminals. Turn ignition switch to RUN position. Turn wiper switch to LO position. Note lowest current draw while wipers are running on dry glass (current draw will fluctuate).
2. If lowest current draw is less than 3.5 amps, replace wiper motor. If lowest current draw is more than 6.5 amps, go to next step. If lowest current draw is less than 6.5 amps, test is complete.
3. Replace wiper blade elements and repeat test. If lowest current draw is still more than 6.5 amps, go to next step. If lowest current draw is not more than 6.5 amps, test is complete.
4. Disconnect drive link from wiper motor crank arm and repeat test. If lowest current draw is still more than 6.5 amps, replace wiper motor. If lowest current draw is not more than 6.5 amps, wiper linkage is binding. Replace or repair as required, and repeat test.

WIPERS WILL NOT SHUT OFF

1. Disconnect 6-pin connector from wiper motor. Turn ignition switch to RUN position. Turn wiper switch to OFF position. Measure voltage between chassis ground and Gray wire terminal of wiper motor 6-pin connector.
2. If zero volts is present, go to next step. If battery voltage is present, check for short to battery voltage in Gray wire. If wire is okay, replace wiper switch.
3. Disconnect 3-pin connector from wiper motor. Measure voltage between chassis ground and Purple wire terminal of wiper motor 3-pin connector. If zero volts is present, repair short to battery voltage in Yellow wire between wiper motor connectors.
4. If battery voltage is present, check for short to battery voltage in Purple wire. If Purple wire is okay, replace wiper switch.

WIPERS CYCLE IN AND OUT OF PARK POSITION AFTER WIPERS ARE

SHUT OFF

If wipers do not operate in LO position, go to the **WIPERS RUN AT HIGH SPEED ONLY (LOW SPEED INOPERATIVE)** test. If wipers operate in LO position, replace wiper park switch. See **WIPER PARK SWITCH** under REMOVAL & INSTALLATION. If symptom still exists, replace wiper motor, then repeat test.

PULSE DELAY OPERATES INCORRECTLY OR NOT AT ALL

1. Turn ignition switch to OFF position. Disconnect wiper switch connector. Turn wiper switch to DELAY position. Connect ohmmeter between Yellow wire and Pink wire terminals of wiper switch connector (switch side of connector). Move wiper switch through entire delay range.
2. Resistance should vary from approximately 24,000 ohms to 1,224,000 ohms. If resistance is not as specified, replace wiper switch. If resistance is as specified, measure resistance between Yellow wire and Gray wire terminals of wiper switch connector (switch side of connector).
3. If resistance is greater than 3 ohms, replace wiper switch. If resistance is less than 3 ohms, check for open Gray wire or Pink wire between wiper switch and wiper motor. If circuits are okay, remove wiper motor cover (circuit board). See **Fig. 1** and **Fig. 2** .
4. Check to see if park switch pulse terminals are touching pads on circuit board. If contacts are touching pads, replace wiper motor cover (circuit board). See **Fig. 1** and **Fig. 2** . If contacts are not touching pads, replace park switch spring contacts.

WASHER MOTOR DOES NOT OPERATE

1. Disconnect washer motor connector. Turn ignition switch to RUN position. Connect test light between terminals of washer motor connector. While observing test light, activate washer switch. If test light is off, go to next step. If test light is on, check for poor wiring connection at washer motor. If connection is okay, replace washer motor.
2. Connect test light between chassis ground and Red wire terminal of washer motor connector. Activate washer switch. If test light is on, go to next step. If test light is off, check for open Red wire. If Red wire is okay, replace wiper switch.
3. Check for open Dark Blue wire. If Dark Blue wire is okay, replace wiper motor (internal ground circuit is open).

WASHER WILL NOT SHUT OFF

1. Turn ignition switch to RUN position. Turn wiper switch to LO position. Disconnect 6-pin connector from wiper motor. Connect test light between wiper motor case (ground) and Pink wire terminal of wiper motor 6-pin connector.
2. Momentarily activate washer switch while observing test light. If test light is on, replace washer switch. If test light is off, replace wiper motor cover (circuit board). See **Fig. 1** and **Fig. 2** . See **WIPER MOTOR COVER (CIRCUIT BOARD)** under REMOVAL & INSTALLATION.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

WIPER ARMS R & I

Removal & Installation

1. Turn ignition switch to RUN position. Turn wiper switch to DELAY position (or LO position on vehicles without pulse system). When wipers are at inner wipe position (bottom of sweep), turn ignition off. Mark position of wiper blades in relation to windshield for installation reference.
2. Disconnect washer fluid hose. Remove protective cap for access to wiper arm nut. Lift wiper arm, and insert a pin or pop rivet through holes next to wiper arm pivot to hold wiper blade away from windshield.
3. Remove nut. Pull wiper arm off of splined shaft, using a battery terminal puller if necessary. To install, reverse removal procedure using new nut. Ensure wiper arms are correctly positioned. See **WIPER ARMS ADJUSTMENT** .

WIPER MOTOR ASSEMBLY

Removal & Installation

1. Disconnect negative battery cable. Remove right wiper arm. See WIPER ARMS. To prevent windshield damage, remove left cowl vent screen, then remove right cowl vent screen. Remove 2 screws and access cover near wiper motor.
2. Separate drive link from crank arm. Disconnect electrical connectors. Remove 3 screws and wiper motor. To install, reverse removal procedure. Ensure wiper arms are correctly positioned. See **WIPER ARMS ADJUSTMENT** .

WIPER MOTOR COVER (CIRCUIT BOARD)

Removal

Remove wiper motor assembly (if necessary). Remove screws and wiper motor cover. See **Fig. 1** .

Installation

Ensure wiper motor is in park position. Ensure drive pin is positioned as illustrated. See **Fig. 2** . To complete installation, reverse removal procedure.

WIPER PARK SWITCH

Removal

Remove wiper motor cover (circuit board). See **WIPER MOTOR COVER (CIRCUIT BOARD)** . If wiper motor is in PARK position, operate motor until lock pawl can be removed from relay slot. See **Fig. 2** . Remove screw and park switch.

Installation

To install, reverse removal procedure. Before installing wiper motor cover, ensure wiper motor is in park position. Ensure drive pin is positioned as illustrated. See **Fig. 2** . To complete installation, reverse removal procedure.

WIPER DRIVE LINKAGE ASSEMBLY

Removal & Installation

1. Disconnect negative battery cable. Remove wiper arms. See **WIPER ARMS R & I** . To prevent windshield damage, remove left cowl vent screen, then remove right cowl vent screen. Remove 2 screws and the access cover near wiper motor.
2. Separate drive link from crank arm. Remove 6 screws securing drive link assembly. Remove drive link assembly through access hole. To install, reverse removal procedure. Ensure wiper arms are correctly positioned. See **WIPER ARMS ADJUSTMENT** .

WIPER/WASHER SWITCH

WARNING: If wiper/washer switch is located on steering column, disable air bag system before removing wiper/washer switch. See the AIR BAG RESTRAINT SYSTEM article.

Removal & Installation

Wiper/washer switch is an integral part of multifunction switch. See the **STEERING COLUMN SWITCHES** article.

WASHER MOTOR

Removal & Installation

Drain and remove washer fluid reservoir. Remove washer motor from reservoir. To install, reverse removal procedure.

WIRING DIAGRAMS

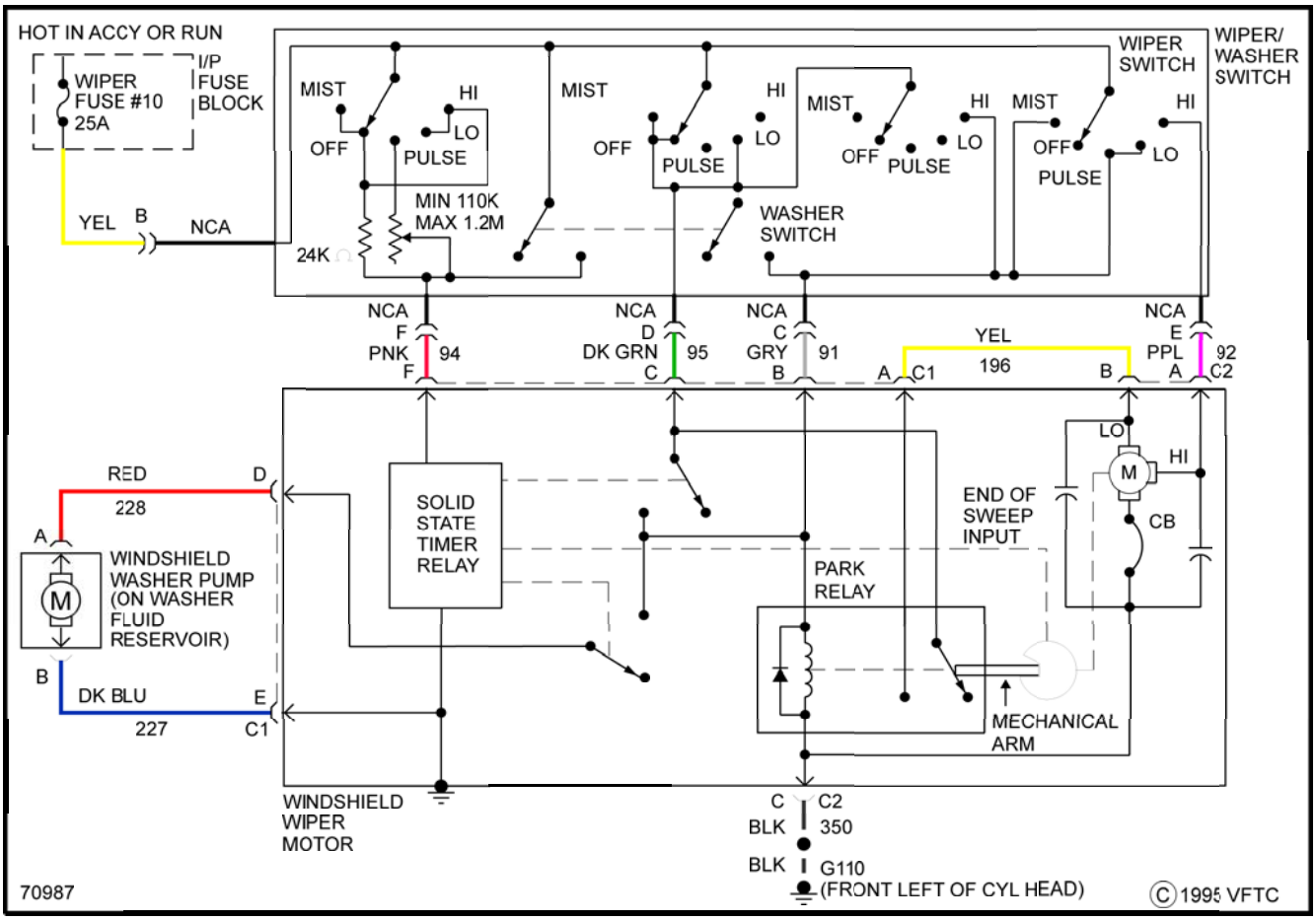


Fig. 3: Front Wiper/Washer System Wiring Diagram

W - WAVEFORM (INJECTOR) - 4.3L CPI VIN [W]

GENERAL MOTORS FUEL INJECTOR WAVEFORM 4.3L/262" OHV V6 CPI VIN [W]

INTRODUCTION

NOTE: **For a tutorial on how to interprete injector waveforms, see WAVEFORMS - INJECTOR PATTERN TUTORIAL found in the GENERAL/GENERAL INFORMATION section.**

NOTE: **To see a list of the other year/make/models these waveform(s) apply to, go to the top of the article.**

VOLTAGE WAVEFORMS

WAVEFORM #1 - HOT IDLE, OPEN LOOP, NO LOAD - GOOD

Quick Hyperlinks

- See **Fig. 1** for the waveform.
- See the **WAVEFORM DATA TABLE #1** for supporting data.

Introduction

The Waveform Data Table is listed first. This table contains supporting information about the waveform illustration and should be used in conjunction with it.

The waveform illustration follows after the table.

NOTE: **A description of the vehicle the waveform came from is not available.**

WAVEFORM DATA #1

Application	Specification
Pattern Type	Voltage
Voltage Base	20 Volts
Time Base	1 Millisecond
Oscilloscope Used	Unknown
Pattern Represents	Single Injector
Injector Driver Type	Current Controlled
Side of Circuit That Driver Switches	Ground
Injector On-Time Shown	2.22 mS
Conditions	Hot Idle, No Load, Open Loop
Cursors On-Screen	Yes
Cursors Are Measuring	Injector On-Time

Status	Known Good Pattern

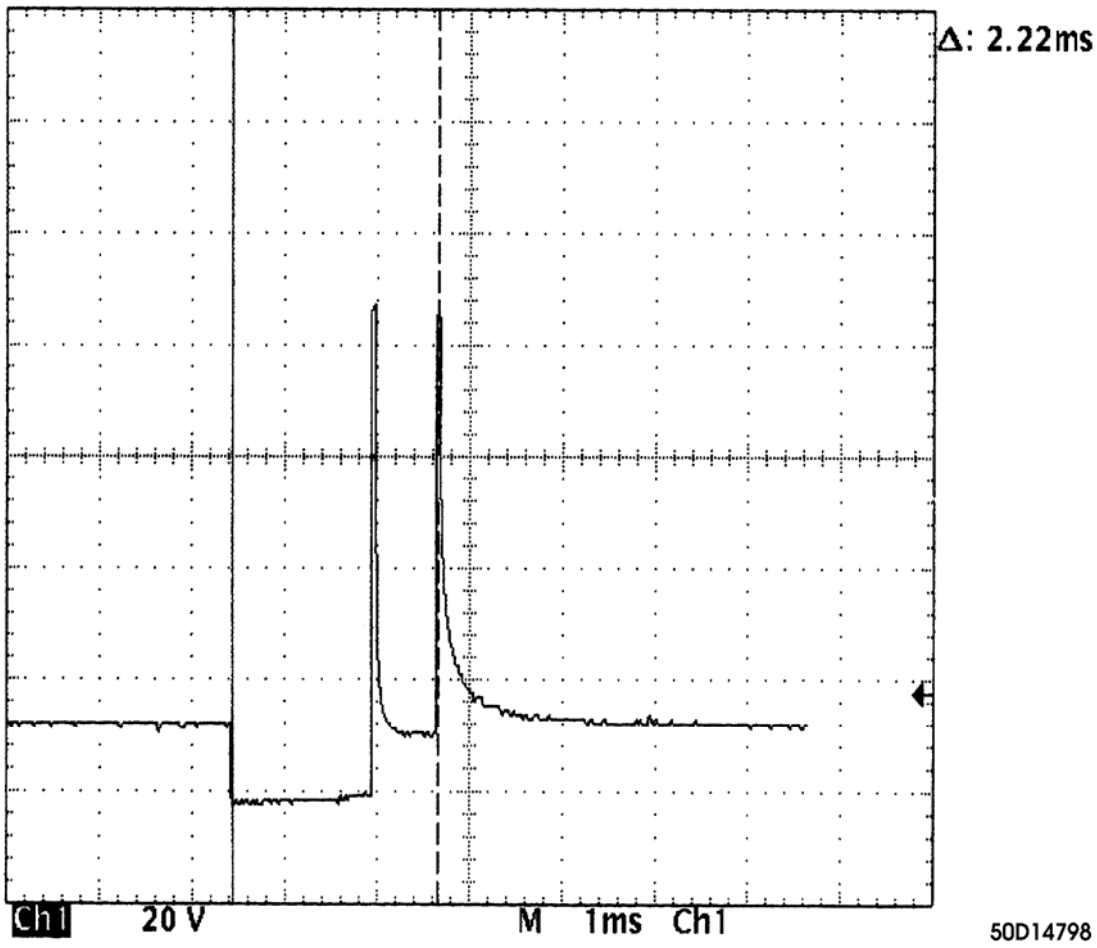


Fig. 1: Injector Waveform (Voltage) - Cursors Used - Known Good

WAVEFORM #2 - HOT IDLE, CLOSED LOOP, NO LOAD - GOOD

Quick Hyperlinks

- See **Fig. 2** for the waveform.
- See the **WAVEFORM DATA TABLE #2** for supporting data.

Introduction

The Waveform Data Table is listed first. This table contains supporting information about the waveform illustration and should be used in conjunction with it.

The waveform illustration follows after the table.

NOTE: **A description of the vehicle the waveform came from is not available.**

WAVEFORM DATA #2

Application	Specification
Pattern Type	Voltage
Voltage Base	20 Volts
Time Base	1 Millisecond
Oscilloscope Used	Unknown
Pattern Represents	Single Injector
Injector Driver Type	Current Controlled
Side of Circuit That Driver Switches	Ground
Injector On-Time Shown	2.02 mS
Conditions	Hot Idle, No Load, Closed Loop
Cursors On-Screen	Yes
Cursors Are Measuring	Injector On-Time
Status	Known Good Pattern

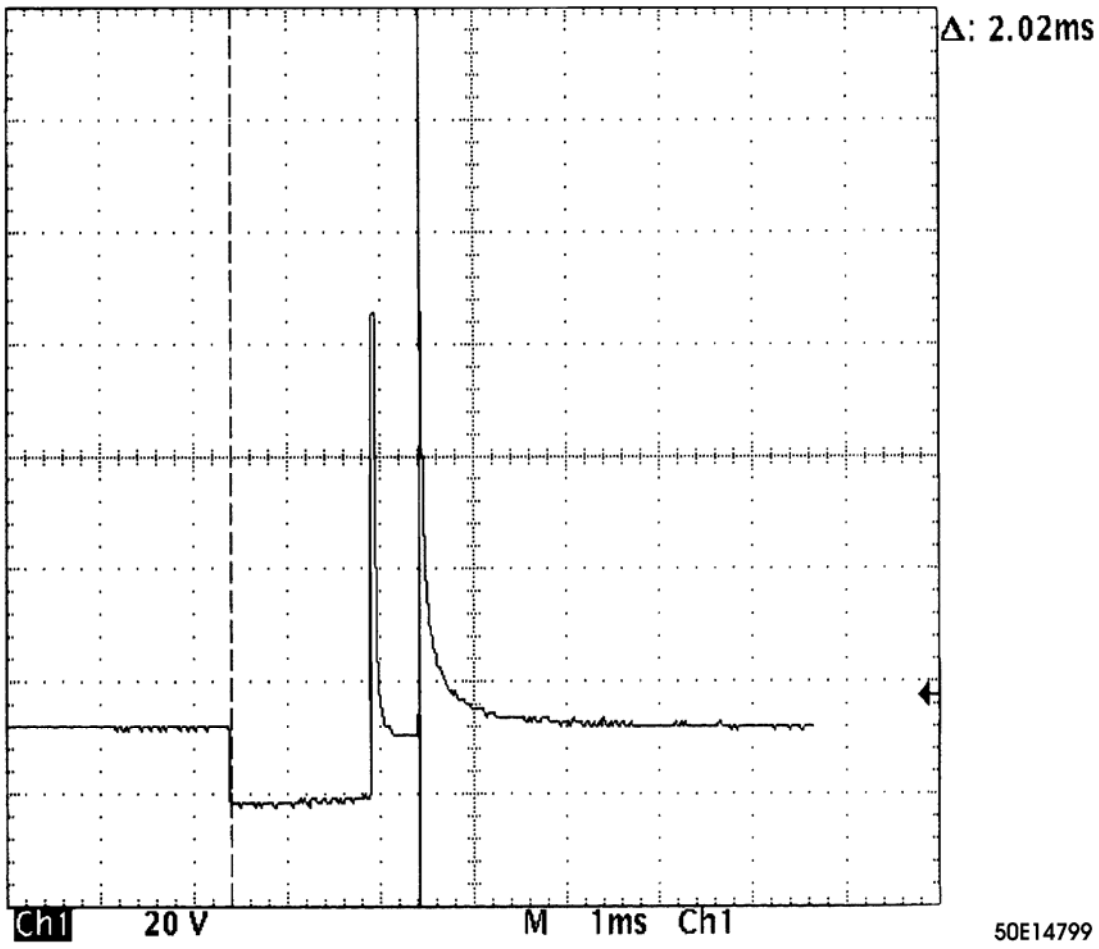


Fig. 2: Injector Waveform (Voltage) - Cursors Used - Known Good

WAVEFORM #3 - COLD CRANKING AT 50°F (10°C) - GOOD

Quick Hyperlinks

- See **Fig. 3** for the waveform.
- See the **WAVEFORM DATA TABLE #3** for supporting data.

Introduction

The Waveform Data Table is listed first. This table contains supporting information about the waveform illustration and should be used in conjunction with it.

The waveform illustration follows after the table.

NOTE: A description of the vehicle the waveform came from is not available.

WAVEFORM DATA #3

Application	Specification
Pattern Type	Voltage
Voltage Base	20 Volts
Time Base	2.5 Milliseconds
Oscilloscope Used	Unknown
Pattern Represents	Single Injector
Injector Driver Type	Current Controlled
Side of Circuit That Driver Switches	Ground
Injector On-Time Shown	7.5 mS
Conditions	During Cranking At 50°F (10°C)
Cursors On-Screen	Yes
Cursors Are Measuring	Injector On-Time
Status	Known Good Pattern

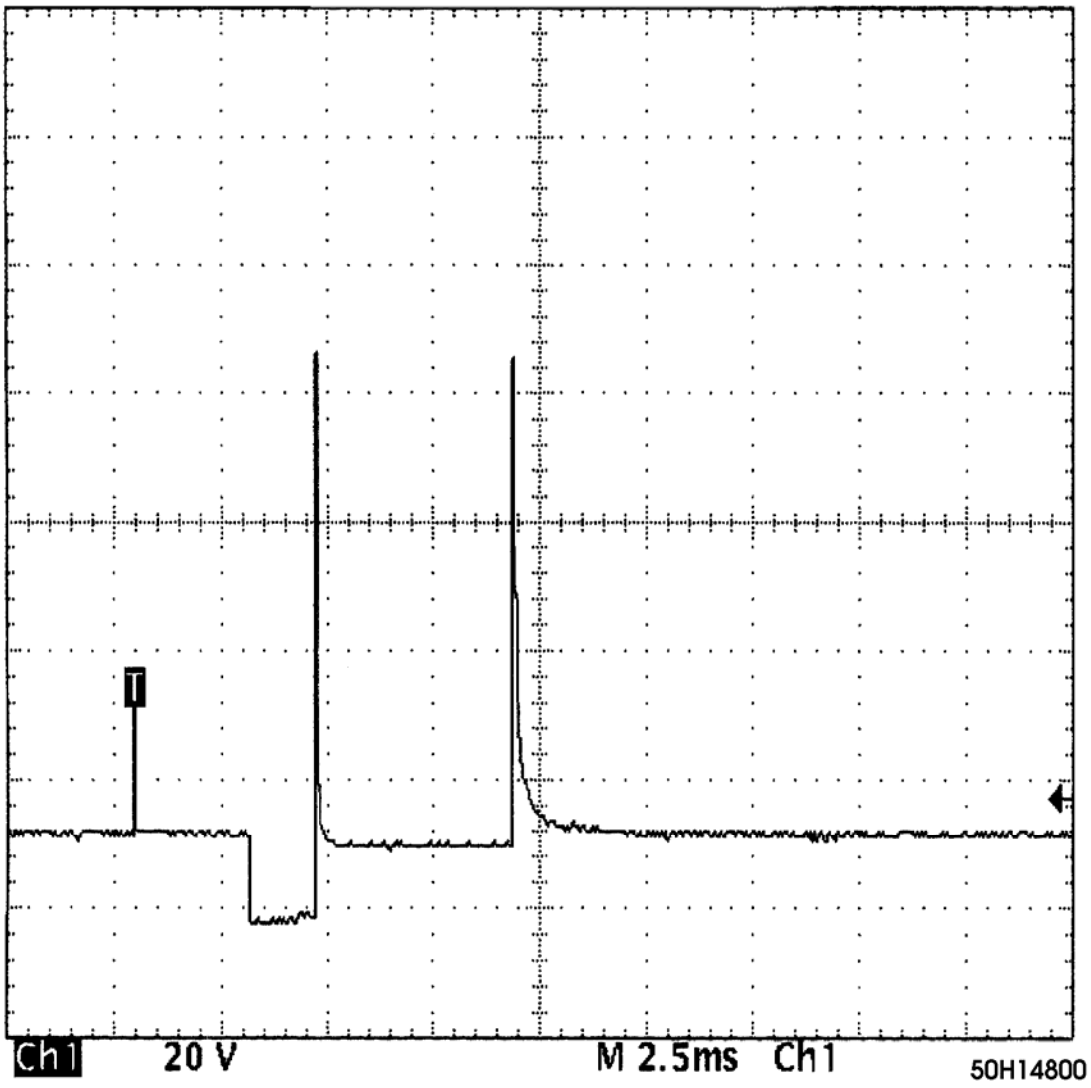


Fig. 3: Injector Waveform (Voltage) - Cursors Used - Known Good

CURRENT WAVEFORM

Quick Hyperlinks

- See **Fig. 4** for the waveform.
- See the **WAVEFORM DATA TABLE #4** for supporting data.

Introduction

The Waveform Data Table is listed first. This table contains supporting information about the waveform illustration and should be used in conjunction with it.

The waveform illustration follows after the table.

NOTE: A description of the vehicle the waveform came from is not available.

WAVEFORM DATA #4

Application	Specification
Pattern Type	Current
Current Base	1 Amp
Time Base	1 Millisecond
Oscilloscope Used	Unknown
Pattern Represents	Single Injector
Injector Driver Type	Current Controlled
Side of Circuit That Driver Switches	Ground
Injector On-Time Shown	N/A
Conditions	Unknown
Cursors On-Screen	No
Cursors Are Measuring	N/A
Status	Known Good Pattern

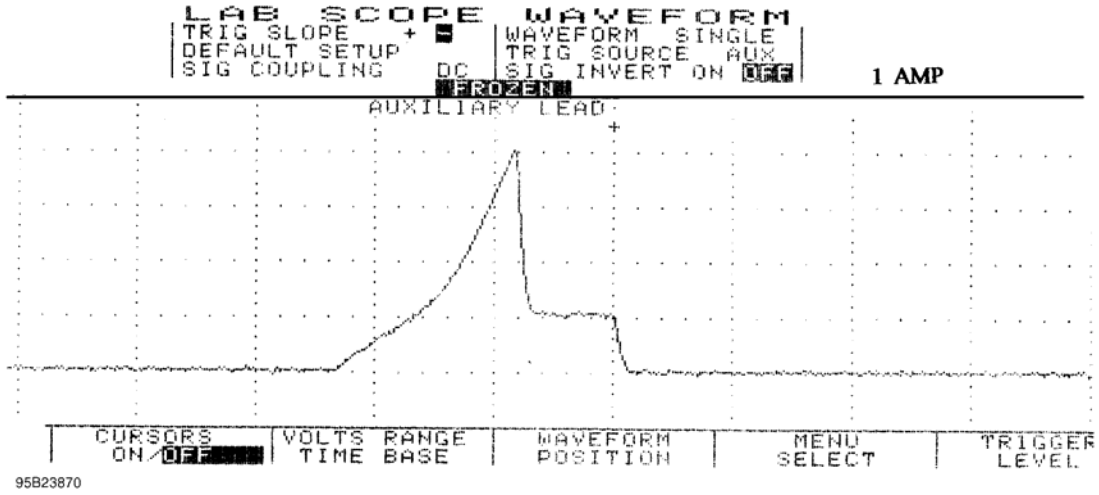


Fig. 4: Injector Waveform (Current) - Cursors Used - Known Good

FUSES & CIRCUIT BREAKERS

FUSIBLE LINKS

Fusible links will melt to prevent fire if a large current flows through electrical systems without passing through fuses.

FUSE PANEL ID (1991-93 CAPRICE)

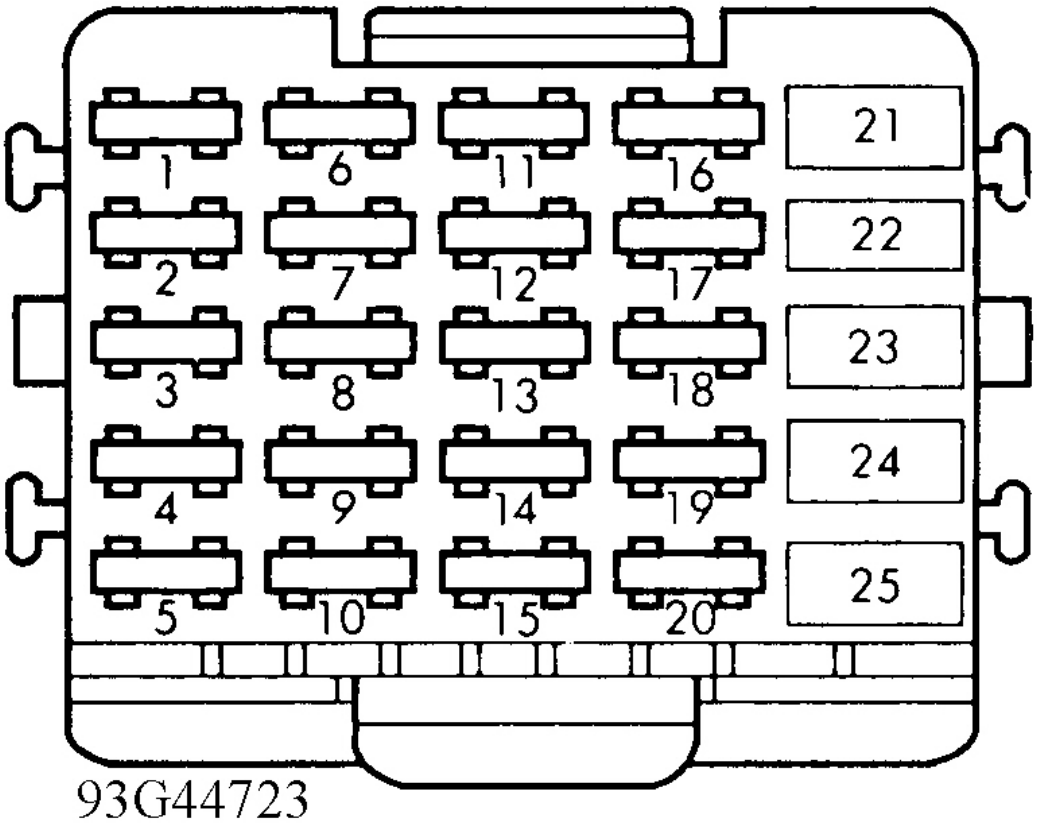


Fig. 1: Fuse Panel ID (1991-93 Caprice)
Courtesy of GENERAL MOTORS CORP.

Fuse & Circuit Breaker Identification

- 1 - 15 Amp Underhood Light, Power Antenna, Keyless Entry, Courtesy Lights, Compass/Lighted Mirror,

Horn, Lighted Visor, Door Locks, Power Mirrors, Rear Glass Release, Audible Warning System

- 2 - 15 Amp Audible Warning System, Cigarette Lighter, Rear Wiper, Glove Box Light, Radio, Trunk Light, Rear Gate Ajar Light, Trunk Release
- 3 - 10 Amp Anti-Lock Brake System (1991 Caprice), Bose Amplifier 1992-93 Caprice)
- 4 - 10 Amp (Exc. 1993 Wagon); 25 Amp (1993 Wagon) Bose Radio Amplifier (1991 Caprice), Electronic A/C 1992 Caprice), Electronic Level Control (10 Amp 1993 Sedan), Electronic Level Control (25 Amp 1993 Wagon)
- 5 - 7.5 Amp Instrument Panel Lights
- 6 - 20 Amp Keyless Entry, Alternator, Heater, Air Conditioner, Daytime Running Lights
- 7 - 30 Amp (1991) Electronic A/C Blower Motor; Blank (1992-93 Caprice)
- 8 - 15 Amp Rear Wiper/Washer
- 9 - 10 Amp Radio
- 10 - 25 Amp Windshield Wiper/Washer, Washer Fluid Level
- 11 - 7.5 Amp Fuel Injectors
- 12 - 10 Amp Supplemental Inflatable Restraint
- 13 - 10 Amp Speed Signal Module, ECM, EGR Solenoid, Air Control ESC Module, Canister Purge, Cluster Electronics/Warning Indicator
- 14 - 15 Amp Twilight Sentinel, Parking, Side Marker & License Lights, Daytime Running Lights
- 15 - 30 Amp Rear Window Defogger
- 16 - 7.5 Amp Heated Mirrors
- 17 - 15 Amp Audible Warning System, TCC Brake Switch, Compass Mirror, Supplemental Inflatable Restraint, Gauges/Warning Indicator, Headlight Switch Illumination, Rear Window Defogger, Fluid Warning, Anti-Lock Brake System, Twilight Sentinel, Daytime Running Lights, Low Oil Module, Park/Neutral Relay, Height Sensor, Power Vent Switch (1991 Caprice)
- 18 - 15 Amp Turn Signal Lights, Back-Up Lights Cruise Control
- 19 - 20 Amp Stoplights, Hazard Lights
- 20 - 5 Amp ECM, Supplemental Inflatable Restraint
- 21 - 30 Amp Circuit Breaker Keyless Entry, Power Door Locks, Power Seats, Tailgate Lock Relay, Power Vent Motor (1991 Caprice)
- 22 - Blank Or Spare
- 23 - 30 Amp Circuit Breaker Power Windows
- 24 - Blank Or Spare
- 25 - Blank Or Spare

FUSE PANEL IDENTIFICATION (1994)

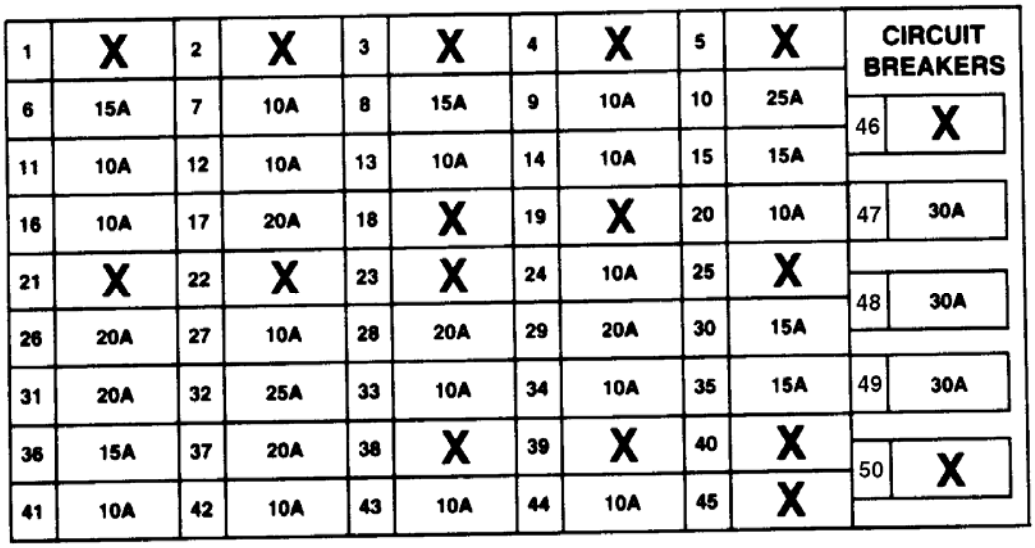


Fig. 2: Fuse Panel Identification (1994)
Courtesy of GENERAL MOTORS CORP.

Fuse & Circuit Breaker Identification

- 1 - Blank
- 2 - Blank
- 3 - Blank
- 4 - Blank
- 5 - Blank
- 6 - 15 Amp Turn Signal Lamp Flasher, Park Neutral Position Sw.
- 7 - 10 Amp Anti-Lock Brake (ABS) Control Module
- 8 - 15 Amp Tailgate Sw. Module (Wagon)
- 9 - 10 Amp Radio
- 10 - 25 Amp Windshield Wiper Motor Module
- 11 - 10 Amp Rear Defog Relay, Air Bag, I/P Cluster, Headlamp Sw.
- 12 - 10 Amp Auto Level Control (Wagon)
- 13 - 10 Amp Automatic Inside Rearview Mirror, Chime Module, TCC Cruise Brake Sw., Twilight Sentinel, Daytime Running Lights Canada), Keyless Entry System
- 14 - 10 Amp Pass-Key II
- 15 - 15 Amp Air Bag
- 16 - 10 Amp Cruise Control
- 17 - 20 Amp Heater & A/C Control
- 18 - Blank

- 19 - Blank
- 20 - 10 Amp Instrument Cluster, Daytime Running Lights (Canada)
- 21 - Blank
- 22 - Blank
- 23 - Blank
- 24 - 10 Amp Air Bag, Theft Deterrent Relay
- 25 - Blank
- 26 - 20 Amp Power Antenna
- 27 - 10 Amp Heat Sensor, Trunk Lamp
- 28 - 20 Amp Cigarette Lighter
- 29 - 20 Amp Keyless Entry System, Trunk Release, Rear Glass Release Liftgate Wiper Latch Sw. (Wagon)
- 30 - 15 Amp Radio
- 31 - 20 Amp Headlamp Sw., Twilight Sentinel, Daytime Running Lights Canada)
- 32 - 25 Amp Horn
- 33 - 10 Amp Chime Module, Heater and A/C, Glove Box Light, Instrument Cluster
- 34 - 10 Amp Pass-Key II
- 35 - 15 Amp Dome Lamp, Front Reading Lights, Rear Reading Lights, Automatic Inside Rearview Mirror, Illuminated Visor Vanity Mirror, Power Door Locks, Front Door Courtesy Lights, Rear Door Courtesy Lights, Power Mirror Sw. Instrument Panel Courtesy Lights
- 36 - 15 Amp Rear Wiper (Wagon)
- 37 - 20 Amp Hazard Warning Flasher, Stop Lights
- 38 - Blank
- 39 - Blank
- 40 - Blank
- 41 - 10 Amp Cornering Lamps, Side Marker Lamp, Turn-Park Lamp
- 42 - 10 Amp Instrument Cluster, Radio, Brightness Control, Headlamp and Instrument Panel Lamp Dimmer Sw., Panel Lamps Dimming Module
- 43 - 10 Amp License Lights, Taillights, Tail/Stop/Turn Lights, Markerlamps
- 44 - 10 Amp Heater Power Mirrors
- 45 - Blank
- 46 - Blank
- 47 - 30 Amp (Circuit Breaker) Power Window Sw., Power Window Lockout Sw.
- 48 - 30 Amp (Circuit Breaker) Door Locks, Power Seat Sw., Passenger Seat Lumbar Controls
- 49 - 30 Amp (Circuit Breaker) Rear Window Defog Sw.
- 50 - Blank

UNDERHOOD FUSE & RELAY IDENTIFICATION (1994)

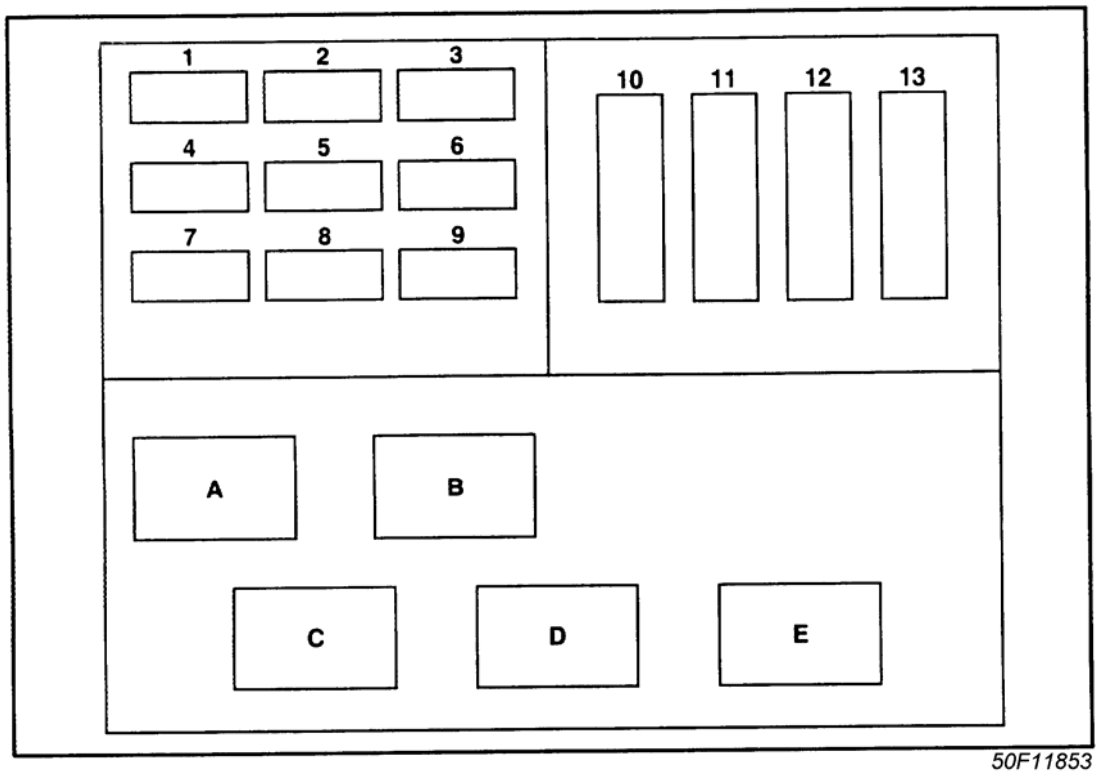


Fig. 3: Underhood Fuse & Relay Identification (1994)
Courtesy of GENERAL MOTORS CORP.

WARNING: Always disconnect battery ground cable before servicing "high-current fuses. It is recommended that "high-current" fuses be replaced by a qualified technician.

Fuse Identification

- 1 - 25 Amp ELC Automatic Level Control Air Compressor (ALC)
- 2 - 15 Amp F/P Fuel Pump Relay, Fuel Pump and Engine Oil Pressure Switch Powertrain Control Module (PCM)
- 3 - 20 Amp AIR Primary Air Pump Relay, Underhood Lamp
- 4 - 10 Amp EMI Automatic Transmission, Mass Air Flow Sensor (MAF), Secondary Air Pump Relay, EGR Control Valve Relay, Evaporative Emission Canister Purge Valve Solenoid, LH Heated Oxygen Sensor, RH Heated Oxygen Sensor
- 5 - 10 Amp PCM/IGN Powertrain Control Module (PCM), Ignition Coil Electronic Brake Control Module
- 6 - 10 Amp FUEL INJ Fuel Injector (1, 4, 6, 7)
- 7 - 10 Amp PRI-FAN Primary Engine Coolant Fan, A/C Compressor Relay
- 8 - 10 Amp SEC-FAN Secondary Engine Coolant Fan, Generator
- 9 - 10 Amp FUEL INJ Fuel Injector (2, 3, 5, 8)

- 10 - 60 Amp BODY 1 Main
- 11 - 60 Amp BODY 2 Fuse Block
- 12 - 40 Amp PRI COOL FAN Primary Engine Coolant Fan
- 13 - 40 Amp SEC COOL FAN Secondary Engine Coolant Fan

Relay Identification

- A - Fuel Pump Relay
- B - A/C Comp Relay
- C - Air Pump Relay
- D - PRI - Cool Relay
- E - SEC - Cool Relay

FUSE & CIRCUIT BREAKER IDENTIFICATION ()

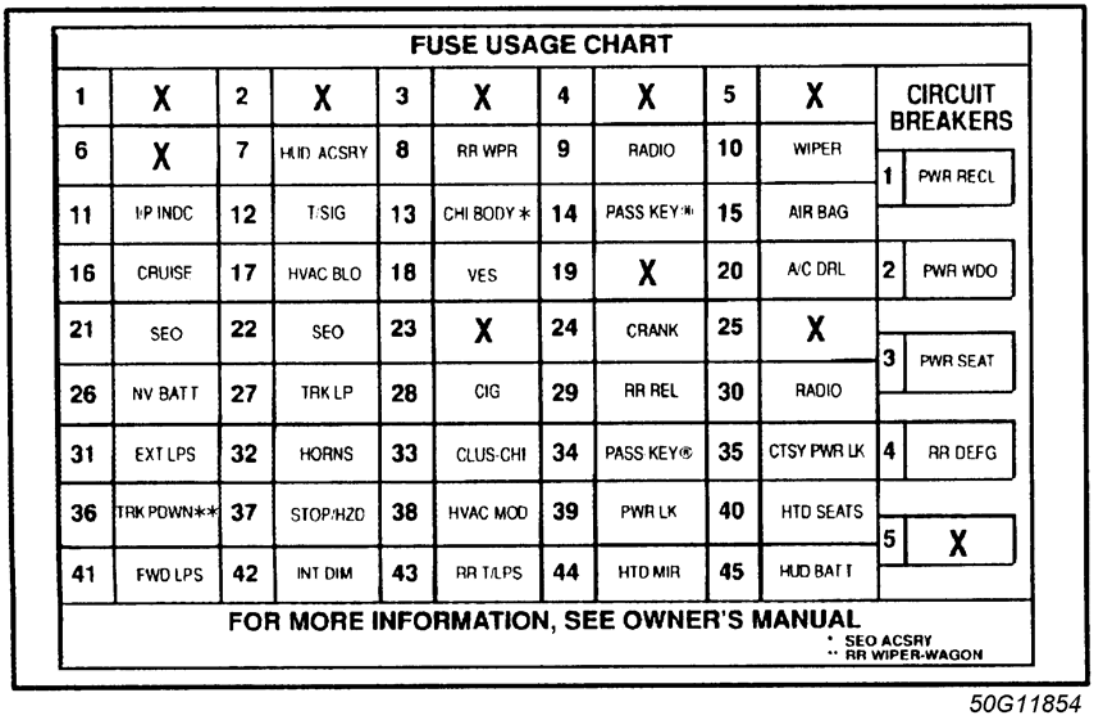


Fig. 4: Fuse & Circuit Breaker Panel ID (1995)
Courtesy of GENERAL MOTORS CORP.

Fuse Identification

- 1 - Blank
- 2 - Blank
- 3 - Blank

- 4 - Blank
- 5 - Blank
- 6 - Blank
- 7 - 10 Amp (SEO - Police Models) HUD Projector, Night Vision Control Unit, Auxiliary Display
- 8 - 15 Amp Rear Wiper
- 9 - 15 Amp Radio
- 10 - 25 Amp Windshield Wiper Motor Module
- 11 - 10 Amp Rear Defogger Relay, Air Bag (DERM), I/P Cluster, Headlamp Switch
- 12 - 15 Amp Turn Signals, Back-up Lamp, PRNDL Position Sensor
- 13 - 10 Amp Automatic Inside Rearview Mirror, Chime Module, TCC Cruise Brake Sw., Twilight Sentinel, Daytime Running Lights Canada), Keyless Entry System
- 14 - 10 Amp Pass-Key II
- 15 - 15 Amp Air Bag (DERM)
- 16 - 10 Amp Cruise Control
- 17 - 20 Amp Heater & A/C Control
- 18 - 10 Amp Seat Heater, Power Steering Control Module
- 19 - Blank
- 20 - 10 Amp Instrument Cluster, Daytime Running Lights (Canada)
- 21 - 15 Amp (SEO - Police Models) RH Spot Lamp (Police)
- 22 - 15 Amp (SEO - Police Models) LH Spot Lamp (Police)
- 23 - Blank
- 24 - 10 Amp Air Bag, Theft Deterrent Relay
- 25 - Blank
- 26 - 10 Amp (SEO - Police Models) Night Vision Roof Unit (Police)
- 27 - 10 Amp Automatic Level Control, Trunk Lamp
- 28 - 20 Amp Cigarette Lighter
- 29 - 20 Amp Keyless Entry System, Trunk Release, Rear Glass Release Liftgate Wiper Latch Sw. (Wagon)
- 30 - 15 Amp Radio
- 31 - 20 Amp Headlamp Switch, Twilight Sentinel, Daytime Running Lights Canada)
- 32 - 25 Amp Horn Relay
- 33 - 10 Amp Chime Module, Heater and A/C, Glove Box Light, Instrument Cluster
- 34 - 10 Amp Pass-Key II
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- 37 - 20 Amp Hazard Warning Flasher, Stop Lights

- 38 - 30 Amp Blower Motor Control
- 39 - 20 Amp Power Door Lock Relay
- 40 - 20 Amp Heated Seats
- 41 - 10 Amp Cornering Lamps, Side Marker Lamp, Turn-Park Lamp
- 42 - 10 Amp Instrument Cluster, Radio, Brightness Control, Headlamp and Instrument Panel Lamp Dimmer Sw., Panel Lamps Dimming Module
- 43 - 10 Amp License Lights, Taillights, Tail/Stop/Turn Lights, Markerlamps
- 44 - 10 Amp Heater Power Mirrors
- 45 - 10 Amp (SEO - Police Models) HUD Projector

Circuit Breaker Identification

- 1 - 20 Amp (Circuit Breaker) Power Seat Recline, Lumbar Support, Power Antenna Relay
- 2 - 30 Amp (Circuit Breaker) Power Window Switch, Power Window Lockout Switch
- 3 - 25 Amp (Circuit Breaker) Door Locks, Power Seat Switch
- 4 - 30 Amp (Circuit Breaker) Rear Window Defogger Switch
- 5 - Not Used

UNDERHOOD FUSE & RELAY IDENTIFICATION (1995)

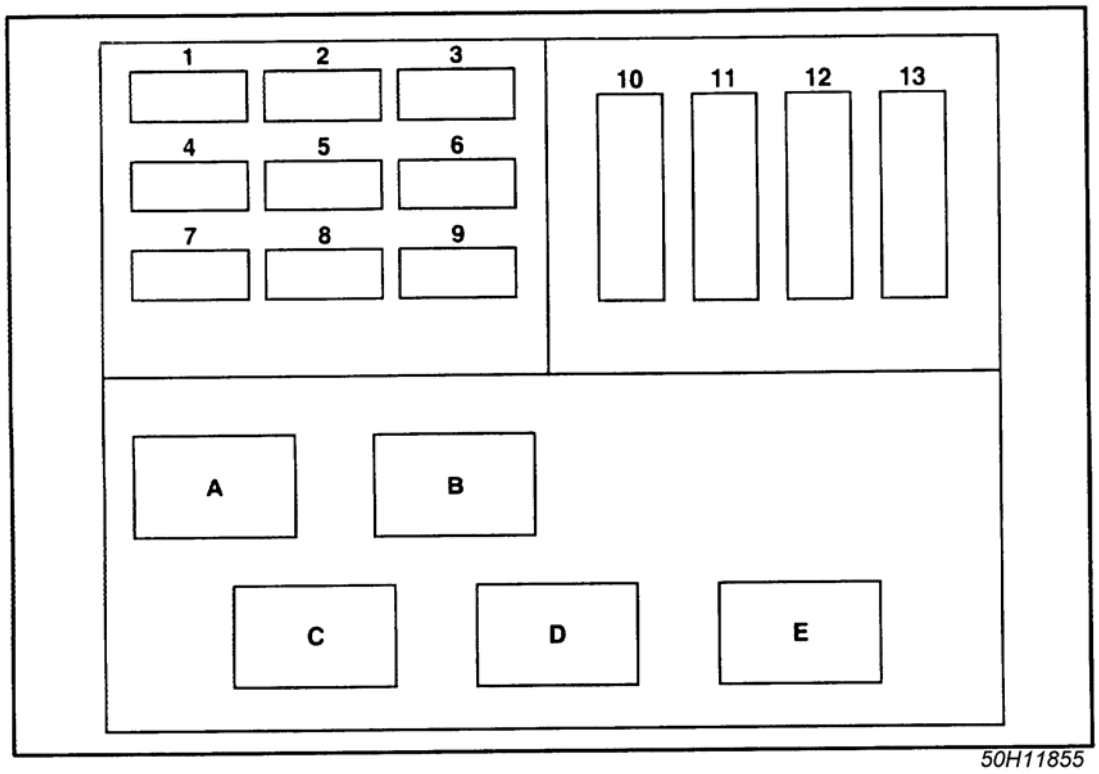


Fig. 5: Underhood Fuse & Relay Identification (1995)

Courtesy of GENERAL MOTORS CORP.

WARNING: Always disconnect battery ground cable before servicing "high-current fuses. It is recommended that "high-current" fuses be replaced by a qualified technician.

Fuse Identification

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- 2 - 15 Amp F/P Fuel Pump Relay, Fuel Pump and Engine Oil Pressure Switch Powertrain Control Module (PCM)
- 3 - 25 Amp AIR Primary Air Pump Relay, Underhood Lamp
- 4 - 15 Amp EMI Automatic Transmission, Mass Air Flow Sensor (MAF), Secondary Air Pump Relay, EGR Control Valve Relay, Evaporative Emission Canister Purge Valve Solenoid, LH Heated Oxygen Sensor, RH Heated Oxygen Sensor
- 5 - 10 Amp PCM/IGN Powertrain Control Module (PCM), Ignition Coil Electronic Brake Control Module
- 6 - 10 Amp FUEL INJ Fuel Injector (1, 4, 6, 7)
- 7 - 10 Amp PRI-FAN Primary Engine Coolant Fan, A/C Compressor Relay
- 8 - 10 Amp SEC-FAN Secondary Engine Coolant Fan, Generator
- 9 - 10 Amp FUEL INJ Fuel Injector (2, 3, 5, 8)
- 10 - 80 Amp BODY 1 Main
- 11 - 60 Amp BODY 2 Fuse Block
- 12 - 40 Amp PRI COOL FAN Primary Engine Coolant Fan
- 13 - 40 Amp SEC COOL FAN Secondary Engine Coolant Fan

Relay Identification

- A - Fuel Pump Relay
- B - A/C Comp Relay
- C - Air Pump Relay
- D - PRI - Cool Relay
- E - SEC - Cool Relay

HEADLIGHTS - AUTOMATIC TWILIGHT SENTINEL

ACCESSORIES & SAFETY EQUIPMENT General Motors Corp. Headlights - Automatic Twilight Sentinel

DESCRIPTION

Headlights on vehicles equipped with twilight sentinel system are controlled by a Lamp Control Module (LCM), Daytime Running Lights (DRL) Module, or Central Control Module (CCM). A photocell is mounted on top of the dash to sense light levels. When the headlights are turned on, or photocell senses darkness, input to the control module is grounded, and the module applies power to exterior lighting circuits.

OPERATION

The system operates automatically whenever ignition is on, headlights are off, and twilight sentinel system is on. When turned on, the system automatically turns on exterior lights at dusk. At daybreak, the system will turn exterior lights off.

The system provides a 30-second delay before switching lights on or off, thus preventing the system from operating under sudden ambient lighting changes, such as passing through tunnels or exposure to bright lights at night.

AIR BAG PRECAUTIONS

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

Observe following precautions when working on vehicles equipped with Supplemental Inflatable Restraint (SIR) air bag systems:

- Before performing any instrument panel testing, diagnosis, or repair, disable SIR system by disconnecting negative battery cable and Yellow 2-pin connector at base of steering column.
- To enable SIR system to power down, wait 20 minutes before making any repairs. System back-up power supply still retains enough voltage to deploy air bag for a short time after battery is disconnected.
- To avoid accidental air bag deployment, avoid Yellow SIR wiring harnesses when trouble shooting, repairing, or replacing instrument panel components. All SIR wiring harnesses are Yellow.

HANDLING PRECAUTIONS

CAUTION: When handling Electrostatic Discharge (ESD) sensitive electronic parts, take special care to avoid damaging components.

1. Discharge personal static electricity by momentarily touching metal grounding point on vehicle before touching electronic components.
2. DO NOT touch terminals on components or connectors with fingers or metal tools. When unplugging connectors, never let metal tool contact any exposed terminal.
3. Never jumper, ground, or use test probes on components or connectors unless specified in diagnosis. Always connect ground lead first.
4. DO NOT remove solid-state components from protective packaging until ready for installation. Touch packaging to ground before opening.
5. DO NOT bump or drop components. DO NOT put component on metal work bench, metal objects, or electrically operated components, such as radio, TV, or oscilloscope.

Components Possibly Damaged By ESD:

- ABS Controller.
- Central Control Module (CCM).
- Chime Module And Cruise Control Module.
- Distributorless Ignition System (DIS) Module.
- Electronic Instrument Cluster Panel (IPC).
- Electronic Control Module (ECM) (Including PROM, CAL-PAK, Or MEM-CAL).
- HVAC Electronic A/C-Heater Controllers And Modules.
- Power Control Module (PCM).
- Radio And Theft Deterrent Modules.
- Twilight Sentinel Module Or Amplifier.

TROUBLE SHOOTING

Preliminary Trouble Shooting

1. Check headlight system operation with manual switch. If all headlights operate okay manually, but twilight sentinel does not operate properly, find test with appropriate symptom. If headlights do not operate properly with manual switch, go to next step.
2. If headlight do not operate at all, inspect all fuses and circuit breakers. If fuses repeatedly blow, check problem circuit for short to ground. If any headlight is dim, inspect ground connections. If one headlight is inoperative, inspect suspect bulb. After making any repair recheck headlight system function.

Lights Do Not Automatically Turn On In Darkness

Loose connection at headlight switch or module connector. Open wiring between fusible link and headlight switch. Inoperative headlight switch or circuit breaker. Open in ground path through on-off switch of time-delay control of sentinel switch. Inoperative photocell or module.

Lights Do Not Turn Off In Daylight

Inoperative or obstructed photocell. Poor contact between photocell and socket, or socket disengaged from

mounting hole. Faulty module.

Lights Do Not Turn Off After Ignition Is Off

Fuse blown. Inoperative time delay control. Open wiring. Inoperative module. Malfunctioning photocell.

Lights Do Not Stay On Proper Time Span After Ignition Is Off

Inoperative time delay control. High resistance at module connector. Short in wiring. Inoperative module.

Warning Chime Does Not Operate

Open wire in chime circuit. Inoperative door jam switch. Poor connection at headlight switch. Inoperative module. Blown fuse. Time delay control malfunction.

DIAGNOSIS & TESTING

WARNING: If vehicle is equipped with an air bag, disable system before working near steering column and instrument cluster. See AIR BAG PRECAUTIONS.

TWILIGHT SENTINEL SYSTEM OPERATION TEST

NOTE: Unless otherwise specified, make all measurements with a digital volt-ohmmeter with an input impedance of 10 megohms.

Without DRL

1. Turn headlights off. Turn ignition on. Set twilight sentinel control to mid position. Cover photocell on top of instrument panel with cardboard. All exterior lighting should come on within 30 seconds.
2. Uncover photocell. Expose photocell to sunlight or bright incandescent light. All exterior lights should turn off within 30 seconds.
3. Again cover photocell with cardboard. Wait until exterior lights come on, then turn ignition off. All exterior lights should turn off after a few minutes delay. Delay depends on position of twilight sentinel switch. With switch in MAX position, lights could remain on for about 3-4 minutes. If system performs as described, twilight sentinel system is operating properly. If system does not perform as described, see appropriate TEST PROCEDURE.

With DRL

1. Turn headlights off. Turn ignition on. Set twilight sentinel switch to mid position. Cover photocell on top of instrument panel with cardboard. All exterior lights should come on within 30 seconds.
2. Uncover photocell. Expose photocell to sunlight or bright incandescent light. All exterior lights should turn off within 30 seconds.
3. Again cover photocell with cardboard. Wait until exterior lights come on, then turn ignition off. All exterior lights should turn off after a few minutes delay. Delay depends on twilight sentinel switch position. With switch in MAX position, lighting could remain on for about 4 minutes.

4. Turn ignition on. Set twilight sentinel control to MIN position. Expose photocell to sunlight or bright incandescent light. Move gear selector lever out of "P" position. Body lights should come on, together with headlights at reduced intensity. Set gear selector lever to "P" position. Body lights should remain on, but headlights should turn off. If lights operate as specified, system is operating properly. If system does not perform as described, see appropriate TEST PROCEDURE.

TEST PROCEDURE

Exterior Lights Are On During Daylight

1. Turn twilight sentinel on. Turn ignition on. Remove photocell light sensor. See TWILIGHT SENTINEL PHOTOCELL under REMOVAL & INSTALLATION.
2. Connect fused jumper wire between both photocell sensor connector terminals (Light Green/Black and Yellow/Black wires). If headlights turn off, replace photocell sensor. If headlights stay on, go to next step.
3. Test for open in Light Green/Black or Yellow wire, or for poor connections at photocell or module. Locate lamp control module (behind right kick/trim panel). Inspect for poor connections at module Blue C1 connector terminals "G" (Light Green/Black wire) and "H" (Yellow/Black wire). If wires and connections are good, temporarily substitute known good lamp control module, then retest system.

Twilight Sentinel Turns On Headlights Only

1. Locate lamp control module (behind right kick/trim panel). Using a grounded test light, backprobe lamp control module Black C2 connector terminal "A" (Orange wire). See **Fig. 1**. If battery voltage exists, go to next step. If battery voltage does not exist, inspect for open in Orange wire between lamp control module and fuse No. 14, repair as necessary.
2. Turn ignition on. Turn twilight sentinel on. Cover photocell on top of instrument panel. Using a grounded test light backprobe lamp control module Black C2 connector, terminal "H" (Brown wire). If battery voltage exists, repair open in Brown wire from lamp control module to fuse panel. If battery voltage does not exist, inspect Brown wire for poor connection at module. If connection is good, temporarily substitute known good lamp control module, then retest system.

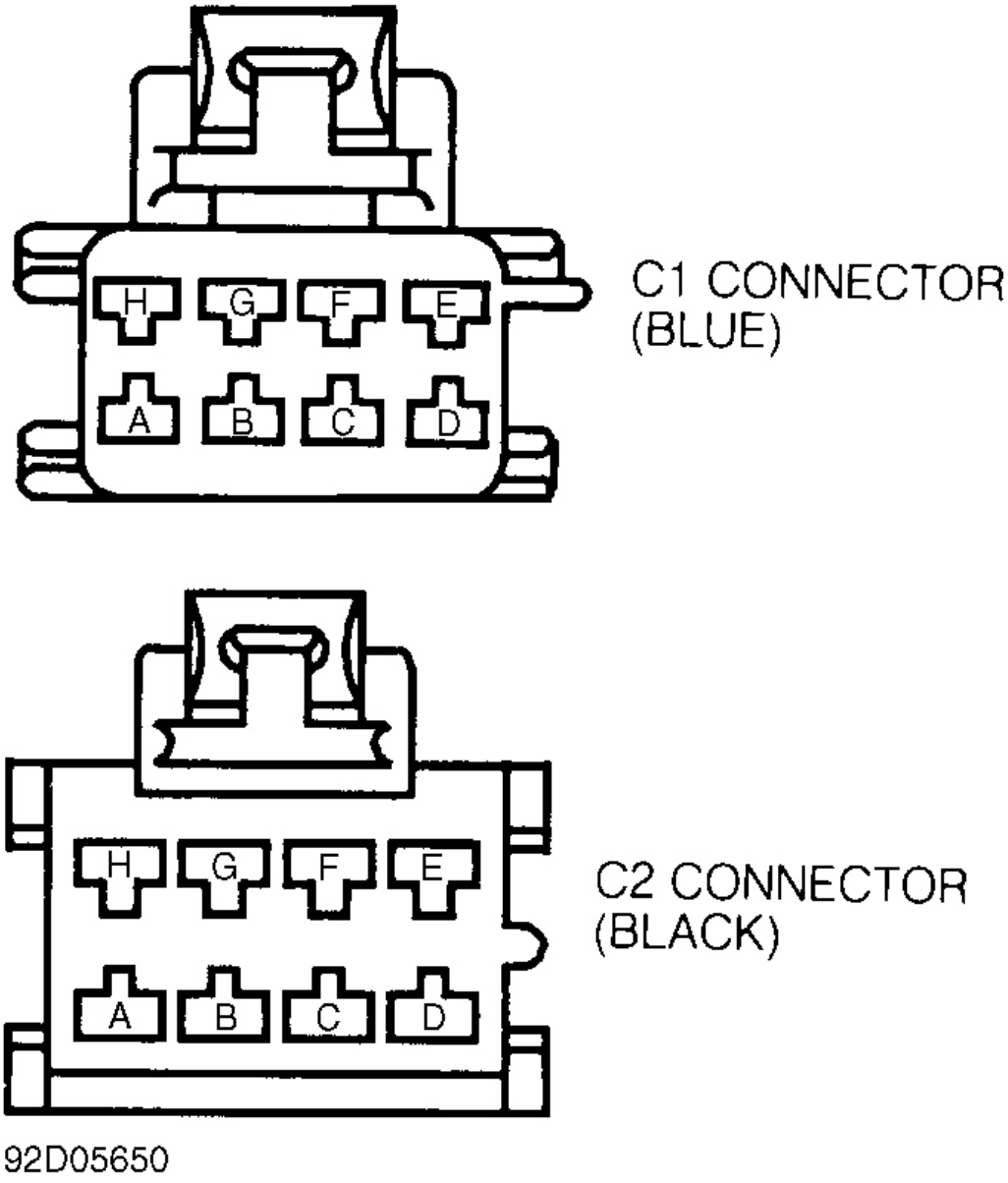


Fig. 1: Identifying Lamp Control Module Terminals
Courtesy of GENERAL MOTORS CORP.

Twilight Sentinel Turns On Body Lights Only

1. Turn twilight sentinel on. Turn ignition on. Cover photocell, located on top of instrument panel. Locate lamp control module, behind right kick panel.
2. Backprobe lamp control module Black C2 connector, terminal "F" (Yellow wire). If battery voltage

exists, repair open in Yellow wire between lamp control module and dimmer switch.

3. If battery voltage does not exist, inspect for poor connection of Yellow wire at module connector. If connection is okay, temporarily substitute known good lamp control module, then retest system.

Twilight Sentinel Inoperative; Headlight Switch Operates

Normally

1. Turn headlights off. Locate lamp control module (behind right kick/trim panel). Using a grounded test light, backprobe lamp control module Black C2 connector terminal "D" (Dark Green/White wire). If battery voltage exists, go to next step. If battery voltage does not exist, go to step 11).
2. Turn ignition on. Backprobe lamp control module Blue C1 connector, terminal "E" (Pink wire). If battery voltage exists, go to next step. If battery voltage does not exist, repair open in Pink wire between lamp control module and fuse No. 17.
3. With a test light, backprobe between module Blue C1 connector terminals "D" (Black wire) and "E" (Pink wire). If battery voltage exists, go to next step. If battery voltage does not exist, repair open in Black wire to ground.
4. Turn twilight sentinel off. Measure voltage at lamp control module connector C1, terminal "A" (Light Green wire). If battery voltage exists, go to next step. If battery voltage does not exist, inspect for poor connection at terminal "A". If connection is okay, temporarily substitute known good lamp control module, then retest system.
5. Measure voltage at twilight sentinel switch terminal "B" (Light Green wire). If battery voltage exists, go to next step. If battery voltage does not exist, inspect for open circuit in Light Green wire from lamp control module to switch.
6. Using test light, backprobe between twilight sentinel switch terminals "B" (Light Green wire) and "C" (Black/White wire). If battery voltage exists, go to next step. If battery voltage does not exist, repair Black/White wire from terminal "C" to ground.
7. Unplug photocell sensor. If headlights and body lights are not on, go to next step. If headlights and body lights come on, replace photocell sensor.
8. Measure voltage at photocell connector Light Green/Black wire. If battery voltage does not exist, go to next step. If battery voltage exists, inspect Light Green/Black wire for short to voltage. If wire is okay, temporarily substitute known good lamp control module, then retest system.
9. Inspect Light Green/Black wire for shorts or open circuit between photocell sensor and twilight sensor module. If wire is okay, measure voltage between Light Green/Black and Yellow/Black wires at photocell sensor connector. If battery voltage exists, go to next step. If battery voltage does not exist, inspect Yellow/Black wire for open. If wire is okay, replace lamp control module.
10. Inspect for poor connections at twilight sentinel switch. If connections are okay, replace switch.
11. Using test light, backprobe Green/White wire at headlight switch. If battery voltage exists, inspect switch connections. If connections are okay, replace switch. If battery voltage does not exist, inspect for open circuit in Green/White wire between switch and lamp control module.

Headlight Delay Inoperative

1. Turn ignition on. Turn twilight sentinel on. Turn headlights off. Using DVOM, backprobe twilight sentinel switch connector terminals "A" (Purple wire) and "D" (Black/White wire).

2. Observe meter while moving twilight sentinel delay control slowly from MIN to MAX position. If voltage does not exist, go to step 3). If voltage varies, temporarily substitute known good lamp control module, then retest system. If battery voltage exists but does not change, inspect for poor connection at terminal "D" (Black/White wire) of twilight sentinel switch. If Black/White wire terminal connection is good, replace twilight sentinel switch.
3. Locate lamp control module (behind right kick/trim panel). Using DVOM, backprobe lamp control module Blue C1 connector, terminal "F" (Purple wire). If battery voltage does not exist, inspect for poor connection at Purple wire terminal at lamp control module connector. If connection is good, replace lamp control module. If battery voltage exists, repair open in Purple wire between twilight sentinel switch and lamp control module.

REMOVAL & INSTALLATION

WARNING: If vehicle is equipped with an air bag, disable system before working near steering column and instrument cluster. See AIR BAG PRECAUTIONS.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

TWILIGHT SENTINEL CONTROL MODULE

NOTE: Twilight sentinel may be also known as daytime running light module, lamp control module, or central control module.

Removal & Installation

Disconnect negative battery cable. Remove right kick/trim panel. Remove screws, unplug connectors, and remove module. To install, reverse removal procedure.

TWILIGHT SENTINEL PHOTOCELL

Removal & Installation

Depending on model, photocell is either mounted under left defroster grille or secured to top of instrument panel. Unsnap defroster grille. Twist photocell counterclockwise to disengage photocell and socket. Unplug connector. To install, reverse removal procedure.

WIRING DIAGRAM

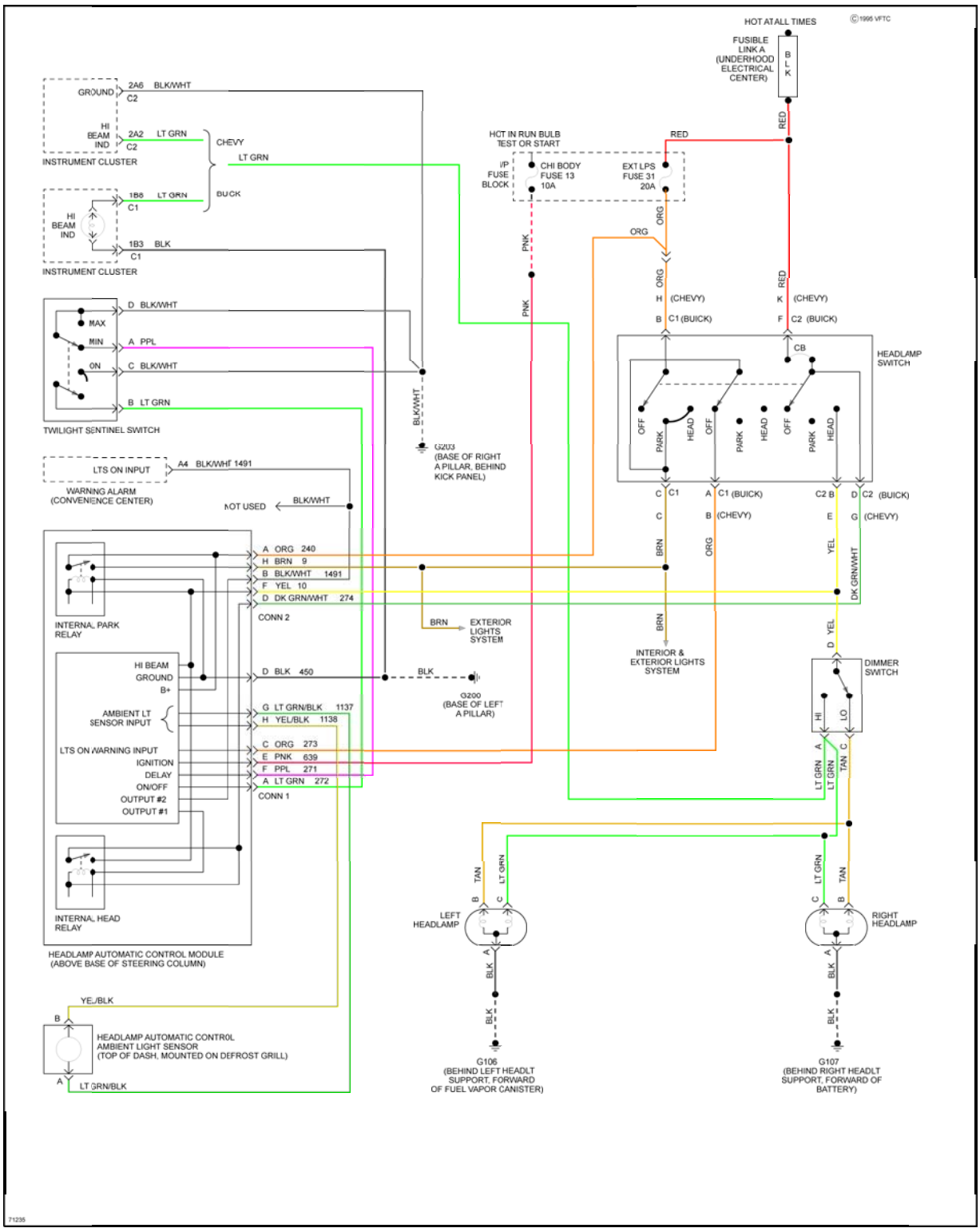


Fig. 2: Headlight System Wiring Diagram

A/C SYSTEM GENERAL SERVICING

GENERAL SERVICING General Motors - General Servicing Procedures USING

R-12 & R-134A REFRIGERANT

NOTE: For additional A/C COMPRESSOR SERVICING information, see the A/C COMPRESSOR SERVICING article or the A/C COMPRESSOR REFRIGERANT OIL CHECKING article in the AIR CONDITIONING & HEAT section.

HANDLING/SAFETY PRECAUTIONS

1. Always work in a well-ventilated, clean area. Refrigerant (R-12 or R-134a) is colorless and invisible as a gas. Refrigerant is heavier than oxygen and will displace oxygen in a confined area. Avoid breathing refrigerant vapors. Exposure may irritate eyes, nose and throat.
2. Always wear eye protection when working around A/C system and refrigerant. The system's high pressure can cause severe injury to eyes and skin if a hose were to burst. If necessary, wear rubber gloves or other protective clothing.
3. Refrigerant evaporates quickly when exposed to atmosphere, freezing anything it contacts. If liquid refrigerant contacts eyes or skin (frostbite), DO NOT rub eyes or skin. Immediately flush affected area with cool water for 15 minutes and consult a doctor or hospital.
4. Never use R-134a in combination with compressed air for leak testing. Pressurized R-134a in the presence of oxygen (air concentrations greater than 60 percent by volume) may form a combustible mixture. DO NOT introduce compressed air into R-134a containers (full or empty), A/C system components, or service equipment.
5. DO NOT expose A/C system components to high temperatures (steam cleaning for example), as excessive heat will cause refrigerant system pressure to increase. Never expose refrigerant directly to open flame. If refrigerant needs to be warmed, place bottom of refrigerant tank in warm water. Water temperature MUST NOT exceed 125°F (52°C).

CAUTION: When R-134a is exposed to an open flame, drawn into engine, or detected with a Halide (propane) leak tester, a poisonous gas is formed. Keep work areas well ventilated.

6. Use care when handling refrigerant containers. DO NOT drop, strike, puncture, or incinerate containers. Use Department Of Transportation (DOT) approved (DOT 4BW or DOT 4BA) refrigerant containers.
7. Never overfill refrigerant containers. The safe filling level of a refrigerant container MUST NOT exceed 60% of the container's gross weight rating. Store refrigerant containers at temperatures less than 125°F (52°C).
8. Freon (R-12) is sold and stored in White colored containers, while R-134a refrigerant is sold and stored in 30- or 50-pound Light Blue containers.
9. Refrigerant R-12 and R-134a must never be mixed, as they and their desiccants and lubricants are not compatible. If the refrigerants are mixed, system cross-contamination or A/C system component failure may occur. Always use separate servicing and refrigerant recovery/recycling equipment.
10. Read and follow equipment manufacturer's instructions for all service equipment to be used. The Material

Safety Data Sheet (MSDS), provided by refrigerant manufacturer/supplier, contains valuable information regarding the safe handling of refrigerants.

IDENTIFYING R-134A SYSTEMS & COMPONENTS

To prevent refrigerant cross-contamination, use following methods to identify R-134a based systems and components.

Fittings & "O" Rings

All R-134a based A/C systems use 1/2" - 16 ACME threaded fittings (identifiable by square threads) and quick-connect service ports. See **Fig. 1**.

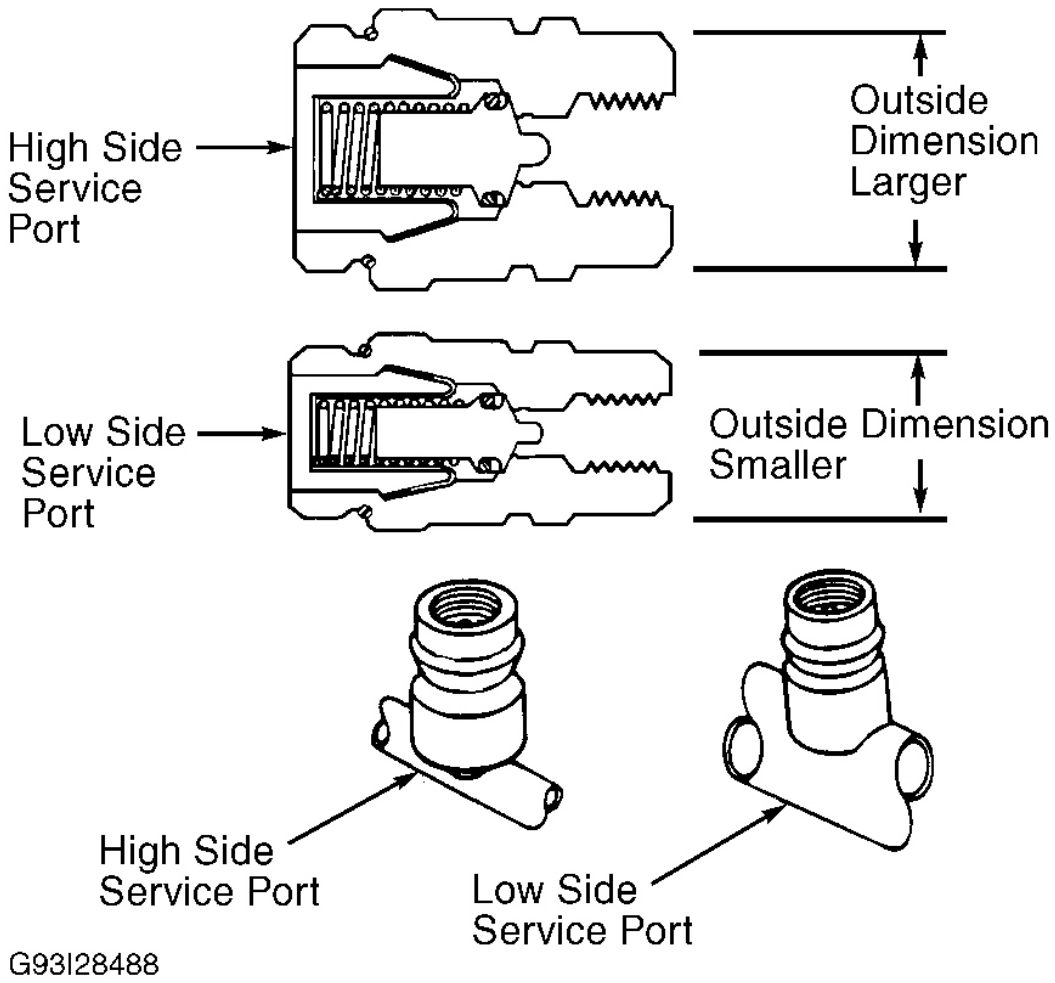


Fig. 1: Identifying R-134a Service Ports
Courtesy of CHRYSLER CORP.

REFRIGERANT OILS

Refrigerant R-12 based systems use mineral oil, while R-134a systems use synthetic Polyalkylene Glycol (PAG) oils. Using a mineral oil based lubricant with R-134a will result in A/C compressor failure due to lack of proper lubrication.

The following R-134a refrigerant oils are used by most domestic vehicles:

GM

On all models except Saturn, use PAG Refrigerant Oil (Part No. 12345923). On Saturn, use Saturn PAG Refrigerant Oil.

NOTE: Use ONLY the specified oil for the appropriate system or A/C compressor. Always check the underhood A/C specification label or A/C compressor label before adding refrigerant oil to A/C compressor/system.

SIGHT GLASS INDICATOR

NOTE: Sight glass indicator conditions listed are for R-12 systems ONLY. R-134a systems may or may not have a sight glass.

Not all systems use a sight glass. If used, a sight glass may be mounted in receiver-drier or in discharge line. Refrigerant's condition can be visually checked while passing through sight glass. The following are possible conditions of sight glass indicator, which may help in the diagnosis of problems. See **Fig. 2**.

NOTE: Sight glass readings are not positive identification of a problem. Readings should be relied upon only when other system symptoms exist.

Clear Sight Glass

A clear sight glass indicates refrigerant level is correct or that the system has a complete lack of refrigerant, a condition accompanied by a lack of any cooling action by the evaporator. Sight glass may be clear, but system might be overcharged (too much refrigerant). This must be verified by test gauge readings.

Bubbly/Foamy Sight Glass

A bubbly or foamy sight glass indicates system is low on refrigerant, and air has probably entered system. Occasional bubbles during clutch cycling or system start-up may be okay.

Oil Streaked Sight Glass

If oil streaks appear on sight glass, a lack of refrigerant may be indicated, and the system's compressor oil is circulating through the system.

Cloudy Sight Glass

A cloudy sight glass indicates desiccant contained in receiver-drier or accumulator has broken down and is being circulated through system.

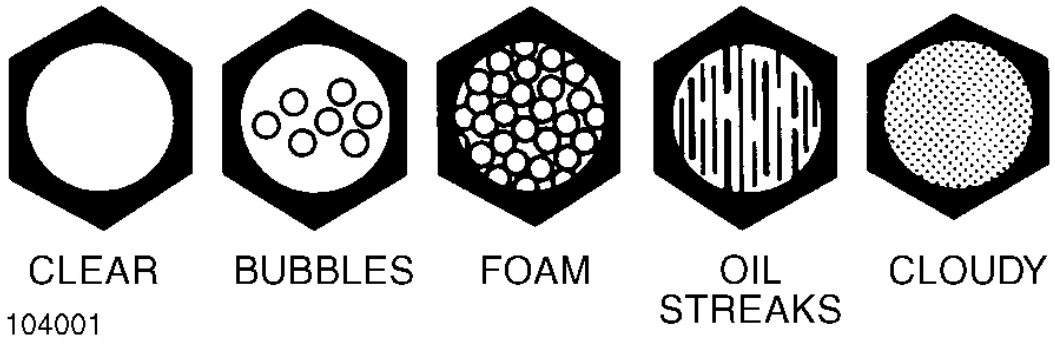


Fig. 2: Identifying Sight Glass Indicator Conditions

SYSTEM SERVICE VALVES

SCHRADER-TYPE VALVES

NOTE: Although similar in construction and operation to a tire valve, NEVER replace a Schrader-type valve with a tire valve.

Schrader valve is similar in construction and operation to a tire valve. See **Fig. 3**. When a test gauge hose is attached (hose has built-in valve core depressor), Schrader stem is pushed inward to the open position and allows system pressure to reach the gauge.

If test hose being used does not have a built-in core depressor, an adapter must be used. Never attach hoses or adapters to a Schrader valve unless it is first connected to manifold gauge set.

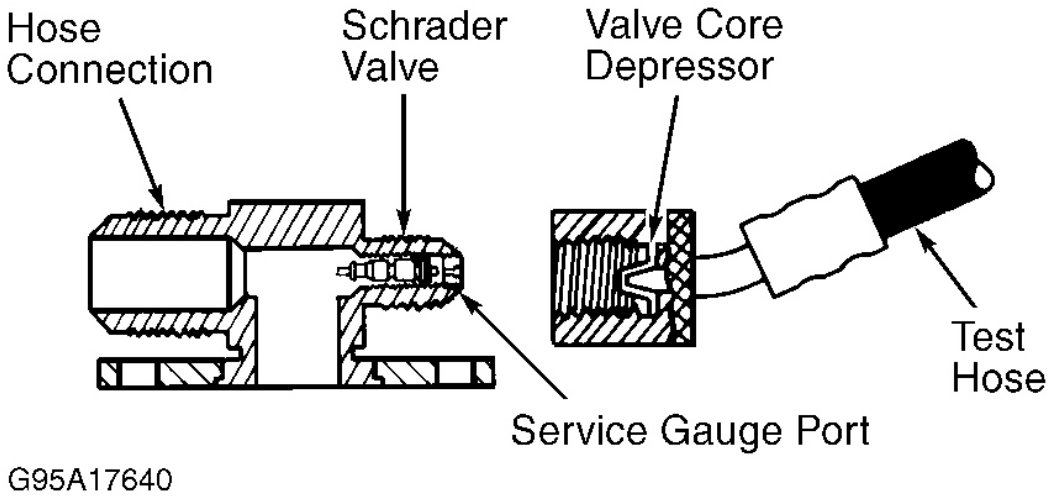


Fig. 3: Schrader Service Valve (Compressor Location Shown)

SPECIAL VALVE CONNECTORS

On some General Motors models, thread size on high-side service valve (3/8" - 24 threads) is different from thread size on low-side service valve (7/16" - 20 threads). Special adapters are required to make this connection. See **Fig. 4**. These adapters are available in 45-degree and 90-degree angles in addition to straight-fixed and flexible adapters.

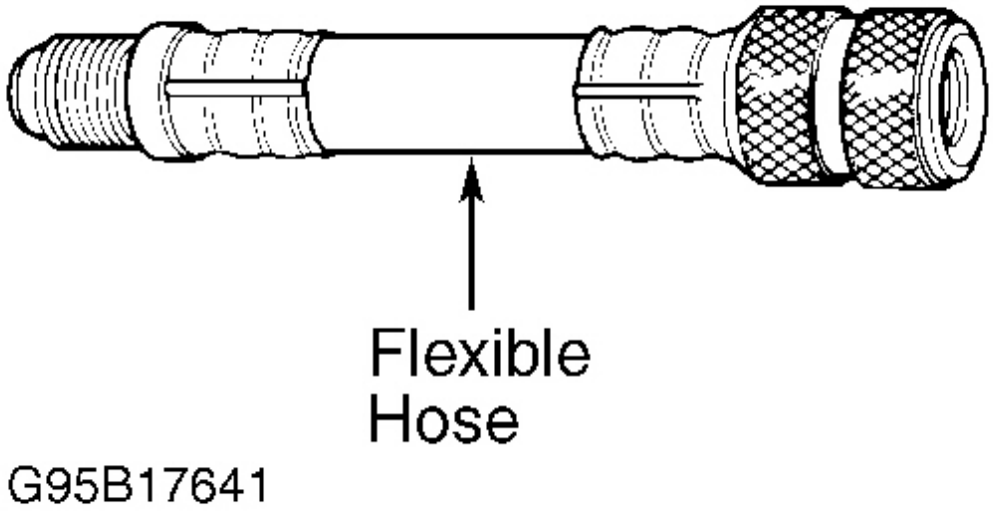


Fig. 4: Flexible High Side Adapter

R-134A SERVICE VALVES/PORTS

All vehicles with R-134a refrigerant use quick-disconnect service valves/ports. All R-134a systems use quick-disconnect fittings with sealing caps that thread into inside of service port instead of onto outside of service port.

The high side uses a large service port, and the low side uses a small service port. See **Fig. 1**. The R-134a service ports have internal metric threads to help prevent the accidental connection of R-12 servicing equipment.

There are 2 types of quick-disconnect service couplings which can be used on R-134a systems. One type of service coupling depresses service port valve when connection is made. The other type connects onto service port but will not depress service port valve until a knob is rotated. See **Fig. 5**.

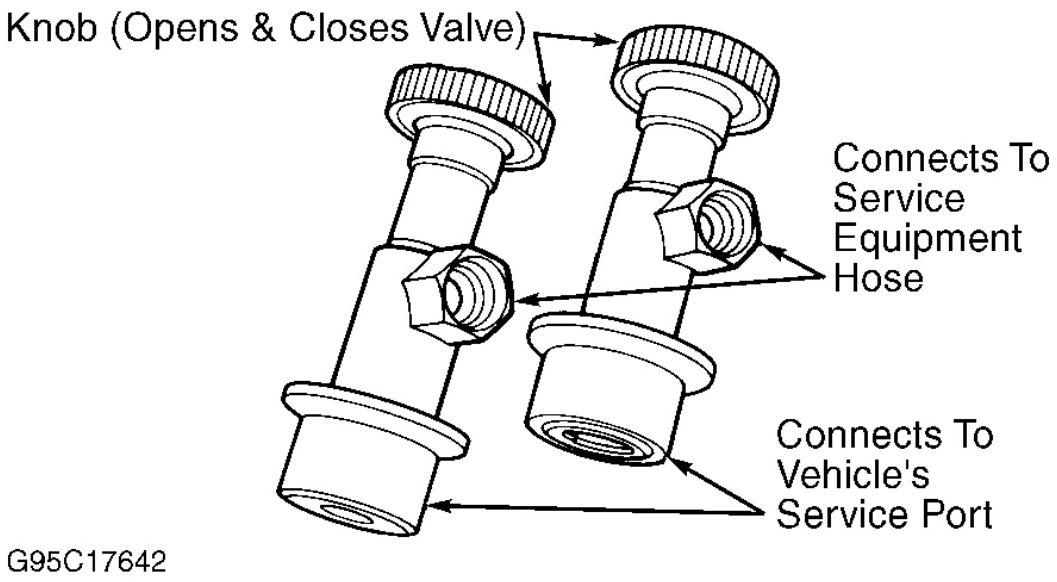


Fig. 5: R-134a Service Couplings
Courtesy of CHRYSLER CORP.

SERVICE VALVE LOCATIONS

For service valve locations, see SERVICE VALVE LOCATIONS (CARS) or SERVICE VALVE LOCATIONS (TRUCKS & VANS) table.

SERVICE VALVE LOCATIONS

Vehicle	High	Low
"A" Body	(4)	(4)
"B" Body	(4)	(4)
"C" & "H" Bodies	(1)	(2)
"D" Body	(1)	(2)
"E" & "K" Bodies	(1)	(3)
"F" Body	(1)	(2)
"G" Body	(1)	(2)
"J" Body	(1)	(2)
"L" Body	(1)	(2)
"N" Body	(1)	(2)
"W" Body	(1)	(2)
"Y" Body	(1)	(2)

(1) In discharge (high pressure) line.

(2) In suction (low pressure) line.

(3) On accumulator-drier or filter-drier.

(4) Information is not available from manufacturer.

SERVICE VALVE LOCATIONS

Vehicle	High	Low
"C" & "K" Series	(1)	(2)
"G" Series	(4)	(4)
"L" & "M" Series	(1)	(3)
"P" Series	(4)	(4)
"S" & "T" Series	(4)	(4)
"U" Series	(1)	(3)

(1) In discharge (high pressure) line.

(2) In suction (low pressure) line.

(3) On accumulator-drier.

(4) Information is not available from manufacturer.

SERVICE EQUIPMENT

Because R-134a is not interchangeable with R-12, separate sets of hoses, gauges and recovery/recycling equipment are required to service vehicles. This is necessary to avoid cross-contamination and damaging system.

All equipment used to service systems using R-134a must meet SAE standard J1991. The service hoses on the manifold gauge set must have manual (turn wheel) or automatic back-flow valves at the service port connector ends. This will prevent refrigerant from being released into the atmosphere.

For identification purposes, R-134a service hoses must have a Black stripe along their length and be clearly labeled SAE J2196/134a. The low pressure test hose is Blue with a Black stripe. The high pressure test hose is Red with a Black stripe. The center test hose is Yellow with a Black stripe.

NOTE: Refrigerant R-12 service hoses will ONLY be labeled SAE J2196.

R-134a manifold gauge sets can be identified by one or all of the following:

- Labeled FOR USE WITH R-134a on set.
- Labeled HFC-134 or R-134a on gauge face.
- Light Blue color on gauge face.

In addition, pressure/temperature scales on R-134a gauge sets are different from R-12 manifold gauge sets.

MANIFOLD GAUGE SET

A manifold gauge set is used to determine system's high-side and low-side pressures, correct refrigerant charge, system diagnosis and operating efficiency. High (discharge) and low (suction) pressures must be compared to determine system operation. Manifold gauge sets for the 2 refrigerant types are basically the same except for fittings at ends of hoses. Fittings are different to ensure connection only to appropriate refrigerant system.

Low-Side Gauge

Low-side gauge, which may have a Blue identifying feature, is used to measure low-side (suction) pressure. Low-side gauge is also called a compound gauge because it can measure pressure and vacuum. Pressure scale ranges from 0 to 150 psi; vacuum scale ranges from 0 to 30 in. Hg.

High-Side Gauge

High-side gauge, which may have a Red identifying feature, is used to measure high-side (discharge) pressure. Gauge scale ranges from 0 to 500 psi.

CONNECTING GAUGE SET

NOTE: R-134a quick disconnect service couplings are connected in the same sequence as Schrader-type service valves.

Schrader-Type Valves

1. Put on safety goggles, and cover vehicle's fender. Slowly remove protective caps from Schrader valves to check for leaky valves.

CAUTION: Ensure hand valves on manifold gauge set and the hose-end shutoff valves are closed before attaching test hoses to Schrader valves.

2. Ensure service hoses are equipped with valve core depressor to match Schrader valve. If not, install special adapters for this purpose. If the high-side service hose connector will not fit on high-side Schrader valve, a special adapter must be used. See SPECIAL VALVE CONNECTORS.
3. Ensure both manifold gauge hand valves are closed. Connect low-side service hose to low-side (suction) service valve, and finger tighten connections. Connect high-side service hose to high-side (discharge) service valve, and finger tighten connections.

NOTE: After test gauges are installed, test hoses must be purged of all air before proceeding with testing.

PURGING TEST HOSES

1. Ensure high-side and low-side hoses are properly connected to service valves, and all hose connections

are tight. Place a clean shop towel over end of center service hose.

2. Purge high-side test hose by opening hand valve on high-side gauge for 3-5 seconds. This allows system's refrigerant to force air through test hoses and out of center service hose into the shop towel. Immediately close high-side gauge hand valve.
3. Purge low-side test hose in the same manner using hand valve of low-side gauge. Close hand valve after 3-5 seconds. Purging of test hoses is now complete, and system is ready for testing.

NOTE: If manifold gauge set is to be used in conjunction with refrigerant recovery/recycling equipment, use instructions provided with the recovery/recycling equipment to properly purge test hoses.

STABILIZING A/C SYSTEM

1. Once manifold gauge set is attached to system and test hoses have been purged, system is ready for testing. Place all test hoses, gauge set and other equipment away from all moving parts of engine.
2. Start engine, and turn A/C controls to maximum cooling position (full cold or "MAX A/C"). Set blower fan on high speed. Open doors and/or windows. Operate system for 5-10 minutes. System should now be stabilized and ready for test readings.

PRESSURE-TEMPERATURE RELATIONSHIP

A refrigerant, when confined in an enclosed space, increases in pressure as the temperature increases. Conversely, if the temperature is lowered, the pressure also decreases.

Depending on temperature, a corresponding pressure will exist in a such an enclosed space. For example, at 70° F (21.1°C) a gauge will indicate about 71.0 psi (5.0 kg/cm^2). The R-134a PRESSURE-TEMPERATURE RELATIONSHIP table shows this relationship.

R-134a PRESSURE-TEMPERATURE RELATIONSHIP

Temperature °F (°C)	**(1) psi (kg/cm^2)**
20 (-6.7)	18 (1.3)
30 (-1.1)	26 (1.8)
40 (4.4)	35 (2.5)
45 (7.2)	40 (2.8)
50 (10.0)	45 (3.2)
55 (12.8)	51 (3.6)
60 (15.6)	57 (4.0)
65 (18.3)	64 (4.5)
70 (21.1)	71 (5.0)
75 (23.9)	79 (5.6)
80 (26.7)	87 (6.1)
85 (29.4)	95 (6.7)
90 (32.2)	104 (7.3)

95 (35.0)	114 (8.0)
100 (37.8)	124 (8.7)
110 (43.3)	147 (10.3)
120 (48.9)	171 (12.0)
130 (54.4)	199 (14.0)
140 (60.0)	229 (16.1)
150 (65.6)	263 (18.5)
160 (71.1)	300 (21.1)
(1) Pressure readings are provided as a general guideline and may not represent actual readings.	

PRESSURE GAUGE READINGS

The pressure gauge readings used represent an expansion valve type system using a Nippondenso 10-cylinder compressor. See **Fig. 6**-14. Gauge indications will vary depending on system configuration and compressor application.

Temperature and humidity, as well as other factors, affect pressure gauge readings. Compared to R-12 systems, pressure readings on R-134a systems are generally lower for low-side pressure and higher for high-side pressure. Pressure gauge readings should be used only as a guide.

NOTE: For additional A/C COMPRESSOR SERVICING information, see the A/C COMPRESSOR SERVICING article or the A/C COMPRESSOR REFRIGERANT OIL CHECKING article in the AIR CONDITIONING & HEAT section.

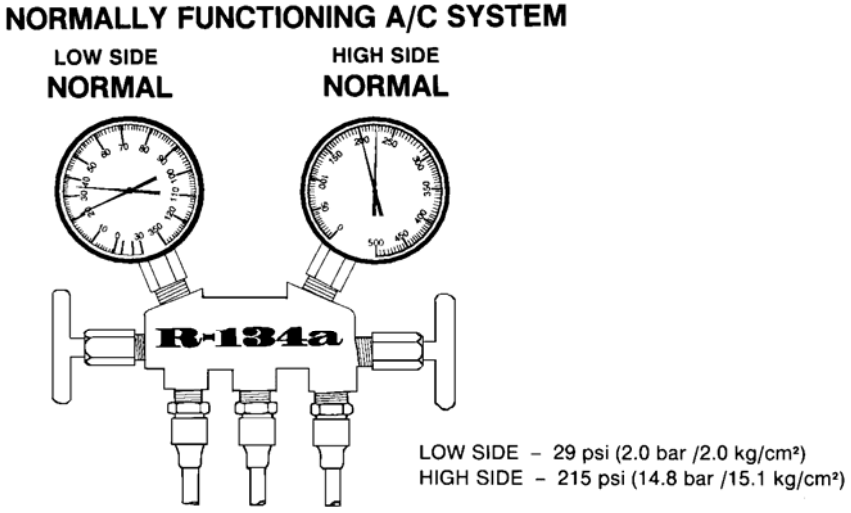


Fig. 6: Normally Functioning R-134a A/C System

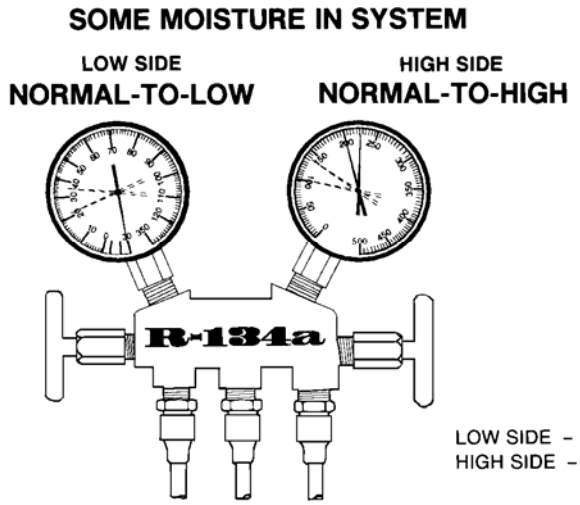


Fig. 7: Some Moisture In R-134a System

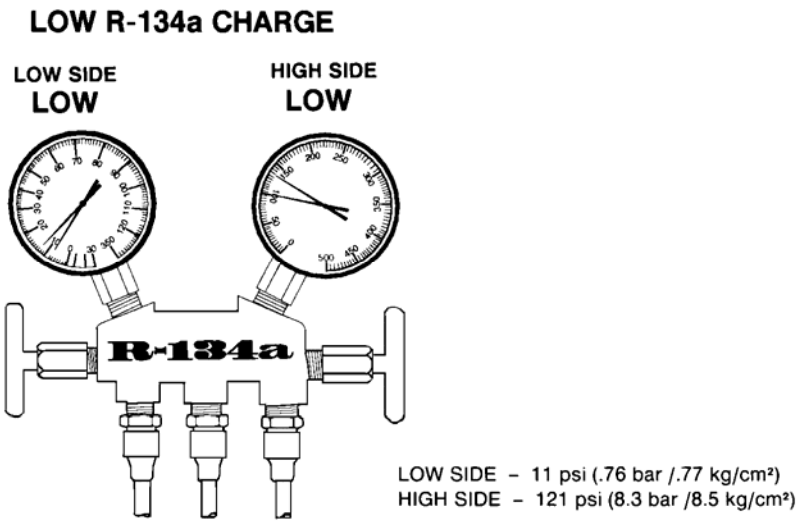


Fig. 8: Low R-134a Charge

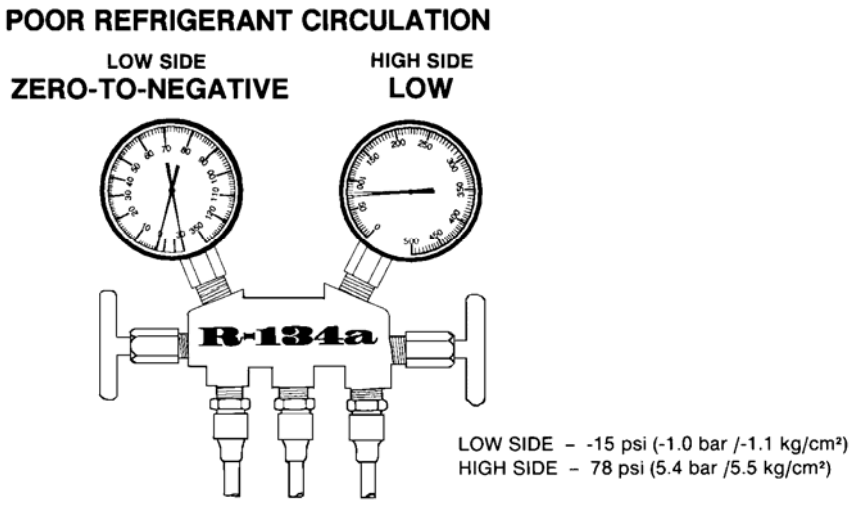


Fig. 9: Poor R-134a Refrigerant Circulation

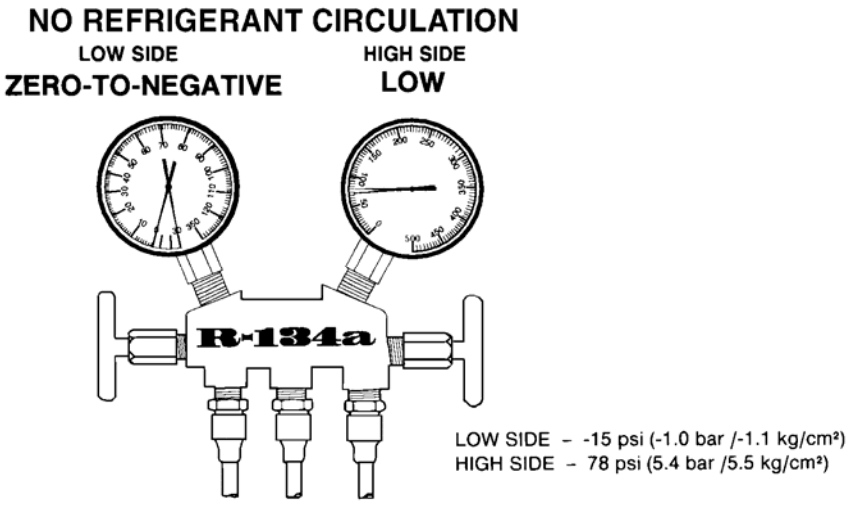
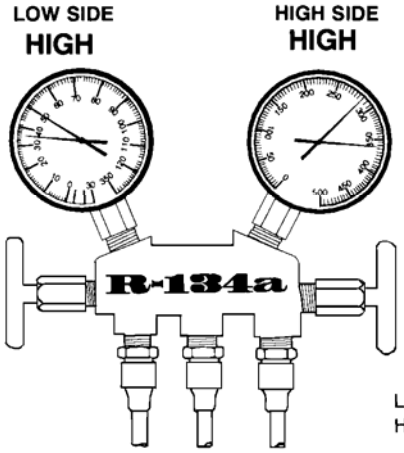


Fig. 10: No R-134a Refrigerant Circulation

INSUFFICIENT COOLING OF CONDENSER OR REFRIGERANT OVERCHARGE



LOW SIDE – 43 psi (3.0 bar /3.0 kg/cm²)
HIGH SIDE – 320 psi (22.1 bar /22.5 kg/cm²)

GAUGE READINGS	**Low Side Gauge –** High **High Side Gauge –** High
OTHER SYMPTOMS	**Sight Glass –** No bubbles visible even after lowering engine RPM.
DIAGNOSIS	**Refrigerant Overcharge, Condenser Cooling Fins Clogged With Dirt Or Cooling Fans Malfunctioning.**
CORRECTION	**1)** Clean condenser cooling fins. **2)** Check cooling fan operation. **3)** Evacuate A/C system. **4)** Charge system with R-134a. **5)** Operate system and check performance.

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Fig. 11: Insufficient Cooling Of Condenser Or R-134a Refrigerant Overcharge

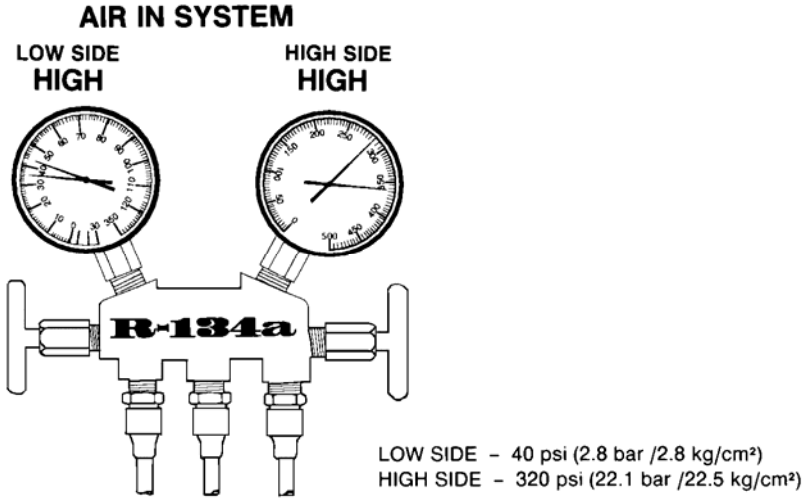
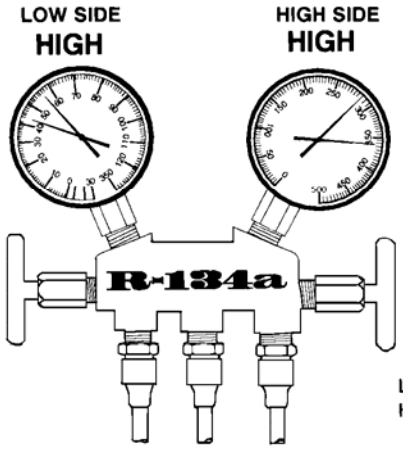


Fig. 12: Air In R-134a System

EXPANSION VALVE IMPROPERLY MOUNTED
OR HEAT SENSING TUBE DEFECTIVE (OPENING TOO WIDE)



LOW SIDE – 50 psi (3.5 bar /3.5 kg/cm²)
HIGH SIDE – 320 psi (22.1 bar /22.5 kg/cm²)

GAUGE READINGS	**Low Side Gauge** – High **High Side Gauge** – High
OTHER SYMPTOMS	**Pipes** – Large amount of frost or moisture on low side pipes.
DIAGNOSIS	**Excessive Refrigerant In Low Side Pipes Possibly From Expansion Valve Being Opened Too Wide.**
CORRECTION	**1)** Check heat sensing tube for proper installation. **2)** If heat sensing tube is properly positioned, evacuate A/C system. **3)** Check expansion valve and replace if defective. **4)** Charge system with R-134a. **5)** Operate system and check performance.

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Fig. 13: Expansion Valve Improperly Mounted Or Heat Sensing Tube Defective (Opening Too Wide)

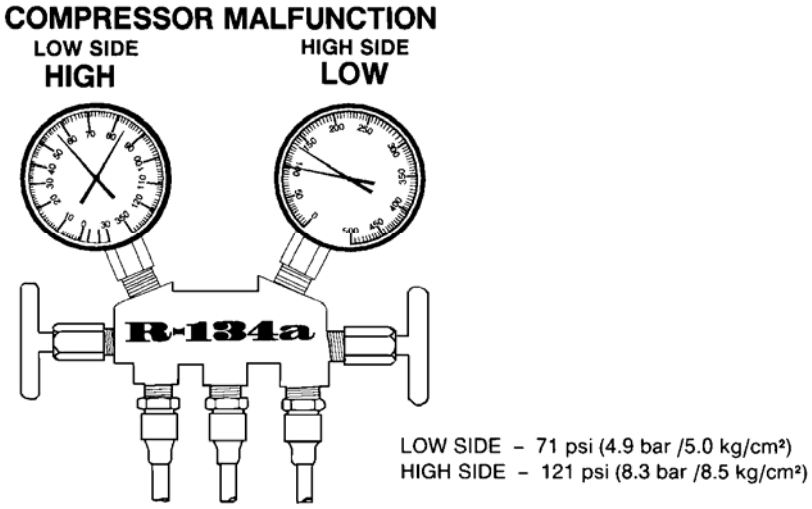


Fig. 14: Compressor Malfunction

ORIFICE TUBE REPLACEMENT

NOTE: Orifice tube is located in end of liquid line closest to component listed in ORIFICE TUBE LOCATION & REMOVER/INSTALLER APPLICATION table. Models not listed use a thermostatic expansion valve.

Removal

1. Locate orifice tube. See ORIFICE TUBE LOCATION & REMOVER/INSTALLER APPLICATION table. Discharge A/C system using approved recovery/recycling equipment. Disconnect liquid line at evaporator inlet. Remove orifice, and disconnect liquid line at evaporator or condenser.
2. Remove orifice tube using needle-nose pliers or orifice tube remover. See ORIFICE TUBE LOCATION & REMOVER/INSTALLER APPLICATION table.
3. If difficulty is encountered during removal of a plugged or restricted orifice tube, remove as much residue as possible. Using a heat gun, carefully heat inlet pipe. If inlet pipe has small dimples, apply heat1/4" from dimples. Be careful not to overheat pipe.

NOTE: If system has a pressure switch near orifice tube location, remove switch before heating inlet pipe to avoid damaging switch.

4. While heat is being applied, install orifice tube extractor. Use a turning motion along with a push or pull

motion to loosen and remove orifice tube.

NOTE: On some models, it may be necessary to use Dual "O" Ring Joint Separator (J-38042) to hold refrigerant line nut while loosening or tightening fitting.

Installation

1. To install orifice tube, coat inside of inlet pipe with refrigerant oil. Lubricate new orifice tube and "O" ring with refrigerant oil and insert them into inlet pipe.
2. Install orifice tube with shorter screen end first (toward evaporator). To complete installation, reverse removal procedure. Recharge and test system for proper operation.

ORIFICE TUBE LOCATION & REMOVER/INSTALLER APPLICATION

Application	Orifice Tube Location	Orifice Tube Remover/Installer
Cars		
"A" Body	Condenser	(1)
"B" Body	Condenser	J-26549-E
"C" & "H" Bodies	Condenser	J-26549-E
"D" Body	Condenser	J-26549-E
"E" & "K" Bodies	Evaporator	J-26549-D
"G" Body	Evaporator	J-26549-E
"J" Body	Condenser - See **Fig. 15**.	J-26549-89
"W" Body	Condenser	J-26549-E
"Y" Body	Evaporator	J-26549-E
Trucks & Vans		
"C" & "K" Series	Condenser	J-26549-E
"G" & "P" Series	Evaporator	J-26549-D
"L" & "M" Series	Evaporator	J-26549-E
"S" & "T" Series	(1)	(1)
"U" Series	(2)	J-26549-E

(1) Information is not available from manufacturer.

(2) In condenser-to-evaporator core refrigerant lines, near support clamp or high-side service valve.

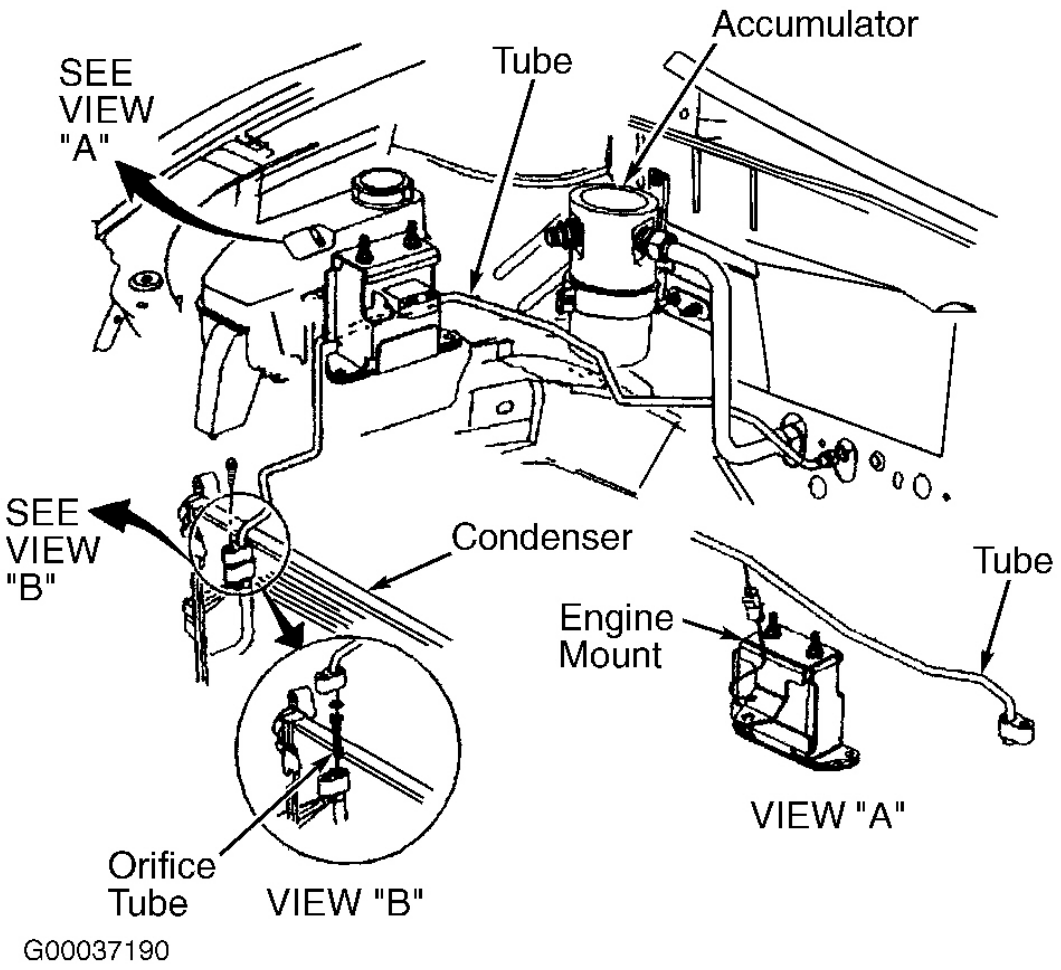


Fig. 15: Orifice Tube Location (Cavalier)
Courtesy of GENERAL MOTORS CORP.

REFRIGERANT RECOVERY/RECYCLING

Refrigerant recovery/recycling equipment is used to remove refrigerant from vehicle's A/C system without polluting atmosphere. To remove and recycle refrigerant, ALWAYS follow instructions provided with the refrigerant recovery/recycling equipment being used.

The removed refrigerant is filtered, dried and stored in a tank within the recovery/recycling equipment until it is ready to be pumped back into the vehicle's A/C system.

NOTE: **Separate sets of hoses, gauges and refrigerant recovery/recycling equipment MUST be used for R-12 and R-134a systems. DO NOT mix R-12 and R-134a refrigerants, as their refrigerant oils and desiccants are NOT compatible.**

1. Close both valves on manifold gauge set. Connect manifold gauge set to high-side and low-side service valves. See SERVICE VALVE LOCATIONS under SYSTEM SERVICE VALVES.
2. Connect center hose on manifold gauge set to inlet port on Refrigerant Recovery/Recycling Equipment (J-39500). Start engine. Turn A/C on for about 2 minutes.

NOTE: Operating A/C for 2 minutes warms refrigerant, allowing greater recovery of refrigerant from system.

3. Shut engine off. Open both valves on manifold gauge set. Simultaneously open both valves on refrigerant recovery/recycling equipment storage tank.
4. Turn refrigerant recovery/recycling equipment on. Depress compressor START switch. Ensure the compressor ON light is activated.
5. The refrigerant recovery/recycling equipment will shut off when manifold gauge indicates vacuum reading of 17 in. Hg. Vacuum should remain at 17 in. Hg for at least 2 minutes.
6. Run recovery/recycling equipment one complete cycle. If vacuum reading is greater than zero after one complete cycle, some refrigerant still remains in vehicle's A/C system. Depress compressor START switch, and operate refrigerant recovery/recycling equipment through another cycle.
7. Once refrigerant is recovered, open accumulator pressure valve on the refrigerant recovery/recycling equipment for 15 seconds. This will pressurize the oil separator so refrigerant oil can be drained.
8. Open oil drain valve on refrigerant recovery/recycling equipment, and drain refrigerant oil into a container. Measure exact amount of oil to be added when system is put back in service.

FLUSHING A/C SYSTEM

1. Manufacturer does not recommend flushing A/C system. If system is contaminated, discharge system and install a liquid line filter between condenser and evaporator.
2. Filter may be an integral part of the line, or line may need to be cut and filter installed (non-integral type). Filters may or may not contain orifice. See **Fig. 16**.
3. Filter with orifice is installed on low pressure side of orifice tube. Remove original orifice tube if installing filter with orifice. Filter without orifice must be installed on high pressure side of orifice tube.
4. To install liquid line filter, discharge A/C system using approved recovery/recycling equipment. Remove liquid line. Using a tubing cutter, cut section from liquid line to allow installation of liquid line filter. Clean all burrs, and smooth surfaces.
5. Install nut over line. Install ferrule on line with small end toward nut. DO NOT install "O" ring at this time.
6. Push line into fitting until it bottoms on filter assembly. Tighten nuts on each joint to 11 ft. lbs. (15 N.m). Disassemble joint assembly.
7. Lubricate new "O" rings with refrigerant oil and install them on lines. Install filter assembly. Ensure arrow on filter indicates proper flow of refrigerant. Tighten nuts to 11 ft. lbs. (15 N.m). Evacuate and charge system. Check system for leaks.

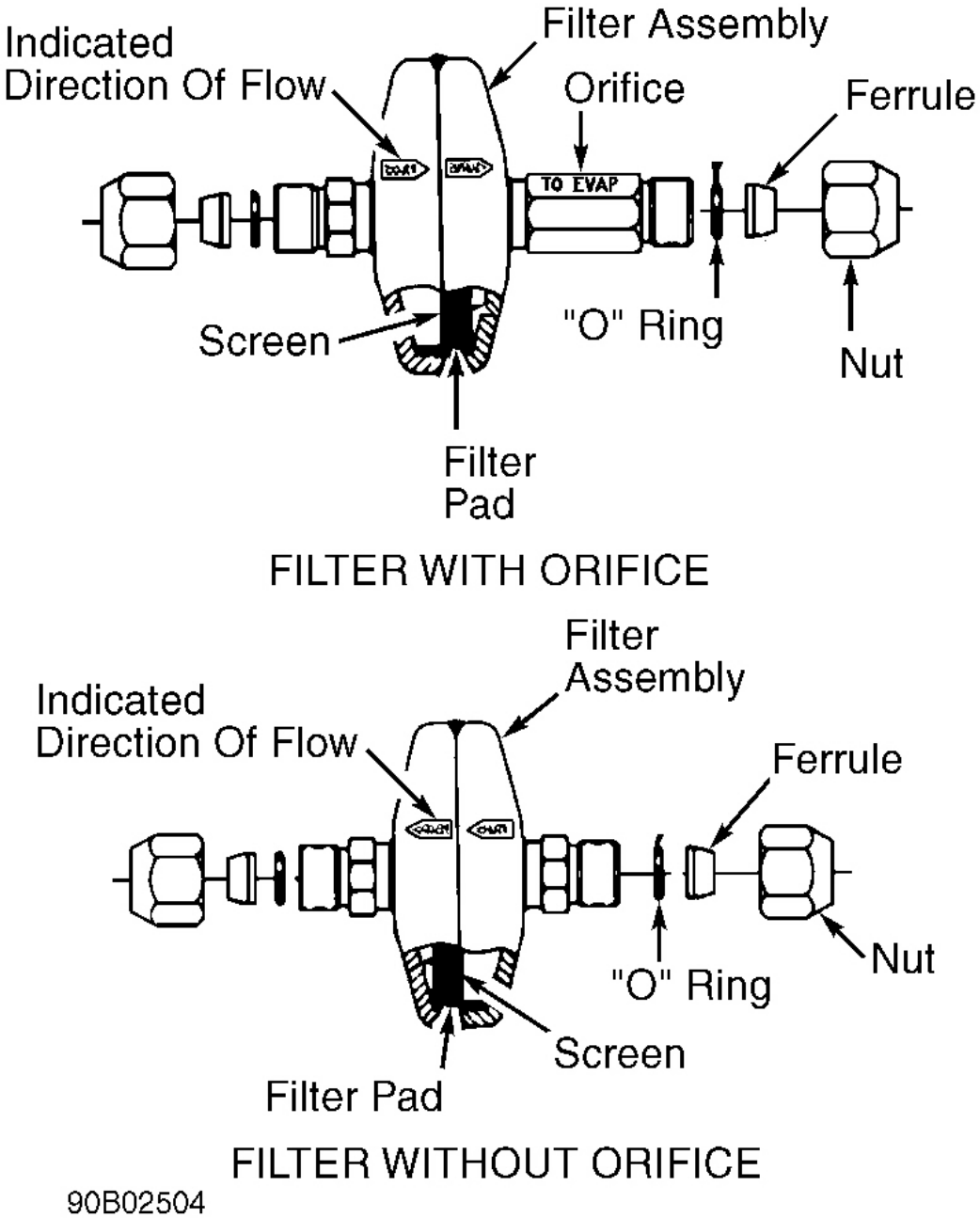


Fig. 16: Exploded View Of Liquid Line Filter & Components
Courtesy of GENERAL MOTORS CORP.

EVACUATING A/C SYSTEM

Information is not available from manufacturer.

CHARGING A/C SYSTEM

NOTE: Manufacturer does not recommend using one-pound cans. Using a charging station will allow precise measurement of refrigerant charge. See the REFRIGERANT OIL SPECIFICATIONS tables in the A/C COMPRESSOR SERVICING article for system capacities.

NOTE: DO NOT connect high-side gauge hose to high-side service port. Perform A/C charging service through low side only.

1. System must be evacuated before charging. With manifold gauge set connected (from evacuation procedure), start engine, but DO NOT turn on A/C. Connect refrigerant drum to hose on center connector of manifold gauge set. Invert refrigerant drum for liquid charging. Open low-side gauge valve on manifold gauge set. Allow 16 ounces of refrigerant to enter system.
2. When 16 ounces of refrigerant have entered system, turn A/C system to normal operating position with blower fan on high speed. Continue charging (liquid charging) until proper amount of refrigerant has entered system.
3. Close refrigerant drum valve, and continue running A/C system for 30 seconds to clear lines and gauges. Turn off valve on manifold gauge set. With engine running, disconnect low-side hose, and install service valve cap at accumulator. Perform leak test procedure. See LEAK TESTING.

LEAK TESTING

TYPES OF LEAK DETECTORS

Bubble Solution Detector

This is a solution applied externally at suspected leak points. Leaking refrigerant will cause the detector to form bubbles and foam. A soap and water solution also works well.

Dye Solution

This is a colored solution that may be introduced into the air conditioning system. The dye will show up and color components at leak points. Some manufacturers offer refrigerant containing a Red dye. This dye-containing refrigerant is installed by normal charging procedures. Other dye solutions are visible with a Black light only.

Electronic Detector

This instrument will draw in any leaking refrigerant through a test probe, and then sound an alarm or create a flashing light if refrigerant is found. It is the most sensitive of the leak detectors used. See **Fig. 17**.

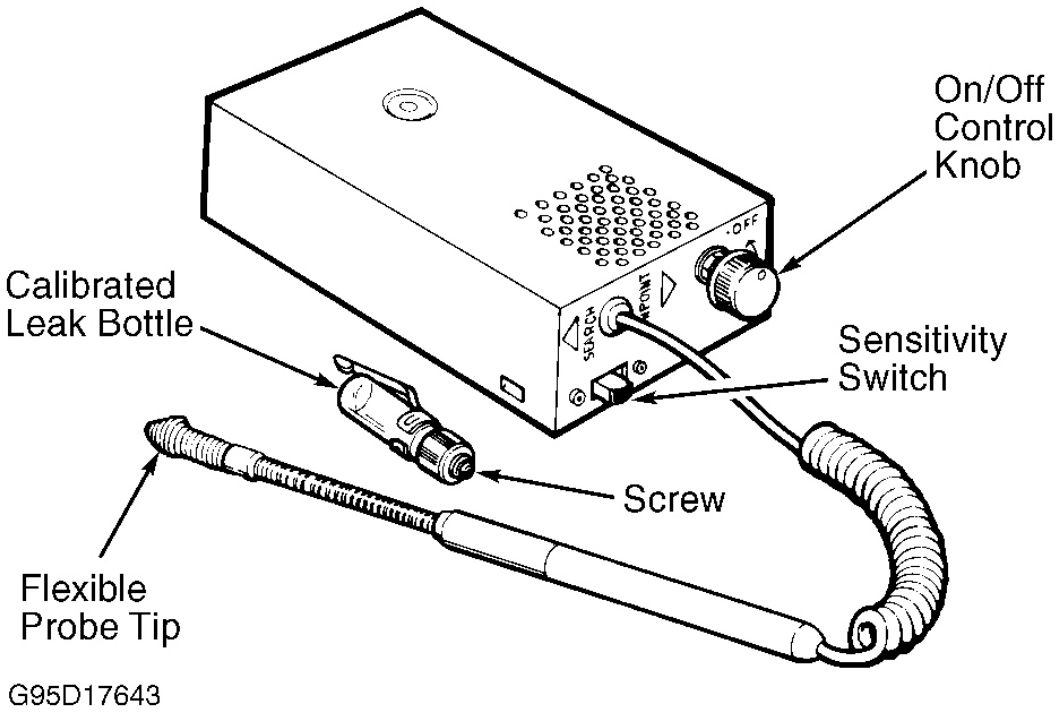


Fig. 17: Electronic Leak Detector

PREPARATION FOR LEAK TESTING

Connect manifold gauge set to air conditioning system. Ensure low-side and high-side gauge set hand valves are closed. Check system pressure. It should be at least 50 psi (3.5 kg/cm^2). If low, add just enough refrigerant to bring system to 50 psi (3.5 kg/cm^2).

Ensure all joints, connections, and fittings are free of oil dirt and other contaminants. Using a refrigerant leak detector, check all refrigerant line connections for leaks. Check condenser and compressor seal area.

Refrigerants are heavier than air. Always check for leaks at bottom of refrigerant lines and components. Refrigerant oil will leak with refrigerant. Visually check all connections and compressor clutch area for oil stains. If compressor shaft seal is leaking, a fresh oil streak will normally be seen on underside of hood, above compressor clutch.

Always perform leak testing after A/C service. Move refrigerant leak detector slowly to check for leaks, as leaks will not be detected if leak testing is performed too quickly.

BUBBLE DETECTOR LEAK TESTING PROCEDURE

This leak detection method is recommended when it is impossible or difficult to determine the exact location of the leak using other methods. Although commercial bubble detectors are more effective, household soap

solutions may be used.

Using the dauber that comes with the commercial soap solution, apply the solution to all joints, connections, fittings or controls where a leak might be suspected. If high-suds household solutions are used, apply them with a small brush. Wherever bubbles form, leaks are present and must be repaired. check the entire system as there may be more than one leak.

ELECTRONIC LEAK TESTING PROCEDURE

NOTE: Some electronic leak detectors will function on only R-12 systems or on only R-134a systems, and some will function on both R-12 and R-134a systems. Familiarize yourself with the test being used and know what type of system you are leak testing.

Electronic leak detectors should be used in well ventilated areas. Avoid using them around explosive gases. Always follow manufacturer's instructions for the specific tester being used. If none are available, proceed as follows:

1) Turn all controls and the sensitivity knob to the OFF position or zero setting. Plug the leak detector into an approved source of voltage if not battery operated. Turn the switch ON, and allow the unit to warm up for approximately 5 minutes.

2) Check operation of the tester by positioning the probe in a reference source where refrigerant is known to be present in small amounts. Adjust the controls and sensitivity knob until detector reacts properly. Move probe away from refrigerant source and the reaction should stop. If it continues, adjust the sensitivity knob to a lower setting.

3) When tester reacts properly, leak test air conditioning system by moving probe under all components, fittings and connections. Keep the probe moving. DO NOT hold it in constant contact with refrigerant. When leaks are found, repair them as necessary. Keep in mind that there may be more than one leak.

DYE SOLUTION LEAK TESTING PROCEDURES

CAUTION: Dye-charged refrigerant cans are available to be used as internal leak detectors. The use of this type of solution may void some manufacturer's warranties. Be sure to check with the A/C system manufacturer concerning the use of dye-charged leak detectors. Dyes which work in R-12 systems will not work in R-134a systems.

The following procedure is for introducing a dye solution, not dye-charged refrigerant, into the air conditioning system:

1) Connect manifold gauge set to air conditioning system in a normal manner. Remove center hose from manifold gauge set, and replace it with a short piece (6" long) of 1/4" tubing using two 1/4" flare nuts. Connect a container of dye solution to the tubing.

2) Connect one end of the gauge set's center hose to the dye solution. Connect a container of refrigerant to the

other end of the hose. Operate the engine at idle speed. Set the air conditioning system for maximum cooling. Slowly open the low-side hand valve to allow the dye solution to enter the system.

3) Charge the system to at least 50% capacity. Operate the system for 15 minutes, and then shut off both the air conditioning system and the engine. Check all connections for signs of the colored dye solution. Check the vehicle again 24 hours later. If leaks are found, repair as necessary.

DESCRIPTION

WARNING: To avoid injury from accidental air bag deployment, read and carefully follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in AIR BAG article in the ACCESSORIES/SAFETY EQUIPMENT Section.

CAUTION: When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.

SYSTEM DESCRIPTION

Manually controlled A/C-heater system delivers heated or cooled and dehumidified air for occupant comfort. System is a Cycling Clutch Orifice Tube (CCOT) design and uses a Harrison HD6 or HR6-HE 6-cylinder radial compressor. Air distribution is controlled through a manual A/C-heater control panel and a series of vacuum-operated doors.

OPERATION

CAUTION: When battery is disconnected, radio will go into anti-theft protection mode. Obtain radio anti-theft protection code from owner prior to servicing.

CONTROL PANEL

Several settings are possible on control panel to provide desired comfort level. See **Fig. 1**. Available mode settings are:

OFF

Blower or air conditioning does not operate in this mode. With vehicle forward movement, a slight amount of air will enter passenger compartment.

MAX

Maximum cooling is provided in this mode. Conditioned air is distributed through dash registers. This is the only mode in which air is recirculated from passenger compartment.

A/C

Conditioned air is directed through dash registers.

B/L (bi-level)

In B/L mode, conditioned air is directed through dash registers and floor outlets.

VENT

In this mode, compressor does not operate. Outside air is delivered through dash registers.

HEAT

In HEAT (heater) mode, compressor does not operate. Outside air is heated and distributed. About 80 percent of heated air is distributed to floor, and 20 percent to windshield and side windows.

BLEND

Blower motor and compressor are operating. Air is directed through defroster and floor air outlets.

DEFROST

In defrost (symbol) position, 80 percent of conditioned air is distributed to windshield and side windows and 20 percent to floor.

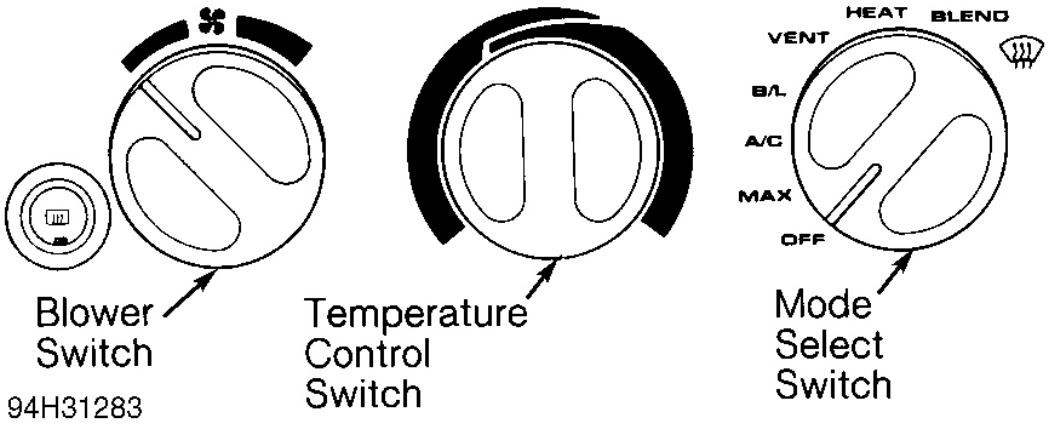


Fig. 1: Identifying Manual A/C-Heater Control Panel
Courtesy of GENERAL MOTORS CORP.

HIGH SPEED BLOWER RELAY

The high speed blower relay is located next to blower motor on bottom of A/C-heater module. High speed blower relay is used to by-pass the blower motor resistor assembly for high speed blower operation. When blower switch is in highest speed setting, the high speed blower relay is energized, applying battery voltage directly to blower motor.

COMPRESSOR CONTROL RELAY

Compressor control relay is located on multi-use relay bracket on right front wheelwell, near accumulator. Powertrain Control Module (PCM) energizes compressor control relay for compressor operation. If PCM receives a signal indicating Wide Open Throttle (WOT) or engine overheating, it will de-energize compressor control relay, stopping compressor operation. During hot engine restart, compressor engagement will not be allowed for 3 seconds to allow engine idle to stabilize.

ORIFICE TUBE

The orifice tube is located in an enlarged portion of condenser outlet pipe. It controls the flow of liquid refrigerant into the evaporator. The orifice tube has filter screens on both inlet and outlet sides. Tube has no moving parts and is not adjustable. If tube is plugged or defective, it must be replaced as a unit.

PRESSURE CYCLING SWITCH

The pressure cycling switch is located on accumulator. It senses low side system pressure and controls power circuit to the compressor control relay. Pressure cycling switch is normally closed at pressure greater than 43-49 psi (3.0-3.4 kg/cm^2), and open at pressure less than 23-25 psi (1.6-1.7 kg/cm^2).

POWER STEERING PRESSURE SWITCH

The power steering pressure switch is located in power steering pressure hose. It temporarily shuts off the compressor when power steering loads exceed 500 psi (35 kg/cm^2) to improve engine idle.

REFRIGERANT PRESSURE SENSOR

The refrigerant pressure sensor is attached to compressor and condenser hose. It senses high side pressures and sends a signal to PCM. If high side pressure exceeds 429 psi (30.1 kg/cm^2), PCM will disable compressor.

TROUBLE SHOOTING

WARNING: To avoid injury from accidental air bag deployment, read and carefully follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in the AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

OPERATIONAL TESTING

When trouble shooting and diagnosing an air conditioning system, always refer to appropriate vacuum and wiring diagrams for the system involved.

If blower operates at all speeds and compressor clutch engages, electrical circuits are functioning properly. If evaporator inlet pipe and accumulator surface appear to be the same temperature when felt by hand, system is properly charged with refrigerant. Ensure vacuum and diaphragm function properly when moving selector control.

A/C COMPRESSOR CLUTCH CONTROLS

NOTE: See the A/C COMPRESSOR CLUTCH CONTROLS article in the AIR CONDITIONING & HEAT section.

AIRFLOW FROM WRONG OUTLETS

Test vacuum check valve. Check vacuum routing. Check for vacuum leaks and inoperative vacuum actuator. See **Fig. 3**.

BLOWER INOPERATIVE AT ANY SPEED

1. Check instrument panel fuse No. 17 (20-amp) and underhood maxi-fuse No. 10 (60-amp). Turn ignition switch to RUN position. Place mode select switch in MAX position. Turn blower switch to highest speed. Using a test light, backprobe Purple wire of high speed blower relay. High speed blower relay is located under right side of instrument panel, to right of blower motor.
2. Test light should illuminate. If test light does not illuminate, go to next step. If test light illuminates, check for open circuit in Purple wire between high speed blower relay and blower motor. Check for open circuit in Black wire between blower motor and ground. If all wires and connections are good, replace blower motor.
3. Backprobe Brown wire of A/C-heater control panel. Test light should illuminate. If test light illuminates, check for poor connections at high speed blower relay. If connections are good, replace high speed blower relay.
4. If test light does not illuminate, check for poor connection at heater and A/C-heater control panel. Check for open circuit in Brown wire between A/C-heater control panel and fuse block. If Brown wire between A/C-heater control panel and fuse block is good, replace control panel.

LOW SPEED INOPERATIVE, MEDIUM & HIGH SPEEDS OPERATE NORMALLY

1. Turn ignition switch to RUN position. Place mode select switch in MAX position. Turn blower switch to lowest speed. Using a test light, backprobe Yellow wire of blower resistor. Blower resistor is located to left of blower motor.
2. Test light should illuminate. If test light does not illuminate, check for poor connection and open circuit in Yellow wire between blower resistor and A/C-heater control unit.
3. If test light illuminates, check for poor connection at blower resistor connector. If connection is good, replace blower resistor.

MEDIUM SPEED(S) INOPERATIVE, LOW & HIGH SPEEDS OPERATE NORMALLY

1. Turn ignition switch to RUN position. Place mode select switch in MAX position. Turn blower switch to medium low speed. Using a test light, backprobe Tan wire of blower resistor. Blower resistor is located to left of blower motor.
2. Test light should illuminate. If test light illuminates, go to next step. If test light does not illuminate, check for poor connection or open in Tan wire between blower resistor and A/C-heater control panel.
3. Turn blower switch to medium high speed. Backprobe Light Blue wire of blower resistor. Test light

should illuminate. If test light does not illuminate, go to next step. If test light illuminates, check for poor connection at blower resistor. If connection is good, replace blower resistor.

4. Check for open circuit and poor connection in Light Blue wire between blower resistor and A/C-heater control panel. If circuit and connections are good, replace blower switch.

HIGH SPEED INOPERATIVE, LOW & MEDIUM SPEEDS OPERATE NORMALLY

1. Turn ignition switch to RUN position. Place mode select switch in MAX position. Turn blower switch to highest speed. Using a test light, backprobe Orange wire of high speed blower relay. Test light should illuminate. If test light illuminates, go to next step. If test light does not illuminate, go to step 3).
2. Backprobe Red wire of high speed blower relay. Test light should illuminate. If test light illuminates, check for poor connection at high speed blower relay and open circuit in Black wire between high speed blower relay and ground. If circuits and connections are good, replace high speed blower relay. If test light does not illuminate, repair open circuit in Red wire between high speed blower relay and fusible link.
3. Backprobe Orange wire of blower switch connector. Test light should illuminate. If test light illuminates, check for open circuit and poor connection in Orange wire between blower switch and high speed blower relay. If test light does not illuminate, check for poor connection at blower switch. If connection is good, replace blower switch.

INSUFFICIENT OR NO HEAT

Check for low coolant level, faulty thermostat or loose fan belt. Check for kinked heater hose or plugged heater core. Check temperature blend door adjustment and mode door operation. Check that cowl plenum airflow is not restricted.

A/C DOES NOT WORK

With engine running and function control switch at NORM position, check for voltage at pressure cycling switch. Check for voltage between pressure cycling switch and compressor clutch. Ground compressor clutch circuit. If clutch engages, check wide-open throttle cut-out switch and A/C compressor cut-off switch.

REFRIGERANT SYSTEM DIAGNOSIS

Insufficient Cooling

NOTE: QUICK CHECK procedure may be used to check for proper refrigerant charge in A/C system, provided ambient air temperature is more than 70°F (21°C). On vehicles with Cycling Clutch Orifice Tube (CCOT) system, compressor will cycle on and off to meet system requirements. CCOT system does not use a sight glass to check refrigerant charge.

Quick Check Procedure

1. Engine must be at normal operating temperature (not on fast idle or cold enrichment). Open vehicle doors and engine hood. Select NORM A/C position. Move temperature lever to COLD position. Turn blower switch to HI position. Engine should be at normal slow idle speed.

2. While compressor is engaged, feel temperature of accumulator surface and evaporator inlet pipe. If temperature of both components is the same (slightly cooler than ambient air), system is normal. If inlet pipe is frosted or feels cooler than accumulator surface, refrigerant charge is low.
3. Add refrigerant in 4-ounce increments, allowing system to stabilize between additions, until accumulator and pipe appear to be same temperature. Add 14 more ounces of refrigerant.

TESTING

A/C SYSTEM PERFORMANCE

1. Park vehicle out of direct sunlight. Connect tachometer. Install manifold gauge set. Start engine. Turn A/C on. Place mode select switch in MAX position, temperature control on maximum cooling and blower switch on highest speed setting.
2. Close doors and windows and open hood. Place a high volume fan in front of radiator to ensure maximum airflow across condenser. Insert thermometer in right center air outlet. Idle engine for 10 minutes. Increase idle to 2000 RPM and measure temperature. Temperatures and pressures should be within correct range. See **A/C SYSTEM PERFORMANCE TEMPERATURE SPECIFICATIONS** and **A/C SYSTEM PERFORMANCE PRESSURE SPECIFICATIONS**.

A/C SYSTEM PERFORMANCE TEMPERATURE SPECIFICATIONS

Ambient Temp. °F (°C)	Outlet Vent Temp. °F (°C)
70 (21)	43 (6)
80 (27)	56 (14)
90 (32)	64 (18)
100 (38)	78 (26)

A/C SYSTEM PERFORMANCE PRESSURE SPECIFICATIONS

Ambient Temp. °F (°C)	High Side psi (kg/cm^2)	Low Side psi (kg/cm^2)
70 (21)	200 (14.0)	23 (1.6)
80 (27)	315 (22.1)	36 (2.5)
90 (32)	365 (25.6)	43 (3.0)
100 (38)	375 (26.3)	55 (3.8)

REMOVAL & INSTALLATION

WARNING: To avoid injury from accidental air bag deployment, read and carefully follow all SERVICE PRECAUTIONS and DISABLING & ACTIVATING AIR BAG SYSTEM procedures in the AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

ACCUMULATOR

Removal

Discharge A/C system using approved refrigerant recovery/recycling equipment. Disconnect refrigerant lines at accumulator and seal openings. Loosen clamp and remove accumulator assembly.

Installation

Add 3.5 ounces of clean refrigerant oil. To install, reverse removal procedure. Use NEW "O" rings. Evacuate, recharge and leak test system.

COMPRESSOR

Removal

1. Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove upper radiator hose and fan shroud on models with mechanical cooling fan. Raise and support vehicle. Remove compressor belt and tensioner assembly. Disconnect electrical connector. Disconnect refrigerant lines, and plug openings.
2. Remove support braces from rear of compressor. Remove long studs and bolt. Remove compressor assembly.

Installation

Add clean refrigerant oil as necessary. See the **A/C COMPRESSOR REFRIGERANT OIL CHECKING** article in the AIR CONDITIONING & HEAT section. Use NEW sealing washers. To install, reverse removal procedure. Evacuate, recharge and leak test system.

CONDENSER

Removal

1. Discharge A/C system using approved refrigerant recovery/recycling equipment. Drain cooling system and remove radiator. Disconnect refrigerant lines at condenser and seal openings to prevent contamination.
2. Remove upper fan shroud (if equipped). Remove bolts from radiator support. Tilt top of radiator rearward and slide condenser out between radiator and support. Remove condenser from vehicle.

Installation

If condenser is new or was drained, add one ounce of clean refrigerant oil. To install, reverse removal procedure. Evacuate, recharge and leak test system. Fill cooling system.

CONTROL PANEL

Removal & Installation

1. Remove instrument panel trim plate. Remove sound insulator panel. Remove cigarette lighter assembly. Working through lighter mounting hole, remove temperature control cable mounting screw. Disconnect control cable from A/C module. Remove screws attaching control panel to instrument panel and pull control panel out.

2. Disconnect electrical connectors and vacuum harness from control panel. Remove control panel with control cable attached. Note cable routing. Use small screwdriver to open tangs and separate cable from control panel. To install, reverse removal procedure.

A/C MODULE LOWER EVAPORATOR CASE

NOTE: Lower evaporator case must be removed from A/C module to access evaporator, heater and certain other components.

Removal

1. Remove right instrument panel sound insulator. Remove nut from shroud panel stud. Remove screw from instrument panel. Remove instrument panel lower reinforcement. Disconnect 2 vacuum harness connectors at lower evaporator case. Position vacuum harnesses aside. Pull right hinge pillar trim finish panel away from front body hinge pillar. Roll carpet back to access lower front area of A/C module.
2. Remove 7 screws attaching flange of lower evaporator case to A/C module. Evaporator case attaching screw on forward flange next to cowl panel may be difficult to locate. Screw head is straight down from vacuum tank and almost directly below lower right heater core tube. Remove lower evaporator case. See **Fig. 2**.

Installation

Clean original sealant from mating surfaces. Apply new sealant to lower evaporator case mounting flanges. Carefully guide lower evaporator case into place without scraping any sealant from flanges. To complete installation, reverse removal procedure.

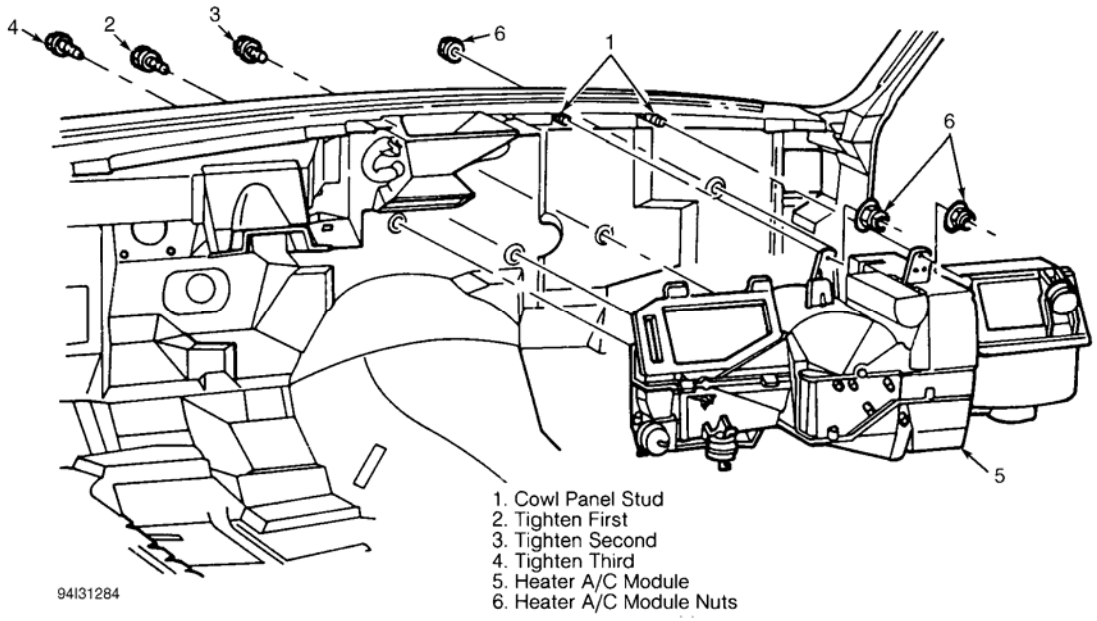


Fig. 2: Location Of Manual A/C-Heater Module

Courtesy of GENERAL MOTORS CORP.

AIR INLET VACUUM ACTUATOR

Removal & Installation

1. Remove instrument panel. See INSTRUMENT PANEL under REMOVAL & INSTALLATION. Disconnect vacuum hose connector at air inlet valve actuator by sliding tab of connector retainer past L-shaped bend in vacuum hose.
2. Slide connector off hose while continuing to hold tab back against body of connector. Using a thin-blade screwdriver, disengage catch locking air inlet valve actuator to A/C module, and slide actuator away to remove it.
3. To install, reverse removal procedure. Engage slot in air inlet valve actuator arm with hook of air inlet valve arm. To lock actuator to module, slide air inlet valve actuator into place until catch clicks.

BLOWER MOTOR RESISTOR & RELAY

Removal & Installation

1. Disconnect negative battery cable. Remove 4 retaining screws from rear edge of right sound insulator. Pull sound insulator straight back until 2 locator studs at forward edge of insulator disengage. Remove sound insulator.
2. Disconnect blower motor resistor. Remove 3 blower motor resistor mounting screws, and guide resistor assembly out of bottom of A/C module. Disconnect high speed blower relay. Remove relay retaining screw, and remove high speed blower relay from A/C module. To install, reverse removal procedure.

COMPRESSOR CONTROL RELAY

Removal & Installation

Disconnect negative battery cable. Disconnect compressor control relay. Remove attaching screw from multi-use bracket on right front wheelwell. Remove compressor control relay. To install, reverse removal procedure.

DEFROST VALVE VACUUM ACTUATOR

Removal & Installation

1. Remove 2 screws, and unsnap and remove steering column opening filler. Disconnect vacuum hose connector at defrost actuator by sliding tab of connector retainer past L-shaped bend in vacuum hose. Slide connector off hose while continuing to hold tab back against body of connector.
2. Using a thin-blade screwdriver, disengage catch locking defrost valve actuator to A/C module, and slide defrost valve actuator away to remove.
3. To install, reverse removal procedure. Engage slot in defrost valve actuator arm with hook of defrost valve crank. To lock actuator to module, slide defrost valve actuator into place until catch clicks.

EVAPORATOR CORE

Removal & installation

1. Discharge A/C system using approved refrigerant recovery/recycling equipment. Remove nuts securing refrigerant lines to evaporator cowl fitting. Remove lines, and plug openings. Remove A/C module lower evaporator case. See A/C MODULE LOWER EVAPORATOR CASE under REMOVAL & INSTALLATION. Remove evaporator mounting bracket screw and bracket.
2. Slide evaporator rearward and then down to remove. To install, reverse removal procedure. Install new "O" rings on refrigerant lines. Evacuate and recharge system, and check for leaks.

HEATER CORE

Removal & Installation

Drain engine coolant. Remove screw securing heater outlet pipe to cowl panel. Remove heater inlet and outlet quick-connect fittings. Remove A/C module lower evaporator case. See A/C MODULE LOWER EVAPORATOR CASE under REMOVAL & INSTALLATION. Remove heater core mounting straps and screws. Pull heater rearward, working heater core tubes out of seal. Remove heater core. To install, reverse removal procedure. Refill cooling system with coolant, and check for leaks.

INSTRUMENT PANEL

Removal

1. Disable air bag system. See AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section. Remove steering column opening filler. Remove 4 knee bolster-to-deflector attaching bolts, and remove bolster. Remove 4 knee deflector-to-tie bar bolts, and remove deflector. Remove brakelight switch. Unclip and remove shift indicator cable.
2. Remove capsule nuts attaching steering column support bracket to instrument panel. Gently lower steering column. Remove 2 bolts attaching steering column guide bracket to instrument panel. Remove steering column guide bracket. Remove right and left trim plates. Remove sound insulator. Remove 4 instrument cluster attaching screws, and remove instrument cluster.
3. Remove headlight switch and accessory switches. Remove parking brake release handle. Remove multifunction alarm module. Remove A/C-heater control panel. See CONTROL PANEL under REMOVAL & INSTALLATION. Remove 3 radio bracket-to-instrument panel screws. Pull radio and bracket from instrument panel. Disconnect electrical connectors and antenna from radio, and remove radio.
4. Remove ashtray/lighter assembly. Remove retainer attaching instrument panel lamp switch assembly to instrument panel, and remove switch assembly. Remove courtesy lights. Remove low oil module and Data Link Connector (DLC). Remove right and left sound covers. Remove 4 bolts attaching instrument panel to lower windshield frame. Remove 2 bolts attaching instrument panel to each door pillar.

NOTE: Mark harness connectors, hose and harness routing before removal.

5. Remove lower reinforcement-to-instrument panel bolt. Unsnap and pull instrument panel from windshield frame flange. Disconnect remaining electrical and vacuum hose connectors.

Installation

To install, reverse removal procedure. Place instrument panel into vehicle. Route wiring harness and connectors according to marks made during removal.

MODE VALVE VACUUM ACTUATOR

Removal & Installation

1. Remove right instrument panel sound insulator by removing 4 retaining screws from upper edge of sound insulator. Pull sound insulator straight back until 2 locator studs at forward edge are disengaged.
2. Disconnect one vacuum hose connector at mode valve actuator by sliding tab of connector retainer past L-shaped bend in vacuum hose. Slide connector off hose while continuing to hold tab back against body of connector.
3. Disconnect other vacuum hose connector by lifting tab off arrow and sliding connector off of vacuum hose. Using a thin-blade screwdriver, disengage catch locking mode valve actuator to A/C module, and slide mode valve actuator away to remove it.
4. To install, reverse removal procedure. Engage slot in mode valve actuator arm with hook of mode valve crank. To lock actuator to module, slide mode valve actuator into place until catch clicks. To complete installation, reverse removal procedure.

PRESSURE CYCLING SWITCH

Removal & Installation

Disconnect negative battery cable. Disconnect pressure cycling switch. Pressure cycling switch is mounted on a Schrader-type valve; discharging refrigerant from system is not necessary. Unscrew switch, and remove "O" ring. To install, coat new "O" ring with refrigerant oil. Install pressure cycling switch, and tighten to 40 INCH lbs. (5 N.m). Connect negative battery cable.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
A/C Compressor Bolt	37 (50)
A/C Compressor Bracket Bolts/Nuts	24 (33)
A/C Compressor Stud	37 (50)
Drive Belt Tensioner Bolt	24 (33)
Refrigerant Hoses (Aluminum Tubing)	
3/8" Diameter	12 (16)
1/2" Diameter	17 (23)
3/4" Diameter	24 (33)
Refrigerant Hoses (Steel Tubing)	
3/8" Diameter	30 (41)
1/2" Diameter	30 (41)
3/4" Diameter	30 (41)

	INCH Lbs. (N.m)
Accumulator-Drier Bolt	53 (6)
Blower Motor Screws	17 (2)
Condenser Bolts	53 (6)
Heater/Evaporator Case Nuts	53 (6)
Heater/Evaporator Case Screws	25 (3)
Instrument Panel	
Center Reinforcement Bolts	89 (10)
Panel-To-Cowl Bolts	89 (10)
Pressure Cycling Switch	40 (5)

VACUUM HOSE DIAGRAM(S)

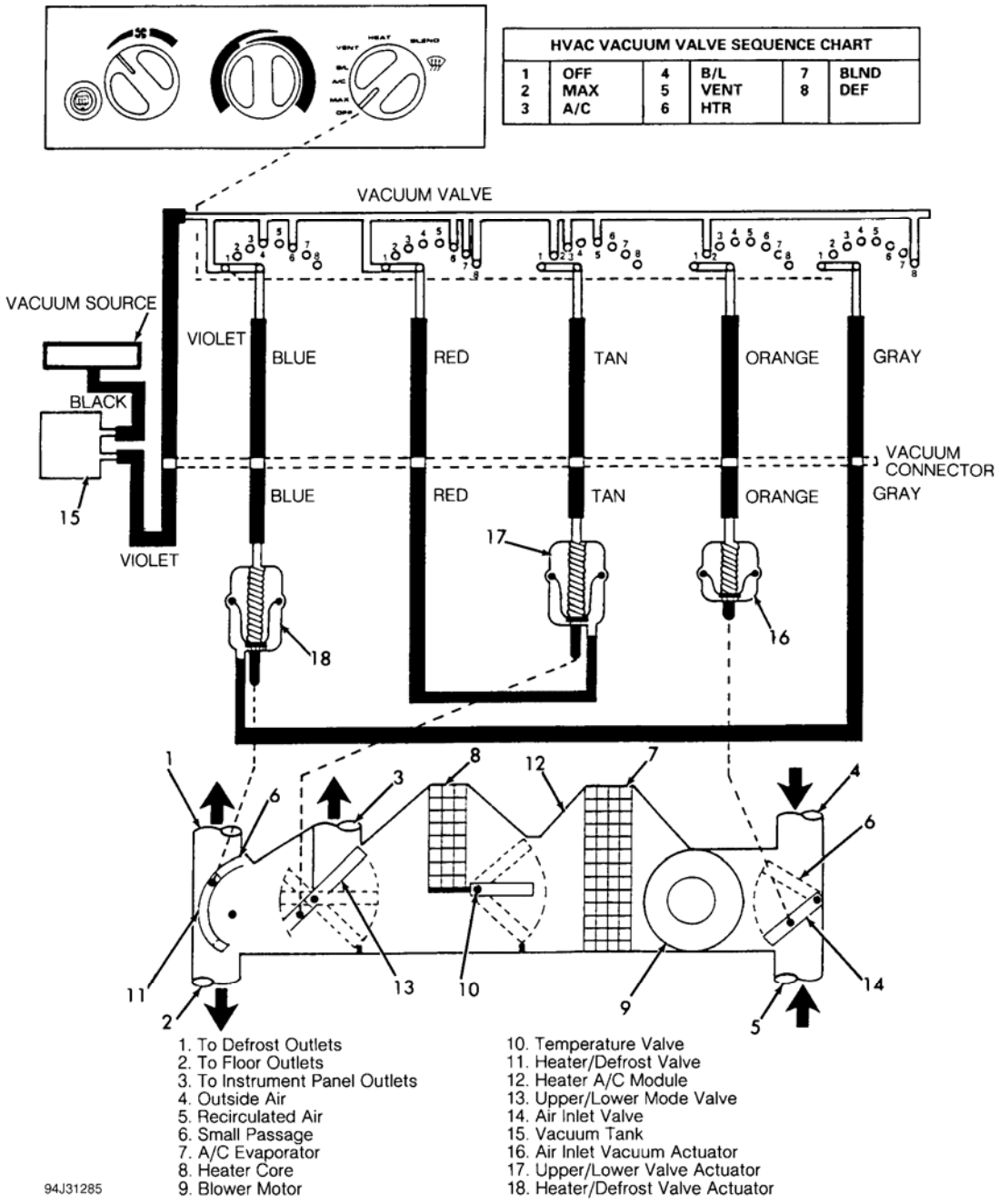


Fig. 3: Manual A/C-Heater System Vacuum Diagram
Courtesy of GENERAL MOTORS CORP.

WIRING DIAGRAM

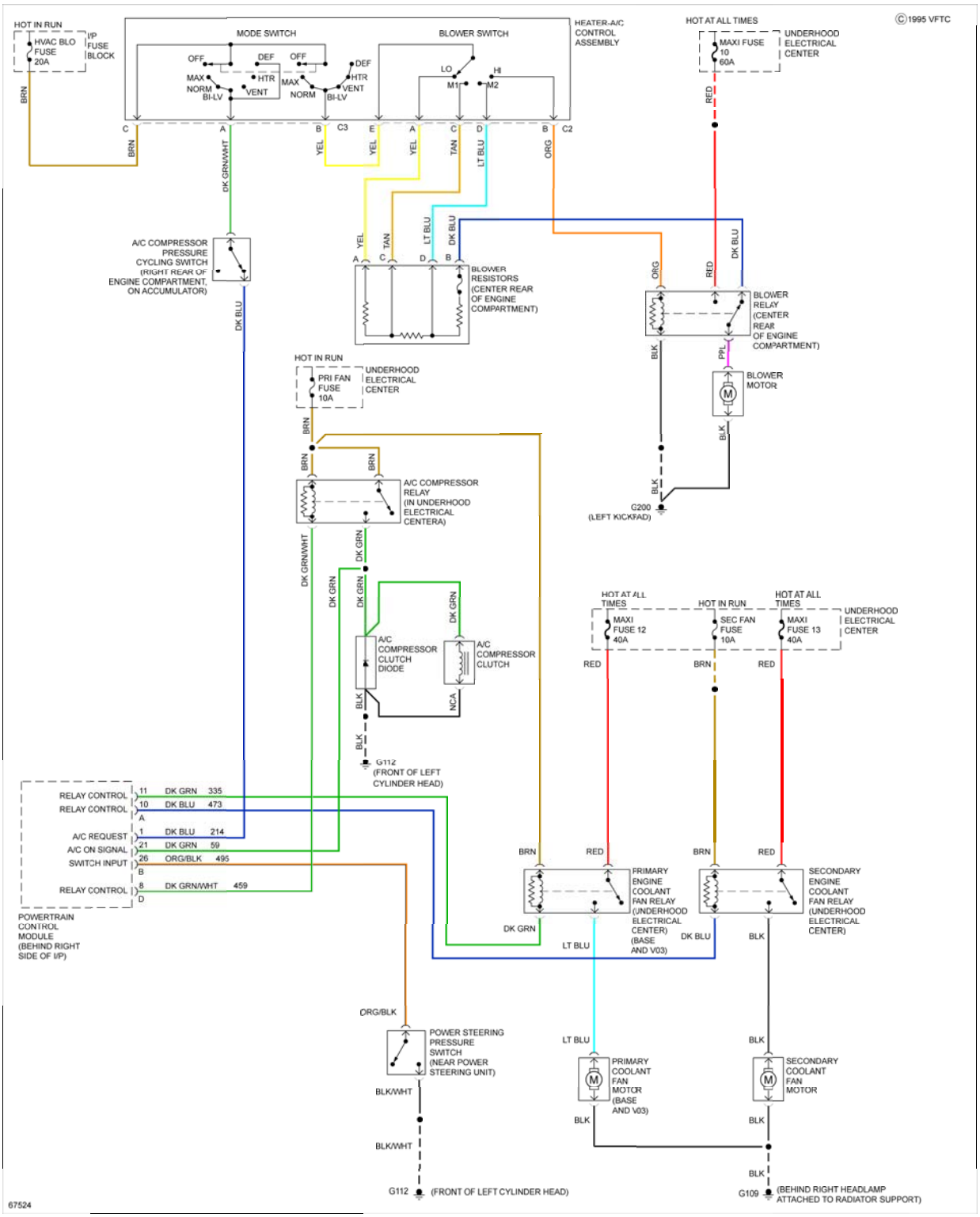


Fig. 4: Manual A/C-Heater System Wiring Diagram

DESCRIPTION & OPERATION

The Instrument Panel Cluster (IPC) consists of speedometer, odometer, trip odometer and fuel gauge. Indicators and gauges include voltage, oil pressure, seat belt, brake system, door/tailgate ajar, SERVICE ENGINE SOON, low coolant, turn signal, high beam, supplemental restraint and anti-theft security. Caprice and Impala SS models are equipped with a digital speedometer. Speedometer receives signal from Vehicle Speed Sensor (VSS).

AIR BAG PRECAUTIONS

Observe following precautions when working with vehicles equipped with Supplemental Inflatable Restraint (SIR) system:

- Before performing any instrument panel testing, diagnosis or repair, disable SIR system by disconnecting negative battery cable and Yellow 2-pin connector at base of steering column.
- Wait 2 minutes before making SIR repairs. SIR system retains enough voltage to deploy air bag after power is disconnected.
- To prevent accidental air bag deployment, avoid SIR wiring harness when trouble shooting instrument panel components. All SIR wires are color-coded Yellow.

TESTING

NOTE: For speedometer testing, see the appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section.

- 4.3L, see: **TESTS W/CODES - 4.3L**
- 5.7L, see: **TESTS W/CODES - 5.7L**

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

FUEL GAUGE TEST

Fuel Gauge Accuracy Test

1. Disconnect fuel gauge sending unit wiring connector. Connect Red lead of Gauge Tester (J-33431) to Purple wire, and connect remaining lead to ground wire or ground.
2. Turn ignition on. Adjust resistance dials of tester to zero ohms and then to 90 ohms. Ensure gauge reads

empty then full. If gauge operates correctly, check IPC and fuel gauge sending unit ground wires for excessive resistance. If wiring is okay, replace fuel gauge sending unit.

3. If gauge fails to operate correctly, check wires to instrument panel for excessive resistance and improper connection. If wiring and connections are okay, replace IPC.

Fuel Gauge Always Reads Empty

1. Disconnect fuel gauge sending unit. Turn ignition on. If gauge indicates full, check ground circuit. If ground circuit is okay, replace fuel gauge sending unit.
2. If gauge indicates empty, turn ignition off. Disconnect instrument cluster connector. Turn ignition on. Connect test light between connector terminals B1 (Purple wire) and B2 (Pink wire). If test light lights, repair short circuit in Purple wire. If test light does not light, replace IPC.

Fuel Gauge Always Reads Full

1. Disconnect fuel gauge sending unit. Connect a test light between battery voltage and fuel gauge sending unit connector terminal "A" (Black wire). If test light does not light, check for poor connections or open circuit(s).
2. If test light lights, connect a fused jumper wire between fuel gauge sending unit connector terminal "B" (Purple wire) and ground. If fuel gauge indicates empty, check for poor connections or open circuit(s) at fuel gauge sending unit connector. If wiring and connector are okay, replace fuel gauge sending unit.
3. If fuel gauge does not indicate empty, check for open circuit in Purple wire or poor connections at IPC connectors, fuel gauge-to-fuse connector circuit, fuel gauge sending unit ground and IPC printed circuit.

OIL PRESSURE GAUGE TEST

Oil Pressure Gauge Operation

Disconnect Tan wire from fuel pump/oil pressure switch. If oil pressure is low, connect fused jumper wire from Tan wire to ground. Replace fuel pump/oil pressure switch if low reading is still indicated. If oil pressure is high, check Tan wire or instrument panel for short circuit.

Oil Pressure Gauge Accuracy Test

1. Turn ignition off. Disconnect instrument cluster. Measure resistance between instrument cluster connector C1 terminal A5 (Tan wire) and ground.
2. If resistance is about one ohm, repair IPC. If resistance is not about one ohm, replace fuel pump/oil pressure switch.

Oil Pressure Gauge Always Reads Low

1. Disconnect fuel pump/oil pressure switch connector. Turn ignition on. If oil pressure gauge reads about 3/4 scale, replace fuel pump switch.
2. If oil pressure gauge does not read about 3/4 scale, turn ignition off. Disconnect IPC connector C1. Measure resistance between IPC connector C1 terminal A5 (Tan wire) and ground.
3. If resistance is not about 68 ohms, check oil pressure resistor for short to ground in Tan wire. If resistance

is about 68 ohms, check for poor connection at IPC connector C1 terminal A5 (Tan wire). If connection is okay, replace IPC.

Oil Pressure Gauge Reads About 3/4 Scale With Ignition Switch

In RUN & Engine Not Running

1) Disconnect fuel pump/oil pressure switch connector. Connect fused jumper wire between connector terminal "A" (Tan wire) and ground. Turn ignition on.

2) If oil pressure gauge reads in about the "L" range, replace fuel pump/oil pressure switch. If oil pressure gauge does not read in about the "L" range, repair open circuit in Tan wire.

TEMPERATURE GAUGE TEST

Coolant Temperature Gauge Always Reads Hot

Disconnect coolant temperature sender/switch. If gauge indicates cold, replace coolant temperature sender/switch. If gauge still indicates hot, check IPC printed circuit and Dark Green wire for a short to ground. If wire and printed circuit are okay, replace coolant temperature gauge.

Coolant Temperature Gauge Always Reads Cold

1. Disconnect coolant temperature sender/switch. Using voltmeter, measure voltage between coolant temperature sender/switch connector terminal "A" (Dark Green wire) and ground. If battery voltage is present, check for poor connection at coolant temperature sender/switch connector. If connector is okay, replace coolant temperature sender/switch.
2. If no voltage is present, check for poor connection or open circuit in Dark Green wire. If connector and wire are okay, replace coolant temperature gauge.

VOLTMETER TEST

Turn ignition on. Install voltmeter between battery terminals and note reading. If voltmeter reading on vehicle differs from battery voltage reading, ensure wiring to voltmeter is okay and connections are tight. If connections and wiring are okay, replace voltmeter or IPC.

OIL PRESSURE INDICATOR

Indicator Stays On With Engine Running

Disconnect fuel pump/oil pressure switch. If indicator goes off, replace switch. If indicator stays on, check Tan wire for a short to ground. Also check instrument cluster printed circuit for a short. Ensure printed circuit connectors make good contact.

Indicator Does Not Come On Before Engine Start

1. Check bulb and replace as necessary. If bulb is okay, measure resistance between ground and fuel pump/oil pressure switch connector. If resistance is about one ohm or more, check Tan wire for an open

circuit.

2. If resistance is not about one ohm or more, connect a fused jumper wire between fuel pump/oil pressure switch terminal "A" (Tan wire) and ground. If indicator comes on, replace switch. If indicator stays off, remove instrument cluster for repair.

TEMPERATURE INDICATOR TEST

Coolant Temperature Indicator Accuracy Test

1. If indicator does not illuminate when cranking engine, check for defective bulb, open light circuit, or defective ignition switch.
2. If indicator remains on with engine running, ensure engine is operating at proper temperature. With ignition on, disconnect electrical connector at temperature sending unit.
3. If indicator goes out, replace sending unit. If indicator remains on, check ground between bulb and sending unit. Check for defective ignition switch or IPC.

LOW COOLANT INDICATOR TEST

Low Coolant Indicator Stays On

Disconnect surge tank/low coolant switch connector. Turn ignition switch to RUN position. If low coolant indicator lights, check Yellow/Black wire for short to ground. If wire is okay, replace IPC. If low coolant indicator does not light, replace surge tank/low coolant switch.

No Low Coolant Indicator With Low Coolant Level

1. Turn ignition on. Disconnect surge tank/low coolant indicator switch connector. Check for battery voltage between switch connector terminal "A" (Yellow/Black wire) and ground. If battery voltage is not present, check for open circuit in Yellow/Black wire. Check indicator bulb. If circuit and bulb are okay, replace IPC.
2. If battery voltage is present, check low coolant indicator probe connector Black ground wire for an open circuit. If wire is okay, replace low coolant indicator probe.

LOW OIL LEVEL INDICATOR TEST

Low Oil Level Indicator Inoperative, Oil Level Low

1. Turn ignition on. Wait 30 seconds and, using Tech 1 scan tester, check for Powertrain Control Module Code 96. If Code 96 is set, see the appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section.
   - 4.3L, see: **TESTS W/CODES - 4.3L**
   - 5.7L, see: **TESTS W/CODES - 5.7L**
2. If code is not set, disconnect engine oil level sensor connector. Check for battery voltage at engine oil level sensor connector terminal "B" (Brown wire). If battery voltage is present, replace sensor. If battery voltage is not present, check for short to ground in sensor Brown wire. If circuit is okay, replace PCM.

Low Oil Level Indicator On, Oil Level Okay

1. Turn ignition on. Wait 30 seconds and, using Tech 1 scan tester, check for Powertrain Control Module Code 96. If Code 96 is set, see the appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section.
    - 4.3L, see: **TESTS W/CODES - 4.3L**
    - 5.7L, see: **TESTS W/CODES - 5.7L**
2. If Code 96 is not set, disconnect engine oil level sensor connector. Check for battery voltage between engine oil level sensor connector terminal "B" (Brown wire) and ground. If battery voltage is not present, check for open circuit or poor connection in Brown wire between PCM terminal No. 27 and oil level sensor terminal "B". If circuit is okay, replace PCM.
3. If battery voltage was present, check Black/White wire ground circuit at oil level sensor terminal "A" for an open circuit or poor connection. If ground circuit is okay, replace oil level sensor.

TAILGATE AJAR INDICATOR TEST

Indicator Inoperative

1. Disconnect tailgate lock ajar switch Dark Green wire outside of tailgate. Using voltmeter, measure voltage between switch terminal "D" (Dark Green wire) and ground. If no voltage is present, check for poor connection in Dark Green wire circuit. If circuit is okay, repair or replace IPC.
2. If battery voltage is present, disconnect tailgate lower lock ajar switch in tailgate. Reconnect tailgate lower lock ajar switch outside of tailgate. Measure voltage between switch connector terminals "A" (Dark Green wire) and "B" (Black wire).
3. If no voltage is present, repair open circuit in switch Black ground wire. If battery voltage is present, check connections at tailgate lower lock ajar switch. If connections are okay, replace tailgate lower lock ajar switch.

Tailgate Ajar Indicator On At All Times

1. Disconnect tailgate lower lock ajar switch. If tailgate ajar indicator is off, replace tailgate lower lock ajar switch. If indicator remains on, disconnect switch Dark Green wire outside of tailgate. If tailgate ajar indicator is off, repair short to ground in Dark Green wire.
2. If tailgate ajar indicator is not off, disconnect IPC connector C2. Check for continuity between connector C2 terminal A8 and ground. If no continuity is present, check for crossed connections at IPC. If connections are okay, replace IPC. If continuity is present, repair short to ground in Dark Green wire.

VOLTS/CHARGE INDICATOR TEST

1. If indicator does not glow when ignition is on, disconnect electrical connector at alternator. Install fused jumper wire between Brown wire of electrical connector and ground.
2. Turn ignition on. If indicator does not illuminate, check for voltage supply to indicator. Check for open circuit in wire from alternator to indicator, or defective printed circuit in IPC. If indicator illuminates, replace alternator.
3. Start engine. If indicator remains on with engine running, disconnect electrical connector from alternator with engine running. If indicator remains on, check wire from alternator to indicator or IPC for short to

ground. Replace alternator if indicator goes out.

HEADLIGHT SWITCH TEST

Battery voltage should always be present at headlight switch Red wire at terminal "K". With headlights on, battery voltage should also be present at Yellow wire at terminal "E". If voltage is not present at any indicated terminals, check fuse, wiring, and switch.

WIPER SWITCH TEST

For testing information on wipers, see the appropriate **WIPER/WASHER SYSTEM - FRONT** article.

INDICATOR & GAUGE PINOUT TEST

Check voltage or resistance at IPC connector to determine if proper signals are supplied to IPC. See **Fig. 1** . See appropriate IPC CONNECTOR PINOUT TEST table.

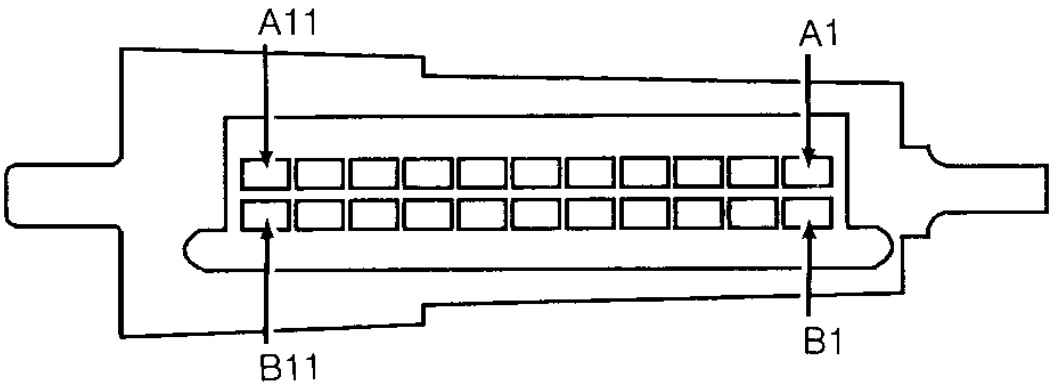


Fig. 1: Instrument Panel Cluster (IPC) Connector C1 & C2
Courtesy of GENERAL MOTORS CORP.

IPC CONNECTOR PINOUT TEST

Application	Wire Color	Pin
Connector C1		
Low Washer Fluid Indicator	Black/White	A1
Vehicle Speed Input	Dk. Green/White	A2
Trip Reset	Lt. Green	A3
Panel Illumination Lights	Gray	A4
Oil Pressure Gauge	Tan	A5
SERVICE ENGINE Indicator	Brown/White	A6

LOW OIL LEVEL Indicator	Brown/White	A7
Volt Gauge	Brown	A10
ABS Indicator	White	A11
Fuel Gauge	Purple	B1
Ignition Input	Pink	B2
Ground	Black	B3
PASS KEY FAULT Indicator	Gray	B8
CHANGE OIL Indicator	Pink	B9
LOW COOLANT Indicator	Gray	B11
Connector C2		
Left Turn Indicator	Lt. Blue	A1
High Beam Indicator	Lt. Green	A2
Coolant Temperature Gauge	Dk. Green	A4
Ignition	Brown	A5
Ground	Black/White	A6
DOOR OPEN Indicator	Dk. Blue/White	A8
GATE AJAR Indicator	Dk. Green	A9
AIR BAG Indicator	Brown	A10
Ignition	Pink	A11
English/Metric Display	Lt. Blue	B1
Step Dim Input	Yellow	B2
Right Turn Indicator	Dk. Blue	B3
Ground	Black	B4
FASTEN BELTS Indicator	Yellow	B5
DOOR OPEN Indicator	Green	B6
BRAKE Indicator	Purple	B8

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

HEADLIGHT SWITCH

Removal & Installation

Remove instrument panel and cluster lower trim plate. Remove screw attaching headlight switch panel to instrument panel. Unsnap headlight switch panel from instrument panel. Disconnect electrical connectors. Remove headlight switch.

INSTRUMENT CLUSTER

Removal & Installation

1. Disconnect negative battery cable. Remove instrument panel lower trim plate and cluster trim plate.
2. On all models, remove 4 cluster-to-instrument panel screws. Unclip shift indicator cable from steering column. Disconnect cluster from instrument panel connectors. Remove cluster from instrument panel carrier. To install, reverse removal procedure. See **Fig. 2** .

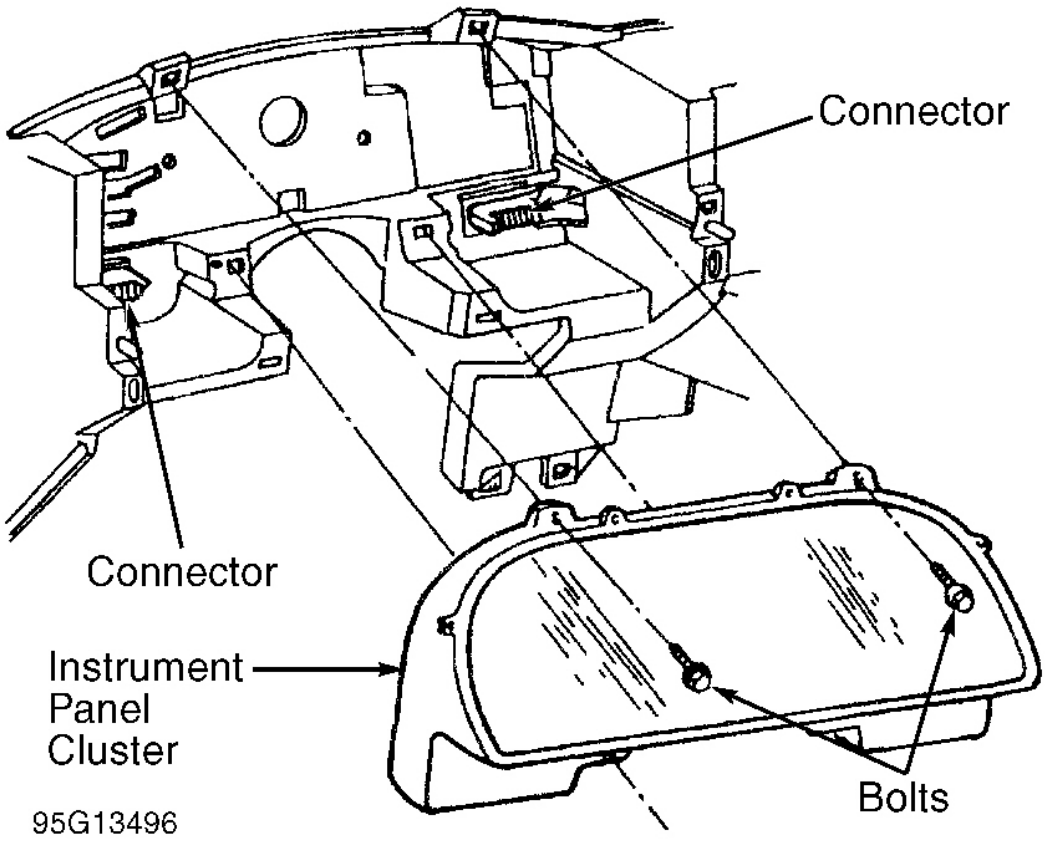


Fig. 2: Removing Instrument Panel Cluster
Courtesy of GENERAL MOTORS CORP.

WIRING DIAGRAMS

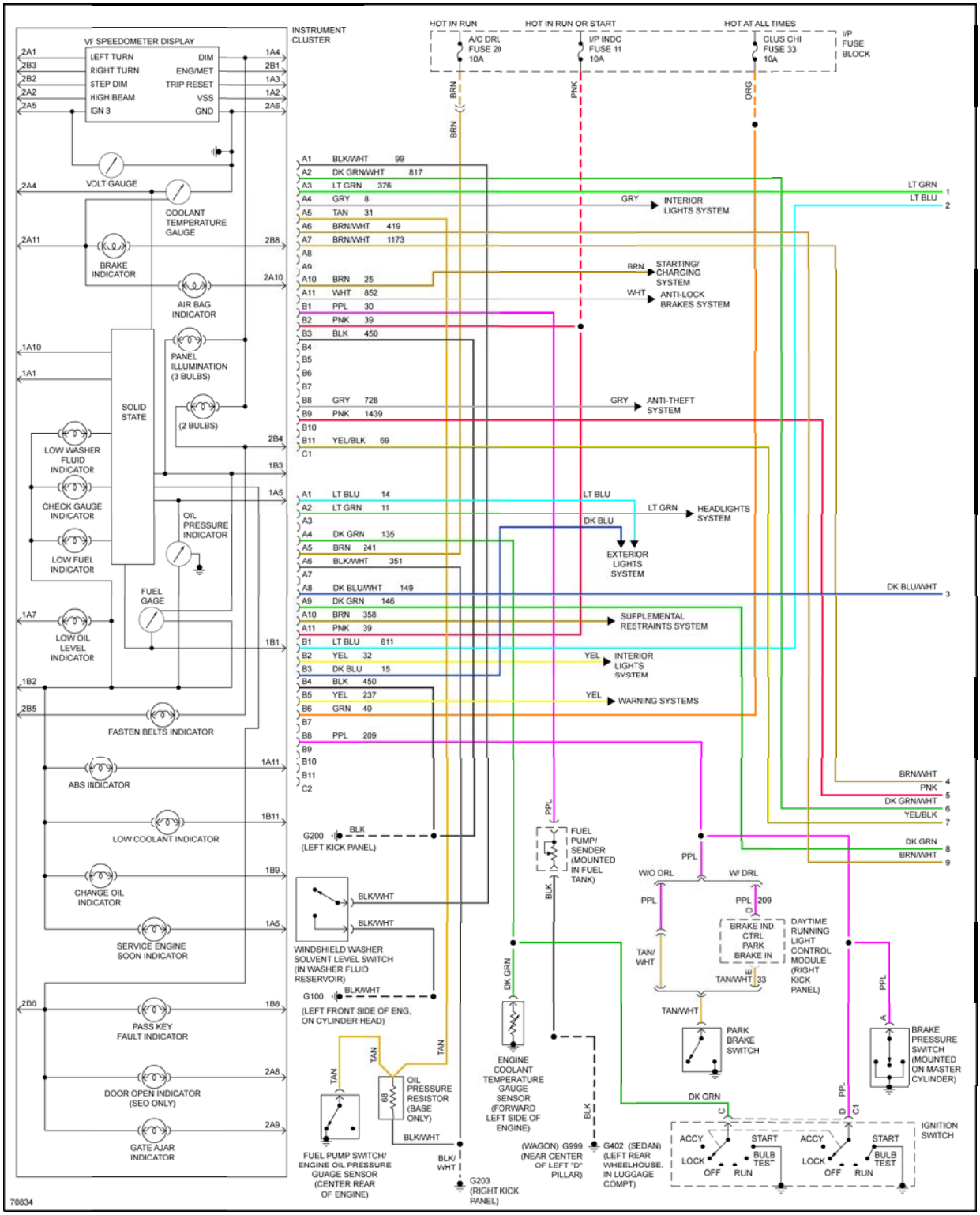


Fig. 3: Instrument Panel Wiring Diagram (1 Of 2)

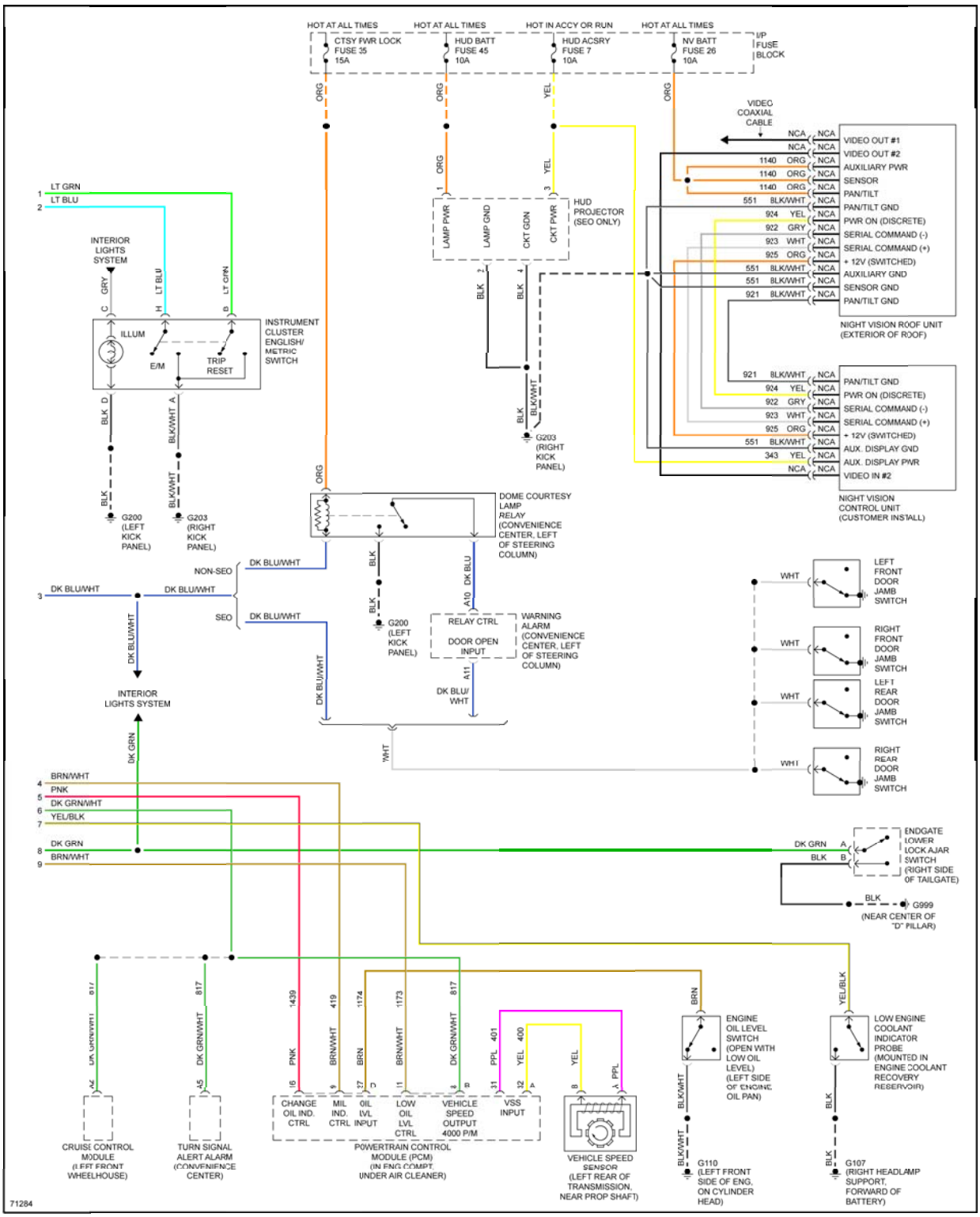


Fig. 4: Instrument Panel Wiring Diagram (2 Of 2)

JACKING & HOISTING

FLOOR JACK

Floor jack may be used under rear axle or front suspension lower control arms. Observe the following precautions:

- NEVER use jack on any part of underbody.
- DO NOT raise entire vehicle at side rail with jack midway between front and rear wheels, or permanent body damage may result.
- DO NOT allow lifting plate fingers to contact axle cover plate when lifting at rear axle housing.
- If vehicle is equipped with a stabilizer bar, DO NOT lift at rear axle housing. See **Fig. 1** and **Fig. 2** .

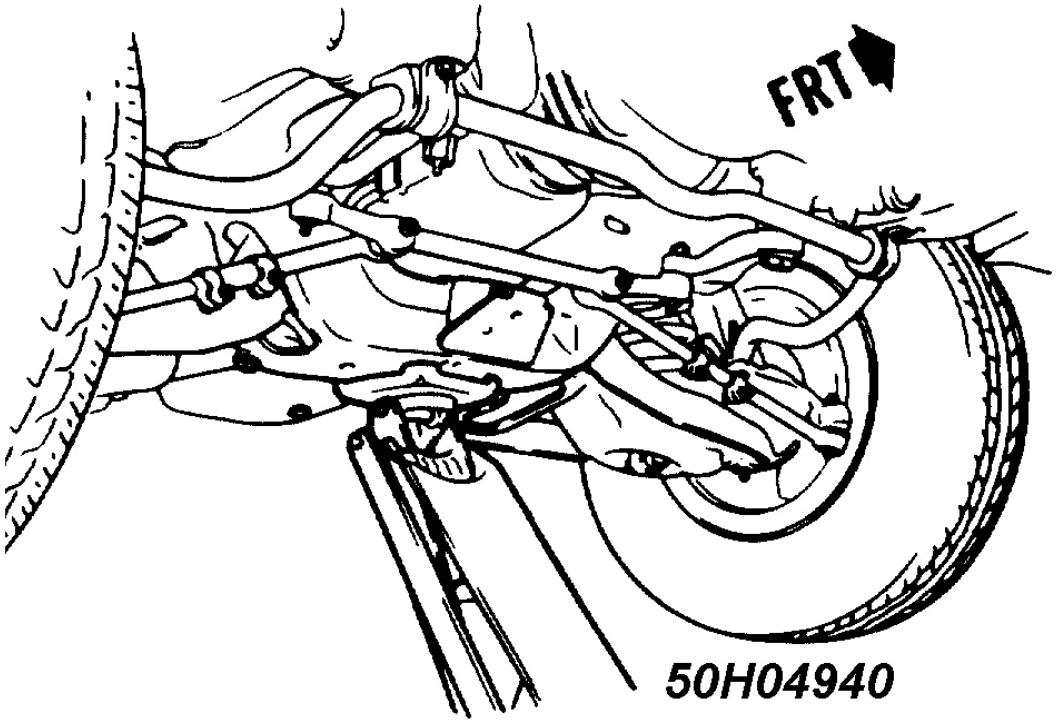


Fig. 1: Using Floor Jack Under Front Crossmember
Courtesy of GENERAL MOTORS CORP.

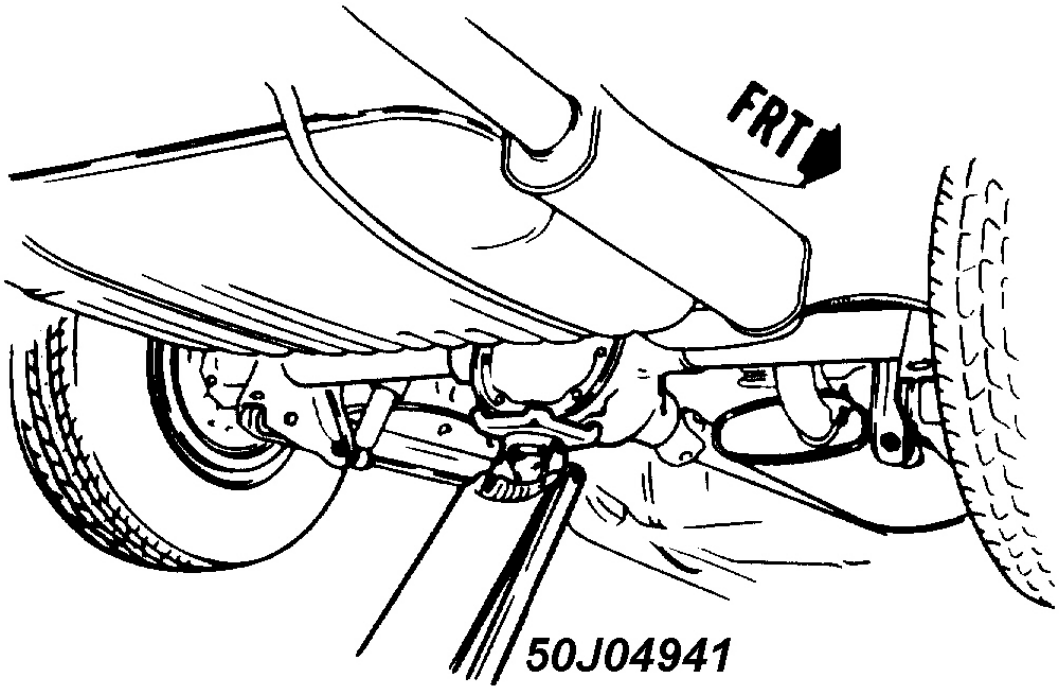


Fig. 2: Using Floor Jack Under Rear Differential
Courtesy of GENERAL MOTORS CORP.

BUMPER JACK

Bumper jack should only be used if supplied as original equipment with vehicle. If vehicle is not supplied with a bumper jack, DO NOT lift vehicle by the bumper at any time. Bumper jack should only be used to change flat tire.

AXLE OR SUSPENSION CONTACT HOIST

NOTE: Always follow hoist manufacturer's instructions. DO NOT allow hoist or adapters to contact suspension, exhaust or steering components. Frame contact must be made. Use adapters if necessary. Lift vehicle as shown in illustrations. See Fig. 3 and Fig. 4 .

Hoist should contact lower control arms, or front crossmember and rear axle as shown in illustrations. See **Fig. 3** and **Fig. 4** .

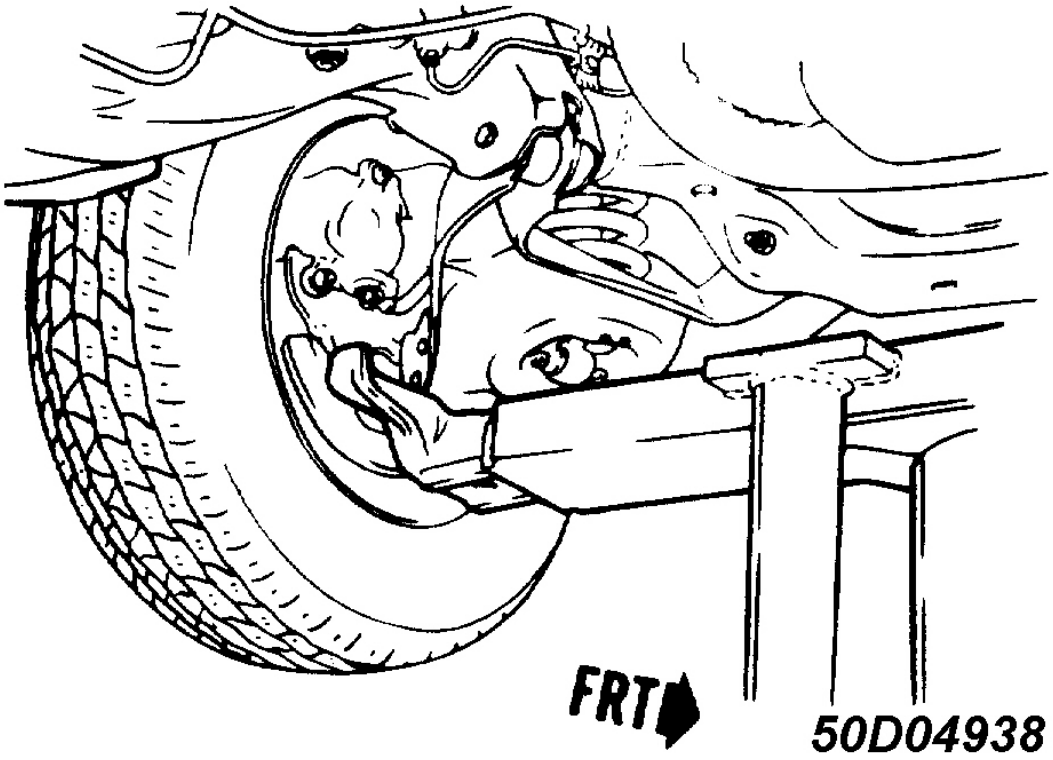


Fig. 3: Using Suspension Contact Hoist Under Front Control Arm
Courtesy of GENERAL MOTORS CORP.

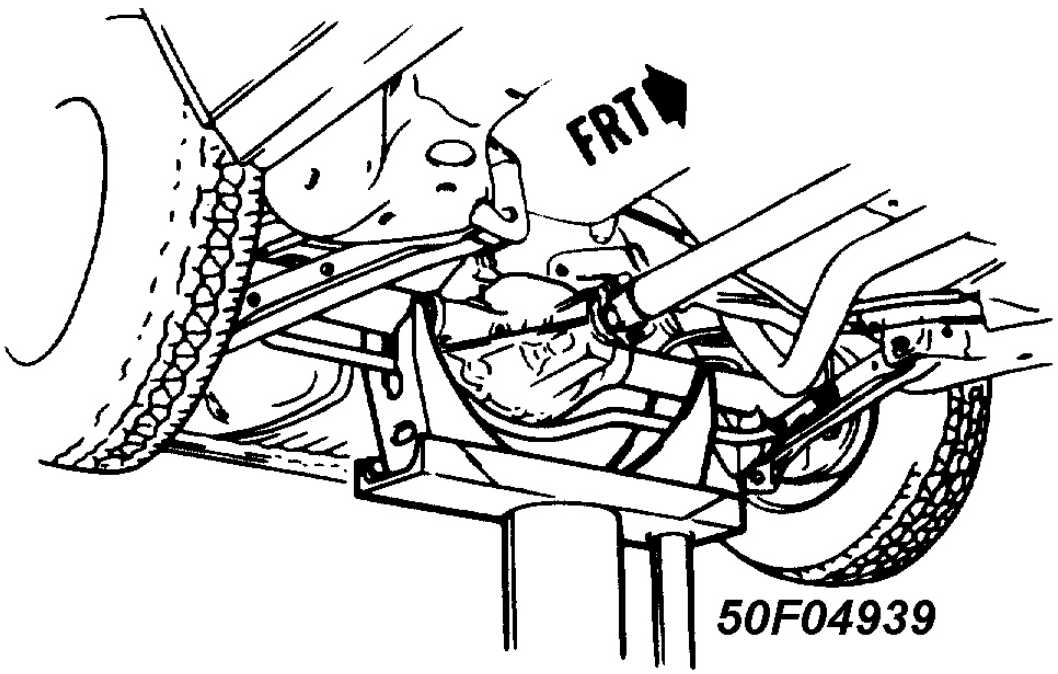


Fig. 4: Using Suspension Contact Hoist Under Rear Differential
Courtesy of GENERAL MOTORS CORP.

FRAME CONTACT HOIST

Hoist adapters must contact vehicle in specified areas. See **Fig. 5**-**Fig. 7** . Adapters must be positioned to distribute load and support vehicle in a stable manner. DO NOT allow lift pads to contact exhaust system components.

CAUTION: If removing rear axle, fuel tank, spare tire or liftgate using single-post hoist, anchor vehicle to hoist. Place jack stands under vehicle, or add weight on rear end of vehicle to prevent tipping when center of gravity changes.

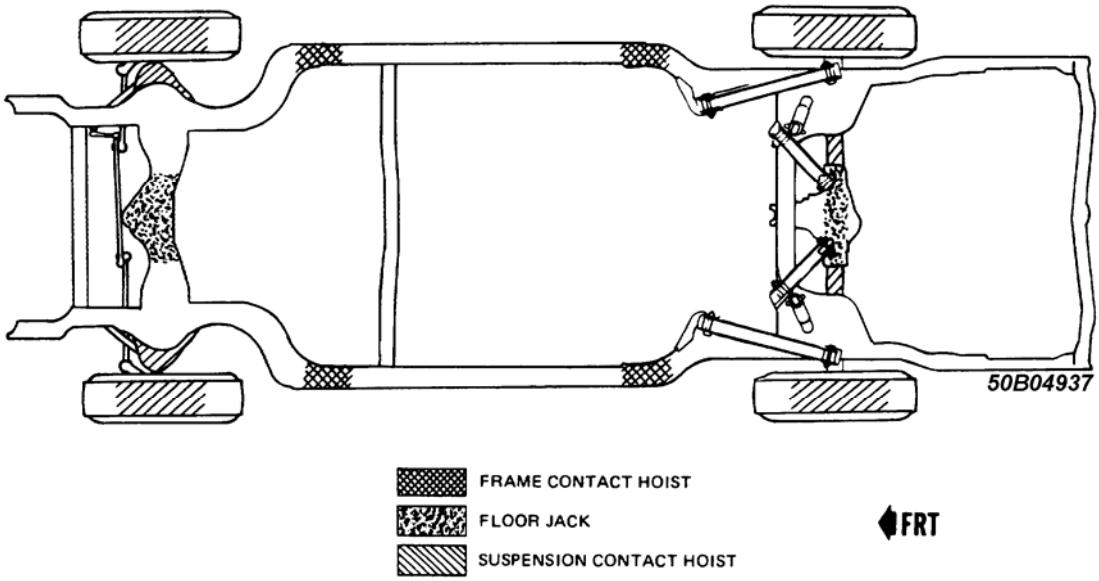


Fig. 5: Frame Lifting Points
Courtesy of GENERAL MOTORS CORP.

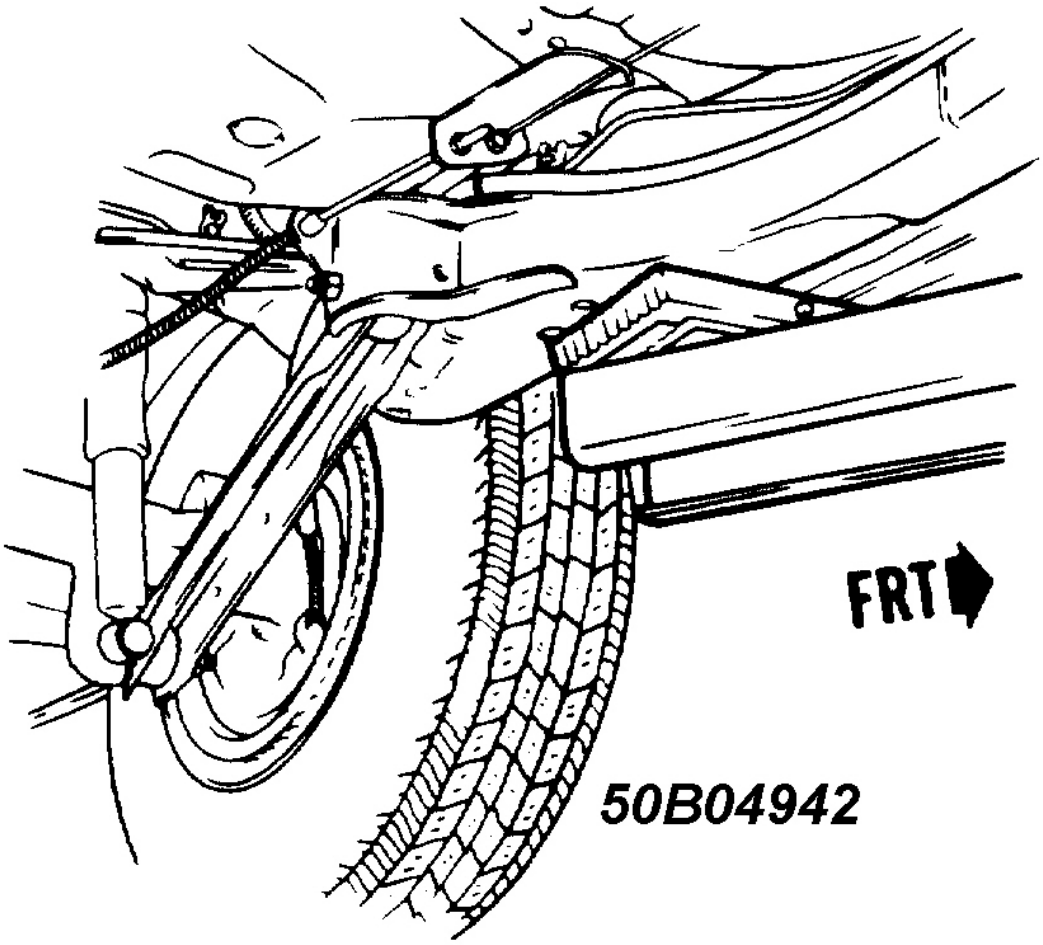


Fig. 6: Using Frame Contact Hoist Forward of Rear Tire
Courtesy of GENERAL MOTORS CORP.

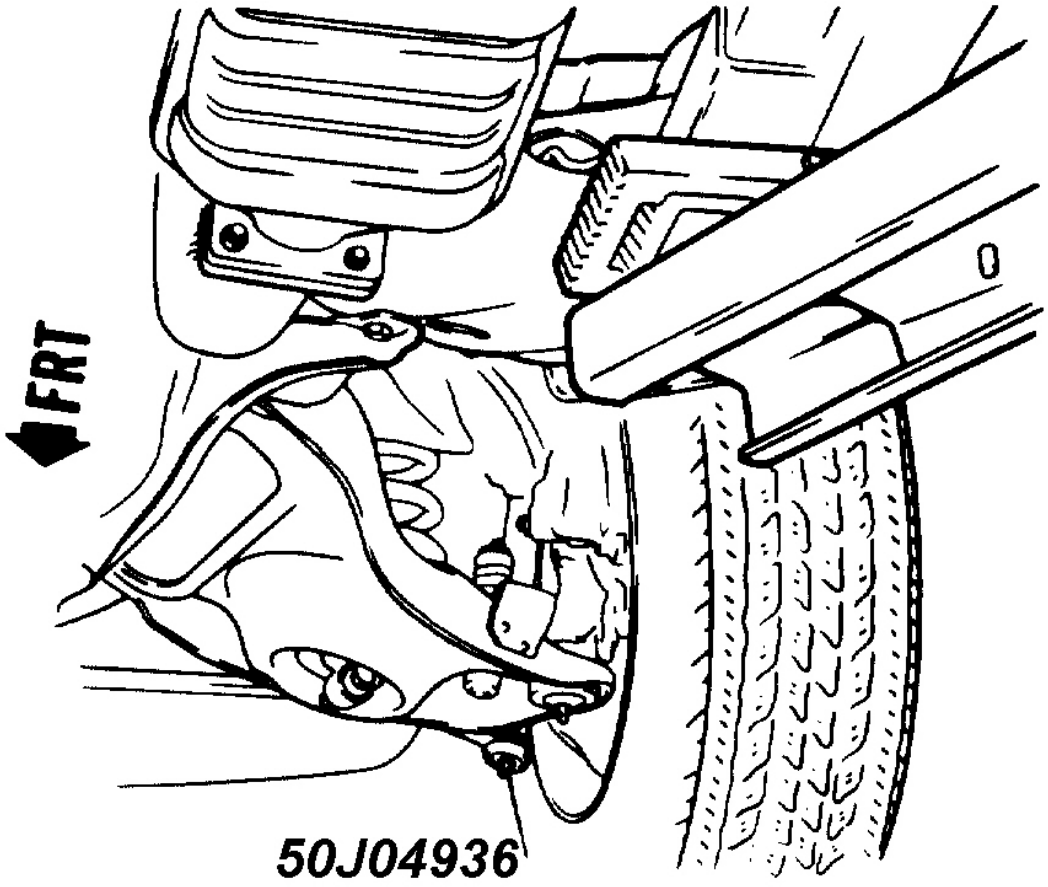


Fig. 7: Using Frame Contact Hoist Rearward of Front Tire
Courtesy of GENERAL MOTORS CORP.

MODEL IDENTIFICATION

VIN LOCATION

The Vehicle Identification Number (VIN) is located on the left side of the dash panel at the base of the windshield. The VIN chart explains the code characters.

VIN CODE ID EXPLANATION

Numbers preceding the explanations in the legend below refer to the sequence of characters as listed on VIN identification label. See VIN example below.

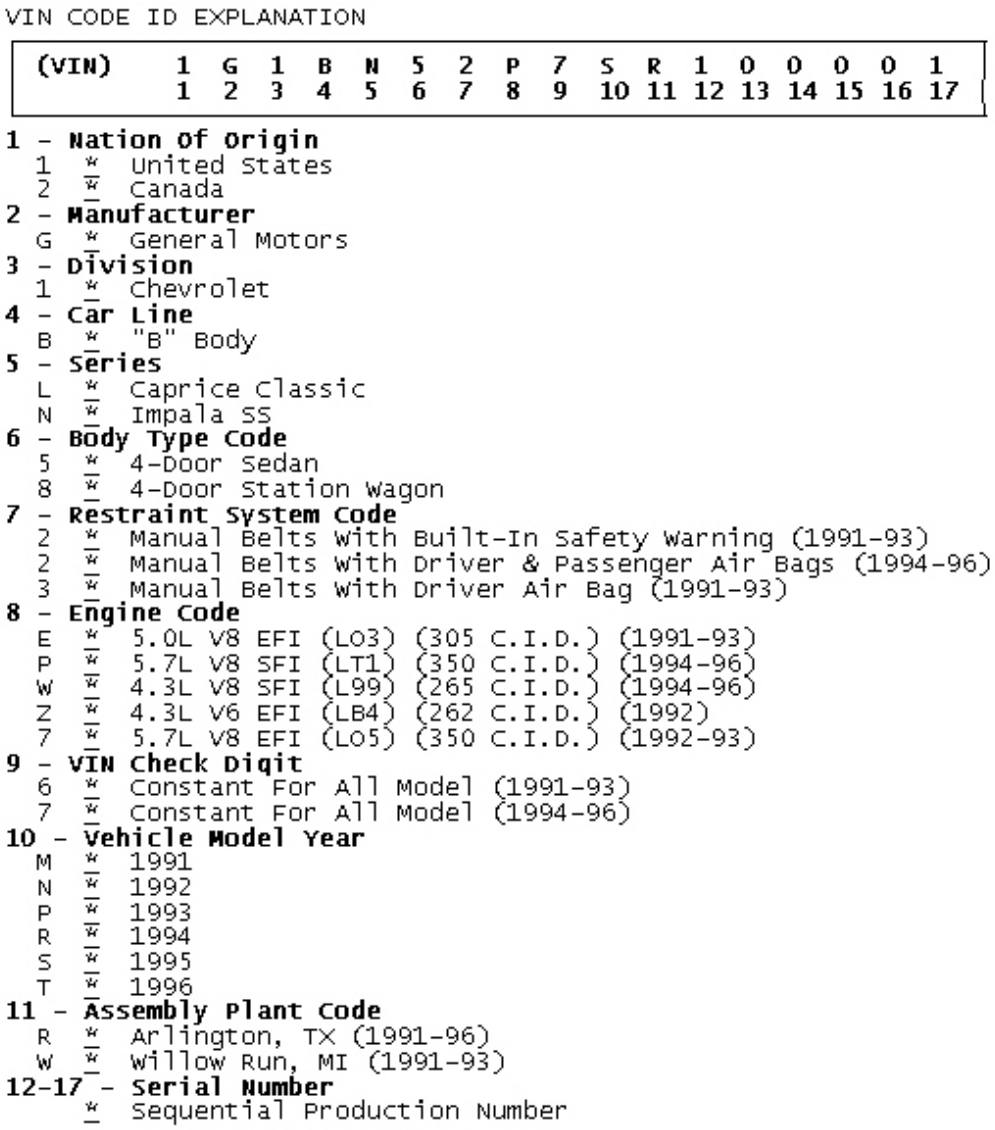


Fig. 1: VIN Code ID Explanation

MAINTENANCE SERVICE INFORMATION

SHORT TRIP/CITY & LONG TRIP/HIGHWAY SERVICE DEFINITIONS

NOTE: **Starting in the 1996 model year, General Motors has renamed their maintenance schedules; One is referred to as the Short-Trip/City and the other is the Long**

Trip/Highway schedule. These schedule requirements are similar to the familiar Severe Service and Normal schedules and can be used in place of one another.

SEVERE & NORMAL SERVICE DEFINITIONS

NOTE: Use the Severe Service schedule if the vehicle to be serviced is operated under ANY (one or more) of these conditions:

Service is recommended at mileage intervals based on vehicle operation. Service schedules are based on the following primary operating conditions:

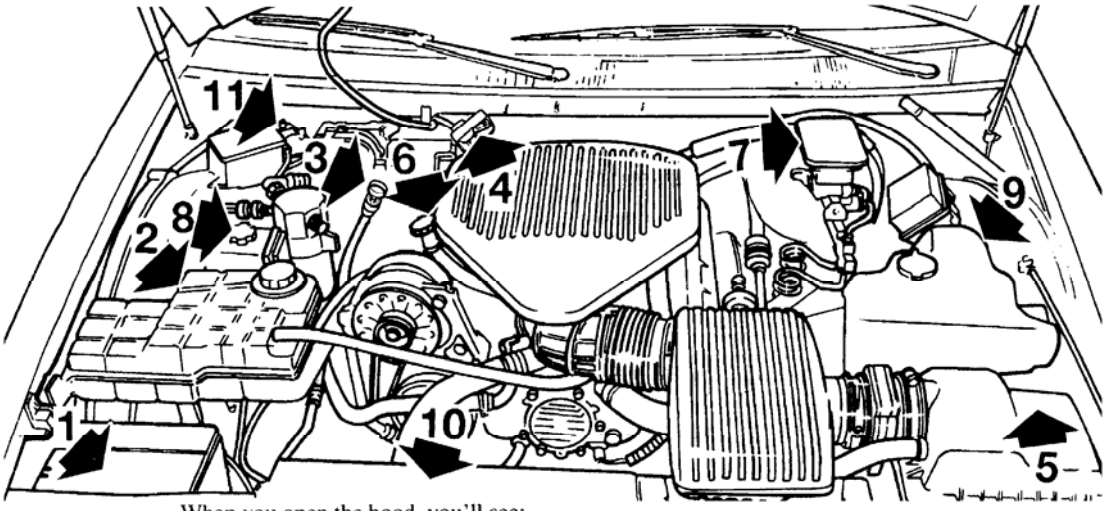
Severe Service

- Short Trips (4 Miles Or Less)
- When Most Trips Are Less Than 10 Miles And Outside Temperatures Remain Below Freezing.
- Towing Or Heavily Loaded
- Severe Dust Conditions
- Hot Weather, Stop-And-Go Driving
- Extensive Idling Conditions (Taxi Or Delivery Type Service)

Normal Service

- Driven More Than 10 Miles Daily
- No Severe Service Operating Conditions

SERVICE POINT LOCATIONS



When you open the hood, you'll see:

1. Battery
2. Coolant Surge Tank
3. Engine Oil Dipstick
4. Automatic Transmission Dipstick
5. Air Cleaner
6. Engine Oil Fill Cap
7. Brake Fluid Reservoir
8. Power Steering Fluid Reservoir
9. Windshield Washer Reservoir
10. Engine Fans
11. Remote Jump Starting Terminal

50E11852

Fig. 2: Engine Service Point Locations (Typical)
Courtesy of GENERAL MOTORS CORP.

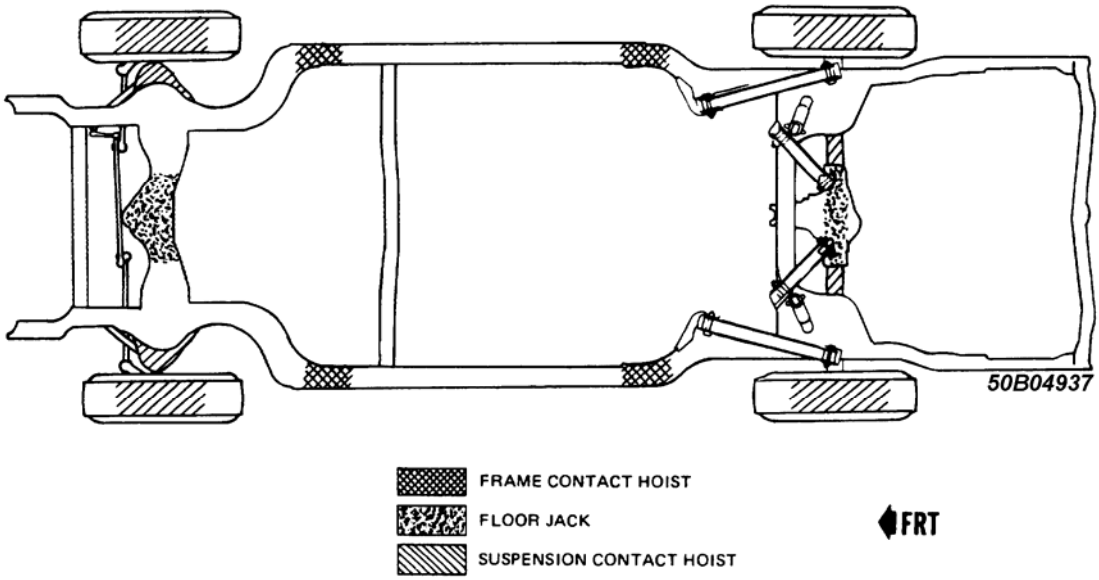


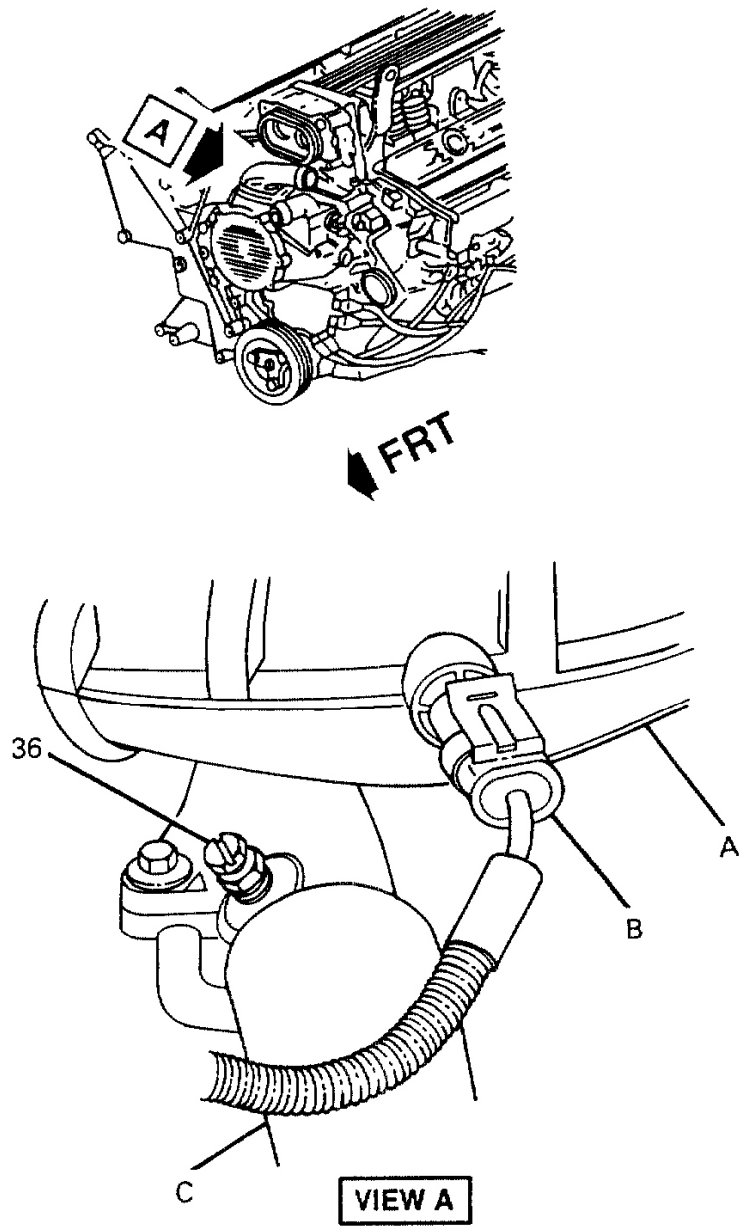
Fig. 3: Frame Lifting Point Locations
Courtesy of GENERAL MOTORS CORP.

NOTE: For more information regarding jacking or hoisting the vehicle, refer to the

JACKING & HOISTING article in the WHEEL ALIGNMENT section.

ADDITIONAL SERVICE INFORMATION

DRAINING & REFILLING COOLING SYSTEM



A DUCT, REAR AIR INTAKE
B ELECTRICAL CONNECTOR, INTAKE AIR TEMPERATURE SENSOR
C HOSE, RADIATOR OUTLET
36 VALVE, HEATER AIR BLEED

50J14661

Fig. 4: Heater Air Bleed Valve Location
Courtesy of GENERAL MOTORS CORP.

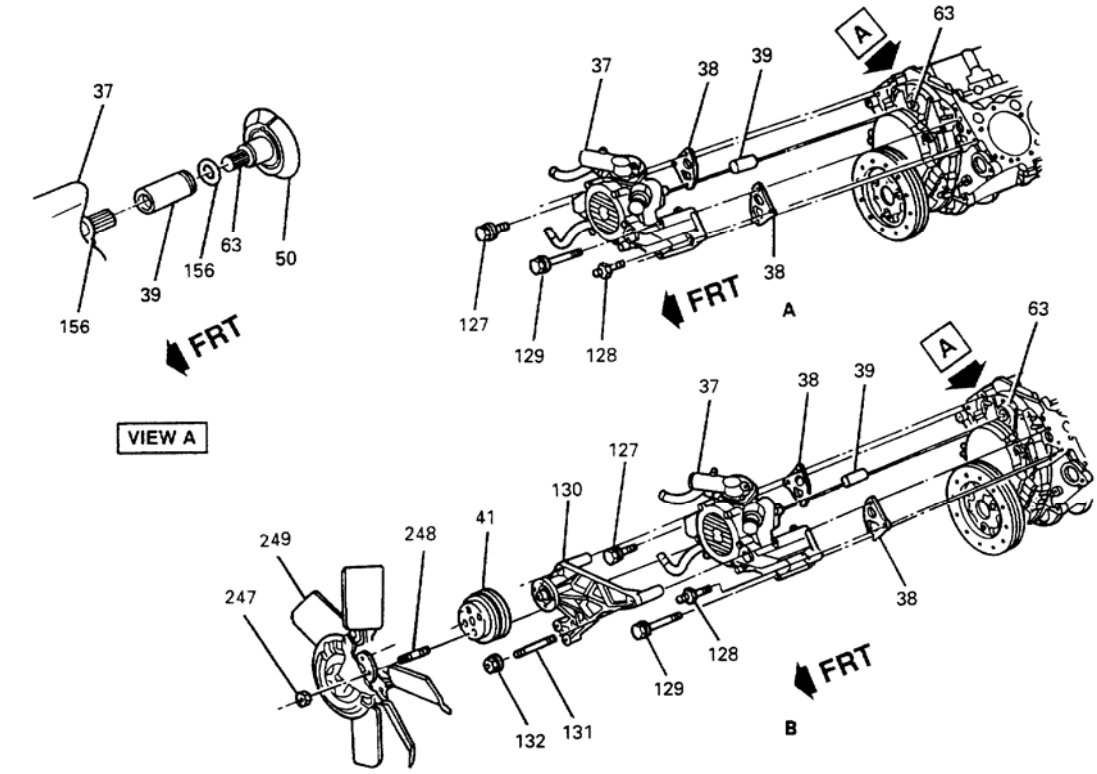


Fig. 5: Auxiliary Fan Component Locations
Courtesy of GENERAL MOTORS CORP.

NOTE: For more information regarding cooling system service, refer to the 5.7L V8 - VIN [P] article in the ENGINE MECHANICAL section.

SERVICE LABOR TIMES

NOTE: Labor times are provided, where available, within appropriate SERVICE INTERVAL table in SCHEDULED SERVICES article.

WHEEL & TIRE SPECIFICATIONS

TIRE INFLATION

Tire pressure specification decal is attached to rear face of driver's door. Inflation pressures listed on decal are

always cold pressures and must never exceed maximum values molded into tire side wall. These pressures should be used for all driving conditions, as they provide the best balance of fuel economy, tire life, riding comfort and handling.

NOTE: When using compact spare tire, it must be inflated to 60 psi, and vehicle must not be driven faster than 50 MPH.

WHEEL TIGHTENING

TIGHTENING SPECIFICATIONS (1)

Application	Ft. Lbs. (N.m)
All	100 (140)
(1) Always tighten wheel lug nuts in a crisscross pattern. All wheel lug nuts have right-hand threads.	

BATTERY SPECIFICATIONS

CAUTION: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section.

CAUTIONS & WARNINGS

SUPPLEMENTAL RESTRAINT SYSTEM (SRS) AIR BAG SYSTEM

NOTE: See the AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT Section.

The SRS has no user-servicable parts. Always have servicing done by an authorized dealer.

When performing maintenance on air bag equipped vehicles always observe proper safety precautions.

WARNING: To avoid injury from accidental air bag deployment, read and carefully follow all warnings and service precautions. See appropriate AIR BAG RESTRAINT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

CAUTION: Disconnect negative battery cable before servicing any air bag system, steering column or passenger side dash component. After any repair, turn ignition key to the ON position from passenger's side of vehicle in case of accidental air bag inflation

ANTI-LOCK BRAKE SYSTEM (ABS)

CAUTION: Never mix different diameter tires. On loose or uneven surfaces, the ABS system may require longer stopping distances than conventional brake systems. Exercise caution when removing mud or snow from the wheels so as not to damage the ABS wiring or speed sensors.

BATTERY WARNING

WARNING: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See appropriate COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section below.

REPLACING BLOWN FUSES

CAUTION: Before replacing a blown fuse, remove ignition key, turn off all lights and accessories to avoid damaging the electrical system. Be sure to use fuse with the correct indicated amperage rating. The use of an incorrect amperage rating fuse may result in a dangerous electrical system overload.

BRAKE PAD WEAR INDICATOR

Indicator will cause a squealing or scraping noise, warning that brake pads need replacement.

CATALYTIC CONVERTER

CAUTION: Continued operation of vehicle with a severe malfunction could cause converter to overheat, resulting in possible damage to converter and vehicle.

COOLANT (PROPYLENE-GLYCOL FORMULATIONS)

CAUTION: To avoid possible damage to vehicle use only ethylene-glycol based coolants with a mixture ratio from 44-68% anti-freeze. DO NOT use 100% anti-freeze as it will cause the formation of cooling system deposits. This results in coolant temperatures of over 300° F (149°C) which can melt plastics. 100% anti-freeze has a freeze point of only -8° F (-22°C).

CAUTION: Propylene-Glycol Mixtures has a smaller temperature range than Ethylene-Glycol. The temperature range (freeze-boil) of a 50/50 Anti-Freeze/Water Mix is as follows: Propylene-Glycol -26° F (-32°C) - 257° F (125°C) or Ethylene-Glycol -35° F (-37°C) - 263° F (128°C).

CAUTION: Propylene-Glycol/Ethylene-Glycol Mixtures can cause the destabilization

of various corrosion inhibitors. Also Propylene-Glycol/Ethylene-Glycol has a different specific gravity than Ethylene-Glycol coolant, which will result in inaccurate freeze point calculations.

ELECTROSTATIC DISCHARGE SENSITIVE (ESD) PARTS

WARNING: Many solid state electrical components can be damaged by static electricity (ESD). Some will display a warning label, but many will not. Discharge personal static electricity by touching a metal ground point on the vehicle prior to servicing any ESD sensitive component.

ENGINE OIL

CAUTION: Never use non-detergent or straight mineral oil.

FUEL SYSTEM SERVICE

WARNING: Relieve fuel system pressure prior to servicing any fuel system component (fuel injection models).

HALOGEN BULBS

WARNING: Halogen bulbs contain pressurized gas which may explode if overheated. DO NOT touch glass portion of bulb with bare hands. Eye protection should be worn when handling or working around halogen bulbs.

RADIATOR CAP

CAUTION: Always disconnect the fan motor when working near the radiator fan. The fan is temperature controlled and could start at any time even when the ignition key is in the OFF position. DO NOT loosen or remove radiator cap when cooling system is hot.

RADIATOR FAN

WARNING: Keep hands away from radiator fan. Fan is controlled by a thermostatic switch which may come on or run for up to 15 minutes even after engine is turned off.

RADIATOR FAN WITH TOW PACKAGE

WARNING: Keep hands away from mechanical (fan-clutch) radiator fan.

SPARK PLUGS

NOTE: Allow engine to cool before removing spark plugs from aluminum cylinder heads.

TAILGATE

WARNING: DO NOT drive vehicle with tailgate open, as carbon monoxide can enter vehicle.

TRACTION CONTROL SYSTEM (IF EQUIPPED)

CAUTION: If tires are allowed to spin at high speeds when TRACTION OFF light is on, tires can explode. Also, spinning the tires with the warning light on can cause the transaxle to overheat. DO NOT spin wheels above 35 MPH.

WARRANTY INFORMATION

CAUTION: Due to the different warranties offered in various regions and the variety of after-market extended warranties available, please refer to the warranty package that came with the vehicle to verify all warranty options.

BUMPER TO BUMPER PLUS COVERAGE LIMITED WARRANTY (1991-93)

Everything covered for 3 years or 50,000 miles, whichever occurs first. Covered by this warranty are any repairs to vehicle which have proven defective during material and workmanship in normal use (tires excluded). Warranty repairs (parts and labor) will be made by the Dealer at no charge using new or remanufactured parts by the Dealer. This warranty is subject to a 100 deductible for each repair visit after the first year or 12,000 miles, whichever occurs first. Maintenance items are covered up to their first scheduled replacement interval only.

NOTE: 1992-93 vehicles are covered for 3 years or 36,000 miles with no deductible.

BUMPER-TO-BUMPER PLUS COVERAGE LIMITED WARRANTY (1994-96)

Everything is covered for 4 years or 50,000 miles, whichever occurs first. Also covered by this warranty are any repairs to vehicle which have proven defective during material and workmanship in normal use (tires excluded). Warranty repairs (parts and labor) will be made by the Dealer at no charge using new or remanufactured parts by the Dealer. Maintenance items are covered up to their first scheduled replacement interval only.

CORROSION WARRANTY

Warranty covers any rust-through in body sheet metal due to corrosion. Warranty period is 6 years or 100,000 miles, whichever occurs first. Warranty begins on date vehicle is delivered or put in use, whichever occurs first.

EMISSION COMPONENTS DEFECT WARRANTY

General Motors Corporation warrants all GM's emission components in vehicle to be free of defects in material and workmanship, which would cause it to fail to meet Federal standards for emission control system at the time vehicle was built. Warranty begins on date vehicle is delivered or first put in use, whichever occurs first. Refer to customer's copy of warranty information for exact warranty periods on specific models.

EMISSION PERFORMANCE WARRANTY

The following are primary components affecting vehicle's emissions performance. Other emission control-related parts are covered by the Performance warranty, where applicable. If another part fails due to the failure of one of these components, both parts are covered.

Primary components are normally covered for 5 years or 50,000 miles with a few exceptions. Refer to customers copy of warranty information for exact warranty periods on specific models.

Gasoline Engines

- Air Injector Reactor (AIR) Pump, Air Distributor And Valves
- Pulse AIR Valve And Associated Parts
- PCV Valve System And Oil Filler Cap
- EGR Valve And Associated Controls
- Choke Switches And Carburetor Parts
- Engine Control Module And Associated Sensors (If Equipped)
- Electronic Fuel Injection System
- Carburetor Feedback Control System
- Throttle Return Control Parts (If Equipped)
- Catalytic Converter, Catalyst And Associated Parts
- Fuel Tank, Filler Cap, Restrictor And Vapor Control Valves
- Evaporative Emission Control Carbon Canister And Associated Controls
- Emission Related Hoses, Clamps, Belts, Pulley, Tubes, Fittings And Wiring Harness
- Thermostatic Air Cleaner Switch, Control Valve And Associated Parts
- EFE Valve, Heater And Associated Controls (If Equipped)
- Exhaust System-To-Catalytic Converter
- Distributor Parts And Associated Controls
- Spark Plugs And Ignition Wires
- Intake, Exhaust Manifolds And Turbocharger (California)

SUPPLEMENTAL INFLATABLE RESTRAINT COVERAGE

Covers supplemental restraint system (if equipped) for 4 years, regardless of mileage.

EMISSIONS DEFECT & PERFORMANCE WARRANTIES (EXCEPT CALIFORNIA)

Defect Warranty ensures that vehicle meets applicable EPA regulations and that vehicle's emission control system is free from defects in materials and workmanship for a period of 5 years or 50,000 miles, whichever occurs first.

The Performance Warranty covers all costs of repairing or adjusting any components or parts as needed in order for the vehicle to pass a federally required state or local emissions test.

Other emission control parts related to these components are covered by the Performance Warranty, where applicable. If another part fails due to the failure of one of these components, both parts are covered. See customer's copy of warranty information for specific items covered.

EMISSION PERFORMANCE WARRANTY (CALIFORNIA)

If vehicle fails a Smog Check inspection, all necessary repairs and adjustments will be made by manufacturer to ensure that vehicle passes the inspection. Warranty begins at warranty start date and lasts for a period of 3 years or 50,000 miles, whichever occurs first.

EMISSION DEFECT WARRANTY (CALIFORNIA)

If any emission-related part on the vehicle is defective, the part will be repaired or replaced by manufacturer. Warranty begins at warranty start date and lasts for a period of 3 years or 50,000 miles, whichever occurs first.

Some emission-related parts are warranted for 7 years or 70,000 miles whichever occurs first, and will be repaired or replaced by manufacturer if found to be defective in material or workmanship. See customer's copy of warranty information for specific items covered.

ROADSIDE ASSISTANCE

Included in the Customer One Care Warranty is 24 Hour Roadside Assistance coverage, which provides the following services:

- Flat Tire Service
- Out of Gas
- Battery Jump Assistance
- Lockout Service
- Towing Service
- Trip Routing
- Trip Interruption Expense

NOTE: 24 Hour Roadside Assistance phone number is 800-442-6537

FUSES & CIRCUIT BREAKERS

FUSIBLE LINKS

Fusible links will melt to prevent fire if a large current flows through electrical systems without passing through fuses.

FUSE PANEL ID (1991-93 CAPRICE)

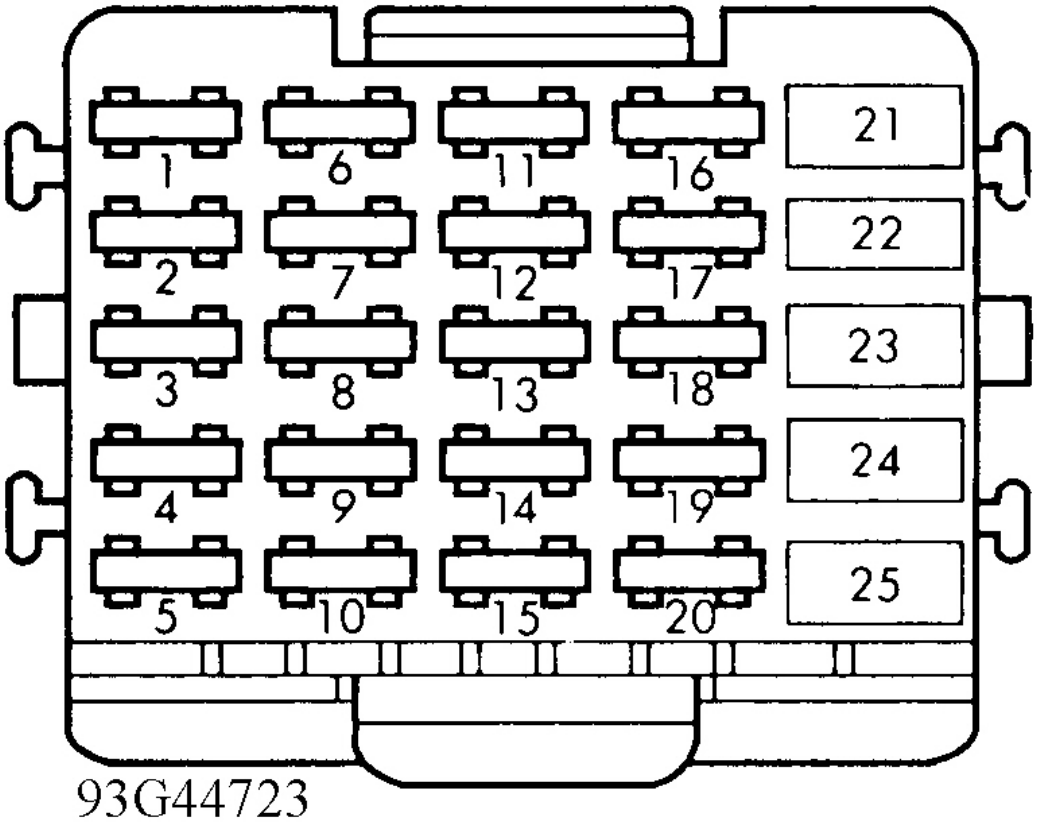


Fig. 6: Fuse Panel ID (1991-93 Caprice)
Courtesy of GENERAL MOTORS CORP.

Fuse & Circuit Breaker Identification

- 1 - 15 Amp Underhood Light, Power Antenna, Keyless Entry, Courtesy Lights, Compass/Lighted Mirror, Horn, Lighted Visor, Door Locks, Power Mirrors, Rear Glass Release, Audible Warning System
- 2 - 15 Amp Audible Warning System, Cigarette Lighter, Rear Wiper, Glove Box Light, Radio, Trunk Light, Rear Gate Ajar Light, Trunk Release
- 3 - 10 Amp Anti-Lock Brake System (1991 Caprice), Bose Amplifier 1992-93 Caprice)
- 4 - 10 Amp (Exc. 1993 Wagon) 25 Amp (1993 Wagon) Bose Radio Amplifier (1991 Caprice), Electronic A/C 1992 Caprice), Electronic Level Control (10 Amp 1993 Sedan), Electronic Level Control (25 Amp 1993 Wagon)

- 5 - 7.5 Amp Instrument Panel Lights
- 6 - 20 Amp Keyless Entry, Alternator, Heater, Air Conditioner, Daytime Running Lights
- 7 - 30 Amp (1991) Electronic A/C Blower Motor Blank (1992-93 Caprice)
- 8 - 15 Amp Rear Wiper/Washer
- 9 - 10 Amp Radio
- 10 - 25 Amp Windshield Wiper/Washer, Washer Fluid Level
- 11 - 7.5 Amp Fuel Injectors
- 12 - 10 Amp Supplemental Inflatable Restraint
- 13 - 10 Amp Speed Signal Module, ECM, EGR Solenoid, Air Control ESC Module, Canister Purge, Cluster Electronics/Warning Indicator
- 14 - 15 Amp Twilight Sentinel, Parking, Side Marker & License Lights, Daytime Running Lights
- 15 - 30 Amp Rear Window Defogger
- 16 - 7.5 Amp Heated Mirrors
- 17 - 15 Amp Audible Warning System, TCC Brake Switch, Compass Mirror, Supplemental Inflatable Restraint, Gauges/Warning Indicator, Headlight Switch Illumination, Rear Window Defogger, Fluid Warning, Anti-Lock Brake System, Twilight Sentinel, Daytime Running Lights, Low Oil Module, Park/Neutral Relay, Height Sensor, Power Vent Switch (1991 Caprice)
- 18 - 15 Amp Turn Signal Lights, Back-Up Lights Cruise Control
- 19 - 20 Amp Stoplights, Hazard Lights
- 20 - 5 Amp ECM, Supplemental Inflatable Restraint
- 21 - 30 Amp Circuit Breaker Keyless Entry, Power Door Locks, Power Seats, Tailgate Lock Relay, Power Vent Motor (1991 Caprice)
- 22 - Blank Or Spare
- 23 - 30 Amp Circuit Breaker Power Windows
- 24 - Blank Or Spare
- 25 - Blank Or Spare

FUSE PANEL IDENTIFICATION (1994 CAPRICE)

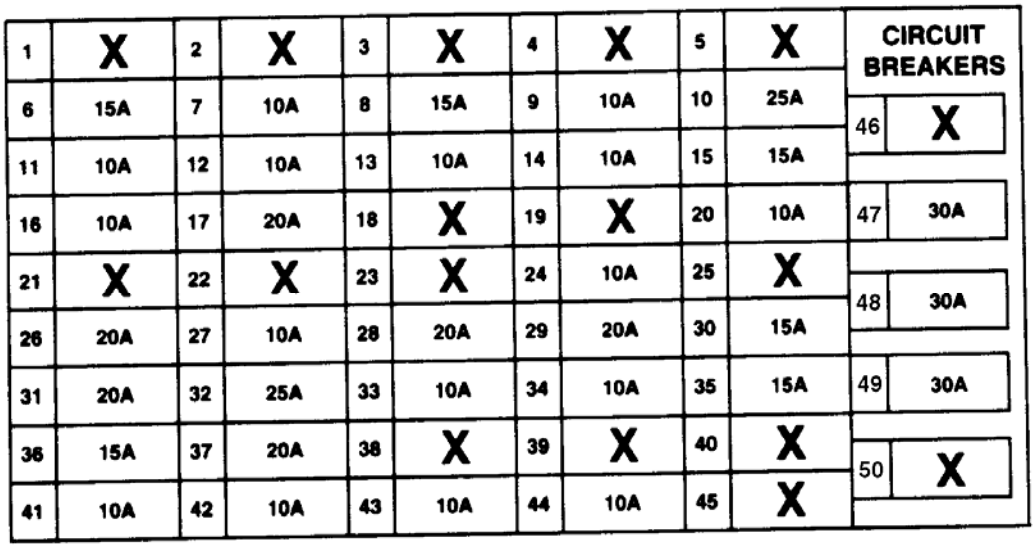


Fig. 7: Fuse Panel Identification (1994 Caprice)
Courtesy of GENERAL MOTORS CORP.

Fuse & Circuit Breaker Identification

- 1 - Blank
- 2 - Blank
- 3 - Blank
- 4 - Blank
- 5 - Blank
- 6 - 15 Amp Turn Signal Lamp Flasher, Park Neutral Position Sw.
- 7 - 10 Amp Anti-Lock Brake (ABS) Control Module
- 8 - 15 Amp Tailgate Sw. Module (Wagon)
- 9 - 10 Amp Radio
- 10 - 25 Amp Windshield Wiper Motor Module
- 11 - 10 Amp Rear Defog Relay, Air Bag, I/P Cluster, Headlamp Sw.
- 12 - 10 Amp Auto Level Control (Wagon)
- 13 - 10 Amp Automatic Inside Rearview Mirror, Chime Module, TCC Cruise Brake Sw., Twilight Sentinel, Daytime Running Lights Canada), Keyless Entry System
- 14 - 10 Amp Pass-Key II
- 15 - 15 Amp Air Bag
- 16 - 10 Amp Cruise Control
- 17 - 20 Amp Heater & A/C Control
- 18 - Blank

- 19 - Blank
- 20 - 10 Amp Instrument Cluster, Daytime Running Lights (Canada)
- 21 - Blank
- 22 - Blank
- 23 - Blank
- 24 - 10 Amp Air Bag, Theft Deterrent Relay
- 25 - Blank
- 26 - 20 Amp Power Antenna
- 27 - 10 Amp Heat Sensor, Trunk Lamp
- 28 - 20 Amp Cigarette Lighter
- 29 - 20 Amp Keyless Entry System, Trunk Release, Rear Glass Release Liftgate Wiper Latch Sw. (Wagon)
- 30 - 15 Amp Radio
- 31 - 20 Amp Headlamp Sw., Twilight Sentinel, Daytime Running Lights Canada)
- 32 - 25 Amp Horn
- 33 - 10 Amp Chime Module, Heater and A/C, Glove Box Light, Instrument Cluster
- 34 - 10 Amp Pass-Key II
- 35 - 15 Amp Dome Lamp, Front Reading Lights, Rear Reading Lights, Automatic Inside Rearview Mirror, Illuminated Visor Vanity Mirror, Power Door Locks, Front Door Courtesy Lights, Rear Door Courtesy Lights, Power Mirror Sw. Instrument Panel Courtesy Lights
- 36 - 15 Amp Rear Wiper (Wagon)
- 37 - 20 Amp Hazard Warning Flasher, Stop Lights
- 38 - Blank
- 39 - Blank
- 40 - Blank
- 41 - 10 Amp Cornering Lamps, Side Marker Lamp, Turn-Park Lamp
- 42 - 10 Amp Instrument Cluster, Radio, Brightness Control, Headlamp and Instrument Panel Lamp Dimmer Sw., Panel Lamps Dimming Module
- 43 - 10 Amp License Lights, Taillights, Tail/Stop/Turn Lights, Marker Lamps
- 44 - 10 Amp Heater Power Mirrors
- 45 - Blank
- 46 - Blank
- 47 - 30 Amp (Circuit Breaker) Power Window Sw., Power Window Lockout Sw.
- 48 - 30 Amp (Circuit Breaker) Door Locks, Power Seat Sw., Passenger Seat Lumbar Controls
- 49 - 30 Amp (Circuit Breaker) Rear Window Defog Sw.
- 50 - Blank

UNDERHOOD FUSE & RELAY IDENTIFICATION (1994 CAPRICE)

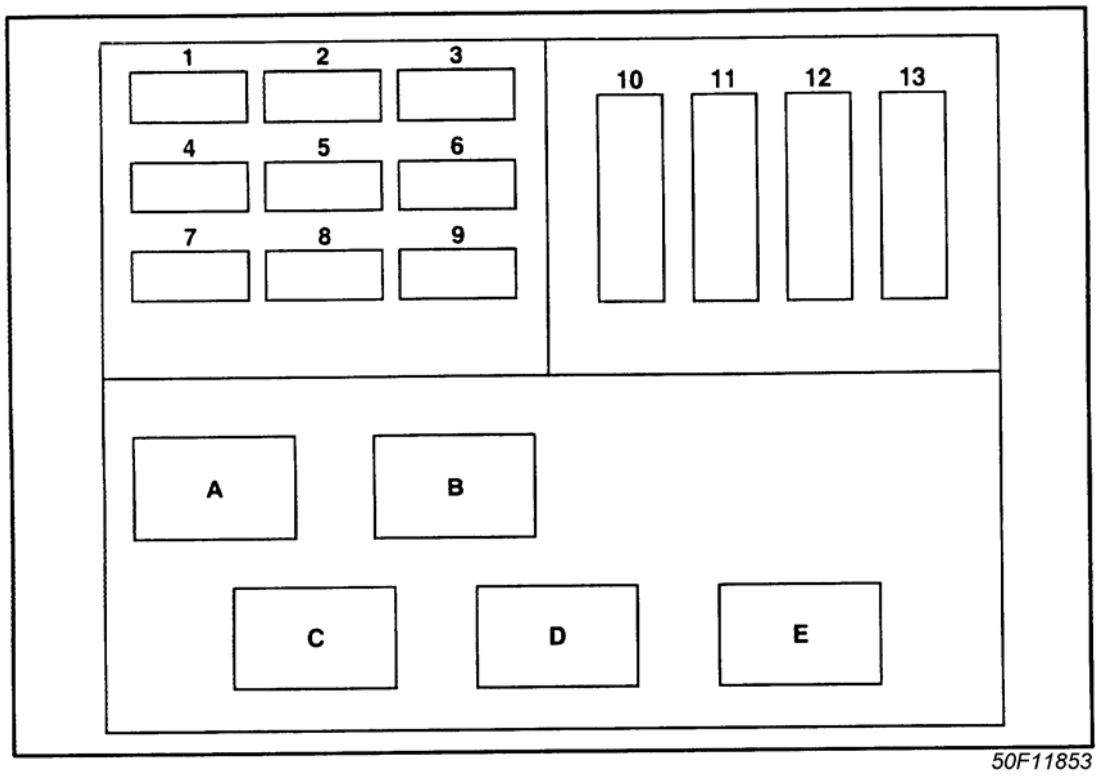


Fig. 8: Underhood Fuse & Relay Identification (1994 Caprice)
Courtesy of GENERAL MOTORS CORP.

> **WARNING: Always disconnect battery ground cable before servicing high-current fuses. It is recommended that high-current fuses be replaced by a qualified technician.**

Fuse Identification

- 1 - 25 Amp ELC Automatic Level Control Air Compressor (ALC)
- 2 - 15 Amp F/P Fuel Pump Relay, Fuel Pump and Engine Oil Pressure Switch Powertrain Control Module (PCM),
- 3 - 20 Amp AIR Primary Air Pump Relay, Underhood Lamp
- 4 - 10 Amp EMI Automatic Transmission, Mass Air Flow Sensor (MAF), Secondary Air Pump Relay, EGR Control Valve Relay, Evaporative Emission Canister Purge Valve Solenoid, LH Heated Oxygen Sensor, RH Heated Oxygen Sensor
- 5 - 10 Amp PCM/IGN Powertrain Control Module (PCM), Ignition Coil Electronic Brake Control Module
- 6 - 10 Amp FUEL INJ Fuel Injector (1, 4, 6, 7)
- 7 - 10 Amp PRI-FAN Primary Engine Coolant Fan, A/C Compressor Relay
- 8 - 10 Amp SEC-FAN Secondary Engine Coolant Fan, Generator

- 9 - 10 Amp FUEL INJ Fuel Injector (2, 3, 5, 8)
- 10 - 60 Amp BODY 1 Main
- 11 - 60 Amp BODY 2 Fuse Block
- 12 - 40 Amp PRI COOL FAN Primary Engine Coolant Fan
- 13 - 40 Amp SEC COOL FAN Secondary Engine Coolant Fan

Relay Identification

- A - Fuel Pump Relay
- B - A/C COMP Relay
- C - Air Pump Relay
- D - PRI - Cool Relay
- E - SEC - Cool Relay

FUSE & CIRCUIT BREAKER IDENTIFICATION (-96 CAPRICE)

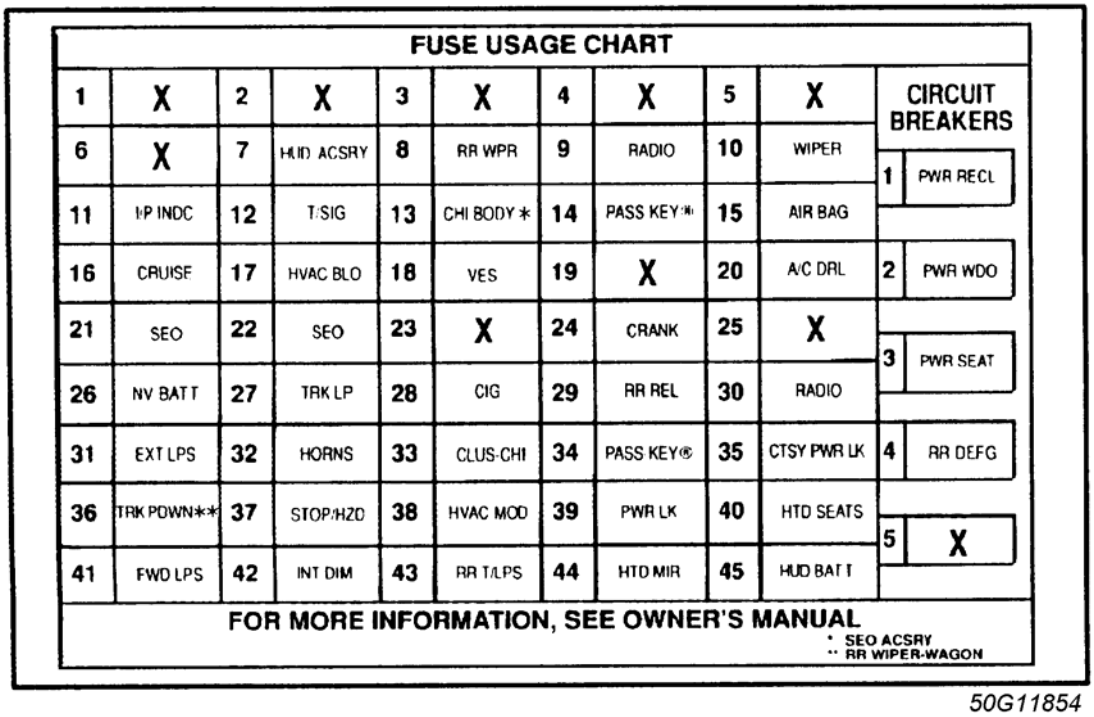


Fig. 9: Fuse & Circuit Breaker Panel ID (1995-96 Caprice)
Courtesy of GENERAL MOTORS CORP.

Fuse Identification

- 1 - Blank

- 2 - Blank
- 3 - Blank
- 4 - Blank
- 5 - Blank
- 6 - Blank
- 7 - 10 Amp (SEO - Police Models) HUD Projector, Night Vision Control Unit, Auxiliary Display
- 8 - 15 Amp Rear Wiper
- 9 - 15 Amp Radio
- 10 - 25 Amp Windshield Wiper Motor Module
- 11 - 10 Amp Rear Defogger Relay, Air Bag (DERM), I/P Cluster, Headlamp Switch
- 12 - 15 Amp Turn Signals, Back-up Lamp, PRNDL Position Sensor
- 13 - 10 Amp Automatic Inside Rearview Mirror, Chime Module, TCC Cruise Brake Sw., Twilight Sentinel, Daytime Running Lights Canada), Keyless Entry System
- 14 - 10 Amp Pass-Key II
- 15 - 15 Amp Air Bag (DERM)
- 16 - 10 Amp Cruise Control
- 17 - 20 Amp Heater & A/C Control
- 18 - 10 Amp Seat Heater, Power Steering Control Module
- 19 - Blank
- 20 - 10 Amp Instrument Cluster, Daytime Running Lights (Canada)
- 21 - 15 Amp (SEO - Police Models) RH Spot Lamp (Police)
- 22 - 15 Amp (SEO - Police Models) LH Spot Lamp (Police)
- 23 - Blank
- 24 - 10 Amp Air Bag, Theft Deterrent Relay
- 25 - Blank
- 26 - 10 Amp (SEO - Police Models) Night Vision Roof Unit (Police)
- 27 - 10 Amp Automatic Level Control, Trunk Lamp
- 28 - 20 Amp Cigarette Lighter
- 29 - 20 Amp Keyless Entry System, Trunk Release, Rear Glass Release Liftgate Wiper Latch Sw. (Wagon)
- 30 - 15 Amp Radio
- 31 - 20 Amp Headlamp Switch, Twilight Sentinel, Daytime Running Lights Canada)
- 32 - 25 Amp Horn Relay
- 33 - 10 Amp Chime Module, Heater and A/C, Glove Box Light, Instrument Cluster
- 34 - 10 Amp Pass-Key II
- 35 - 15 Amp Dome Lamp, Front Reading Lights, Rear Reading Lights, Automatic Inside Rearview Mirror, Illuminated Visor Vanity Mirror, Power Door Locks, Front Door Courtesy Lights, Rear Door Courtesy Lights, Power Mirror Sw. Instrument Panel Courtesy Lights

- 36 - 15 Amp Rear Wiper (Wagon)
- 37 - 20 Amp Hazard Warning Flasher, Stop Lights
- 38 - 30 Amp Blower Motor Control
- 39 - 20 Amp Power Door Lock Relay
- 40 - 20 Amp Heated Seats
- 41 - 10 Amp Cornering Lamps, Side Marker Lamp, Turn-Park Lamp
- 42 - 10 Amp Instrument Cluster, Radio, Brightness Control, Headlamp and Instrument Panel Lamp Dimmer Sw., Panel Lamps Dimming Module
- 43 - 10 Amp License Lights, Taillights, Tail/Stop/Turn Lights, Marker Lamps
- 44 - 10 Amp Heater Power Mirrors
- 45 - 10 Amp (SEO - Police Models) HUD Projector

Circuit Breaker Identification

- 1 - 20 Amp (Circuit Breaker) Power Seat Recline, Lumbar Support, Power Antenna Relay
- 2 - 30 Amp (Circuit Breaker) Power Window Switch, Power Window Lockout Switch
- 3 - 25 Amp (Circuit Breaker) Door Locks, Power Seat Switch
- 4 - 30 Amp (Circuit Breaker) Rear Window Defogger Switch
- 5 - Not Used

UNDERHOOD FUSE & RELAY IDENTIFICATION (1995-96 CAPRICE)

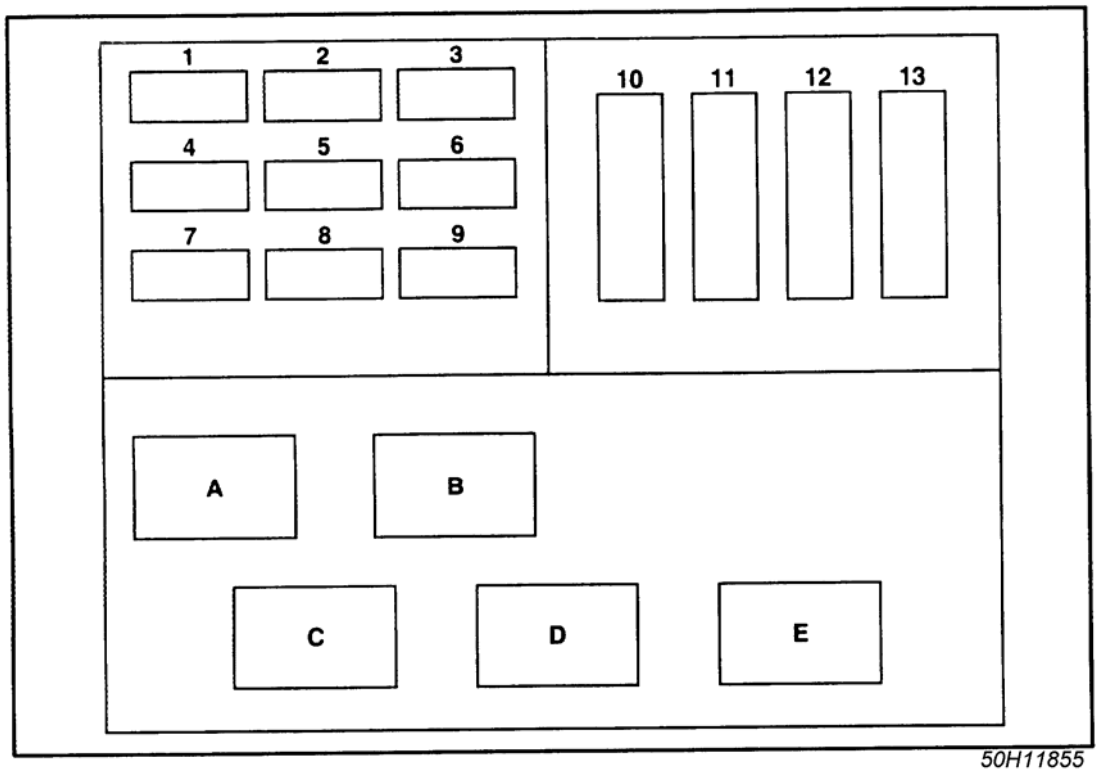


Fig. 10: Underhood Fuse & Relay Identification (1995-96 Caprice)
Courtesy of GENERAL MOTORS CORP.

> **WARNING: Always disconnect battery ground cable before servicing high-current fuses. It is recommended that high-current fuses be replaced by a qualified technician.**

Fuse Identification

- 1 - 25 Amp ELC Automatic Level Control Air Compressor (ALC)
- 2 - 15 Amp F/P Fuel Pump Relay, Fuel Pump and Engine Oil Pressure Switch Powertrain Control Module (PCM),
- 3 - 25 Amp AIR Primary Air Pump Relay, Underhood Lamp
- 4 - 15 Amp EMI Automatic Transmission, Mass Air Flow Sensor (MAF), Secondary Air Pump Relay, EGR Control Valve Relay, Evaporative Emission Canister Purge Valve Solenoid, LH Heated Oxygen Sensor, RH Heated Oxygen Sensor
- 5 - 10 Amp PCM/IGN Powertrain Control Module (PCM), Ignition Coil Electronic Brake Control Module
- 6 - 10 Amp FUEL INJ Fuel Injector (1, 4, 6, 7)
- 7 - 10 Amp PRI-FAN Primary Engine Coolant Fan, A/C Compressor Relay
- 8 - 10 Amp SEC-FAN Secondary Engine Coolant Fan, Generator

- 9 - 10 Amp FUEL INJ Fuel Injector (2, 3, 5, 8)
- 10 - 80 Amp BODY 1 Main
- 11 - 60 Amp BODY 2 Fuse Block
- 12 - 40 Amp PRI COOL FAN Primary Engine Coolant Fan
- 13 - 40 Amp SEC COOL FAN Secondary Engine Coolant Fan

Relay Identification

- A - Fuel Pump Relay
- B - A/C COMP Relay
- C - Air Pump Relay
- D - PRI - Cool Relay
- E - SEC - Cool Relay

REMINDER INDICATOR RESET PROCEDURES

GM - Buick / Cadillac / Chevrolet / GMC / Olds / Pontiac - 1980-14

CHANGE TRANS FLUID MESSAGE

NOTE: To determine the appropriate reset procedure, refer to CHANGE TRANS FLUID MESSAGE RESET INDEX. Only the vehicles listed in this index have a CHANGE TRANS FLUID MESSAGE reset.

CHANGE TRANS FLUID MESSAGE RESET INDEX

Model & Year	Reset Procedure
Aurora	
1995-99	Change Trans Fluid Message Reset - Procedure 4
Concours	
1994-98	Change Trans Fluid Message Reset - Procedure 1
1999	Change Trans Fluid Message Reset - Procedure 2
CTS	
2003	Change Trans Fluid Message Reset - Procedure 3
2004	Change Trans Fluid Message Reset - Procedure 2
DeVille	
1992-97	Change Trans Fluid Message Reset - Procedure 1
1998-04	Change Trans Fluid Message Reset - Procedure 2
Eldorado	
1992-98	Change Trans Fluid Message Reset - Procedure 1
1999-00	Change Trans Fluid Message Reset - Procedure 2
2001-02	Change Trans Fluid Message Reset - Procedure 1
Seville	
1992-97	Change Trans Fluid Message Reset - Procedure 1
1998-04	Change Trans Fluid Message Reset - Procedure 2
SRX	
2004	Change Trans Fluid Message Reset - Procedure 2

CHANGE TRANS FLUID MESSAGE RESET - PROCEDURE 1

This message will appear on the Driver Information Center (DIC) when transaxle fluid change is due. Change fluid in both the oil pan and side cover.

1. To reset display, turn ignition ON with engine OFF.
2. On the climate control panel, press and hold OFF and REAR DEFOG buttons until TRANS FLUID RESET message appears in DIC (about 5-20 seconds).

CHANGE TRANS FLUID MESSAGE RESET - PROCEDURE 2

The CHANGE TRANS FLUID message will appear on the Driver Information Center (DIC) when transaxle fluid change is due. Percentage of transaxle fluid life remaining may be checked at any time by pressing INFO button several times until TRANS FLUID LIFE message appears.

1. To reset display, turn ignition key ON with engine OFF.
2. Press the INFO button until TRANS FLUID LIFE message appears.
3. Press and hold INFO RESET button until display shows 100 percent TRANS FLUID LIFE. Transaxle fluid life index is now reset.

CHANGE TRANS FLUID MESSAGE RESET - PROCEDURE 3

Resetting With Base Audio System

Press CLR button located to the right of the DIC display to acknowledge the CHANGE TRANS FLUID message. This will clear the message from the display and reset it. To reset transmission fluid life indicator, press up or down arrow on INFO button located to the right of the DIC display to access the DIC menu. Once percentage TRANS FLUID LIFE menu item is highlighted, press and hold CLR button. Percentage will return to 100, and transmission fluid life indicator will be reset. Repeat if percentage does not return to 100.

Resetting With Navigation System

Press multifunction button located to the right of the DIC display, next to the OK prompt to acknowledge the CHANGE TRANS FLUID message. This will clear the message form the display and reset it. To reset transmission fluid life indicator, turn system on by pressing PWR/VOL knob once. PWR/VOL knob is located to the lower left of the DIC display. Press INFO button located to the left of the DIC display to access the VEHICLE INFO menu. Turn TUNE/SEL knob located to the lower right of the DIC display until TRANS FLUID LIFE is highlighted. Press knob once to select it. Once percentage TRANS FLUID LIFE is displayed, press multifunction button next to the RESET prompt in the upper right corner of the display. Percentage will return to 100, and transmission fluid life indicator will be reset. Repeat if percentage does not return to 100.

CHANGE TRANS FLUID MESSAGE RESET - PROCEDURE 4

1. The Driver Information Center (DIC) displays estimated percentage of the remaining useful life of transaxle fluid. When remaining fluid life is 0 percent, the display will show CHANGE TRNS FLUID NOW. After changing transaxle fluid, reset oil life display.
2. To reset the display, turn ignition on with engine off. Press ENG button to select the TRNS FLUID LIFE percentage display. Then, press and hold in RESET for at least 5 seconds.
3. The word RESET will appear. Then, TRNS FLUID 100 will be displayed.

CHECK ENGINE LIGHT

NOTE: To determine the appropriate reset procedure, refer to CHECK ENGINE LIGHT RESET INDEX. Only vehicles listed in this index have a check engine light reset.

CHECK ENGINE LIGHT RESET INDEX

Model & Year	Reset Procedure

Geo Tracker	
1989-94	**Check Engine Light Reset - Procedure 1**

CHECK ENGINE LIGHT RESET - PROCEDURE 1

Federal Emissions

1. CHECK ENGINE light functions as a service reminder indicator and emission system service. CHECK ENGINE light will come on each 50,000 miles (PCV and EGR), each 80,000 miles (oxygen sensor) and each 100,000 miles (charcoal canister) to indicate needed emission system service.
2. After servicing and/or replacing components, reset CHECK ENGINE light by sliding cancel switch to its opposite position. See **CHECK ENGINE LIGHT RESET SWITCH LOCATION (GEO TRACKER)** for switch location.

CHECK ENGINE LIGHT RESET SWITCH LOCATION (GEO TRACKER)

Application	Location
1989-91	Behind Access Panel, Directly Below Steering Column
1992-94	(1) Behind Instrument Panel, Next To Left Speaker
(1) See **Fig. 1**.	

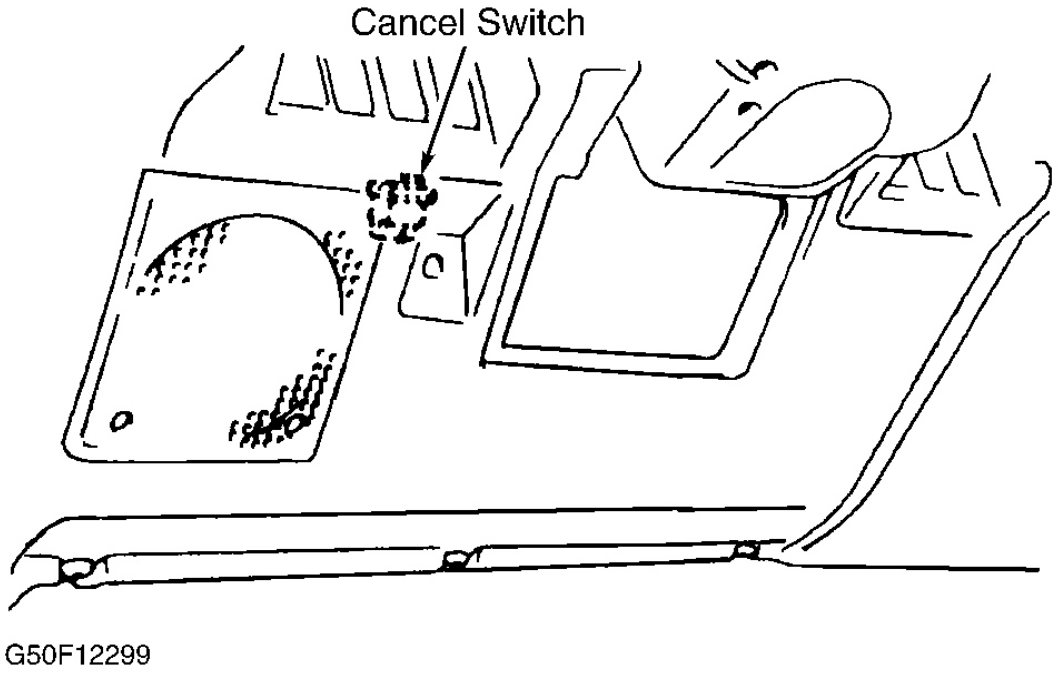


Fig. 1: Check Engine Light Reset Switch Location (1992-94 Geo Tracker - Federal Emissions)
Courtesy of GENERAL MOTORS CORP.

California Emissions

CHECK ENGINE light indicates when it is necessary to have emission system serviced, regardless of mileage. CHECK ENGINE light comes on briefly when starting as a bulb check. If light does not come on or stays on constantly, repair as necessary.

FUEL FILTER LIFE

NOTE: To determine the appropriate reset procedure, refer to Fuel Filter Life Reset Index. Only vehicles listed in this index have a fuel filter life reset.

FUEL FILTER LIFE RESET INDEX

Application	Reset Procedure
Some Models	Fuel Filter Life Reset - Procedure 1

NOTE: ALWAYS reset the FUEL FILTER LIFE system (if equipped) after a fuel filter change.

"FUEL FILTER LIFE" message will appear when a reset is performed either by using the steering wheel controls or performing manual reset procedure.

FUEL FILTER LIFE RESET - PROCEDURE 1

1. On vehicles with steering wheel controls, press and hold the select button for 5 seconds while the FUEL FILTER LIFE message is displayed. This message will appear on the Driver Information Center (DIC) for 10 seconds.
2. On vehicles without steering wheel controls, go to next step.
3. Without pressing the pedals, turn the ignition key to the ON position, engine off. Wait 5 seconds.
4. Completely depress the brake and accelerator pedals simultaneously and hold for 10 seconds. The system is now reset. Turn ignition key OFF.
5. On all vehicles, the next time engine is started, the message will no longer be displayed.

OIL CHANGE REMINDER

NOTE: Most 1981-88 General Motors vehicles do not use a Service Reminder Indicator (SRI).

NOTE: To determine the appropriate reset procedure, refer to Oil Change Reminders Reset Index. Only vehicles listed in this index have an oil change reminder reset.

OIL CHANGE REMINDERS RESET INDEX

Model & Year	Reset Procedure
Alero	

1999-03	**Oil Change Reminder Reset - Procedure 1**
2004	**Oil Change Reminder Reset - Procedure 3**
Acadia	
2007-10	**Oil Change Reminder Reset - Procedure 16**
2011-15	**Oil Change Reminder Reset - Procedure 6**
Allante	
1989-93	**Oil Change Reminder Reset - Procedure 23**
ATS	
2013-14	**Oil Change Reminder Reset - Procedure 33**
Aurora	
1995-99	**Oil Change Reminder Reset - Procedure 27**
2001-03	**Oil Change Reminder Reset - Procedure 6**
Avalanche	
2002-06	**Oil Change Reminder Reset - Procedure 3**
2007-13	**Oil Change Reminder Reset - Procedure 6**
Aveo	
2009-11	**Oil Change Reminder Reset - Procedure 3**
Aztek	
2001-05	**Oil Change Reminder Reset - Procedure 3**
Bravada	
2002-04	**Oil Change Reminder Reset - Procedure 11**
Bonneville	
2003-05	**Oil Change Reminder Reset - Procedure 6**
Brougham	
1992	**Oil Change Reminder Reset - Procedure 3**
Camaro	
1998-02	**Oil Change Reminder Reset - Procedure 1**
2010-14	**Oil Change Reminder Reset - Procedure 18**
Canyon	
2004-12	**Oil Change Reminder Reset - Procedure 10**
Caprice	
1994	**Oil Change Reminder Reset - Procedure 2**
1995-96	**Oil Change Reminder Reset - Procedure 3**
2011-14	**Oil Change Reminder Reset - Procedure 18**
Captiva Sport	
2012-15	**Oil Change Reminder Reset - Procedure 6**
Classic	
2005	**Oil Change Reminder Reset - Procedure 4**
Cobalt & G5 Pursuit (Canadian)	
2005-09	**Oil Change Reminder Reset - Procedure 4**
Colorado	
2004-12	

	Oil Change Reminder Reset - Procedure 10
Concours	
1994-96	**Oil Change Reminder Reset - Procedure 19**
1997-99	**Oil Change Reminder Reset - Procedure 6**
Corvette	
1990-96	**Oil Change Reminder Reset - Procedure 5**
1997-13	**Oil Change Reminder Reset - Procedure 6**
2014	**Oil Change Reminder Reset - Procedure 33**
Cruze	
2011-14	**Oil Change Reminder Reset - Procedure 18**
CTS	
2003-04	**Oil Change Reminder Reset - Procedure 20**
2005-08	**Oil Change Reminder Reset - Procedure 22**
2009	**Oil Change Reminder Reset - Procedure 6**
2010-11	**Oil Change Reminder Reset - Procedure 3** or **Oil Change Reminder Reset - Procedure 19**
2012-14	**Oil Change Reminder Reset - Procedure 6**
Cutlass Calais, Cutlass Supreme, Cutlass Ciera, Cutlass Cruiser & Touring Sedan	
1990-91	**Oil Change Reminder Reset - Procedure 28**
DeVille	
1991-93	**Oil Change Reminder Reset - Procedure 25**
1994-99	**Oil Change Reminder Reset - Procedure 19**
2000-05	**Oil Change Reminder Reset - Procedure 16**
DTS	
2006-11	**Oil Change Reminder Reset - Procedure 6**
Eighty Eight & Ninety Eight	
1990-91	**Oil Change Reminder Reset - Procedure 28**
1992-94	**Oil Change Reminder Reset - Procedure 29**
1995-97	**Oil Change Reminder Reset - Procedure 30**
Eldorado	
1989-91	**Oil Change Reminder Reset - Procedure 24**
1992-93	**Oil Change Reminder Reset - Procedure 26**
1994-97	**Oil Change Reminder Reset - Procedure 19**
1997-02	**Oil Change Reminder Reset - Procedure 6**
ELR	
2014	**Oil Change Reminder Reset - Procedure 33**
Enclave	
2008-15	**Oil Change Reminder Reset - Procedure 16**
Encore	
2013-14	**Oil Change Reminder Reset - Procedure 18**
Envoy/ XL	

2002-06	**Oil Change Reminder Reset - Procedure 6**
2007-09	**Oil Change Reminder Reset - Procedure 4**
Equinox	
2005-09	**Oil Change Reminder Reset - Procedure 3**
2011-14	**Oil Change Reminder Reset - Procedure 6**
Escalade Series	
2002-06	**Oil Change Reminder Reset - Procedure 3**
2007-14	**Oil Change Reminder Reset - Procedure 6**
2015	**Oil Change Reminder Reset - Procedure 33**
Express/ Cutaway/ RV	
2003-14	**Oil Change Reminder Reset - Procedure 3**
Firebird	
1998-02	**Oil Change Reminder Reset - Procedure 6**
Fleetwood	
1991-92	**Oil Change Reminder Reset - Procedure 25**
1993-96	**Oil Change Reminder Reset - Procedure 3**
Grand Am	
1999-02	**Oil Change Reminder Reset - Procedure 2**
2003-05	**Oil Change Reminder Reset - Procedure 3**
Grand Prix	
1998-03	**Oil Change Reminder Reset - Procedure 3**
2004-08	**Oil Change Reminder Reset - Procedure 6**
GTO	
2004-06	**Oil Change Reminder Reset - Procedure 3**
G5	
2007-09	**Oil Change Reminder Reset - Procedure 4**
G6	
2005-10	**Oil Change Reminder Reset - Procedure 32**
G8	
2008-09	**Oil Change Reminder Reset - Procedure 9**
HHR	
2006-11	**Oil Change Reminder Reset - Procedure 4**
Impala	
2000-06	**Oil Change Reminder Reset - Procedure 8**
2007-13	**Oil Change Reminder Reset - Procedure 6**
2014-15	**Oil Change Reminder Reset - Procedure 33**
Impala Limited	
2014	**Oil Change Reminder Reset - Procedure 6**
Intrigue	
1998-02	**Oil Change Reminder Reset - Procedure 3**
LaCrosse & Allure	
2005-14	

	Oil Change Reminder Reset - Procedure 18
LeSabre	
1994-99	**Oil Change Reminder Reset - Procedure 12**
2000-05	**Oil Change Reminder Reset - Procedure 14**
Lucerne	
2006-10	**Oil Change Reminder Reset - Procedure 6**
2011	**Oil Change Reminder Reset - Procedure 18**
Lumina	
1997-01	**Oil Change Reminder Reset - Procedure 6**
Malibu	
2004-07	**Oil Change Reminder Reset - Procedure 13**
2008-12	**Oil Change Reminder Reset - Procedure 4**
2013-15	**Oil Change Reminder Reset - Procedure 18**
Montana	
2000-05	**Oil Change Reminder Reset - Procedure 3**
2006	**Oil Change Reminder Reset - Procedure 6**
Monte Carlo	
1997-99	**Oil Change Reminder Reset - Procedure 6**
2000-06	**Oil Change Reminder Reset - Procedure 8**
2007	**Oil Change Reminder Reset - Procedure 6**
Park Avenue	
1991-94	**Oil Change Reminder Reset - Procedure 15**
1995-96	**Oil Change Reminder Reset - Procedure 12**
1997-05	**Oil Change Reminder Reset - Procedure 14**
Pickup/Cab & Chassis (C/K)	
1996-00	**Oil Change Reminder Reset - Procedure 3**
Rainier	
2004-07	**Oil Change Reminder Reset - Procedure 17**
Regal	
1997-04	**Oil Change Reminder Reset - Procedure 6**
2011-14	**Oil Change Reminder Reset - Procedure 18**
Rendezvous	
2002-07	**Oil Change Reminder Reset - Procedure 17**
Roadmaster	
1994	**Oil Change Reminder Reset - Procedure 15** or **Oil Change Reminder Reset - Procedure 2**
1995-96	**Oil Change Reminder Reset - Procedure 3**
Savana/ Cutaway/ RV	
2003-14	**Oil Change Reminder Reset - Procedure 3**
Seville	
1989-91	**Oil Change Reminder Reset - Procedure 24**

1992-93	**Oil Change Reminder Reset - Procedure 26**
1994-97	**Oil Change Reminder Reset - Procedure 19**
1998-04	**Oil Change Reminder Reset - Procedure 16**
Sierra 1500/ 2500/ 3500	
1999-06	**Oil Change Reminder Reset - Procedure 3**
2007-15	**Oil Change Reminder Reset - Procedure 6**
Silhouette	
2000-01	**Oil Change Reminder Reset - Procedure 3**
2002-04	**Oil Change Reminder Reset - Procedure 6**
Silverado 1500/ 2500/ 3500	
2001-06	**Oil Change Reminder Reset - Procedure 3**
2007-15	**Oil Change Reminder Reset - Procedure 6**
Solstice	
2006-10	**Oil Change Reminder Reset - Procedure 4**
Sonic	
2012-14	**Oil Change Reminder Reset - Procedure 18**
Spark	
2013-14	**Oil Change Reminder Reset - Procedure 18**
SRX	
2004	**Oil Change Reminder Reset - Procedure 20**
2005-06	**Oil Change Reminder Reset - Procedure 22**
2007-09	**Oil Change Reminder Reset - Procedure 6**
2010-12	**Oil Change Reminder Reset - Procedure 18**
2013-15	**Oil Change Reminder Reset - Procedure 33**
SS	
2014	**Oil Change Reminder Reset - Procedure 18**
SSR	
2004	**Oil Change Reminder Reset - Procedure 3**
2005-06	**Oil Change Reminder Reset - Procedure 6**
STS	
2005-11	**Oil Change Reminder Reset - Procedure 7**
Suburban	
2000-06	**Oil Change Reminder Reset - Procedure 3**
2007-15	**Oil Change Reminder Reset - Procedure 6**
Tahoe	
2000-06	**Oil Change Reminder Reset - Procedure 3**
2007-15	**Oil Change Reminder Reset - Procedure 6**
Terrain	
2011-14	**Oil Change Reminder Reset - Procedure 6**
Toronado	
1989-92	**Oil Change Reminder Reset - Procedure 31**
Torrent	

2006-09	**Oil Change Reminder Reset - Procedure 3**
Trailblazer	
2002-09	**Oil Change Reminder Reset - Procedure 11**
Traverse	
2009-14	**Oil Change Reminder Reset - Procedure 6**
Uplander, Montana SV6 (Canadian)	
2005-08	**Oil Change Reminder Reset - Procedure 6**
Venture	
2000-04	**Oil Change Reminder Reset - Procedure 3**
2005	**Oil Change Reminder Reset - Procedure 6**
Verano	
2012-14	**Oil Change Reminder Reset - Procedure 18**
Volt	
2011-14	**Oil Change Reminder Reset - Procedure 21**
XLR	
2004	**Oil Change Reminder Reset - Procedure 6**
2005-09	**Oil Change Reminder Reset - Procedure 19**
XTS	
2013-14	**Oil Change Reminder Reset - Procedure 33**
Yukon/ XL	
2000-06	**Oil Change Reminder Reset - Procedure 3**
2007-13	**Oil Change Reminder Reset - Procedure 6**

OIL CHANGE REMINDER RESET - PROCEDURE 1

1. The CHANGE OIL (or CHANGE ENGINE OIL) message is displayed when its time to change engine oil, usually between 3000 and 7500 miles since last oil change.
2. To reset the oil life monitor, turn the ignition switch to RUN position, with engine off. Press the TRIP/OIL RESET button on the instrument panel for 12 seconds. The OIL CHANGE light will start to flash to confirm that system is reset (on some models a chime will also sound). Reset is complete when OIL CHANGE light goes out.

OIL CHANGE REMINDER RESET - PROCEDURE 2

Engine oil life monitor calculates engine oil temperature and RPM. It indicates when the engine oil is nearly worn out. A CHANGE OIL light on the instrument cluster is illuminated when it is time to change the engine oil. To reset CHANGE OIL light:

1. Remove IP fuse block cover (cover can be seen when driver's door is open).
2. Turn ignition ON, engine OFF.
3. Press OIL RESET button and hold for 5 seconds.
4. If Oil Life light does not reset, repeat procedure with ignition OFF.

OIL CHANGE REMINDER RESET - PROCEDURE 3

Engine oil life monitor calculates engine oil temperature and RPM. It indicates when the engine oil is nearly worn out. A CHANGE OIL light on the instrument cluster is illuminated when it is time to change the engine oil.

1. To reset oil life monitor and turn off CHANGE OIL light, turn ignition switch to ON position with engine off.
2. Depress accelerator pedal to wide open throttle 3 times within 5 seconds. This throttle signal will inform the PCM to reset the oil life monitor and turn off the light. If light does not turn off, turn ignition off and repeat procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 4

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL SOON message will come on. Change the engine oil as soon as possible within the next 600 miles (1,000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

Reset Procedure

1. Turn the ignition key to RUN with the engine OFF.
2. Press the INFO and RESET buttons on the Driver Information Center (DIC) at the same time to enter the personalization menu.
3. Press the INFO button to scroll through the available personalization menu modes until the DIC display shows OIL-LIFE RESET.
4. Press the INFO and RESET buttons at the same time for one second and release.
5. Press and hold the reset button until the DIC display shows ACKNOWLEDGED. This will tell you the system has been reset.
6. Turn the key to LOCK/OFF.

Alternate Method (Some Models)

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 5

Engine oil life monitor calculates engine oil temperature and RPM. It indicates when the oil is nearly worn out. A CHANGE OIL light on left side of instrument cluster is illuminated when it is time to change oil. To reset oil life monitor:

1. Turn ignition on.
2. Depress ENG MET button on trip monitor and release.
3. Within 5 seconds, depress and release ENG MET button again.
4. Within 5 seconds, depress and hold the ENG MET or GAUGES button again. The CHANGE OIL light should flash.
5. Depress and hold the RANGE or GAUGES button until the CHANGE OIL light stops flashing and goes out. When the light goes out, the engine oil life monitor is reset. This should take about 10 seconds.

NOTE: If the light does not reset, turn ignition off and repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 6

The Driver Information Center (DIC) will display a CHANGE OIL message when an oil change is due. The instrument cluster may also have a CHANGE OIL light. To reset the oil life monitor:

Reset Procedure

1. Turn ignition switch to RUN position, with engine off.
2. Press the TRIP (on some models SELECT or SET/RESET) button, located on the DIC, until the OIL LIFE display appears. Message will display percentage of oil life remaining.

NOTE: On models without DIC buttons, use the TRIP/ODOMETER reset stem.

3. Press and hold SET/RESET button (on some models, the check-symbol button) on DIC for at least 5 seconds. The message will change to indicate that the Oil Life has been reset. On some models, 3 chimes will also sound.
4. Turn ignition off.
5. Turn the key to OFF. If the light or message comes back on when you start your vehicle, the oil life system has not reset. Repeat the procedure.

NOTE: On some models, if oil life system does not reset, try turning ignition OFF after displaying oil life message. Then press and hold reset button.

Alternate Method (Some Models)

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 7

When the system has calculated that oil life has been diminished, it indicates that an oil change is necessary. A

CHANGE ENGINE OIL SOON message in the DIC comes on. Reset the system whenever the engine oil is changed so that the system can calculate the next engine oil change. To reset the system:

1. Press the up or down arrow to scroll the DIC to show OIL LIFE.
2. Once the XXX% ENGINE OIL LIFE menu item is highlighted, press and hold the RESET button until the percentage shows 100%

OIL CHANGE REMINDER RESET - PROCEDURE 8

The CHANGE ENGINE OIL message is displayed when its time to change engine oil, usually between 3000 and 7500 miles since last oil change. The oil change interval is not based on mileage, but on engine revolutions and engine operating temperature.

1. There are 2 ways to reset the engine oil life monitor. To reset the engine oil life monitor using the accelerator pedal, go to step 4. To reset the engine oil life monitor using the radio, turn the radio off. Turn ignition to ACC or ON, with the engine off. Press and hold the DISP (on some models, TUNE DISP) button (or knob) on the radio for at least 5 seconds until SETTINGS is displayed.
2. Press the SEEK (on some models, SEEK PTYPE or SEEK PSCAN) up or down arrow to scroll through the main menu. Scroll until OIL LIFE appears on the display. Press the PREV or NEXT button to enter the sub-menu. RESET will be displayed.
3. Press the DISP/TUNE DISP button to reset. A chime will sound to verify the new setting and DONE will be displayed for one second. Once the message indicator has been reset, scroll through the menu until EXIT appears on the display. Press the DISP/TUNE DISP button to exit the program. A chime will sound to verify the exit.
4. To reset the engine oil life monitor using the accelerator pedal, turn ignition on with engine off. Fully depress and release the accelerator pedal slowly 3 times within 5 seconds. If CHANGE ENGINE OIL light flashes, oil life monitor is reset. If the CHANGE ENGINE OIL light comes back on and stays on, oil life monitor has not reset. Repeat reset procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 9

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE message will come on. Change the engine oil as soon as possible within the next 600 miles (1000 km). It is possible that, if driving under the best conditions, the oil life may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

To reset the Engine Oil Life System, do the following:

1. Press and hold the TRIP button on the steering wheel while turning on the ignition. Do not start the engine.
2. The instrument panel cluster will prompt to clear the service code.
3. Release the button.
4. Press and hold ENTER Switch on the left side of the steering wheel for approximately one second.
5. Turn off the ignition.

If the CHANGE ENGINE OIL SOON message comes back on when you start the vehicle, the engine oil life system has not reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 10

1. Turn ignition ON, with engine off.
2. Press and release reset stem on instrument panel while OIL LIFE message is displayed.
3. Once the alternating OIL LIFE and RESET messages appear, press and hold stem in until several beeps will sound. This confirms that oil life system has been reset. Turn ignition off or full LOCK position. If CHANGE OIL messages comes back after starting engine, repeat reset procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 11

Reset Procedure

If vehicle is equipped with a Driver Information Center (DIC), reset oil life monitor by pressing the Driver Information Center SELECT button for 5 seconds while ENGINE OIL LIFE is displayed.

Alternate Method

To reset the oil life monitor, turn ignition switch to ON or RUN position with engine off. Depress accelerator pedal slowly to wide open throttle 3 times within 5 seconds. If CHANGE ENG OIL light flashes for 5 seconds, oil life monitor is reset. If the CHANGE ENG OIL light does not flash, oil life monitor has not reset. Repeat this step.

OIL CHANGE REMINDER RESET - PROCEDURE 12

1. CHANGE OIL SOON light will come on when engine oil has broken down enough to require changing. After changing oil, reset oil life display.
2. To reset light, turn ignition on. Open glove box to access oil reset button. Press and hold oil reset button in glove box for at least 5 seconds, but not longer than 60 seconds. The CHANGE OIL SOON light will flash 4 times to indicate light has been reset.

OIL CHANGE REMINDER RESET - PROCEDURE 13

GM Oil Life System calculates when to change your engine oil and filter based on vehicle use. Anytime oil is changed, reset the system so it can calculate when the next oil change is required. If a situation occurs where you change your oil prior to a Change Oil Soon message being turned on, reset the system. After changing the engine oil, reset the system.

1. Display OIL LIFE RESET on the DIC.
2. Press and hold ENTER button for at least one second. An ACKNOWLEDGED display message will appear for 3 seconds or until the next button is pressed. This will tell you the system has been reset.
3. Turn key to OFF.
4. If Change Oil Soon message comes back on when you start your vehicle, engine oil life system has not reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 14

1. To display this light, press the GAGE INFO or GAGES button on the Driver Information Center (DIC). When oil life index is less than 10 percent, display will show OIL LIFE INDEX CHANGE OIL. After changing oil, reset system.
2. To reset light, display OIL LIFE INDEX. Hold RESET button for more than 5 seconds. After reset, oil life will change to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 15

1. CHANGE OIL SOON light will come on when engine oil has broken down enough to require changing. After changing oil, reset oil life display.
2. To reset light, locate reset button hole under the dash near passenger door. Use a pencil or similar object to push and hold button (inside hole) for 5 seconds. The CHANGE OIL SOON light will flash 4 times to indicate light has been reset.

OIL CHANGE REMINDER RESET - PROCEDURE 16

Vehicles WITHOUT Driver Information Center (DIC) Buttons

1. Turn the ignition to ON/RUN, with the engine off. The vehicle must be in P (Park) to access this display. Press the trip odometer reset stem until OIL LIFE REMAINING displays.
2. Press and hold the trip odometer reset stem until OIL LIFE REMAINING shows "100%." Three chimes sound and the CHANGE ENGINE OIL SOON message goes off.
3. Turn the key to LOCK/OFF. If the CHANGE ENGINE OIL SOON message comes back on when the vehicle is started, the engine oil life system has not been reset. Repeat the procedure.

Vehicles WITH Driver Information Center (DIC) Buttons

1. Turn the ignition to ON/RUN position, with the engine off.
2. Press the VEHICLE INFORMATION BUTTON (i) until OIL LIFE REMAINING displays.
3. Press and hold the SET/RESET button (check-mark symbol) until "100%" is displayed. Three chimes sound (on some models) and the CHANGE ENGINE OIL SOON message goes off.
4. Turn ignition to LOCK/OFF position. If the CHANGE ENGINE OIL SOON message comes back on when engine is started, repeat reset procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 17

Reset Procedure

1. Turn the ignition to ON, with the engine off.
2. Press the MODE button until the Driver Information Center (DIC) reads OIL LIFE LEFT/HOLD SET TO RESET.
3. Press and hold the SET button until 100% is displayed. You will hear three chimes and the CHANGE ENGINE OIL message will go off. Turn the key to OFF.

4. If the CHANGE ENGINE OIL message comes back on when engine is started, the engine oil life system has not reset. Repeat the procedure.

Alternate Method (Some Models)

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 18

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL message or light will come on. Change the engine oil as soon as possible within the next 600 miles (1 000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

NOTE: Be careful not to reset the oil life display accidentally at any time other than after the oil is changed. It cannot be reset accurately until the next oil change.

Vehicles with Driver Information Center (DIC)

1. Turn the ignition to ON/RUN with the engine off.
2. Press the DIC MENU button on the turn signal lever to enter the Vehicle Information Menu. Use the thumbwheel to scroll through the menu items until you reach REMAINING OIL LIFE. See **Fig. 2**.
3. Press the SET/CLR button (on some models, the check-symbol button) while the oil life display is active. After a few seconds, there will be a single chime (on some models) and the oil life will be reset to 100%
4. Turn the ignition to LOCK/OFF.

The system is reset when the CHANGE OIL message is off and the REMAINING OIL LIFE 100% message is displayed.

NOTE: If the CHANGE OIL message comes back on or Code 82 DIC message comes on when the vehicle is started, the engine oil life system has not been reset. Repeat the procedure.

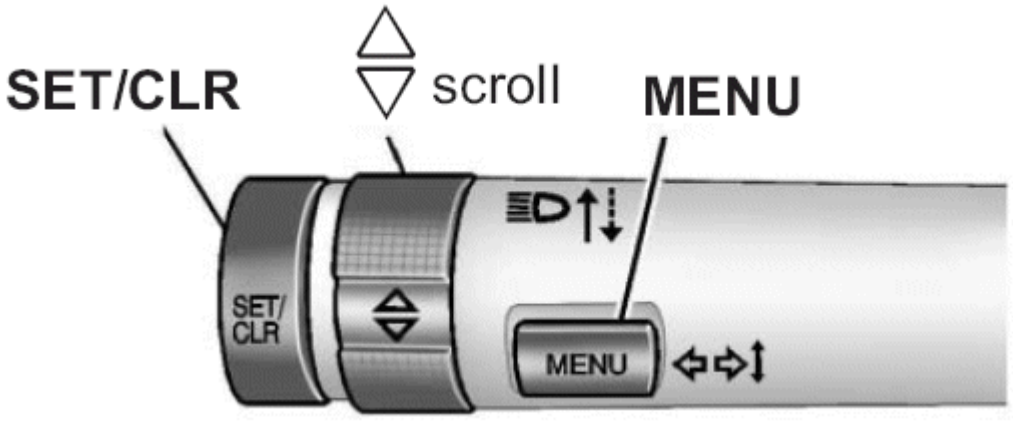


Fig. 2: Identifying DIC Controls (Turn Signal Lever)
Courtesy of GENERAL MOTORS CORP.

Vehicles without DIC (Some Models)

1. With the engine OFF, turn the ignition key to RUN.
2. Fully press and release the accelerator pedal slowly three times within five seconds.
3. Turn the key to OFF, than start the vehicle.

Reset Using Diagnostic Scan Tool (Some Models)

1. Turn on ignition.
2. Connect scan tool.
3. Select Module Diagnosis.
4. Select Engine Control Module.
5. Select Configuration/Reset function.
6. Select Engine Oil System Reset.
7. Push Enter button to run function.
8. Confirm Executed successfully.
9. Turn ignition of and confirm.
10. Turn ignition on and confirm.

OIL CHANGE REMINDER RESET - PROCEDURE 19

1. The Driver Information Center (DIC) will display remaining oil life as a percentage estimate of the useful life of oil.
2. When remaining oil life is 10 percent or less, the system will display CHANGE OIL SOON. When oil life expires, display will show CHANGE ENGINE OIL. After changing oil, reset oil life display.
3. To reset oil life display, press INFORMATION (or INFORMATION SKIP) button to display OIL LIFE LEFT. Press and hold RESET (or RESET NO) button until 100 OIL LIFE LEFT (0.0 OIL LIFE LEFT on some early models) is displayed.

OIL CHANGE REMINDER RESET - PROCEDURE 20

With Base Audio System

Press up or down arrow on the INFO button located to right of Driver Information Center (DIC) display to access DIC menu. Once 100 percent ENGINE OIL LIFE menu item is highlighted, press and hold the CLR button. Percentage will return to 100 and oil life indicator will be reset. Repeat procedure if the percentage does not return to 100.

With Navigation System

Turn the system on by pressing PWR/VOL knob once. PWR/VOL knob is located to lower left of DIC display. Press INFO button located to left of the display to access Vehicle Information menu. Turn TUNE/SEL knob located to lower right of the display until ENGINE OIL LIFE is highlighted. Press TUNE/SEL knob once to select it. When 100 percent Engine Oil Life is displayed, press multifunction button next to reset prompt in upper right corner of the display. Percentage will return to 100 and the oil life indicator will be reset. Repeat procedure if the percentage does not return to 100.

OIL CHANGE REMINDER RESET - PROCEDURE 21

1. Use the SELECT knob to select OIL LIFE on the DIC menu.
2. Press SELECT to start the OIL LIFE reset procedure.
3. The DIC menu will display "Are you sure that you want to reset?" Use SELECT to choose YES to reset oil life or NO to exit and return to the previous menu.
4. If YES is selected, the DIC menu will display RESET OIL LIFE for a short time and then 100% OIL LIFE will be display when OIL LIFE is successfully reset.

OIL CHANGE REMINDER RESET - PROCEDURE 22

With Base Audio System

1. Press the CLR button located to the right of the driver information center (DIC) display to acknowledge the Change Engine Oil message. This will clear the message from the display and reset it.
2. Press the up or down arrow on the INFO button located to the right of the Driver Information Center (DIC) display to access the DIC menu.
3. Once 100% ENGINE OIL LIFE menu item is highlighted, press and hold the CLR button. The percentage will return to 100 and the oil life indicator will be reset. Repeat the steps if the percentage does not return to 100.
4. Turn OFF the key. If the Change Engine Oil message comes back on when you start the vehicle, the engine oil life system has not reset. Repeat the procedure.

Without DIC

1. With the engine OFF, turn the ignition key to RUN.
2. Fully press and release the accelerator pedal slowly three times within five seconds.
3. Turn the key to OFF, then start the vehicle.

With Navigation System

1. Press the multifunction button, next to the OK prompt in the upper right of the display to acknowledge the Change Engine Oil message. This will clear the message from the display and reset it.
2. Turn the system on by pressing the PWR/VOL knob once. The PWR/VOL knob is located to the lower left of the driver information center (DIC) display.
3. Press the INFO button located to the left of the display to access the Vehicle Information menu.
4. Turn the TUNE/SEL knob located to the lower right of the display until Engine Oil Life is highlighted. Press the knob once to select it.
5. Once the 100% Engine Oil Life is displayed, press the multifunction button next to the Reset prompt in the upper right corner of the display. The percentage will return to 100 and the oil life indicator will be reset. Repeat the steps if the percentage does not return to 100.
6. Turn OFF the key. If the Change Engine Oil message comes back on when you start the vehicle, the engine oil life system has not reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 23

1. An OIL LIFE INDEX is one of the displays on Driver Information Center (DIC). It will display remaining oil life as a percentage estimate of the useful life of oil.
2. It will show 100 percent when the system is reset. When the oil life is 0 percent, the display will show CHANGE ENGINE OIL. After changing oil, reset oil life display.
3. To reset service reminder on 1989 models, press RANGE button until OIL LIFE INDEX appears on display. Depress and hold in AVG ECON and RANGE buttons for more than 5 seconds or until 100 is displayed. This will reset remaining oil life to 100 percent.
4. On 1990-93 models, press RANGE button until OIL LIFE INDEX appears on DIC display. Depress and hold in AVG SPEED and RANGE buttons for more than 5 seconds or until 100 is displayed. This will reset remaining oil life to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 24

1. An OIL LIFE INDEX is one of 4 displays on Driver Information Center (DIC). It will display remaining oil life as a percentage estimate of the useful life of oil.
2. Display will show 100 percent when the system is reset. When remaining oil life is 10 percent or less, the system will display CHANGE OIL SOON. When the oil life expires, the display will show CHANGE ENGINE OIL. After changing oil, reset oil life display.
3. To reset oil life display, press ENG DATA button until OIL LIFE INDEX appears on DIC display. Depress and hold in ENG DATA and RANGE buttons until 100 is displayed. This will reset remaining oil life to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 25

1. An OIL LIFE INDEX is one of the displays on Driver Information Center (DIC). It will display remaining oil life as a estimated percentage of the useful life of oil.
2. It will show 100 percent when the system is reset. When the oil life is 0 percent, the display will show CHANGE ENGINE OIL. After performing necessary services, reset service reminder.

3. To reset service reminder, turn ignition to on position. Do not start engine. Depress and hold RANGE and FUEL USED buttons until OIL LIFE INDEX appears on DIC display. Depress and hold RANGE and RESET buttons for 5-60 seconds.
4. When CHANGE OIL SOON light flashes 4 times, remaining oil life index is reset to 100 percent. If CHANGE OIL SOON comes on and stays on for 5 seconds, display did not reset. Repeat step 3.

OIL CHANGE REMINDER RESET - PROCEDURE 26

1. Oil change reminder display on the Driver Information Center (DIC) is similar to 1990-91 models, but reset procedures are different. After changing oil, reset oil life display.
2. To reset, press INFORMATION button to display OIL LIFE INDEX. Press and hold STORE/RECALL button until 100 is displayed. This will reset oil life display to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 27

1. The Driver Information Center (DIC) displays estimated percentage of the remaining useful life of engine oil or transaxle fluid. When remaining oil or fluid life is 0 percent, the display will show CHANGE OIL NOW or CHANGE TRNS FLUID NOW. After changing engine oil or transaxle fluid, reset oil life display.
2. To reset the display, turn ignition on with engine off. Press ENG button to select the OIL LIFE or TRNS FLUID LIFE percentage display. Then, press and hold in RESET for at least 5 seconds.
3. The word RESET will appear. Then, OIL LIFE 100 or TRNS FLUID 100 will be displayed.

OIL CHANGE REMINDER RESET - PROCEDURE 28

1. An oil change reminder displays estimated percentage of the remaining useful life of the oil. When engine is started, a tone will sound and approximate distance to next oil change will be displayed.
2. When remaining oil life is 10 percent or less, the system will calculate distance to next oil change. When the oil life is 0 percent, the display will show CHANGE OIL NOW. After changing oil, reset oil life display.
3. To reset the display, press and hold in OIL button to select the oil life display. Then, press and hold in RESET and OIL buttons for at least 5 seconds. This will reset oil life display to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 29

1. To reset the display, press and release the TEST button.
2. Press and release the OIL button.
3. Press and hold the RESET button for at least 7 seconds. This will reset oil life display to 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 30

1. To reset the display, press and release RESET button on Driver Information Center (DIC).
2. Press SEL button (with down arrow) to select OIL.
3. Press SEL button (with left and right arrows) to display oil life.

4. Press and hold RESET button for about 5 seconds.
5. A reset message will display, then oil life will display 100 percent.

OIL CHANGE REMINDER RESET - PROCEDURE 31

With Information Center Display

OIL LIFE INDEX is one of 4 engine data displays used on models with Information Center display. It will display remaining oil life as estimated percentage of the useful life of oil. It will show 100 percent when the system is reset. After changing oil, reset oil life display.

1. To reset the display, press ENG DATA button (1989-90) or OPTIONS button (1991-92) until oil life index is displayed.
2. Then, press and hold in ENG DATA and GAGE buttons (1989) or RESET/ENTER button (1990-92) for at least 5 seconds. This will reset remaining oil life to 100 percent.

With Visual Information Center

OIL LIFE is one of the displays used on models with a Visual Information Center (VIC). It will display data regarding previous oil change. A bar graph display shows full when oil is changed. Bar graph will go down as vehicle is driven and oil ages. When bar graph reaches CHANGE OIL mark, oil should be changed. After changing oil, reset oil life display.

1. To reset the display, press INFO hard key and then OIL LIFE soft key to display oil life index.
2. Press RESET soft key.
3. A reset confirmation page will appear and ask if oil has been changed. Press YES soft key to reset bar graph, and update last oil change date and mileage information.

OIL CHANGE REMINDER RESET - PROCEDURE 32

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL SOON message will come on. Change the engine oil as soon as possible within the next 600 miles (1000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

To reset the Engine Oil Life System, do the following:

1. With the CHANGE OIL SOON message displayed, press any of the three driver information center (DIC) buttons to clear the CHANGE OIL SOON message.
2. Display OIL LIFE RESET on the DIC.
3. Press and hold the ENTER button for at least one second. An ACKNOWLEDGED display message will appear for three seconds or until the next button is pressed. This will tell you the system has reset.
4. Turn the ignition to OFF.

If the CHANGE ENGINE OIL message comes back on when you start the vehicle the Engine Oil Life System

has not reset. Repeat the procedure.

OIL CHANGE REMINDER RESET - PROCEDURE 33

This vehicle has a computer system that indicates when to change the engine oil and filter. This is based on a combination of factors which include engine revolutions, engine temperature, and miles driven. Based on driving conditions, the mileage at which an oil change is indicated can vary considerably. For the oil life system to work properly, the system must be reset every time the oil is changed. To reset the system:

Reset Procedure

1. Using the DIC controls on the right side of the steering wheel, display REMAINING OIL LIFE on the driver information center (DIC).
2. Press SEL on the DIC controls and hold SEL down for a few seconds to clear the CHANGE ENGINE OIL SOON message and reset the oil life at 100%.

NOTE: Be careful not to reset the oil life display accidentally at any time other than after the oil is changed. It cannot be reset accurately until the next oil change.

Alternate Method (Some Models)

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

OXYGEN SENSOR REMINDER FLAG

NOTE: To determine the appropriate reset procedure, refer to OXYGEN SENSOR REMINDER FLAG RESET. Only vehicles listed in this index have an oxygen sensor reminder flag reset.

OXYGEN SENSOR REMINDER FLAG RESET INDEX

Model & Year	Reset Procedure
Some Models	
1980	Oxygen Sensor Reminder Flag - Procedure 1

OXYGEN SENSOR REMINDER FLAG - PROCEDURE 1

1. Every 30,000 miles, a reminder flag appears in speedometer face, indicating service of oxygen sensor is necessary. See **Fig. 3**. Inspect and service oxygen sensor as necessary and reset flag.
2. To reset flag, remove instrument panel trim plate. Remove instrument cluster lens. Using pointed tool, apply light downward pressure on notches of flag until it is reset. An alignment mark will appear in left

center of odometer window when flag is fully reset.

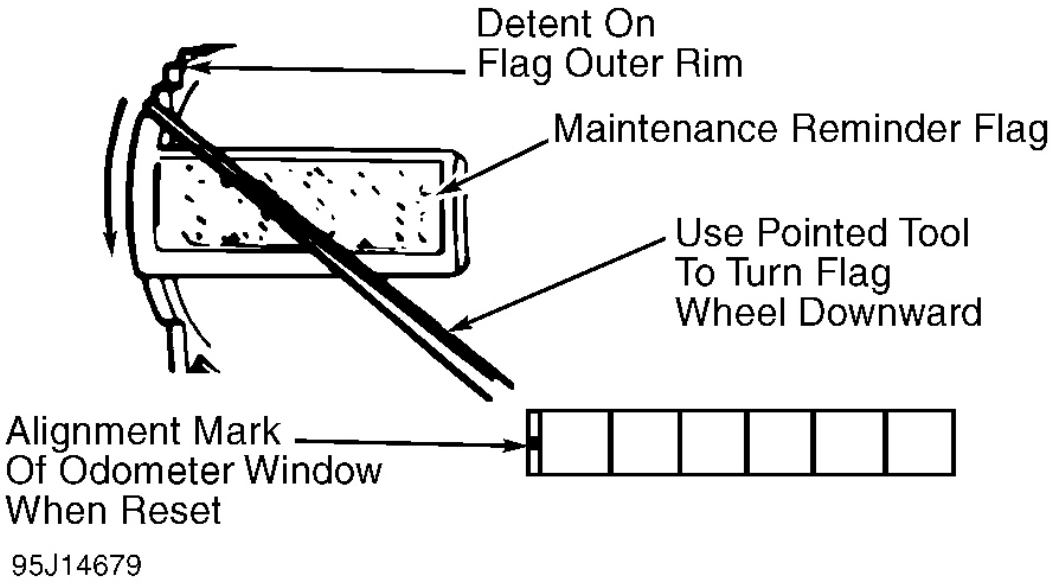


Fig. 3: Resetting Reminder Flag
Courtesy of GENERAL MOTORS CORP.

OXYGEN SENSOR WARNING LIGHT

NOTE: To determine the appropriate reset procedure, refer to OXYGEN SENSOR WARNING LIGHT RESET INDEX. Only vehicles listed in this index have an oxygen sensor warning light reset.

OXYGEN SENSOR WARNING LIGHT RESET INDEX

Model & Year	Reset Procedure
Sprint	
1985-86	Oxygen Sensor Warning Light Reset - Procedure 1

OXYGEN SENSOR WARNING LIGHT RESET - PROCEDURE 1

At 30,000 mile intervals, a SENSOR light in dash will start flashing, indicating oxygen sensor needs replacement. To reset mileage counter (after sensor replacement), locate SENSOR light cancel switch on right side of fuse box. Return cancel switch to OFF position. Start engine to ensure light remains off.

SERVICE REMINDER MESSAGE

NOTE: To determine the appropriate reset procedure, refer to Service Reminder Reset

Index. Only vehicles listed in this index have a Service Reminder reset.

SERVICE REMINDER RESET INDEX

Model & Year	Reset Procedure
6000 STE	
1987-89	Service Reminder Message Reset - Procedure 1
Bonneville	
1988-91	Service Reminder Message Reset - Procedure 1
Caprice	
2011	Service Reminder Message Reset - Procedure 2

SERVICE REMINDER MESSAGE RESET - PROCEDURE 1

The SERVICE REMINDER message light is used on models with a Driver Information Center (DIC). After performing necessary services, reset service reminder light.

1. To reset service reminder, push DIC button until desired service item is displayed.
2. Press and hold down the DIC button. With button pressed, the distance display will decrease in increments of 500 miles.
3. Release button when desired distance is displayed on the DIC.

SERVICE REMINDER MESSAGE RESET - PROCEDURE 2

The displayed service reminder is reset using a scan tool or by the following procedure:

1. Turn the ignition to the OFF position.
2. Press and hold the TRIP button.
3. Turn the ignition to the ON position.
4. Release the TRIP button.
5. Once in the Service Reset screen, press and hold the ENTER switch for 3-5 seconds. A confirmation beep will sound upon reset.
6. Turn the ignition to the OFF position.

NOTE: If the service reminder comes back on when you start the vehicle, the Service Reminder Display has not reset. Repeat the procedure.

TIRE PRESSURE MONITOR SYSTEM (TPMS)

NOTE: To determine the appropriate reset procedure, refer to TPMS RESET INDEX. Only vehicles listed in this index have a TPMS reset.

TPMS RESET INDEX

Model	Application	Procedure

Buick		
Allure	2007	**TPMS Reset - Procedure 1**
	2008-09	**TPMS Reset - Procedure 2**
Century	1999-05	(1) **TPMS Reset - Procedure 21**
Enclave	2008-12	**TPMS Reset - Procedure 2**
	2013-15	**TPMS Reset - Procedure 9**
Encore	2013-14	**TPMS Reset - Procedure 25**
LaCrosse	2006-09	**TPMS Reset - Procedure 2**
	2010-12	**TPMS Reset - Procedure 11**
	2013-14	**TPMS Reset - Procedure 26**
LaSabre	2002-05	(1) **TPMS Reset - Procedure 20**
Lucerne	2006	(1) **TPMS Reset - Procedure 22**
	2007-11	**TPMS Reset - Procedure 2**
Park Avenue	1998-05	(1) **TPMS Reset - Procedure 20**
Rainier	2006-07	**TPMS Reset - Procedure 1**
Regal	1999-04	(1) **TPMS Reset - Procedure 21**
	2011-12	**TPMS Reset - Procedure 11**
	2013-14	**TPMS Reset - Procedure 26**
Rendezvous	2003-07	(1) **TPMS Reset - Procedure 24**
Verano	2012	**TPMS Reset - Procedure 11**
	2013-14	**TPMS Reset - Procedure 26**
Cadillac		
ATS	2013-14	**TPMS Reset - Procedure 11**
CTS	2004-11	**TPMS Reset - Procedure 31**
	2012	With RPO UH3: **TPMS Reset - Procedure 9** W/O RPO UH3: **TPMS Reset - Procedure 10**
	2013-14	**TPMS Reset - Procedure 9**
Deville	2001-05	**TPMS Reset - Procedure 4**
DTS	2006-11	**TPMS Reset - Procedure 2**
ELR	2014	**TPMS Reset - Procedure 11**
Escalade Series	2004-06	**TPMS Reset - Procedure 1**
	2008-12	**TPMS Reset - Procedure 2**
	2013-14	**TPMS Reset - Procedure 9**
	2015	**TPMS Reset - Procedure 11**
Seville	2001-04	**TPMS Reset - Procedure 4**
SRX	2008-11	**TPMS Reset - Procedure 2**
	2012-14	**TPMS Reset - Procedure 11**
STS	2005-11	**TPMS Reset - Procedure 3**

XLR	2008	**TPMS Reset - Procedure 2**
XTS	2013-14	**TPMS Reset - Procedure 11**
Chevrolet		
Avalanche	2004-07	**TPMS Reset - Procedure 1**
	2008-11	**TPMS Reset - Procedure 2**
	2012	**TPMS Reset - Procedure 3**
	2013	**TPMS Reset - Procedure 9**
Aveo	2008-11	(2) **TPMS Reset - Procedure 7**
Camaro	2010-11	**TPMS Reset - Procedure 2**
	2012	**TPMS Reset - Procedure 11**
	2013-14	**TPMS Reset - Procedure 25**
Caprice	2011-13	**TPMS Reset - Procedure 31**
	2014	**TPMS Reset - Procedure 25**
Captiva Sport	2012-14	**TPMS Reset - Procedure 2**
Cobalt	2008-10	**TPMS Reset - Procedure 3**
Colorado	2006-12	**TPMS Reset - Procedure 1**
Corvette	1987-96	(1) **TPMS Reset - Procedure 20**
	1997-04	**TPMS Reset - Procedure 6**
	2005-06	**TPMS Reset - Procedure 3**
	2007-13	**TPMS Reset - Procedure 9**
	2014	**TPMS Reset - Procedure 8**
Cruze	2011-12	**TPMS Reset - Procedure 11**
	2013-14	**TPMS Reset - Procedure 25**
Equinox	2007	**TPMS Reset - Procedure 5**
	2008-11	**TPMS Reset - Procedure 2**
	2012	**TPMS Reset - Procedure 11**
	2013-14	**TPMS Reset - Procedure 25**
HHR	2008-11	**TPMS Reset - Procedure 3**
G-Series Van	2008-12	**TPMS Reset - Procedure 2**
	2013-14	**TPMS Reset - Procedure 27**
Impala	2000-02	(1) **TPMS Reset - Procedure 13**
	2003-05	(1) **TPMS Reset - Procedure 14**
	2006-07	**TPMS Reset - Procedure 5**
	2008-12	**TPMS Reset - Procedure 2**
	2013	**TPMS Reset - Procedure 9**
	2014	**TPMS Reset - Procedure 28**
Impala Limited	2014	**TPMS Reset - Procedure 9**
Malibu/Classic	2008-11	**TPMS Reset - Procedure 3**
	2012	**TPMS Reset - Procedure 2**
	2013-14	**TPMS Reset - Procedure 25**

	2015	**TPMS Reset - Procedure 28**
Monte Carlo	2000-02	(1) **TPMS Reset - Procedure 13**
	2003-05	(1) **TPMS Reset - Procedure 14**
	2006-07	**TPMS Reset - Procedure 5**
Orlando (Canada)	2012	**TPMS Reset - Procedure 11**
Silverado Series	2006-07	**TPMS Reset - Procedure 1**
	2008-11	**TPMS Reset - Procedure 2**
	2012	**TPMS Reset - Procedure 3**
	2013	**TPMS Reset - Procedure 27**
	2014-15	**TPMS Reset - Procedure 26**
Sonic	2012	**TPMS Reset - Procedure 11**
	2013-14	**TPMS Reset - Procedure 25**
Spark	2012-14	**TPMS Reset - Procedure 29**
Spark EV	2014-15	**TPMS Reset - Procedure 30**
SS	2014	**TPMS Reset - Procedure 25**
Suburban	2004-07	**TPMS Reset - Procedure 1**
	2008-11	**TPMS Reset - Procedure 2**
	2012	**TPMS Reset - Procedure 3**
	2013-14	**TPMS Reset - Procedure 9**
	2015	**TPMS Reset - Procedure 26**
Tahoe	2004-07	**TPMS Reset - Procedure 1**
	2008-11	**TPMS Reset - Procedure 2**
	2012	**TPMS Reset - Procedure 3**
	2013-14	**TPMS Reset - Procedure 9**
	2015	**TPMS Reset - Procedure 26**
TrailBlazer	2006-07	**TPMS Reset - Procedure 1**
Traverse	2009-12	**TPMS Reset - Procedure 2**
	2013-15	**TPMS Reset - Procedure 9**
Uplander	2008	**TPMS Reset - Procedure 3**
Volt	2011-12	**TPMS Reset - Procedure 11**
	2013-14	**TPMS Reset - Procedure 30**
GMC		
Acadia	2007-11	**TPMS Reset - Procedure 3**
	2012	**TPMS Reset - Procedure 2**
	2013-15	**TPMS Reset - Procedure 9**
Canyon	2006-12	**TPMS Reset - Procedure 1**
Envoy	2006-09	**TPMS Reset - Procedure 1**
Savana Series	2008-12	**TPMS Reset - Procedure 2**
	2013-14	**TPMS Reset - Procedure 27**
Sierra Series	2006-07	**TPMS Reset - Procedure 1**
	2008-11	**TPMS Reset - Procedure 2**

	2012	**TPMS Reset - Procedure 3**
	2013	**TPMS Reset - Procedure 9**
	2014-15	**TPMS Reset - Procedure 26**
Terrain	2010-11	**TPMS Reset - Procedure 2**
	2012-14	**TPMS Reset - Procedure 12**
Yukon Series	2004-07	**TPMS Reset - Procedure 1**
	2008-11	**TPMS Reset - Procedure 2**
	2012	**TPMS Reset - Procedure 3**
	2013-14	**TPMS Reset - Procedure 9**
	2015	**TPMS Reset - Procedure 26**
Oldsmobile		
Alero	1999-00	(1) **TPMS Reset - Procedure 16**
Aurora	2001-03	(1) **TPMS Reset - Procedure 17**
Pontiac		
Aztek	2003-05	(1) **TPMS Reset - Procedure 23**
Bonneville	2000-05	(1) **TPMS Reset - Procedure 15**
G3	2009	**TPMS Reset - Procedure 2**
G5	2008-09	**TPMS Reset - Procedure 2**
G6	2008-10	**TPMS Reset - Procedure 2**
G8	2008-09	**TPMS Reset - Procedure 2**
Grand Am	1999-05	(1) **TPMS Reset - Procedure 18**
Grand Prix	2008	**TPMS Reset - Procedure 2**
Solstice	2008-10	**TPMS Reset - Procedure 2**
Torrent	2008-09	**TPMS Reset - Procedure 2**
Wave	2008	**TPMS Reset - Procedure 2**
Vibe	2005-07	(1) **TPMS Reset - Procedure 19**

(1) This is an Indirect TPM System. A tire sensor activation tool is not required for this procedure.

(2) A tire sensor activation tool cannot be used for this procedure.

TPMS RESET - PROCEDURE 1

NOTE: When the wheels have been rotated, or a tire pressure sensor or EGM/LGM has been replaced, retrain tire pressure sensors.

NOTE: The DIC will display the "SERVICE TIRE MONITOR" message if one or more of the tire pressure sensors has malfunctioned or if all of the sensors have not been programmed successfully. If, after the relearn procedure, the warning indicators are still on, there is a problem in the TPM system.

NOTE: **If this procedure is performed following replacement and reprogramming of the Liftgate Module (LGM), DIC may display a low tire pressure fault and all tire pressures read 0 psi. If this problem occurs, see appropriate manufacturer service information.**

NOTE: **The TPM system will cancel the learn mode if more than 2 minutes have passed and no sensors have been learned, or if the system has been in learn mode for more than 5 minutes. If the learn mode is canceled before any sensor has been learned, the EGM/LGM will remember all current sensor IDs and their locations. As soon as the first sensor ID code is learned, all other IDs are erased from the EGM/LGM's memory. On models that display the individual tire pressure on DIC, updated tire pressures will not be displayed until EGM/LGM receives 2 more valid transmissions from each sensor.**

NOTE: **Before proceeding with the steps below, ensure that no other sensor learn procedure is being performed simultaneously, or that tire pressures are not being adjusted on a TPM equipped vehicle within close proximity.**

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF. Apply parking brake.

NOTE: **If Learn Mode cannot be enabled, TPM system is not enabled in EGM/LGM. See appropriate manufacturer service information.**

3. To enable Learn Mode, turn headlight switch from OFF to parking lamps 4 times within 4 seconds. A double horn chirp will sound and the low tire pressure indicator will begin to flash to indicate the learn mode has been enabled.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, turn ignition switch to OFF position to exit Learn Mode.
7. Test drive the vehicle above 25 mph for at least 2 minutes before viewing tire pressures on DIC.

TPMS RESET - PROCEDURE 2

NOTE: **If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be retrained.**

NOTE: **When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.**

NOTE: **Under the following conditions, the TPM system may not function properly:**

- **If one or more of the tire pressure sensors are missing or inoperable.**
- **A compact spare tire is used.**

NOTE: **If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be retrained.**

NOTE: **The relearn procedure must be completed within 15 minutes from when the vehicle is stationary after being driven at 20 mph (32 km/h), or greater, for 10 seconds.**

NOTE: **The learn mode will cancel if the ignition is cycled to OFF or if more than 2 minutes has elapsed for any sensor that has not been learned. If the learn mode is cancelled before the first sensor is learned, the original sensor IDs will be maintained. If the learn mode is canceled after the first sensor is learned, the following will occur:**

- **All stored sensor IDs will be invalidated in the RCDLR memory.**
- **If equipped, the DIC will display dashes instead of tire pressures.**
- **DTC C0775 will be set.**

These conditions will now require the learn procedure to be repeated for the system to function properly.

IMPORTANT: **Ensure that no other learn procedure is being performed simultaneously or that tire pressures are not being adjusted on another TPM equipped vehicle within close proximity. Stray signals from other TPM equipped vehicles just driving by can be inadvertently learned. If any random horn chirps are heard from the vehicle while performing the learn procedure, most likely a stray sensor has been learned and the procedure will need to be cancelled and repeated. Under these circumstances, performing the TPM Learn Procedure away from other vehicles would be highly recommended. In the event a particular sensor activation does not cause the horn to chirp, it may be necessary to rotate the wheel valve stem to a different position due to the sensor signal is being blocked by another component.**

1. Turn ignition switch to ACC position. Apply parking brake.
2. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
3. To enable Learn Mode:
    - On vehicles equipped with keyless entry, simultaneously press the keyless entry transmitters lock and unlock buttons until a double horn chirp sounds indicating the Learn Mode has been enabled. On vehicles with DIC, a TIRE LEARN message may be displayed. The left front turn signal will

also be illuminated.

- On vehicles not equipped with keyless entry, press and release the driver information center (DIC) INFO button until the TIRE LEARN message appears on the DIC display. Press and hold the SET/RESET button until a double horn chirp sounds indicating the Learn Mode has been enabled. The left front turn signal will also be illuminated.

4. Ignition ON.
5. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
6. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
7. After left rear sensor has been learned, turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 3

NOTE: If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be relearned.

NOTE: When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: In vehicles without the "UH3" option, each turn signal will illuminate one at a time indicating which location is to be learn.

NOTE: The TPM system will cancel the learn mode if more then 2 minutes have passed and no sensors have been learned, or if the ignition switch is turn to the OFF position. If the learn mode is canceled before the first ID is learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory. If the learn mode is canceled after the first ID is learned, the RCDLR will store the IDs as invalid and the DIC will display dashes instead of tire pressures.

NOTE: Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition switch to ACC position. Apply parking brake.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a double horn chirp sounds, indicating the Learn Mode has been enabled.

NOTE: The left front turn signal will also illuminate to indicate the learn mode has been enabled.

4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 4

NOTE: If the wheels have been rotated, or tire pressure sensor or Remote Control Door Lock Receiver (RCDLR) is replaced, the TPM system needs to relearn tire pressure sensor IDs.

NOTE: When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: The TPM system will cancel Learn Mode if ignition is turned off, if more than 1 or 2 minutes has passed and no sensors have been learned, vehicle battery voltage is less than 8 volts, all 4 sensors have been learned, or if the RCDLR has been in Learn Mode for more than 5 minutes. If Learn Mode is cancelled before any IDs are learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory.

NOTE: Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF.

NOTE: If the TPM Learn Mode cannot be enabled, ensure the TPM option is enabled in the RCDLR. See appropriate manufacturer service information.

3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a horn chirp sounds, indicating Learn Mode has been enabled.

NOTE: If a horn chirp does not sound after 15 seconds, remove, then re-apply TPM sensor relearn magnet.

4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After the horn chirp sounds, proceed to the next 3 sensors in the following order: right front, right rear, then left rear.
6. After the left rear sensor ID is learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn the ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 5

NOTE: If the wheels have been rotated, or tire pressure sensor or Remote Control Door Lock Receiver (RCDLR) is replaced, the TPM system needs to relearn tire pressure sensor IDs.

NOTE: When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: The TPM system will cancel Learn Mode if ignition is turned off, if more than 1 or 2 minutes has passed and no sensors have been learned, vehicle battery voltage is less than 8 volts, all 4 sensors have been learned, or if the RCDLR has been in Learn Mode for more than 5 minutes. If Learn Mode is cancelled before any IDs are learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory.

NOTE: Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a horn chirp sounds, indicating Learn Mode has been enabled.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After the horn chirp sounds, proceed to the next 3 sensors in the following order: right front, right rear, then left rear.
6. After the left rear sensor ID is learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn the ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 6

NOTE: If the wheels have been rotated, or tire pressure sensor or Remote Control Door

Lock Receiver (RCDLR) is replaced, the TPM system needs to relearn tire pressure sensor IDs.

NOTE: When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: The TPM system will cancel Learn Mode if ignition is turned off, if more than 1 or 2 minutes has passed and no sensors have been learned, vehicle battery voltage is less than 8 volts, all 4 sensors have been learned, or if the RCDLR has been in Learn Mode for more than 5 minutes. If Learn Mode is cancelled before any IDs are learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF.
3. Press RESET button on DIC in order to clear any warning messages.
4. Press and release OPTIONS button until display is blank.
5. Press and hold RESET button for 3 seconds.

NOTE: If the DIC does not display "TIRE TRAINING" message, ensure TPM option is enabled in the RCDLR. See appropriate manufacturer service information.

6. Press and release OPTIONS button until "TIRE TRAINING" is displayed.
7. Press and release RESET button. The DIC should display "LEARN L FRONT TIRE", verifying Learn Mode has been enabled.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After the horn chirp sounds, proceed to the next 3 sensors in the following order: right front, right rear, then left rear.
10. Turn the ignition switch to OFF position to exit the learn mode.

TPMS RESET - PROCEDURE 7

NOTE: An OEM scan tool or Pressure Increase/Decrease Method is used to perform this procedure.

NOTE: Before proceeding with this process, ensure that no other learn procedure is being performed simultaneously or that tire pressures are not being adjusted on another TPM equipped vehicle within close proximity. Stray signals from

other TPM equipped vehicles just driving by can be inadvertently learned. If any random horn chirps are heard from the vehicle while performing the learn procedure, most likely a stray sensor has been learned and the procedure will need to be cancelled and repeated. Under these circumstances, performing the TPM Learn Procedure away from other vehicles would be highly recommended. In the event a particular sensor activation does not cause the horn to chirp, it may be necessary to rotate the wheel valve stem to a different position due to the sensor signal is being blocked by another component.

1. Ignition ON with engine OFF, apply the parking brake.
2. Using a scan tool, initiate the TPM Learn Mode.
3. Perform the procedure by following the menu selections. A double horn chirp will sound and the IPC tire pressure monitor indicator warning lamp icon will flash indicating Learn Mode is enabled.
4. Starting with the left front tire, active the sensors by one of the following methods:
    - Hold the antenna of the scan tool, aimed upward, against the tire sidewall close to the wheel rim at the valve stem location. Press and release the activate button and wait for a horn chirp. Once the horn chirp has sounded, the sensor information is learned.
    - Increase/decrease the tire pressure for 8-10 seconds then wait for a horn chirp. The horn chirp may occur before or up to 30 seconds after the 8-10 second pressure increase/decrease time period has been reached. Once the horn chirp has sounded, the sensor information has been learned.
5. After the horn chirp has sounded, repeat step 4 for the remaining 3 sensors in the following order: Right front, Right rear, Left rear.
6. After the left rear sensor is learned, a double horn chirp will sound indicating all sensor IDs have been learned and the tire pressure module will exit the Learn mode turning OFF the IPC tire pressure monitor warning indicator lamp icon.
7. Ignition OFF, adjust all tires to the recommended pressures. Refer to the tire placard label.

TPMS RESET - PROCEDURE 8

Automatic Sensor Learn Process

Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the tires or replacing one or more of the TPMS sensors. When a tire is installed, the vehicle must be stationary for about 20 minutes before the system recalculates. The following relearn process takes up to 10 minutes, driving at a minimum speed of 12 mph (19 km/h). A dash (-) or pressure value will display in the DIC. A warning message displays in the DIC if a problem occurs during the relearn process.

TPMS RESET - PROCEDURE 9

NOTE: If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be relearned.

NOTE: When the tire pressure warning light illuminates and warning message appears

on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: The TPM system will cancel the learn mode if more then 2 minutes have passed and no sensors have been learned, or if the ignition switch is turn to the OFF position. If the learn mode is canceled before the first ID is learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory. If the learn mode is canceled after the first ID is learned, the RCDLR will store the IDs as invalid and the DIC will display dashes instead of tire pressures.

NOTE: Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition switch to RUN position. Apply parking brake.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a double horn chirp sounds, indicating the Learn Mode has been enabled.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 10

NOTE: If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be relearned.

NOTE: When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: The TPM system will cancel the learn mode if more then 2 minutes have passed and no sensors have been learned, or if the ignition switch is turn to the OFF position. If the learn mode is canceled before the first ID is learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first

sensor ID is learned, all other IDs are erased from the RCDLR's memory. If the learn mode is canceled after the first ID is learned, the RCDLR will store the IDs as invalid and the DIC will display dashes instead of tire pressures.

NOTE: Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Depending on ignition type:
   - With standard ignition switch, place the switch in the RUN position.
   - With electronic keyless ignition, place the switch in the ACC position.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a double horn chirp sounds, indicating the Learn Mode has been enabled.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 11

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Place the vehicle power mode in ON/RUN/START.
4. Make sure the Tire Pressure info display option is turned on. The info displays on the DIC can be turned on and off through the Settings menu.
5. Use the five-way DIC control on the right side of the steering wheel to scroll to the Tire Pressure screen under the DIC info page.
6. Press and hold the SEL button located in the center of the five-way DIC control. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen
7. Start with the driver side front tire. Place a tire sensor activation tool against the tire sidewall, near the valve stem. Then press the button to activate the TPMS sensor. A horn chirp confirms that the sensor identification code has been matched to this tire and wheel position.
8. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
9. After left rear sensor has been learned, the horn sounds two times to indicate the sensor identification code has been matched to the driver side rear tire, and the TPMS sensor matching process is no longer active. The TIRE LEARNING ACTIVE message on the DIC display screen goes off.
10. Press STOP to turn the ignition off.

TPMS RESET - PROCEDURE 12

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine off.
4. Use the MENU button (center console) to select the Vehicle Information Menu in the Driver Information Center (DIC). Use the arrow keys to scroll to the Tire Pressure screen
5. Press the SET/CLR button to begin the sensor matching process. A message requesting acceptance of the process should display.
6. Press the SET/CLR button again to confirm the selection. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
7. Start with the driver side front tire. Place a tire sensor activation tool against the tire sidewall, near the valve stem. Then press the button to activate the TPMS sensor. A horn chirp confirms that the sensor identification code has been matched to this tire and wheel position.
8. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
9. After left rear sensor has been learned, the horn sounds two times to indicate the sensor identification code has been matched to the driver side rear tire, and the TPMS sensor matching process is no longer active. The TIRE LEARNING ACTIVE message on the DIC display screen goes off.
10. Turn the ignition to LOCK/OFF.

TPMS RESET - PROCEDURE 13

LOW TIRE PRESSURE light comes on if air pressure in one tire drops to 12 psi (kPa) less than the other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, if air pressure is adjusted or when vehicle battery is disconnected. Light will stay on until ignition is turned off or RESET button is pressed. Check and adjust air pressure in all 4 tires before resetting system.

1. There are 2 ways to reset the tire inflation monitor. To reset the tire inflation monitor using the exterior or interior lamp controls, go to step 4. To reset tire inflation monitor using the radio, turn the radio off. Turn ignition to ACC or ON, with the engine OFF. Press and hold the TUNE DISP button on the radio for at least 5 seconds until settings is displayed.
2. To scroll through the main menu:
   - On Impala, press the SEEK PTYPE up or down arrow.
   - On Monte Carlo, press the SEEK PSCAN up or down arrow.

   On all models, scroll until TIRE MON appears on the display. Press the 1 PREV or 2 NEXT button to enter the sub-menu. RESET will be displayed.
3. Press the TUNE DISP button to reset. A chime will sound to verify the new setting and DONE will be displayed for one second. Once the message has been reset, scroll through the menu until EXIT appears on the display. Press the TUNE DISP button to exit the program. A chime will sound to verify the exit.
4. Reset the tire inflation monitor:
   - On Impala, using the interior lighting controls, turn the switch from OFF to ON position 3 times with ignition switch in ON position.

- On Monte Carlo, using the exterior lighting controls, turn the switch from OFF to parking lamps 3 times with ignition switch in ON position.

TPMS RESET - PROCEDURE 14

NOTE: There are 3 different ways to reset the Tire Pressure Monitor (TPM) system. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the 3 speed ranges to complete the calibration process.

Using Exterior Lamp Switch

1. Adjust all tire pressures to the recommended kPa/psi.
2. Turn ignition ON with engine OFF.
3. Cycle the exterior lamp switch from OFF to parking lamps 3 times within 5 seconds.
4. Use the scan tool in order to clear the TPM DTC.

Using RDS Radio, If Equipped

1. Adjust all tire pressures to the recommended kPa/psi.
2. Turn the ignition to ACC or ON, with the engine OFF.
3. Turn the radio OFF.
4. Press and hold the DISP button until SETTINGS is displayed.
5. Press the SEEK up or down arrows until TIRE MON is displayed.
6. Press the PREV or NEXT button to enter the sub-menu. RESET will be displayed.
7. Press the DISP button, A chime will sound and DONE will be displayed.
8. Scroll until EXIT is displayed.
9. Press the DISP button to exit the TPM reset mode. A chime will sound to verify exit.
10. Use the scan tool in order to clear the TPM DTC.

Using Scan Tool

1. Adjust all tire pressures to the recommended kPa/psi.
2. Install the scan tool.
3. Turn ignition ON with engine OFF.
4. With the scan tool select Special Functions.
5. Select TIM Reset.
6. Press the Reset soft key.
7. Use the scan tool in order to clear the TPM DTC.

TPMS RESET - PROCEDURE 15

CHECK TIRE PRESSURE or TIRE PRESS message will come on if air pressure in one tire is lower than the

other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, or if air pressure is adjusted. Message will stay on until system is recalibrated. Check and adjust air pressure in all 4 tires before recalibrating system.

NOTE: If vehicle is equipped with Systems Monitor, go to step 2.

1. To recalibrate vehicle equipped with Driver Information Center (DIC), turn ignition ON with engine OFF. Using the MODE and SELECT button on DIC, change display until TIRE PRESSURE appears. Press and hold RESET button for 5 seconds. TIRE PRESSURE RESET should now appear on display. If TIRE PRESSURE RESET does not appear on display after 5 seconds, repair system as necessary. Using a scan tool, clear TPM DTC.
2. To recalibrate vehicle equipped with Systems Monitor, turn ignition ON with engine OFF. Press and hold TIRE PRESS RESET button for 5 seconds. TIRE PRESS light on the Systems Monitor should begin to flash. Release the TIRE PRESS RESET button. TIRE PRESS light should go out and system is now reset. If TIRE PRESS light does not begin to flash after 5 seconds, repair system as necessary. Using a scan tool, clear TPM DTC.

TPMS RESET - PROCEDURE 16

CHECK TIRE PRESSURE light comes on if air pressure in one tire drops to 12 psi (kPa) less than the other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, or if air pressure is adjusted. Light will stay on until ignition is turned off or RESET button is pressed. Check and adjust air pressure in all 4 tires before resetting system.

1. To reset tire inflation monitor, turn ignition ON with engine OFF. Press and release the RESET button. RESET button is located inside of driver's side instrument panel fuse block (left end of instrument panel). The CHANGE OIL indicator light will begin to flash.
2. Press and release the RESET button again. The CHANGE OIL indicator light will turn off, and the CHECK TIRE PRESSURE indicator light will begin to flash. While the CHECK TIRE PRESSURE indicator light is flashing, press and hold the RESET button until the chime sounds indicating system is reset. If CHECK TIRE PRESSURE light does not go out, repeat reset procedure. If system still will not reset, repair system as necessary.

TPMS RESET - PROCEDURE 17

NOTE: When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.

NOTE: When the low tire pressure warning messages appear, immediately check air pressure of all tires and adjust to the specified pressure. If warning messages are still displayed, there is a malfunction in the TPM system. See appropriate manufacturer service information.

NOTE: Under the following conditions, the system may not function properly:

- **More than one tire is low.**

- **Only one tire is replaced with a new tire during service.**
- **Vehicle is moving faster than 65 mph (105 km/h).**
- **The system is not yet calibrated.**
- **Tire treadwear is uneven.**
- **Compact spare tire is installed.**
- **Tire chains are being used.**
- **Vehicle is being driven on a rough or frozen road.**
- **If ABS warning light is on.**

CAUTION: DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a tire pressure is low or high.

NOTE: There are 2 ways to recalibrate the Tire Pressure Monitor (TPM) system:

- ***Using DIC Reset Button*** **(if no scan tool is available)**
- ***Using Scan Tool*** **(if an OBD-II compatible scan tool is available).**

Using DIC Reset Button

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press SELECT right arrow button until "GAGE" is displayed.
5. Press SELECT down arrow button until "TIRE PRESSURE" is displayed.
6. Press and hold RESET button until "TIRE PRESSURE RESET" is displayed.
7. Release RESET button. DIC should display "TIRE PRESSURE NORMAL".
8. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
   - 15-40 mph (24-64 km/h).
   - 40-70 mph (64-113 km/h).
   - 70-90 mph (113-145 km/h).

NOTE: The EBCM learns tire pressure calibration for each speed range independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.

NOTE: Learning process does not need to be completed during a single trip.

Using Scan Tool

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Connect scan tool. Turn ignition ON with engine OFF.
4. Using scan tool, select "SPECIAL FUNCTIONS".
5. Select "TIRE PRESSURE RESET".
6. Press RESET soft key. A "TIRE PRESSURE NORMAL" message should appear on display.
7. If necessary, use scan tool to clear any TPM Diagnostic Trouble Codes (DTCs).
8. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
   - 15-40 mph (24-64 km/h).
   - 40-70 mph (64-113 km/h).
   - 70-90 mph (113-145 km/h).

NOTE: The EBCM learns tire pressure calibration for each speed range independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.

NOTE: Learning process does not need to be completed during a single trip.

TPMS RESET - PROCEDURE 18

The Tire Pressure Monitor (TPM) system alerts the driver when a large change in the pressure of one tire exists, while the vehicle is being driven. The TPM system uses the Electronic Brake Control Module (EBCM), ABS wheel speed sensor inputs, class 2 serial data circuit, and the Driver Information Center (DIC) to perform the system functions. The EBCM contains software to calculate relative tire pressure differences. The software requires approximately 30 minutes of straight line driving in 3 different speed ranges to complete the calibration process to have full capability for detecting a tire pressure condition. The speed ranges are 15-40 mph, 40-70 mph and 70-90 mph.

1. LOW TIRE PRESSURE light comes on if air pressure in one tire drops to 12 psi less than the other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, if air pressure is adjusted or if vehicle battery is disconnected. Light will stay on until ignition is turned off or RESET button is pressed. Check and adjust air pressure in all 4 tires before resetting system.
2. To reset tire inflation monitor, turn ignition ON with engine OFF. Press and release the RESET button. RESET button is located inside of driver's side instrument panel fuse block (left end of instrument panel). The CHANGE OIL indicator light will begin to flash.
3. Press and release the RESET button again. The CHANGE OIL indicator light will turn off, and the LOW

TIRE PRESSURE indicator light will begin to flash. While the LOW TIRE PRESSURE indicator light is flashing, press and hold the RESET button until the chime sounds indicating system is reset. If the LOW TIRE PRESSURE indicator light does not go out, repeat reset procedure. If system still will not reset, repair system as necessary.

TPMS RESET - PROCEDURE 19

NOTE: After resetting, the tire pressure monitoring (TPM) system requires 60 minutes or more of driving at a speed of 30 km/h (19 mph) or above to complete the calibration process to have full capability for detecting a tire pressure condition.

1. Adjust all tire pressures to the recommended kPa/psi.
2. Turn ignition ON with engine OFF.
3. Press and hold the tire pressure warning reset switch until the tire pressure warning indicator blinks 3 times at one second intervals.
4. If the tire pressure warning indicator does not blink, repeat the procedure starting at step 2.
5. Drive the vehicle for 60 minutes or more at a speed of 30 km/h (19 mph).
6. Verify the system has initialized. Turn ignition ON with engine OFF and observe the tire pressure warning indicator.
    - System Initialized: light on for 3 seconds.
    - System not initialized: light on for 4 seconds.

TPMS RESET - PROCEDURE 20

NOTE: When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.

CAUTION: DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a tire pressure is low or high.

NOTE: When the tire pressure warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning message is still displayed, there is a malfunction in the TPM system. See appropriate manufacturer service information.

NOTE: Under the following conditions, the system may not function properly:

- **More than one tire is low.**
- **Vehicle is moving faster than 65 mph (105 km/h).**
- **The system is not yet calibrated.**

- **Tire treadwear is uneven.**
- **Compact spare tire is installed.**
- **Tire chains are being used.**
- **Vehicle is being driven on a rough or frozen road.**
- **If ABS warning light is on.**

NOTE: There are 2 ways to recalibrate the Tire Pressure Monitor (TPM) system:

- ***Using DIC Reset Button*** **(if no scan tool is available)**
- ***Using Scan Tool*** **(if an OBD-II compatible scan tool is available).**

Using DIC Reset Button

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press and hold appropriate button (located on left side of steering column) until "TIRE PRESSURE" message appears on display:
   - 1997-99 models: Press and hold GAGES button
   - 2000-05 models: Press and hold GAGES INFO button
5. Press and hold RESET button for 5 seconds. After 5 seconds, "TIRE PRESSURE RESET" message should appear on display.
6. Release RESET button. A "TIRE PRESSURE NORMAL" message should appear on display.
7. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
   - 15-40 mph (24-64 km/h).
   - 40-70 mph (64-113 km/h).
   - 70-90 mph (113-145 km/h).

NOTE: The EBCM learns tire pressure calibration for each speed range independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.

NOTE: Learning process does not need to be completed during a single trip.

Using Scan Tool

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.

3. Connect scan tool. Turn ignition ON with engine OFF.
4. Using scan tool, select SPECIAL FUNCTIONS.
5. Select TIM RESET.
6. Press RESET soft key. A "TIRE PRESSURE NORMAL" message should appear on display.
7. If necessary, use scan tool to clear any TPM Diagnostic Trouble Codes (DTCs).
8. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
    - 15-40 mph (24-64 km/h).
    - 40-70 mph (64-113 km/h).
    - 70-90 mph (113-145 km/h).

NOTE: The EBCM learns tire pressure calibration for each speed range independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.

NOTE: Learning process does not need to be completed during a single trip.

TPMS RESET - PROCEDURE 21

Using Reset Button (1999-05 Models)

1. Adjust all tire pressures to the recommended Psi (kPa). See vehicle's Loading Information Label for recommended tire pressure. Turn ignition ON with engine OFF.
2. Press and hold the red RESET button located in the passenger side instrument panel fuse block.
3. The LOW TIRE indicator will flash 3 times, then turn off.
4. Use scan tool to clear the TPM DTC.

Using Scan Tool (2003-05 Models)

1. Adjust all tire pressures to the recommended Psi (kPa). See vehicle's Loading Information Label for recommended tire pressure. Turn ignition ON with engine OFF.
2. Install scan tool. Turn ignition ON with engine OFF.
3. With scan tool, select Special Functions.
4. Select TIM Reset.
5. Press Reset soft key.
6. LOW TIRE indicator will flash 3 times, then turn OFF.
7. Clear the TPM DTC.

TPMS RESET - PROCEDURE 22

NOTE: When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.

CAUTION: DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a tire pressure is low or high.

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press and hold the MODE button until DIC display reads "LOW TIRE PRESSURE HOLD SET TO RESET".
5. Press and hold SET button chime sounds and "TIRE PRESSURE RESET" is displayed and a chime sounds 3 times.
6. Release SET button and DIC will display "TIRE PRESSURE NORMAL".

NOTE: If low tire pressure warning message is still set, TPM system has not reset. Repeat procedure. If it does not work after two tries, refer to appropriate service information.

7. After resetting, the TPM system requires up to 5 miles of driving in each of the following speed ranges to complete the calibration process:
   - 25-40 mph (40-64 km/h).
   - 40-60 mph (65-96 km/h).
   - 60-85 mph (96-136 km/h).

NOTE: Learning process does not need to be completed during a single trip.

TPMS RESET - PROCEDURE 23

1. Check and adjust air pressure in all 4 tires before resetting system. Refer to tire placard located on the inside edge of the driver's door. Turn ignition ON, with engine OFF.
2. Press the MODE button on the Driver Information System until LOW TIRE PRESSURE HOLD SET TO RESET is displayed.
3. Press and hold the SET button until a chime sounds and TIRE PRESSURE RESET is displayed and a chime sounds 3 times.
4. Release the SET button and TIRE PRESSURE NORMAL will be displayed.

TPMS RESET - PROCEDURE 24

NOTE: When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.

CAUTION: DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a tire pressure is low or high.

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press and hold the MODE button until DIC display reads "LOW TIRE PRESSURE HOLD SET TO RESET".
5. Press and hold SET button until a chime sounds and "TIRE PRESSURE RESET" is displayed.
6. System will now sound a chime 3 times, and DIC will display "TIRE PRESSURE NORMAL".

NOTE: If low tire pressure warning message is still set, TPM system has not reset. Repeat procedure.

7. After resetting, the TPM system requires up to 5 miles (8 km) of flat, smooth road, straight line driving in each of the 4 speed ranges (about 10-20 minutes in each range) to complete the calibration process:
   - 19-40 mph (31-65 km/h).
   - 40-59 mph (65-95 km/h).
   - 59-74.5 mph (95-120 km/h).
   - 74.5-90 mph (120-145 km/h).

NOTE: The EBCM learns tire pressure calibration for each speed range independently. In Calibration Mode, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Detection Mode, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.

NOTE: Learning process does not need to be completed during a single trip.

TPMS RESET - PROCEDURE 25

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/ RUN with the engine OFF or place the vehicle power mode in ON/ RUN/ START. See **Fig. 4**.
4. Use the MENU button to select the VEHICLE INFORMATION MENU in the Driver Information Center (DIC). See **Fig. 5**.
5. Use the thumbwheel (or up and down arrows) to scroll to the TIRE PRESSURE MENU item screen.
6. Press the SET/CLR button to begin the sensor matching process. A message requesting acceptance of the

process should display.

7. Press the SET/CLR button again to confirm the selection. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

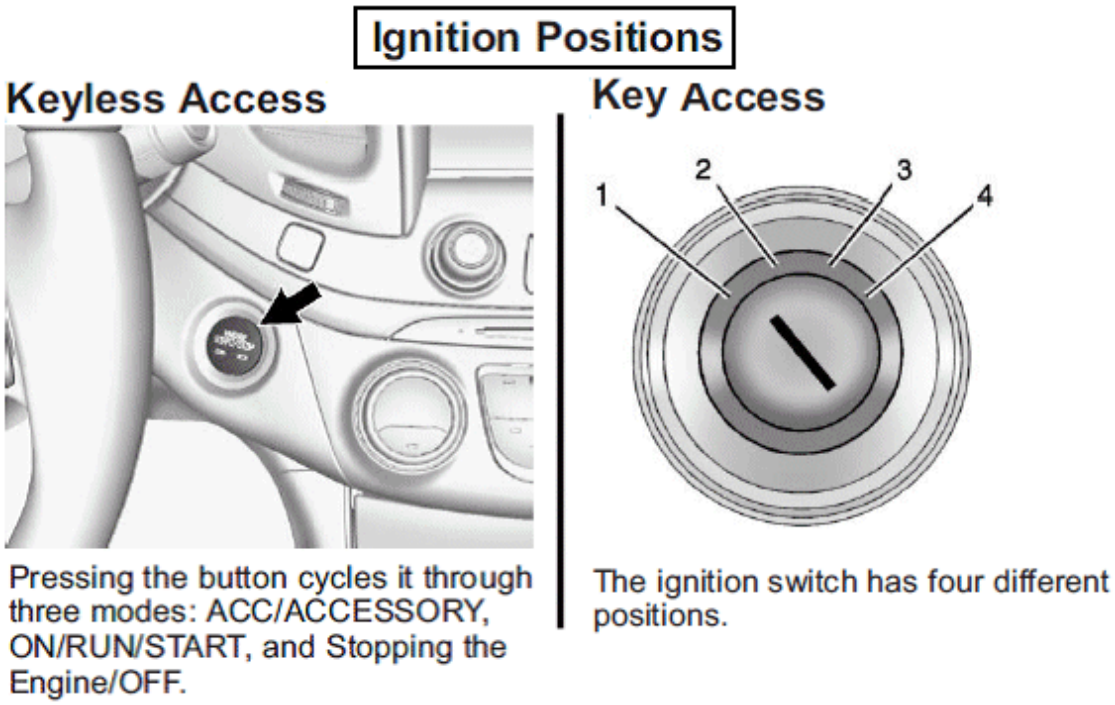


Fig. 4: Ignition Positions (Key & Keyless)
Courtesy of GENERAL MOTORS CORP.

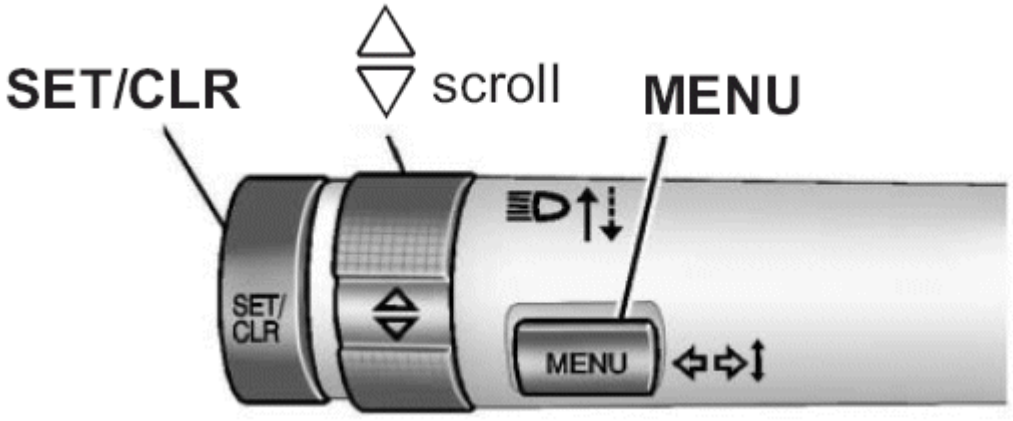


Fig. 5: Identifying DIC Controls (Turn Signal Lever)

Courtesy of GENERAL MOTORS CORP.

TPMS RESET - PROCEDURE 26

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine OFF.
4. Up-level Driver Information Center (DIC) Only: Make sure the TIRE PRESSURE INFO page option is turned on. The info pages on the DIC can be turned on and off through the SETTINGS menu.
5. If the vehicle has an up-level DIC, use the DIC controls (arrow buttons) on the right side of the steering wheel to scroll to the TIRE PRESSURE screen under the DIC info page. If the vehicle has a base-level DIC, use the TRIP ODOMETER RESET stem to scroll to the TIRE PRESSURE screen.
6. If the vehicle has an up-level DIC, press and hold the SET/RESET button (check-mark symbol) located in the center of the DIC controls. If the vehicle has a base-level DIC, press and hold the TRIP ODOMETER RESET stem for about five seconds. A message asking if the process should begin should appear. Select YES and press the TRIP ODOMETER RESET stem to confirm the selection.
7. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 27

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition switch to ON/RUN position, with engine OFF.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a horn chirp sounds, indicating Learn Mode has been enabled. The TIRE LEARNING ACTIVE message displays on the DIC screen.

NOTE: **If the vehicle does not have RKE, press the Driver Information Center (DIC) vehicle information button until the PRESS (check mark symbol) TO RELEARN TIRE POSITIONS message displays. The horn sounds twice to signal the receiver is in relearn mode and TIRE LEARNING ACTIVE message displays on the DIC screen. If the vehicle does not have RKE or DIC buttons, press the trip odometer reset stem on the instrument cluster until the PRESS (check mark symbol) TO RELEARN TIRE POSITIONS message displays. The horn sounds twice to signal the receiver is in relearn mode and TIRE LEARNING ACTIVE message displays on the DIC screen.**

4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 28

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/ RUN with the engine OFF or place the vehicle power mode in ON/ RUN/ START. See **Fig. 4**.
4. Make sure the Tire Pressure info page option is turned on. The info pages on the Driver Information Center (DIC) can be turned on and off through the Settings menu.
5. Use the DIC controls on the right side of the steering wheel to scroll to the Tire Pressure screen under the DIC info page.
6. Press and hold the SET/RESET button (check mark symbol) located in the center of the DIC controls.
7. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 29

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine OFF.
4. Press the MENU button once on the Driver Information Center (DIC).
5. Press the up or down arrow button until the Tire Learn screen is displayed.
6. Press and hold the SET/CLR button to begin the sensor matching process.
7. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have

been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 30

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Put the vehicle in ON/ RUN and place the vehicle in P (Park).
4. If the Driver Information Center (DIC) display is minimized, press the SELECT knob to maximize it.
5. Use the SELECT knob to scroll to the Tire Pressure display screen.
6. Press and hold the SELECT knob for five seconds to begin the sensor matching process. A message displays confirming to begin the process.
7. Use the SELECT knob to select YES with the highlighted selection, and press the SELECT knob again to confirm the selection.
8. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
9. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
10. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
11. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS RESET - PROCEDURE 31

NOTE: You have two minutes to match the first tire/wheel position, and five minutes overall to match all four tire/wheel positions. If it takes longer, the matching process stops and must be restarted.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine off.
4. Enter the learn sequence from the TPM Learn screen, located under the Customization Menu in the instrument panel cluster. Press SRCE button until you see Customize Options and then press ENTER (left pointing arrow). Move the thumbwheel up or down to scroll through the available options. Press ENTER to select an item. To exit the current menu, or go back, use the thumbwheel to select BACK (left arrow) at the top of the screen and then press ENTER.
5. Start with the driver side front tire. The driver side front indicator lamp also comes on to indicate that corner's sensor is ready to be learned. Place a tire sensor activation tool against the tire sidewall, near the valve stem. Then press the button to activate the TPMS sensor. A horn chirp confirms that the sensor identification code has been matched to this tire and wheel position
6. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
7. After the driver side rear TPMS sensor has been learned the horn chirps two times. The driver side rear

indicator lamp turns off and the TPMS sensor matching process is done. Turn the ignition switch to LOCK/OFF.

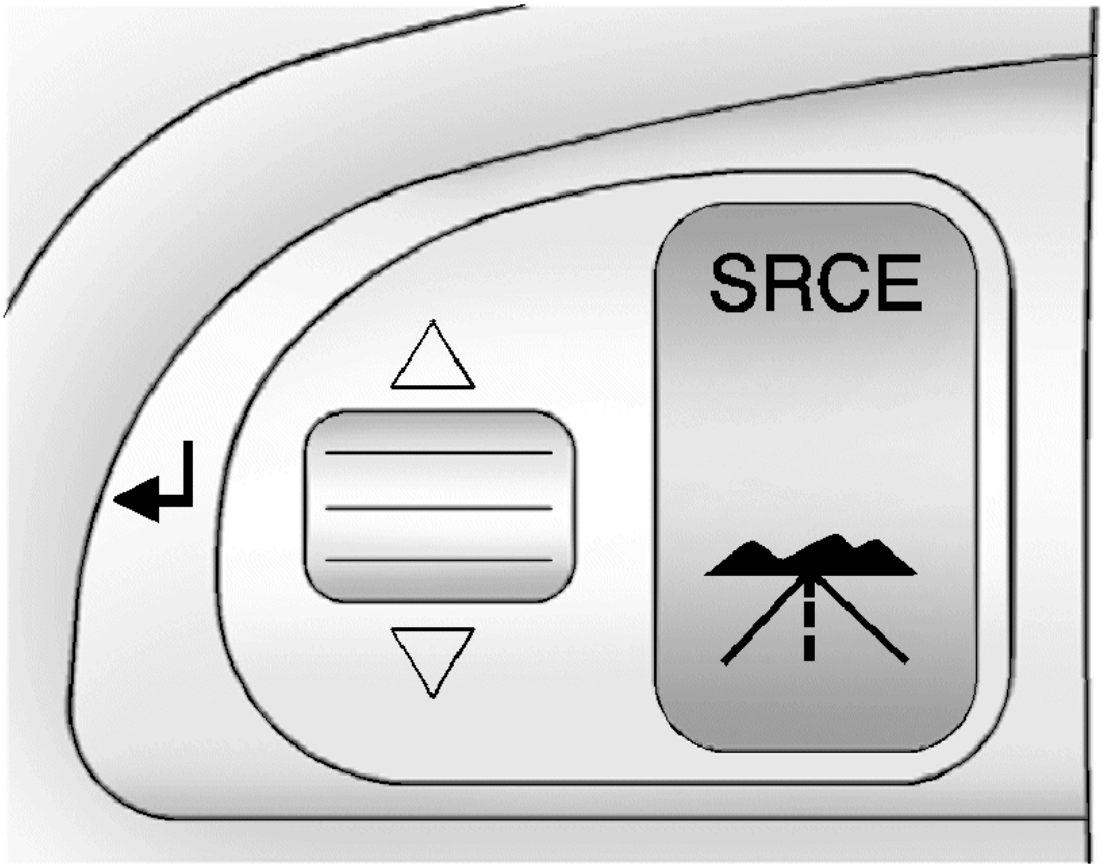


Fig. 6: Identifying DIC Controls
Courtesy of GENERAL MOTORS CORP.

MIRROR - AUTOMATIC DAY/NIGHT

ACCESSORIES & SAFETY EQUIPMENT General Motors Corp. Mirrors - Automatic Day/Night

DESCRIPTION

Electrochromic day/night rearview mirror automatically changes reflectance to reduce glare from headlights. At night, as glare of headlamps from behind increases, mirror will gradually become darker to absorb glare. During daylight or when shift selector is in REVERSE position, mirror will be clear and fully reflective. On vehicles with Regular Production Option (RPO) code DD0, driver side outside mirror will also be an electrochromic day/night mirror that is controlled by inside mirror. Inside rearview mirrors on Ninety Eight and Eighty Eight models also include a compass.

OPERATION

Day/night mirror(s) use a thin layer of electrochromic material between 2 plates of conductive glass. Two photocell sensors signal levels of light to a logic circuit. A forward facing photocell sensor measures ambient light levels. A rear facing photocell sensor measures glare from approaching vehicle headlights. When logic circuit senses more light from the headlight sensor than the ambient light sensor, the electrochromic drive circuit applies voltage to mirror(s). Approximately 1.15 volts is applied to mirror(s) when a large amount of glare is present, causing mirror(s) to darken. Voltage will be reduced to 0.01 volt when both photocells indicate the same light level.

When shift selector is put into reverse, battery voltage is applied to mirror reset terminal. Mirror will gradually change to a clear state for better vision when backing up.

TESTING

NOTE: Electrochromic mirror cannot be repaired and must be replaced as an assembly.

SYSTEM CHECK FOR NORMAL OPERATION

1. Turn ignition to RUN position and shift selector to PARK position. Place mirror ON-OFF switch to ON position or OFF-MIN-MAX switch to MAX position. Cover ambient photocell sensor (windshield side) with a dark cloth. Shine a flashlight onto headlight photocell sensor (mirror side). If inside rear view mirror and left outside mirror (if equipped) gradually darken, go to next step. If mirror(s) do not darken, check connections. If connections are okay, check Pink wire and/or Pink/Black wire circuit between mirror ON-OFF switch and fuse block for an open or a short to ground. Check Black wire or Black/White ground circuit for an open. See **WIRING DIAGRAMS** .
2. **DO NOT** remove dark cloth and flashlight. Move shift selector to REVERSE position. If mirror(s) gradually lightens to a clear state, go to step 4). If outside mirror does not lighten, go to next step. If mirror(s) does not lighten, check connections. If connections are okay, check park/neutral position switch operation. If park/neutral position switch is okay, check Light Green wire circuit between inside mirror and park/neutral position switch. If Light Green wire circuit is okay, check Pink wire circuit between

park/neutral position switch and fuse block.

3. If electrochromic outside mirror (if equipped) did not change, check Gray wire and Pink wire circuits between inside mirror and outside mirror.
4. **DO NOT** remove dark cloth and flashlight. Place shift selector to PARK position. Mirror(s) should gradually darken. Remove dark cloth and flashlight. Mirror(s) should gradually lighten to a clear state. If mirror(s) change as described, system is operating normally. If mirror(s) do not change as described and fuses, connections and circuits are okay, replace suspect mirror assembly and retest system.

REMOVAL & INSTALLATION

CAUTION: Electrochromic material may irritate eyes and skin. In case of eye contact rinse thoroughly with water. In case of skin contact, wash thoroughly with soap and water. If material is ingested, consult a physician or poison control center immediately.

NOTE: It is not necessary to use tools or other objects to pry mirror mount or mirror away from windshield. Use of tools may damage mirror, mirror mount or windshield.

REARVIEW MIRROR

Removal

Gain access to mirror wiring harness inside of headliner. Disconnect mirror harness connector. Adjust mirror to full down position. Grasp mirror with left hand between mirror and windshield. With right hand positioned at other end of mirror, pull mirror away from support. See **Fig. 1** .

Installation

Center bottom of inside rearview mirror to top of mirror support. Slide mirror onto mirror support keeping mirror parallel to windshield. As mirror mount starts to grip, apply at least 20 lbs. of force to fully seat mirror onto mirror support. A click will be heard when mirror is fully seated. Connect mirror harness connector. Install harness and connector into headliner. See **Fig. 1** .

OUTSIDE MIRROR

Removal & Installation

1. Disconnect negative battery cable. To remove door switches, pry from front or rear of switch panel to release retaining tabs. Carefully remove all switches and warning light/reflector from door panel. Disconnect wiring connectors. Remove all retaining screws and door panel fasteners. Remove door panel.
2. Peel water deflector back to access mirror wiring connector and retaining nuts. Disconnect wiring connector. While supporting mirror, remove mirror retaining nuts and remove mirror. To install reverse removal procedure. Tighten mirror retaining nuts to 54 INCH lbs. (6 N.m).

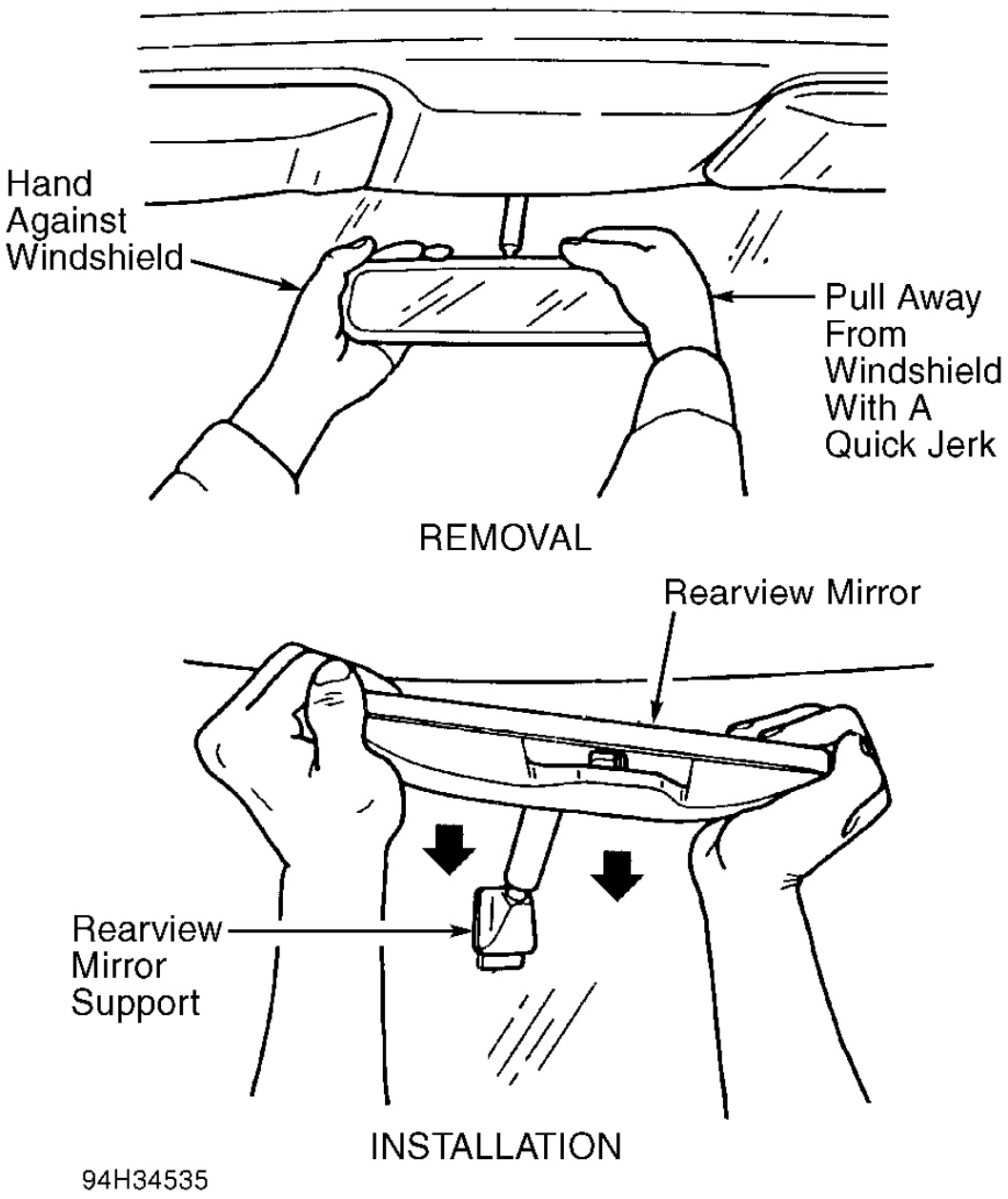


Fig. 1: Rearview Mirror Removal & Installation
Courtesy of GENERAL MOTORS CORP.

WIRING DIAGRAMS

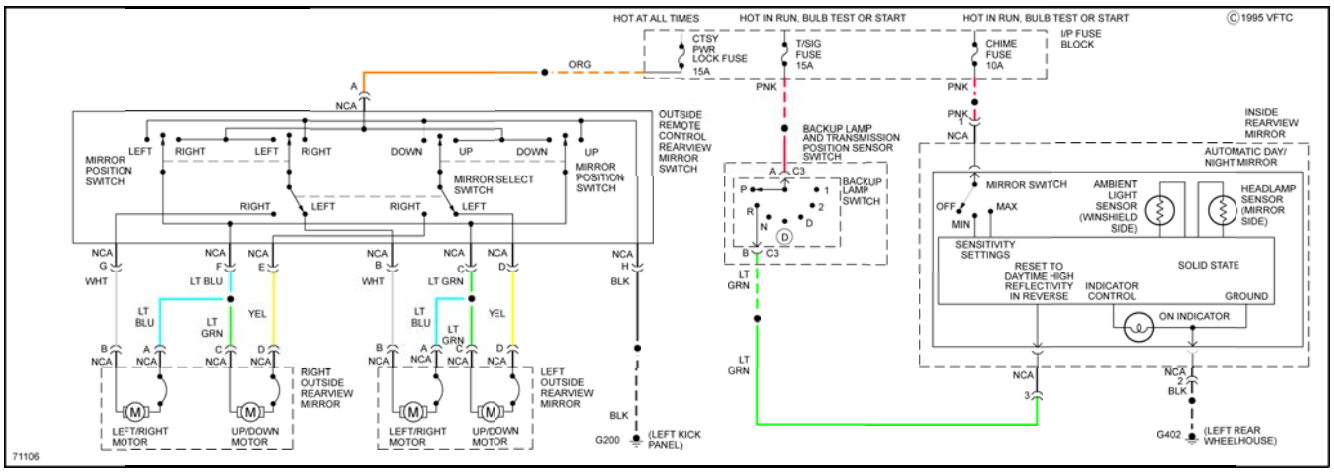


Fig. 2: Power/Automatic Day/Night Mirror Wiring Diagram (Caprice & Impala SS)

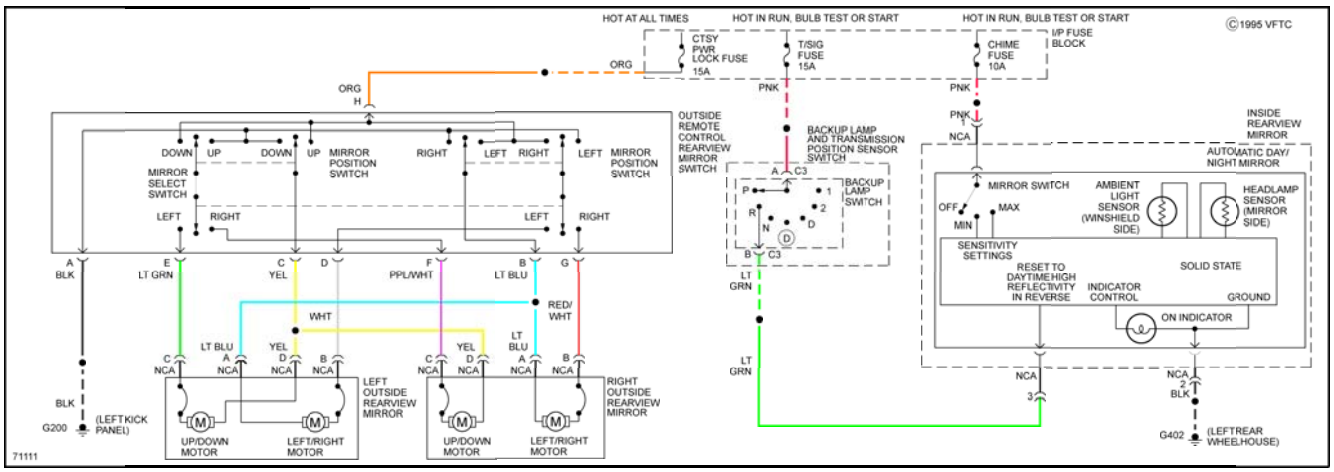


Fig. 3: Power/Automatic Day/Night Mirror Wiring Diagram (Roadmaster)

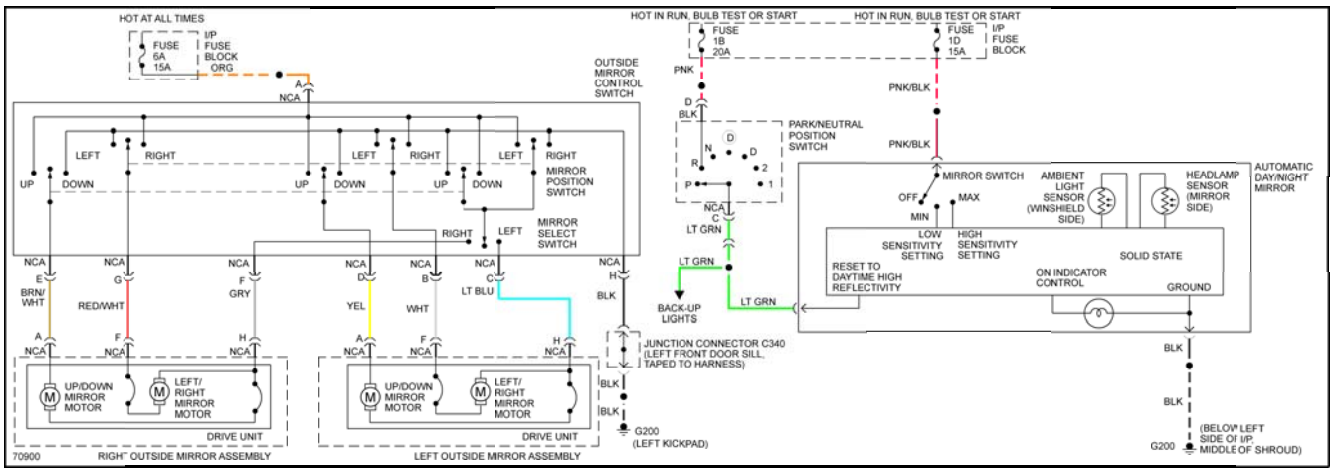


Fig. 4: Power/Automatic Day/Night Mirror Wiring Diagram (Bonneville)

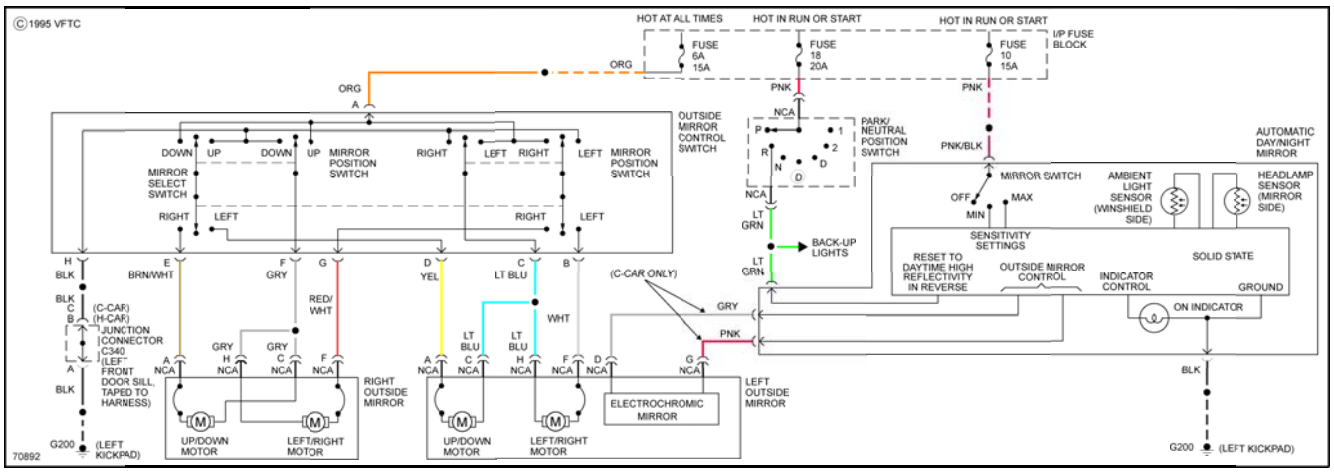


Fig. 5: Power/Automatic Day/Night Mirror Wiring Diagram (88 & 98)

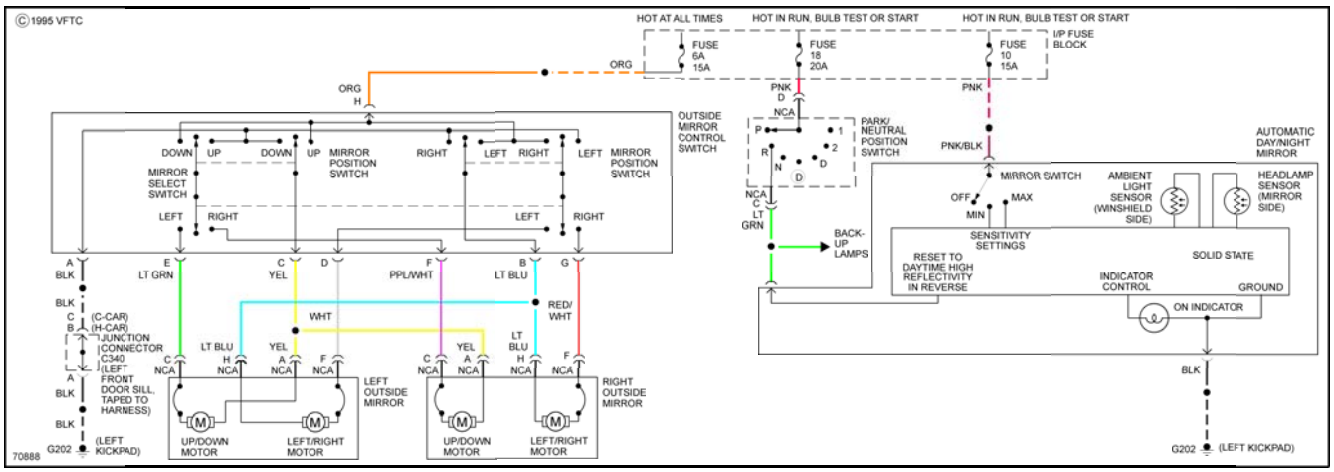


Fig. 6: Power/Automatic Day/Night Mirror Wiring Diagram (LeSabre & Park Avenue)

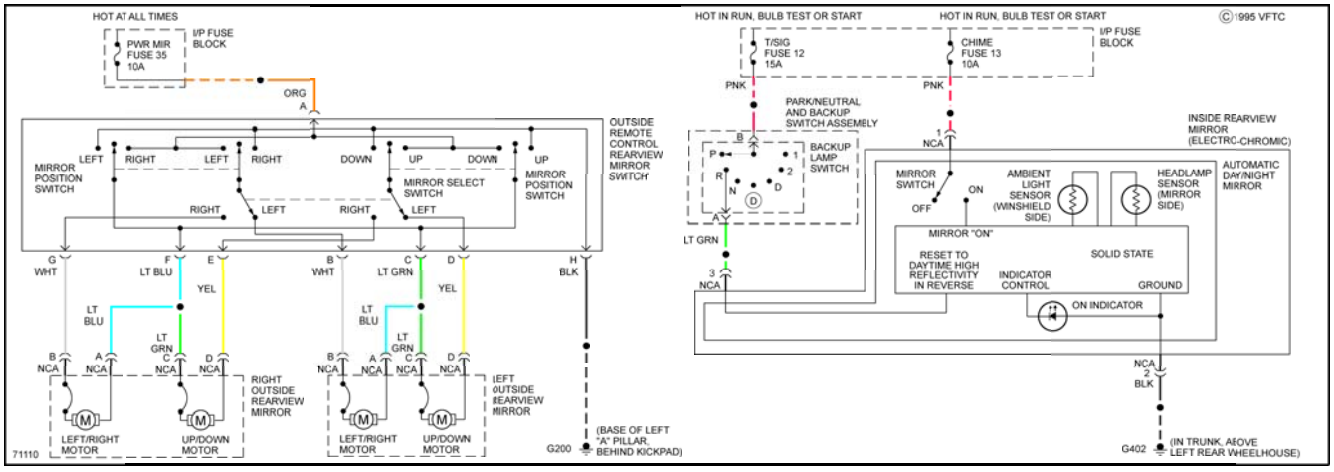


Fig. 7: Power/Automatic Day/Night Mirror Wiring Diagram (Fleetwood)

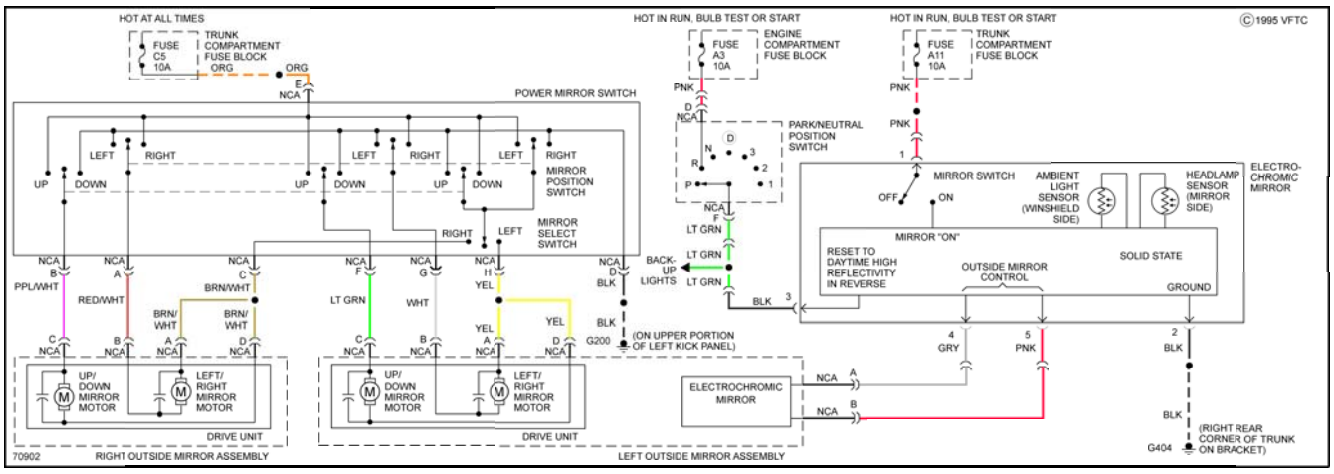


Fig. 8: Power/Automatic Day/Night Mirror Wiring Diagram (Concours & DeVille)

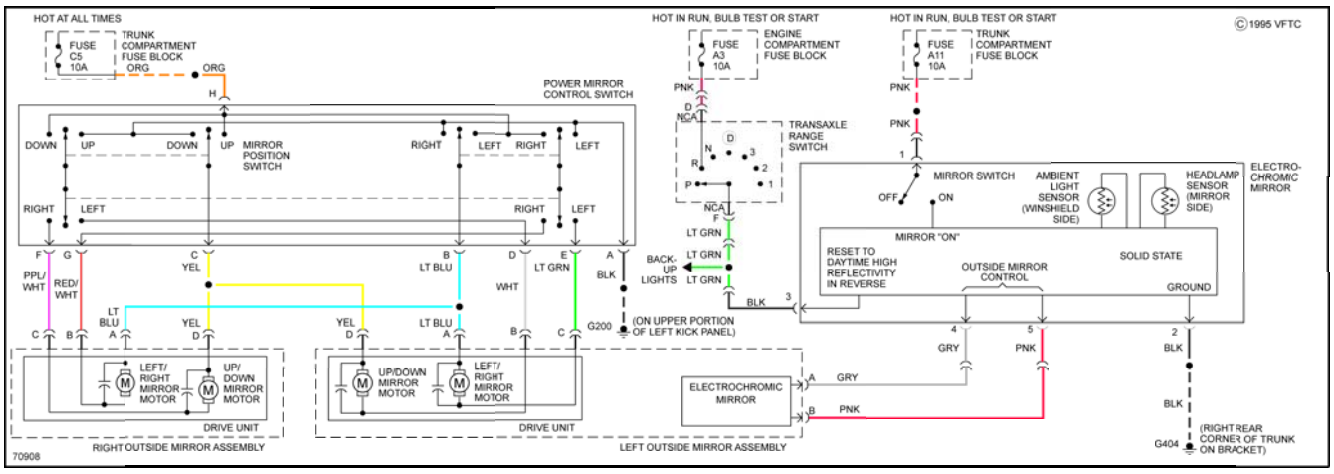


Fig. 9: Power/Automatic Day/Night Mirror Wiring Diagram (Eldorado & Seville)

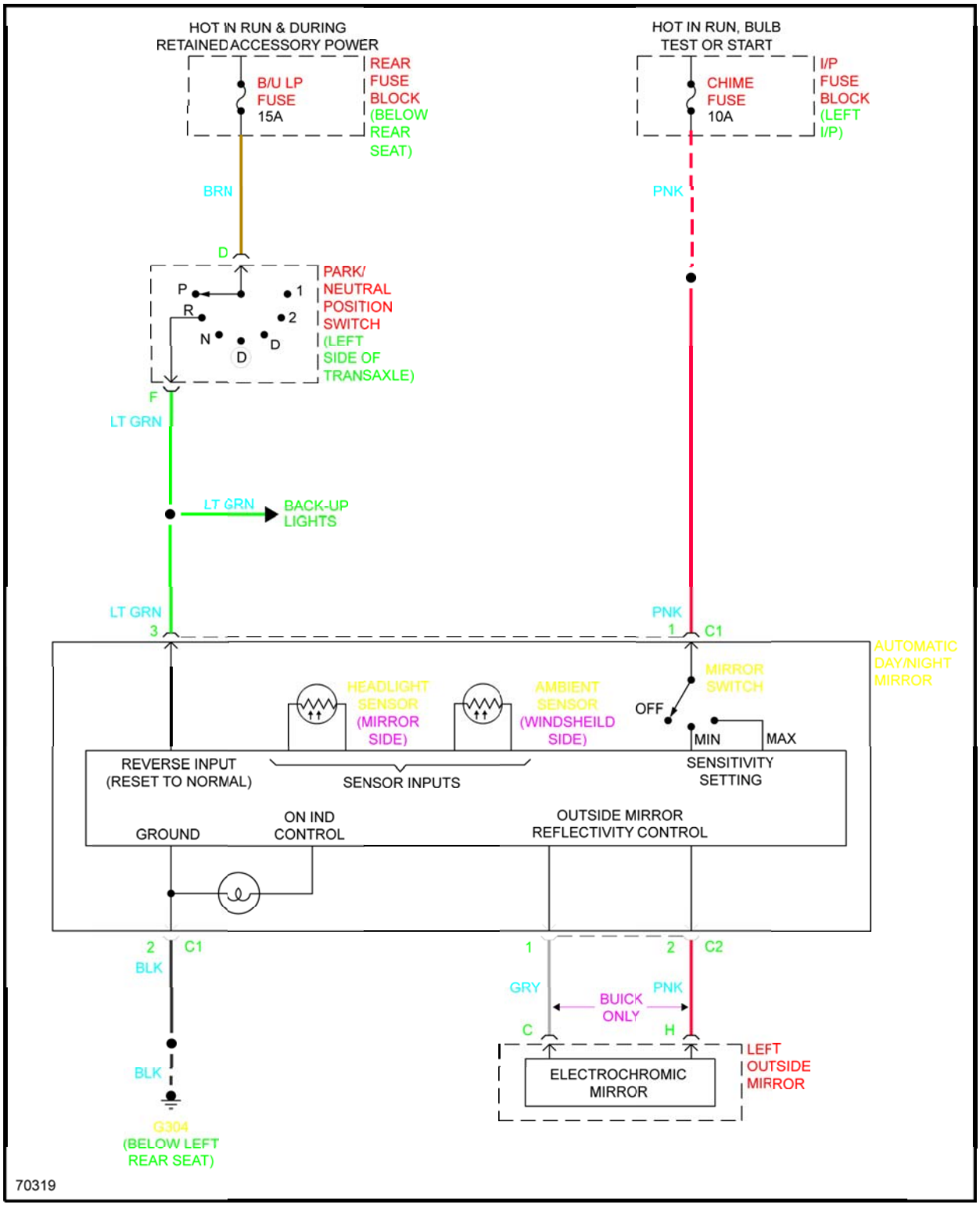


Fig. 10: Power/Automatic Day/Night Mirror Wiring Diagram (Aurora & Riviera

DESCRIPTION

Power seats operate using toggle switches located on seat side or in door arm rest. Seat adjusters are powered by a 12-volt reversible motor with an internal circuit breaker. A 30-amp, plug-in circuit breaker is located in fuse panel and protects power seat wiring.

OPERATION

6-WAY POWER SEATS

Two types of power seats are used. One type has 3 reversible motors that operate seat functions. Front and back parts of seat are operated by different motors and can be raised and lowered independently. Third motor controls forward/backward movement. Drive cables connect motor to gear nuts, which turn jack screws and adjusters at each side of seat.

In second type, each seat uses a single motor with 3 solenoids, 6 drive cables and a transmission. One solenoid controls front vertical movement, one controls rear vertical movement and one controls horizontal movement. Motor then moves the seat. Releasing switch disengages drive motor from cables.

POWER RECLINING SEAT BACK

Power reclining seat back is an option on some models. System includes an under-seat motor, drive cable, actuator and control switch. Switch is on seat edge or armrest. Power seat back recliners operate independently of other power seat adjustments.

SPORT LUMBAR SEATS

Sport lumbar seat is an option on some models. See **Fig. 1** . It is used on either the driver's seat only, or on both front seats. Power is supplied by a 30-amp circuit breaker in fuse block. Adjustments are made by a solenoid valve assembly located under seat(s). Operation is controlled by a switch located on seat side, or in center console.

Backrest lateral restraints (side bolsters) are power adjusted 15 degrees in or out. Lumbar support can be pneumatically adjusted from soft to firm by inflating the 3 compartment bladders located in seat back. Inflation of bladders is controlled by a pressure pump, bleed down valves and a control switch. Seat back angle is power adjusted by a control in left bolster.

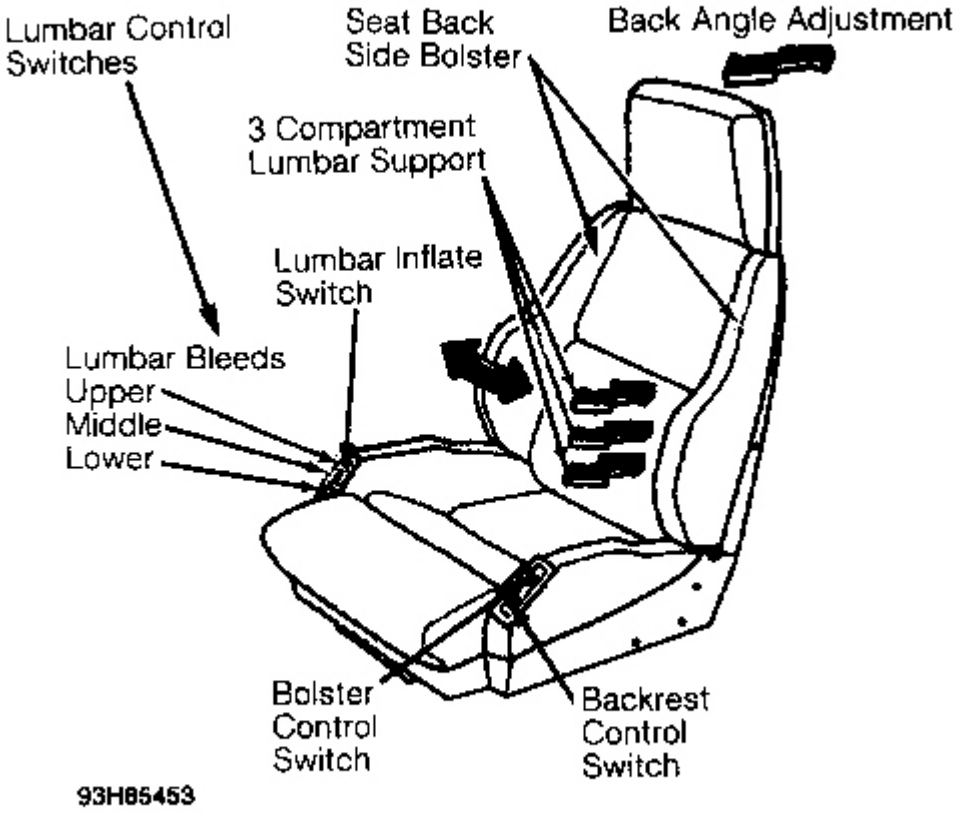


Fig. 1: Sport Lumbar Power Seat System (Typical)
Courtesy of GENERAL MOTORS CORP.

ADJUSTMENTS

HORIZONTAL ACTUATOR

1. Chucking can be corrected by adjusting horizontal actuator and pinion gear to fully mesh with lower adjuster track rack gear. Operate seat to full up position and about 3/4 forward. Loosen horizontal actuator attaching screws. See **Fig. 2** .
2. Using a large screwdriver, apply outward pressure on horizontal actuator (about 15-25 ft. lbs.) and energize horizontal switch to move seat slightly fore and aft. This keeps seat horizontal actuator pinion gear teeth in close contact with lower track rack gear teeth and eliminates free play between gear teeth. Tighten screws while maintaining outward pressure against horizontal actuators.

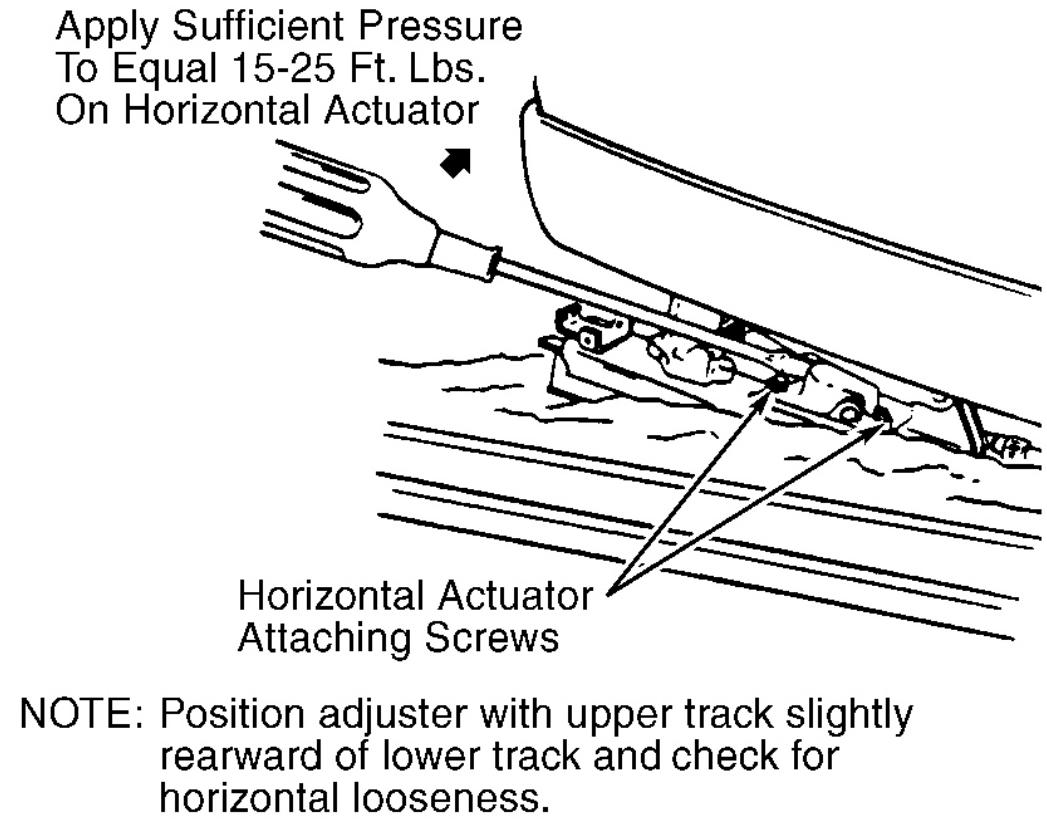


Fig. 2: Adjusting Horizontal Actuator
Courtesy of GENERAL MOTORS CORP.

SEAT ADJUSTER PHASING

When installing power seat adjusters (except at back recliner), ensure each pair of adjusters is in phase with each other. When adjusters are out of phase, one adjuster will reach its maximum travel limit before the other, resulting in improper seat travel.

Horizontal Travel

Operate seat until one adjuster reaches full forward position. Detach horizontal drive cable from adjuster which has reached its travel limit. Operate seat forward until other adjuster reaches its full forward position. Reconnect drive cable of first adjuster. Adjusters are now in phase.

Vertical Travel (Front Or Rear)

1. Operate seat until one adjuster has reached fully raised position at both front and rear vertical travel limits. Disconnect both front and rear vertical drive cables from adjuster which has reached its travel

limit.

2. Operate seat until other adjuster reaches fully raised position. Reconnect previously disconnected front and rear vertical drive cables. Seat should be in phase. If not, repeat procedure.

TROUBLE SHOOTING

Jerky Horizontal Operation

1. Check for improper lubrication of adjuster shoes and channels. To correct operation, lubricate adjuster upper channel and adjuster shoes.
2. Check for horizontal actuator-to-rack gear adjusted too tight. See **HORIZONTAL ACTUATOR** under ADJUSTMENTS.

Horizontal Chuck Or Looseness

Check for horizontal actuator improperly adjusted. See **HORIZONTAL ACTUATOR** under ADJUSTMENTS.

One Adjuster Will Not Operate Horizontally

1. Check for disconnected or damaged horizontal drive cable. To correct operation, check horizontal drive cables and replace if damaged.
2. Check for inoperative horizontal actuator. To correct operation, replace horizontal actuator assembly.

One Adjuster Will Not Operate Vertically

1. Check for disconnected or damaged vertical drive cable. To correct operation, check vertical drive cables and replace if damaged.
2. Vertical gear nut inoperative. To correct operation, replace vertical actuator assembly.

Both Adjusters Will Not Operate Horizontally &/Or Vertically

Check for inoperative horizontal and/or vertical solenoid in transmission. Check for damaged, broken or inoperable solenoid plunger, shaft, gear or drive gear. To correct operation, replace damaged or defective parts.

Vertical Chuck Or Looseness

Check for excessive clearance at vertical gear nut tension spring. To correct looseness, grind top of vertical gear nut shoulder until slack is removed.

Power Reclining Seat Back Motor Operates, But Seat Back Does

Not Move

Check for disconnected or broken drive cable. Check for damaged or broken reclining actuator gear nut. Ensure reclining actuator is not disconnected from arm of seat back lock or support. Check for incorrect application of seat back lock or support.

Power Reclining Seat Back Operation Jerky

Check for kink or damage to drive cable. Check for bind in reclining hinge arm. Check for damaged or bent jack screw. Check for damaged actuator gear nut. Ensure there is sufficient lubrication. Check for loose jack screw lock nut.

ELECTRICAL

Inoperative Adjuster Motor

Check for shorted or open circuit between power source, switch or motor. Check for a defective adjuster motor.

Motor Operates But Adjuster Will Not Operate

Check for a shorted or open circuit between switch and solenoid. Check solenoid for defects.

Motor Operates, But Adjusters Or Recliner Only Operates In

One Direction

Check for a shorted or open circuit between motor fields and control switch. Check for a defective field coil.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

BASIC SEAT ASSEMBLY

Removal & Installation

1. Remove seat belt-to-floor anchor plate bolts. Where required, remove door sill plates and turn back carpet to gain access to adjuster-to-floor bolts. Operate seat to full forward and upward position. At rear of adjusters, remove adjuster-to-floor rear bolts.
2. Operate seat to full rearward and full rear tilt position. Remove front adjuster-to-floor pan nuts. Disconnect electrical connector(s), air hose (if equipped) under seat, A/C-heater duct in armrest (if equipped) and remove seat. To install, reverse removal procedure.

POWER SEAT ADJUSTER ASSEMBLY

Removal & Installation

1. Remove seat. See **BASIC SEAT ASSEMBLY** . Place seat upside-down on a clean bench. Disconnect drive cables at adjuster being removed. See **Fig. 3** . Squeeze oblong connector to remove. On bucket

seats, remove motor support-to-adjuster bolt.

2. Remove adjuster-to-seat bottom bolts and remove seat adjuster. Note locations of spacers (if equipped). To install, reverse procedure and ensure seats are in phase. See **SEAT ADJUSTER PHASING** under ADJUSTMENTS.

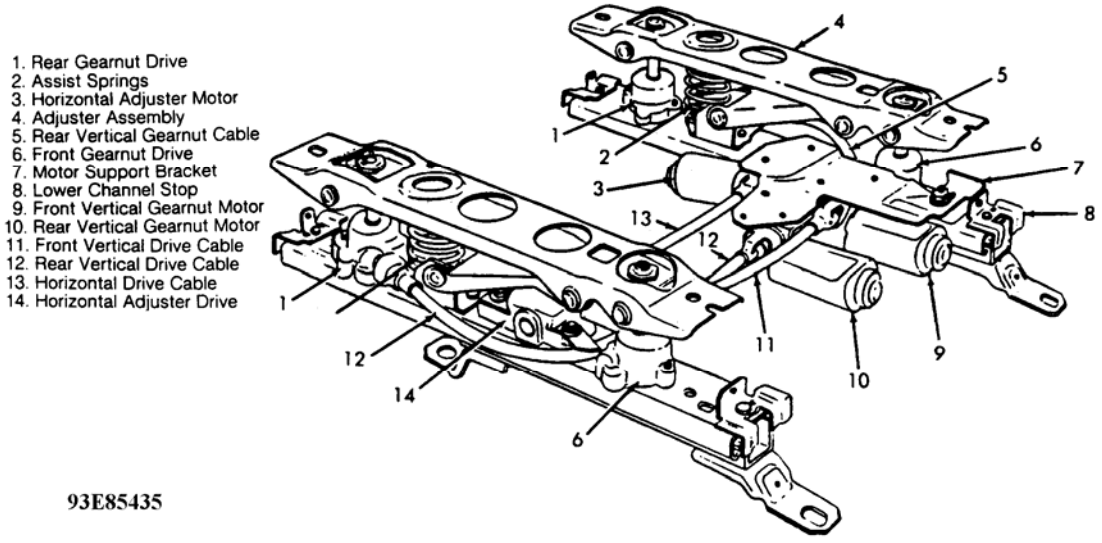


Fig. 3: Power Seat Adjuster Assembly
Courtesy of GENERAL MOTORS CORP.

SEAT BACK RECLINING ACTUATOR

Removal & Installation

Remove seat. See **BASIC SEAT ASSEMBLY** . Place seat upside-down on clean bench. Remove trim on outside of seat for access to actuator. Unscrew reclining back drive cable from reclining actuator and detach cable from actuator. Remove pin securing reclining actuator coupling-to-hinge arm. Remove actuator. To install, reverse removal procedure.

DRIVE MOTOR

Removal & Installation

1. Remove seat. See **BASIC SEAT ASSEMBLY** . Place seat upside-down on clean bench. Disconnect wiring. On single motor seats, remove transmission-to-support screws and cable ends plates on transmission ends. Separate motor and transmission and disengage rubber coupling.
2. On 3-motor seats, remove motor support-to-motor mounting bracket screw. Disconnect drive cables from adjusters, remove nut from motor retaining rod and remove motor. To install, reverse removal procedure and check phasing. See **SEAT ADJUSTER PHASING** under ADJUSTMENTS.

BACK ANGLE OR BOLSTER SWITCH

Removal & Installation

Disconnect battery ground cable. Remove seat cushion. Remove 2 left side control panel trim plate screws. Pull face plate with switches attached out of armrest to gain access to electrical connector. Remove defective switch. To install, reverse removal procedure.

LUMBAR CONTROL OR VALVE BODY

Removal & Installation

1. Disconnect battery ground cable. Remove seat cushion and release bail clip from frame panel. Disconnect pneumatic tubing and electrical connector to lumbar control assembly. Remove hog ring at underside of seat to gain access.
2. Remove face plate and remove control assembly through bottom of seat cushion. If necessary, valve body can also be replaced at this time. To install, reverse removal procedure.

LUMBAR MOTOR & PUMP ASSEMBLY

Removal & Installation

1. Disconnect battery ground cable. Remove seat cushion. Remove 4 cushion frame panel-to-adjuster bolts. Disconnect air supply hoses and electrical connectors. Remove seat from vehicle.
2. Disconnect electrical and pneumatic harness connectors at motor. Remove motor and pump assembly-to-frame parts. Remove motor from seat cushion frame. To install, reverse removal procedure. Check operation of motor and pump.

TESTING

NOTE: Testing procedures are not available for all seat types. For circuit and terminal identification, see WIRING DIAGRAM .

WITHOUT LUMBAR

No Seat Functions Operate

1. Do not disconnect seat switch connector. Using a test light, backprobe between switch connector terminal Orange wire and ground. If test light comes on, go to next step. If test light does not come on, repair open in Orange wire circuit between 30-amp circuit breaker and seat switch connector.
2. Using a test light, backprobe between seat switch connector terminals Black wire and Orange wire. If test light does not come on, repair open in Black wire circuit between seat switch connector and ground. If test light comes on, ensure switch is connected properly. If connection is okay, replace seat switch.

Seat Will Not Go FORWARD/BACK, UP/DOWN Operates Normally

1. Locate forward/back motor 2-pin connector. Using a test light, backprobe between forward/back motor connector terminal "A" (Tan wire) and ground. Move seat switch to FORWARD position. If test light comes on, go to next step. If test light does not come on, check for a poor connection or an open in Tan

wire between seat switch connector and forward/back motor. If circuit is okay, replace seat switch.

2. Using test light, backprobe between motor connector terminal "B" (Light Green wire) and ground. Move seat switch to BACK position. If test light comes on, go to next step. If test light does not come on, check for a poor connection or an open in Light Green wire between seat switch connector and forward/back motor. If circuit is okay, replace seat switch.
3. Using a test light, backprobe between forward/back motor connector terminals "A" (Tan wire) and "B" (Light Green wire). Move seat switch to FORWARD and BACK positions. If test light comes on, check for a poor connection at forward/back motor. If connection is okay, replace forward/back motor. If test light does not come on, replace seat switch.

Seat Will Not Go UP/DOWN, FORWARD/BACK Operates Normally

If front height adjustment operates properly, go to REAR HEIGHT WILL NOT GO UP/DOWN, FORWARD/BACK OPERATES NORMALLY. If front height adjustment does not operate properly and rear height does operate properly, go to FRONT HEIGHT WILL NOT GO UP/DOWN, FORWARD/BACK OPERATES NORMALLY. If neither front nor rear height adjustments operate properly, check for poor connections at seat switch or forward/back motor. If connections are okay, replace seat switch.

Front Height Will Not Go UP/DOWN, FORWARD/BACK Operates

Normally

1. Locate front height motor 2-pin connector. Using a test light, backprobe between front height motor connector terminal "B" (Dark Green wire) and ground. Move seat switch to FRONT HEIGHT UP position. If test light comes on, go to next step. If test light does not come on, check for a poor connection or an open in Dark Green wire between seat switch connector and front height motor. If circuit is okay, replace seat switch.
2. Using a test light, backprobe from between front height motor connector terminal "A" (Dark Blue wire) and ground. Move seat switch to FRONT HEIGHT DOWN position. If test light comes on, go to next step. If test light does not come on, check for a poor connection or an open in Dark Blue wire between seat switch connector and front height motor. If circuit is okay, replace seat switch.
3. Using a test light, backprobe between front height motor connector terminals "A" (Dark Blue wire) and "B" (Dark Green wire). Move seat switch to ENTIRE SEAT UP position. If test light comes on, go to next step. If test light does not come on, replace seat switch.
4. Using a test light, backprobe between front height motor connector terminals "A" (Dark Blue wire) and "B" (Dark Green wire). Move seat switch to ENTIRE SEAT DOWN position. If test light comes on, check for poor connection at front height motor. If connection is okay, replace front height motor. If test light does not come on, replace seat switch.

Rear Height Will Not Go UP/DOWN, FORWARD/BACK Operates

Normally

1. Locate rear height motor 2-pin connector. Using a test light, backprobe between rear height motor connector terminal "A" (Yellow wire) and ground. Move seat switch to REAR HEIGHT UP position. If test light comes on, go to next step. If test light does not come on, check for a poor connection or an open in Yellow wire between seat switch connector and rear height motor. If circuit is okay, replace seat

switch.

2. Using a test light, backprobe from between rear height motor connector terminal "B" (Light Blue wire) and ground. Move seat switch to REAR HEIGHT DOWN position. If test light comes on, go to next step. If test light does not come on, check for a poor connection or an open in Light Blue wire between seat switch connector and rear height motor. If circuit is okay, replace seat switch.
3. Using a test light, backprobe between rear height motor connector terminals "A" (Yellow wire) and "B" (Light Blue wire). Move seat switch to ENTIRE SEAT UP position. If test light comes on, go to next step. If test light does not come on, replace seat switch.
4. Using a test light, backprobe between rear height motor connector terminals "A" (Yellow wire) and "B" (Light Blue wire). Move seat switch to ENTIRE SEAT DOWN position. If test light comes on, check for poor connection at rear height motor. If connection is okay, replace rear height motor. If test light does not come on, replace seat switch.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Adjuster-To-Seat Cushion Frame Bolt	17-21 (23-28)
Seat Belt-To-Floor Anchor Plate Bolt	31 (42)

WIRING DIAGRAM

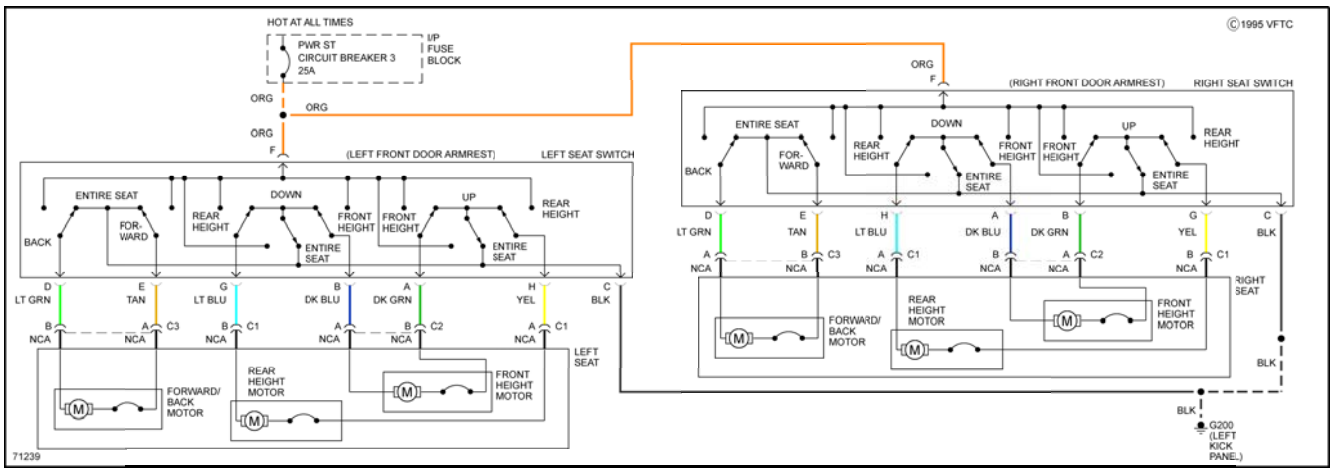


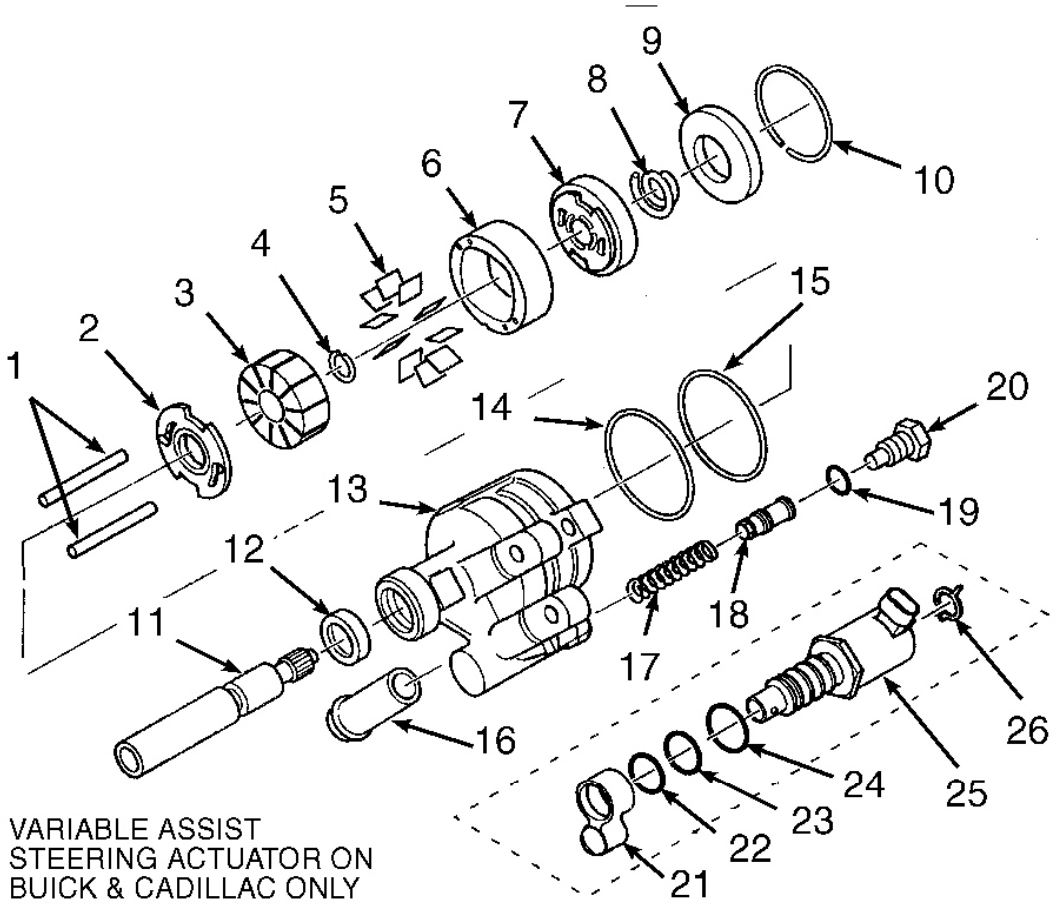
Fig. 4: Power Seats Wiring Diagram

POWER STEERING PUMP

STEERING Saginaw Power Steering Pump

DESCRIPTION & OPERATION

Power steering pump is a constant displacement vane-type pump with a remote fluid reservoir. When fluid pressure exceeds preset limits, an internal flow control pressure relief valve opens, allowing fluid to return to reservoir and inlet side of pump. See **Fig. 1** .



VARIABLE ASSIST
STEERING ACTUATOR ON
BUICK & CADILLAC ONLY

1. Dowel Pin
2. Thrust Plate
3. Rotor
4. Retaining Ring
5. Vanes
6. Pump Ring
7. Pressure Plate
8. Pressure Plate Spring
9. End Plate
10. Retaining Ring
11. Drive Shaft
12. Drive Shaft Seal
13. Housing
14. "O" Ring (Pressure Plate)
15. "O" Ring (End Cover)
16. Inlet Tube
17. Control Valve Spring
18. Flow Control Valve
19. "O" Ring
20. Fitting
21. Discharge Fitting
22. "O" Ring
23. "O" Ring
24. "O" Ring
25. VES Actuator
26. Retaining Clip

95E13411

Fig. 1: Exploded View Of Power Steering Pump
Courtesy of GENERAL MOTORS CORP.

TROUBLE SHOOTING

NOTE: See the TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

TESTING

NOTE: Incorrect fluid level, belt tension, idle speed or damaged pump pulley can affect test results. Correct such conditions before testing power steering system.

1. On Fleetwood, connect Power Steering Pressure Tester (J-5176-D) or Power Steering System Analyzer (J-25323-A) in pressure line from pump. On Caprice, Impala SS and Roadmaster, remove intake duct. Remove brake control valve bracket bolts and reposition to access steering gear. Connect tester in pressure line from steering gear.
2. On all models, open valve fully. Start and run engine until fluid reaches normal operating temperature. Bleed power steering system. See **HYDRAULIC SYSTEM BLEEDING** . Check fluid level. Add fluid as necessary.
3. With engine at operating temperature, pressure reading should be less than 150 psi (10.5 kg/cm^2). If pressure is more than 150 psi (10.5 kg/cm^2), inspect system for restrictions. Check for proper installation of check valve in steering gear for.

   CAUTION: To prevent pump damage, DO NOT hold valve closed for more than 5 seconds.

4. Completely close valve for less than 5 seconds and then open it, recording highest pressure obtained when valve is closed. Repeat procedure 2 more times. Each reading should be at least 1000 psi (70.3 kg/cm^2).
5. If readings are within 50 psi (3.5 kg/cm^2) of each other, pump is okay. If readings are high and not within 50 psi (3.5 kg/cm^2) of each other, flow control valve is sticking. Remove and clean flow control valve with crocus cloth. Flush system if dirty.
6. If pressure readings are less than 1000 psi (70.3 kg/cm^2), replace flow control valve, then repeat test. If pressure is still low after replacing flow control valve, replace rotor and vanes. Refer to the **POWER STEERING PUMP** procedures under OVERHAUL.
7. If pump meets specification, leave valve open. Turn steering wheel from stop to stop, recording highest pressure at each stop. If pressure at both stops is not equal to pressure recorded in step 4), steering gear is leaking internally. Repair or replace steering gear.

LUBRICATION

CAPACITY

NOTE: Information is not available from manufacturer.

FLUID TYPE

When adding or changing fluid, use power steering fluid meeting GM Specification No. 9985010. Use of improper fluid will cause hose, pump and seal damage, resulting in fluid leaks and/or failure to operate.

FLUID LEVEL CHECK

Fluid level is indicated by marks on reservoir dipstick. When fluid is at operating temperature, about 170°F (77° C), fluid level should be at FULL HOT mark. Fluid level should be at FULL COLD mark when fluid is cold, about 70°F (21°C).

HYDRAULIC SYSTEM BLEEDING

CAUTION: If air is introduced into hydraulic system during servicing, bleed complete system. Aerated fluid, which appears Light Tan in color, results in poor steering performance and will cause severe pump damage.

1. With engine off, raise and support vehicle with front wheels off ground and turned fully to left. Add power steering fluid to FULL COLD mark on dipstick. Leave cap off.
2. Turn wheels from side to side, without touching stops at either end. Add fluid, if necessary, to maintain level at FULL COLD mark. It may be necessary to repeat this step several times.
3. Start engine. With engine idling, recheck fluid level. Add fluid, if necessary, to bring level to FULL COLD mark. Install cap. Ensure wheels are at center, straight-ahead position. Lower vehicle. Continue to run engine for 2-3 minutes to eliminate air in system.
4. Road test vehicle. Check for leaks. Ensure fluid level is at FULL HOT mark when fluid is stabilized at operating temperature.

ADJUSTMENTS

POWER STEERING PUMP BELT

Power steering pump is driven by serpentine belt. Belt tension is maintained by automatic tensioner. No maintenance or adjustment is necessary. Check belt operating range, indicated by marks on tensioner. If belt is not within operating range, check for proper installation before replacing belt.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

IDLE SPEED PRESSURE SWITCH

Removal & Installation

Raise and support vehicle. Remove electrical connector. Remove pressure switch from steering gear inlet hose. Lubricate "O" ring and threads of switch with power steering fluid. Install and tighten pressure switch to 115 INCH lbs. (13 N.m). Install electrical connector. Fill and bleed the power steering hydraulic system. See the **HYDRAULIC SYSTEM BLEEDING** procedures under LUBRICATION.

FLUID RESERVOIR

Removal & Installation

Siphon fluid from reservoir. Place drain pan under reservoir, and remove hoses. With rocking motion, pull reservoir from A/C accumulator assembly bracket. To install, reverse removal procedure. Ensure reservoir is seated properly. Fill and bleed system. Refer to the **HYDRAULIC SYSTEM BLEEDING** procedures under LUBRICATION.

POWER STEERING PUMP R & I

NOTE: It may be necessary to remove pump bracket with pump. Bracket mounting bolts may extend into water jacket.

Removal & Installation

1. Siphon fluid from power steering reservoir. Drain cooling system. On vehicles equipped with mechanical fan, Disconnect negative battery cable. Remove upper fan shroud. Remove fan and clutch assembly. Remove cooling fan pulley bracket (if necessary). Remove radiator outlet hose and pipe assembly.
2. On all models, remove heater hoses from water pump and alternator and power steering pump bracket. Remove drive belt. Disconnect fluid reservoir and pressure hoses from pump. Remove pump mounting bolts. Remove power steering pump pulley (if necessary). Remove pump. To install, reverse removal procedure. Fill and bleed hydraulic system. See **HYDRAULIC SYSTEM BLEEDING** under LUBRICATION. Fill and bleed cooling system.

PUMP PULLEY

CAUTION: When clamping pump in vise or mounting fixture, DO NOT exert excessive force on front hub. Housing may be distorted.

Removal & Installation

Remove drive belt. If necessary, remove pump for clearance. See **POWER STEERING PUMP** . Install Pulley Remover (J-25034-B) on pulley. Remove pulley from shaft by holding body of tool with wrench and turning bolt. To install, use Pulley Installer (J-25033-B). Draw pulley onto drive shaft until face of pulley hub is even with shaft. DO NOT use a press to install pulley. Install pump (if removed).

PUMP DRIVE SHAFT SEAL

Removal & Installation

Remove pump and pulley. Refer to the **POWER STEERING PUMP** and **PUMP PULLEY** procedures. Protect pump shaft with shim stock. Using a chisel, cut and remove seal. To install, coat shaft seal with power steering fluid. Using Shaft Oil Seal Installer (J-22670), drive new seal until it bottoms on shoulder.

NOTE: DO NOT disassemble flow control valve. If valve is sticking, clean with crocus cloth or replace valve.

PUMP FLOW CONTROL VALVE

Removal & Installation

Remove Pump. See **POWER STEERING PUMP** . On vehicles with Variable Effort Steering (VES) system, remove VES actuator and pressure line adapter. On vehicles without VES, remove union bolt (flow control valve fitting). See **Fig. 1** . On all vehicles, remove flow control valve and spring. To install, reverse removal procedure using a new, lubricated "O" ring. Tighten fittings to specification. Refer to **TORQUE SPECIFICATIONS** .

OVERHAUL

POWER STEERING PUMP

CAUTION: When clamping pump in vise or mounting fixture, DO NOT exert excessive force on front hub. Housing may be distorted.

Disassembly

1. Remove pulley, drive shaft seal and flow control valve. See the **PUMP PULLEY** removal and installation procedures. Also refer to the **DRIVE SHAFT SEAL** procedures as well as the removal and installation procedures in **PUMP FLOW CONTROL VALVE** procedures under REMOVAL & INSTALLATION. Remove end cover retainer ring. See **Fig. 1** . Remove end cover and pressure plate spring. Check shaft for corrosion. If shaft is corroded, clean with crocus cloth to prevent damaging shaft bushing when tapping shaft out of housing.
2. Tap lightly on end of shaft with plastic mallet to remove pressure plate. Remove pump ring and vanes. Remove and disassemble shaft, rotor and thrust plate assembly. Remove "O" rings from housing.

Inspection

1. Clean all parts in solvent. Clean residue from pump magnet. Inspect flow control valve for wear or damage. Inspect seal bore in housing for burrs, nicks or scoring. Inspect fit of vanes in rotor. Vanes must slide freely into rotor slots without binding.
2. Excessively loose vanes require replacement of rotor and/or vanes. Examine inner surface of pump ring for heavy scuff or chatter marks. Inspect flat surfaces of pressure and thrust plates for wear or scoring.
3. Light scoring can be removed by lapping on a flat surface. Inspect pump housing drive shaft bushing for excessive wear. Replace pump housing and bushing as an assembly if badly worn or scored. Replace any

damaged or worn parts.

Reassembly

1. Lubricate all "O" rings and sealing areas with power steering fluid. Place pump housing on flat surface. Using Shaft Oil Seal Installer (J-22670), drive new shaft seal into bore. To prevent seal from being distorted, DO NOT use excessive force.
2. Clamp pump housing in vise with shaft down. Install end cover and pressure plate "O" rings in grooves in pump cavity. With drive shaft clamped (splined end up), install thrust plate on drive shaft with ported side up. See **Fig. 2** .
3. Slide rotor over splines, and install rotor lock ring. Insert both dowel pins in holes of pump cavity. Rotor must move freely on splines. Install drive shaft assembly into pump body, ensuring dowel pins are properly engaged in thrust plate.
4. Install vanes in rotor slots. Slide pump ring over rotor on dowel pins with arrows facing up. See **Fig. 3** . Position pressure plate on dowel pins with plate spring groove facing upward. Place a 1 1/4" socket in groove of pressure plate. Seat entire assembly on "O" ring in pump cavity by pressing down with both thumbs.
5. Place pressure plate spring into groove in pressure plate. Position end cover lip edge up over spring. Press end cover down below retainer ring groove with thumb. Install retainer ring. Ensure ring is seated in groove. Use care to avoid cocking end cover in bore or distorting assembly.
6. Install flow control valve in bore, with control valve spring and hex end of valve facing interior of bore. Using new "O" rings, install union bolt (or VES actuator) into flow control valve bore and tighten to specification. See **TORQUE SPECIFICATIONS** . Install pump pulley.

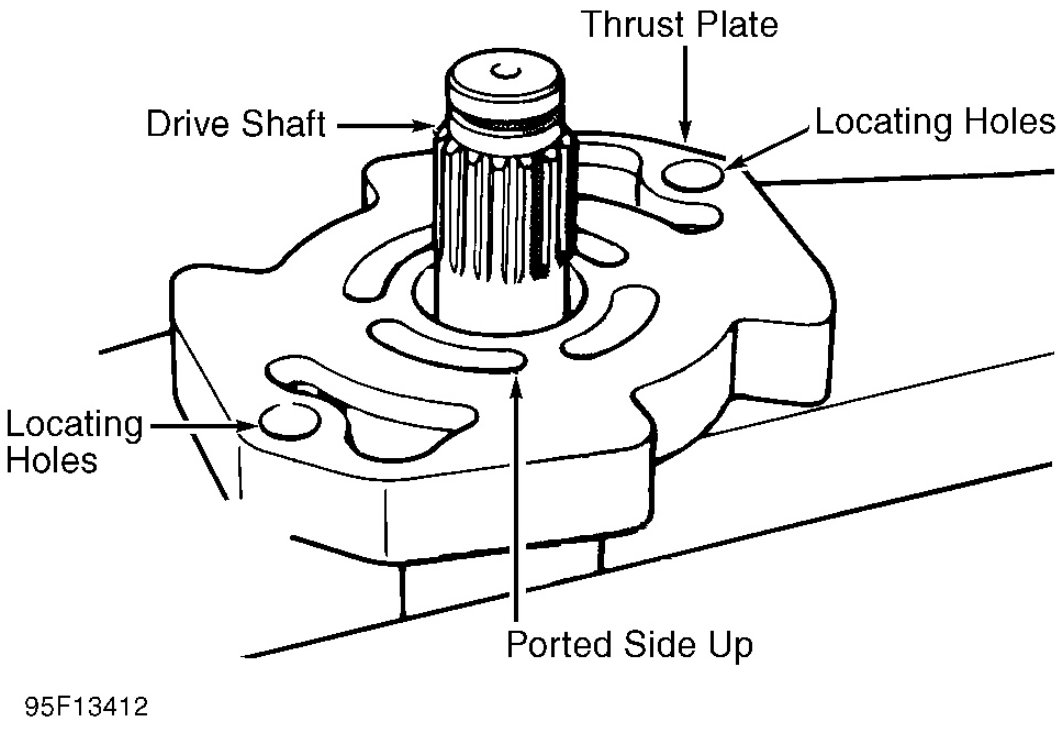


Fig. 2: Installing Thrust Plate
Courtesy of GENERAL MOTORS CORP.

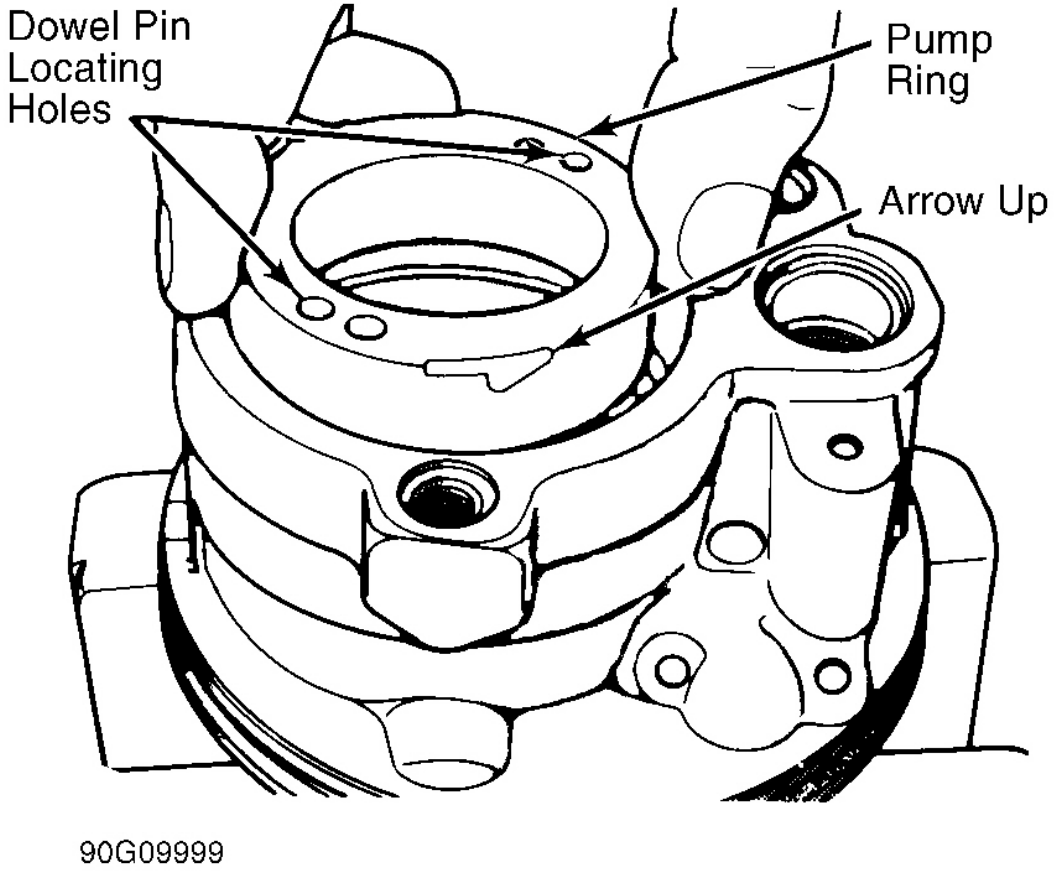


Fig. 3: Installing Pump Ring
Courtesy of GENERAL MOTORS CORP.

TORQUE SPECIFICATIONS

POWER STEERING PUMP TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Alternator Bracket Bolts	37 (50)
Fan Clutch Bolt/Nut	18 (24)
Fluid Line Fittings	21 (28)
Pump Mounting Bolts	30 (41)
Union Bolt (1)	55 (75)
VES Actuator (2)	46 (62)

(1)

Union bolt retains flow control valve (vehicles without VES).

(2) VES actuator retains pressure line fitting and flow control valve.

ADJUSTMENTS

PRE-ALIGNMENT INFORMATION

NOTE: Prior to performing wheel alignment, perform visual and mechanical inspection of wheels, tires and suspension components. See the PRE-ALIGNMENT CHECKS article in this section. For basic wheel alignment theory, refer to WHEEL ALIGNMENT THEORY/OPERATION article in the GENERAL INFORMATION section.

ORDER OF ALIGNMENT

To ensure accurate alignment, align wheels in the following order:

- Rear Camber
- Rear Toe-In
- Front Caster
- Front Camber
- Front Toe-In

CAMBER ADJUSTMENT (REAR)

Rear camber is not adjustable. If rear camber is not as specified, repair or replace worn or damaged components.

TOE-IN ADJUSTMENT (REAR)

Rear toe-in is not adjustable. If rear toe-in is not as specified, repair or replace worn or damaged components.

CASTER ADJUSTMENT

Remove, add or transfer shims at bolts securing upper control arm shaft to frame. See **Fig. 1** . One shim pack can be thicker than the other, but not by more than .40" (10.2 mm).

CAMBER ADJUSTMENT (FRONT)

Remove, add or transfer shims at bolts securing upper control arm shaft to frame. See **Fig. 1** . One shim pack can be thicker than the other, but not by more than .40" (10.2 mm).

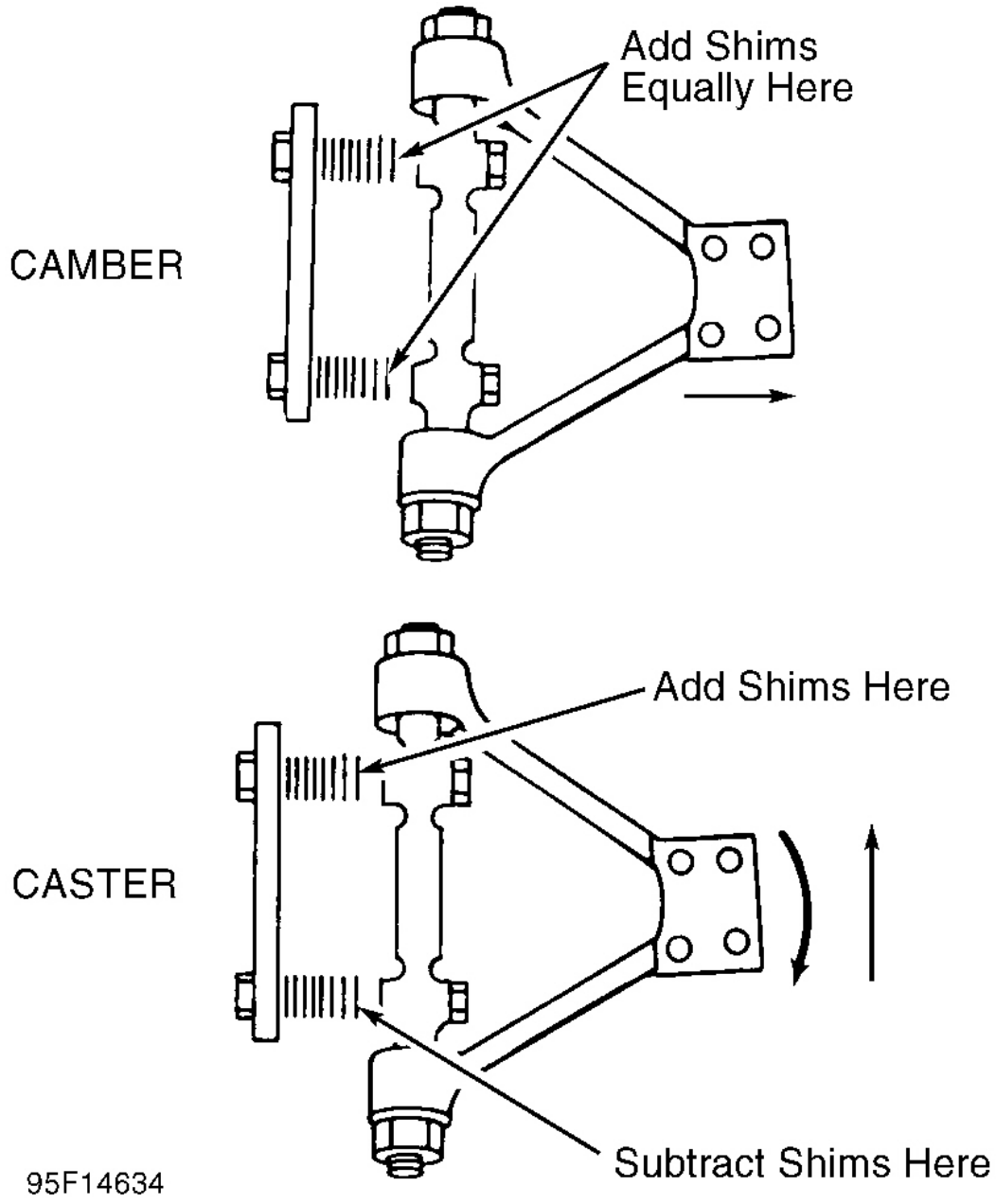


Fig. 1: Adjusting Front Camber & Caster ("B" & "D" Bodies)
Courtesy of GENERAL MOTORS CORP.

TOE-IN ADJUSTMENT (FRONT)

1. Center steering wheel and keep it centered throughout procedure. Loosen adjusting sleeve clamps. See **Fig. 2** . Rotate adjusting sleeve until threaded part of both tie rod ends is covered by adjusting sleeve (no

threads are showing).

2. Turn adjusting sleeve until toe-in is as specified. See **ALIGNMENT SPECIFICATIONS** . Ensure slot in adjusting sleeve is NOT aligned with gap in clamp. Ensure angle of clamp bolt (in relation to horizontal line) is as illustrated. See **Fig. 2** . Ensure bolt head is facing rearward. Tighten clamp bolts to specification. See **TORQUE SPECIFICATIONS** .

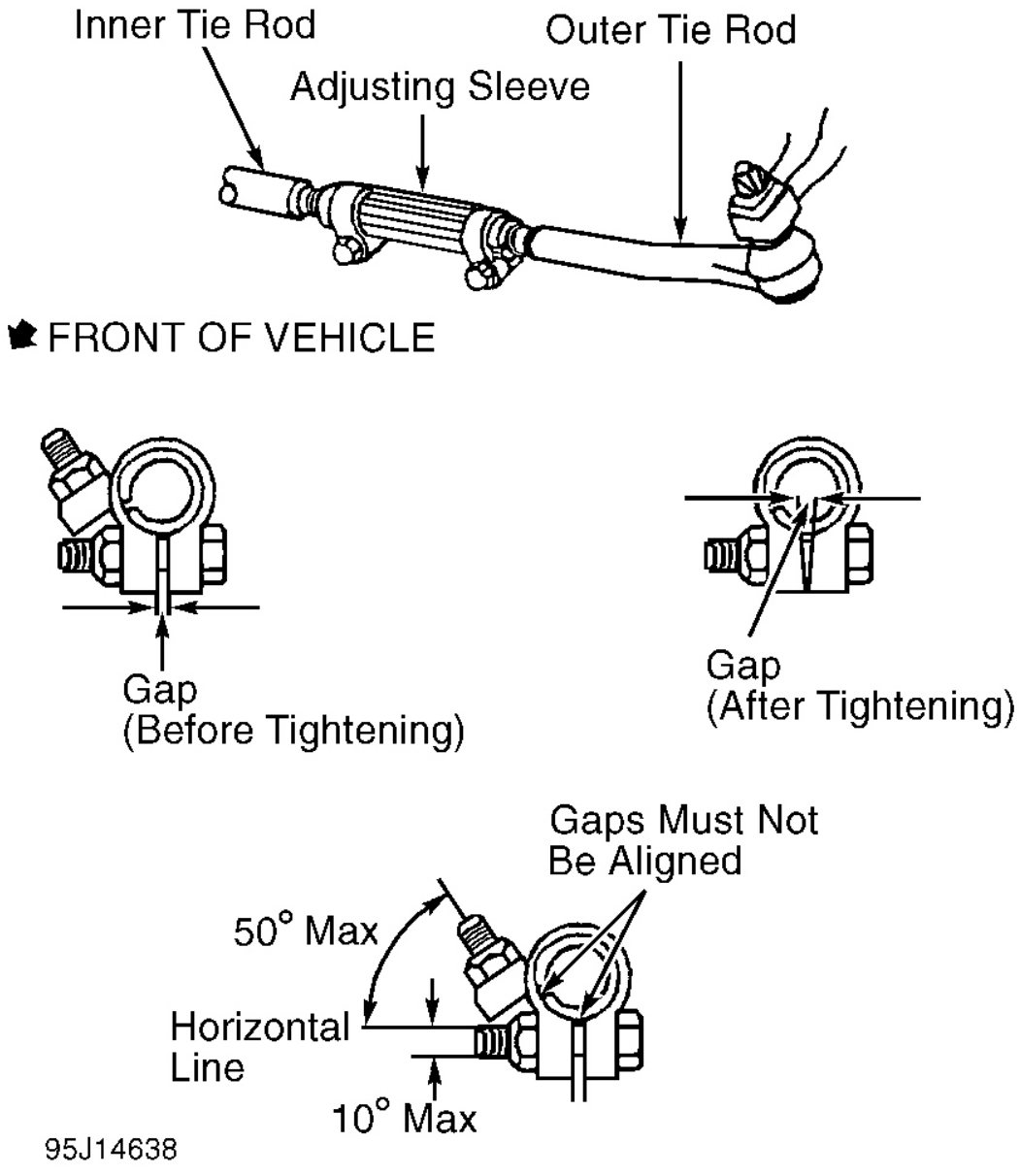


Fig. 2: Adjusting Front Toe-In
Courtesy of GENERAL MOTORS CORP.

ALIGNMENT SPECIFICATIONS

WHEEL ALIGNMENT SPECIFICATIONS

Application	Preferred	Range
Camber (Degrees) Front	0	-1 to 1
Camber (Degrees) Rear	N/A	N/A
Caster (Degrees) Front Right	3.75	2.75 to 4.75
Caster (Degrees) Front Left	3.25	2.25 to 4.25
Caster (Degrees) Rear	N/A	N/A
Toe-In (Inches) Front	0.08	-0.02 to 0.18
Toe-In (Inches) Rear	N/A	N/A
Toe-In (Millimeters) Front	2	0.5 to 4.5
Toe-In (Millimeters) Rear	N/A	N/A
Toe-In (Degrees) Front	0.16	-0.04 to 0.36
Toe-In (Degrees) Rear	N/A	N/A
Wheelbase (Inches)	115.9	N/A
Wheelbase (Millimeters)	2944	N/A

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Front Suspension	
Lower Ball Joint Nut	79 (109)
Lower Control Arm Bushing Nut	95 (125)
Shock Absorber Lower Bolt	20 (27)
Tie Rod Nut	35 (47)
Upper Ball Joint Nut	60 (82)
Upper Control Arm	
Bushing Nut	72 (98)
Pivot Shaft Nut	85 (115)
Wheel Lug Nut	100 (140)
Rear Suspension	
Lower Control Arm Bushing	
Bolt	74 (100)
Nut	91 (123)
Shock Absorber	
Lower Nut	48 (65)
Upper Bolt	20 (27)
Upper Nut	12 (16)
Upper Control Arm	

Front Bushing	
Bolt	114 (155)
Nut	91 (123)
Rear Bushing	
Bolt	80 (108)
Nut	70 (95)

ACCESSORIES & EQUIPMENT General Motors Corp. - Remote Keyless Entry System

DESCRIPTION & OPERATION

Passive Keyless Entry (PKE) system consists of a transmitter and in-vehicle receiver. Press UNLOCK button once and release to unlock driver's front side door only. Press UNLOCK button a second time (within 1-5 seconds of first depression) to unlock remaining front and rear side doors.

To release trunk/tailgate, press bottom button marked with vehicle symbol on top cover. To lock front and rear side doors, press DOOR button marked with key symbol.

RECEIVER PROGRAMMING

1. On sedan, move trim located in left side of trunk to gain access to programming connector. See **Fig. 1** . On wagon, remove right back body pillar finish panel to access programming connector. See **Fig. 2** . On all models, use a jumper wire and ground programming connector. Door locks and rear trunk/tailgate lock will cycle. This indicates receiver is in program mode.
2. Press any button once on transmitter. Door locks and trunk/tailgate lock will cycle once to ensure transmitter code is programmed. Receiver is now programmed to transmitter. Previously programmed codes are erased.
3. If programming a receiver to match a second transmitter, do not disconnect program connector jumper wire. Press any button once on second transmitter. Door locks and trunk/tailgate lock will cycle once to ensure transmitter code is programmed.
4. Disconnect programming connector. System will not operate unless ground connection jumper wire is removed. Ensure transmitter is operating properly. On sedan, reposition trunk trim assembly.

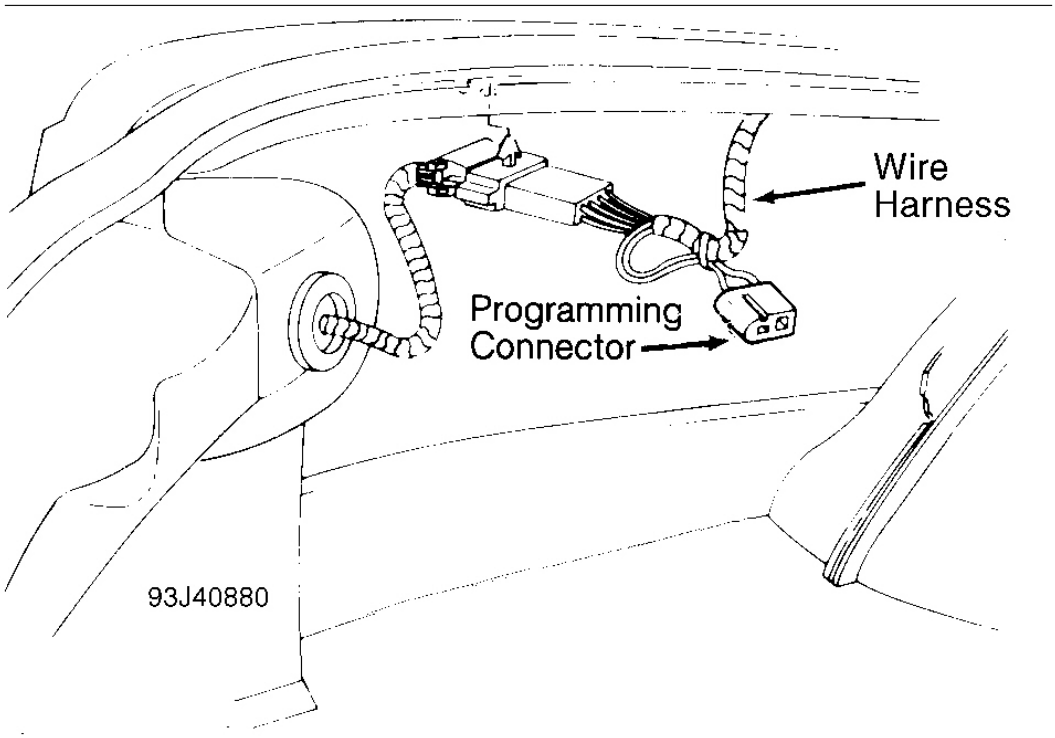


Fig. 1: Locating Receiver Programming Connector (Sedan)
Courtesy of GENERAL MOTORS CORP.

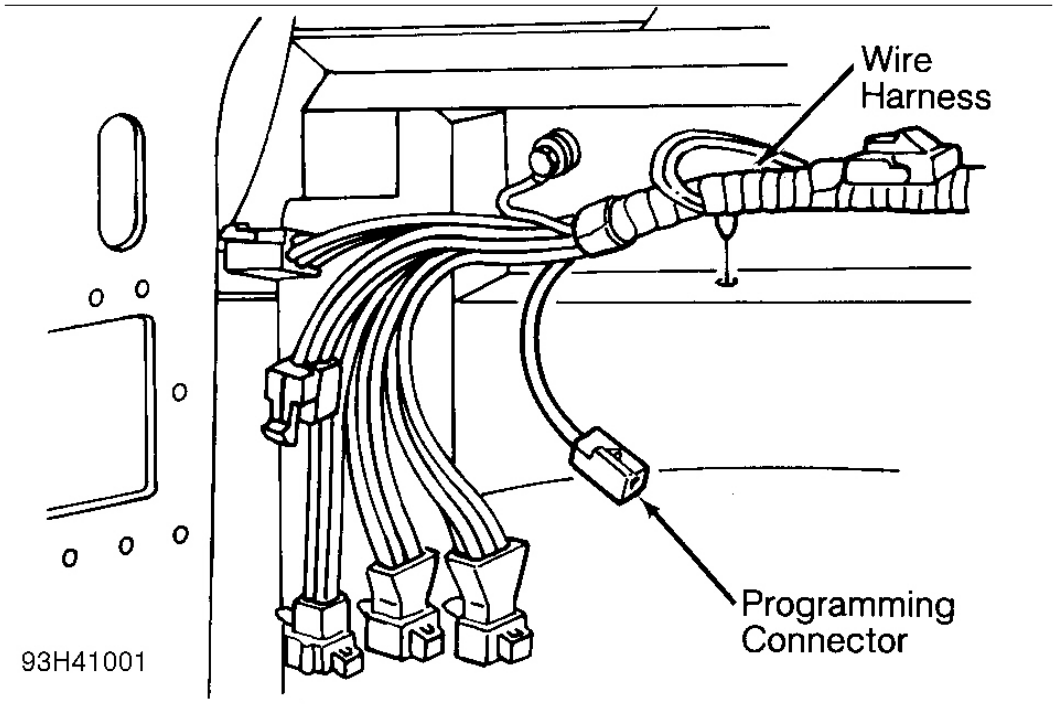


Fig. 2: Locating Receiver Programming Connector (Wagon)
Courtesy of GENERAL MOTORS CORP.

TROUBLE SHOOTING

Ensure power door locks function using left and right front door lock switches. Ensure interior lights operate when any door is opened. Ensure transmitter battery terminals are clean and battery is good. Try a known good transmitter, if available.

TESTING

Keyless Entry System Inoperative

1. If power door locks do not operate correctly, see the **DOOR LOCKS - POWER** article in this section. If power door locks do operate correctly, go to next step.
2. Disconnect Remote Control Door Lock Receiver (RCDLR) connector C2. Connect test light between connector terminal "A" (Orange wire) and ground. If test light lights, go to next step. If test light does not light, repair open or short to ground in Orange wire to RCDLR.
3. Connect test light between connector terminals "A" (Orange wire) and "F" (Black/White wire). If test light does not light, repair open circuit in Black/White wire. If test light lights, check for poor connections at RCDLR. If connections are okay, program a known good transmitter. If system is still inoperative, replace RCDLR.

Driver's Door Lock Or Unlock Function Inoperative, Passenger

Door Locks Operate Normally

1) If power door locks do not operate correctly, see the **DOOR LOCKS - POWER** article in this section. If power door locks do operate correctly, go to next step.

2) Backprobe Remote Control Door Lock Receiver (RCDLR) connector C1 with a test light between terminal "E" (White wire) and ground. Press and hold front door lock switch in unlock position. If test light lights, go to next step. If test light does not light, repair open circuit in White wire.

3) Backprobe RCDLR connector C2 with a test light between terminal "D" (Tan wire) and ground. If test light does not light, go to next step. If test light lights, check for short to voltage in Tan wire.

4) Backprobe RCDLR connector C2 with a test light between terminal "D" (Tan wire) and ground. Press and hold front door lock switch in unlock position. If test light lights, go to next step. If test light does not light, check for short to ground in Tan wire.

5) Backprobe RCDLR connector C2 with a test light between terminals "A" (Orange wire) and "D" (Tan wire). If test light does not light, check for poor connection at RCDLR C2 connector. If test light lights, check for open circuit in Gray wire between door lock relay terminal "B" and lock actuator, or open circuit in Tan wire between RCDLR and lock actuator. Also check for poor connection at driver's door lock actuator. If all circuits are okay, replace driver's door lock actuator.

Rear Glass Release Inoperative (Roadmaster Wagon)

1. Shift transmission to Park. Backprobe Remote Control Door Lock Receiver (RCDLR) connector C1 with a test light between terminal "C" (Light Green wire) and ground.
2. If test light does not light, check for poor connection at transmission position switch or open circuit in Light Green wire. If connection and wire are okay, replace transmission position switch.
3. If test light lights, check for poor connection at RCDLR connector C1 terminal "C" (Light Green wire), RCDLR connector C2 terminal "B" (Dark Blue wire), or open circuit in Dark Blue wire. If connections are wire are okay, program a known good transmitter. If rear glass release operates, transmitter was defective. If release is still inoperative, replace RCDLR.

Rear Glass Release Available With Ignition Switch In RUN

Position & Transmission Out Of Park (Roadmaster Wagon)

1) Disconnect RCDLR connector C1. Turn ignition switch to RUN position. Connect test light between RCDLR connector C1 terminal "B" (Pink wire) and ground. If test light lights, go to next step. If test light does not light, repair open or short to ground in Pink wire.

2) Set parking brake. Shift transmission to Drive. Connect test light between connector C1 terminal "C" (Light Green wire) and ground. If test light lights, check for short to voltage in Light Green wire. If Light Green wire is okay, replace transmission position switch. If test light does not light, check for poor connection at keyless receiver connector C1 terminal "B" (Pink wire). If connection is okay, replace RCDLR.

Courtesy Lights Do Not Turn On When Unlock Function is

Operated; Unlock Function Operates Normally (Roadmaster)

1) Turn ignition off. Disconnect Remote Control Door Lock Receiver (RCDLR) connectors C2 and C1. Connect voltmeter between connector C1 terminal "B" (Pink wire) and ground.

2) If any voltage is present, repair short to voltage in Pink wire. If no voltage is present, connect fused jumper wire between RCDLR connector C2 terminal "E" (Dark Blue wire) and ground.

3) If courtesy lights come on, check for poor connection at RCDLR connector C2. If connection is okay, replace RCDLR. If courtesy lights stay off, repair open circuit in Dark Blue wire to RCDLR.

Rear Compartment Lid Release Inoperative

1. Shift transmission to Park. Connect test light between Remote Control Door Lock Receiver (RCDLR) connector C1 terminal "C" (Light Green wire) and ground. If test light does not light, check for poor connection at transmission position switch or open circuit in Light Green wire. If switch and wire are okay, replace transmission position switch.
2. If test light lights, check for poor connection at RCDLR connector C1 terminal "C" (Light Green wire), or connector C2 terminal "B" (Black wire). Also check for open circuit in Black wire. If connections and wire are okay, program a known good transmitter. If compartment lid release is still inoperative, replace RCDLR.

Rear Compartment Lid Release Available With Ignition Switch

In RUN Position & Transmission Out Of Park

1) Disconnect Remote Control Door Lock Receiver (RCDLR) connector C1. Turn ignition switch to RUN position. Connect test light between connector C1 terminal "B" (Pink wire) and ground. If test light does not light, repair open or short to ground in Pink wire.

2) If test light lights, set parking brake. Shift transmission to Drive. Connect test light between RCDLR connector C1 terminal "C" (Light Green wire) and ground.

3) If test light lights, check for short to voltage at Light Green wire. If wire is okay, replace transmission position switch. If test light does not light, check for poor connection at RCDLR connector C1 terminal "C" (Light Green wire). If connection is okay, replace RCDLR.

Remote Control Door Lock Receiver/Transmitter Will Not

Program)

1) Front probe keyless programming connector with voltmeter between terminal "B" (Black/White wire) and ground. If 6-7 volts are present, program a known good transmitter. If Remote Control Door Lock Receiver (RCDLR) does not program, replace RCDLR.

2) If zero voltage is present, check for open or short to ground in Black/White wire or poor connection at

RCDLR connector C1 terminal "H" (Black/White wire). If connection and wire are okay, replace RCDLR.

Doors Do Not Unlock With Ignition Switch In RUN Position &

Transmission Shifted To Park (Roadmaster)

1) Set parking brake. Turn ignition switch to RUN position. Shift transmission to Drive. Connect test light between Remote Control Door Lock Receiver (RCDLR) connector C1 terminal "C" (Light Green wire) and ground.

2) If test light lights, check for short to voltage in Light Green wire, incorrectly adjusted back-up light, and transmission position switch. If all components are okay, replace transmission position switch.

3) If test light does not light, shift transmission to Park. Connect test light between RCDLR connector C1 terminal "C" (Light Green wire) and ground.

4) If test light does not light, check for poor connection at transmission position switch or open circuit in Light Green wire. If connection and wire are okay, replace switch. If test light lights, check for poor connection at RCDLR connector C1 terminals "C" (Light Green wire) and "D" (Light Blue wire). If connections and wiring are okay, replace RCDLR.

Doors Do Not Automatically Lock When All Doors Are Closed &

Transmission Is Shifted Out Of Park With Ignition In Run

(Roadmaster)

1) Set parking brake. Turn ignition switch to RUN position. Shift transmission into Drive. Disconnect Remote Control Door Lock Receiver (RCDLR) connector C1. Connect test light between connector C1 terminal "C" and ground.

2) If test light lights, check for short to voltage in Light Green wire. If wire is okay, replace back-up light and transmission position switch. If test light does not light, shift transmission to Park. Connect test light between connector C1 terminal "C" (Light Green wire) and ground.

3) If test light lights, check for poor connections at RCDLR connectors. If connectors are okay, replace RCDLR. If test light does not light, check for poor connection at transmission position switch. If connection is okay, replace RCDLR.

REMOVAL & INSTALLATION

RECEIVER

Removal & Installation (Caprice & Impala SS Except Wagon)

Receiver is located under rear shelf and is accessed through trunk and forward access hole. See **Fig. 3** . Remove 6 rivets attaching receiver to bottom of rear shelf. Slide receiver through forward access hole. Disconnect electrical connector from receiver. To install, reverse removal procedure.

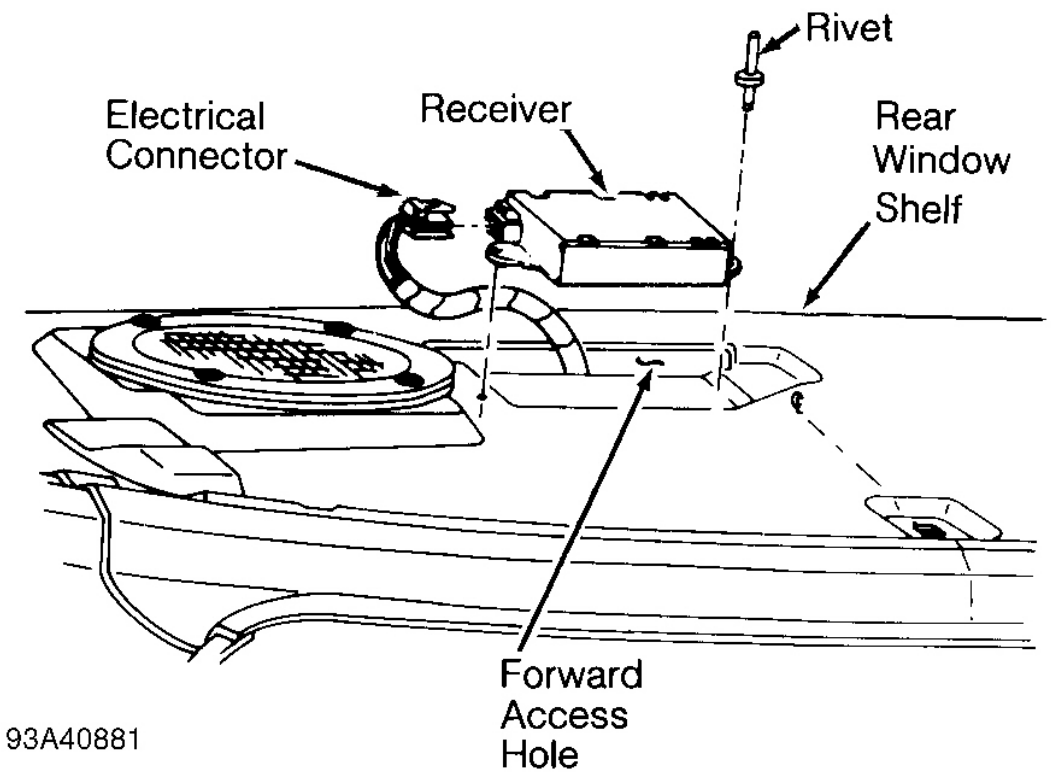


Fig. 3: Locating Receiver (Typical Sedan)
Courtesy of GENERAL MOTORS CORP.

Removal & Installation (Caprice Wagon & Roadmaster)

1. On sedan models, remove rear window panel trim assembly. On wagon models, remove left quarter inner rear trim finish panel assembly. On all models, disconnect electrical connectors from receiver assembly. See **Fig. 4** or **Fig. 5** .
2. On sedan, remove rivets attaching receiver assembly to rear window panel assembly. On wagon, remove bolts/screws attaching receiver assembly to bracket. On all models, if system programming is necessary, see **RECEIVER PROGRAMMING** . To install, reverse removal procedure.

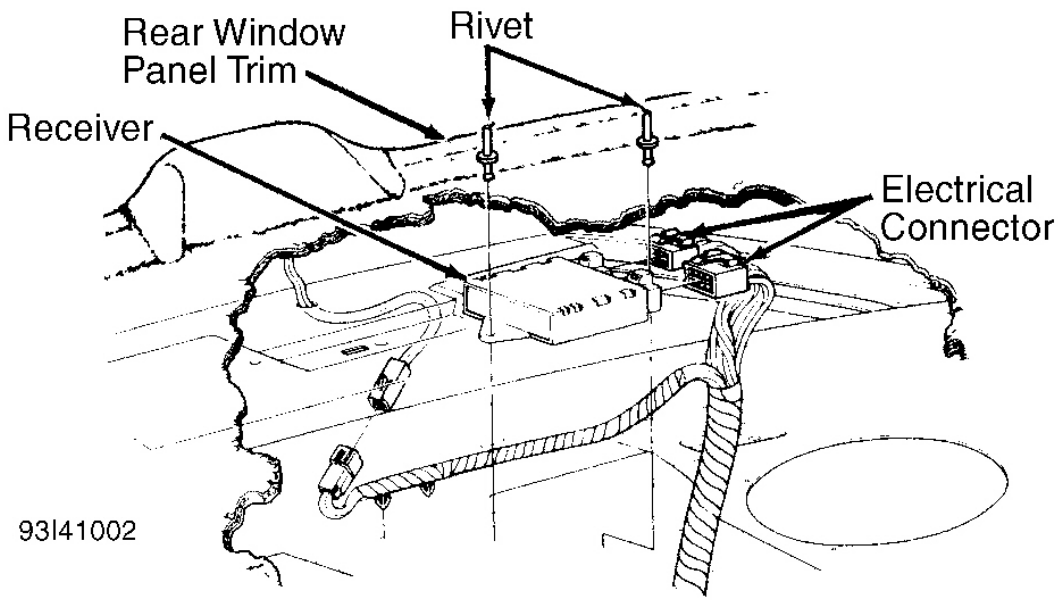


Fig. 4: Locating Receiver Assembly (Roadmaster Sedan)
Courtesy of GENERAL MOTORS CORP.

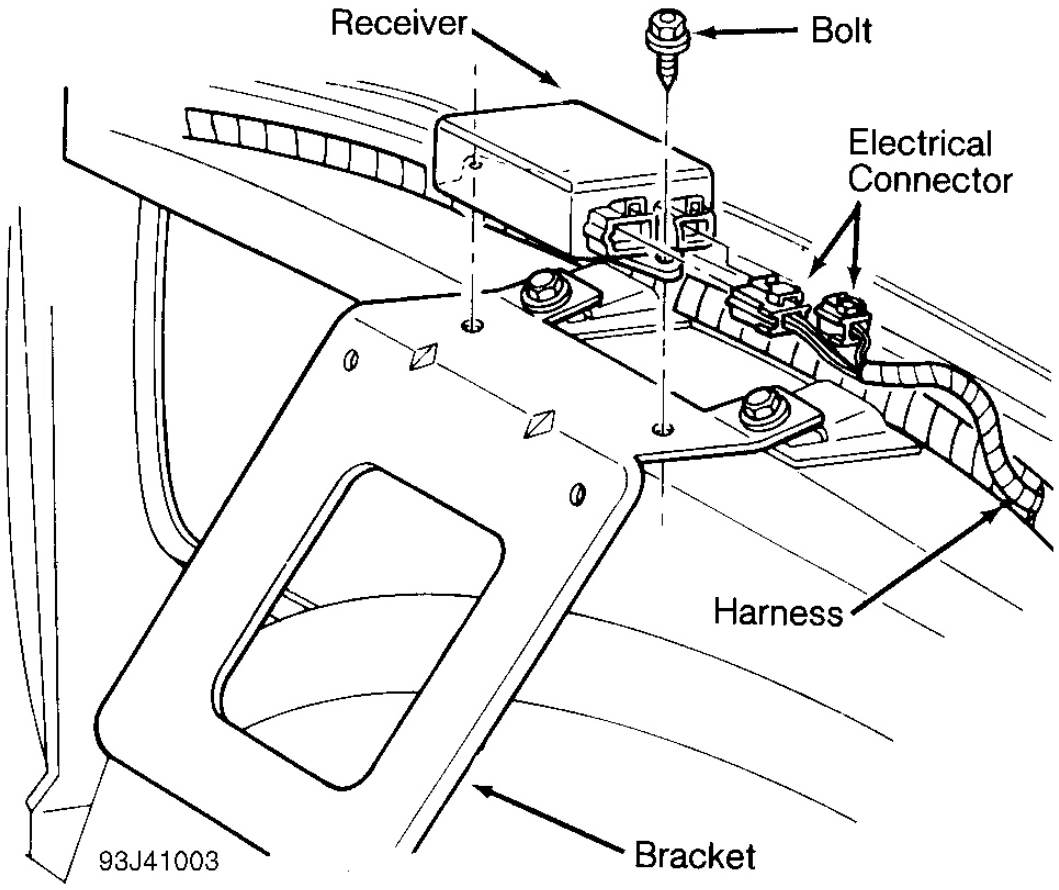


Fig. 5: Locating Receiver Assembly (Wagon)
Courtesy of GENERAL MOTORS CORP.

WIRING DIAGRAM

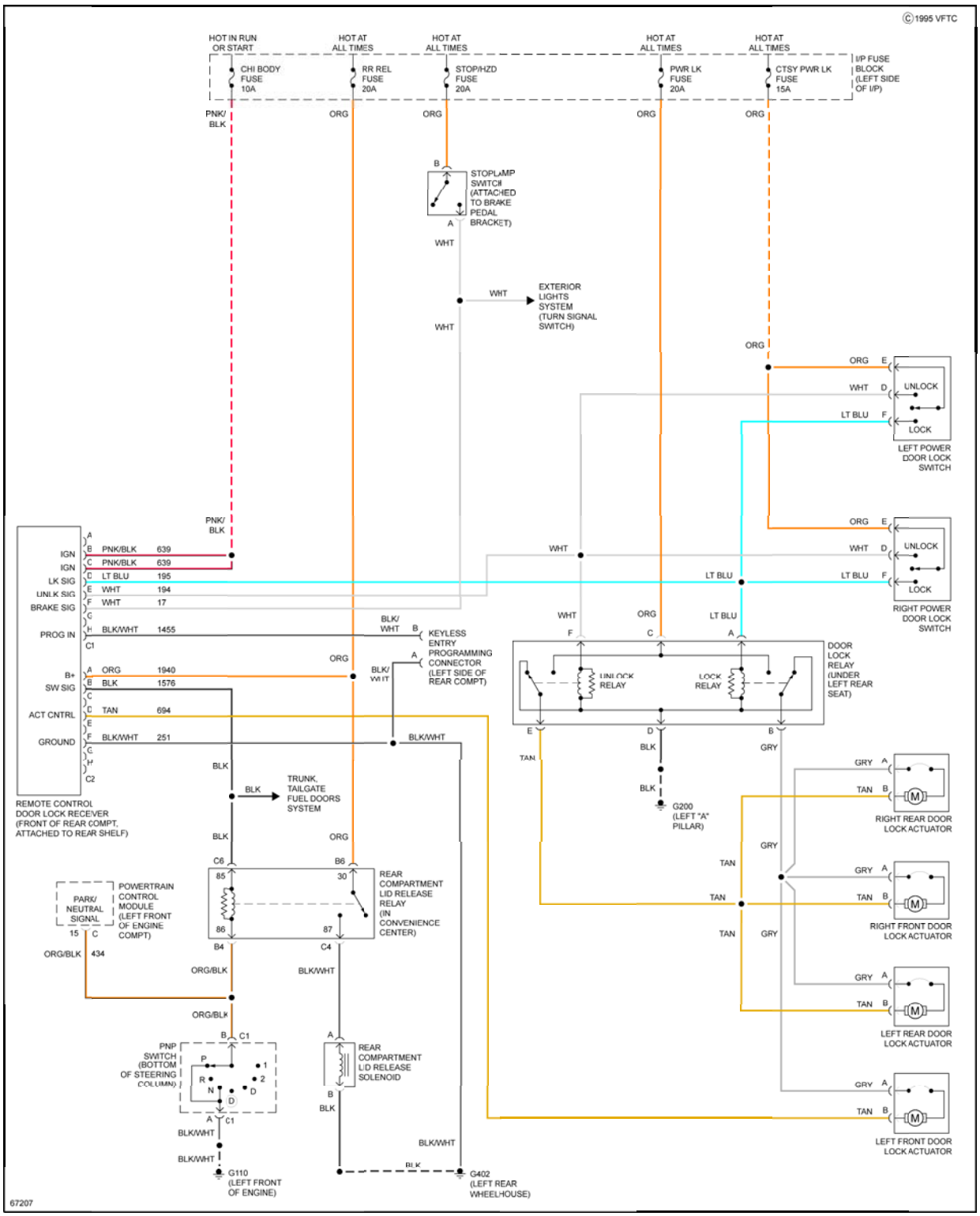


Fig. 6: Remote Keyless Entry System Wiring Diagram (Caprice & Impala SS)

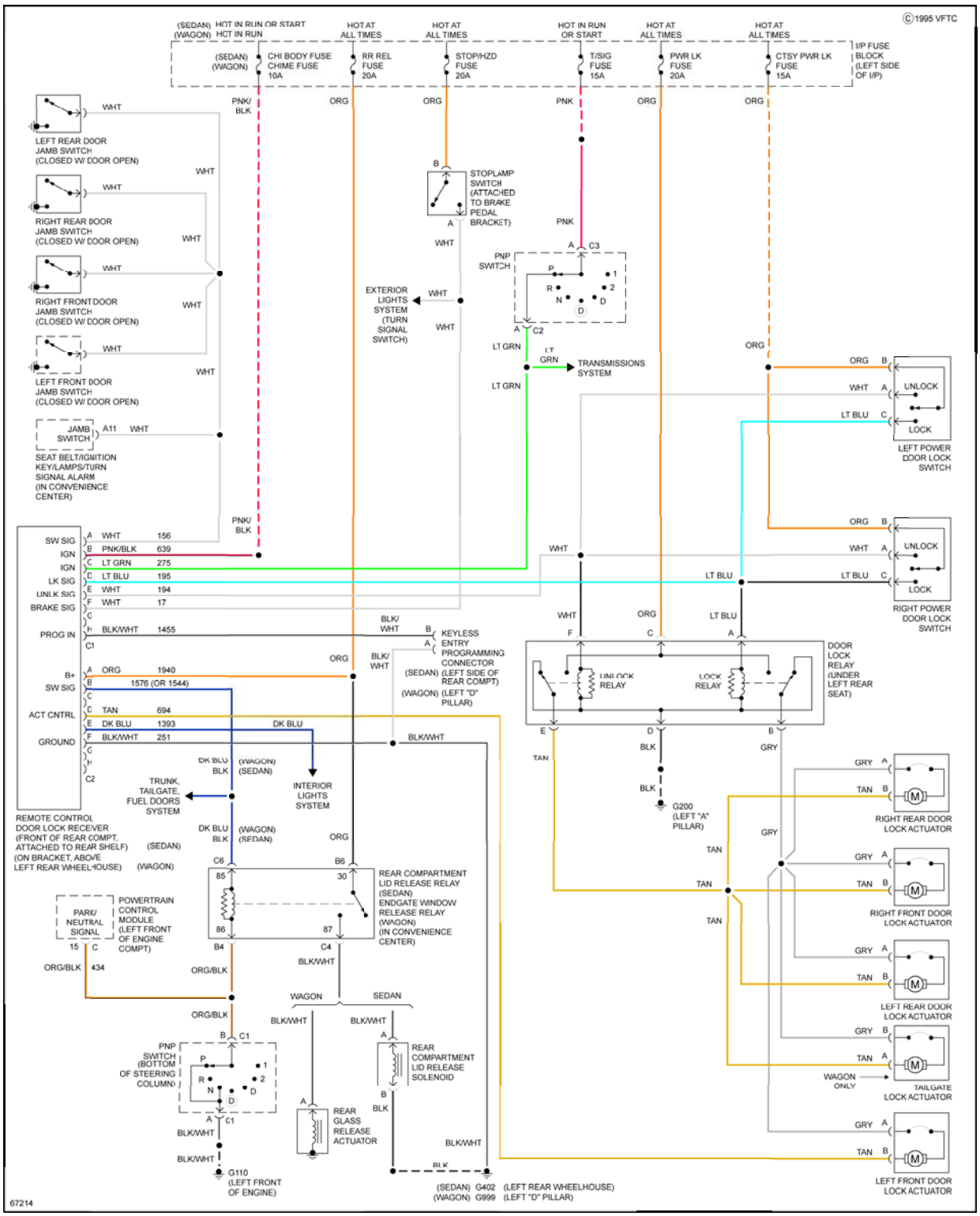


Fig. 7: Remote Keyless Entry System Wiring Diagram (Roadmaster)

TRANSMISSION REMOVAL & INSTALLATION - A/T

AUTOMATIC TRANSMISSION REMOVAL General Motors Passenger Cars

REMOVAL & INSTALLATION

WARNING: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

3T40 TRANSAXLE

Removal ("A" Body)

1. Disconnect and shield negative battery cable. Remove air cleaner. Remove bolt securing transaxle throttle valve cable to transaxle. Remove shift cable and bracket from transaxle. Disconnect electrical connectors as necessary.
2. Disconnect oil cooler lines from transaxle. Plug ends of lines. Remove all transaxle-to-engine bolts except bolt nearest starter motor (leave this bolt loosely installed). Support engine from top. Raise and support vehicle on hoist. Remove left front wheel. Remove left engine splash shield. Remove pinch bolt from left ball joint. Disconnect ball joint from left control arm.

CAUTION: If steering intermediate shaft is not disconnected from steering gear stub shaft as described in next step, these components could be damaged, possibly resulting in loss of steering control.

3. Remove pinch bolt securing steering intermediate shaft to steering gear stub shaft. Remove stabilizer bar. Center-punch the 2 spot welds securing left crossmember to rear crossmember. Left crossmember is the 90-degree frame piece that acts as left frame and front crossmember. Drill out spot welds using 7/16" drill bit.
4. Remove bolt securing left end of steering rack to rear crossmember. Remove 4 bolts securing left crossmember to right frame. Using jack stand, support left crossmember from bottom. Remove 2 bolts securing left crossmember to body.
5. Remove 2 nuts securing left transaxle mount to left crossmember. Remove left crossmember and jack stand. Remove starter and torque converter covers. Remove 3 flexplate-to-converter bolts. Remove 2 transaxle extension bolts from engine-to-transaxle bracket.
6. Remove rear transaxle mount bracket assembly (it may be necessary to raise transaxle). Using transaxle jack, support transaxle from bottom. Remove 2 braces from right end of transaxle. Remove left drive axle. See appropriate AXLE SHAFTS article in AXLE SHAFTS & TRANSFER CASES.
7. Remove remaining transaxle-to-engine bolt near starter. Remove transaxle and right drive axle as an assembly.

Installation ("A" Body)

To install, reverse removal procedure. Adjust throttle valve cable and shift cable after installation. See ADJUSTMENTS in appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section. Refill transaxle to proper level with fluid.

Removal ("J" Body)

1. Disconnect negative battery cable. Drain cooling system. Disconnect heater hoses from heater core. Remove air intake duct. Remove throttle valve cable. Remove fluid fill tube. Support engine from top using Engine Support Fixture(J-28467-A).
2. Disconnect electrical connectors as necessary. Disconnect shift cable from transaxle. Remove 2 top transaxle-to-engine bolts. Remove upper left transaxle mount and bracket assembly. Remove rubber hose from transaxle-to-vent pipe. Remove remaining upper engine-to-transaxle bolts. Raise and support vehicle.
3. Remove front wheels. Drain transaxle. Separate ball joints from steering knuckles. Install Drive Axle Boot Protectors (J-34753). Remove drive axles. See appropriate DRIVE AXLE article in DRIVE AXLE section. Remove transaxle-to-engine brace. Remove transaxle mounting strut.
4. Remove pin bolt from left stabilizer shaft link. Remove clamp nuts from left stabilizer shaft frame bushing. Remove left suspension support assembly. On 2.2L engines, disconnect exhaust pipe from manifold. On 3.1L engines, remove front exhaust manifold and pipe.
5. On all vehicles, remove starter. Remove torque converter cover. Mark torque converter in relation to flexplate for alignment during installation. Remove torque converter-to-flexplate bolts.
6. Disconnect fluid cooler lines from transaxle. Remove transaxle-to-engine support bracket. Support transaxle with jack. Remove remaining engine-to-transaxle bolts. Lower transaxle.

Installation ("J" Body)

To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Apply a thin film of chassis grease to torque converter pilot hub. Adjust throttle valve cable and shift cable. See appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section.

Removal ("L" Body)

1. Disconnect negative battery cable. Remove air intake duct. Remove throttle valve cable. Remove fluid fill tube. Remove bolt securing wiring harness to transaxle. Disconnect electrical connectors from torque converter clutch and neutral safety switch.
2. Remove upper shift control cable bracket. Disconnect shift cable from shift lever at transaxle. Remove transaxle-to-vent pipe rubber hose.
3. Support engine from top using Engine Support Fixture (J-28467-A). Remove 2 top transaxle-to-engine bolts and remaining upper transaxle-to-engine bolts. Raise and support vehicle.
4. Remove front wheels. Remove left splash shield. Remove transaxle mount-to-body bolts. Install Drive Axle Boot Protectors (J-34754) on both boots. Remove drive axles. See appropriate DRIVE AXLE article in DRIVE AXLE section. Remove left and right stabilizer links. Remove left stabilizer bar clamp nuts. Remove left suspension support and attaching bolts.
5. Disconnect vehicle speed sensor connector from transaxle. Remove torque converter cover. Mark torque converter in relation to flexplate for alignment during installation. Remove torque converter-to-flexplate

bolts. Remove starter.

6. Disconnect fluid cooler lines from transaxle. Remove transaxle shift cable from lower cable bracket. Remove transaxle-to-engine brace bolts at transaxle. Support transaxle with jack. Remove remaining engine-to-transaxle bolts. Lower transaxle.

Installation ("L" Body)

To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Adjust shift cable. See appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section.

Removal ("N" Body)

1. Disconnect negative battery cable. Drain cooling system. Disconnect heater hoses from heater core. Remove air intake duct. Remove control cable cover. Remove shift cable and throttle valve cable. Disconnect vacuum hoses and electrical connectors as necessary.
2. Remove power steering pump with hoses attached and set aside. Remove fluid fill tube. Support engine from top using Engine Support Fixture (J-28467-A). Remove 4 top transaxle-to-engine bolts. Raise and support vehicle. Remove front wheels. Remove left splash shield. Disconnect both front Anti-Lock Brake System (ABS) wheel speed sensors and harness from left suspension support.
3. Separate ball joints from steering knuckles. Remove left and right stabilizer links. Remove front air deflector and left suspension support. Install Drive Axle Boot Protectors (J-37292-B). Remove drive axles. See appropriate DRIVE AXLE article in DRIVE AXLE section. Remove transaxle-to-engine brace. Remove torque converter cover.
4. Mark torque converter in relation to flexplate for alignment during installation. Remove torque converter-to-flexplate bolts. Disconnect fluid cooler lines from transaxle. Remove exhaust brace.
5. Remove bolts from engine and transaxle mounts. Remove transaxle mount-to-body bolts. Support transaxle with jack. Remove remaining engine-to-transaxle bolts. Lower transaxle.

Installation ("N" Body)

1. To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Apply a thin film of chassis grease to torque converter pilot hub. Adjust transaxle throttle valve cable and shift cable. See appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section.
2. When connecting neutral safety switch connector, ensure "T" latch on connector is secure to prevent intermittent operation of switch due to poor connections. Fill transaxle to proper fluid level.

4T40-E TRANSAXLE

Removal ("J" Body)

1. Disconnect negative battery cable. Remove air cleaner assembly. Disconnect shift linkage from transaxle. Disconnect all wiring connectors. Install engine support.
2. Remove upper transaxle-to-engine bolts. Raise and support vehicle. Remove front wheels. Remove left and right splash shields. Remove wheel speed sensor harness from left suspension support and both front

wheel speed sensors.

3. Separate tie rod ends and lower ball joints from steering knuckles. Remove front suspension support brace. Remove engine strut mount. Place lift support under suspension support assembly and remove bolts. Lower suspension support assembly enough to disconnect power steering hoses and steering coupler.
4. Remove drive axles from transaxle. See appropriate DRIVE AXLE article in the DRIVE AXLE section. Remove transaxle-to-engine brace. Remove shift cable bracket. Remove starter. Remove torque converter cover. Mark torque converter in relation to flexplate for alignment during installation. Remove torque converter-to-flexplate bolts.
5. Disconnect transaxle cooler hoses. Remove brake hose bracket from body. Remove transaxle mount pipe expansion bolt and transaxle mount body bolts. Lower vehicle.
6. Lower engine/transaxle assembly with engine support enough to remove transaxle. Raise vehicle and support transaxle. Remove remaining engine-to-transaxle bolts. Lower transaxle.

Installation ("J" Body)

1. To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Apply a thin film of chassis grease to torque converter pilot hub. Adjust throttle valve cable and shift cable. See ADJUSTMENTS in appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section.
2. When connecting neutral safety switch connector, ensure "T" latch on connector is secure. This will prevent intermittent operation of switch due to poor connections. Refill transaxle to proper fluid level.

4T60-E TRANSAXLE

Removal ("A" Body)

1. Disconnect and shield negative battery cable. Remove air cleaner. Disconnect electrical connectors as necessary. Remove shift cable and bracket from transaxle. Disconnect vacuum modulator hose from modulator. Remove 3 upper transaxle-to-engine bolts.

CAUTION: If steering intermediate shaft is not disconnected from steering gear stub shaft as described in next step, these components could be damaged, possibly resulting in loss of steering control.

2. Remove pinch bolt securing steering intermediate shaft to steering gear stub shaft. Support engine from top. Raise and support vehicle on hoist. Remove front wheels. Remove engine splash shields. Remove pinch bolts from ball joints. Disconnect ball joints from control arms.
3. Remove stabilizer bar. Center-punch the 2 spot welds securing left crossmember to rear crossmember. Left crossmember is the 90-degree frame piece that acts as left frame and front crossmember. Drill out spot welds using 7/16" drill bit.
4. Remove nuts from front and rear transaxle mounts. Remove bolts from power steering cooler line bracket. Remove bolts securing left crossmember to right frame. Using jack stand, support left crossmember from bottom. Loosen 2 right frame mounts and discard bolts.
5. Remove 2 left crossmember-to-body bolts. Remove left crossmember. Remove torque converter covers. Remove flexplate-to-converter bolts. Remove drive axles. See appropriate DRIVE AXLE article in the

DRIVE AXLE section.

6. Remove transaxle support bracket bolts from transaxle. Disconnect transaxle cooler lines from transaxle. Using transaxle jack, support transaxle from bottom. Remove rear transaxle bolts from engine. Remove remaining transaxle-to-engine bolts. Remove transaxle.

Installation ("A" Body)

To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Adjust throttle valve cable and shift linkage. See ADJUSTMENTS in appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section. Adjust front wheel toe-in, if necessary. Fill transaxle to proper fluid level.

CAUTION: Before installing pinch bolt in hole at steering gear stub shaft, ensure shaft is seated. If shaft is not seated, components may separate, causing loss of steering control.

Removal ("C", "H" & "K" Bodies)

1. Disconnect negative battery cable. Remove cross brace from strut towers. Reinstall inboard strut nuts. Remove air intake duct. Disconnect cruise control cable from throttle body and cruise control servo. Disconnect shift cable from transaxle.
2. Disconnect vacuum hoses and electrical connectors as necessary. Remove fuel line retainers. Remove 3 top transaxle-to-engine bolts. Support engine from top using Engine Support Fixture (J-28467-A). Slightly lift engine/transaxle assembly just enough to take pressure off of mounts. Turn steering wheel to full left position.
3. Raise and support vehicle. Remove front wheels. Separate both lower ball joints from steering knuckles. Remove right drive axle from transaxle. **DO NOT** remove axle from hub/knuckle assembly. See appropriate DRIVE AXLE article in the DRIVE AXLE section.
4. Remove left drive axle from transaxle and hub/knuckle assembly. Support transaxle. Remove left front transaxle mount. Remove torque strut bracket from transaxle, if equipped.
5. Remove left rear transaxle mount-to-transaxle bolts. Remove transaxle brace from engine bracket. Remove stabilizer bar from control arm. Remove flexplate cover. Mark torque converter in relation to flexplate for alignment during installation. Remove flexplate-to-converter bolts. Remove bolts attaching rear frame-to-front frame member. Remove left frame-to-body bolts.
6. Remove right front frame member bolts. Swing frame assembly down and aside, then support with jack stand. Disconnect fluid cooler lines from transaxle. Remove remaining transaxle-to-engine bolts. Ensure all wiring harness connectors and hoses are disconnected. Lower transaxle from vehicle.

NOTE: One transaxle-to-engine bolt is installed from engine side. It may be necessary to use access hole located in right fenderwell and a 3-foot extension to reach bolt for removal.

Installation ("C", "H" & "K" Bodies)

To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Adjust shift cable. See ADJUSTMENTS in appropriate TRANSMISSION SERVICING

- A/T article in the AUTOMATIC TRANSMISSION SERVICING section. Refill transaxle to proper fluid level.

Removal ("G" Body)

1. Disconnect negative battery cable. Remove air intake duct. Disconnect cruise control cable from throttle body and cruise control servo. Disconnect shift cable from transaxle and shift lever at manual shaft.
2. Disconnect vacuum hoses and electrical connectors as necessary. Remove exhaust manifold crossover pipe bolts. Remove fuel line retainers. Support engine from top using Engine Support Fixture (J-28467-A). Slightly lift engine/transaxle assembly just enough to take pressure off of mounts. Remove 3 top transaxle-to-engine bolts.
3. Raise and support vehicle. Remove front wheels. Remove left steering rack retaining bolt. Remove left front splash shield. Separate both lower ball joints from steering knuckles.
4. Remove air deflector. Remove power steering hose retaining brackets from frame. Remove right steering rack retaining bolt. Support cradle assembly and remove transaxle mount through bolts. Remove cradle assembly.
5. Remove torque converter cover. Mark torque converter in relation to flexplate for alignment during installation. Remove torque converter-to-flexplate bolts. Remove starter.
6. Remove left and right axle shaft from transaxle. DO NOT remove axle from hub/knuckle assembly. See appropriate DRIVE AXLE article in the DRIVE AXLE section. Support transaxle. Remove rear transaxle mount. Remove rear spark plug wires from spark plugs.
7. Remove transaxle dipstick tube from transaxle. Remove right exhaust manifold. Remove remaining transaxle-to-engine bolts. Disconnect transaxle cooler hoses from transaxle. Remove rear transaxle mount bracket. Lower transaxle from vehicle.

Installation ("G" Body)

To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Adjust shift cable. See ADJUSTMENTS in appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section. Refill transaxle to proper fluid level.

Removal ("L" & "N" Bodies)

1. Disconnect negative battery cable. Remove air intake duct. Disconnect shift linkage from transaxle. Disconnect vacuum modulator vacuum line at modulator. Disconnect electrical connectors from torque converter clutch, neutral safety switch and shift solenoid connector.
2. Support engine from top using Engine Support Fixture (J-28467-A). Remove 2 top transaxle-to-engine bolts and remaining upper transaxle-to-engine bolts. Disconnect rubber hose from transaxle-to-vent pipe. Raise and support vehicle on hoist.
3. Remove front wheels. Remove splash shields. Remove both front ABS wheel speed sensors and harness from left side suspension support. Disconnect both ball joints from control arms. Disconnect left stabilizer shaft frame bushing clamp nuts and left stabilizer shaft frame bushing clamp.
4. Disconnect left suspension support assembly. Install Drive Axle Boot Protector (J-34754) on both boots. Remove drive axles. See appropriate DRIVE AXLE article in the DRIVE AXLE section. Remove left and right stabilizer links. Remove left suspension support and attaching bolts. Remove starter.

5. Disconnect vehicle speed sensor connector from transaxle. Remove torque converter cover. Mark torque converter in relation to flexplate for alignment during installation. Remove torque converter-to-flexplate bolts.
6. Disconnect fluid cooler lines from transaxle. Remove transaxle shift cable from lower cable bracket. Remove transaxle-to-engine brace bolts at transaxle. Support transaxle with jack. Remove remaining engine-to-transaxle bolts. Lower transaxle.

Installation ("L" & "N" Bodies)

To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Adjust shift cable. See ADJUSTMENTS in appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section. Refill transaxle to proper fluid level.

Removal ("W" Body)

1. Disconnect negative battery cable. Remove hood panel assembly. Remove transaxle fluid level indicator assembly. Remove engine mount strut brackets. Remove electric engine cooling fan assemblies. Support engine from top using Engine Support Fixture (J-28467-A).
2. Remove air intake duct. Disconnect transaxle modulator pipe assembly. Disconnect electrical connectors from transaxle. Disconnect transaxle range selector assembly from transaxle. Remove upper transaxle-to-engine bolts and screws.
3. Raise and support vehicle. Remove front wheels. Remove left splash shield. Remove exhaust crossover pipe. Remove steering gear heat shield assembly and steering gear bolts and screws. Disconnect front lower control arm assemblies from front suspension strut assemblies.
4. Remove power steering fluid cooling pipe assembly. Support drivetrain and front suspension frame assembly with jack stands. Remove transaxle mount side bracket nuts and engine mount frame side nuts. Remove transaxle brace. Remove drivetrain and front suspension frame bolts. Remove drivetrain and front suspension frame assembly.
5. Disconnect electrical connector from vehicle speed sensor. Remove drive axles from transaxle. See appropriate DRIVE AXLE article in the DRIVE AXLE section. Remove transaxle converter cover. Remove starter. Remove torque converter-to-flexplate bolts.
6. Remove transaxle oil cooler upper and lower pipe assembly. Install transaxle jack. Remove transaxle mount assembly from engine assembly. Remove transaxle fluid filler tube assembly. Remove transaxle-to-engine bolts. Remove transaxle.

Installation ("W" Body)

To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Adjust shift cable. See ADJUSTMENTS in appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section. Refill transaxle to proper fluid level.

4T80-E TRANSAXLE

Removal ("E" & "K" Bodies)

1. Disconnect negative battery cable. Remove air cleaner assembly. Remove torque struts. Disconnect range control cable and bracket at transaxle. Disconnect manual shaft lever and transaxle range switch. Install Engine Support Fixture (J-28467-A).
2. Raise and support vehicle on hoist. Remove front wheels. Remove front splash shields. Disconnect vacuum hoses and electrical connectors as necessary. Disconnect power steering pressure hose at steering gear. Install plugs into steering gear and pressure line to prevent fluid leakage or contamination.
3. Disconnect power steering return hose at auxiliary cooler. Install plugs into cooler and return hose to prevent fluid leakage or contamination. Rotate steering intermediate shaft allowing steering gear stub shaft clamp bolt access from left wheel opening. Remove clamp bolt and steering intermediate shaft from steering gear.

NOTE: Failure to disconnect intermediate shaft from rack and pinion stub shaft can result in damage to steering gear and/or intermediate shaft and personal injury.

CAUTION: DO NOT rotate steering wheel or move position of steering gear once intermediate shaft is disconnected. This will reposition inflatable restraint coil in steering column. If inflatable restraint coil becomes off centered, it may be damaged during vehicle operation.

4. Disconnect front suspension position sensors from lower control arms and position out of way. Disconnect stabilizer links from lower control arms. Remove tie rod cotter pins and nuts. Separate tie rods from steering knuckles.
5. Remove drive axle nuts, and separate drive axles from hubs. Remove drive axles from transaxle. See appropriate DRIVE AXLE article in the DRIVE AXLE section. Remove A/C splash shield from frame. Disconnect ABS modulator from bracket and support. Remove engine oil pan-to-transaxle bracket.
6. Remove torque converter cover. Remove flexplate-to-converter bolts. Disconnect transaxle cooler pipes from transaxle. Remove left and right transaxle mount nuts and right engine mount nuts at frame. Support frame.
7. Remove 6 frame mount bolts. Lower frame and/or raise vehicle with steering gear attached. Remove left transaxle mount and bracket from transaxle. Remove engine-to-transaxle bracket. Install Transaxle Support Fixture (J-28664). Remove engine-to-transaxle bolts. Lower and remove transaxle.

Installation ("E" & "K" Bodies)

To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Adjust shift cable. See ADJUSTMENTS in appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section. Refill transaxle to proper fluid level.

Removal ("G" Body)

1. Disconnect negative battery cable. Disconnect shift cable and bracket at transaxle. Disconnect manual shaft lever and transaxle range switch. Install Engine Support Fixture (J-28467-A). Drain cooling system. Disconnect brake booster vacuum hose. Disconnect transaxle vent hose. Disconnect electrical connectors as necessary.

2. Disconnect upper transaxle cooler line at radiator and lower transaxle cooler line at transaxle. Remove retaining bracket nut at transaxle. Disconnect coolant by-pass pipe at thermostat housing and set aside. Remove left and right transaxle mount bolts. Raise and support vehicle.
3. Remove left front wheel. Remove left splash shield. Remove tie rod end cotter pins and nuts. Separate tie rod ends from steering knuckles. Remove lower ball joint cotter pins and nuts. Separate ball joints from steering knuckles. Remove left axle shaft nut. Remove axle from hub assembly. Remove drive axles. See appropriate DRIVE AXLE article in the DRIVE AXLE section.
4. Remove engine oil pan-to-transaxle bracket. Remove torque converter cover. Remove flexplate-to-converter bolts. Mark position of flexplate in relation to torque converter for installation reference. Remove complete exhaust system. Remove exhaust manifold rear pipe. Remove steering rack-to-right transaxle mount bolts. Remove bolt from right transaxle mount.
5. Remove frame-to-right transaxle mount bolt and remove mount. Remove power steering line retaining clamp from frame. Remove through bolt from right side of steering rack and support steering rack assembly. Remove support frame. Remove knock sensor shield.
6. Remove engine-to-transaxle brace. Remove transaxle mount-to-bracket retaining nuts. Remove rear transaxle mount bracket from transaxle and body. Disconnect neutral safety switch electrical connector. Remove right and left lower transaxle-to-engine bolt. Remove frame bolts and frame. Remove engine-to-transaxle bolts. Lower transaxle.

Installation ("G" Body)

To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Adjust shift cable. See ADJUSTMENTS in appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section. Refill transaxle to proper fluid level.

4L60-E TRANSMISSION

Removal ("B", "D" & "F" Bodies)

1. Disconnect negative battery cable. Remove air cleaner, if necessary. On "B" and "D" bodies, remove transmission dipstick. On "F" body, remove transmission dipstick tube. Raise and support vehicle.
2. On "F" body, remove torque arm from rear suspension (requires removing rear coil springs). On all vehicles, mark drive shaft for installation reference. Remove drive shaft. Disconnect shift linkage from transmission. Disconnect electrical connectors as necessary. Remove starter.
3. Remove torque converter cover. Mark position of flexplate in relation to torque converter for installation reference. Remove torque converter bolts. Remove catalytic converter support bracket (raise transmission slightly, if necessary). Remove transmission mount nut.
4. Remove transmission-to-mount bolts. Remove transmission crossmember-to-frame bolts. Support transmission. Slide transmission crossmember rearward. Partially lower transmission to gain access to fluid line fittings.
5. On "B" and "D" bodies, remove transmission filler tube. On all vehicles, disconnect fluid lines from transmission. Support engine. Remove torque converter housing bolts. Move transmission rearward far enough to install Torque Converter Holder (J-21366). Remove transmission.

Installation ("B", "D" & "F" Bodies)

1. To install, reverse removal procedure. Align index marks made during removal. Tighten torque converter-to-flexplate bolts finger tight, then tighten to specification. Tighten other nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .
2. Rotate torque converter by hand to ensure it rotates freely. Adjust shift linkage. See ADJUSTMENTS in appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section.

Removal ("Y" Body)

1. Disconnect negative battery cable. Drain transmission fluid. Remove fluid fill tube. Raise and support vehicle.
2. Remove upper and lower underbody braces, if equipped. Remove complete exhaust system. Support transmission on stand. Remove drive shaft support beam. Mark drive shaft for installation reference. Remove drive shaft. Disconnect electrical connectors as necessary. Disconnect shift control cable from transmission.
3. Remove flexplate cover. Mark position of flexplate in relation to torque converter for installation reference. Remove flexplate-to-torque converter bolts. Disconnect fluid lines from transmission. Support engine. Remove torque converter housing bolts. Pull transmission back far enough to install Torque Converter Holder (J-21366). Lower transmission from vehicle.

Installation ("Y" Body)

1. To install, reverse removal procedure. Align index marks made during removal. Tighten torque converter-to-flexplate bolts finger tight, then tighten to specification. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .
2. Rotate torque converter by hand to ensure it rotates freely. Adjust shift cable. See ADJUSTMENTS in appropriate TRANSMISSION SERVICING - A/T article in the AUTOMATIC TRANSMISSION SERVICING section. Refill transaxle to proper fluid level.

GEO VEHICLES

Removal ("M" Body - Metro)

1. Disconnect negative battery cable. Disconnect throttle valve cable adjustment cover and cable from accelerator cable at top of transaxle. Loosen shift cable adjustment nut from end of shift cable. Remove shift cable from manual cable joint. Remove retaining clip and shift cable from bracket at top of transaxle.
2. Remove accelerator cable from bracket at top of transaxle. Remove 2 bolts and engine harness bracket from rear of transaxle case. Disconnect electrical connections and speedometer cable. Remove 2 clamps and fluid cooler hoses from cooler pipes. Plug hoses to prevent fluid leaks. Disconnect connector at starter. Remove starter.
3. Remove upper rear transaxle mount-to-bulkhead bolt. Remove through bolt and nut from rear transaxle mount. Remove 2 upper transaxle-to-engine bolts. Install Engine Support Fixture (J-28467-A) to engine. Remove negative battery cable from transaxle case. Raise and support vehicle. Drain transaxle fluid.
4. Remove left and right splash shields. Remove lower ball joint nuts and bolts from steering knuckles. Install Drive Axle Boot Protector (J-28712) on both boots. Remove drive axles. See appropriate DRIVE AXLE article in the DRIVE AXLE section. Remove 3 bolts and rear engine torque rod from transaxle

case. Remove lower cover from torque converter housing. Remove flexplate-to-torque converter bolts. Flexplate can be held by engaging a screwdriver into flexplate ring gear through notch provided at underside of transaxle case.

5. Remove exhaust hanger from rear engine mount bracket. Remove one lower rear engine mount-to-bulkhead bolt and rear engine mount from vehicle. Remove rear engine mount bracket. Lower vehicle. Lower engine slightly. Support transaxle with a jack. Disconnect transaxle mounts. Remove transaxle-to-engine bolts. Remove transaxle assembly.

Installation ("M" Body - Metro)

1. To install, reverse removal procedure. Apply grease around cup at center of torque converter. Ensure torque converter is correctly installed. Distance from torque converter drive lugs to engine mating surface of transaxle housing should be at least .85" (21.4 mm). Reverse removal procedure.
2. When installing transaxle, guide right axle into differential side gear as transaxle is being raised. After inserting inner CV joints of right and left axles into differential side gears, push inner joints into side gears until snap rings on axle shafts engage with side gears.
3. Tighten all fasteners to specification. See **TORQUE SPECIFICATIONS** . Adjust all control cables. Fill and check fluid levels.

Removal ("S" Body - Prizm)

1. Support engine from above with Engine Support Fixture (J-28467-A). Disconnect battery cables. Remove battery and tray. Remove air cleaner assembly.
2. Disconnect throttle valve cable at throttle body. Disconnect ground cable at transaxle. Disconnect electrical connections, speedometer cable and control cables and brackets from transaxle.
3. Disconnect and plug oil cooler lines from transaxle. On left side of engine compartment, remove brace that connects upper part of transaxle to transaxle mount. Remove transaxle-to-mount through bolt. Remove 2 upper transaxle-to-engine bolts.
4. Raise and support vehicle. Drain transaxle fluid. Remove starter. Remove wheels. Remove lower splash shields. Remove nut and washer from ends of both axle shafts at hub assemblies.
5. Remove tie rod nuts from steering knuckles. Separate tie rods from steering knuckles. Remove lower ball joint-to-steering knuckle bolts. Separate ball joints from steering knuckles.
6. Remove brake caliper and rotor from steering knuckle. Using brass hammer, tap on axle shaft until it is free of hub assembly. Using slide hammer and Shaft Puller (J-35762), pull axle shafts from transaxle.
7. Remove 2 center crossmember-to-radiator support bolts. Remove transaxle mount bolts. Remove center crossmember-to-main crossmember bolts.
8. Remove exhaust hanger bracket. Supporting main crossmember with jack, remove all bolts securing main crossmember and lowerA-frame brackets to body. Slowly lower main crossmember, being careful to support center crossmember.
9. Remove torque converter-to-flexplate bolts. Support transaxle with jack. Remove remaining transaxle-to-engine bolts. Remove remaining transaxle mounts and lower transaxle from vehicle. It may be necessary to lower engine slightly so transaxle can clear body.

Installation ("S" Body - Prizm)

1. To install, reverse removal procedure. Beforeinstalling, apply grease around cup at center of torque converter.
2. Ensure torque converter is correctly installed. Distance from torque converter drive lugs to engine mating surface of transaxle housing should be at least .9" (23 mm).
3. Tighten all fasteners to specification. See **TORQUE SPECIFICATIONS** . Adjust all control cables. Fill and check fluid levels.

SATURN VEHICLES

Removal & Installation

1. To disable air bag system, turn ignition off. Remove SIR fuse from fuse block. Remove Connector Position Assurance (CPA) clip from Yellow SIR connector at base of steering column. Disconnect Yellow connector. Wait 15 minutes before working on vehicle.

WARNING: DERM maintains back-up voltage for about 15 minutes after disabling air bag system. Wait at least 15 minutes after disabling air bag system before servicing, as accidental deployment may result in personal injury.

2. Disconnect negative battery cable. Remove inlet air duct fasteners and remove inlet air duct assembly. Remove air box fasteners and remove air box.
3. Remove transaxle strut-to-cradle mounting bolt. Loosen transaxle strut-to-transaxle mounting bolt and flip strut over onto transaxle. Remove positive battery cable, hold down, shield and battery. Remove 4 battery tray retaining bolts and battery tray.
4. Disconnect all electrical connectors from transaxle. Remove top 2 converter housing-to-engine bolts. Remove Distributorless Ignition System (DIS) coil pack, and discard retaining bolts.
5. Wire radiator to upper radiator support prior to removing cradle. Install Engine Support Bar Assembly (SA9105E). Raise and support vehicle. Drain transaxle. Remove front wheels. Remove left and right splash shields. Remove front splash shield and fascia braces (if equipped).
6. Remove engine strut cradle bracket-to-cradle bolts below front pulley. Remove transaxle lower rear mount-to-cradle nut. Disconnect front exhaust header pipe at exhaust manifold and catalytic converter.
7. Remove front exhaust pipe. Remove engine-to-transaxle brackets. Support steering gear with wire and remove steering gear-to-cradle bolts. Disengage brake line from rear of cradle.
8. Remove torque converter cover. Remove torque converter-to-flexplate bolts. Separate lower ball joints from steering knuckles.

CAUTION: DO NOT damage ABS sensor ring while disengaging ball joints.

9. Support powertrain on powertrain support dolly. Using a pry bar, separate left and right drive axles from transaxle or intermediate shaft. On DOHC models, remove intake manifold-to-intermediate shaft bracket. Remove intermediate shaft bracket bolts and intermediate shaft.
10. Disconnect transaxle cooler lines and cap to prevent contamination. Support transaxle with suitable jack.

Remove 4 cradle-to-body bolts, and lower cradle and powertrain assembly using powertrain support dolly.

11. Remove 2 lower converter housing-to-engine bolts and separate transaxle from engine enough to reach shifter cable. Disconnect shifter cable from transaxle. To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Use NEW retaining bolts for DIS coil pack.
12. To activate air bag system, turn ignition off. Connect Yellow SIR connector and CPA clip at base of steering column. Install AIR BAG fuse. Turn ignition switch to RUN position. Observe AIR BAG indicator light. If light does not flash 7 times, and then go out, system is faulty.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
"A" Body	
Flexplate-To-Converter Bolt	46 (62)
Frame Mount Bolt	40 (54)
Intermediate Shaft-To-Steering Gear Shaft Bolt	40 (54)
Shift Control Cable Bracket-To-Transaxle Bolt	18 (24)
Transaxle-To-Engine Bolt	55 (75)
Wheel Lug Nuts	100 (136)
"B", "D", "F" & "Y" Bodies	
Flexplate-To-Converter Bolt	46 (62)
Torque Arm-To Rear Differential Nut	98 (133)
Transmission Crossmember-To-Frame Bolt	25 (34)
Transmission-To-Engine Bolt	35 (47)
Transmission Mount-To-Engine Bolt	35 (47)
Transmission Mount-To-Transmission Crossmember Nut	30 (41)
"C", "H" & "K" Bodies (4T60-E Transaxle)	
Flexplate-To-Converter Bolt	46 (62)
Frame-To-Body Bolt	83 (113)
Shift Control Cable Bracket-To-Transaxle Bolt	18 (24)
Starter Mounting Bolt	32 (43)
Transaxle Brace-To-Engine Assembly Bolt	37 (50)
Transaxle-To-Engine Bolt	55 (75)
Transaxle Mount Bolt	38 (52)
Wheel Lug Nuts	100 (136)
"E" & "K" Bodies (4T80-E Transaxle)	
Flexplate-To-Converter Bolt	35 (47)
Flexplate-To-Cover Bolt	(1)
Frame-To-Body Bolt	74 (100)
Shift Control Cable Bracket-To-Transaxle Bolt	18 (24)

Starter Mounting Bolt	32 (43)
Transaxle Brace-To-Engine Assembly Bolt	35 (47)
Transaxle Mount Bolt	35 (47)
Transaxle-To-Engine Bolt	35 (47)
Wheel Lug Nuts	100 (136)
"G" Body (4T60-E Transaxle)	
Cooler Pipes	24-33 (33-45)
Flexplate-To-Converter Bolt	46 (62)
Transaxle-To-Engine Bolt	71 (96)
Transaxle Brace Bolt	46 (62)
"G" Body (4T80-E Transaxle)	
Cooler Pipes	24-33 (33-45)
Engine-To-Transaxle Brace	35 (47)
Flexplate-To-Converter Bolt	44 (60)
Frame Assembly & Mounting Bolt	142 (193)
Left Transaxle Mount-To-Engine Bolt	43 (58)
Left Transaxle Mount-To-Frame Bolt	63 (85)
Rear Transaxle Bracket Bolt	43 (58)
Right Transaxle Mount-To-Engine Bolt	81 (110)
Right Transaxle Mount-To-Frame Bolt	54 (73)
Transaxle-To-Engine Bolt	55 (75)
"J" Body	
Cooler Pipes	16 (22)
Flexplate-To-Converter Bolt	46 (62)
Transaxle-To-Engine Bolt (3T40)	71 (96)
Transaxle-To-Engine Bolt (4T40-E)	66 (89)
Transaxle Brace Bolt	37 (50)
"L" Body	
Cooler Pipes	16 (22)
Flexplate-To-Converter Bolt	46 (62)
Frame-To-Body Bolt	37 (50)
Transaxle-To-Engine Bolt	55 (75)
"M" Body (Metro)	
Axle Shaft Nut	129 (175)
Ball Joint Bolt	44 (60)
Torque Converter Bolt	14 (19)
Transaxle-To-Engine Bolt	40 (54)
Wheel Lug Nut	44 (60)
"N" Body	
Cooler Pipes	16 (22)
Flexplate-To-Converter Bolt	46 (62)
Starter Bolt	

	32 (43)
Transaxle-To-Engine Bolt	55 (75)
"S" Body (Prizm)	
Axle Shaft Nut	159 (216)
Ball Joint-To-Lower Control Arm Bolt	105 (142)
Brake Caliper Bolt	65 (88)
Center Crossmember-To-Radiator Support Bolt	45 (61)
Center Mount-To-Transaxle Bolt	45 (61)
Front Transaxle Mount Bolt	47 (64)
Left Transaxle Mounting Bracket Bolt	35 (47)
Main Crossmember-To-Body Bolt	152 (206)
Tie Rod Nut	40 (54)
Torque Converter Bolt	14 (19)
Transaxle Mount Bolt	45 (61)
Transaxle-To-Engine Bolt	47 (64)
Rear Transaxle Mount Nut	42 (57)
Wheel Lug Nut	76 (103)
"W" Body	
Cooler Pipes	16 (22)
Flexplate-To-Converter Bolt	44 (60)
Frame-To-Body Bolt	103 (140)
Transaxle-To-Engine Bolt	55 (75)
Saturn Vehicles	
Converter Housing-To-Engine (Lower) Bolts	103 (140)
Converter Housing-To-Engine (Upper) Bolts	74 (100)
Cradle-To-Body Bolts	155 (210)
Engine-To-Transaxle Brackets	35 (47)
Exhaust Pipe-To-Catalytic Converter Bolts	33 (45)
Exhaust Pipe-To-Manifold Nuts	23 (31)
Lower Ball Joint Nut	55 (75)
Steering Gear-To-Cradle Nuts	37 (50)
Tie Rod End Nut	33 (45)
Torque Converter-To-Flexplate Bolts	52 (71)
Transaxle Drain Plug	22 (30)
Transaxle Lower Rear Mount-To-Cradle Nut	40 (54)
Transaxle Strut-To-Cradle Bracket Bolts	52 (71)
Transaxle Strut-To-Cradle Bracket Nuts	52 (71)
Wheel Lug Nuts	103 (140)

ADJUSTMENTS

RIDING HEIGHT ADJUSTMENT

NOTE: On vehicles with electronic chassis controls, ensure all systems are functional before adjusting riding height or wheel alignment.

Before adjusting alignment, check riding height. Check riding height with vehicle on level floor and tires properly inflated. Tire inflation specifications can be found on door pillar, side wall of tire, sun visor or glove box. Bounce vehicle several times and allow suspension to settle.

Visually inspect vehicle for signs of abnormal height from front to rear or side to side. Remove extra heavy items from passenger and luggage compartments. If riding height is not within specifications, check, repair or replace suspension components. See appropriate **RIDING HEIGHT SPECIFICATIONS** table. See **Fig. 1** .

RIDING HEIGHT MEASURING LOCATIONS

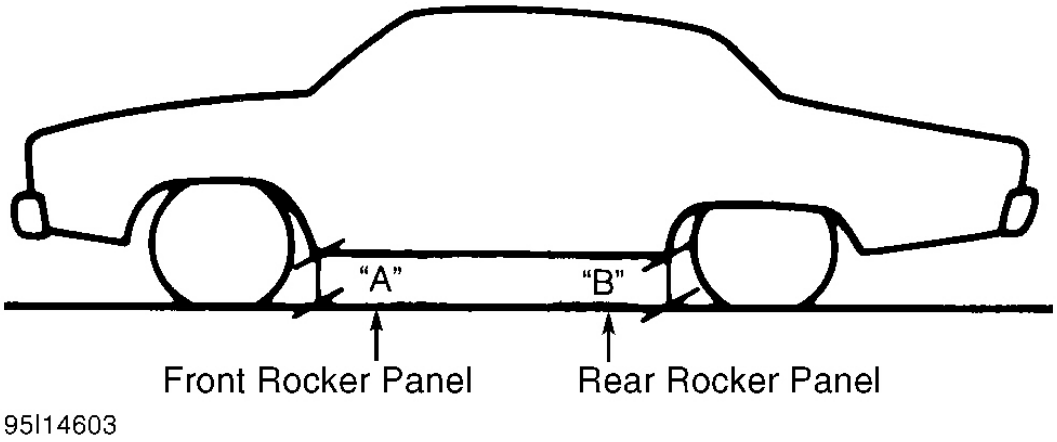


Fig. 1: Riding Height Measuring Points

SPECIFICATIONS

RIDING HEIGHT SPECIFICATIONS ("B" BODY)

Application	(1) Front "A" In. (mm)	(2) Rear "B" In. (mm)
Caprice & Impala SS		

(3) (4)	10.1 (257)	10.2 (259)
(5) (4)	9.9 (252)	10.0 (254)
(6) (4)	8.9 (227)	9.0 (229)
All Others	9.9 (252)	10.4 (264)
Roadmaster	9.9 (252)	10.4 (264)

(1) Location "A" measured 31.9" (810 mm) from center of the front axle.

(2) Location "B" measured 24.2" (615 mm) from center of the rear axle.

(3) With RPO Code FE1 and P215/75R15 tires.

(4) RPO codes are listed on Service Parts Identification label, located on inside of trunk lid (Sedan) or right side of tailgate door jamb (Wagon).

(5) With RPO Codes FE2 (except SEO), FE3 and F41 (except SEO).

(6) With RPO FE4.

ENGINE PERFORMANCE

Self-Diagnostics - 4.3L

INTRODUCTION

Most engine control problems are the result of mechanical breakdowns, poor electrical connections or damaged vacuum hoses. Before considering the computer system as a possible cause of problems, perform checks and inspections covered in appropriate **BASIC TESTING** article in this section. Failure to do so may result in lost diagnostic time.

If no faults were found while performing BASIC DIAGNOSTIC PROCEDURES, proceed with DIAGNOSTIC PROCEDURE under SELF-DIAGNOSTIC SYSTEM. If no fault codes are present and driveability problems exist, proceed to **TESTS W/O CODES** article in this section for diagnosis by symptom (i.e., ROUGH IDLE, NO START, etc.). If only intermittent codes are present, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

SELF-DIAGNOSTIC SYSTEM

INTRODUCTION

NOTE: Powertrain Control Module (PCM) may also be referred to as Electronic Control Module (ECM) in some diagnostic charts and figures. Terms are used interchangeably.

Control module is equipped with a self-diagnostic system, which detects system failures or abnormalities. When a malfunction occurs, control module will store a numerical code and, in most cases, illuminate SERVICE ENGINE SOON light located on instrument panel. SERVICE ENGINE SOON light is also referred to as the Malfunction Indicator Light (MIL). Malfunctions are recorded as hard failures or as intermittent failures.

NOTE: Models equipped with OBD II diagnostic systems may have additional diagnostic information and procedures available; however, to fully utilize information and procedures requires the use of a Tech 1 scan tester. See tester owners manual for additional information.

Hard Failures

Most hard failures cause SERVICE ENGINE SOON light to glow and remain on until malfunction is repaired. If light comes on and remains on (light may flash) during vehicle operation, cause of malfunction must be determined using diagnostic (code) charts. If a sensor fails, control module will use a substitute value in its calculations to continue engine operation. In this condition, vehicle is functional, but it will most likely display degraded driveability.

Intermittent Failures

Intermittent failures cause SERVICE ENGINE SOON light to flicker or glow and go out about 10 seconds after intermittent fault goes away. Corresponding trouble code, however, will be retained in control module memory.

If related fault does not reoccur within 50 engine starts, trouble code will be erased from control module memory. Intermittent failures may be caused by sensor, connector or wiring related problems. See INTERMITTENTS in **TESTS W/O CODES** article in this section.

DIAGNOSTIC PROCEDURE

Diagnosis of computerized engine control system should be performed in following order:

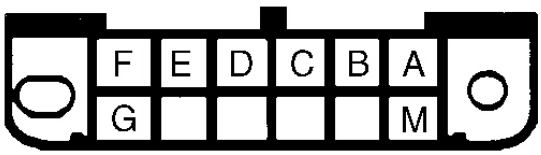
1. Ensure all engine systems not related to computer system are operating properly. **DO NOT** proceed with testing unless all other problems have been repaired. DIAGNOSTIC CIRCUIT CHECK must be performed before using trouble code charts. See **BASIC TESTING** article in this section.
2. If trouble codes were displayed, determine whether codes are hard or intermittent trouble codes. Hard codes will cause SERVICE ENGINE SOON light to glow continuously while engine is running. See **HARD OR INTERMITTENT TROUBLE CODE DETERMINATION** . For diagnosing hard codes, proceed to appropriate trouble code chart. For diagnosing intermittent codes, proceed to INTERMITTENTS in **TESTS W/O CODES** article in this section.
3. If no trouble codes are present and a driveability problem exists, refer to SYMPTOMS in **TESTS W/O CODES** article in this section. Doing so will help identify proper system or component to check in **SYSTEM/COMPONENT TESTS - 4.3L** article in this section.
4. After necessary repairs are made, clear trouble codes, verify vehicle will enter "closed loop" operation and ensure code does not reset.

NOTE: For specific information on retrieving codes using a scan tester, refer to user and reference manuals supplied with tester.

NOTE: Field service mode check can only be performed on vehicles equipped with 12-pin DLC with a wire present in test terminal "B". See DATA LINK CONNECTOR (DLC) TEST TERMINALS .

DATA LINK CONNECTOR (DLC) TEST TERMINALS

Application	Ground/Test
12-Pin DLC 4.3L (VIN W)	"A" & "B"



12-PIN DLC

A – Ground
B – Test Terminal
C – Air Injection (If Equipped)
D – Service Engine Soon Light (If Used)
E – Serial Data
F – TCC (If Used)
G – Fuel Pump (If Used)
M – Serial Data (Some Models)

90B01199

Fig. 1: Identifying 12-Pin DLC Connector Terminals
Courtesy of GENERAL MOTORS CORP.

READING TROUBLE CODES

Control module stores component failure information under a related trouble code which can be recalled for diagnosis and repair. Trouble codes may be read by counting flashes of SERVICE ENGINE SOON light (some models) or by reading digital display on a scan tester. Scan tester is faster to use, more accurate and capable of reading information which otherwise would necessitate testing individual control module and sensor/solenoid connector terminals using a digital voltmeter. See **SCAN TESTER USAGE** and **SCAN DATA** .

NOTE: When using most scan testers, a time delay exists between serial data updates. For instantaneous response, a digital voltmeter must be used.

If scan tester is not available, reading flashes of SERVICE ENGINE SOON light is possible by grounding diagnostic test terminal "B" (if a wire is present) of DLC with ignition on and engine off. See **Fig. 1** . For example, "FLASH, FLASH, pause, FLASH, longer pause" identifies Code 21. First series of flashes is first digit of trouble code. Second series of flashes is second digit of trouble code. Trouble codes are displayed starting with lowest numbered code. Each code is displayed 3 times. Codes will continue to repeat as long as DLC test terminal is grounded.

TROUBLE CODE DEFINITION

TROUBLE CODE DEFINITION

Code No.	Circuit Affected
CODE 11	Malfunction Indicator Light
CODE 12(1)	No RPM Reference Pulse
CODE 13	Left Heated Oxygen Sensor Circuit Open
CODE 14	Coolant Tempperature Sensor Signal Vltge Low (High Temperature Indicated)

CODE 15	Coolant Temp Sensor Signal Voltage Low
CODE 16	Opti-Spark Ignition System Low Resolution Pulse
CODE 18	Injector Circuit
CODE 21	Throttle Position Sensor Signal Voltage High
CODE 22	Throttle Position Sensor Signal Voltage Low
CODE 23	IAT Sensor Signal Voltage High (Low Temp Indicated)
CODE 24	Vehicle Speed Sensor
CODE 25	IAT Sensor Signal Voltage Low (High Temp Indicated)
CODE 26	Canister Purge Solenoid
CODE 27	EGR Sol Valve
CODE 28	Trans. Range Pressure Switch
CODE 29	Secondary Air Injection
CODE 32	EGR System Error
CODE 33	MAP Sensor Signal Voltage High
CODE 34	MAP Sensor Signal Voltage Low
CODE 36	Opti-Spark High Resolution Pulse
CODE 37	TCC Brake Switch Error
CODE 38	Brake Switch Error
CODE 41	Opti-Spark Ignition System Open Or Shorted Est Ckt
CODE 42	IC Circuit Grounded
CODE 43	Knock Sensor Circuit (Dual Sensors)
CODE 44	Left Heated Oxygen Sensor Lean Exhaust Indication
CODE 45	Left Heated Oxygen Sensor Rich Exhaust Indication
CODE 46	Pass-Key Circuit
CODE 47	Knock Sensor Module
CODE 48	MASS Airflow Sensor
CODE 50	System Voltage Low
CODE 52	Faulty CAL-PAK
CODE 53	System Voltage High
CODE 55	PCM Error
CODE 55	Fuel Lean Monitor
CODE 58	Trans Temperature Sensor High Temperature
CODE 59	Trans. Temperature Sensor Low Temperature
CODE 63	Right Heated Oxygen Sensor Circuit Open
CODE 64	Right Heated Oxygen Sensor Lean Exhaust Indication
CODE 65	Right Heated Oxygen Sensor Rich Exhaust Indication
CODE 66	A/C Pressure Sensor
CODE 67	A/C Pressure Sensor
CODE 68	A/C Relay Circuit Shorted
CODE 69	A/C Compressor Relay
CODE 70	A/C Compressor Relay Driver
CODE 72	

	Vehicle Speed Sensor Loss
CODE 73	Pressure Control Solenoid
CODE 75	Transmission Voltage Low
CODE 77	Primary Cooling Fan Driver
CODE 78	Secondary Cooling Fan Driver
CODE 79	Transmission Fluid Overtemp
CODE 81	2-3 Shift Solenoid
CODE 82	1-2 Shift Solenoid
CODE 83	TCC PWM Solenoid - A/T
CODE 84	3-2 Control Solenoid - With A/T
CODE 85	TCC Stuck On
CODE 90	TCC Solenoid Circuit
CODE 95	Change Oil Light
CODE 96	Low Oil Light
CODE 97	VSS Output Circuit

(1) Display of a Code 12 is normal when reference pulses are not being received by control module (engine not running).

TROUBLE CODE CONVERSION

New Code No.	Old Code No.	Circuit
P0101	34	MAF Sensor
P0112	23	Air Temperature Sensor
P0113	25	Air Temperature Sensor
P0116	New	Coolant Sensor Range
P0117	15	Coolant Temperature Sensor
P0118	14	Coolant Temperature Sensor
P0122	22	Throttle Position Sensor
P0123	21	Throttle Position Sensor
P0125	New	Coolant Temperature Sensor
P0131	44	Oxygen Sensor
P0132	45	Oxygen Sensor
P0133	New	Oxygen Sensor
P0134	13	Oxygen Sensor
P0135	New	Oxygen Sensor Heater
P0137	New	(Catalyst) Oxygen Sensor
P0138	New	(Catalyst) Oxygen Sensor
P0140	New	(Catalyst) Oxygen Sensor
P0151	44	Oxygen Sensor
P0152	45	Oxygen Sensor
P0153	New	Oxygen Sensor
P0154	13	Oxygen Sensor

P0155	New	Oxygen Sensor Heater
P0158	45	Oxygen Sensor
P0160	13	Oxygen Sensor
P0161	New	Oxygen Sensor Heater
P0171	New	Fuel Lean
P0172	New	Fuel Rich
P0174	New	Fuel Lean
P0175	New	Fuel Rich
P0300	New	Misfire
P0321	17	Spark Reference
P0325	43	Knock Sensor
P0341	18	Cam Signal
P0342	41	Cam Signal
P0401	53/54/55	EGR
P0420	New	Catalyst System
P0501/0502	24	Vehicle Speed Sensor
P0703	38	TCC Brake Switch
P0705	31	Trans. Range Switch
P0712	59	Trans. Fluid Temp. Sensor
P0713	58	Trans. Fluid Temp. Sensor
P0740	39	TCC
P0755	36	Shift Solenoid "B"
P1114	New	Coolant Sensor
P1115	New	Coolant Sensor
P1133	New	Oxygen Sensor
P1153	New	Oxygen Sensor
P1158	New	Oxygen Sensor
P1200	New	Injector Circuit
P1257	57	Supercharger Boost
P1350/1361	42	Ignition
P1403/1404/1405	75/76/77	EGR Solenoid(s)
P1406	32	EGR
P1520	New	Park/Neutral
P1530	69	A/C Pressure Sensor/Switch
P1531	66	A/C Charge Low
P1550	New	Cruise
P1558	63	Cruise
P1561	61	Cruise
P1562	62	Cruise
P1565	65	Cruise
P1567	67	Cruise
P1568		

	68	Cruise
P1571	New	Traction Control
P1573	New	Traction Control
P1599	99	Cruise
P1619	New	Oil Life Reset
P1623	51	PROM Error
P1626/1629	58	Pass-Key
P1630	16	Voltage High/Low
P1640	26/56	Quad-Driver
P1650	26/56	Quad-Driver
P1670	26/56	Quad-Driver
P1860	New	TCC PWM Solenoid

HARD OR INTERMITTENT TROUBLE CODE DETERMINATION

During any diagnostic procedure, determine if codes are hard failure codes or intermittent failure codes. Diagnostic charts will not usually help analyze intermittent codes. To determine hard codes and intermittent codes:

1. Enter diagnostic mode. Read and record all stored trouble codes. Exit diagnostic mode, and clear trouble codes. See **CLEARING TROUBLE CODES** .
2. Apply parking brake, and place transmission in Neutral or Park. Block drive wheels, and start engine. SERVICE ENGINE SOON light should go out. Run warm engine at specified curb idle for 2 minutes and note SERVICE ENGINE SOON light.
3. If SERVICE ENGINE SOON light comes on, enter diagnostic mode. Read and record trouble codes. This will reveal hard failure codes. Oxygen sensor related codes may require a road test to reset hard failure after trouble codes were cleared.
4. If SERVICE ENGINE SOON light does not come on, all stored trouble codes were intermittent failures, except as noted above.

NOTE: Trouble codes will be recorded at various operating times. Some codes require operation of that sensor or switch for 5 seconds; others require operation for 5 minutes or longer at normal operating temperature, vehicle speed and load. Therefore, some codes may not set in a service bay operational mode and may require road testing vehicle in order to duplicate conditions under which code will set.

CLEARING TROUBLE CODES

To clear trouble codes from memory, either to determine if malfunction will occur again or after making necessary repairs, disconnect power supply to PCM for at least 30 seconds or clear codes using a scan tester with code clearing capability.

PCM LOCATION

On most models, engine control module is located behind right or left side of dash, behind right or left kick panel or on left or right side of engine compartment. For more precise location, see COMPONENT LOCATIONS in **SYSTEM/COMPONENT TESTS - 4.3L** article in this section.

DIAGNOSTIC MATERIALS

Diagnostic Aids

Diagnostic aids (located in many trouble code charts) are additional tips used to help diagnose trouble codes when inspected circuit is okay. Diagnostic aids may help lead to a definitive solution to trouble code problem.

Field Service Mode Check (If Available)

If DLC test terminal "B" is grounded with engine running, SERVICE ENGINE SOON light will indicate operational mode of engine. This test confirms proper operation of fuel system and verifies "closed loop" operation. Clear codes and perform this test after any repair is completed. Most models require the use of a scan tester to enter field service mode. See FIELD SERVICE MODE CHECK in **BASIC TESTING** article in this section.

NOTE: Vehicles utilizing a 12-terminal DLC with terminal "B" not used, must use a scan tester for retrieving codes or enter Field Service Mode.

SPECIAL TOOLS (DIAGNOSTIC)

NOTE: A scan tester plugged into DLC may be used to read trouble codes and check voltages in system on serial data line. On most models scan tester is REQUIRED to retrieve vehicle information. For additional information, see SCAN TESTER USAGE and SCAN DATA .

Computerized engine control system is most easily diagnosed using scan tester; however, other tools may aid in diagnosing problems if a scan tester is unavailable. These tools are a tachometer, test light, ohmmeter, digital voltmeter with a 10-megohm input impedance (minimum), vacuum pump, vacuum gauge, fuel injector test lights and 6 jumper wires 6" long (one wire with female connectors at both ends, one wire with male connectors at both ends and 4 wires with male and female connectors at opposite ends). A test light, rather than a voltmeter, must be used when indicated by a diagnostic chart. In addition, special jumper harnesses or testers may be required by manufacturer to facilitate diagnosis.

SCAN TESTER USAGE

NOTE: Before connecting scan tester to vehicle, diagnostic system should be checked to determine if system is operating properly and if information received will be accurate. This is done by performing DIAGNOSTIC CIRCUIT CHECK or ON-BOARD DIAGNOSTIC SYSTEM CHECK located in BASIC TESTING article in this section. If vehicle does not pass diagnostic check, information received may be invalid.

Scan tester is a specialized tester which, when plugged into DLC, can be used to diagnose on-board computer

control systems by providing instant access to circuit voltage information without need to crawl under dash or hood to backprobe sensors and connectors.

Scan tester cuts down diagnostic time dramatically by furnishing input data (voltage signals) which can be compared to specification parameters. See **SCAN DATA** . They may also furnish information on output device (solenoids and motors) status. However, status parameters only indicate output signals have been sent to devices by control module; they do not indicate whether devices have responded properly to signal. Verify proper response at output device using a voltmeter or test light.

A problem may exist even if trouble codes are not present. About 80 percent of driveability problems occur without trouble codes. Sensors that are out of calibration will not set a trouble code but will cause driveability problems.

Using a scan tester is the easiest method of checking sensor specifications and other data parameters. Tester is also useful in finding intermittent wiring problems by wiggling wiring harnesses and connections (key on, engine off) while observing data parameters. See **SCAN DATA** .

NOTE: If erroneous voltage signals are suspected, verify tester information using a digital voltmeter and wiring schematic. If non-existent codes are displayed, DO NOT use scan tester for diagnosis. Contact tester manufacturer for additional information.

SCAN DATA

NOTE: Information contained in SCAN DATA is typical of readings taken on vehicle with engine idling, upper radiator hose hot, closed throttle, transmission in Park or Neutral, "closed loop" status achieved and all accessories off (except as noted in tables). Data parameters are updated a minimum of every 1 1/4 seconds, more often on most models. Not all devices and systems are used on all models; following lists only represent most commonly used parameters. For additional information, refer to owner manual furnished with tester.

SCAN DATA

Tester Position	Units Measured	Nominal Value
A/C Clutch	On/Off	On With A/C
A/C Request	Yes/No	Yes With Request
BARO	Volts	3.0-4.5
Battery Voltage	Volts	13.5-14.5
Brake Switch	App/Rel	Applied with Brakes On
Canister Purge Sol.	On/Off	On/Engine Cold (Idle Some)
Clear Flood	On/Off	See Tester Manual
Coolant Fan(s)	On/Off	On With Command
Coolant Temp.	°C	85-105° (Norm. Temperature)
Crank RPM	RPM	100-900
Cross Counts	Counts	0-255

EGR Solenoid	On/Off	On When Energized
EGR Duty Cycle	0-100%	0/Closed; 100/Fully Open
Fan Relay	On/Off	On When Energized
Fan Request	On/Off	On With Request
Fuel Back-Up	Yes/No	Yes When Engaged
Fuel Trim (ST)	Counts	110-150 ((1) 128 Normal)
Fuel Trim (LT)	Counts	110-150 ((1) 128 Normal)
IAC	Counts	0-50
Ignition/Crank	On/Off	On With Ignition/Crank
Injector Pulse Width	Mil./Sec	.8-3.0
Intake Air Temp.	°C	10-90°
Knock Retard	Counts	0-255
Knock Signal	Yes/No	Yes When Knock Exists
MAP	Volts	1.0 (Idle) to 4.5 (WOT)
"Open/Closed Loop Status"	Ol/Cl	Closed/Open During
O2 Sensor	Millivolts	100 (Lean) To 999 (Rich)
P/N Switch	P/N/RDL	Park/Neutral
P/S Switch	Norm/Hi	Normal
PROM I.D.	PROM #	Original Factory Number
QDM	Hi/Lo	Lo Energized
RPM	RPM	Spec. +/-25 RPM Drive (A/T)
RPM	RPM	Spec. +/-50 RPM Neut. (M/T)
Spark Advance	Degrees	Varies
TCC	On/Off	Off (On With Command)
TP Sensor	Volts	1.00 (Idle) To 5.00 (WOT)
Throttle Angle	0-100%	0 (Idle) To 100 (WOT)
Throttle Switch	Open/Closed	Open At Off Idle
Trans. Fluid Temp.	°C	100 (Normal)
Trouble Codes	Code No.	No Codes
Upshift Light (M/T)	On/Off	Off
VSS Or MPH	MPH	0-Actual
1st Gear Switch	On/Off	On/1st Gear Only
3rd Gear Switch	On/Off	On/3rd & 4th Gear
4th Gear Switch	On/Off	On/4th Gear

(1) Long Term (LT) fuel trim has a tendency to follow Short Term (ST) fuel trim. Extended idle may drive ST fuel trim to read less than 100 counts.

ECM/PCM CODE CHARTS

NOTE: In following diagnostic tests, schematics and illustrations

CODE 11, MALFUNCTION INDICATOR LIGHT

MIL should always be on steady with ignition on and engine stopped. Ignition voltage is supplied directly to bulb. PCM turns on light by providing a path to ground.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If MIL driver circuit or ignition feed circuit to bulb is open, MIL will not illuminate.
2. Jumper Harness (J 35616-A) should be used instead of directly probing harness. This will prevent damage to harness.
3. MIL should go off after engine starts. If it does, problem is not present at this time. If light does not go off, drive circuit is shorted to ground or PCM is faulty.
4. If other codes exist, use other code charts first, then restart at beginning of this chart.

Diagnostic Aids

If ignition feed circuit is suspected of being open, check and see if other bulbs on that circuit illuminate. Code 11 will cause MIL to remain on, even if malfunction clears.

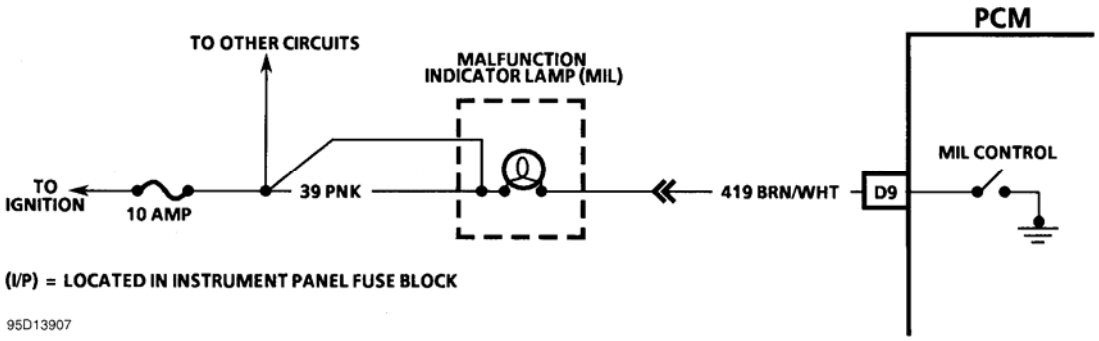


Fig. 2: Code 11 Schematic (Caprice) MIL Circuit

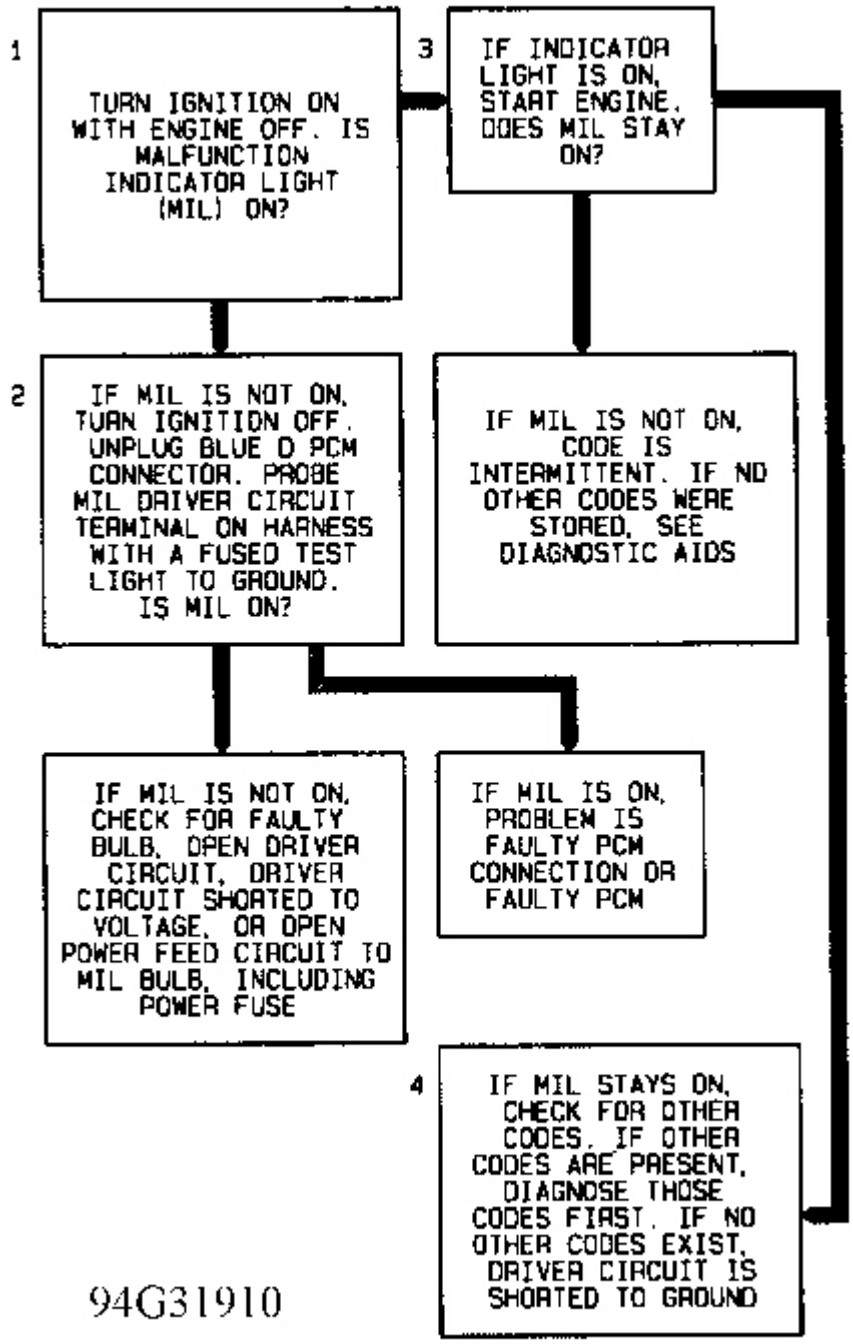


Fig. 3: Code 11 Diagnostic Flow Chart (Caprice) MIL Circuit

CODE 13, LEFT HEATED OXYGEN SENSOR CIRCUIT OPEN

NOTE: The 5.7L (VIN P) engine is equipped with 2 oxygen sensors. On this model, code will set if the left sensor circuit is open. Code 63 will set if the right sensor circuit is open. Oxygen sensors use a heating element. Heating element is not controlled by PCM.

Code will set if Codes 21 and 22 are not set, engine is at normal operating temperature, oxygen sensor voltage is constant within a specified range (.35-.55 volt), throttle angle is greater than idle, a precalibrated amount of time has elapsed since start-up and all conditions have existed for a precalibrated amount of time. Most likely causes of code are: open sensor signal (high) circuit, faulty PCM connection, faulty PCM, faulty oxygen sensor connection or faulty oxygen sensor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This tests if problem still exists. Vehicle cannot enter "closed loop" mode if oxygen sensor circuit is open. Code indicates an open in O2 sensor circuit (steady .35-.55 volt).
2. Determines if oxygen sensor, wiring or control module is at fault. If wiring is good, grounding oxygen sensor wire will cause .45 volt reference supplied by control module to pull low.
3. This tests oxygen sensor circuit wiring. Use only a high impedance (10-megohm minimum) digital voltmeter.

Diagnostic Aids

Control module will not go into closed loop if code is set. Code may set if vehicle runs out of fuel or stalls while vehicle is in motion. If oxygen sensor ground becomes loose, a false oxygen sensor reading will occur. This can result in a Code 13 being set. On models equipped with an oxygen sensor heating element, element resistance should be 3.5-14.0 ohms.

CODE 13 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
Left O2 Signal	C20	Purple/White
Left O2 Ground	C19	Tan/White

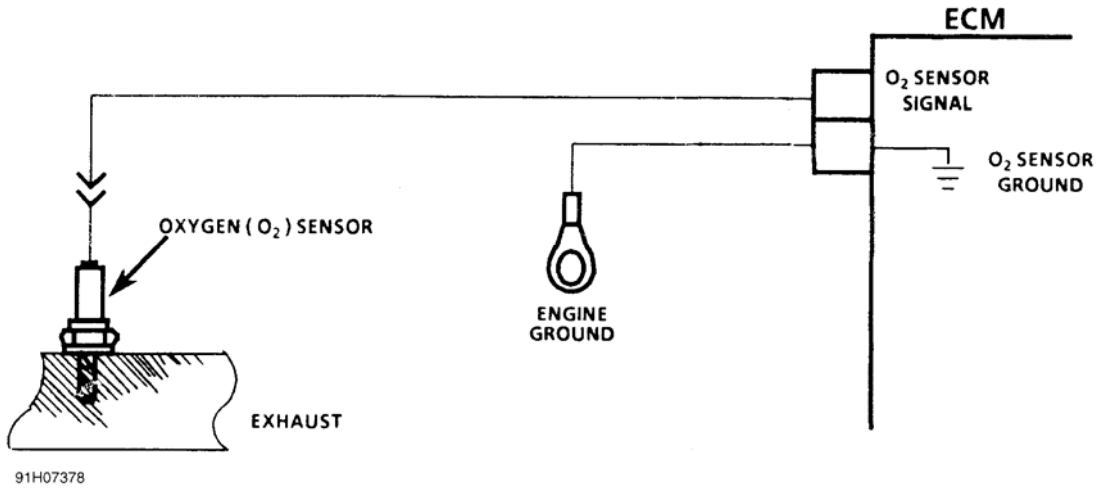


Fig. 4: Code 13 Schematic (Caprice) Open Oxygen Sensor Circuit

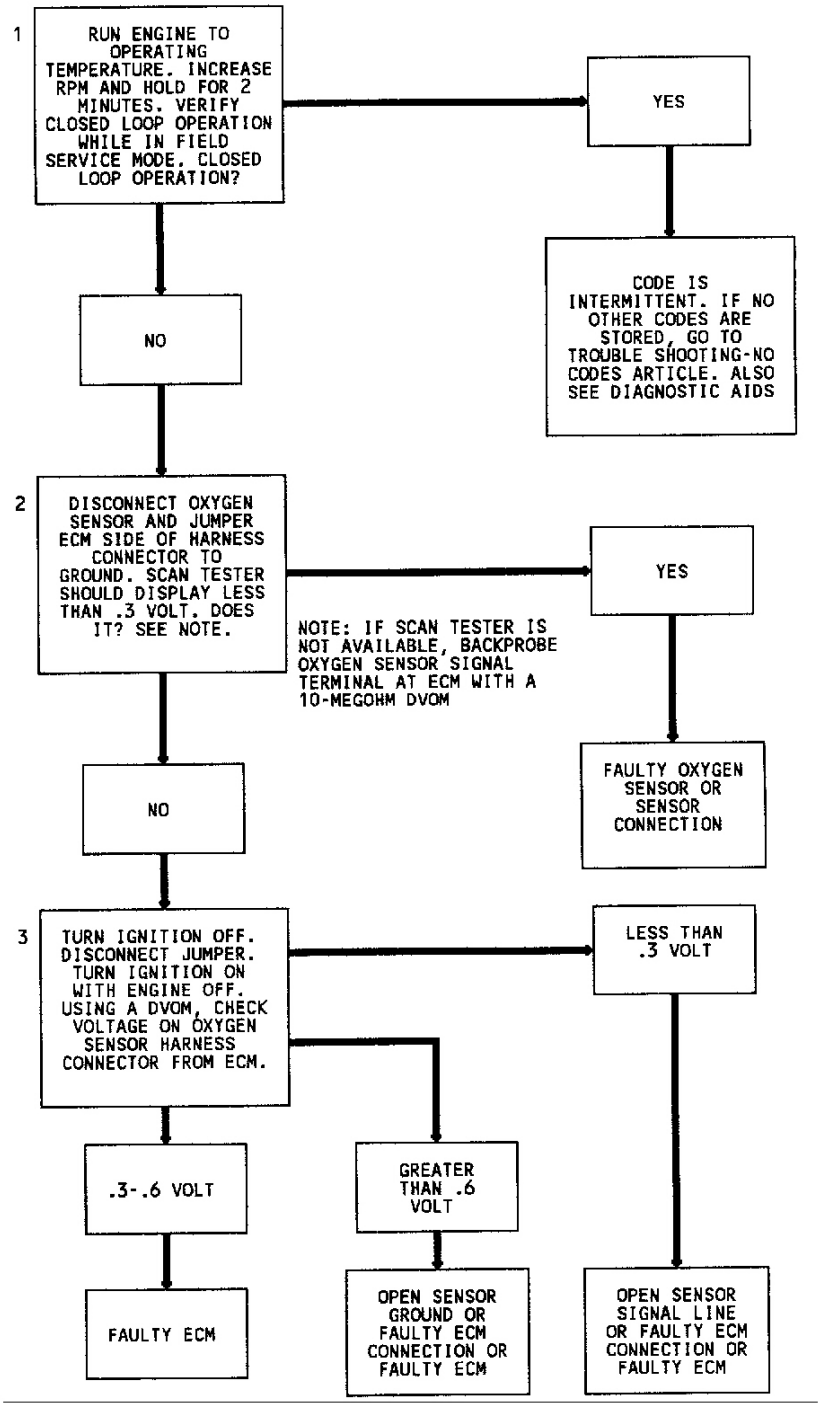


Fig. 5: Code 13 Diagnostic Flow Chart (Caprice) Open Oxygen Sensor Circuit

CODE 14, COOLANT TEMP SENS SGNL VLTGE LOW (HI TEMP INDICATED)

Code will set if PCM sees an extremely high temperature signal (low voltage). Most likely causes of code are:

sensor signal circuit shorted to ground, faulty coolant temperature sensor or faulty PCM.

NOTE: This chart assumes engine cooling system is functioning properly (not overheating). Test numbers refer to numbers on diagnostic chart.

1. This checks if conditions for code still exist.
2. This tests for grounded sensor signal line between control module and coolant sensor.

Diagnostic Aids

After engine is started, temperature should rise steadily to about 90°C and then stabilize when thermostat opens. At normal operating temperature, signal voltage at control module terminal should be 1.5-2.0 volts. Check sensor for shifted calibration by using sensor TEMPERATURE-TO-RESISTANCE VALUES table. When code is set, control module will turn on electric cooling fan(s) if equipped.

CODE 14 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
CTS Signal	C25	Yellow
CTS Ground	B6	Black

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

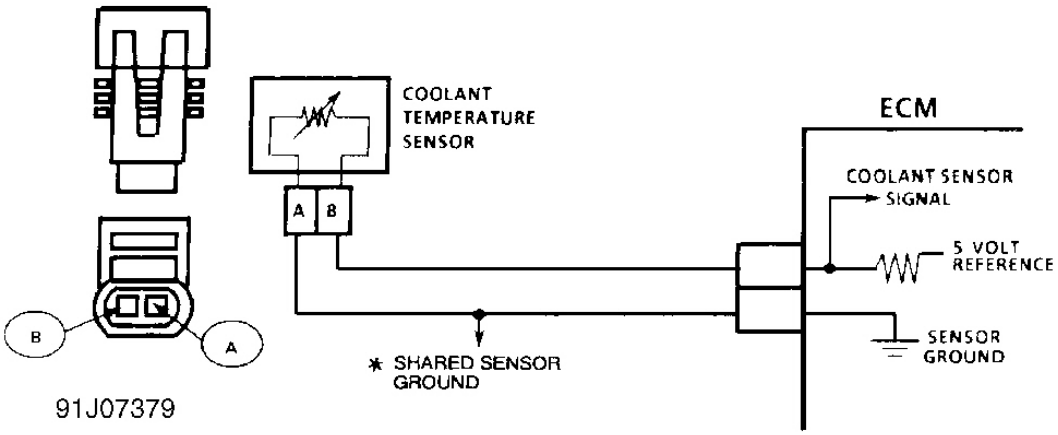


Fig. 6: Code 14 Schematic (Caprice) Coolant Temperature Sensor Signal Voltage Low (High Temp. Indicated)

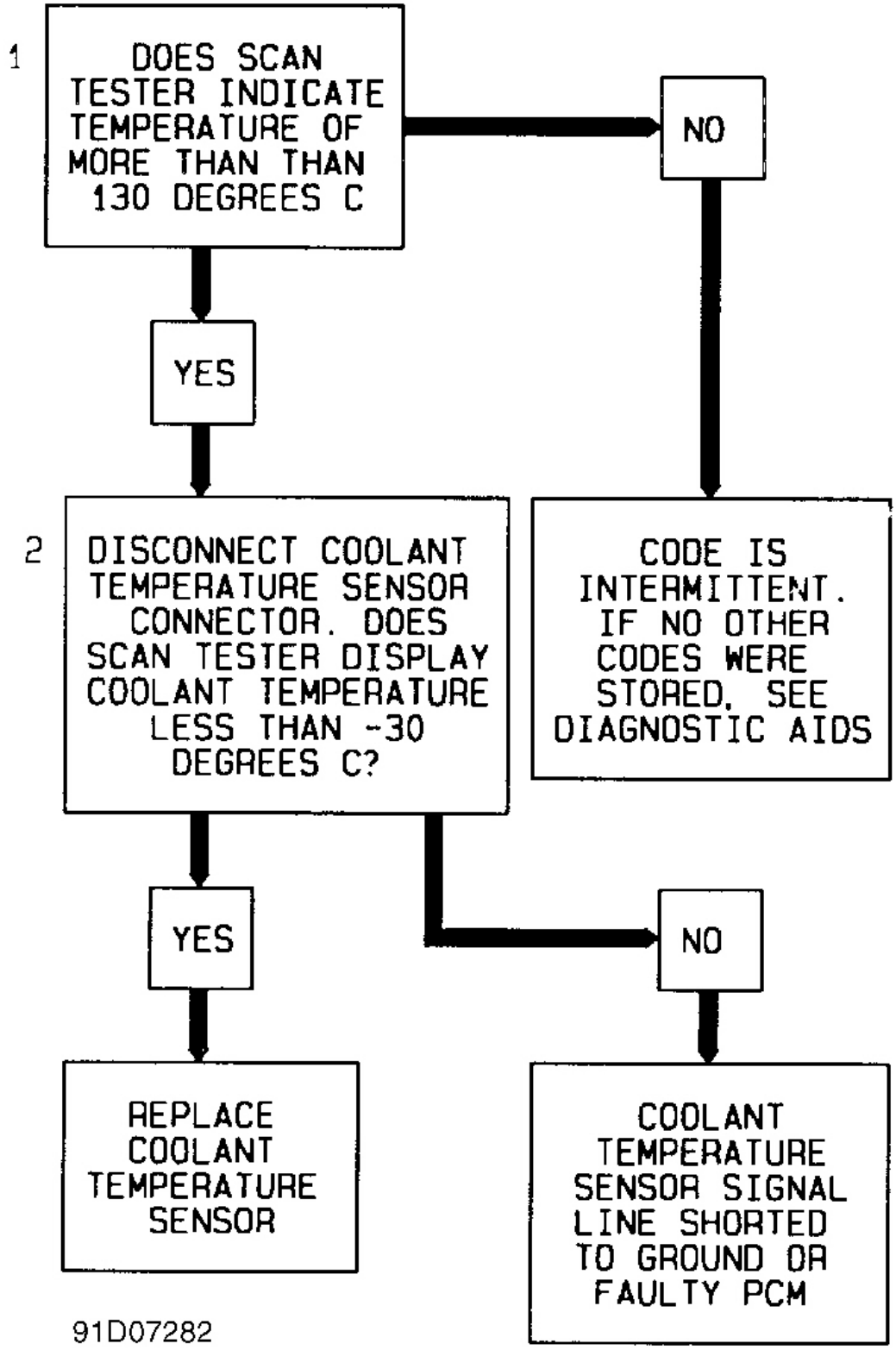

1
DOES SCAN TESTER INDICATE TEMPERATURE OF MORE THAN THAN 130 DEGREES C
NO
YES
2
DISCONNECT COOLANT TEMPERATURE SENSOR CONNECTOR. DOES SCAN TESTER DISPLAY COOLANT TEMPERATURE LESS THAN -30 DEGREES C?
CODE IS INTERMITTENT. IF NO OTHER CODES WERE STORED, SEE DIAGNOSTIC AIDS
YES
NO
REPLACE COOLANT TEMPERATURE SENSOR
COOLANT TEMPERATURE SENSOR SIGNAL LINE SHORTED TO GROUND OR FAULTY PCM
91D07282

Fig. 7: Code 14 Diagnostic Flow Chart (Caprice) Coolant Temperature Sensor Signal Voltage Low (High Temp. Indicated)

CODE 15, COOLANT TEMP SENSOR SIGNAL VOLTAGE LOW

Code indicates control module has seen high resistance (high monitored voltage) in coolant sensor circuit. This could be due to high resistance (cold temperature) or high voltage at coolant sensor terminal at control module for a precalibrated period of time. Most likely causes of code are: open sensor signal circuit, open sensor ground circuit (not allowing path to ground for 5-volt reference), faulty sensor connection, faulty sensor, faulty PCM connection or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This checks if conditions for code still exist.
2. This test simulates a low voltage condition. If control module recognizes low voltage signal, scan tester will display greater than about 130°C. This indicates control module and wiring are not at fault.
3. This test determines if coolant sensor ground or signal circuit is open.

Diagnostic Aids

After engine is started, temperature should rise steadily to about 90°C and then stabilize when thermostat opens. At normal operating temperature, signal voltage at control module terminal should be 1.5-2.0 volts. Check sensor for shifted calibration by using sensor TEMPERATURE-TO-RESISTANCE VALUES table. When code is set, control module will turn on electric cooling fan(s) if equipped.

CODE 15 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
CTS Signal	C25	Yellow
CTS Ground	B6	Black

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

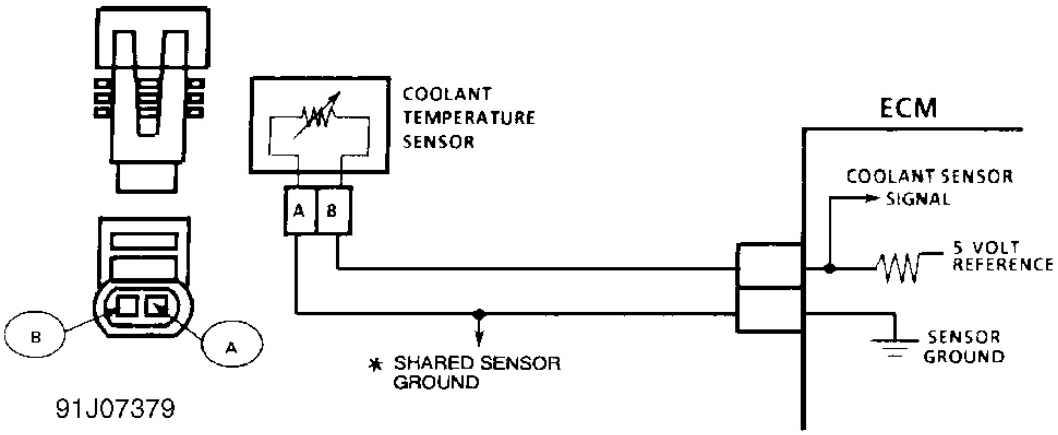
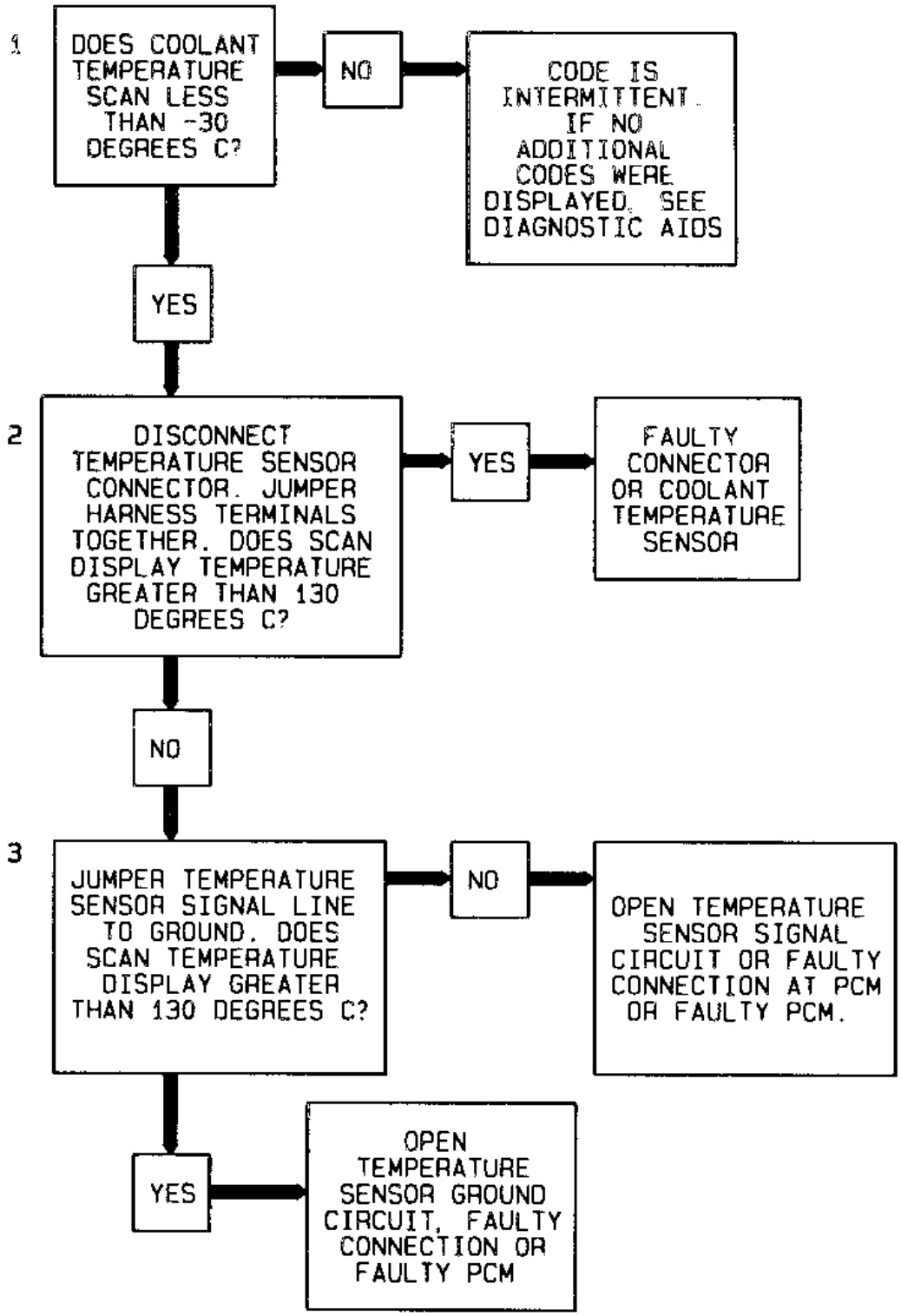


Fig. 8: Code 15 Schematic (Caprice) Coolant Temp Sensor Signal Voltage Low


1
DOES COOLANT TEMPERATURE SCAN LESS THAN -30 DEGREES C?
NO
CODE IS INTERMITTENT. IF NO ADDITIONAL CODES WERE DISPLAYED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TEMPERATURE SENSOR CONNECTOR. JUMPER HARNESS TERMINALS TOGETHER. DOES SCAN DISPLAY TEMPERATURE GREATER THAN 130 DEGREES C?
YES
FAULTY CONNECTOR OR COOLANT TEMPERATURE SENSOR
NO
3
JUMPER TEMPERATURE SENSOR SIGNAL LINE TO GROUND. DOES SCAN TEMPERATURE DISPLAY GREATER THAN 130 DEGREES C?
NO
OPEN TEMPERATURE SENSOR SIGNAL CIRCUIT OR FAULTY CONNECTION AT PCM OR FAULTY PCM.
YES
OPEN TEMPERATURE SENSOR GROUND CIRCUIT, FAULTY CONNECTION OR FAULTY PCM

91F07283

Fig. 9: Code 15 Diagnostic Flow Chart (Caprice) Coolant Temp Sensor Signal Voltage Low

CODE 16, OPTI-SPARK IGNITION SYSTEM LOW RESOLUTION PULSE

Ignition system supplies 2 timing inputs to PCM, a high resolution signal (360 pulses per camshaft revolution) and a low resolution signal (4 pulses per camshaft revolution). PCM can determine if either timing input is not being received by comparing inputs. If PCM detects high resolution pulse without detecting low pulse, Code 16 will set. Reference signal on resolution line toggles between zero and 5 volts as camshaft turns.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If engine starts at this time, code is intermittent.
2. This step determines if PCM is sending out a signal to distributor for processing. If this signal is not available or is shorted to ground or voltage, distributor cannot ground it to produce reference pulses.
3. If Code 41 and/or 42 is also set with Code 16 and no external fault can be found, replace PCM. If only Code 16 is set and distributor connections are okay, replace distributor.

Diagnostic Aids

An open, a short to voltage, a short to ground or a defective sensor inside distributor can prevent reference voltage from pulsing at PCM resolution terminal. If Code 16 does not reset and vehicle still does not start, go to NO START - ENGINE CRANKS OKAY in **BASIC TESTING** article in this section.

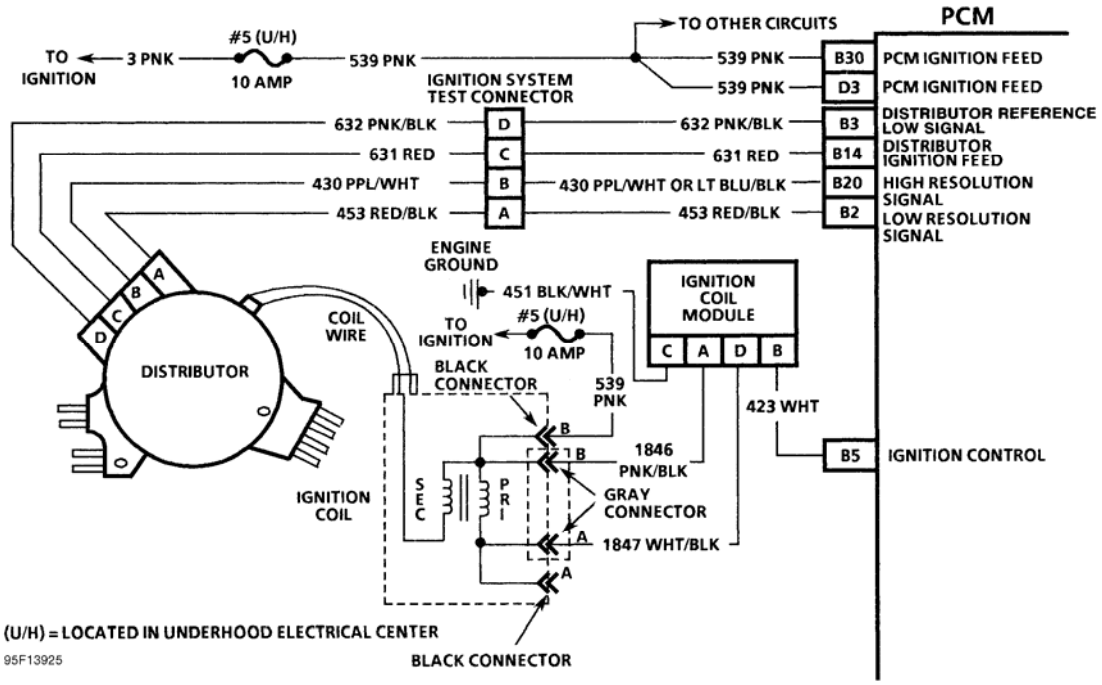


Fig. 10: Code 16 Schematic (Caprice) Opti-spark Ignition System Low Resolution Pulse

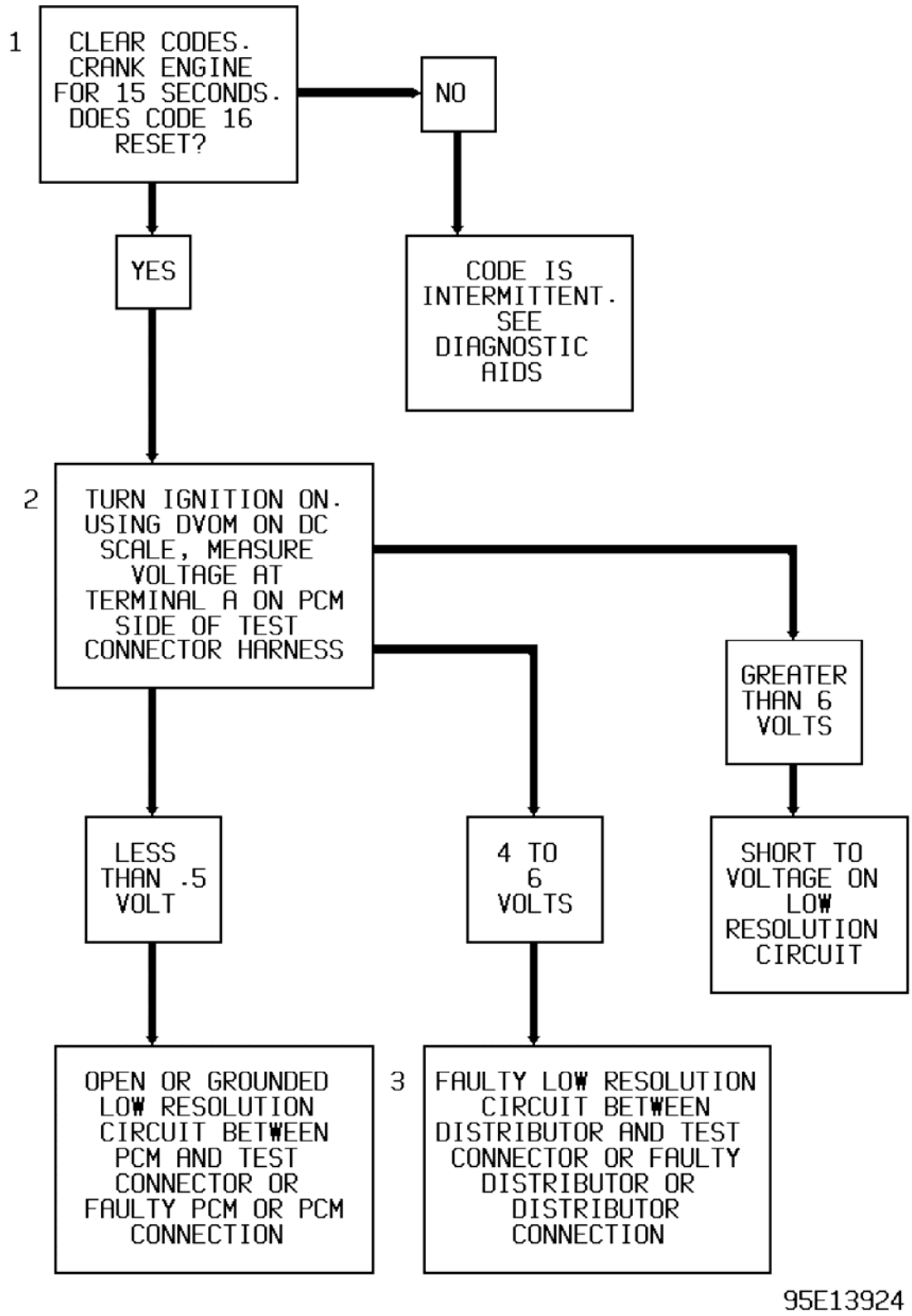


Fig. 11: Code 16 Diagnostic Flow Chart (Caprice) Opti-spark Ignition System Low Resolution Pulse

CODE 18, INJECTOR CIRCUIT

Injectors are provided voltage when ignition is on. PCM energizes injectors by providing an individual ground for each injector. Injectors are energized on the intake stroke of each cylinder. PCM continuously monitors voltage on each driver circuit. When PCM detects a voltage that is out of range, Code 18 will set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Injector fuses are located in the underhood electrical center.
2. Performing an injector balance test will determine which injector circuit is faulty. See **SYSTEM/COMPONENT TESTS - 4.3L** article in this section.
3. See mini-schematic to determine which fuse powers injector banks.
4. When checking injector resistance, injector should be cold.

Diagnostic Aids

If an injector is disconnected and then reconnected while engine is running, injector driver is disabled for a predetermined time and Code 18 will set. When driver is disabled, an engine misfire will be evident.

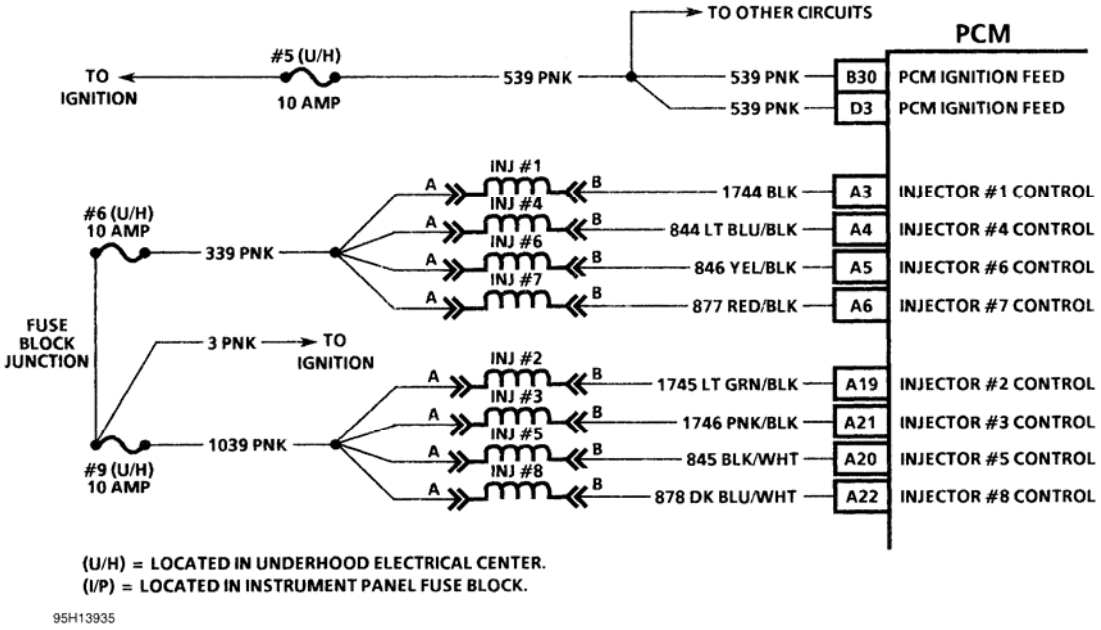


Fig. 12: Code 18 Schematic (Caprice) Injector Circuit

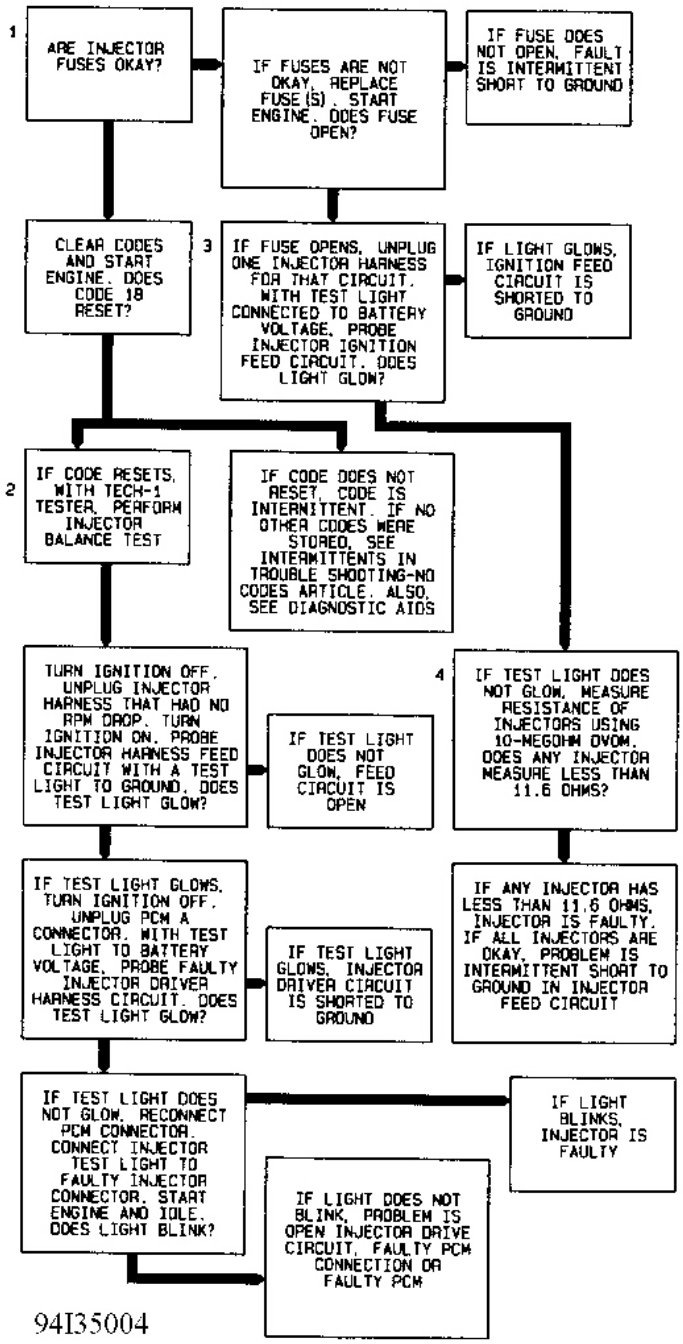


Fig. 13: Code 18 Diagnostic Flow Chart (Caprice) Injector Circuit

CODE 21, THROTTLE POSITION SENSOR SIGNAL VOLTAGE HIGH

Code will set if engine is idling (closed throttle), MAP value is low, a MAP code is not set and PCM sees high

TP sensor voltage. Most likely causes for code are: TP sensor signal circuit shorted to voltage, open sensor ground circuit, faulty sensor connection, faulty TP sensor or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks if code is result of a hard failure or an intermittent condition.
2. This test simulates a low-voltage condition. If control module recognizes change of state, control module and wiring are okay.
3. This step isolates a faulty sensor, control module or open sensor ground circuit. If sensor ground is shared by another sensor, an accompanying code related to that sensor may exist.

Diagnostic Aids

A scan tester displays throttle position in volts. Closed throttle voltage should be low. Voltage should increase gradually to about 4.5 volts at a steady rate as throttle angle is increased. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 21 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
TPS Signal	C22	Dark Blue
TPS Ground	B6	Black
TPS Reference	B28	Gray

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

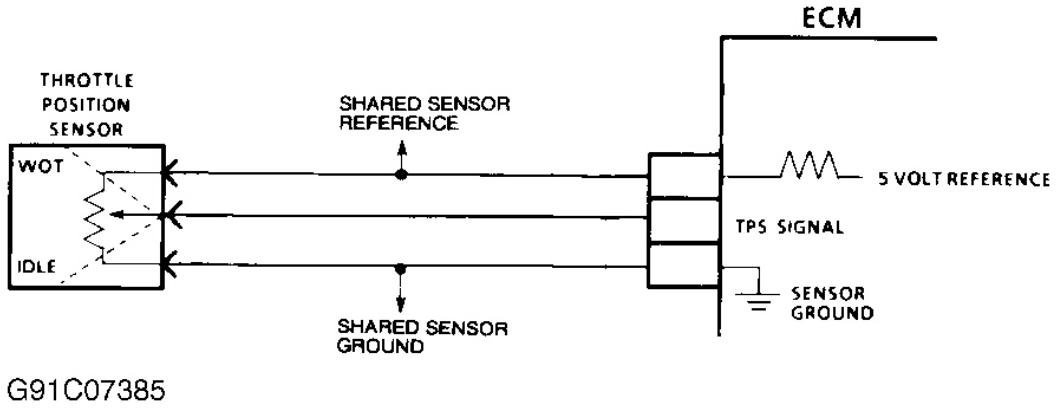


Fig. 14: Code 21 Schematic (Caprice) Throttle Position Sensor Signal Voltage High

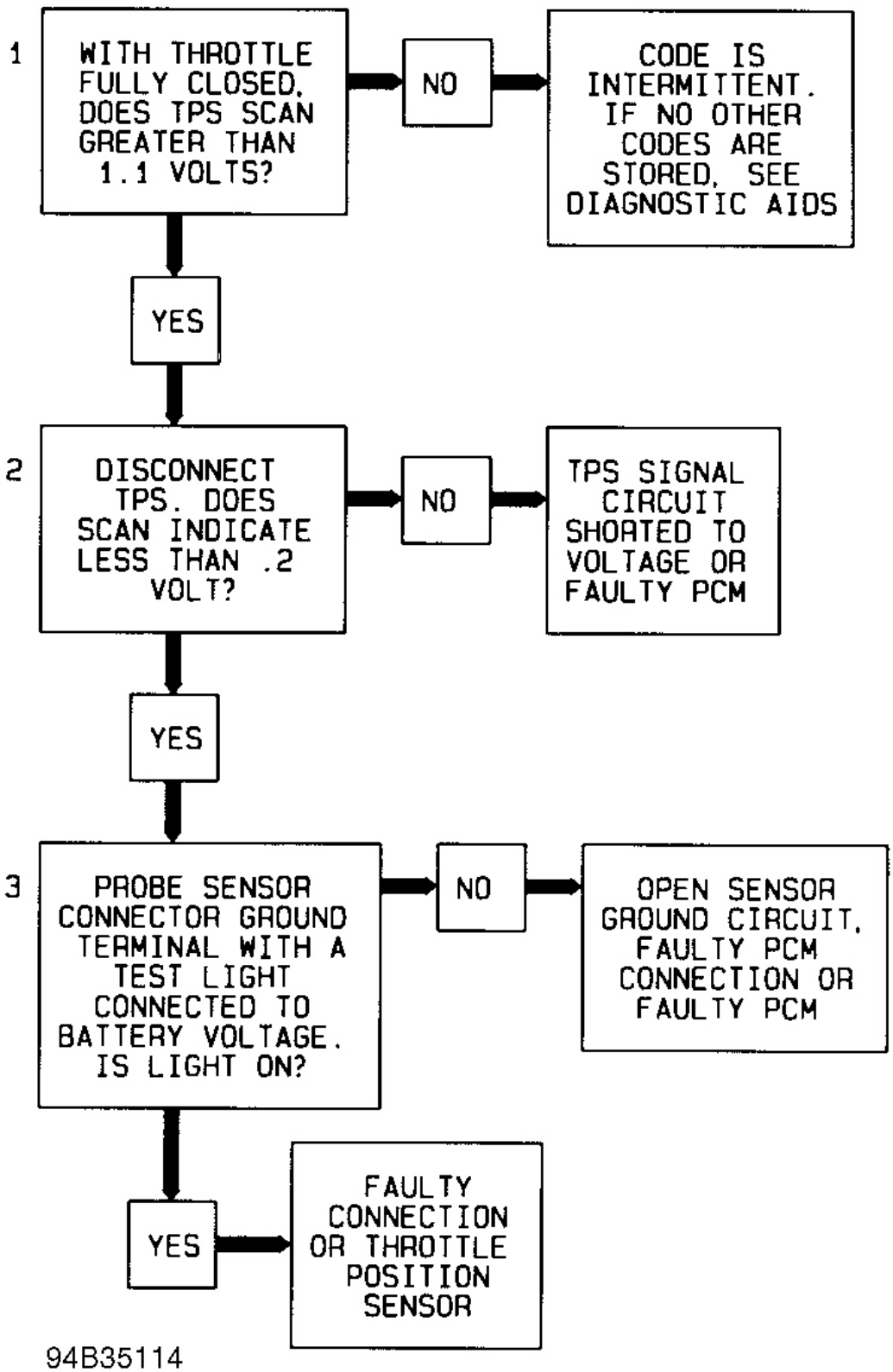

1
WITH THROTTLE FULLY CLOSED, DOES TPS SCAN GREATER THAN 1.1 VOLTS?
NO
CODE IS INTERMITTENT. IF NO OTHER CODES ARE STORED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TPS. DOES SCAN INDICATE LESS THAN .2 VOLT?
NO
TPS SIGNAL CIRCUIT SHORTED TO VOLTAGE OR FAULTY PCM
YES
3
PROBE SENSOR CONNECTOR GROUND TERMINAL WITH A TEST LIGHT CONNECTED TO BATTERY VOLTAGE. IS LIGHT ON?
NO
OPEN SENSOR GROUND CIRCUIT, FAULTY PCM CONNECTION OR FAULTY PCM
YES
FAULTY CONNECTION OR THROTTLE POSITION SENSOR
94B35114

Fig. 15: Code 21 Diagnostic Flow Chart (Caprice) Throttle Position Sensor Signal Voltage High

CODE 22, THROTTLE POSITION SENSOR SIGNAL VOLTAGE LOW

Code will set if engine is running and TP sensor voltage is lower than base idle voltage (auto zero voltage). Most likely causes of code are: TP sensor signal circuit open or shorted to ground, 5-volt reference open or shorted to ground (should also set other codes), faulty sensor connection, faulty sensor, faulty PCM connection or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks if code is result of a hard failure or an intermittent condition.
2. This test simulates high voltage conditions. If control module recognizes change of state, control module and wiring are okay.
3. This simulates a high signal voltage to check for an open in TP sensor signal line to control module. Scan tester should recognize this signal and display high TP sensor voltage.

Diagnostic Aids

A scan tester displays throttle position in volts. Closed throttle voltage should be low. Voltage should increase gradually to about 4.5 volts at a steady rate as throttle angle is increased. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 22 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
TPS Signal	C22	Dark Blue
TPS Ground	B6	Black
TPS Reference	B28	Gray

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

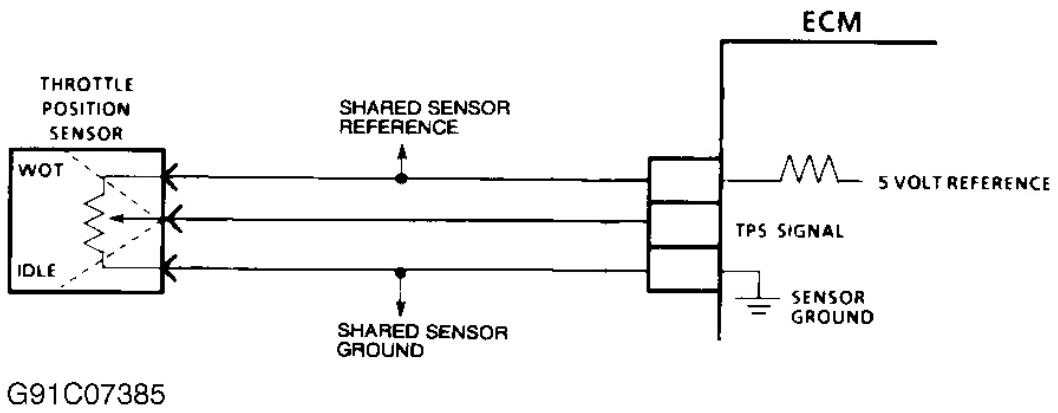
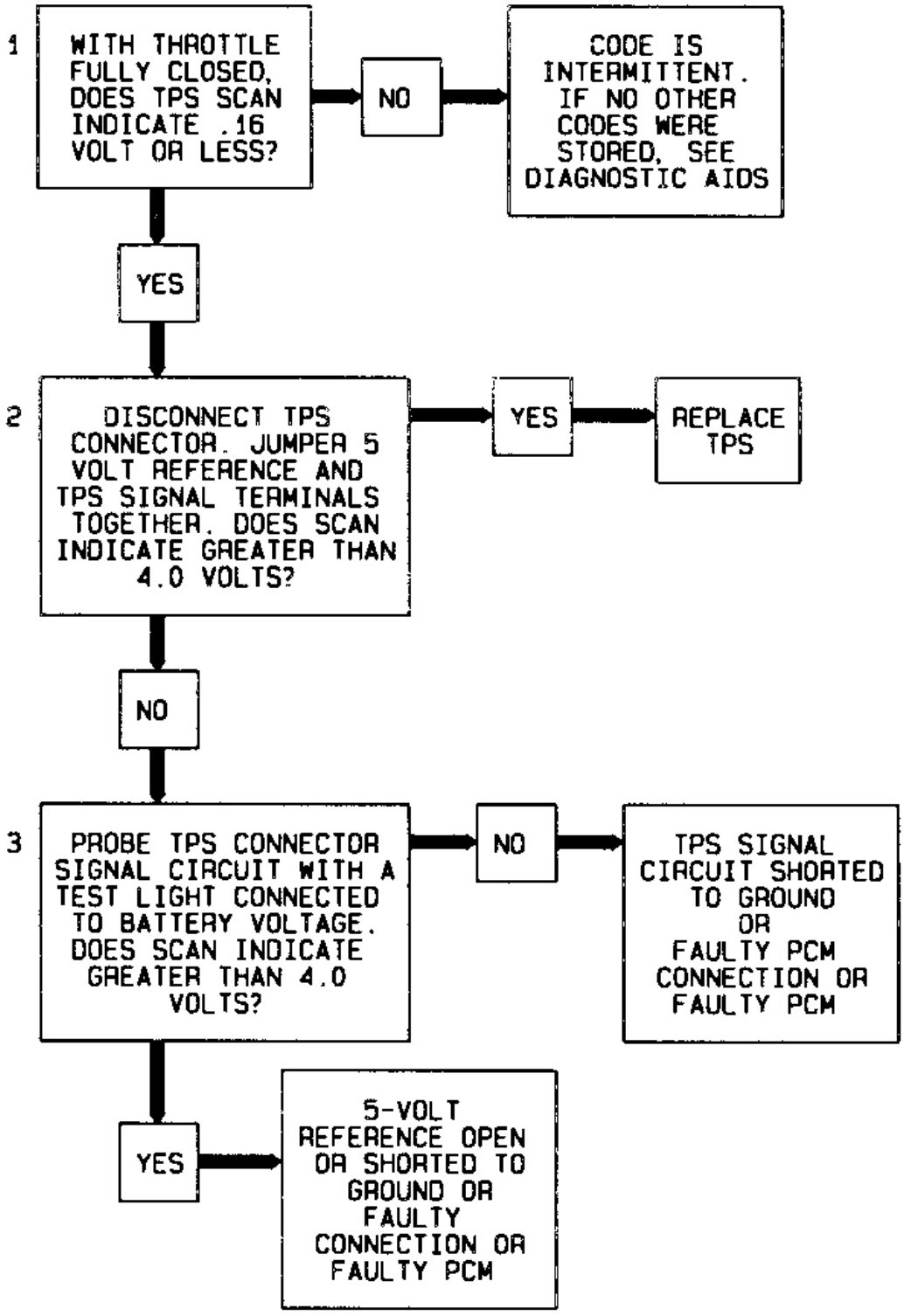


Fig. 16: Code 22 Schematic (Caprice) Throttle Position Sensor Signal Voltage Low


1
WITH THROTTLE FULLY CLOSED, DOES TPS SCAN INDICATE .16 VOLT OR LESS?
NO
CODE IS INTERMITTENT. IF NO OTHER CODES WERE STORED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TPS CONNECTOR. JUMPER 5 VOLT REFERENCE AND TPS SIGNAL TERMINALS TOGETHER. DOES SCAN INDICATE GREATER THAN 4.0 VOLTS?
YES
REPLACE TPS
NO
3
PROBE TPS CONNECTOR SIGNAL CIRCUIT WITH A TEST LIGHT CONNECTED TO BATTERY VOLTAGE. DOES SCAN INDICATE GREATER THAN 4.0 VOLTS?
NO
TPS SIGNAL CIRCUIT SHORTED TO GROUND OR FAULTY PCM CONNECTION OR FAULTY PCM
YES
5-VOLT REFERENCE OPEN OR SHORTED TO GROUND OR FAULTY CONNECTION OR FAULTY PCM

94I35111

Fig. 17: Code 22 Diagnostic Flow Chart (Caprice) Throttle Position Sensor Signal Voltage Low

CODE 23, IAT SENSOR SIGNAL VOLTAGE HIGH (LOW TEMP INDICATED)

Code will set if engine has been running for a precalibrated period of time, has reached operating temperature and signal voltage indicates a low intake air temperature (high voltage). Most likely causes of code are: open sensor signal circuit, open sensor ground circuit (not allowing path to ground for 5-volt reference), faulty sensor connection, faulty sensor, faulty PCM connection or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks if code is result of a hard failure or an intermittent condition.
2. This simulates low voltage (high temperature) conditions. If scan tester displays a high temperature, control module and wiring are not at fault.
3. This checks for continuity of sensor signal and ground circuits using process of elimination. If ground circuit is shared by other sensors and ground circuit is open, accompanying codes related to those sensors may be present.

Diagnostic Aids

If engine is allowed to cool overnight, coolant and IAT sensor values should be close to each other when measured by scan tester. Code will result if signal and ground circuits become open. Check sensor for shifted calibration by using sensor TEMPERATURE-TO-RESISTANCE VALUES table.

CODE 23 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
IAT Signal	C21	Tan
IAT Ground	B16	Black

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

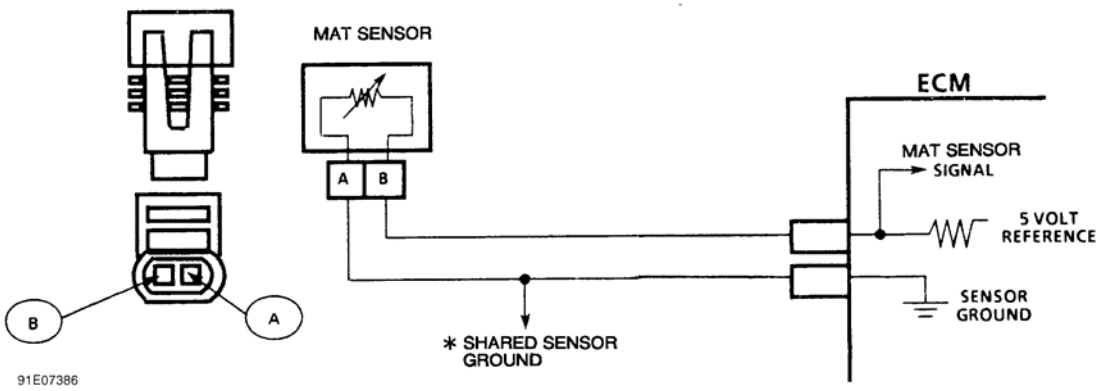


Fig. 18: Code 23 Schematic (Caprice) IAT Sensor Signal Voltage High (Low Temp Indicated)

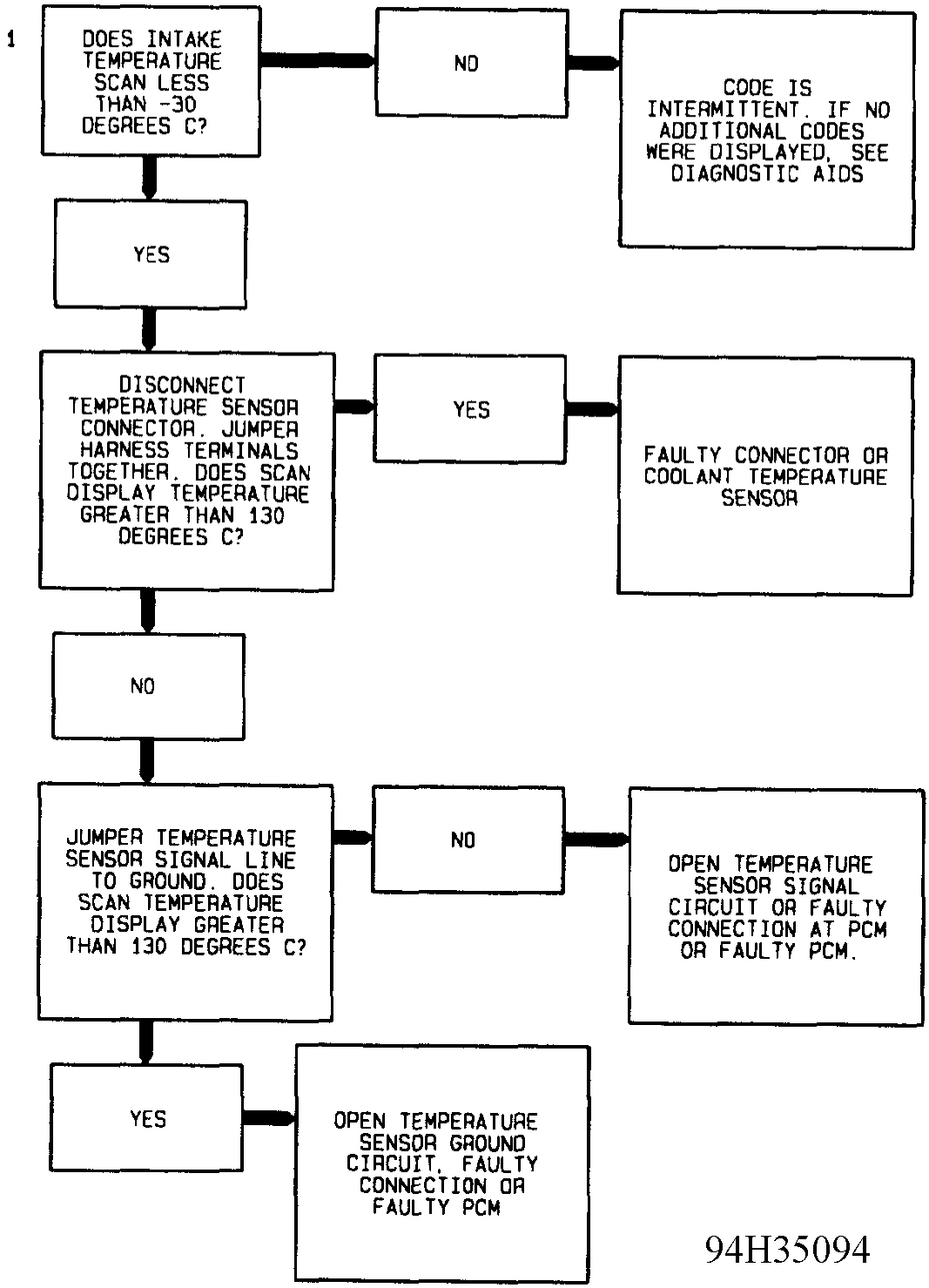


Fig. 19: Code 23 Diagnostic Flow Chart (Caprice) IAT Sensor Signal Voltage High (Low Temp Indicated)

CODE 24, VEHICLE SPEED SENSOR

Speed sensor, which is a Permanent Magnet (PM) generator, provides control module with vehicle speed information. PM generator, mounted in transmission, produces a pulsing AC voltage signal whenever vehicle speed is greater than about 2 MPH. Voltage level and pulses increase with vehicle speed. Control module converts pulsing voltage to MPH, which is used by control module to calculate vehicle adjustments.

NOTE: Test numbers refer to numbers on diagnostic chart.

NOTE: Prior to testing Corvette for Code 24, disable ASR system.

1. PM generator only produces a voltage signal if drive wheels are turning greater than about 2 MPH.

Diagnostic Aids

A faulty or misadjusted park/neutral switch may set a false Code 24. Use scan tester to check for proper signal in Drive while wiggling shifter. Code 24 may set if vehicle is power braked (brakes applied and throttle depressed) for more than 10 seconds.

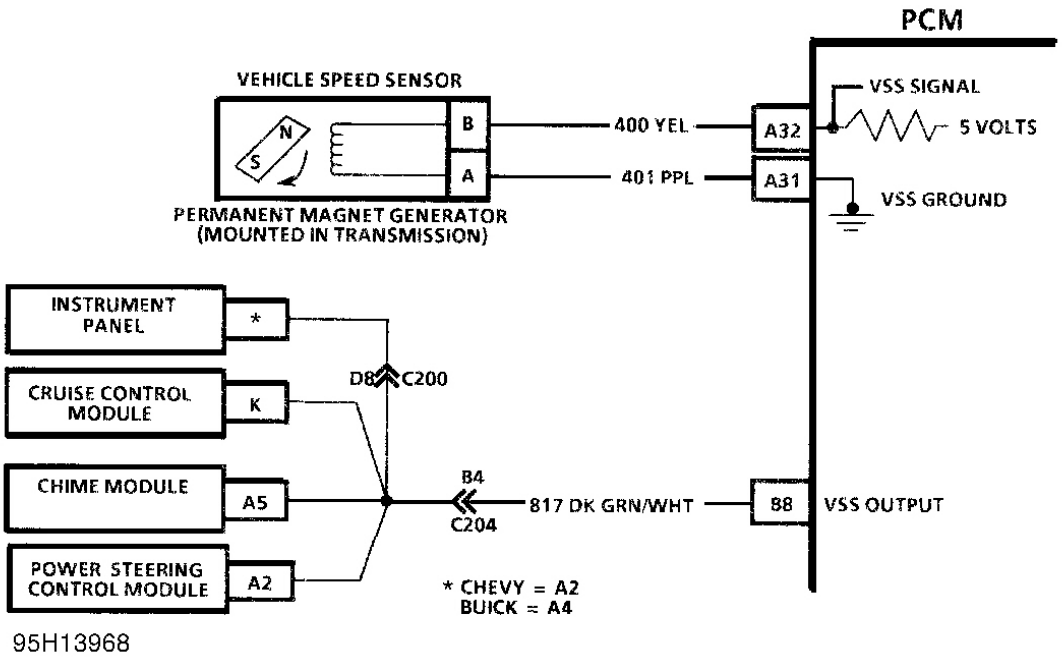


Fig. 20: Code 24 Schematic (Caprice) Vehicle Speed Sensor

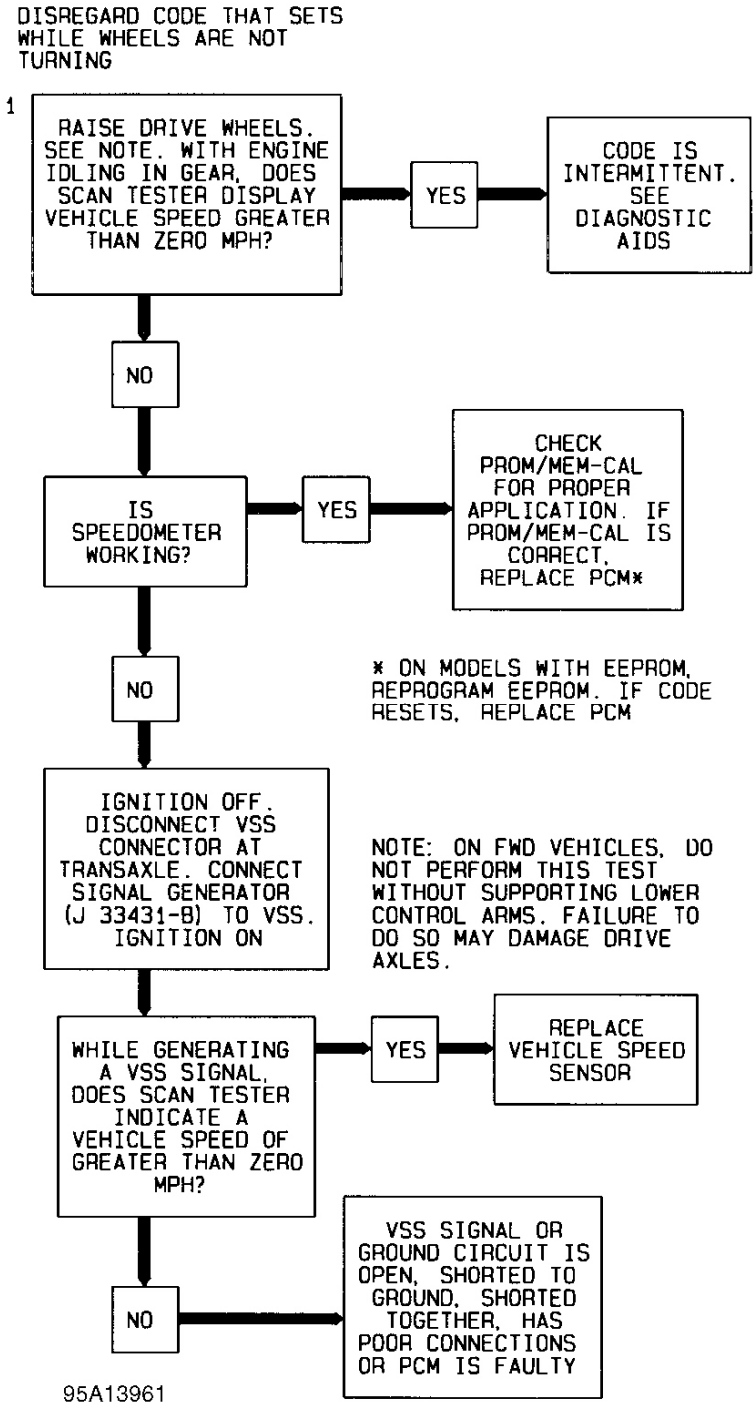


Fig. 21: Code 24 Diagnostic Flow Chart (Caprice) Vehicle Speed Sensor

CODE 25, IAT SENSOR SIGNAL VOLTAGE LOW (HIGH TEMP INDICATED)

Code will set if intake air temperature is extremely high (sensor signal voltage low) for a precalibrated period of

time. Most likely causes of code are: sensor signal circuit shorted to ground, faulty coolant temperature sensor or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This checks if code is hard failure or intermittent condition.
2. This simulates low temperature (high resistance) conditions. If control module recognizes open circuit and scan tester displays temperature of less than about -30°C, control module and wiring are okay.

Diagnostic Aids

If engine is allowed to cool overnight, coolant temperature sensor and IAT sensor values should be close to each other when measured by a scan tester. A Code 25 will result if sensor signal circuit is shorted to ground. Check sensor for shifted calibration by using sensor TEMPERATURE-TO-RESISTANCE VALUES table.

CODE 25 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
IAT Signal	C21	Tan
IAT Ground	B16	Black

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

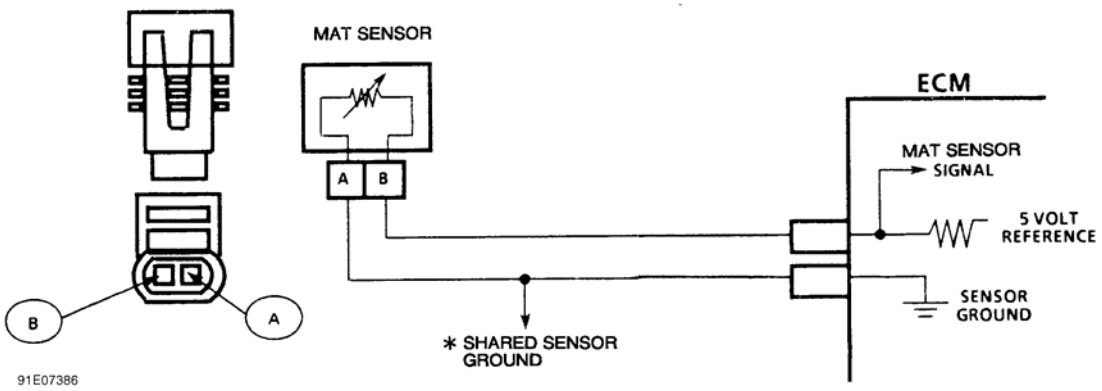


Fig. 22: Code 25 Schematic (Caprice) IAT Sensor Signal Voltage Low (High Temp Indicated)

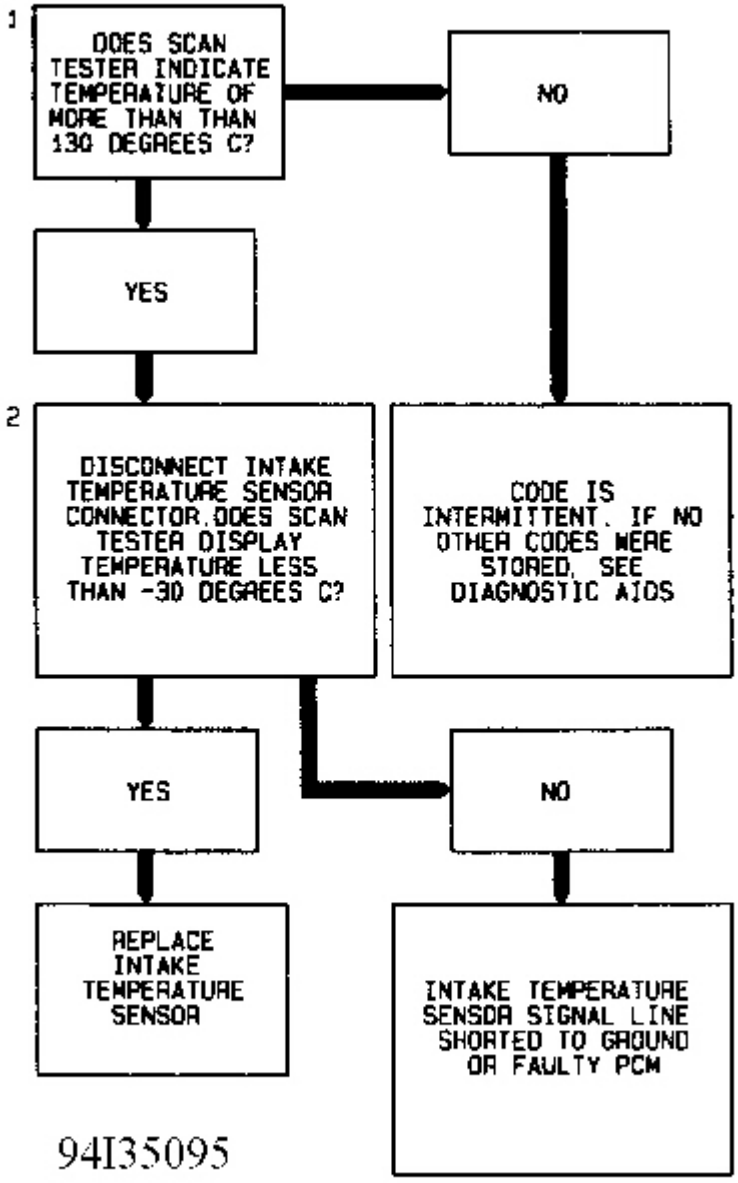


Fig. 23: Code 25 Diagnostic Flow Chart (Caprice) IAT Sensor Signal Voltage Low (High Temp Indicated)

CODE 26, CANISTER PURGE SOLENOID

Solenoid is supplied voltage when ignition is on. PCM controls solenoid valve by providing a ground through one of its Quad-Drivers Modules (QDM). When solenoid is actuated, terminal is grounded and its monitored

voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Code 26 will set if the PCM detects the wrong voltage potential. Test will determine if solenoid can be controlled by PCM.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative solenoid.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

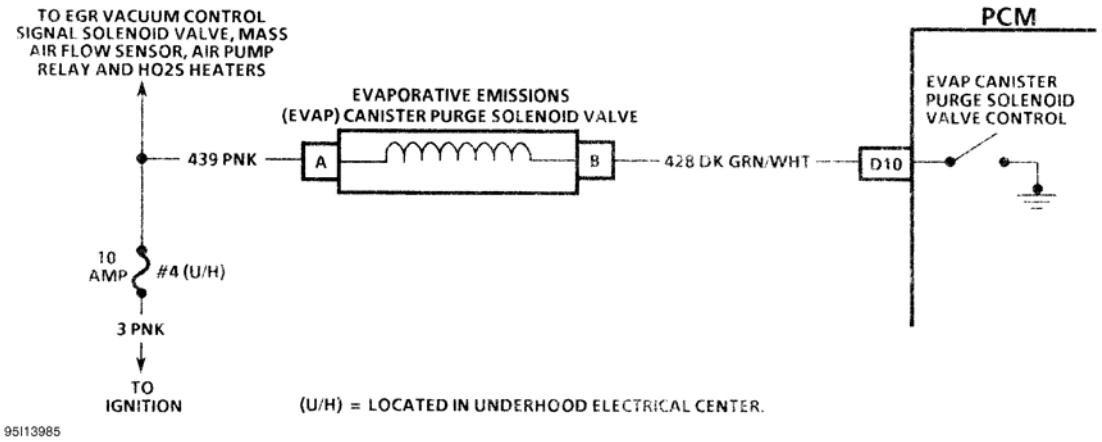


Fig. 24: Code 26 Schematic (Caprice) Canister Purge Solenoid

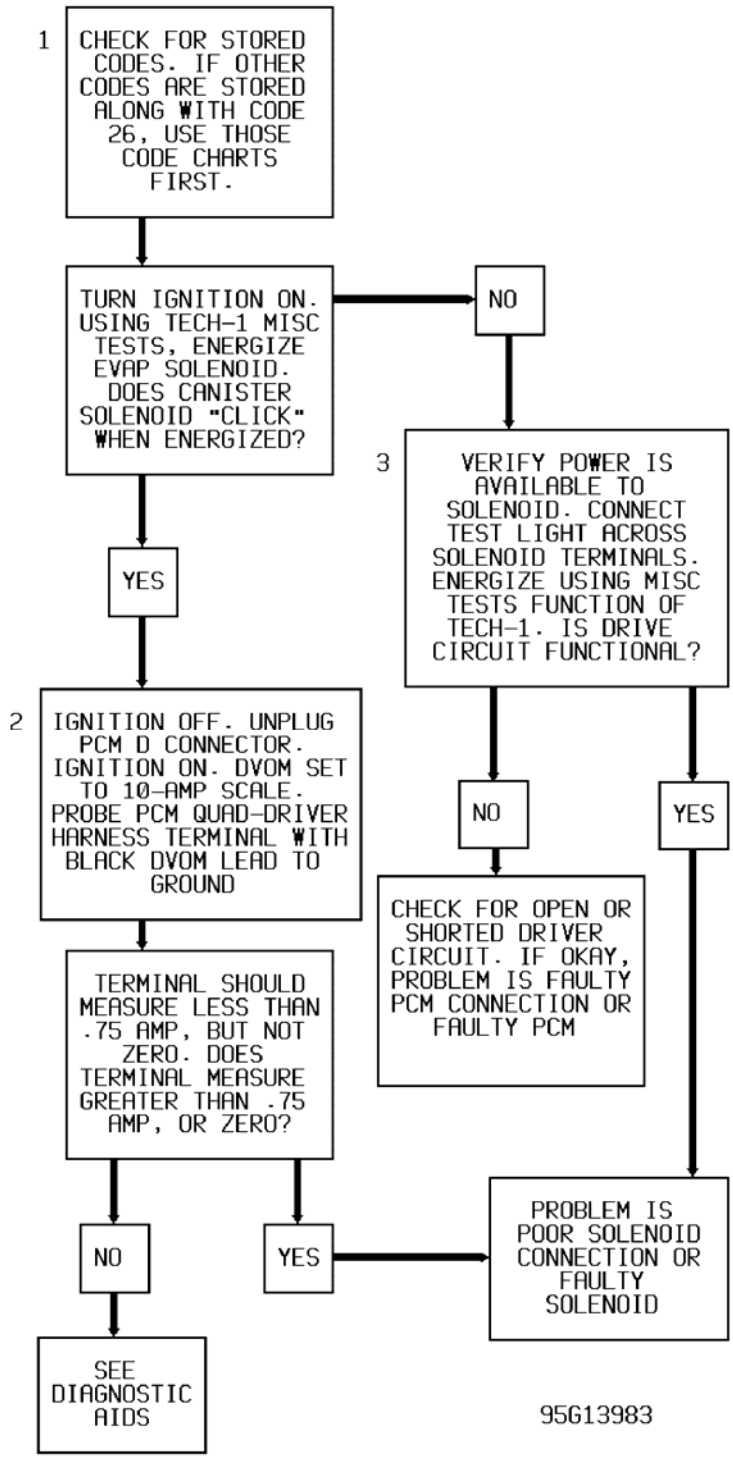


Fig. 25: Code 26 Diagnostic Flow Chart (Caprice) Canister Purge Solenoid

CODE 27, EGR SOL VALVE

Ignition voltage is supplied voltage when ignition is on. PCM controls solenoid valve by providing a ground

through one of its Quad-Drivers Modules (QDM). When solenoid is actuated, terminal is grounded and its monitored voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Code 27 will set if the PCM detects the wrong voltage potential. Test will determine if solenoid can be controlled by PCM.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative solenoid.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

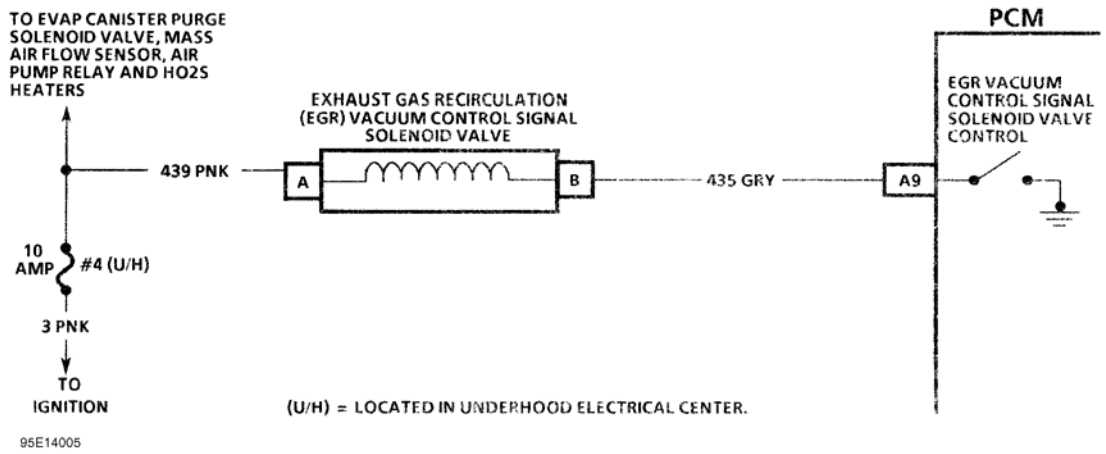


Fig. 26: Code 27 Schematic (Caprice) EGR Solenoid Valve

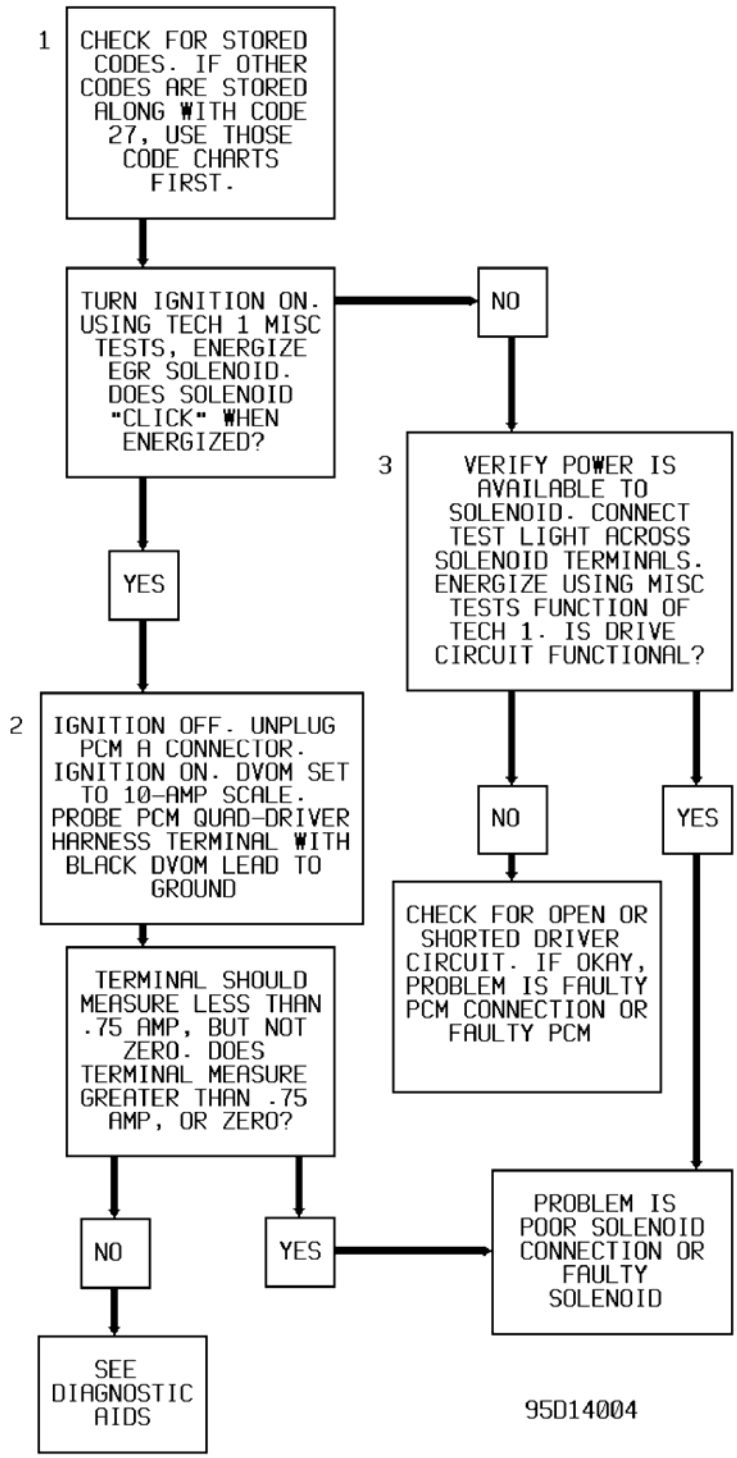


Fig. 27: Code 27 Diagnostic Flow Chart (Caprice) EGR Solenoid Valve

CODE 28, TRANS. RANGE PRESSURE SWITCH

Transmission range pressure switch assembly consists of 5 pressure switches (2 normally closed, 3 normally

open), and a fluid temperature sensor combined into one unit and mounted on the valve body. PCM supplies voltage to each range signal. By grounding one or more of these circuits through various combinations of pressure switches, PCM detects which manual valve position has been selected. With ignition on and engine off, Park/Neutral will be indicated. Code 28 will set when range signals "A" and "C" are both zero volts (on) for 2 seconds.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks indicated range signal to valve position signal actually selected.
2. Checks for correct voltage from PCM to transmission external connector.
3. Checks for short to ground in any one of the 3 valve position circuits.

Diagnostic Aids

Code will set if PCM detects one of 2 illegal combinations. Check all connections for good contact.

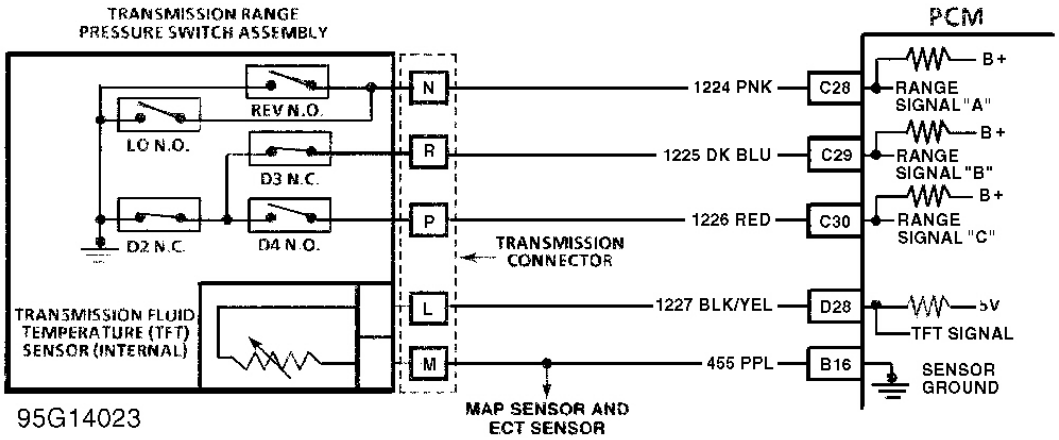


Fig. 28: Code 28 Schematic (Caprice) Transmission Range Pressure Switch

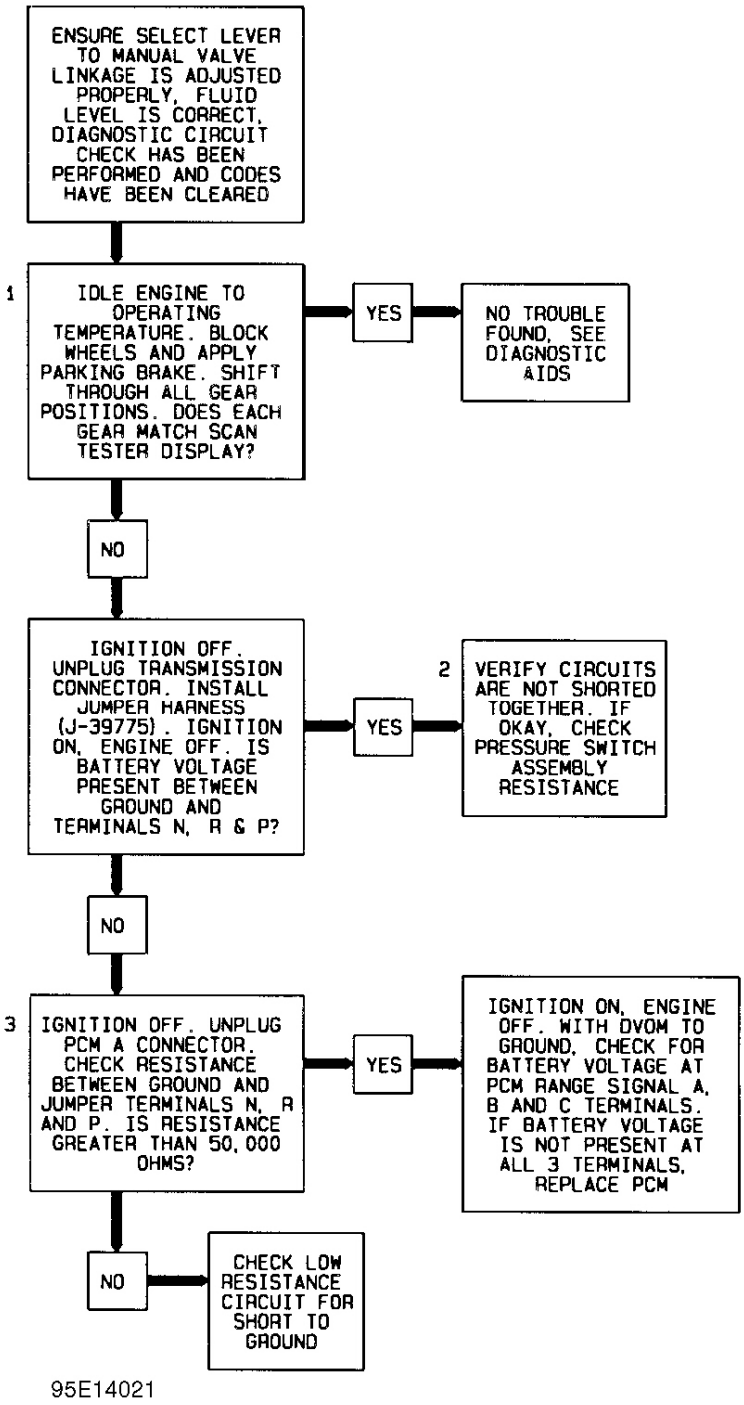


Fig. 29: Code 28 Diagnostic Flow Chart (Caprice) Transmission Range Pressure Switch

CODE 29, SECONDARY AIR INJECTION

Ignition voltage is supplied voltage when ignition is on. PCM controls air pump relay by providing a ground

through one of its Quad-Driver Modules (QDM). When relay is actuated, terminal is grounded and its monitored voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Code 29 will set if the PCM detects the wrong voltage potential. Test will determine if relay can be controlled by PCM.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative relay.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

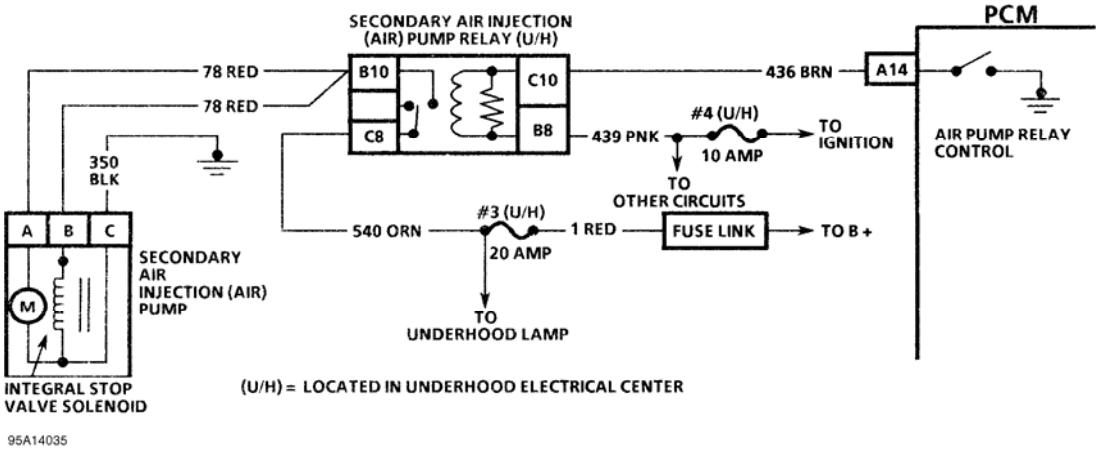


Fig. 30: Code 29 Schematic (Caprice) Secondary Air Injection

CODE 32, EGR SYSTEM ERROR

EGR vacuum is regulated by an PCM-controlled, normally closed solenoid. PCM will turn EGR on and off (duty cycle) by grounding and ungrounding solenoid drive circuit. Duty cycle is calculated by PCM based on coolant temperature, airflow and engine RPM. PCM will check EGR operation when vehicle speed is 16-32 MPH, MAP is within calibrated range, throttle angle is zero percent and vehicle is coasting.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. See following:
   - **Plugged Intake Passage** Shut off engine, and remove EGR valve. Plug exhaust side port using a shop rag or suitable plug. Attempt to start engine. If engine runs at a very high idle (up to 3000 RPM is possible) or if engine starts and stalls, EGR intake passage is not plugged. If vehicle starts

and idles normally, intake side passage is plugged.

- **Plugged Exhaust Passage** With EGR valve removed, plug intake manifold side passage using a suitable plug. Start engine and listen for exhaust noise. If no exhaust gas escapes from open EGR port, exhaust passage is plugged.

2. Using Tech 1 tester, EGR solenoid should energize and allow vacuum to be applied to gauge. Vacuum at gauge may or may not slowly bleed off; however, gauge is able to read amount of vacuum being applied.
3. Upon exiting field service mode, gauge vacuum should bleed off through a vent in solenoid. Pump gauge vacuum may or may not bleed off; this does not indicate a problem.
4. Remaining tests check ability of EGR valve to interact with exhaust system. This system uses a negative backpressure EGR valve which will hold vacuum with engine off.
5. When engine is started, exhaust backpressure at base of EGR valve should open valve's internal bleed. This will vent applied vacuum, allowing valve to seat.

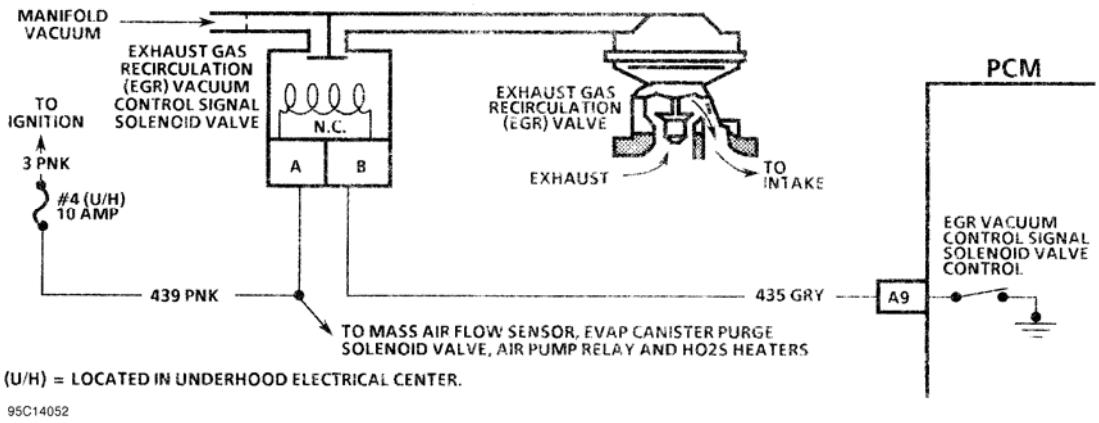


Fig. 31: Code 32 Schematic (Caprice) EGR System Error

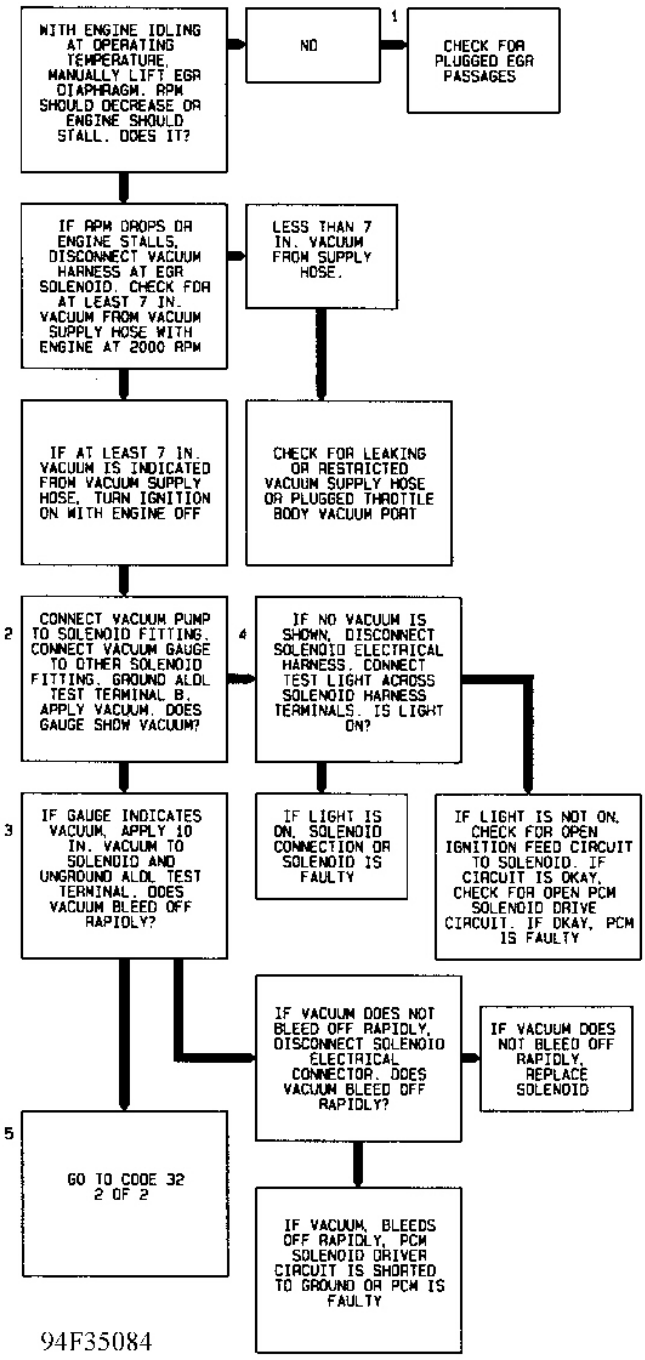


Fig. 32: Code 32 Diagnostic Flow Chart - 1 Of 2 (Caprice) EGR System Error

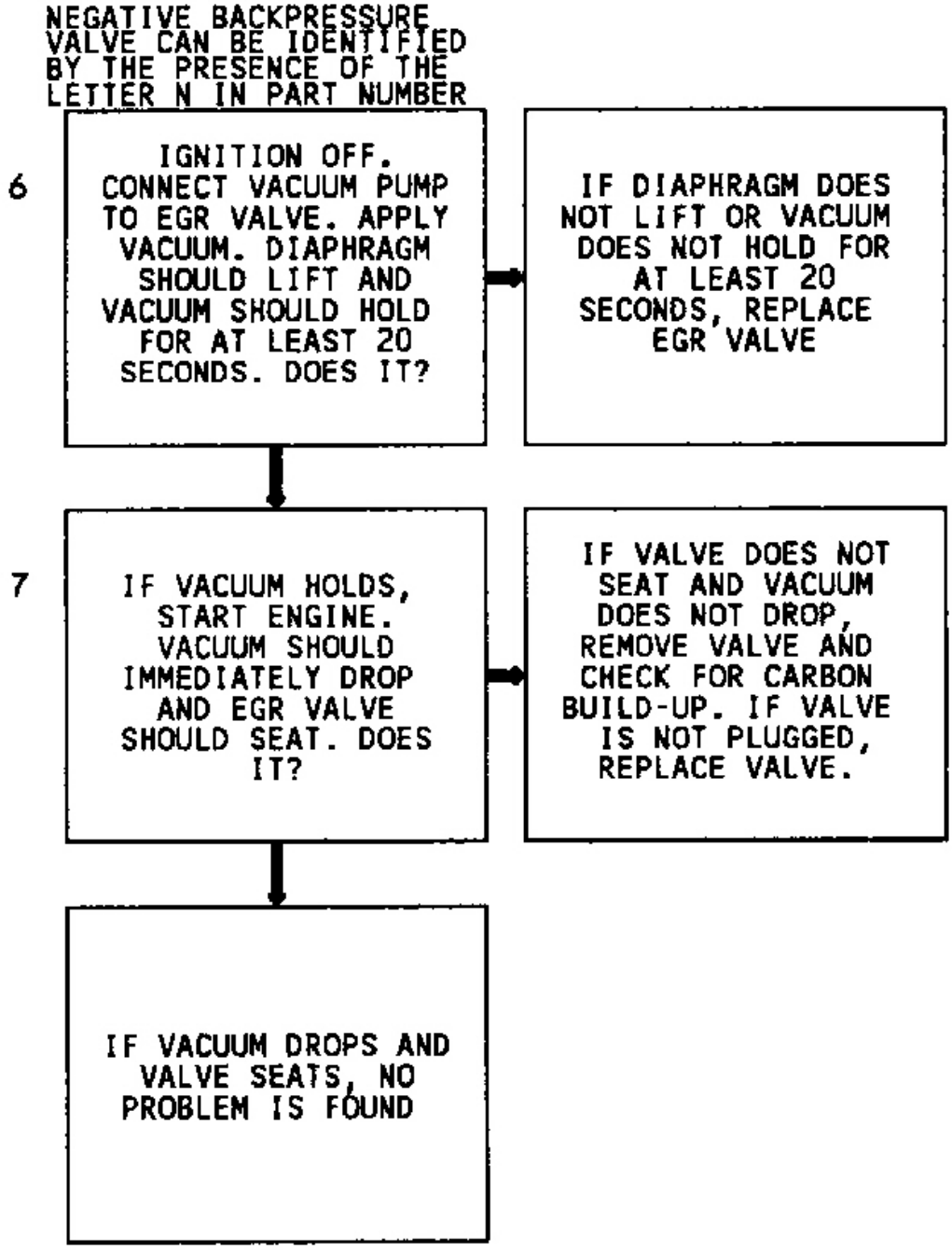


Fig. 33: Code 32 Diagnostic Flow Chart - 2 Of 2 (Caprice) EGR System Error

CODE 33, MAP SENSOR SIGNAL VOLTAGE HIGH

Code 33 will set when MAP signal voltage reading is high for greater than a precalibrated period of time, TPS voltage indicates throttle is closed and neither Code 21 nor 22 is present. Most likely causes for code are: open sensor ground circuit, sensor signal circuit shorted to voltage, faulty MAP sensor, MAP sensor vacuum leak or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test confirms Code 33 and determines if it is result of a hard failure or an intermittent condition.
2. This step simulates conditions for a Code 34. If control module recognizes and sets Code 34, low MAP signal, control module and 5-volt reference and MAP signal circuits are not at fault. If ground circuit is shared with other sensors and ground circuit becomes open, additional codes related to these sensors may be set.

Diagnostic Aids

With ignition switch in ON position and engine stopped, manifold pressure is equal to atmospheric pressure and signal voltage will be high. Comparison of BARO readings from a known good vehicle using same sensor is a good way to check accuracy of suspect sensor. Readings should be same within .4 volt. Code 33 will result if ground circuit is open, MAP signal circuit is shorted to voltage or to 5-volt reference circuit.

CODE 33 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
MAP Signal	C23	Light Green
MAP Ground	B16	Purple
MAP Reference	B29	Gray

- For shared sensor reference and shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

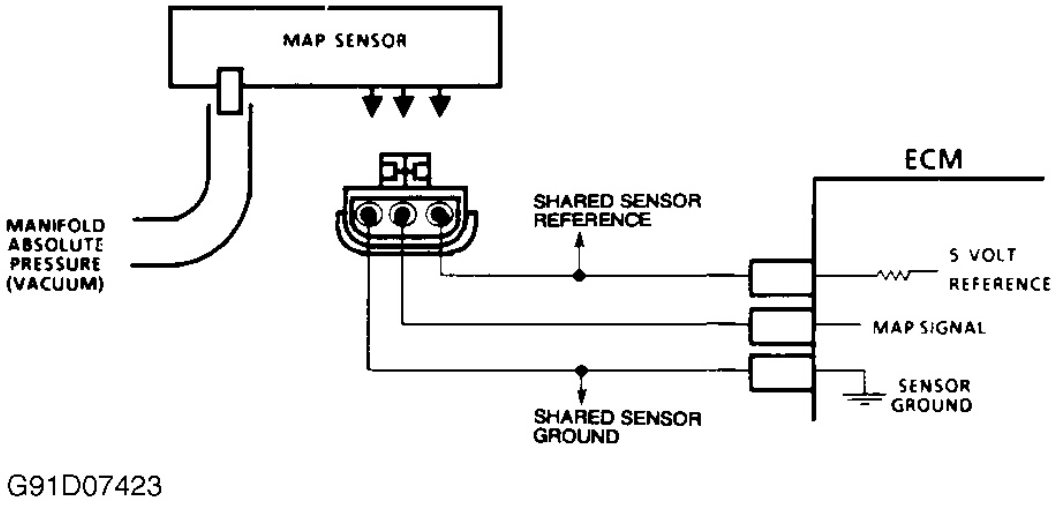


Fig. 34: Code 33 Schematic (Caprice) MAP Sensor Signal Voltage High

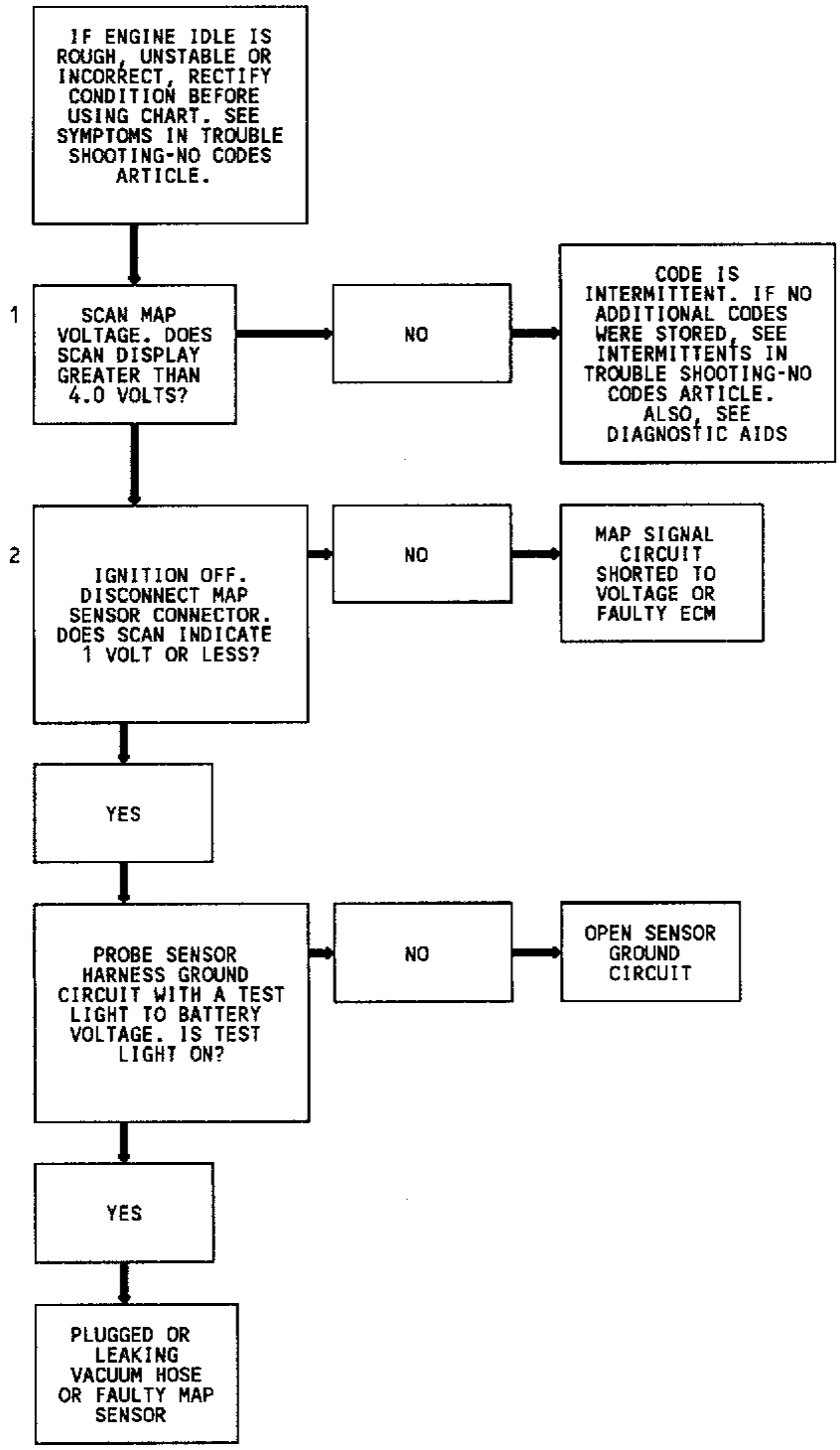


Fig. 35: Code 33 Diagnostic Flow Chart (Caprice) MAP Sensor Signal Voltage High

CODE 34, MAP SENSOR SIGNAL VOLTAGE LOW

Code 34 will set when ignition is on, throttle is off idle, no TP sensor code exists and MAP signal voltage is lower than expected for off idle engine operation. Most likely causes for code are: MAP sensor signal circuit open or shorted to ground, 5-volt reference circuit open or shorted to ground, faulty sensor connection, faulty sensor or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This confirms conditions for Code 34 and determines if code was caused by a hard failure or an intermittent fault.
2. Jumpering MAP signal to 5-volt reference at MAP harness connector will determine if sensor is at fault or if a problem exists with control module or wiring.
3. Scan tester may not display 12 volts. Control module recognizes voltage as greater than 4 volts (high MAP voltage signal), indicating control module and MAP signal circuit are not at fault.

Diagnostic Aids

With ignition switch in ON position and engine stopped, manifold pressure is equal to atmospheric pressure and signal voltage will be high. Comparing BARO readings with a known good vehicle using same sensor is a good way to check accuracy of suspect sensor.

Readings should be same within .4 volt. A Code 34 will also result if 5-volt reference and MAP signal circuits are open or shorted to ground.

CODE 34 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
MAP Signal	C23	Light Green
MAP Ground	B16	Purple
MAP Reference	B29	Gray

- For shared sensor reference and shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

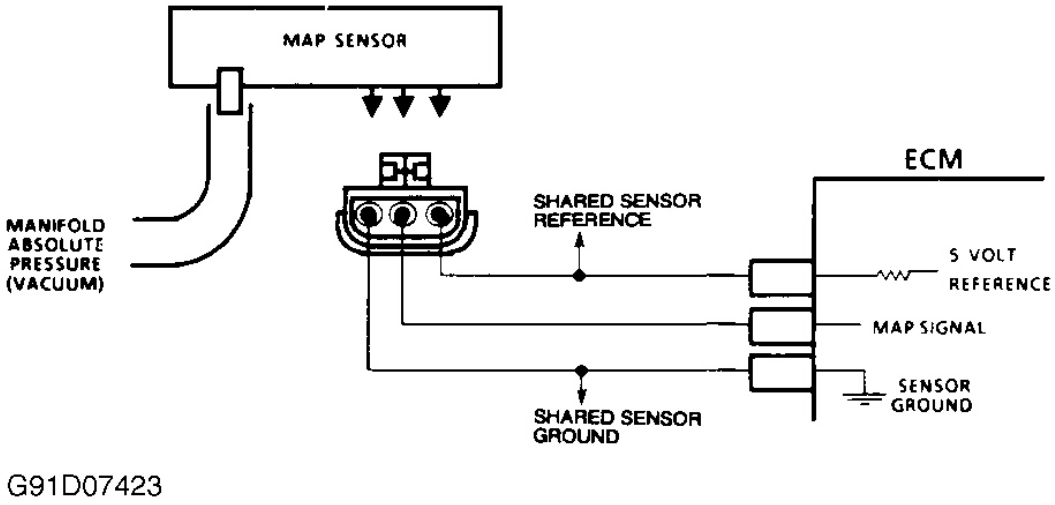


Fig. 36: Code 34 Schematic (Caprice) MAP Sensor Signal Voltage Low

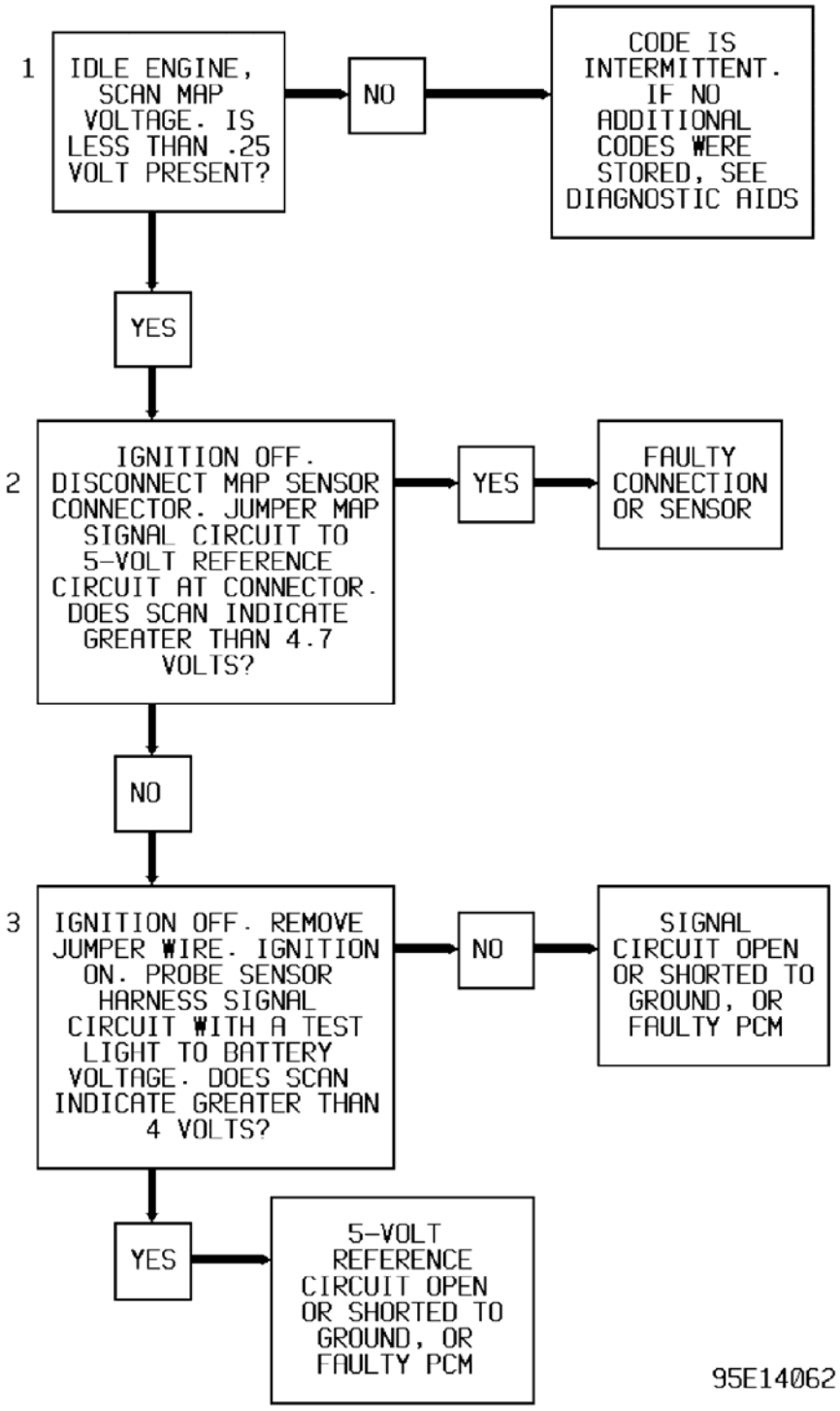


Fig. 37: Code 34 Diagnostic Flow Chart (Caprice) MAP Sensor Signal Voltage Low

CODE 36, OPTI-SPARK HIGH RESOLUTION PULSE

Ignition system supplies 2 timing inputs to PCM, a high resolution signal (360 pulses per camshaft revolution)

and a low resolution signal (8 pulses per camshaft revolution). PCM can determine if either timing input is not being received by comparing inputs. If PCM detects 40 low resolution pulse without detecting high pulse, Code 36 will set. Reference signal on resolution line toggles between zero and 5 volts as camshaft turns.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Determines if code is intermittent.
2. This step determines if PCM is sending out a signal to distributor for processing. If this signal is not available or is shorted to ground or voltage, distributor cannot ground it to produce reference pulses.
3. If Code 41 and/or 42 is set with Code 36 and no external fault can be found, replace PCM. If Code 36 is set alone and distributor connections are okay, replace distributor.

Diagnostic Aids

An open, a short to voltage, a short to ground or a defective sensor inside distributor can prevent reference voltage from pulsing at PCM resolution terminal. If Code 36 is present and vehicle still does not start, check for Code 16 and use that chart first. If vehicle still will not start, go to NO START - ENGINE CRANKS OKAY in **BASIC TESTING** article in this section.

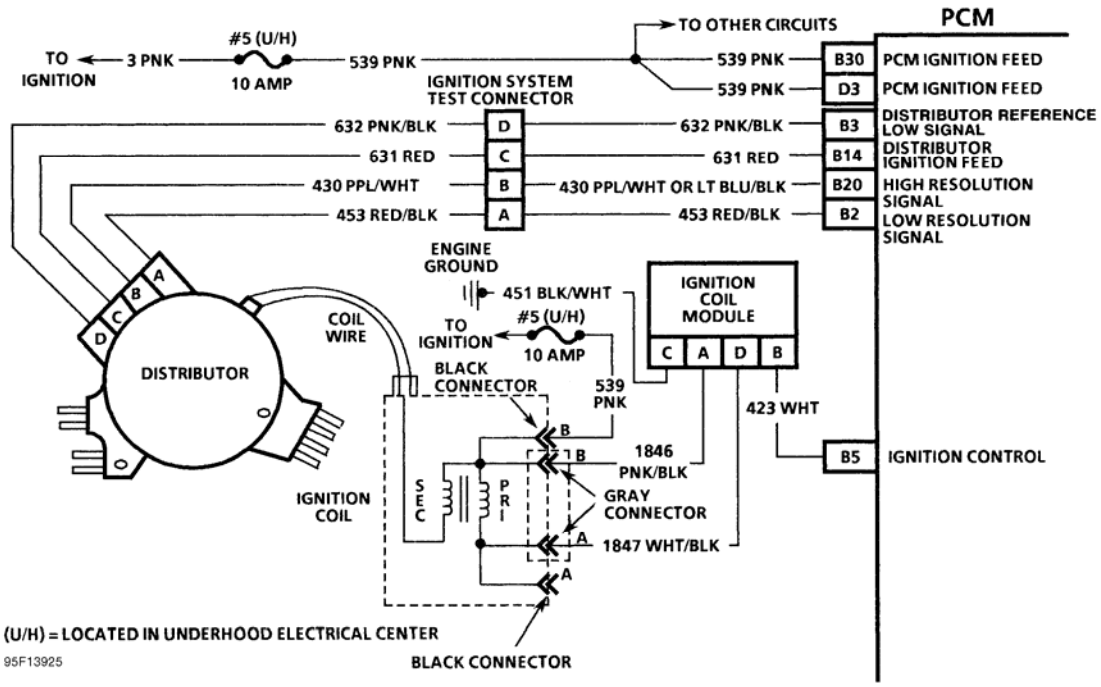


Fig. 38: Code 36 Schematic (Caprice) Opti-Spark High Resolution Pulse

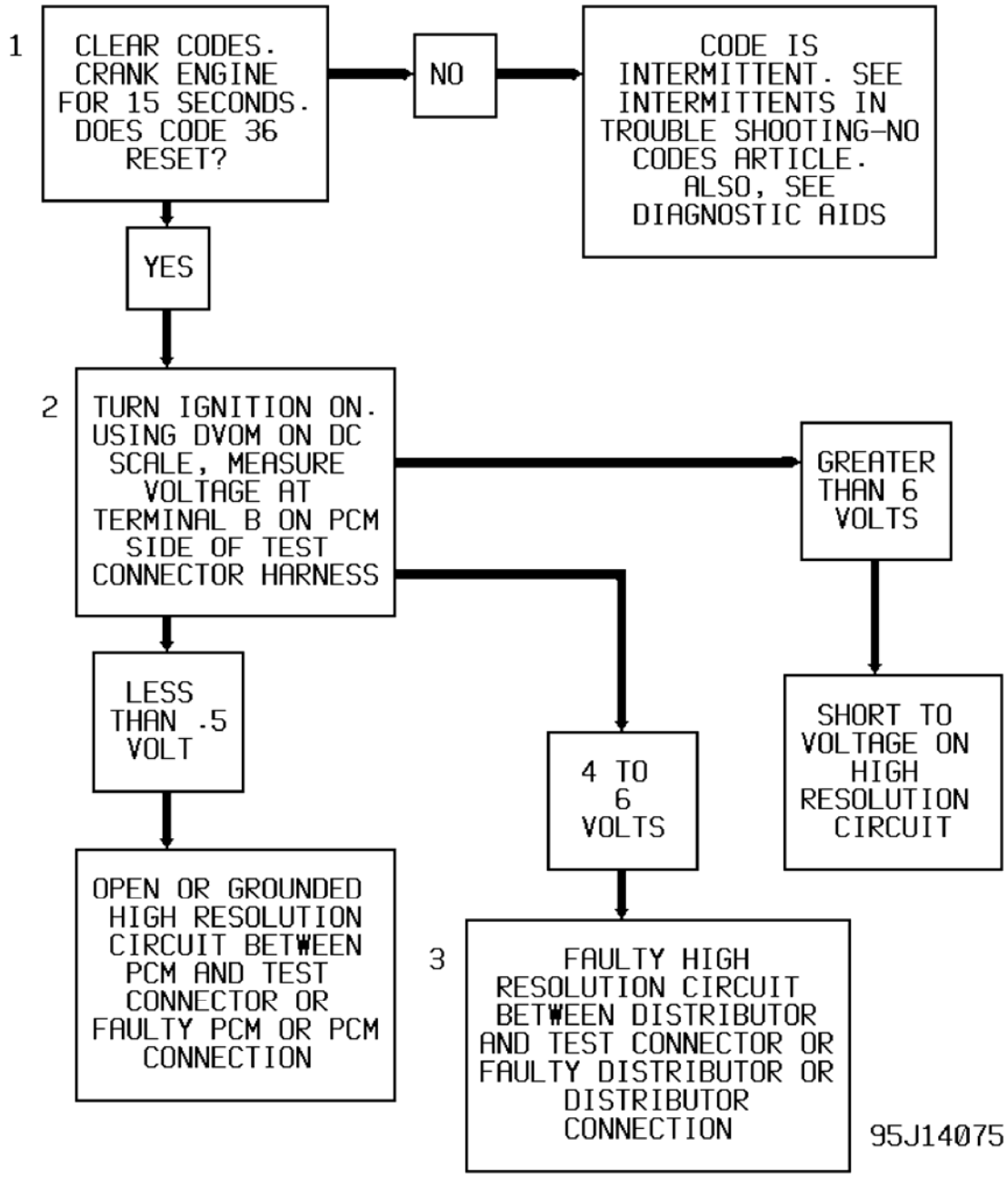


Fig. 39: Code 36 Diagnostic Flow Chart (Caprice) Opti-Spark High Resolution Pulse

CODE 37, TCC BRAKE SWITCH ERROR

PCM monitors activity of the normally-closed brake switch. Switch opens when brake pedal is applied.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for voltage at brake switch.

2. Simulates brake switch closed or brakes off.
3. Checks TCC brake switch circuit between PCM and switch.

Diagnostic Aids

Code 37 can be caused by a misadjusted brake switch or a poor connection. Code may also be set by unusual driving habits (i.e. stop-and-go expressway driving).

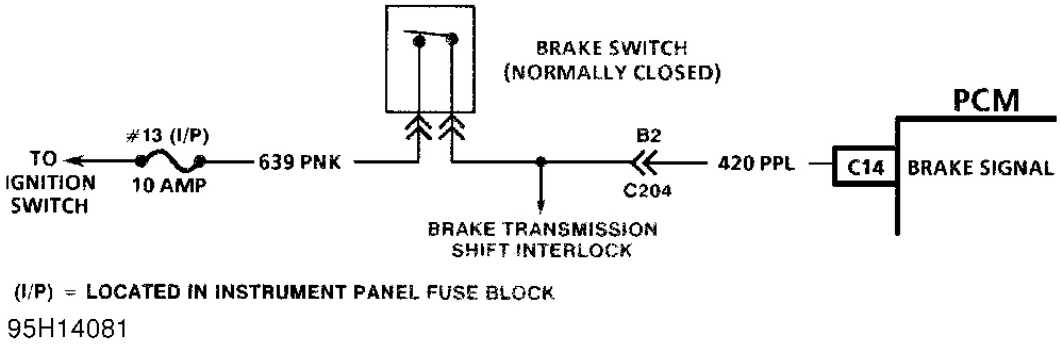


Fig. 40: Code 37 Schematic (Caprice) TCC Brake Switch Error

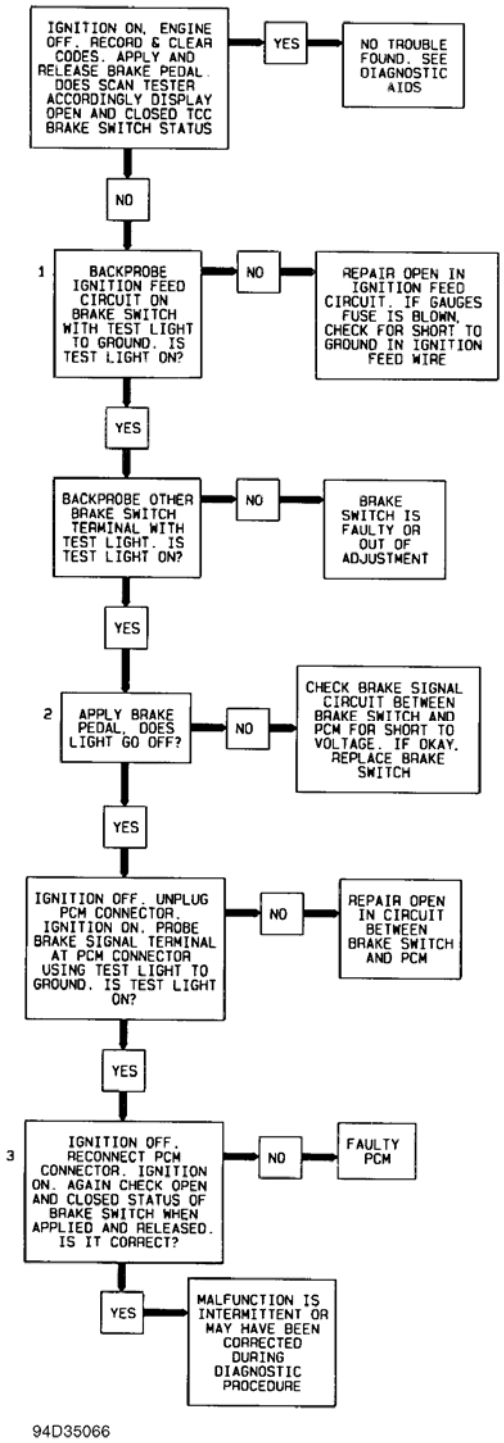


Fig. 41: Code 37 Diagnostic Flow Chart (Caprice) TCC Brake Switch Error

CODE 38, BRAKE SWITCH ERROR

PCM monitors activity of the normally-closed brake switch. Switch opens when brake pedal is applied. Code

will set if PCM has seen conditions which would have required brake applications at least 7 times and no transition in brake switch has been detected.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for voltage at brake switch.
2. Simulates brake switch closed or brakes off. Checks brake switch circuit between PCM and switch.
3. Checks circuit between brake switch and PCM.

Diagnostic Aids

Code may also be set by unusual driving habits (i.e. stop-and-go expressway driving).

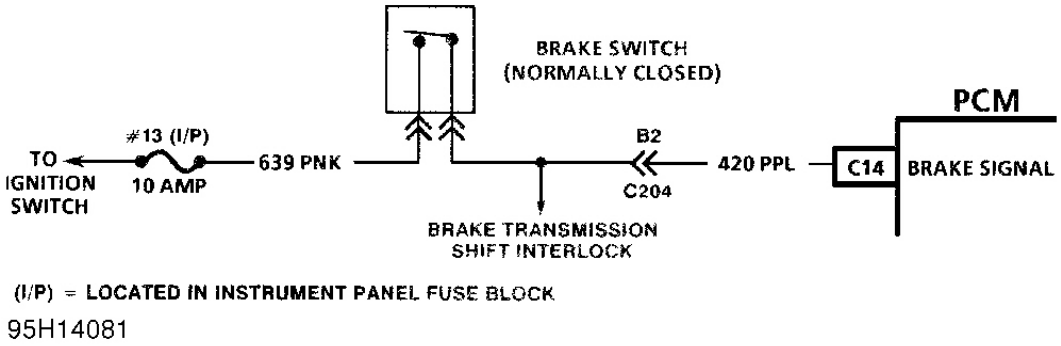


Fig. 42: Code 38 Schematic (Caprice) Brake Switch Error

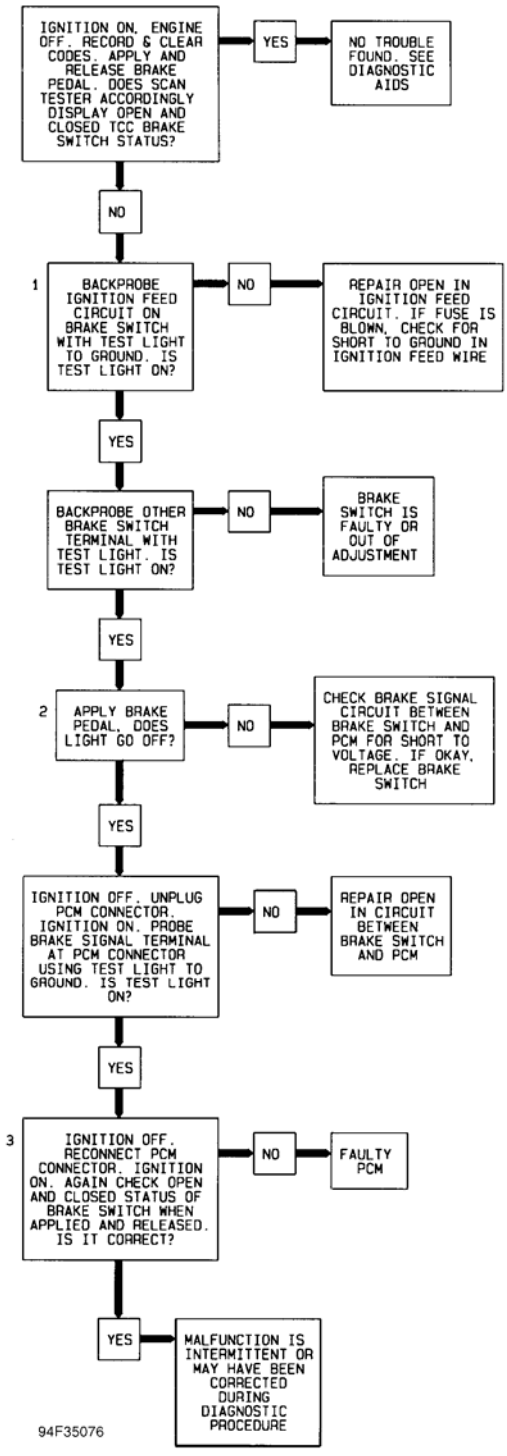


Fig. 43: Code 38 Diagnostic Flow Chart (Caprice) Brake Switch Error

CODE 41, OPTI-SPARK IGNITION SYSTEM OPEN OR SHORTED EST CKT

Ignition system provides 2 timing inputs to PCM, high resolution (360 pulses per camshaft revolution) and low

resolution (4 pulses per crankshaft revolution). PCM uses these 2 inputs to determine individual spark timing for each cylinder. Once PCM calculates ignition timing, timing signal will be sent to ignition coil driver on IC circuit. Each timing pulse received by ignition coil driver will trigger coil driver to operate ignition coil. IC signal voltage ranges from about .5 volt to 4.5 volts. If a Code 41 is set, PCM will disable fuel injectors to prevent flooding of engine.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Determines if code is intermittent.
2. This step determines if IC signal from PCM is available at ignition coil driver. IC circuit voltage should be between about .5 volt and 4.5 volts.
3. Remaining steps ensure coil driver circuitry is okay. If all wiring and connections are okay, check ignition coil and ignition coil voltage supply.

Diagnostic Aids

Because coil driver gets its power from coil, check ignition feed circuit to ignition coil for opens, including coil fuse.

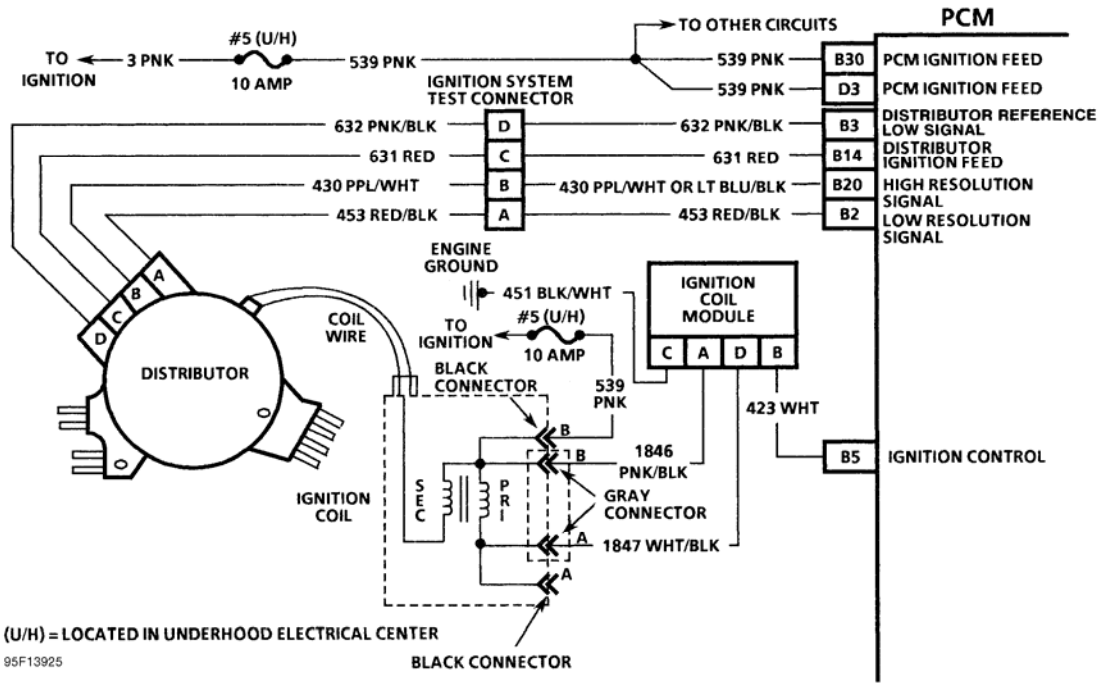


Fig. 44: Code 41 Schematic (Caprice) Opti-Spark Ignition System Open Or Shorted EST Circuit

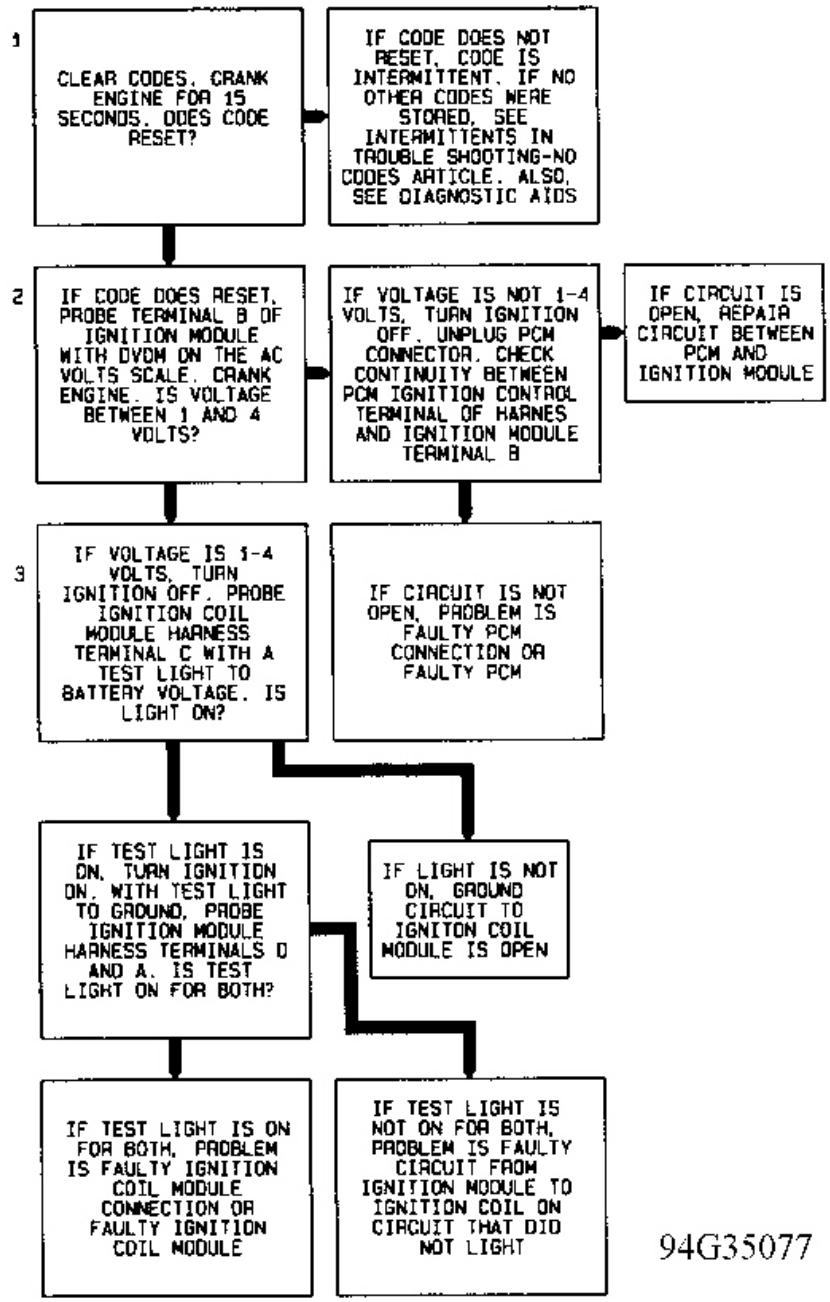


Fig. 45: Code 41 Diagnostic Flow Chart (Caprice) Opti-Spark Ignition System Open Or Shorted EST Circuit

CODE 42, IC CIRCUIT GROUNDED

Ignition system provides 2 timing inputs to PCM, high resolution (360 pulses per camshaft revolution) and low resolution (4 pulses per crankshaft revolution). PCM uses these 2 inputs to determine individual spark timing for each cylinder. Once PCM calculates ignition timing, timing signal will be sent to ignition coil driver on IC circuit. Each timing pulse received by ignition coil driver will trigger coil driver to operate ignition coil. IC signal voltage ranges from about .5 volt to 4.5 volts.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If engine starts, code is intermittent.
2. This test checks for an IC signal from PCM to ignition coil driver.
3. Remaining tests check driver circuitry. Because coil driver gets its power from coil, check ignition coil feed circuit to ignition coil for opens.

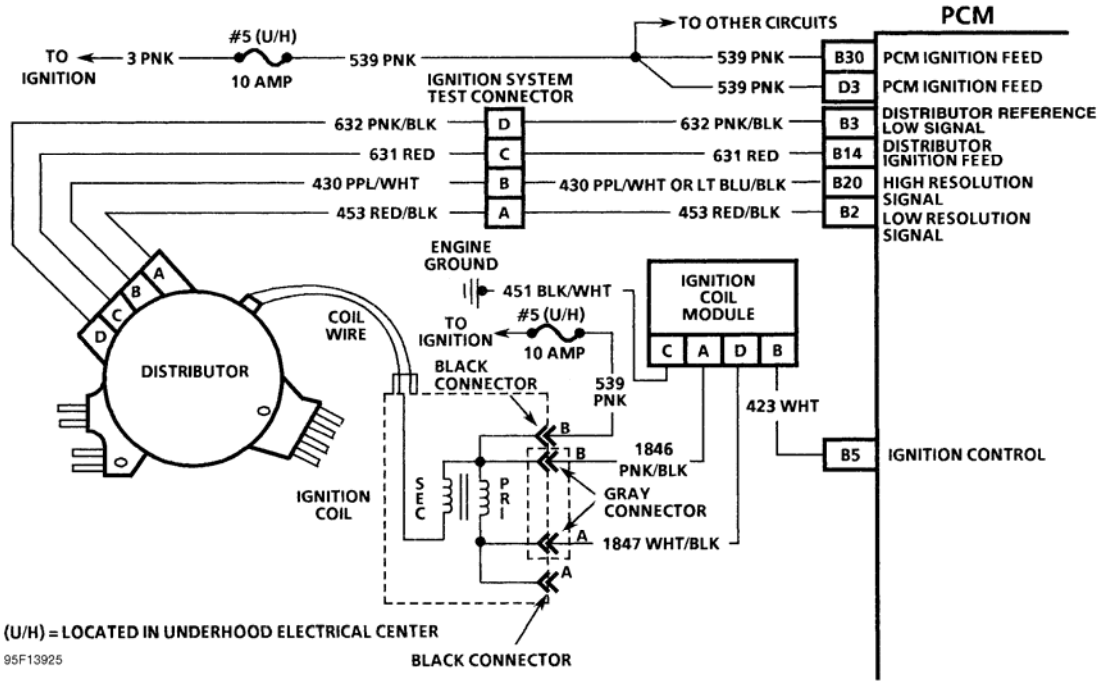


Fig. 46: Code 42 Schematic (Caprice) IC Circuit Grounded

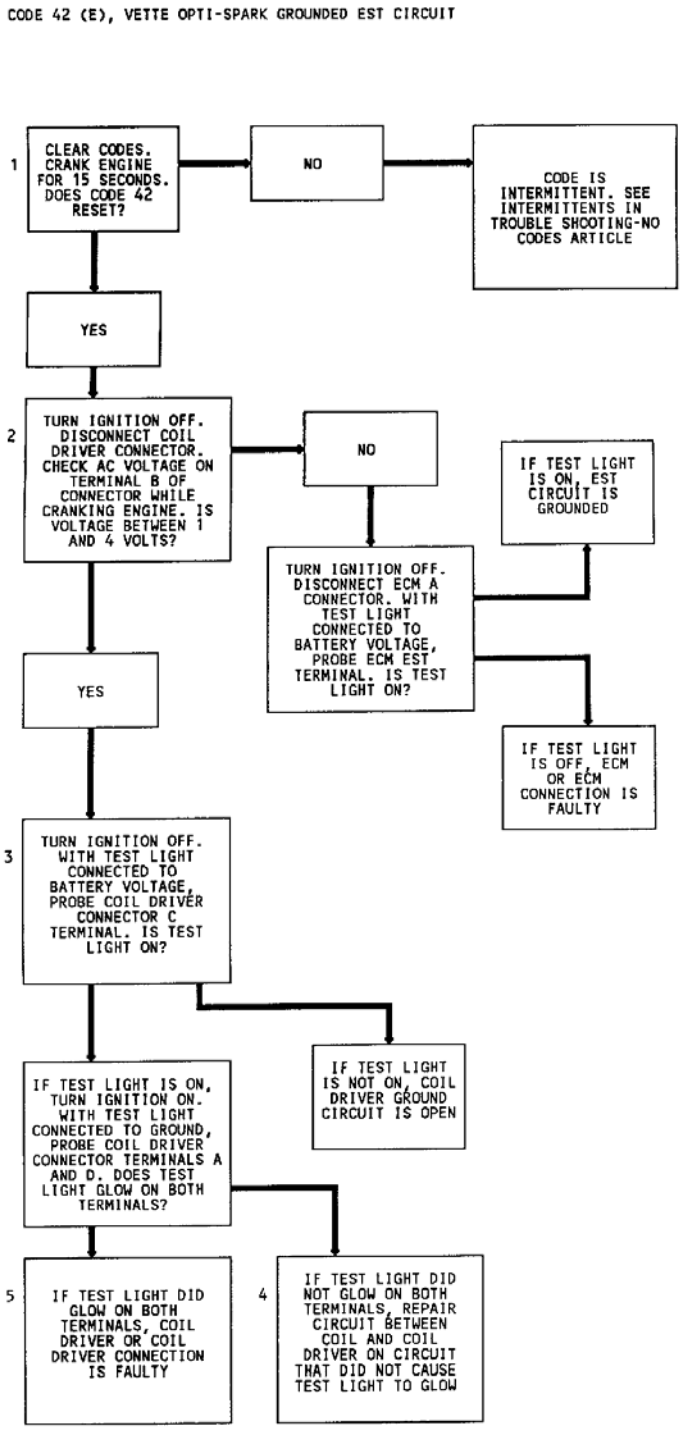


Fig. 47: Code 42 Diagnostic Flow Chart (Caprice) IC Circuit Grounded

CODE 43, KNOCK SENSOR CIRCUIT (DUAL SENSORS)

Knock sensor informs PCM of engine detonation. PCM will retard ignition timing based on signals from knock

sensors. Knock sensors produce an AC voltage signal which is proportional to amount of engine detonation (knock). Internal sensor circuitry causes 5-volt DC reference signal sent by PCM to be pulled low to about 1.5 volts. Any AC voltage produced by sensors will travel to PCM on this same reference line. Code 43 will set if: one sensor circuit becomes open, resulting in a 2.2 to 4.1-volt reference being monitored by PCM, both sensor circuits become open, resulting in a reference voltage greater than 4.1 volts being seen by PCM, or one or both circuits become grounded, resulting in a low (less than .78 volt) reference voltage being seen by PCM.

If an audible knock is heard from engine, repair internal engine problem, as normally no knock should be detected at idle. PCM supplies 5 volts on knock sensor circuit which should be present at knock sensor terminals when sensors are disconnected. If knock sensor circuit is shorted to voltage, Code 43 will set. With both sensors and PCM disconnected, no voltage should be present. An improperly installed sensor can prevent knock sensor from grounding to block.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If an audible knock is heard from engine, repair internal engine problem, as normally no knock should be detected at idle.
2. Determines if knock sensor is faulty or if module is faulty.
3. Sensor signal circuit shorted to voltage will set code. With sensor and PCM unplugged, no voltage should be present.
4. An improperly installed sensor can cause code to set.
5. If short to battery voltage is found, additional component damage may have occurred. If code resets after repairs, rerun chart to detect additional faults.

Diagnostic Aids

PCM has the ability to diagnose opens and shorts on knock sensor circuit. Scan tester will display if one or both sensors are open, or if both are grounded. Also, ensure knock sensor module is properly installed.

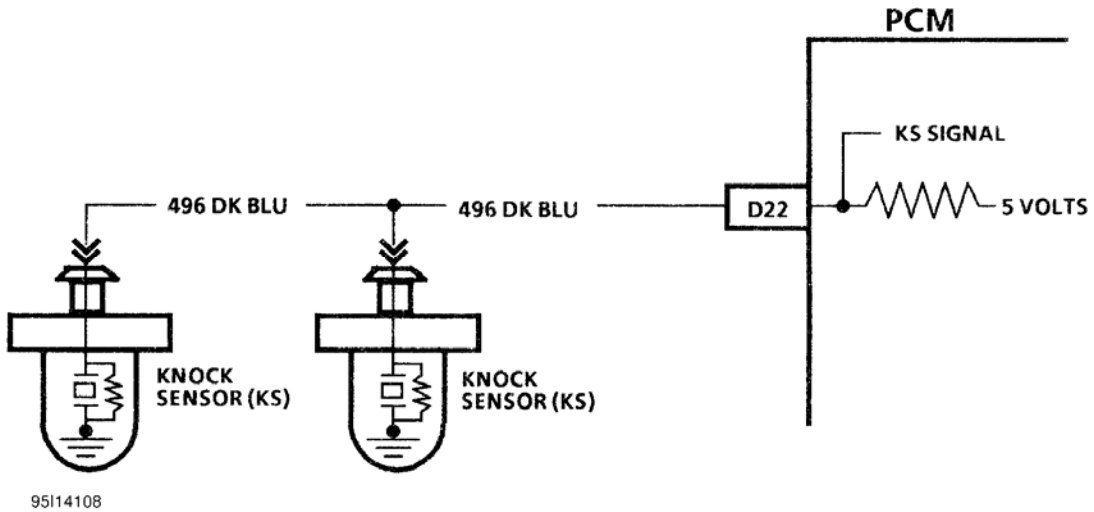


Fig. 48: Code 43 Schematic (Caprice) Knock Sensor Circuit (Dual Sensors)

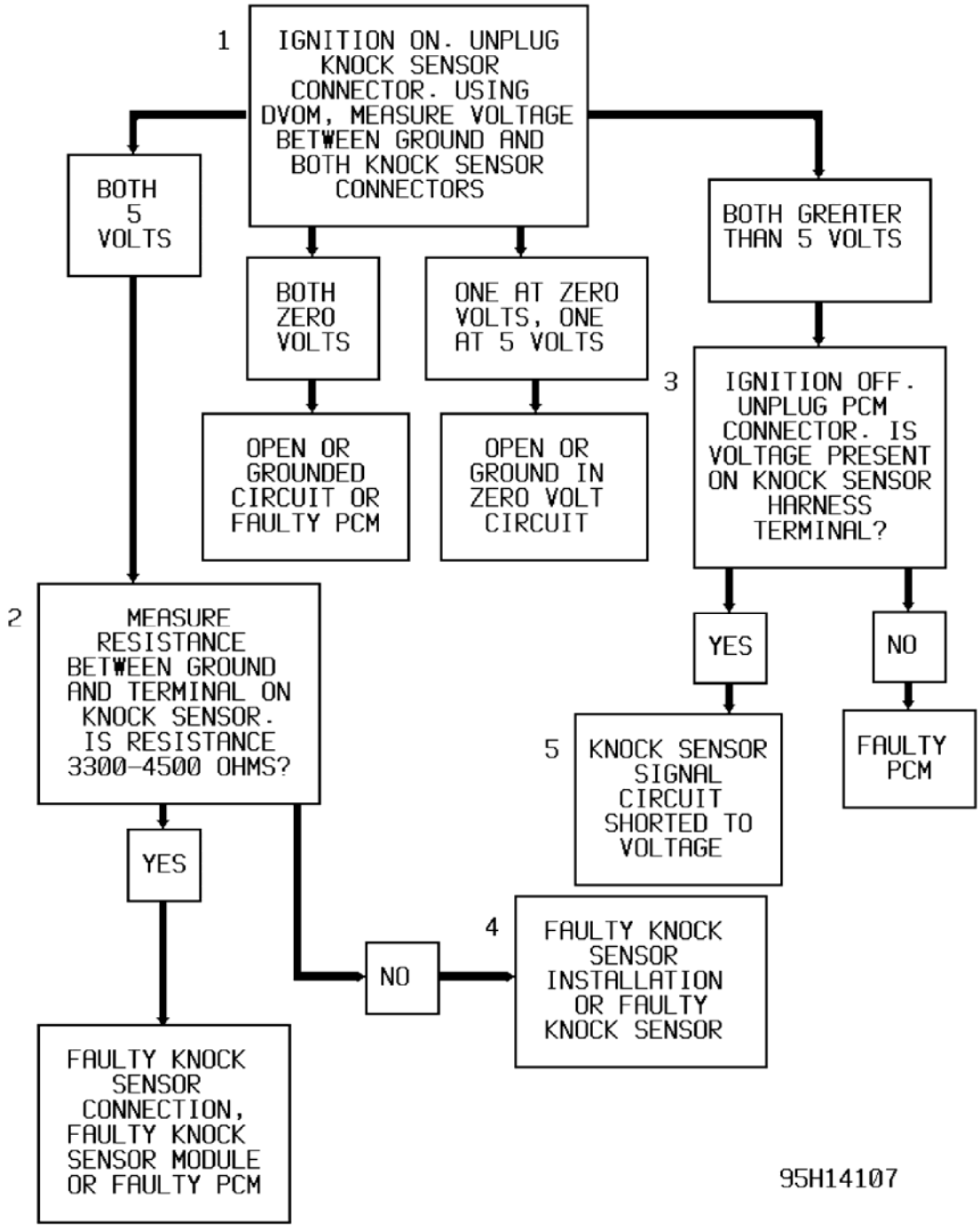


Fig. 49: Code 43 Diagnostic Flow Chart (Caprice) Knock Sensor Circuit (Dual Sensors)

CODE 44, LEFT HEATED OXYGEN SENSOR LEAN EXHAUST INDICATION

NOTE: Models are equipped with 2 oxygen sensors. On these models, Code 44 will set

if the left sensor circuit is lean. Code 64 will set if the right sensor circuit is lean.

O2 sensor acts like an open sensor circuit and produces no voltage when exhaust temperature is less than 600°F (316°C). An open sensor circuit or cold sensor causes "open loop" operation. Code 44 will reflect a lean left O2 sensor; Code 64 will indicate a lean right O2 sensor. Perform test procedures for right or left sensor as necessary.

Code is set when O2 sensor voltage signal at control module is low (less than 0.3 volt) for a precalibrated period and fuel system is operating in "closed loop" and attempting to richen mixture. Most likely causes for setting of code are: an actual lean condition, a short to ground on sensor signal circuit or a faulty PCM.

NOTE: Test number refers to number on diagnostic chart.

1. Checks to see if O2 sensor is registering a lean condition.

Diagnostic Aids

Using scan tester, observe Block Learn Memory (BLM) value at different RPMs. If conditions for a lean exhaust code exist, block learn value will be about 150.

O2 Sensor Wire

O2 sensor wire may be mispositioned and laying against exhaust manifold. Check for ground between sensor and wire connector.

Fuel Contamination

Water, even small amounts, near in-tank fuel pump inlet can be delivered to injector. Water may cause a lean exhaust, setting code.

Fuel Pressure

System will be lean if fuel pressure is low. If necessary, monitor fuel pressure while driving vehicle. For fuel pressure checking procedure, see **BASIC TESTING** article in this section.

Exhaust Leaks

If exhaust system has large leaks, exhaust system negative pressure pulses can cause outside air to be drawn into system and past O2 sensor. Vacuum or crankcase leaks can also cause a lean condition.

Misfire Or Stall

If engine misfires or stalls (including running out of fuel) while vehicle is moving, code may set. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 44 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color

Left O2 Signal	C20	Purple/White
Left O2 Ground	C19	Tan/White

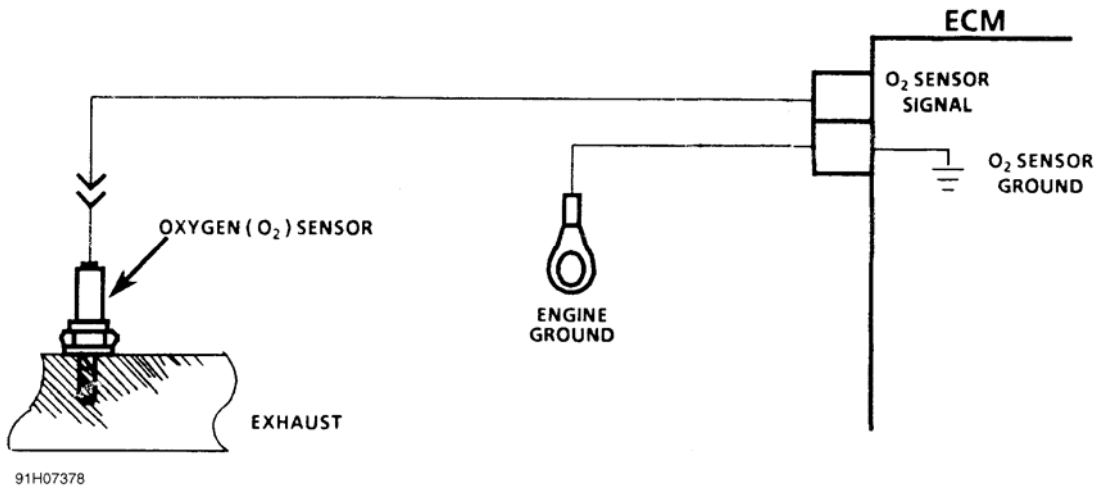


Fig. 50: Code 44 Schematic (Caprice) Lean Exhaust Indication

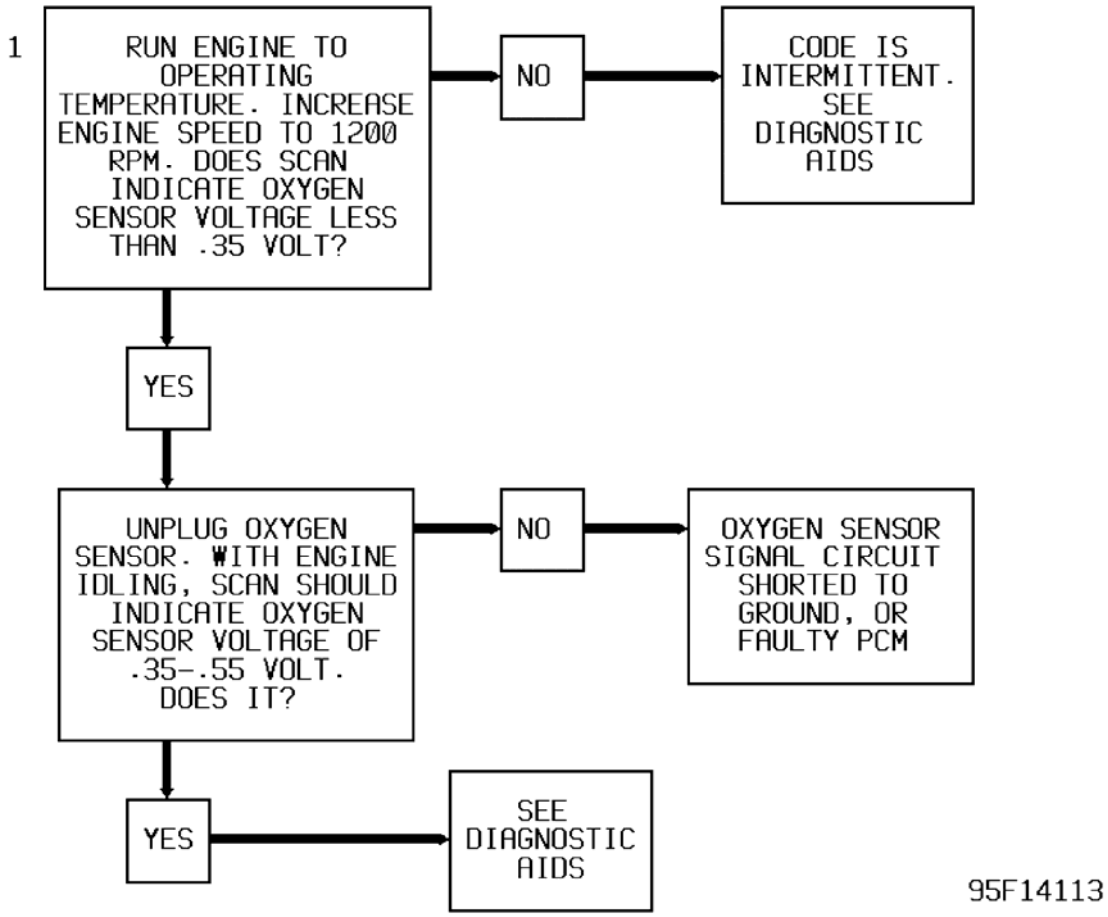


Fig. 51: Code 44 Diagnostic Flow Chart (Caprice) Lean Exhaust Indication

CODE 45, LEFT HEATED OXYGEN SENSOR RICH EXHAUST INDICATION

NOTE: Models are equipped with 2 oxygen sensors. On these models, Code 45 will set if the left sensor circuit is rich. Code 65 will set if the right sensor circuit is lean.

O2 sensor acts like an open sensor circuit and produces no voltage when exhaust temperature is less than 600°F (316°C). An open sensor circuit or cold sensor causes "open loop" operation. Code 45 indicates a rich exhaust. Diagnosis should begin with fuel pressure, leaking injector, ignition shielding (ground), vapor canister fuel saturation, coolant sensor, MAP sensor, O2 sensor contamination and TPS intermittent output.

Code is set when fuel system is operating in "closed loop", throttle angle is greater than idle, O2 sensor signal at control module is greater than .7 volt for a precalibrated period, fuel system is attempting to lean mixture and time since engine start is one minute or more. Most likely causes of code are: an actual rich condition, a short to voltage on sensor signal circuit or a faulty PCM.

NOTE: Test number refers to number on diagnostic chart.

1. Test checks to see if O2 sensor is registering a rich condition.

Diagnostic Aids

If other codes of lower number are set with code, use those charts first. Malfunction in MAP or TPS sensor circuits can cause a rich exhaust code to set. If other codes are not set, rich exhaust is most likely caused by:

Fuel Pressure High

If fuel pressure is too high, air/fuel ratio will be rich. For fuel pressure checking procedure, see **BASIC TESTING** article in this section. Control module can compensate for slight increases, but a code will be set if air/fuel ratio becomes too rich.

Ignition Ground

If an open occurs on HEI ground circuit, HEI induced electrical "noise" may result, causing simulated reference pulses to be picked up by control module on reference line of EST harness. Additional pulses result in a higher than actual engine speed signal. Control module will increase injector pulse width ("on" time) to match increased RPM signal. Scan tester will show higher than actual RPM, which can help in diagnosing this problem.

Evaporative Fuel Canister

Fuel saturation of charcoal canister will cause a rich air/fuel ratio. If canister is full of fuel, check canister control valves and hoses.

MAP Sensor

An output causing control module to sense a higher than normal manifold pressure (low vacuum) can cause system to go rich. Disconnecting MAP sensor will allow control module to substitute a fixed value for MAP sensor. If condition disappears, substitute a different MAP sensor, and continue testing.

TPS

An intermittent TPS output will cause system to operate rich due to a false indication of engine acceleration.

O2 Sensor Contamination

O2 sensor contamination, caused by silicone in certain fuels or use of improper RTV sealant, may cause a White powdery coating to cover exterior of O2 sensor. False high signal voltage (low oxygen content sensed) produced is interpreted by control module as a rich mixture, causing control module to set code.

EGR Problem

EGR valve sticking open at idle is usually accompanied by a rough idle and/or stalling. Also check for shorted/leaking injector and fuel-contaminated oil. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 45 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
Right O2 Signal	C8	Purple
Right O2 Ground	C7	Tan

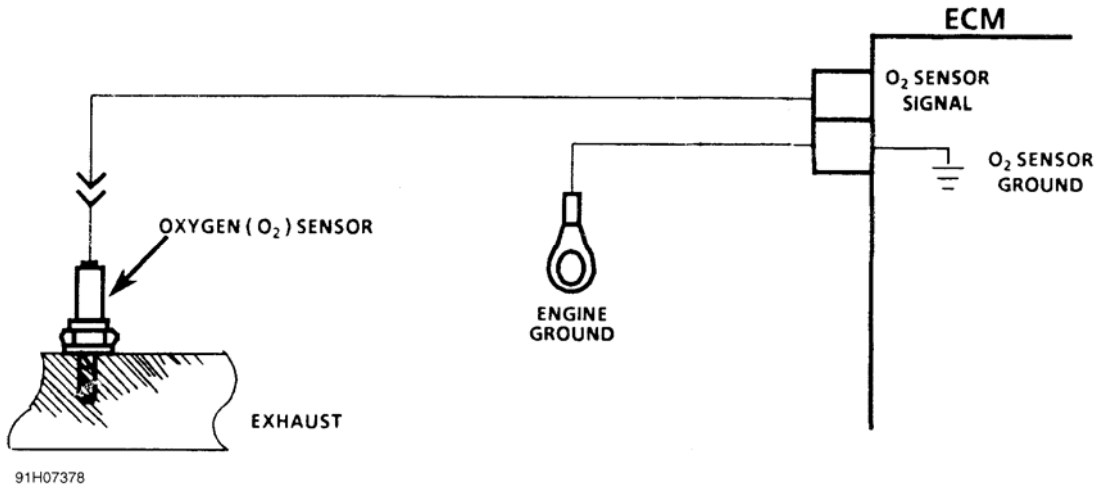


Fig. 52: Code 45 Schematic (Caprice) Rich Exhaust Indication

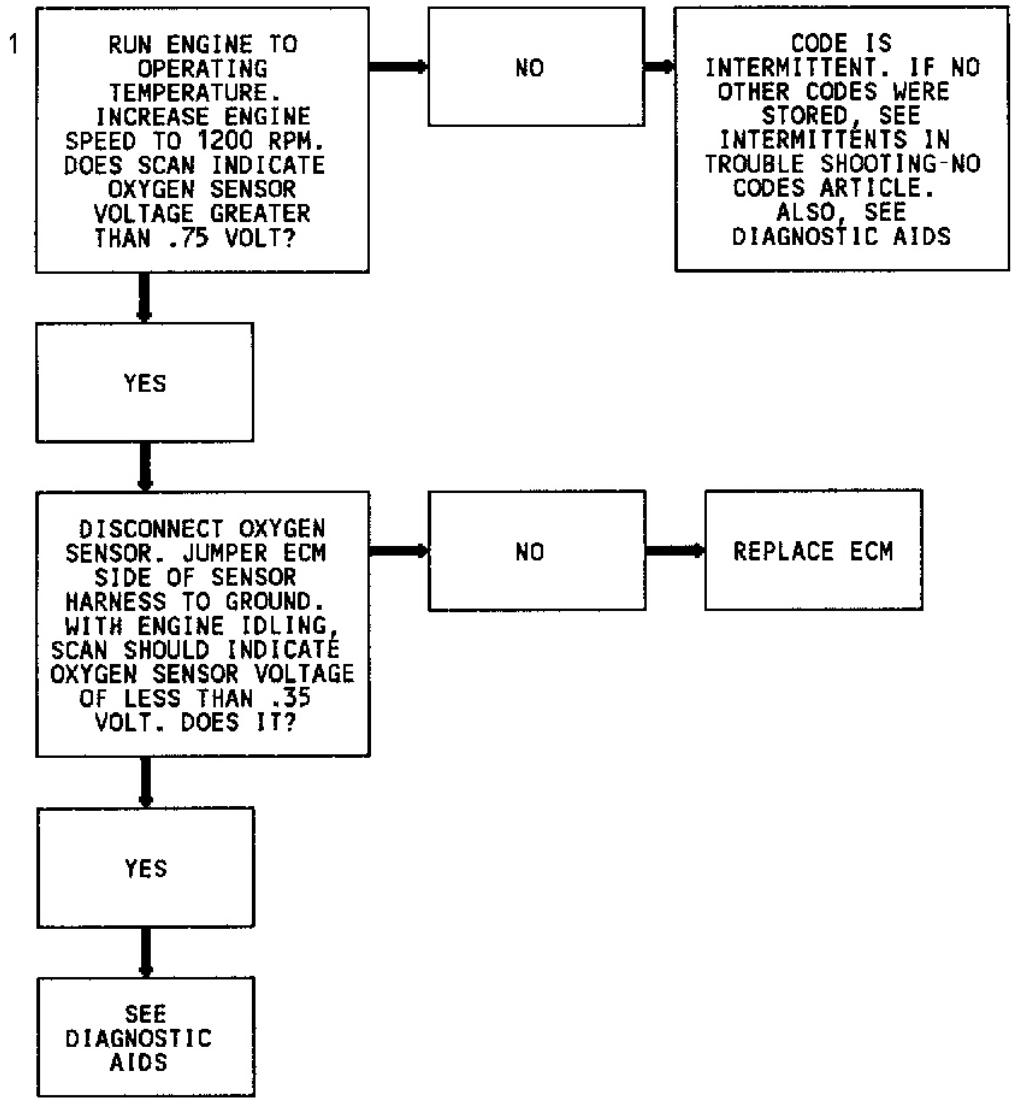


Fig. 53: Code 45 Diagnostic Flow Chart (Caprice) Rich Exhaust Indication

CODE 46, PASS-KEY CIRCUIT

The PASS-Key system is designated to disable vehicle operation if the incorrect key or starting procedure is used. PASS-Key decoder module sends a signal to the PCM if the correct key is being used. If the proper signal does not reach the PCM, the PCM will not pulse the injectors, thus not allowing the vehicle to start. Code 46 will set if proper signal is not being received on fuel enable signal circuit to PCM when ignition is turned on.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If engine cranks but does not start, it indicates the portion of the module which generates the signal to the PCM is not operating or fuel enable signal circuit is open, shorted to ground or possibly shorted to voltage. If decoder module is found to be okay, PCM may be at faulty, but this not a likely condition.
2. If Code 46 is stored and engine will not crank, it indicates that there is a Pass-Key problem or incorrect key or starting procedure is being used.

Pass-Key Diagnosis

NOTE: For complete system diagnosis, see ANTI-THEFT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

PASS-Key is a sophisticated system that interfaces PCM and starter with a power source, decoder module, starter enable relay, ignition switch and instrument cluster. Check system for following common problems:

- Ensure ignition key resistor pellet is not cracked, dirty or coated. Ensure excess plastic does not exist around pellet contacts.
- Check ignition key pellet sensing contacts in ignition lock cylinder. Look into cylinder lock. If contacts are damaged or are not Silver in color, replace cylinder lock.
- Check related fuses.
- Check security indicator bulb in the instrument panel.

A defective resistor pellet within ignition key or incorrect resistance value of key (15 different assigned values) will prevent vehicle from starting. Key must be correct electrically and mechanically. If incorrect key is used to try to start vehicle, decoder will not allow vehicle to start for 2-4 minutes, even after correct key is inserted.

If starter enable relay must be replaced, check circuit to starter solenoid for possible short. A short may have caused relay to fail.

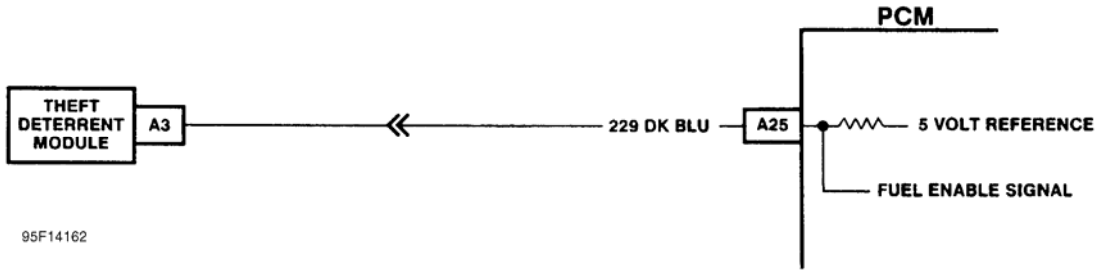


Fig. 54: Code 46 Schematic (Caprice) Pass-Key Circuit

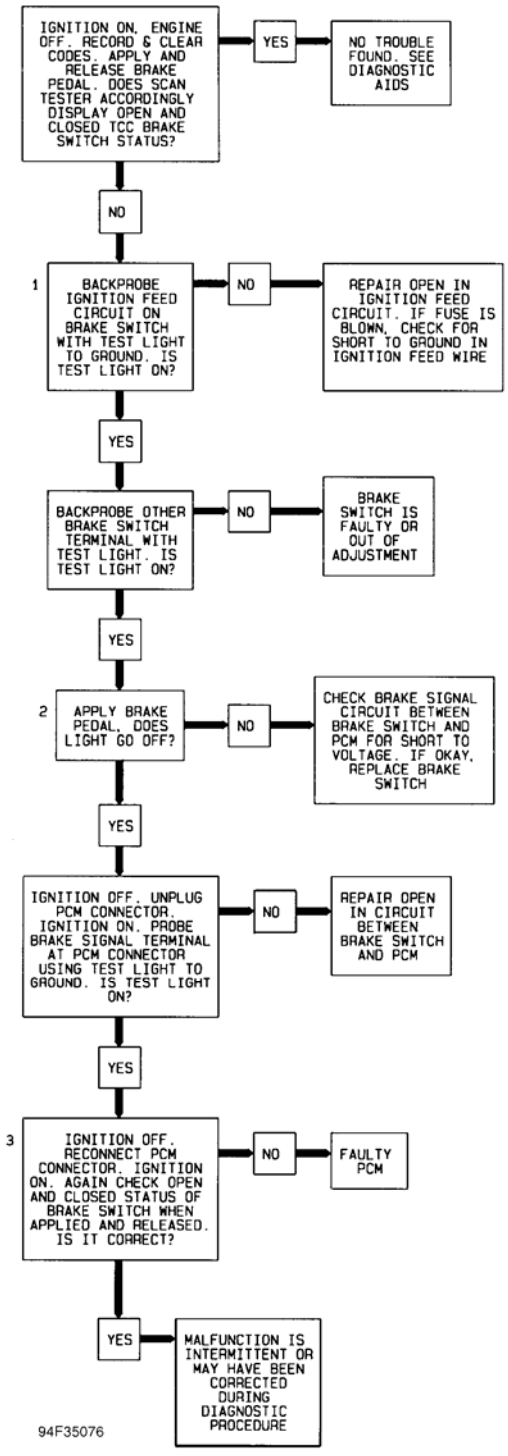


Fig. 55: Code 46 Schematic (Caprice) Pass-Key Circuit

CODE 47, KNOCK SENSOR MODULE

Knock sensor module is located inside PCM.

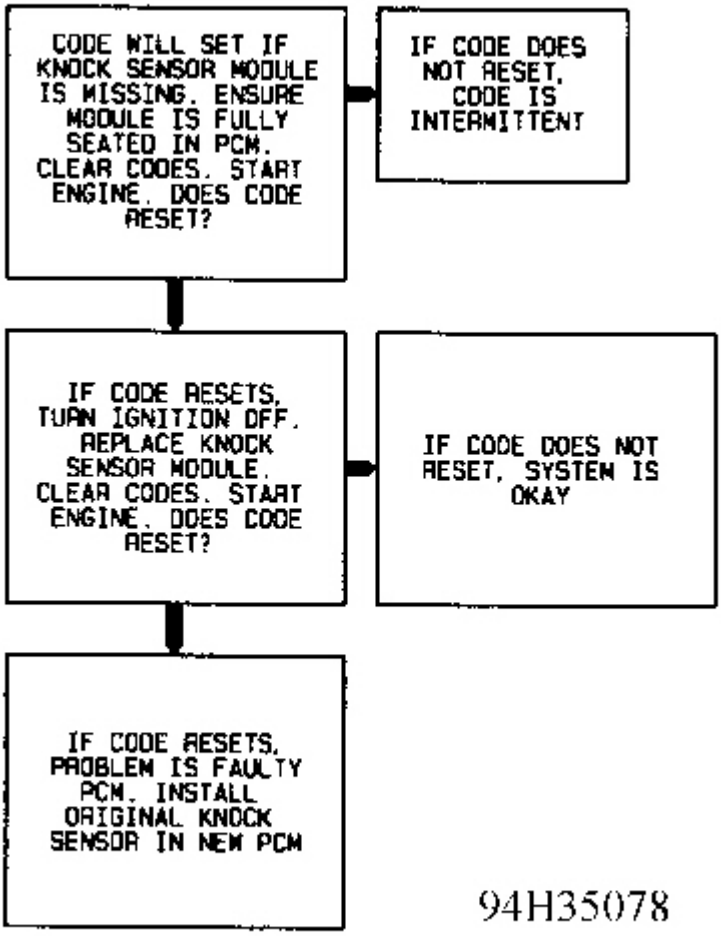


Fig. 56: Code 47 Diagnostic Flow Chart (Caprice) Knock Sensor Module

CODE 48, MASS AIRFLOW SENSOR

Mass airflow meter measures amount of induction airflow. This information is used by PCM to determine adjustments to air/fuel ratio. MAF sensor is a hot-wire type. Sensor maintains hot wire at a predetermined temperature. The greater the airflow across the hot wire, the more current is required to maintain hot wire temperature. Sensor changes the current requirements into a frequency signal which is read by the PCM. The PCM calculates airflow based upon this signal.

NOTE: Test numbers refer to numbers on diagnostic charts.

1. Determines if fault is a hard failure or an intermittent condition.

2. Checks for 5-volt reference from PCM.
3. Verifies both ignition voltage and a good ground circuit are available.

Diagnostic Aids

An intermittent may be caused by a poor connection, mis-routed harness, rubbed through wire insulation or a broken wire inside insulation. Code 48 could be caused by a vacuum leak. Check short and long term fuel trim for being in optimum range (both banks).

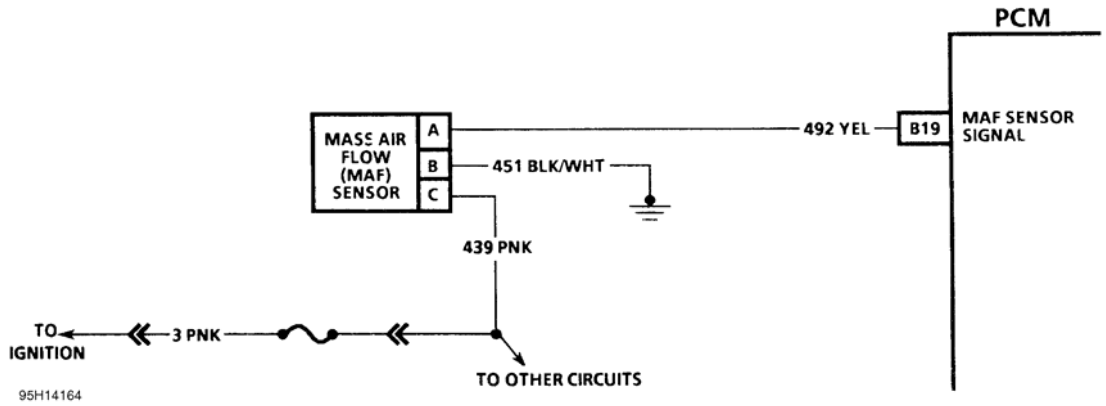


Fig. 57: Code 48 Schematic (Caprice) Mass Airflow Sensor

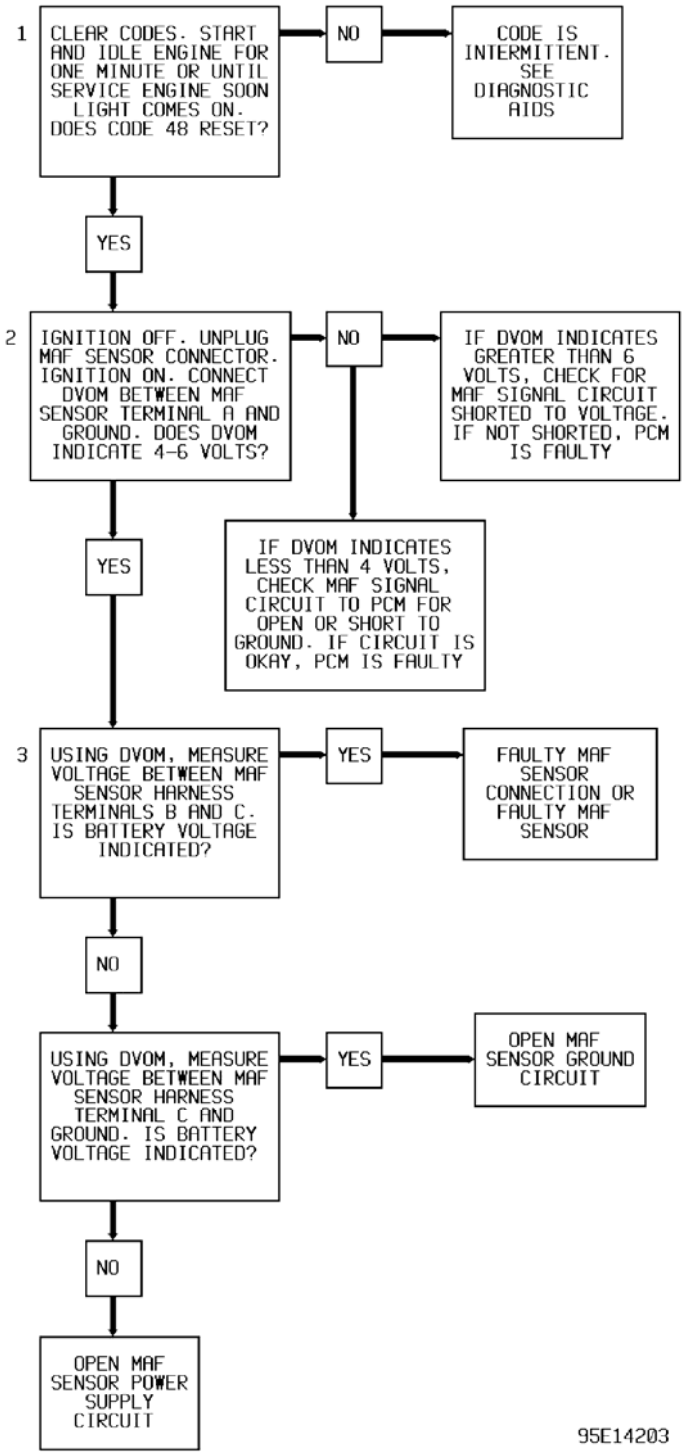


Fig. 58: Code 48 Diagnostic Flow Chart (Caprice)

CODE 50, SYSTEM VOLTAGE LOW

PCM monitors voltage on ignition feed circuit (Pink wire). Normal voltage is 9.6-16 volts. If voltage drops

below 8 volts, Code 50 will set and Malfunction Indicator Light (MIL) will illuminate.

Diagnostic Aids

An open in ignition feed circuit (Pink wire) or extremely low voltage may cause loss of serial data, no start condition and malfunction of the MIL. Additional codes may be set.

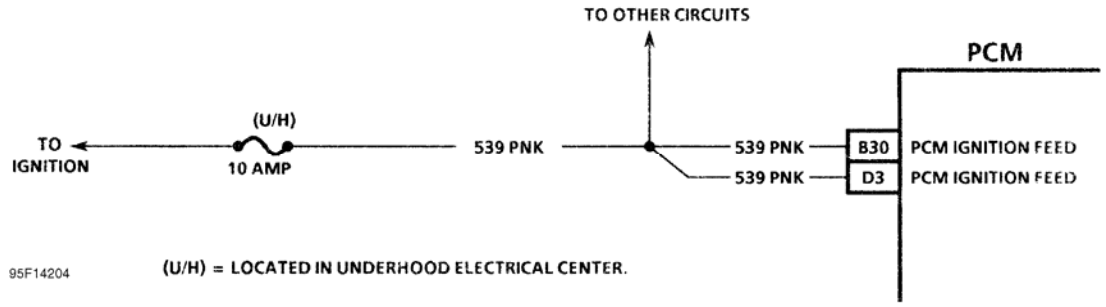


Fig. 59: Code 50 Schematic (Caprice) System Voltage Low

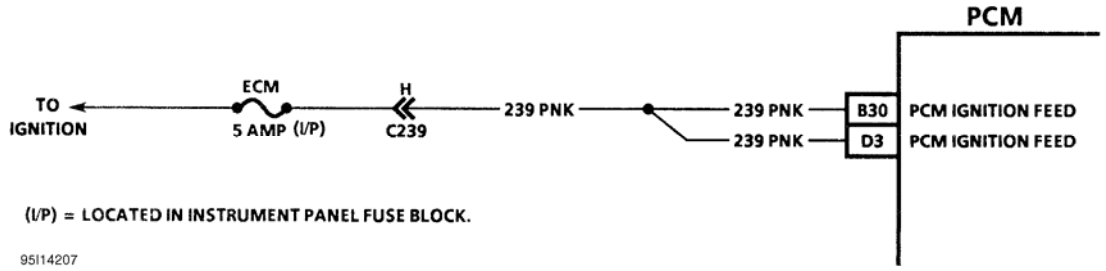


Fig. 60: Code 50 Schematic (Caprice) System Voltage Low

CODE 52, FAULTY CAL-PAK

Ensure all pins are fully inserted in socket. If pins are okay, replace CAL-PAK, clear memory and recheck. If Code 51 reappears, replace control module.

CODE 53, SYSTEM VOLTAGE HIGH

This code indicates a basic charging system problem. Code 53 will set when voltage at control module terminal is greater than specification for a precalibrated time. If voltage at PCM battery voltage terminal is not within specification, check and repair charging system.

CHARGING SYSTEM SPECIFICATIONS

Application	Minimum Charge	Maximum Charge
Caprice	9.6	16.0

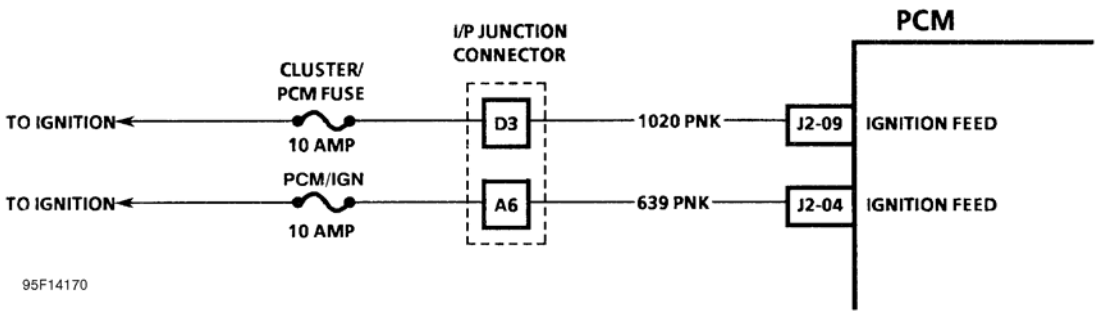


Fig. 61: Code 53 Schematic (Caprice) System Voltage High

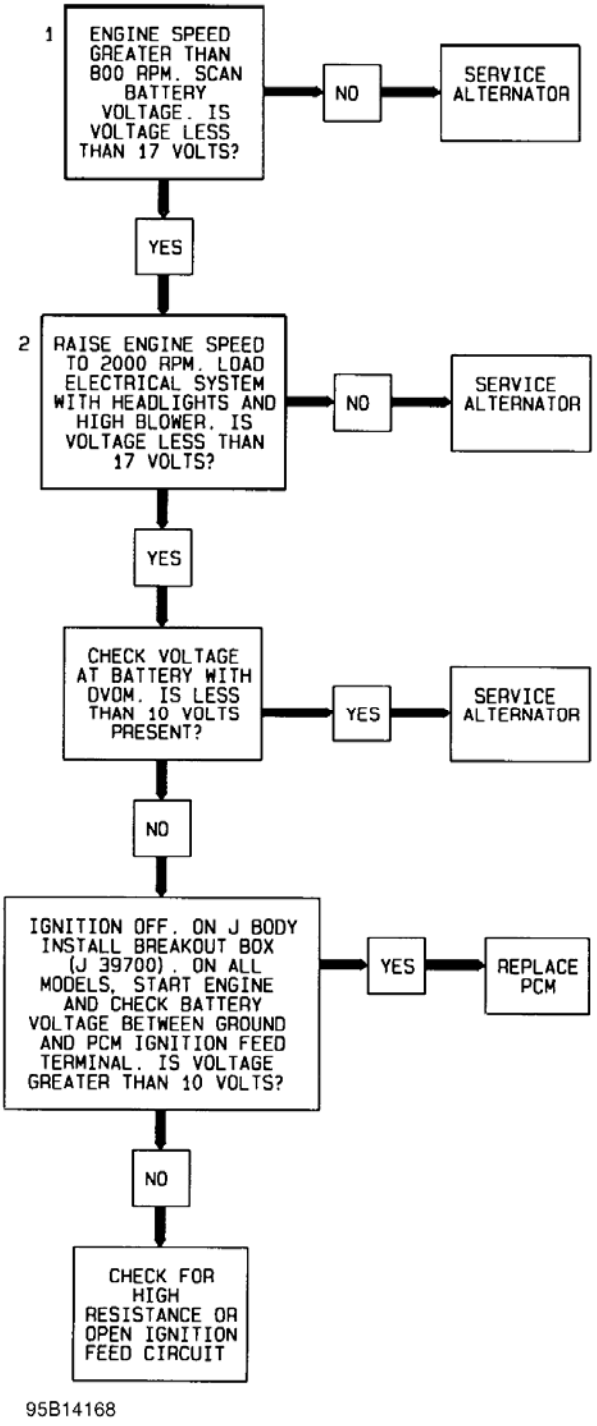


Fig. 62: Code 53 Diagnostic Flow Chart (Caprice) System Voltage High

CODE 55, PCM ERROR

Ensure PCM grounds are okay. Ensure correct EPROM is being used and that it is properly installed. If okay,

replace PCM. Clear codes, confirm closed loop operation and check operation of Malfunction Indicator Light (MIL).

CODE 55, FUEL LEAN MONITOR

PCM is capable of determining if fuel system can deliver adequate fuel during power enrichment (heavy acceleration). During power enrichment conditions, PCM expects to see both O2 sensors registering rich. If both sensors do not register rich, Code 55 will set.

Low fuel pressure or restricted fuel flow may cause a lean condition. Check for plugged injectors, poor or contaminated fuel, low fuel level and restricted fuel supply. Vapor lock can also cause Code 55.

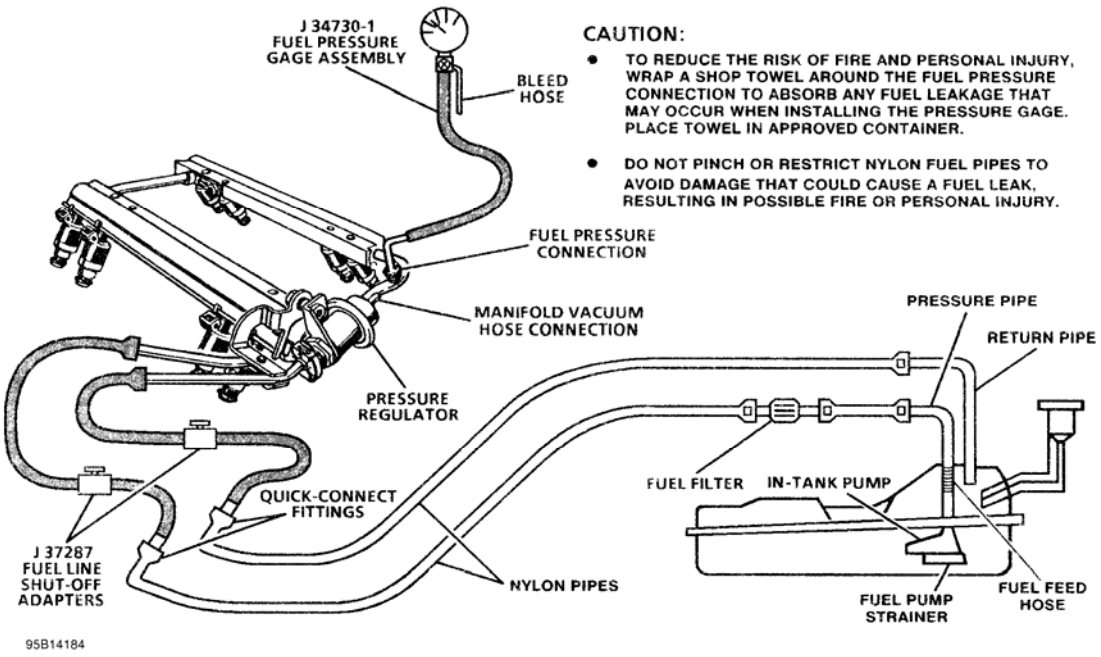


Fig. 63: Code 55 Schematic (Caprice) Fuel Lean Monitor

CODE 58, TRANS TEMPERATURE SENSOR HIGH TEMPERATURE

Temperature sensor is a 2 wire thermistor located in transaxle. This sensor operates in the same manner as engine coolant temperature sensor and intake air temperature sensor. PCM applies 5 volts to sensor on signal circuit. Voltage sensed at PCM signal circuit terminal will be high when transmission fluid is cold and as fluid warms voltage signal will drop. A very low signal voltage indicates a high fluid temperature or a failure in sensor circuit. Normal fluid temperature range is 75-100°C.

Code 58 will set when sensor indicates a high fluid temperature for a precalibrated period of time. Malfunction Indicator Light (MIL) will illuminate and PCM will use a warm default sensor value.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for a short to ground or an out-of-calibration sensor.
2. Checks for an internal fault within the transmission by creating an open.

Diagnostic Aids

Check harness routing for a potential short to ground in signal circuit. Temperature should rise steadily to about 90°C then stabilize. A skewed sensor could result in delayed shifts or TCC enabled complaints.

Use temperature-to-resistance table to check sensor at various levels to determine if sensor is out-of-calibration, which could result in firm shifts or TCC enable.

TEMPERATURE-TO-RESISTANCE VALUES (1)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700
(1) Measure resistance across sensor terminals.	

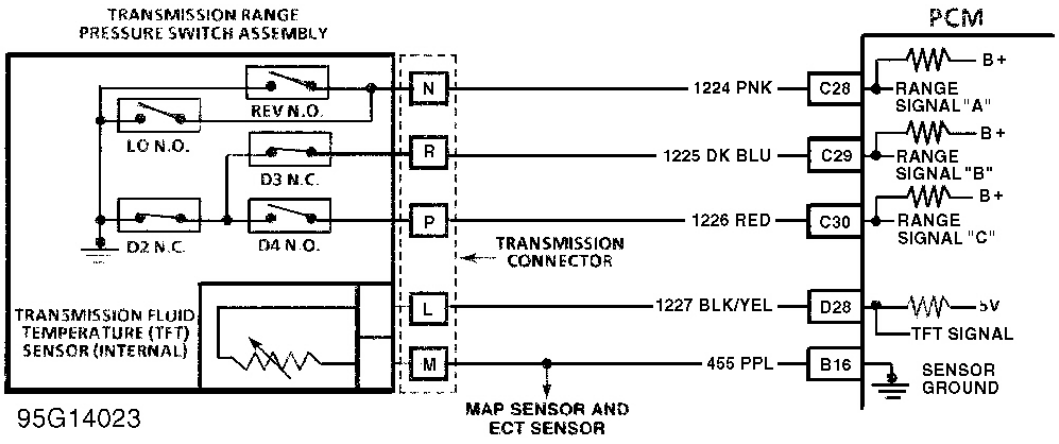


Fig. 64: Code 58 Schematic (Caprice) Transmission Temperature Sensor High Temperature

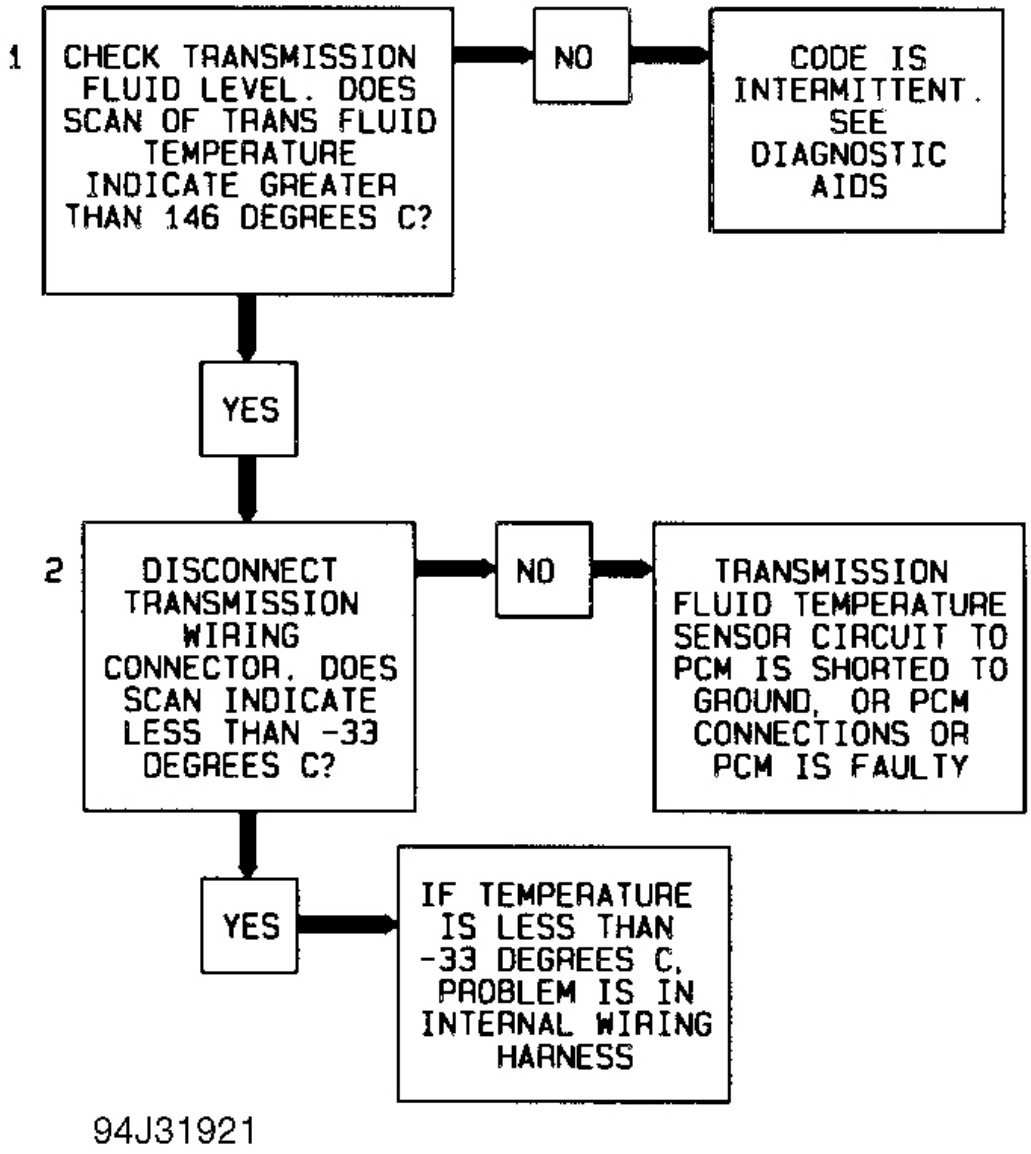


Fig. 65: Code 58 Diagnostic Flow Chart (Caprice) Transmission Temperature Sensor High Temperature

CODE 59, TRANS. TEMPERATURE SENSOR LOW TEMPERATURE

Temperature sensor is a 2 wire thermistor located in transaxle. This sensor operates in the same manner as engine coolant temperature sensor and intake air temperature sensor. PCM applies 5 volts to sensor on signal circuit. Voltage sensed at PCM signal circuit terminal will be high when transmission fluid is cold and as fluid warms voltage signal will drop. A very high signal voltage indicates a low fluid temperature or a failure in sensor circuit. Normal fluid temperature range is 75-100°C.

Code 59 will set when sensor indicates a low temperature for a precalibrated period of time. Malfunction Indicator Light (MIL) will not illuminate and PCM will use a warm default sensor value.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test determines if a current condition exists.
2. Simulates a Code 58. If PCM recognizes low signal voltage, and scan displays about 146°C or higher, PCM and wiring are okay.
3. Checks if signal circuit is open. Five volts should be present at sensor connector.

Diagnostic Aids

Temperature should rise steadily to about 90°C, then stabilize. A faulty connection or an open in ground or signal circuit can result in Code 59. A skewed sensor could result in firm shifts or TCC enabled complaints. Use temperature-to-resistance table to check sensor at various levels to determine if sensor is out-of-calibration, which could result in firm shifts or TCC enable.

TEMPERATURE-TO-RESISTANCE VALUES (1)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

(1) Measure resistance across sensor terminals.

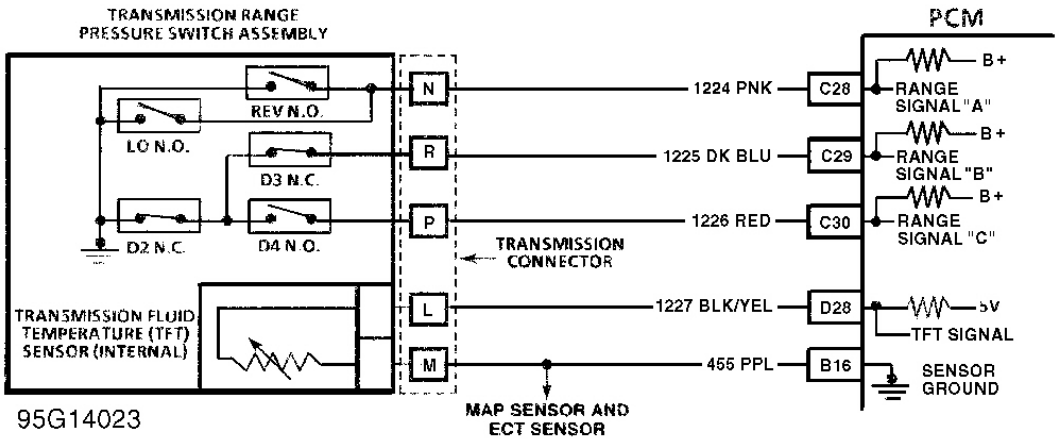


Fig. 66: Code 59 Schematic (Caprice) Transmission Temperature Sensor Low Temperature

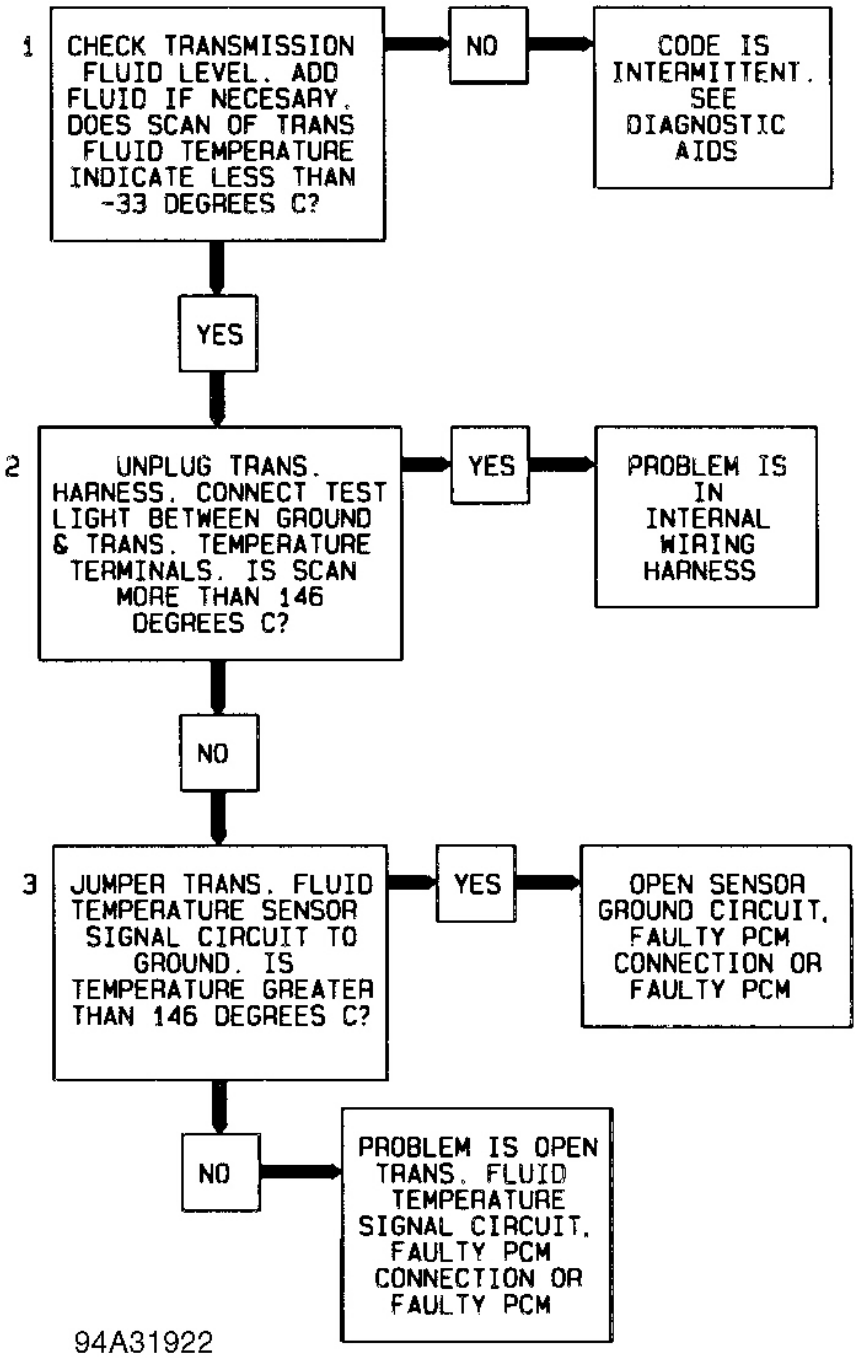


Fig. 67: Code 59 Diagnostic Flow Chart (Caprice) Transmission Temperature Sensor Low Temperature

CODE 63, RIGHT HEATED OXYGEN SENSOR CIRCUIT OPEN

NOTE: Engine is equipped with 2 oxygen sensors. On this model, code will set if the right sensor circuit is open. Code 13 will set if the left sensor circuit is open. Oxygen sensors use a heating element. Heating element is not controlled by PCM.

Code will set if Codes 21 and 22 are not set, engine is at normal operating temperature, oxygen sensor voltage is constant within a specified range (.35-.55 volt), throttle angle is greater than idle, a precalibrated amount of time has elapsed since start-up and all conditions have existed for a precalibrated amount of time. Most likely causes of code are: open sensor signal (high) circuit, faulty PCM connection, faulty PCM, faulty oxygen sensor connection or faulty oxygen sensor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This tests if problem still exists. Vehicle cannot enter "closed loop" mode if oxygen sensor circuit is open. Code indicates an open in O2 sensor circuit (steady .35-.55 volt).
2. Determines if oxygen sensor, wiring or control module is at fault. If wiring is good, grounding oxygen sensor wire will cause .45 volt reference supplied by control module to pull low.
3. This tests oxygen sensor circuit wiring. Use only a high impedance (10-megohm minimum) digital voltmeter.

Diagnostic Aids

Control module will not go into closed loop if code is set. Code may set if vehicle runs out of fuel or stalls while vehicle is in motion. If oxygen sensor ground becomes loose, a false oxygen sensor reading will occur. This can result in a Code 63 being set. On models equipped with an oxygen sensor heating element, element resistance should be 3.5-14.0 ohms.

CODE 63 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
Right O2 Signal	C8	Purple
Right O2 Ground	C7	Tan

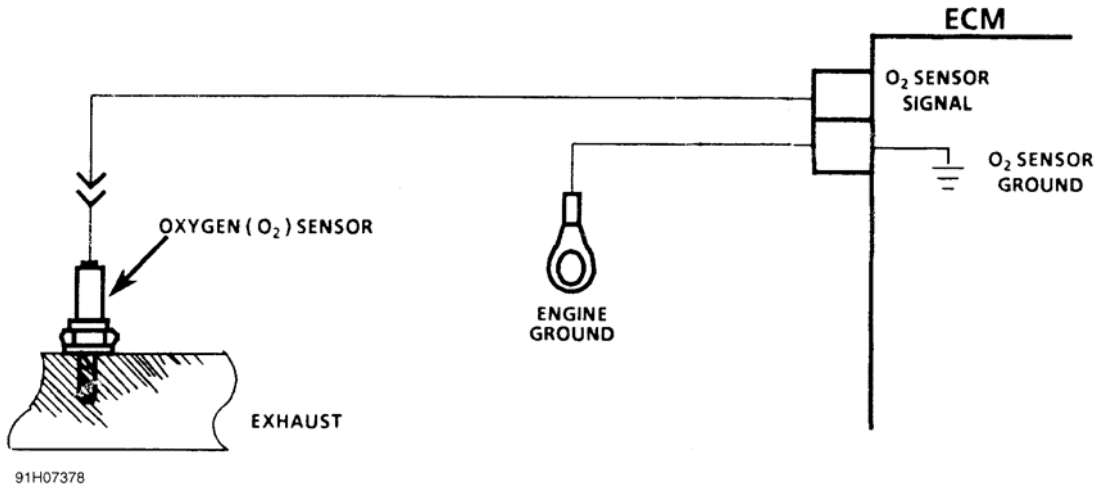


Fig. 68: Code 63 Schematic Open Oxygen Sensor Circuit

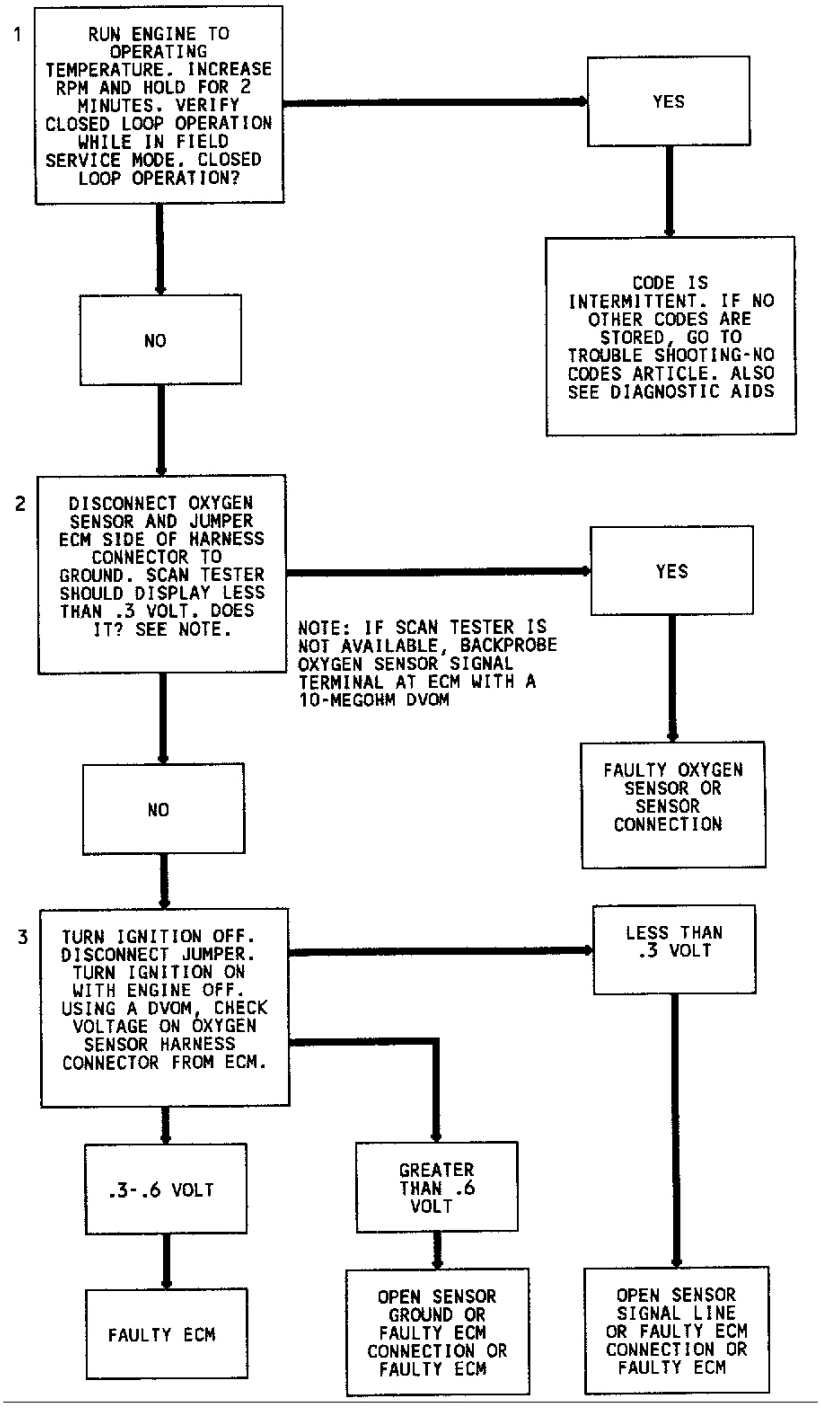


Fig. 69: Code 63 Diagnostic Flow Chart Open Oxygen Sensor Circuit

CODE 64, RIGHT HEATED OXYGEN SENSOR LEAN EXHAUST INDICATION

NOTE: Models are equipped with 2 oxygen sensors. On these models, Code 64 will set if the right sensor circuit is lean. Code 44 will set if the left sensor circuit is lean.

O2 sensor acts like an open sensor circuit and produces no voltage when exhaust temperature is less than 600°F (316°C). An open sensor circuit or cold sensor causes "open loop" operation. On models with 2 oxygen sensors, Code 44 will reflect a lean left O2 sensor; Code 64 will indicate a lean right O2 sensor. Perform test procedures for right or left sensor as necessary.

Code is set when O2 sensor voltage signal at control module is low (less than 0.3 volt) for a precalibrated period and fuel system is operating in "closed loop" and attempting to richen mixture. Most likely causes for setting of code are: an actual lean condition, a short to ground on sensor signal circuit or a faulty PCM.

NOTE: Test number refers to number on diagnostic chart.

1. Checks to see if O2 sensor is registering a lean condition.

Diagnostic Aids

Using scan tester, observe Block Learn Memory (BLM) value at different RPMs. If conditions for a lean exhaust code exist, block learn value will be about 150.

O2 Sensor Wire

O2 sensor wire may be mispositioned and laying against exhaust manifold. Check for ground between sensor and wire connector.

Fuel Contamination

Water, even small amounts, near in-tank fuel pump inlet can be delivered to injector. Water may cause a lean exhaust, setting code.

Fuel Pressure

System will be lean if fuel pressure is low. If necessary, monitor fuel pressure while driving vehicle. For fuel pressure checking procedure, see **BASIC TESTING** article in this section.

Exhaust Leaks

If exhaust system has large leaks, exhaust system negative pressure pulses can cause outside air to be drawn into system and past O2 sensor. Vacuum or crankcase leaks can also cause a lean condition.

Misfire Or Stall

If engine misfires or stalls (including running out of fuel) while vehicle is moving, code may set. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 64 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
Right O2 Signal	C8	Purple
Right O2 Ground	C7	Tan

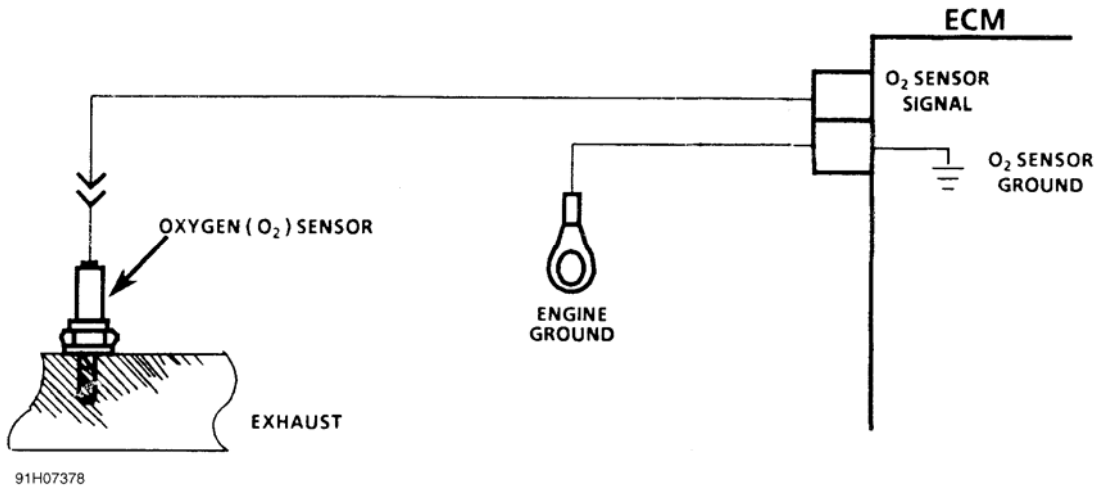


Fig. 70: Code 64 Schematic Lean Exhaust Indication

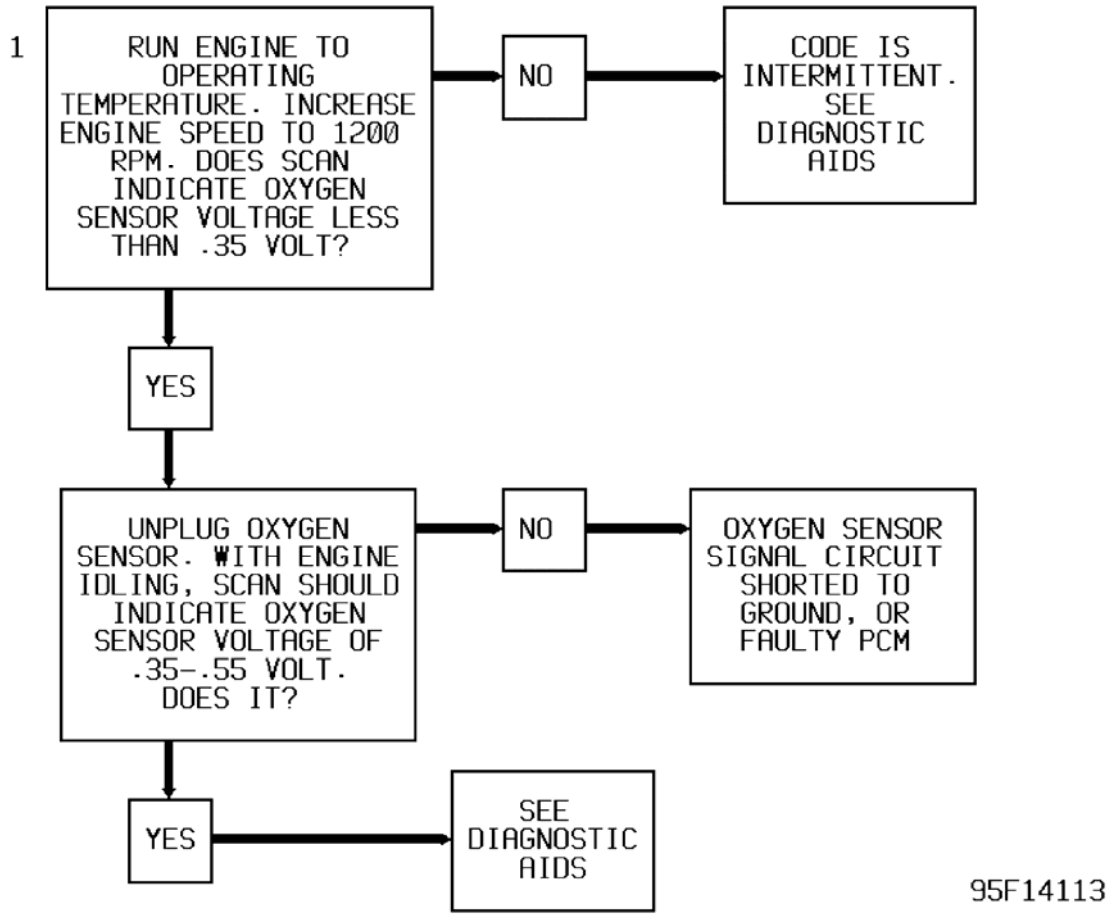


Fig. 71: Code 64 Diagnostic Flow Chart Lean Exhaust Indication

CODE 65, RIGHT HEATED OXYGEN SENSOR RICH EXHAUST INDICATION

NOTE: Models are equipped with 2 oxygen sensors. On these models, Code 65 will set if the right sensor circuit is rich. Code 45 will set if the left sensor circuit is lean.

O2 sensor acts like an open sensor circuit and produces no voltage when exhaust temperature is less than 600°F (316°C). An open sensor circuit or cold sensor causes "open loop" operation. Code 45 indicates a rich exhaust. Diagnosis should begin with fuel pressure, leaking injector, ignition shielding (ground), vapor canister fuel saturation, coolant sensor, MAP sensor, O2 sensor contamination and TPS intermittent output.

Code is set when fuel system is operating in "closed loop", throttle angle is greater than idle, O2 sensor signal at control module is greater than .7 volt for a precalibrated period, fuel system is attempting to lean mixture and time since engine start is one minute or more. Most likely causes of code are: an actual rich condition, a short to voltage on sensor signal circuit or a faulty PCM.

NOTE: Test number refers to number on diagnostic chart.

1. Test checks to see if O2 sensor is registering a rich condition.

Diagnostic Aids

If other codes of lower number are set with code, use those charts first. Malfunction in MAP or TPS sensor circuits can cause a rich exhaust code to set. If other codes are not set, rich exhaust is most likely caused by:

Fuel Pressure High

If fuel pressure is too high, air/fuel ratio will be rich. For fuel pressure checking procedure, see **BASIC TESTING** article in this section. Control module can compensate for slight increases, but a code will be set if air/fuel ratio becomes too rich.

Ignition Ground

If an open occurs on HEI ground circuit, HEI induced electrical "noise" may result, causing simulated reference pulses to be picked up by control module on reference line of EST harness. Additional pulses result in a higher than actual engine speed signal. Control module will increase injector pulse width ("on" time) to match increased RPM signal. Scan tester will show higher than actual RPM, which can help in diagnosing this problem.

Evaporative Fuel Canister

Fuel saturation of charcoal canister will cause a rich air/fuel ratio. If canister is full of fuel, check canister control valves and hoses.

MAP Sensor

An output causing control module to sense a higher than normal manifold pressure (low vacuum) can cause system to go rich. Disconnecting MAP sensor will allow control module to substitute a fixed value for MAP sensor. If condition disappears, substitute a different MAP sensor, and continue testing.

TPS

An intermittent TPS output will cause system to operate rich due to a false indication of engine acceleration.

O2 Sensor Contamination

O2 sensor contamination, caused by silicone in certain fuels or use of improper RTV sealant, may cause a White powdery coating to cover exterior of O2 sensor. False high signal voltage (low oxygen content sensed) produced is interpreted by control module as a rich mixture, causing control module to set code.

EGR Problem

EGR valve sticking open at idle is usually accompanied by a rough idle and/or stalling. Also check for shorted/leaking injector and fuel-contaminated oil. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 65 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
Right O2 Signal	C8	Purple
Right O2 Ground	C7	Tan

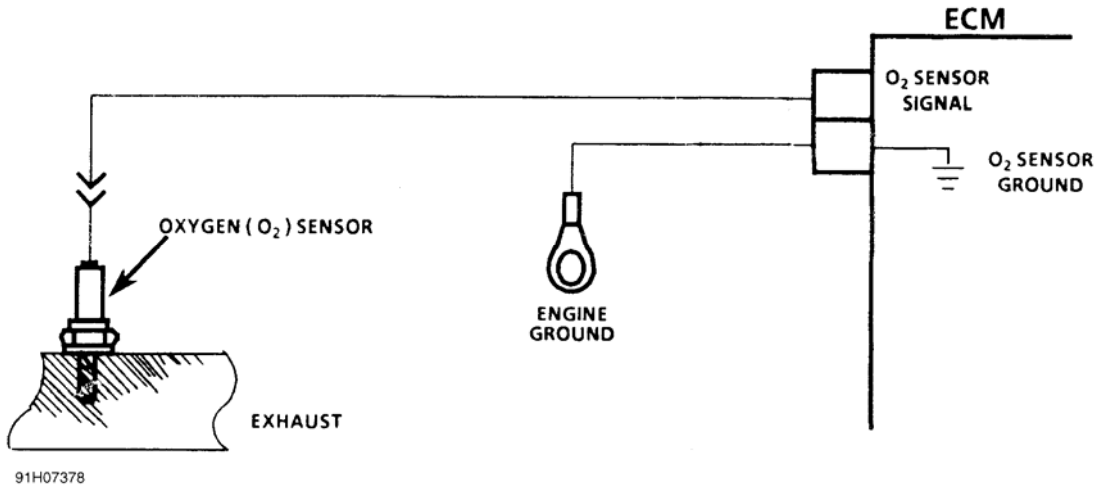


Fig. 72: Code 65 Schematic Rich Exhaust Indication

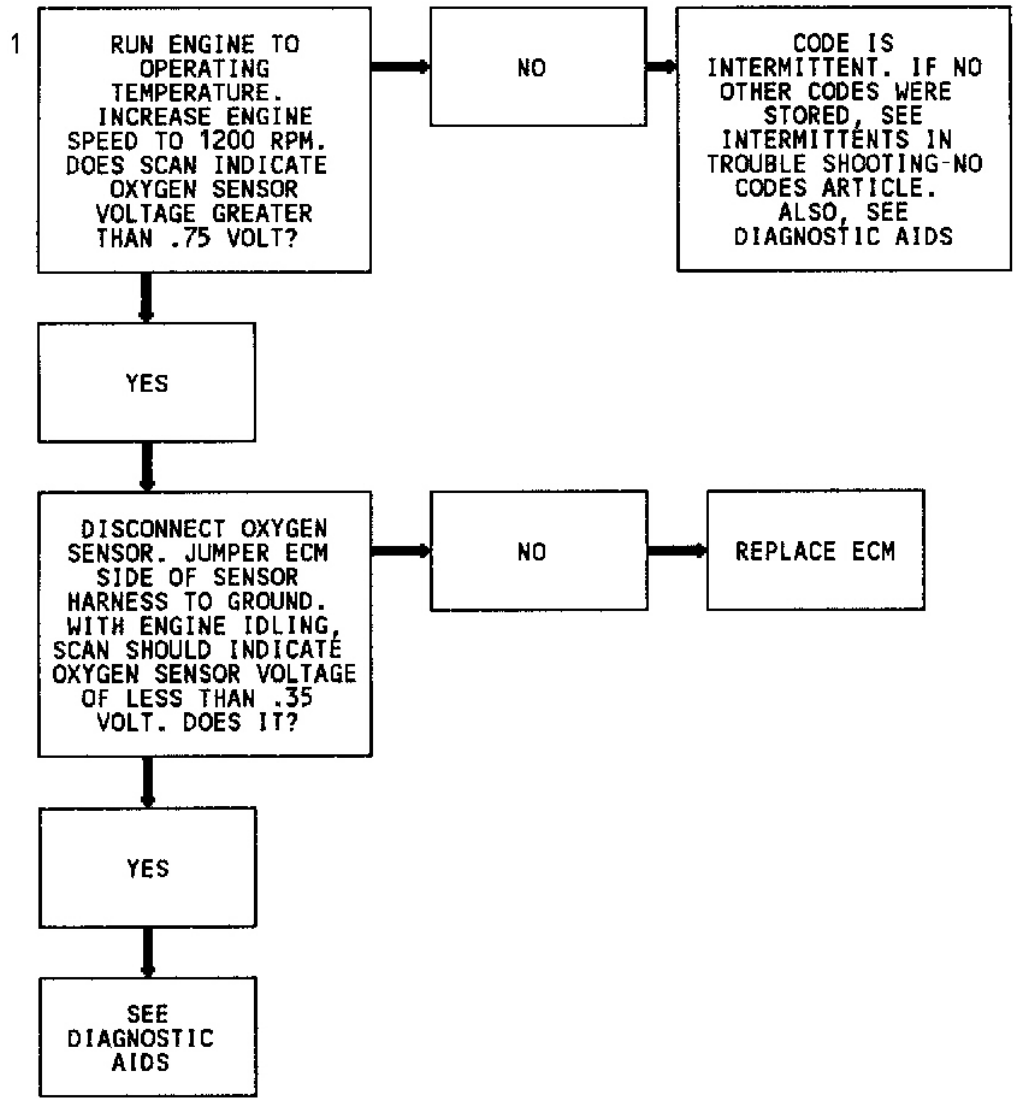


Fig. 73: Code 65 Diagnostic Flow Chart Rich Exhaust Indication

CODE 66, A/C PRESSURE SENSOR

A/C pressure sensor responds to changes in A/C refrigerant system high side pressure. PCM uses A/C compressor load input to determine engine idle speed. Sensor uses a 5-volt reference signal from PCM and returns an input signal to PCM on a separate line. Low pressure (zero psi) will return a signal of about .1 volt. High pressure will return a signal of about 4.6 volts.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks voltage signal from A/C pressure sensor to PCM. Normal voltage is 0.1-1.8 volts.
2. Checks to see if high signal is from a shorted sensor or a short to voltage in circuit. Normally, disconnecting sensor would make a normal circuit go to nearly zero volts.
3. Checks to see if low voltage signal is from sensor or circuit. Jumpering sensor signal circuit to 5-volt reference checks circuit, connections and PCM.
4. Checks to see if low voltage signal was due to an open in sensor circuit or 5-volt reference circuit. Previous step eliminated pressure sensor as a possible cause.

Diagnostic Aids

Code 66 sets when signal voltage falls outside normal sensor range and is not due to a A/C system problem. If problem is intermittent, check for opens or shorts in harness and poor connections. If wiring is okay, replace pressure sensor. If code resets, replace PCM.

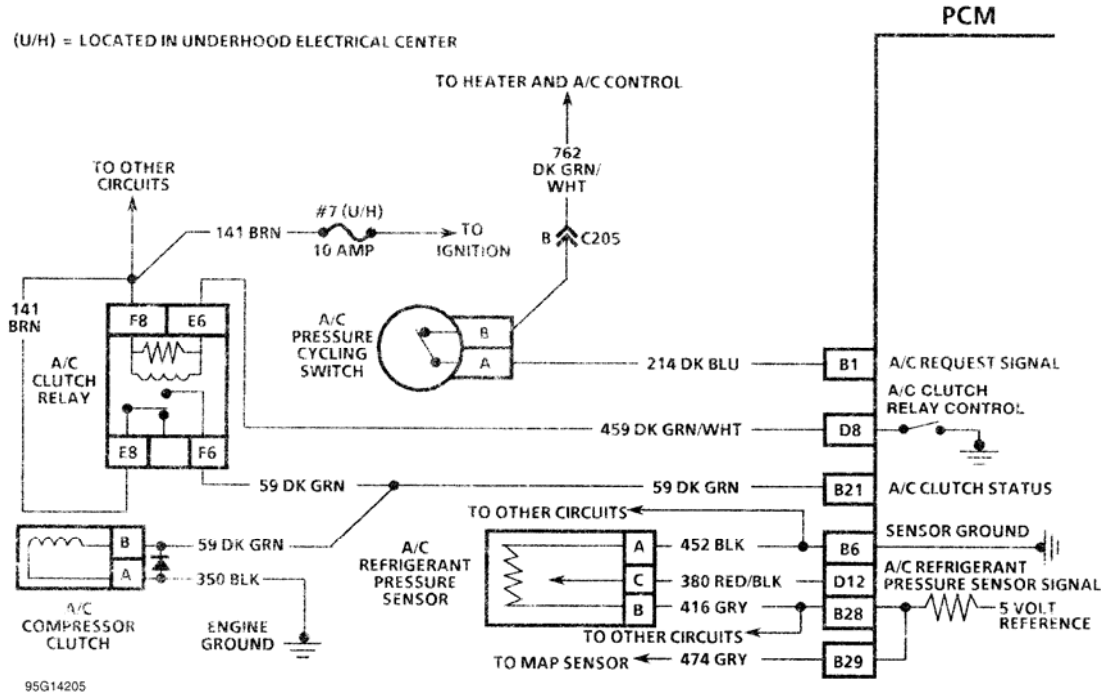


Fig. 74: Code 66 Schematic (Caprice) A/C Pressure Sensor

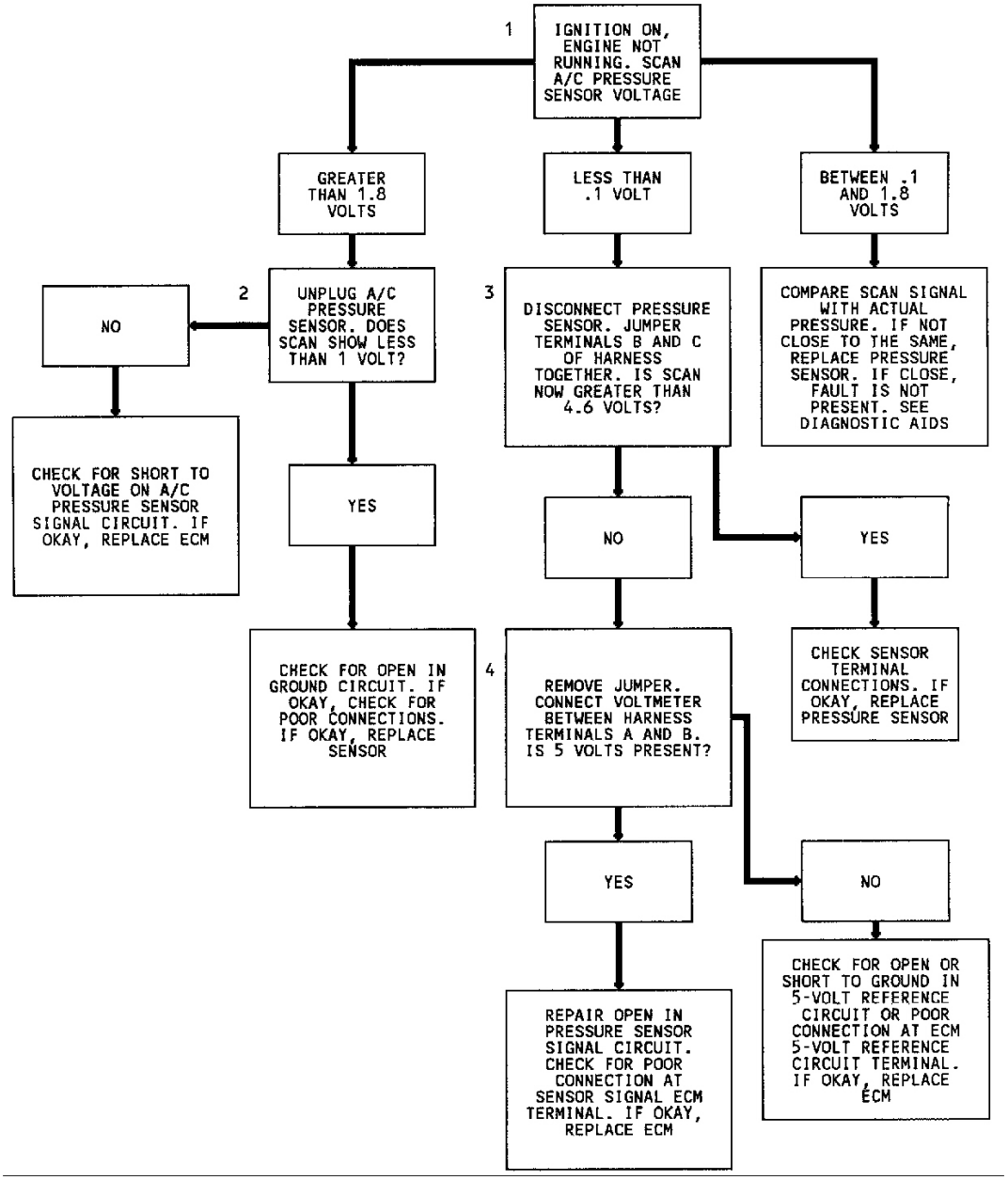


Fig. 75: Code 66 Diagnostic Flow Chart (Caprice) A/C Pressure Sensor

CODE 67, A/C PRESSURE SENSOR

PCM determines when A/C clutch is engaged by monitoring A/C status line. If A/C pressure does not increase by at least 4 psi when A/C clutch is turned on, Code 67 will set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Code 67 will set if PCM does not detect an A/C pressure change when A/C clutch has been cycled.
2. If relay power feed is intermittent, A/C clutch status terminal may not detect voltage when A/C is commanded on.
3. Check A/C electrical harness for problems. If A/C clutch status line becomes intermittently open or shorted while compressor is on, PCM will be wrongly detecting A/C clutch going on and off. When this occurs and clutch remains engaged, PCM will not detect pressure change and a Code 67 will be set.
4. If A/C compressor clutch status circuit is intermittently open or shorted while compressor is on, PCM will wrongly detect compressor cycling on and off, but PCM will detect no pressure change and a Code 67 will set.

Diagnostic Aids

A Code 67 will store in PCM memory but will not turn on the SERVICE ENGINE SOON light. An A/C system low on charge could cause a Code 67 to set.

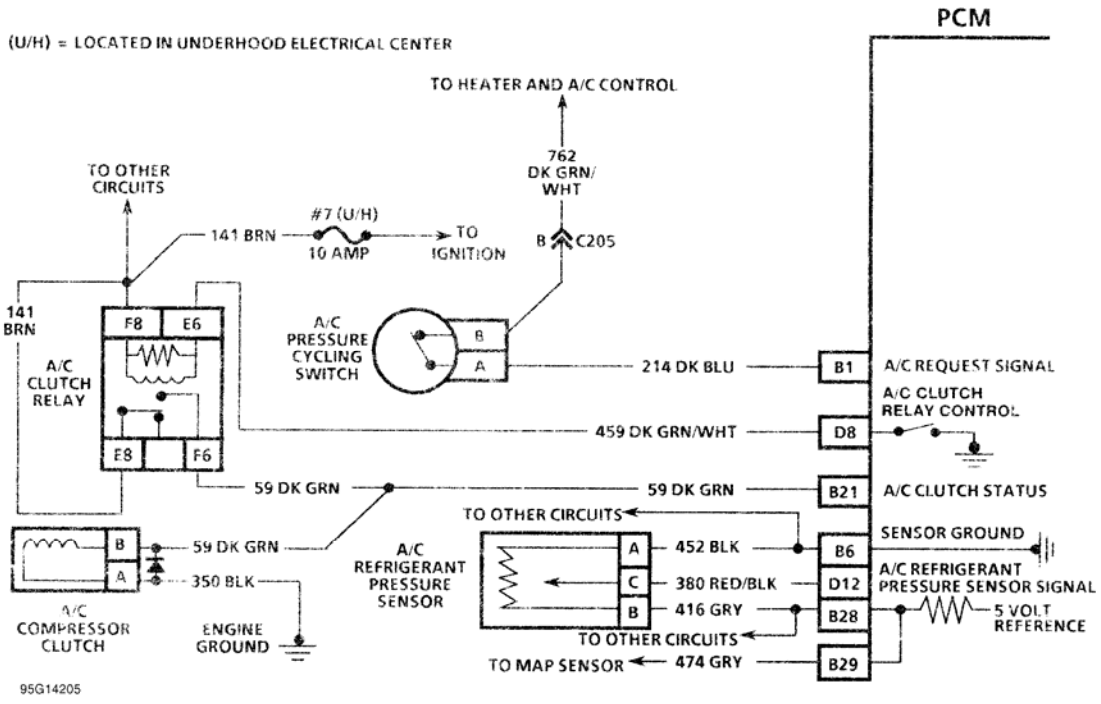


Fig. 76: Code 67 Schematic (Caprice) A/C Pressure Sensor

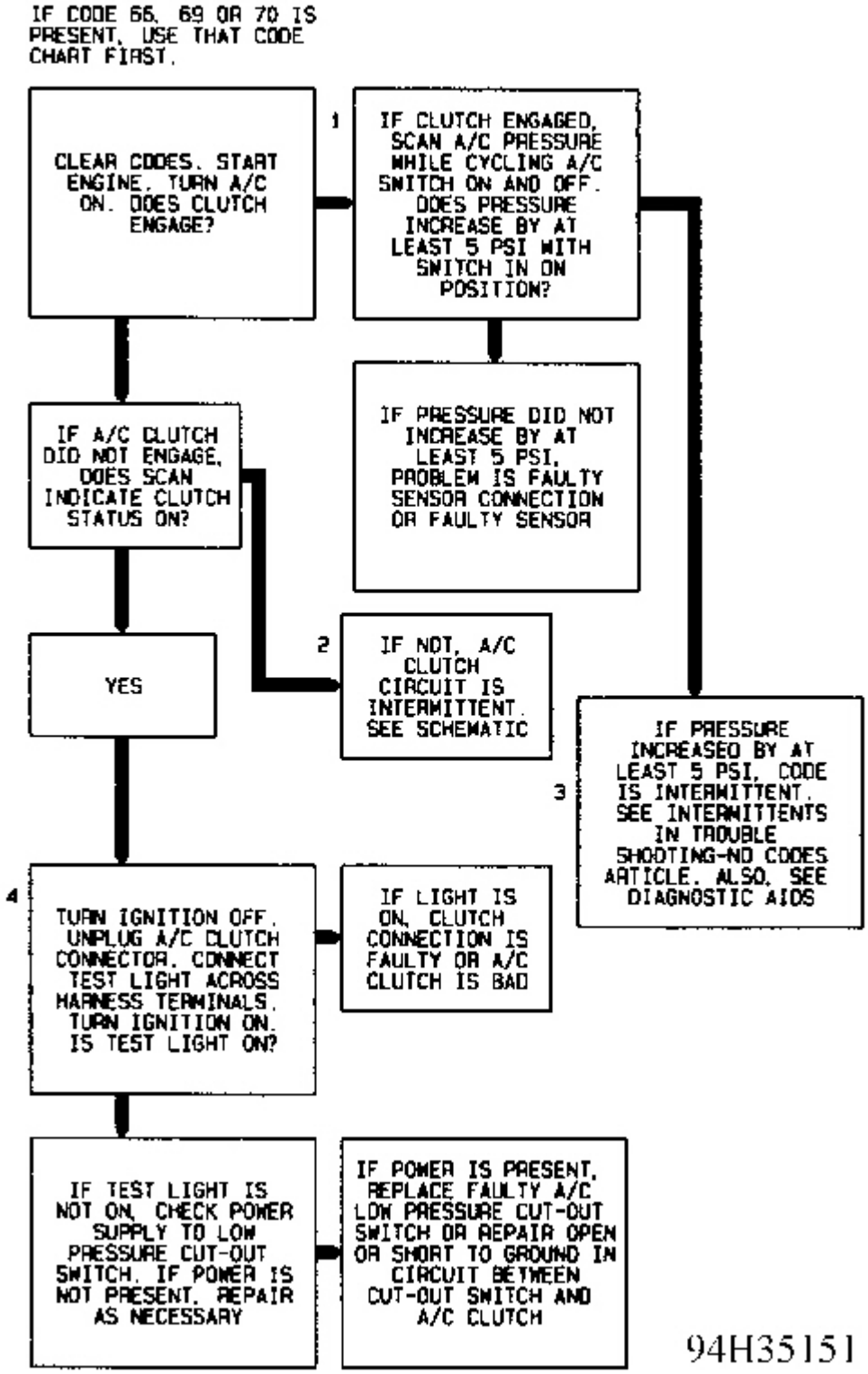

IF CODE 66, 69 OR 70 IS PRESENT, USE THAT CODE CHART FIRST.
CLEAR CODES, START ENGINE, TURN A/C ON. DOES CLUTCH ENGAGE?
1
IF CLUTCH ENGAGED, SCAN A/C PRESSURE WHILE CYCLING A/C SWITCH ON AND OFF. DOES PRESSURE INCREASE BY AT LEAST 5 PSI WITH SWITCH IN ON POSITION?
IF PRESSURE DID NOT INCREASE BY AT LEAST 5 PSI, PROBLEM IS FAULTY SENSOR CONNECTION OR FAULTY SENSOR
IF A/C CLUTCH DID NOT ENGAGE, DOES SCAN INDICATE CLUTCH STATUS ON?
YES
2
IF NOT, A/C CLUTCH CIRCUIT IS INTERMITTENT. SEE SCHEMATIC
3
IF PRESSURE INCREASED BY AT LEAST 5 PSI, CODE IS INTERMITTENT. SEE INTERMITTENTS IN TROUBLE SHOOTING-NO CODES ARTICLE. ALSO, SEE DIAGNOSTIC AIDS
4
TURN IGNITION OFF, UNPLUG A/C CLUTCH CONNECTOR. CONNECT TEST LIGHT ACROSS HARNESS TERMINALS. TURN IGNITION ON. IS TEST LIGHT ON?
IF LIGHT IS ON, CLUTCH CONNECTION IS FAULTY OR A/C CLUTCH IS BAD
IF TEST LIGHT IS NOT ON, CHECK POWER SUPPLY TO LOW PRESSURE CUT-OUT SWITCH. IF POWER IS NOT PRESENT, REPAIR AS NECESSARY
IF POWER IS PRESENT, REPLACE FAULTY A/C LOW PRESSURE CUT-OUT SWITCH OR REPAIR OPEN OR SHORT TO GROUND IN CIRCUIT BETWEEN CUT-OUT SWITCH AND A/C CLUTCH
94H35151

Fig. 77: Code 67 Diagnostic Flow Chart (Caprice) A/C Pressure Sensor

CODE 68, A/C RELAY CIRCUIT SHORTED

When PCM detects A/C has been requested, PCM will activate A/C clutch relay. When relay is activated, voltage should be present at both A/C compressor clutch and A/C clutch status terminal at PCM. If PCM detects voltage on A/C status line when A/C has not been commanded on, Code 68 will set. A short to voltage anywhere on A/C status line, or stuck relay contacts, will set Code 68. When Code 68 is set, PCM does not turn on SERVICE ENGINE SOON light.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. A/C must be off while performing test.
2. This step will isolate ignition feed portion of circuit from clutch circuit.
3. If Code 68 reappears at this step, PCM is internally shorted to voltage.

Diagnostic Aids

Check for intermittent shorts to A/C clutch circuit or sticking A/C relay.

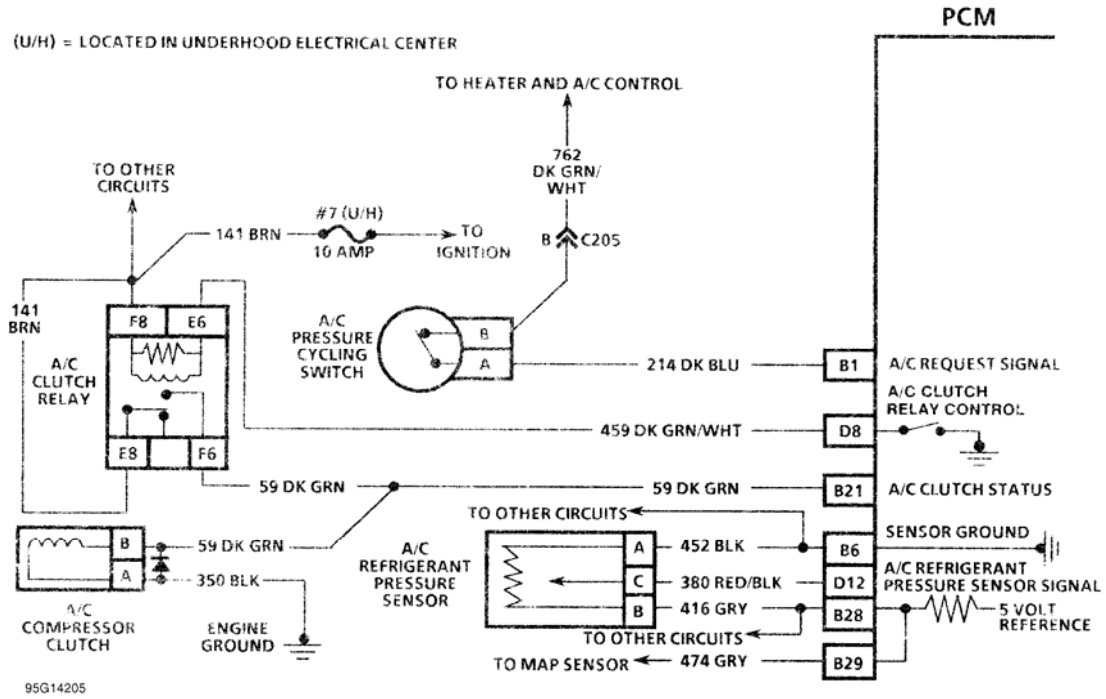


Fig. 78: Code 68 Schematic (Caprice) A/C Relay Circuit Shorted

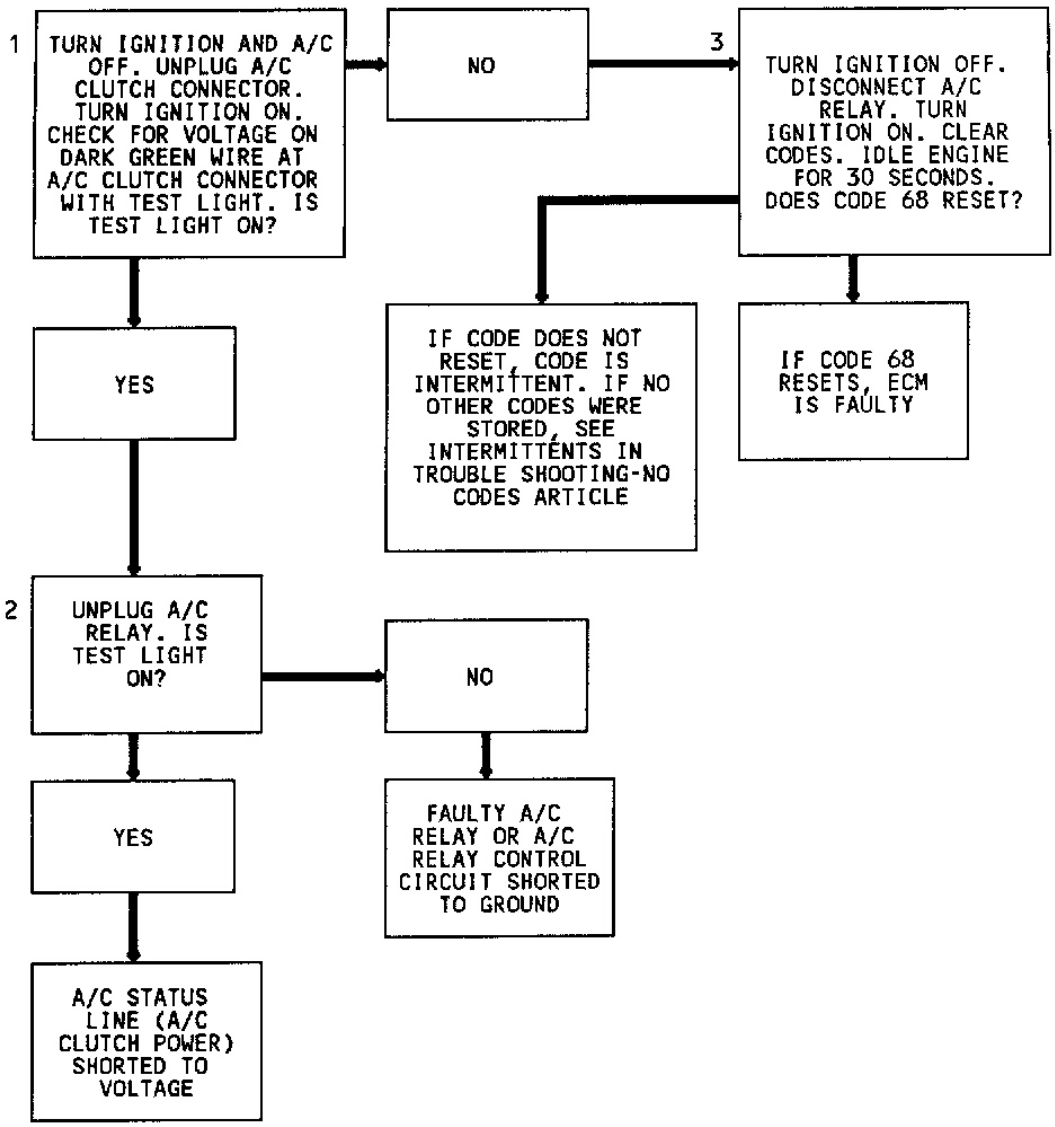


Fig. 79: Code 68 Diagnostic Flow Chart (Caprice) A/C Relay Circuit Shorted

CODE 69, A/C COMPRESSOR RELAY

When PCM detects A/C has been requested, PCM will activate the A/C clutch relay. When the relay has been activated, voltage should be present at both the A/C compressor clutch and the A/C clutch status line terminal of the PCM. If the PCM activates the A/C clutch relay but does not detect voltage present at A/C status terminal for more than 10 seconds, Code 69 will set. An open or short to ground at any point in the A/C status circuit will cause Code 69 to set. A Code 69 fault will be stored in PCM memory but will not turn on the SERVICE ENGINE SOON light.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. A problem that may prevent compressor from engaging may or may not cause Code 69 to set.
2. If the A/C compressor clutch operates properly and scan tester indicates A/C status off, then an open exists between the PCM and the splice to the compressor.

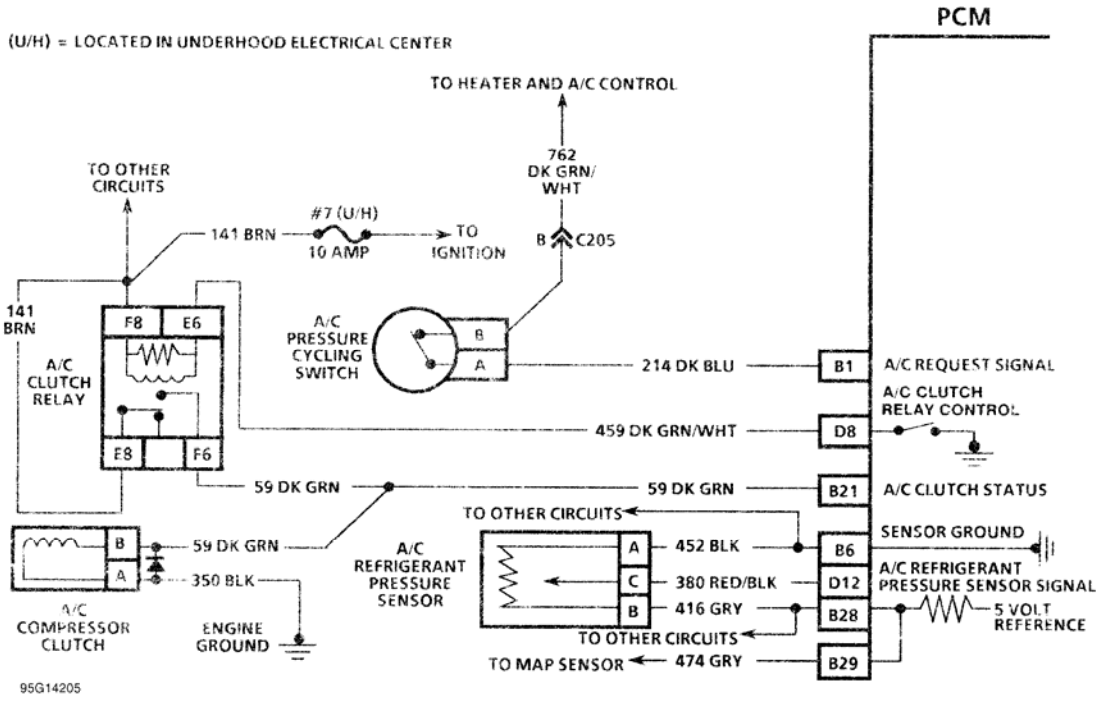


Fig. 80: Code 69 Schematic (Caprice) A/C Compressor Relay

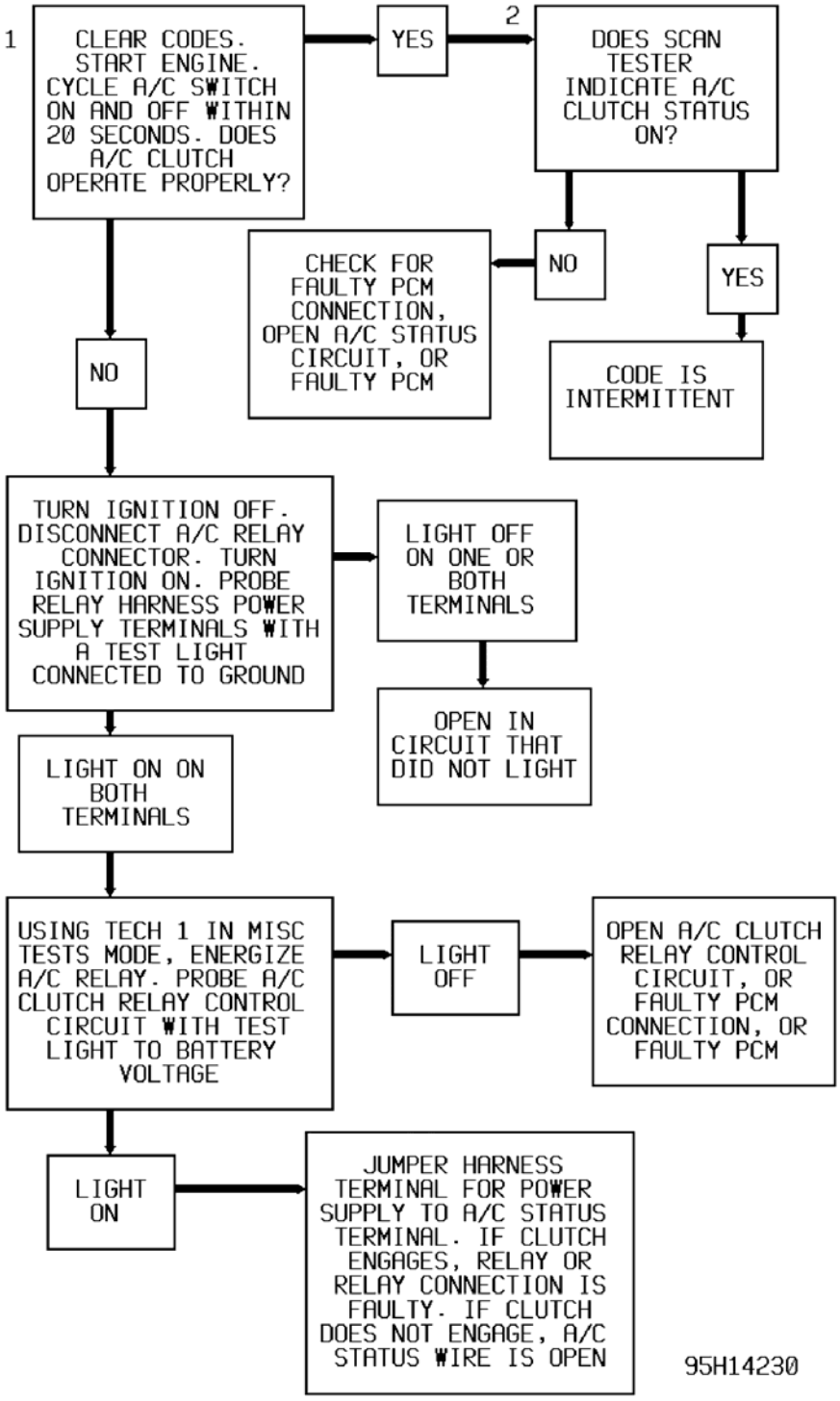


Fig. 81: Code 69 Diagnostic Flow Chart (Caprice) A/C Compressor Relay

CODE 70, A/C COMPRESSOR RELAY DRIVER

Relay is supplied voltage when ignition is on. PCM controls solenoid valve by providing a ground through one

of its Quad-Driver Modules (QDM). When relay is actuated, terminal is grounded and its monitored voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Tech 1 will enable circuit for 5 seconds.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative relay.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

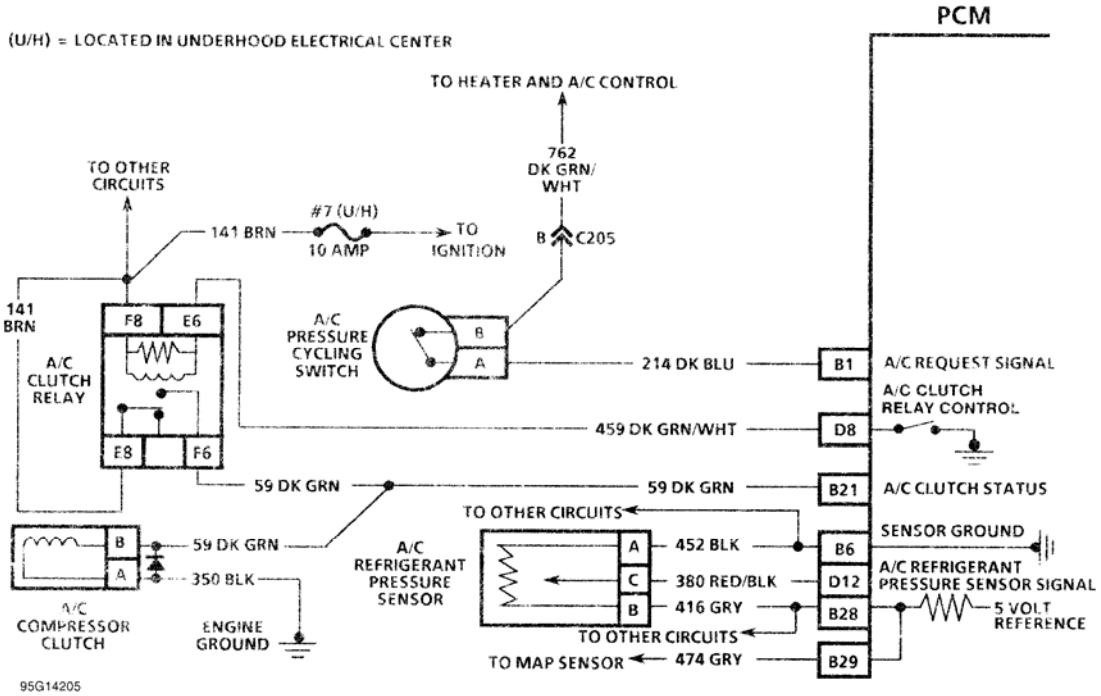


Fig. 82: Code 70 Schematic (Caprice) A/C Compressor Relay Driver

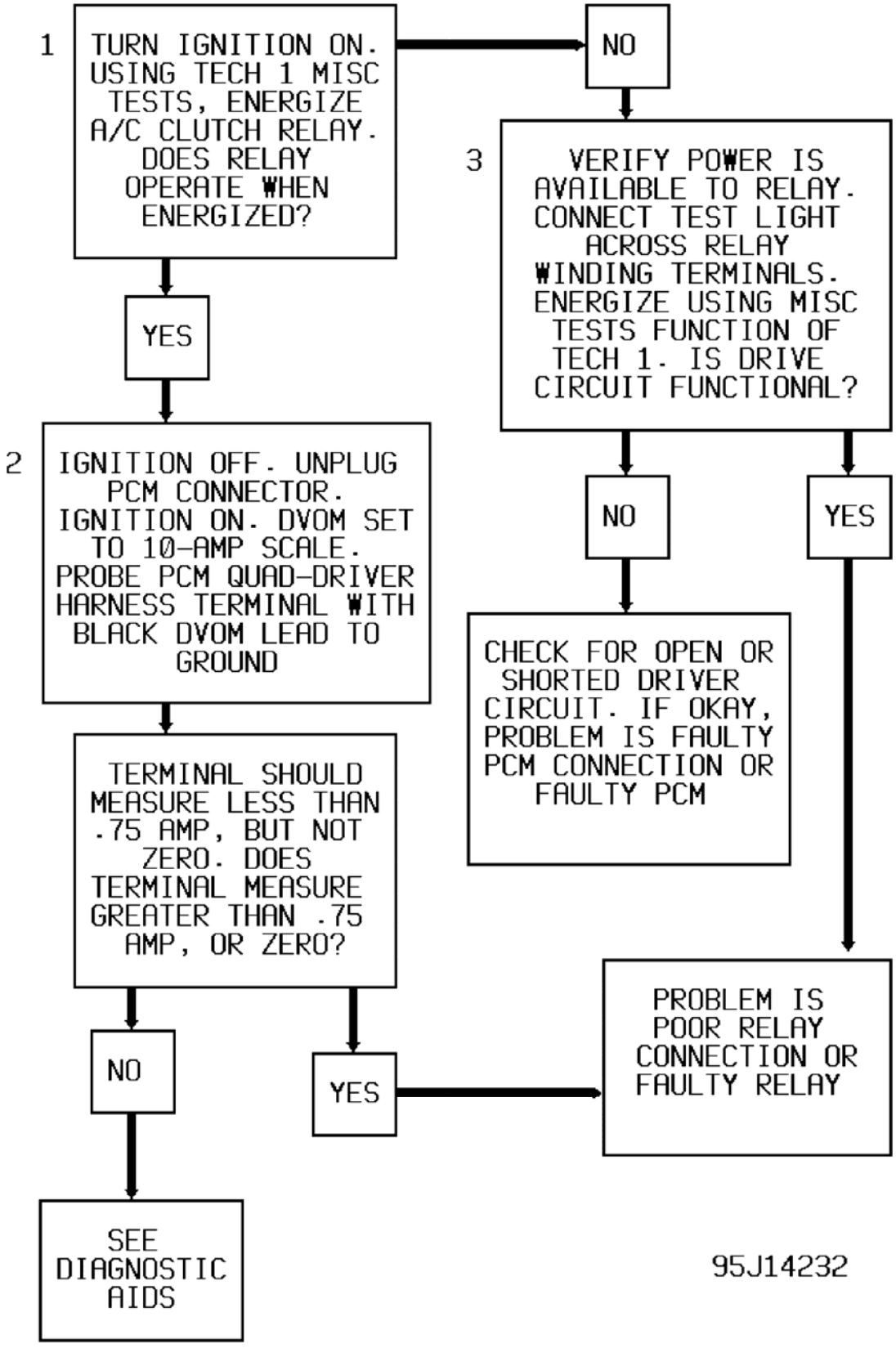

1
TURN IGNITION ON. USING TECH 1 MISC TESTS, ENERGIZE A/C CLUTCH RELAY. DOES RELAY OPERATE WHEN ENERGIZED?
NO
3
VERIFY POWER IS AVAILABLE TO RELAY. CONNECT TEST LIGHT ACROSS RELAY WINDING TERMINALS. ENERGIZE USING MISC TESTS FUNCTION OF TECH 1. IS DRIVE CIRCUIT FUNCTIONAL?
YES
2
IGNITION OFF. UNPLUG PCM CONNECTOR. IGNITION ON. DVOM SET TO 10-AMP SCALE. PROBE PCM QUAD-DRIVER HARNESS TERMINAL WITH BLACK DVOM LEAD TO GROUND
NO
YES
CHECK FOR OPEN OR SHORTED DRIVER CIRCUIT. IF OKAY, PROBLEM IS FAULTY PCM CONNECTION OR FAULTY PCM
TERMINAL SHOULD MEASURE LESS THAN .75 AMP, BUT NOT ZERO. DOES TERMINAL MEASURE GREATER THAN .75 AMP, OR ZERO?
NO
YES
PROBLEM IS POOR RELAY CONNECTION OR FAULTY RELAY
SEE DIAGNOSTIC AIDS
95J14232

Fig. 83: Code 70 Diagnostic Flow Chart (Caprice) A/C Compressor Relay Driver

CODE 72, VEHICLE SPEED SENSOR LOSS

Speed sensor, which is a Permanent Magnet (PM) generator, provides control module with vehicle speed information. PM generator, mounted in transmission, produces a pulsing AC voltage signal whenever vehicle speed is greater than about 2 MPH. Voltage level and pulses increase with vehicle speed. Control module converts pulsing voltage to MPH, which is used by control module to calculate vehicle adjustments.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. An intermittent connection at VSS or PCM may cause code to set. Inspect harness and all related connections. Check for damage or pushed out terminals.
2. Ensure harness is routed away from hot exhaust components.
3. If software/calibration is incorrect, code will set. Ensure calibration is correct before replacing PCM.

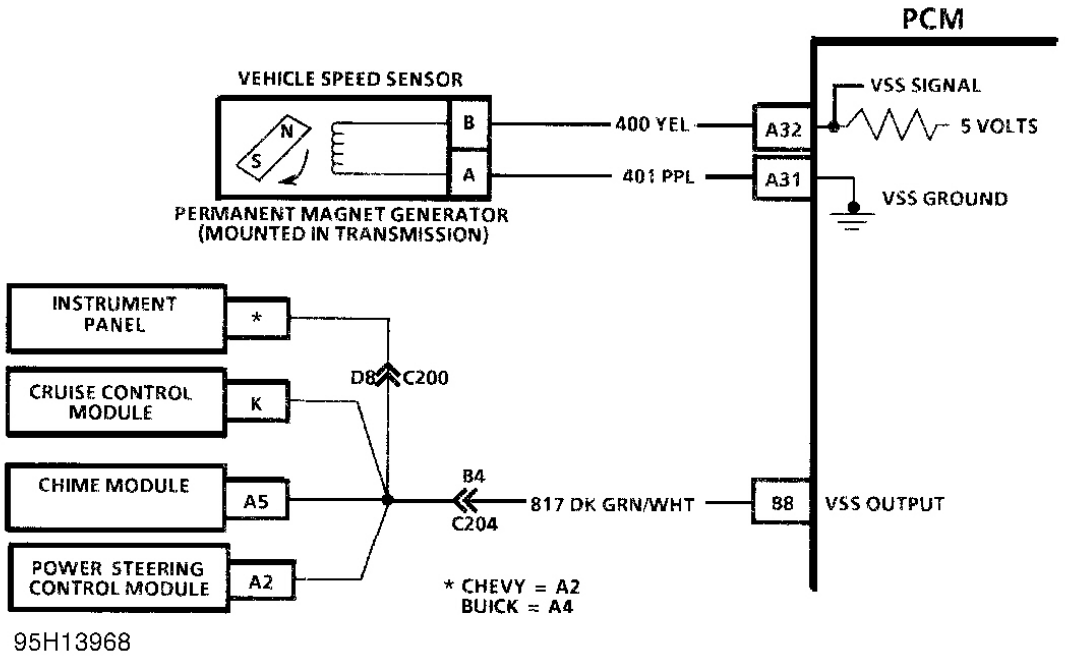


Fig. 84: Code 72 Schematic (Caprice) Vehicle Speed Sensor Loss

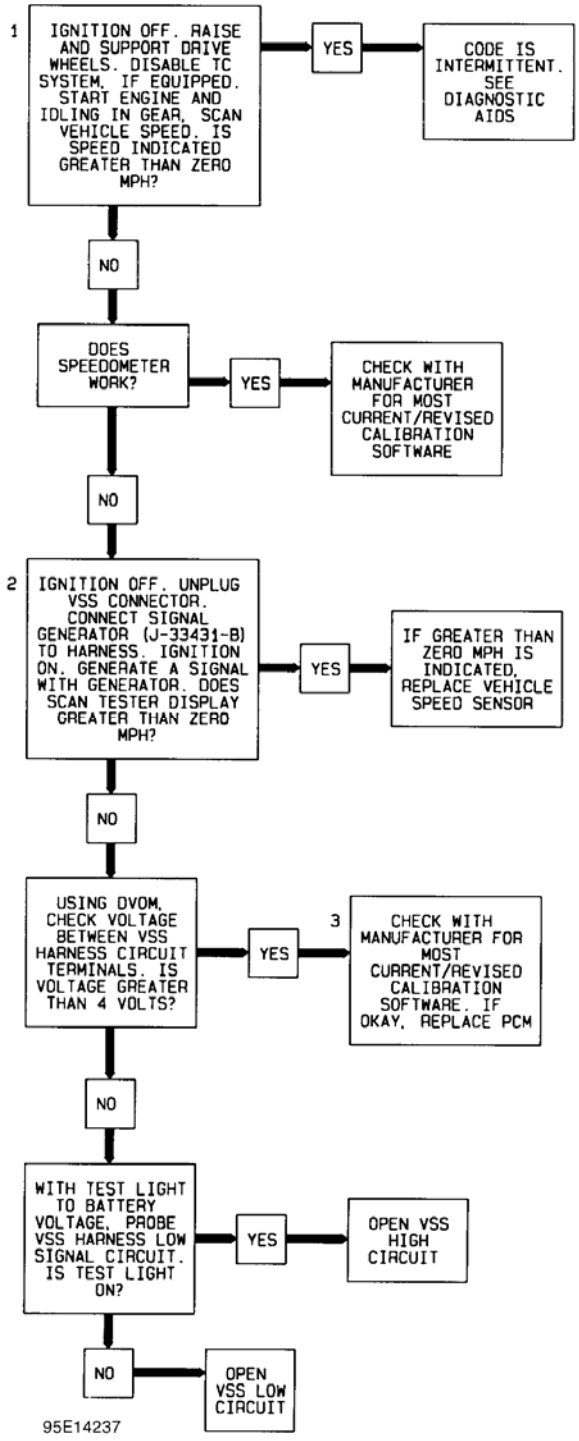


Fig. 85: Code 72 Diagnostic Flow Chart (Caprice) Vehicle Speed Sensor Loss

CODE 73, PRESSURE CONTROL SOLENOID

Pressure control solenoid is a PCM-controlled device used to regulate transmission line pressure. PCM

compares TPS voltage, engine RPM and other inputs to determine proper line pressure for a given load. PCM regulates pressure by applying a varying amperage to pressure control solenoid. Amperage varies from 0.1 to 1.1 amps.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks ability of the PCM to command pressure control solenoid.
2. Checks for voltage at PCM.

Diagnostic Aids

Check for poor connections at PCM and at transmission connector.

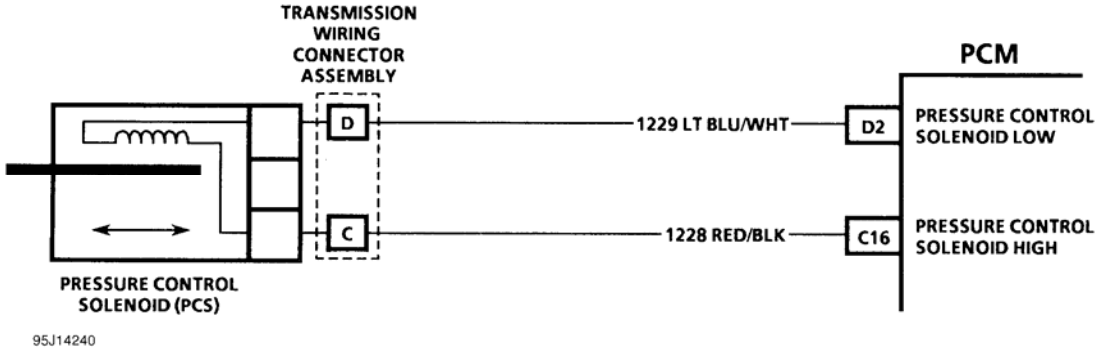


Fig. 86: Code 73 Schematic (Caprice) Pressure Control Solenoid

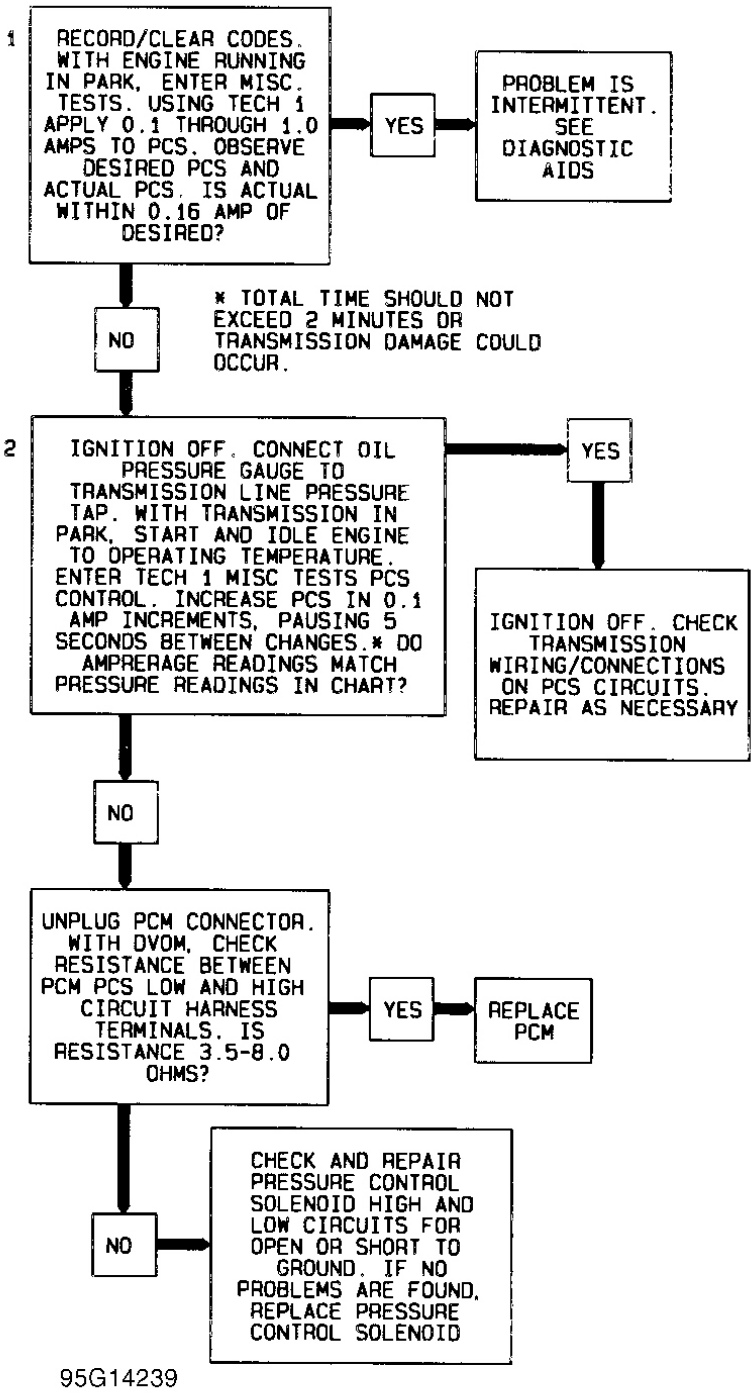


Fig. 87: Code 73 Diagnostic Flow Chart (Caprice) Pressure Control Solenoid

CODE 75, TRANSMISSION VOLTAGE LOW

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for normal battery voltage of 9-15 volts.
2. Checks if low voltage is due to generator voltage supply circuit, or PCM. If voltage is less than 9 volts, PCM is okay.

Diagnostic Aids

If code sets when an accessory is operated, check for poor connections or excessive current draw. Also, check for poor connections at starter solenoid or fusible link.

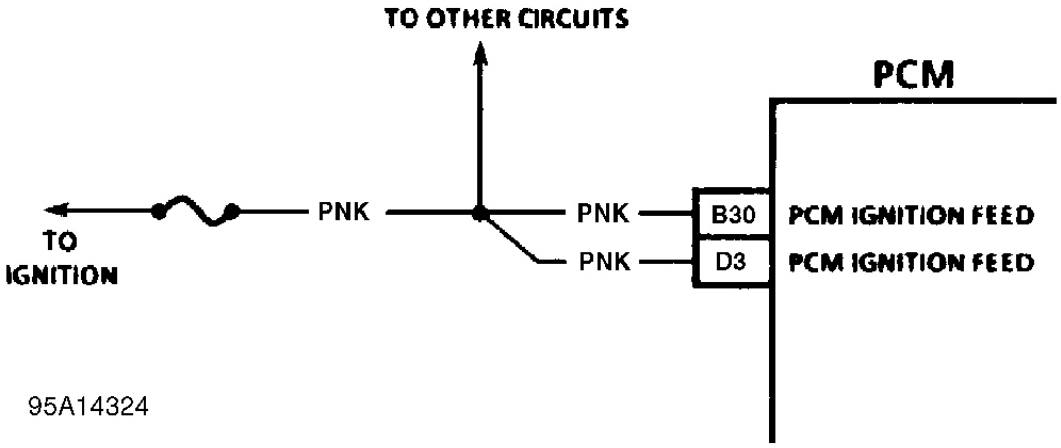


Fig. 88: Code 75 Schematic (Caprice) Transmission Voltage Low

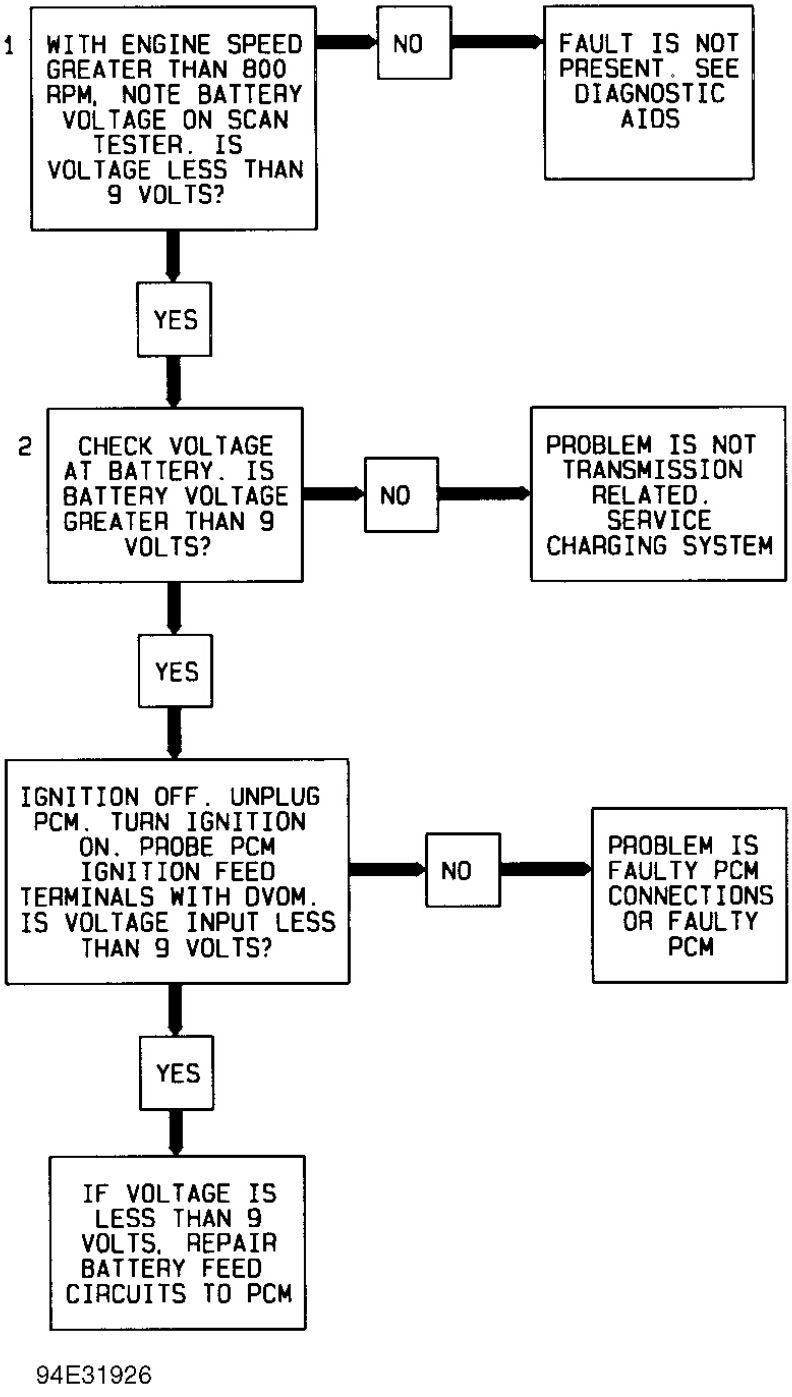


Fig. 89: Code 75 Diagnostic Flow Chart (Caprice) Transmission Voltage Low

CODE 77, PRIMARY COOLING FAN DRIVER

Cooling fan relay is supplied voltage when ignition is on. PCM controls solenoid valve by providing a ground

through one of its Quad-Driver Modules (QDM). When relay is actuated, terminal is grounded and its monitored voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Even if the fan does not operate, listen for an audible click from relay.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative relay.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

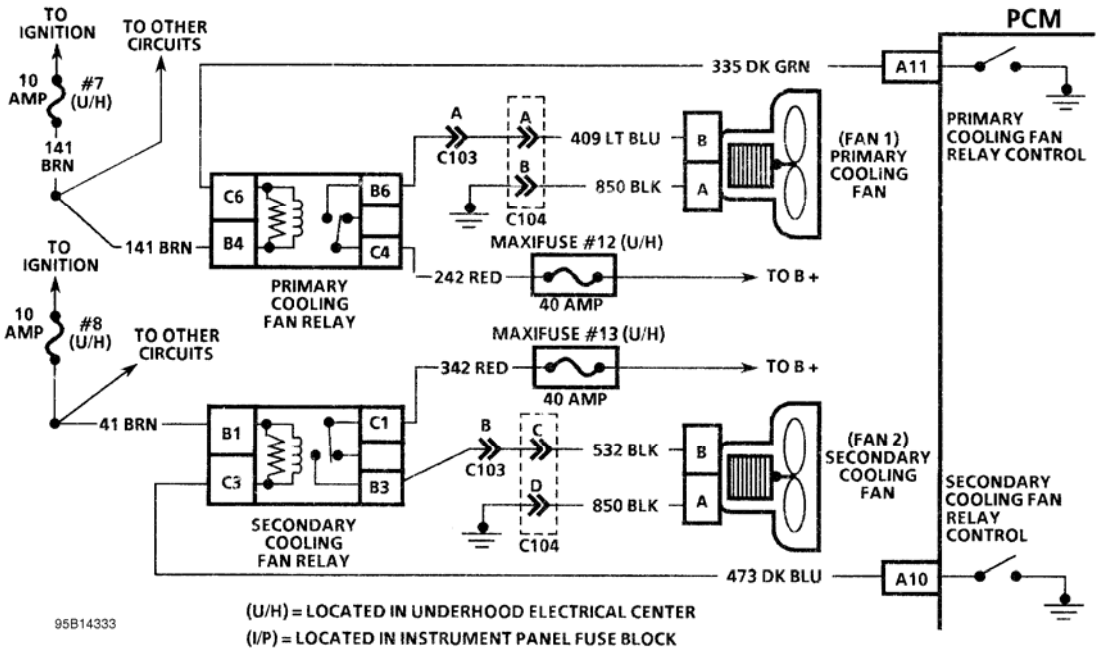


Fig. 90: Code 77 Schematic (Caprice) Primary Cooling Fan Driver

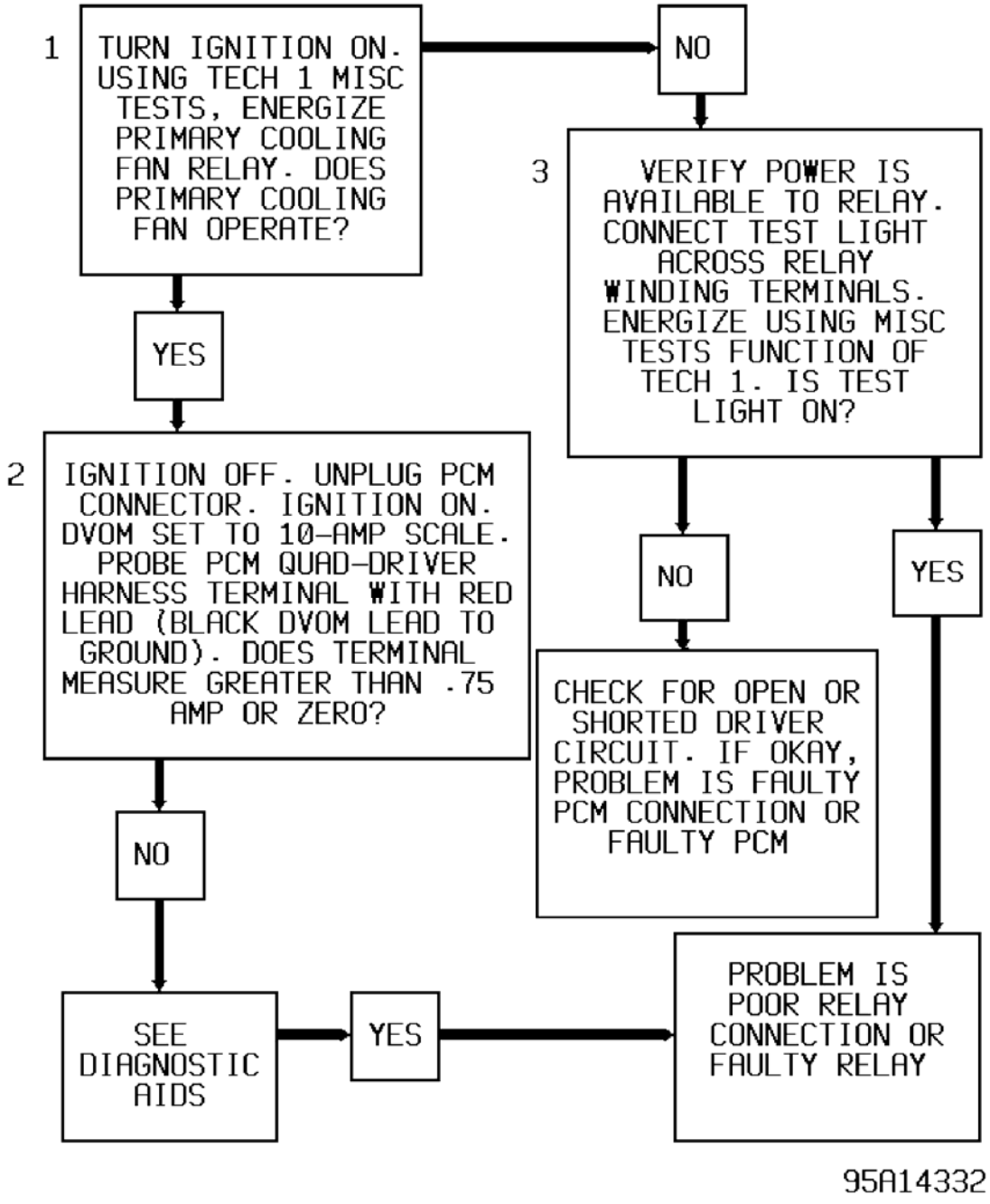


Fig. 91: Code 77 Diagnostic Flow Chart (Caprice) Primary Cooling Fan Driver

CODE 78, SECONDARY COOLING FAN DRIVER

Cooling fan relay is supplied voltage when ignition is on. PCM controls solenoid valve by providing a ground through one of its Quad-Driver Modules (QDM). When relay is actuated, terminal is grounded and its monitored voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Even if the fan does not operate, listen for an audible click from relay.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative relay.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

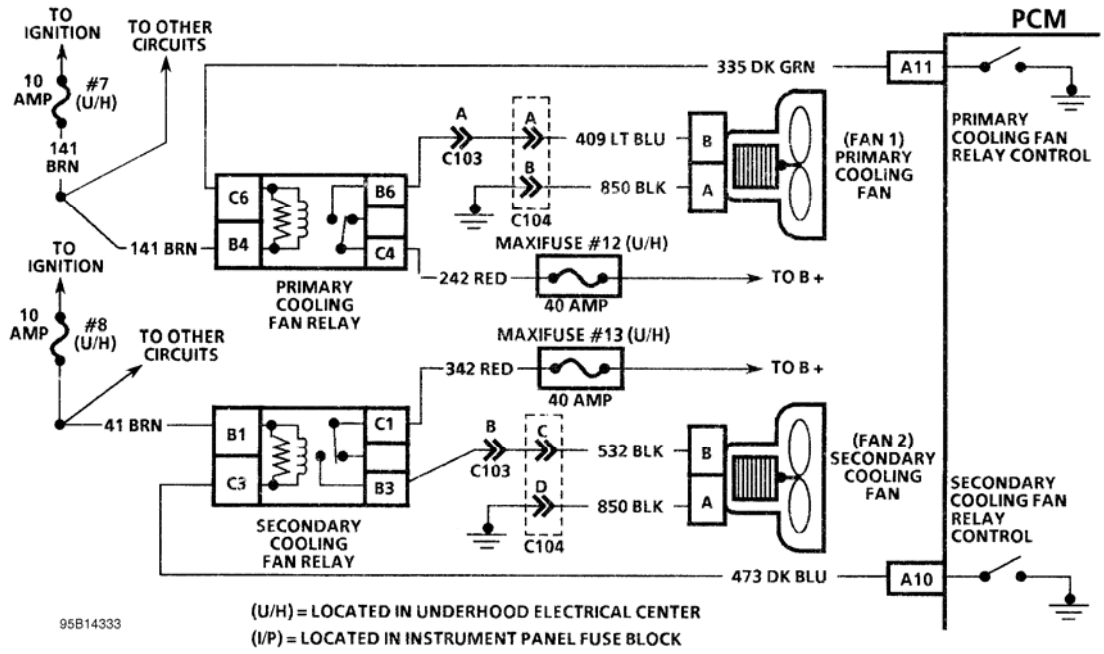


Fig. 92: Code 78 Schematic (Caprice) Secondary Cooling Fan Driver

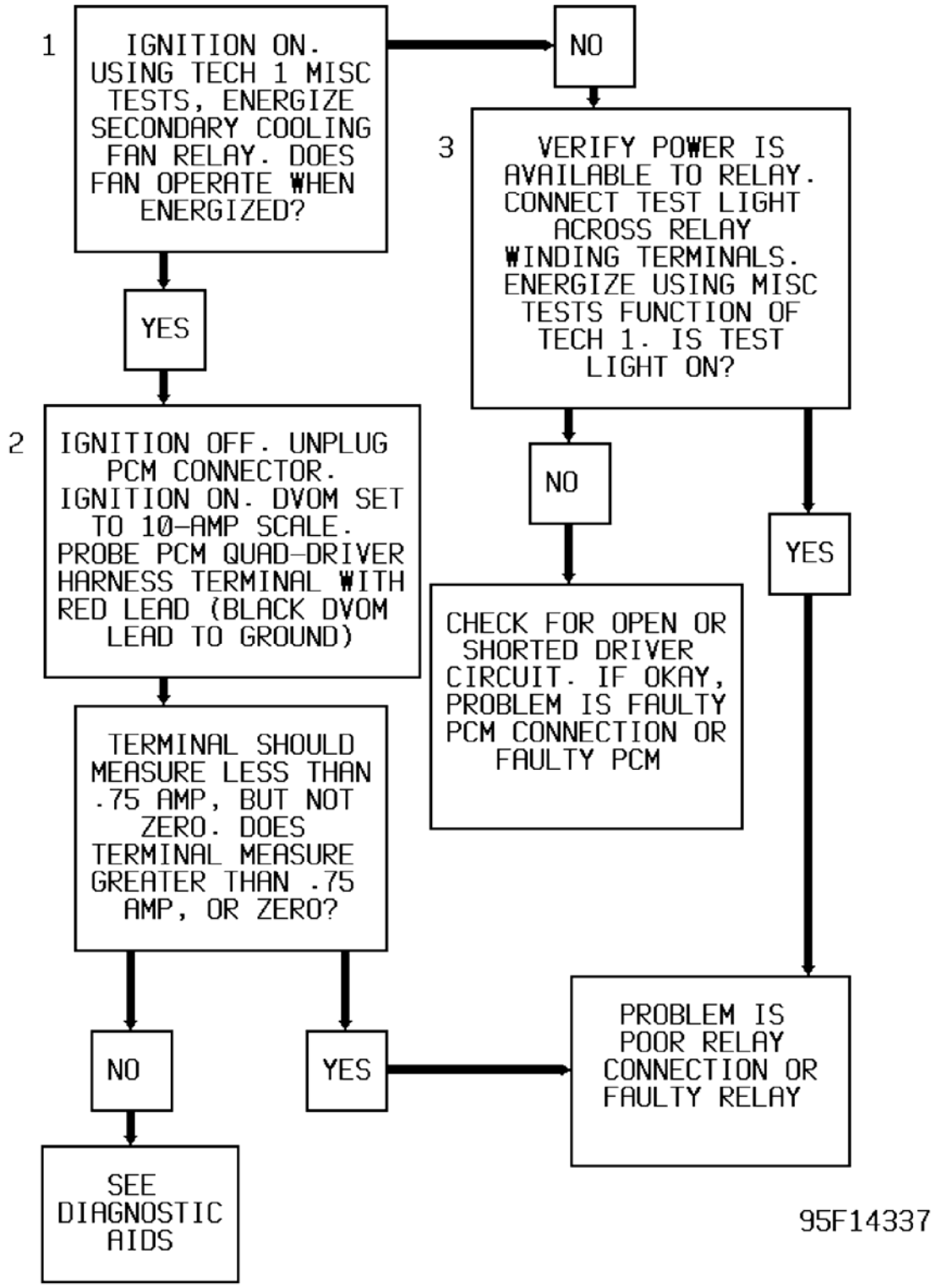


Fig. 93: Code 78 Diagnostic Flow Chart (Caprice) Secondary Cooling Fan Driver

CODE 79, TRANSMISSION FLUID OVERTEMP

PCM supplies and monitors a 5-volt reference to sensor. As transmission temperature changes, sensor resistance changes, affecting monitored voltage. When fluid is cold, resistance is high, resulting in a high monitored voltage. When fluid is hot, resistance is low, resulting in a low monitored voltage. Code will set if transmission temperature is 120-130°C for 5 seconds and Codes 58 and 59 are not set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for out-of-calibration sensor or shorted circuit. 2 Simulates Code 59.

Diagnostic Aids

Check harness for potential short to ground. See Code 59 chart to check transmission temperature sensor temperature-to-resistance values. Also, check transmission fluid level. Check for conditions which could cause transmission to overheat i.e. trailer towing, steep grades, etc.

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

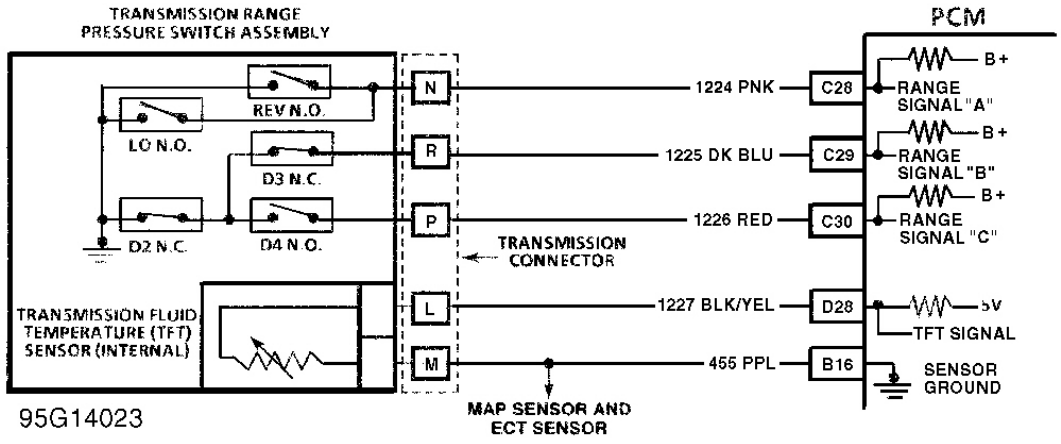


Fig. 94: Code 79 Schematic (Caprice) Transmission Fluid Overtemp

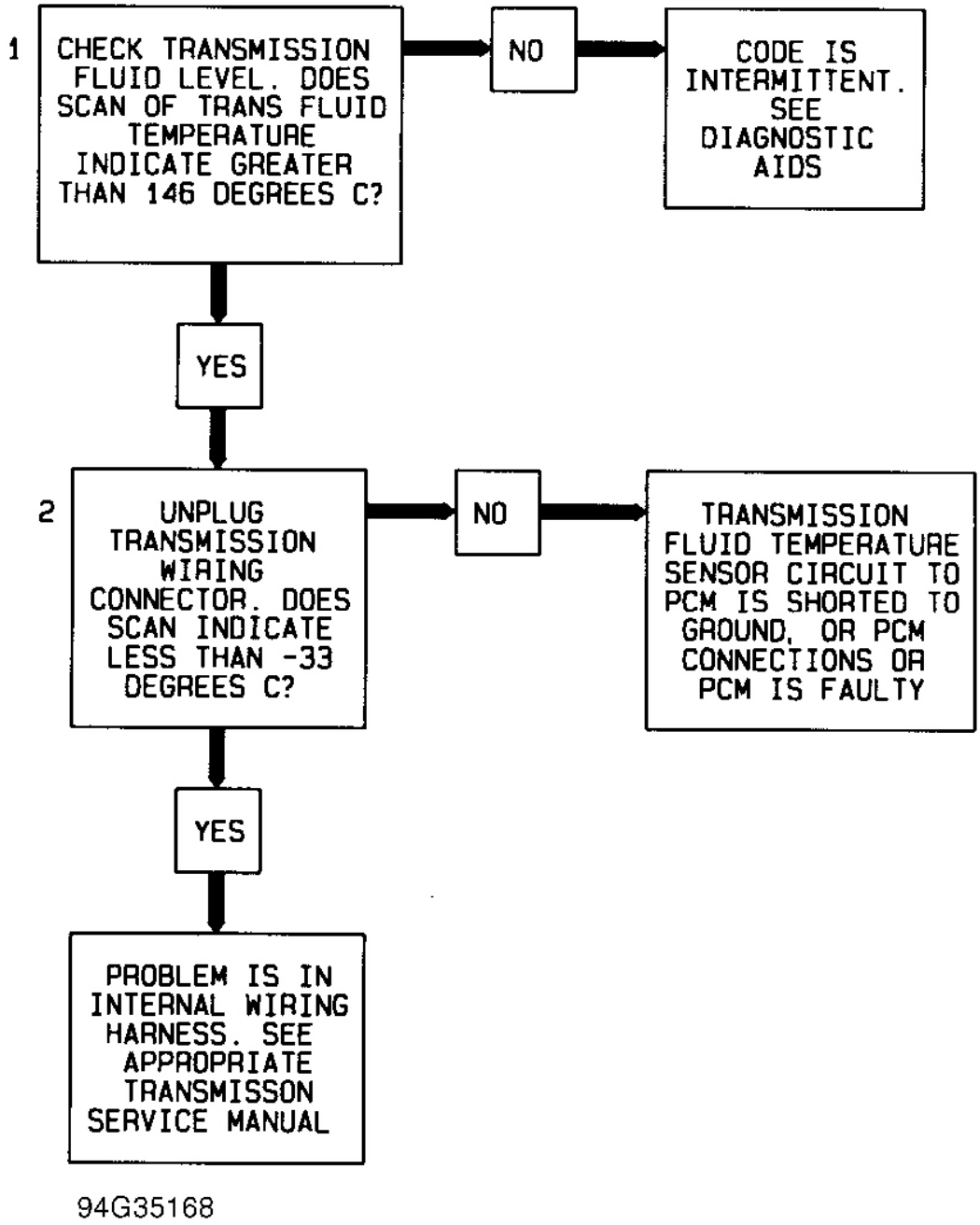


Fig. 95: Code 79 Diagnostic Flow Chart (Caprice) Transmission Fluid Overtemp

CODE 81, 2-3 SHIFT SOLENOID

Voltage is supplied directly to solenoid. PCM controls solenoid by providing a ground circuit.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks 2-3 shift solenoid and internal transmission for shorts.
2. Checks for power to 2-3 shift solenoid from ignition through the fuse.

Diagnostic Aids

Check all connections at the transmission. An open in ignition feed circuit can cause multiple codes to set.

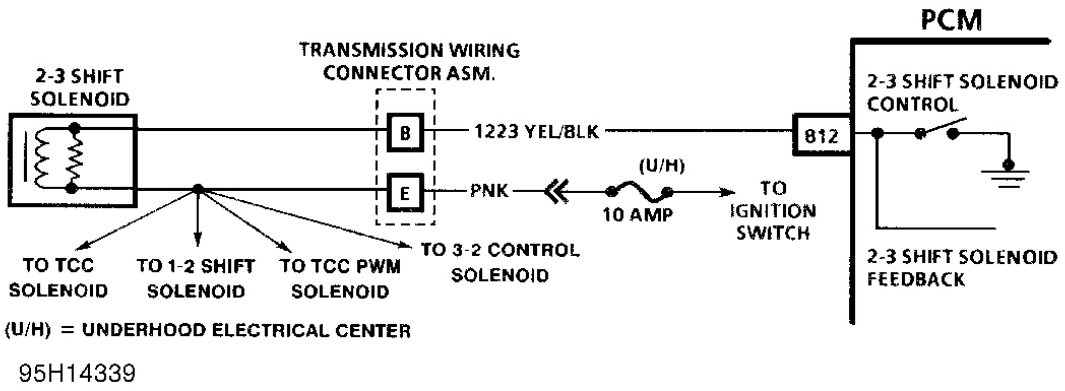
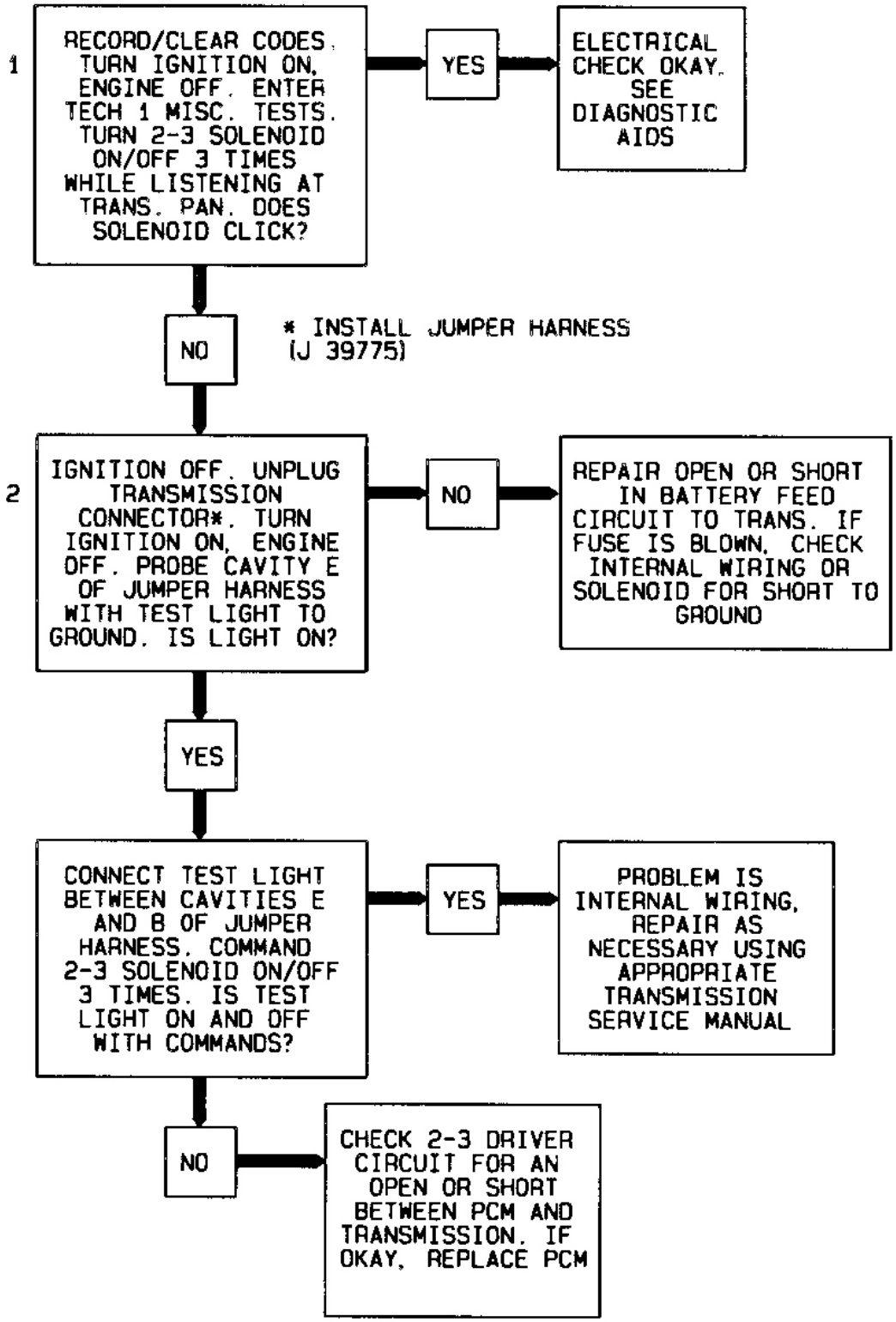


Fig. 96: Code 81 Schematic (Caprice) 2-3 Shift Solenoid


1
RECORD/CLEAR CODES. TURN IGNITION ON, ENGINE OFF. ENTER TECH 1 MISC. TESTS. TURN 2-3 SOLENOID ON/OFF 3 TIMES WHILE LISTENING AT TRANS. PAN. DOES SOLENOID CLICK?
YES
ELECTRICAL CHECK OKAY. SEE DIAGNOSTIC AIDS
NO
* INSTALL JUMPER HARNESS (J 39775)
2
IGNITION OFF. UNPLUG TRANSMISSION CONNECTOR*. TURN IGNITION ON, ENGINE OFF. PROBE CAVITY E OF JUMPER HARNESS WITH TEST LIGHT TO GROUND. IS LIGHT ON?
NO
REPAIR OPEN OR SHORT IN BATTERY FEED CIRCUIT TO TRANS. IF FUSE IS BLOWN, CHECK INTERNAL WIRING OR SOLENOID FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN CAVITIES E AND B OF JUMPER HARNESS. COMMAND 2-3 SOLENOID ON/OFF 3 TIMES. IS TEST LIGHT ON AND OFF WITH COMMANDS?
YES
PROBLEM IS INTERNAL WIRING, REPAIR AS NECESSARY USING APPROPRIATE TRANSMISSION SERVICE MANUAL
NO
CHECK 2-3 DRIVER CIRCUIT FOR AN OPEN OR SHORT BETWEEN PCM AND TRANSMISSION. IF OKAY, REPLACE PCM

94C31940

Fig. 97: Code 81 Diagnostic Flow Chart (Caprice) 2-3 Shift Solenoid

CODE 82, 1-2 SHIFT SOLENOID

Voltage is supplied directly to solenoid. PCM controls solenoid by providing a ground circuit for solenoid.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks 1-2 shift solenoid and internal transmission for shorts.
2. Checks for power to 1-2 shift solenoid from ignition through the fuse.

Diagnostic Aids

Check all connections at the transmission. An open in ignition feed circuit can cause multiple codes to set.

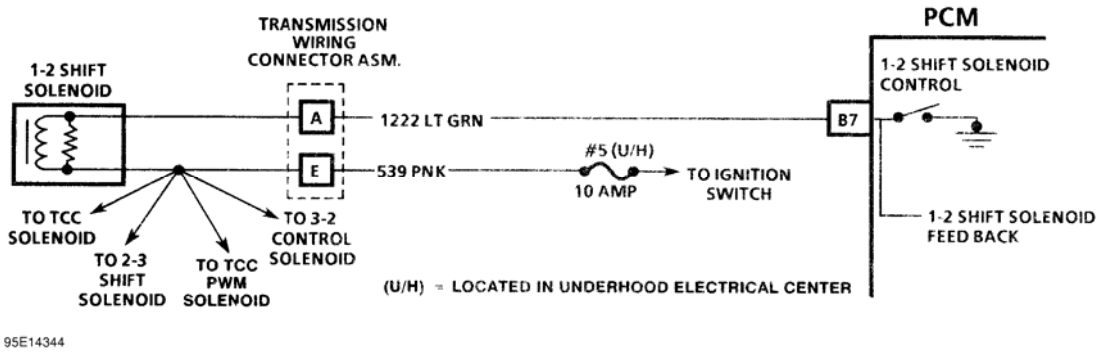
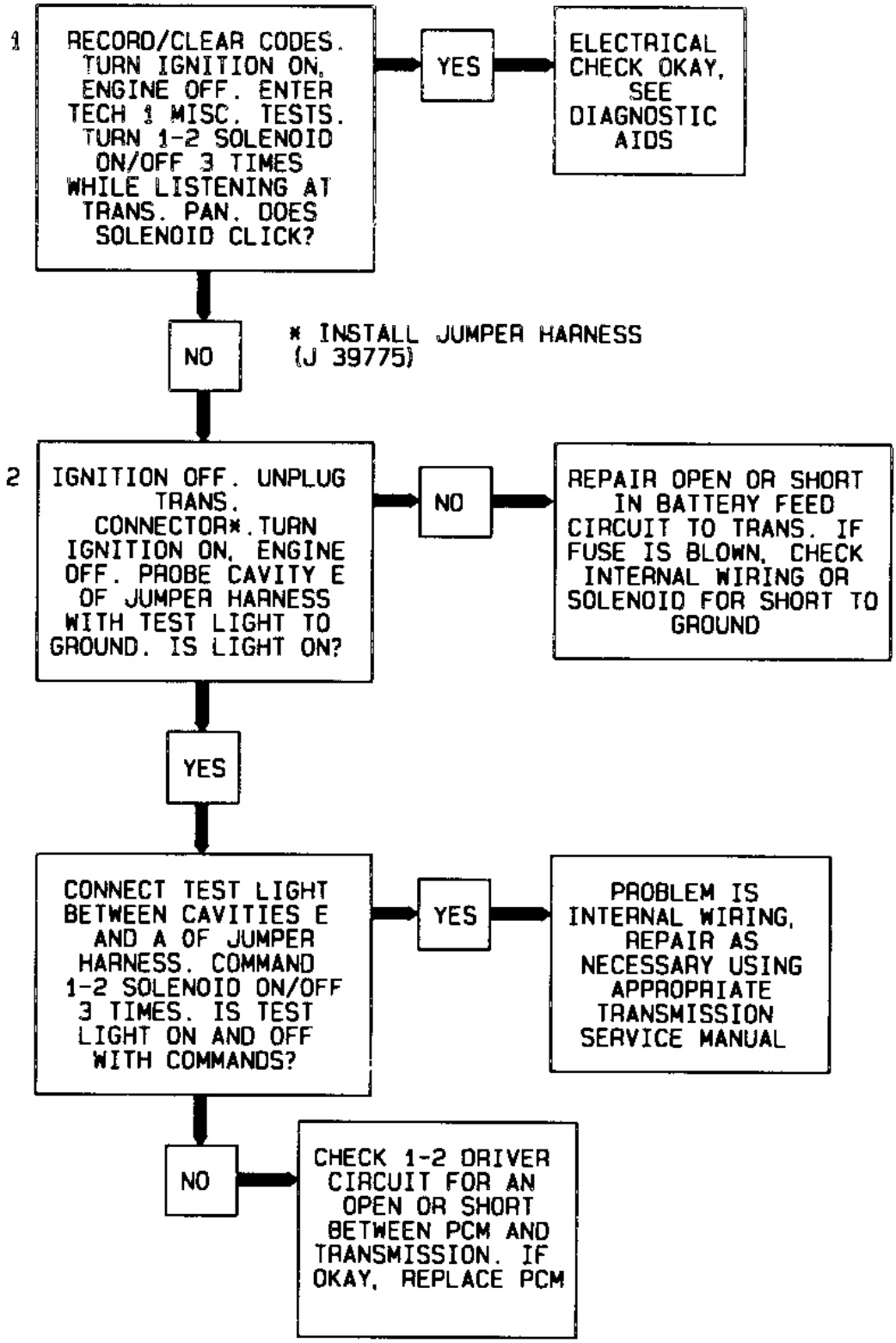


Fig. 98: Code 82 Schematic (Caprice) 1-2 Shift Solenoid


1
RECORD/CLEAR CODES. TURN IGNITION ON, ENGINE OFF. ENTER TECH 1 MISC. TESTS. TURN 1-2 SOLENOID ON/OFF 3 TIMES WHILE LISTENING AT TRANS. PAN. DOES SOLENOID CLICK?
YES
ELECTRICAL CHECK OKAY, SEE DIAGNOSTIC AIDS
NO
* INSTALL JUMPER HARNESS (J 39775)
2
IGNITION OFF. UNPLUG TRANS. CONNECTOR*. TURN IGNITION ON, ENGINE OFF. PROBE CAVITY E OF JUMPER HARNESS WITH TEST LIGHT TO GROUND. IS LIGHT ON?
NO
REPAIR OPEN OR SHORT IN BATTERY FEED CIRCUIT TO TRANS. IF FUSE IS BLOWN, CHECK INTERNAL WIRING OR SOLENOID FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN CAVITIES E AND A OF JUMPER HARNESS. COMMAND 1-2 SOLENOID ON/OFF 3 TIMES. IS TEST LIGHT ON AND OFF WITH COMMANDS?
YES
PROBLEM IS INTERNAL WIRING, REPAIR AS NECESSARY USING APPROPRIATE TRANSMISSION SERVICE MANUAL
NO
CHECK 1-2 DRIVER CIRCUIT FOR AN OPEN OR SHORT BETWEEN PCM AND TRANSMISSION. IF OKAY, REPLACE PCM

94H31952

Fig. 99: Code 82 Diagnostic Flow Chart (Caprice) 1-2 Shift Solenoid

CODE 83, TCC PWM SOLENOID - A/T

PCM controls and monitors TCC PWM solenoid drive circuit. If voltage remains high when solenoid is commanded on or remains low when commanded off, code will set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks if PCM is commanding TCC solenoid on.
2. Checks for voltage to solenoid.

Diagnostic Aids

Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connections or damaged harness. Perform intermittent check by monitoring circuit and code status while wiggling related wiring and connectors. If failure is induced, monitored circuit status will change rapidly and/or related code will set.

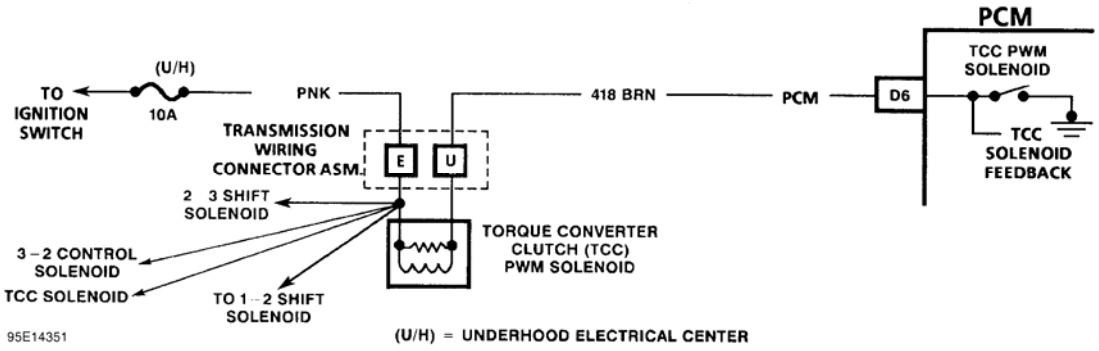
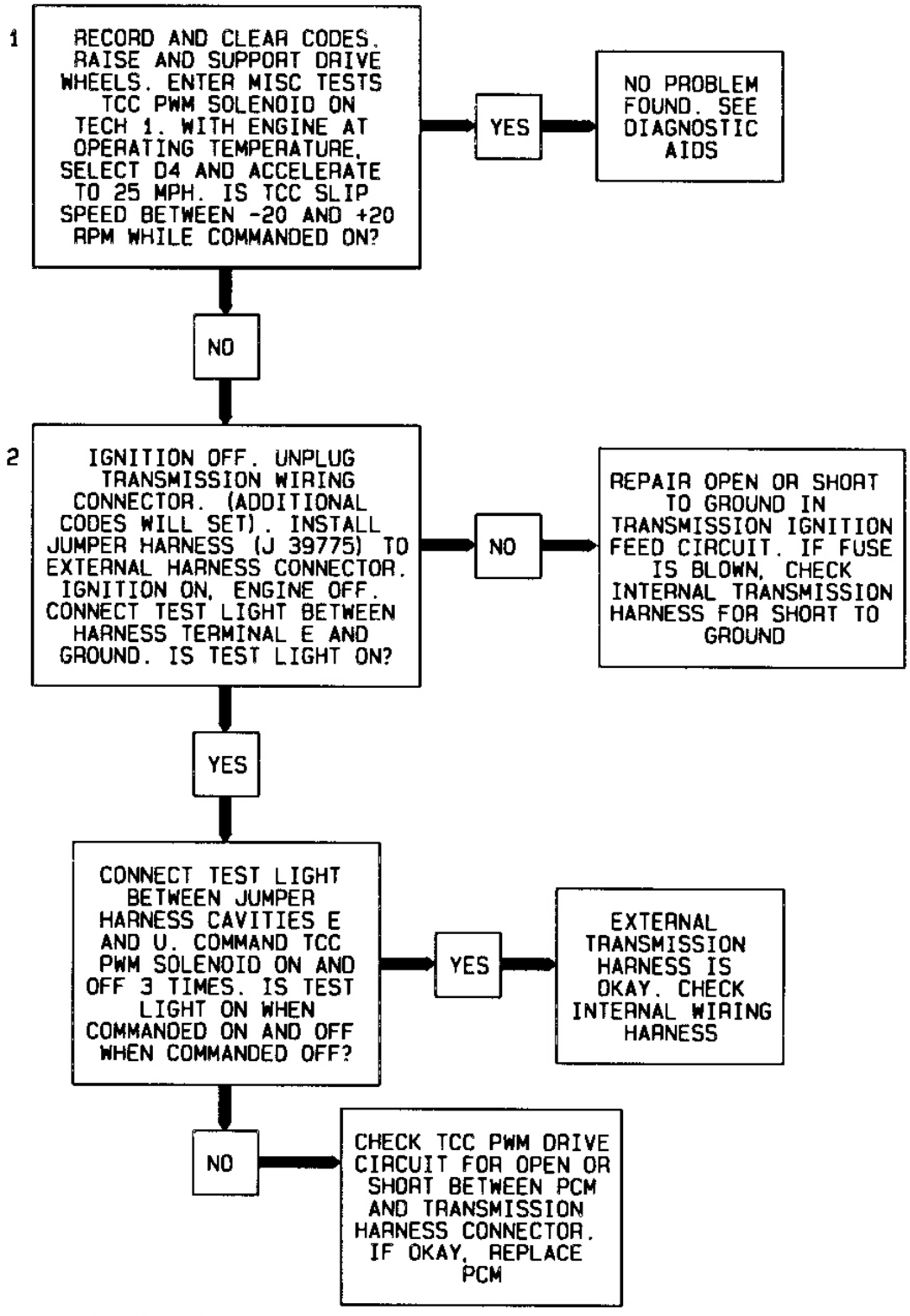


Fig. 100: Code 83 Schematic (Caprice W/ A/T) TCC PWM Solenoid


1
RECORD AND CLEAR CODES. RAISE AND SUPPORT DRIVE WHEELS. ENTER MISC TESTS TCC PWM SOLENOID ON TECH 1. WITH ENGINE AT OPERATING TEMPERATURE, SELECT D4 AND ACCELERATE TO 25 MPH. IS TCC SLIP SPEED BETWEEN -20 AND +20 RPM WHILE COMMANDED ON?
YES
NO PROBLEM FOUND. SEE DIAGNOSTIC AIDS
NO
2
IGNITION OFF. UNPLUG TRANSMISSION WIRING CONNECTOR. (ADDITIONAL CODES WILL SET). INSTALL JUMPER HARNESS (J 39775) TO EXTERNAL HARNESS CONNECTOR. IGNITION ON, ENGINE OFF. CONNECT TEST LIGHT BETWEEN HARNESS TERMINAL E AND GROUND. IS TEST LIGHT ON?
NO
REPAIR OPEN OR SHORT TO GROUND IN TRANSMISSION IGNITION FEED CIRCUIT. IF FUSE IS BLOWN, CHECK INTERNAL TRANSMISSION HARNESS FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN JUMPER HARNESS CAVITIES E AND U. COMMAND TCC PWM SOLENOID ON AND OFF 3 TIMES. IS TEST LIGHT ON WHEN COMMANDED ON AND OFF WHEN COMMANDED OFF?
YES
EXTERNAL TRANSMISSION HARNESS IS OKAY. CHECK INTERNAL WIRING HARNESS
NO
CHECK TCC PWM DRIVE CIRCUIT FOR OPEN OR SHORT BETWEEN PCM AND TRANSMISSION HARNESS CONNECTOR. IF OKAY, REPLACE PCM

95D14350

Fig. 101: Code 83 Diagnostic Flow Chart (Caprice W/ A/T) TCC PWM Solenoid

CODE 84, 3-2 CONTROL SOLENOID - WITH A/T

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks 3-2 shift solenoid and internal transmission harness for shorts.
2. Checks for power to 3-2 shift solenoid from ignition through the fuse.

Diagnostic Aids

Check all connections at the transmission. An open in ignition feed circuit can cause multiple codes to set.

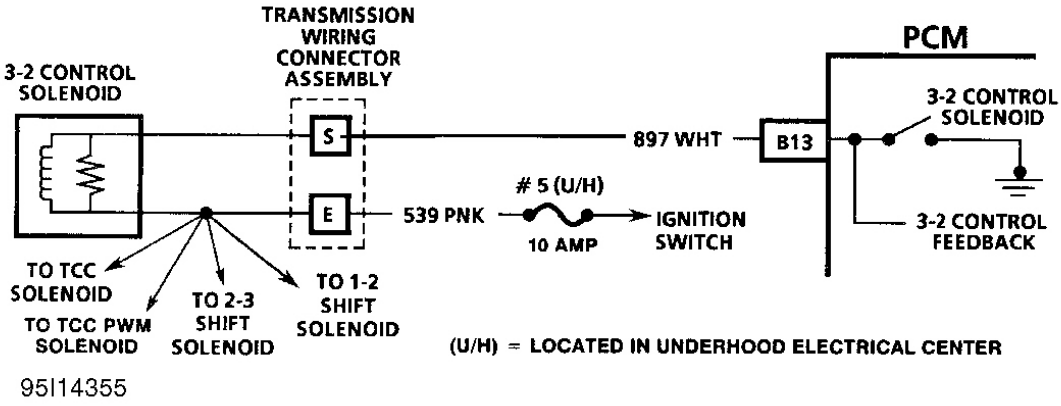


Fig. 102: Code 84 Schematic (Caprice With A/T) 3-2 Control Solenoid

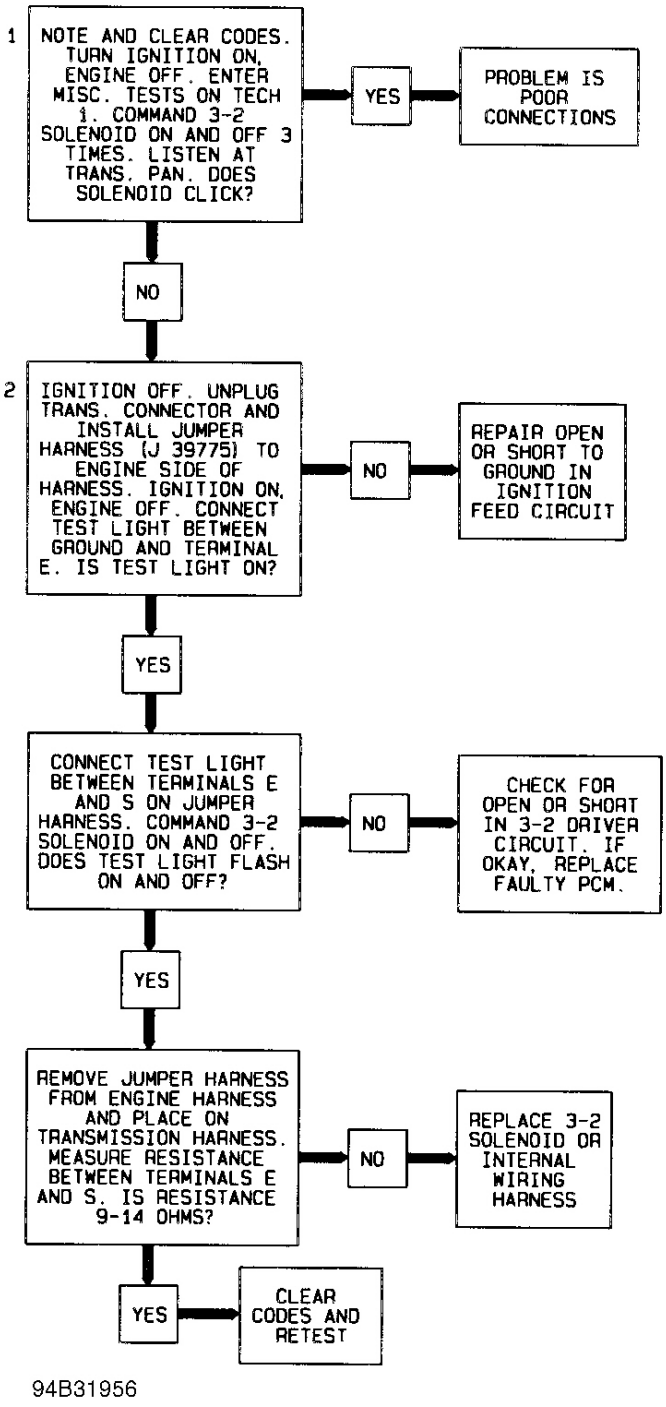


Fig. 103: Code 84 Diagnostic Flow Chart (Caprice With A/T) 3-2 Control Solenoid

CODE 85, TCC STUCK ON

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks mechanical state of TCC when PCM commands TCC solenoid off. TCC slip speed should increase.

Diagnostic Aids

Check for proper TP sensor operation. If TCC is mechanically stuck on, vehicle speed is zero, brakes are applied, and D2 is selected, TCC fluid will mechanically apply the TCC, causing an engine stall.

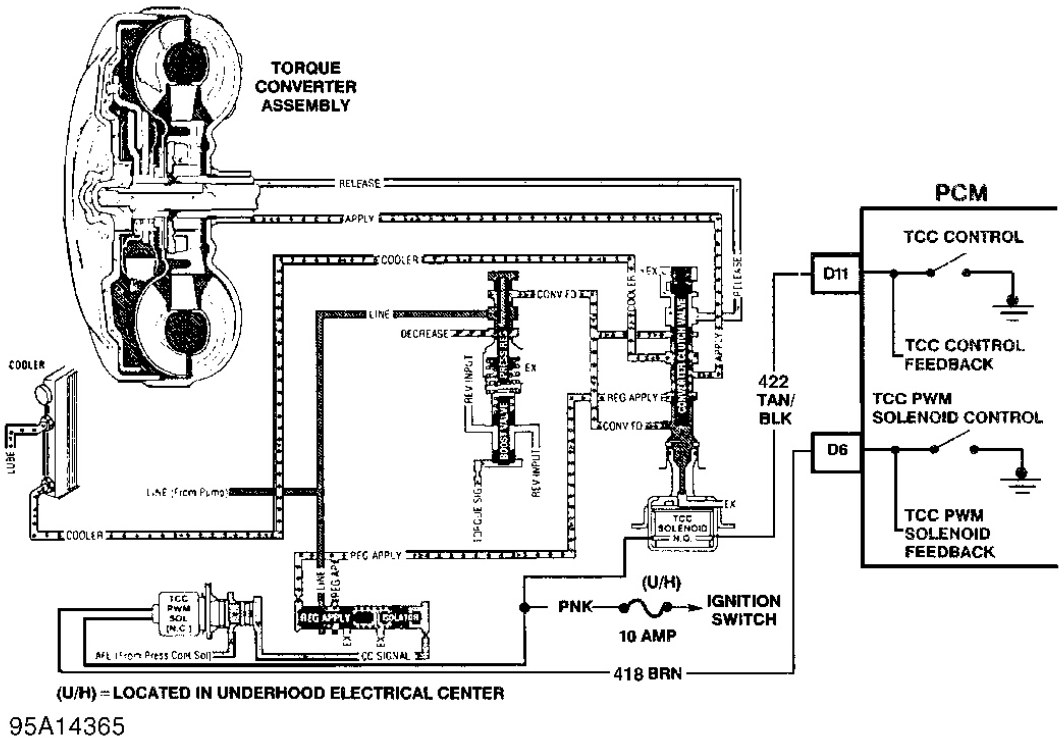


Fig. 104: Code 85 Schematic (Caprice) TCC Stuck On

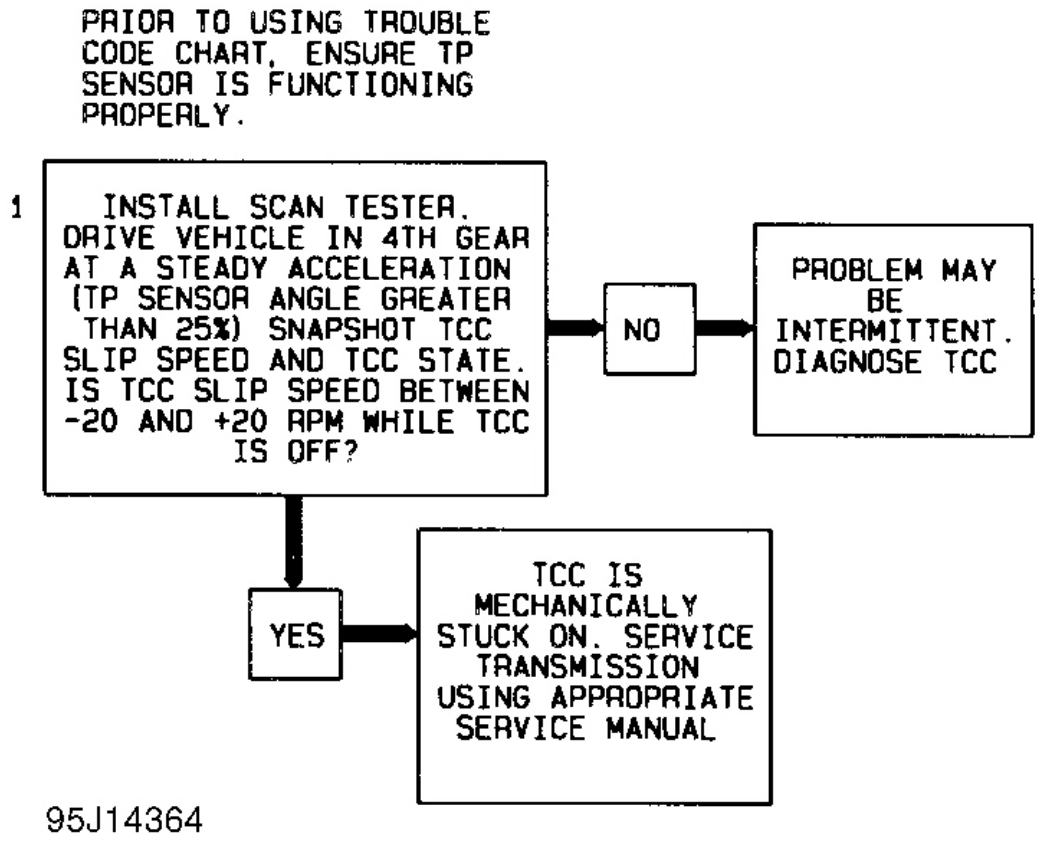


Fig. 105: Code 85 Diagnostic Flow Chart (Caprice) TCC Stuck On

CODE 90, TCC SOLENOID CIRCUIT

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for a shorted internal transmission harness or TCC solenoid.
2. Checks power supply to TCC solenoid.

Diagnostic Aids

Check all connections to transmission pass-through connector. An open in the ignition feed circuit will cause multiple codes to set.

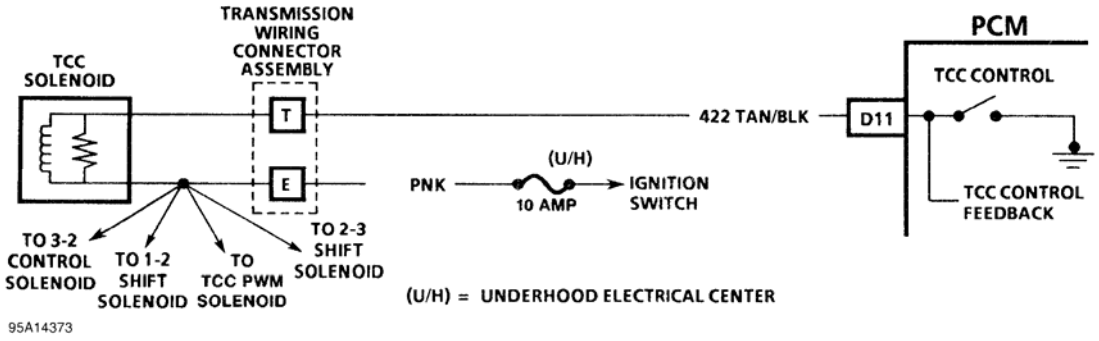


Fig. 106: Code 90 Schematic (Caprice) TCC Solenoid Circuit

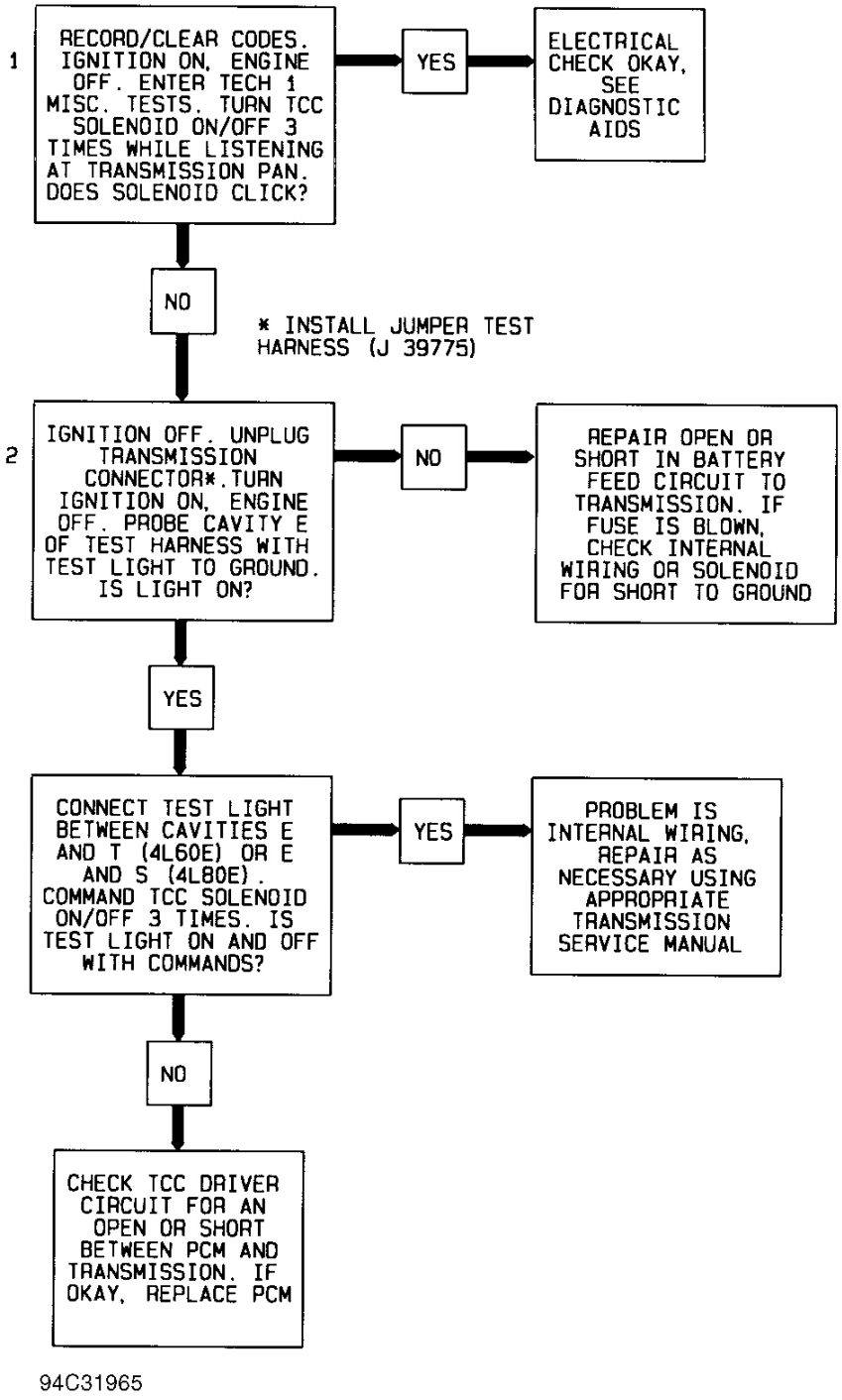


Fig. 107: Code 90 Diagnostic Flow Chart (Caprice) TCC Solenoid Circuit

CODE 95, CHANGE OIL LIGHT

PCM monitors driving conditions and determines when to turn on change oil light. Maximum possible mileage

accumulation is 7500 miles; however, PCM may turn on light sooner depending upon driving conditions (i.e. temperature and engine load history). Code will set and PCM will turn on light if wrong monitored voltage is present on light circuit for 26 seconds or more. PCM will not turn on SERVICE ENGINE SOON light.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Unplugging PCM will determine if circuit is shorted to ground or if PCM is at fault.

Diagnostic Aids

To reset oil light, turn ignition on with engine off. Cycle accelerator pedal from closed throttle to wide open throttle 3 times within 5 seconds. If light will not reset, check throttle angle. Throttle angle must go from less than 7.5 percent to greater than 75 percent for reset to occur. If this cannot be obtained, check for binding linkage, cable or throttle shaft. Service as necessary.

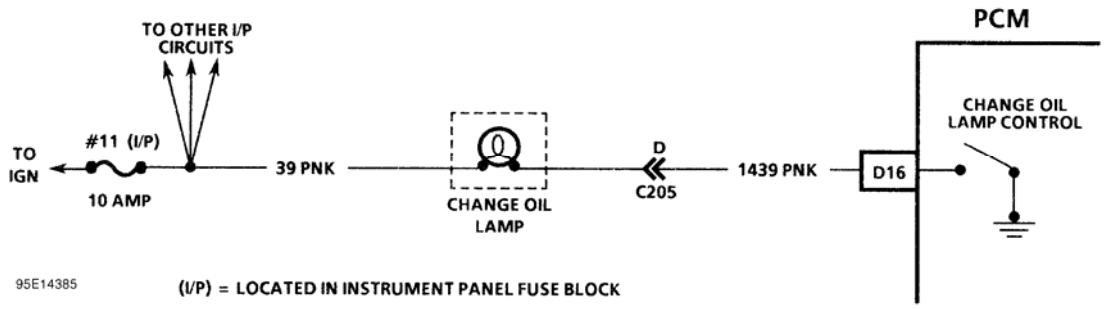


Fig. 108: Code 95 Schematic (Caprice) Change Oil Light

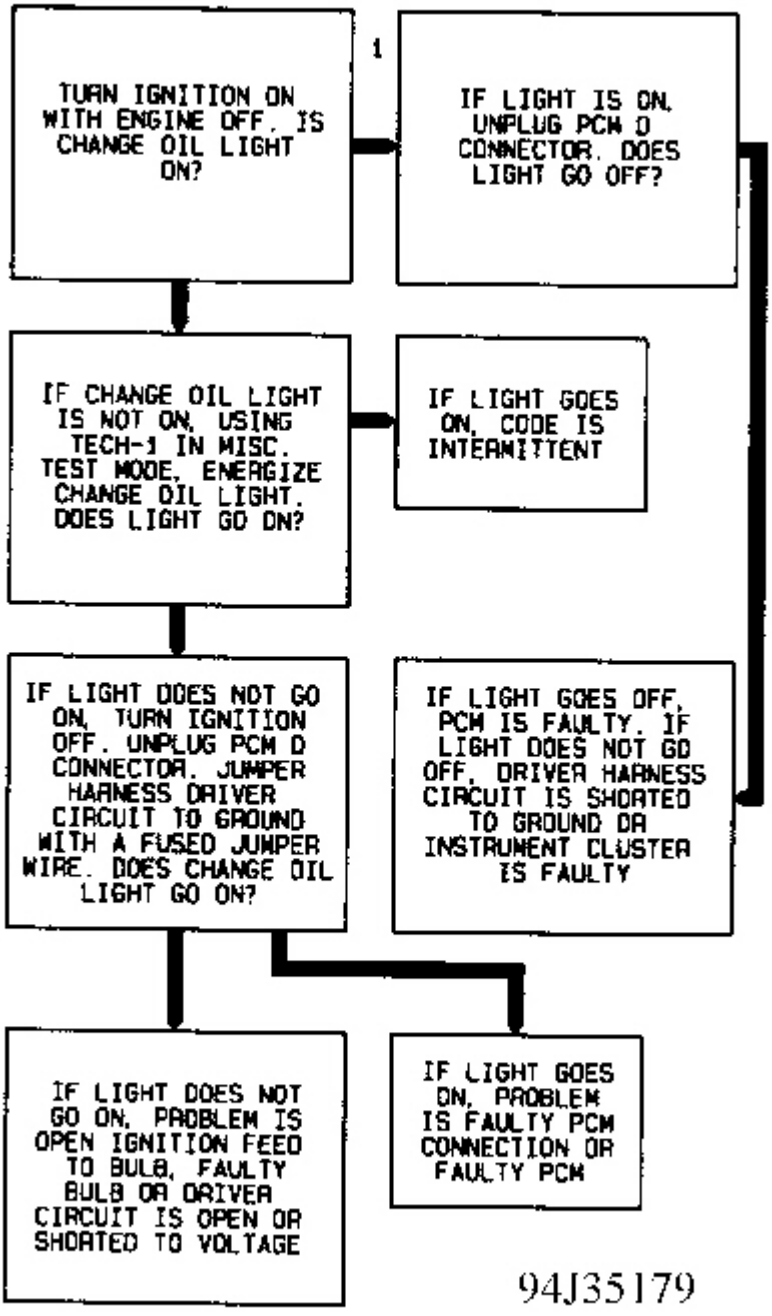


Fig. 109: Code 95 Diagnostic Flow Chart (Caprice) Change Oil Light

CODE 96, LOW OIL LIGHT

Code will set and PCM will turn on light if wrong monitored voltage is present on light circuit for 26 seconds or more. PCM will not turn on SERVICE ENGINE SOON light.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Unplugging PCM will determine if circuit is shorted to ground or if PCM is at fault.

Diagnostic Aids

Inspect harness and all related connections, including PCM connections. These may cause an intermittent code to set.

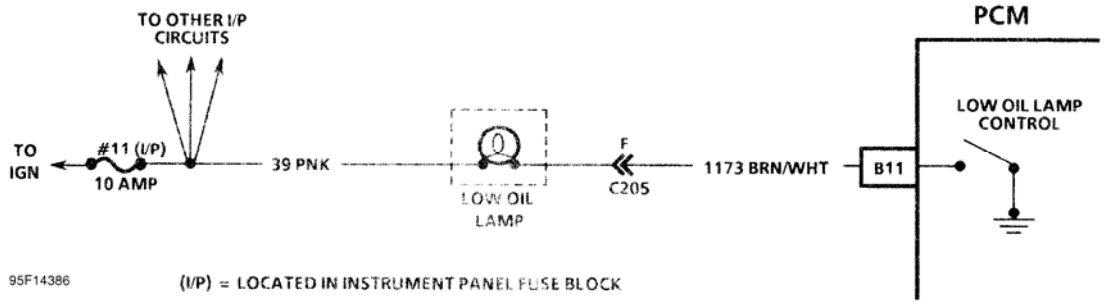


Fig. 110: Code 96 Schematic (Caprice) Low Oil Light

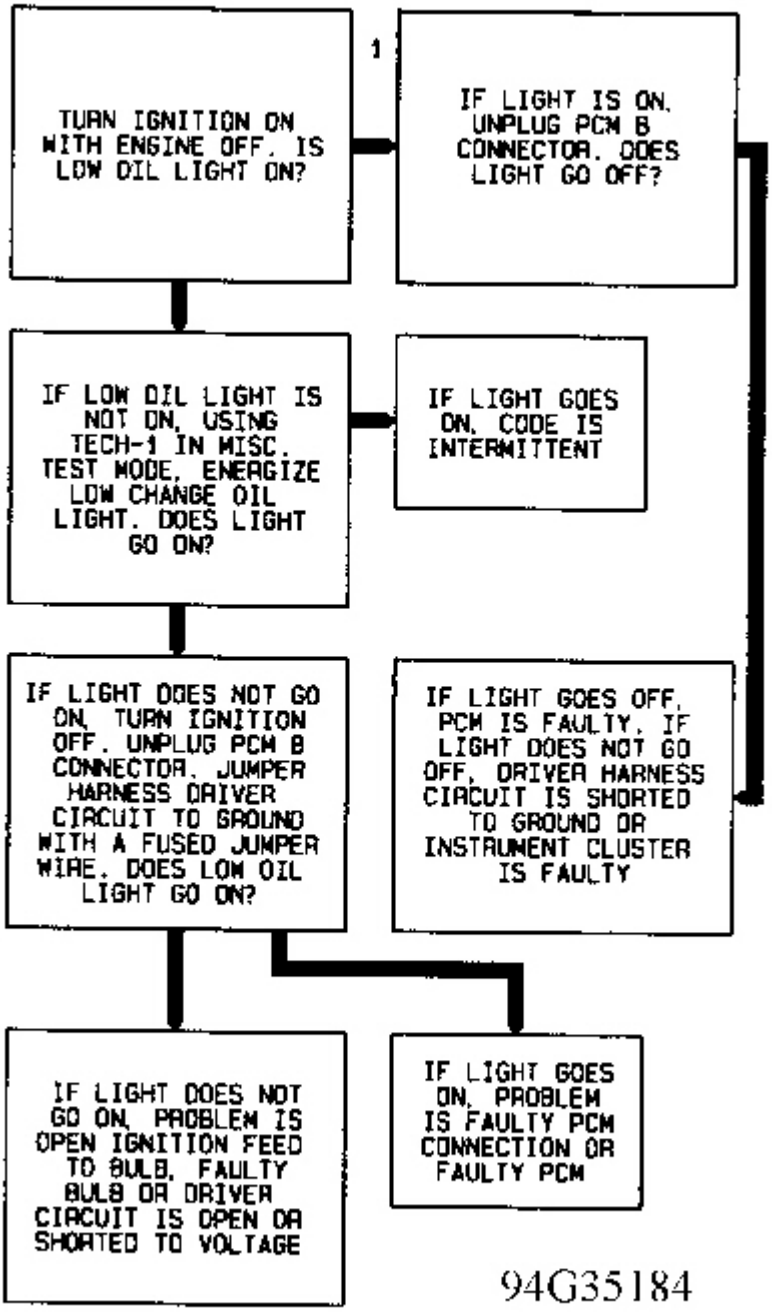


Fig. 111: Code 96 Diagnostic Flow Chart (Caprice) Low Oil Light

CODE 97, VSS OUTPUT CIRCUIT

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Disable Traction Control (TC) system (if equipped) prior to this step. Switch is located in glove box. Whenever ignition is cycled off and then on, TC system will default to on. If vehicle speed is indicated at this point, code is intermittent.
2. Use Jumper Harness (J 35616-A) to prevent damage to harness.

Diagnostic Aids

Inspect harness and all related connections, including PCM connections.

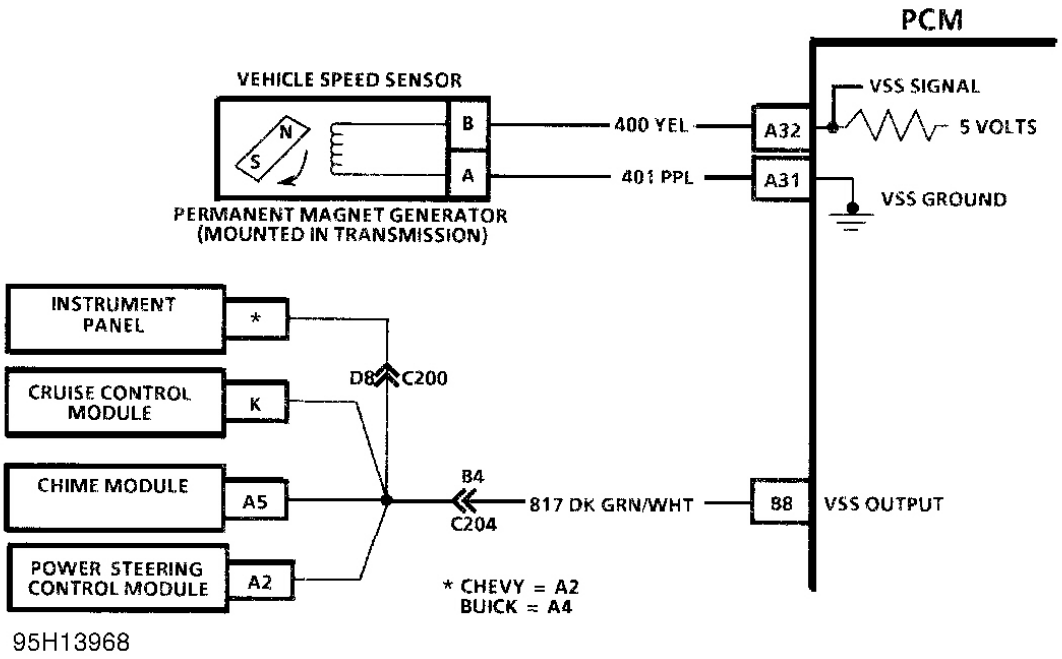


Fig. 112: Code 97 Schematic (Caprice) VSS Output Circuit

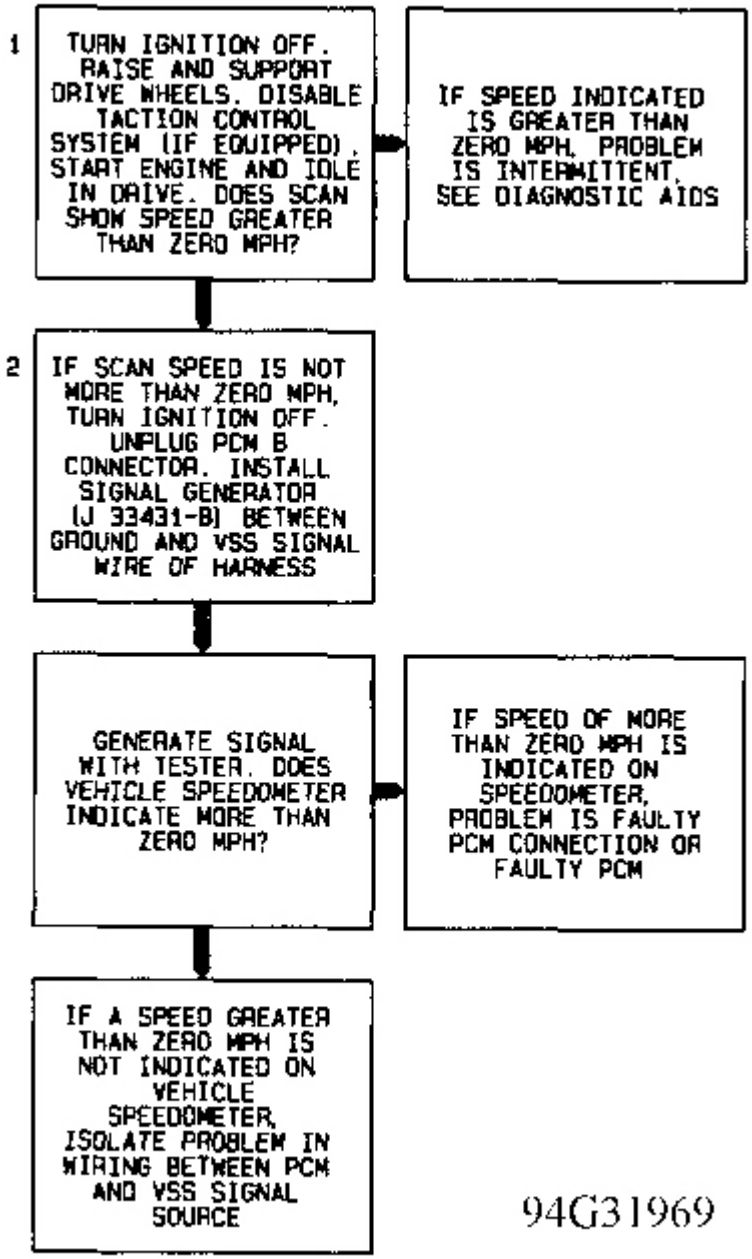


Fig. 113: Code 97 Diagnostic Flow Chart (Caprice) VSS Output Circuit

SUMMARY

If no hard fault codes are present, driveability symptoms exist or intermittent codes exist, proceed to appropriate **TESTS W/O CODES** article in this section for diagnosis by symptom (i.e., ROUGH IDLE, NO START, etc.) or intermittent diagnostic procedures.

WIRING DIAGRAMS

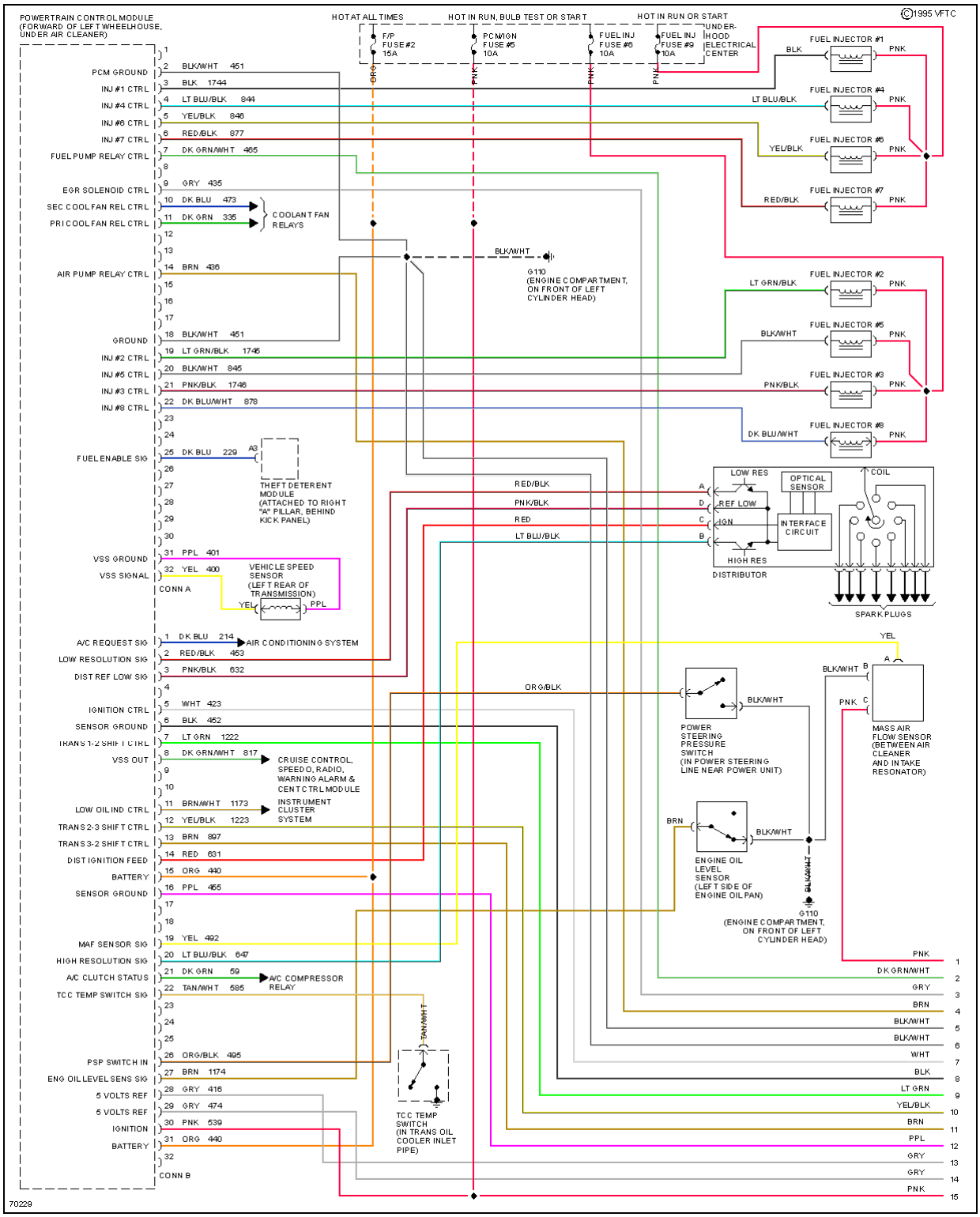


Fig. 114: 4.3L (VIN W) PCM Wiring Diagram (1 Of 3)

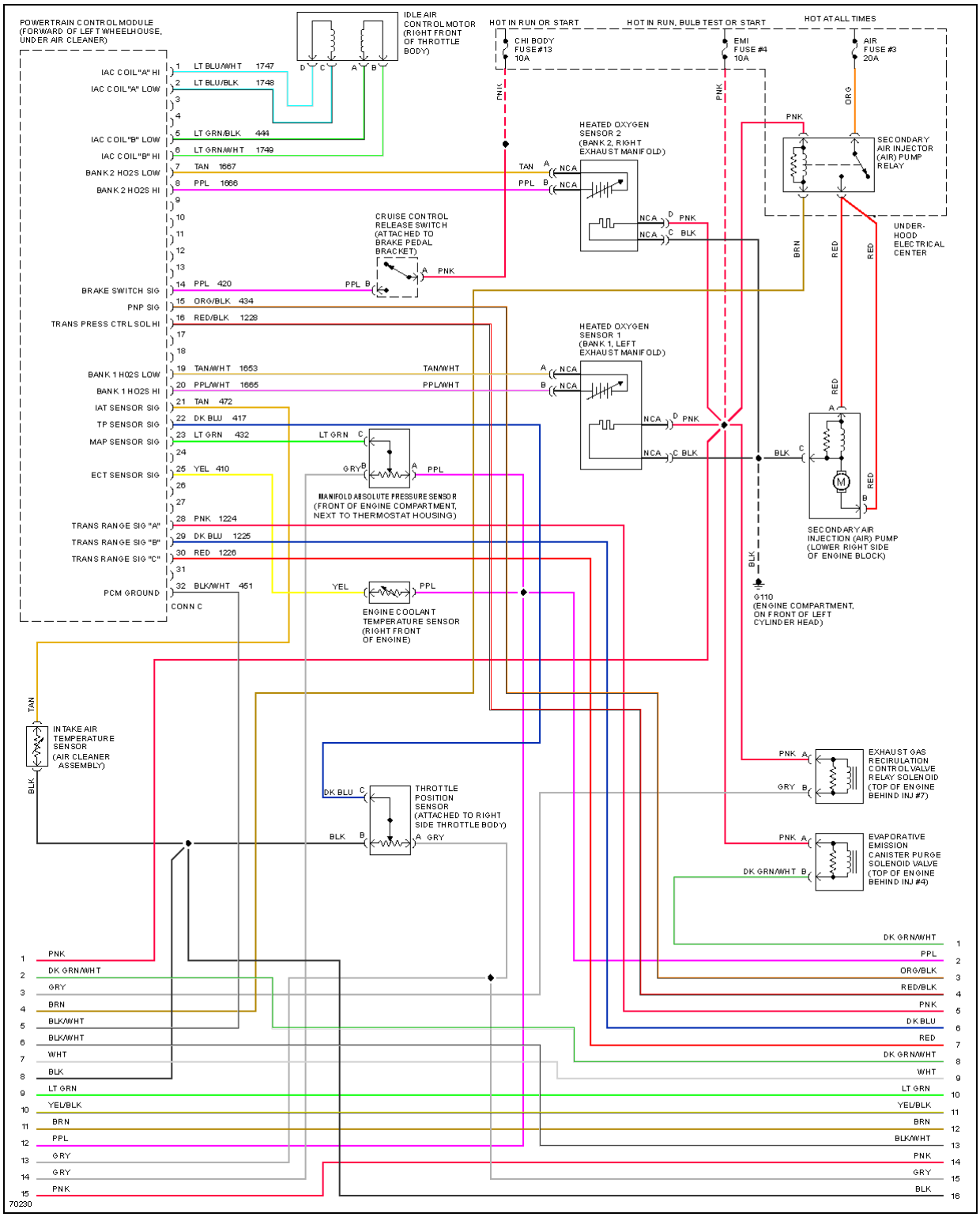


Fig. 115: 4.3L (VIN W) PCM Wiring Diagram (2 Of 3)

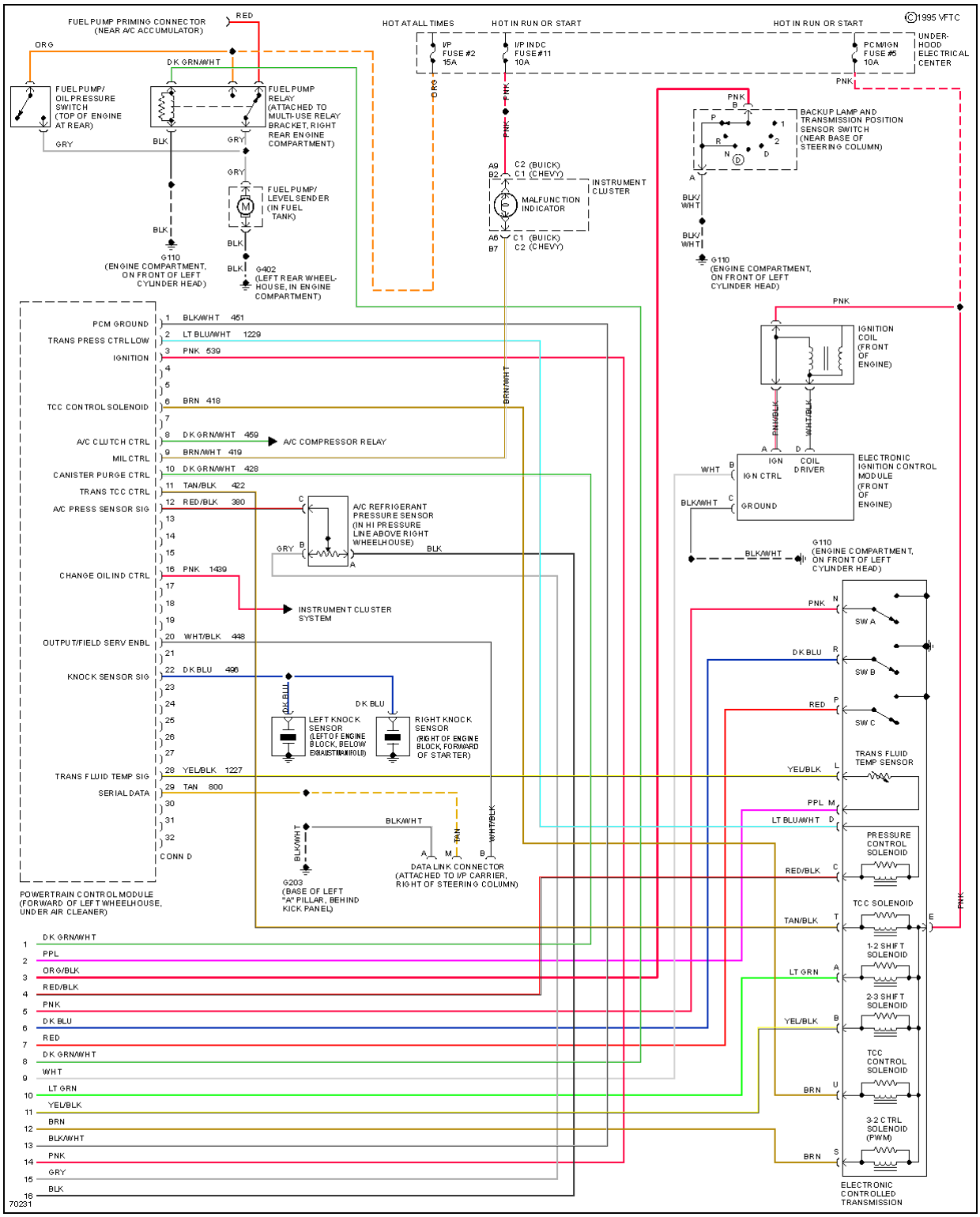


Fig. 116: 4.3L (VIN W) PCM Wiring Diagram (3 Of 3)

ENGINE PERFORMANCE

Self-Diagnostics - 5.7L

INTRODUCTION

Most engine control problems are the result of mechanical breakdowns, poor electrical connections or damaged vacuum hoses. Before considering the computer system as a possible cause of problems, perform checks and inspections covered in appropriate **BASIC TESTING** article in this section. Failure to do so may result in lost diagnostic time.

If no faults were found while performing BASIC DIAGNOSTIC PROCEDURES, proceed with DIAGNOSTIC PROCEDURE under SELF-DIAGNOSTIC SYSTEM. If no fault codes are present and driveability problems exist, proceed to **TESTS W/O CODES** article in this section for diagnosis by symptom (i.e., ROUGH IDLE, NO START, etc.). If only intermittent codes are present, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

SELF-DIAGNOSTIC SYSTEM

NOTE: Powertrain Control Module (PCM) may also be referred to as Electronic Control Module (ECM) in some diagnostic charts and figures. Terms are used interchangeably.

Control module is equipped with a self-diagnostic system, which detects system failures or abnormalities. When a malfunction occurs, control module will store a numerical code and, in most cases, illuminate SERVICE ENGINE SOON light located on instrument panel. SERVICE ENGINE SOON light is also referred to as the Malfunction Indicator Light (MIL). Malfunctions are recorded as hard failures or as intermittent failures.

NOTE: Models equipped with OBD II diagnostic systems may have additional diagnostic information and procedures available; however, to fully utilize information and procedures requires the use of a Tech 1 scan tester. See tester owners manual for additional information.

HARD FAILURES

Most hard failures cause SERVICE ENGINE SOON light to glow and remain on until malfunction is repaired. If light comes on and remains on (light may flash) during vehicle operation, cause of malfunction must be determined using diagnostic (code) charts. If a sensor fails, control module will use a substitute value in its calculations to continue engine operation. In this condition, vehicle is functional, but it will most likely display degraded driveability.

INTERMITTENT FAILURES

Intermittent failures cause SERVICE ENGINE SOON light to flicker or glow and go out about 10 seconds after intermittent fault goes away. Corresponding trouble code, however, will be retained in control module memory. If related fault does not reoccur within 50 engine starts, trouble code will be erased from control module

memory. Intermittent failures may be caused by sensor, connector or wiring related problems. See INTERMITTENTS in **TESTS W/O CODES** article in this section.

DIAGNOSTIC PROCEDURE

Diagnosis of computerized engine control system should be performed in following order:

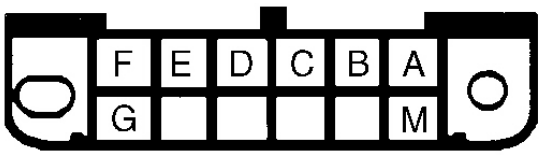
1. Ensure all engine systems not related to computer system are operating properly. DO NOT proceed with testing unless all other problems have been repaired. DIAGNOSTIC CIRCUIT CHECK must be performed before using trouble code charts. See **BASIC TESTING** article in this section.
2. If trouble codes were displayed, determine whether codes are hard or intermittent trouble codes. Hard codes will cause SERVICE ENGINE SOON light to glow continuously while engine is running. See **HARD OR INTERMITTENT TROUBLE CODE DETERMINATION** . For diagnosing hard codes, proceed to appropriate trouble code chart. For diagnosing intermittent codes, proceed to INTERMITTENTS in **TESTS W/O CODES** article in this section.
3. If no trouble codes are present and a driveability problem exists, refer to SYMPTOMS in **TESTS W/O CODES** article in this section. Doing so will help identify proper system or component to check in **SYSTEM/COMPONENT TESTS - 5.7L** article in this section.
4. After necessary repairs are made, clear trouble codes, verify vehicle will enter "closed loop" operation and ensure code does not reset.

NOTE: For specific information on retrieving codes using a scan tester, refer to user and reference manuals supplied with tester.

NOTE: Field service mode check can only be performed on vehicles equipped with 12-pin DLC with a wire present in test terminal "B". See DATA LINK CONNECTOR (DLC) TEST TERMINALS .

DATA LINK CONNECTOR (DLC) TEST TERMINALS

Application	Ground/Test
16-Pin DLC 5.7L (VIN P)	N/A



12-PIN DLC

A – Ground
B – Test Terminal
C – Air Injection (If Equipped)
D – Service Engine Soon Light (If Used)
E – Serial Data
F – TCC (If Used)
G – Fuel Pump (If Used)
M – Serial Data (Some Models)

90B01199

Fig. 1: Identifying 12-Pin DLC Connector Terminals
Courtesy of GENERAL MOTORS CORP.

READING TROUBLE CODES

Control module stores component failure information under a related trouble code which can be recalled for diagnosis and repair. Trouble codes may be read by counting flashes of SERVICE ENGINE SOON light (some models) or by reading digital display on a scan tester. Scan tester is faster to use, more accurate and capable of reading information which otherwise would necessitate testing individual control module and sensor/solenoid connector terminals using a digital voltmeter. See **SCAN TESTER USAGE** and **SCAN DATA** .

NOTE: When using most scan testers, a time delay exists between serial data updates. For instantaneous response, a digital voltmeter must be used.

If scan tester is not available, reading flashes of SERVICE ENGINE SOON light is possible by grounding diagnostic test terminal "B" (if a wire is present) of DLC with ignition on and engine off. See **Fig. 1** . For example, "FLASH, FLASH, pause, FLASH, longer pause" identifies Code 21. First series of flashes is first digit of trouble code. Second series of flashes is second digit of trouble code. Trouble codes are displayed starting with lowest numbered code. Each code is displayed 3 times. Codes will continue to repeat as long as DLC test terminal is grounded.

TROUBLE CODE DEFINITIONS

DIAGNOSTIC TROUBLE CODE (DTC) DEFINITIONS

DTC	Circuit Affected
11	Malfunction Indicator Light
12(1)	No RPM Reference Pulse
13	Left Heated Oxygen Sensor Circuit Open
14	Coolant Temp Sens Sgnl Vltge Low (HI TEMP Indicated)

15	Coolant Temp Sensor Signal Voltage Low
16	Opti-Spark Ignition System Low Resolution Pulse
18	Injector Circuit
21	Throttle Position Sensor Signal Voltage High
22	Throttle Position Sensor Signal Voltage Low
23	IAT Sensor Signal Voltage High (LOW TEMP Indicated)
24	Vehicle Speed Sensor
25	IAT Sensor Signal Voltage Low (HIGH TEMP Indicated)
26	Canister Purge Solenoid
27	EGR Sol Valve
28	Trans. Range Pressure Switch
29	Secondary Air Injection
32	EGR System Error
33	MAP Sensor Signal Voltage High
34	MAP Sensor Signal Voltage Low
36	Opti-Spark High Resolution Pulse
37	TCC Brake Switch Error
38	Brake Switch Error
41	Opti-Spark Ignition System Open Or Shorted EST Ckt
42	IC Circuit Grounded
43	Knock Sensor Circuit (Dual Sensors)
44	Left Heated Oxygen Sensor Lean Exhaust Indication
45	Left Heated Oxygen Sensor Rich Exhaust Indication
46	Pass-Key Circuit
47	Knock Sensor Module
48	Mass Airflow Sensor
50	System Voltage Low
52	Faulty Cal-Pak
53	System Voltage High
55	PCM Error
55	Fuel Lean Monitor
58	Trans Temperature Sensor High Temperature
59	Trans. Temperature Sensor Low Temperature
63	Right Heated Oxygen Sensor Circuit Open
64	Right Heated Oxygen Sensor Lean Exhaust Indication
65	Right Heated Oxygen Sensor Rich Exhaust Indication
66	A/C Pressure Sensor
67	A/C Pressure Sensor
68	A/C Relay Circuit Shorted
69	A/C Compressor Relay
70	A/C Compressor Relay Driver
72	

	Vehicle Speed Sensor Loss
73	Pressure Control Solenoid
75	Transmission Voltage Low
77	Primary Cooling Fan Driver
78	Secondary Cooling Fan Driver
79	Transmission Fluid Overtemp
81	2-3 Shift Solenoid
82	1-2 Shift Solenoid
83	TCC PWM Solenoid
84	3-2 Control Solenoid
85	TCC Stuck On
90	TCC Solenoid Circuit
95	Change Oil Light
96	Low Oil Light
97	VSS Output Circuit

(1) Display of a Code 12 is normal when reference pulses are not being received by control module (engine not running).

TROUBLE CODE CONVERSION (1)

New Code No.	Old Code No.	Circuit
P0101	34	MAF Sensor
P0112	23	Air Temperature Sensor
P0113	25	Air Temperature Sensor
P0116	New	Coolant Sensor Range
P0117	15	Coolant Temperature Sensor
P0118	14	Coolant Temperature Sensor
P0122	22	Throttle Position Sensor
P0123	21	Throttle Position Sensor
P0125	New	Coolant Temperature Sensor
P0131	44	Oxygen Sensor
P0132	45	Oxygen Sensor
P0133	New	Oxygen Sensor
P0134	13	Oxygen Sensor
P0135	New	Oxygen Sensor Heater
P0137	New	(Catalyst) Oxygen Sensor
P0138	New	(Catalyst) Oxygen Sensor
P0140	New	(Catalyst) Oxygen Sensor
P0151	44	Oxygen Sensor
P0152	45	Oxygen Sensor
P0153	New	Oxygen Sensor
P0154	13	Oxygen Sensor

P0155	New	Oxygen Sensor Heater
P0158	45	Oxygen Sensor
P0160	13	Oxygen Sensor
P0161	New	Oxygen Sensor Heater
P0171	New	Fuel Lean
P0172	New	Fuel Rich
P0174	New	Fuel Lean
P0175	New	Fuel Rich
P0300	New	Misfire
P0321	17	Spark Reference
P0325	43	Knock Sensor
P0341	18	Cam Signal
P0342	41	Cam Signal
P0401	53/54/55	EGR
P0420	New	Catalyst System
P0501/0502	24	Vehicle Speed Sensor
P0703	38	TCC Brake Switch
P0705	31	Trans. Range Switch
P0712	59	Trans. Fluid Temp. Sensor
P0713	58	Trans. Fluid Temp. Sensor
P0740	39	TCC
P0755	36	Shift Solenoid "B"
P1114	New	Coolant Sensor
P1115	New	Coolant Sensor
P1133	New	Oxygen Sensor
P1153	New	Oxygen Sensor
P1158	New	Oxygen Sensor
P1200	New	Injector Circuit
P1257	57	Supercharger Boost
P1350/1361	42	Ignition
P1403/1404/1405	75/76/77	EGR Solenoid(s)
P1406	32	EGR
P1520	New	Park/Neutral
P1530	69	A/C Pressure Sensor/Switch
P1531	66	A/C Charge Low
P1550	New	Cruise
P1558	63	Cruise
P1561	61	Cruise
P1562	62	Cruise
P1565	65	Cruise
P1567	67	Cruise
P1568		

	68	Cruise
P1571	New	Traction Control
P1573	New	Traction Control
P1599	99	Cruise
P1619	New	Oil Life Reset
P1623	51	PROM Error
P1626/1629	58	Pass-Key
P1630	16	Voltage High/Low
P1640	26/56	Quad-Driver
P1650	26/56	Quad-Driver
P1670	26/56	Quad-Driver
P1860	New	TCC PWM Solenoid
(1) All P0 and P1 codes are located at the end of the pre-existing code charts.		

HARD OR INTERMITTENT TROUBLE CODE DETERMINATION

During any diagnostic procedure, determine if codes are hard failure codes or intermittent failure codes. Diagnostic charts will not usually help analyze intermittent codes. To determine hard codes and intermittent codes:

1. Enter diagnostic mode. Read and record all stored trouble codes. Exit diagnostic mode, and clear trouble codes. See **CLEARING TROUBLE CODES** .
2. Apply parking brake, and place transmission in Neutral or Park. Block drive wheels, and start engine. SERVICE ENGINE SOON light should go out. Run warm engine at specified curb idle for 2 minutes and note SERVICE ENGINE SOON light.
3. If SERVICE ENGINE SOON light comes on, enter diagnostic mode. Read and record trouble codes. This will reveal hard failure codes. Oxygen sensor related codes may require a road test to reset hard failure after trouble codes were cleared.
4. If SERVICE ENGINE SOON light does not come on, all stored trouble codes were intermittent failures, except as noted above.

NOTE: Trouble codes will be recorded at various operating times. Some codes require operation of that sensor or switch for 5 seconds; others require operation for 5 minutes or longer at normal operating temperature, vehicle speed and load. Therefore, some codes may not set in a service bay operational mode and may require road testing vehicle in order to duplicate conditions under which code will set.

CLEARING TROUBLE CODES

To clear trouble codes from memory, either to determine if malfunction will occur again or after making necessary repairs, disconnect power supply to PCM for at least 30 seconds or clear codes using a scan tester with code clearing capability.

PCM LOCATION

On most models, engine control module is located behind right or left side of dash, behind right or left kick panel or on left or right side of engine compartment. For more precise location, see COMPONENT LOCATIONS in **SYSTEM/COMPONENT TESTS - 5.7L** article in this section.

DIAGNOSTIC MATERIALS

Diagnostic Aids

Diagnostic aids (located in many trouble code charts) are additional tips used to help diagnose trouble codes when inspected circuit is okay. Diagnostic aids may help lead to a definitive solution to trouble code problem.

Field Service Mode Check (If Available)

If DLC test terminal "B" is grounded with engine running, SERVICE ENGINE SOON light will indicate operational mode of engine. This test confirms proper operation of fuel system and verifies "closed loop" operation. Clear codes and perform this test after any repair is completed. Most models require the use of a scan tester to enter field service mode. See FIELD SERVICE MODE CHECK in **BASIC TESTING** article in this section.

NOTE: Vehicles utilizing a 12-terminal DLC with terminal "B" not used, must use a scan tester for retrieving codes or enter Field Service Mode.

SPECIAL TOOLS (DIAGNOSTIC)

NOTE: A scan tester plugged into DLC may be used to read trouble codes and check voltages in system on serial data line. On most models scan tester is REQUIRED to retrieve vehicle information. For additional information, see SCAN TESTER USAGE and SCAN DATA .

Computerized engine control system is most easily diagnosed using scan tester; however, other tools may aid in diagnosing problems if a scan tester is unavailable. These tools are a tachometer, test light, ohmmeter, digital voltmeter with a 10-megohm input impedance (minimum), vacuum pump, vacuum gauge, fuel injector test lights and 6 jumper wires 6" long (one wire with female connectors at both ends, one wire with male connectors at both ends and 4 wires with male and female connectors at opposite ends). A test light, rather than a voltmeter, must be used when indicated by a diagnostic chart. In addition, special jumper harnesses or testers may be required by manufacturer to facilitate diagnosis.

SCAN TESTER USAGE

NOTE: Before connecting scan tester to vehicle, diagnostic system should be checked to determine if system is operating properly and if information received will be accurate. This is done by performing DIAGNOSTIC CIRCUIT CHECK or ON-BOARD DIAGNOSTIC SYSTEM CHECK located in appropriate BASIC TESTING article in this section. If vehicle does not pass diagnostic check, information received may be invalid.

Scan tester is a specialized tester which, when plugged into DLC, can be used to diagnose on-board computer control systems by providing instant access to circuit voltage information without need to crawl under dash or hood to backprobe sensors and connectors.

Scan tester cuts down diagnostic time dramatically by furnishing input data (voltage signals) which can be compared to specification parameters. See SCAN DATA. They may also furnish information on output device (solenoids and motors) status. However, status parameters only indicate output signals have been sent to devices by control module; they do not indicate whether devices have responded properly to signal. Verify proper response at output device using a voltmeter or test light.

A problem may exist even if trouble codes are not present. About 80 percent of driveability problems occur without trouble codes. Sensors that are out of calibration will not set a trouble code but will cause driveability problems.

Using a scan tester is the easiest method of checking sensor specifications and other data parameters. Tester is also useful in finding intermittent wiring problems by wiggling wiring harnesses and connections (key on, engine off) while observing data parameters. See **SCAN DATA** .

NOTE: **If erroneous voltage signals are suspected, verify tester information using a digital voltmeter and wiring schematic. If non-existent codes are displayed, DO NOT use scan tester for diagnosis. Contact tester manufacturer for additional information.**

SCAN DATA

NOTE: **Information contained in SCAN DATA is typical of readings taken on vehicle with engine idling, upper radiator hose hot, closed throttle, transmission in Park or Neutral, "closed loop" status achieved and all accessories off (except as noted in tables). Data parameters are updated a minimum of every 1 1/4 seconds, more often on most models. Not all devices and systems are used on all models; following lists only represent most commonly used parameters. For additional information, refer to owner manual furnished with tester.**

SCAN DATA

Tester Position	Units Measured	Nominal Value
A/C Clutch	On/Off	On With A/C
A/C Request	Yes/No	Yes With Request
BARO	Volts	3.0-4.5
Battery Voltage	Volts	13.5-14.5
Brake Switch	App/Rel	Applied with Brakes On
Canister Purge Sol.	On/Off	On/Engine Cold (Idle Some)
Clear Flood	On/Off	See Tester Manual
Coolant Fan(s)	On/Off	On With Command
Coolant Temp.	°C	85-105° (Norm. Temperature)
Crank RPM	RPM	100-900

Cross Counts	Counts	0-255
EGR Solenoid	On/Off	On When Energized
EGR Duty Cycle	0-100%	0/Closed; 100/Fully Open
Fan Relay	On/Off	On When Energized
Fan Request	On/Off	On With Request
Fuel Back-Up	Yes/No	Yes When Engaged
Fuel Trim (ST)	Counts	110-150 ((1) 128 Normal)
Fuel Trim (LT)	Counts	110-150 ((1) 128 Normal)
IAC	Counts	0-50
Ignition/Crank	On/Off	On With Ignition/Crank
Injector Pulse Width	Mil./Sec	.8-3.0
Intake Air Temp.	°C	10-90°
Knock Retard	Counts	0-255
Knock Signal	Yes/No	Yes When Knock Exists
MAP	Volts	1.0 (Idle) to 4.5 (WOT)
"Open/Closed Loop Status"	Ol/Cl	Closed/Open During
O2 Sensor	Millivolts	100 (Lean) To 999 (Rich)
P/N Switch	P/N/RDL	Park/Neutral
P/S Switch	Norm/Hi	Normal
PROM I.D.	PROM #	Original Factory Number
QDM	Hi/Lo	Lo Energized
RPM	RPM	Spec. +/-25 RPM Drive (A/T)
RPM	RPM	Spec. +/-50 RPM Neut. (M/T)
Spark Advance	Degrees	Varies
TCC	On/Off	Off (On With Command)
TP Sensor	Volts	1.00 (Idle) To 5.00 (WOT)
Throttle Angle	0-100%	0 (Idle) To 100 (WOT)
Throttle Switch	Open/Closed	Open At Off Idle
Trans. Fluid Temp.	°C	100 (Normal)
Trouble Codes	Code No.	No Codes
Upshift Light (M/T)	On/Off	Off
VSS Or MPH	MPH	0-Actual
1st Gear Switch	On/Off	On/1st Gear Only
3rd Gear Switch	On/Off	On/3rd & 4th Gear
4th Gear Switch	On/Off	On/4th Gear

(1) Long Term (LT) fuel trim has a tendency to follow Short Term (ST) fuel trim. Extended idle may drive ST fuel trim to read less than 100 counts.

ECM/PCM CODE CHARTS

NOTE: In following diagnostic tests, schematics and illustrations are courtesy of

General Motors Corp.

CODE 11, MALFUNCTION INDICATOR LIGHT

MIL should always be on steady with ignition on and engine stopped. Ignition voltage is supplied directly to bulb. PCM turns on light by providing a path to ground.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If MIL driver circuit or ignition feed circuit to bulb is open, MIL will not illuminate.
2. Jumper Harness (J 35616-A) should be used instead of directly probing harness. This will prevent damage to harness.
3. MIL should go off after engine starts. If it does, problem is not present at this time. If light does not go off, drive circuit is shorted to ground or PCM is faulty.
4. If other codes exist, use other code charts first, then restart at beginning of this chart.

Diagnostic Aids

If ignition feed circuit is suspected of being open, check and see if other bulbs on that circuit illuminate. Code 11 will cause MIL to remain on, even if malfunction clears.

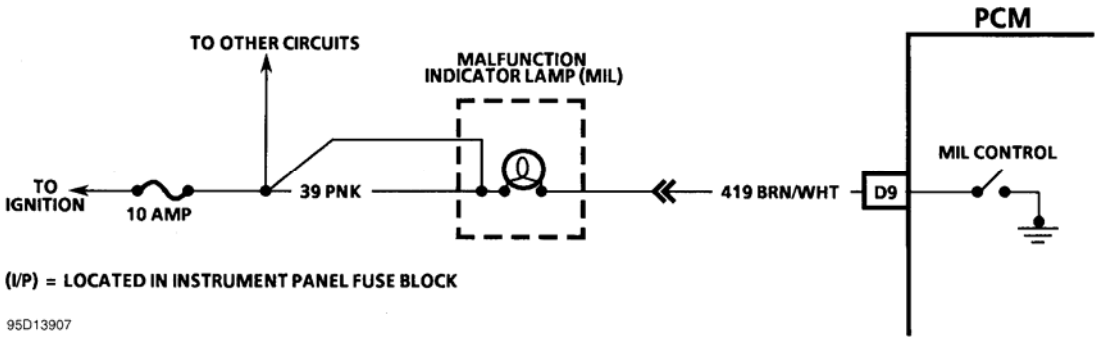


Fig. 2: Code 11 Schematic (5.7L) MIL Circuit

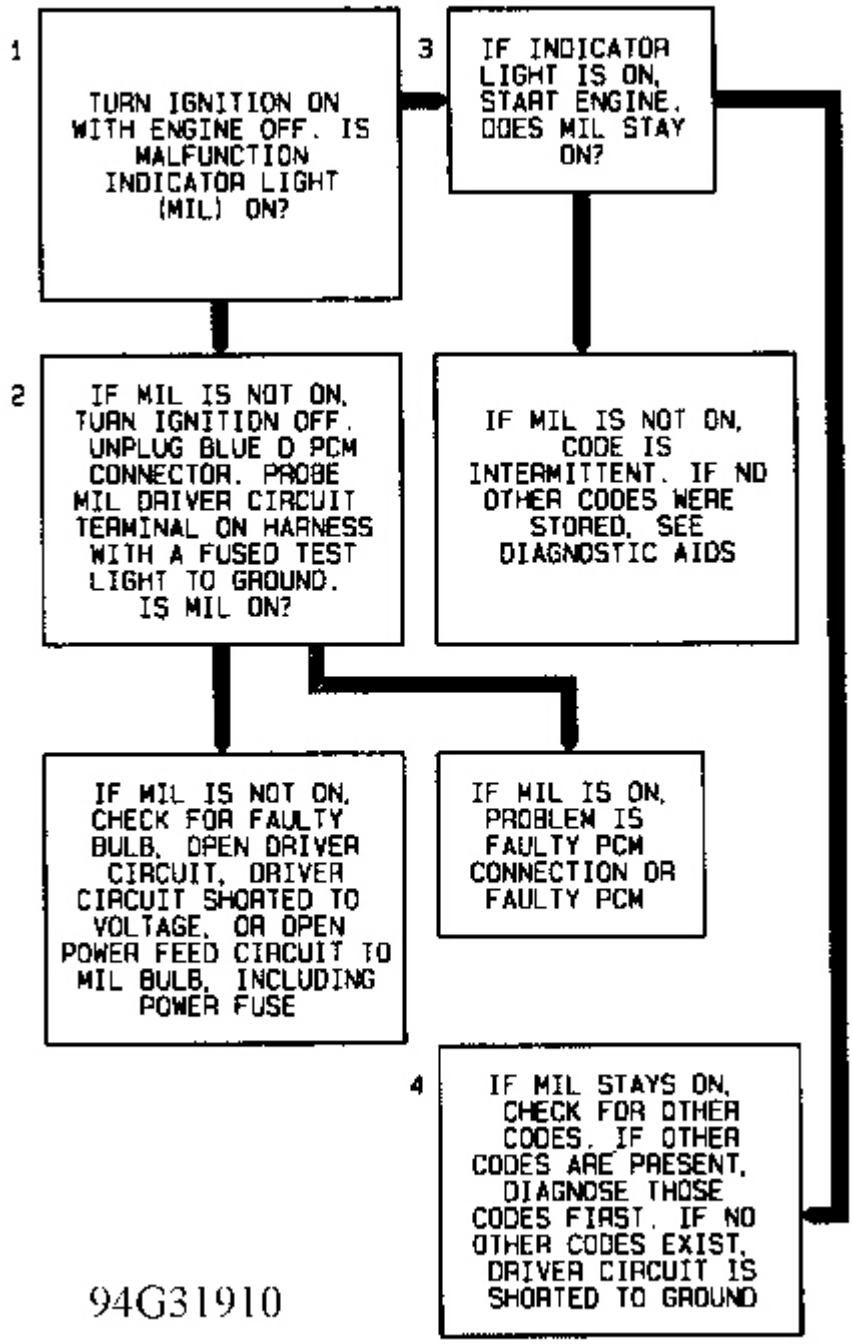


Fig. 3: Code 11 Diagnostic Flow Chart (5.7L) MIL Circuit

CODE 13, LEFT HEATED OXYGEN SENSOR CIRCUIT OPEN

NOTE: The 5.7L (VIN P) engine is equipped with 2 oxygen sensors. On this model, code will set if the left sensor circuit is open. Code 63 will set if the right sensor circuit is open. Oxygen sensors use a heating element. Heating element is not controlled by PCM.

Code will set if Codes 21 and 22 are not set, engine is at normal operating temperature, oxygen sensor voltage is constant within a specified range (.35-.55 volt), throttle angle is greater than idle, a precalibrated amount of time has elapsed since start-up and all conditions have existed for a precalibrated amount of time. Most likely causes of code are: open sensor signal (high) circuit, faulty PCM connection, faulty PCM, faulty oxygen sensor connection or faulty oxygen sensor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This tests if problem still exists. Vehicle cannot enter "closed loop" mode if oxygen sensor circuit is open. Code indicates an open in O2 sensor circuit (steady .35-.55 volt).
2. Determines if oxygen sensor, wiring or control module is at fault. If wiring is good, grounding oxygen sensor wire will cause .45 volt reference supplied by control module to pull low.
3. This tests oxygen sensor circuit wiring. Use only a high impedance (10-megohm minimum) digital voltmeter.

Diagnostic Aids

Control module will not go into closed loop if code is set. Code may set if vehicle runs out of fuel or stalls while vehicle is in motion. If oxygen sensor ground becomes loose, a false oxygen sensor reading will occur. This can result in a Code 13 being set. On models equipped with an oxygen sensor heating element, element resistance should be 3.5-14.0 ohms.

CODE 13 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
Left O2 Signal	C20	Purple/White
Left O2 Ground	C19	Tan/White

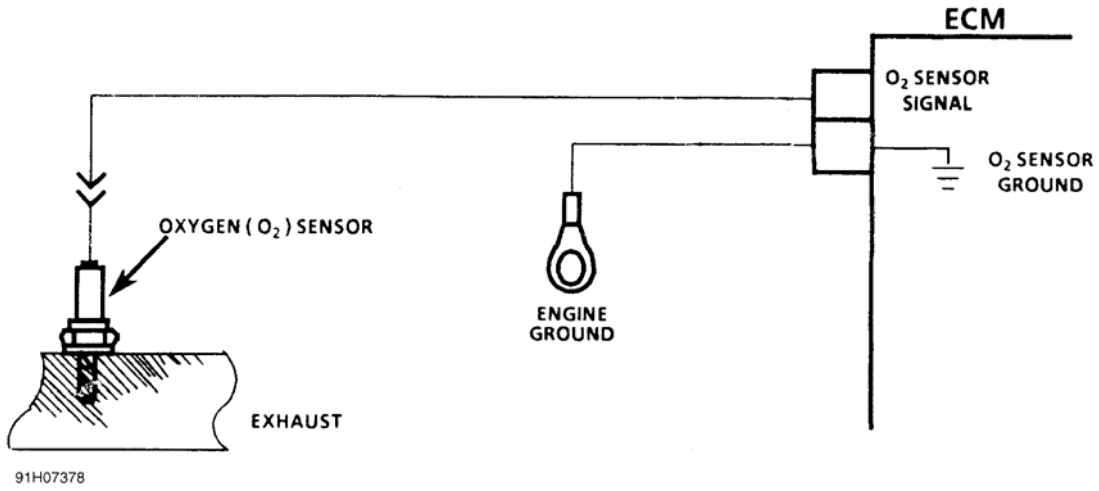


Fig. 4: Code 13 Schematic (5.7L) Open Oxygen Sensor Circuit

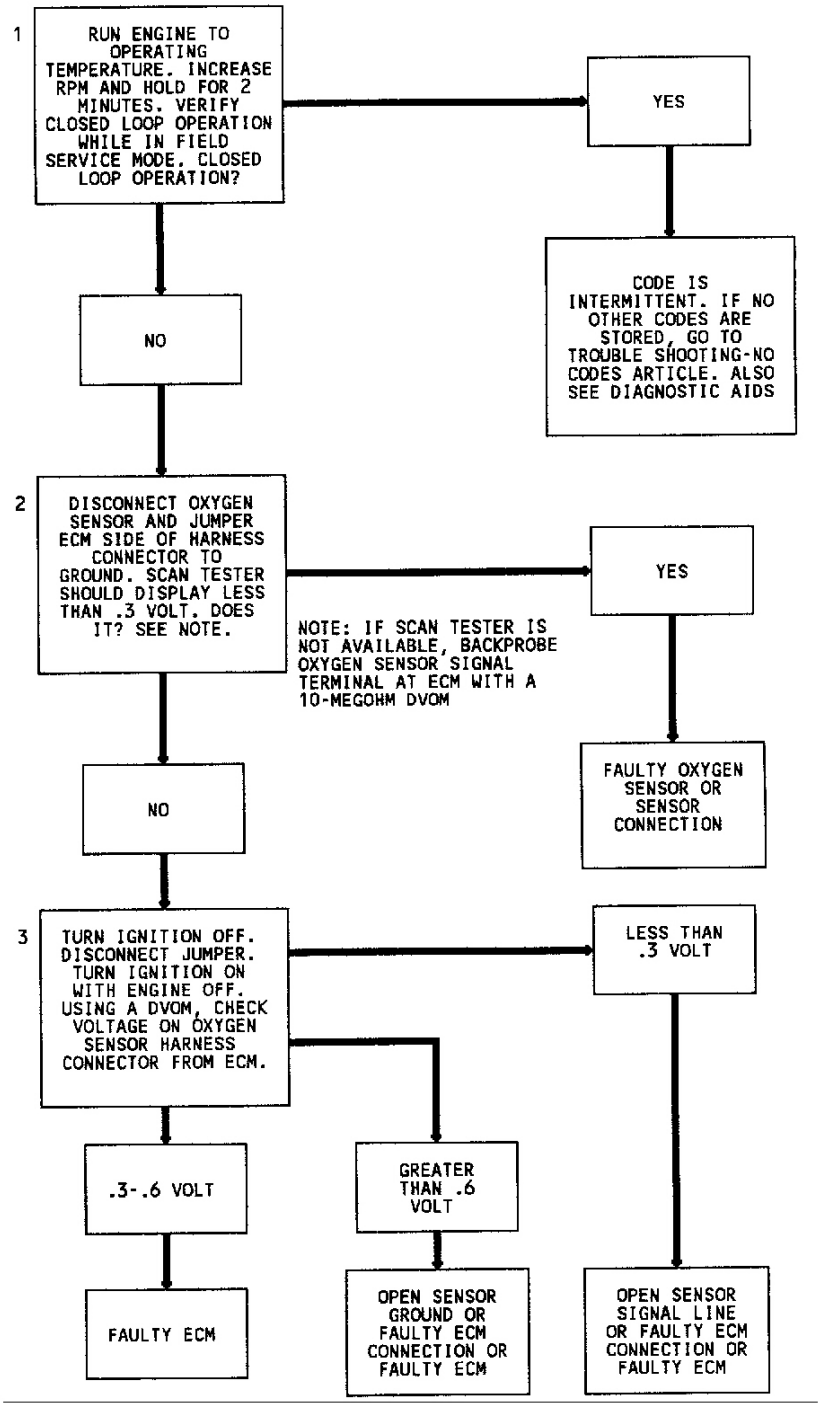


Fig. 5: Code 13 Diagnostic Flow Chart (5.7L) Open Oxygen Sensor Circuit

CODE 14, COOLANT TEMP SENS SGNL VLTGE LOW (HI TEMP INDICATED)

Code will set if PCM sees an extremely high temperature signal (low voltage). Most likely causes of code are:

sensor signal circuit shorted to ground, faulty coolant temperature sensor or faulty PCM.

NOTE: This chart assumes engine cooling system is functioning properly (not overheating). Test numbers refer to numbers on diagnostic chart.

1. This checks if conditions for code still exist.
2. This tests for grounded sensor signal line between control module and coolant sensor.

Diagnostic Aids

After engine is started, temperature should rise steadily to about 90°C and then stabilize when thermostat opens. At normal operating temperature, signal voltage at control module terminal should be 1.5-2.0 volts. Check sensor for shifted calibration by using sensor TEMPERATURE-TO-RESISTANCE VALUES table. When code is set, control module will turn on electric cooling fan(s) if equipped.

CODE 14 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
CTS Signal	C25	Yellow
CTS Ground	B6	Black

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

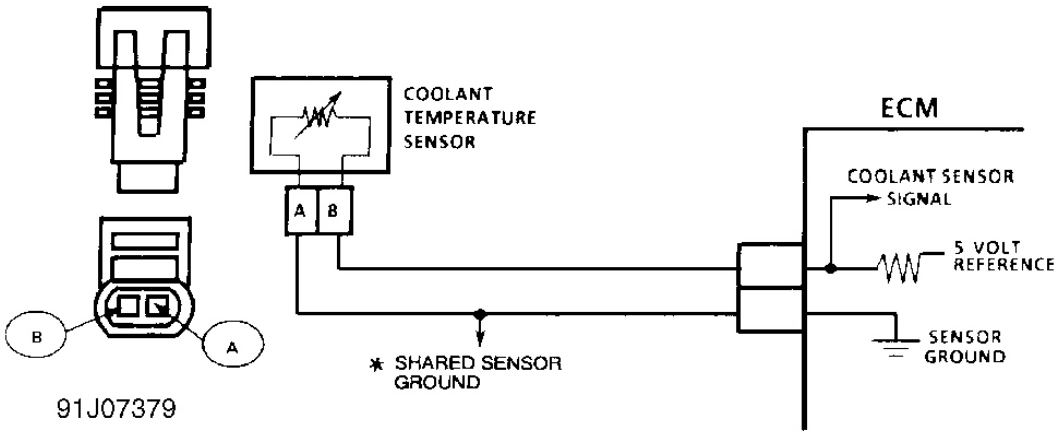


Fig. 6: Code 14 Schematic (5.7L) Coolant Temperature Sensor Signal Voltage Low (High Temp. Indicated)

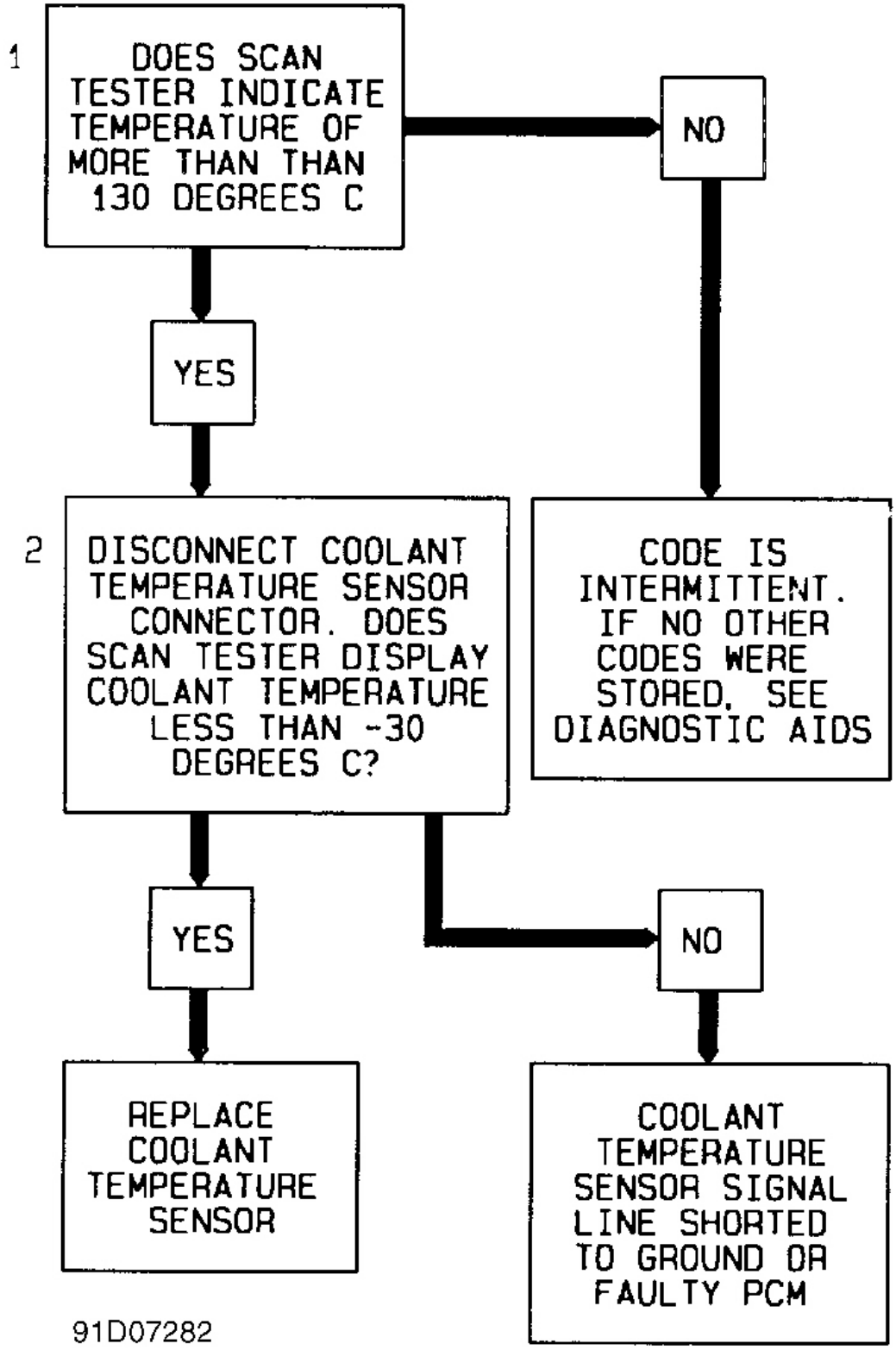

1
DOES SCAN TESTER INDICATE TEMPERATURE OF MORE THAN THAN 130 DEGREES C
NO
YES
2
DISCONNECT COOLANT TEMPERATURE SENSOR CONNECTOR. DOES SCAN TESTER DISPLAY COOLANT TEMPERATURE LESS THAN -30 DEGREES C?
CODE IS INTERMITTENT. IF NO OTHER CODES WERE STORED, SEE DIAGNOSTIC AIDS
YES
NO
REPLACE COOLANT TEMPERATURE SENSOR
COOLANT TEMPERATURE SENSOR SIGNAL LINE SHORTED TO GROUND OR FAULTY PCM
91D07282

Fig. 7: Code 14 Diagnostic Flow Chart (5.7L) Coolant Temperature Sensor Signal Voltage Low (High Temp. Indicated)

CODE 15, COOLANT TEMP SENSOR SIGNAL VOLTAGE LOW

Code indicates control module has seen high resistance (high monitored voltage) in coolant sensor circuit. This could be due to high resistance (cold temperature) or high voltage at coolant sensor terminal at control module for a precalibrated period of time. Most likely causes of code are: open sensor signal circuit, open sensor ground circuit (not allowing path to ground for 5-volt reference), faulty sensor connection, faulty sensor, faulty PCM connection or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This checks if conditions for code still exist.
2. This test simulates a low voltage condition. If control module recognizes low voltage signal, scan tester will display greater than about 130°C. This indicates control module and wiring are not at fault.
3. This test determines if coolant sensor ground or signal circuit is open.

Diagnostic Aids

After engine is started, temperature should rise steadily to about 90°C and then stabilize when thermostat opens. At normal operating temperature, signal voltage at control module terminal should be 1.5-2.0 volts. Check sensor for shifted calibration by using sensor TEMPERATURE-TO-RESISTANCE VALUES table. When code is set, control module will turn on electric cooling fan(s) if equipped.

CODE 15 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
CTS Signal	C25	Yellow
CTS Ground	B6	Black

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

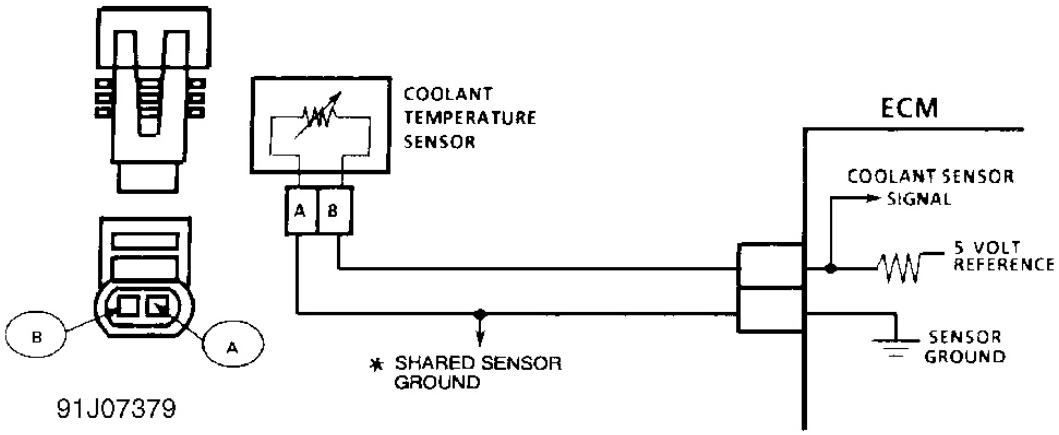
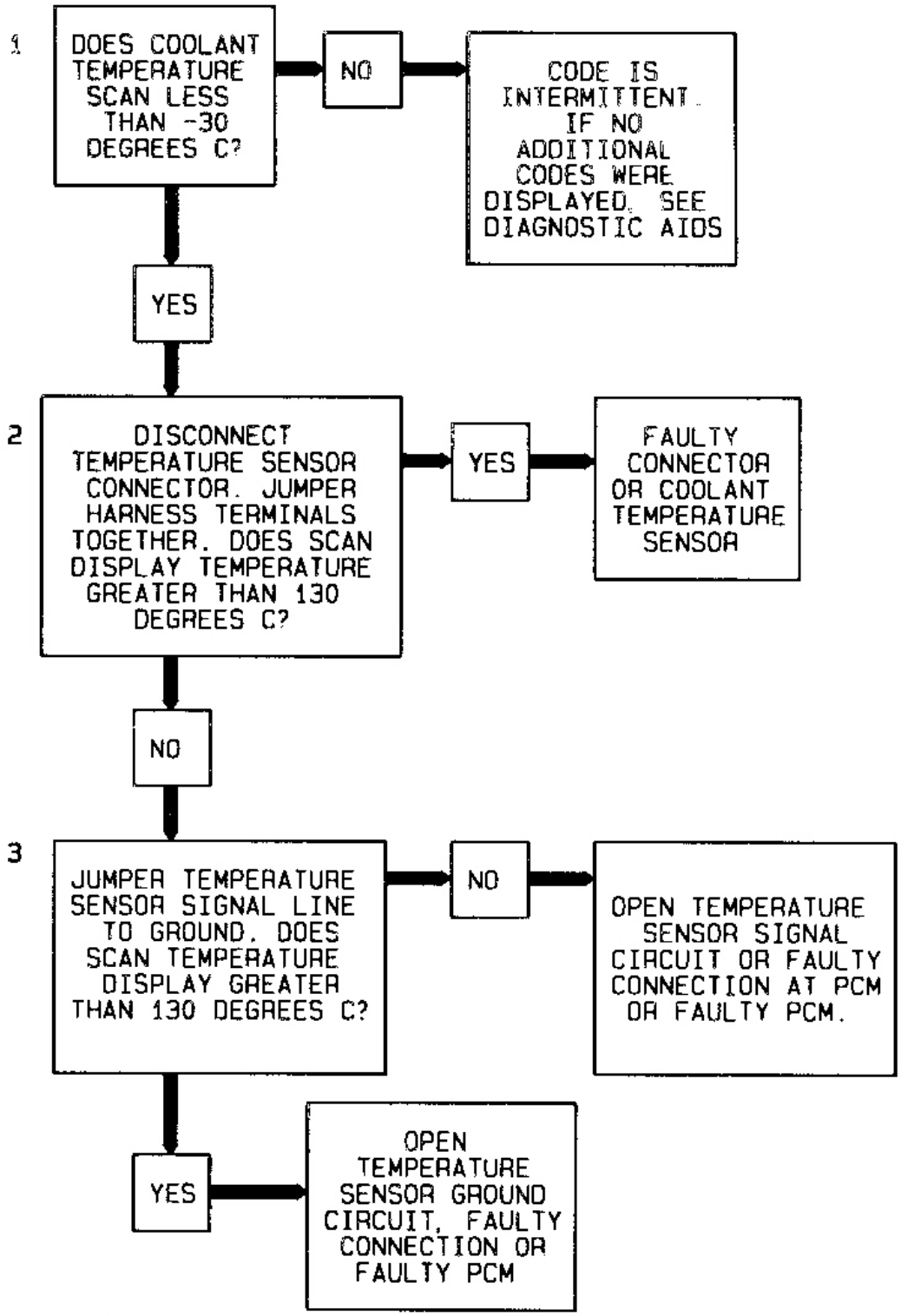


Fig. 8: Code 15 Schematic (5.7L) Coolant Temp Sensor Signal Voltage Low


1
DOES COOLANT TEMPERATURE SCAN LESS THAN -30 DEGREES C?
NO
CODE IS INTERMITTENT. IF NO ADDITIONAL CODES WERE DISPLAYED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TEMPERATURE SENSOR CONNECTOR. JUMPER HARNESS TERMINALS TOGETHER. DOES SCAN DISPLAY TEMPERATURE GREATER THAN 130 DEGREES C?
YES
FAULTY CONNECTOR OR COOLANT TEMPERATURE SENSOR
NO
3
JUMPER TEMPERATURE SENSOR SIGNAL LINE TO GROUND. DOES SCAN TEMPERATURE DISPLAY GREATER THAN 130 DEGREES C?
NO
OPEN TEMPERATURE SENSOR SIGNAL CIRCUIT OR FAULTY CONNECTION AT PCM OR FAULTY PCM.
YES
OPEN TEMPERATURE SENSOR GROUND CIRCUIT, FAULTY CONNECTION OR FAULTY PCM

91F07283

Fig. 9: Code 15 Diagnostic Flow Chart (5.7L) Coolant Temp Sensor Signal Voltage Low

CODE 16, OPTI-SPARK IGNITION SYSTEM LOW RESOLUTION PULSE

Ignition system supplies 2 timing inputs to PCM, a high resolution signal (360 pulses per camshaft revolution) and a low resolution signal (4 pulses per camshaft revolution). PCM can determine if either timing input is not being received by comparing inputs. If PCM detects high resolution pulse without detecting low pulse, Code 16 will set. Reference signal on resolution line toggles between zero and 5 volts as camshaft turns.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If engine starts at this time, code is intermittent.
2. This step determines if PCM is sending out a signal to distributor for processing. If this signal is not available or is shorted to ground or voltage, distributor cannot ground it to produce reference pulses.
3. If Code 41 and/or 42 is also set with Code 16 and no external fault can be found, replace PCM. If only Code 16 is set and distributor connections are okay, replace distributor.

Diagnostic Aids

An open, a short to voltage, a short to ground or a defective sensor inside distributor can prevent reference voltage from pulsing at PCM resolution terminal. If Code 16 does not reset and vehicle still does not start, go to NO START - ENGINE CRANKS OKAY in **BASIC TESTING** article in this section.

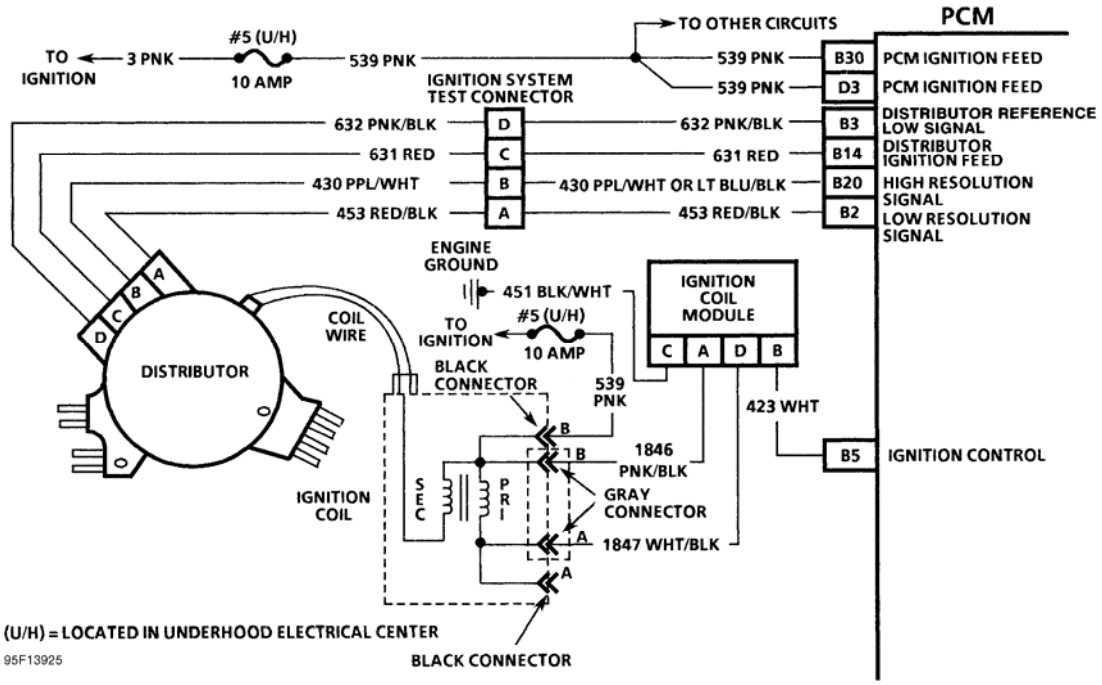


Fig. 10: Code 16 Schematic (5.7L) Opti-spark Ignition System Low Resolution Pulse

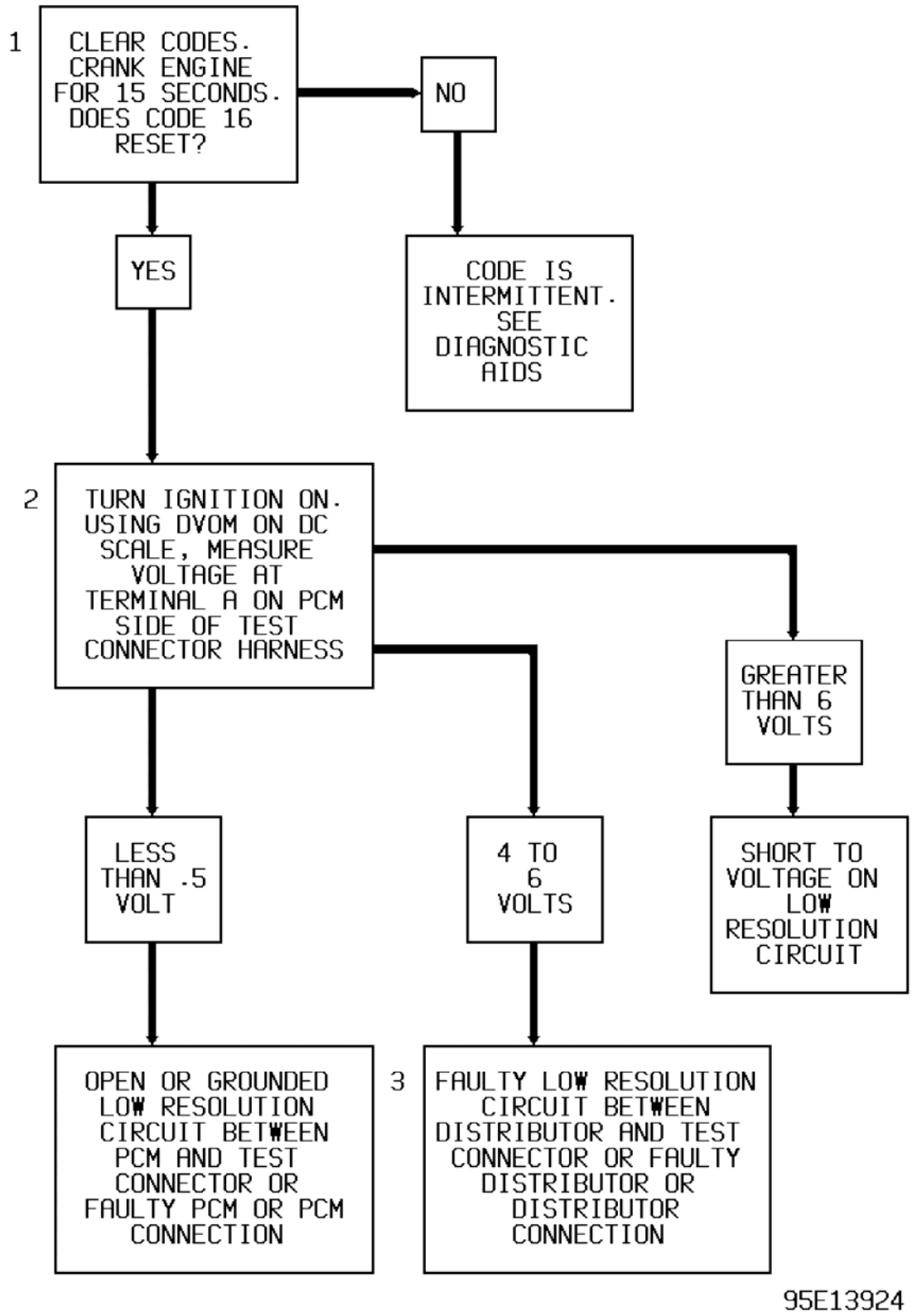


Fig. 11: Code 16 Diagnostic Flow Chart (5.7L) Opti-spark Ignition System Low Resolution Pulse

CODE 18, INJECTOR CIRCUIT

Injectors are provided voltage when ignition is on. PCM energizes injectors by providing an individual ground for each injector. Injectors are energized on the intake stroke of each cylinder. PCM continuously monitors voltage on each driver circuit. When PCM detects a voltage that is out of range, Code 18 will set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Injector fuses are located in the underhood electrical center.
2. Performing an injector balance test will determine which injector circuit is faulty. See **SYSTEM/COMPONENT TESTS - 5.7L** article in this section.
3. See mini-schematic to determine which fuse powers injector banks.
4. When checking injector resistance, injector should be cold.

Diagnostic Aids

If an injector is disconnected and then reconnected while engine is running, injector driver is disabled for a predetermined time and Code 18 will set. When driver is disabled, an engine misfire will be evident.

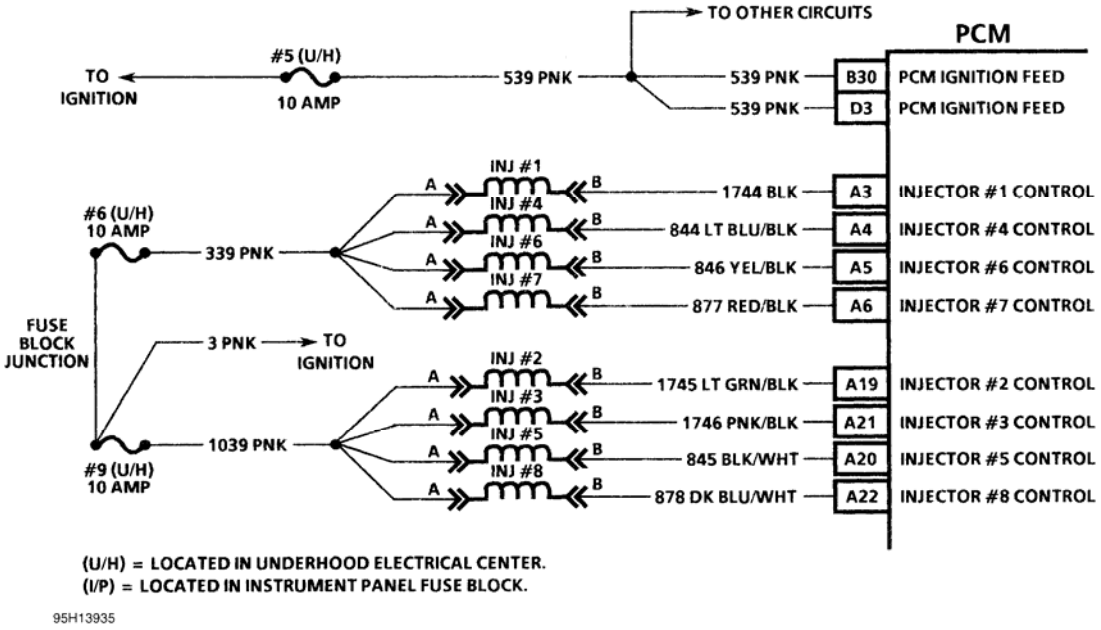


Fig. 12: Code 18 Schematic (5.7L) Injector Circuit

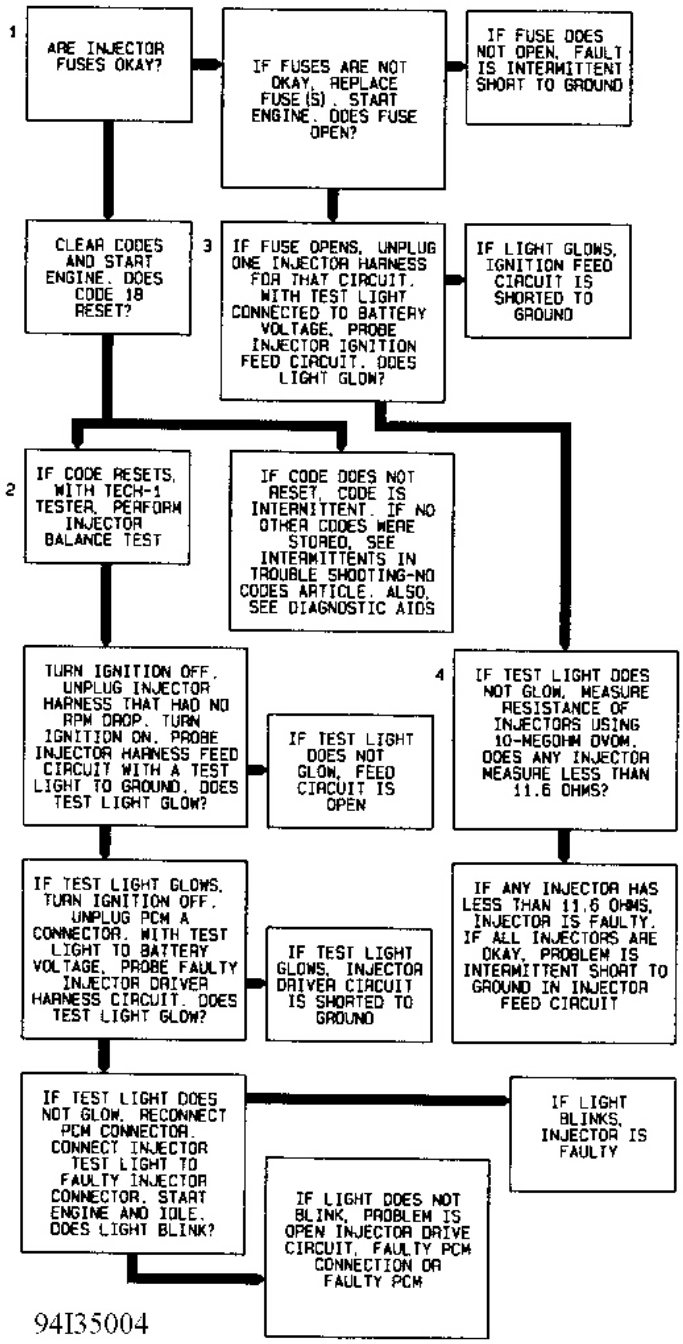


Fig. 13: Code 18 Diagnostic Flow Chart (5.7L) Injector Circuit

CODE 21, THROTTLE POSITION SENSOR SIGNAL VOLTAGE HIGH

Code will set if engine is idling (closed throttle), MAP value is low, a MAP code is not set and PCM sees high

TP sensor voltage. Most likely causes for code are: TP sensor signal circuit shorted to voltage, open sensor ground circuit, faulty sensor connection, faulty TP sensor or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks if code is result of a hard failure or an intermittent condition.
2. This test simulates a low-voltage condition. If control module recognizes change of state, control module and wiring are okay.
3. This step isolates a faulty sensor, control module or open sensor ground circuit. If sensor ground is shared by another sensor, an accompanying code related to that sensor may exist.

Diagnostic Aids

A scan tester displays throttle position in volts. Closed throttle voltage should be low. Voltage should increase gradually to about 4.5 volts at a steady rate as throttle angle is increased. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 21 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
TPS Signal	C22	Dark Blue
TPS Ground	B6	Black
TPS Reference	B28	Gray

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

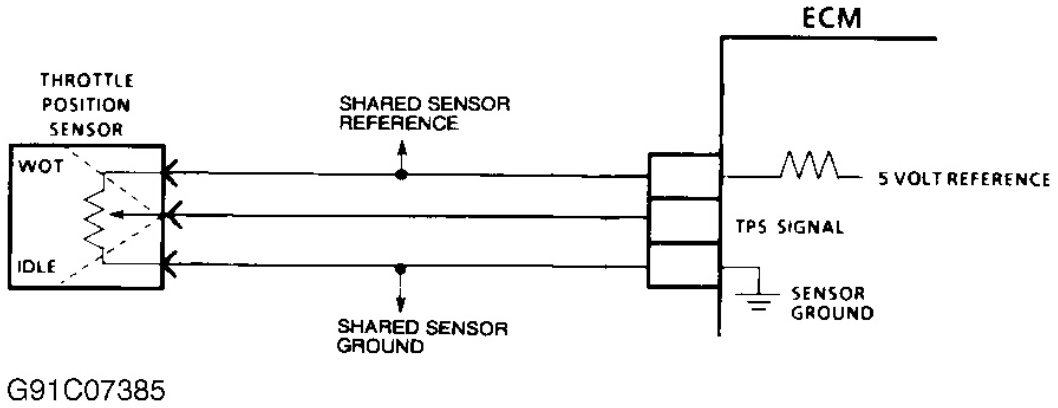


Fig. 14: Code 21 Schematic (5.7L) Throttle Position Sensor Signal Voltage High

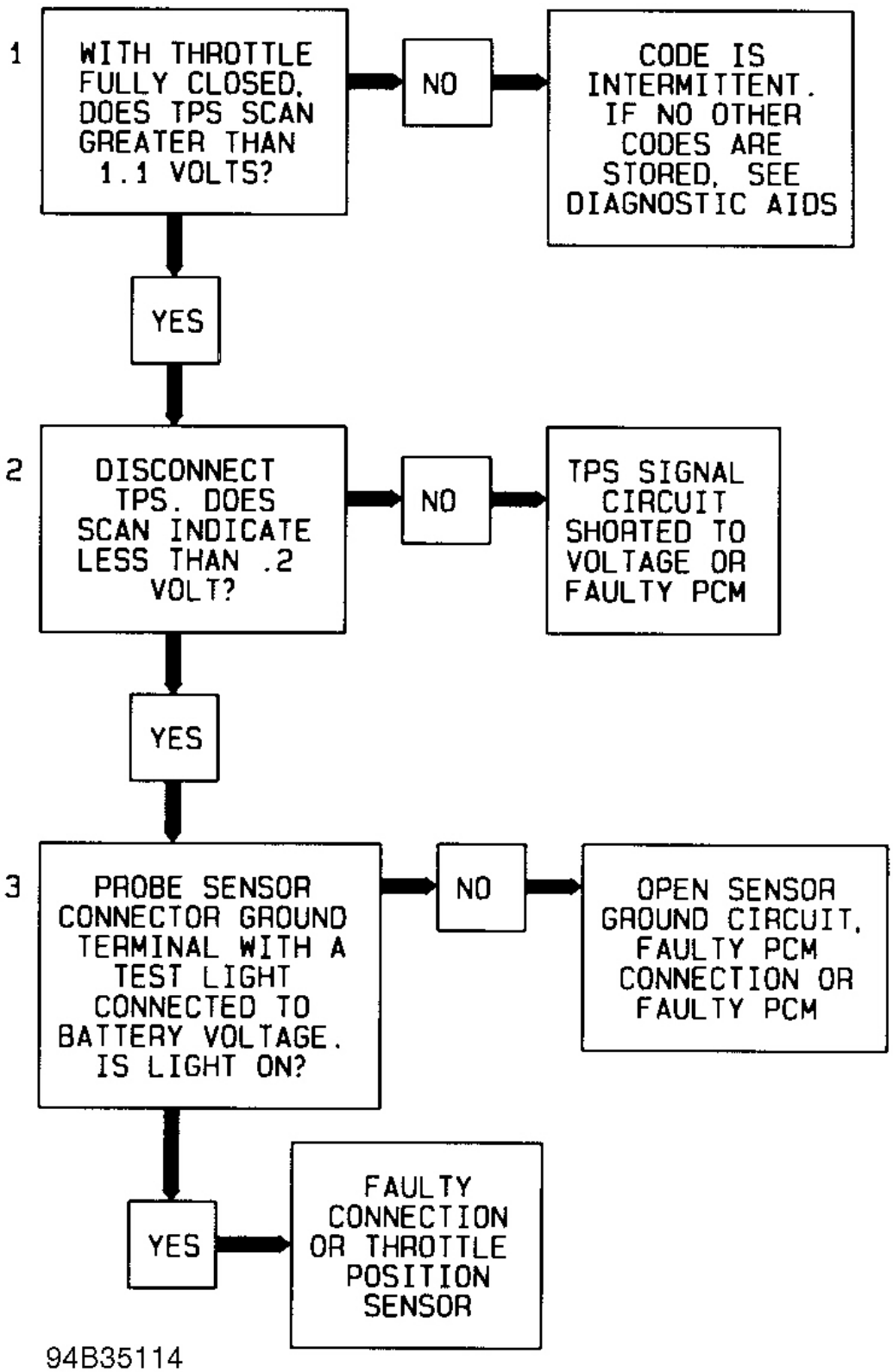

1
WITH THROTTLE FULLY CLOSED, DOES TPS SCAN GREATER THAN 1.1 VOLTS?
NO
CODE IS INTERMITTENT. IF NO OTHER CODES ARE STORED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TPS. DOES SCAN INDICATE LESS THAN .2 VOLT?
NO
TPS SIGNAL CIRCUIT SHORTED TO VOLTAGE OR FAULTY PCM
YES
3
PROBE SENSOR CONNECTOR GROUND TERMINAL WITH A TEST LIGHT CONNECTED TO BATTERY VOLTAGE. IS LIGHT ON?
NO
OPEN SENSOR GROUND CIRCUIT, FAULTY PCM CONNECTION OR FAULTY PCM
YES
FAULTY CONNECTION OR THROTTLE POSITION SENSOR
94B35114

Fig. 15: Code 21 Diagnostic Flow Chart (5.7L) Throttle Position Sensor Signal Voltage High

CODE 22, THROTTLE POSITION SENSOR SIGNAL VOLTAGE LOW

Code will set if engine is running and TP sensor voltage is lower than base idle voltage (auto zero voltage). Most likely causes of code are: TP sensor signal circuit open or shorted to ground, 5-volt reference open or shorted to ground (should also set other codes), faulty sensor connection, faulty sensor, faulty PCM connection or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test checks if code is result of a hard failure or an intermittent condition.
2. This test simulates high voltage conditions. If control module recognizes change of state, control module and wiring are okay.
3. This simulates a high signal voltage to check for an open in TP sensor signal line to control module. Scan tester should recognize this signal and display high TP sensor voltage.

Diagnostic Aids

A scan tester displays throttle position in volts. Closed throttle voltage should be low. Voltage should increase gradually to about 4.5 volts at a steady rate as throttle angle is increased. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 22 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
TPS Signal	C22	Dark Blue
TPS Ground	B6	Black
TPS Reference	B28	Gray

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

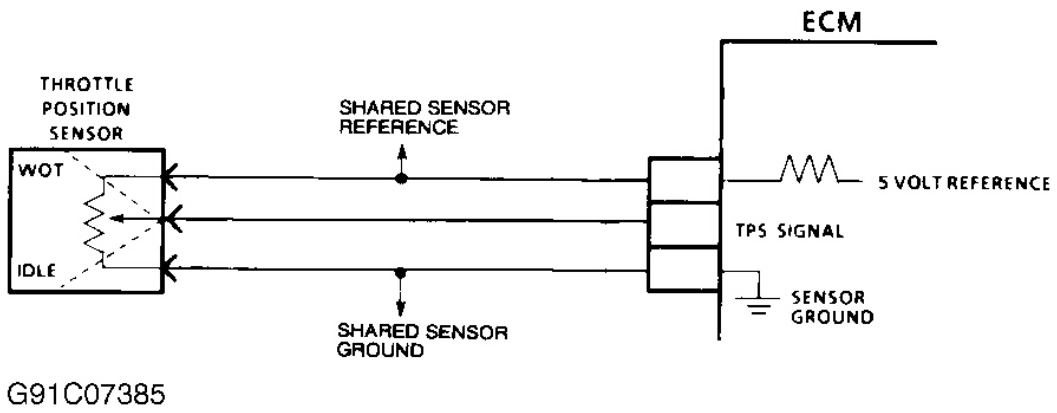
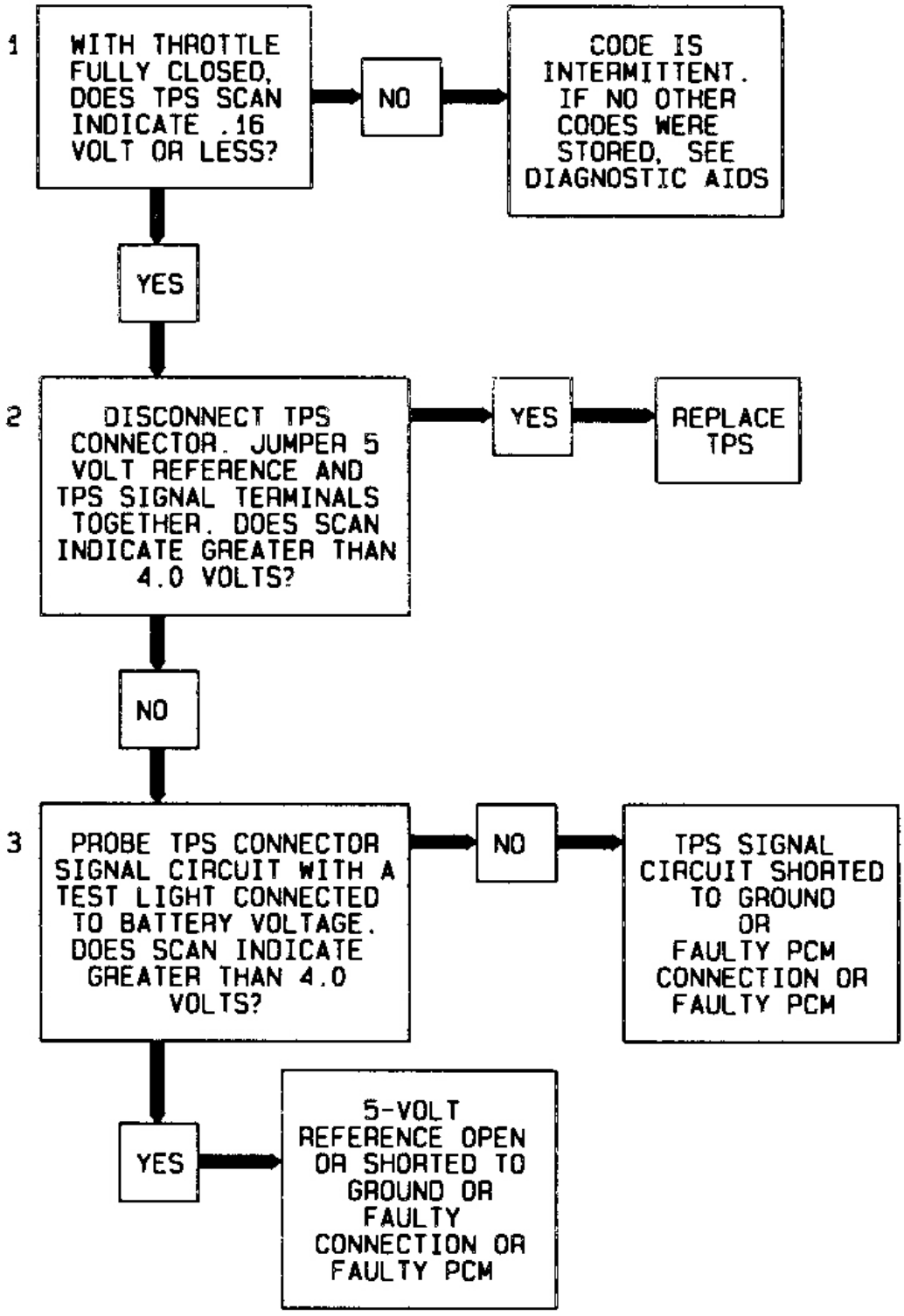


Fig. 16: Code 22 Schematic (5.7L) Throttle Position Sensor Signal Voltage Low


1
WITH THROTTLE FULLY CLOSED, DOES TPS SCAN INDICATE .16 VOLT OR LESS?
NO
CODE IS INTERMITTENT. IF NO OTHER CODES WERE STORED, SEE DIAGNOSTIC AIDS
YES
2
DISCONNECT TPS CONNECTOR. JUMPER 5 VOLT REFERENCE AND TPS SIGNAL TERMINALS TOGETHER. DOES SCAN INDICATE GREATER THAN 4.0 VOLTS?
YES
REPLACE TPS
NO
3
PROBE TPS CONNECTOR SIGNAL CIRCUIT WITH A TEST LIGHT CONNECTED TO BATTERY VOLTAGE. DOES SCAN INDICATE GREATER THAN 4.0 VOLTS?
NO
TPS SIGNAL CIRCUIT SHORTED TO GROUND OR FAULTY PCM CONNECTION OR FAULTY PCM
YES
5-VOLT REFERENCE OPEN OR SHORTED TO GROUND OR FAULTY CONNECTION OR FAULTY PCM

94I35111

Fig. 17: Code 22 Diagnostic Flow Chart (5.7L) Throttle Position Sensor Signal Voltage Low

CODE 23, IAT SENSOR SIGNAL VOLTAGE HIGH (LOW TEMP INDICATED)

Code will set if engine has been running for a precalibrated period of time, has reached operating temperature and signal voltage indicates a low intake air temperature (high voltage). Most likely causes of code are: open sensor signal circuit, open sensor ground circuit (not allowing path to ground for 5-volt reference), faulty sensor connection, faulty sensor, faulty PCM connection or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks if code is result of a hard failure or an intermittent condition.
2. This simulates low voltage (high temperature) conditions. If scan tester displays a high temperature, control module and wiring are not at fault.
3. This checks for continuity of sensor signal and ground circuits using process of elimination. If ground circuit is shared by other sensors and ground circuit is open, accompanying codes related to those sensors may be present.

Diagnostic Aids

If engine is allowed to cool overnight, coolant and IAT sensor values should be close to each other when measured by scan tester. Code will result if signal and ground circuits become open. Check sensor for shifted calibration by using sensor TEMPERATURE-TO-RESISTANCE VALUES table.

CODE 23 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
IAT Signal	C21	Tan
IAT Ground	B16	Black

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

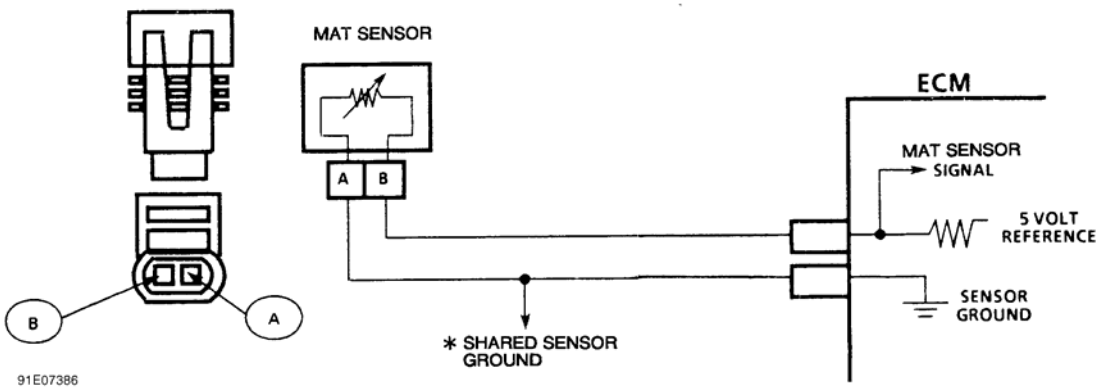


Fig. 18: Code 23 Schematic (5.7L) IAT Sensor Signal Voltage High (Low Temp Indicated)

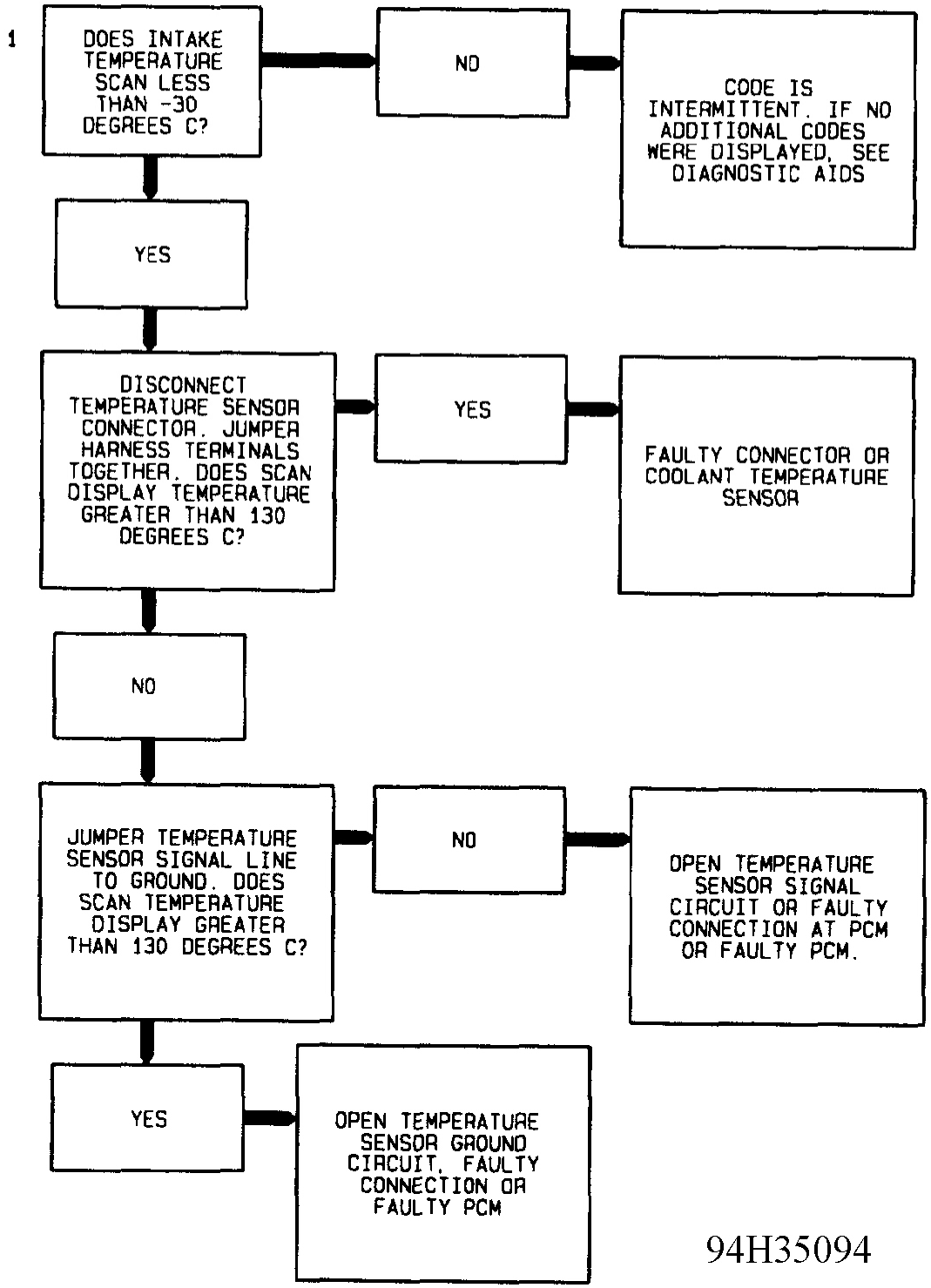


Fig. 19: Code 23 Diagnostic Flow Chart (5.7L) IAT Sensor Signal Voltage High (Low Temp Indicated)

CODE 24, VEHICLE SPEED SENSOR

Speed sensor, which is a Permanent Magnet (PM) generator, provides control module with vehicle speed information. PM generator, mounted in transmission, produces a pulsing AC voltage signal whenever vehicle speed is greater than about 2 MPH. Voltage level and pulses increase with vehicle speed. Control module converts pulsing voltage to MPH, which is used by control module to calculate vehicle adjustments.

NOTE: Test numbers refer to numbers on diagnostic chart.

NOTE: Prior to testing Corvette for Code 24, disable ASR system.

1. PM generator only produces a voltage signal if drive wheels are turning greater than about 2 MPH.

Diagnostic Aids

A faulty or misadjusted park/neutral switch may set a false Code 24. Use scan tester to check for proper signal in Drive while wiggling shifter. Code 24 may set if vehicle is power braked (brakes applied and throttle depressed) for more than 10 seconds.

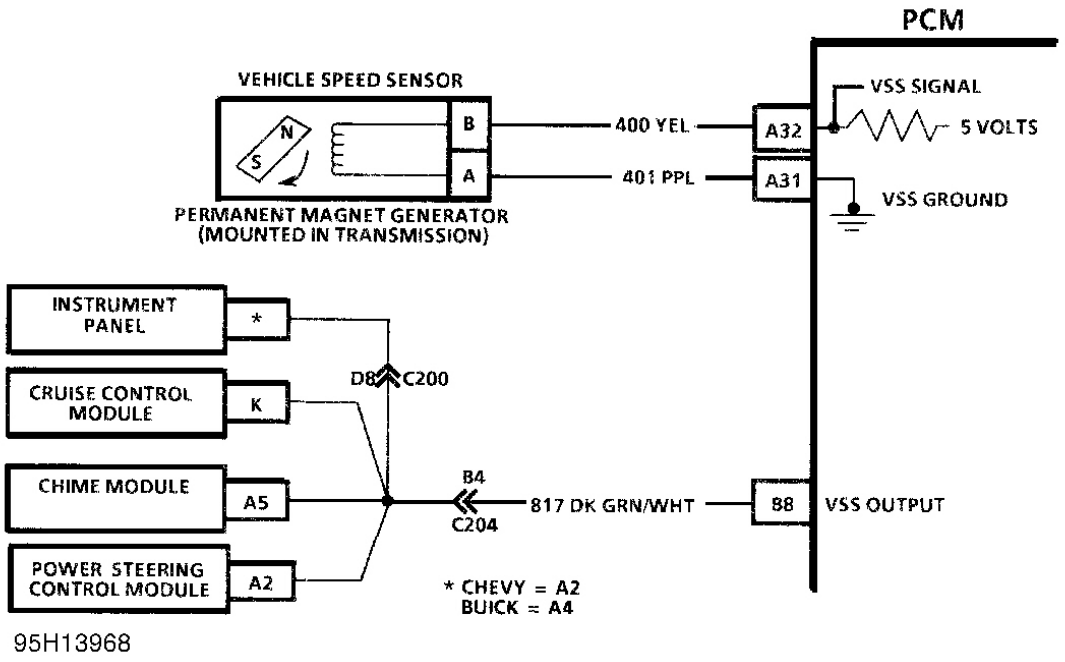


Fig. 20: Code 24 Schematic (5.7L) Vehicle Speed Sensor

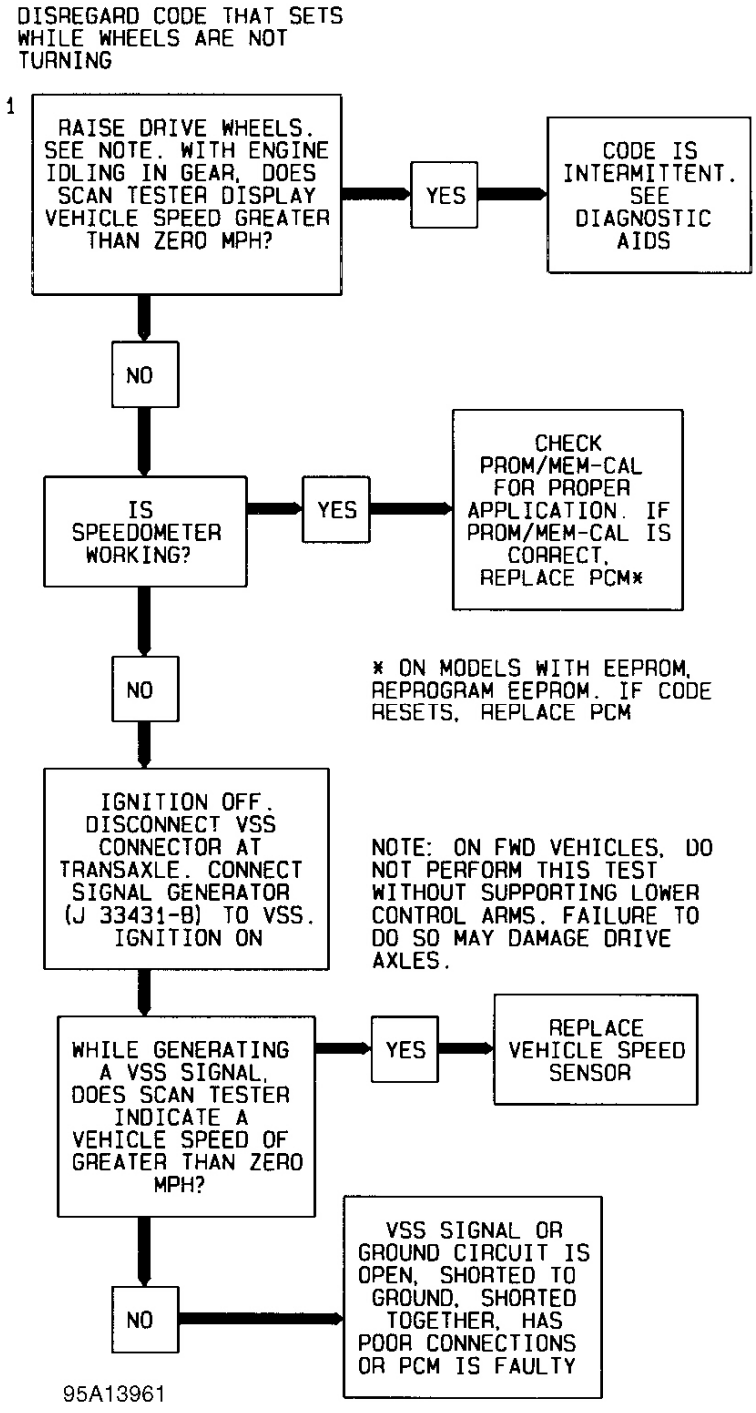


Fig. 21: Code 24 Diagnostic Flow Chart (5.7L) Vehicle Speed Sensor

CODE 25, IAT SENSOR SIGNAL VOLTAGE LOW (HIGH TEMP INDICATED)

Code will set if intake air temperature is extremely high (sensor signal voltage low) for a precalibrated period of

time. Most likely causes of code are: sensor signal circuit shorted to ground, faulty coolant temperature sensor or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This checks if code is hard failure or intermittent condition.
2. This simulates low temperature (high resistance) conditions. If control module recognizes open circuit and scan tester displays temperature of less than about -30°C, control module and wiring are okay.

Diagnostic Aids

If engine is allowed to cool overnight, coolant temperature sensor and IAT sensor values should be close to each other when measured by a scan tester. A Code 25 will result if sensor signal circuit is shorted to ground. Check sensor for shifted calibration by using sensor TEMPERATURE-TO-RESISTANCE VALUES table.

CODE 25 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
IAT Signal	C21	Tan
IAT Ground	B16	Black

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

- For shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

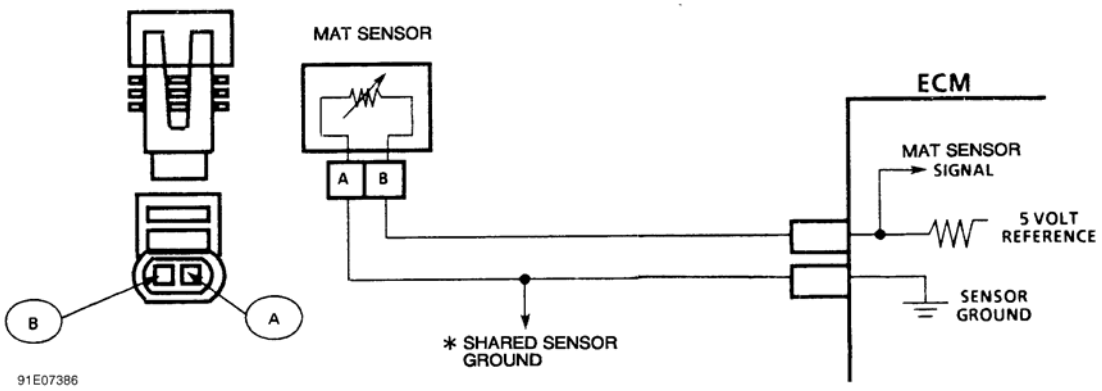


Fig. 22: Code 25 Schematic (5.7L) IAT Sensor Signal Voltage Low (High Temp Indicated)

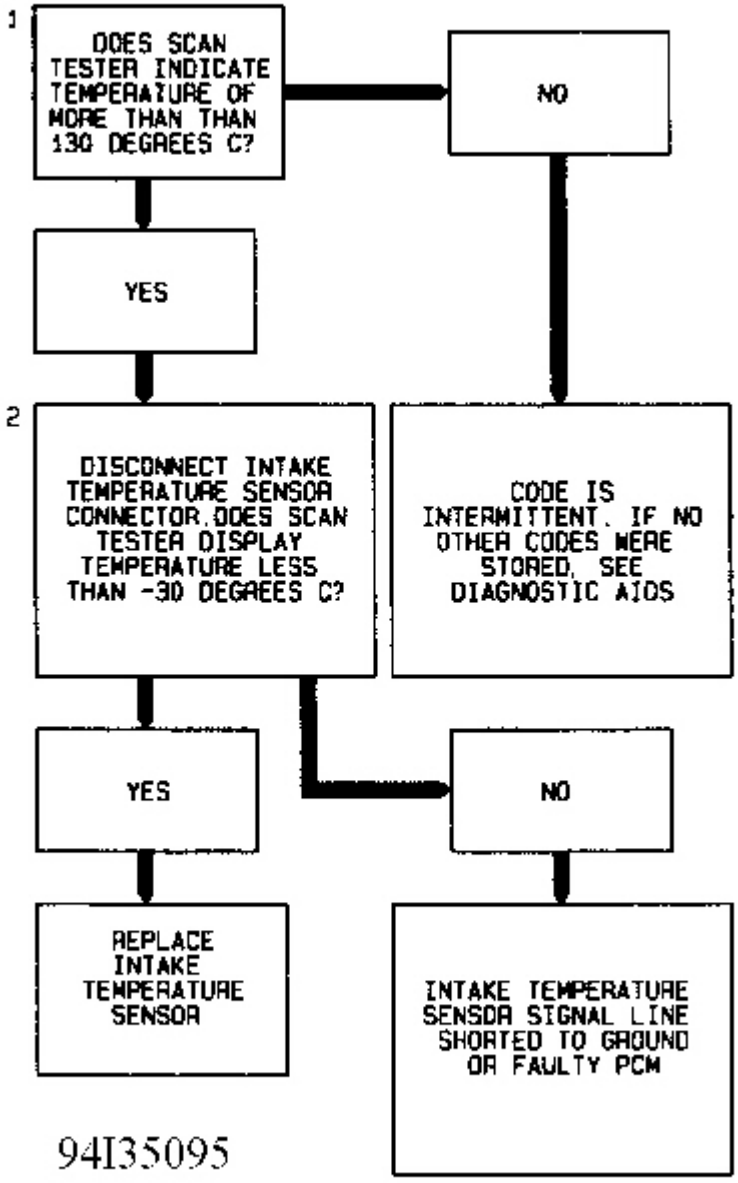


Fig. 23: Code 25 Diagnostic Flow Chart (5.7L) IAT Sensor Signal Voltage Low (High Temp Indicated)

CODE 26, CANISTER PURGE SOLENOID

Solenoid is supplied voltage when ignition is on. PCM controls solenoid valve by providing a ground through one of its Quad-Drivers Modules (QDM). When solenoid is actuated, terminal is grounded and its monitored

voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Code 26 will set if the PCM detects the wrong voltage potential. Test will determine if solenoid can be controlled by PCM.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative solenoid.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

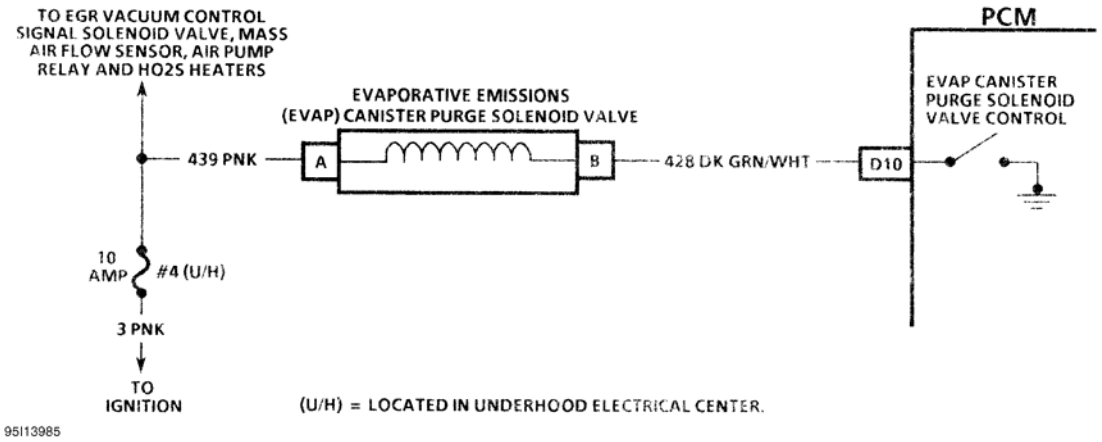


Fig. 24: Code 26 Schematic (5.7L) Canister Purge Solenoid

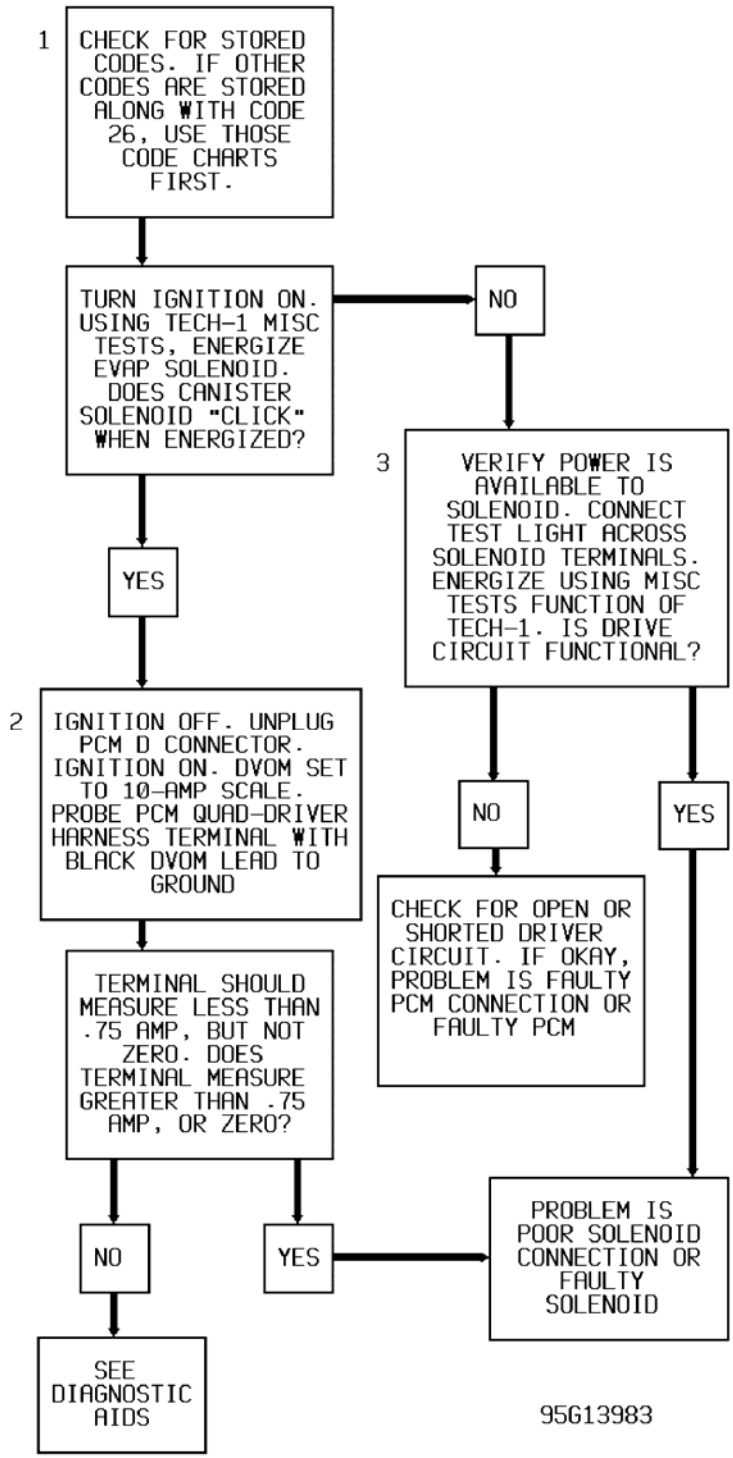


Fig. 25: Code 26 Diagnostic Flow Chart (5.7L) Canister Purge Solenoid

CODE 27, EGR SOL VALVE

Ignition voltage is supplied voltage when ignition is on. PCM controls solenoid valve by providing a ground

through one of its Quad-Drivers Modules (QDM). When solenoid is actuated, terminal is grounded and its monitored voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Code 27 will set if the PCM detects the wrong voltage potential. Test will determine if solenoid can be controlled by PCM.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative solenoid.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

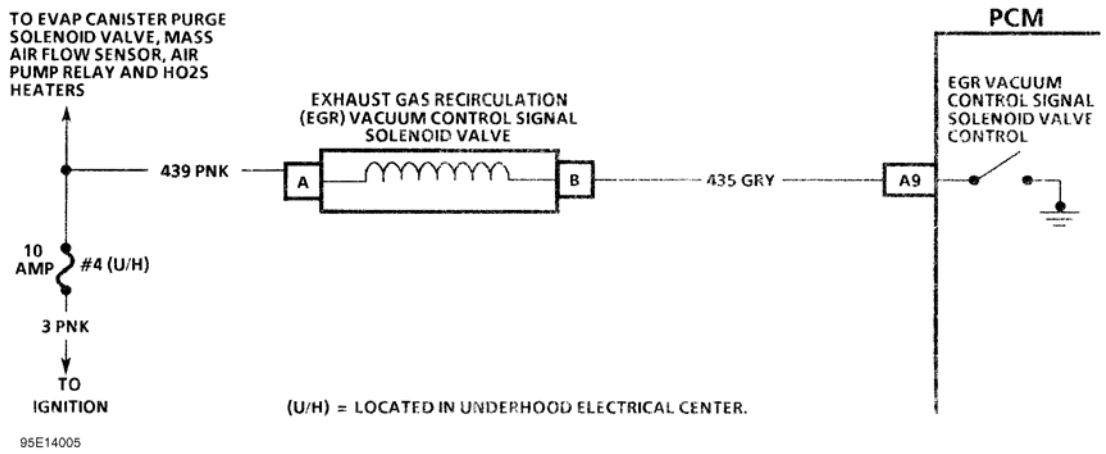


Fig. 26: Code 27 Schematic (5.7L) EGR Solenoid Valve

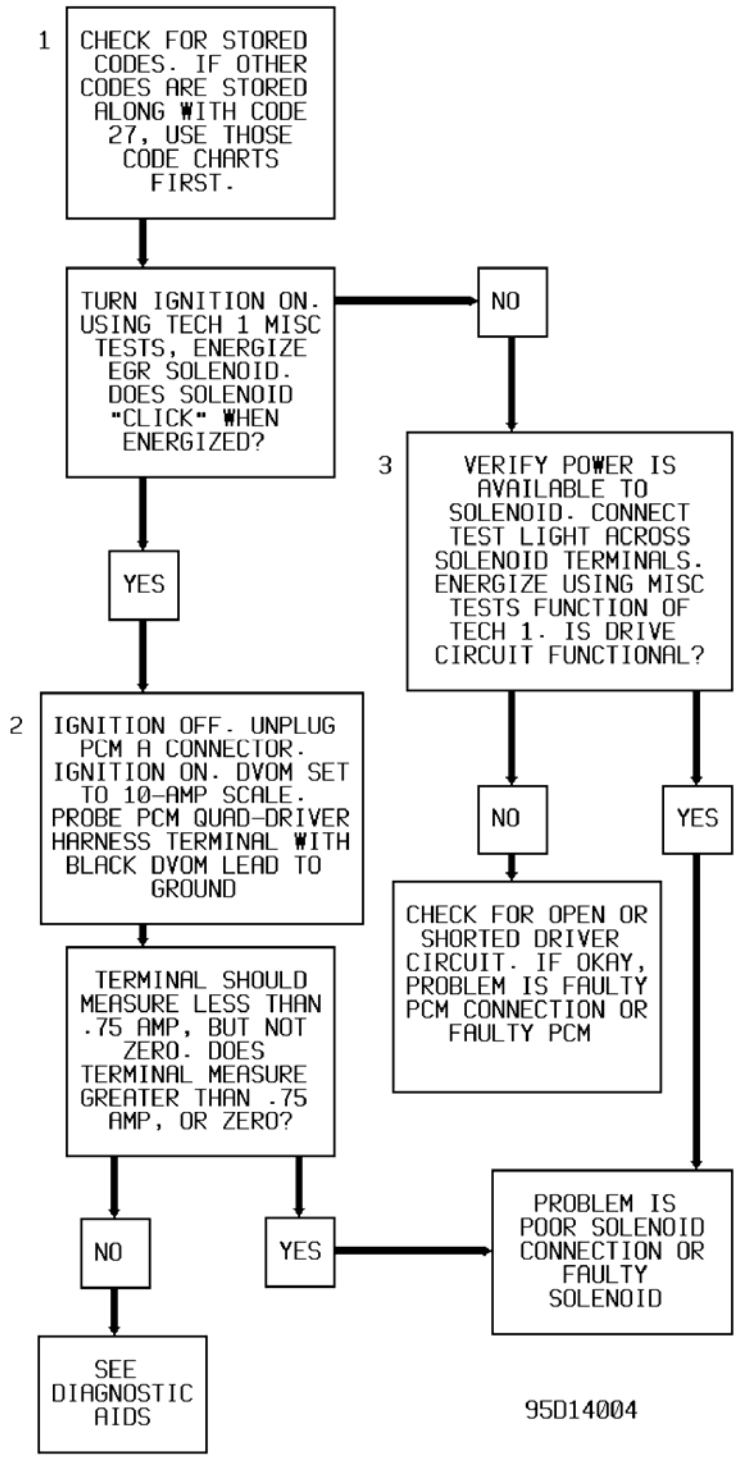


Fig. 27: Code 27 Diagnostic Flow Chart (5.7L) EGR Solenoid Valve

CODE 28, TRANS. RANGE PRESSURE SWITCH

Transmission range pressure switch assembly consists of 5 pressure switches (2 normally closed, 3 normally

open), and a fluid temperature sensor combined into one unit and mounted on the valve body. PCM supplies voltage to each range signal. By grounding one or more of these circuits through various combinations of pressure switches, PCM detects which manual valve position has been selected. With ignition on and engine off, Park/Neutral will be indicated. Code 28 will set when range signals "A" and "C" are both zero volts (on) for 2 seconds.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks indicated range signal to valve position signal actually selected.
2. Checks for correct voltage from PCM to transmission external connector.
3. Checks for short to ground in any one of the 3 valve position circuits.

Diagnostic Aids

Code will set if PCM detects one of 2 illegal combinations. Check all connections for good contact.

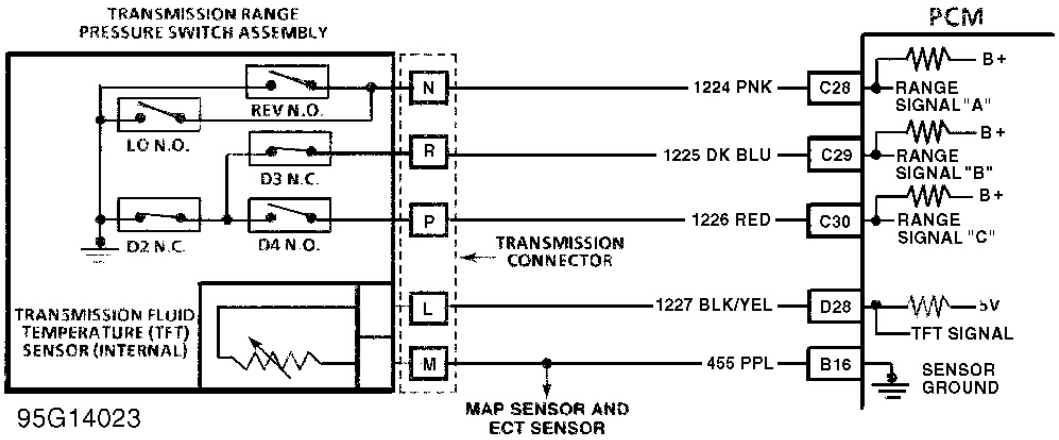


Fig. 28: Code 28 Schematic (5.7L) Transmission Range Pressure Switch

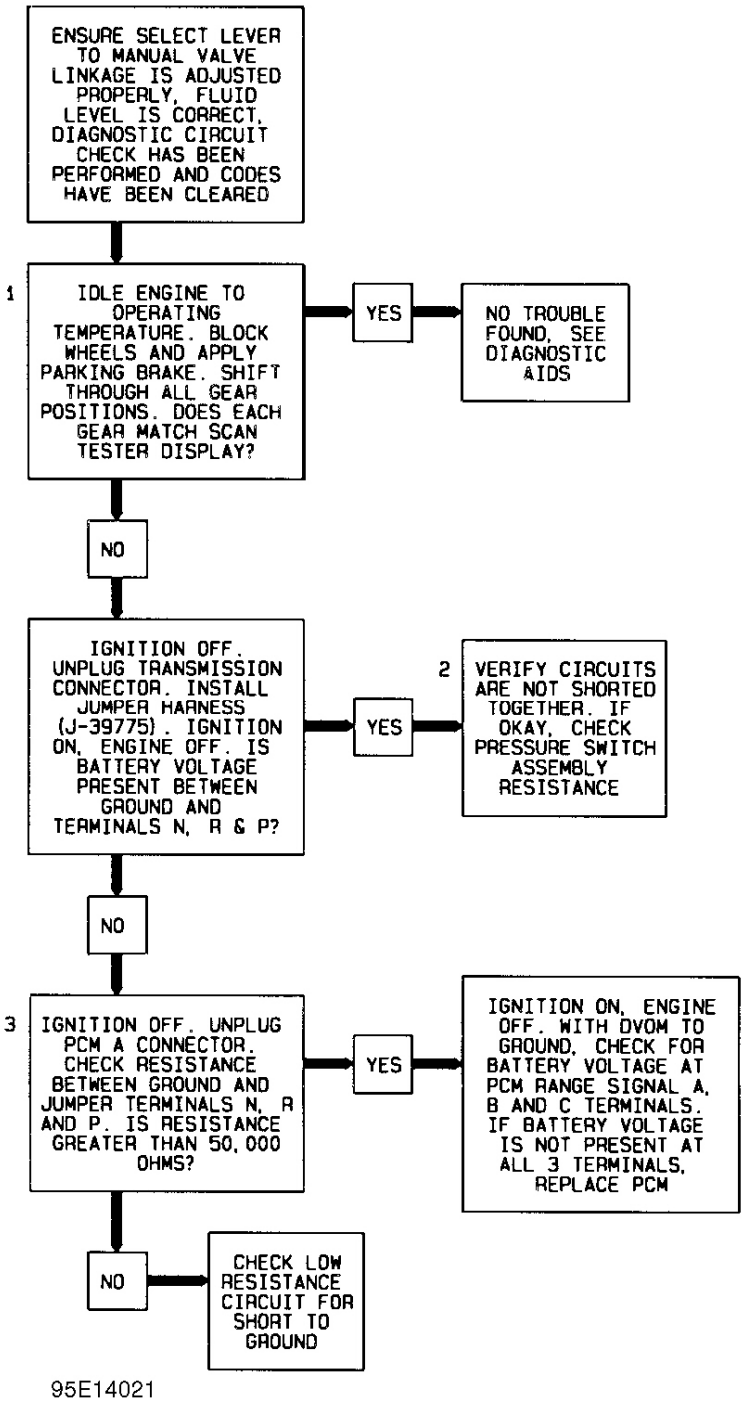


Fig. 29: Code 28 Diagnostic Flow Chart (5.7L) Transmission Range Pressure Switch

CODE 29, SECONDARY AIR INJECTION

Ignition voltage is supplied voltage when ignition is on. PCM controls air pump relay by providing a ground

through one of its Quad-Driver Modules (QDM). When relay is actuated, terminal is grounded and its monitored voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Code 29 will set if the PCM detects the wrong voltage potential. Test will determine if relay can be controlled by PCM.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative relay.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

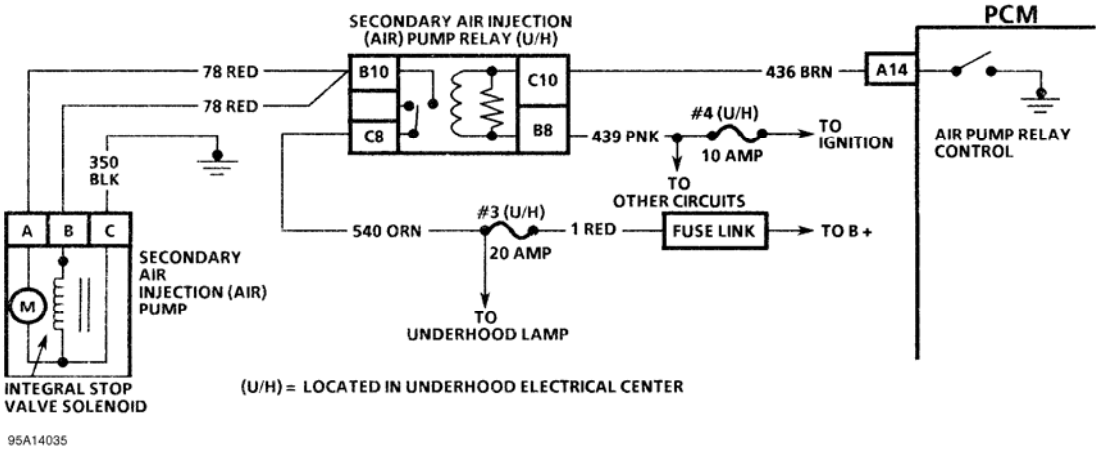


Fig. 30: Code 29 Schematic (5.7L) Secondary Air Injection

CODE 32, EGR SYSTEM ERROR

EGR vacuum is regulated by an PCM-controlled, normally closed solenoid. PCM will turn EGR on and off (duty cycle) by grounding and ungrounding solenoid drive circuit. Duty cycle is calculated by PCM based on coolant temperature, airflow and engine RPM. PCM will check EGR operation when vehicle speed is 16-32 MPH, MAP is within calibrated range, throttle angle is zero percent and vehicle is coasting.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. See following:
   - **Plugged Intake Passage** Shut off engine, and remove EGR valve. Plug exhaust side port using a shop rag or suitable plug. Attempt to start engine. If engine runs at a very high idle (up to 3000 RPM is possible) or if engine starts and stalls, EGR intake passage is not plugged. If vehicle starts

and idles normally, intake side passage is plugged.

- **Plugged Exhaust Passage** With EGR valve removed, plug intake manifold side passage using a suitable plug. Start engine and listen for exhaust noise. If no exhaust gas escapes from open EGR port, exhaust passage is plugged.

2. Using Tech 1 tester, EGR solenoid should energize and allow vacuum to be applied to gauge. Vacuum at gauge may or may not slowly bleed off; however, gauge is able to read amount of vacuum being applied.
3. Upon exiting field service mode, gauge vacuum should bleed off through a vent in solenoid. Pump gauge vacuum may or may not bleed off; this does not indicate a problem.
4. Remaining tests check ability of EGR valve to interact with exhaust system. This system uses a negative backpressure EGR valve which will hold vacuum with engine off.
5. When engine is started, exhaust backpressure at base of EGR valve should open valve's internal bleed. This will vent applied vacuum, allowing valve to seat.

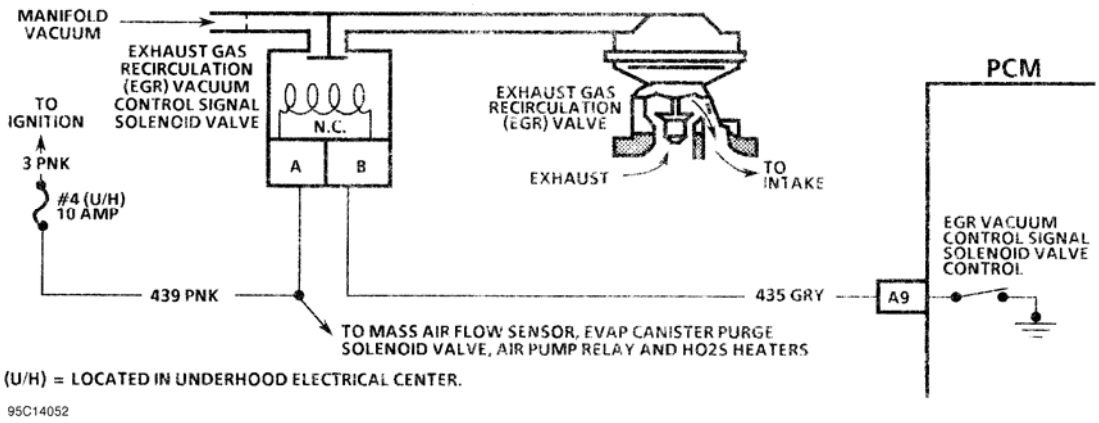


Fig. 31: Code 32 Schematic (5.7L) EGR System Error

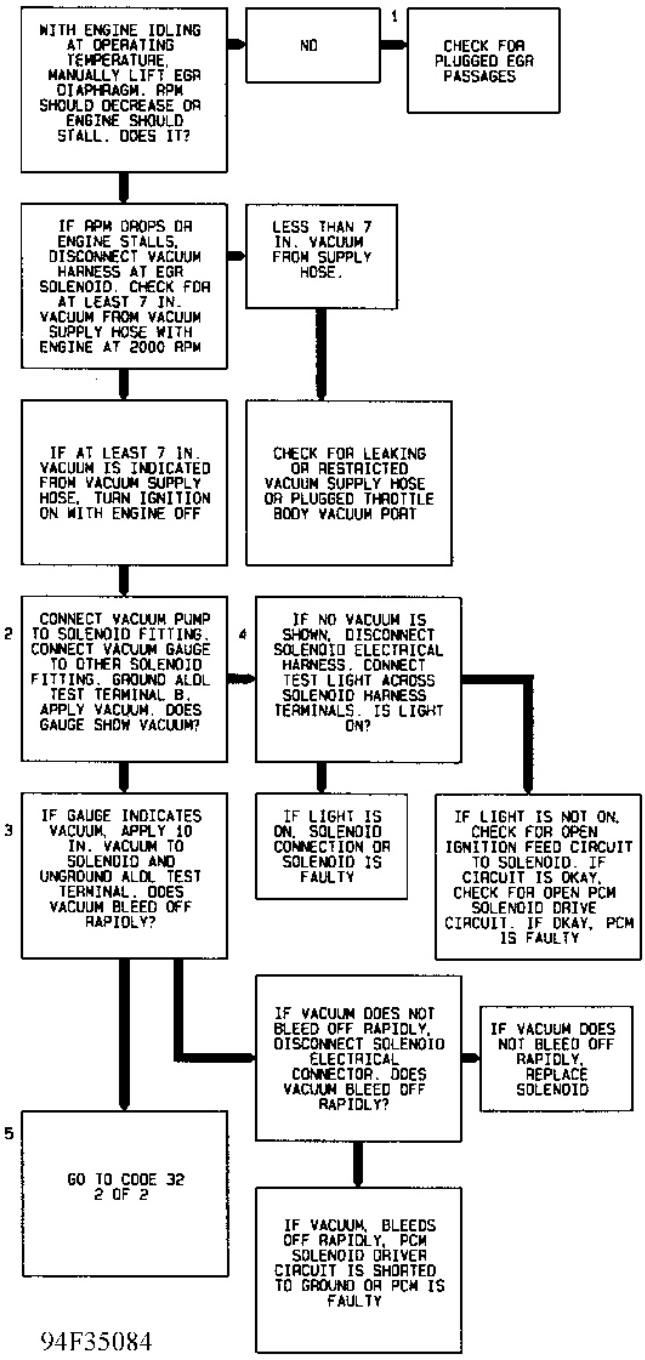


Fig. 32: Code 32 Diagnostic Flow Chart - 1 Of 2 (5.7L) EGR System Error

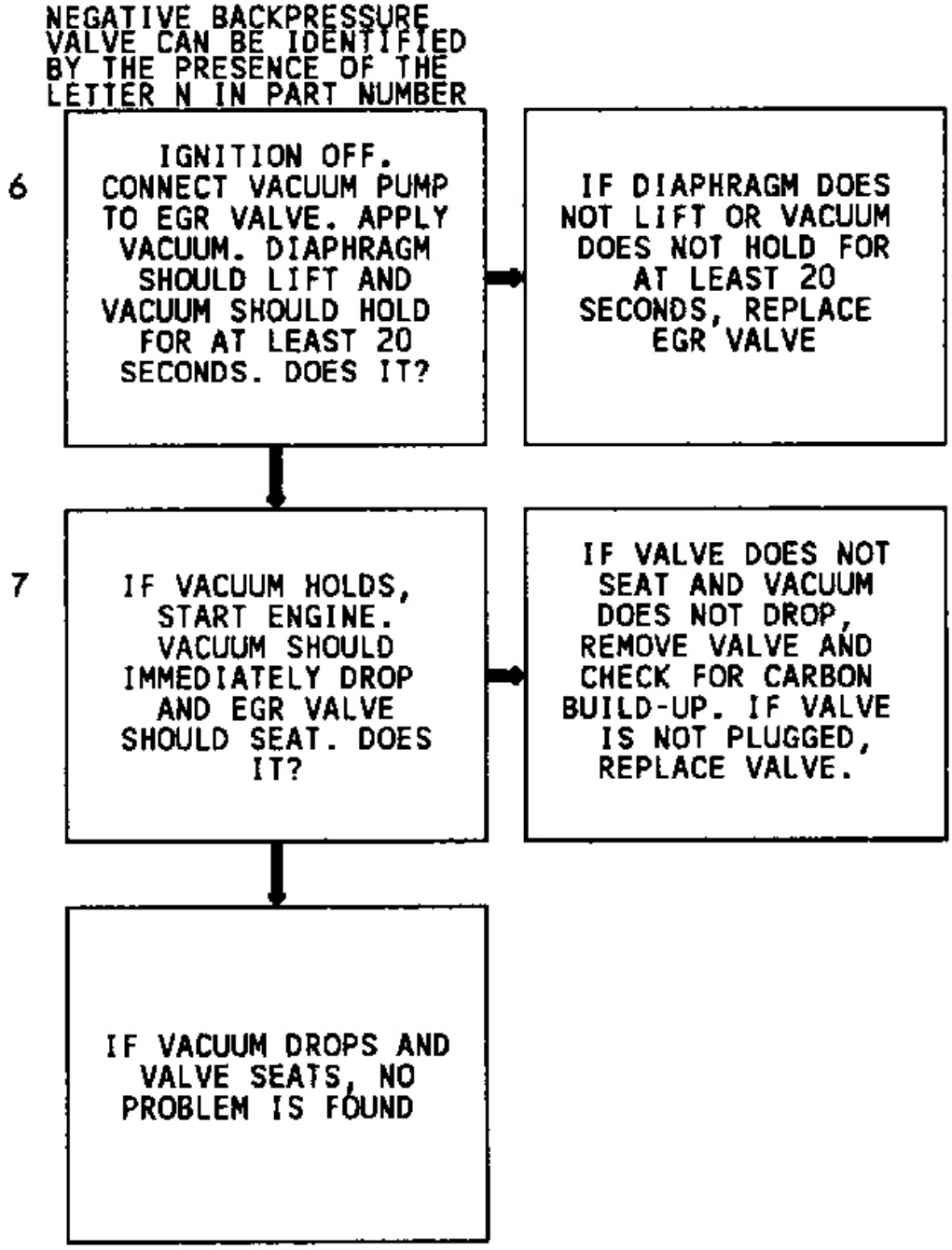


Fig. 33: Code 32 Diagnostic Flow Chart - 2 Of 2 (5.7L) EGR System Error

CODE 33, MAP SENSOR SIGNAL VOLTAGE HIGH

Code 33 will set when MAP signal voltage reading is high for greater than a precalibrated period of time, TPS voltage indicates throttle is closed and neither Code 21 nor 22 is present. Most likely causes for code are: open sensor ground circuit, sensor signal circuit shorted to voltage, faulty MAP sensor, MAP sensor vacuum leak or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test confirms Code 33 and determines if it is result of a hard failure or an intermittent condition.
2. This step simulates conditions for a Code 34. If control module recognizes and sets Code 34, low MAP signal, control module and 5-volt reference and MAP signal circuits are not at fault. If ground circuit is shared with other sensors and ground circuit becomes open, additional codes related to these sensors may be set.

Diagnostic Aids

With ignition switch in ON position and engine stopped, manifold pressure is equal to atmospheric pressure and signal voltage will be high. Comparison of BARO readings from a known good vehicle using same sensor is a good way to check accuracy of suspect sensor. Readings should be same within .4 volt. Code 33 will result if ground circuit is open, MAP signal circuit is shorted to voltage or to 5-volt reference circuit.

CODE 33 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
MAP Signal	C23	Light Green
MAP Ground	B16	Purple
MAP Reference	B29	Gray

- For shared sensor reference and shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

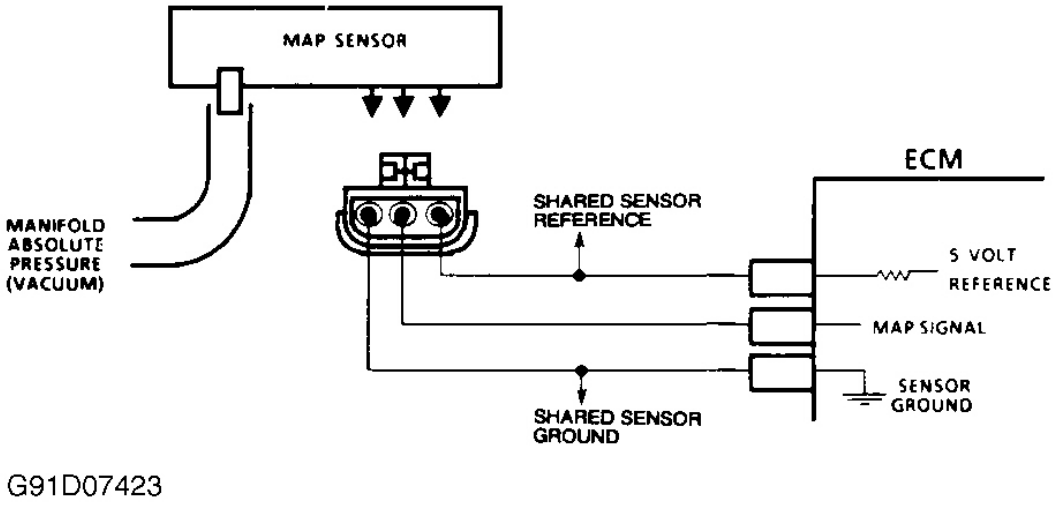


Fig. 34: Code 33 Schematic (5.7L) MAP Sensor Signal Voltage High

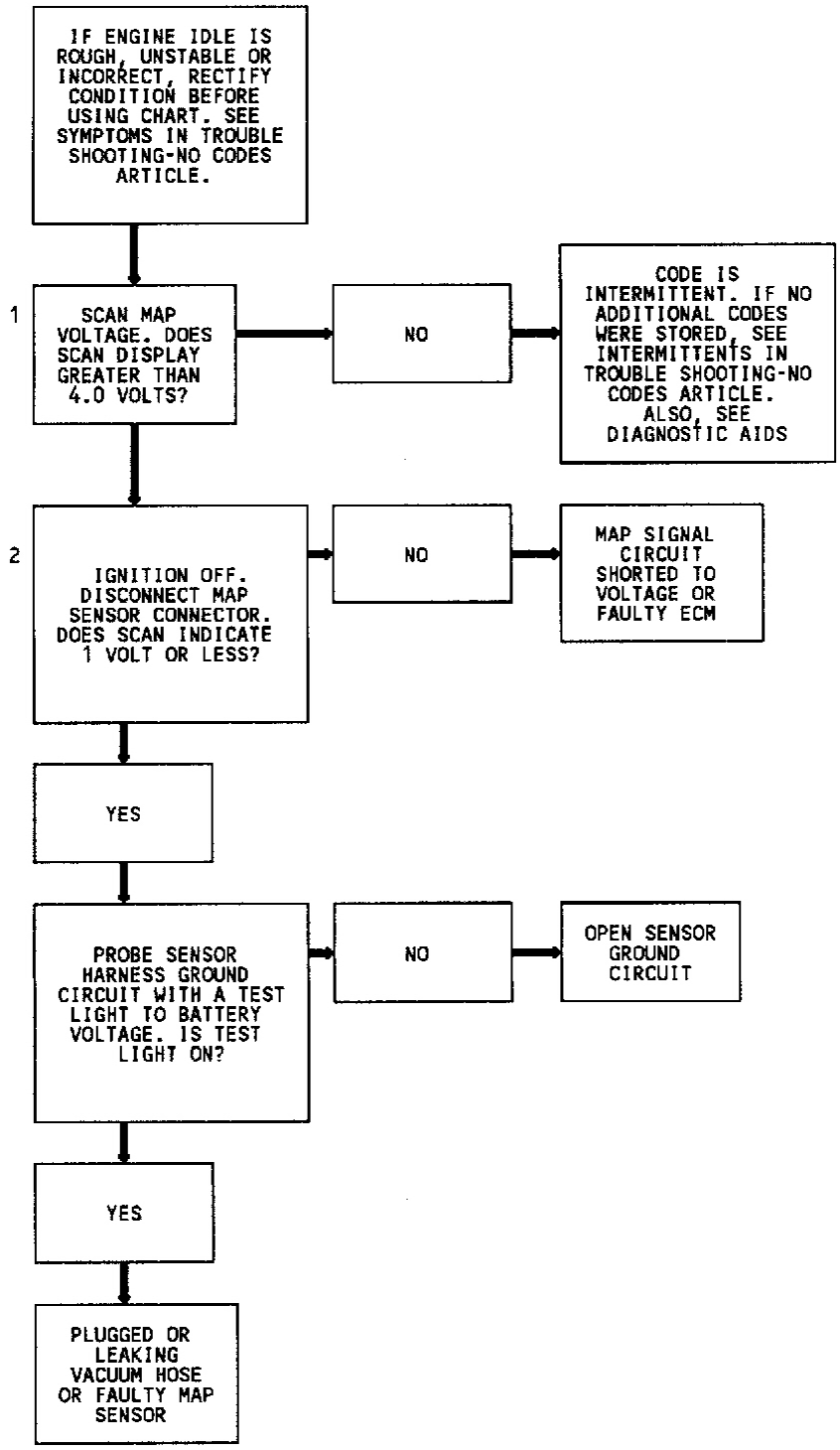


Fig. 35: Code 33 Diagnostic Flow Chart (5.7L) MAP Sensor Signal Voltage High

CODE 34, MAP SENSOR SIGNAL VOLTAGE LOW

Code 34 will set when ignition is on, throttle is off idle, no TP sensor code exists and MAP signal voltage is lower than expected for off idle engine operation. Most likely causes for code are: MAP sensor signal circuit open or shorted to ground, 5-volt reference circuit open or shorted to ground, faulty sensor connection, faulty sensor or faulty PCM.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This confirms conditions for Code 34 and determines if code was caused by a hard failure or an intermittent fault.
2. Jumpering MAP signal to 5-volt reference at MAP harness connector will determine if sensor is at fault or if a problem exists with control module or wiring.
3. Scan tester may not display 12 volts. Control module recognizes voltage as greater than 4 volts (high MAP voltage signal), indicating control module and MAP signal circuit are not at fault.

Diagnostic Aids

With ignition switch in ON position and engine stopped, manifold pressure is equal to atmospheric pressure and signal voltage will be high. Comparing BARO readings with a known good vehicle using same sensor is a good way to check accuracy of suspect sensor.

Readings should be same within .4 volt. A Code 34 will also result if 5-volt reference and MAP signal circuits are open or shorted to ground.

CODE 34 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
MAP Signal	C23	Light Green
MAP Ground	B16	Purple
MAP Reference	B29	Gray

- For shared sensor reference and shared sensor ground tie-offs, see appropriate wiring diagram in WIRING DIAGRAMS section.

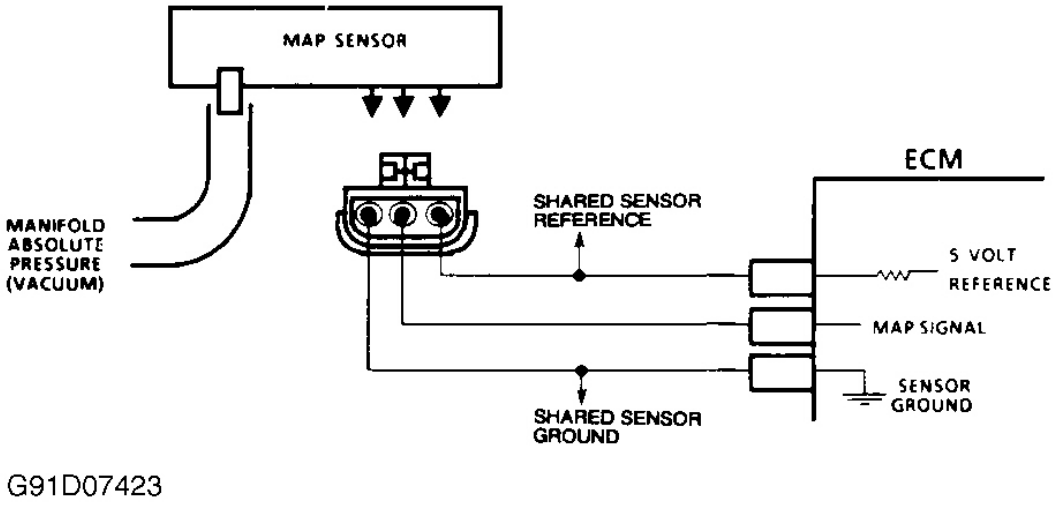


Fig. 36: Code 34 Schematic (5.7L) MAP Sensor Signal Voltage Low

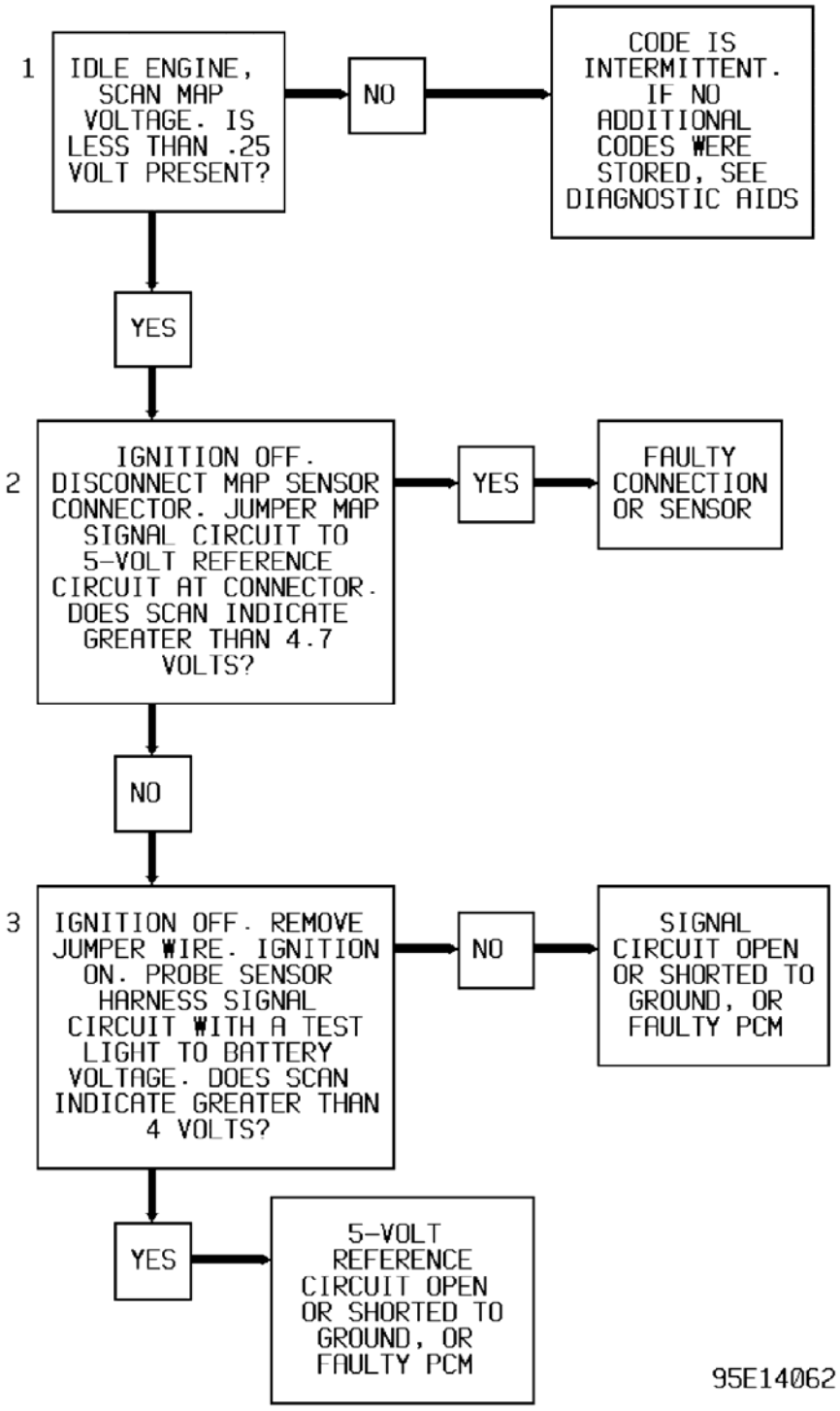


Fig. 37: Code 34 Diagnostic Flow Chart (5.7L) MAP Sensor Signal Voltage Low

CODE 36, OPTI-SPARK HIGH RESOLUTION PULSE

Ignition system supplies 2 timing inputs to PCM, a high resolution signal (360 pulses per camshaft revolution)

and a low resolution signal (8 pulses per camshaft revolution). PCM can determine if either timing input is not being received by comparing inputs. If PCM detects 40 low resolution pulse without detecting high pulse, Code 36 will set. Reference signal on resolution line toggles between zero and 5 volts as camshaft turns.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Determines if code is intermittent.
2. This step determines if PCM is sending out a signal to distributor for processing. If this signal is not available or is shorted to ground or voltage, distributor cannot ground it to produce reference pulses.
3. If Code 41 and/or 42 is set with Code 36 and no external fault can be found, replace PCM. If Code 36 is set alone and distributor connections are okay, replace distributor.

Diagnostic Aids

An open, a short to voltage, a short to ground or a defective sensor inside distributor can prevent reference voltage from pulsing at PCM resolution terminal. If Code 36 is present and vehicle still does not start, check for Code 16 and use that chart first. If vehicle still will not start, go to NO START - ENGINE CRANKS OKAY in **BASIC TESTING** article in this section.

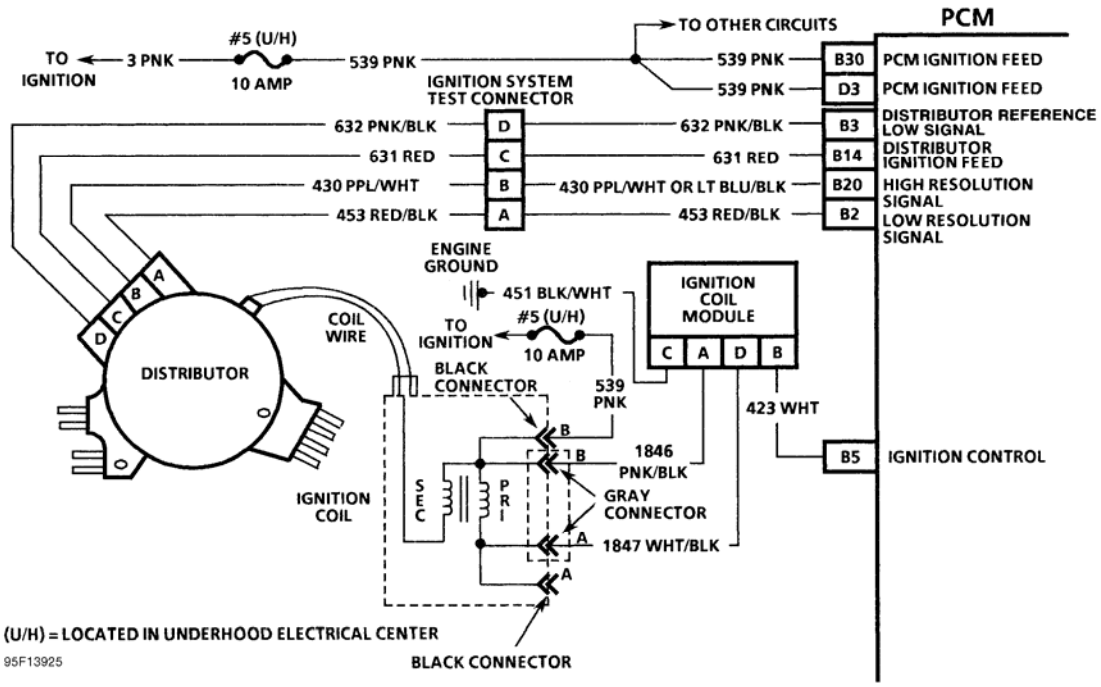


Fig. 38: Code 36 Schematic (5.7L) Opti-Spark High Resolution Pulse

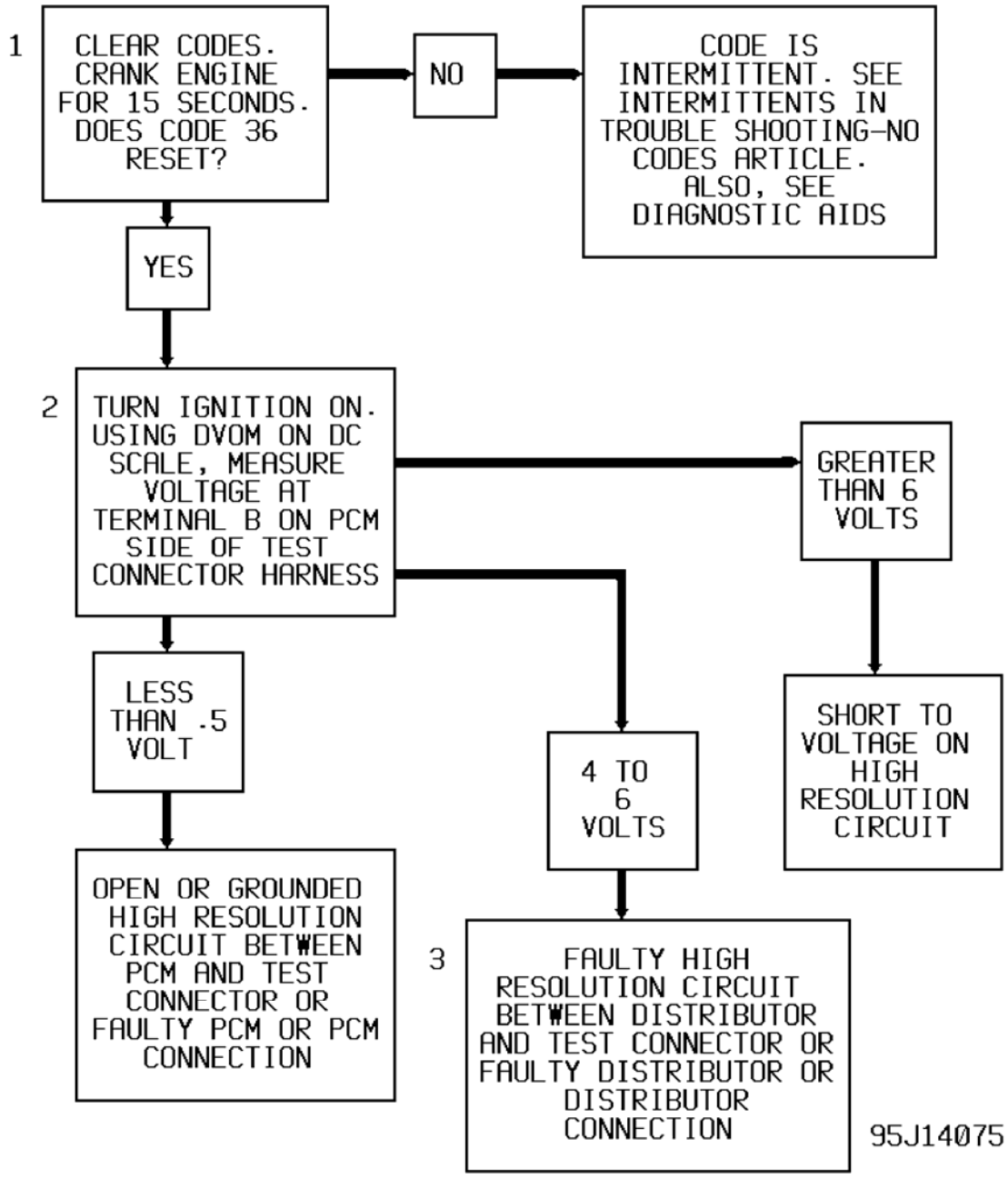


Fig. 39: Code 36 Diagnostic Flow Chart (5.7L) Opti-Spark High Resolution Pulse

CODE 37, TCC BRAKE SWITCH ERROR

PCM monitors activity of the normally-closed brake switch. Switch opens when brake pedal is applied.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for voltage at brake switch.

2. Simulates brake switch closed or brakes off.
3. Checks TCC brake switch circuit between PCM and switch.

Diagnostic Aids

Code 37 can be caused by a misadjusted brake switch or a poor connection. Code may also be set by unusual driving habits (i.e. stop-and-go expressway driving).

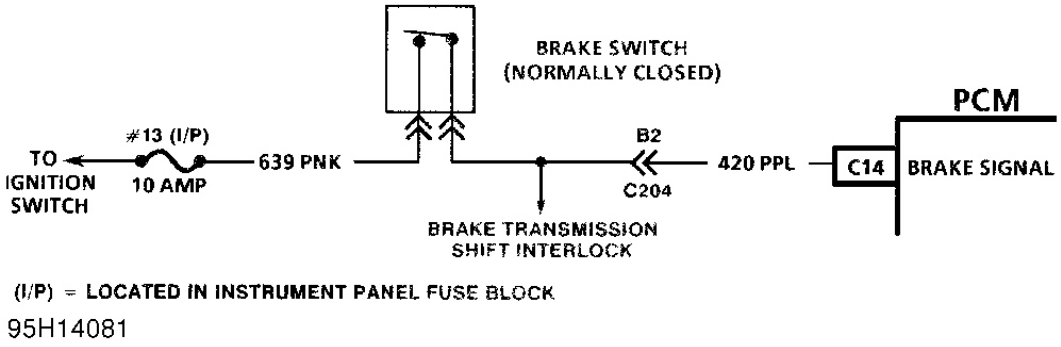


Fig. 40: Code 37 Schematic (5.7L) TCC Brake Switch Error

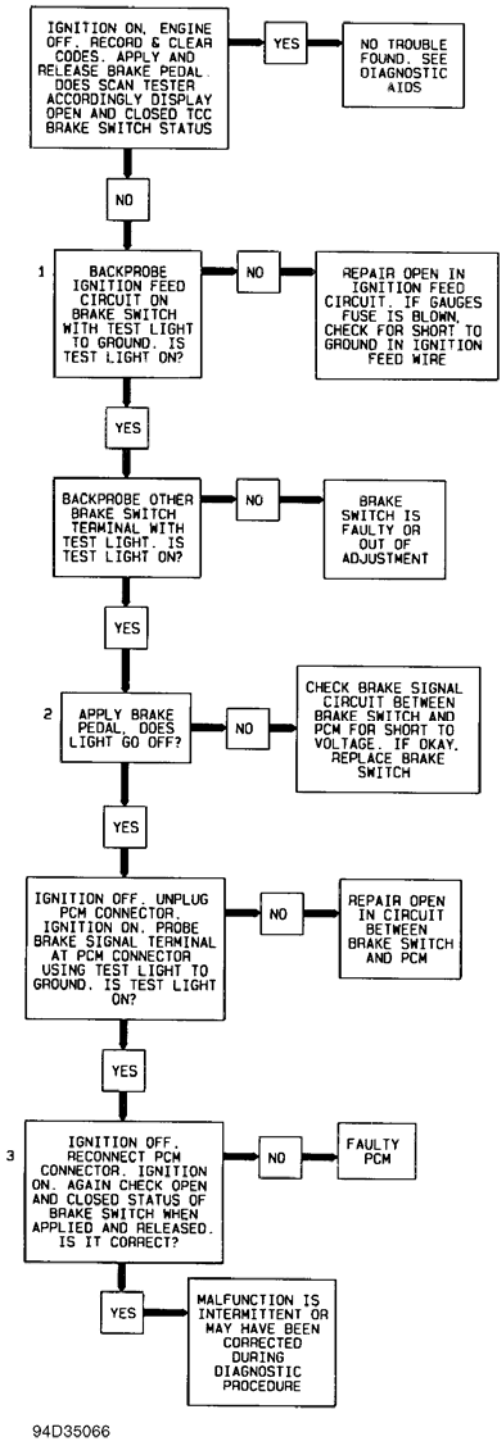


Fig. 41: Code 37 Diagnostic Flow Chart (5.7L) TCC Brake Switch Error

CODE 38, BRAKE SWITCH ERROR

PCM monitors activity of the normally-closed brake switch. Switch opens when brake pedal is applied. Code

will set if PCM has seen conditions which would have required brake applications at least 7 times and no transition in brake switch has been detected.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for voltage at brake switch.
2. Simulates brake switch closed or brakes off. Checks brake switch circuit between PCM and switch.
3. Checks circuit between brake switch and PCM.

Diagnostic Aids

Code may also be set by unusual driving habits (i.e. stop-and-go expressway driving).

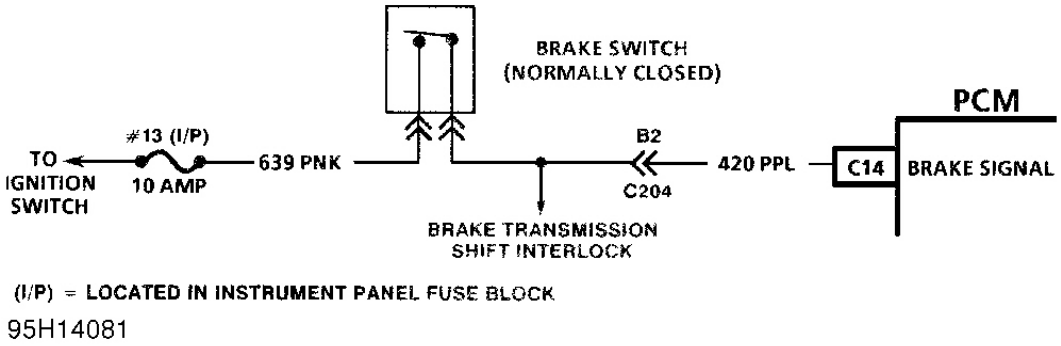


Fig. 42: Code 38 Schematic (5.7L) Brake Switch Error

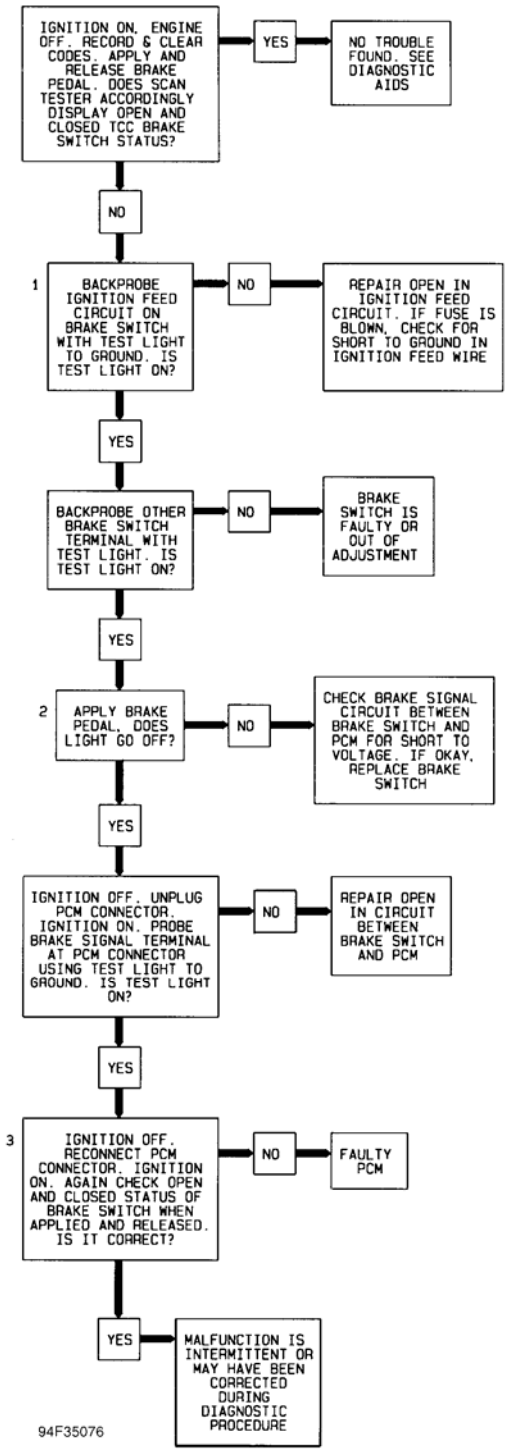


Fig. 43: Code 38 Diagnostic Flow Chart (5.7L) Brake Switch Error

CODE 41, OPTI-SPARK IGNITION SYSTEM OPEN OR SHORTED EST CKT

Ignition system provides 2 timing inputs to PCM, high resolution (360 pulses per camshaft revolution) and low

resolution (4 pulses per crankshaft revolution). PCM uses these 2 inputs to determine individual spark timing for each cylinder. Once PCM calculates ignition timing, timing signal will be sent to ignition coil driver on IC circuit. Each timing pulse received by ignition coil driver will trigger coil driver to operate ignition coil. IC signal voltage ranges from about .5 volt to 4.5 volts. If a Code 41 is set, PCM will disable fuel injectors to prevent flooding of engine.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Determines if code is intermittent.
2. This step determines if IC signal from PCM is available at ignition coil driver. IC circuit voltage should be between about .5 volt and 4.5 volts.
3. Remaining steps ensure coil driver circuitry is okay. If all wiring and connections are okay, check ignition coil and ignition coil voltage supply.

Diagnostic Aids

Because coil driver gets its power from coil, check ignition feed circuit to ignition coil for opens, including coil fuse.

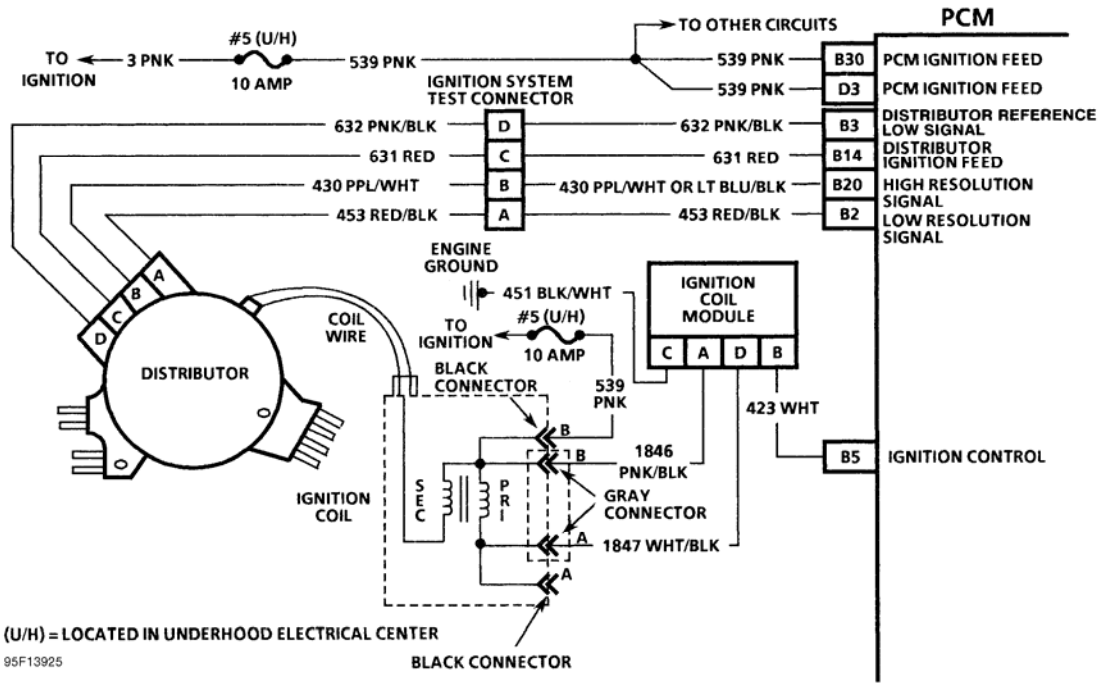


Fig. 44: Code 41 Schematic (5.7L) Opti-Spark Ignition System Open Or Shorted EST Circuit

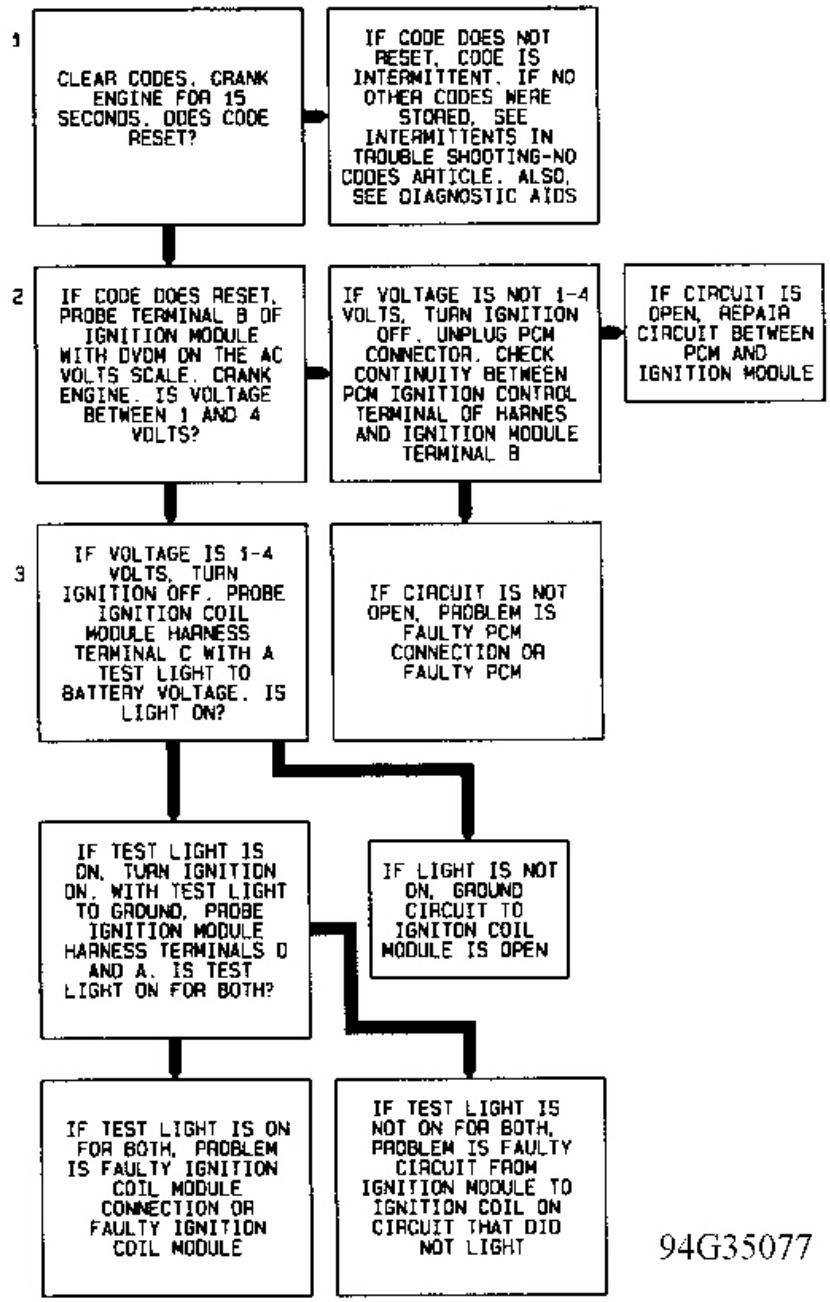


Fig. 45: Code 41 Diagnostic Flow Chart (5.7L) Opti-Spark Ignition System Open Or Shorted EST Circuit

CODE 42, IC CIRCUIT GROUNDED

Ignition system provides 2 timing inputs to PCM, high resolution (360 pulses per camshaft revolution) and low

resolution (4 pulses per crankshaft revolution). PCM uses these 2 inputs to determine individual spark timing for each cylinder. Once PCM calculates ignition timing, timing signal will be sent to ignition coil driver on IC circuit. Each timing pulse received by ignition coil driver will trigger coil driver to operate ignition coil. IC signal voltage ranges from about .5 volt to 4.5 volts.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If engine starts, code is intermittent.
2. This test checks for an IC signal from PCM to ignition coil driver.
3. Remaining tests check driver circuitry. Because coil driver gets its power from coil, check ignition coil feed circuit to ignition coil for opens.

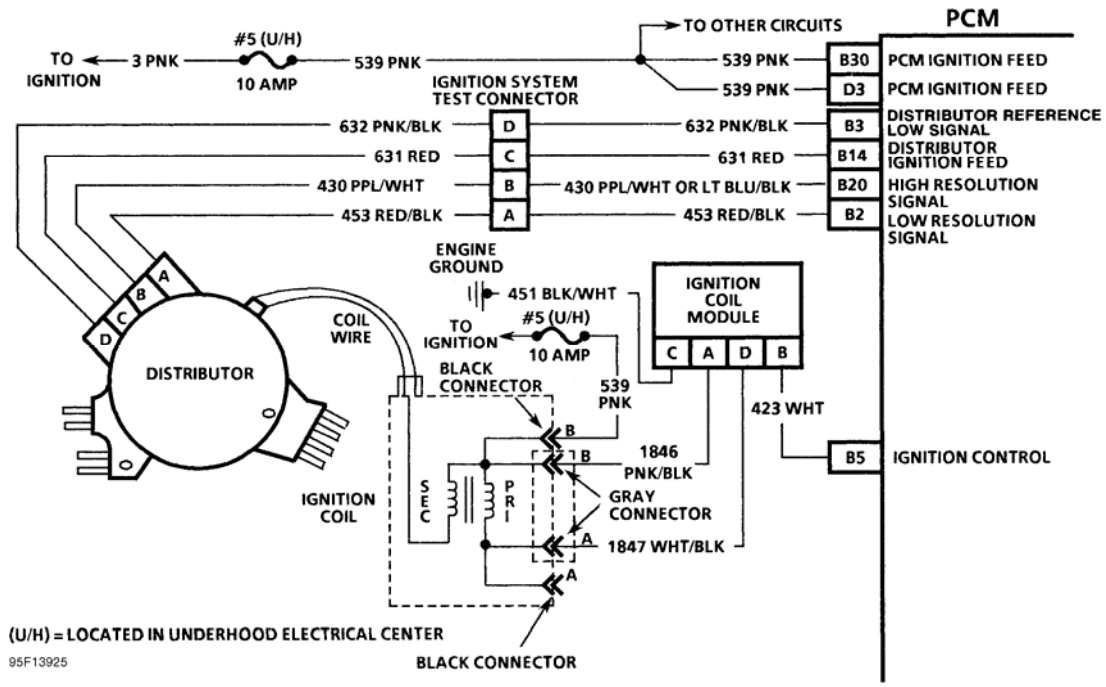


Fig. 46: Code 42 Schematic (5.7L) IC Circuit Grounded

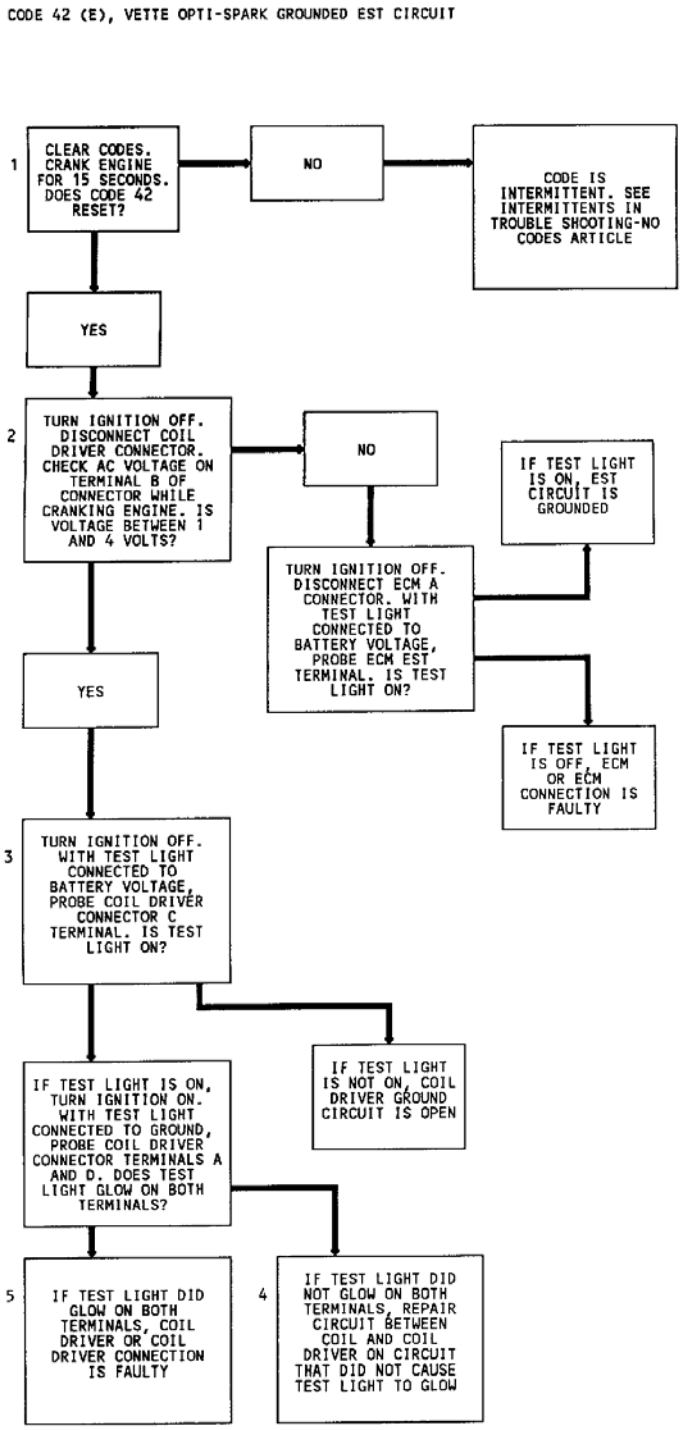


Fig. 47: Code 42 Diagnostic Flow Chart (5.7L) IC Circuit Grounded

CODE 43, KNOCK SENSOR CIRCUIT (DUAL SENSORS)

Knock sensor informs PCM of engine detonation. PCM will retard ignition timing based on signals from knock

sensors. Knock sensors produce an AC voltage signal which is proportional to amount of engine detonation (knock). Internal sensor circuitry causes 5-volt DC reference signal sent by PCM to be pulled low to about 1.5 volts. Any AC voltage produced by sensors will travel to PCM on this same reference line. Code 43 will set if: one sensor circuit becomes open, resulting in a 2.2 to 4.1-volt reference being monitored by PCM, both sensor circuits become open, resulting in a reference voltage greater than 4.1 volts being seen by PCM, or one or both circuits become grounded, resulting in a low (less than .78 volt) reference voltage being seen by PCM.

If an audible knock is heard from engine, repair internal engine problem, as normally no knock should be detected at idle. PCM supplies 5 volts on knock sensor circuit which should be present at knock sensor terminals when sensors are disconnected. If knock sensor circuit is shorted to voltage, Code 43 will set. With both sensors and PCM disconnected, no voltage should be present. An improperly installed sensor can prevent knock sensor from grounding to block.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If an audible knock is heard from engine, repair internal engine problem, as normally no knock should be detected at idle.
2. Determines if knock sensor is faulty or if module is faulty.
3. Sensor signal circuit shorted to voltage will set code. With sensor and PCM unplugged, no voltage should be present.
4. An improperly installed sensor can cause code to set.
5. If short to battery voltage is found, additional component damage may have occurred. If code resets after repairs, rerun chart to detect additional faults.

Diagnostic Aids

PCM has the ability to diagnose opens and shorts on knock sensor circuit. Scan tester will display if one or both sensors are open, or if both are grounded. Also, ensure knock sensor module is properly installed.

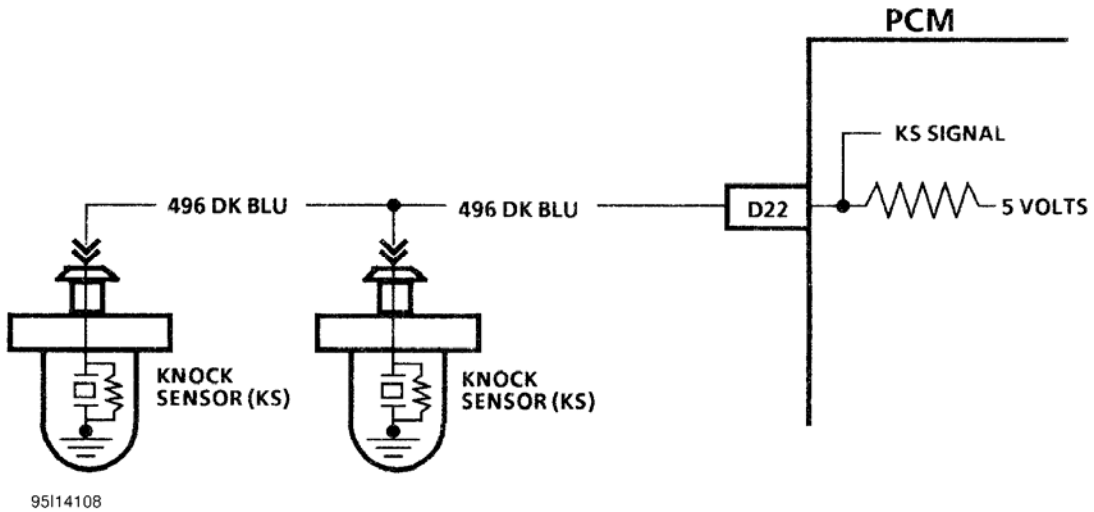


Fig. 48: Code 43 Schematic (5.7L) Knock Sensor Circuit (Dual Sensors)

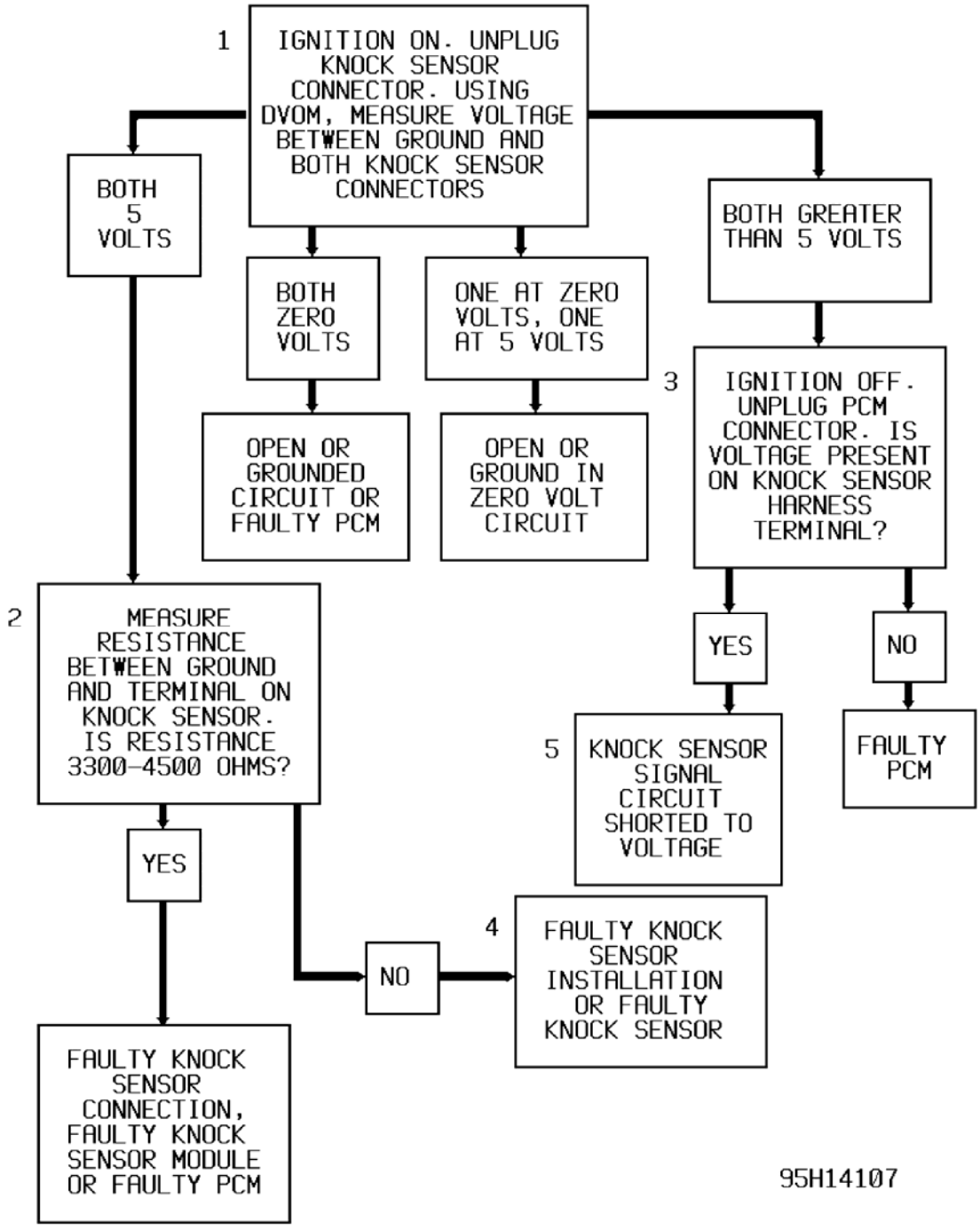


Fig. 49: Code 43 Diagnostic Flow Chart (5.7L) Knock Sensor Circuit (Dual Sensors)

CODE 44, LEFT HEATED OXYGEN SENSOR LEAN EXHAUST INDICATION

NOTE: Models are equipped with 2 oxygen sensors. On these models, Code 44 will set

if the left sensor circuit is lean. Code 64 will set if the right sensor circuit is lean.

O2 sensor acts like an open sensor circuit and produces no voltage when exhaust temperature is less than 600°F (316°C). An open sensor circuit or cold sensor causes "open loop" operation. On models with 2 oxygen sensors, Code 44 will reflect a lean left O2 sensor; Code 64 will indicate a lean right O2 sensor. Perform test procedures for right or left sensor as necessary.

Code is set when O2 sensor voltage signal at control module is low (less than 0.3 volt) for a precalibrated period and fuel system is operating in "closed loop" and attempting to richen mixture. Most likely causes for setting of code are: an actual lean condition, a short to ground on sensor signal circuit or a faulty PCM.

NOTE: Test number refers to number on diagnostic chart.

1. Checks to see if O2 sensor is registering a lean condition.

Diagnostic Aids

Using scan tester, observe Block Learn Memory (BLM) value at different RPMs. If conditions for a lean exhaust code exist, block learn value will be about 150.

O2 Sensor Wire

O2 sensor wire may be mispositioned and laying against exhaust manifold. Check for ground between sensor and wire connector.

Fuel Contamination

Water, even small amounts, near in-tank fuel pump inlet can be delivered to injector. Water may cause a lean exhaust, setting code.

Fuel Pressure

System will be lean if fuel pressure is low. If necessary, monitor fuel pressure while driving vehicle. For fuel pressure checking procedure, see **BASIC TESTING** article in this section.

Exhaust Leaks

If exhaust system has large leaks, exhaust system negative pressure pulses can cause outside air to be drawn into system and past O2 sensor. Vacuum or crankcase leaks can also cause a lean condition.

Misfire Or Stall

If engine misfires or stalls (including running out of fuel) while vehicle is moving, code may set. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 44 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color

Left O2 Signal	C20	Purple/White
Left O2 Ground	C19	Tan/White

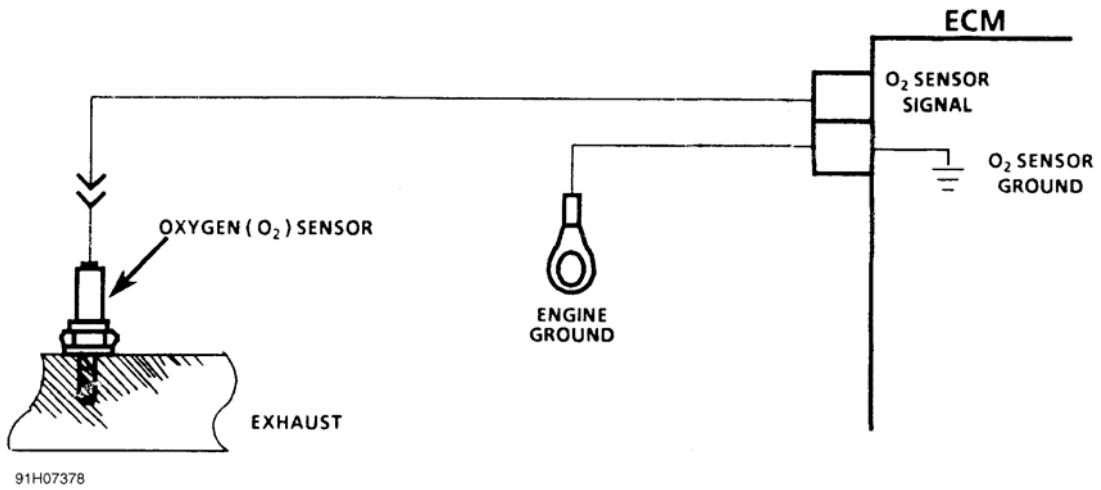


Fig. 50: Code 44 Schematic (5.7L) Lean Exhaust Indication

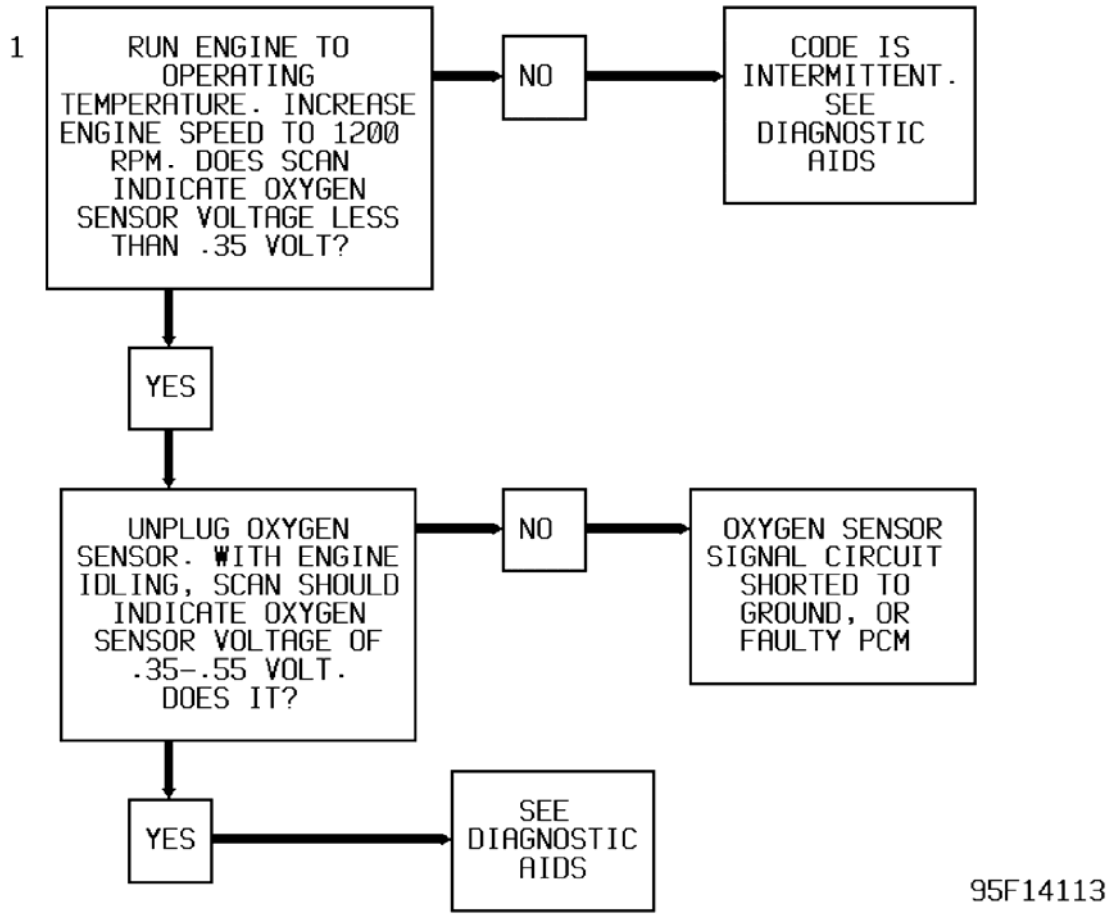


Fig. 51: Code 44 Diagnostic Flow Chart (5.7L) Lean Exhaust Indication

CODE 45, LEFT HEATED OXYGEN SENSOR RICH EXHAUST INDICATION

NOTE: Models are equipped with 2 oxygen sensors. On these models, Code 45 will set if the left sensor circuit is rich. Code 65 will set if the right sensor circuit is lean.

O2 sensor acts like an open sensor circuit and produces no voltage when exhaust temperature is less than 600°F (316°C). An open sensor circuit or cold sensor causes "open loop" operation. Code 45 indicates a rich exhaust. Diagnosis should begin with fuel pressure, leaking injector, ignition shielding (ground), vapor canister fuel saturation, coolant sensor, MAP sensor, O2 sensor contamination and TPS intermittent output.

Code is set when fuel system is operating in "closed loop", throttle angle is greater than idle, O2 sensor signal at control module is greater than .7 volt for a precalibrated period, fuel system is attempting to lean mixture and time since engine start is one minute or more. Most likely causes of code are: an actual rich condition, a short to voltage on sensor signal circuit or a faulty PCM.

NOTE: Test number refers to number on diagnostic chart.

1. Test checks to see if O2 sensor is registering a rich condition.

Diagnostic Aids

If other codes of lower number are set with code, use those charts first. Malfunction in MAP or TPS sensor circuits can cause a rich exhaust code to set. If other codes are not set, rich exhaust is most likely caused by:

Fuel Pressure High

If fuel pressure is too high, air/fuel ratio will be rich. For fuel pressure checking procedure, see **BASIC TESTING** article in this section. Control module can compensate for slight increases, but a code will be set if air/fuel ratio becomes too rich.

Ignition Ground

If an open occurs on HEI ground circuit, HEI induced electrical "noise" may result, causing simulated reference pulses to be picked up by control module on reference line of EST harness. Additional pulses result in a higher than actual engine speed signal. Control module will increase injector pulse width ("on" time) to match increased RPM signal. Scan tester will show higher than actual RPM, which can help in diagnosing this problem.

Evaporative Fuel Canister

Fuel saturation of charcoal canister will cause a rich air/fuel ratio. If canister is full of fuel, check canister control valves and hoses.

MAP Sensor

An output causing control module to sense a higher than normal manifold pressure (low vacuum) can cause system to go rich. Disconnecting MAP sensor will allow control module to substitute a fixed value for MAP sensor. If condition disappears, substitute a different MAP sensor, and continue testing.

TPS

An intermittent TPS output will cause system to operate rich due to a false indication of engine acceleration.

O2 Sensor Contamination

O2 sensor contamination, caused by silicone in certain fuels or use of improper RTV sealant, may cause a White powdery coating to cover exterior of O2 sensor. False high signal voltage (low oxygen content sensed) produced is interpreted by control module as a rich mixture, causing control module to set code.

EGR Problem

EGR valve sticking open at idle is usually accompanied by a rough idle and/or stalling. Also check for shorted/leaking injector and fuel-contaminated oil. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 45 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
Left O2 Signal	C20	Purple/White
Left O2 Ground	C19	Tan/White

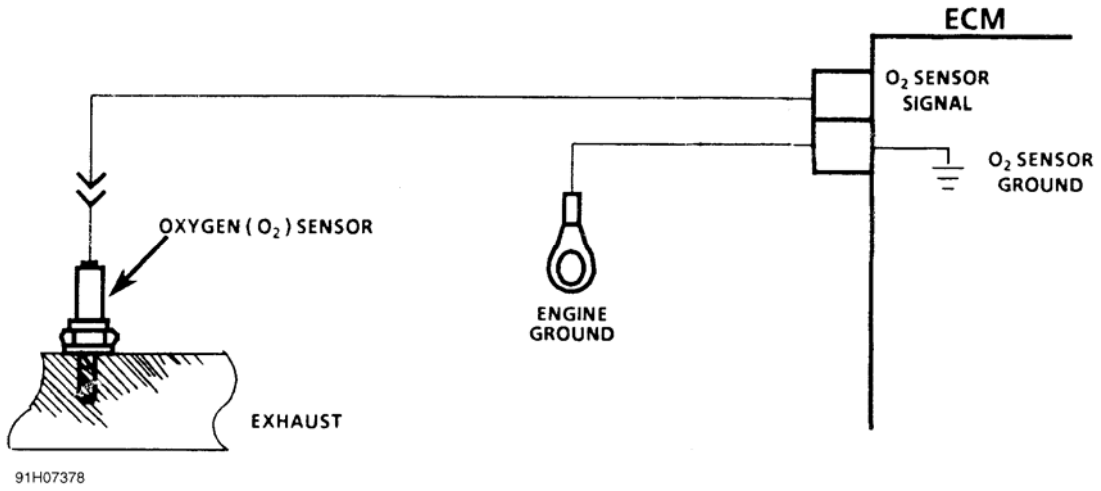


Fig. 52: Code 45 Schematic (5.7L) Rich Exhaust Indication

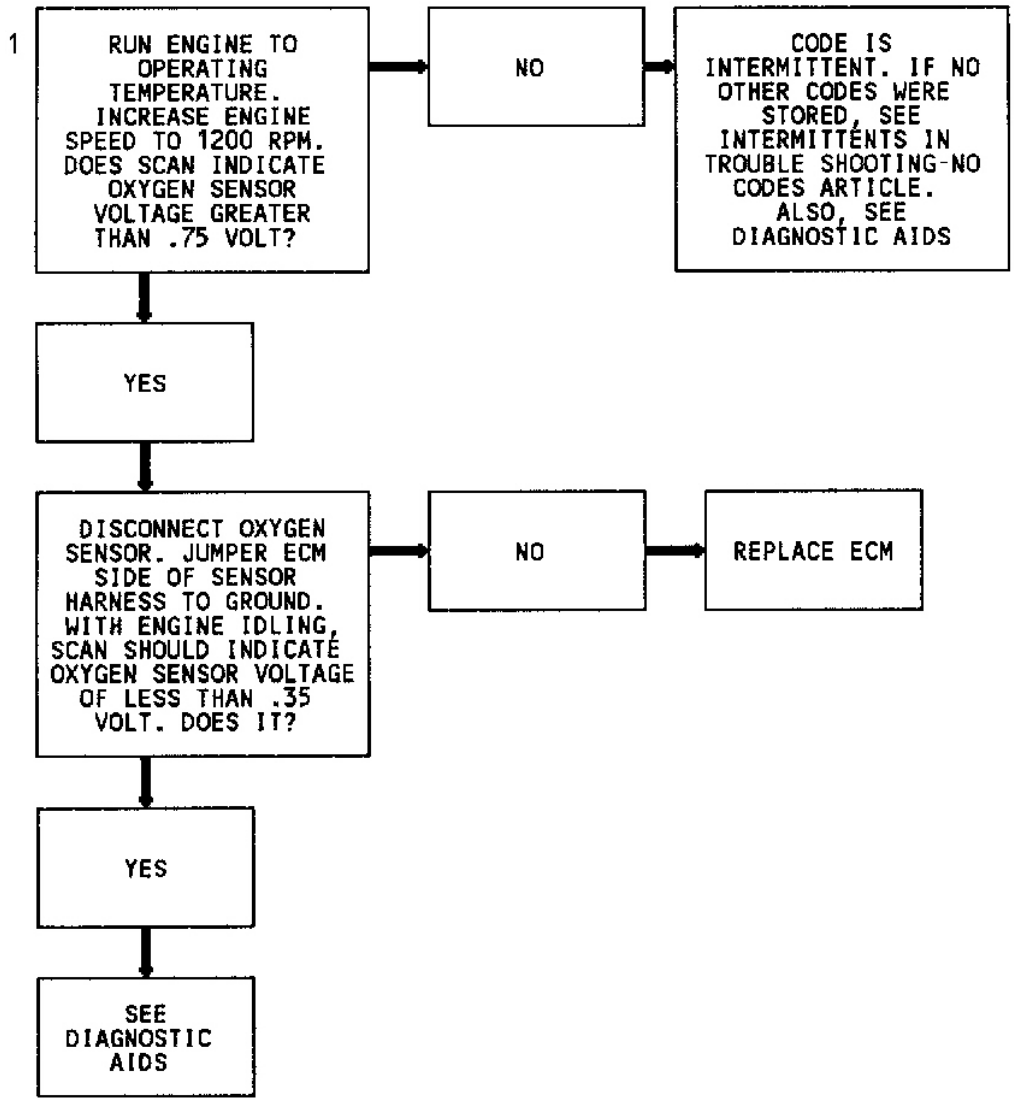


Fig. 53: Code 45 Diagnostic Flow Chart (5.7L) Rich Exhaust Indication

CODE 46, PASS-KEY CIRCUIT

The PASS-Key system is designated to disable vehicle operation if the incorrect key or starting procedure is used. PASS-Key decoder module sends a signal to the PCM if the correct key is being used. If the proper signal does not reach the PCM, the PCM will not pulse the injectors, thus not allowing the vehicle to start. Code 46 will set if proper signal is not being received on fuel enable signal circuit to PCM when ignition is turned on.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. If engine cranks but does not start, it indicates the portion of the module which generates the signal to the PCM is not operating or fuel enable signal circuit is open, shorted to ground or possibly shorted to voltage. If decoder module is found to be okay, PCM may be at faulty, but this not a likely condition.
2. If Code 46 is stored and engine will not crank, it indicates that there is a Pass-Key problem or incorrect key or starting procedure is being used.

Pass-Key Diagnosis

NOTE: For complete system diagnosis, see ANTI-THEFT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section.

PASS-Key is a sophisticated system that interfaces PCM and starter with a power source, decoder module, starter enable relay, ignition switch and instrument cluster. Check system for following common problems:

- Ensure ignition key resistor pellet is not cracked, dirty or coated. Ensure excess plastic does not exist around pellet contacts.
- Check ignition key pellet sensing contacts in ignition lock cylinder. Look into cylinder lock. If contacts are damaged or are not Silver in color, replace cylinder lock.
- Check related fuses.
- Check security indicator bulb in the instrument panel.

A defective resistor pellet within ignition key or incorrect resistance value of key (15 different assigned values) will prevent vehicle from starting. Key must be correct electrically and mechanically. If incorrect key is used to try to start vehicle, decoder will not allow vehicle to start for 2-4 minutes, even after correct key is inserted.

If starter enable relay must be replaced, check circuit to starter solenoid for possible short. A short may have caused relay to fail.

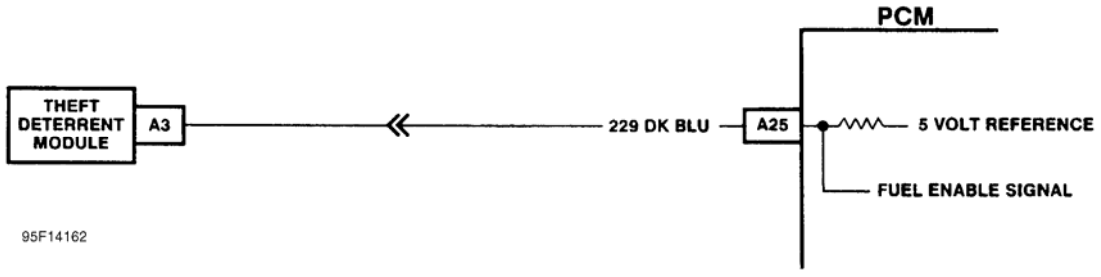


Fig. 54: Code 46 Schematic (5.7L) Pass-Key Circuit

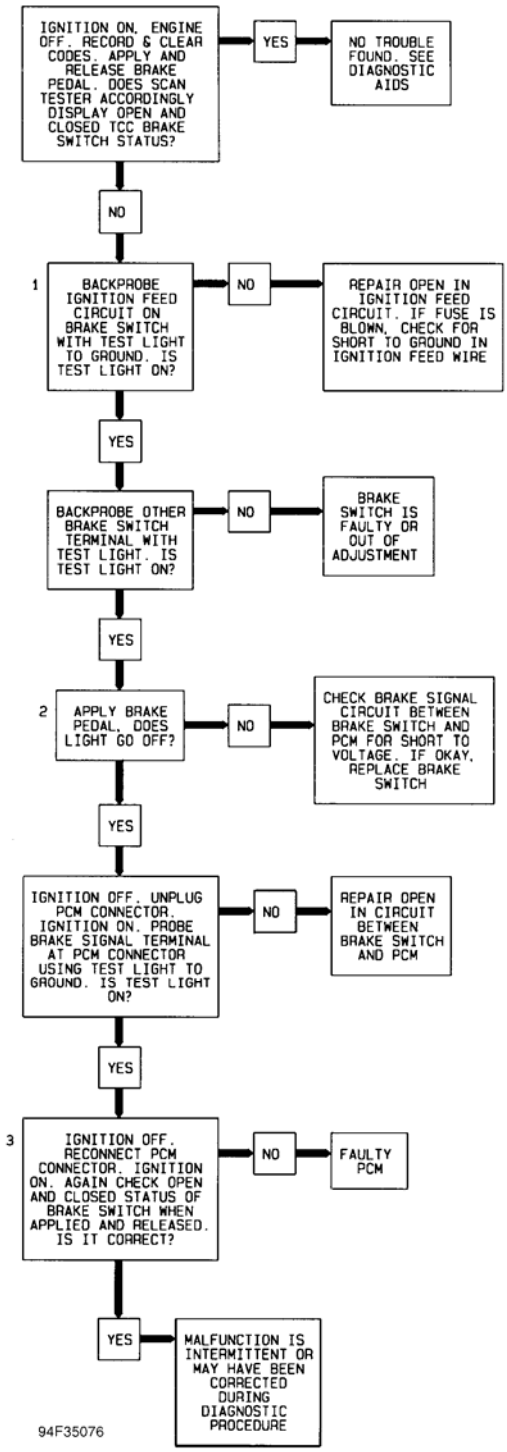


Fig. 55: Code 46 Schematic (5.7L) Pass-Key Circuit

CODE 47, KNOCK SENSOR MODULE

Knock sensor module is located inside PCM.

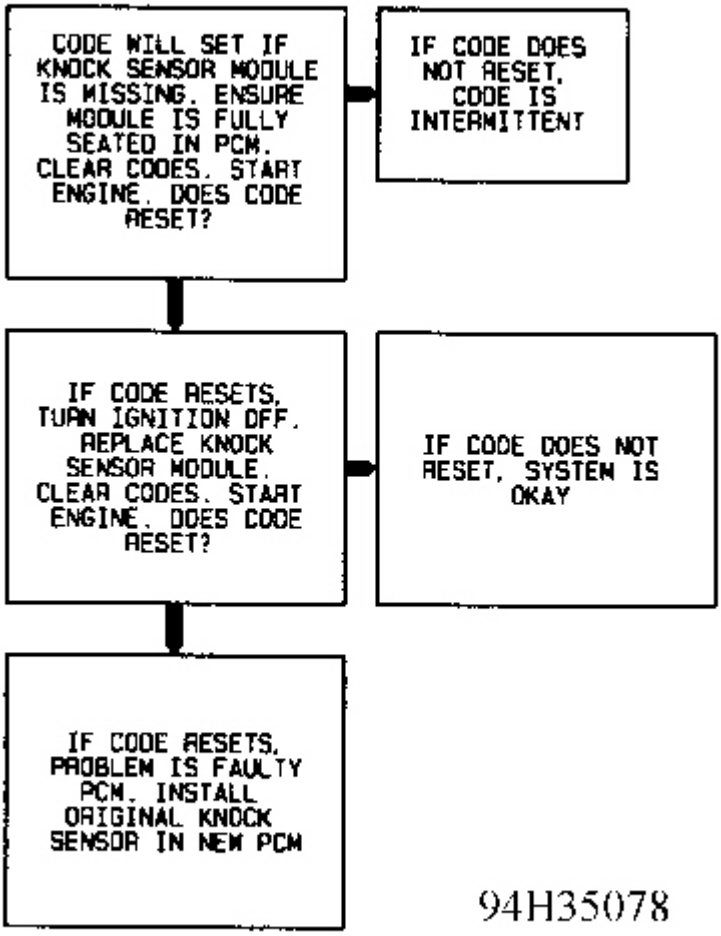


Fig. 56: Code 47 Diagnostic Flow Chart (5.7L) Knock Sensor Module

CODE 48, MASS AIRFLOW SENSOR

Mass airflow meter measures amount of induction airflow. This information is used by PCM to determine adjustments to air/fuel ratio. MAF sensor is a hot-wire type. Sensor maintains hot wire at a predetermined temperature. The greater the airflow across the hot wire, the more current is required to maintain hot wire temperature. Sensor changes the current requirements into a frequency signal which is read by the PCM. The PCM calculates airflow based upon this signal.

NOTE: Test numbers refer to numbers on diagnostic charts.

1. Determines if fault is a hard failure or an intermittent condition.

2. Checks for 5-volt reference from PCM.
3. Verifies both ignition voltage and a good ground circuit are available.

Diagnostic Aids

An intermittent may be caused by a poor connection, mis-routed harness, rubbed through wire insulation or a broken wire inside insulation. Code 48 could be caused by a vacuum leak. Check short and long term fuel trim for being in optimum range (both banks).

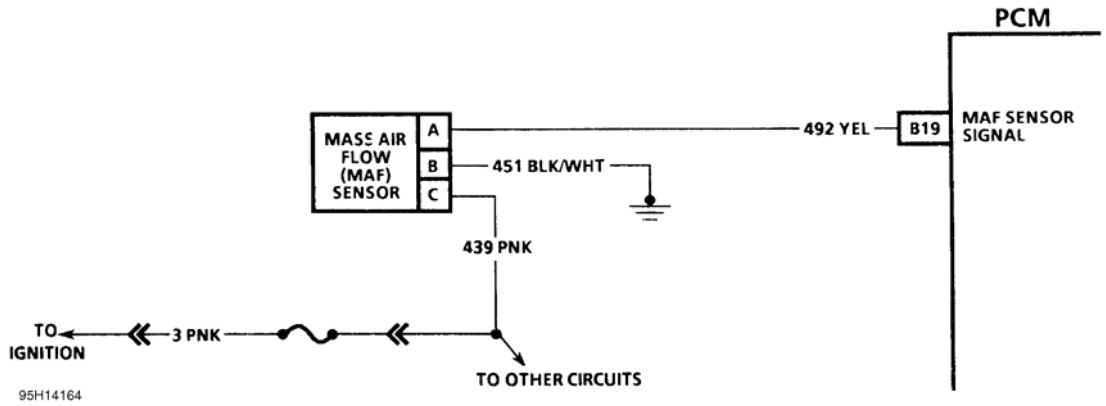


Fig. 57: Code 48 Schematic (5.7L) Mass Airflow Sensor

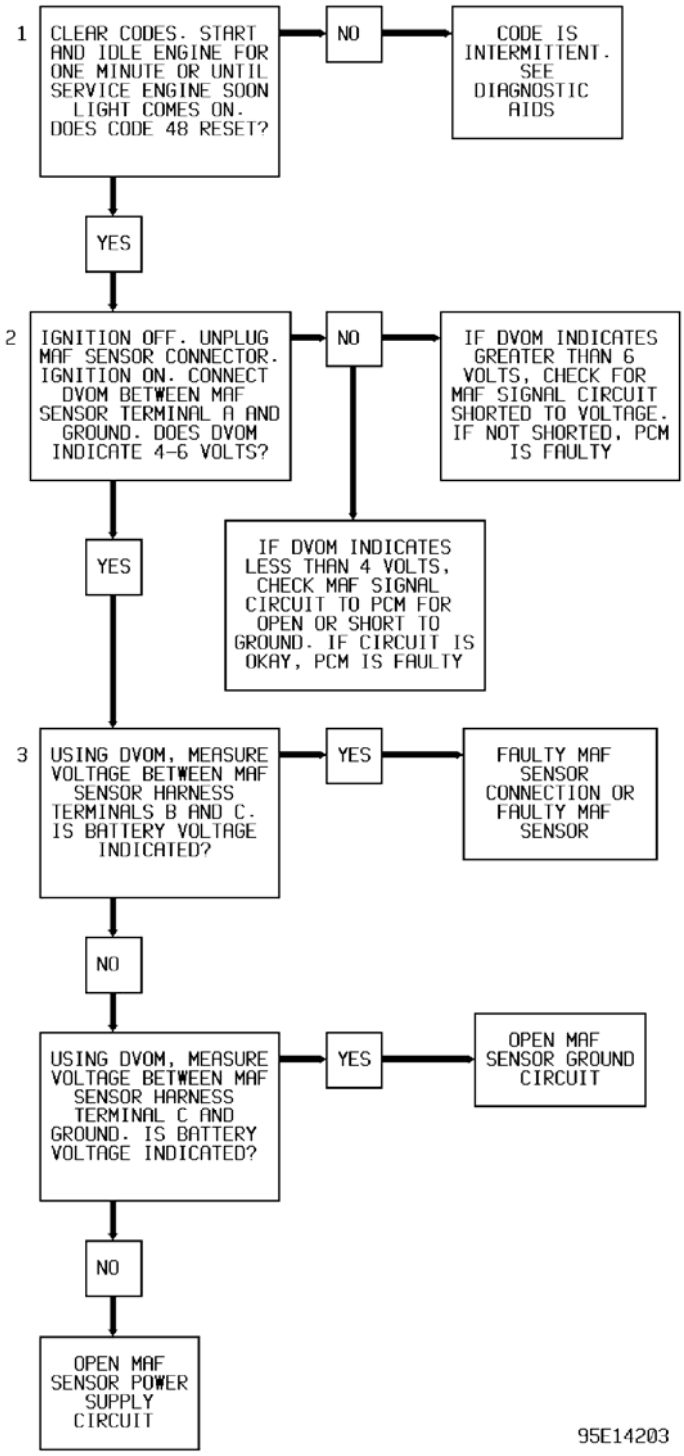


Fig. 58: Code 48 Diagnostic Flow Chart (5.7L)

CODE 50, SYSTEM VOLTAGE LOW

PCM monitors voltage on ignition feed circuit (Pink wire). Normal voltage is 9.6-16 volts. If voltage drops

below 8 volts, Code 50 will set and Malfunction Indicator Light (MIL) will illuminate.

Diagnostic Aids

An open in ignition feed circuit (Pink wire) or extremely low voltage may cause loss of serial data, no start condition and malfunction of the MIL. Additional codes may be set.

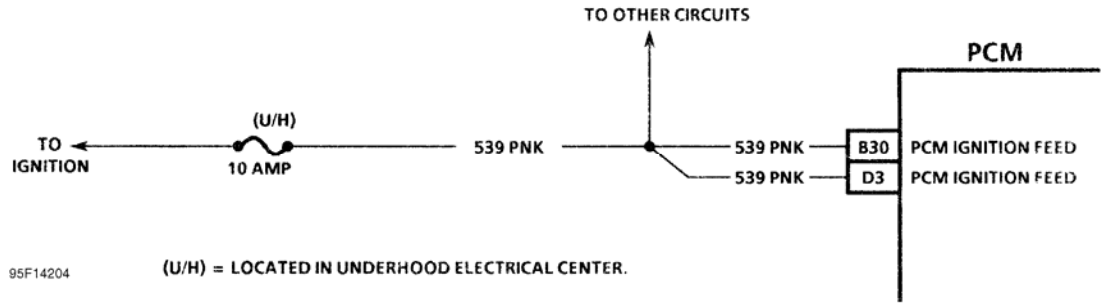


Fig. 59: Code 50 Schematic (5.7L) System Voltage Low

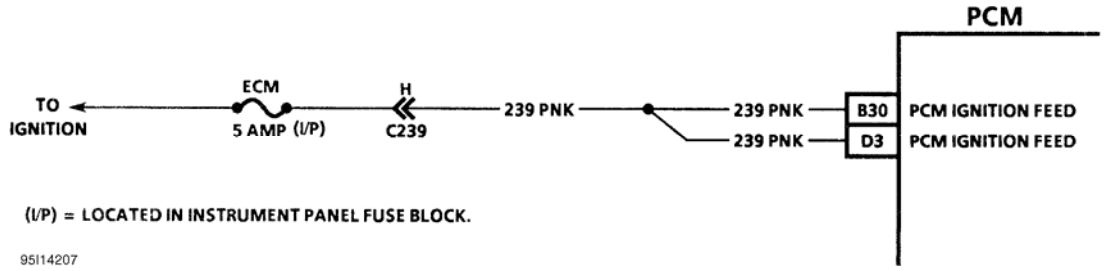


Fig. 60: Code 50 Schematic (5.7L) System Voltage Low

CODE 52, FAULTY CAL-PAK

Ensure all pins are fully inserted in socket. If pins are okay, replace CAL-PAK, clear memory and recheck. If Code 51 reappears, replace control module.

CODE 53, SYSTEM VOLTAGE HIGH

This code indicates a basic charging system problem. Code 53 will set when voltage at control module terminal is greater than specification for a precalibrated time. If voltage at PCM battery voltage terminal is not within specification, check and repair charging system.

CHARGING SYSTEM SPECIFICATIONS

Application	Minimum Charge	Maximum Charge
5.7L	9.6	16.0

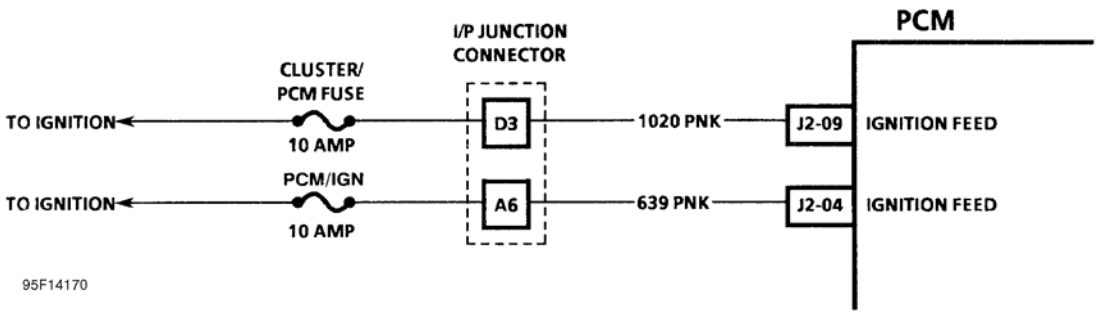


Fig. 61: Code 53 Schematic (5.7L) System Voltage High

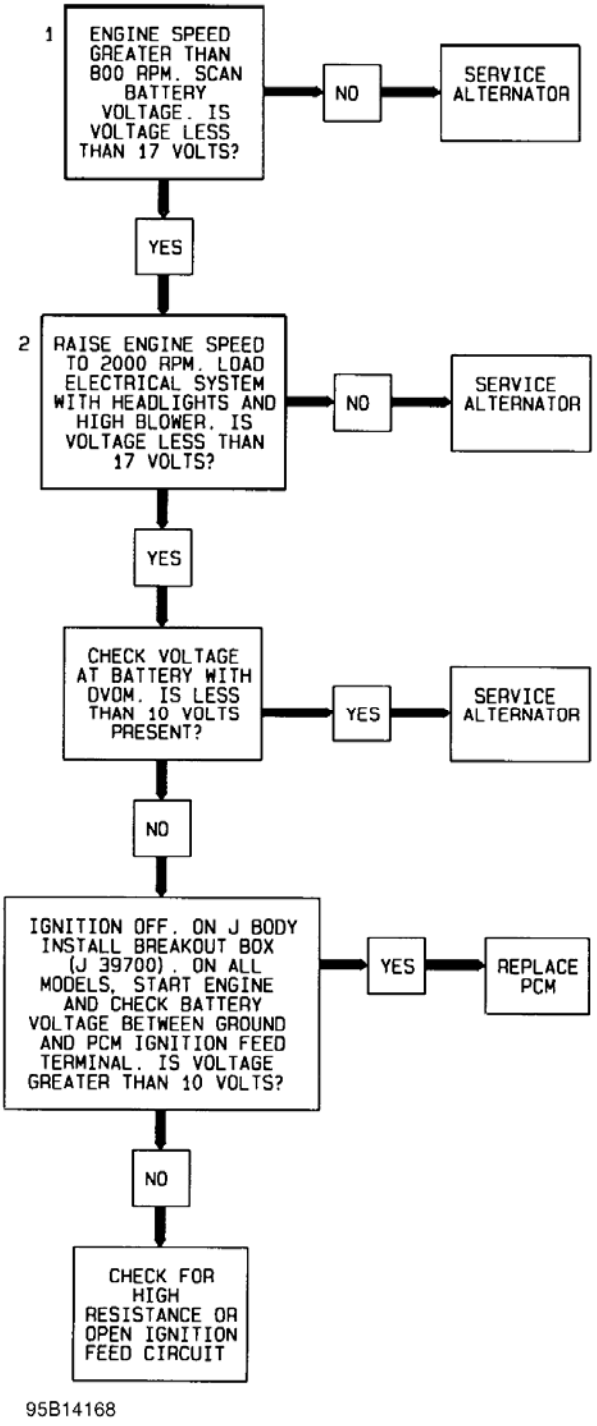


Fig. 62: Code 53 Diagnostic Flow Chart (5.7L) System Voltage High

CODE 55, PCM ERROR

Ensure PCM grounds are okay. Ensure correct EPROM is being used and that it is properly installed. If okay,

replace PCM. Clear codes, confirm closed loop operation and check operation of Malfunction Indicator Light (MIL).

CODE 55, FUEL LEAN MONITOR

PCM is capable of determining if fuel system can deliver adequate fuel during power enrichment (heavy acceleration). During power enrichment conditions, PCM expects to see both O2 sensors registering rich. If both sensors do not register rich, Code 55 will set.

Low fuel pressure or restricted fuel flow may cause a lean condition. Check for plugged injectors, poor or contaminated fuel, low fuel level and restricted fuel supply. Vapor lock can also cause Code 55.

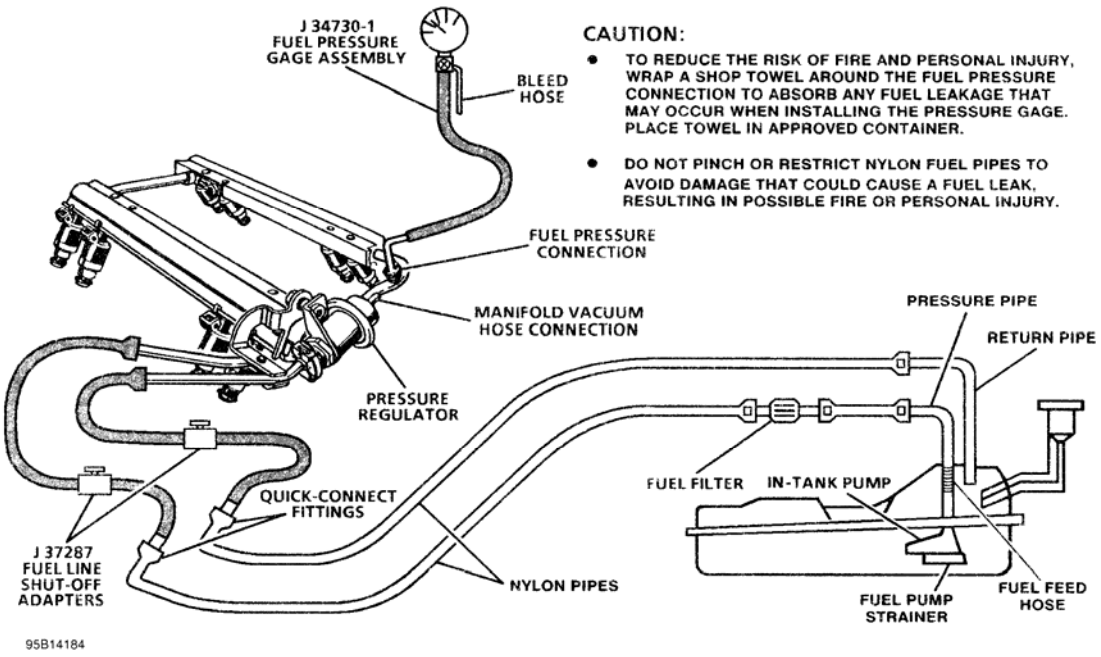


Fig. 63: Code 55 Schematic (5.7L) Fuel Lean Monitor

CODE 58, TRANS TEMPERATURE SENSOR HIGH TEMPERATURE

Temperature sensor is a 2 wire thermistor located in transaxle. This sensor operates in the same manner as engine coolant temperature sensor and intake air temperature sensor. PCM applies 5 volts to sensor on signal circuit. Voltage sensed at PCM signal circuit terminal will be high when transmission fluid is cold and as fluid warms voltage signal will drop. A very low signal voltage indicates a high fluid temperature or a failure in sensor circuit. Normal fluid temperature range is 75-100°C.

Code 58 will set when sensor indicates a high fluid temperature for a precalibrated period of time. Malfunction Indicator Light (MIL) will illuminate and PCM will use a warm default sensor value.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for a short to ground or an out-of-calibration sensor.
2. Checks for an internal fault within the transmission by creating an open.

Diagnostic Aids

Check harness routing for a potential short to ground in signal circuit. Temperature should rise steadily to about 90°C then stabilize. A skewed sensor could result in delayed shifts or TCC enabled complaints.

Use temperature-to-resistance table to check sensor at various levels to determine if sensor is out-of-calibration, which could result in firm shifts or TCC enable.

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

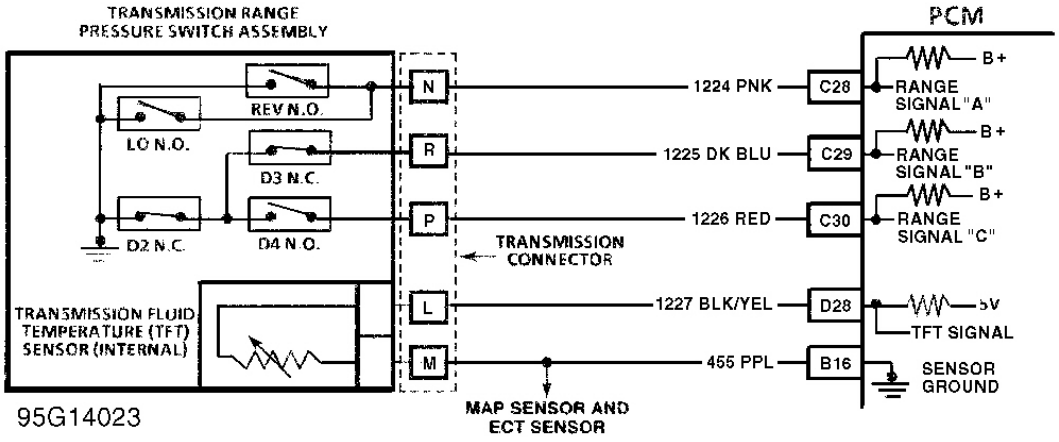


Fig. 64: Code 58 Schematic (5.7L) Transmission Temperature Sensor High Temperature

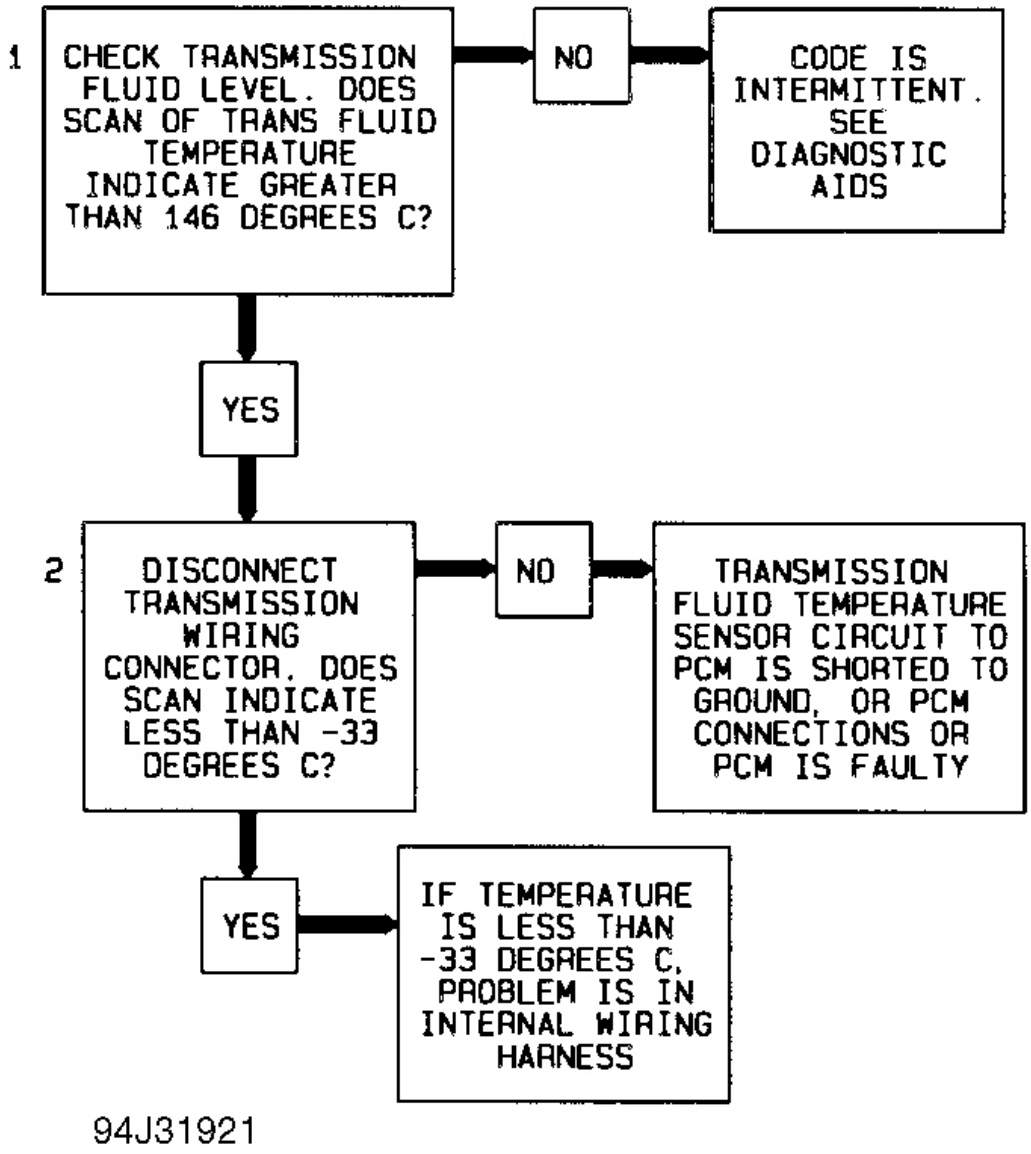


Fig. 65: Code 58 Diagnostic Flow Chart (5.7L) Transmission Temperature Sensor High Temperature

CODE 59, TRANS. TEMPERATURE SENSOR LOW TEMPERATURE

Temperature sensor is a 2 wire thermistor located in transaxle. This sensor operates in the same manner as engine coolant temperature sensor and intake air temperature sensor. PCM applies 5 volts to sensor on signal circuit. Voltage sensed at PCM signal circuit terminal will be high when transmission fluid is cold and as fluid warms voltage signal will drop. A very high signal voltage indicates a low fluid temperature or a failure in sensor circuit. Normal fluid temperature range is 75-100°C.

Code 59 will set when sensor indicates a low temperature for a precalibrated period of time. Malfunction Indicator Light (MIL) will not illuminate and PCM will use a warm default sensor value.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This test determines if a current condition exists.
2. Simulates a Code 58. If PCM recognizes low signal voltage, and scan displays about 146°C or higher, PCM and wiring are okay.
3. Checks if signal circuit is open. Five volts should be present at sensor connector.

Diagnostic Aids

Temperature should rise steadily to about 90°C, then stabilize. A faulty connection or an open in ground or signal circuit can result in Code 59. A skewed sensor could result in firm shifts or TCC enabled complaints. Use temperature-to-resistance table to check sensor at various levels to determine if sensor is out-of-calibration, which could result in firm shifts or TCC enable.

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	**Ohms**
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

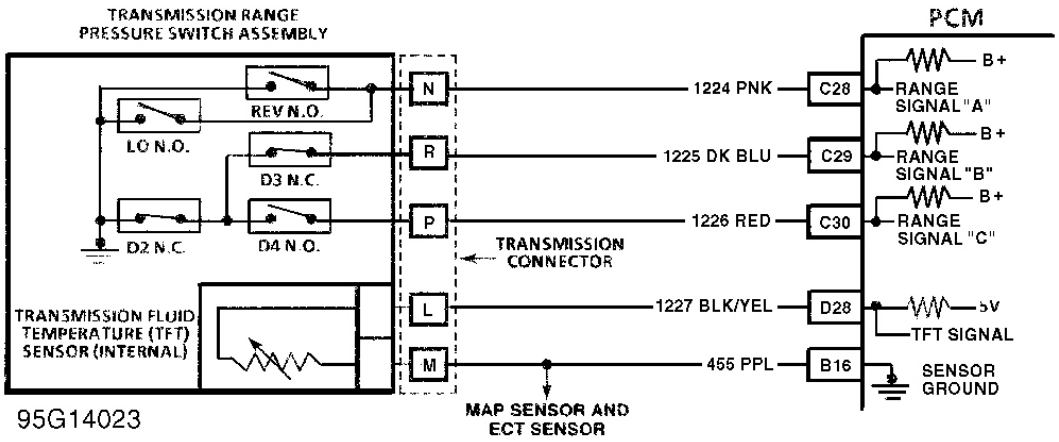


Fig. 66: Code 59 Schematic (5.7L) Transmission Temperature Sensor Low Temperature

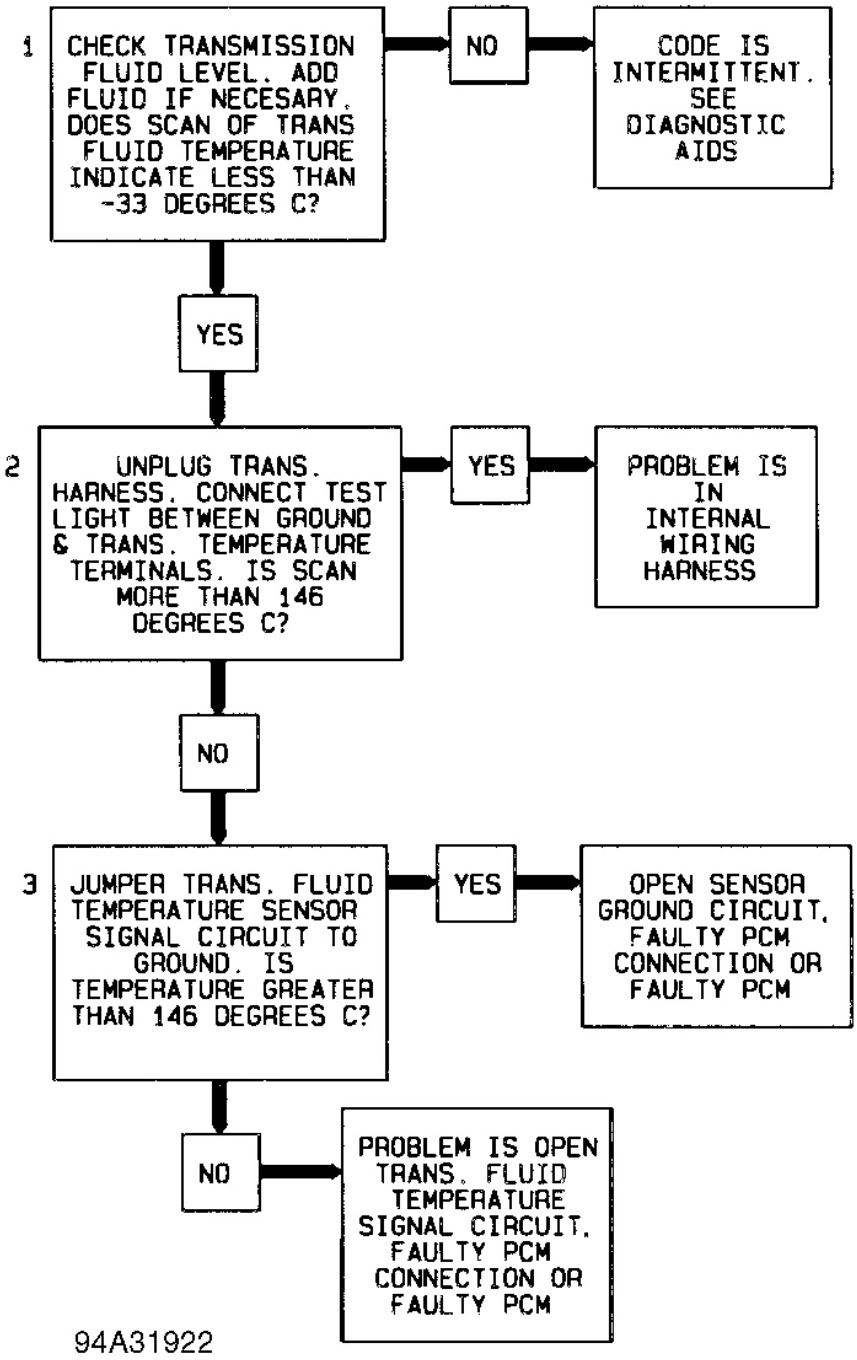


Fig. 67: Code 59 Diagnostic Flow Chart (5.7L) Transmission Temperature Sensor Low Temperature

CODE 63, RIGHT HEATED OXYGEN SENSOR CIRCUIT OPEN

NOTE: The 5.7L (VIN P) engine is equipped with 2 oxygen sensors. On this model, code will set if the right sensor circuit is open. Code 13 will set if the left sensor circuit is open. Oxygen sensors use a heating element. Heating element is not controlled by PCM.

Code will set if Codes 21 and 22 are not set, engine is at normal operating temperature, oxygen sensor voltage is constant within a specified range (.35-.55 volt), throttle angle is greater than idle, a precalibrated amount of time has elapsed since start-up and all conditions have existed for a precalibrated amount of time. Most likely causes of code are: open sensor signal (high) circuit, faulty PCM connection, faulty PCM, faulty oxygen sensor connection or faulty oxygen sensor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. This tests if problem still exists. Vehicle cannot enter "closed loop" mode if oxygen sensor circuit is open. Code indicates an open in O2 sensor circuit (steady .35-.55 volt).
2. Determines if oxygen sensor, wiring or control module is at fault. If wiring is good, grounding oxygen sensor wire will cause .45 volt reference supplied by control module to pull low.
3. This tests oxygen sensor circuit wiring. Use only a high impedance (10-megohm minimum) digital voltmeter.

Diagnostic Aids

Control module will not go into closed loop if code is set. Code may set if vehicle runs out of fuel or stalls while vehicle is in motion. If oxygen sensor ground becomes loose, a false oxygen sensor reading will occur. This can result in a Code 63 being set. On models equipped with an oxygen sensor heating element, element resistance should be 3.5-14.0 ohms.

CODE 63 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
Right O2 Signal	C8	Purple
Right O2 Ground	C7	Tan

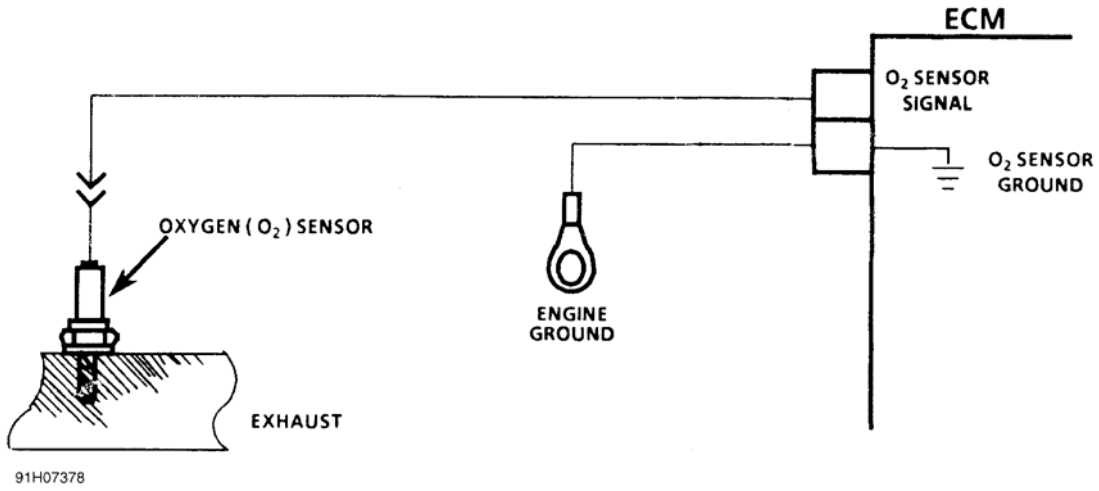


Fig. 68: Code 63 Schematic (5.7L) Open Oxygen Sensor Circuit

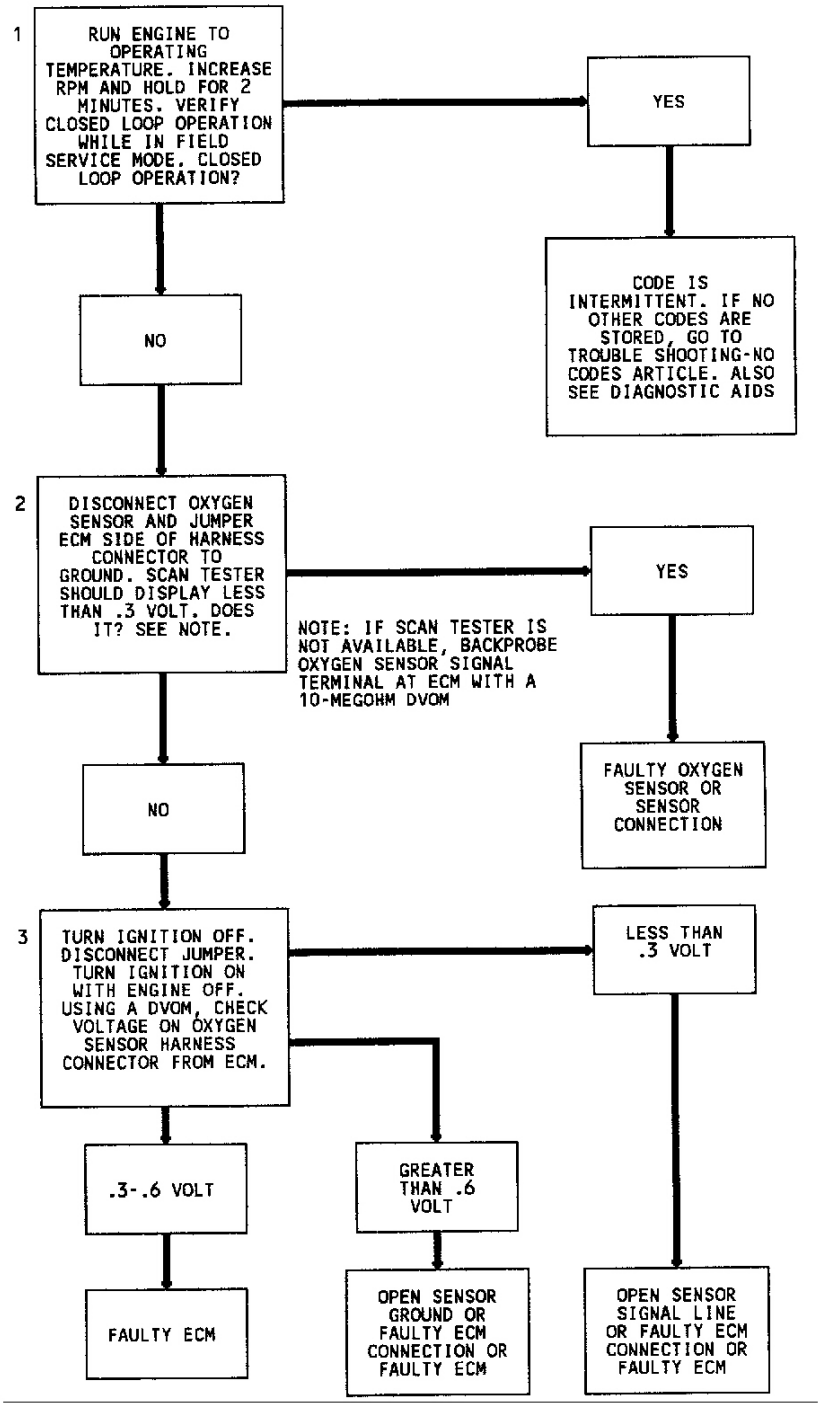


Fig. 69: Code 63 Diagnostic Flow Chart (5.7L) Open Oxygen Sensor Circuit

CODE 64, RIGHT HEATED OXYGEN SENSOR LEAN EXHAUST INDICATION

NOTE: Models are equipped with 2 oxygen sensors. On these models, Code 64 will set if the right sensor circuit is lean. Code 44 will set if the left sensor circuit is lean.

O2 sensor acts like an open sensor circuit and produces no voltage when exhaust temperature is less than 600°F (316°C). An open sensor circuit or cold sensor causes "open loop" operation. On models with 2 oxygen sensors, Code 44 will reflect a lean left O2 sensor; Code 64 will indicate a lean right O2 sensor. Perform test procedures for right or left sensor as necessary.

Code is set when O2 sensor voltage signal at control module is low (less than 0.3 volt) for a precalibrated period and fuel system is operating in "closed loop" and attempting to richen mixture. Most likely causes for setting of code are: an actual lean condition, a short to ground on sensor signal circuit or a faulty PCM.

NOTE: Test number refers to number on diagnostic chart.

1. Checks to see if O2 sensor is registering a lean condition.

Diagnostic Aids

Using scan tester, observe Block Learn Memory (BLM) value at different RPMs. If conditions for a lean exhaust code exist, block learn value will be about 150.

O2 Sensor Wire

O2 sensor wire may be mispositioned and laying against exhaust manifold. Check for ground between sensor and wire connector.

Fuel Contamination

Water, even small amounts, near in-tank fuel pump inlet can be delivered to injector. Water may cause a lean exhaust, setting code.

Fuel Pressure

System will be lean if fuel pressure is low. If necessary, monitor fuel pressure while driving vehicle. For fuel pressure checking procedure, see **BASIC TESTING** article in this section.

Exhaust Leaks

If exhaust system has large leaks, exhaust system negative pressure pulses can cause outside air to be drawn into system and past O2 sensor. Vacuum or crankcase leaks can also cause a lean condition.

Misfire Or Stall

If engine misfires or stalls (including running out of fuel) while vehicle is moving, code may set. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 64 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
Right O2 Signal	C8	Purple
Right O2 Ground	C7	Tan

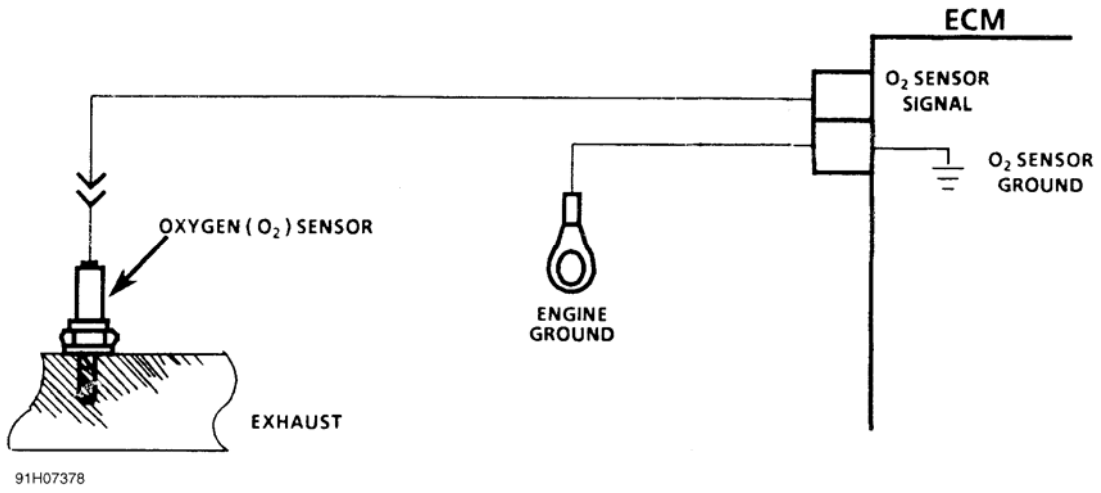


Fig. 70: Code 64 Schematic (5.7L) Lean Exhaust Indication

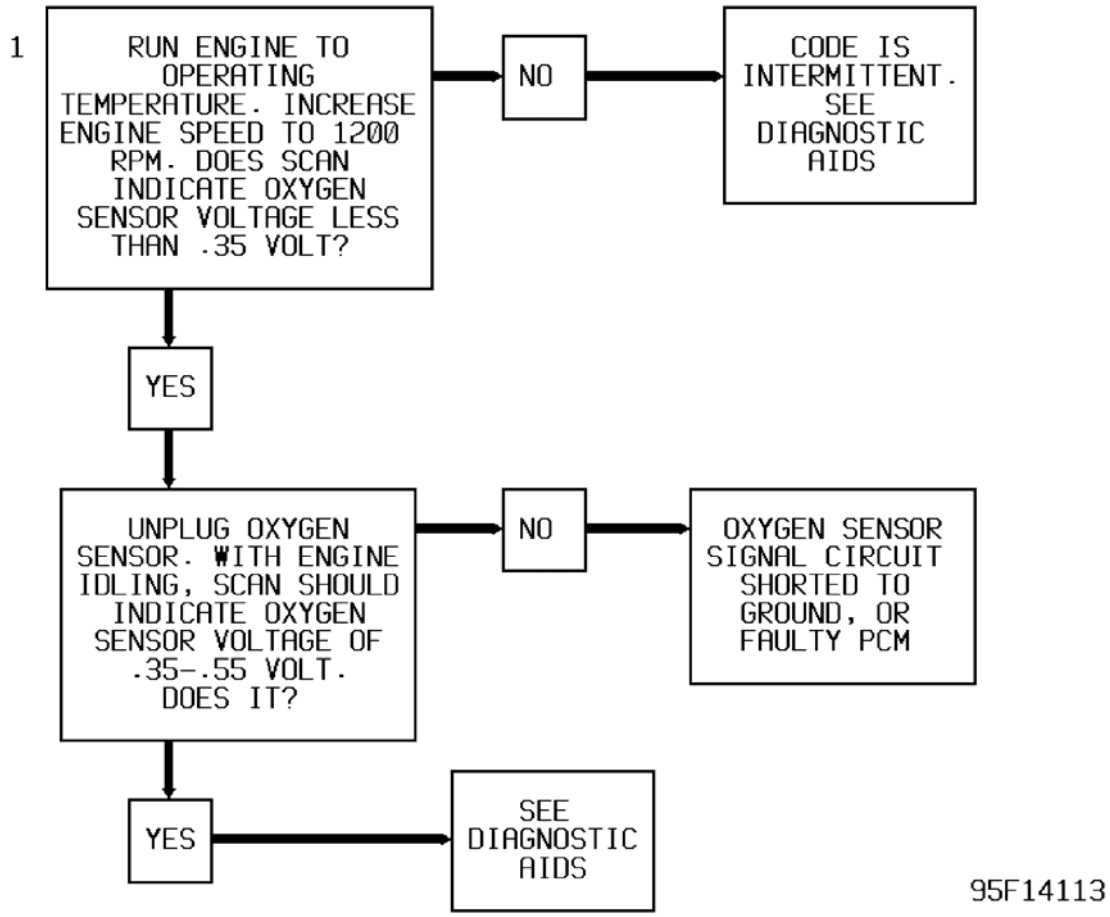


Fig. 71: Code 64 Diagnostic Flow Chart (5.7L) Lean Exhaust Indication

CODE 65, RIGHT HEATED OXYGEN SENSOR RICH EXHAUST INDICATION

NOTE: Models are equipped with 2 oxygen sensors. On these models, Code 65 will set if the right sensor circuit is rich. Code 45 will set if the left sensor circuit is lean.

O2 sensor acts like an open sensor circuit and produces no voltage when exhaust temperature is less than 600°F (316°C). An open sensor circuit or cold sensor causes "open loop" operation. Code 45 indicates a rich exhaust. Diagnosis should begin with fuel pressure, leaking injector, ignition shielding (ground), vapor canister fuel saturation, coolant sensor, MAP sensor, O2 sensor contamination and TPS intermittent output.

Code is set when fuel system is operating in "closed loop", throttle angle is greater than idle, O2 sensor signal at control module is greater than .7 volt for a precalibrated period, fuel system is attempting to lean mixture and time since engine start is one minute or more. Most likely causes of code are: an actual rich condition, a short to voltage on sensor signal circuit or a faulty PCM.

NOTE: Test number refers to number on diagnostic chart.

1. Test checks to see if O2 sensor is registering a rich condition.

Diagnostic Aids

If other codes of lower number are set with code, use those charts first. Malfunction in MAP or TPS sensor circuits can cause a rich exhaust code to set. If other codes are not set, rich exhaust is most likely caused by:

Fuel Pressure High

If fuel pressure is too high, air/fuel ratio will be rich. For fuel pressure checking procedure, see **BASIC TESTING** article in this section. Control module can compensate for slight increases, but a code will be set if air/fuel ratio becomes too rich.

Ignition Ground

If an open occurs on HEI ground circuit, HEI induced electrical "noise" may result, causing simulated reference pulses to be picked up by control module on reference line of EST harness. Additional pulses result in a higher than actual engine speed signal. Control module will increase injector pulse width ("on" time) to match increased RPM signal. Scan tester will show higher than actual RPM, which can help in diagnosing this problem.

Evaporative Fuel Canister

Fuel saturation of charcoal canister will cause a rich air/fuel ratio. If canister is full of fuel, check canister control valves and hoses.

MAP Sensor

An output causing control module to sense a higher than normal manifold pressure (low vacuum) can cause system to go rich. Disconnecting MAP sensor will allow control module to substitute a fixed value for MAP sensor. If condition disappears, substitute a different MAP sensor, and continue testing.

TPS

An intermittent TPS output will cause system to operate rich due to a false indication of engine acceleration.

O2 Sensor Contamination

O2 sensor contamination, caused by silicone in certain fuels or use of improper RTV sealant, may cause a White powdery coating to cover exterior of O2 sensor. False high signal voltage (low oxygen content sensed) produced is interpreted by control module as a rich mixture, causing control module to set code.

EGR Problem

EGR valve sticking open at idle is usually accompanied by a rough idle and/or stalling. Also check for shorted/leaking injector and fuel-contaminated oil. If code is intermittent, see INTERMITTENTS in **TESTS W/O CODES** article in this section.

CODE 65 PCM TERMINAL & CIRCUIT WIRING IDENTIFICATION

Application	PCM Terminal	Wire Color
Right O2 Signal	C8	Purple
Right O2 Ground	C7	Tan

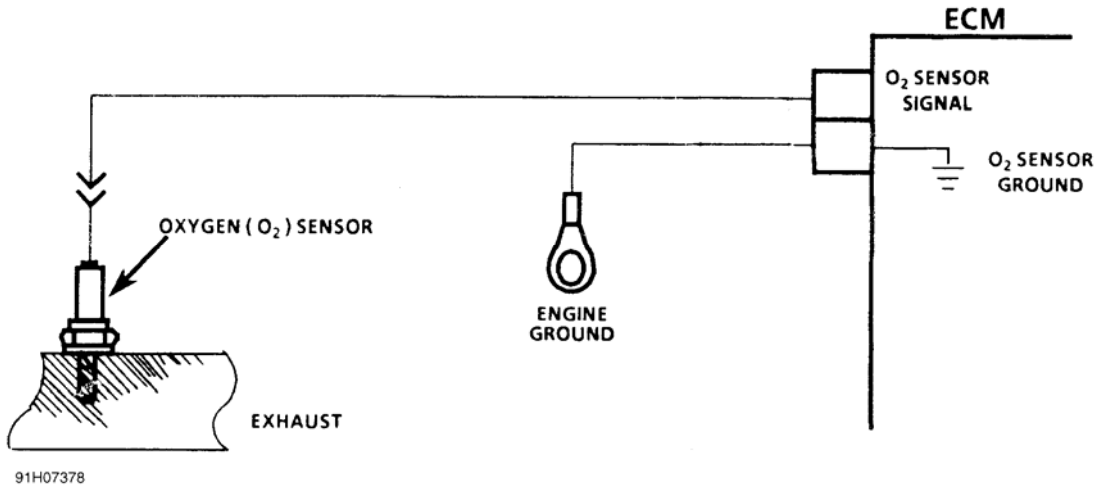


Fig. 72: Code 65 Schematic (5.7L) Rich Exhaust Indication

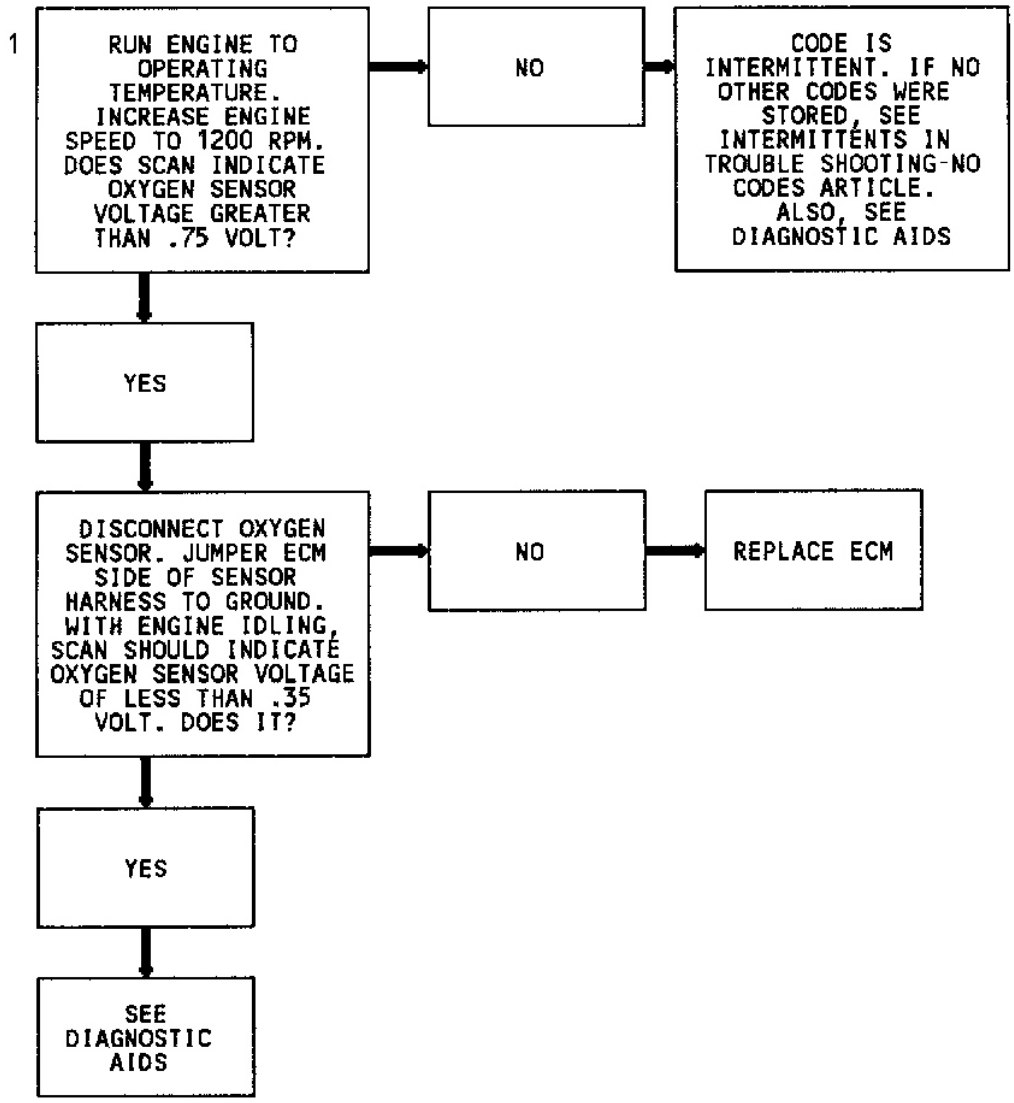


Fig. 73: Code 65 Diagnostic Flow Chart (5.7L) Rich Exhaust Indication

CODE 66, A/C PRESSURE SENSOR

A/C pressure sensor responds to changes in A/C refrigerant system high side pressure. PCM uses A/C compressor load input to determine engine idle speed. Sensor uses a 5-volt reference signal from PCM and returns an input signal to PCM on a separate line. Low pressure (zero psi) will return a signal of about .1 volt. High pressure will return a signal of about 4.6 volts.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks voltage signal from A/C pressure sensor to PCM. Normal voltage is 0.1-1.8 volts.
2. Checks to see if high signal is from a shorted sensor or a short to voltage in circuit. Normally, disconnecting sensor would make a normal circuit go to nearly zero volts.
3. Checks to see if low voltage signal is from sensor or circuit. Jumpering sensor signal circuit to 5-volt reference checks circuit, connections and PCM.
4. Checks to see if low voltage signal was due to an open in sensor circuit or 5-volt reference circuit. Previous step eliminated pressure sensor as a possible cause.

Diagnostic Aids

Code 66 sets when signal voltage falls outside normal sensor range and is not due to a A/C system problem. If problem is intermittent, check for opens or shorts in harness and poor connections. If wiring is okay, replace pressure sensor. If code resets, replace PCM.

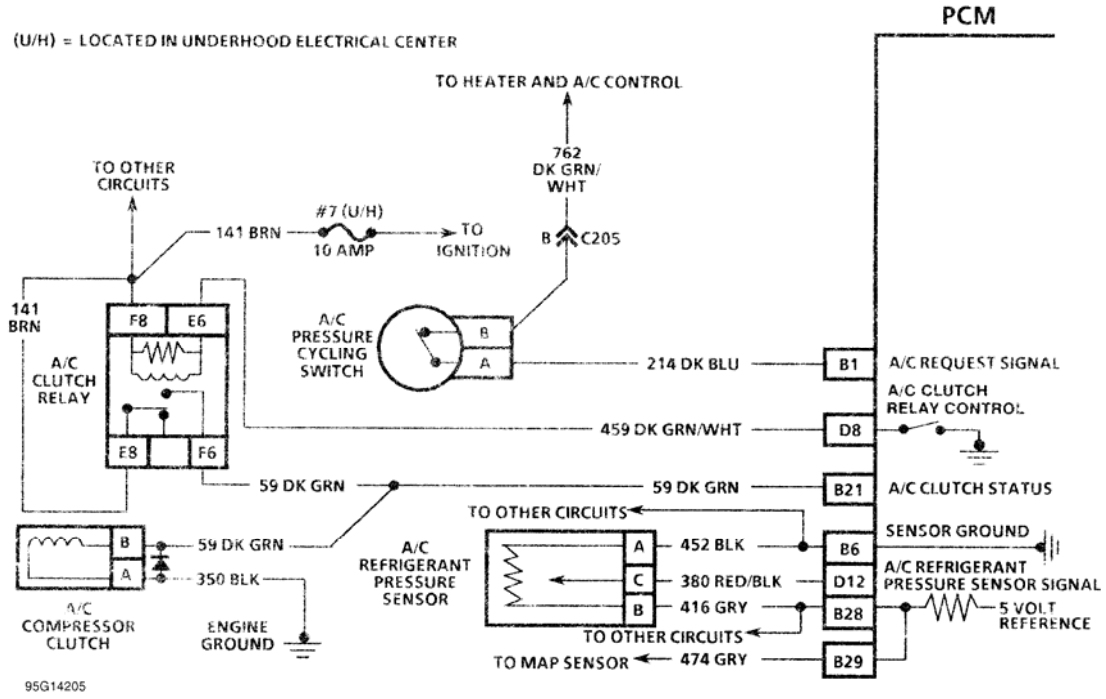


Fig. 74: Code 66 Schematic (5.7L) A/C Pressure Sensor

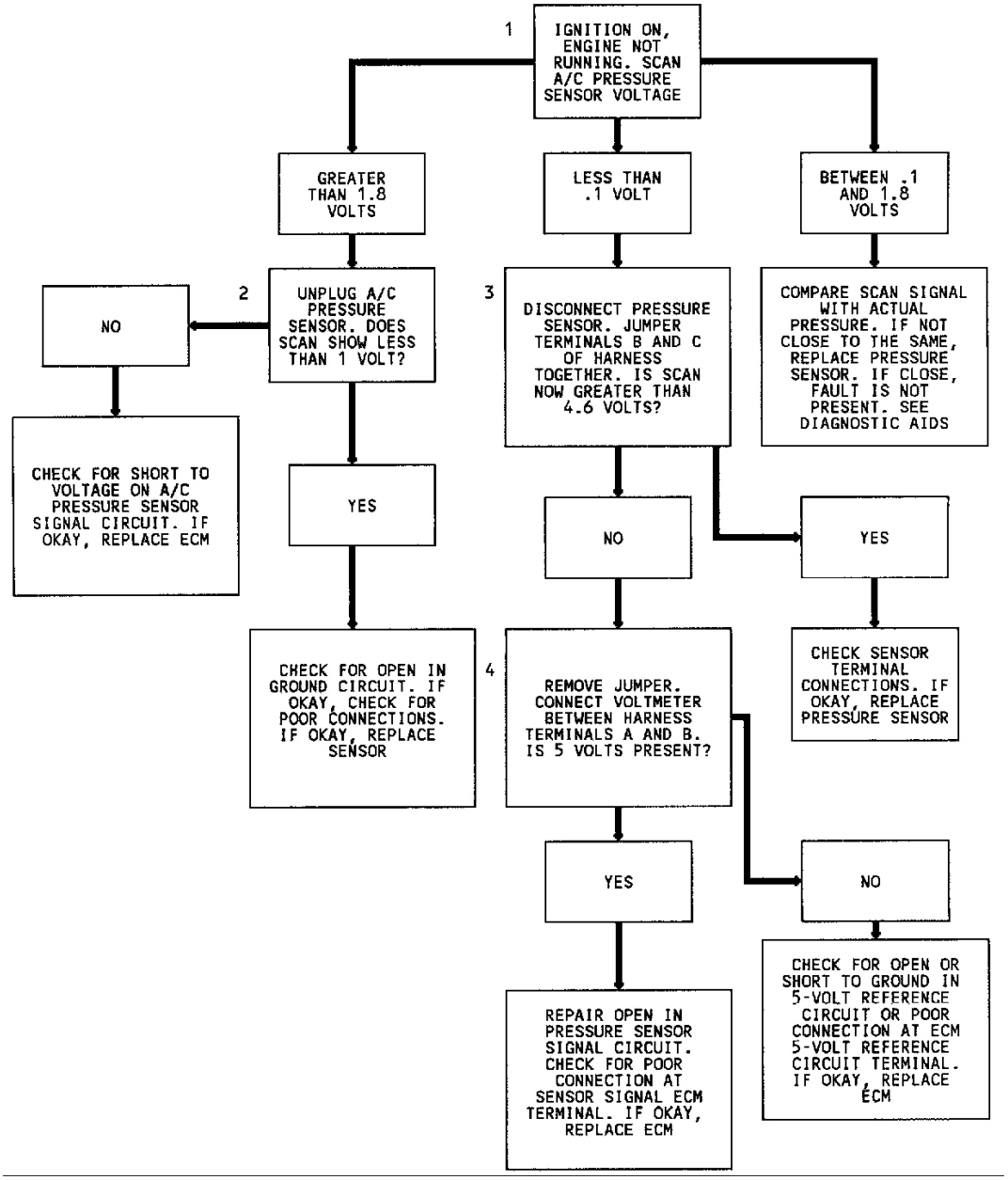


Fig. 75: Code 66 Diagnostic Flow Chart (5.7L) A/C Pressure Sensor

CODE 67, A/C PRESSURE SENSOR

PCM determines when A/C clutch is engaged by monitoring A/C status line. If A/C pressure does not increase by at least 4 psi when A/C clutch is turned on, Code 67 will set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Code 67 will set if PCM does not detect an A/C pressure change when A/C clutch has been cycled.
2. If relay power feed is intermittent, A/C clutch status terminal may not detect voltage when A/C is commanded on.
3. Check A/C electrical harness for problems. If A/C clutch status line becomes intermittently open or shorted while compressor is on, PCM will be wrongly detecting A/C clutch going on and off. When this occurs and clutch remains engaged, PCM will not detect pressure change and a Code 67 will be set.
4. If A/C compressor clutch status circuit is intermittently open or shorted while compressor is on, PCM will wrongly detect compressor cycling on and off, but PCM will detect no pressure change and a Code 67 will set.

Diagnostic Aids

A Code 67 will store in PCM memory but will not turn on the SERVICE ENGINE SOON light. An A/C system low on charge could cause a Code 67 to set.

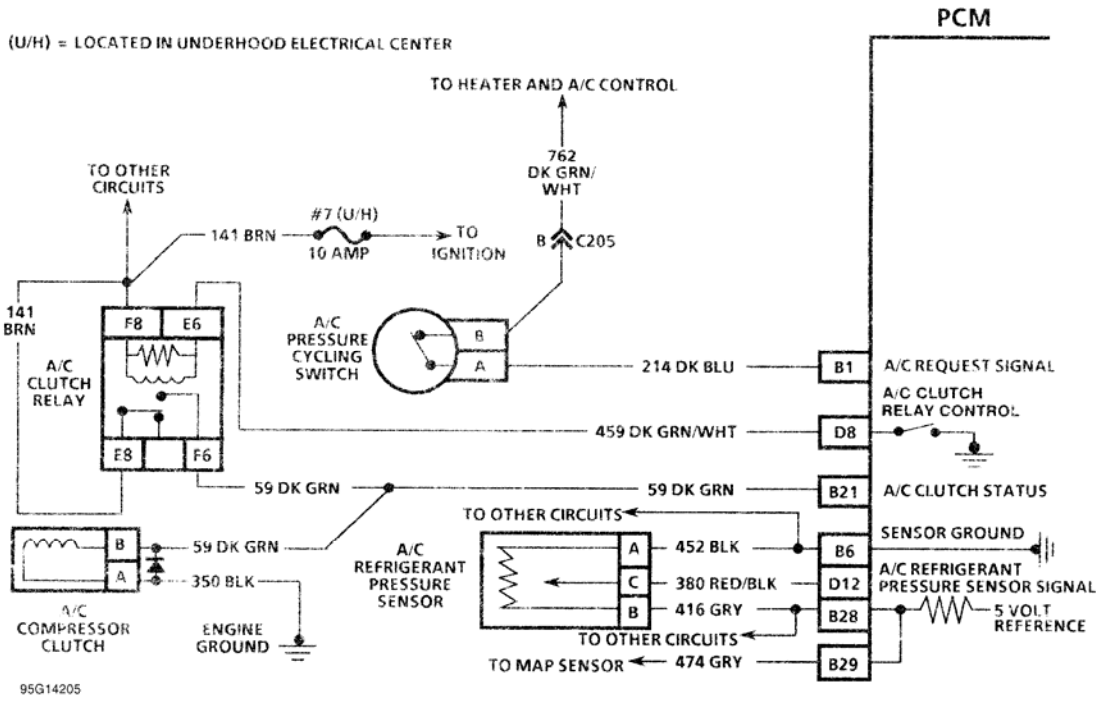


Fig. 76: Code 67 Schematic (5.7L) A/C Pressure Sensor

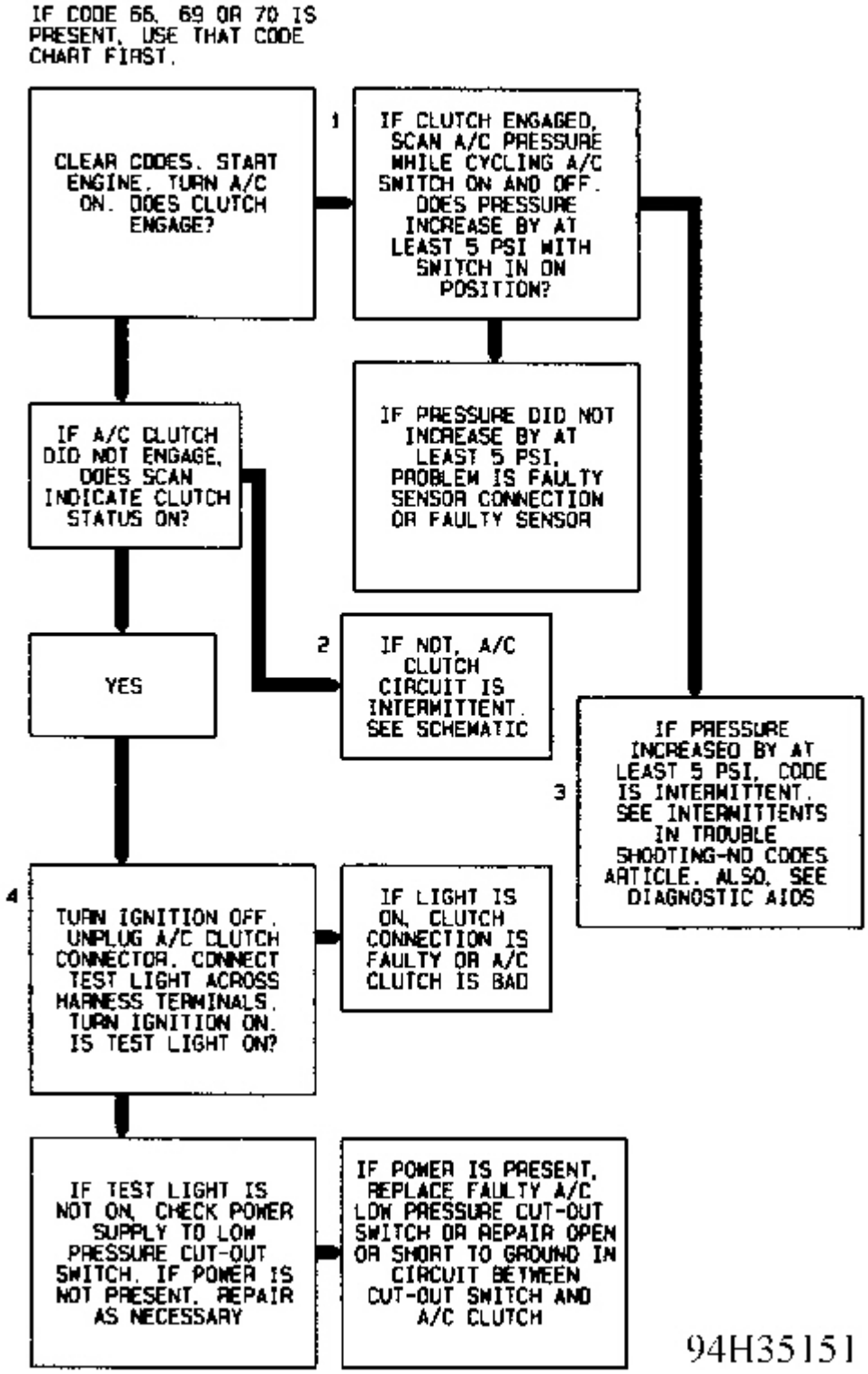

IF CODE 66, 69 OR 70 IS PRESENT, USE THAT CODE CHART FIRST.
CLEAR CODES, START ENGINE, TURN A/C ON. DOES CLUTCH ENGAGE?
1
IF CLUTCH ENGAGED, SCAN A/C PRESSURE WHILE CYCLING A/C SWITCH ON AND OFF. DOES PRESSURE INCREASE BY AT LEAST 5 PSI WITH SWITCH IN ON POSITION?
IF PRESSURE DID NOT INCREASE BY AT LEAST 5 PSI, PROBLEM IS FAULTY SENSOR CONNECTION OR FAULTY SENSOR
IF A/C CLUTCH DID NOT ENGAGE, DOES SCAN INDICATE CLUTCH STATUS ON?
YES
2
IF NOT, A/C CLUTCH CIRCUIT IS INTERMITTENT. SEE SCHEMATIC
3
IF PRESSURE INCREASED BY AT LEAST 5 PSI, CODE IS INTERMITTENT. SEE INTERMITTENTS IN TROUBLE SHOOTING-NO CODES ARTICLE. ALSO, SEE DIAGNOSTIC AIDS
4
TURN IGNITION OFF, UNPLUG A/C CLUTCH CONNECTOR. CONNECT TEST LIGHT ACROSS HARNESS TERMINALS. TURN IGNITION ON. IS TEST LIGHT ON?
IF LIGHT IS ON, CLUTCH CONNECTION IS FAULTY OR A/C CLUTCH IS BAD
IF TEST LIGHT IS NOT ON, CHECK POWER SUPPLY TO LOW PRESSURE CUT-OUT SWITCH. IF POWER IS NOT PRESENT, REPAIR AS NECESSARY
IF POWER IS PRESENT, REPLACE FAULTY A/C LOW PRESSURE CUT-OUT SWITCH OR REPAIR OPEN OR SHORT TO GROUND IN CIRCUIT BETWEEN CUT-OUT SWITCH AND A/C CLUTCH
94H35151

Fig. 77: Code 67 Diagnostic Flow Chart (5.7L) A/C Pressure Sensor

CODE 68, A/C RELAY CIRCUIT SHORTED

When PCM detects A/C has been requested, PCM will activate A/C clutch relay. When relay is activated, voltage should be present at both A/C compressor clutch and A/C clutch status terminal at PCM. If PCM detects voltage on A/C status line when A/C has not been commanded on, Code 68 will set. A short to voltage anywhere on A/C status line, or stuck relay contacts, will set Code 68. When Code 68 is set, PCM does not turn on SERVICE ENGINE SOON light.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. A/C must be off while performing test.
2. This step will isolate ignition feed portion of circuit from clutch circuit.
3. If Code 68 reappears at this step, PCM is internally shorted to voltage.

Diagnostic Aids

Check for intermittent shorts to A/C clutch circuit or sticking A/C relay.

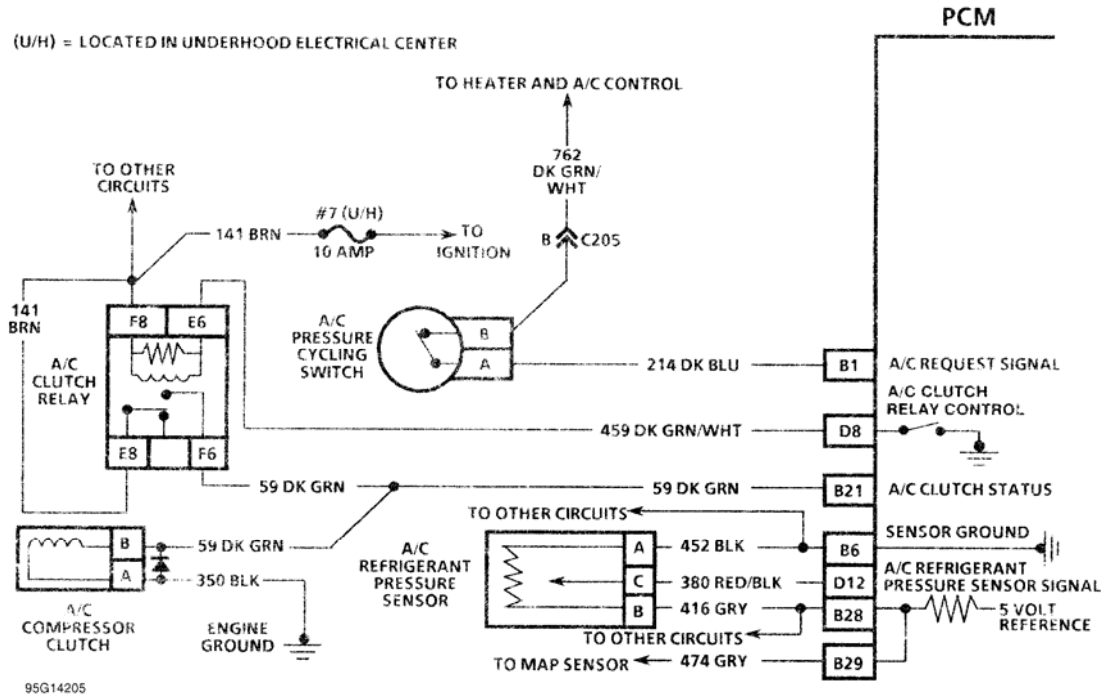


Fig. 78: Code 68 Schematic (5.7L) A/C Relay Circuit Shorted

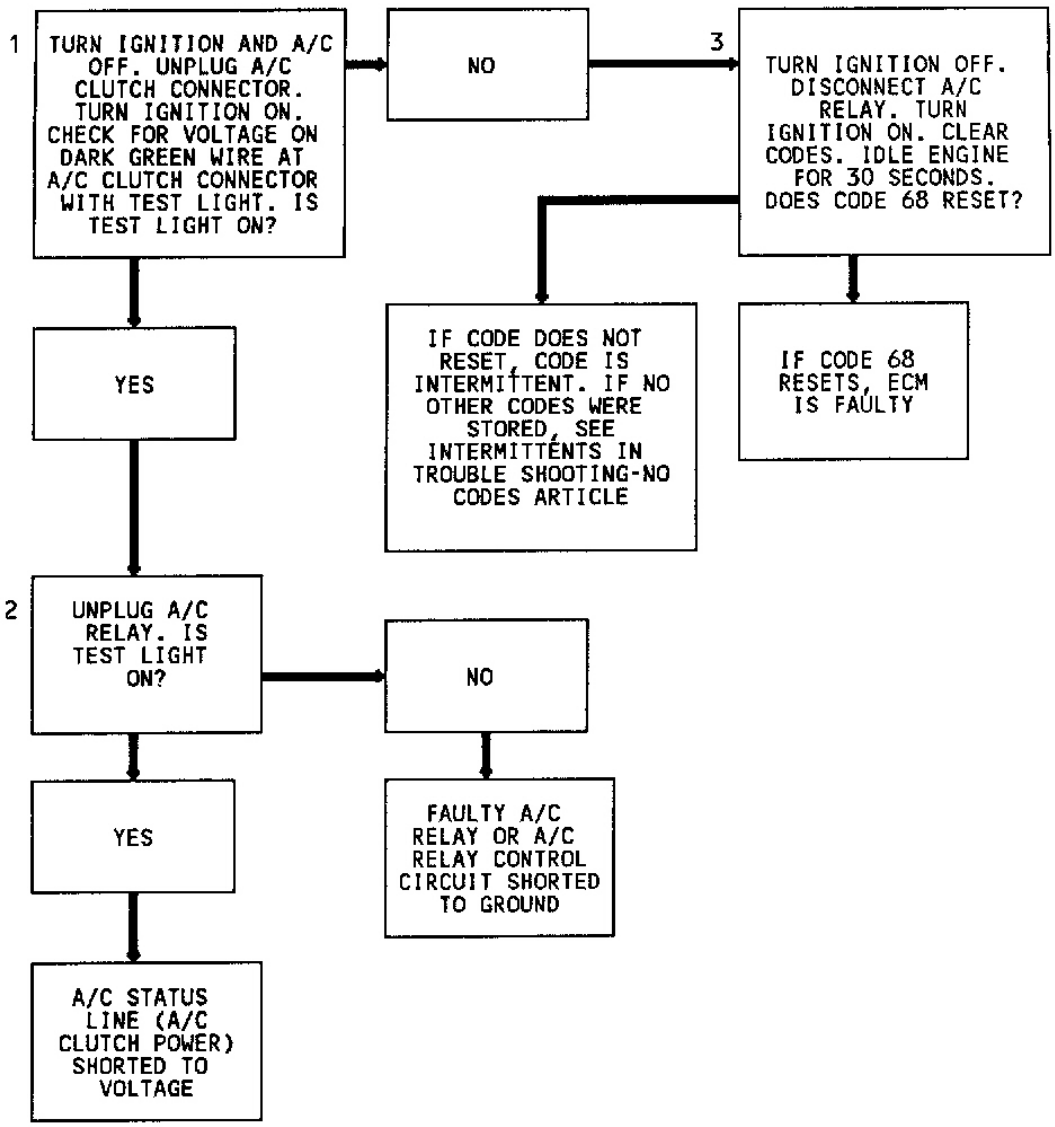


Fig. 79: Code 68 Diagnostic Flow Chart (5.7L) A/C Relay Circuit Shorted

CODE 69, A/C COMPRESSOR RELAY

When PCM detects A/C has been requested, PCM will activate the A/C clutch relay. When the relay has been activated, voltage should be present at both the A/C compressor clutch and the A/C clutch status line terminal of the PCM. If the PCM activates the A/C clutch relay but does not detect voltage present at A/C status terminal for more than 10 seconds, Code 69 will set. An open or short to ground at any point in the A/C status circuit will cause Code 69 to set. A Code 69 fault will be stored in PCM memory but will not turn on the SERVICE ENGINE SOON light.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. A problem that may prevent compressor from engaging may or may not cause Code 69 to set.
2. If the A/C compressor clutch operates properly and scan tester indicates A/C status off, then an open exists between the PCM and the splice to the compressor.

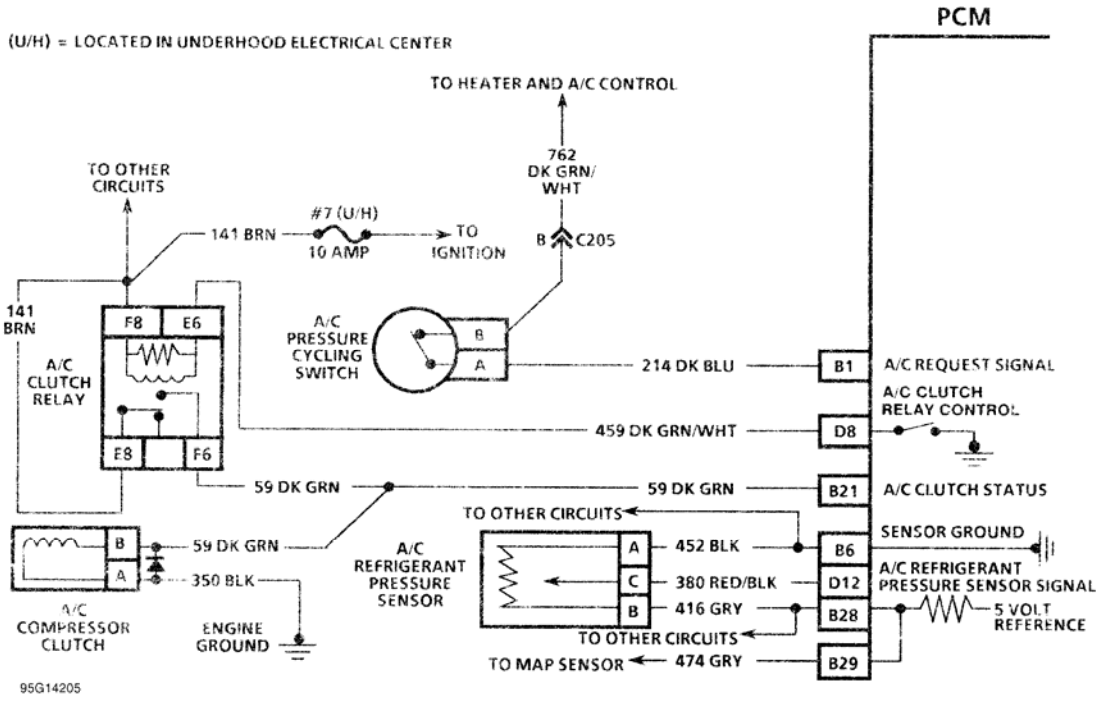


Fig. 80: Code 69 Schematic (5.7L) A/C Compressor Relay

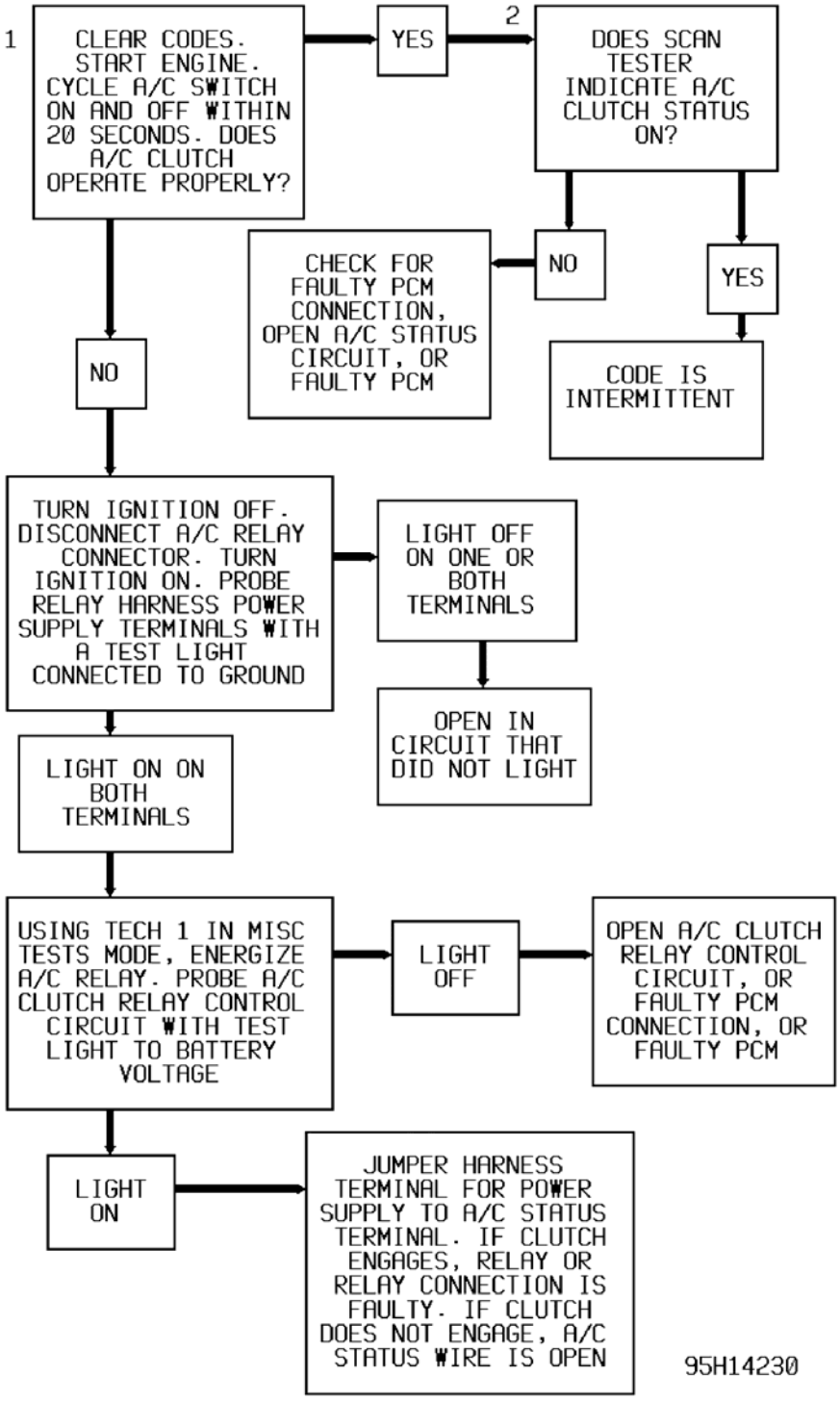


Fig. 81: Code 69 Diagnostic Flow Chart (5.7L) A/C Compressor Relay

CODE 70, A/C COMPRESSOR RELAY DRIVER

Relay is supplied voltage when ignition is on. PCM controls solenoid valve by providing a ground through one

of its Quad-Driver Modules (QDM). When relay is actuated, terminal is grounded and its monitored voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Tech 1 will enable circuit for 5 seconds.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative relay.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

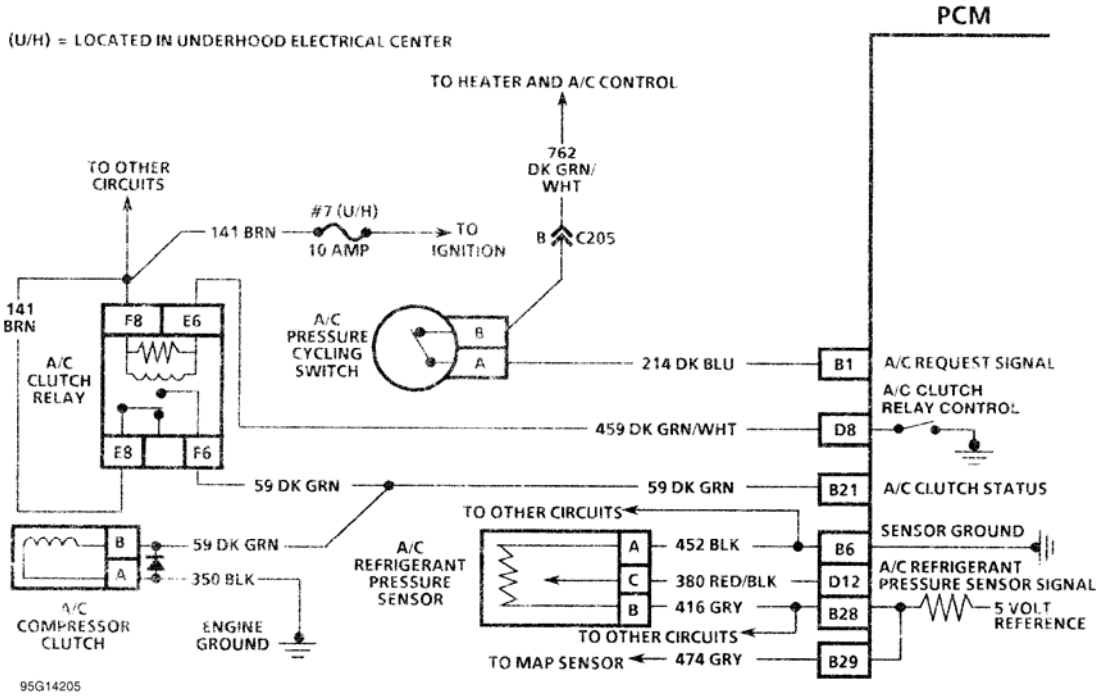


Fig. 82: Code 70 Schematic (5.7L) A/C Compressor Relay Driver

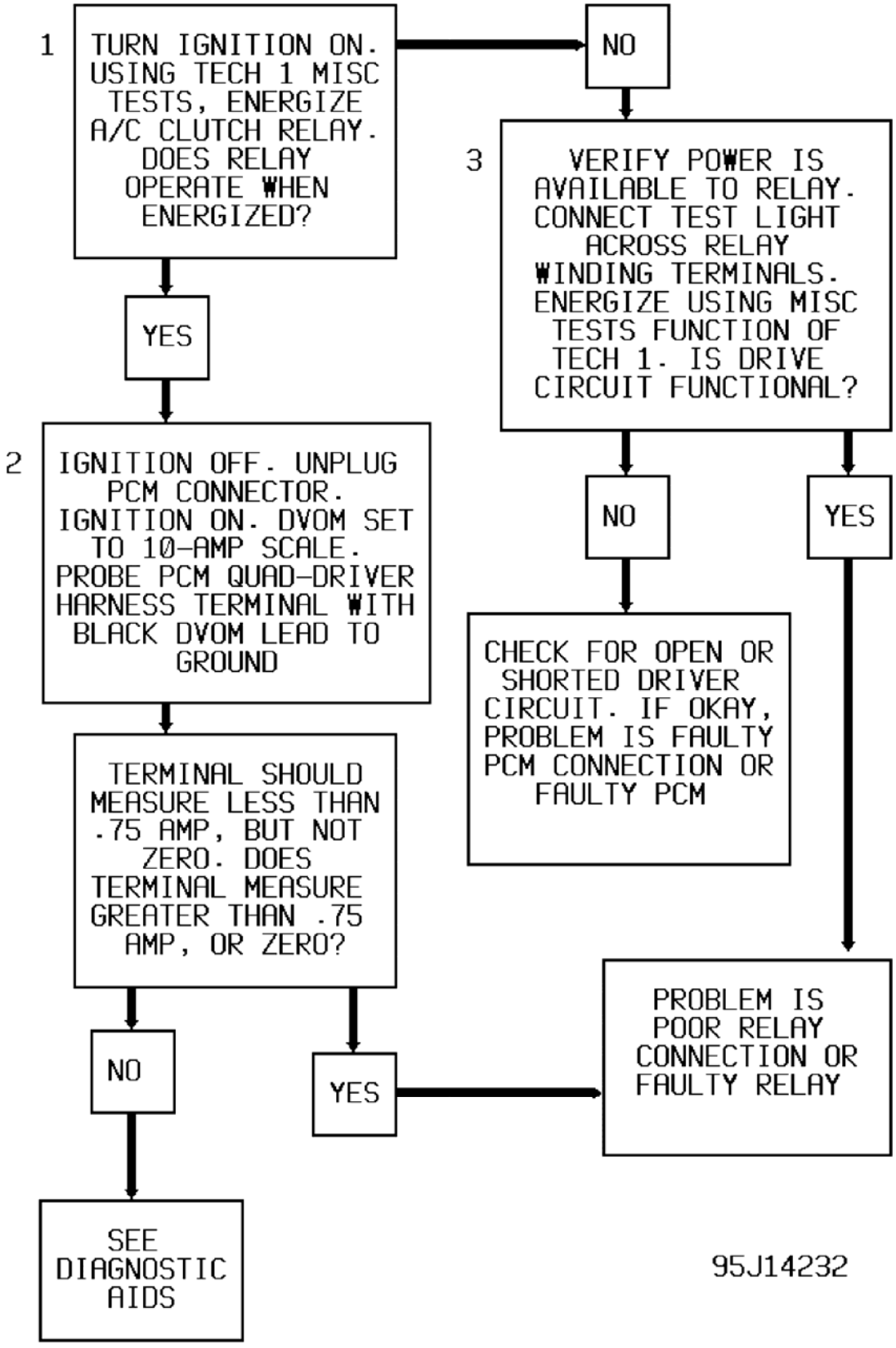

1
TURN IGNITION ON. USING TECH 1 MISC TESTS, ENERGIZE A/C CLUTCH RELAY. DOES RELAY OPERATE WHEN ENERGIZED?
NO
3
VERIFY POWER IS AVAILABLE TO RELAY. CONNECT TEST LIGHT ACROSS RELAY WINDING TERMINALS. ENERGIZE USING MISC TESTS FUNCTION OF TECH 1. IS DRIVE CIRCUIT FUNCTIONAL?
YES
2
IGNITION OFF. UNPLUG PCM CONNECTOR. IGNITION ON. DVOM SET TO 10-AMP SCALE. PROBE PCM QUAD-DRIVER HARNESS TERMINAL WITH BLACK DVOM LEAD TO GROUND
NO
YES
CHECK FOR OPEN OR SHORTED DRIVER CIRCUIT. IF OKAY, PROBLEM IS FAULTY PCM CONNECTION OR FAULTY PCM
TERMINAL SHOULD MEASURE LESS THAN .75 AMP, BUT NOT ZERO. DOES TERMINAL MEASURE GREATER THAN .75 AMP, OR ZERO?
NO
YES
PROBLEM IS POOR RELAY CONNECTION OR FAULTY RELAY
SEE DIAGNOSTIC AIDS
95J14232

Fig. 83: Code 70 Diagnostic Flow Chart (5.7L) A/C Compressor Relay Driver

CODE 72, VEHICLE SPEED SENSOR LOSS

Speed sensor, which is a Permanent Magnet (PM) generator, provides control module with vehicle speed information. PM generator, mounted in transmission, produces a pulsing AC voltage signal whenever vehicle speed is greater than about 2 MPH. Voltage level and pulses increase with vehicle speed. Control module converts pulsing voltage to MPH, which is used by control module to calculate vehicle adjustments.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. An intermittent connection at VSS or PCM may cause code to set. Inspect harness and all related connections. Check for damage or pushed out terminals.
2. Ensure harness is routed away from hot exhaust components.
3. If software/calibration is incorrect, code will set. Ensure calibration is correct before replacing PCM.

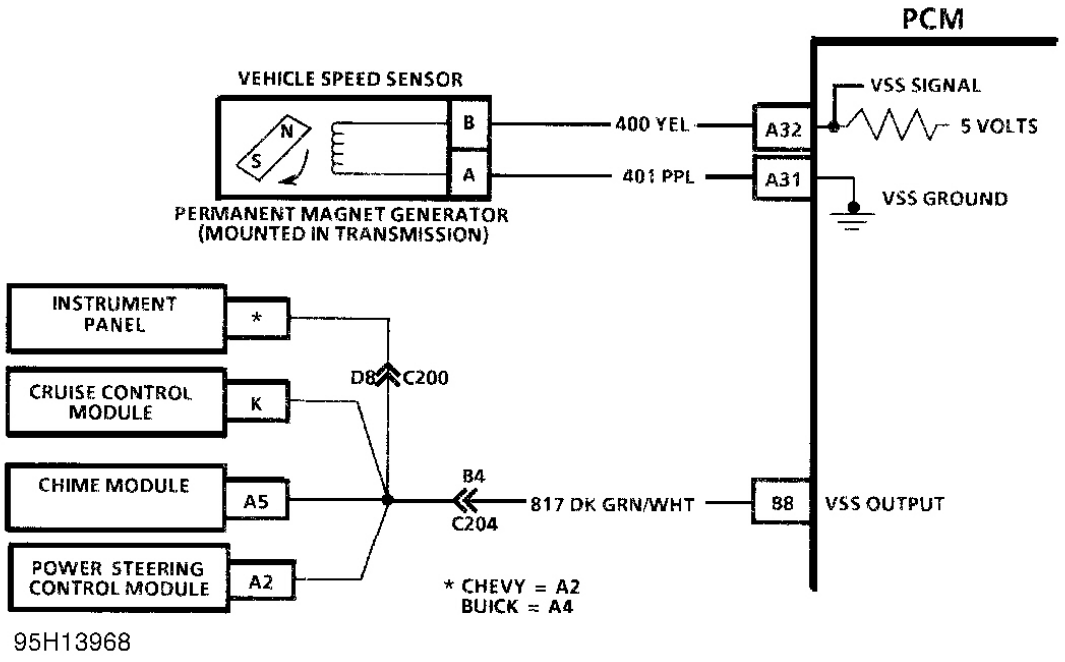


Fig. 84: Code 72 Schematic (5.7L) Vehicle Speed Sensor Loss

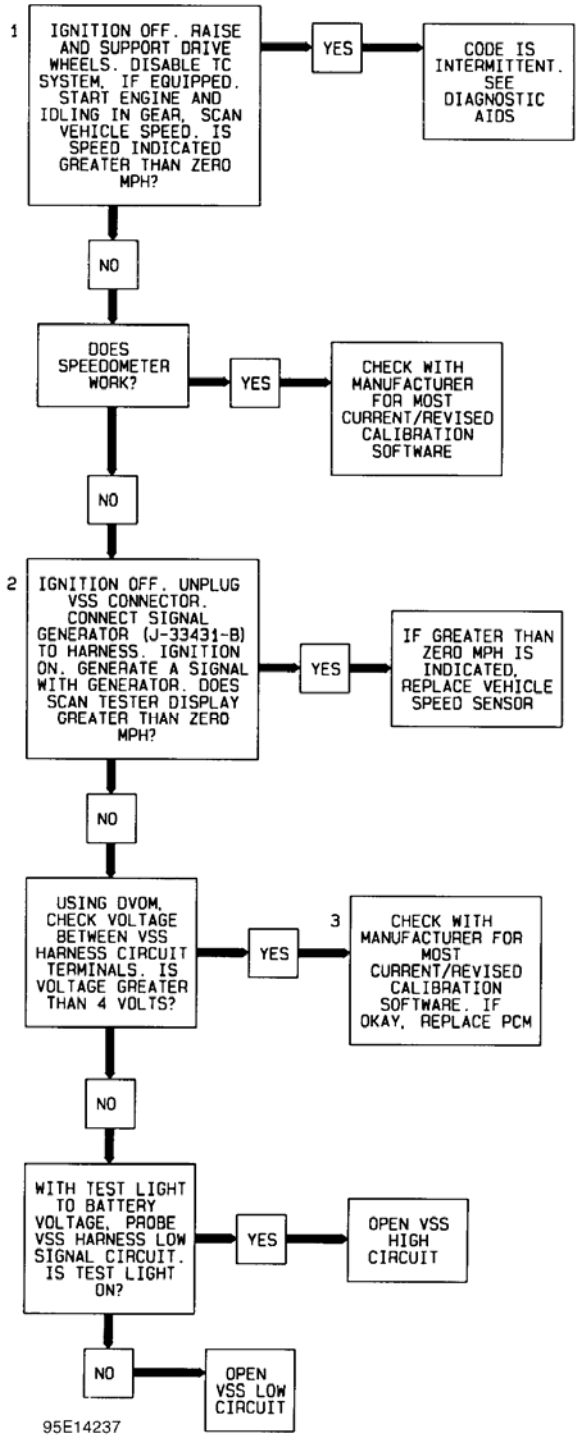


Fig. 85: Code 72 Diagnostic Flow Chart (5.7L) Vehicle Speed Sensor Loss

CODE 73, PRESSURE CONTROL SOLENOID

Pressure control solenoid is a PCM-controlled device used to regulate transmission line pressure. PCM

compares TPS voltage, engine RPM and other inputs to determine proper line pressure for a given load. PCM regulates pressure by applying a varying amperage to pressure control solenoid. Amperage varies from 0.1 to 1.1 amps.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks ability of the PCM to command pressure control solenoid.
2. Checks for voltage at PCM.

Diagnostic Aids

Check for poor connections at PCM and at transmission connector.

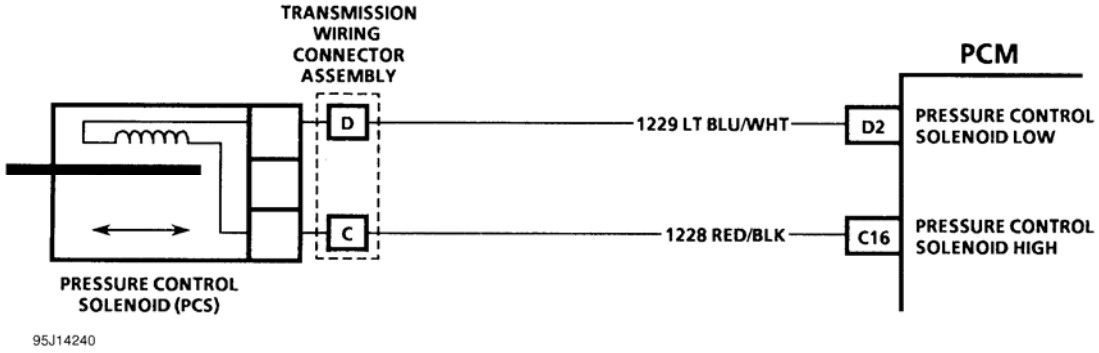


Fig. 86: Code 73 Schematic (5.7L) Pressure Control Solenoid

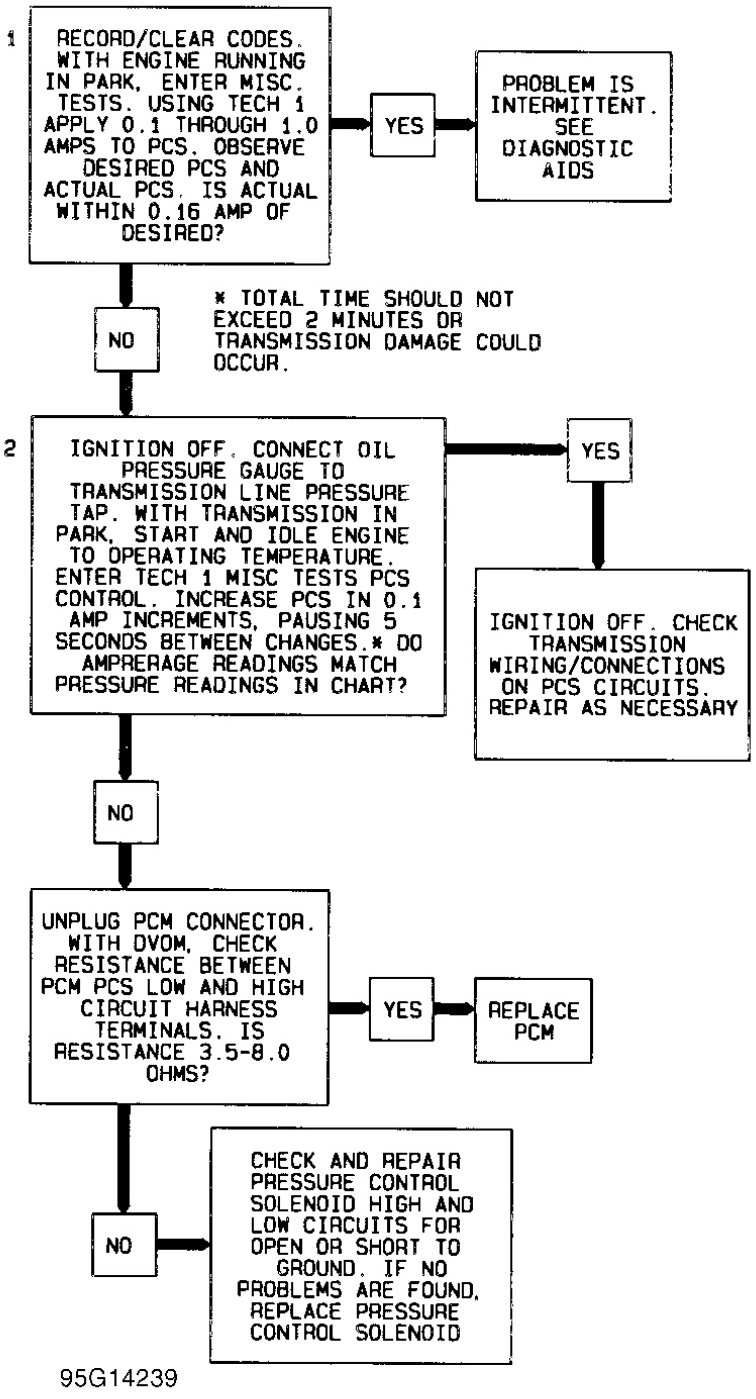


Fig. 87: Code 73 Diagnostic Flow Chart (5.7L) Pressure Control Solenoid

CODE 75, TRANSMISSION VOLTAGE LOW

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for normal battery voltage of 9-15 volts.
2. Checks if low voltage is due to generator voltage supply circuit, or PCM. If voltage is less than 9 volts, PCM is okay.

Diagnostic Aids

If code sets when an accessory is operated, check for poor connections or excessive current draw. Also, check for poor connections at starter solenoid or fusible link.

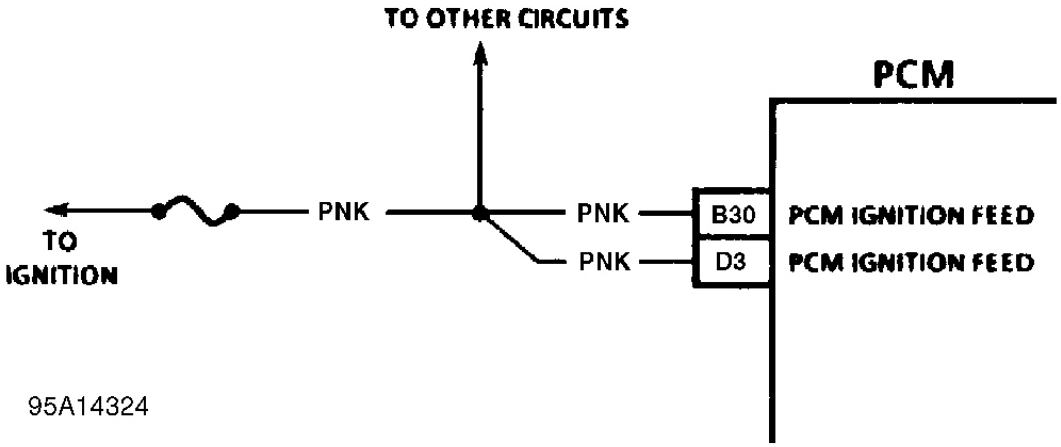


Fig. 88: Code 75 Schematic (5.7L) Transmission Voltage Low

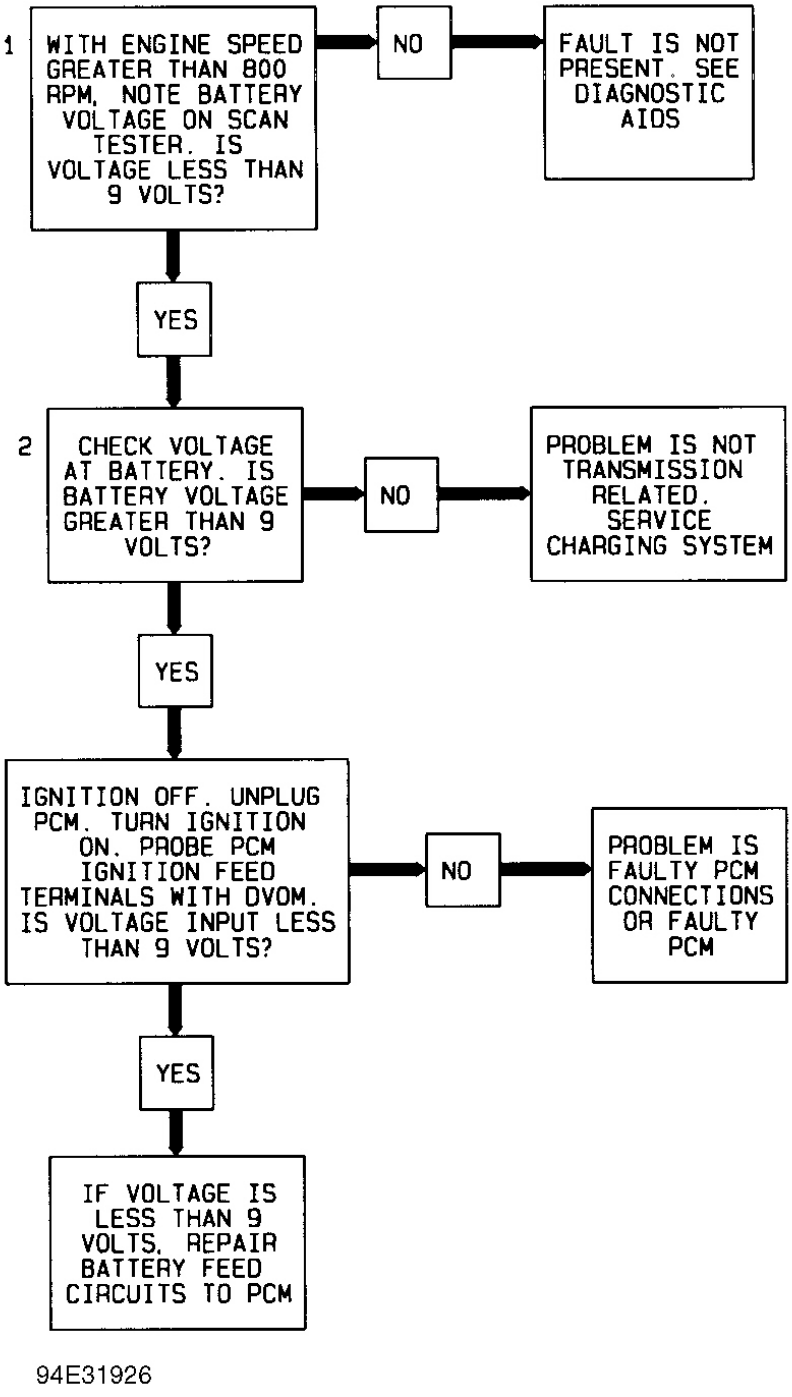


Fig. 89: Code 75 Diagnostic Flow Chart (5.7L) Transmission Voltage Low

CODE 77, PRIMARY COOLING FAN DRIVER

Cooling fan relay is supplied voltage when ignition is on. PCM controls solenoid valve by providing a ground

through one of its Quad-Driver Modules (QDM). When relay is actuated, terminal is grounded and its monitored voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Even if the fan does not operate, listen for an audible click from relay.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative relay.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

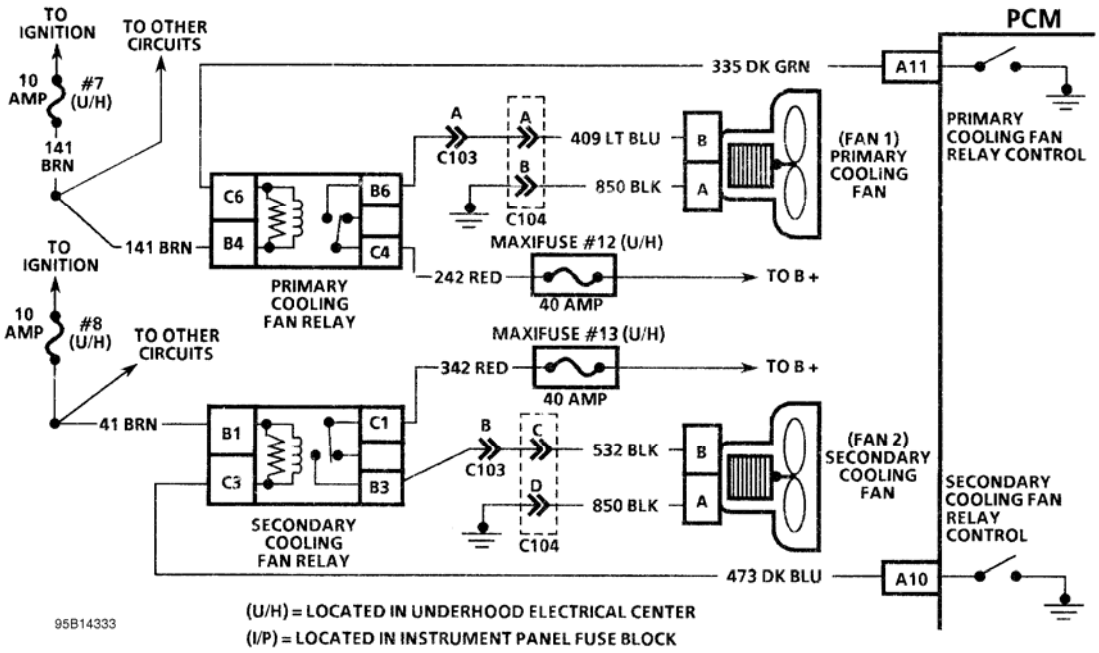


Fig. 90: Code 77 Schematic (5.7L) Primary Cooling Fan Driver

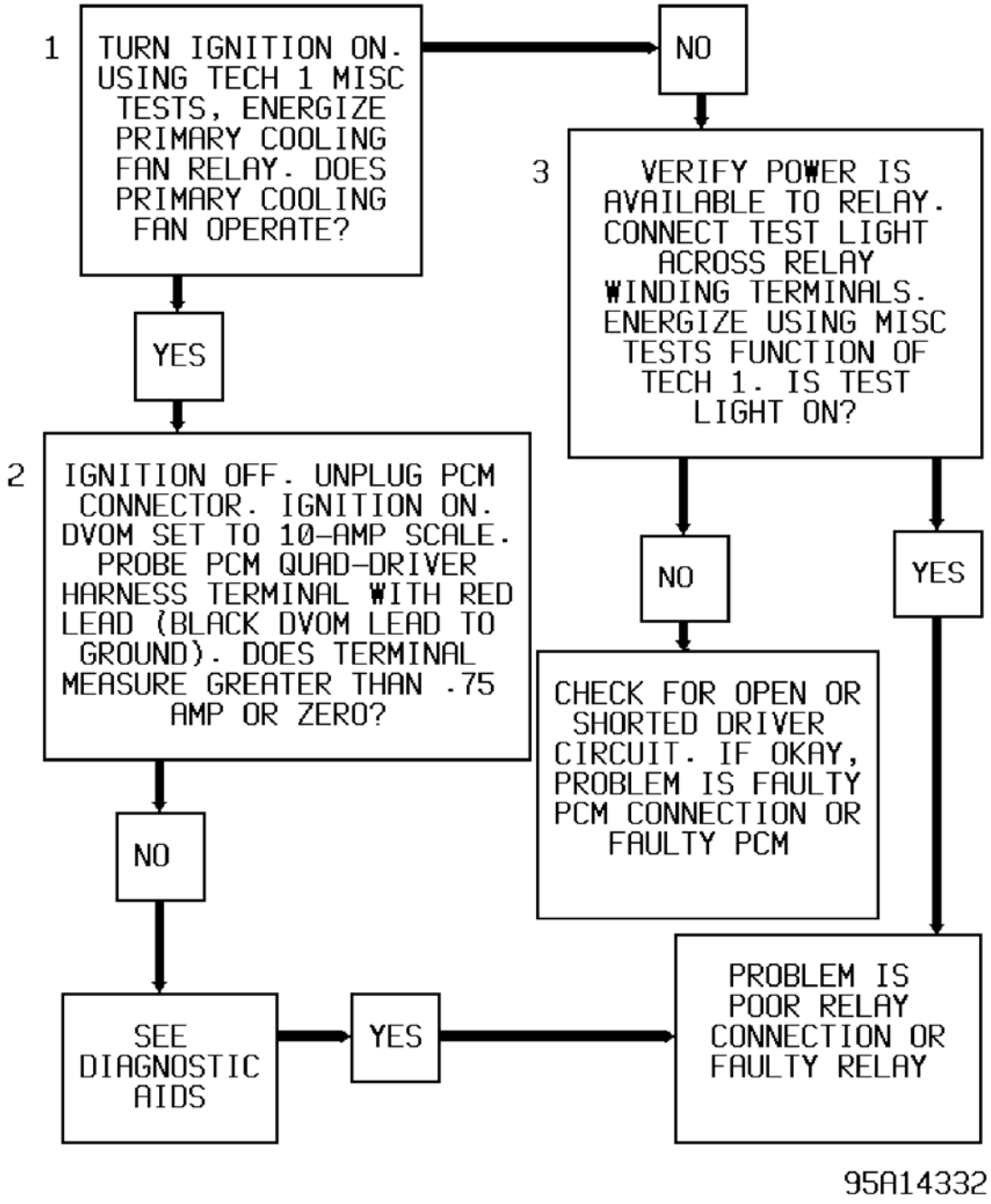


Fig. 91: Code 77 Diagnostic Flow Chart (5.7L) Primary Cooling Fan Driver

CODE 78, SECONDARY COOLING FAN DRIVER

Cooling fan relay is supplied voltage when ignition is on. PCM controls solenoid valve by providing a ground through one of its Quad-Driver Modules (QDM). When relay is actuated, terminal is grounded and its monitored voltage will be low. When an output is off, its terminal voltage will be high. Each QDM has a separate fault line to indicate presence of a current fault to control module central processor.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Even if the fan does not operate, listen for an audible click from relay.
2. This check can detect a partially shorted coil which would cause excessive current flow. Excessive current flow to a QDM will be detected as a fault and set a code.
3. The remaining checks will identify a circuit problem that has caused an excessive current flow or inoperative relay.

Diagnostic Aids

Check related harness connectors, including PCM harness. Check for damaged or pushed out terminals.

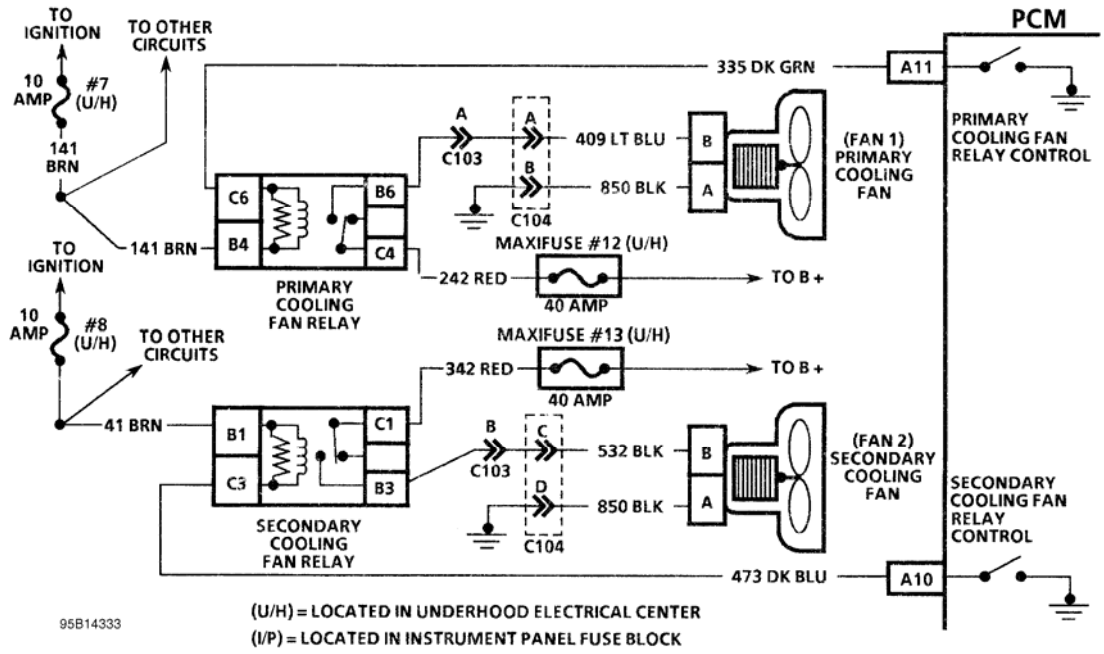


Fig. 92: Code 78 Schematic (5.7L) Secondary Cooling Fan Driver

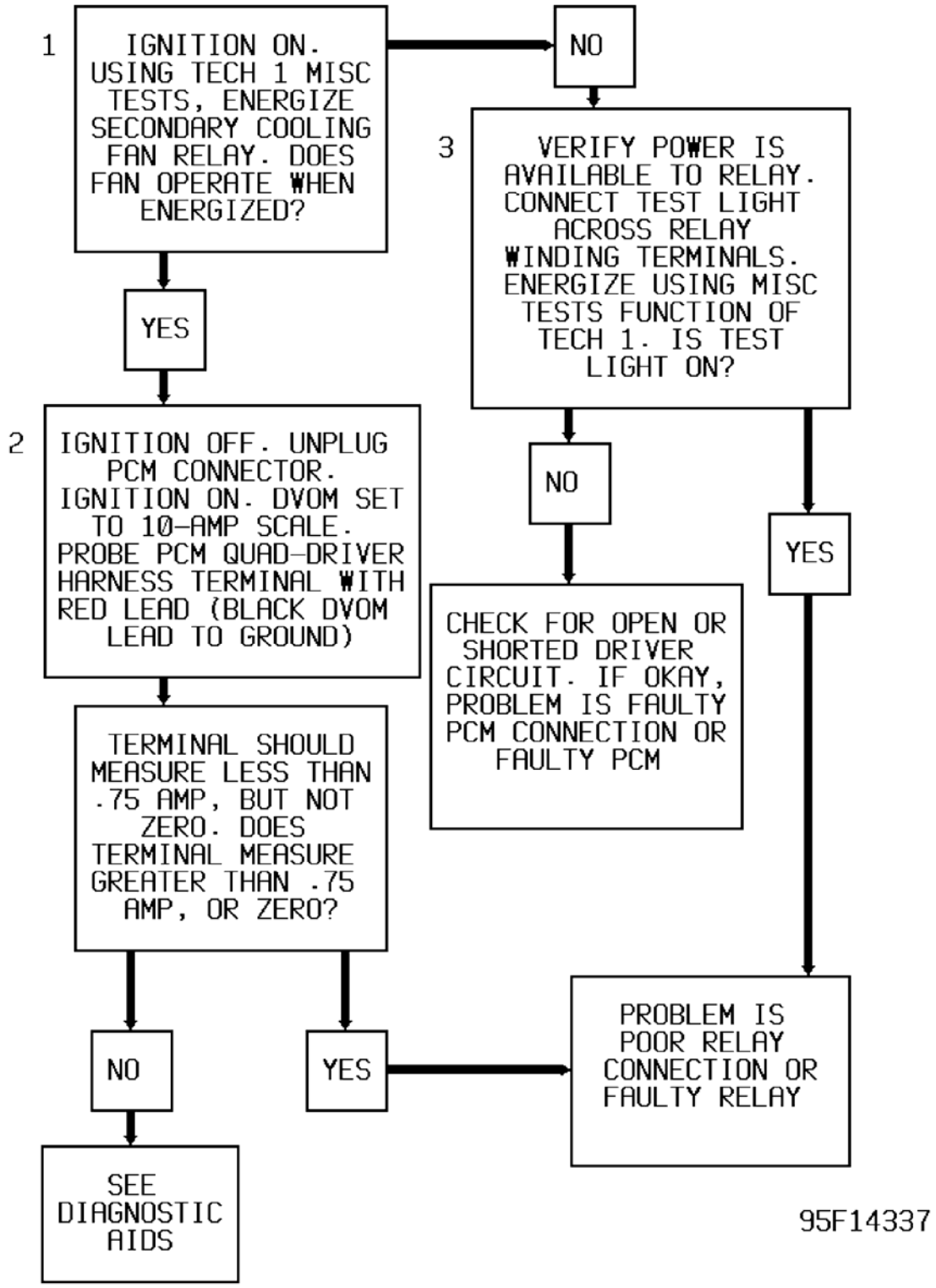


Fig. 93: Code 78 Diagnostic Flow Chart (5.7L) Secondary Cooling Fan Driver

CODE 79, TRANSMISSION FLUID OVERTEMP

PCM supplies and monitors a 5-volt reference to sensor. As transmission temperature changes, sensor resistance changes, affecting monitored voltage. When fluid is cold, resistance is high, resulting in a high monitored voltage. When fluid is hot, resistance is low, resulting in a low monitored voltage. Code will set if transmission temperature is 120-130°C for 5 seconds and Codes 58 and 59 are not set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for out-of-calibration sensor or shorted circuit. 2 Simulates Code 59.

Diagnostic Aids

Check harness for potential short to ground. See Code 59 chart to check transmission temperature sensor temperature-to-resistance values. Also, check transmission fluid level. Check for conditions which could cause transmission to overheat i.e. trailer towing, steep grades, etc.

TEMPERATURE-TO-RESISTANCE VALUES (Measure resistance across sensor terminals)

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

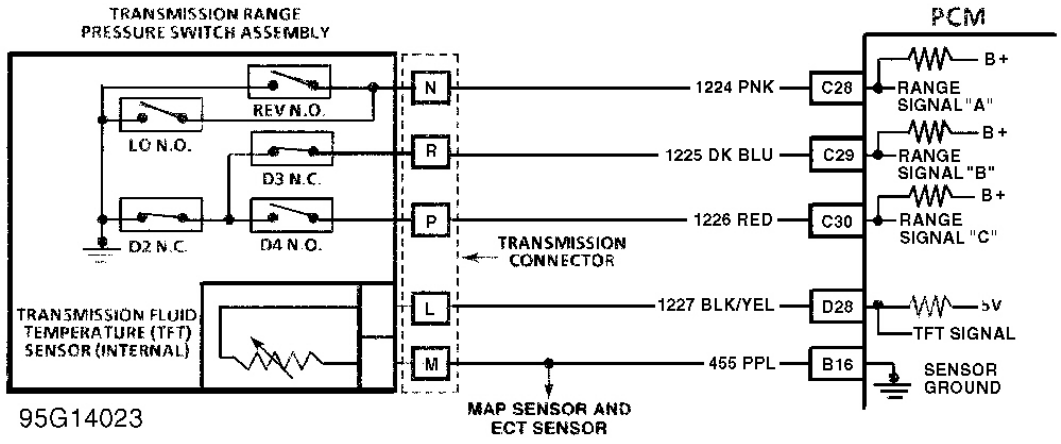


Fig. 94: Code 79 Schematic (5.7L) Transmission Fluid Overtemp

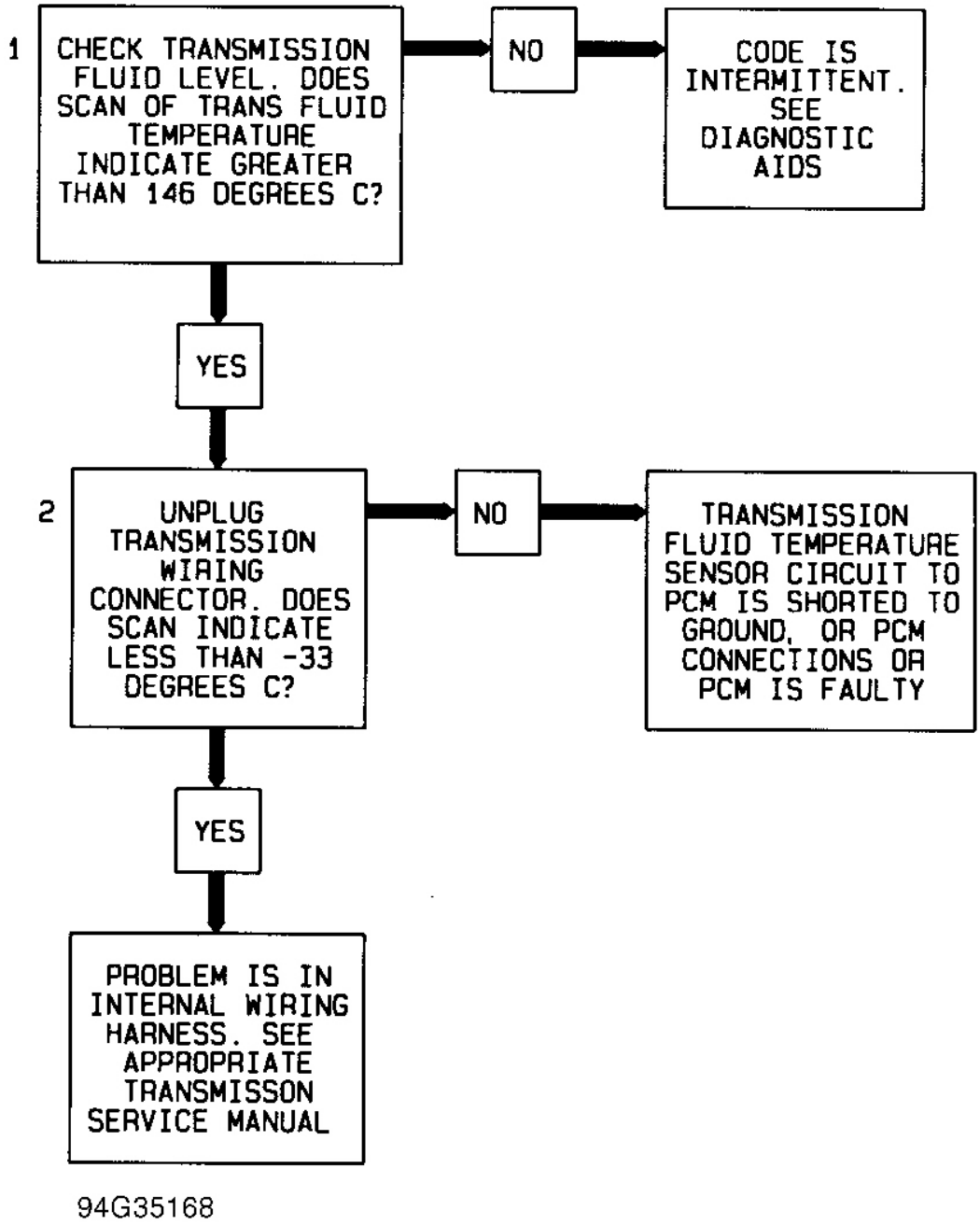


Fig. 95: Code 79 Diagnostic Flow Chart (5.7L) Transmission Fluid Overtemp

CODE 81, 2-3 SHIFT SOLENOID

Voltage is supplied directly to solenoid. PCM controls solenoid by providing a ground circuit.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks 2-3 shift solenoid and internal transmission for shorts.
2. Checks for power to 2-3 shift solenoid from ignition through the fuse.

Diagnostic Aids

Check all connections at the transmission. An open in ignition feed circuit can cause multiple codes to set.

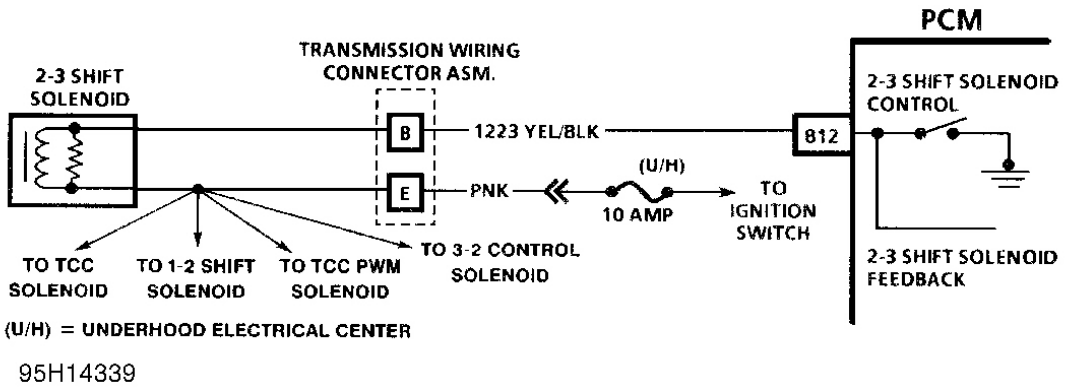
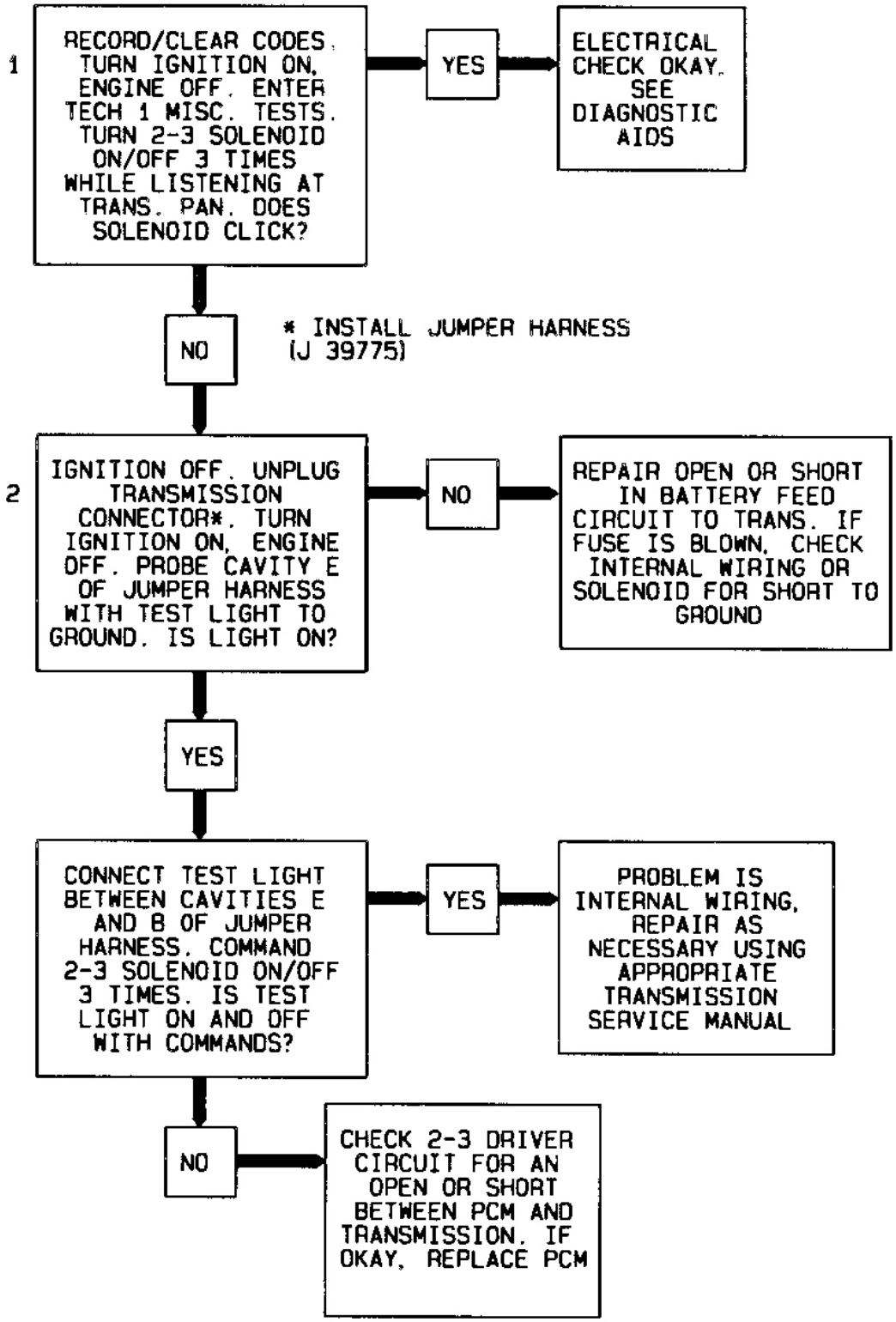


Fig. 96: Code 81 Schematic (5.7L) 2-3 Shift Solenoid


1
RECORD/CLEAR CODES. TURN IGNITION ON, ENGINE OFF. ENTER TECH 1 MISC. TESTS. TURN 2-3 SOLENOID ON/OFF 3 TIMES WHILE LISTENING AT TRANS. PAN. DOES SOLENOID CLICK?
YES
ELECTRICAL CHECK OKAY. SEE DIAGNOSTIC AIDS
NO
* INSTALL JUMPER HARNESS (J 39775)
2
IGNITION OFF. UNPLUG TRANSMISSION CONNECTOR*. TURN IGNITION ON, ENGINE OFF. PROBE CAVITY E OF JUMPER HARNESS WITH TEST LIGHT TO GROUND. IS LIGHT ON?
NO
REPAIR OPEN OR SHORT IN BATTERY FEED CIRCUIT TO TRANS. IF FUSE IS BLOWN, CHECK INTERNAL WIRING OR SOLENOID FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN CAVITIES E AND B OF JUMPER HARNESS. COMMAND 2-3 SOLENOID ON/OFF 3 TIMES. IS TEST LIGHT ON AND OFF WITH COMMANDS?
YES
PROBLEM IS INTERNAL WIRING, REPAIR AS NECESSARY USING APPROPRIATE TRANSMISSION SERVICE MANUAL
NO
CHECK 2-3 DRIVER CIRCUIT FOR AN OPEN OR SHORT BETWEEN PCM AND TRANSMISSION. IF OKAY, REPLACE PCM

94C31940

Fig. 97: Code 81 Diagnostic Flow Chart (5.7L) 2-3 Shift Solenoid

CODE 82, 1-2 SHIFT SOLENOID

Voltage is supplied directly to solenoid. PCM controls solenoid by providing a ground circuit for solenoid.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks 1-2 shift solenoid and internal transmission for shorts.
2. Checks for power to 1-2 shift solenoid from ignition through the fuse.

Diagnostic Aids

Check all connections at the transmission. An open in ignition feed circuit can cause multiple codes to set.

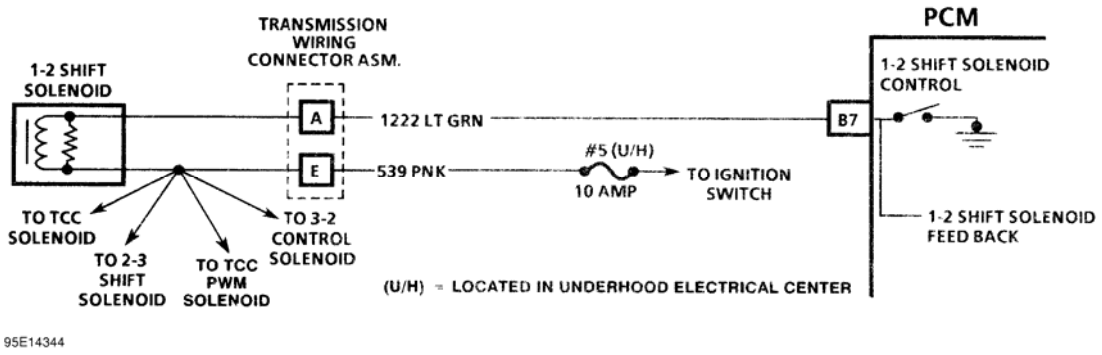
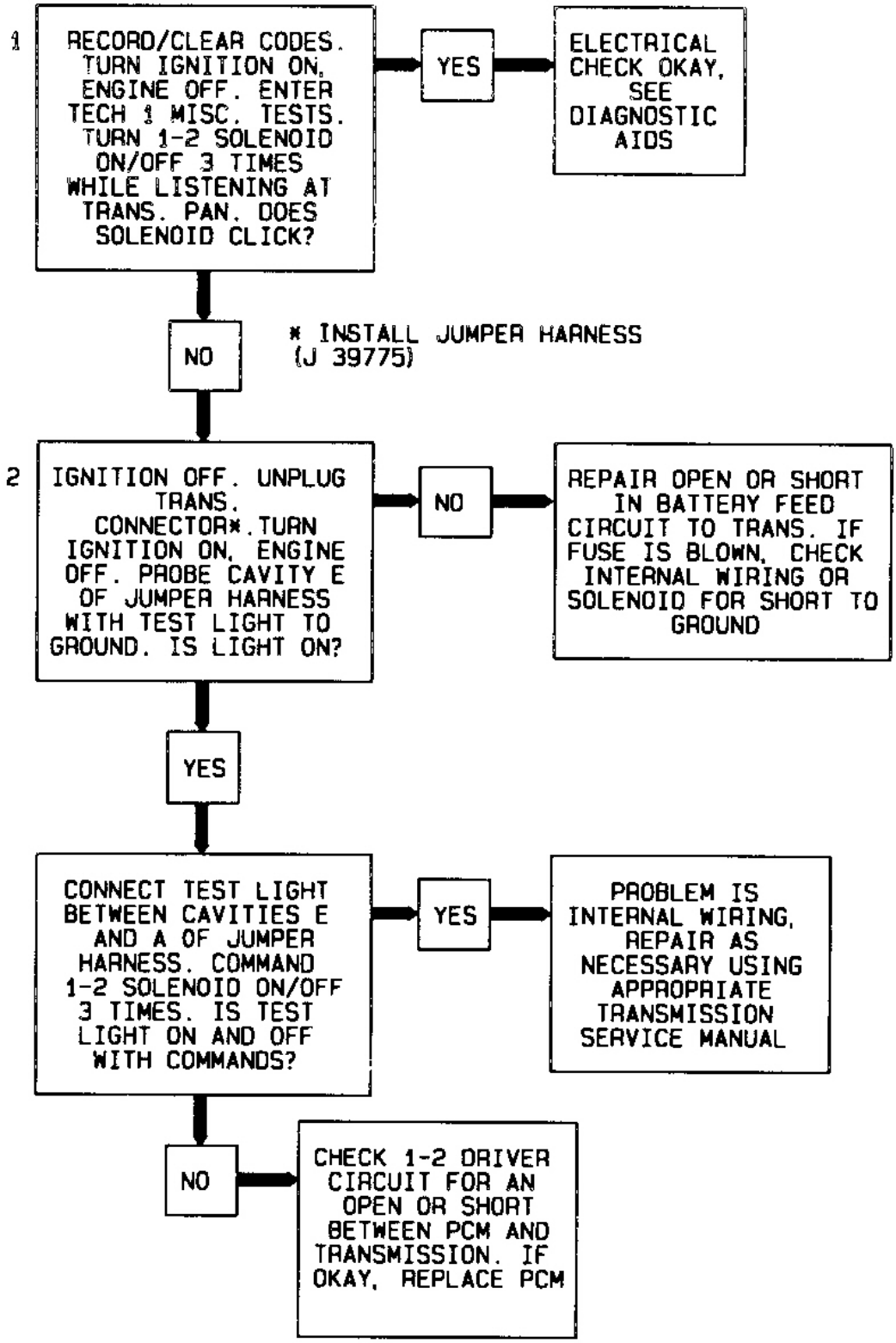


Fig. 98: Code 82 Schematic (5.7L) 1-2 Shift Solenoid


1
RECORD/CLEAR CODES. TURN IGNITION ON, ENGINE OFF. ENTER TECH 1 MISC. TESTS. TURN 1-2 SOLENOID ON/OFF 3 TIMES WHILE LISTENING AT TRANS. PAN. DOES SOLENOID CLICK?
YES
ELECTRICAL CHECK OKAY, SEE DIAGNOSTIC AIDS
NO
* INSTALL JUMPER HARNESS (J 39775)
2
IGNITION OFF. UNPLUG TRANS. CONNECTOR*. TURN IGNITION ON, ENGINE OFF. PROBE CAVITY E OF JUMPER HARNESS WITH TEST LIGHT TO GROUND. IS LIGHT ON?
NO
REPAIR OPEN OR SHORT IN BATTERY FEED CIRCUIT TO TRANS. IF FUSE IS BLOWN, CHECK INTERNAL WIRING OR SOLENOID FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN CAVITIES E AND A OF JUMPER HARNESS. COMMAND 1-2 SOLENOID ON/OFF 3 TIMES. IS TEST LIGHT ON AND OFF WITH COMMANDS?
YES
PROBLEM IS INTERNAL WIRING, REPAIR AS NECESSARY USING APPROPRIATE TRANSMISSION SERVICE MANUAL
NO
CHECK 1-2 DRIVER CIRCUIT FOR AN OPEN OR SHORT BETWEEN PCM AND TRANSMISSION. IF OKAY, REPLACE PCM

94H31952

Fig. 99: Code 82 Diagnostic Flow Chart (5.7L) 1-2 Shift Solenoid

CODE 83, TCC PWM SOLENOID - A/T

PCM controls and monitors TCC PWM solenoid drive circuit. If voltage remains high when solenoid is commanded on or remains low when commanded off, code will set.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks if PCM is commanding TCC solenoid on.
2. Checks for voltage to solenoid.

Diagnostic Aids

Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connections or damaged harness. Perform intermittent check by monitoring circuit and code status while wiggling related wiring and connectors. If failure is induced, monitored circuit status will change rapidly and/or related code will set.

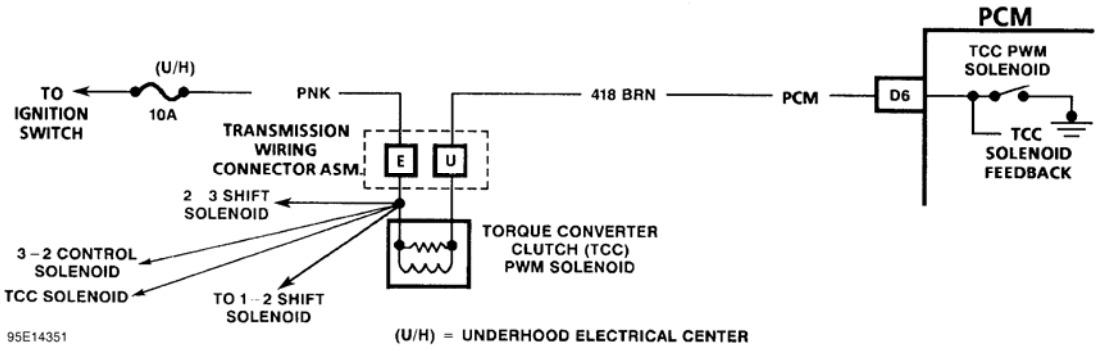
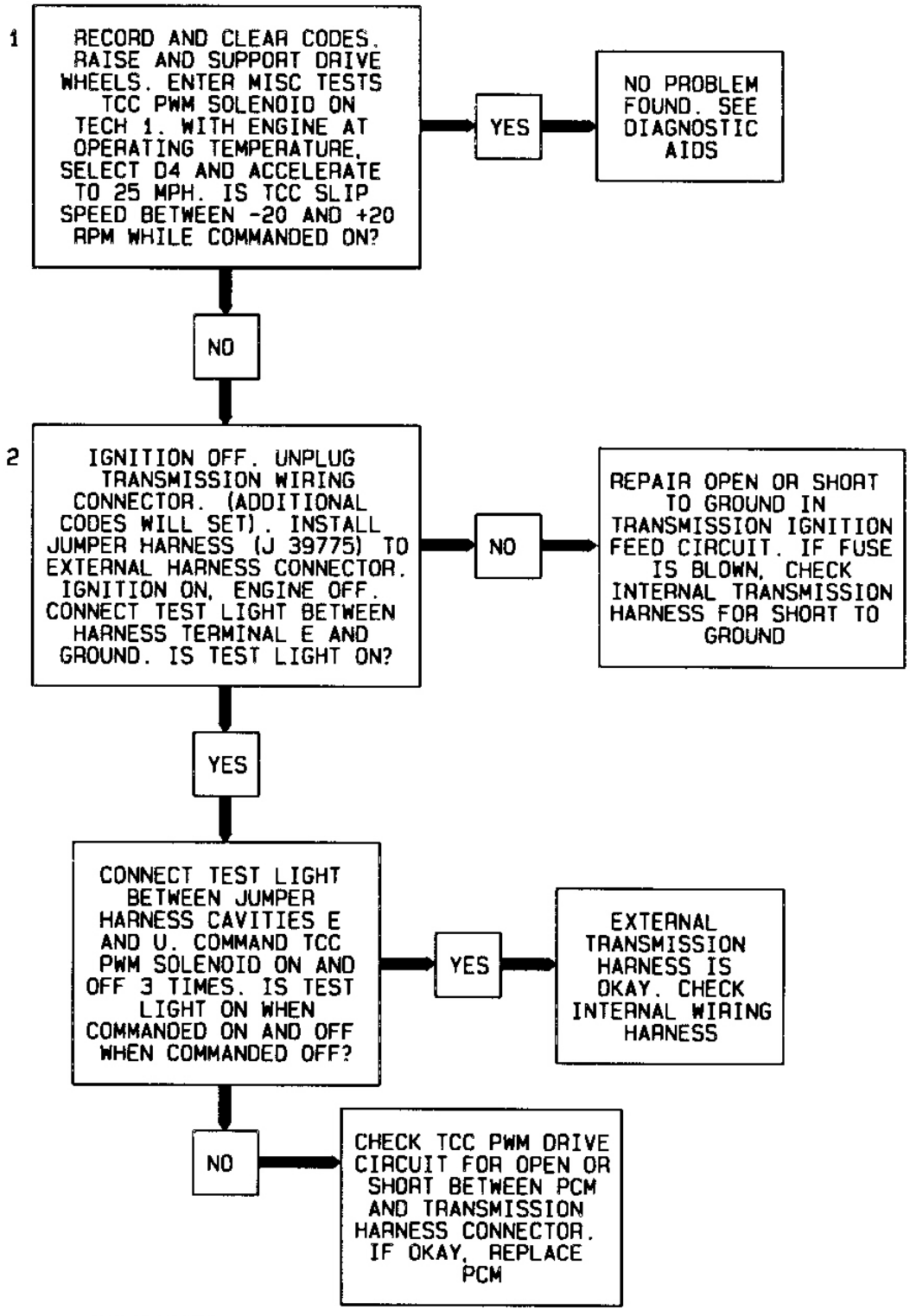


Fig. 100: Code 83 Schematic (5.7L W/ A/T) TCC PWM Solenoid


1
RECORD AND CLEAR CODES. RAISE AND SUPPORT DRIVE WHEELS. ENTER MISC TESTS TCC PWM SOLENOID ON TECH 1. WITH ENGINE AT OPERATING TEMPERATURE, SELECT D4 AND ACCELERATE TO 25 MPH. IS TCC SLIP SPEED BETWEEN -20 AND +20 RPM WHILE COMMANDED ON?
YES
NO PROBLEM FOUND. SEE DIAGNOSTIC AIDS
NO
2
IGNITION OFF. UNPLUG TRANSMISSION WIRING CONNECTOR. (ADDITIONAL CODES WILL SET). INSTALL JUMPER HARNESS (J 39775) TO EXTERNAL HARNESS CONNECTOR. IGNITION ON, ENGINE OFF. CONNECT TEST LIGHT BETWEEN HARNESS TERMINAL E AND GROUND. IS TEST LIGHT ON?
NO
REPAIR OPEN OR SHORT TO GROUND IN TRANSMISSION IGNITION FEED CIRCUIT. IF FUSE IS BLOWN, CHECK INTERNAL TRANSMISSION HARNESS FOR SHORT TO GROUND
YES
CONNECT TEST LIGHT BETWEEN JUMPER HARNESS CAVITIES E AND U. COMMAND TCC PWM SOLENOID ON AND OFF 3 TIMES. IS TEST LIGHT ON WHEN COMMANDED ON AND OFF WHEN COMMANDED OFF?
YES
EXTERNAL TRANSMISSION HARNESS IS OKAY. CHECK INTERNAL WIRING HARNESS
NO
CHECK TCC PWM DRIVE CIRCUIT FOR OPEN OR SHORT BETWEEN PCM AND TRANSMISSION HARNESS CONNECTOR. IF OKAY, REPLACE PCM

95D14350

Fig. 101: Code 83 Diagnostic Flow Chart (5.7L W/ A/T) TCC PWM Solenoid

CODE 84, 3-2 CONTROL SOLENOID - WITH A/T

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks 3-2 shift solenoid and internal transmission harness for shorts.
2. Checks for power to 3-2 shift solenoid from ignition through the fuse.

Diagnostic Aids

Check all connections at the transmission. An open in ignition feed circuit can cause multiple codes to set.

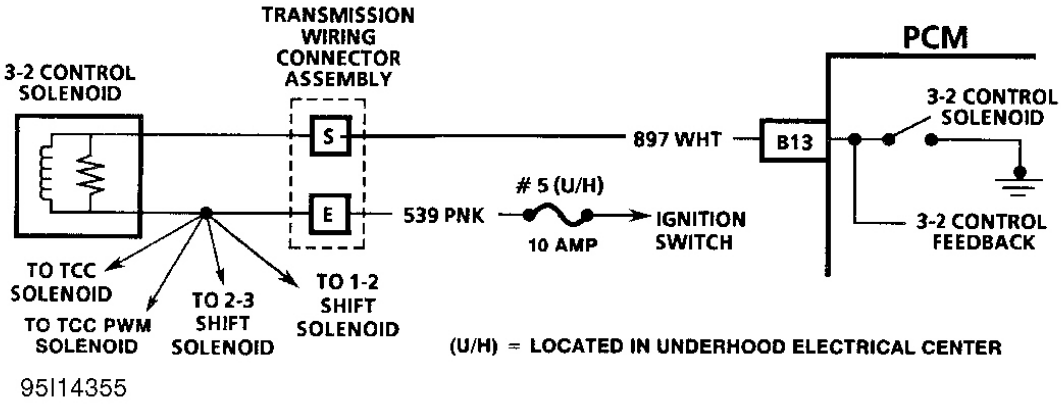


Fig. 102: Code 84 Schematic (5.7L With A/T) 3-2 Control Solenoid

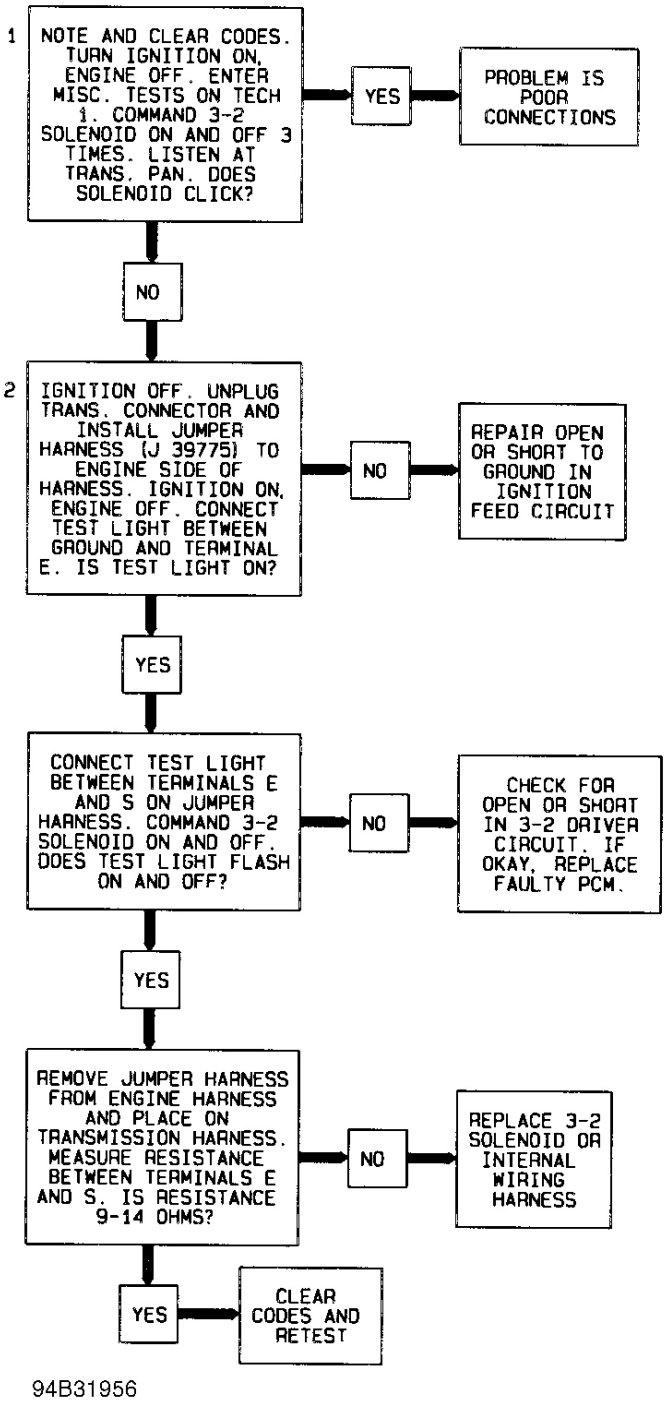


Fig. 103: Code 84 Diagnostic Flow Chart (5.7L With A/T) 3-2 Control Solenoid

CODE 85, TCC STUCK ON

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks mechanical state of TCC when PCM commands TCC solenoid off. TCC slip speed should increase.

Diagnostic Aids

Check for proper TP sensor operation. If TCC is mechanically stuck on, vehicle speed is zero, brakes are applied, and D2 is selected, TCC fluid will mechanically apply the TCC, causing an engine stall.

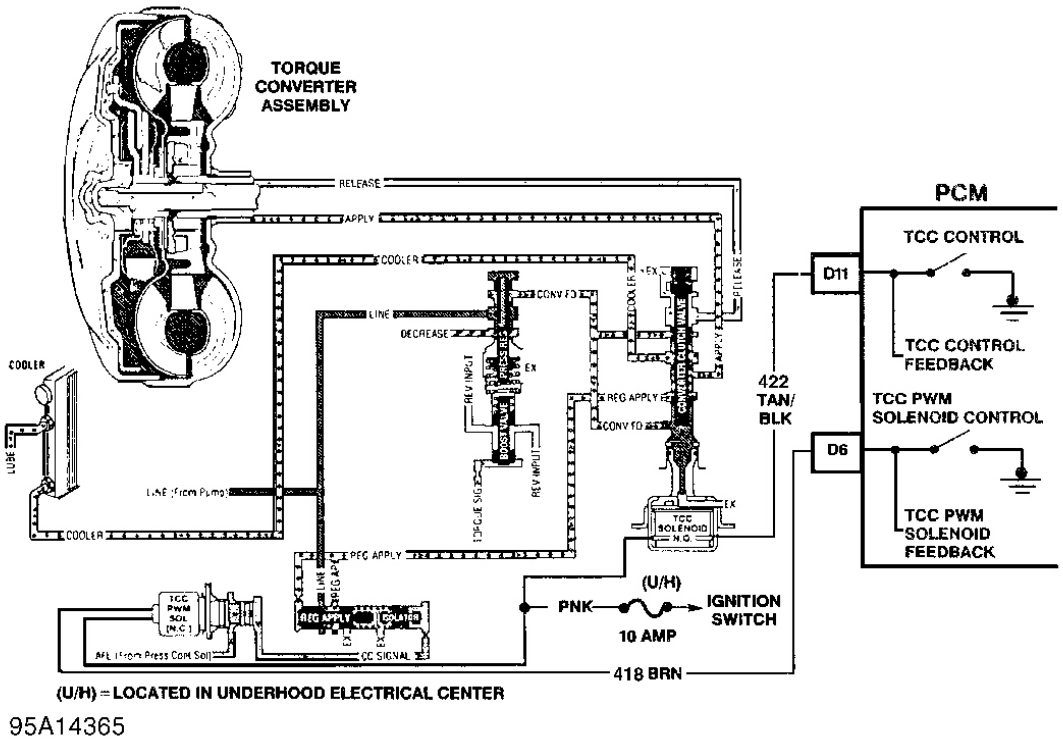


Fig. 104: Code 85 Schematic (5.7L) TCC Stuck On

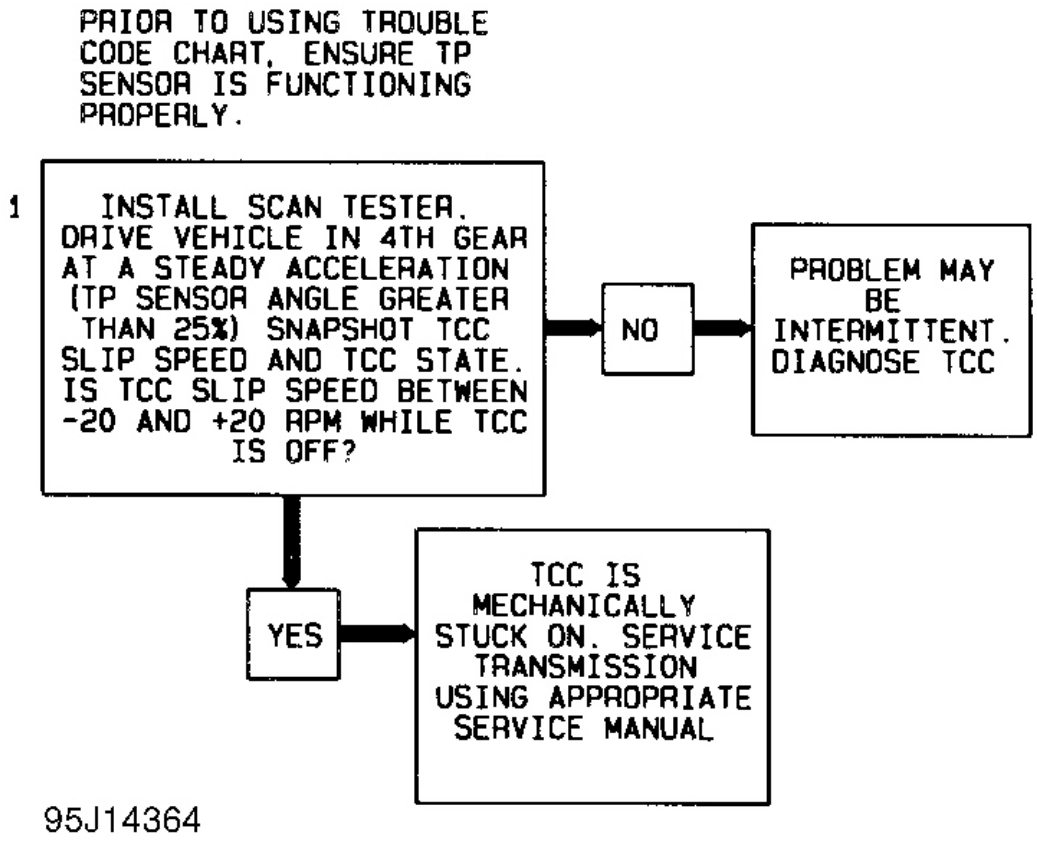


Fig. 105: Code 85 Diagnostic Flow Chart (5.7L) TCC Stuck On

CODE 90, TCC SOLENOID CIRCUIT

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks for a shorted internal transmission harness or TCC solenoid.
2. Checks power supply to TCC solenoid.

Diagnostic Aids

Check all connections to transmission pass-through connector. An open in the ignition feed circuit will cause multiple codes to set.

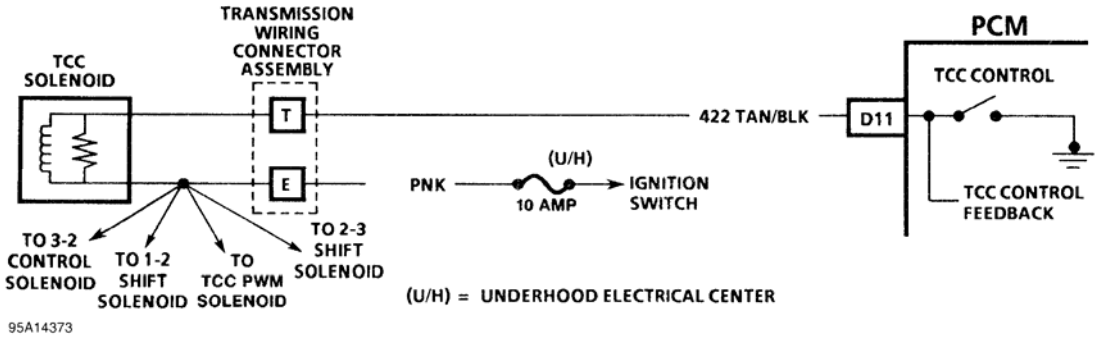


Fig. 106: Code 90 Schematic (5.7L) TCC Solenoid Circuit

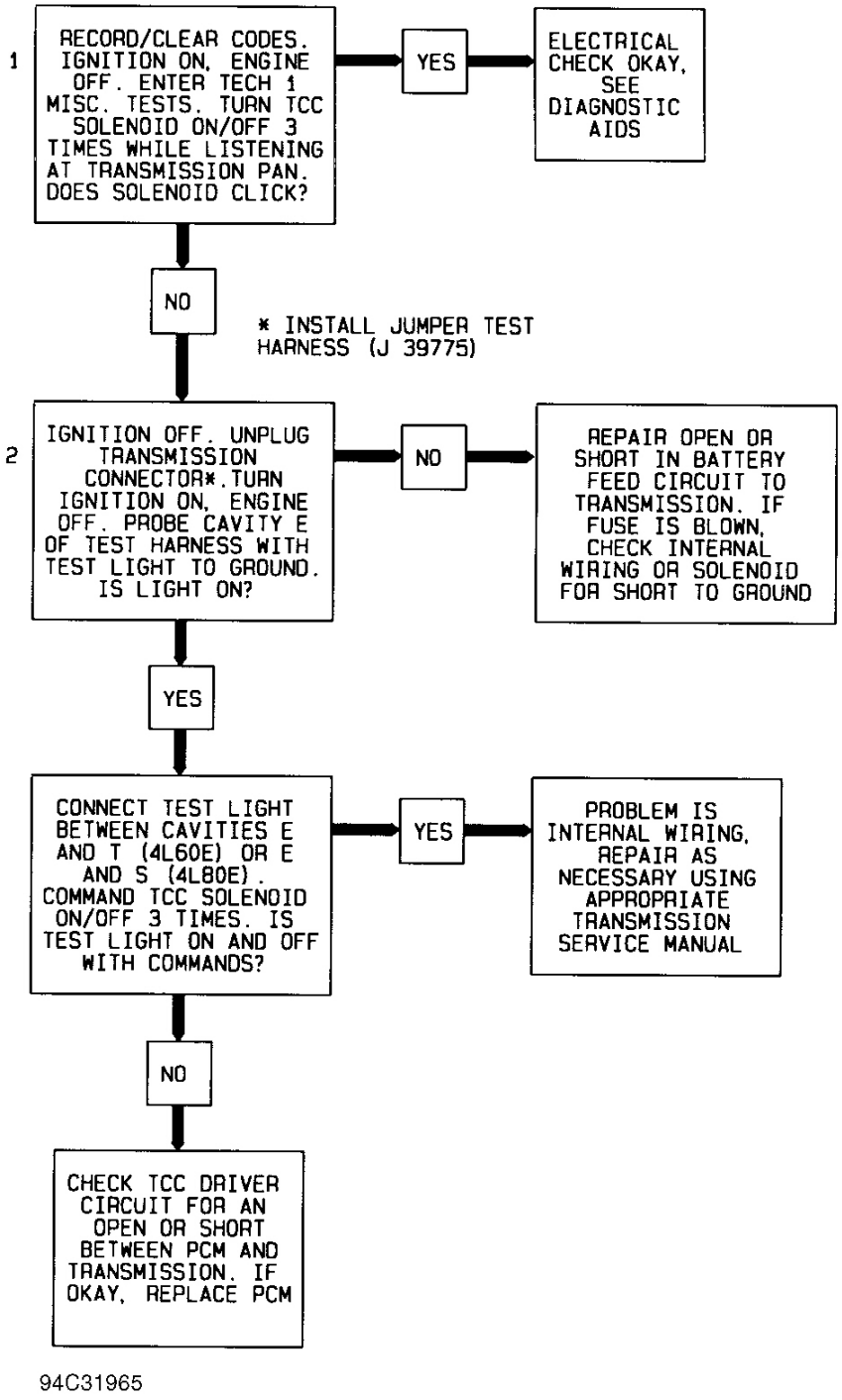


Fig. 107: Code 90 Diagnostic Flow Chart (5.7L) TCC Solenoid Circuit

CODE 95, CHANGE OIL LIGHT

PCM monitors driving conditions and determines when to turn on change oil light. Maximum possible mileage

accumulation is 7500 miles; however, PCM may turn on light sooner depending upon driving conditions (i.e. temperature and engine load history). Code will set and PCM will turn on light if wrong monitored voltage is present on light circuit for 26 seconds or more. PCM will not turn on SERVICE ENGINE SOON light.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Unplugging PCM will determine if circuit is shorted to ground or if PCM is at fault.

Diagnostic Aids

To reset oil light, turn ignition on with engine off. Cycle accelerator pedal from closed throttle to wide open throttle 3 times within 5 seconds. If light will not reset, check throttle angle. Throttle angle must go from less than 7.5 percent to greater than 75 percent for reset to occur. If this cannot be obtained, check for binding linkage, cable or throttle shaft. Service as necessary.

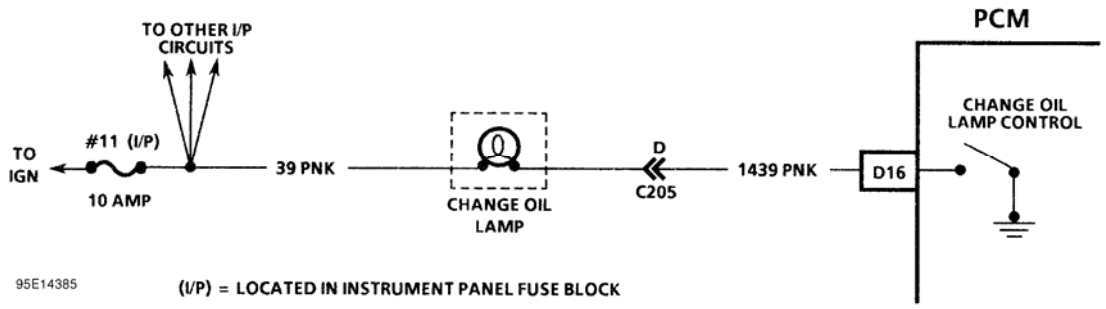


Fig. 108: Code 95 Schematic (5.7L) Change Oil Light

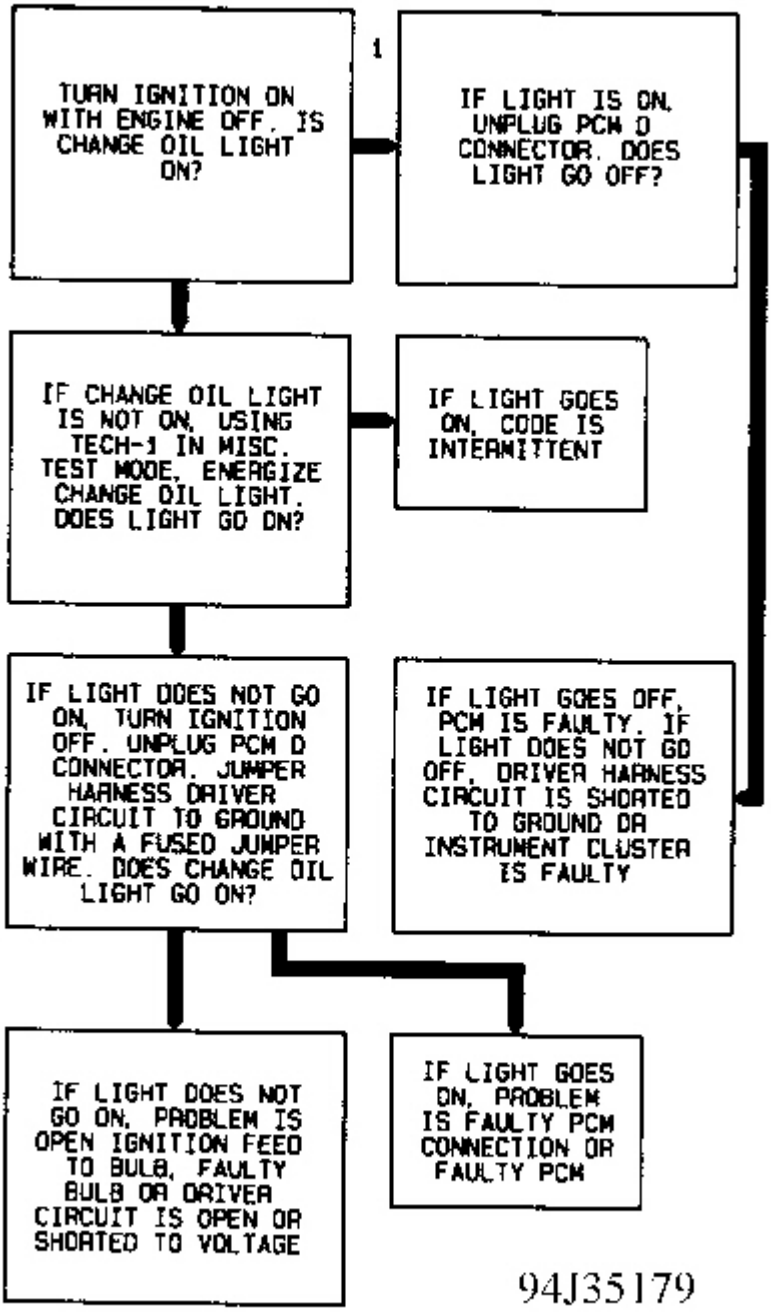


Fig. 109: Code 95 Diagnostic Flow Chart (5.7L) Change Oil Light

CODE 96, LOW OIL LIGHT

Code will set and PCM will turn on light if wrong monitored voltage is present on light circuit for 26 seconds or more. PCM will not turn on SERVICE ENGINE SOON light.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Unplugging PCM will determine if circuit is shorted to ground or if PCM is at fault.

Diagnostic Aids

Inspect harness and all related connections, including PCM connections. These may cause an intermittent code to set.

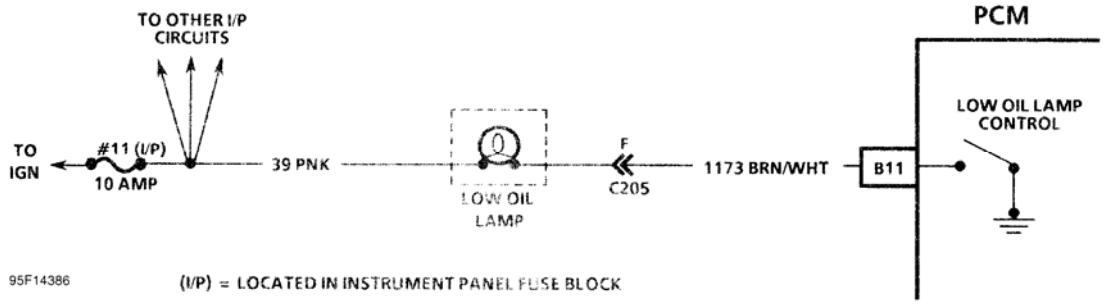


Fig. 110: Code 96 Schematic (5.7L) Low Oil Light

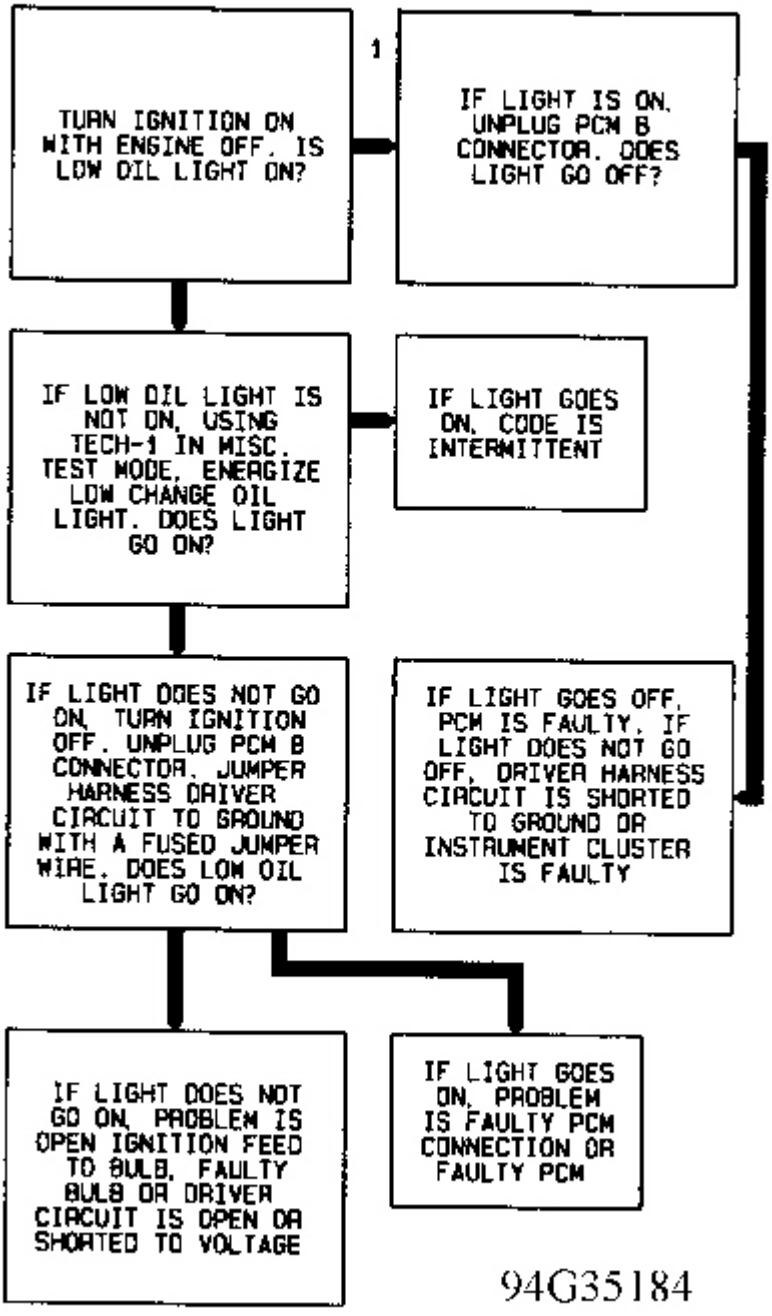


Fig. 111: Code 96 Diagnostic Flow Chart (5.7L) Low Oil Light

CODE 97, VSS OUTPUT CIRCUIT

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Disable Traction Control (TC) system (if equipped) prior to this step. Switch is located in glove box. Whenever ignition is cycled off and then on, TC system will default to on. If vehicle speed is indicated at this point, code is intermittent.
2. Use Jumper Harness (J 35616-A) to prevent damage to harness.

Diagnostic Aids

Inspect harness and all related connections, including PCM connections.

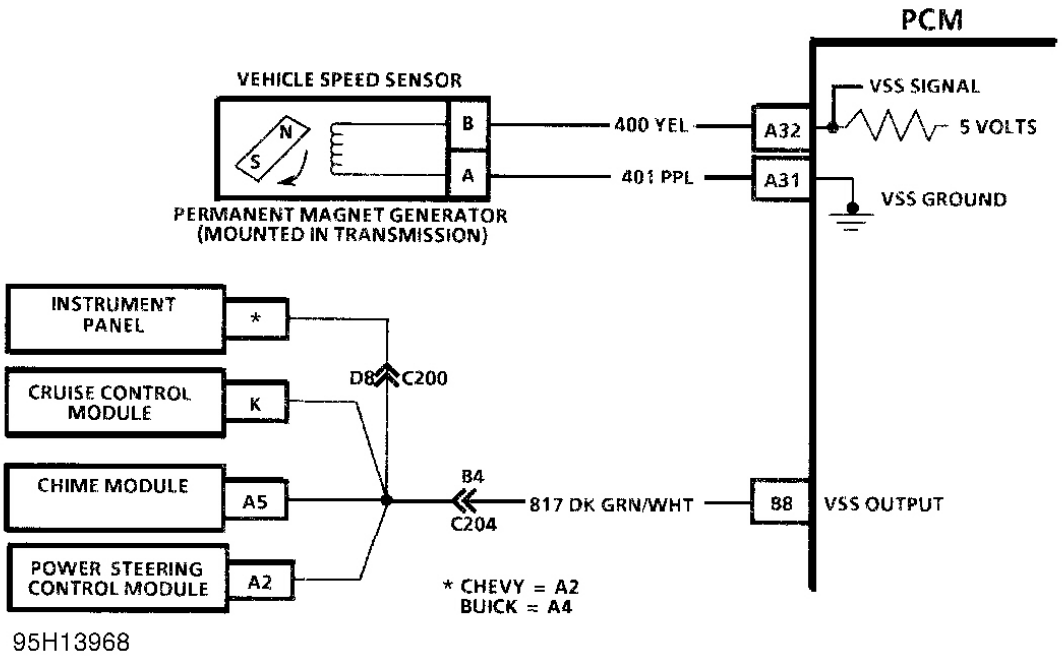


Fig. 112: Code 97 Schematic (5.7L) VSS Output Circuit

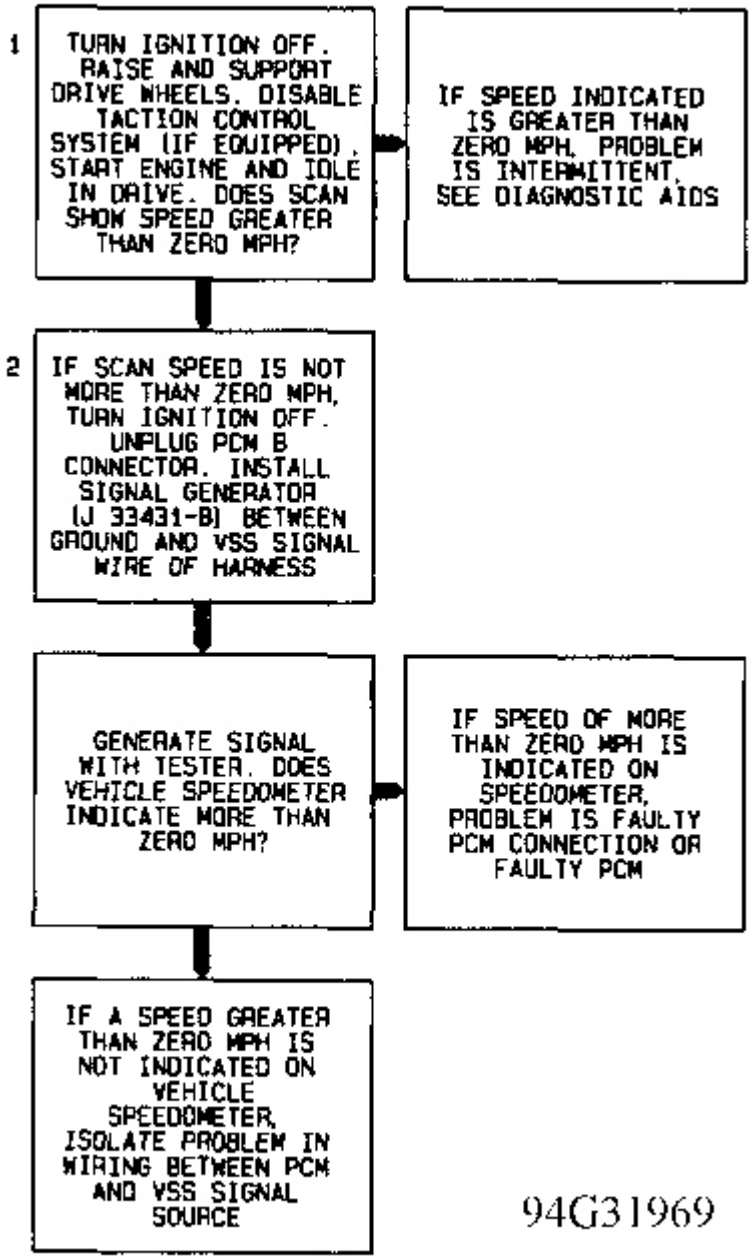


Fig. 113: Code 97 Diagnostic Flow Chart (5.7L) VSS Output Circuit

SUMMARY

If no hard fault codes are present, driveability symptoms exist or intermittent codes exist, proceed to appropriate **TESTS W/O CODES** article in this section for diagnosis by symptom (i.e., ROUGH IDLE, NO START, etc.) or intermittent diagnostic procedures.

WIRING DIAGRAMS

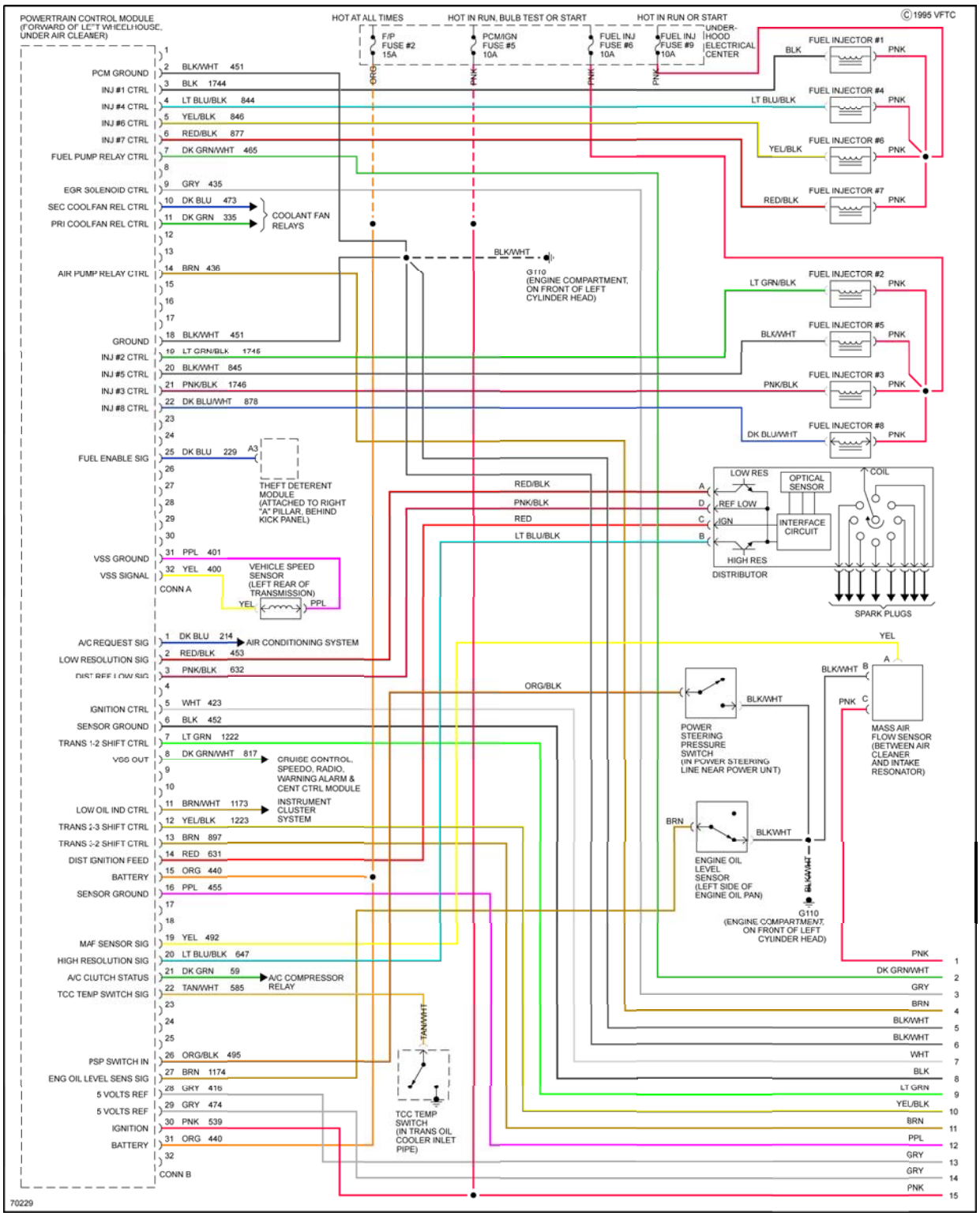


Fig. 114: 5.7L (VIN P) PCM Wiring Diagram (1 Of 3)

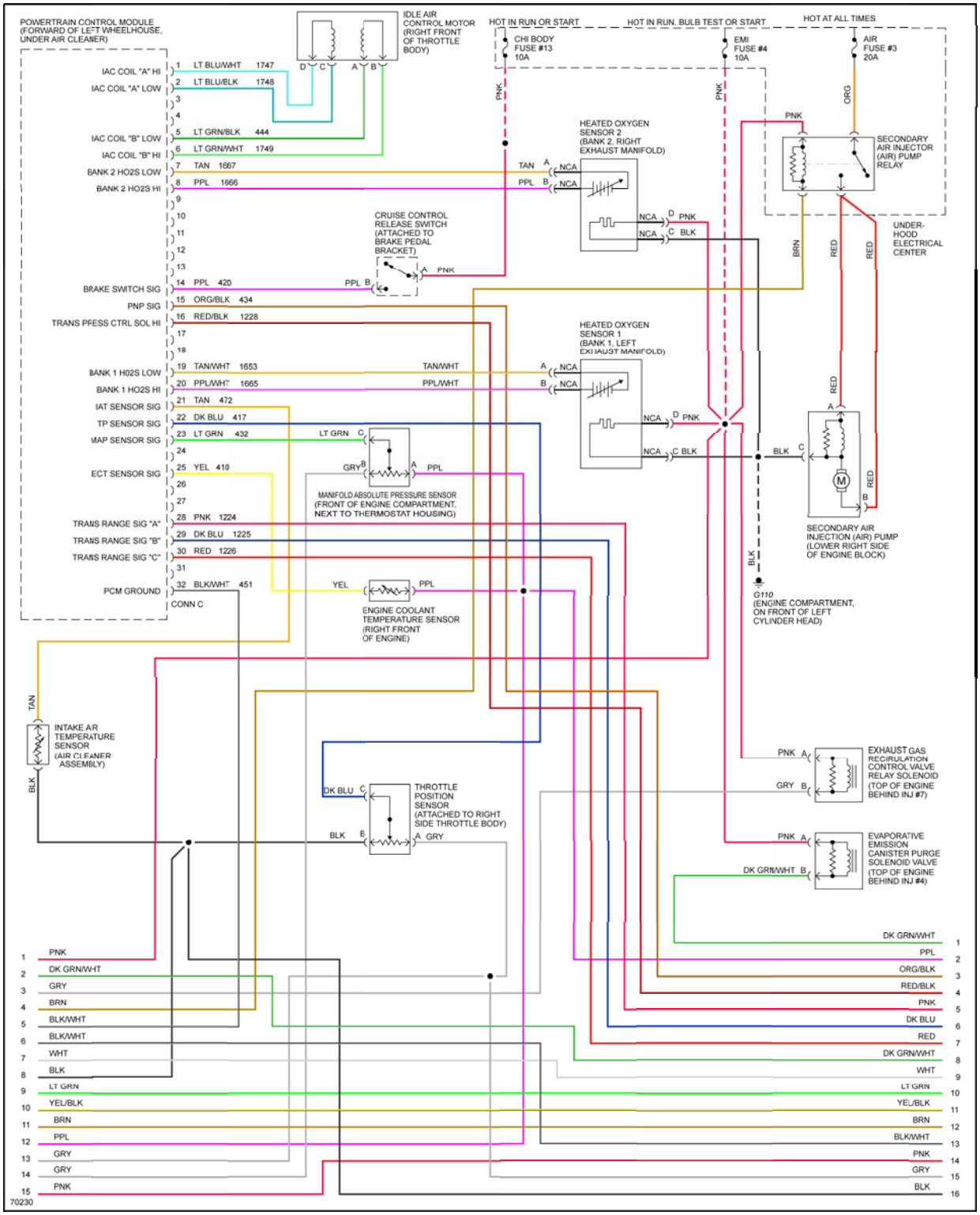


Fig. 115: 5.7L (VIN P) PCM Wiring Diagram (2 Of 3)

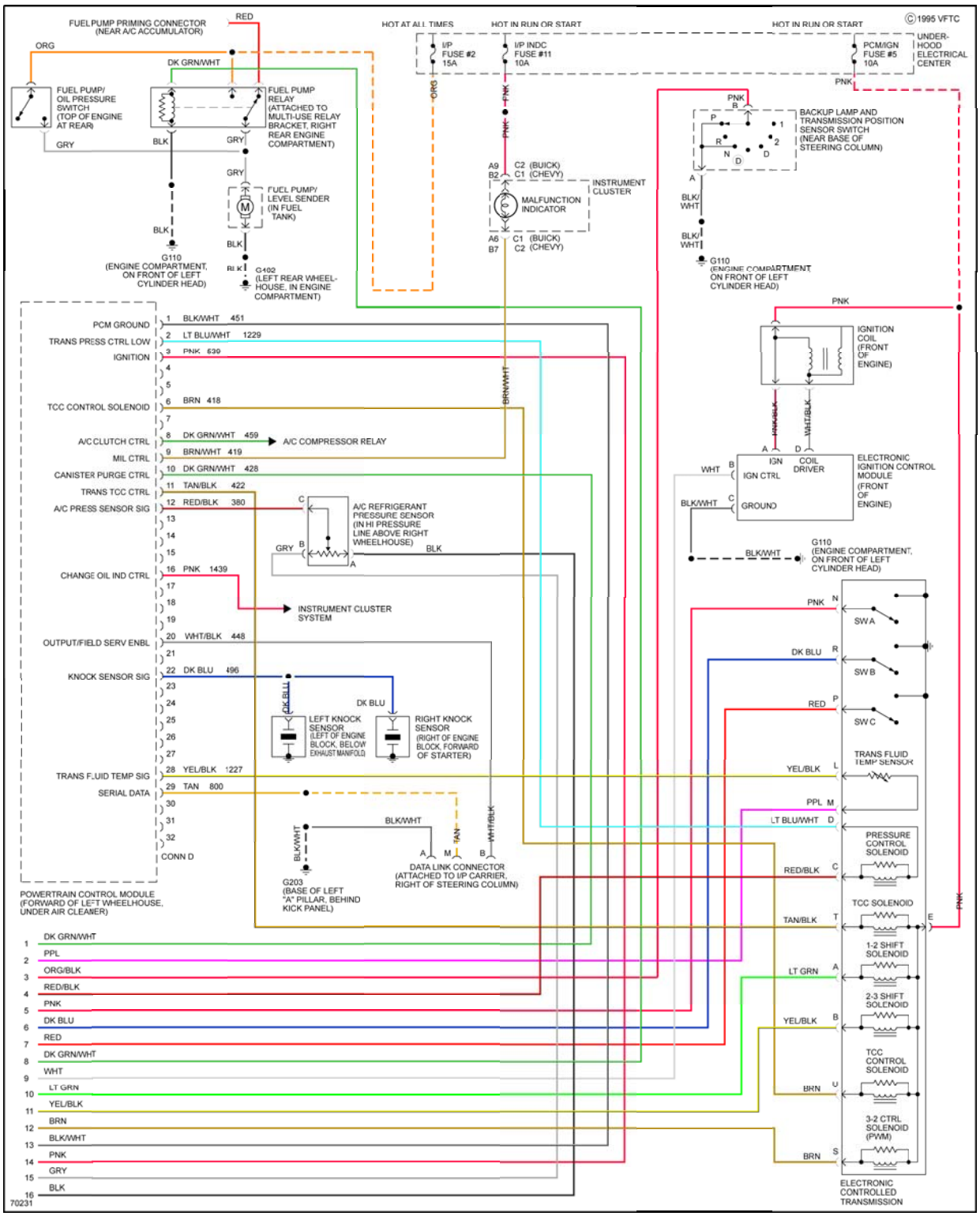


Fig. 116: 5.7L (VIN P) PCM Wiring Diagram (3 Of 3)

SERVICE INDICATOR & WARNING LIGHTS

ENGINE OIL LIFE MONITOR RESET - -96 MODELS

The CHANGE OIL warning light on the instrument panel is a reminder to change the vehicles oil. This light is controlled by the PCM on -96 models and is reset by performing the following:

1. The light must be reset each time the oil in the vehicle has been changed, whether it was on prior to the oil change or not.
2. Turn the ignition switch to the ON position, but DO NOT start engine.
3. Fully depress the accelerator pedal to wide open throttle (WOT) position and release it three (3) times within five (5) seconds.
4. If the CHANGE OIL light flashes then goes out, the system has been reset.
5. If the CHANGE OIL does not reset, turn the ignition switch to the OFF position and repeat procedure.

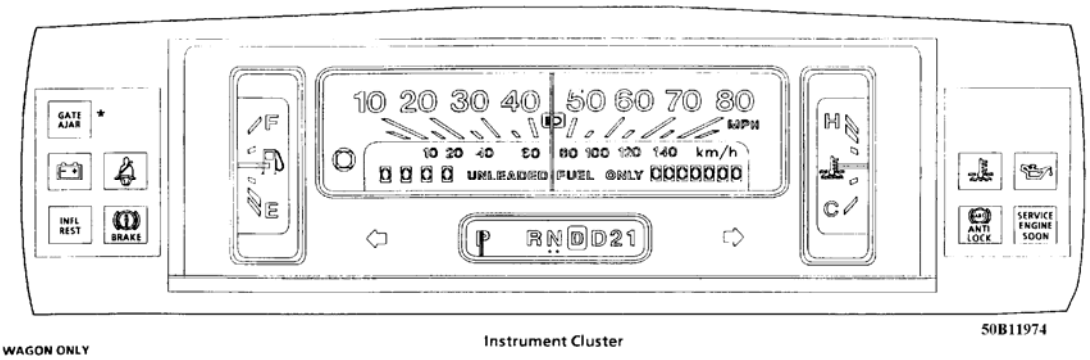
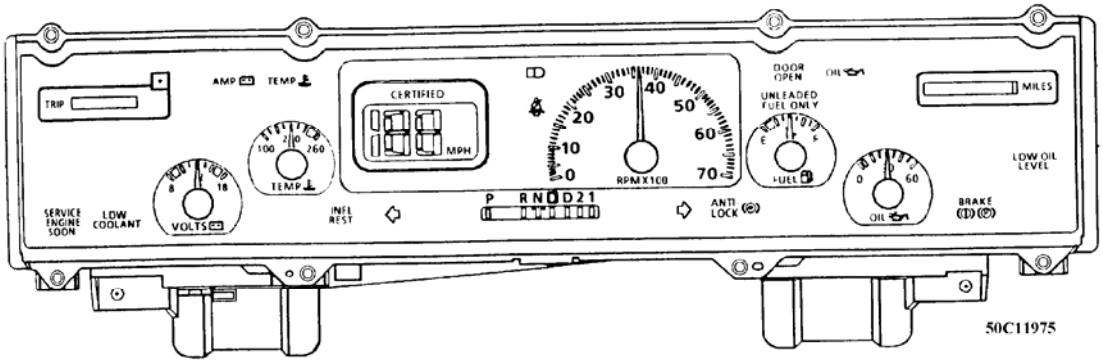


Fig. 1: Instruments & Controls (1991-93 Caprice - Analog)
Courtesy of GENERAL MOTORS CORP.



INSTRUMENT CLUSTER: DIGITAL

Fig. 2: Instruments & Controls (1991-93 Caprice - Electronic)
Courtesy of GENERAL MOTORS CORP.

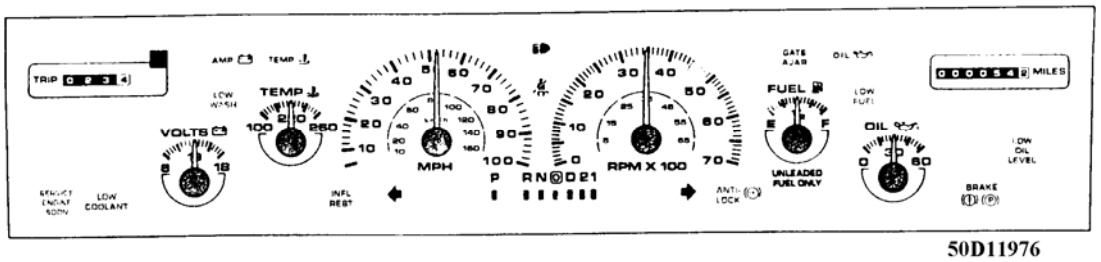


Fig. 3: Instruments & Controls (Custom Cruiser)
Courtesy of GENERAL MOTORS CORP.

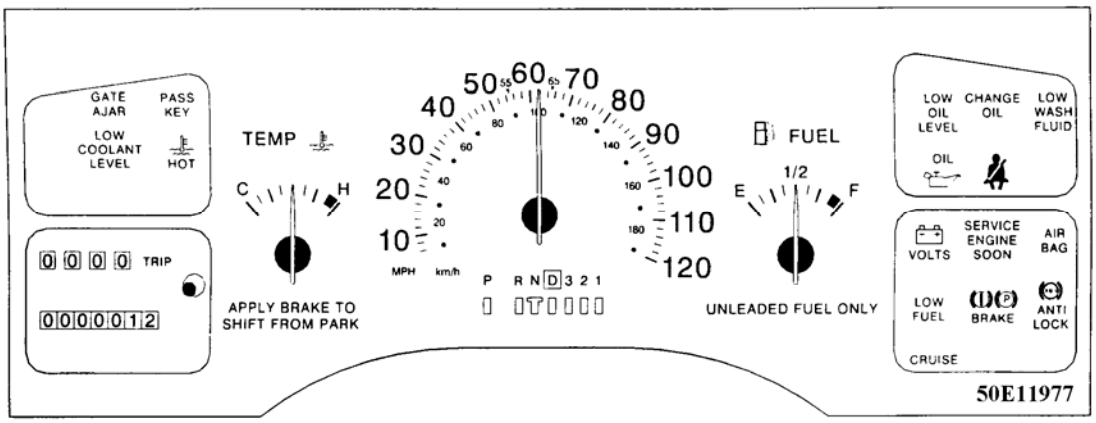


Fig. 4: Instruments & Controls (Roadmaster)
Courtesy of GENERAL MOTORS CORP.

NOTE: The CHANGE OIL light shown for the Roadmaster is only on 1994-95 models.

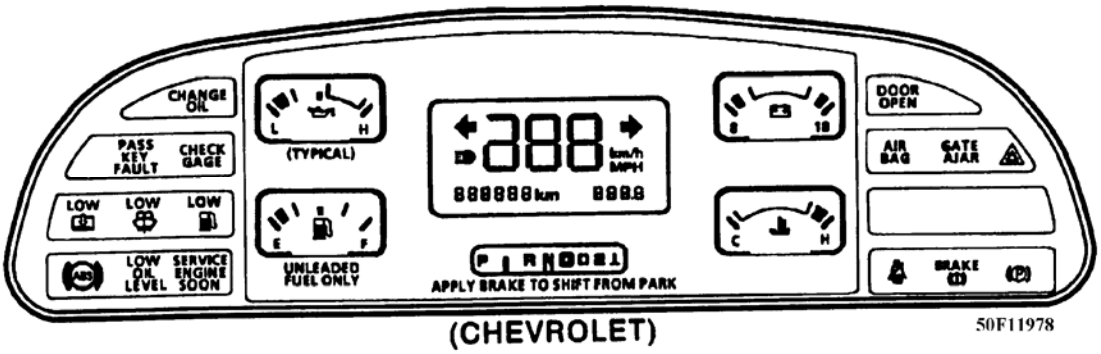


Fig. 5: Instruments & Controls (1994-95 Caprice)
Courtesy of GENERAL MOTORS CORP.

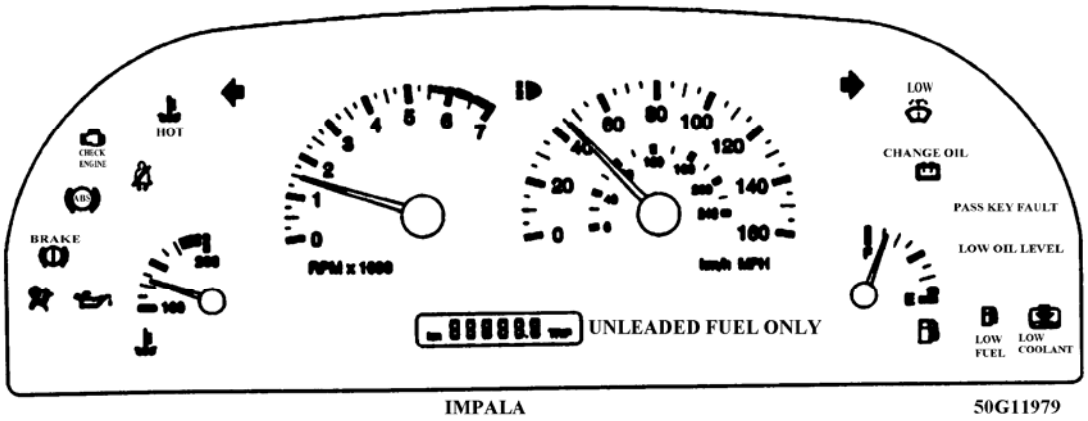
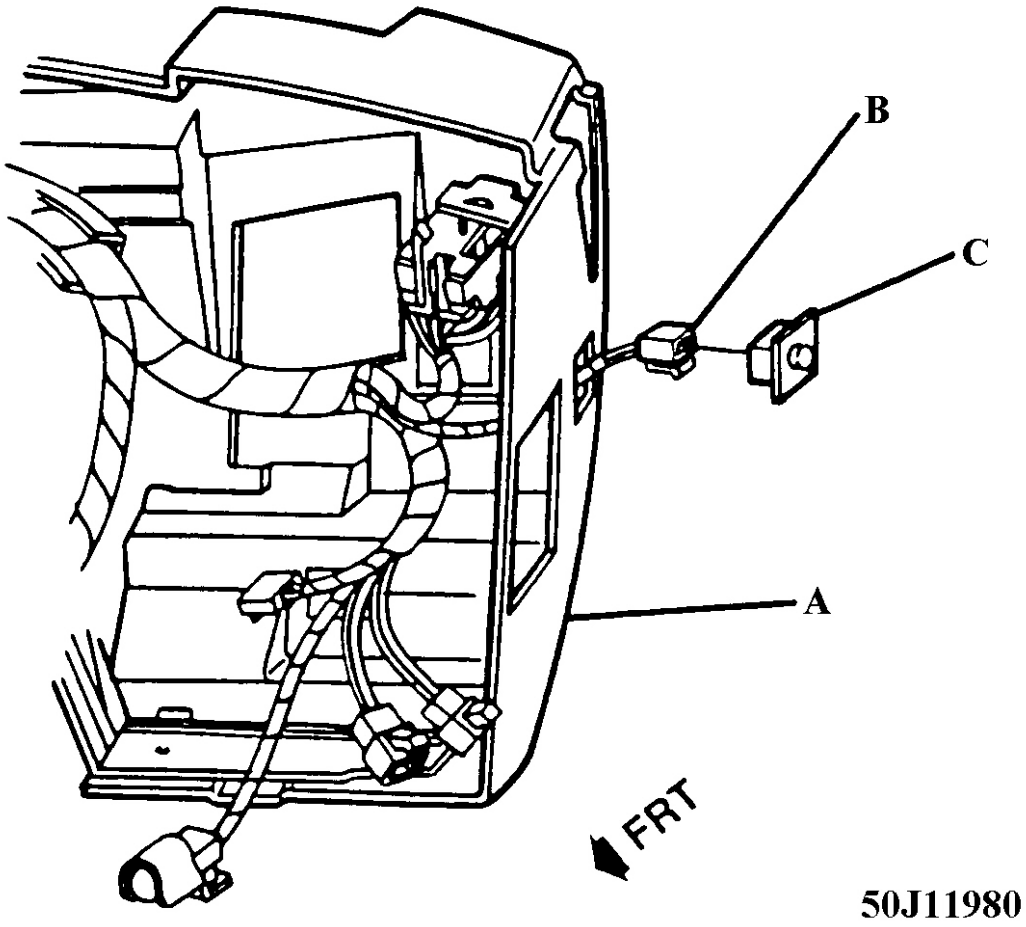


Fig. 6: Instruments & Controls (1994-95 Impala SS)
Courtesy of GENERAL MOTORS CORP.



A PANEL ASSEMBLY, INSTRUMENT
B CONNECTOR, OIL RESET
C SWITCH ASSEMBLY, ENGINE OIL CHANGE RESET

Fig. 7: Change Oil Light Reset (1994 Models Only)
Courtesy of GENERAL MOTORS CORP.

OIL PRESSURE INDICATOR

Light indicates low engine oil pressure, but does not indicate amount of oil in engine. Light should come on as a bulb check when ignition switch is in ON position, but should go out after engine is started. Have the system checked and serviced if light remains on or comes on while driving. DO NOT operate vehicle until cause is located and corrected.

ALTERNATOR (CHARGING SYSTEM) LIGHT

Light should come on when ignition switch is in ON position, but should go out after engine is started. If light remains on or comes on when engine is running, have the system checked and serviced as soon as possible.

ENGINE COOLANT TEMPERATURE LIGHT

Light is designed to come on briefly when engine is first started as a bulb check. If it remains on or comes on while driving, it indicates a potential engine overheating condition. Stop vehicle operation as soon as possible.

LOW COOLANT WARNING LIGHT (IF EQUIPPED)

Warning light is designed to come on if engine coolant level is low by 3 quarts or more. Continued operation of vehicle in this condition without adding coolant may result in engine damage due to overheating. Light will also come on briefly during engine starting as a bulb check. Check fuse and bulb if light fails to come on as described.

BRAKE WARNING LIGHT

Vehicle is equipped with dual braking system, which provides back-up braking capability should failure occurs in either half of the hydraulic system. If there is failure in either half of dual braking system, warning light will come on when brake pedal is depressed. In such case, have system checked and serviced as soon as possible. Light should come on briefly as a bulb check when engine is first started. Light will also come on with ignition switch in ON position and parking brake applied.

ANTI-LOCK BRAKE WARNING LIGHT (IF EQUIPPED)

Warning light comes on if there is a malfunction in the rear brake lock-up system. If a malfunction occurs in anti-lock brake system, conventional brake system will still operate normally but without anti-lock assistance. Light is designed to come on briefly as a bulb check with ignition switch in ON position; light should go out after engine is started. If light remains on or comes on while driving, have system checked and serviced.

SERVICE ENGINE SOON/CHECK ENGINE WARNING LIGHT

SERVICE ENGINE SOON or CHECK ENGINE warning light indicates a malfunction in engine control system. If functioning correctly, light comes on when ignition is turned on and goes out after engine is started.

If light does not come on as described or comes on with engine running, have system checked and serviced. Prolonged vehicle operation without having system serviced could affect fuel economy and driveability; emission control system may also be damaged.

SERVICE ENGINE SOON/CHECK ENGINE WARNING LIGHT

SERVICE ENGINE SOON or CHECK ENGINE warning light indicates a malfunction in engine control system. If functioning correctly, light comes on when ignition is turned on and goes out after engine is started.

If light does not come on as described or comes on with engine running, have system checked and serviced. Prolonged vehicle operation without having system serviced could affect fuel economy and driveability; emission control system may also be damaged.

ENGINE OIL LIFE MONITOR RESET - 1994 MODELS

The CHANGE OIL warning light on the instrument panel is a reminder to change the vehicles oil, and is reset by:

1. The light must be reset each time the oil in the vehicle has been changed, whether it was on prior to the oil change or not.
2. Locate Oil Change Reset Button on the left side of the instrument panel, next to the fuse panel. See **Fig. 7** .
3. Turn the ignition switch to the RUN position, but DO NOT start engine.
4. Fully depress the reset button and hold for five seconds.
5. If the CHANGE OIL light flashes then goes out, the system has been reset.
6. If the CHANGE OIL does not reset, turn the ignition switch to the OFF position and repeat procedure.

SPECIFICATIONS INDEX

CAPRICE, ROADMASTER SPECIFICATIONS INDEX

System	Specification/Procedure
Air Conditioning	
Service	
Caprice	**A/C SYSTEM SPECIFICATIONS**
Roadmaster	**A/C SYSTEM SPECIFICATIONS**
Torque	
Automatic	**TORQUE SPECIFICATIONS**
Caprice Manual	**TORQUE SPECIFICATIONS**
Roadmaster Manual	**TORQUE SPECIFICATIONS**
Axle Nut/Hub Nut	NA
Battery	**CAPACITIES**
Brakes	
Bleeding Sequence	RR, LR, RF, LF
Disc Brakes	
Service Specifications	**DISC BRAKE SPECIFICATIONS**
Torque	**TORQUE SPECIFICATIONS**
Drum Brakes	
Service Specifications	**DRUM BRAKE SPECIFICATIONS**
Torque	**TORQUE SPECIFICATIONS**
Charging	
Generator	**GENERATOR SPECIFICATIONS**
Torque	**TORQUE SPECIFICATIONS**
Drive Belts	
Adjustment	**BELT ADJUSTMENT**
Drive Belt Routing	See appropriate figure under **BELT ROUTING**
Engine Cooling	
General Service Specifications	**COOLING SYSTEM SPECIFICATIONS**
Radiator Cap Pressure	15 psi
Thermostat R & I	
4.3L	NA

5.7L	NA
Water Pump R & I	
4.3L	**WATER PUMP**
5.7L	**WATER PUMP**
Engine Mechanical	
4.3L	
Compression	**COMPRESSION**
Oil Pressure	6 psi (41.4 kPa) at 1,000 RPM 18 psi (124.1 kPa) at 2,000 RPM 24 psi (165.5 kPa) at 4,000 RPM
Overhaul	**ENGINE SPECIFICATIONS**
Torque	**TORQUE SPECIFICATIONS**
5.7L	
Compression	**COMPRESSION**
Oil pressure	6 psi (41.4 kPa) at 1,000 RPM 18 psi (124.1 kPa) at 2,000 RPM 24 psi (165.5 kPa) at 4,000 RPM
Overhaul	**ENGINE SPECIFICATIONS**
Torque	**TORQUE SPECIFICATIONS**
Fluid Specifications	See FLUIDS under MAINTENANCE/FLUIDS tab. From within Manager or Service Writer, click the "30/60/90 Interval" or "Maint." button.
Flywheel/Flex Plate/Drive Plate Torque	74 Ft. lbs. (100 N.m) Tighten bolts evenly in crisscross sequence
Fuel System	
Pressure Specification	41-47 psi (283-324 kPa)
Fuel Pressure Test Procedure	**FUEL SYSTEM PRESSURE TEST**
Fuel Filter Location	In fuel line between tank and Injector rail.
Fuel Filter R & I	**IN-LINE FUEL FILTER**
Ignition	
Firing Order & Cylinder Identification	**FIRING ORDER & TIMING MARKS**
Ignition Wires (Resistance)	30,000 Ohms Maximum
Ignition Wires (Routing)	See figure under **OPTI-SPARK DISTRIBUTOR**
Spark Plug	
Type	AC 41-906
Gap	.050 In. (1.27 mm)
Torque	20 Ft. lbs. (27 N.m)

Starting	
Starter	**STARTER SPECIFICATIONS**
Torque	**TORQUE SPECIFICATIONS**
Wheel Alignment	
Adjustment Specifications	**ALIGNMENT SPECIFICATIONS**
Torque	**TORQUE SPECIFICATIONS**
Wheel & Tire	
Wheel Lug Nut Torque	100 Ft. lbs. (136 N.m.)

STARTER

STARTING & CHARGING SYSTEMS General Motors Corp. - Starters

DESCRIPTION

The Delco-Remy starter is part of the cranking circuit, which also consists of the battery, ignition switch and related wiring. See **Fig. 1**. When the ignition switch is turned to the START position, the starter solenoid windings are energized. This causes the solenoid plunger to move the shift lever, which engages the pinion with the engine flywheel ring gear. The movement of the plunger also closes the main solenoid contacts, applying battery voltage to the starter.

When the engine starts, the pinion will overrun, protecting the armature from excessive speed and the flywheel from damage. When the ignition switch is released, the plunger return spring disengages the pinion.

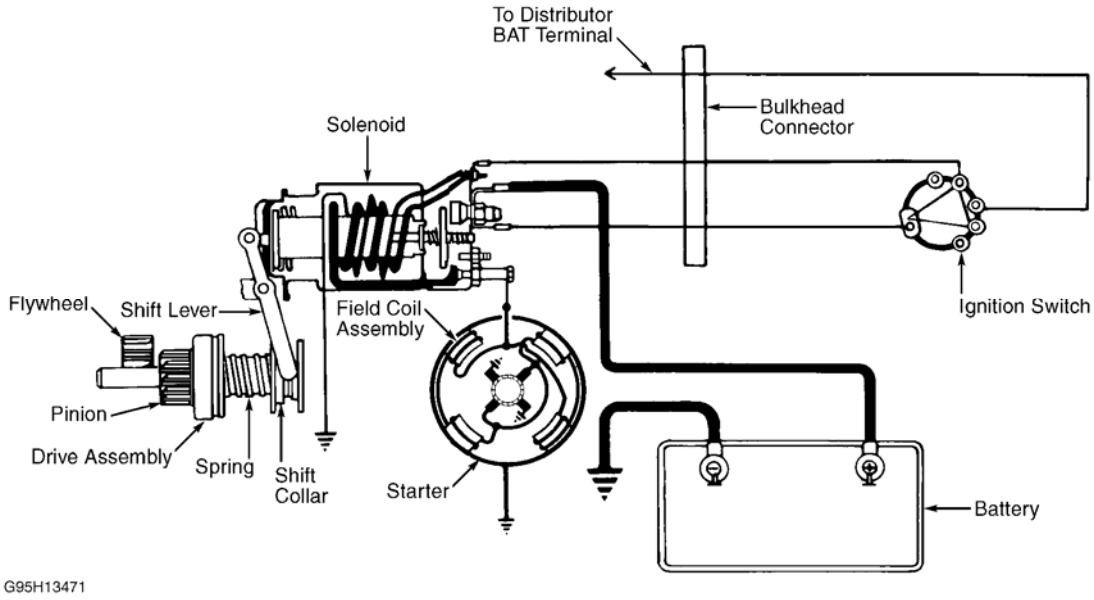


Fig. 1: Typical Cranking Circuit
Courtesy of GENERAL MOTORS CORP.

TROUBLE SHOOTING

STARTER NOISE

CAUTION: Never operate starter for periods of more than 30 seconds. Excessive cranking can cause starter to overheat. Allow starter to cool for at least 2 minutes after each time operated.

1. A high-pitched whine, heard while cranking (before engine starts), indicates excessive distance between starter pinion and flywheel. If high-pitched whine is heard after engine starts and key is released, distance

between starter pinion and flywheel is too small.

2. If loud, siren-like "whoop" sound is heard after the engine starts, drive assembly is likely defective. If "rumble", "growl" or "knock" is present as starter is coasting to a stop after starting engine, starter armature is bent or unbalanced.

NOTE: Check flywheel ring gear for damage.

3. If diagnosis indicates pinion should be closer to flywheel, ensure proper starter motor was installed. During initial starter motor installation, shim(s) are not used. If shim(s) are present, remove as necessary.
4. If diagnosis indicates pinion should be moved away from flywheel, add one shim. Consult manufacturer for required shim size. If condition is not corrected, another shim may be added. Refer to **REMOVAL & INSTALLATION**.

NOTE: For additional trouble shooting information, refer to the TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

ON-VEHICLE TESTING

CRANKING TEST

NOTE: The following tests assume that engine and battery are operating normally and that there are no engine problems that would cause a no start condition.

NOTE: Anti-Theft and PASS-Key II systems interact with cranking system through a starter enable relay or theft deterrent relay. On models with Anti-Theft system, ensure both systems and related controls are operating properly. See the ANTI-THEFT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section. On models with Anti-Theft system, an unauthorized entry will cancel starter enable operation. On all models, ensure no diagnostic trouble codes are present.

Slower Or No Crank After Extended Periods Of Vehicle Non-Use

There may be a parasitic load on electrical system. See the PARASITIC LOAD EXPLANATION & TEST PROCEDURES article in the GENERAL INFORMATION section.

Engine Does Not Crank, Starter Solenoid Does Not Click

1. Turn ignition switch to START position. Using DVOM, measure voltage between starter solenoid terminal "S" (Yellow wire) and ground. See **Fig. 2**. See WIRING DIAGRAMS. If voltage is greater than 9.5 volts, replace starter solenoid. If voltage is less than 9.5 volts and vehicle has a anti-theft system, go to next step. If voltage is less than 9.5 volts and vehicle does not have a anti-theft system, go to step 3).
2. Using DVOM, backprobe anti-theft relay 6-pin connector terminal C1 (Yellow wire next to Purple wire) to ground. Turn ignition switch to START position and measure voltage. If voltage is greater than 9.5 volts, problem exists within anti-theft system. See the ANTI-THEFT SYSTEM article in the ACCESSORIES/SAFETY EQUIPMENT section. If voltage is less than 9.5 volts, go to next step.

3. Using DVOM, backprobe ignition switch connector terminal "A" (Yellow wire) to ground. Turn ignition switch to START position and measure voltage. If voltage is greater than 9.5 volts, check ignition switch for a poor connection. If connection is okay, repair open in Yellow wire circuit between ignition switch and starter solenoid terminal "S". If voltage is less than 9.5 volts, go to next step.
4. Using DVOM, backprobe ignition switch connector terminal "D" (Red wire) to ground and measure voltage. If voltage is greater than 9.5 volts, check ignition switch for a poor connection. If connection is okay, repair open in Red wire circuit between 60-amp fuse (BODY 2), located in underhood electrical center, and ignition switch.
5. If voltage is less than 9.5 volts, check Red wire circuit between 60-amp fuse (BODY 2), located in underhood electrical center, and ignition switch for an open. If Red wire circuit is okay, check 60-amp fuse for an open. If fuse is okay, repair open in Black wire circuit between battery and starter solenoid terminal "B".

Solenoid Clicks, Engine Does Not Crank

1. Turn ignition switch to START position. Using DVOM, measure voltage between battery positive terminal and starter solenoid terminal "B" (Black wire). See **Fig. 2**. See WIRING DIAGRAM. If voltage is greater than 0.5 volt, replace battery positive cable. If voltage is less than 0.5 volt, go to next step.
2. Turn ignition switch to START position. Locate battery negative terminal ground. Using DVOM, measure voltage between battery negative terminal and battery negative terminal ground connection. If voltage is greater than 0.5 volt, replace negative battery cable. If voltage is less than 0.5 volt, replace starter solenoid.

SOLENOID WINDINGS TESTS

NOTE: To prevent overheating, DO NOT allow solenoid pull-in current to flow for more than 15 seconds.

NOTE: Current will decrease as windings heat up.

Hold-In Windings Test

1. If solenoid is not removed from starter motor assembly, disconnect field lead from terminal "M" on solenoid and insulate field lead from solenoid motor terminal. Connect an ammeter in series with 12-volt battery and starter solenoid terminal "S". See **Fig. 2**. Connect a voltmeter between solenoid terminal "S" and ground. Connect a carbon pile across battery.
2. Turn switch on and adjust carbon pile load until voltage reads 10 volts (11.5 volts on PG260). Check ammeter reading. Turn off carbon pile and open switch. If amperage reading is not between 10-20 amps, replace starter solenoid.

Pull-In Windings Test

Connect test equipment as in hold-in windings test. See HOLD-IN WINDINGS TEST above. See **Fig. 2**. Ground starter solenoid terminal "M". Turn switch on and adjust carbon pile load until voltage reads 10 volts. Check ammeter reading. Turn off carbon pile and open switch. See **PULL-IN WINDINGS SPECIFICATIONS** table. If ammeter reading is not as specified, replace starter solenoid.

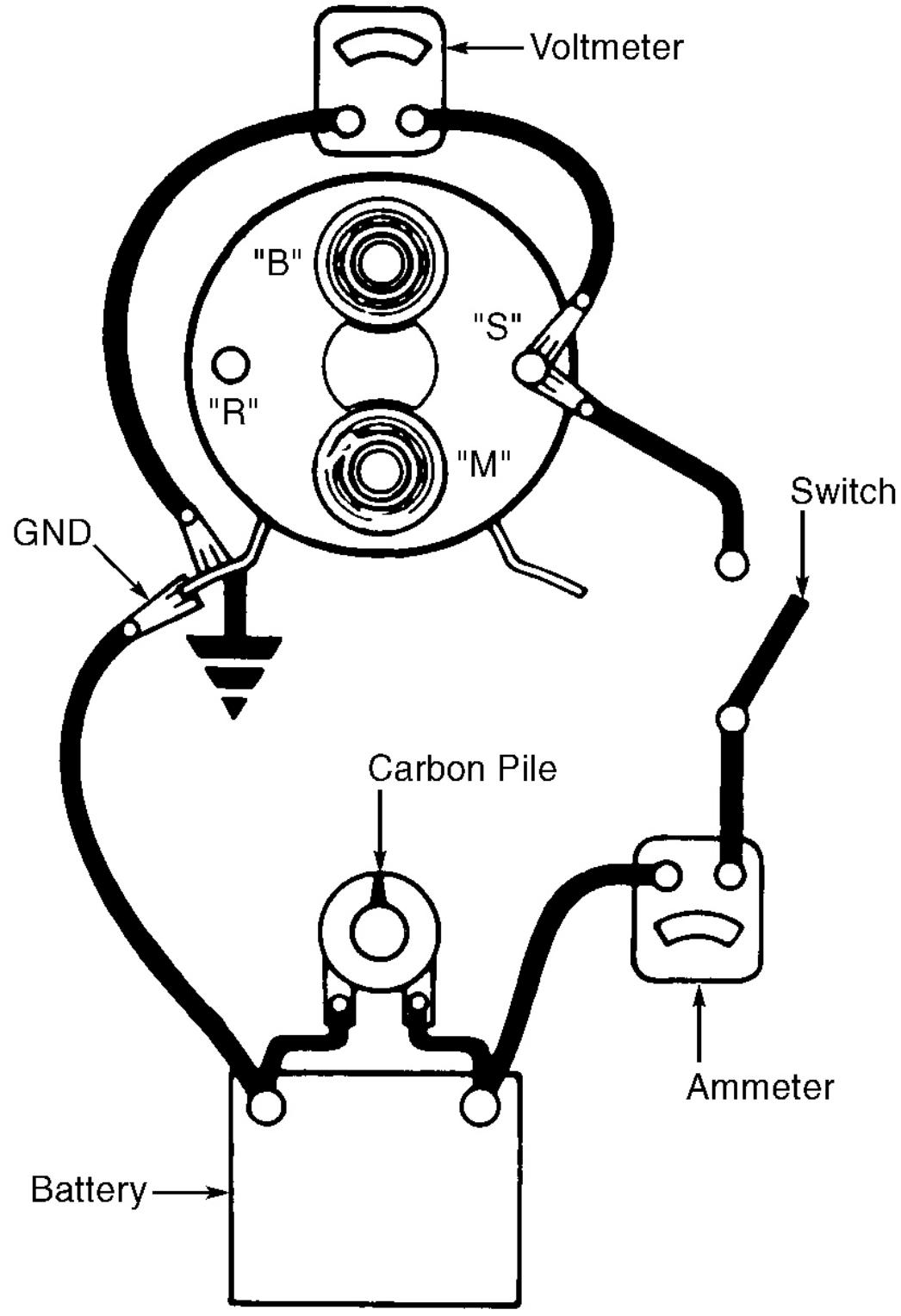

Voltmeter
"B"
"S"
"R"
"M"
Switch
GND
Carbon Pile
Ammeter
Battery
G95G13470

Fig. 2: Solenoid Winding Test Connections
Courtesy of GENERAL MOTORS CORP.

STARTER NO-LOAD TEST

1. Secure starter in vise. Turn carbon pile off and open switch. Connect test equipment to starter. See **Fig. 3**. Turn switch on and adjust carbon pile until voltage reads 10 volts. Check ammeter reading and pinion speed on RPM indicator. Turn off carbon pile and open switch. Compare RPM and amperage readings with specifications. See the **STARTER NO-LOAD TEST SPECIFICATIONS**.

CAUTION: DO NOT apply more voltage than specified. Excessive voltage may cause armature to throw windings due to excessive speed.

2. If amperage and RPM readings are as specified, starter motor is okay. If test indicates low free speed and/or high current draw, unit may have tight, dirty or worn bearings or bushings, shorted or grounded armature, or a grounded field.
3. High current draw with pinion moving into cranking position but no pinion rotation indicates a direct ground in field, or frozen bearings or bushings. No pinion movement and very low or no current draw indicates an open or ground in solenoid windings.
4. Pinion moves into cranking position but does not turn and very low current draw indicates an open in field circuit or armature windings, or no current flow between solenoid battery and motor field terminals while motor is engaged. Connect a jumper wire between solenoid battery and motor field terminal "M". If motor now turns at specified RPM, replace solenoid.
5. Low no-load and low current draw indicates high internal resistance due to poor brush lead connections; a dirty commutator; an open in armature windings; broken, worn or weak brush springs; or worn, damaged or dirty brushes. High no-load speed and high current draw indicates shorted field coils or shorted armature windings.

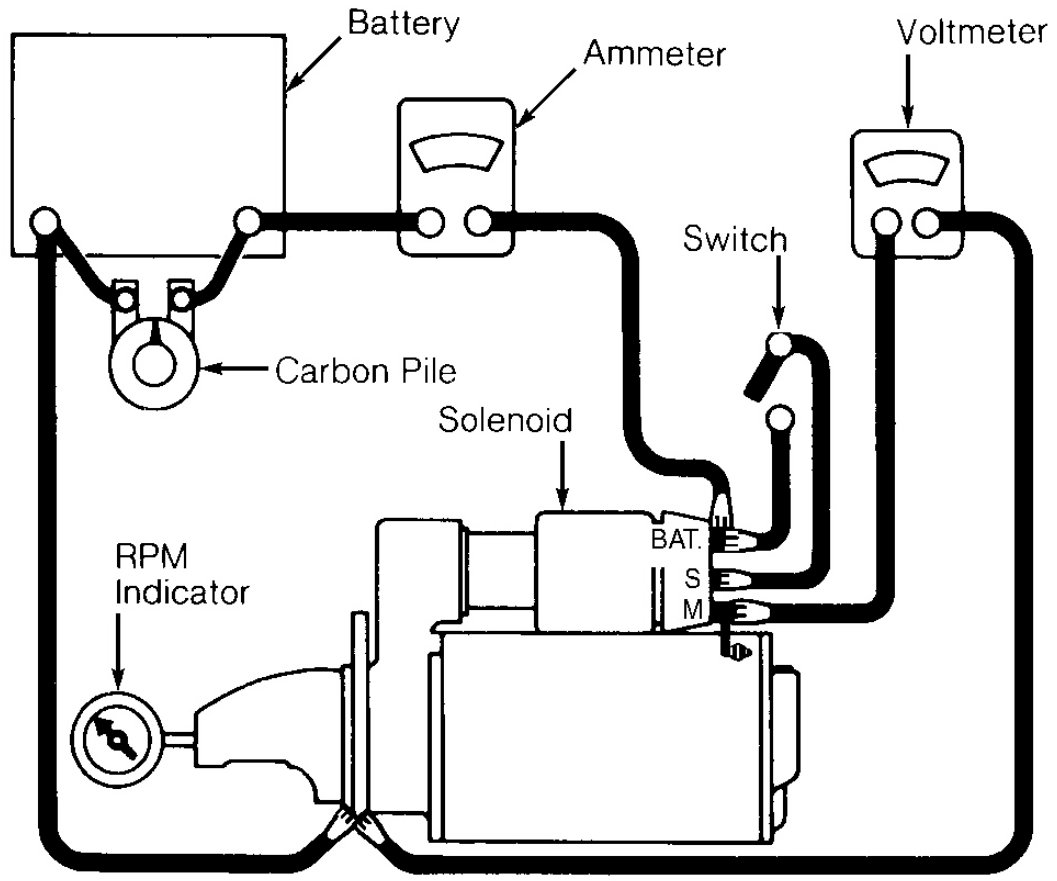


Fig. 3: Starter No-Load Test Connections
Courtesy of GENERAL MOTORS CORP.

BENCH TESTING

PRELIMINARY TESTS

Remove starter from vehicle. See STARTER under REMOVAL & INSTALLATION. Check starter for damage such as broken or stripped electrical terminals, broken or cracked drive end housing, etc. If no obvious damage is found, perform starter no-load test and pinion clearance check before disassembling starter motor.

ARMATURE TEST

1. Inspect solder joints between armature windings and commutator bars. If any have come loose, replace armature. If commutator is rough or damaged, replace armature. **DO NOT** turn commutator in lathe or undercut spaces between bars. If commutator is dirty, clean with 400 grit emery cloth and blow away any copper dust.

2. Using growler, check armature for shorts. Using self-powered test light, check for a ground between commutator bars and armature shaft. Place one lead on armature shaft and other lead on commutator. Test light should not illuminate. If test light illuminates, armature is shorted or grounded and must be replaced.
3. If no-load test indicated armature may be rubbing against inside of frame and field assembly, inspect outside of armature for signs of rubbing. If armature is scored only on one side of laminations, armature shaft may be bent and armature should be replaced. If scoring is all around armature laminations, check frame and field assembly for an out-of-position pole or for a foreign object lodged inside. Repair or replace frame and field assembly.

CAUTION: Some starters have a molded-type commutator. DO NOT undercut insulation as it may cause serious damage to commutator.

FIELD COIL OPEN TEST

Remove armature from frame and field assembly. Using self-powered test light, place one lead on field lead connection and other lead on one insulated brush. See **Fig. 4**. Test light should illuminate. If test light does not illuminate, field coil is open. Repair or replace field and frame assembly. Repeat test for each insulated brush.

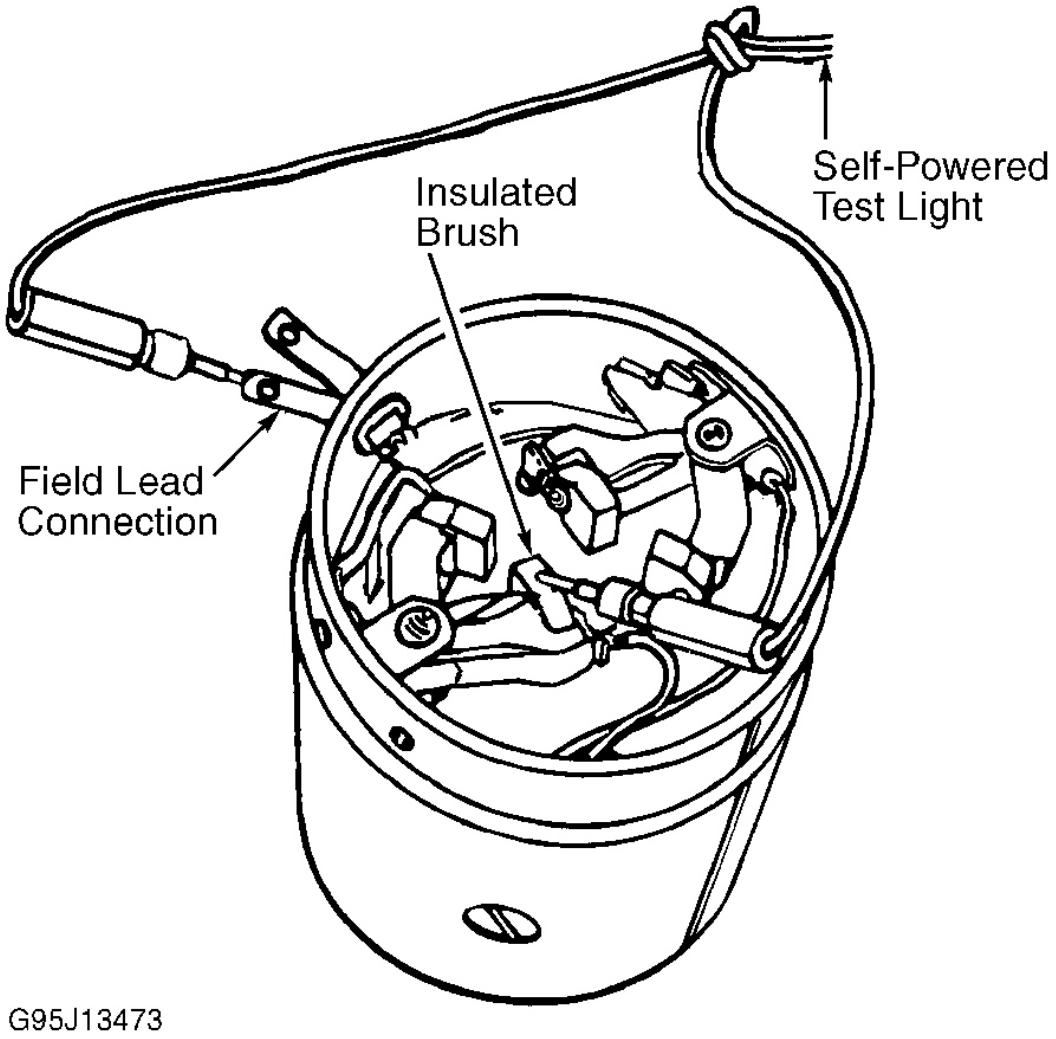


Fig. 4: Testing Field Coil For Open
Courtesy of GENERAL MOTORS CORP.

FIELD COIL GROUND TEST

Remove armature from field and frame assembly. On starters with shunt lead, separate field and shunt lead connections during test. Ensure field lead connection is NOT touching ground during test. Using self-powered test light, place one lead on grounded brush holder and other lead on one insulated brush. See **Fig. 5**. Test light should not illuminate. If test light illuminates, field coil is grounded. Repair or replace field and frame assembly. Repeat test for each insulated brush.

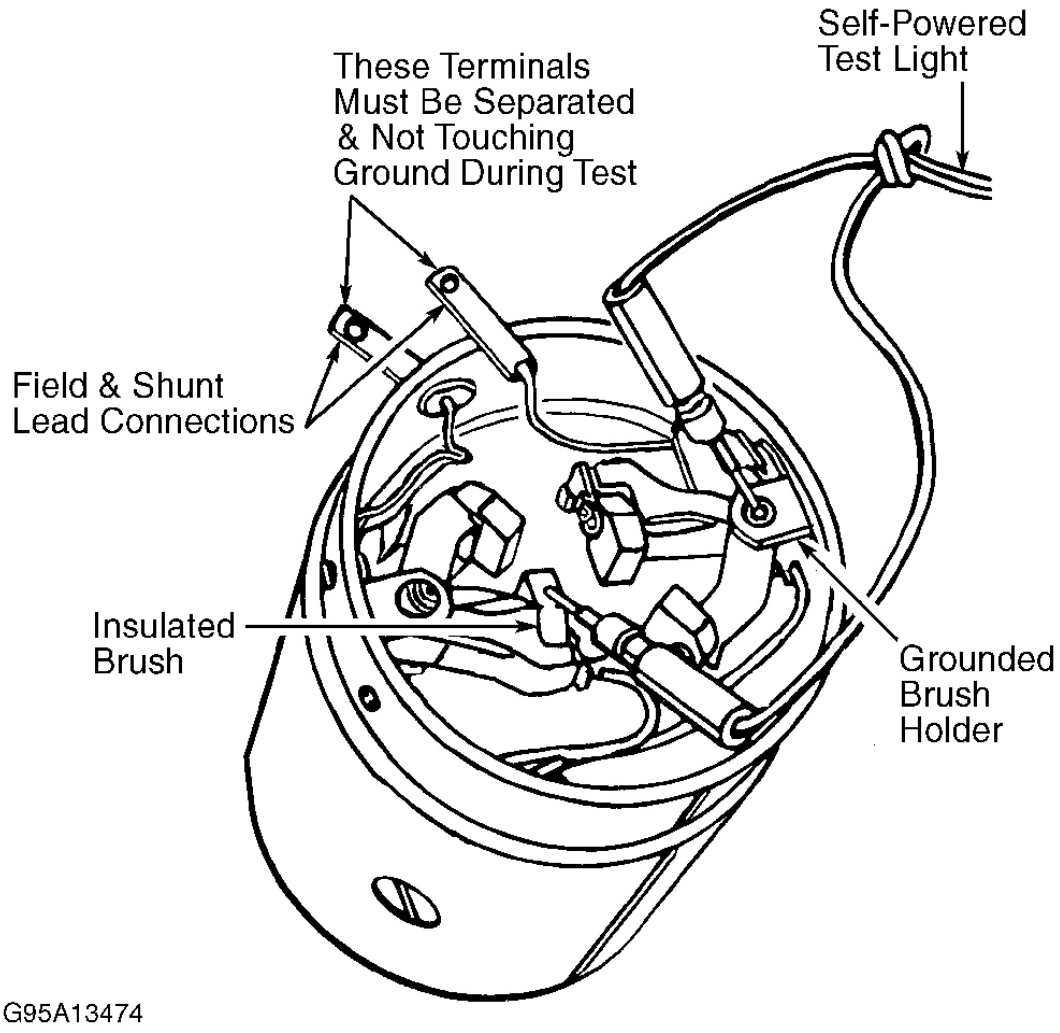


Fig. 5: Testing Field Coil For Ground
Courtesy of GENERAL MOTORS CORP.

BRUSHES, SPRINGS & HOLDERS CHECK

Replace brushes if worn to 1/2 of original length, oil-soaked or pitted. Check brush spring tension and replace springs if weak, discolored or distorted. Ensure brush holders are clean and brushes are not binding in holders. Ensure full surface of brush contacts commutator for proper performance.

DRIVE ASSEMBLY CHECK

1. Check pinion teeth for chips, cracks or excessive wear. If pinion teeth are damaged, replace drive assembly. Also check flywheel for damage. Check drive assembly for slipping before disassembly from armature. With drive assembly attached to armature, cover armature with shop towels and secure in a vise.

2. Using a 12-point socket and a torque wrench, turn pinion counterclockwise. Pinion should lock and withstand a torque of 50 ft. lbs. (68 N.m) without slipping. If pinion slips before 50 ft. lbs. (68 N.m) is reached, replace drive assembly.
3. Using a 12-point socket and a torque wrench, turn pinion clockwise. Pinion should turn freely in overrunning direction (clockwise) only. If pinion does not turn freely in clockwise direction, replace drive assembly.

PINION CLEARANCE CHECK

1. Secure starter motor in vise with opening in housing accessible for measurement. Disconnect field lead at solenoid terminal "M" and insulate from solenoid field terminal "M". Connect battery negative terminal lead to starter frame. Connect 12 volts to starter solenoid terminal "S". Momentarily touch jumper lead from starter solenoid terminal "M" to starter frame, shifting pinion into cranking position.
2. Push pinion as far as possible away from retainer. Using a feeler gauge, ensure there is .010-.160" (.25-4.06 mm) clearance between pinion and retainer. See **Fig. 6**.

NOTE: Pinion clearance is not adjustable. If clearance is not within specification, disassemble and check starter motor for worn or damaged components.

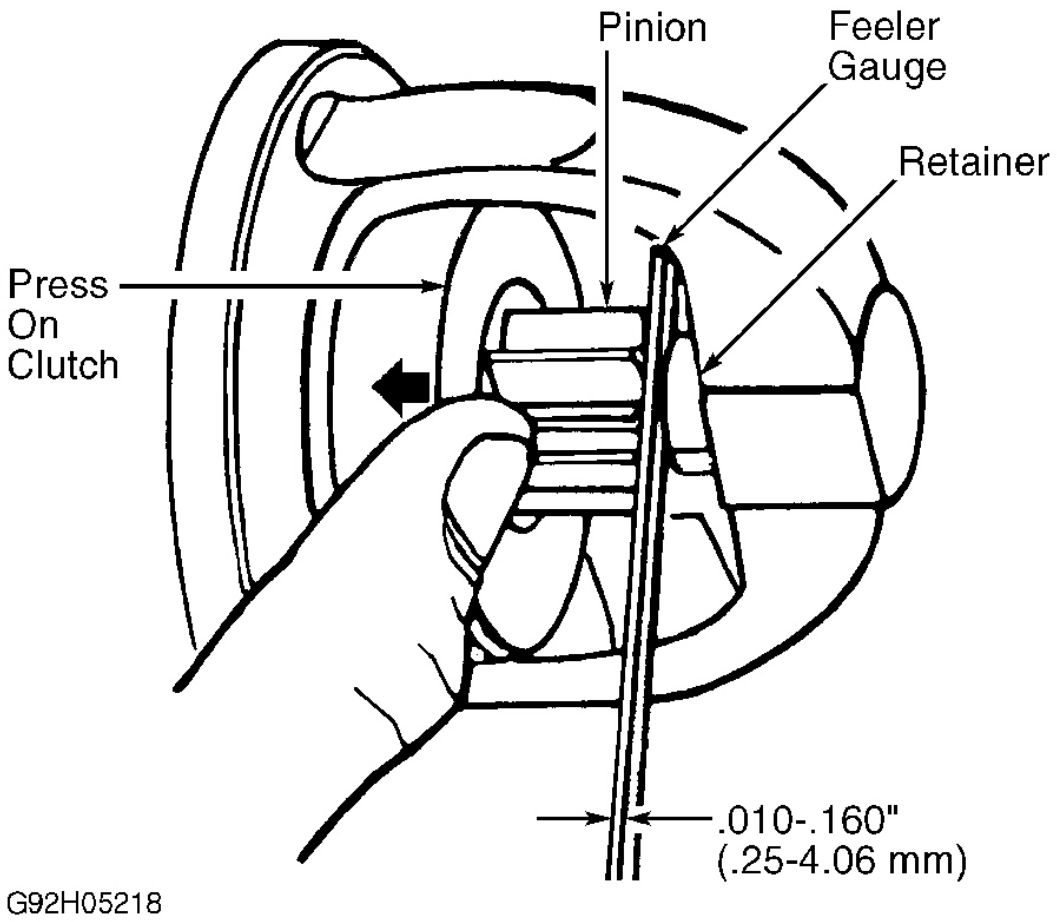


Fig. 6: Checking Pinion Clearance
Courtesy of GENERAL MOTORS CORP.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

STARTER

NOTE: Vehicles are designed for starter mounting without shims. A single shim or double shims may have been added to correct a noise or engagement condition. When installing starter any previously installed shims should be

replaced in original location to ensure proper pinion to flywheel clearance.

Removal

1. Disconnect negative battery cable. Raise and support vehicle. As required, remove nuts from A/C compressor, exhaust system and/or engine braces, adjacent to starter. On M/T models, remove bending brace from around starter (if equipped). On all models, remove other items that may interfere with removal of starter.
2. If necessary, remove nut from engine cross brace. Using pry bar between upper engine mount and engine, pry rearward and support engine.
3. If necessary, remove oil filter, air induction tube and cooling fan. Remove flywheel inspection cover (if equipped). Remove starter solenoid terminal "S" nut and battery cable nut. Separate wiring from starter. Remove starter mounting bolts and any shims. Remove starter.

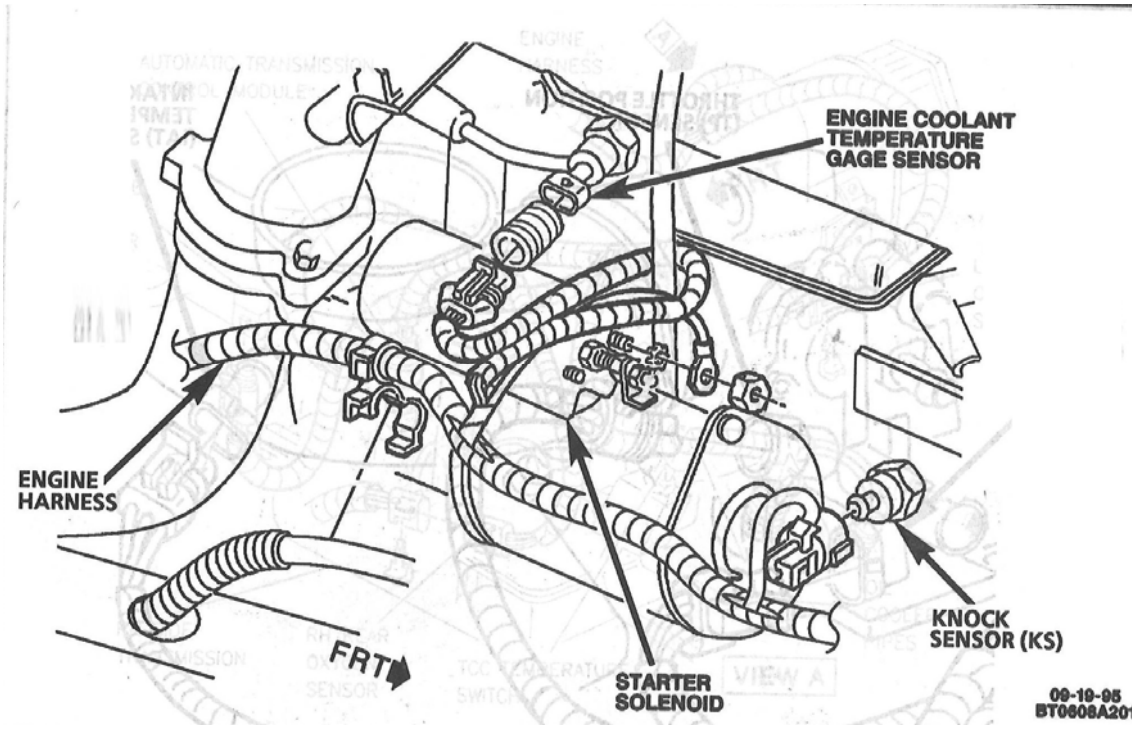


Fig. 7: Locating ECT Gauge Sensor, Knock Sensor, Starter
Courtesy of GENERAL MOTORS CORP.

Installation

Before installing starter onto engine, tighten inner solenoid terminal nuts to ensure they are secure in cap. Starter failure may occur due to terminal or cap damage. Ensure pinion-to-flywheel clearance is .020" (0.5 mm). See **Fig. 8**. Add or subtract shims as necessary. To complete installation, reverse removal procedure. Tighten mounting bolts to specification. See **TORQUE SPECIFICATIONS**.

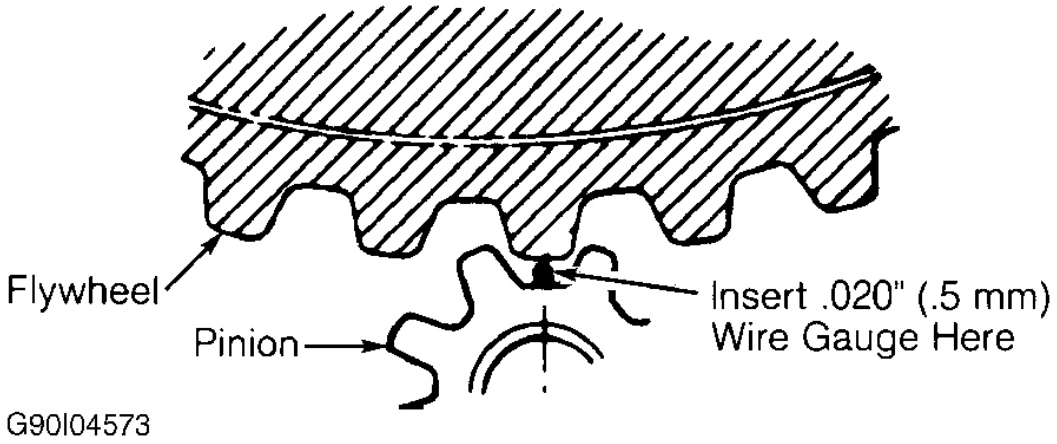


Fig. 8: Measuring Pinion-To-Flywheel Clearance
Courtesy of GENERAL MOTORS CORP.

OVERHAUL

STARTER

CAUTION: DO NOT clean starter in degreasing tank or with grease dissolving solvents. This will remove lubricant from clutch mechanism, and damage insulation on armature and field coil.

Starter motors do not require lubrication, except during overhaul. Roll-type overrunning clutch requires no lubrication. Drive assembly, however, should be wiped clean and lubricated with silicon grease on shaft, underneath overrunning clutch assembly. See **Fig. 9** and **Fig. 10** .

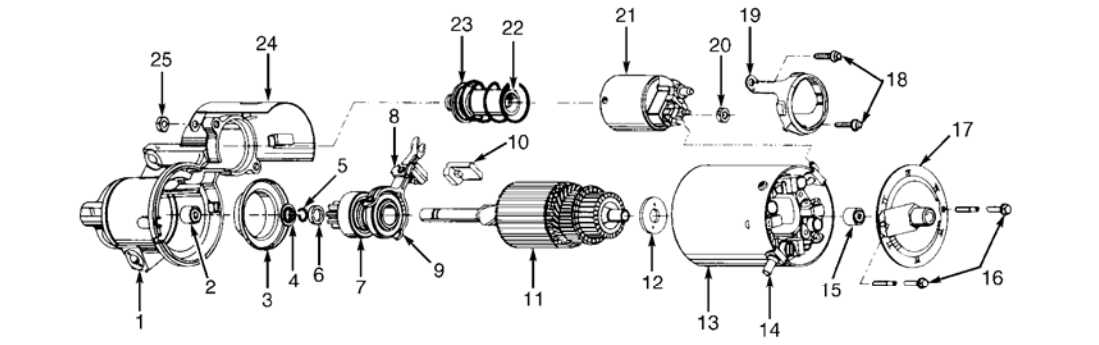


Fig. 9: Exploded View Of Delco-Remy Starter Motor (SD260)
Courtesy of GENERAL MOTORS CORP.

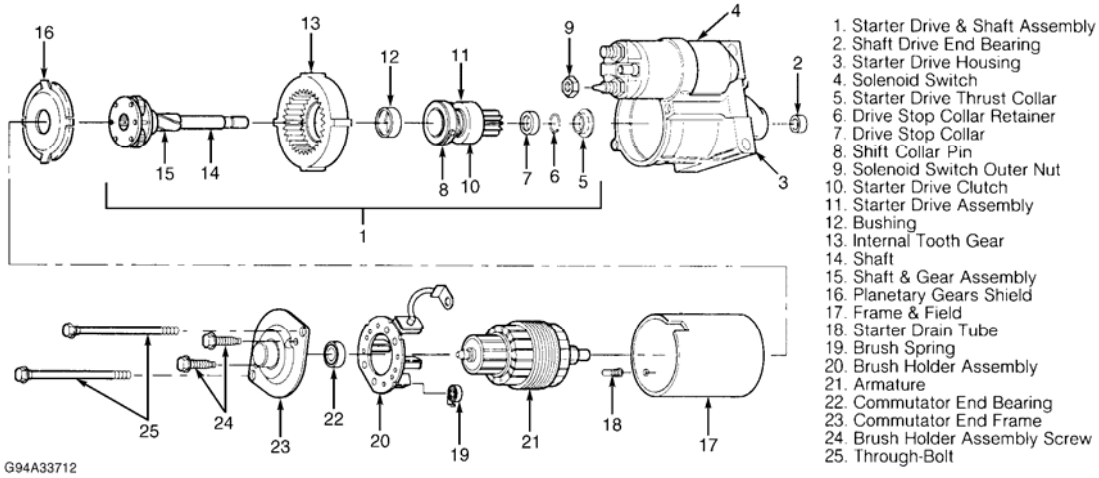


Fig. 10: Exploded View Of Delco-Remy Starter Motor (PG250)
Courtesy of GENERAL MOTORS CORP.

STARTER SPECIFICATIONS

PULL-IN WINDINGS SPECIFICATIONS

Engine	Starter Motor	Amps
4.3L	SD260	(1) 56-80
5.7L	PG250 & PG260	(1) 60-85

(1) At 10 volts.

STARTER NO-LOAD TEST SPECIFICATIONS

Application	Starter	(1) Amps	RPM
4.3L	SD260	(1) 51-71	7000-11,000
5.7L	PG250	(1) 65-90	2700-3200
5.7L (Option)	PG260	(1) 64-95	2825-3275

(1) At 10 volts.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Starter Mounting Bolts	35 (47)

WIRING DIAGRAM

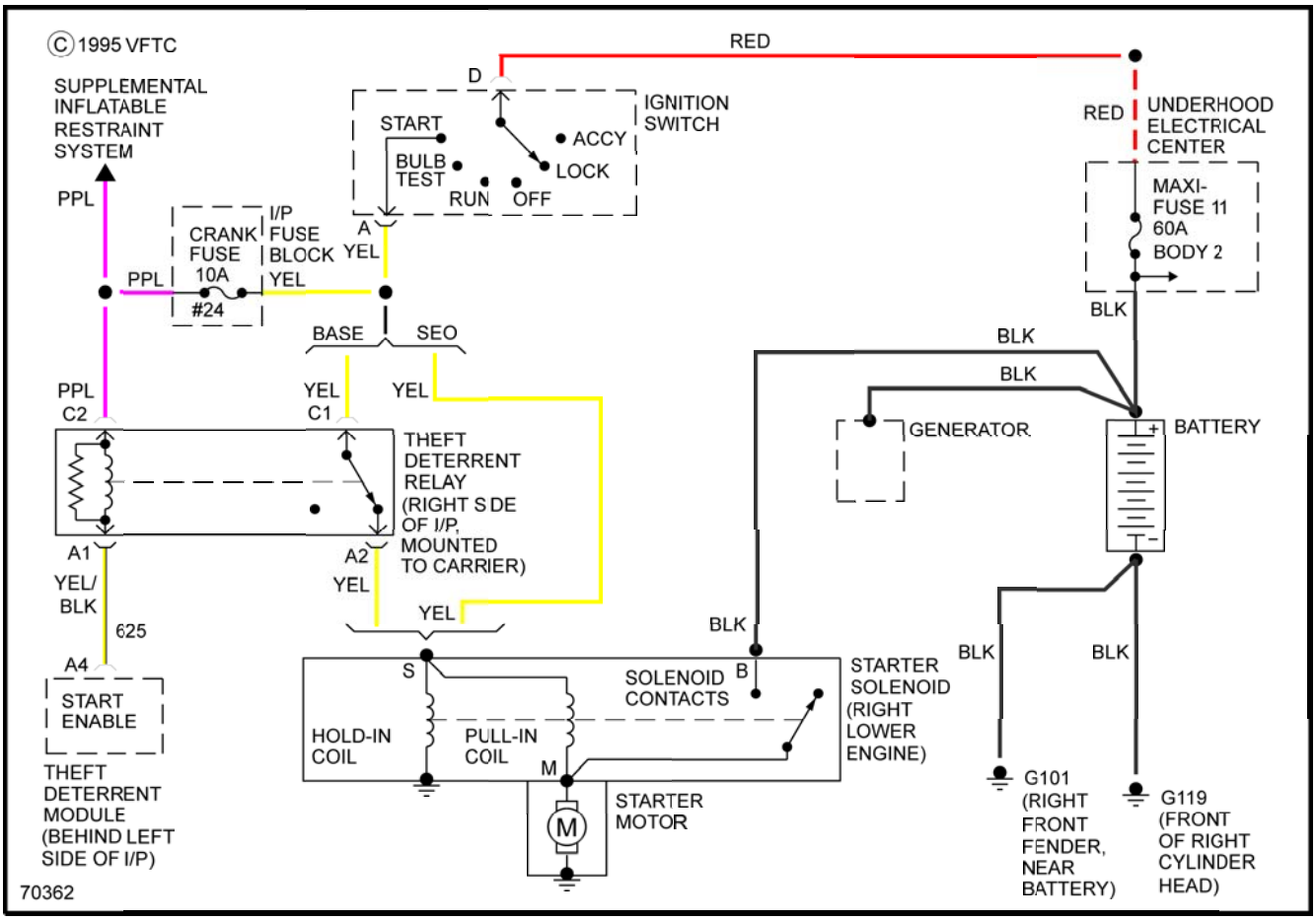


Fig. 11: Starting System Wiring Diagram

STEERING COLUMN SWITCHES

ACCESSORIES & SAFETY EQUIPMENT General Motors Corp. Steering Column Switches

DESCRIPTION

WARNING: All vehicles are equipped with air bags. To avoid injury from accidental air bag deployment, read and carefully follow all SERVICE PRECAUTIONS . Before performing any repair procedures, See DISABLING & ACTIVATING AIR BAG SYSTEM For any additional information, the AIR BAG RESTRAINT SYSTEM article.

Steering columns are designated as fixed column or tilt column, and as column shift or floor shift. Column shift and floor shift columns are basically the same except for shift lever and related components. Floor shift models with automatic transmission are equipped with a park lock cable and ignition interlock. Some column shift models are equipped with an solenoid and interlock assembly.

Multifunction switch, on left side of column, incorporates wiper/washer switch, and acts as mechanical link to dimmer and turn signal switches.

SERVICE PRECAUTIONS

The following precautions should be observed when working with air bag systems:

- Before any repairs are performed, disconnect and shield battery ground. Because system has ability to retain voltage, remove SIR or AIR BAG fuse, and disconnect Yellow SIR connector at base of steering column, and, on vehicles with passenger-side air bags, disconnect Yellow SIR connector at base of right instrument panel behind knee bolster.
- Wait 2 minutes before working on vehicle. All connectors used on SIR system use Connector Position Assurance (CPA) clips to ensure connector retention. Even if system is disconnected, always use caution when working near inflator modules.
- Use special care when handling a sensor. DO NOT strike or jar a sensor, as air bag deployment, personal injury or improper operation of SIR system could result. A sensor must be replaced if dropped 3 feet or more.
- Sensors and mounting bracket bolts must be carefully torqued to ensure correct operation. Never power up SIR system when any sensor is not rigidly attached to vehicle, since sensor is easily activated and could cause air bag deployment.
- Special care is necessary when handling and storing a live (undeployed) inflator module. Rapid gas generation, produced during deployment of air bag, could throw inflator module, or any object in front of inflator module, through air.
- When carrying a live inflator module, ensure bag and trim cover are pointed away from body. If an accidental deployment occurs, bag will then deploy with reduced chance of injury. When placing a live inflator module on a bench or other surface, always face bag and trim cover up and away from surface so space is provided to allow air bag to expand in case of deployment. In addition, never carry any SIR component by wires or connector.

DISABLING & ACTIVATING

DISABLING & ACTIVATING AIR BAG SYSTEM

To Disable

1. Before proceeding, follow air bag service precautions. See **SERVICE PRECAUTIONS** . Turn steering wheel to place vehicle wheels in straight-ahead position. Turn ignition switch to LOCK position.
2. Remove SIR or AIR BAG fuse. Remove Connector Position Assurance (CPA) clip and disconnect Yellow SIR connector at base of steering column (it may be necessary to remove left sound insulator).
3. If equipped with passenger-side air bag, disconnect Yellow SIR connector under right instrument panel or behind glove box door assembly. Some models have access to connector through a trap door in glove box. Wait 2 minutes before beginning service.

To Activate

Connect Yellow SIR connector at base of steering column, and under right side instrument panel (if equipped). Install Connector Position Assurance (CPA) clips and fuse. Turn ignition switch to RUN position and ensure AIR BAG warning light flashes 7-9 times and then goes out.

ADJUSTMENTS

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

NOTE: For exploded view of upper steering column, see Fig. 7 .

COLUMN SHIFT INDICATOR

"T" Adjuster Type

1. Position shift lever in "N" position. Move "T" adjuster on left side of steering column to allow both dots above "N" position to be filled by position indicator.
2. Move shift lever through all positions, and back to "N" position to check adjustment. Verify flag fills window for each graphic, and does not show 2 gear positions at same time. See **Fig. 1** .

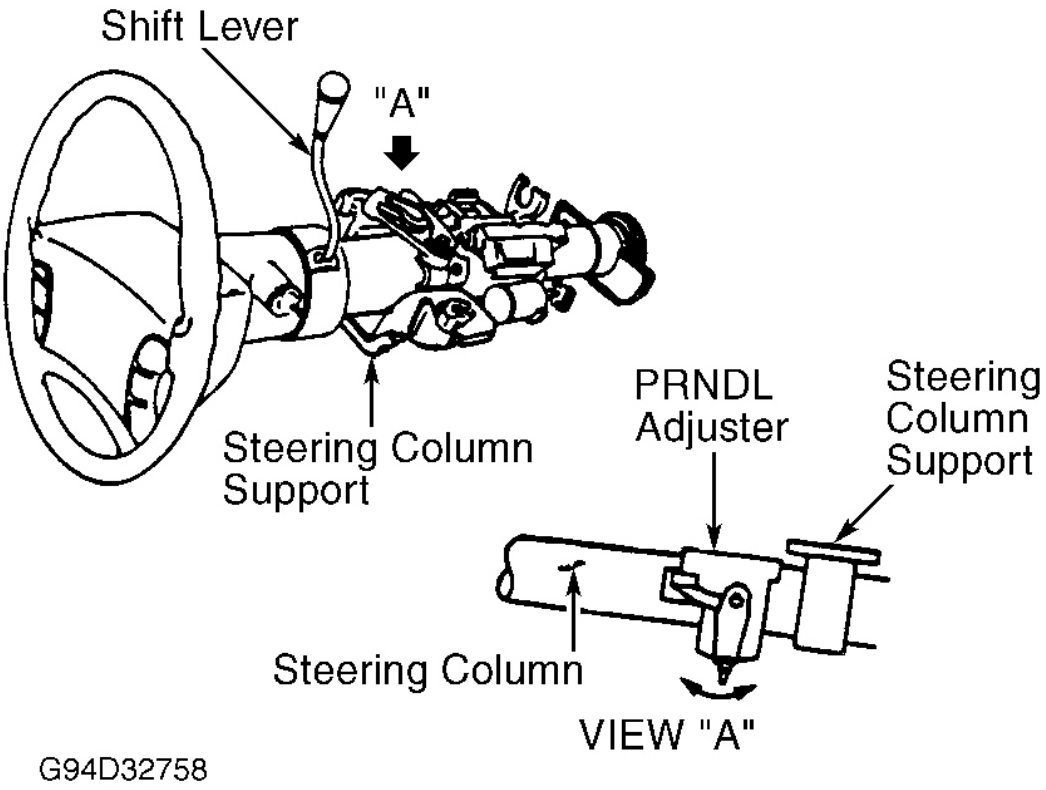


Fig. 1: Adjusting Column Shift Indicator ("T" Adjuster Type)
Courtesy of GENERAL MOTORS CORP.

Guide Clip Type

1. Position shift lever in "N" position. Position guide clip on edge of shift bowl to central position pointer on "N" position. Push clip onto bowl. Care must be taken to position cable rests on bowl and not on column jacket.
2. With gear selector in "N" position, "N" must be visible on both sides of pointer. Pointer must cover portions of "1" or be to right of "1" when transaxle is in "LOW" position. See **Fig. 2** .

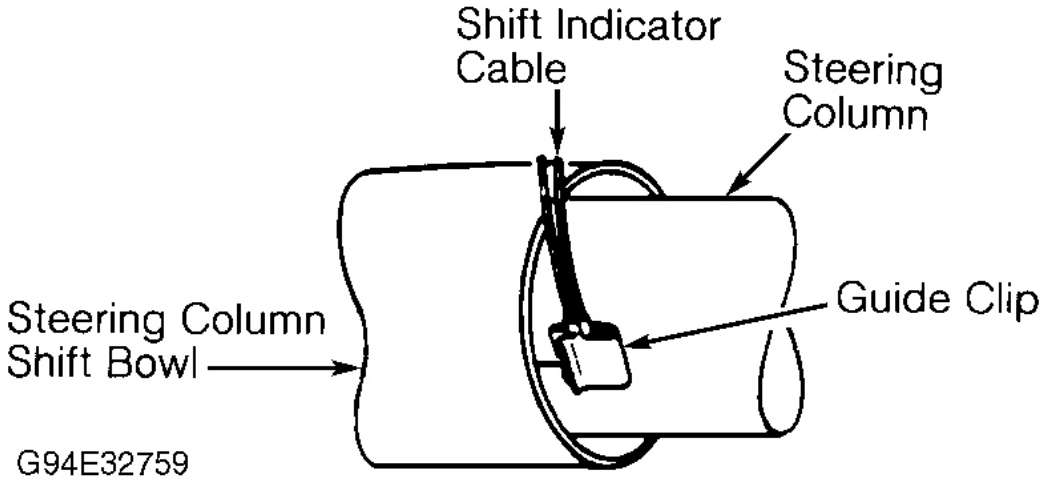


Fig. 2: Adjusting Column Shift Indicator (Guide Clip Type)
Courtesy of GENERAL MOTORS CORP.

DIMMER SWITCH ADJUSTMENT

1. With switch removed from column bracket, insert a 3/32" drill bit into adjusting pin hole to limit switch travel. See **Fig. 3** . Insert actuator rod into switch. Install switch to column bracket and finger-tighten screws.
2. Lightly push switch upward against actuator rod until no lash (free-play) exists between rod and switch. Tighten mounting screws to 35 INCH lbs. (4 N.m). Remove drill bit. Ensure proper switch operation using dimmer/headlight switch handle.

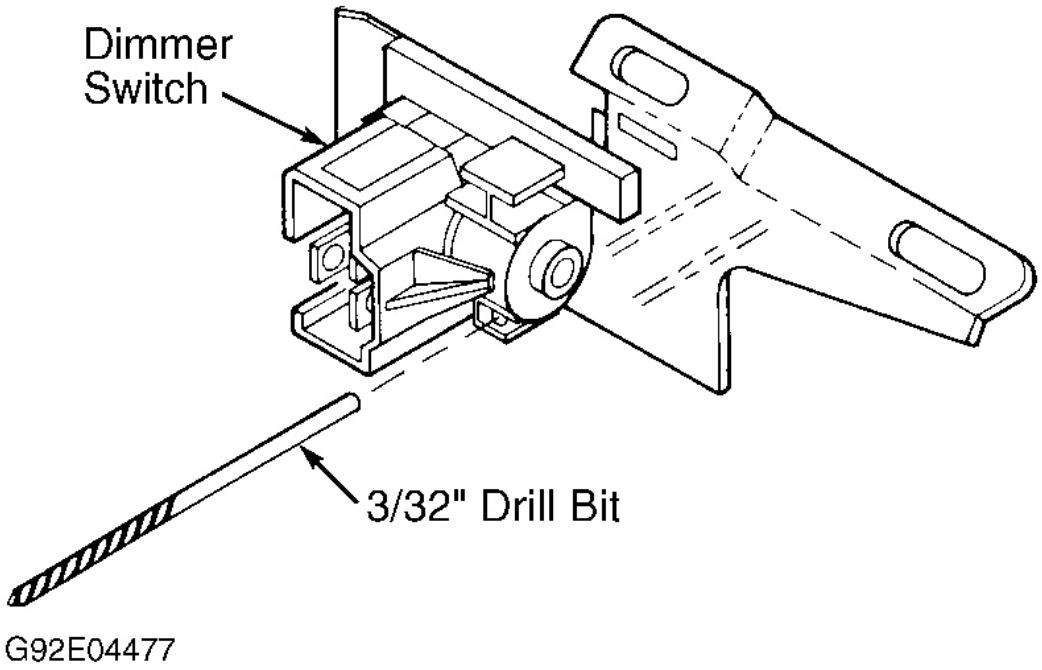


Fig. 3: Adjusting Dimmer Switch
Courtesy of GENERAL MOTORS CORP.

HORN

Current draw for horns while operating is 4.5-5.5 amps at 11.5-12.5 volts. High current (more that 20 amps) indicates an overheated winding or shorted horn. If horn overheated because of winding or shorted, replace horn. Current reading of 18 amps indicates contact points are not opening. Adjust horn current.

No current reading indicates a broken connection, or an open circuit due to a broken lead or overheated horn. An overheated horn must be replaced. No current reading indicates contact points are open. Adjust horn.

To adjust horn (adjusting screw is located at rear of horn assembly):

- Current adjustments should be made 1/4 turn (90°) increments.
- Turn adjusting screw clockwise to increase current.
- Turn adjusting screw counterclockwise to decrease current.

IGNITION SWITCH ADJUSTMENT

CAUTION: New ignition switch is pinned in the OFF-LOCK position. Plastic pin must be removed before operating switch.

1. Set key lock cylinder in OFF-LOCK position. On fixed column, set ignition switch slider (where actuator rod connects to switch) to the OFF-LOCK position by moving slider to left as far as possible and then one detent to right. See **Fig. 4** .
2. On tilt column, set ignition switch slider (where actuator rod connects to switch) to OFF-LOCK position by moving slider to right as far as possible, and then one detent to left. See **Fig. 4** .
3. On all columns, install switch. Tighten switch screws to 35 INCH lbs. (4 N.m). Ensure ignition switch functions properly with lock cylinder in all positions.

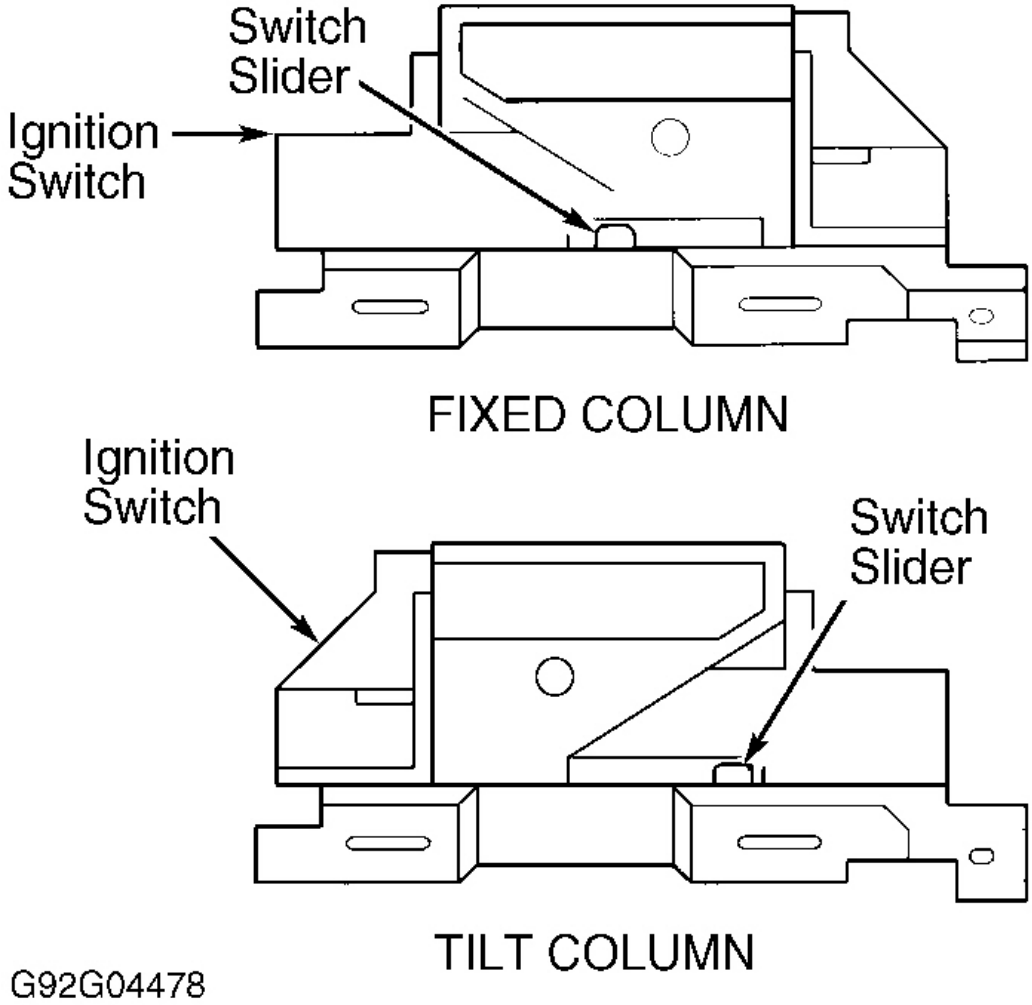


Fig. 4: Adjusting Ignition Switch
Courtesy of GENERAL MOTORS CORP.

PARK LOCK CABLE

NOTE: Lock cylinder MUST be in RUN position when park lock cable is removed from or inserted into ignition switch inhibitor.

1. Disconnect negative battery cable. Remove center console trim for access to base of shift lever. Place shift lever in Park. If park lock cable is not already inserted into ignition switch inhibitor, turn lock cylinder to RUN position and insert cable into inhibitor.
2. Unlock cable adjuster at base of shift lever by pressing locking button upward. Turn lock cylinder to LOCK position. Push cable connector nose forward to remove slack. With no load applied to cable connector nose, lock cable adjuster button by pressing locking button down. Install center console trim. Connect negative battery cable.

SIR COIL ASSEMBLY

NOTE: If the coil assembly hub or the steering shaft were rotated after the assembly was removed, use the following procedure to center the coil ribbon before installing assembly. A new coil ribbon does not require centering, as it is already centered and held in this position with a Blue plastic tab. Remove tab after coil assembly is installed.

1. Hold coil assembly with clear bottom upward to see coil ribbon. Note there are 2 different styles of coil assemblies: one rotates clockwise and other counterclockwise.
2. While holding coil assembly housing and pressing spring lock, rotate hub in direction of arrow (on bottom of assembly) until it stops. Coil assembly should now be wound up snug against center hub.
3. Rotate coil assembly hub in opposite direction about 2 1/2 turns. Release spring lock between locking tabs in front of arrow. Coil assembly can now be installed if front wheels are in straight-ahead position.

SOLENOID & INTERLOCK ASSEMBLY (IN-VEHICLE)

1. Disable air bag restraint system. See the **DISABLING & ACTIVATING AIR BAG SYSTEM** procedures. Connect shift cable without tension or kinks onto shift tube lever. Ensure ignition switch is in RUN position. Position shift lever to Park position.
2. Unlock shift cable. Pull cable away from solenoid until cable fitting starts to extend compressing spring inside joint socket. Do not extend cable fitting. Allow cable to move back .04-.08" (1-2 mm). Engage locking button. Function check solenoid and interlock assembly. Solenoid must release gearshift lever bowl assembly when pressure is applied to brake pedal. See **Fig. 5** .

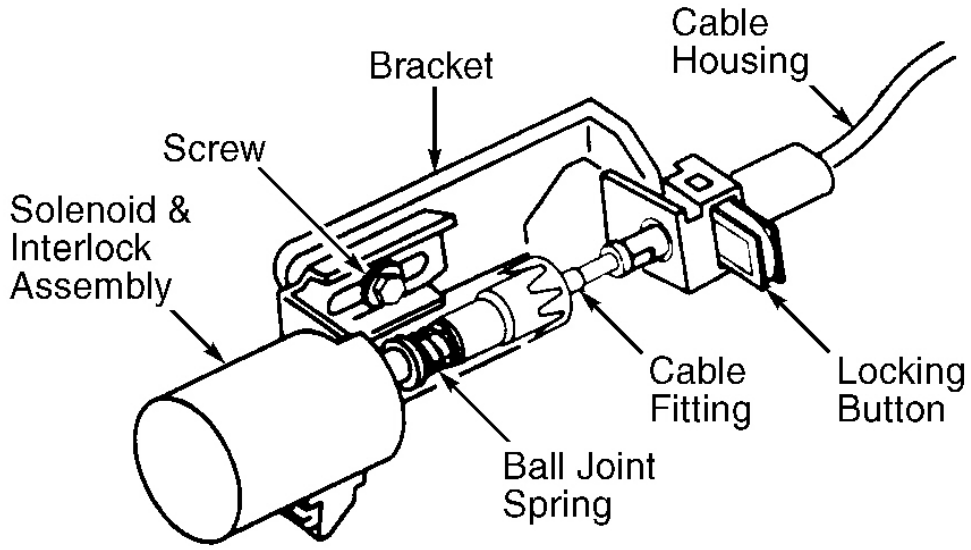


Fig. 5: Adjusting Solenoid & Interlock Assembly (In-Vehicle)
Courtesy of GENERAL MOTORS CORP.

SOLENOID & INTERLOCK ASSEMBLY (OFF-VEHICLE)

1. With steering column removed from vehicle, place ignition switch in LOCK position to prevent SIR coil assembly from becoming off centered. Position shift tube in Park position. Hold interlock lever and bumper down against lower shift tube lever pin.
2. Measure clearance between lower shift tube lever pin and interlock and bumper lever assembly contact. See **Fig. 6** . Loosen 2 solenoid adjustment bolts. Slide interlock and bumper assembly to obtain 0.22-0.32" (5.6-8.0 mm) clearance. Tighten 2 solenoid adjustment bolts evenly to 12 ft. lbs. (16 N.m).

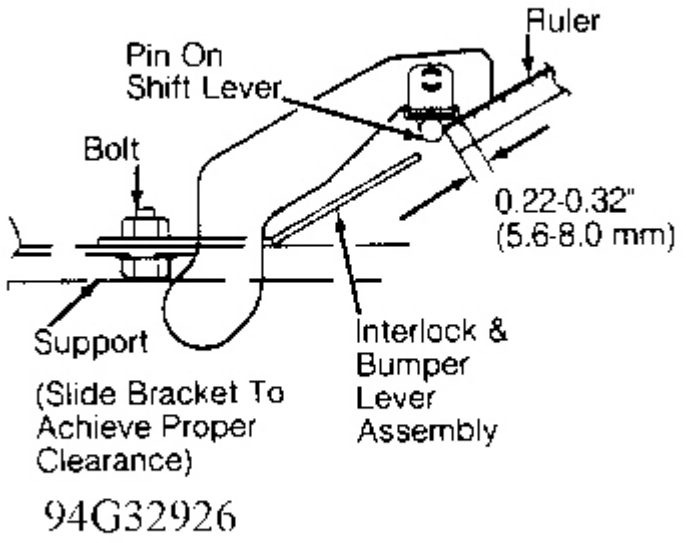


Fig. 6: Adjusting Solenoid & Interlock Assembly (Off-Vehicle)
Courtesy of GENERAL MOTORS CORP.

TESTING

HORN CIRCUIT

Horns Inoperative

1. Remove horn relay. See **HORN RELAY LOCATION** table. Using a test light, check for voltage at both Orange (Orange/Black on some models) wire terminals at horn relay connector. If test light is on at both terminals, go to next step. If test light is off at one or both terminals, repair open in Orange (Orange/Black) wire between fuse and horn relay.
2. Connect a test light between Orange (Orange/Black) and Black wire terminals of horn relay connector. Press horn button. If test light is on, go to step 4). If test light is off, check for open in Black wire between horn relay and horn switch.
3. With horn relay removed, connect a fused jumper wire between Orange and Dark Green wire terminals at horn relay connector. If horns sound, replace horn relay. If horns do not sound, leave jumper wire connected and go to next step.
4. Check for battery voltage at Dark Green wire terminal of horn connectors. If no voltage is present, repair open in Dark Green wire. If battery voltage is present, check for open in horn ground (Black wire). If Black wire is okay, replace horn.

Horns Sound Continuously

1. Remove horn relay. See **HORN RELAY LOCATION** table. If horns stop sounding, go to next step. If horns continue to sound, repair short to battery in Dark Green wire between horn relay and horns.
2. With relay still removed, connect a test light between Orange (Orange/Black on some models) and Black wire terminals of horn relay connector. If test light is off, replace horn relay. If test light is on, repair short to ground in circuit between horn relay and horn switch.

Only One Horn Inoperative

Disconnect electrical connector from inoperative horn. Connect a test light to horn connector terminal "B" (Dark Green wire) and ground. Push horn button. If test light is off, check for open in Dark Green wire between horn relay and horn. If test light is on, check for poor connection at horn. If connection is okay, replace horn.

HORN RELAY LOCATION

Application	Location
"B" Body	Behind Instrument Panel, In Convenience Center

COLUMN SWITCHES

NOTE: For wiring diagrams and switch testing procedures on cruise control, lighting, wiper/washer and other components, see appropriate article in ACCESSORIES & EQUIPMENT. Use the following procedure to test components not covered.

Disconnect switch connector. Check continuity between appropriate terminals of switch connector according to selected switch position. If continuity is not correct for selected switch position, replace switch.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

AIR BAG (INFLATOR) MODULE

Removal (Driver-Side)

1. Before proceeding, follow air bag service precautions. See **SERVICE PRECAUTIONS** . Disable air bag system. See the **DISABLING & ACTIVATING AIR BAG SYSTEM** procedures.
2. Remove screws and nuts from underside of steering wheel. Partially remove inflator module and disconnect steering wheel inflator module connector, CPA clip and disconnect horn contact from inflator. Remove radio control switch connector, if equipped. Remove inflator module.

Installation

1. Install horn contact, steering wheel inflator module connector and CPA clip. Install inflator module to steering wheel. Tighten inflator module screws to proper specification. See **TORQUE SPECIFICATIONS** .
2. To complete installation, reverse removal procedure. Reactivate air bag system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

STEERING WHEEL

Removal & Installation

1. Set front wheels in straight-ahead position. Turn ignition switch to LOCK position. Remove air bag module. See **AIR BAG (INFLATOR) MODULE** .
2. Mark steering wheel hub in relation to steering shaft for installation reference. Remove steering wheel nut. Using appropriate steering wheel puller, remove steering wheel. See the **STEERING WHEEL PULLER SPECIFICATIONS** table. DO NOT install puller bolts too deeply into hub, as SIR coil assembly will be damaged.
3. To install, reverse removal procedure. Align marks on steering wheel hub and steering shaft before installing steering wheel. Tighten steering wheel nut to 30 ft. lbs. (41 N.m). Activate SIR system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

STEERING WHEEL PULLER SPECIFICATIONS

Application	Tool (Part No.)
"B" Body	Puller (J-1859-A)

SIR COIL ASSEMBLY R & I

NOTE: Front wheels of vehicle must be turned to straight-ahead position before beginning service. Failure to do so can result in coil assembly being removed without being centered. Reinstalling coil assembly under such circumstances causes ribbon in coil assembly to break when steering wheel is turned fully. Ensure key is always in LOCK position to prevent wheel from turning and uncentering coil assembly. To recenter coil assembly, see ADJUSTMENTS .

Removal

1. Before proceeding, follow air bag service precautions. See **SERVICE PRECAUTIONS** . Disable air bag system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .
2. Remove inflator module. See **AIR BAG (INFLATOR) MODULE** . Remove horn contact wire from steering column. Remove steering wheel. See **STEERING WHEEL** . DO NOT install puller bolts too far, as damage to coil assembly can result.
3. Remove coil assembly retaining ring from steering shaft. Grasp clear plastic wire protector shield on underside of steering column, and slide downward. Partially remove coil assembly from end of steering wheel shaft and allow coil to hang freely. Note orientation to steering column housing before removal.
4. Remove wave washer from steering shaft. Using Shaft Lock Remover (J-23653-C), depress shaft lock and remove shaft lock retaining ring. Remove shaft lock plate and upper bearing spring. Remove turn

signal canceling cam.

5. Remove hazard knob and attaching screw. Remove turn signal switch arm. Remove 3 turn signal switch screws and partially withdraw switch. Disconnect any remaining electrical connectors. Attach mechanics wire to coil assembly lower connector (at base of steering column) and carefully pull wire through gear shift lever bowl, column housing and lock housing cover.

Installation

1. Carefully feed coil assembly wire and lower connector through lock housing cover, column housing and gear shift lever bowl and allow coil assembly to hang freely.

NOTE: Use care not to pinch wires when installing components. After wire is fed through, attach CAUTION tag to wire near connector at base of steering column. Tag is included in coil assembly repair kit.

2. Install turn signal switch and torque screws to 30 INCH lbs. (3.4 N.m). Install turn signal switch arm and torque attaching screw to 20 INCH lbs. (2.3 N.m).
3. Install hazard knob and attaching screw. Install turn signal canceling cam and shaft lock plate. Install shaft lock retaining ring. Using lock plate compressor, align block tooth on shaft, and depress shaft lock plate. Install wave washer.
4. Ensure coil assembly hub and steering shaft are centered. Coil assembly will become uncentered if column is separated from steering gear and is allowed to rotate, or if centering spring is depressed, allowing hub to rotate while coil assembly is removed from column.
5. Install coil assembly, using horn tower on canceling cam to align hole on inner ring of coil and projections on steering column housing with projections on outer ring of coil. To complete installation, reverse removal procedure. Reactivate air bag system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

TURN SIGNAL SWITCH

Removal & Installation

1. Remove steering wheel and SIR coil spring (if equipped). See **STEERING WHEEL** and **SIR COIL ASSEMBLY R & I** . Remove steering shaft lock plate retaining ring using Shaft Lock Remover (J-23653-C) and small tip screwdriver or scribe. Remove shaft lock plate.
2. Remove turn signal cancel cam and upper bearing spring. Remove screw retaining hazard flasher knob assembly. Remove lower instrument panel and steering column covers. Disconnect turn signal switch harness connector from column.
3. Tie mechanics wire to turn signal switch harness connector to ease installation of turn signal switch harness connector down through column. Remove turn signal switch from steering shaft while pulling harness up through column. To install, reverse removal procedure.

LOCK CYLINDER

Removal & Installation

Remove turn signal switch. See **TURN SIGNAL SWITCH** . With ignition key removed, remove buzzer switch. Insert key into lock cylinder. Turn lock cylinder to LOCK position. Remove lock cylinder retaining screw. Remove lock cylinder. To install, reverse removal procedure.

DIMMER SWITCH

Removal

Disconnect negative battery cable. Remove trim panel(s) from base of column as necessary to access the dimmer switch. Disconnect electrical connector from dimmer switch. Remove dimmer switch from actuator rod.

Installation

Install and adjust dimmer switch using adjustment procedure. See **DIMMER SWITCH ADJUSTMENT** . To install remaining components, reverse removal procedure.

IGNITION SWITCH

Removal

Disconnect negative battery cable. Remove trim panel(s) from base of column as necessary to access the ignition switch. Remove dimmer switch, if necessary. Disconnect electrical connector from ignition switch. Remove ignition switch from actuator rod.

Installation

Install and adjust ignition switch using adjustment procedure. See **IGNITION SWITCH ADJUSTMENT** . If dimmer switch was removed, install and adjust dimmer switch using adjustment procedure. See **DIMMER SWITCH ADJUSTMENT** . To install remaining components, reverse removal procedure.

LOCK HOUSING

NOTE: Lock housing may also be referred to as main steering column housing.

Removal & Installation

1. Remove steering wheel, SIR coil assembly, turn signal switch and lock cylinder. Remove dimmer and ignition switches. Remove cover from lock housing. Disconnect cruise control switch connector (if equipped) near multifunction switch.
2. Disconnect multifunction switch connector. Set multifunction switch lever in OFF position (centered), grasp lever and pull straight out to remove. Remove lock housing screws. Remove lock housing. To install, reverse removal procedure.

MULTIFUNCTION SWITCH

NOTE: Multifunction switch incorporates wiper/washer switch and acts as mechanical

link to the turn signal switch and headlight dimmer switch. Also, cruise control switch (if equipped) is on end of multifunction switch lever. Manufacturer's procedure requires that the lock housing be removed to remove switch.

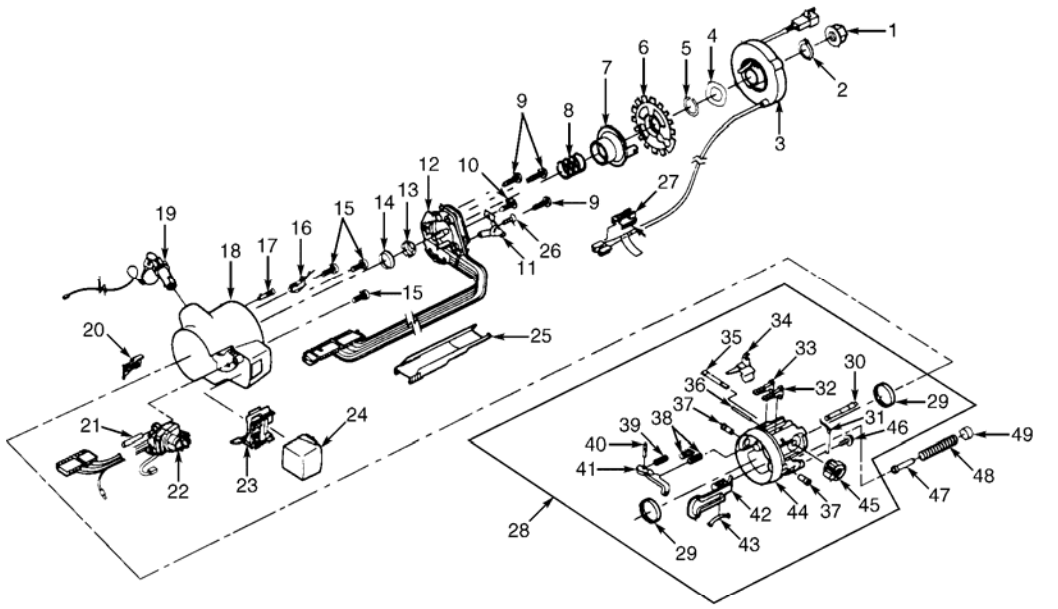
Removal & Installation

Remove lock housing. See **LOCK HOUSING** . Remove multifunction switch actuator pivot pin. Remove multifunction switch. To install, reverse removal procedure.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Steering Wheel Nut	30 (41)
	INCH Lbs. (N.m)
Dimmer Switch Screws	35 (4)
Ignition Switch Screws	35 (4)
Inflator Module Nut/Screw (Driver Side)	27 (3)
Lock Cylinder Screws	22 (2.5)
Multifunction Switch Arm Screws	19 (2.2)
Multifunction Switch Screws	27 (3.1)



1. Nut
2. Retaining Ring
3. SIR Coil Assembly
4. Wave Washer
5. Retainer Ring
6. Shaft Lock
7. Turn Signal Cancel Cam
8. Upper Bearing Spring
9. Screw
10. Screw
11. Turn Signal Switch Arm
12. Turn Signal Switch
13. Upper Bearing Inner Race Seat
14. Inner Race
15. Screw
16. Buzzer Switch
17. Screw
18. Lock Housing Cover
19. Lock Cylinder
20. Dimmer Switch Rod Actuator
21. Pivot Pin
22. Pivot & Pulse Switch
23. Base Plate
24. Cover End Cap
25. Wiring Protector
26. Screw
27. Connector Shroud
28. Housing Assembly
29. Bearing Assembly
30. Lock Bolt
31. Lock Bolt Spring
32. Lock Shoe
33. Lock Shoe
34. Protector Shield
35. Drive Shaft
36. Dowel Pin
37. Pivot Pin
38. Shoe Spring
39. Lever Spring
40. Lever Pin
41. Release Lever
42. Actuator Rack
43. Preload Spring
44. Housing
45. Actuator Sector
46. Screw
47. Spring Guide
48. Spring
49. Spring Retainer

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Fig. 7: Exploded View Of Upper Steering Column
Courtesy of GENERAL MOTORS CORP.

WIRING DIAGRAMS

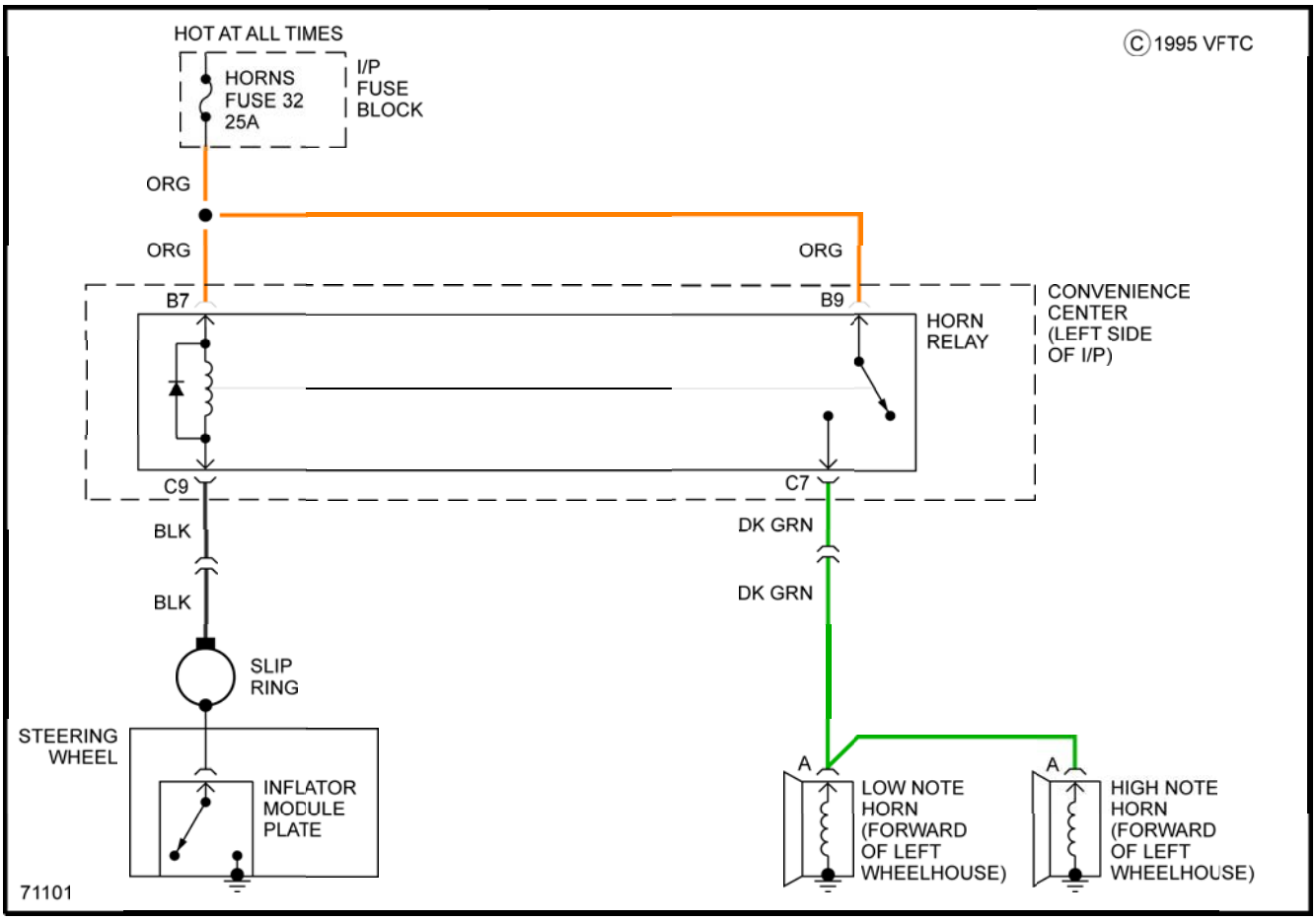


Fig. 8: Horn Circuit Wiring Diagram (Caprice & Impala SS)

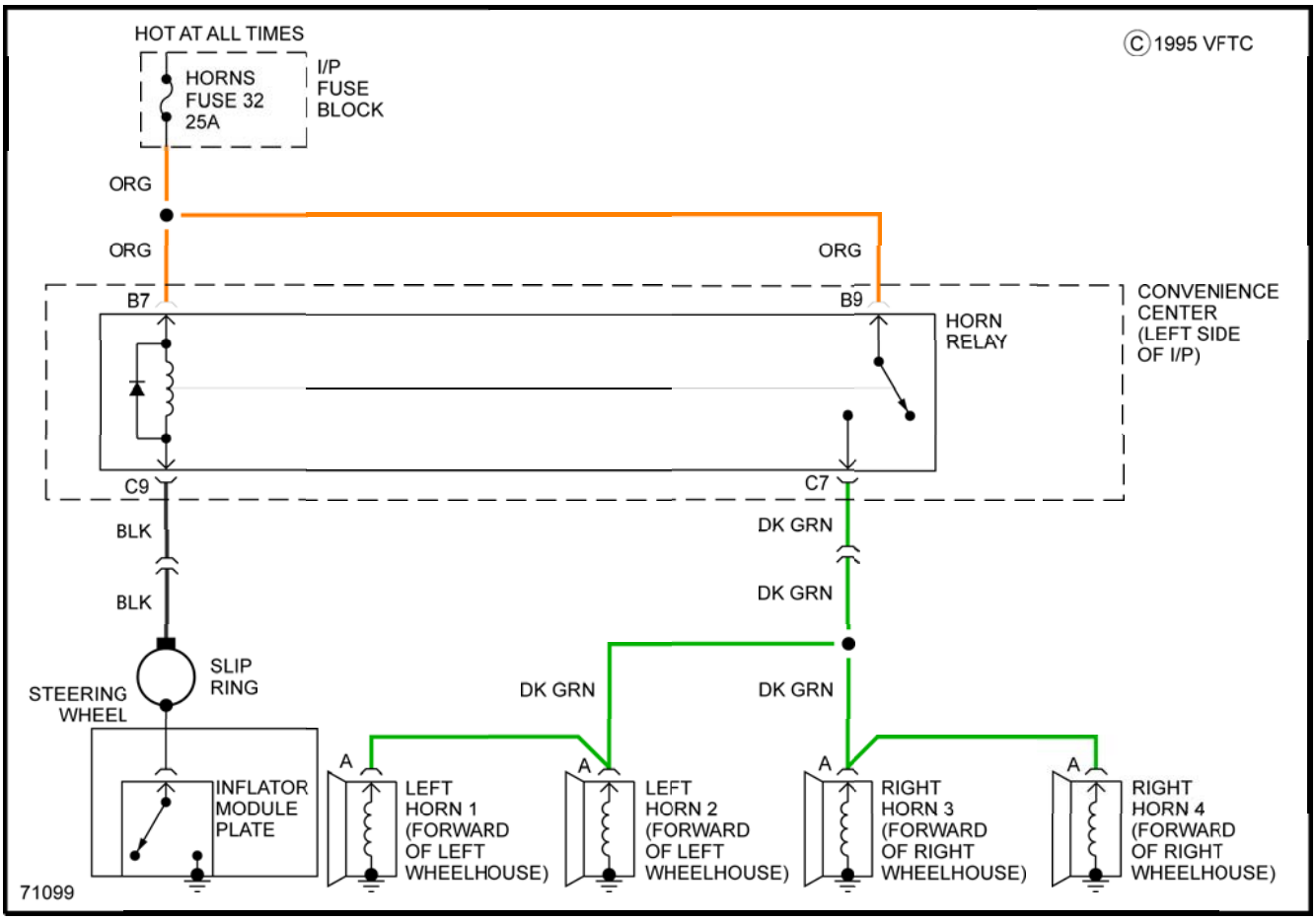


Fig. 9: Horn Circuit Wiring Diagram (Roadmaster Sedan)

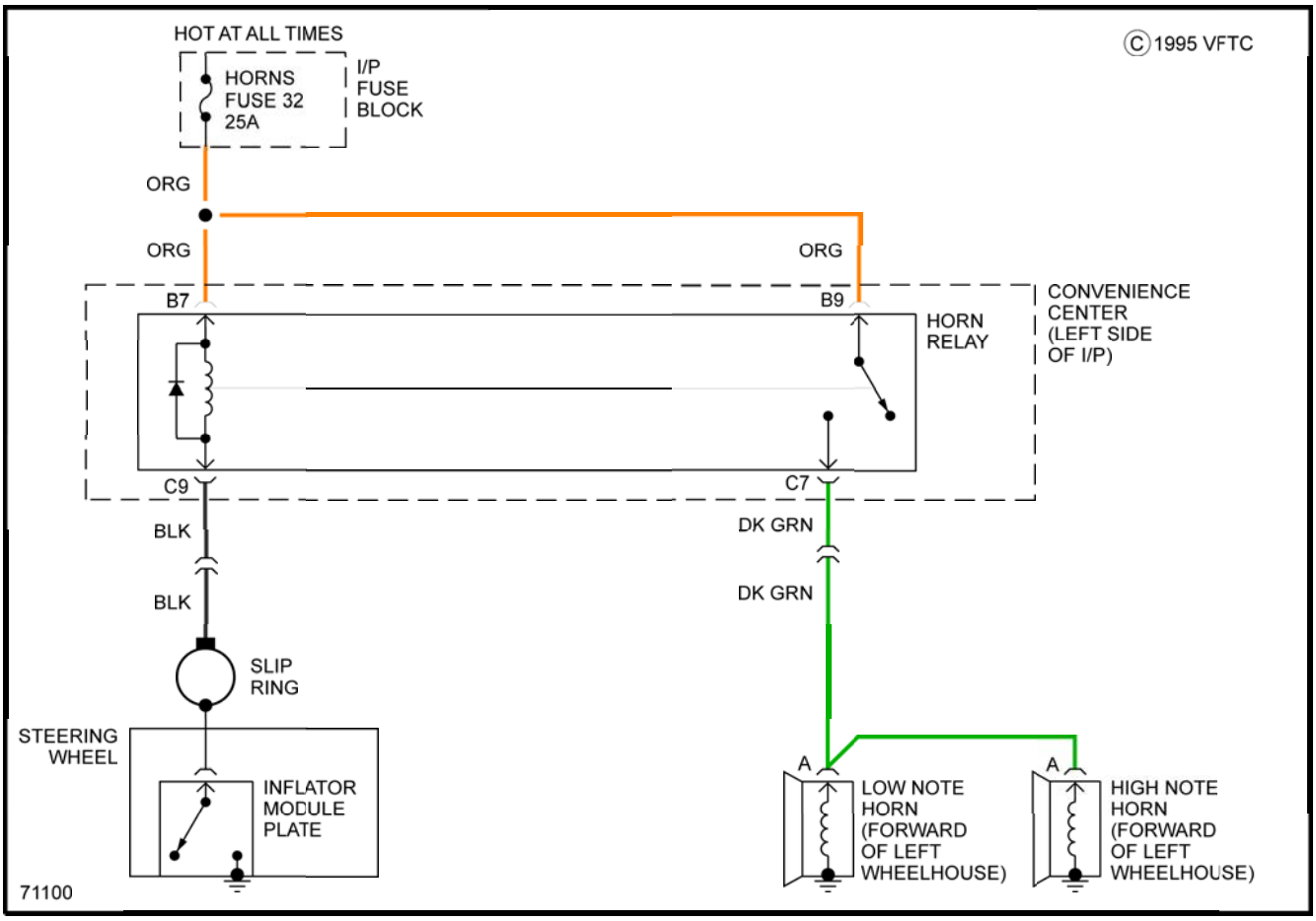


Fig. 10: Horn Circuit Wiring Diagram (Roadmaster Wagon)

DESCRIPTION & OPERATION

Steering columns are designated as fixed or tilt column, and as column shift or floor shift. Column shift and floor shift columns are basically the same, except for the shift tube on column shift steering columns.

Steering column components are designed to collapse if impacted during a collision. Steering shaft, column jacket and shift tube (column shift) are 2-piece units injected with plastic to hold the 2 pieces together as one unit. If column and/or steering wheel are impacted, the injected plastic will shear, allowing the column assembly to collapse.

BRAKE/TRANSMISSION SHIFT INTERLOCK (BTSI) SYSTEM

This system does not allow shift lever to be moved out of Park unless brake pedal is pressed. With brake pedal released and ignition on, current flows through BTSI solenoid to ground, energizing solenoid. With solenoid energized, a lock pawl protrudes from solenoid, preventing shift lever from being moved.

With brake pedal pressed, current flows through stoplight switch to ground side of solenoid. Under this condition, battery voltage is available on positive and negative sides of solenoid. This causes solenoid to de-energize, releasing lock pawl.

COLUMN COLLAPSE FEATURE

Steering column is designed to collapse if impacted during a collision. Steering shaft and column jacket are both 2-piece units which are internally injected with plastic. Plastic protrudes from holes in each unit keeping 2 separate pieces held together as one unit. See **Fig. 13** . If the column or steering wheel is forcefully impacted, plastic pieces break off, allowing column and shaft to collapse.

IGNITION LOCK SYSTEM

Models with column shift, use a wedged shaped mechanical finger on the ignition switch actuator rod to prevent the lock cylinder from being turned to START position unless shift lever is in Park or Neutral. A column mounted Park Neutral Position (PNP) switch is used.

PARK LOCK CABLE SYSTEM (A/T)

A park lock cable system prevents shift lever from being moved out of Park position unless ignition lock cylinder is out of LOCK position. It also prevents the lock cylinder from being turned to LOCK position unless shift lever is in Park position. This is accomplished by a park lock cable connected between lock cylinder and shift lever.

STEERING WHEEL ROTATION SENSOR

The steering wheel rotation sensor, on vehicles equipped with variable effort steering, senses rotation speed of

the steering wheel assembly. This information provides more assist during sudden directional changes at highway speeds.

WARNING: All vehicles are equipped with air bag. Refer to SERVICE PRECAUTIONS . Also, refer to DISABLING & ACTIVATING AIR BAG SYSTEM before attempting any repairs to steering column or components.

SERVICE PRECAUTIONS

Observe the following precautions when servicing air bag system:

- Disable air bag system before attempting any repairs to steering column or components. Refer to **DISABLING & ACTIVATING AIR BAG SYSTEM** .
- After disabling air bag system, Diagnostic Energy Reserve Module (DERM) retains back-up voltage for about 10 minutes. To avoid accidental air bag deployment, wait at least 10 minutes after disabling air bag system before working on vehicle components.
- Always wear safety glasses when working around air bag system.
- Always carry a live (undeployed) air bag with trim cover facing away from your body. This minimizes the chance of injury if air bag accidentally deploys.
- Place a live (undeployed) air bag on a bench or other surface with trim cover facing up, away from surface. This will reduce motion of air bag if it accidentally deploys.
- Never probe air bag inflator module connectors. Air bag may accidentally deploy.
- Never attempt repair of any air bag system components. Replace any faulty components as required.

DISABLING & ACTIVATING AIR BAG SYSTEM

WARNING: Supplemental Inflatable Restraint (SIR) Diagnostic Energy Reserve Module (DERM) retains back-up voltage for about 10 minutes after disabling SIR system. Wait a minimum of 10 minutes after disabling SIR before servicing steering column components. Servicing steering column components before 10-minute period may cause accidental deployment of air bag and possible personal injury.

1. Before proceeding, follow air bag service precautions. See **SERVICE PRECAUTIONS** . To disable air bag, with wheels in straight-ahead position, turn ignition to OFF-LOCK position and remove key. Remove SIR fuse (air bag fuse) from fuse block.
2. Remove left sound insulator. Remove Connector Position Assurance (CPA) clip from Yellow SIR harness connector at base of steering column. All SIR system connectors use CPA clips to ensure connector retention. Disconnect Yellow SIR connector. Wait at least 10 minutes before working on vehicle.
3. With SIR fuse removed and ignition on, AIR BAG indicator light will be on. This is normal operation for SIR system and does not indicate a fault code or system problem.
4. To activate air bag system, ensure ignition is off. Connect Yellow SIR connector and CPA clip at base of steering column. Install SIR fuse. Turn ignition switch to RUN position. Observe AIR BAG indicator

light. Light should flash 7-9 times and then go out. If AIR BAG indicator light does not function as described, a malfunction in air bag system exists.

ADJUSTMENTS

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in INFORMATION before disconnecting battery.

NOTE: For aid in adjustments, see exploded views of column assemblies. See Fig. 14 .

BTSI & PARK LOCK SYSTEM ADJUSTMENT

System Check

1. Place shift lever in Park position. Turn lock cylinder to OFF-LOCK position. Remove key. If lock cylinder cannot be turned to OFF-LOCK position or key cannot be removed, perform appropriate ADJUSTMENT procedure.
2. With lock cylinder in OFF-LOCK position, try to move shift lever out of Park. If shift lever can be moved out of Park, perform appropriate ADJUSTMENT procedure.
3. Turn lock cylinder to RUN position. Try to move shift lever out of Park. If shift lever can be moved out of Park, perform appropriate ADJUSTMENT procedure. Depress brake pedal, move shift lever out of Park. If shift lever cannot be moved out of Park, perform appropriate ADJUSTMENT procedure.
4. Try to turn lock cylinder to OFF-LOCK position. Ignition switch should stop turning before reaching the OFF-LOCK position, and the key should not be able to be removed. If system does not operate as specified, perform appropriate ADJUSTMENT procedure.
5. With key in same position as in previous step (just before OFF-LOCK position), place shift lever in Park position. Turn lock cylinder toward RUN position, and then to OFF-LOCK position. Remove key. If system does not operate as specified, perform appropriate ADJUSTMENT procedure.

Adjustment (Column Shift)

Turn lock cylinder to RUN position, depress brake pedal. Move shift lever out of Park position. Disengage locking button, pull cable away from solenoid until fitting starts to extend, compressing spring inside ball joint. Allow cable to move back .04-.08" (1-2 mm), engage locking button. See **Fig. 1** . Recheck BTSI system. If system does not operate as specified, repeat procedure.

NOTE: Lock cylinder MUST be in RUN position when park lock cable is removed from or inserted into ignition switch inhibitor.

Adjustment (Floor Shift)

1. Remove center console trim for access to base of shift lever. Place shift lever in Park. Turn lock cylinder to RUN position to energize BTSI solenoid. Unlock cable adjuster at base of shift lever by pressing locking button upward. Turn lock cylinder to LOCK position.

2. With no load applied to cable, lock cable adjuster button by pressing locking button down. Install center console trim. Connect negative battery cable.
3. Recheck BTSI system. If system does not operate as specified, repeat previous step.

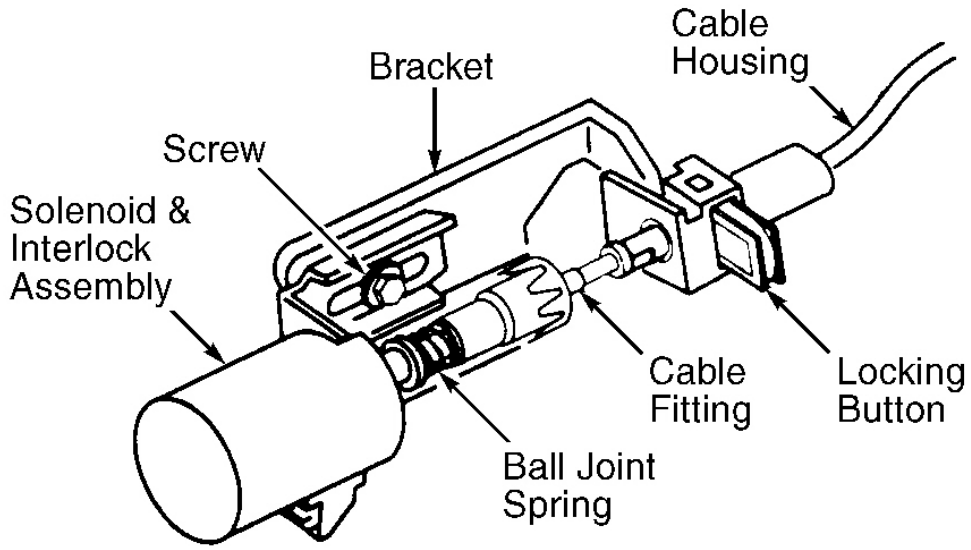


Fig. 1: Adjusting Park Lock Cable
Courtesy of GENERAL MOTORS CORP.

DIMMER SWITCH ADJUSTMENT

1. With switch removed from column bracket, insert a 3/32" drill bit into adjusting pin hole to limit switch travel. See **Fig. 2** . Insert actuator rod into switch. Install switch to column bracket, finger-tighten screws.
2. Lightly push switch upward against actuator rod until no lash (free-play) exists between rod and switch. Tighten mounting screws to 35 INCH lbs. (4 N.m). Remove drill bit. Ensure proper switch operation using dimmer/headlight switch handle.

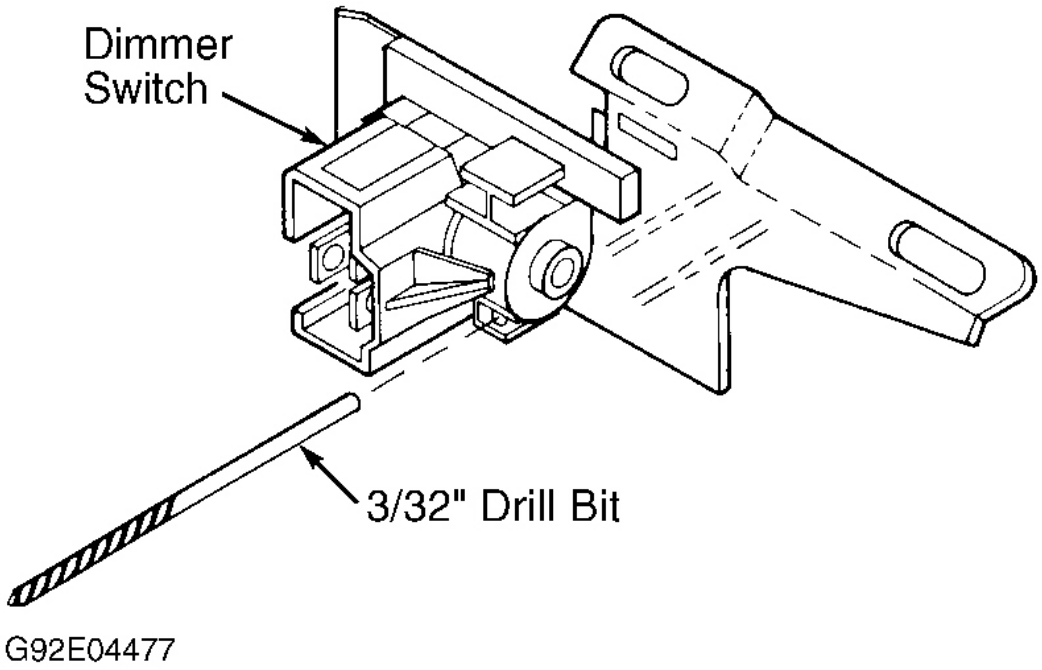


Fig. 2: Adjusting Dimmer Switch
Courtesy of GENERAL MOTORS CORP.

IGNITION SWITCH ADJUSTMENT

CAUTION: New ignition switch is pinned in OFF-LOCK position. Plastic pin must be removed before operating switch.

1. Set key lock cylinder in OFF-LOCK position. On fixed column, set ignition switch slider (where actuator rod connects to switch) to OFF-LOCK position by moving slider as far left as possible, and then one detent to right. See **Fig. 3** .
2. On tilt column, set ignition switch slider (where actuator rod connects to switch) to OFF-LOCK position by moving slider to right as far as possible, and then one detent to left. See **Fig. 3** .
3. Install switch. Tighten switch screws to 35 INCH lbs. (4 N.m). Ensure ignition switch functions properly with lock cylinder in all positions.

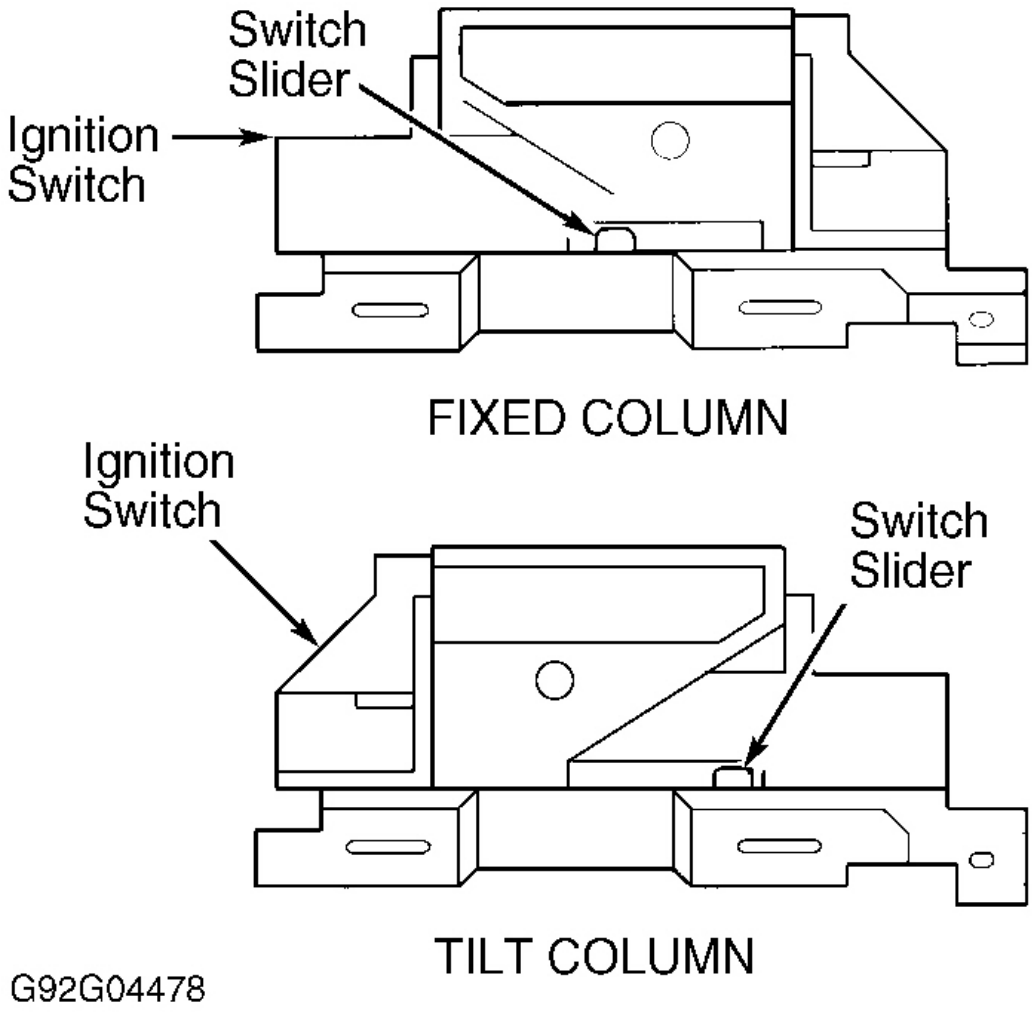


Fig. 3: Adjusting Ignition Switch
Courtesy of GENERAL MOTORS CORP.

COLUMN SHIFT INDICATOR ADJUSTMENT

1. Position shift lever in "N" position. Position guide clip on edge of shift bowl to center position pointer on "N" position. Push clip onto bowl. Ensure that cable rests on bowl and not on column jacket.
2. With gear selector in "N" position, holes must be visible on both sides of pointer. Pointer must cover portions of "1" or be to right of "1" when transaxle is in "LOW" position. See **Fig. 4** .

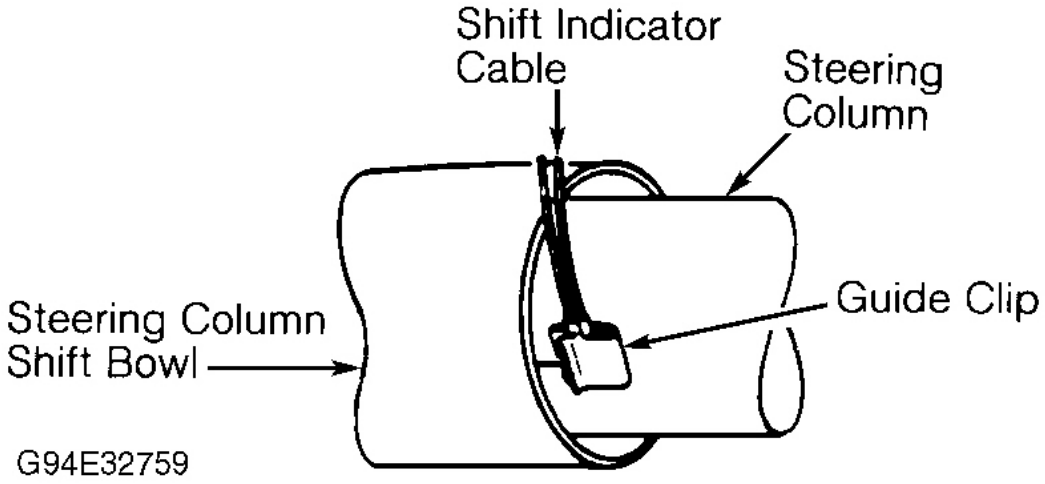


Fig. 4: Adjusting Column Shift Indicator
Courtesy of GENERAL MOTORS CORP.

SIR COIL ASSEMBLY ADJUSTMENT

NOTE: If coil assembly hub or steering shaft were rotated after assembly was removed, use the following procedure to center coil ribbon before installing assembly. A new coil ribbon does not require centering, as it is already centered and held in position with a plastic tab. Remove tab after coil assembly is installed.

1. Hold coil assembly with clear bottom upward to see coil ribbon. While holding coil assembly housing and pressing spring lock, rotate hub in direction of arrow (on bottom of assembly) until it stops. Coil assembly should now be wound up snug against center hub.
2. Rotate coil assembly hub in opposite direction about 2 1/2 turns. Release spring lock between locking tabs in front of arrow. Coil assembly can now be installed if wheels are in straight-ahead position.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in INFORMATION before disconnecting battery.

NOTE: All components listed under REMOVAL & INSTALLATION can be removed without removing steering column. To remove all other components, remove steering column, and then perform appropriate procedure under OVERHAUL . See Fig. 14 .

AIR BAG (INFLATOR) MODULE R & I

Removal

1. Observe all precautions. See **SERVICE PRECAUTIONS** . Disable SIR system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .
2. Loosen screws behind steering wheel using No. 30 Torx bit, until air bag module is released from steering wheel. Pull up air bag module, and then disconnect electrical connectors from rear of module. Remove module and position aside with pad facing upward.

Installation

Connect electrical connectors to rear of module. Install module in steering wheel and install retaining screws. Tighten screws to specification. See **TORQUE SPECIFICATIONS** . Activate SIR system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

PARK NEUTRAL POSITION (PNP) SWITCH R & I

Removal ("B" Body)

Disconnect negative battery cable. Remove instrument panel sound insulator. Disconnect electrical connector. Remove PNP switch by carefully prying switch tangs from holes in column jacket.

Installation

Place shift lever in Neutral. Align switch actuator with hole in shift tube. Position connector side of switch into cutout on column jacket. Push switch down to lock tangs into jacket. Place shift lever in Park. Switch will self adjust as indicated by ratcheting sound. To complete installation, reverse removal procedure.

STEERING WHEEL R & I

Removal & Installation

1. Set front wheels in straight-ahead position. Turn ignition switch to LOCK. Remove air bag module. See **AIR BAG (INFLATOR) MODULE** .
2. Mark steering wheel hub in relation to steering shaft for installation reference. Remove steering wheel nut. Using steering wheel puller, remove steering wheel. **DO NOT** install puller bolts too deeply into hub, as SIR coil assembly will be damaged.
3. To install, reverse removal procedure. Align marks on steering wheel hub and steering shaft before installing steering wheel. Tighten steering wheel nut to 30 ft. lbs. (41 N.m). Activate SIR system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

SIR COIL ASSEMBLY R & I

CAUTION: Set front wheels in straight-ahead position before removing or installing coil assembly. This centers the coil assembly. If an off centered coil assembly is installed, ribbon in coil assembly will break when steering

wheel is turned. Always keep ignition switch in LOCK position to prevent wheel from turning and off centering coil assembly. To center the coil assembly, see SIR COIL ASSEMBLY ADJUSTMENT .

Removal

1. Set the front wheels in straight-ahead position and turn the ignition switch to the LOCK position. Disable the SIR system. Refer to **DISABLING & ACTIVATING AIR BAG SYSTEM** . Remove air bag module. See **AIR BAG (INFLATOR) MODULE R & I** . Remove steering wheel. Refer to **STEERING WHEEL R & I** .
2. Remove coil assembly retaining ring. Note orientation of coil assembly to steering column housing. Remove coil assembly, allowing assembly to hang by wiring. Remove wave washer. Remove and discard lock plate retaining ring using Lock Plate Compressor(J-23653-SIR). See **Fig. 5** . Remove lock plate, turn signal cancel cam and upper bearing spring. Remove upper bearing inner race seat and inner race.
3. Remove multifunction switch lever by grasping and pulling lever straight out. Move turn signal switch up to right turn position. Remove screws and allow switch to hang by wiring.
4. To aid in installing SIR coil wiring and connector down through column assembly, attach long piece of mechanics wire to coil assembly lower wiring connector at base of steering column. Carefully pull coil assembly, wiring and connector up and out of column. Disconnect mechanics wire from connector and allow wire to hang.

NOTE: Use care not to pinch wires when installing components. After wiring is fed through column, attach CAUTION tag to wiring near connector at base of steering column. Tag is included in SIR coil assembly repair kit.

Installation

To install, reverse removal procedure. Ensure coil assembly hub and steering shaft are centered before installing coil assembly. After coil assembly is installed, remove slack from coil assembly wiring in steering column to prevent wire damage. Activate SIR system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

TURN SIGNAL SWITCH R & I

Removal & Installation

1. Remove steering wheel. See **STEERING WHEEL R & I** . Remove SIR coil assembly. See **SIR COIL ASSEMBLY R & I** . Remove lock plate retaining ring using Lock Plate Compressor(J-23653-SIR) and small tip screwdriver or scribe. See **Fig. 5** . Remove lock plate.
2. Remove turn signal cancel cam, upper bearing spring, upper bearing inner race seat and inner race. Remove screw retaining hazard flasher knob assembly. Remove lower instrument panel and steering column covers. Disconnect turn signal switch harness connector from vehicle harness.
3. Tie mechanics wire to turn signal switch harness connector to ease installation of turn signal switch harness connector down through column. Remove turn signal switch from steering shaft while pulling harness up through column. To install, reverse removal procedure.

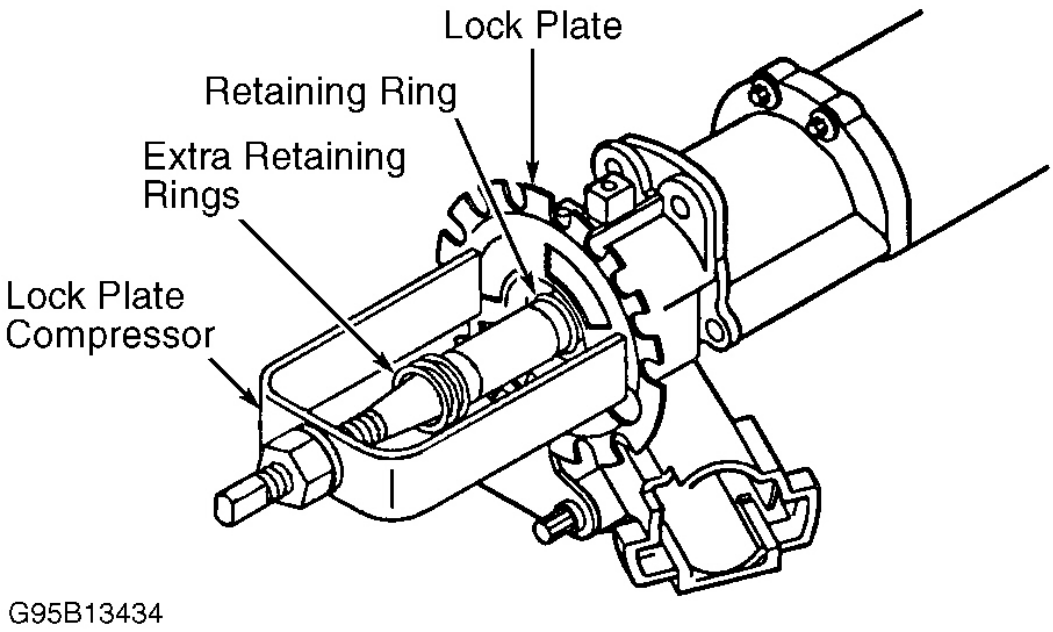


Fig. 5: Removing Shaft Lock Retaining Ring
Courtesy of GENERAL MOTORS CORP.

LOCK CYLINDER R & I

Removal & Installation

Remove turn signal switch. See **TURN SIGNAL SWITCH R & I** . With ignition key removed, remove buzzer switch. Insert key into lock cylinder. Turn lock cylinder to LOCK position. Remove lock cylinder retaining screw. To install, reverse removal procedure.

DIMMER SWITCH R & I

Removal

Disable the SIR system. Refer to **DISABLING & ACTIVATING AIR BAG SYSTEM** . Remove lower instrument panel trim panel(s) from base of column to access dimmer switch. Disconnect electrical connector from dimmer switch mounted on column. Remove 2 screws retaining dimmer switch and remove switch from actuator rod.

Installation

Install and adjust dimmer switch using adjustment procedure. See **DIMMER SWITCH ADJUSTMENT** . To install remaining components, reverse removal procedure.

IGNITION SWITCH R & I

Removal

Disable the SIR system. Refer to **DISABLING & ACTIVATING AIR BAG SYSTEM** . Disconnect negative battery cable. Remove lower instrument panel trim panel(s) from base of steering column to access ignition switch. Remove dimmer switch. See **DIMMER SWITCH R & I** . Lift and remove ignition switch from actuator rod. Disconnect electrical connectors from ignition switch.

Installation

Connect electrical connectors to ignition switch. Install and adjust ignition switch using appropriate adjustment procedure as per type of column. See **IGNITION SWITCH ADJUSTMENT** . Install and adjust dimmer switch. See **DIMMER SWITCH ADJUSTMENT** . To install remaining components, reverse removal procedure.

LOCK HOUSING COVER R & I

Removal & Installation

1. Remove steering wheel, SIR coil assembly, turn signal switch and lock cylinder. Remove dimmer and ignition switches. Remove column end cover from lock housing (if equipped). Disconnect cruise control switch connector (if equipped) near multifunction switch.
2. Disconnect multifunction switch connector. Set multifunction switch lever in OFF position (centered). Remove multifunction switch lever by grasping and pulling lever straight out.
3. Unscrew and remove tilt lever (if equipped). Remove lock housing screws. Remove lock housing from column. See **Fig. 14** . To install, reverse removal procedure.

MULTIFUNCTION SWITCH R & I

NOTE: Multifunction switch incorporates wiper/washer switch and acts as mechanical link to turn signal switch and headlight dimmer switch. Also, cruise control switch (if equipped) is on end of multifunction switch lever.

Removal & Installation

Ensure lever is in center OFF position. Firmly grasp tilt lever and rotate counterclockwise to remove. Remove housing end cap. Disconnect electrical connector. Remove multifunction switch lever by pulling it straight out of turn signal switch. To install, reverse removal procedure.

STEERING WHEEL ROTATION SENSOR R & I

Removal & Installation

1. Set front wheels in straight-ahead position and turn ignition switch to LOCK position. Disconnect negative battery cable. Disable SIR system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** . Remove bolt and nut from coupling attaching upper intermediate steering shaft assembly to lower steering shaft assembly. See **Fig. 6** .
2. Remove upper intermediate steering shaft assembly from lower steering shaft assembly. Disconnect

electrical connector. Remove lower bearing adapter clip. Remove steering wheel rotation sensor. To install, reverse removal procedure. Tighten intermediate shaft nut to 40 ft. lbs. (54 N.m).

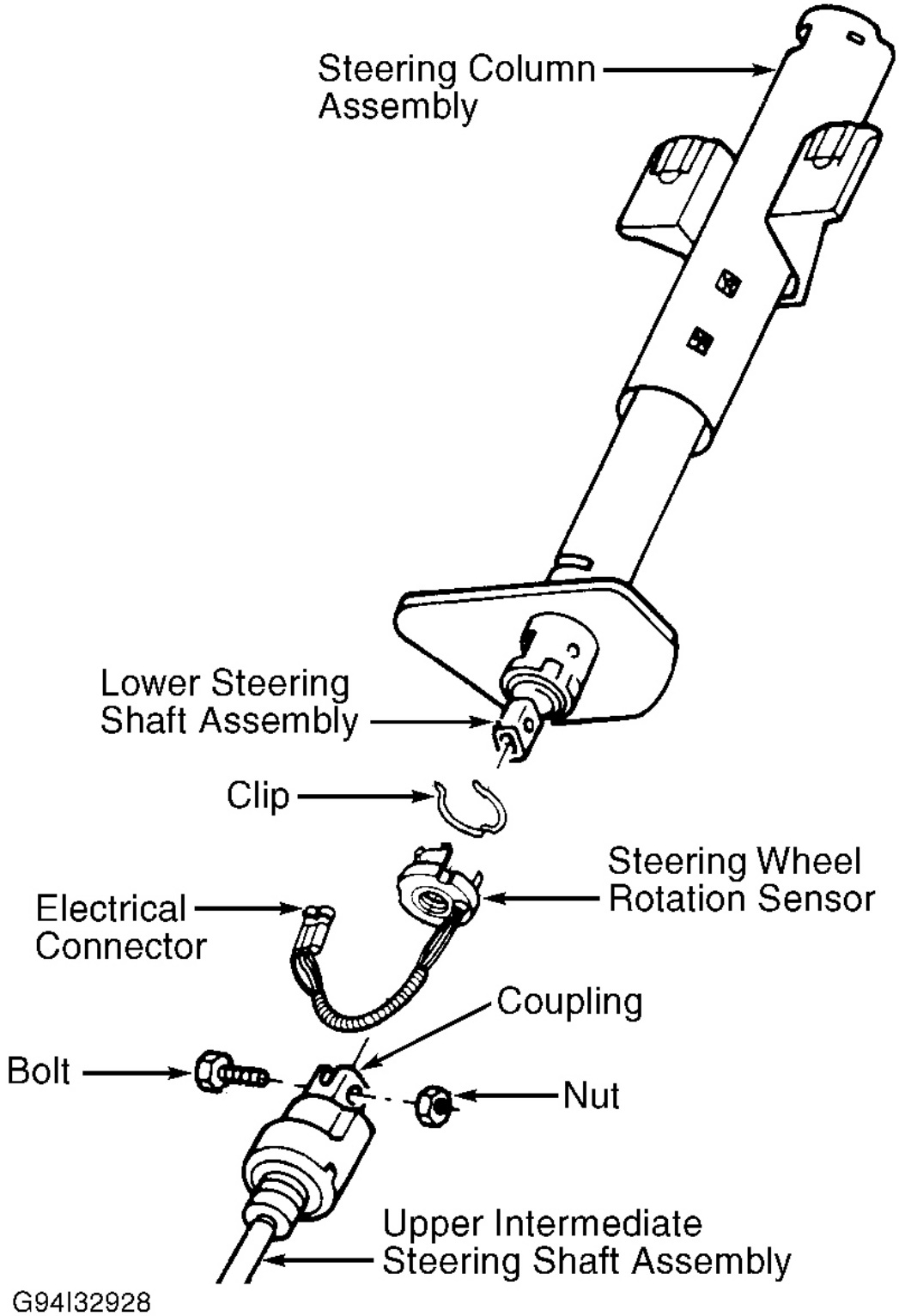

Steering Column Assembly
Lower Steering Shaft Assembly
Clip
Steering Wheel Rotation Sensor
Electrical Connector
Coupling
Bolt
Nut
Upper Intermediate Steering Shaft Assembly
G94I32928

Fig. 6: Removing Steering Wheel Rotation Sensor
Courtesy of GENERAL MOTORS CORP.

STEERING COLUMN R & I

CAUTION: Column must be handled with care when removed from vehicle. Use only fasteners of the same or equivalent part number if replacement is necessary. Improper fasteners or tightening could result in column failure. Applying excessive pressure, or causing impact to mainshaft during service, may cause column to collapse. If weight of column is supported by lower attachment, lower retainer or bushing will be damaged. On vehicles with SIR, DO NOT rotate steering shaft after column is removed. SIR coil assembly will be damaged.

Removal

1. Disable SIR system (if equipped). Refer to **DISABLING & ACTIVATING AIR BAG SYSTEM** . Disconnect negative battery cable. Set front wheels in straight-ahead position and turn ignition switch to LOCK position. Remove trim panels from around steering column as necessary.
2. Remove steering wheel. See **STEERING WHEEL R & I** . Remove stoplight switch. On most models, remove lower column joint coupling bolt attaching steering rack intermediate shaft to steering column shaft. If required, remove lower column toe plate-to-firewall attaching bolts.
3. On column shift models, disconnect transmission linkage rod or cable from lever on shift tube and disconnect gear indicator cable from column. On floor shift models, disconnect park lock cable from ignition lock inhibitor. Disconnect electrical connectors as necessary. Remove steering column bracket(s) mounting nuts. On Corvette, remove accelerator pedal bracket nuts. Remove steering column.

Installation

To install, reverse removal procedure. Tighten column bracket mounting nuts to 20 ft. lbs. (27 N.m). Tighten shaft joint coupling nut to 35 ft. lbs. (47 N.m). Tighten column harness connector bolt to 42 INCH lbs. (4.8 N.m). After installation is complete, activate SIR system. See **DISABLING & ACTIVATING AIR BAG SYSTEM** .

LOWER BEARING & RELATED COMPONENTS R & I

Removal & Installation

Remove steering column and lower shaft joint coupling. Remove column snap ring or retaining clip to remove lower bearing and related components. To install, reverse removal procedure.

OVERHAUL

CAUTION: DO NOT strike steering shaft with hammer to remove steering wheel. Hammering will loosen plastic injections which maintain column rigidity. DO NOT thread steering wheel puller bolts completely through steering

wheel hub, as this will damage to SIR coil assembly.

NOTE: For aid in overhaul, see exploded views of column assemblies. See Fig. 14 .

Preparation

Remove steering wheel and steering column, and then remove all other components listed under REMOVAL & INSTALLATION. Overhaul procedures are similar and typical of all column variations.

Disassembly (Fixed Column)

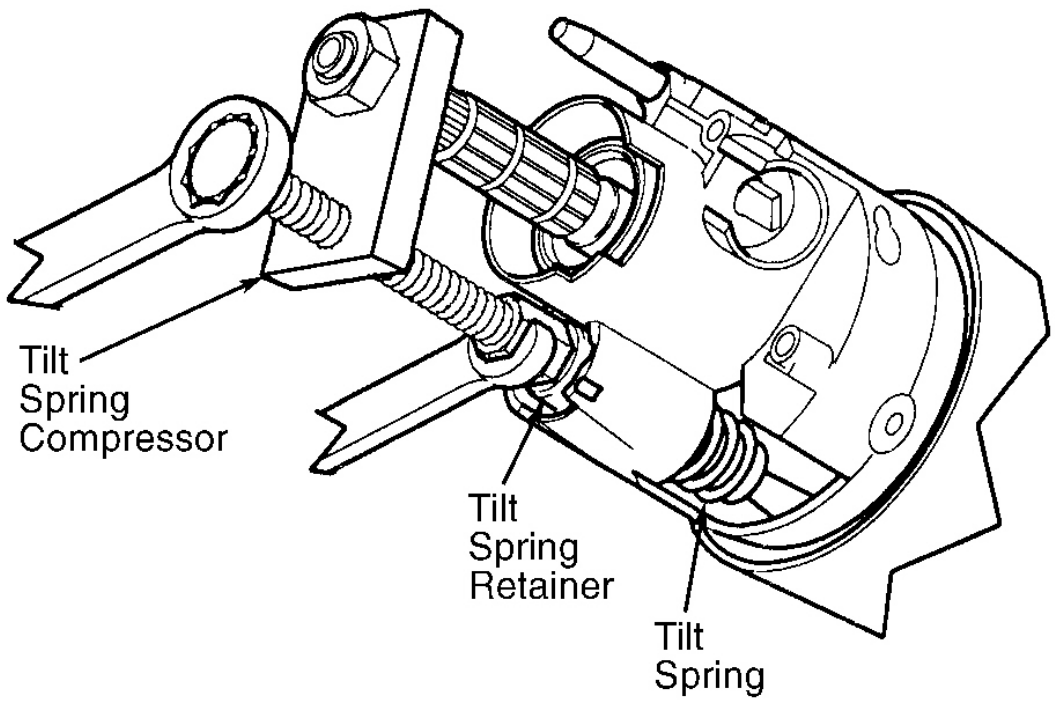
Remove the lower bearing and related components. Refer to **LOWER BEARING & RELATED COMPONENTS R & I** . Remove retaining ring from top of steering column shaft. Remove steering column shaft. Remove shift lever bowl (column shift) or bowl (floor shift). Remove bowl shroud and shift tube from column jacket.

Disassembly (Tilt Column)

1. Using Tilt Spring Compressor (J-39346), compress spring retainer at least 1/4". Rotate lower hex of tilt spring compressor counterclockwise 1/4 turn to release retainer. Remove tilt spring compressor, retainer, spring and guide. See **Fig. 7** .
2. Using Pivot Pin Remover (J-21854-01), remove pivot pins from column housing. See **Fig. 8** . Install tilt lever. Pull back tilt lever, and then pull column housing down and away from column. Components can now be removed from column housing. Remove lower bearing and related components. Remove steering column shaft.

   NOTE: Mark upper shaft in relation to lower shaft for reassembly reference. Failure to assemble properly will cause steering wheel to be turned 180 degrees from its correct position.

3. Remove upper and lower shaft assembly. Note orientation of pinch bolt notch to upper shaft block tooth. Tilt shafts at 90-degree angle to each other to disengage. Rotate centering spheres 90 degrees, and then remove spheres. Remove joint pre-load spring from centering sphere.
4. Remove column housing support, shift lever gate and shift tube retaining ring. Remove thrust washer, shaft lock, wave washer and shift tube. Remove shift lever bowl (column shift) or bowl (floor shift). Remove bowl shroud. Remove shift lever spring from gearshift lever bowl. Remove gearshift bowl shroud from gearshift lever bowl (column shift).



NOTE: Seat counterbore of tool over Steering Shaft & secure with standard hexagon nut.
Turn counterclockwise to remove Spring Retainer.

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Fig. 7: Removing Tilt Spring
Courtesy of GENERAL MOTORS CORP.

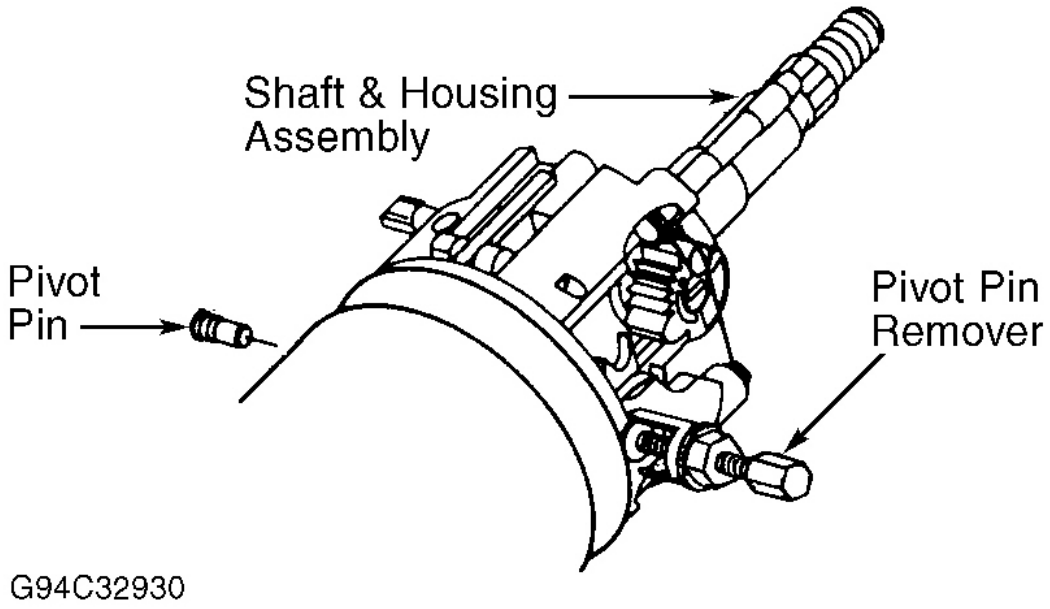


Fig. 8: Removing Pivot Pin
Courtesy of GENERAL MOTORS CORP.

NOTE: Vehicles involved in an accident with frame damage, major body damage, impact to steering column or air bag deployment may have a damaged or misaligned steering column. Use following procedures to inspect steering column for damage.

Inspection (Column Bracket)

1. Check capsules on steering column bracket assembly. Capsules should be within .062" (1.59 mm) from bottom of slots. See **Fig. 9** . If capsules are not within specification, replace bracket if bracket is bolted to column jacket, or replace column jacket if bracket is welded to column jacket.
2. Check for contact between bolt head and surface "A" on capsules. If bolt head contacts surface "A", shear load will increase, preventing column collapse upon impact. If contact is made, replace bracket or column jacket.

Inspection (Column Jacket)

Remove lower bearing from bottom of steering column. Using the **COLUMN JACKET COLLAPSE MEASUREMENTS** table as a guide, measure distance between points on column jacket as specified in illustration. See **Fig. 10** . If distance measured is not as specified, replace column jacket.

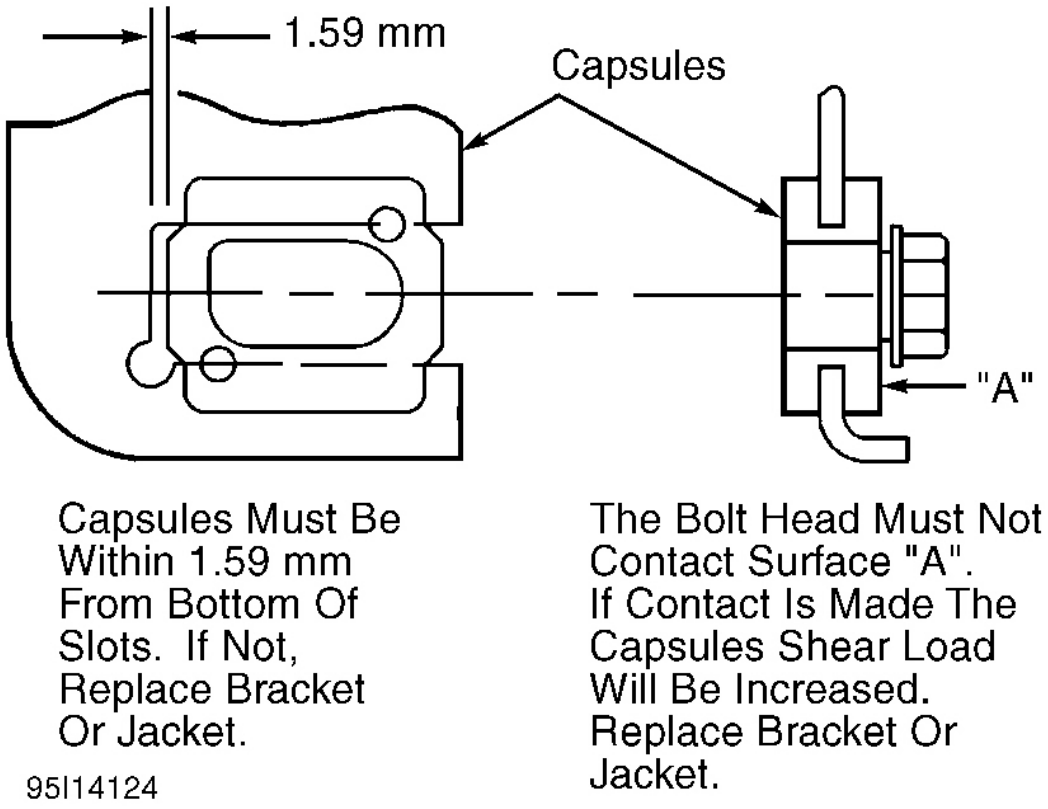


Fig. 9: Inspecting Column Bracket
Courtesy of GENERAL MOTORS CORP.

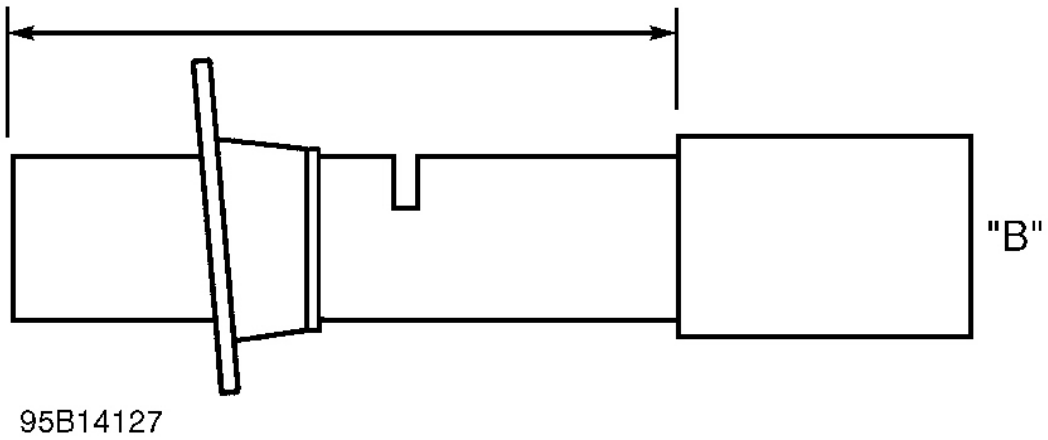


Fig. 10: Measuring Column Jacket
Courtesy of GENERAL MOTORS CORP.

COLUMN JACKET COLLAPSE MEASUREMENTS

Application	Illustration (1)	In. (mm)
"B" Body	"B"	11.11-11.15 (282.27-283.27)

(1)
See **Fig. 10** .

Inspection (Shift Tube)

Inspect the shift tube for sheared injection plastic. See **Fig. 11** . If injection plastic is sheared, replace shift tube. Check shift lever operation. If lever can be moved to Park position without raising the lever, upper shift tube plastic bearing is broken. Replace shift tube.

Inspection (Steering Shaft)

Inspect steering shaft for sheared injection plastic. See **Fig. 12** . If injection plastic is sheared, replace steering shaft. Check steering shaft runout by installing a dial indicator at lower end of steering shaft, and then rotating steering wheel. If runout exceeds .062" (1.59 mm), replace steering shaft.

Reassembly (All Columns)

To reassemble, reverse disassembly procedure. Apply a thin coat of lithium-based grease to all friction points when reassembling.

Spring Height Measurement

Measure distance from adapter face and bearing assembly to lower spring retainer. Spring height must equal 1.0" (25.4 mm). See **Fig. 13** .

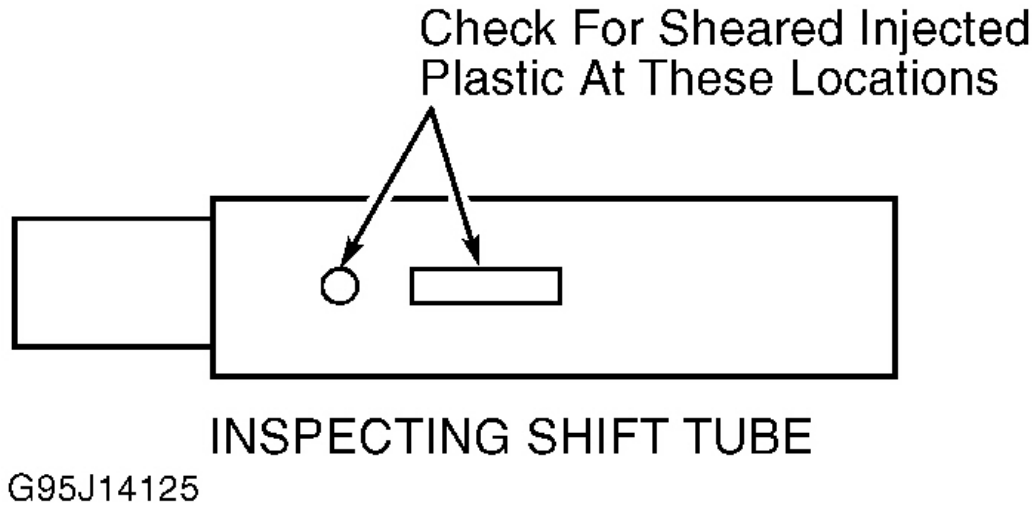


Fig. 11: Inspecting Shift Tube
Courtesy of GENERAL MOTORS CORP.

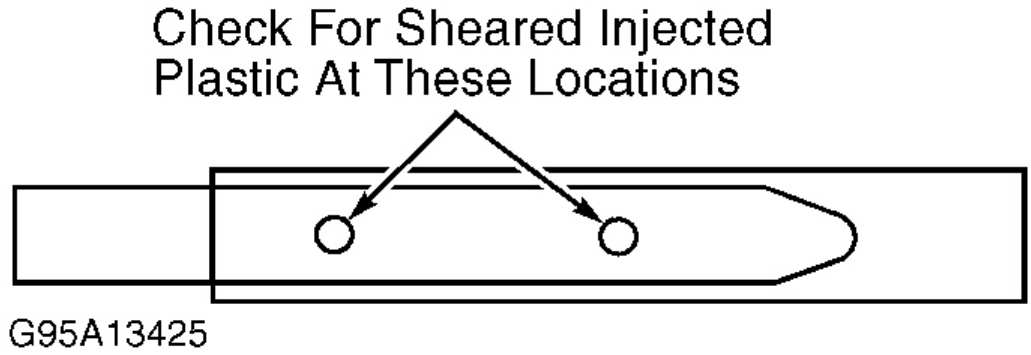


Fig. 12: Inspecting Steering Shaft
Courtesy of GENERAL MOTORS CORP.

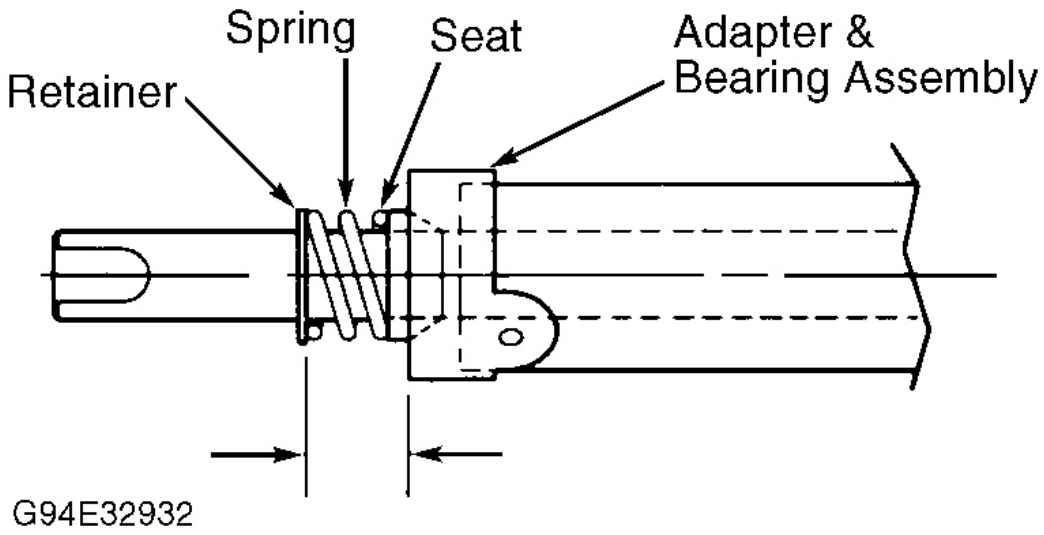
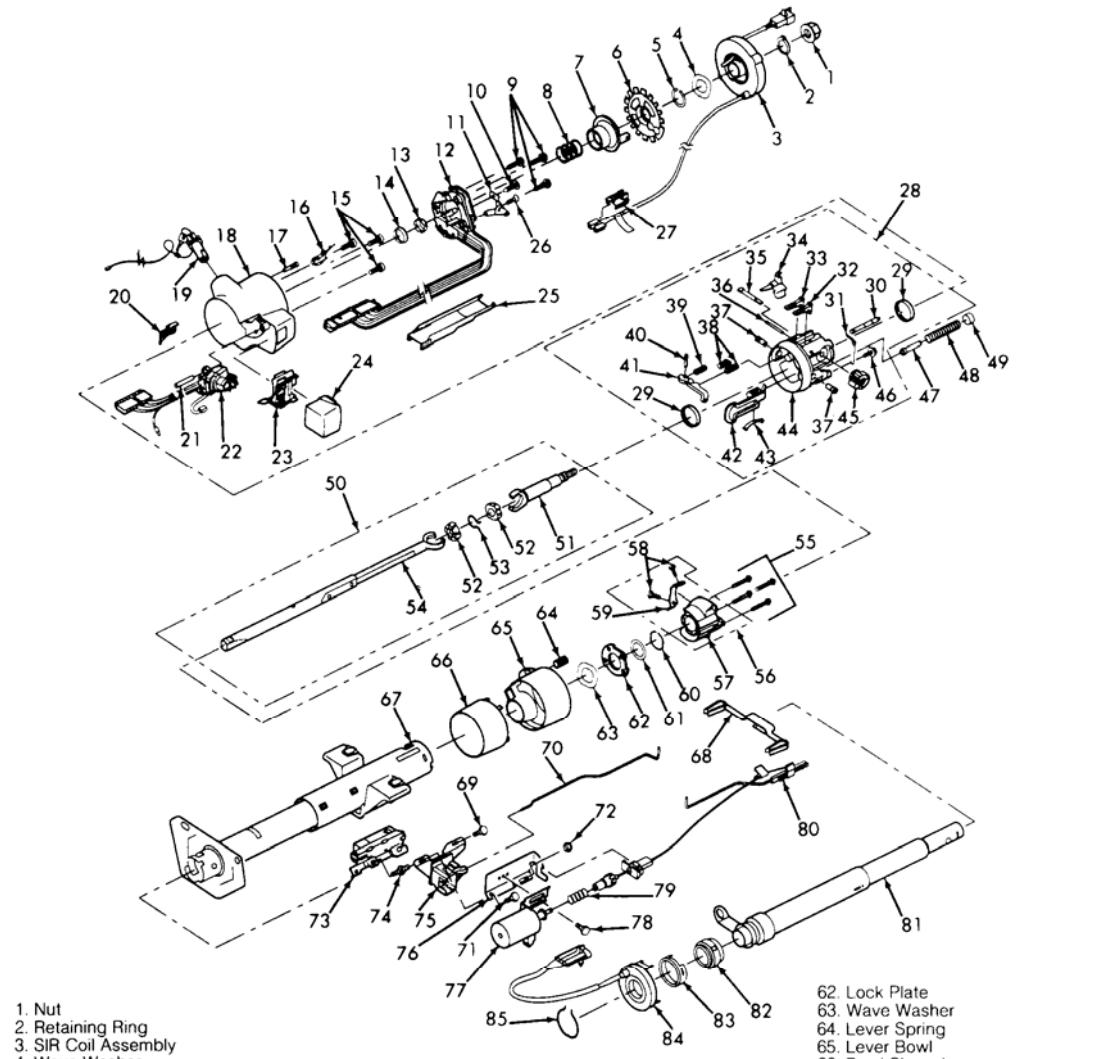


Fig. 13: Measuring Spring Height
Courtesy of GENERAL MOTORS CORP.



1. Nut
2. Retaining Ring
3. SIR Coil Assembly
4. Wave Washer
5. Retainer Ring
6. Shaft Lock
7. Turn Signal Cancel Cam
8. Spring
9. Screw
10. Screw
11. Turn Signal Switch Arm
12. Turn Signal Switch
13. Seat
14. Inner Race
15. Screw
16. Buzzer Switch
17. Screw
18. Housing Cover
19. Lock Cylinder
20. Dimmer Switch Rod Actuator
21. Pivot Pin
22. Pivot & Pulse Switch
23. Base Plate
24. Cover End Cap
25. Wiring Protector
26. Screw
27. Connector Shroud
28. Housing
29. Bearing Assembly
30. Lock Bolt
31. Lock Bolt Spring
32. Lock Shoe
33. Lock Shoe
34. Protector Shield
35. Drive Shaft
36. Dowel Pin
37. Pivot Pin
38. Shoe Spring
39. Lever Spring
40. Lever Pin
41. Release Lever
42. Actuator Rack
43. Preload Spring
44. Housing
45. Actuator Sector
46. Screw
47. Spring Guide
48. Spring
49. Spring Retainer
50. Steering Shaft
51. Race & Upper Shaft
52. Centering Sphere
53. Preload Spring
54. Lower Steering Shaft
55. Screw
56. Support
57. Support
58. Screw
59. Lever Gate
60. Retaining Ring
61. Thrust Washer
62. Lock Plate
63. Wave Washer
64. Lever Spring
65. Lever Bowl
66. Bowl Shroud
67. Jacket Assembly
68. Cable Retainer
69. Screw
70. Dimmer Switch Rod
71. Screw
72. Nut
73. Ignition Switch
74. Stud
75. Dimmer Switch
76. Bracket
77. Solenoid & Interlock Assembly
78. Screw
79. Ball Joint Spring
80. Ignition Switch Actuator
81. Shift Tube
82. Shaft Bushing
83. Adapter Retainer
84. Steering Wheel Rotation Sensor
85. Adapter Clip

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Fig. 14: Exploded View Of Steering Column Assembly
Courtesy of GENERAL MOTORS CORP.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Column Bracket-To-Instrument Panel Stud Nuts	20 (27)
Column Bracket-To-Upper Support Bolts	20 (27)
Column Bracket-To-Instrument Panel Stud Nuts	20 (27)
Flexible Coupling Nuts	20 (27)
Intermediate Shaft-To-Steering Shaft Bolt	35 (47)
Lower Intermediate Shaft-To-Steering Gear Box Bolt	35 (47)
Steering Wheel Nut	30 (41)
Upper Intermediate Shaft-To-Steering Column Bolt	40 (54)
Steering Wheel Rotation Sensor	40 (54)
INCH Lbs. (N.m)	
Air Bag Module Screws	25 (2.8)
Dimmer Switch Nut And Stud	35 (4)
Ignition Switch Screw And Stud	35 (4)
Lock Cylinder Screws	22 (2.5)
Lock Housing Cover Screws	80 (9)
Support-To-Jacket Screws	(1) 77 (8.8)
Turn Signal Switch Screws	30 (3.4)

(1) Steering column upper support assembly-to-column jacket assembly mounting screws.

STEERING GEAR - POWER

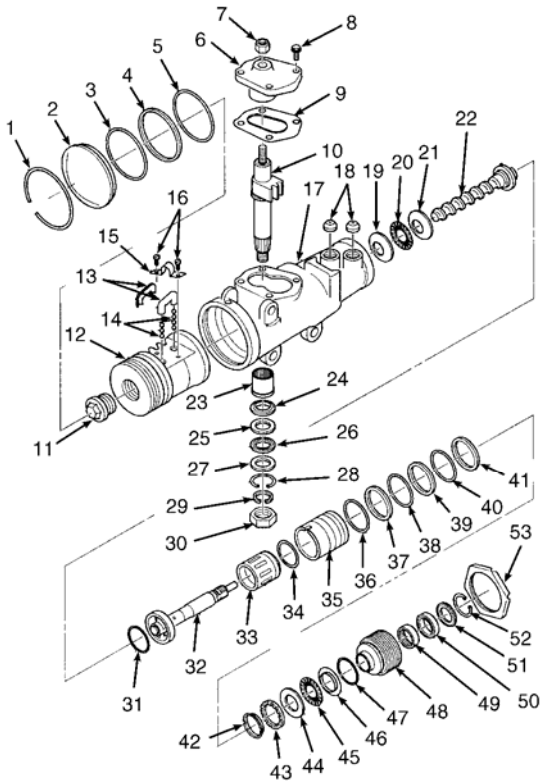
STEERING Power Recirculating Ball

DESCRIPTION & OPERATION

STEERING GEAR

NOTE: Some Roadmaster models are equipped with Variable Effort Steering (VES) system, identified by a solenoid on power steering pump at pressure line outlet. Refer to the appropriate STEERING SYSTEM - VARIABLE EFFORT article.

Steering gear assembly contains a recirculating ball system which acts as a rolling thread between worm shaft and rack piston. See **Fig. 1** . Steering gear housing contains a control valve that directs hydraulic pressure through rotary valve spool and body, to either side of rack piston. Hydraulic pressure exerted on rack piston lessens mechanical force required to turn pitman shaft and steering linkage.



1. Retaining Ring
2. End Plug
3. "O" Ring Seal
4. Teflon Ring
5. "O" Ring Seal
6. Side Cover
7. Adjuster Lock Nut
8. Bolt
9. Gasket
10. Pitman Shaft
11. Plug
12. Rack Piston
13. Ball Guide
14. Balls
15. Clamp
16. Screw
17. Housing
18. Check Valve
19. Race
20. Bearing
21. Race
22. Worm Shaft
23. Bearing
24. Single Lip Seal
25. Washer
26. Double Lip Seal
27. Washer
28. Retaining Ring
29. Lock Washer
30. Nut
31. "O" Ring
32. Stub Shaft
33. Valve Spool
34. "O" Ring
35. Valve Body
36. "O" Ring
37. Ring
38. "O" Ring
39. Ring
40. "O" Ring
41. Spacer
42. Bearing Retainer
43. Spacer
44. Race
45. Bearing
46. Race
47. "O" Ring
48. Adjuster Plug
49. Needle Bearing
50. Seal
51. Seal
52. Retaining Ring
53. Lock Nut

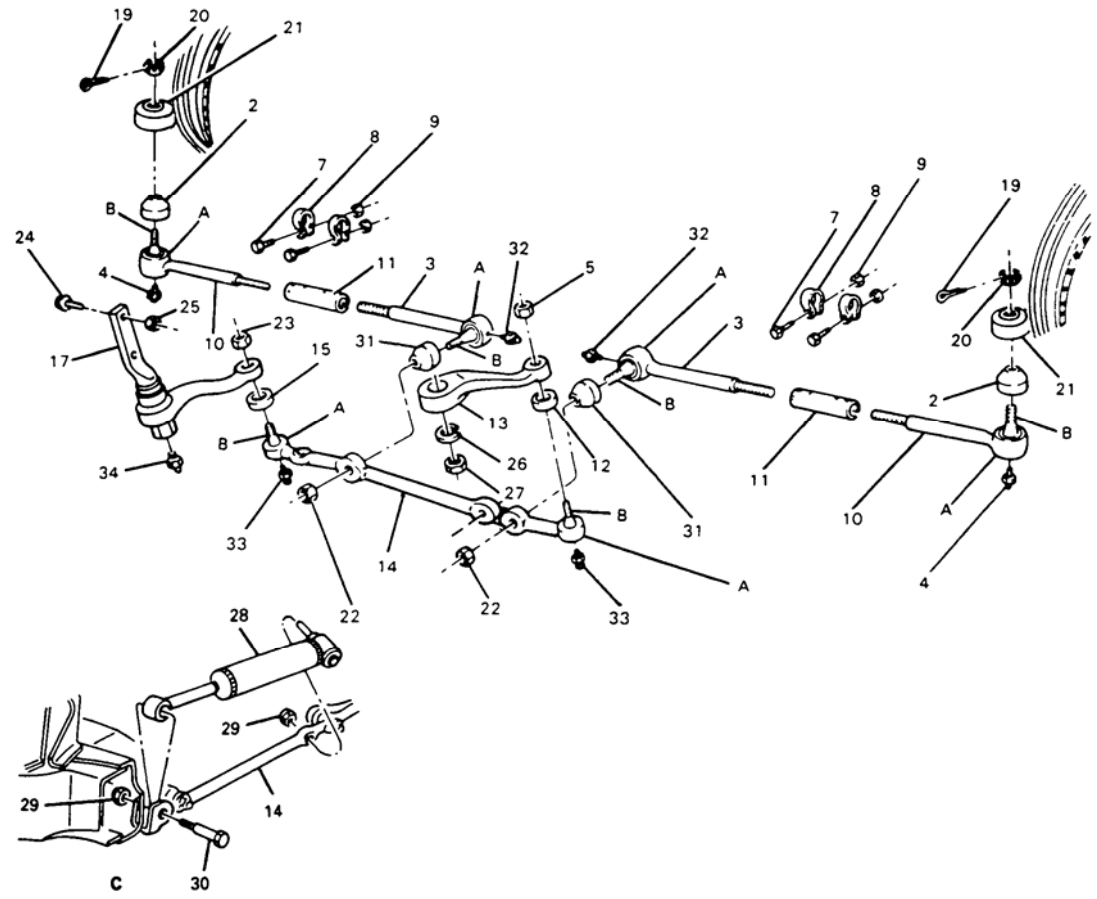
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Courtesy of General Motors Corp.

Fig. 1: Exploded View Of Power Steering Gear
Courtesy of GENERAL MOTORS CORP.

STEERING LINKAGE

Steering linkage connects steering gear to front wheels through pitman arm. Steering linkage consists of pitman arm, idler arm, relay rod and tie rods. See **Fig. 2** . Tie rod ends connect to relay rod by ball studs. Adjuster tubes between inner and outer tie rod ends are used to adjust toe. Some models have a shock absorber attached to relay rod.



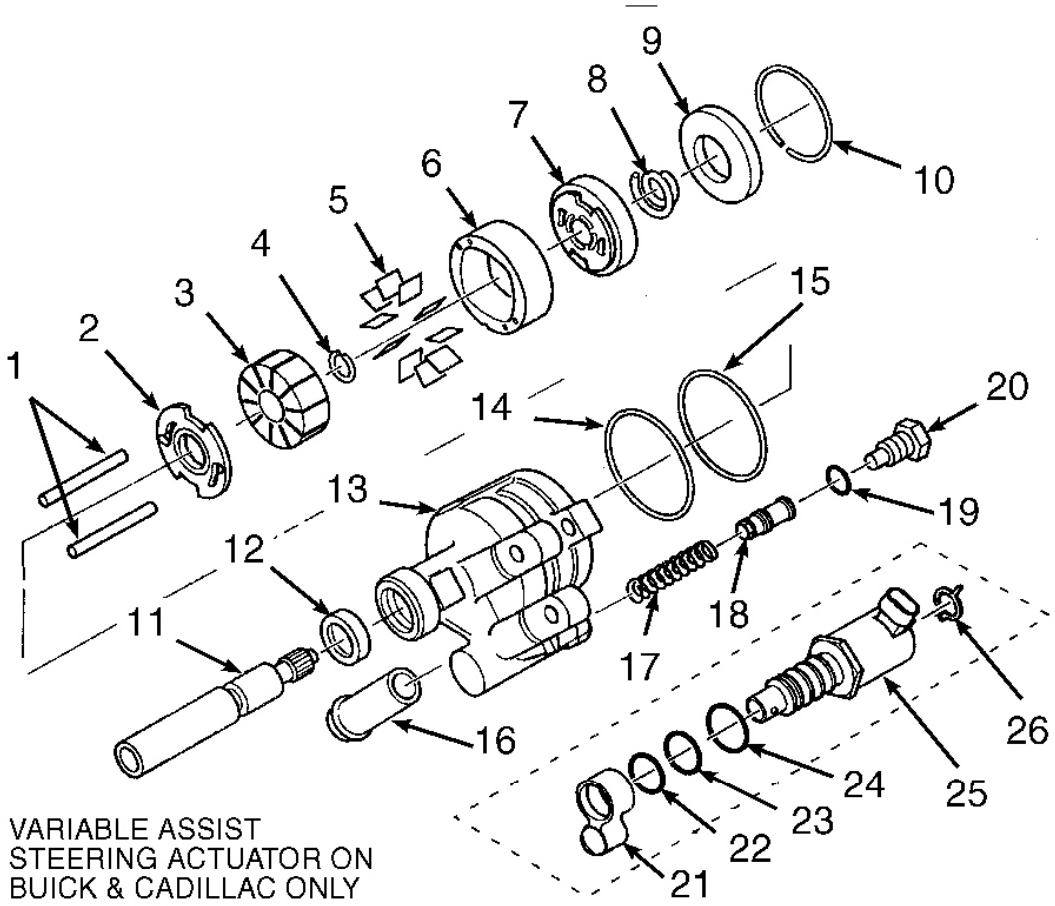
A BALL JOINTS
B BALL STUD
C BUICK WITH RPO NV7 (VARIABLE EFFORT STEERING)
2 SEAL, STEERING LINKAGE OUTER TIE ROD
3 ROD, STEERING LINKAGE INNER TIE
4 FITTING, STEERING LINKAGE OUTER TIE ROD LUBRICATE
5 NUT, STEERING LINKAGE RELAY ROD
7 BOLT/SCREW, STEERING LINKAGE TIE ROD, ADJUST CLAMP
8 CLAMP, STEERING LINKAGE TIE ROD ADJUST
9 NUT, STEERING LINKAGE TIE ROD ADJUST CLAMP
10 ROD, STEERING LINKAGE OUTER TIE
11 ADJUSTER, STEERING LINKAGE TIE ROD
12 SEAL, STEERING LINKAGE RELAY ROD
13 ARM, PITMAN
14 ROD, STEERING LINKAGE RELAY
15 SEAL, STEERING LINKAGE RELAY ROD
17 ARM, STEERING LINKAGE IDLER
19 PIN, STEERING LINKAGE OUTER TIE ROD COTTER
20 NUT, STEERING LINKAGE OUTER TIE ROD
21 KNUCKLE AND HUB ASSEMBLY, STEERING
22 NUT, STEERING LINKAGE INNER TIE ROD
23 NUT, STEERING LINKAGE RELAY ROD
24 BOLT/SCREW, STEERING LINKAGE IDLER ARM
25 NUT, STEERING LINKAGE IDLER ARM
26 WASHER, PITMAN ARM
27 NUT, PITMAN ARM
28 ABSORBER ASSEMBLY, STEERING LINKAGE SHOCK
29 NUT, STEERING LINKAGE SHOCK ABSORBER
30 BOLT/SCREW, STEERING LINKAGE SHOCK ABSORBER
31 SEAL, STEERING LINKAGE INNER TIE ROD
32 FITTING, STEERING LINKAGE INNER TIE ROD LUBRICATE
33 FITTING, STEERING LINKAGE RELAY ROD LUBRICATE
34 FITTING, STEERING LINKAGE IDLER ARM LUBRICATE

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Fig. 2: Exploded View Of Steering Linkage
Courtesy of GENERAL MOTORS CORP.

POWER STEERING PUMP

Power steering pump is a constant displacement vane-type pump with a remote fluid reservoir. When fluid pressure exceeds preset limits, an internal flow control pressure relief valve opens, allowing fluid to return to reservoir and inlet side of pump. See **Fig. 3** .



VARIABLE ASSIST
STEERING ACTUATOR ON
BUICK & CADILLAC ONLY

1. Dowel Pin
2. Thrust Plate
3. Rotor
4. Retaining Ring
5. Vanes
6. Pump Ring
7. Pressure Plate
8. Pressure Plate Spring
9. End Plate
10. Retaining Ring
11. Drive Shaft
12. Drive Shaft Seal
13. Housing
14. "O" Ring (Pressure Plate)
15. "O" Ring (End Cover)
16. Inlet Tube
17. Control Valve Spring
18. Flow Control Valve
19. "O" Ring
20. Fitting
21. Discharge Fitting
22. "O" Ring
23. "O" Ring
24. "O" Ring
25. VES Actuator
26. Retaining Clip

95E13411

Fig. 3: Exploded View Of Power Steering Pump
Courtesy of GENERAL MOTORS CORP.

TROUBLE SHOOTING

NOTE: See the TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

TESTING

NOTE: Incorrect fluid level, belt tension, idle speed or damaged pump pulley can affect test results. Correct such conditions before testing power steering system.

1. On Fleetwood, connect Power Steering Pressure Tester (J-5176-D) or Power Steering System Analyzer (J-25323-A) in pressure line from pump. On Caprice, Impala SS and Roadmaster, remove intake duct. Remove brake control valve bracket bolts and reposition to access steering gear. Connect tester in pressure line from steering gear.
2. On all models, open valve fully. Start and run engine until fluid reaches normal operating temperature. Bleed power steering system. See **HYDRAULIC SYSTEM BLEEDING** . Check fluid level. Add fluid as necessary.
3. With engine at operating temperature, pressure reading should be less than 150 psi (10.5 kg/cm^2). If pressure is more than 150 psi (10.5 kg/cm^2), inspect system for restrictions. Check for proper installation of check valve in steering gear for.

   CAUTION: To prevent pump damage, DO NOT hold valve closed for more than 5 seconds.

4. Completely close valve for less than 5 seconds and then open it, recording highest pressure obtained when valve is closed. Repeat procedure 2 more times. Each reading should be at least 1000 psi (70.3 kg/cm^2).
5. If readings are within 50 psi (3.5 kg/cm^2) of each other, pump is okay. If readings are high and not within 50 psi (3.5 kg/cm^2) of each other, flow control valve is sticking. Remove and clean flow control valve with crocus cloth. Flush system if dirty.
6. If pressure readings are less than 1000 psi (70.3 kg/cm^2), replace flow control valve, then repeat test. If pressure is still low after replacing flow control valve, replace rotor and vanes. Refer to the **POWER STEERING PUMP** procedures under OVERHAUL.
7. If pump meets specification, leave valve open. Turn steering wheel from stop to stop, recording highest pressure at each stop. If pressure at both stops is not equal to pressure recorded in step 4), steering gear is leaking internally. Repair or replace steering gear.

LUBRICATION

CAPACITY

NOTE: Information is not available from manufacturer.

FLUID TYPE

When adding or changing fluid, use power steering fluid meeting GM Specification No. 9985010. Use of improper fluid will cause hose, pump and seal damage, resulting in fluid leaks and/or failure to operate.

FLUID LEVEL CHECK

Fluid level is indicated by marks on reservoir dipstick. When fluid is at operating temperature, about 170°F (77° C), fluid level should be at FULL HOT mark. Fluid level should be at FULL COLD mark when fluid is cold, about 70°F (21°C).

HYDRAULIC SYSTEM BLEEDING

CAUTION: If air is introduced into hydraulic system during servicing, bleed complete system. Aerated fluid, which appears Light Tan in color, results in poor steering performance and will cause severe pump damage.

1. With engine off, raise and support vehicle with front wheels off ground and turned fully to left. Add power steering fluid to FULL COLD mark on dipstick. Leave cap off.
2. Turn wheels from side to side, without touching stops at either end. Add fluid, if necessary, to maintain level at FULL COLD mark. It may be necessary to repeat this step several times.
3. Start engine. With engine idling, recheck fluid level. Add fluid, if necessary, to bring level to FULL COLD mark. Install cap. Ensure wheels are at center, straight-ahead position. Lower vehicle. Continue to run engine for 2-3 minutes to eliminate air in system.
4. Road test vehicle. Check for leaks. Ensure fluid level is at FULL HOT mark when fluid is stabilized at operating temperature.

ADJUSTMENTS

POWER STEERING PUMP BELT

Power steering pump is driven by serpentine belt. Belt tension is maintained by automatic tensioner. No maintenance or adjustment is necessary. Check belt operating range, indicated by marks on tensioner. If belt is not within operating range, check for proper installation before replacing belt.

WORM BEARING PRELOAD ADJUSTMENT

See **WORM BEARING PRELOAD** under OVERHAUL.

PITMAN SHAFT OVER-CENTER TURNING TORQUE

See **PITMAN SHAFT OVER-CENTER TURNING TORQUE** under OVERHAUL.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

NOTE: After replacing or repairing steering components, check wheel alignment. See WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES in the WHEEL ALIGNMENT section.

IDLE SPEED PRESSURE SWITCH

Removal & Installation

Raise and support vehicle. Remove electrical connector. Remove pressure switch from steering gear inlet hose. Lubricate "O" ring and threads of switch with power steering fluid. Install and tighten pressure switch to 115 INCH lbs. (13 N.m). Install electrical connector. Fill and bleed the power steering hydraulic system. See the **HYDRAULIC SYSTEM BLEEDING** procedures under LUBRICATION.

INNER & OUTER TIE ROD ENDS

CAUTION: Tie rod adjuster parts often become rusted in service. In such cases, it is recommended that if the torque required to remove the tie rod clamp nut from the bolt/screw after breakaway exceeds 80 INCH lbs. (9 N.m), discard bolts/screws and nuts. Install NEW bolts/screws and nuts having the same part number to ensure proper clamping at specified tie rod clamp nut torque.

NOTE: Count the number of turns required to remove the inner or outer tie rod end from the tie rod adjuster tube for reassembly reference.

Removal

Raise and support vehicle. Remove cotter pins and outer tie rod end nuts. See **Fig. 2** . Remove inner tie rod end nuts. Using Universal Steering Linkage Puller (J-24319-01), remove outer tie rod ball studs from steering knuckle and inner tie rod ball studs from relay rod. Loosen adjuster tube clamp bolts and clamps. Unscrew and remove tie rod ends from adjuster tube.

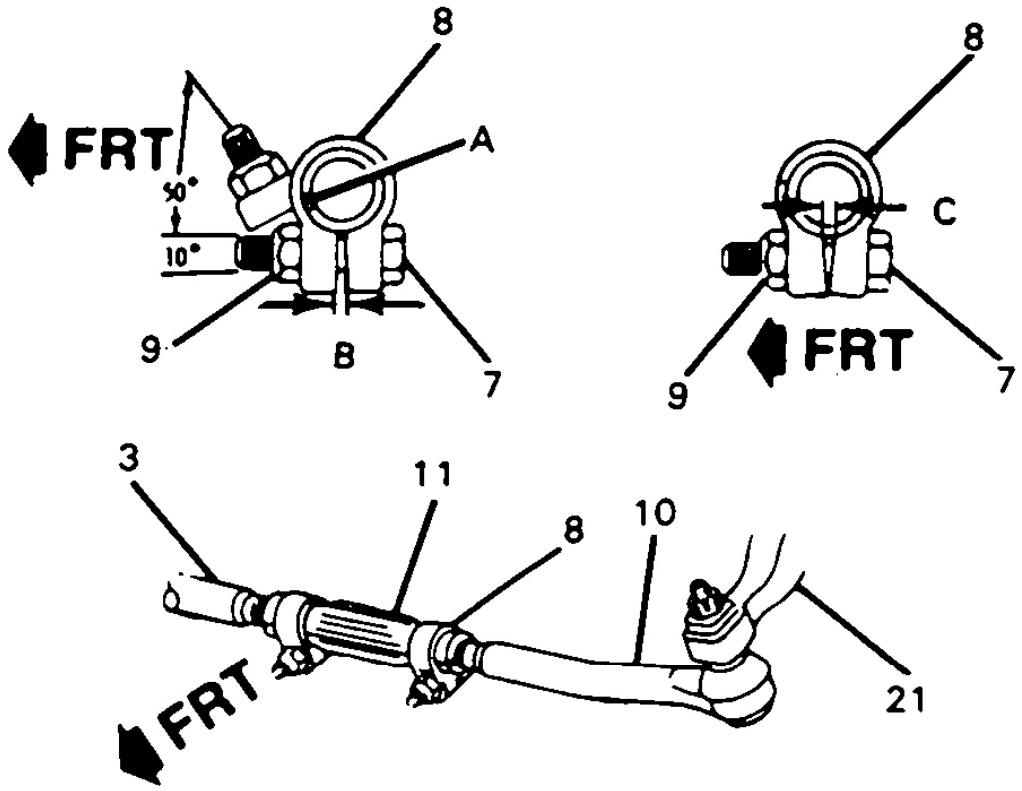
Installation

1. Lubricate tie rod end threads with chassis lubricant before installing. Install inner and outer tie rod ends to adjuster tube, referencing the number of turns required when removing tie rod ends. Inner and outer tie rod end threads must be adjusted equally within 3 threads. Install adjuster clamps and clamp bolts. Ensure clamps are positioned between locating dimples on ends of adjuster tube.

2. Tie rod ends must rotate full travel and travel must be maintained during clamp tightening. Slot in adjuster tube and slot in clamp must be properly positioned. See **Fig. 4** .
3. Install inner tie rod ends to relay rod ensuring seal is on ball stud. Tighten Steering Linkage Installer (J-29193) to 15 ft. lbs. (20 N.m) to seat tapers. Install and tighten inner tie rod end-to-relay rod nuts to specification. See **TORQUE SPECIFICATIONS** .

CAUTION: When installing outer tie rod end nut, tighten nut to align cotter pin hole. DO NOT tighten nut more than an additional 1/6 turn to align cotter pin hole. DO NOT back off nut to insert cotter pin.

4. Install outer tie rod end to steering knuckle. Install and tighten outer tie rod end nut to specification. See **TORQUE SPECIFICATIONS** . Install cotter pin. Adjust toe-in. See **WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES** article in SUSPENSION.



A ADJUSTER TUBE SLOT
8 GAP
C GAP AFTER TIGHTENING
3 ROD, STEERING LINKAGE INNER TIE
7 BOLT/SCREW, STEERING LINKAGE TIE ROD ADJUST CLAMP
8 CLAMP, STEERING LINKAGE TIE ROD ADJUST
9 NUT, STEERING LINKAGE TIE ROD ADJUST CLAMP
10 ROD, STEERING LINKAGE OUTER TIE
11 ADJUSTER, STEERING LINKAGE TIE ROD
21 KNUCKLE AND HUB ASSEMBLY, STEERING

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Fig. 4: Positioning Tie Rod End/Connecting Rod End & Adjuster Tube Clamps
Courtesy of GENERAL MOTORS CORP.

RELAY ROD

Removal

1. Raise and support vehicle. Remove inner tie rod end nuts. See **Fig. 2** . Using Universal Steering Linkage Puller (J-24319-01), remove inner tie rod ball studs from relay rod.
2. Remove nut securing pitman arm to relay rod. Using steering linkage puller, separate pitman arm from relay rod. Steering may have to be placed in Unlock position and turned to remove relay rod from pitman arm.
3. Remove steering shock absorber nut from relay rod (if equipped). Using steering linkage puller, remove steering shock absorber from relay rod (if equipped).
4. Remove nut securing idler arm to relay rod. Using steering linkage puller, remove idler arm from relay rod. Remove relay rod.

Installation

To install, reverse removal procedure. Ensure seals are on ball studs. Using Steering Linkage Installer (J-29193), seat all tapers to 15 ft. lbs. (20 N.m). Remove steering linkage installer. Tighten all nuts to specification. See **TORQUE SPECIFICATIONS** . Adjust toe-in. See the **WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES** article in SUSPENSION.

IDLER ARM

NOTE: Replace idler arm assembly if an up and down force of 25 ft. lbs. (110 N.m), applied at relay rod end of idler arm, produces a lash of more than 1/8" (3 mm).

Removal

Raise and support vehicle. Remove idler arm-to-frame nuts and bolts. See **Fig. 2** . Remove nut securing idler arm to relay rod. Using Steering Linkage Puller (J-24319-01), remove idler arm from relay rod. Remove idler arm.

Installation

NOTE: Idler arm must be properly located on it's threaded support so idler arm ball socket will be level with pitman arm ball socket. Idler arm support must be threaded into idler arm bushing until distance from center of lower mounting bolt is 2.281-2.407" (57.84-61.04 mm). See Fig. 5 . The position of the idler arm must be adjusted before installation. After adjustment, idler arm support must be free to rotate 90 degrees in each direction.

To install, reverse removal procedure. Ensure seal is on idler arm ball stud. Using Steering Linkage Installer (J-29193), seat taper between idler arm and relay rod to 15 ft. lbs. (20 N.m). Install nut securing idler arm to relay rod and tighten to specification. See **TORQUE SPECIFICATIONS** . Install idler arm to frame. Tighten idler arm-to-frame bolts/nuts to specification. Adjust toe-in. See procedures in the **WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES** article in SUSPENSION.

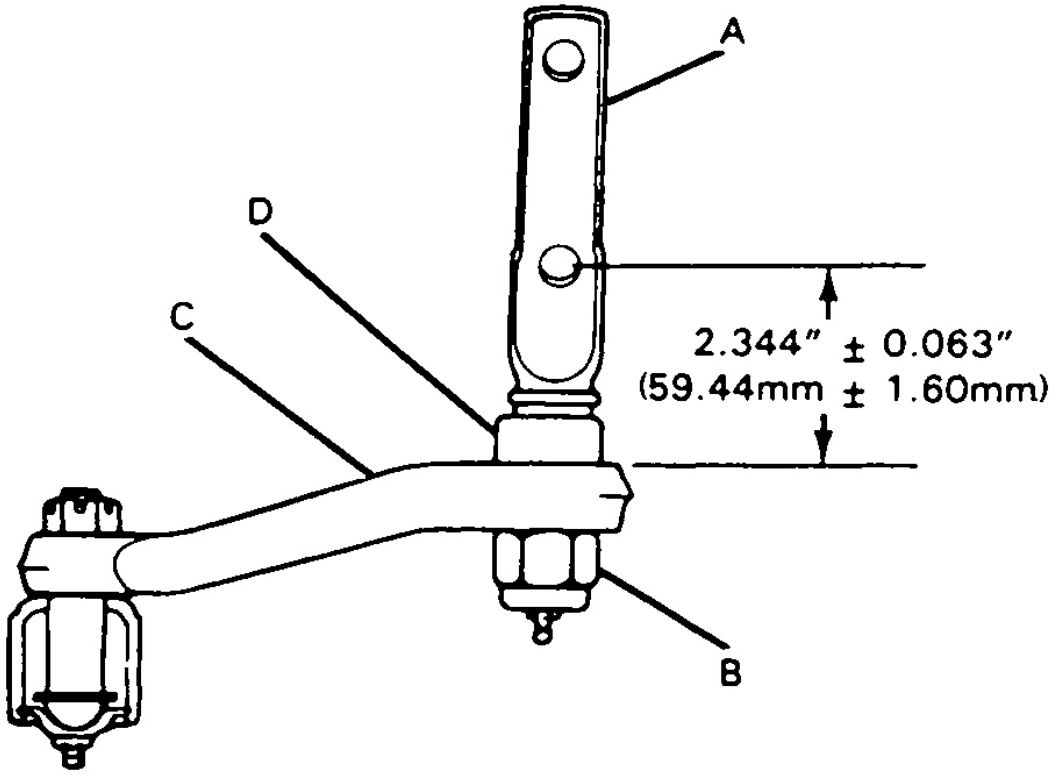


Fig. 5: Identifying Correct Idler Arm Adjustment
Courtesy of GENERAL MOTORS CORP.

PITMAN ARM

Removal

Raise and support vehicle. Remove nut securing pitman arm to relay rod. See **Fig. 2** . Using Steering Linkage Puller (J-24319-01), remove pitman arm from relay rod. Remove pitman arm nut and washer. Mark relationship of pitman arm-to-pitman shaft. Using Pitman Arm Puller (J-9172), remove pitman arm.

Installation

Install pitman arm onto pitman shaft and ensure pitman arm-to-pitman shaft reference marks are aligned. Install NEW nut and washer and tighten to specification. See **TORQUE SPECIFICATIONS** . Ensure seal is on relay rod ball stud. Install relay rod to pitman arm. Using Steering Linkage Installer (J-29193), seat taper between pitman arm and relay rod to 15 ft. lbs. (20 N.m). Install and tighten nut securing pitman arm to relay rod to specification.

FLUID RESERVOIR

Removal & Installation

Siphon fluid from reservoir. Place drain pan under reservoir, and remove hoses. With rocking motion, pull reservoir from A/C accumulator assembly bracket. To install, reverse removal procedure. Ensure reservoir is seated properly. Fill and bleed system. Refer to the **HYDRAULIC SYSTEM BLEEDING** procedures under LUBRICATION.

PITMAN SHAFT SEALS

Removal

1. Remove pitman arm nut and washer. Using appropriate puller, separate pitman arm from pitman shaft. Clean exposed end of Pitman shaft and bottom end of steering gear housing. Place drain pan under Pitman shaft. Using internal snap ring pliers, remove retaining ring.
2. Prepare to catch fluid and components that will be forced out under system pressure. Start engine. Turn wheels fully to left to force out washer and double lip seal. Stop engine.
3. If necessary, finish removing washer and double lip seal using a small tipped screwdriver or hooked scratch awl. **DO NOT** scratch housing bore or pitman shaft surfaces.
4. Replace pitman shaft if shaft seal surfaces are pitted or rough. Remove burrs from housing, if present.

Installation

Install single-lip seal and washer. Coat double-lip seal and washer with grease. Using Seal Installer (J-6219), install double-lip seal and washer. Install retaining ring. Position pitman arm onto shaft. Install NEW washer and nut. Tighten pitman arm nut to specification. See **TORQUE SPECIFICATIONS** . Fill and bleed system. Refer to **HYDRAULIC SYSTEM BLEEDING** under LUBRICATION.

POWER STEERING PUMP

NOTE: It may be necessary to remove pump bracket with pump. Bracket mounting bolts may extend into water jacket.

Removal & Installation

1. Siphon fluid from power steering reservoir. Drain cooling system. On vehicles equipped with mechanical fan, disconnect negative battery cable. Remove upper fan shroud. Remove fan and clutch assembly. Remove cooling fan pulley bracket (if necessary). Remove radiator outlet hose and pipe assembly.
2. On all models, remove heater hoses from water pump and alternator and power steering pump bracket. Remove drive belt. Disconnect fluid reservoir and pressure hoses from pump. Remove pump mounting bolts. Remove power steering pump pulley (if necessary). Remove pump. To install, reverse removal procedure. Fill and bleed hydraulic system. See **HYDRAULIC SYSTEM BLEEDING** under LUBRICATION. Fill and bleed cooling system.

POWER STEERING PUMP PULLEY

CAUTION: When clamping pump in vise or mounting fixture, DO NOT exert excessive force on front hub. Housing may be distorted.

Removal & Installation

Remove drive belt. If necessary, remove pump for clearance. See **POWER STEERING PUMP** . Install Pulley Remover (J-25034-B) on pulley. Remove pulley from shaft by holding body of tool with wrench and turning bolt. To install, use Pulley Installer (J-25033-B). Draw pulley onto drive shaft until face of pulley hub is even with shaft. **DO NOT** use a press to install pulley. Install pump (if removed).

POWER STEERING PUMP DRIVE SHAFT SEAL

Removal & Installation

Remove pump and pulley. Refer to the **POWER STEERING PUMP** and **PUMP PULLEY** procedures. Protect pump shaft with shim stock. Using a chisel, cut and remove seal. To install, coat shaft seal with power steering fluid. Using Shaft Oil Seal Installer (J-22670), drive new seal until it bottoms on shoulder.

NOTE: DO NOT disassemble flow control valve. If valve is sticking, clean with crocus cloth or replace valve.

POWER STEERING PUMP FLOW CONTROL VALVE

Removal & Installation

Remove Pump. See **POWER STEERING PUMP** . On vehicles with Variable Effort Steering (VES) system, remove VES actuator and pressure line adapter. On vehicles without VES, remove union bolt (flow control valve fitting). See **Fig. 3** . On all vehicles, remove flow control valve and spring. To install, reverse removal procedure using a new, lubricated "O" ring. Tighten fittings to specification. See **TORQUE SPECIFICATIONS** .

STEERING GEAR

NOTE: If steering gear is to be overhauled, remove pitman shaft seals before removing steering gear. See PITMAN SHAFT SEALS .

Removal & Installation

1. Siphon fluid from reservoir. Disconnect pressure and return lines from steering gear. Remove intermediate steering shaft lower coupling pinch bolt. Separate intermediate steering shaft lower coupling from steering gear stub shaft.
2. Remove pitman arm nut and washer. Using appropriate puller, separate pitman arm from steering gear. Remove ABS modulator bracket nut from steering gear (if equipped). While supporting steering gear, remove steering gear bolts. Remove steering gear.
3. To install, reverse removal procedure. Ensure steering gear is aligned as straight as possible with intermediate shaft. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .

OVERHAUL

POWER STEERING PUMP OVERHAUL

CAUTION: When clamping pump in vise or mounting fixture, DO NOT exert excessive force on front hub. Housing may be distorted.

Disassembly

1. Remove pulley, drive shaft seal and flow control valve. See **PUMP PULLEY** . Also refer to the procedures for removal and installation in **PUMP DRIVE SHAFT SEAL** . Also refer to removal and installation procedures in **PUMP FLOW CONTROL VALVE** under REMOVAL & INSTALLATION. Remove end cover retainer ring. See **Fig. 3** . Remove end cover and pressure plate spring. Check shaft for corrosion. If shaft is corroded, clean with crocus cloth to prevent damaging shaft bushing when tapping shaft out of housing.
2. Tap lightly on end of shaft with plastic mallet to remove pressure plate. Remove pump ring and vanes. Remove and disassemble shaft, rotor and thrust plate assembly. Remove "O" rings from housing.

Inspection

1. Clean all parts in solvent. Clean residue from pump magnet. Inspect flow control valve for wear or damage. Inspect seal bore in housing for burrs, nicks or scoring. Inspect fit of vanes in rotor. Vanes must slide freely into rotor slots without binding.
2. Excessively loose vanes require replacement of rotor and/or vanes. Examine inner surface of pump ring for heavy scuff or chatter marks. Inspect flat surfaces of pressure and thrust plates for wear or scoring.
3. Light scoring can be removed by lapping on a flat surface. Inspect pump housing drive shaft bushing for excessive wear. Replace pump housing and bushing as an assembly if badly worn or scored. Replace any damaged or worn parts.

Reassembly

1. Lubricate all "O" rings and sealing areas with power steering fluid. Place pump housing on flat surface. Using Shaft Oil Seal Installer (J-22670), drive new shaft seal into bore. To prevent seal from being distorted, **DO NOT** use excessive force.
2. Clamp pump housing in vise with shaft down. Install end cover and pressure plate "O" rings in grooves in pump cavity. With drive shaft clamped (splined end up), install thrust plate on drive shaft with ported side up. See **Fig. 6** .
3. Slide rotor over splines, and install rotor lock ring. Insert both dowel pins in holes of pump cavity. Rotor must move freely on splines. Install drive shaft assembly into pump body, ensuring dowel pins are properly engaged in thrust plate.
4. Install vanes in rotor slots. Slide pump ring over rotor on dowel pins with arrows facing up. See **Fig. 7** . Position pressure plate on dowel pins with plate spring groove facing upward. Place a 1 1/4" socket in groove of pressure plate. Seat entire assembly on "O" ring in pump cavity by pressing down with both thumbs.
5. Place pressure plate spring into groove in pressure plate. Position end cover lip edge up over spring. Press

end cover down below retainer ring groove with thumb. Install retainer ring. Ensure ring is seated in groove. Use care to avoid cocking end cover in bore or distorting assembly.

6. Install flow control valve in bore, with control valve spring and hex end of valve facing interior of bore. Using new "O" rings, install union bolt (or VES actuator) into flow control valve bore and tighten to specification. See **TORQUE SPECIFICATIONS** . Install pump pulley.

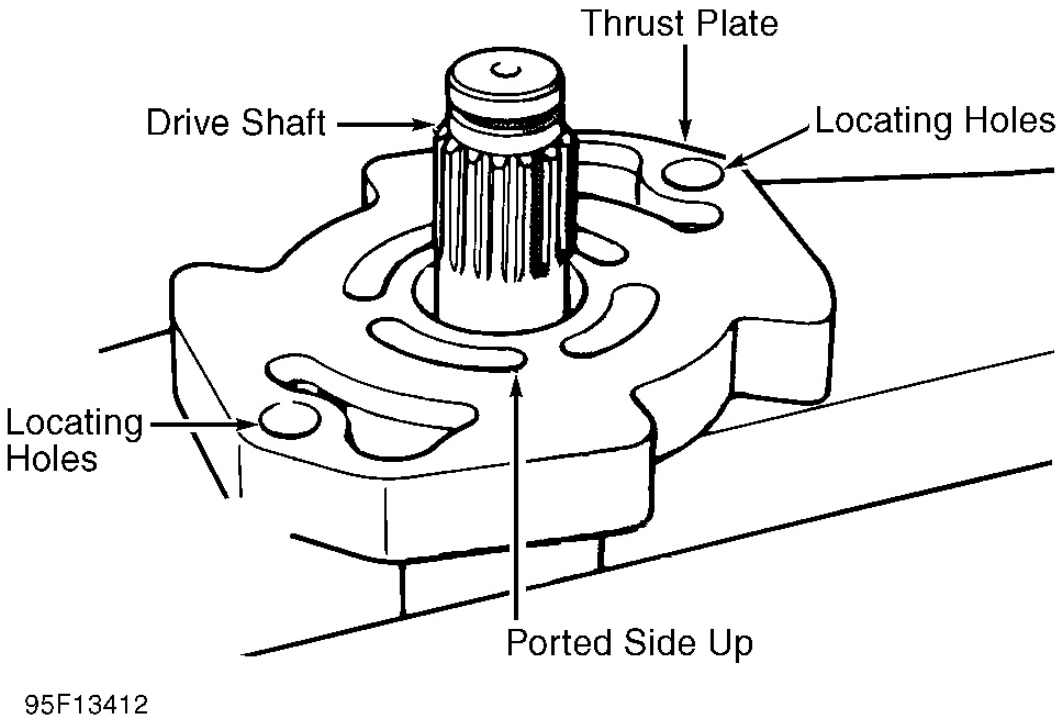


Fig. 6: Installing Thrust Plate
Courtesy of GENERAL MOTORS CORP.

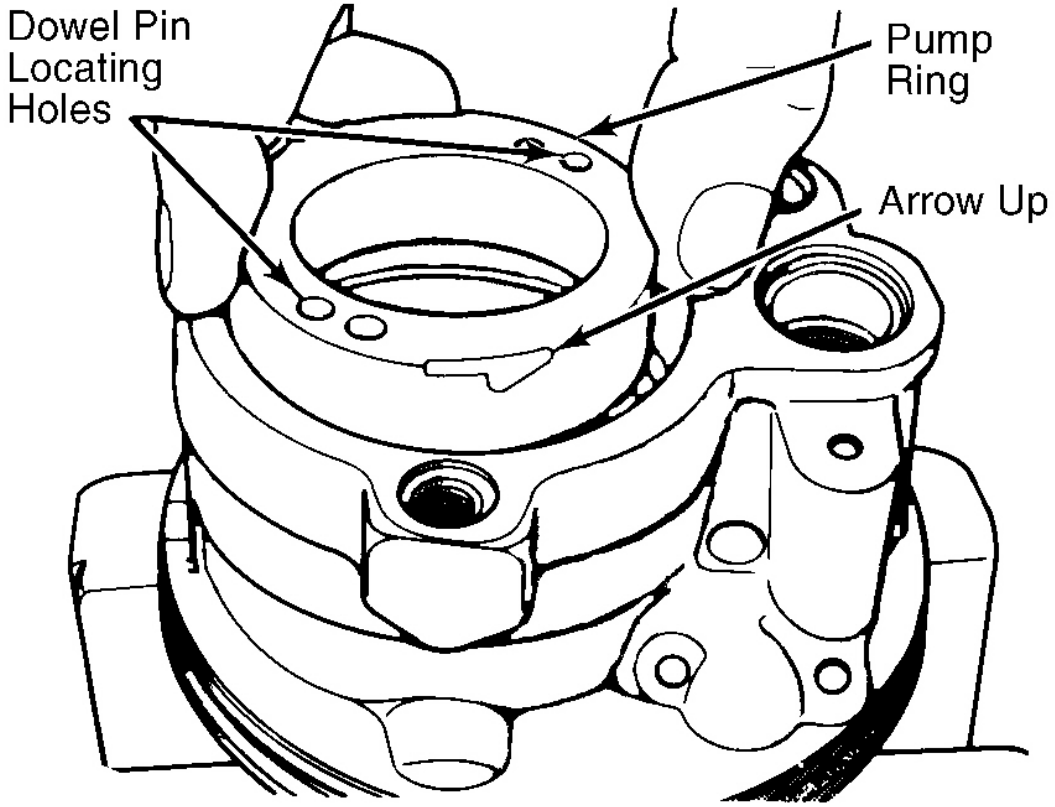


Fig. 7: Installing Pump Ring
Courtesy of GENERAL MOTORS CORP.

STEERING GEAR

NOTE: Before removing steering gear, remove pitman shaft seals. See PITMAN SHAFT SEALS under REMOVAL & INSTALLATION.

Disassembly

1. Remove pitman shaft seals. See **PITMAN SHAFT SEALS** under REMOVAL & INSTALLATION. Mount steering gear in soft-jawed vise with pitman shaft pointing down.
2. Remove pitman shaft adjuster lock nut. See **Fig. 1** . Remove side cover bolts. Rotate stub shaft to center the gear. Remove side cover, gasket and pitman shaft as an assembly. Unseat housing end plug retaining ring by inserting punch into housing access hole. Remove housing end plug and "O" ring seal.
3. Turn stub shaft counterclockwise until rack piston begins to emerge from housing bore. Remove rack piston plug. Insert Rack Piston Arbor (J-21552) into rack piston. Hold arbor firmly against worm shaft while turning stub shaft counterclockwise to force rack piston from housing. Remove rack piston, balls

and rack piston arbor.

4. Remove worm shaft, thrust bearing and races. Remove worm bearing and races. Remove arbor from rack piston. Remove balls, clamp, and ball guide. Remove Teflon ring and "O" ring seal. Using Internal Snap Ring Pliers (J-4245), remove pitman shaft seal retaining ring.

CAUTION: DO NOT score housing bore or shaft surfaces when prying out shaft seals and washers.

5. Pry washer and double-lip seal from housing. Pry out washer and single-lip seal. Insert Pitman Shaft Bearing Remover/Installer (J-6278) through hole in top of housing. Drive out bearing. Carefully pry check valve from housing.
6. Remove stub shaft adjuster lock nut, using punch against edge of slots. Using Spanner Wrench (J-7624), remove adjuster plug. Pry thrust washer bearing retainer from adjuster plug. Remove bearing spacer, races, thrust bearing, "O" ring and retaining ring.
7. Place adjuster plug on suitable support with outside face down. Using Adjuster Plug Bearing Remover/Installer (J-6221), drive needle bearing, dust seal and lip seal from adjuster plug.
8. Remove stub shaft and valve as an assembly. Tap stub shaft lightly on wooden block to loosen shaft cap. Pull cap and valve 1/4" (6 mm) out from body. Disengage stub shaft pin from hole in valve spool. Pull and rotate valve spool to remove it from valve body. Remove valve spool "O" ring, valve body, Teflon rings and "O" ring seals.

NOTE: DO NOT disassemble valve body. If valve body is defective, replace entire valve body as an assembly.

Inspection

Clean housing and lubricate all internal components with power steering fluid. Replace steering gear housing if bore is damaged. Replace worn or damaged components.

NOTE: Lubricate all "O" rings and lip seals with power steering fluid before installation.

Reassembly

1. Drive check valve into housing using a 3/8" (9.5 mm) diameter tubing, 4" (102 mm) long. Coat pitman shaft double-lip seal and washer with grease. Using Pitman Shaft Bearing Remover/Installer (J-6278), install needle bearing.
2. Using Pitman Shaft Oil Seal Installer (J-6219), install single-lip seal, then washer. Install double-lip seal and back-up washer. Using Internal Snap Ring Pliers (J-4245), install retaining ring. Install worm shaft "O" ring seal and Teflon ring. Fully seat worm shaft to rack piston. Align worm shaft groove with rack piston ball return guide hole.

NOTE: Black balls are smaller than Silver balls. Black and Silver balls must be installed alternately into rack piston and ball guide to maintain preload.

3. Lubricate balls with power steering fluid. Insert balls into ball return guide holes while turning worm

shaft counterclockwise. Install remaining balls into ball guide. Apply light grease to each end of ball guide to retain balls. Install ball guide and guide clamp. Tighten ball guide clamp screws.

4. Insert Rack Piston Arbor (J-21552) into rack piston bore while turning worm shaft counterclockwise. Install races and thrust bearing onto worm shaft. Insert worm shaft into housing.
5. Lubricate valve spool and "O" ring seal with power steering fluid. Assemble valve spool "O" ring seal and valve spool. Assemble valve spool and valve body by pushing and rotating until hole in valve spool for stub shaft pin is accessible from opposite end of valve body.
6. Assemble stub shaft and valve spool. Insert retaining pin. Ensure notch in stub shaft cap fully engages valve body pin and seats against valve body shoulder.
7. Assemble "O" ring seals, Teflon rings and valve body. Assemble stub shaft, valve assembly and worm shaft. Ensure pin on stub shaft aligns with slot in valve assembly. Install stub shaft and worm shaft into housing. Hold rack piston arbor tightly against worm shaft while turning stub shaft clockwise until rack piston seats on worm shaft. Install rack piston plug. Use Rack Piston Teflon Ring Compressor (J-8947) to compress seals.
8. Place stub shaft adjuster plug on suitable support with outside of plug facing up. Using Adjuster Plug Bearing Remover/Installer (J-6221), assemble stub shaft needle bearing and adjuster plug. Ensure identification mark on needle bearing faces remover/installer during installation. Using adjuster plug bearing remover/installer, assemble lip seal and dust seal. Install retaining ring.
9. Assemble "O" ring seal, large bearing race, thrust bearing, small bearing race, bearing spacer, thrust bearing retainer and adjuster plug. Install adjuster plug assembly into housing using Spanner Wrench (J-7624). **DO NOT** cut seals when installing adjuster plug.
10. Install housing end plug "O" ring seal, end plug and retaining ring into housing. Ensure open end of retaining ring is about one inch (25 mm) from access hole in housing.
11. Screw pitman shaft into side cover until it is fully seated. Install pitman shaft lock nut. Place gasket on side cover, bending gasket tabs around edge of side cover. Install pitman shaft and side cover into housing. Install and tighten cover bolts to specification. See **TORQUE SPECIFICATIONS** .
12. Using Pitman Shaft Oil Seal Installer (J-6219), install the pitman shaft seals, washers and retaining ring. Adjust the steering gear, referring to the **WORM BEARING PRELOAD** and the **PITMAN SHAFT OVER-CENTER TURNING TORQUE** procedures.

WORM BEARING PRELOAD OVERHAUL

NOTE: This procedure adjusts amount of compression force exerted by the worm shaft on worm shaft conical bearing.

1. Remove steering gear. See **STEERING GEAR** under REMOVAL & INSTALLATION. Rotate stub shaft in both directions to drain fluid from steering gear. Using punch, remove adjuster plug lock nut from adjuster plug near stub shaft. See **Fig. 1** .
2. Using Spanner Wrench (J-7624), tighten adjuster plug until firmly seated in housing. See **Fig. 8** . This requires 22 ft. lbs. (30 N.m) of torque. Mark gear housing at a place opposite one hole in adjuster plug. Measure back (counterclockwise) 1/2" (13 mm) from first mark, and then make another mark on housing.
3. Turn adjuster plug counterclockwise until hole in adjuster plug is aligned with second mark on housing. Hold adjuster plug to maintain alignment with index mark. Tighten adjuster plug lock nut securely.

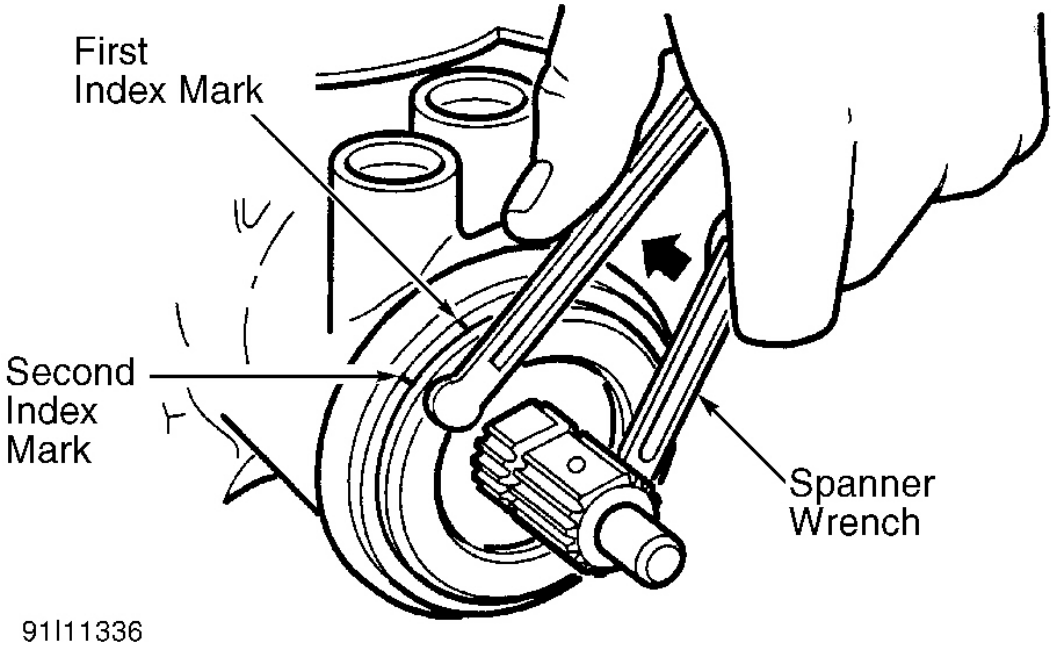


Fig. 8: Aligning Adjuster Plug
Courtesy of GENERAL MOTORS CORP.

PITMAN SHAFT OVER-CENTER TURNING TORQUE OVERHAUL

NOTE: Adjust worm bearing preload before performing this procedure. See WORM BEARING PRELOAD . This procedure adjusts clearance between rack piston and pitman shaft sector teeth.

1. Remove steering gear. See **STEERING GEAR** under REMOVAL & INSTALLATION. Rotate stub shaft in both directions to drain fluid from steering gear. Loosen pitman shaft adjuster lock nut. See **Fig. 1** . Rotate pitman shaft adjuster screw counterclockwise until fully extended, and then turn clockwise one full turn.
2. Turn stub shaft from stop to stop, counting number of turns between stops. Beginning at either stop, turn shaft away from stop 1/2 the number of turns counted. This centers the gear. With gear centered, flat on stub shaft should face upward, parallel to side cover, and master spline on pitman shaft should align with adjuster screw.
3. Using an INCH-lb. torque wrench with handle pointing upward, rotate stub shaft 45 degrees to each side of center to measure worm bearing preload torque. See **Fig. 9** . Record highest turning torque measured on or near center.
4. If turning torque measured is not 6-15 INCH lbs. (.7-1.7 N.m), turn pitman shaft adjuster screw clockwise until torque is as specified, and then tighten screw an additional 6-10 INCH lbs. (.7-1.1 N.m). While preventing adjuster screw from turning, tighten lock nut.

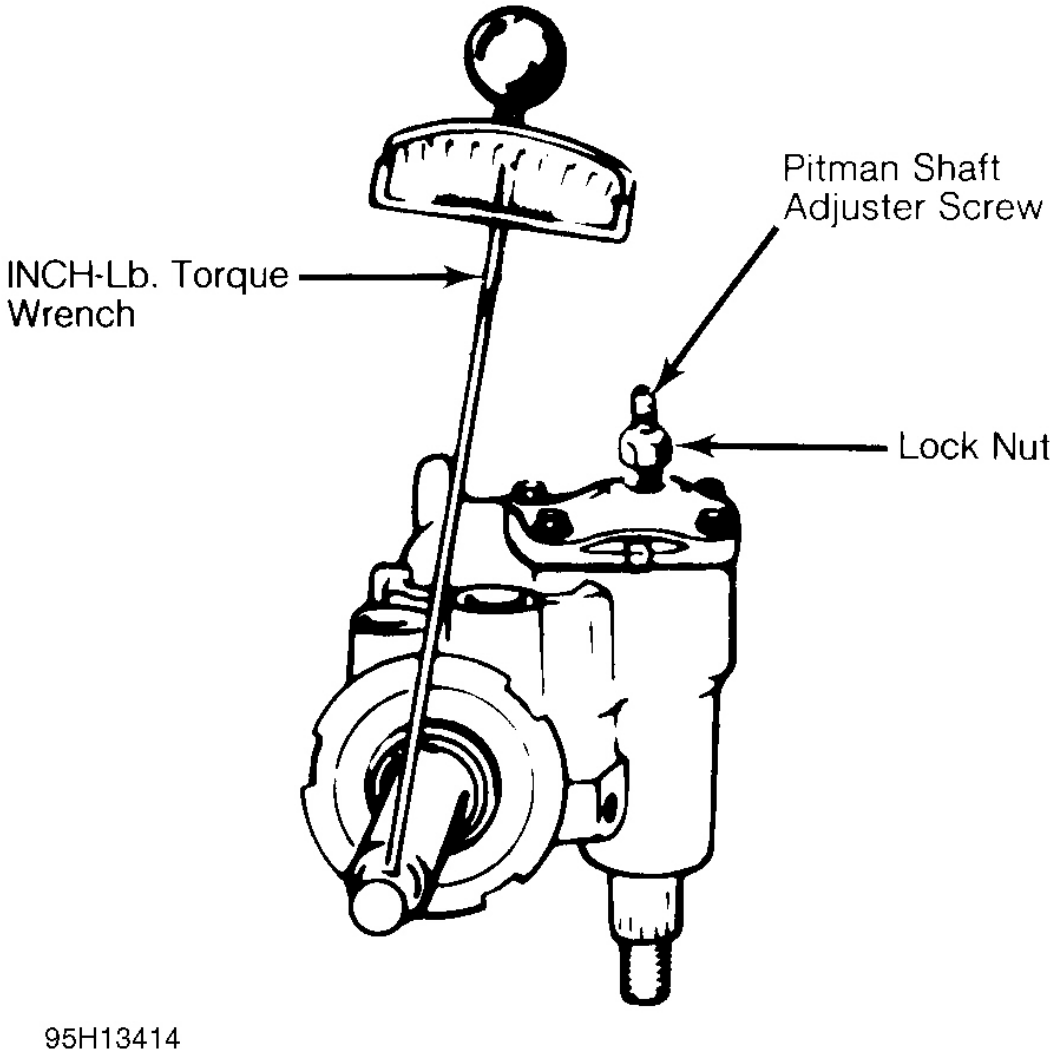


Fig. 9: Adjusting Pitman Shaft Turning Torque
Courtesy of GENERAL MOTORS CORP.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Adjuster Plug Lock Nut	80 (108)
Alternator Bracket Bolts	37 (50)
Fan Clutch Bolt/Nut	18 (24)
Flexible Coupling Pinch Bolt	23 (31)
Fluid Line Fittings	21 (28)

Idler Arm-To-Frame Bolt/Nut	61 (83)
Pitman Arm Nut	179 (243)
Pitman Shaft Adjuster Lock Nut	36 (49)
Pump Mounting Bolts	30 (41)
Relay Rod End Nut	35 (47)
Shock Absorber-To-Frame Bolt/Nut	40 (54)
Shock Absorber-To-Steering Linkage Nut (NV7)	40 (54)
Side Cover Bolts	44 (60)
Steering Gear Mounting Bolts	64 (87)
Tie Rod Adjust Clamp Bolt/Screw & Nut	14 (19)
Tie Rod End Nut	35 (47)
Union Bolt (MD121)	55 (75)
Variable Effort Steering Actuator (MD122)	46 (62)

SUSPENSION - FRONT

SUSPENSION Front

DESCRIPTION

System is an independent coil spring and shock absorber suspension with upper and lower control arms and ball joints, steering knuckle and stabilizer bar. See **Fig. 1** .

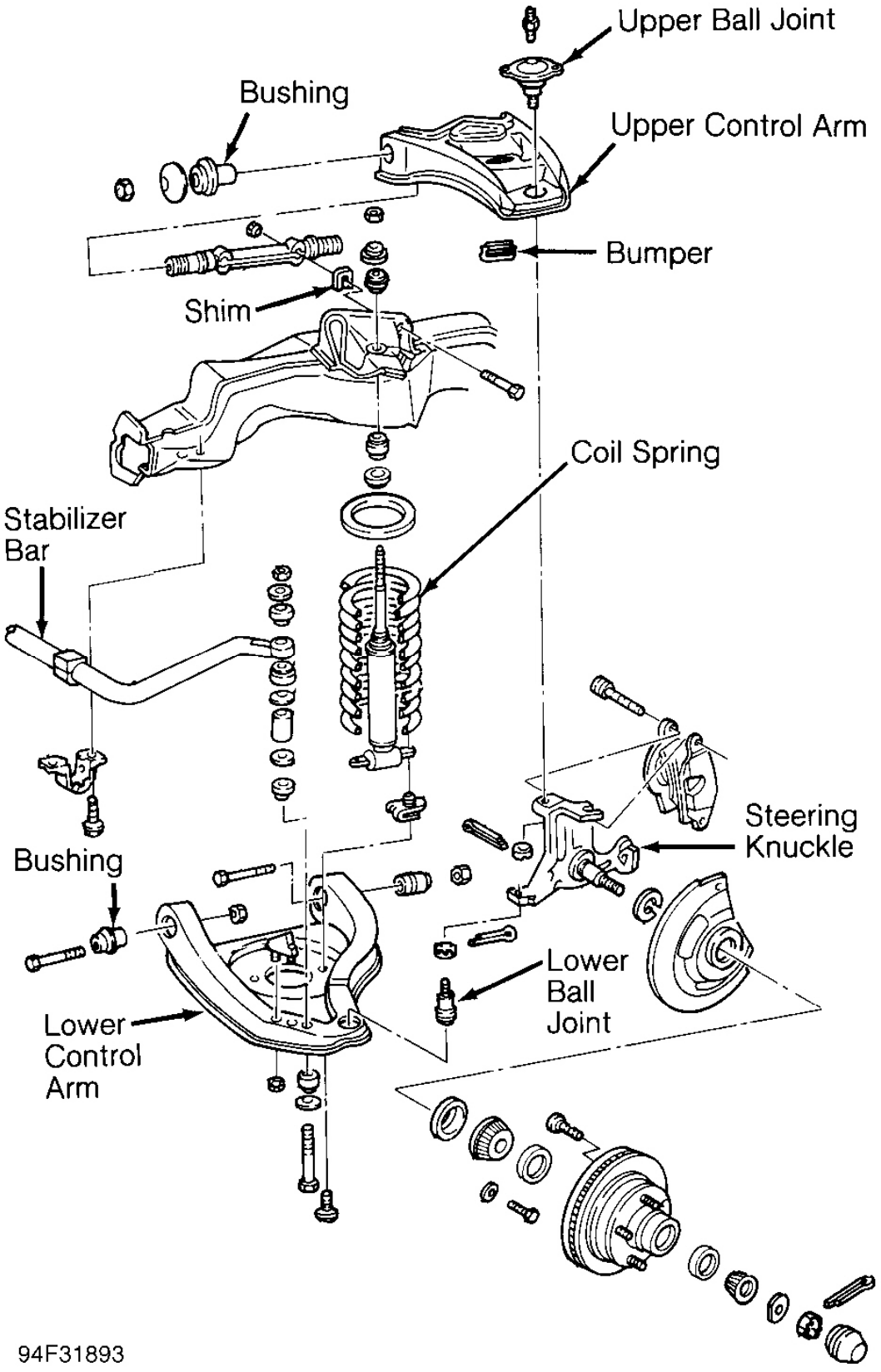

Upper Ball Joint
Bushing
Upper Control Arm
Bumper
Shim
Coil Spring
Stabilizer Bar
Steering Knuckle
Bushing
Lower Ball Joint
Lower Control Arm
94F31893

Fig. 1: Exploded View Of Front Suspension
Courtesy of GENERAL MOTORS CORP.

ADJUSTMENTS

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

NOTE: See the WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES article in the WHEEL ALIGNMENT section.

WHEEL BEARINGS

1. Raise and support vehicle at lower control arms. Remove dust cap and cotter pin. Tighten spindle nut to 12 ft. lbs. (16 N.m) while spinning wheel forward by hand. Back off nut until just loose.
2. Hand-tighten nut until either hole in spindle lines up with a slot in nut. DO NOT move nut more than one-half hex. Install NEW cotter pin.
3. Adjustment should provide .001-.005" (.03-.13 mm) wheel hub end play. Install dust cap, and lower vehicle.

RIDING HEIGHT

NOTE: See the WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES article in the WHEEL ALIGNMENT section.

INSPECTION

BALL JOINT CHECKING

Upper Ball Joint

1. Raise vehicle, and position jack stands under lower control arms near each ball joint. Ensure upper control arm bumpers do not contact frame. Ensure wheel bearings are properly adjusted. See **WHEEL BEARINGS** under ADJUSTMENTS.
2. Position dial indicator against lowest point of rim. Grasp wheel at top and bottom, and move it in and out. If gauge indicates more than .125" (3.18 mm), replace ball joint. Whenever ball joint is disconnected from steering knuckle, if stud can be rotated in socket with finger pressure, replace ball joint.

Lower Ball Joint

Rest vehicle on wheels to load ball joint. Ensure ball joint grease fitting shoulder protrudes from ball joint cover. See **Fig. 2** . If grease fitting shoulder is even with cover or is below surface of cover, replace ball joint. If boot is torn, replace ball joint.

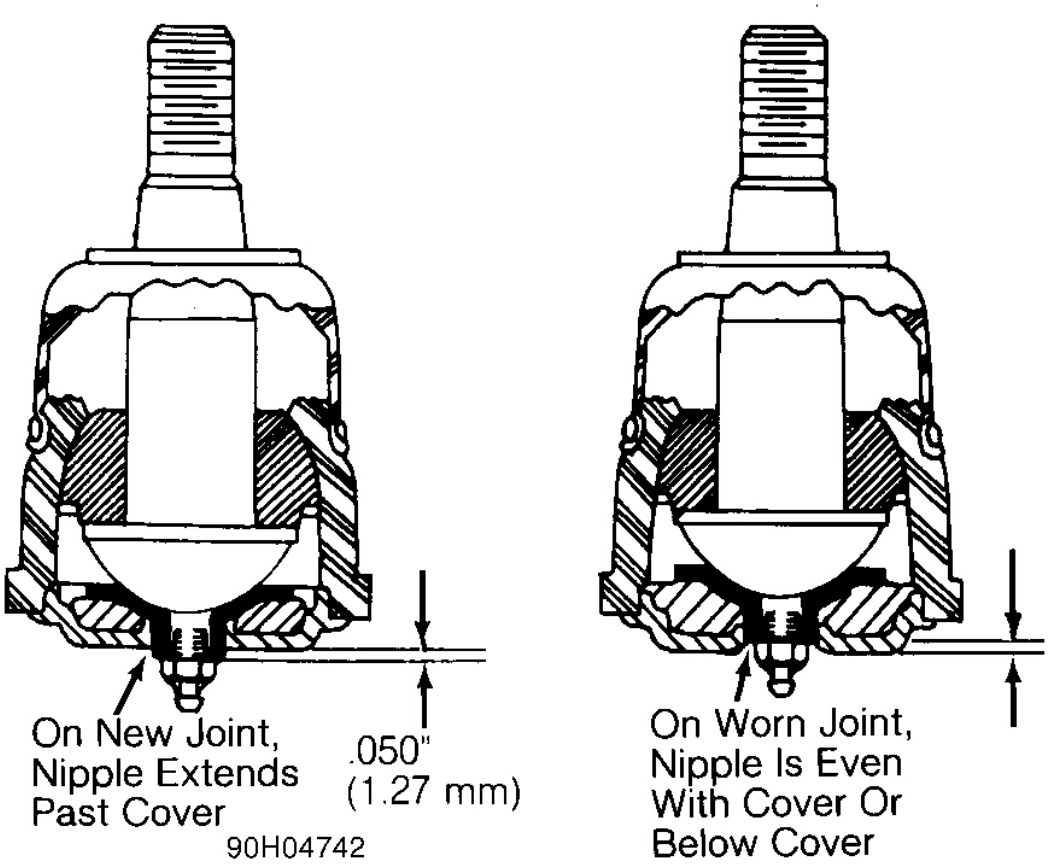


Fig. 2: Inspecting Lower Ball Joint
Courtesy of GENERAL MOTORS CORP.

REMOVAL & INSTALLATION

COIL SPRING

Removal

1. Raise and support vehicle, allowing suspension to hang free. Remove wheel. Remove ABS wheel speed sensor and harness from steering knuckle, and secure out of way. Remove shock absorber. Disconnect stabilizer bar from lower control arm. Remove cotter pin and nut from tie rod end.
2. Using Tie Rod Puller (J-6627-A), separate tie rod ball joint from steering knuckle. Install universal spring compressor, and compress spring. Remove bolts securing lower control arm to frame. Pivot lower control arm rearward. DO NOT use force to remove spring. Proper maneuvering of spring will allow it to be removed easily. Remove spring compressor. Remove spring.

Installation

1. Lower end of spring is identified by band of tape around coil, and coils are round. Upper end of spring is identified by flat coil with gripper notch. Note inspection holes in spring seat on lower control arm. Install spring so end of coil is positioned between holes, or is visible through either hole. Ensure spring insulator is in place. Install spring compressor. DO NOT exceed compressed dimension of 9 1/2" (241 mm).
2. To complete installation, reverse removal procedure. Bolts securing lower control arm to frame must be installed with bolt heads facing toward the front of vehicle. Tighten all nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Check wheel alignment. Refer to the **WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES** article in the WHEEL ALIGNMENT section.

LOWER CONTROL ARM BALL JOINT

WARNING: DO NOT separate lower control arm ball joint stud from steering knuckle unless a floor jack or stand is placed under the lower control arm, between the spring seat and ball joint.

Removal

1. Raise and support vehicle, allowing suspension to hang free. Remove wheel. Place floor jack under lower control arm spring seat. Remove cotter pin and nut from ball joint stud.
2. Using Ball Joint Separator (J-23742), separate stud from steering knuckle. Lower floor jack until outer end of lower control arm clears brake splash shield. Move steering knuckle out of way. If tapered stud hole in steering knuckle is deformed, replace steering knuckle
3. Remove grease fitting. Press ball joint out of lower control arm using Ball Joint Installer (J-9519-16), Control Arm Bushing Installer (J-21474-13) and Ball Joint Fixture (J-9519-30). See **Fig. 3** .

Installation

1. Press ball joint into lower control arm using Ball Joint Fixture (J-9519-30) and Large Installer (J-9519-9). See **Fig. 3** and **Fig. 4** . Ensure ball joint is fully seated.
2. To complete installation, reverse removal procedure. Ensure grease purge on boot seal faces inboard (toward frame). Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Check wheel alignment. See **WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES** in the WHEEL ALIGNMENT section.

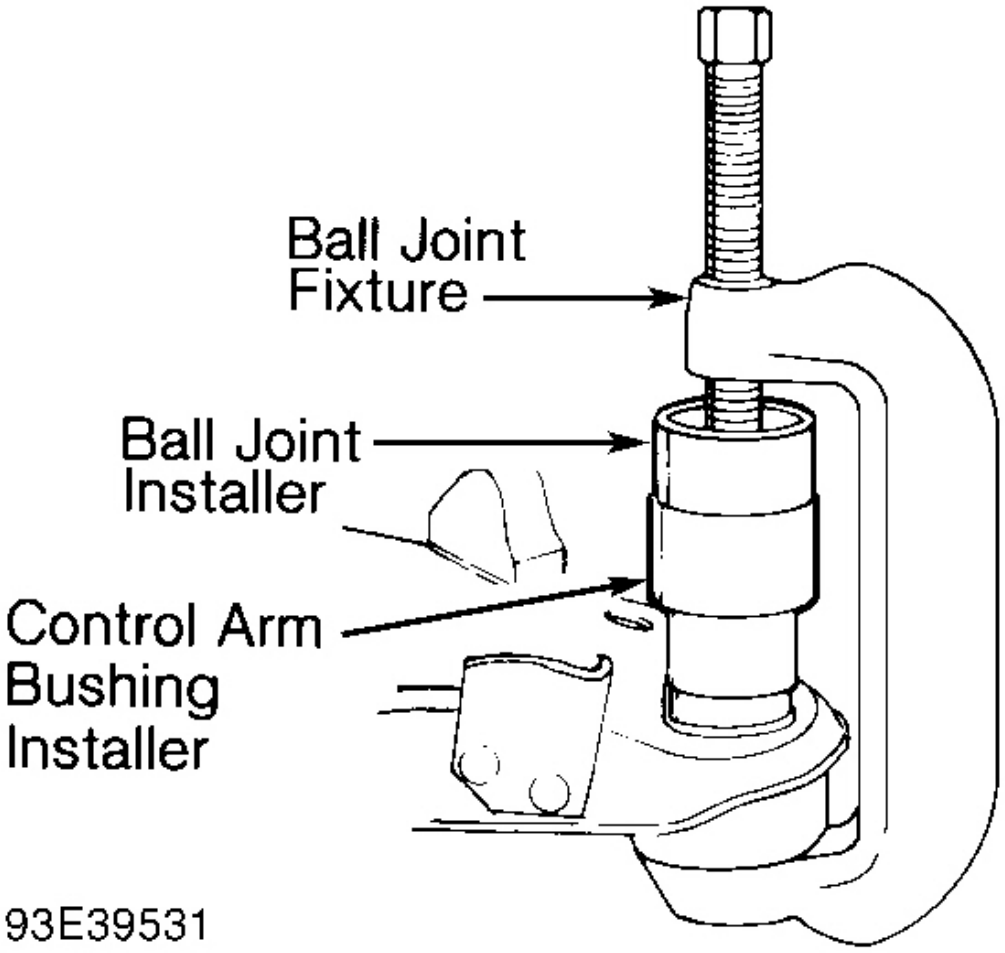


Fig. 3: Replacing Lower Control Arm Ball Joint (1 of 2)
Courtesy of GENERAL MOTORS CORP.

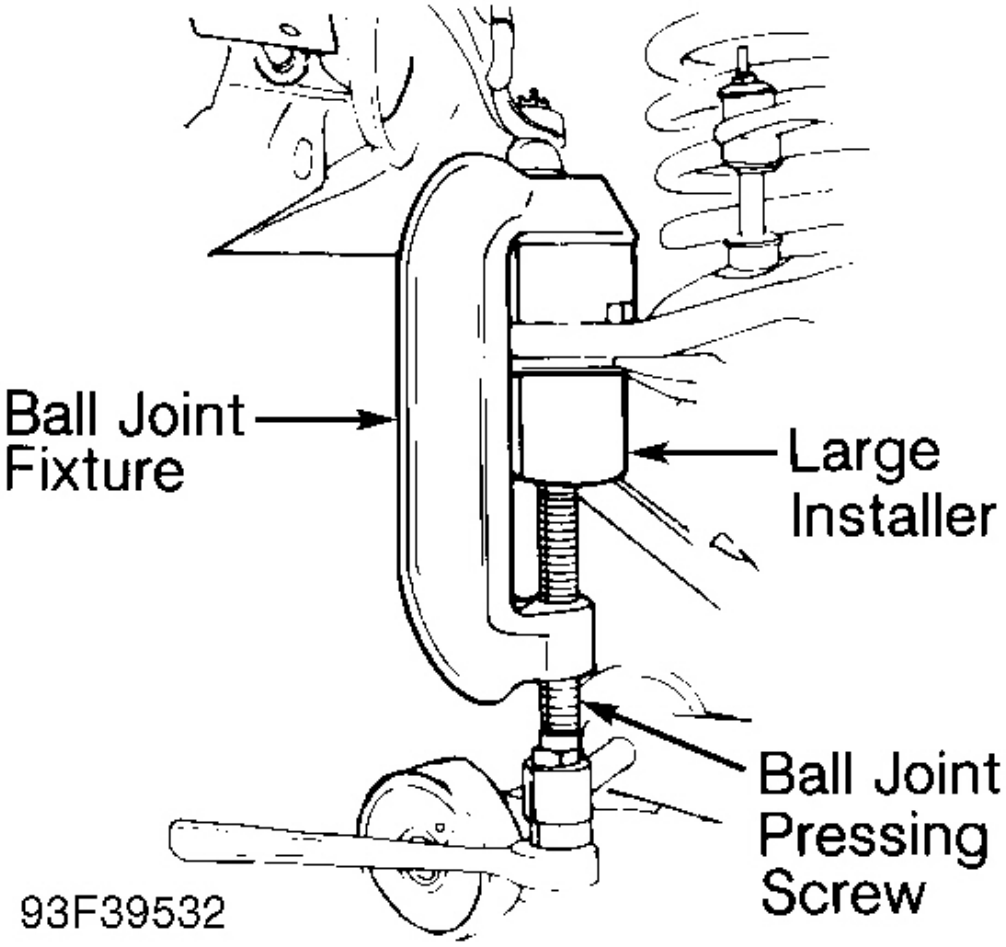


Fig. 4: Replacing Lower Control Arm Ball Joint (1 of 2)
Courtesy of GENERAL MOTORS CORP.

LOWER CONTROL ARM & BUSHINGS

Removal

Remove coil spring. See **COIL SPRING** . Separate ball joint from steering knuckle using Ball Joint Separator (J-23742). Remove lower control arm bolts. Remove lower control arm.

Front Bushing Replacement

1. Using a blunt chisel, drive 45-degree bushing flare down until it is even with bushing rubber. See **Fig. 5** . Press out bushing using Control Arm Bushing Remover (J-21474-5 , J-21474-8 , J-21474-12 and J-

21474-19).

2. Using Bushing Installer (J-21474-2 , J-21474-12 , J-21474-13 and J-21474-18), press new bushing into place. Flare bushing after installation using Flaring Set (J-21474-2 , J-21474-12 , J-21474-18 and J-21474-19). See **Fig. 5** .

Rear Bushing Replacement

Remove and install bushing using Control Arm Bushing Remover (J-21474-5 , J-21474-8 , J-21474-12 , J-21474-18 , J-21474-19). Press in new bushing using Control Arm Bushing Installer (J-21474-5 , J-21474-12 , J-21474-13 , J-21474-18 and J-21474-19). Ensure bushing is fully seated.

Installation

To install, reverse removal procedure. Lower control arm bushing nuts MUST be tightened to specification AFTER vehicle is at proper riding height and wheels are supporting weight of vehicle. Check wheel alignment. See **WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES** in the WHEEL ALIGNMENT section.

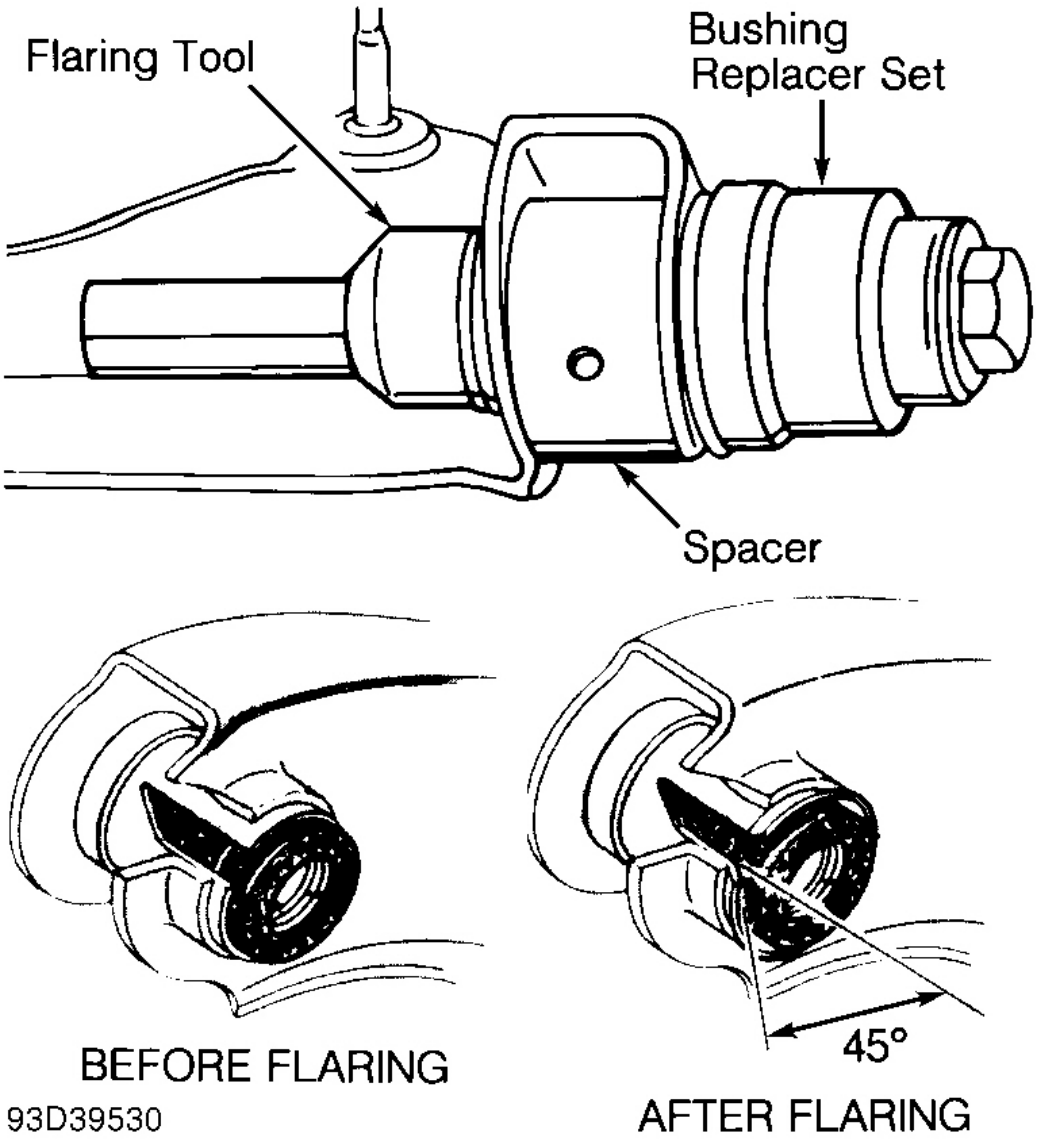


Fig. 5: Flaring Lower Control Arm Front Bushing
Courtesy of GENERAL MOTORS CORP.

STABILIZER BAR

Removal & Installation

Raise and support vehicle, allowing suspension to hang free. Disconnect stabilizer bar ends from lower control arms. Disconnect stabilizer bar from frame. Remove stabilizer bar. To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** .

STEERING KNUCKLE

WARNING: DO NOT separate lower control arm ball joint stud from steering knuckle unless a floor jack or stand is placed under the lower control arm, between the spring seat and ball joint.

Removal

1. Raise and support vehicle, allowing suspension to hang free. Remove wheel, ABS speed sensor, caliper assembly, and hub and rotor assembly. Remove splash shield. Separate tie rod end from steering knuckle using Tie Rod Puller (J-6627-A).
2. Remove spindle/hub seal if steering knuckle is being replaced. Place floor jack under lower control arm to keep coil spring in place. Remove lower ball joint cotter pin and loosen nut. Separate lower ball joint stud from steering knuckle using Ball Joint Separator (J-23742).
3. Remove upper ball joint cotter pin and loosen nut. Using ball joint separator, separate upper ball joint stud from steering knuckle and remove steering knuckle.

Installation

To install, reverse removal procedure. Tighten nuts and bolts to specification. See **TORQUE SPECIFICATIONS** . Adjust front wheel bearings. See **WHEEL BEARINGS** under ADJUSTMENTS.

UPPER CONTROL ARM BALL JOINT

WARNING: DO NOT separate lower control arm ball joint stud from steering knuckle unless a floor jack or stand is placed under the lower control arm, between the spring seat and ball joint.

Removal

1. Raise and support vehicle, by lower control arms. Remove wheel. Remove upper ball joint cotter pin, and loosen stud nut. Separate upper ball joint stud from steering knuckle using Ball Joint Separator (J-23742).
2. Support steering knuckle to prevent damage to brake hose. With control arm raised, drill a 1/8" hole about 1/4" deep into ball joint rivets. Use a 1/2" drill bit to drill off rivet heads. Drive out rivets with a punch. Remove ball joint. Remove burrs and rough edges from rivet holes in control arm.

Installation

1. Install boot seal onto new ball joint. Position ball joint into control arm. Install bolts (supplied in service kit) with bolt heads facing down. Tighten bolts to specification provided in service kit.
2. Engage ball joint stud into steering knuckle. Tighten ball joint stud nut. See **TORQUE SPECIFICATIONS** . Install cotter pin. Install ball joint grease fitting. Pack ball joint with grease until boot seal begins to expand. Install wheel. Check wheel alignment. Refer to the **WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES** article in the WHEEL ALIGNMENT section.

UPPER CONTROL ARM & BUSHINGS

WARNING: DO NOT separate lower control arm ball joint stud from steering knuckle unless a floor jack or stand is placed under the lower control arm, between the spring seat and ball joint.

Removal

1. If removing right upper control arm, go to next step. If removing left upper control arm, remove air cleaner. Turn lock cylinder to locked position to prevent damage to air bag clockspring on steering column. Remove intermediate steering shaft assembly.
2. Raise vehicle and support lower control arm by placing a floor jack or safety stand between spring seat and ball joint. Remove wheel. Remove ABS wheel speed sensor and harness clips, and secure out of way.
3. Loosens nuts securing upper control arm pivot shaft to frame. Note position of alignment shims for installation. Remove shims and tape them together. Remove upper ball joint cotter pin. Loosen upper ball joint stud nut.
4. Using Ball Joint Separator (J-23742), separate upper ball joint stud from steering knuckle and remove steering knuckle. Support caliper/rotor/steering knuckle assembly to prevent brakeline damage. Remove upper control arm pivot bolts and nuts, and remove upper control arm.

Bushing Replacement

Remove nuts from ends of pivot shaft. Press out bushings using Tie Rod End & Upper Control Arm Bushing Remover/Installer (J-22269-1). To install bushing, place pivot shaft into control arm opening with depression in pivot shaft facing inboard. Slide bushing over end of pivot shaft. Using Installer, press bushing into control arm. Loosely install pivot shaft end nuts. DO NOT tighten nuts.

Installation

To install, reverse removal procedure. If bushings were replaced, fully tighten control arm pivot shaft end nuts after vehicle is on ground and at proper riding height. See **TORQUE SPECIFICATIONS** . Check wheel alignment. See **WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES** in the WHEEL ALIGNMENT section.

WHEEL BEARINGS

Removal

1. Raise and support vehicle. Remove wheel. Remove ABS wheel speed sensor and harness clips, and secure out of way. Remove brake caliper bolts. Remove caliper, and wire aside. Remove dust cap, cotter pin, spindle nut and washer and outer bearing. Remove hub and rotor assembly.
2. Pry inner grease seal out of hub. Remove inner bearing. Discard inner grease seal. Drive races from hub using a drift punch or Race Remover (J-29117-A). Wash parts thoroughly in cleaning solvent, and blow dry using compressed air. DO NOT spin bearing with compressed air.

Installation

Press races into hub. Grease bearings, hub and spindle. Install inner bearing. Using a flat plate, install new grease seal until even with hub. Lightly lubricate seal lip with grease. Install hub and rotor assembly, outer bearing, washer and nut. Adjust bearing preload. See **WHEEL BEARINGS** under ADJUSTMENTS. Install brake caliper.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft/ Lbs. (N.m)**
Ball Joint Stud Nut	(1) 125 (169)
Lower Control Arm-To-Frame Bolt	92 (125)
Stabilizer Bar	
At Frame (Nut)	24 (33)
At Lower Control Arm (Bolt/Nut)	18 (24)
Tie Rod End Nut	(1) 35 (47)
Upper Ball Joint-To-Control Arm Bolt/Nut	(2)
Upper Control Arm	
Bushing Nut	(3) 92 (125)
Pivot Shaft-To-Frame Nut	(3) 70 (95)
Wheel Lug Nut	100 (136)

(1) Always advance nut to line up cotter pin slot; DO NOT loosen.

(2) Use torque specification included with replacement ball joint.

(3) Tighten with wheels on ground and with body at proper riding height. See **RIDING HEIGHT ADJUSTMENT** in the WHEEL ALIGNMENT section.

SUSPENSION - REAR

SUSPENSION Rear - "B" Bodies

DESCRIPTION

Coil springs bear weight of vehicle. See **Fig. 1**. Rear axle pivots on upper and lower control arms. Control arms maintain a geometrical relationship between rear axle and frame to oppose torque reaction on acceleration and braking.

NOTE: For information on electrical/electronic part of suspension, see appropriate ELECTRONIC article in SUSPENSION.

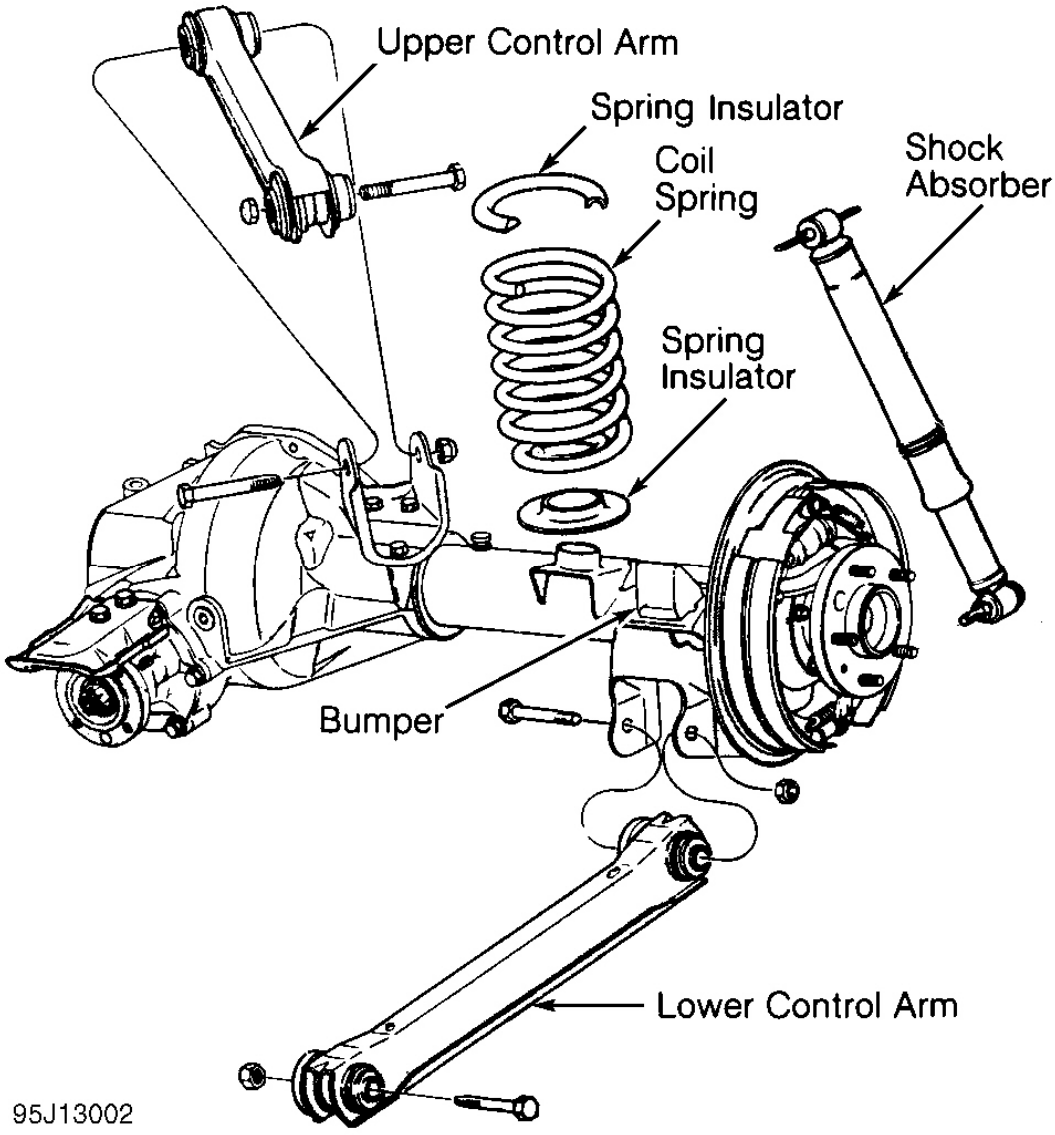


Fig. 1: Exploded View Of Typical Rear Suspension
Courtesy of GENERAL MOTORS CORP.

ADJUSTMENTS

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

NOTE: See the WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES article in the WHEEL ALIGNMENT section.

RIDING HEIGHT

NOTE: See the RIDING HEIGHT ADJUSTMENT article in the WHEEL ALIGNMENT section.

REMOVAL & INSTALLATION

SHOCK ABSORBERS

Removal

Raise and support vehicle at frame. Support rear axle. On vehicles with air shocks, disconnect air line from shock absorber fitting by turning spring clip 90 degrees and pulling air line coupling away from fitting. See **Fig. 2**. On all vehicles, disconnect shock absorber from upper mount and lower mount, and remove shock absorber. When removing or installing lower mount nut, DO NOT allow stud to turn or damage to bond between bushing and stud may occur.

Installation

To install, reverse removal procedure. Tighten shock absorber nuts to specification. See **TORQUE SPECIFICATIONS**.

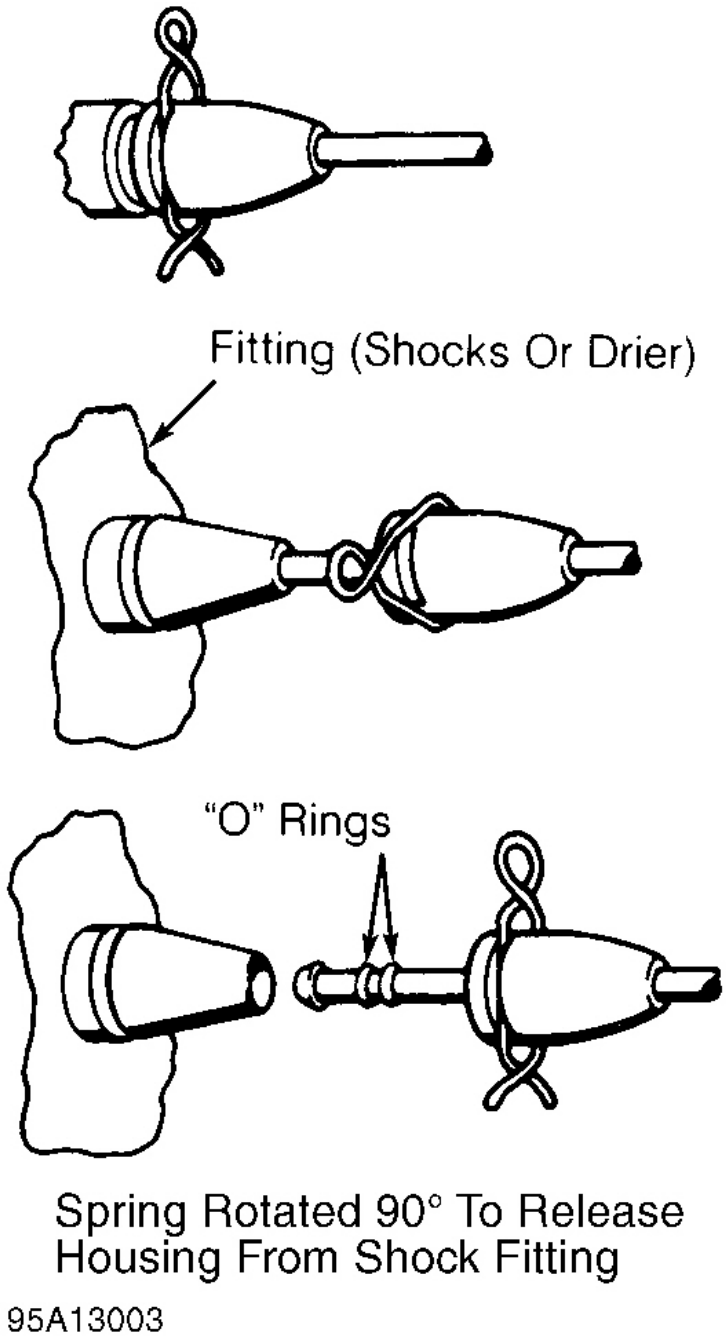


Fig. 2: Disconnecting Air Line From Fitting
Courtesy of GENERAL MOTORS CORP.

COIL SPRINGS & INSULATORS

WARNING: To keep rear axle stationary, remove and install one coil spring at a time.

Removal

1. Raise and support vehicle at frame. Support rear axle with an adjustable lifting device. Disconnect wheel speed sensor from axle housing. Disconnect height sensor link (if equipped) from upper control arm. Remove bolt securing rear brake hose to center of rear axle (DO NOT open brake hydraulic system).
2. On vehicles with air shocks, disconnect air line from shock absorber fitting by turning spring clip 90 degrees and pulling air line coupling away from fitting. See **Fig. 2**. On all vehicles, disconnect shock absorber from upper mount and lower mount, and remove shock absorber. When removing or installing lower mount nut, DO NOT allow stud to turn or damage to bond between bushing and stud may occur. Slowly lower rear axle enough to remove spring.

Installation

1. Top of spring is identified by tape on coil. Set spring with insulator into position at spring seat on frame. Spring leg must face left side of vehicle so it forms a 90-degree angle in relation to center line of vehicle. See **Fig. 3**. A deviation of 15 degrees forward or 5 degrees rearward of perpendicular line is allowed.
2. Raise rear axle until bottom of spring contacts lower spring seat on rear axle. To complete installation, reverse removal procedure. Tighten fasteners to specification. See **TORQUE SPECIFICATIONS**. Adjust height sensor (if equipped). See appropriate REAR - ELECTRONIC LEVEL CONTROL article in SUSPENSION.

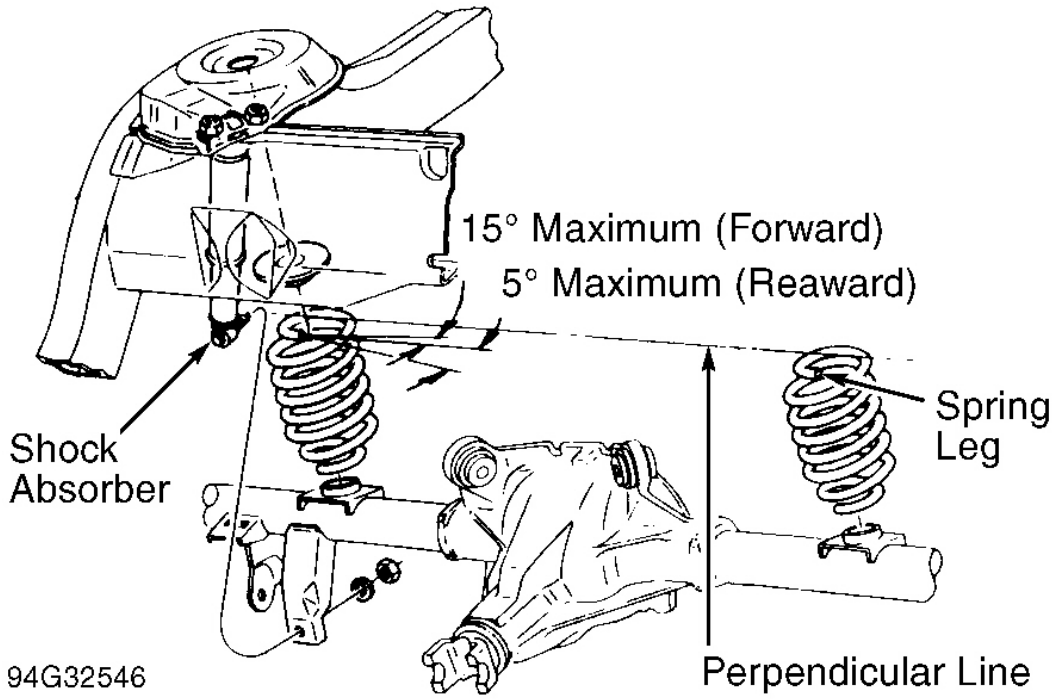


Fig. 3: Positioning Spring Leg
Courtesy of GENERAL MOTORS CORP.

UPPER CONTROL ARM & BUSHING

> **WARNING: To keep rear axle stationary, remove and install one upper control arm at a time.**

Removal

Raise and support vehicle at frame. Place jackstand under nose of rear axle (near drive shaft flange). Disconnect wheel speed sensor from axle housing. Disconnect height sensor link (if equipped with electronic level control) from upper control arm. Disconnect upper control arm from rear axle. Disconnect upper control arm from frame, and remove upper control arm.

Bushing Replacement

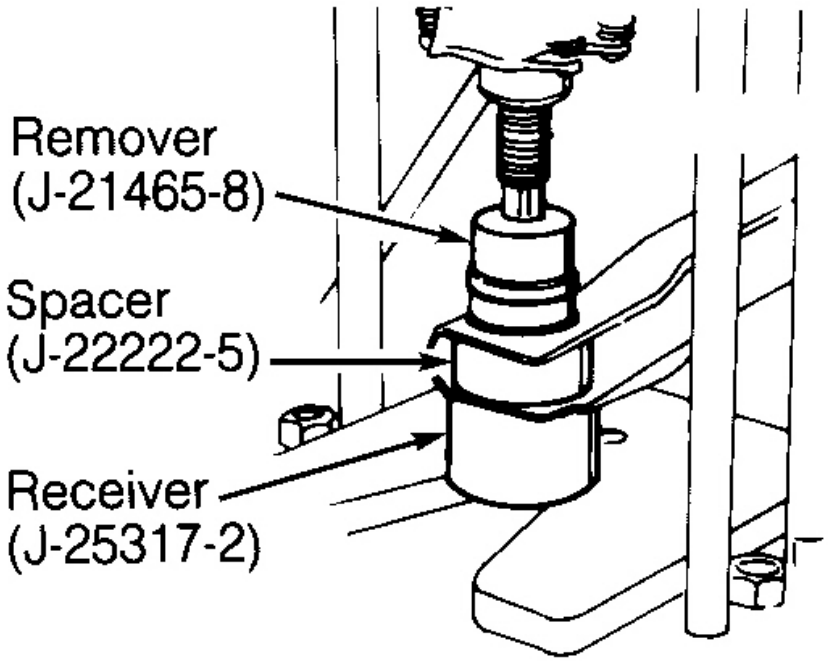
Use a blunt chisel to drive down bushing flare (if equipped) on inside of control arm. Press bushing out of control arm. Refer to **Fig. 4**. To install, press bushing into control arm. If necessary, use Bushing Flaring Set (J-21474) to flare bushing at a 45-degree angle. See **Fig. 4**. This retains bushing in control arm.

Bushing Replacement (At Rear Axle)

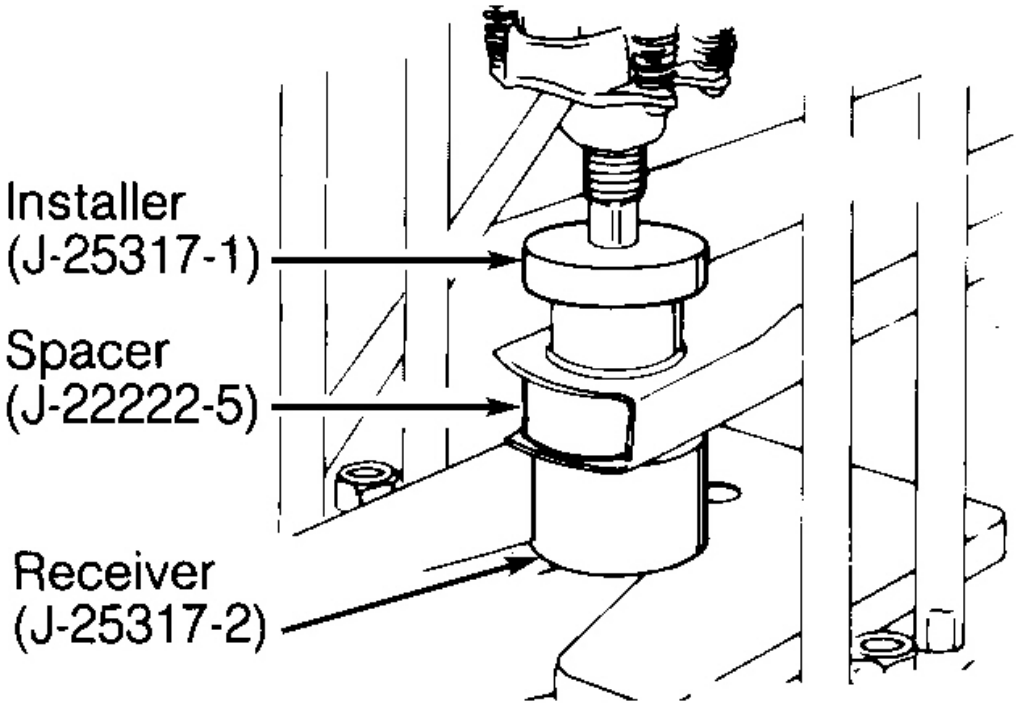
Replace bushing using Bushing Remover/Installer Set (J-21474).

Installation

To install, reverse removal procedure. Tighten lower control arm bolts/nuts to specification with vehicle on ground and at curb height. See **TORQUE SPECIFICATIONS**. Adjust height sensor (if equipped). See appropriate REAR - ELECTRONIC LEVEL CONTROL article in SUSPENSION.



REMOVING BUSHING



91107883 INSTALLING BUSHING

Fig. 4: Replacing Control Arm Bushings (Typical)
Courtesy of GENERAL MOTORS CORP.

LOWER CONTROL ARM & BUSHING

> **WARNING: To keep rear axle stationary, remove and install one lower control arm at a time.**

Removal

Raise and support vehicle at frame. Support rear axle to relieve tension on control arm bolts. Disconnect stabilizer bar (if equipped) from lower control arm. Disconnect lower control arm from rear axle. Disconnect lower control arm from frame, and remove control arm.

Bushing Replacement

Use a blunt chisel to drive down bushing flare on inside of control arm. Press bushing out of control arm. See **Fig. 4**. To install, press bushing into control arm. See **Fig. 4**. Use Bushing Flaring Set (J-21474) to flare bushing at a 45-degree angle. This retains bushing in control arm.

Bushing Replacement (At Rear Axle)

Replace bushing using Bushing Remover/Installer Set (J-21474).

Installation

To install, reverse removal procedure. Tighten lower control arm bolts/nuts to specification with vehicle on ground and at curb height. See **TORQUE SPECIFICATIONS**.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft/ Lbs. (N.m)
Lower Control Arm-To-Axle	
Bolt	140 (190)
Nut	107 (145)
Lower Control Arm-To-Frame	
Bolt	140 (190)
Nut	107 (145)
Shock Absorber	
Lower Mount (Nut)	63 (85)
Upper Mount	
Bolt	18 (24)
Nut	13 (18)
Stabilizer Bar Bracket-To-Lower Control Arm Bolt	21 (28)

Stabilizer Bar-To-Bracket Bolt	63 (85)
Upper Control Arm-To-Axle	
Bolt	88 (119)
Nut	85 (115)
Upper Control Arm-To-Frame (Crossmember)	
Bolt	136 (184)
Nut	107 (145)
Wheel Lug Nut	100 (136)

SUSPENSION - ELECTRONIC LEVEL CONTROL

SUSPENSION General Motors Corp. - Rear Electronic Suspension - ELC

DESCRIPTION

Electronic Level Control (ELC) automatically adjusts rear height of vehicle to compensate for vehicle load. System consists of compressor, air drier, exhaust solenoid valve, compressor relay, height sensor, air adjustable shock absorbers and connecting air lines. Air drier (mounted on compressor) contains moisture-absorbing dry chemical and valves that maintain minimum system air pressure at about 8-14 psi (.56-.98 kg/cm^2).

OPERATION

SYSTEM OPERATION

When weight is added to vehicle, height sensor arm rotates upward. When arm rotates upward, a time delay of about 8-15 seconds begins in the height sensor. After this delay, the height sensor grounds the compressor relay, allowing power to air compressor. Air is pumped into shock absorbers and vehicle rises. As vehicle rises, height sensor arm rotates downward until it reaches curb height position. Height sensor then opens ground circuit to compressor relay, turning compressor off.

When weight is removed from vehicle, height sensor arm rotates downward. After delay of about 8-15 seconds, downward rotation of arm grounds exhaust solenoid valve circuit, energizing exhaust solenoid valve. This causes air to vent from shock absorbers, lowering vehicle. As vehicle is lowered, height sensor arm rotates upward to curb height position. Height sensor opens exhaust solenoid valve circuit, causing exhaust solenoid valve to close.

To ensure system is operating with at least minimum air pressure, height sensor commands air replenishment cycle each time ignition is turned on. If height sensor determines that vehicle is at normal operating height, internal timer circuit is activated. After delay of about 35-40 seconds, compressor turns on for about 4 seconds to ensure residual system pressure exists. Air drier maintains minimum shock absorber air pressure of 8-14 psi (.56-.98 kg/cm^2).

If weight is added to or removed from vehicle during 35-40 second delay, air replenishment cycle will be overridden and vehicle will rise or lower after normal time delay.

Battery voltage is applied to compressor and height sensor at all times. This allows system to vent after load is removed with ignition off. Height sensor limits compressor operation or exhaust solenoid valve energized time to 4.5-7.0 minutes. Time limit is necessary to prevent continuous compressor operation in case of air leak. Turning ignition switch from OFF to ON position will reset compressor operation or exhaust solenoid valve energized time.

Low compressor motor starting current is obtained by 1.5 second actuation of exhaust solenoid valve. This reduces air pressure in compressor cylinder, allowing for easier compressor operation.

COMPONENT OPERATION

Air Adjustable Shock Absorber

Air adjustable shock absorber is a conventional shock absorber that contains an air chamber. When pressure is applied to air chamber, air chamber extends the shock absorber.

Air Drier

Air drier is attached to compressor output. Air drier absorbs moisture from air being delivered to air adjustable shock absorbers. Air drier contains valving which maintains minimum air pressure of 8-14 psi (.56-.98 kg/cm^2) in shock absorber.

Compressor

Piston-type compressor is mounted on frame rail near left front wheelwell. Compressor provides air pressure for system.

Compressor Relay

Height sensor grounds the compressor relay, allowing power to compressor. Compressor relay is mounted on compressor.

Exhaust Solenoid Valve

Exhaust solenoid valve (part of compressor head assembly) is controlled by height sensor. Valve exhausts air from system and limits compressor output pressure by acting as a blow-off valve.

Height Sensor

Height sensor is located on crossmember above rear axle. Movement of height sensor arm (attached to rear axle by a link) controls compressor relay and exhaust solenoid valve ground circuits to adjust vehicle height. Height sensor limits compressor operation or exhaust solenoid valve energized time to 4.5-7.0 minutes. Time limit is necessary to prevent continuous operation of compressor in case of air leak.

ADJUSTMENTS

HEIGHT SENSOR

1. Adjust height sensor if riding height is not as specified. See appropriate RIDING HEIGHT ADJUSTMENT article in WHEEL ALIGNMENT section:
   - **RIDING HEIGHT ADJUSTMENT** - Caprice, Impala SS, Roadmaster
   - **RIDING HEIGHT ADJUSTMENT** - Fleetwood
2. Vehicle should be on level surface with full gas tank and no load in vehicle. Push bumper down and up slowly a few times to normalize suspension. Turn ignition on.
3. Loosen lock bolt securing height sensor metal arm to plastic arm bracket. See **Fig. 1** . To increase riding height, move metal arm upward in relation to plastic arm bracket. To decrease riding height, move metal arm downward in relation to plastic arm bracket. Tighten lock nut. Allow for delay when rechecking riding height. If adjustment cannot be made, repair problem with rear springs or suspension.

NOTE: **Height sensor arm angle can be changed a total of 5 degrees. One degree of change in arm angle results in about 1/4" (6 mm) change in riding height. Total change in riding height is about 1 1/4" (32 mm).**

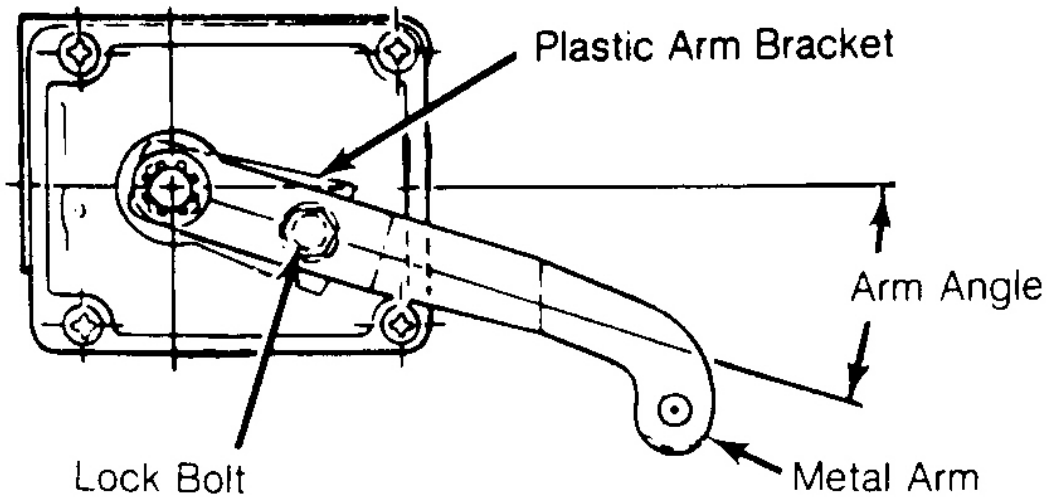


Fig. 1: Adjusting Height Sensor
Courtesy of GENERAL MOTORS CORP.

RIDING HEIGHT

NOTE: **See appropriate RIDING HEIGHT ADJUSTMENT article in WHEEL ALIGNMENT section:**

- **RIDING HEIGHT ADJUSTMENT - Caprice, Impala SS, Roadmaster**
- **RIDING HEIGHT ADJUSTMENT - Fleetwood**

SYSTEM TESTING

SYSTEM OPERATION TEST

1. Place vehicle on flat surface. Remove heavy items from vehicle. Measure distance between floor and a suitable spot on rocker panel, forward of rear wheelwell opening. This distance is unloaded height. Turn ignition on. Add 300 lbs. (136 kg) of weight to rear of vehicle. If compressor starts within 8-15 seconds, go to step 4).
2. If compressor does not start within 8-15 seconds, and vehicle is within one inch (25.4 mm) of unloaded height measured in step 1), go to **AIR DRIER TEST** under COMPONENT TESTING.
3. If compressor does not start within 8-15 seconds, and vehicle is not within one inch (25.4 mm) of unloaded height, adjust height sensor, and then retest system. See **HEIGHT SENSOR** under

ADJUSTMENTS. If compressor still does not start within 8-15 seconds, go to **COMPRESSOR INOPERATIVE** under ELECTRICAL TESTING.

4. If compressor stops within 7 minutes, go to next step. If compressor runs continuously, go to **HEIGHT SENSOR TEST** under COMPONENT TESTING.
5. If system leaks down, go to **COMPRESSOR LEAK TEST** under COMPONENT TESTING. If vehicle returns to within one inch (25.4 mm) of unloaded height, go to step 7).
6. If vehicle does not return to within one inch (25.4 mm) of unloaded height, adjust height sensor, and retest system. See **HEIGHT SENSOR** under ADJUSTMENTS. If vehicle still does not return to within one inch (25.4 mm) of unloaded height, go to **VEHICLE WILL NOT LOWER** under ELECTRICAL TESTING.
7. Remove 300 lbs. (136 kg) of weight from rear of vehicle. If system does not exhaust within 8-15 seconds, go to **VEHICLE WILL NOT LOWER** under ELECTRICAL TESTING. If system exhausts within 8-15 seconds, but vehicle does not return to within one inch (25.4 mm) of unloaded height, adjust height sensor. See **HEIGHT SENSOR** under ADJUSTMENTS.
8. If system exhausts within 8-15 seconds, and after 2 minutes the vehicle returns to within one inch (25.4 mm) of unloaded height, system is operating correctly.

SYSTEM LEAK TEST

NOTE: System leak test will determine if a leak exists and if leak is internal or external to compressor.

1. Install Pressure Gauge (J-22124-A) and Adapter Hose (J-22124-91) in line between air drier fitting at compressor and existing air line to shock absorbers. See **Fig. 2** . Install pressure gauge so shutoff valve is on compressor side of gauge. With shutoff valve open, apply shop air pressure through service valve until gauge reads 100-120 psi (7.03-8.43 kg/cm^2).
2. If leak is indicated, close shutoff valve to isolate compressor and continue to watch gauge for decrease in pressure. If pressure continues to decrease, leak is external to compressor. Leak test all connections.
3. If pressure stops decreasing after shutoff valve is closed, leak is in compressor assembly. Check compressor for leaks. See **COMPRESSOR LEAK TEST** under COMPONENT TESTING. If pressure builds up rapidly but vehicle does not rise, check for pinched air line and stuck or binding shocks.

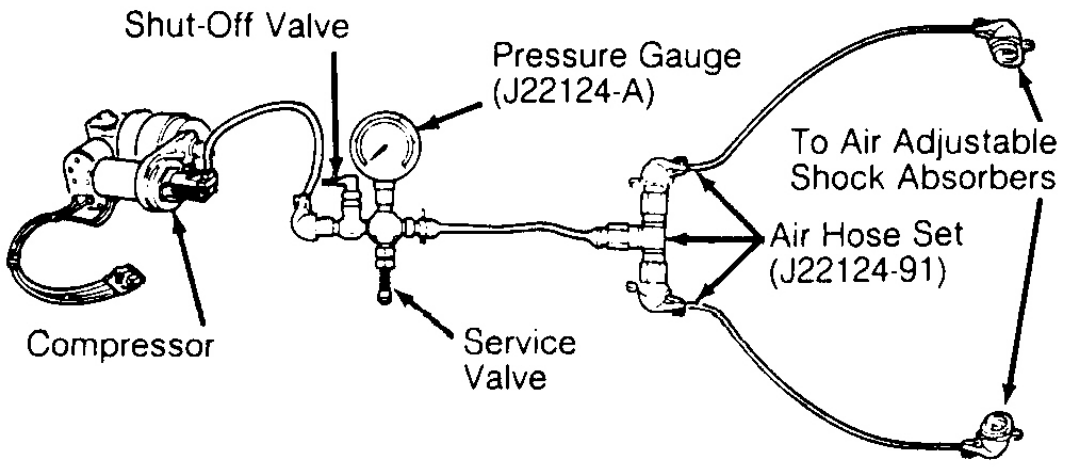


Fig. 2: Checking System For Leakage
Courtesy of GENERAL MOTORS CORP.

COMPONENT TESTING

AIR DRIER TEST

NOTE: Air drier is tested to ensure valve maintains a minimum pressure of 8-14 psi (.56-.98 kg/cm^2) in air adjustable shock absorbers.

1. Install Pressure Gauge (J-22124-A) and Adapter Hose (J-22124-91). See **Fig. 2** . Turn ignition on. Disconnect link from height sensor metal arm.
2. Move arm upward to inflate shock absorbers. Move arm downward to deflate shock absorbers. Note pressure gauge reading. Turn ignition off to deflate shock absorbers through pressure gauge valve. Pressure gauge should read 8-14 psi (.56-.98 kg/cm^2) after air adjustable shock absorbers are deflated. If air pressure reading is not within specification, replace air drier.

COMPRESSOR OPERATION TEST

NOTE: This test measures amount of compressor current draw, air output and pressure leak-down.

1. Remove compressor. Connect Adapter Hose (J-22124-91) to air drier fitting. Connect Pressure Gauge (J-22124-A) to adapter hose.
2. Connect 12-volt power supply and ammeter to compressor harness terminals to measure current draw. See **Fig. 3** . If current draw exceeds 14 amps or compressor motor does not run, replace compressor.
3. If current draw is 14 amps or less, allow pressure to reach 100 psi (7.0 kg/cm^2) and then disconnect ammeter from compressor connector. If pressure holds at 100 psi (7.0 kg/cm^2), compressor is okay.

4. If pressure decreases to less than 90 psi (6.3 kg/cm^2), but does not continue to decrease, replace compressor head assembly. See **COMPRESSOR HEAD** under REMOVAL & INSTALLATION. If pressure fully leaks off, or pressure builds up but does not reach 100 psi (7.0kg/cm^2), check compressor for leaks. See **COMPRESSOR LEAK TEST** .

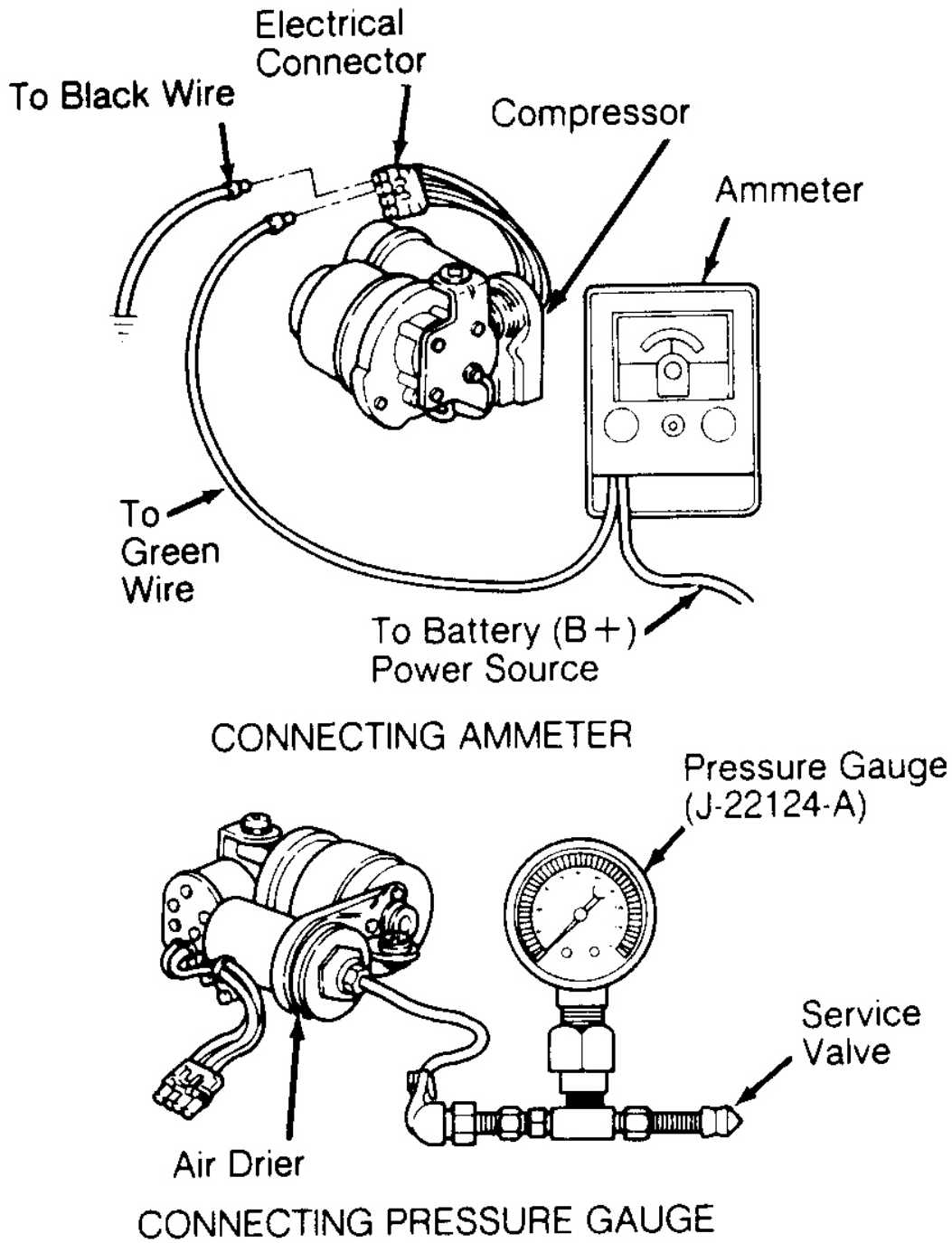


Fig. 3: Connecting Ammeter & Pressure Gauge
Courtesy of GENERAL MOTORS CORP.

COMPRESSOR LEAK TEST

1. Remove compressor. Connect Adapter Hose (J-22124-91) to air drier fitting. Connect Pressure Gauge (J-22124-A) to adapter hose. Apply shop air pressure through service valve on pressure gauge until pressure is 100 psi (7.0 kg/cm^2).
2. Using soapy water solution, check for leaks around air drier cover, air drier "O" ring casting bore, edge of cover gasket, edge of solenoid valve housing and air intake and exhaust opening in head casting. See **Fig. 4** .
3. If leak exists at compressor head bolts, tighten bolts to specification, and recheck for leaks. See **TORQUE SPECIFICATIONS** table. Remove pressure gauge.

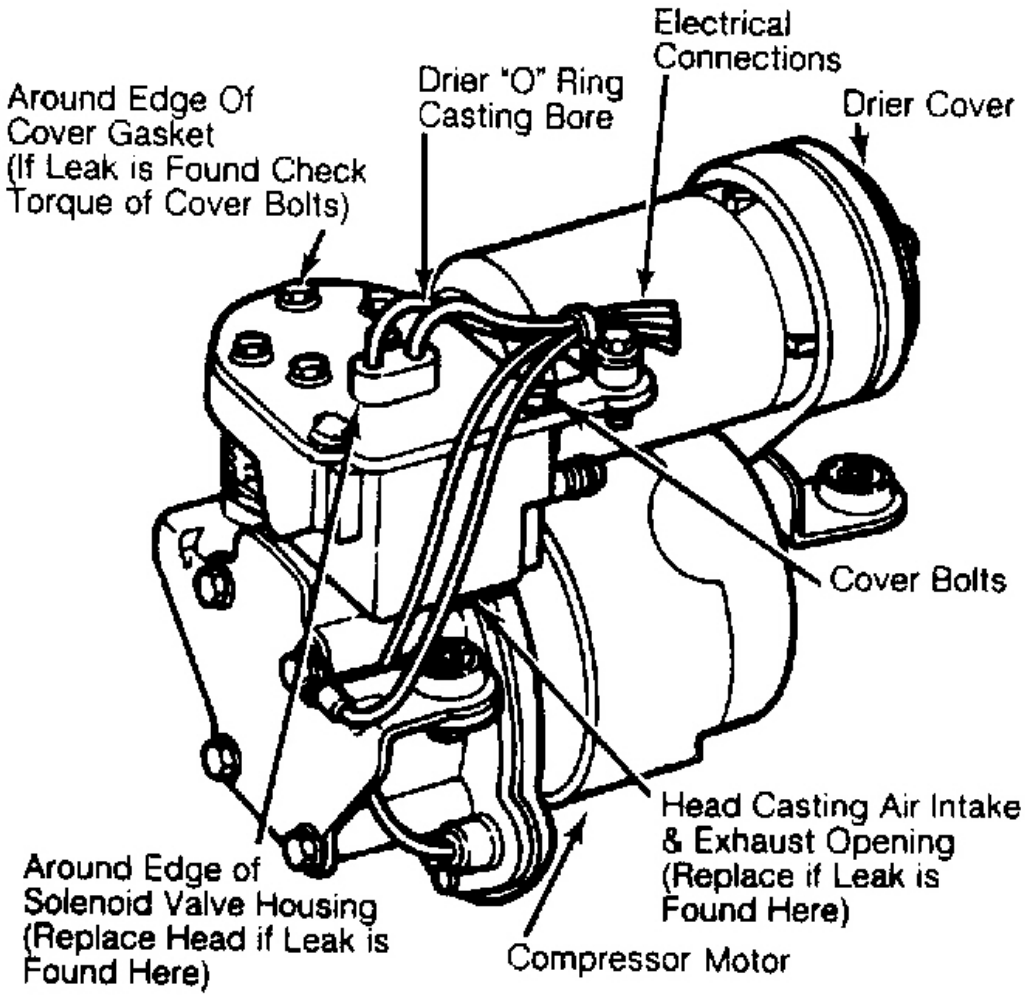


Fig. 4: Checking For Compressor Leaks
Courtesy of GENERAL MOTORS CORP.

HEIGHT SENSOR TEST

1. Turn ignition off then on to reset height sensor timer circuit. Raise vehicle on hoist by wheels (alignment rack type hoist) or by rear axle to position vehicle at normal riding height.
2. Disconnect link from height sensor metal arm. Ensure height sensor connector is securely connected and ground wire is secure. Move height sensor metal and plastic arm assemblies upward. After 8-15 second delay, compressor should turn on and inflate shocks. If compressor does not turn on, go to **COMPRESSOR INOPERATIVE** under ELECTRICAL TESTING. If compressor turns on and shocks start to inflate, move metal and plastic arm assemblies down until compressor just stops.
3. Move metal and plastic arm assemblies down to point just below where compressor stopped. After 8-15 second delay, shocks should begin to deflate. If shocks do not begin to deflate, go to **VEHICLE WILL NOT LOWER** under ELECTRICAL TESTING. Reconnect link to height sensor metal arm. Lower vehicle.

ELECTRICAL TESTING

NOTE: Use SYSTEM OPERATION TEST under SYSTEM TESTING as a guide to determine which test to perform. Before performing test, ensure system fuses are okay and link is connected between height sensor and suspension control arm. When using the following procedures, refer to appropriate wiring diagram. See WIRING DIAGRAMS .

COMPRESSOR INOPERATIVE

NOTE: For connector terminal identification, see WIRING DIAGRAMS .

Preliminary Test

Disconnect height sensor connector. Connect a fused jumper wire between ground and Yellow wire (terminal "B") of height sensor connector. If compressor operates, perform TEST NO. 1. If compressor does not operate, perform TEST NO. 2.

Test No. 1

1. Disconnect fused jumper wire. Connect test light between ground and Orange wire (terminal "C") of height sensor connector. If test light does not come on, repair open Orange wire. If test light comes on, connect test light between Orange wire and Black wire terminals (terminals "C" and "A") of height sensor connector.
2. If test light does not come on, repair open Black wire. If test light comes on, turn ignition switch to RUN position. Connect test light between ground and Pink/Black wire terminal (terminal "D") of height sensor connector.
3. If test light does not come on, repair open Pink/Black wire. If test light comes on, check for poor connection at height sensor connector. If connection is okay, adjust height sensor. See **HEIGHT SENSOR** under ADJUSTMENTS. Retest system. If system still does not operate, replace height sensor.

Test No. 2

Disconnect compressor relay connector. Connect a fused jumper wire between Orange and Black wire terminals

of compressor relay connector (leave jumper wire connected only as long as necessary to check compressor operation). If compressor operates, go to TEST NO. 3. If compressor does not operate, go to TEST NO. 4.

Test No. 3

Connect a test light between ground and Orange wire terminal of compressor relay connector (terminal No. 5 on Caprice, Impala SS and Roadmaster; terminal No. 2 on Fleetwood). If test light does not come on, repair open Orange wire. If test light comes on, check for open Yellow wire between compressor relay and height sensor. If Yellow wire is okay, replace compressor relay.

Test No. 4

Connect a test light between ground and Orange wire terminal of compressor relay connector (terminal No. 1 on Caprice, Impala SS and Roadmaster; terminal No. 3 on Fleetwood). If test light does not come on, repair open Orange wire. If test light comes on, check for open Black wire between compressor and ground. If Black wire is okay, replace compressor assembly.

VEHICLE WILL NOT LOWER

NOTE: This procedure checks operation of exhaust solenoid valve in compressor head. If exhaust solenoid valve is defective, replace compressor head. For connector terminal identification, see WIRING DIAGRAMS .

Preliminary Test

Disconnect height sensor connector. Connect a fused jumper wire between ground and White wire terminal (terminal "E") of height sensor connector. If exhaust solenoid valve does not click and air is not exhausted, perform TEST NO. 1. If exhaust solenoid valve clicks and air is exhausted, perform TEST NO. 2.

Test No. 1

Disconnect compressor connector. Connect test light between ground and Orange wire terminal (terminal"C") of compressor connector. If test light does not come on, check for open Orange wire. If test light comes on, check for open White wire between compressor and height sensor. If White wire is okay, replace compressor head assembly. See **COMPRESSOR HEAD** under REMOVAL & INSTALLATION.

Test No. 2

Connect test light between Orange and Black wire terminals (terminals "C" and "A") of height sensor connector. If test light does not come on, repair open Black wire. If test light comes on, check for poor connection at height sensor connector. If connection is okay, adjust height sensor. See **HEIGHT SENSOR** under ADJUSTMENTS. Retest system. If system still does not operate, replace height sensor.

COMPRESSOR OPERATES CONTINUOUSLY (LONGER THAN 7 MINUTES)

NOTE: For connector terminal identification, see WIRING DIAGRAMS .

1. Disconnect compressor relay connector. If compressor continues to operate, repair short to battery voltage in appropriate wire. If compressor stops operating, connect test light between Orange and Yellow wire terminals of compressor relay connector (terminals No. 5 and 2 on Caprice, Impala SS and Roadmaster; terminals No. 2 and 1 on Fleetwood).
2. If test light does not come on, replace compressor relay. If test light comes on, disconnect height sensor connector. Connect test light between Yellow and Orange wire terminals (terminals "B" and "C") of height sensor connector.
3. If test light comes on, repair short to ground in Yellow wire between compressor relay and height sensor. If test light does not come on, replace height sensor.

REMOVAL & INSTALLATION

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION before disconnecting battery.

AIR ADJUSTABLE SHOCK ABSORBER

Removal

Raise and support vehicle. Support rear axle. Disconnect air lines from shock absorbers by rotating spring clip and removing air line. Remove upper bolts and nuts on shock absorber. Remove lower nut and washer. DO NOT allow lower stud to rotate when removing nut. Remove shock absorbers.

Installation

To install, reverse removal procedure. Tighten bolts and nuts to specification. See **TORQUE SPECIFICATIONS** table. Before installing air lines, lubricate "O" rings with petroleum jelly. Ensure air line and connector are fully seated in fitting.

HEIGHT SENSOR

Removal

Disconnect negative battery cable. Raise and support vehicle. Disconnect height sensor harness. Disconnect height sensor link from height sensor actuating arm. Remove height sensor screws.

Installation

To install, reverse removal procedure. Tighten height sensor screws to specification. See **TORQUE SPECIFICATIONS** table. Adjust height sensor. See **HEIGHT SENSOR** under ADJUSTMENTS.

COMPRESSOR

Removal

Disconnect negative battery cable. Raise and support vehicle. Remove cover from left front wheelwell for access to compressor on frame rail. Disconnect compressor electrical connectors. Disconnect air lines as necessary. Remove compressor bolts and compressor.

Installation

To install, reverse removal procedure. Pre-pressurize system by grounding test connector (Yellow wire terminal) with jumper wire. Turn ignition on and allow system to cycle. Check for leaks using soap and water solution.

COMPRESSOR HEAD

Removal

Remove air drier. See **AIR DRIER** . Remove head-to-compressor screws. Remove head and "O" ring seal.

Installation

To install, reverse removal procedure. Use NEW "O" ring seal. Pre-pressurize system by grounding test connector (Yellow wire terminal) with jumper wire. Turn ignition on and allow system to cycle. Check for leaks using soap and water solution.

AIR DRIER

Removal

Disconnect high pressure line by turning spring clip 90 degrees and removing tube assembly. Disconnect drier from compressor by turning spring clip and sliding drier and "O" ring from compressor head assembly.

Installation

Lubricate "O" ring and install in port of compressor head. Return retainer spring to its original position. Install drier on compressor head assembly. If difficulty arises when installing drier in compressor head assembly, rotate slightly while applying pressure. Check system for leaks.

AIR LINE REPAIR

Repair air line by splicing coupling at leak area. Inflate system to 100 psi (7.0 kg/cm^2). Use soap and water solution to locate leak. Deflate system through service valve, and cut out leaking area. Install coupling, and tighten tube nuts to 72 INCH lbs. (8 N.m). See **Fig. 5** . Inflate system, and check for leaks using soap and water solution.

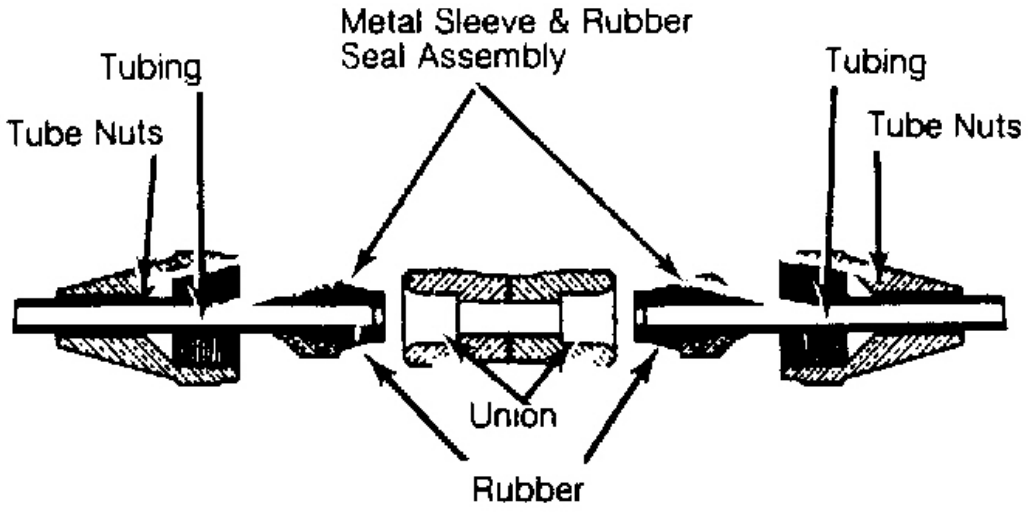


Fig. 5: Assembling Air Line Repair Coupling
Courtesy of GENERAL MOTORS CORP.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	**Ft. Lbs. (N.m)**
Air Adjustable Shock Absorber	
Lower Nut	48 (65)
Upper Bolt	20 (27)
Upper Nut	16 (22)
Height Sensor Bolt	10 (14)
	INCH Lbs. (N.m)
Air Drier-To-Compressor Bolt	34 (3.8)
Air Filter Bolt	89 (10.0)
Compressor Head Bolt	35 (3.9)

WIRING DIAGRAMS

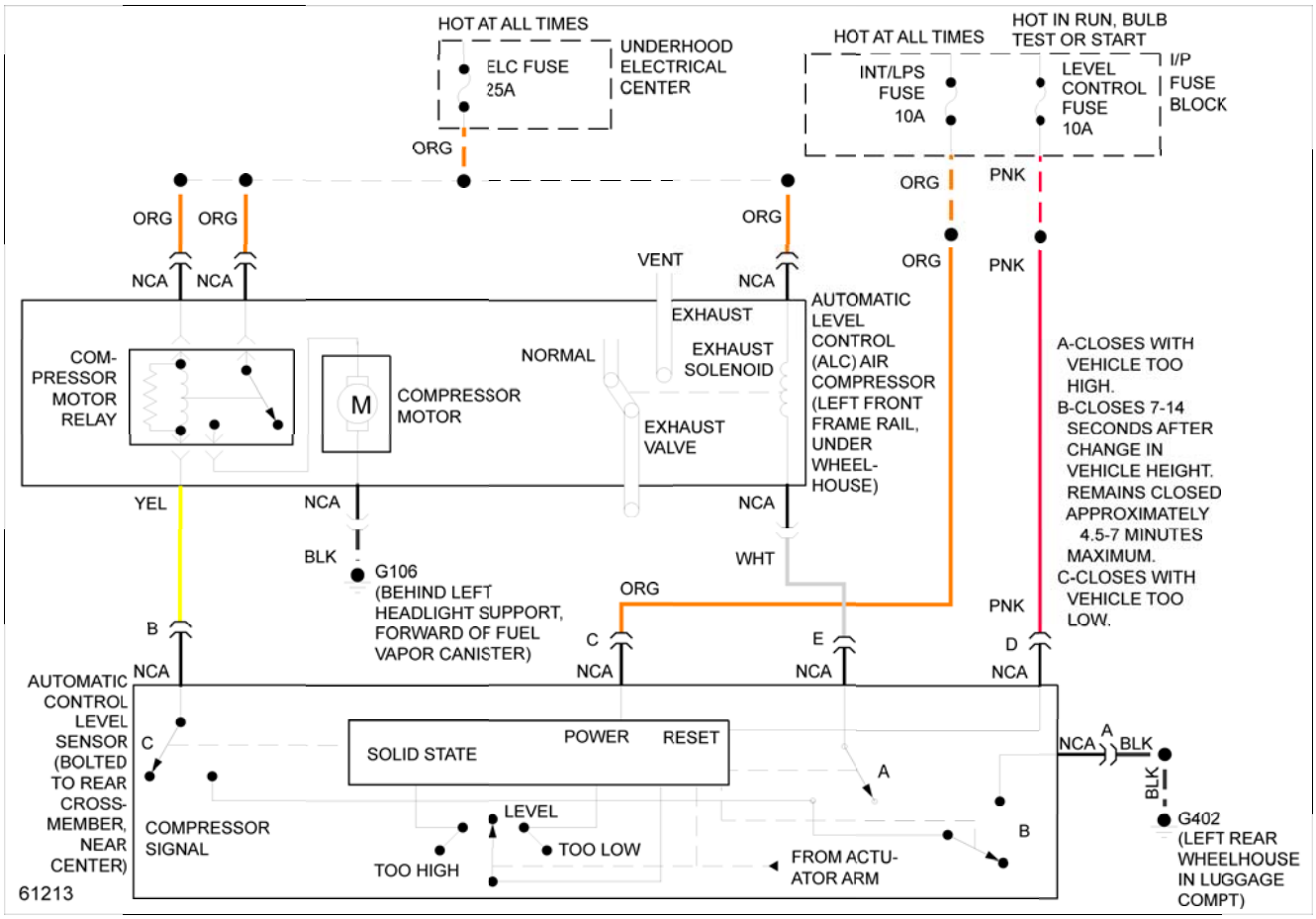


Fig. 6: ELC System Wiring Diagram (Caprice, Impala SS & Roadmaster)

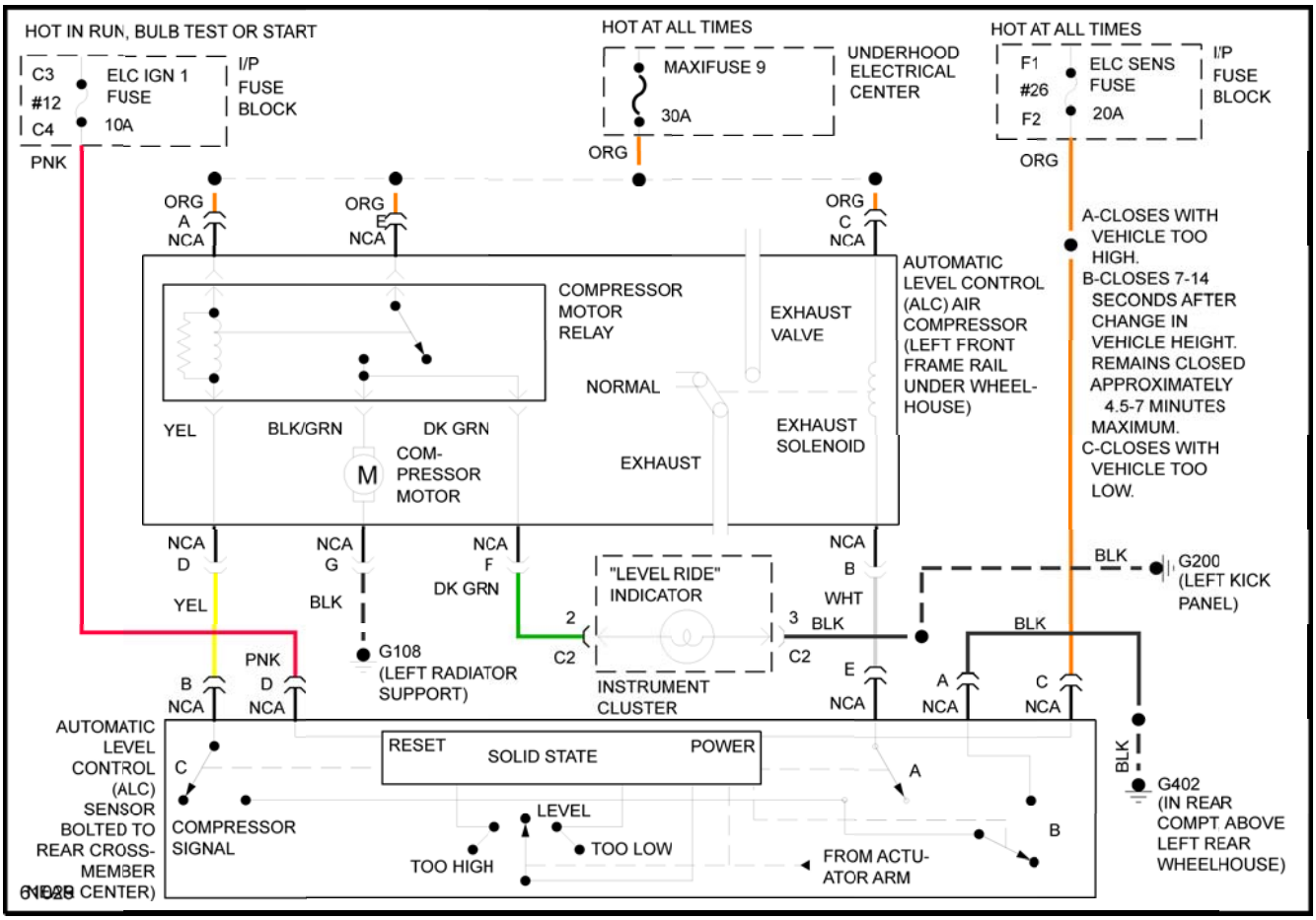


Fig. 7: ELC System Wiring Diagram (Fleetwood)

I - SYSTEM/COMPONENT TESTS - 4.3L

ENGINE PERFORMANCE General Motors Corp. System & Component Testing - 4.3L

INTRODUCTION

Before testing separate components or systems, perform all procedures listed in **BASIC TESTING** article in the ENGINE PERFORMANCE section. Since many computer-controlled and monitored components will set a diagnostic trouble code if they malfunction, it is also recommended that self-diagnosis be performed. See **TESTS W/CODES - 4.3L** article in the ENGINE PERFORMANCE section.

NOTE: Testing individual components does not isolate shorts or opens. Perform all voltage tests with a Digital Volt-Ohmmeter (DVOM) with a minimum 10-megohm input impedance, unless stated otherwise in test procedure. Use ohmmeter to isolate wiring harness shorts or opens. The following table provides the location of commonly used diagnostic information. These former "A" and "C" charts are now written in text and inserted into the appropriate location in the new Engine Performance workflow. To familiarize yourself with the Engine Performance workflow, see AA - HOW TO USE THE ENGINE PERFORMANCE SECTION article in GENERAL INFORMATION section.

GENERAL MOTORS A & C CHART REFERENCE

System Or Component	Diagnostic Information Location
A-1 & A-2, MALFUNCTION INDICATOR LIGHT (MIL)	(1) See DIAGNOSTIC CIRCUIT CHECK
A-3, No Start	(1) See NO START - ENGINE CRANKS OKAY
A-5, Fuel Pump Relay	See FUEL SYSTEM in this article
A-7, Fuel System Diagnosis	(1) See BASIC FUEL SYSTEM CHECKS
C-1, ECM/PCM Replacement Check	(1) See ECM/PCM REPLACEMENT CHECK
C-1, MAP Sensor	See ENGINE SENSORS & SWITCHES in this article
C-1, Power Steering Pressure Switch	See ENGINE SENSORS & SWITCHES in this article
C-1, Park/Neutral Position Switch	See ENGINE SENSORS & SWITCHES in this article
C-2, Injector Balance Test	See FUEL SYSTEM in this article
C-2, Injector Coil Test	See FUEL SYSTEM in this article
C-2, Injector Leak Test	See FUEL SYSTEM in this article
C-2, IAC Motor	See IDLE CONTROL SYSTEM in this article
C-2, ISC Motor	See IDLE CONTROL SYSTEM in this article
C-3, Canister Purge System (Fuel Evaporation Control)	See EMISSION SYSTEMS & SUB-SYSTEMS in this article
C-4, EST Ignition Check	See BASIC IGNITION SYSTEM CHECKS in this article
C-5, KS Ignition Check	See IGNITION SYSTEM in this article
C-6, Air Injection System	See EMISSION SYSTEMS & SUB-SYSTEMS in this article
C-7, EGR System	See EMISSION SYSTEMS & SUB-SYSTEMS in this article

C-8, Manual Transmission Shift Lights (Transmission)	See MISCELLANEOUS CONTROLS in this article
C-8, Torque Converter Clutch (Transmission)	(2) See MISCELLANEOUS CONTROLS in this article
C-10, A/C Clutch Control	See MISCELLANEOUS CONTROLS in this article
C-12, Electric Cooling Fan Control	See MISCELLANEOUS CONTROLS in this article
C-16, Engine Coolant Level Switch	See ENGINE SENSORS & SWITCHES in this article
C-16, Fuel Pump/Oil Pressure Switch	See ENGINE SENSORS & SWITCHES in this article
C-16, Oil Level Switch	See ENGINE SENSORS & SWITCHES in this article
C-18, Supercharger Boost Control	See AIR INDUCTION SYSTEMS in this article
(1) See **BASIC TESTING** article in the ENGINE PERFORMANCE section. (2) Covered in entirety in appropriate TRANSMISSION SERVICING & REPAIR manual.	

COMPUTERIZED ENGINE CONTROLS

CONTROL UNIT

Ground Circuits

1. Using an ohmmeter, check for continuity to ground on control unit ground terminals. Use appropriate wiring diagram in WIRING DIAGRAMS section to determine PCM ground terminals. Resistance to ground should be zero ohms. If reading is other than zero ohms, repair open to circuit ground.
2. Using a DVOM, touch negative lead of voltmeter to a good ground. Touch positive lead of voltmeter to each ground terminal. With vehicle running, voltmeter should indicate less than one volt. If voltmeter reading is one volt or more, check for open, corroded or loose connection on ground lead.

Power Circuits

1. Using a voltmeter, check for battery voltage between control unit constant battery power terminals and ground. If battery voltage is not present, check control unit power supply fuse. If fuse is okay, check for open in power supply or control unit wiring.
2. Turn ignition switch to the ON position. Using a voltmeter, check for battery voltage between control unit ignition power terminals and ground. If battery voltage is not present, check power supply fuse(s). If fuse is okay, check for an open in wiring between fuse and control unit, or check for a defective ignition switch.
3. Connect voltmeter between ground and control unit start (crank) signal terminal. Turn ignition switch to the START position. Battery voltage should be present between control unit start terminal and ground ONLY when ignition switch is in the START position.
4. If voltage is not present, check fuse(s). If fuse is okay, check for an open in wiring between fuse and control unit, or check for a defective ignition switch.

ENGINE SENSORS & SWITCHES

NOTE: For additional sensor testing specifications, see SENSOR RANGE CHARTS article in the ENGINE PERFORMANCE section.

A/C ON (A/C REQUEST) SWITCH TEST

1. Start engine and allow to idle. If a scan tester is available, scan A/C request parameter. Move A/C mode selector back and forth between ON and OFF positions. Scan status should change.
2. If scan tester is not available or scan status does not change, measure voltage between ground and PCM A/C request terminal. For wiring schematics, see mini-schematics under A/C CLUTCH (C-10) & ELECTRIC COOLING FAN (C-12) under MISCELLANEOUS CONTROLS.
3. With A/C mode selector in the ON position, battery voltage should be present. If battery voltage is not present, check for open between A/C mode select switch and PCM A/C request terminal, low A/C refrigerant level causing low pressure switch to open, bad A/C fuse or bad A/C mode select switch.

A/C PRESSURE SENSOR

A malfunction in A/C pressure sensor circuit will set a related diagnostic trouble code. For testing procedures, see **TESTS W/CODES - 4.3L** article in the ENGINE PERFORMANCE section. For wiring schematics, see mini-schematics under A/C CLUTCH (C-10) & ELECTRIC COOLING FAN (C-12) under MISCELLANEOUS CONTROLS.

A/C PRESSURE SWITCH

1. Connect A/C pressure gauges to system and start engine. Note high and low pressure readings. If pressures are normal, go to next step. If pressures are less than normal, check system for leaks. Evacuate and recharge as necessary. If pressures are high, check for system overcharge, overheating or mechanical failure in refrigerant delivery system.
2. Disconnect high and low pressure switches. Install jumper across each switch harness connector to allow A/C system to function normally. Using an ohmmeter, check continuity between pressure switch terminals.
3. Continuity should be present on both high and low switches (if equipped). If continuity is not present, replace A/C pressure switch. For wiring schematics, see mini-schematics under A/C CLUTCH (C-10) & ELECTRIC COOLING FAN (C-12) under MISCELLANEOUS CONTROLS.

BRAKE SWITCH

Disconnect brake switch harness connector. Using an ohmmeter, check continuity between brake switch terminals. Continuity should be present. Depress brake pedal to activate brake switch. Continuity should not be present.

CRANKSHAFT POSITION SENSOR

A malfunction in the crankshaft position sensor circuit will set a related diagnostic trouble code. For testing procedures, see **TESTS W/CODES - 4.3L** article in the ENGINE PERFORMANCE section. To diagnose position crankshaft sensor, the following procedures can be used:

1. If a scan tester is available, scan RPM parameter while cranking engine. If RPM is indicated, crankshaft position sensor is operating properly.
2. If scan tester is not available, disconnect crankshaft position sensor harness connector. Set ohmmeter to 2-k/ohm position, and measure resistance across sensor terminals. Resistance should be 800-1200 ohms.
3. Set voltmeter on the 2-volt AC scale. Crank engine and measure output voltage across sensor terminals. Voltmeter reading should be .8-1.4 volts. If resistance reading is not as specified or sensor does not produce the specified output voltage reading, repair faulty wiring or faulty crankshaft position sensor.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

If a coolant sensor-related diagnostic trouble code is present, see **TESTS W/CODES - 4.3L** article in the ENGINE PERFORMANCE section. An out-of-calibration sensor may not set a diagnostic trouble code. Use following procedure to test sensor calibration. Disconnect ECT sensor connector. Measure resistance between sensor terminals. Resistance should be high when engine is cold and drop as engine warms. See ECT SENSOR RESISTANCE VALUES table.

ECT SENSOR RESISTANCE VALUES

°F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467
104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

INTAKE AIR TEMPERATURE (IAT) SENSOR

IAT sensor may also be referred to as a Manifold Air Temperature (MAT) sensor. If a IAT sensor related code is present, see **TESTS W/CODES - 4.3L** article in the ENGINE PERFORMANCE section. An out-of-calibration sensor may not set a diagnostic trouble code. Use following procedure to test calibration. Disconnect IAT sensor harness connector. Connect ohmmeter between sensor terminals. Sensor resistance should be as specified. See IAT SENSOR RESISTANCE VALUES table. After vehicle has sat overnight, MAT sensor and coolant sensor should have close to the same resistance reading.

IAT SENSOR RESISTANCE VALUES

Temperature °F (°C)	Ohms
212 (100)	177
194 (90)	241
158 (70)	467

104 (40)	1459
68 (20)	3520
23 (-5)	12,300
14 (-10)	16,180
0 (-18)	25,000
-4 (-20)	28,680
-22 (-30)	52,700
-40 (-40)	100,700

KNOCK SENSOR (KS)

Disconnect knock sensor harness connector. Using an ohmmeter, measure knock sensor resistance between sensor terminal and engine block. Resistance should be 3300-4500 ohms. Connect DVOM between sensor terminal and ground. Set voltmeter to 2-volt AC scale. Start and idle engine. Tap on engine block near sensor. A signal should be indicated on voltmeter. If no signal is indicated, replace knock sensor. Also, see TIMING CONTROL SYSTEMS under IGNITION SYSTEM. If a code is present, see **TESTS W/CODES - 4.3L** article in the ENGINE PERFORMANCE section.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR (C-1)

1. A malfunction in the MAP sensor circuit should set a related diagnostic trouble code in PCM memory. If a code is present, see **TESTS W/CODES - 4.3L** article in the ENGINE PERFORMANCE section. An out-of-calibration sensor may not set a diagnostic trouble code. Use following procedure to test sensor calibration. If driveability problems exist, MAP sensor failure is suspected and no MAP code is present, disconnect MAP sensor connector. See **Fig. 1** . If driveability condition improves, replace MAP sensor.
2. With ignition on and engine off, check MAP sensor parameter using a scan tester connected to Data Link Connector (DLC). Voltage should be as specified. See MAP SENSOR VOLTAGE RANGE table. If MAP sensor voltage is as specified, go to step 3). If voltage is not as specified, check for 5-volt reference supplied to sensor. Check harness integrity. If no problems are evident, replace MAP sensor.
3. Using a hand-held vacuum pump, apply 10 in. Hg to MAP sensor, and note voltage change. Voltage should drop about 1.2-2.3 volts less than as specified in table. If voltage is not as specified or voltage reading does not immediately follow vacuum change, MAP sensor is faulty.

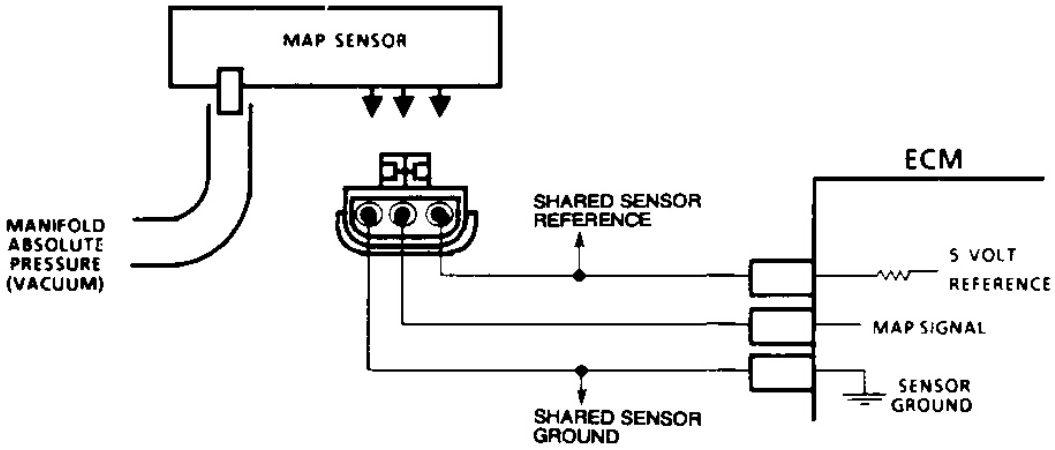


Fig. 1: MAP Sensor Circuit (4.3L)
Courtesy of GENERAL MOTORS CORP.

MAP SENSOR VOLTAGE RANGE

Altitude (Ft.)	Volts
Below 1000	3.8-5.5
1000-2000	3.6-5.3
2000-3000	3.5-5.1
3000-4000	3.3-5.0
4000-5000	3.2-4.8
5000-6000	3.0-4.6
6000-7000	2.9-4.5
7000-8000	2.8-4.3
8000-9000	2.6-4.2
9000-10,000	2.5-4.0

MANIFOLD AIR TEMPERATURE (MAT) SENSOR

MAT sensor may also be referred to as an Intake Air Temperature (IAT) sensor. See INTAKE AIR TEMPERATURE (IAT) SENSOR. A malfunction in the MAT sensor will set a related diagnostic trouble code. For testing procedures, see **TESTS W/CODES - 4.3L** article in the ENGINE PERFORMANCE section.

OXYGEN SENSOR (O2S)

1. Start engine and warm to operating temperature. Disconnect oxygen sensor. Connect a DVOM between lead of oxygen sensor and ground. Place DVOM on the 2-volt scale. Voltmeter reading should increase to greater than .8 volt.

2. Using another DVOM on the 20-volt scale, connect voltmeter in series between the oxygen sensor wire from PCM and positive post of battery. Reading on voltmeter connected to oxygen sensor should decrease to a low voltage (less than .3 volt).
3. If a second DVOM is not available, install short jumper in oxygen sensor wire from PCM. Hold jumper in one hand and touch positive post of battery with other hand. This should cause oxygen sensor to produce less than .3 volt. For additional testing procedures, see **TESTS W/CODES - 4.3L** article in the ENGINE PERFORMANCE section.

PARK/NEUTRAL POSITION (PNP) SWITCH (C-1)

1. Disconnect PNP switch harness connector. Connect ohmmeter between the PNP switch terminals. See **Fig. 2** . Continuity should be present only when gear shift selector is in Park or Neutral. If continuity is present, go to next step. If continuity is not present, check PNP switch adjustment or replace defective PNP switch.
2. With PNP switch connector disconnected, turn ignition on. Check for 12 volts on the Orange/Black wire of PNP switch harness. If 12 volts are not present, check for open or short to ground between switch harness connector and PCM.

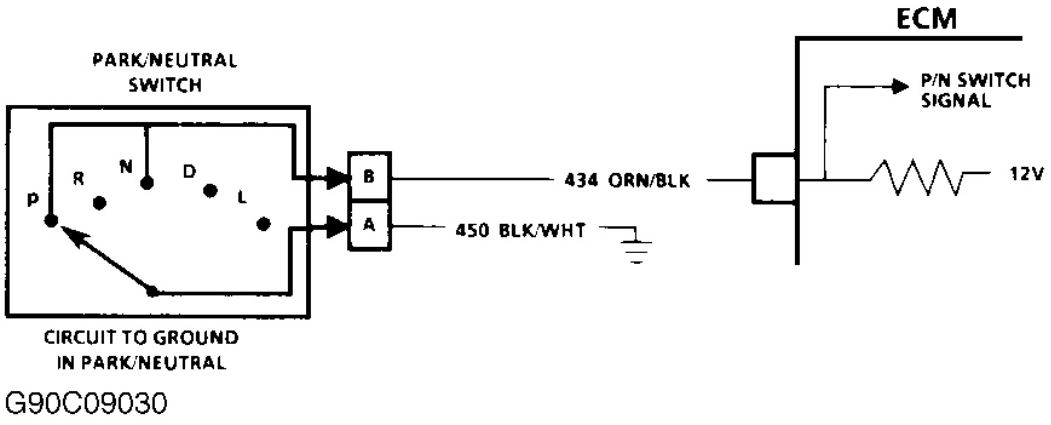


Fig. 2: Park/Neutral Position (PNP) Switch Circuit (4.3L)
Courtesy of GENERAL MOTORS CORP.

POWER STEERING PRESSURE (PSP) SWITCH

1. If scan tester is available, scan power steering pressure switch status. Note status with engine running and wheels in straight-ahead position. Turn steering wheel to full left or right position and again note status. If status changed, power steering pressure switch is okay. If status did not change or scan tester is not available, go to next step.
2. Turn ignition off. Disconnect PSP switch harness connector. Connect ohmmeter between PSP switch terminals. Start engine. With no-load on power steering, continuity should not be present. Turn steering wheel to full left or right position. Continuity should now be present. If readings are not as specified,

replace PSP switch.

3. With PSP switch connector disconnected and ignition on, check for battery voltage on PSP switch harness from PCM. If battery voltage is not present, check for open or short to ground in harness between PSP switch connector and PCM.

THROTTLE POSITION (TP) SENSOR

Install jumper wires to enable connection of a DVOM in parallel between TP sensor harness connectors. Connect DVOM positive lead to Dark Blue TP sensor signal wire terminal. Connect negative lead to Black, Black/Orange or Purple sensor ground wire terminal. See **Fig. 3** . Turn ignition on, with engine off. Signal voltage should gradually change from less than one volt at closed throttle to about 5.0 volts at wide open throttle position. If reading is not as specified, adjust or replace TP sensor. See **ADJUSTMENTS** article in the ENGINE PERFORMANCE section.

A malfunction in the TP sensor circuit should set a related diagnostic trouble code. For further information, see **TESTS W/CODES - 4.3L** article in the ENGINE PERFORMANCE section.

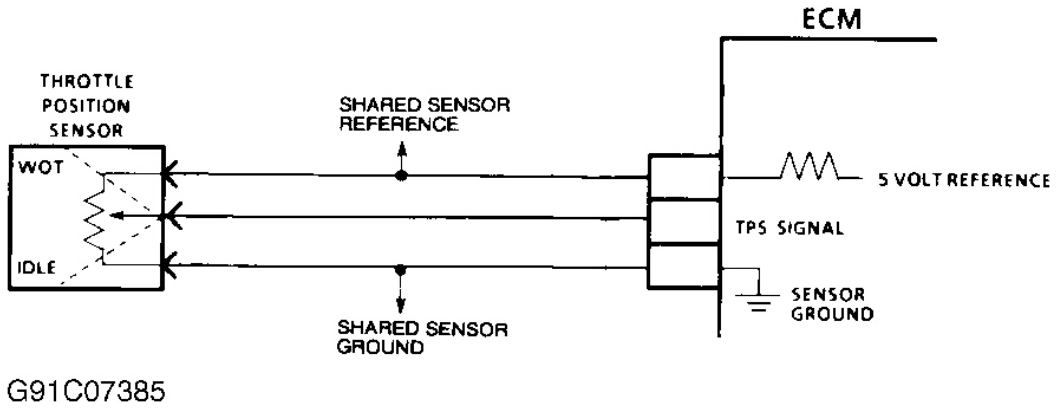


Fig. 3: Throttle Position (TP) Sensor Circuit (4.3L)
Courtesy of GENERAL MOTORS CORP.

VEHICLE SPEED SENSOR (PM GENERATOR TYPE)

Disconnect vehicle speed sensor harness connector (located in transaxle). Place gear selector in Neutral. Raise vehicle drive wheels off the ground. Turn drive wheels by hand (greater than 3 MPH). Measure AC signal voltage between sensor terminals. Voltage reading should vary from 0.1-0.5 volt AC as the wheel is turned. If reading is not as specified, replace vehicle speed sensor.

VEHICLE SPEED SENSOR (LED TYPE)

A speed sensor or buffer malfunction should set a related diagnostic trouble code in PCM memory. If a code is set, refer to **TESTS W/CODES - 4.3L** article for diagnosis in the ENGINE PERFORMANCE section.

MOTORS, RELAYS & SOLENOIDS

MOTORS

Secondary AIR Elec. Air Pump

Locate secondary AIR electric air pump on left front of engine compartment. Disconnect 3-wire connector from electric air pump. Apply ground to terminal "C" (Black wire) of pump. Apply battery voltage with a fused jumper wire to terminal "A" (Red wire) of pump. Pump should run. If pump does not operate, replace pump.

Idle Air Control (IAC) Motor & Idle Speed Control (ISC) Motor

See IDLE CONTROL SYSTEM.

RELAYS

A/C Clutch Relay

See MISCELLANEOUS CONTROLS.

Electric AIR Pump Relay

See EMISSION SYSTEMS & SUB-SYSTEMS.

Fuel Pump Relay

See FUEL SYSTEM.

SOLENOIDS

NOTE: All PCM-controlled solenoids should have at least 20 ohms of resistance when checked with positive ohmmeter lead connected to power supply terminal of solenoid and negative ohmmeter lead connected to ground terminal of solenoid. Some solenoids are equipped with internal diodes. On these solenoids, resistance values will differ if ohmmeter test leads are reversed.

AIR By-Pass Valve Solenoid

See EMISSION SYSTEMS & SUB-SYSTEMS.

Canister Purge Solenoid

See EMISSION SYSTEMS & SUB-SYSTEMS.

EGR Control Solenoid

See EMISSION SYSTEMS & SUB-SYSTEMS.

FUEL SYSTEM

FUEL DELIVERY

NOTE: For fuel system pressure testing, see BASIC TESTING article in the ENGINE PERFORMANCE section.

Fuel Pressure Regulator

1. Install fuel pressure gauge to fuel rail fuel pressure test fitting. Remove vacuum hose from fuel pressure regulator. Turn ignition on and note fuel pressure on gauge.
2. Start engine. Check for manifold vacuum at pressure regulator vacuum hose. If vacuum is not present, repair as necessary. Reconnect vacuum hose to pressure regulator and note fuel pressure on gauge. Compare first and second reading.
3. Fuel pressure reading should be 4-7 psi (.28-.49 kg/cm^2) less with vacuum hose installed. Fuel pressure should decrease as vacuum increases. If results are not as specified, replace fuel pressure regulator.

NOTE: For further fuel pump circuit diagnosis, refer to appropriate FUEL SYSTEM test under NO-START DIAGNOSIS (A-3) in BASIC TESTING article in the ENGINE PERFORMANCE section.

Fuel Pump Relay (A-5)

1. Disconnect fuel pump relay connector. See COMPONENT LOCATIONS at end of article to locate fuel pump relay. Apply battery voltage and ground to fuel pump relay winding terminals. To identify fuel pump relay terminals, see appropriate wiring diagram in WIRING DIAGRAMS section.
2. Using an ohmmeter, check for continuity between fuel pump relay power supply terminal and fuel pump drive terminal. Continuity should exist ONLY with relay energized. If relay does not test as indicated, replace relay.
3. To by-pass fuel pump relay (to test fuel pump and wiring when fuel pump is not energizing), see FUEL PUMP RELAY BY-PASS PROCEDURE.

Fuel Pump Relay By-Pass Procedure

1. If fuel pump will not energize, relay may be by-passed to test fuel pump and related wiring. See **Fig. 4** . Turn ignition off. Disconnect fuel pump relay connector.
2. Using a fused jumper wire, apply battery voltage to fuel pump test connector (located in engine compartment). For fuel pump test connector location, see COMPONENT LOCATIONS at end of this article. See **Fig. 12** .
3. If fuel pump runs and relay tests okay, check for faulty connections at relay. If fuel pump does not run, check for faulty wiring between relay and fuel pump or replace defective fuel pump.

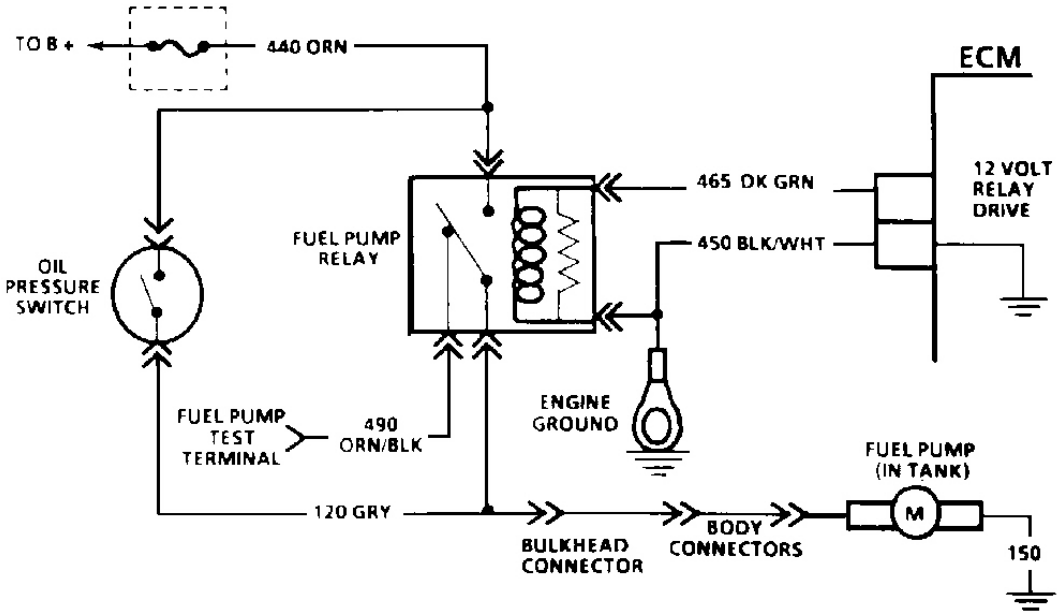


Fig. 4: Fuel Pump Relay Schematic (4.3L)
Courtesy of GENERAL MOTORS CORP.

Oil Pressure Switch Fuel Pump Back-Up

With engine idling, disconnect fuel pump relay. Engine should continue to run through oil pressure switch back-up circuit. If engine stalls, check oil pressure switch and related wiring.

FUEL CONTROL

Fuel Injector(s)

Disconnect fuel injector harness connector. Measure resistance across injector terminals at each injector. Resistance should be as specified. See INJECTOR RESISTANCE SPECIFICATIONS table.

INJECTOR RESISTANCE SPECIFICATIONS

Application	Ohms
4.3	11.8-12.6

NOTE: If injectors are dirty, they should be cleaned using approved injector cleaning procedure before performing INJECTOR BALANCE TEST.

Injector Balance Test (C-2)

The injector balance test is used to pulse the injector for a precise amount of time, spraying a measured amount of fuel in the intake manifold. As each injector is pulsed, a drop in fuel rail pressure occurs. This pressure drop can be recorded and compared to other injectors. An injector with a pressure drop of 1.5 psi (.11 kg/cm^2) or more, greater than or less than other injectors, should be considered faulty.

NOTE: Allow engine to cool down to avoid irregular readings due to "hot soak" fuel boiling. To prevent flooding, the INJECTOR BALANCE TEST should not be repeated more than once without starting and running engine.

CAUTION: To avoid possible vehicle fire, wrap a shop towel around fitting to absorb fuel spillage.

1. Ensure engine is at normal operating temperature. Connect Fuel Pressure Gauge (J-34730-1) to pressure test port. Energize fuel pump using fuel pump test connector or Tech 1 scan tester.
2. Bleed air from fuel gauge and hose to ensure accurate gauge reading. Repeat this procedure until all air is bled from system. Run fuel pump and note fuel pressure. Fuel pressure should be as specified. See FUEL PRESSURE RANGE chart. If fuel pressure range is not as specified, see BASIC FUEL SYSTEM CHECKS in **BASIC TESTING** article in the ENGINE PERFORMANCE section.
3. Turn fuel pump off. When fuel pump stops, pressure may slightly drop then should hold steady. If fuel pressure does not hold steady, refer to BASIC FUEL SYSTEM CHECKS in **BASIC TESTING** article in the ENGINE PERFORMANCE section.
4. Install Fuel Injector Tester (J-39021) to an injector. Set amperage supply selector switch to "Balance Test, 0.5-2.5 amp." position. Cycle fuel pump on and off to pressurize fuel system. Record stabilized fuel pressure.
5. Depress "Push To Start Test" button on fuel injector tester to energize injector. Note fuel pressure the instant fuel gauge needle stops. Record fuel pressure reading. Perform the same test to all injectors.
6. To obtain pressure drop values, subtract second pressure reading from first pressure reading on each injector. Add all pressure drop values and divide by number of injectors to obtain an average pressure drop.
7. Retest an injector that appears faulty. Replace any injector with a 1.5 psi (.11 kg/cm^2) difference, either greater than or less than the average pressure drop. If injectors are all okay, remove test equipment, plug in disconnected harness connectors and review SYMPTOMS in **TESTS W/O CODES** article in the ENGINE PERFORMANCE section.

FUEL PRESSURE RANGE CHART

Application	psi (kg/cm^2)
4.3L	41-47 (2.9-3.3)

CAUTION: To avoid possible vehicle fire, wrap shop towel around fitting to absorb fuel spillage.

Fuel Injector Leak Test

1. Turn engine off. Relieve fuel pressure. Access fuel injectors. Connect Fuel Injector Tester (J-39021) to vehicle battery and to a fuel injector. If coolant temperature is 50-95°F (10-35°C), go to next step. If coolant temperature is not 50-95°F (10-35°C), go to step 5).
2. Set fuel injector tester's amperage supply selector switch to "Coil Test 0.5 amp" position. Connect a Digital Volt-Ohmmeter (DVOM) to fuel injector tester. Set DVOM to tenths scale (0.0).
3. Ensure engine coolant temperature is 50-95°F (10-35°C). Press "Push To Start" tester button. Observe DVOM. Voltage reading may climb during test. Record lowest voltage displayed immediately after activation.
4. Perform voltage reading on all injectors. If voltage reading is erratic or falls out of specified range, perform injector balance test or replace faulty injector. See INJECTOR TEST VOLTAGE RANGE table or INJECTOR BALANCE TEST (C2).
5. Press "Push To Start" button on fuel injector tester. Observe DVOM. Voltage reading may climb during test. Record lowest voltage displayed immediately after activation. Perform voltage reading at least twice on all injectors.
6. If voltage reading is erratic or is greater than 9.5 volts, replace affected fuel injector. If voltage reading is not erratic or not greater than 9.5 volts, go to next step.
7. From recorded voltages (except readings greater than 9.5 volts), identify highest voltage reading and subtract from the other recorded voltages. If subtracted value is greater than 0.6 volts, replace affected fuel injector. If subtracted value is less than 0.6 volts, perform injector balance test. See INJECTOR BALANCE TEST (C2).

INJECTOR TEST VOLTAGE RANGE

Application	Volts
4.3L	5.7-6.6

Oxygen Sensor

See ENGINE SENSORS & SWITCHES.

IDLE CONTROL SYSTEM (C-2)

IDLE AIR CONTROL (IAC) MOTOR

1. Disconnect harness connector to motor. Check resistance across IAC coil terminals "A" and "B" (coil "B") and "C" and "D" (coil "A"). See **Fig. 5** . Resistance should be 40-80 ohms. If resistance is as specified, go to next step. If resistance is not as specified, replace IAC motor.
2. Check resistance between IAC terminals "B" to "C" and "A" to "D". Resistance should be infinite. If resistance is not as specified, replace IAC motor.

NOTE: Additional testing of Idle Air Control (IAC) motor requires an IAC motor actuator and node light, or a scan tester capable of cycling PCM output devices (General Motors Tech 1).

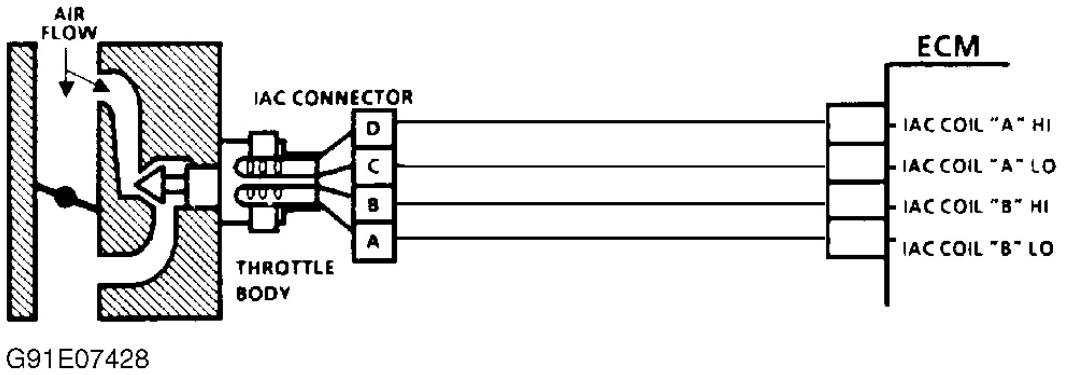


Fig. 5: IAC Motor Circuit (4.3L)
Courtesy of GENERAL MOTORS CORP.

IGNITION SYSTEM

NOTE: For basic ignition system checks, see BASIC TESTING article in the ENGINE PERFORMANCE section.

TIMING CONTROL SYSTEMS

Ignition Control (IC) Timing Advance System

1. A malfunction in the IC circuit (formerly referred to as the EST circuit) should set a related diagnostic trouble code. Start engine and warm to operating temperature. On vehicles equipped with a manual transmission, increase engine speed to about 2000 RPM. On vehicle equipped with an automatic transmission, slightly increase idle speed.
2. Ground DLC "test" terminal "B" (not applicable to all models). A noticeable change in engine speed should occur. If no change occurs, see DIAGNOSTIC CIRCUIT CHECK in **BASIC TESTING** article in the ENGINE PERFORMANCE section.

Knock Sensor (KS) System Without KS Controller (C-5)

1. An open or short circuit on the KS wire to the PCM will set a related diagnostic trouble code. A false detonation signal will not cause PCM to set a code.
2. If a scan tester is available, connect it to the DLC. Tap on engine next to knock sensor and note "knock" parameter. Knock should be indicated on scan tester.
3. If a scan tester is not available, connect tachometer to engine. Start engine and hold RPM above idle. Using a metal object, tap on engine close to knock sensor. A noticeable decrease in engine RPM should occur. If no RPM decrease occurred, check knock sensor-to-PCM circuit.
4. On vehicles equipped with automatic transmission, it may be necessary to place transmission in Drive for timing change to occur. Also, see KNOCK SENSOR (KS) under ENGINE SENSORS & SWITCHES.

Knock Sensor (KS) System With KS Controller (C-5)

1. An open or short circuit on KS wire to PCM will cause a loss of 12-volt KS controller signal. This will cause PCM to fully retard ignition timing.
2. If scan tester is available, connect it to the DLC. Tap on engine next to knock sensor and note "knock" parameter. Knock should be indicated on scan tester.
3. If scan tester is not available, connect a DVOM to PCM ESC signal terminal. With engine idling, 12 volts should be present at this terminal. Using a metal object, tap on engine close to knock sensor. Voltage signal at PCM terminal should drop to zero volts, and return when knock signal ceases.
4. If signal does not respond as described, check knock sensor signal to KS controller. On vehicles equipped with automatic transmission, it may be necessary to place transmission in Drive for timing change to occur. Also, see KNOCK SENSOR (KS) under ENGINE SENSORS & SWITCHES.

EMISSION SYSTEMS & SUB-SYSTEMS

AIR INJECTION (C-6)

AIR Pump (Belt-Driven)

Accelerate engine to approximately 1500 RPM and observe airflow from hoses. If airflow increases as engine is accelerated, pump is working properly. If airflow does not increase, check hoses, pump belt tension, leaky valves or defective air injection pump.

Check Valve

Detach check valve and blow through valve in direction of check valve flow (to cylinder head). Attempt to suck air back. Replace valve if airflow is allowed against the direction of flow.

Electric AIR Pump Relay

1. Start engine. With engine operating in open loop, electric air pump should run and air should be coming out of electric air pump exhaust port.
2. If electric air pump is operating, allow engine to idle for at least 3 minutes. With vehicle in closed loop (or about 3 minutes after start), PCM should de-energize electric air pump relay and electric air pump should stop. If this does not occur, go to next step. If air pump operates as described, relay is functioning properly.
3. Remove air pump relay from fuse/relay block. Air pump should stop. If air pump stops, check or replace faulty relay. If air pump does not stop, check circuit to air pump for a short to battery voltage.

EXHAUST GAS RECIRCULATION (C-7)

There are 3 types of EGR systems used: pulse width modulated backpressure (positive and negative) EGR with a control solenoid, pulse width modulated backpressure (positive and negative) EGR without a control solenoid, digital and linear EGR. See EGR SYSTEM IDENTIFICATION table.

EGR SYSTEM IDENTIFICATION

Application	System Type	Solenoid Type
4.3L	BP/EGR	Normally Closed

System Test (Vacuum Operated)

Start and run engine to normal operating temperature. With engine at idle, push up on underside of EGR diaphragm. RPM should drop as EGR valve is opened. If RPM does not drop, remove EGR valve and check for blocked EGR passages. If RPM drops as diaphragm is lifted and EGR vacuum supply is regulated by an PCM-controlled solenoid, verify vacuum is available to solenoid at 2000 RPM and check solenoid using appropriate procedure. See appropriate EGR CONTROL SOLENOID procedure.

CAUTION: Wear gloves if handling EGR valve when it is hot.

EGR Control Solenoid (Normally Closed)

1. Disconnect EGR solenoid electrical harness connector and vacuum hoses. Connect a hand-held vacuum pump to solenoid vacuum source port. Connect vacuum gauge to solenoid EGR port. Pump up vacuum pump. Vacuum should not be present at port to EGR valve.
2. Activate EGR solenoid with a 12-volt power supply. Vacuum should now be present or registered at vacuum gauge. If vacuum is not present, check EGR solenoid resistance. Solenoid should have at least 20 ohms of resistance.

EGR Control Solenoid (Normally Open)

1. Disconnect solenoid harness connector. Install vacuum pump to vacuum source side of solenoid. Apply vacuum to solenoid. Vacuum should pass through when solenoid connector is disconnected.
2. Apply battery voltage and ground to solenoid terminals. With solenoid energized, apply vacuum to solenoid. Vacuum should not pass through solenoid. If results are not as specified, check EGR solenoid resistance. Solenoid should have at least 20 ohms of resistance.

Negative Backpressure EGR Valve

With engine off, disconnect vacuum hose to EGR valve. Connect vacuum pump to EGR and apply 10 in. Hg. EGR diaphragm should move up and stay up for 20 seconds. If valve does not operate as indicated, replace EGR valve.

Positive Backpressure EGR Valve

1. Place transmission in Park or Neutral. Set parking brake and block drive wheels. Connect tachometer. With engine running at normal operating temperature, run engine at 2000 RPM.
2. Disconnect vacuum hose from EGR valve and plug hose. EGR valve diaphragm should move down and engine RPM should increase.

NOTE: On some engines with PCM-controlled solenoid, EGR vacuum is locked out in Park/Neutral and solenoid must be by-passed with vacuum supply

hose.

3. Reconnect vacuum hose. EGR diaphragm should move up and engine RPM should decrease. A slight vibration of diaphragm plate may be noticed in backpressure EGR valves.
4. If engine RPM did not change and EGR diaphragm moved, the EGR valve is functioning properly. If engine RPM did not change and diaphragm did not move, remove EGR valve and apply 10 in. Hg to EGR vacuum signal port. EGR valve should not open.
5. If EGR valve opens, replace EGR valve. With vacuum still applied, direct a stream of air (15 psi maximum) into valve seat. EGR valve should open completely.
6. If air is not available, connect a short piece of hose over EGR valve seat. Connect vacuum pump to signal port. With thumb plugging intake port of EGR valve, operate vacuum pump while alternately blowing through hose and pausing.
7. With vacuum present at signal port, EGR valve should open while pressure is applied and should close when no vacuum is present.

FUEL EVAPORATION CONTROL (C-3)

NOTE: One of 2 types of solenoid is used: normally open or normally closed. See CANISTER PURGE SOLENOID IDENTIFICATION table.

CANISTER PURGE SOLENOID IDENTIFICATION

Application	Solenoid Type
4.3L	Normally Closed

Canister Purge Solenoid (Normally Closed)

1. Disconnect canister purge solenoid harness connector and vacuum hose. Apply 10 in. Hg to ported intake manifold vacuum side of solenoid valve. If vacuum holds, go to next step. If vacuum does not hold, replace canister purge solenoid.
2. Using a 12-volt power source, energize canister purge solenoid. Vacuum should release. If vacuum does not release, replace canister purge solenoid. Solenoid resistance should be at least 20 ohms.

Canister Purge Solenoid (Normally Open)

1. Disconnect canister purge solenoid harness connector and vacuum hose. Apply vacuum to ported intake manifold vacuum side of solenoid valve. If vacuum holds, go to next step. If vacuum does not hold, replace canister purge solenoid.
2. Using a 12-volt power source, energize canister purge solenoid. Vacuum should release. If vacuum does not release, replace canister purge solenoid. Solenoid resistance should be at least 20 ohms.

Fuel Tank Pressure Control Valve

Apply approximately 15 in. Hg to fuel tank pressure control valve. The diaphragm should hold vacuum for at least 20 seconds. If fuel tank pressure control valve does not hold vacuum, replace tank pressure control valve.

POSITIVE CRANKCASE VENTILATION (PCV)

Required Service

The PCV system may require service for obstructions if any of the following conditions exist:

- Rough idle.
- Stalling or slow idle speed.
- Oil leaks.
- Oil in air cleaner.
- Sludge in engine.

A leaking PCV valve or hose could cause:

- Rough idle.
- Stalling.
- High idle speed.

If engine idles roughly, check for clogged PCV valve or plugged or broken hoses BEFORE adjusting idle. Check PCV valve application to ensure the correct valve is fitted. Replace PCV valve if required.

Checking PCV Valve Function

1. Remove PCV valve from rocker cover. Run engine at idle. Place thumb over open end of valve to check for vacuum. If there is no vacuum at valve, check for obstruction in manifold port, hoses or PCV valve. Repair or replace as necessary.
2. Turn engine off. Remove PCV valve. Shake valve and listen for rattle of check valve inside. If a clear rattle is not heard, replace PCV valve.
3. Visually inspect valve for varnish or deposits which may make PCV valve operation sticky or restricted, or cause incomplete seating of valve. Replace if necessary.
4. An engine must be sealed for the PCV system to function as designed. If leakage, sludging or dilution of oil is noted and the PCV system is functioning properly, check engine for cause and repair as required to ensure PCV system will continue to function properly.
5. An engine operating without any crankcase ventilation can be damaged, so it is important to replace PCV valve and air cleaner breather (if equipped) at regular intervals (at least every 30,000 miles). Check all hoses and clamps for failure or deterioration.

MISCELLANEOUS CONTROLS

NOTE: Although some of the controlled devices listed here are not technically engine performance components, they can affect driveability if they malfunction.

HOT LIGHT OR COOLANT TEMPERATURE LIGHT

NOTE: **These checks assume vehicle is not overheating. Verify proper operation of cooling system prior to diagnosing hot light. The coolant temperature sensor, in rare cases, may fail to indicate correct coolant temperature without setting a diagnostic trouble code (Code 14 or 15). This could result in hot light turning on without having an overheating condition. It could also result in engine overheating without hot light turning on. Check coolant sensor temperature-to-resistance values in SENSOR RANGE CHARTS article in the ENGINE PERFORMANCE section.**

Hot light is powered by the 10-amp INDIC or GAGES fuse. Light will turn on when PCM provides a ground for the circuit. If circuit grounds between light and PCM, light will illuminate any time the ignition is turned on.

1. 1) Turn ignition on with engine off (bulb test position). If hot light illuminates, go to step 3). If hot light does not illuminate, check the following and proceed to next step:
   - 10-amp INDIC or GAGES fuse.
   - Faulty instrument cluster bulb.
   - Open circuit between fuse and hot light.
2. Backprobe PCM hot light driver terminal with a test light to battery voltage. Turn ignition on. If test light does not illuminate, PCM terminal connection is bad or PCM is faulty. If test light illuminates, turn ignition off. Disconnect PCM connectors. Jumper PCM hot light driver harness terminal to ground. Turn ignition on. If hot light does not illuminate, check for open circuit between hot light and PCM. If all circuits are okay and power is available to light, instrument cluster must be replaced.
3. Start engine. If hot light goes off, no problem is evident. If hot light is on, turn ignition off. Disconnect PCM connector. Probe PCM hot light driver harness terminal with a test light to battery voltage. If test light does not illuminate, replace PCM. If test light illuminates, repair short to ground in hot light driver circuit. If circuit is okay, replace instrument cluster.

TRANSMISSION (C-8)

NOTE: **Computerized transmission controls are also covered in greater detail in appropriate TRANSMISSION SERVICING & REPAIR manual.**

Converter Clutch Solenoid

Disconnect harness connector to Torque Converter Clutch (TCC) solenoid. Measure resistance between TCC solenoid terminals "A" and "D". Solenoid resistance should be greater than 20 ohms.

NOTE: **Some solenoids have an internal pressure switch in series with the solenoid winding and will not show continuity until that pressure switch is applied by transmission hydraulic pressure.**

Converter Lock-Up Signal At Transmission

1. Warm engine to operating temperature. Raise vehicle and support drive wheels. Support suspension where necessary to prevent damage to drive axles.

2. Disconnect converter clutch connector at transmission. Connect a test light across terminals "A" and "D" of converter clutch harness. Start engine and place transmission in Drive. Accelerate vehicle to 45 MPH and note test light.
3. If test light is not on, check solenoid power supply wire of harness for open or short to ground. Check ground circuit for open between harness connector and PCM. If harness is okay, see CONVERTER LOCK-UP SIGNAL FROM PCM.

Converter Lock-Up Signal From PCM

1. Warm engine to operating temperature. Raise vehicle and support drive wheels. Support suspension where necessary to prevent damage to drive axles.
2. Connect a test light to battery voltage. Touch TCC control driver terminal with test light. On some vehicles, this is terminal "F" of Data Link Connector (DLC). Accelerate vehicle to 45 MPH and note test light. If test light does not illuminate, problem is a faulty PCM connector or PCM.

A/C CLUTCH (C-10) & ELECTRIC COOLING FAN (C-12)

NOTE: For additional information on electric cooling fans, see ENGINE COOLING FANS article in ENGINE COOLING section.

A/C Clutch Relay

1. Disconnect A/C clutch relay harness connector. Using proper mini-schematic and an ohmmeter, check continuity between A/C clutch relay winding terminals. See **Fig. 6** - **Fig. 11** . Continuity should exist. Check continuity between clutch drive circuit terminals of relay. Continuity should not exist.
2. Using jumper wires, apply ground and battery voltage to relay winding of relay. Continuity should now exist between clutch drive circuit terminals of relay. Replace A/C clutch relay if readings are not as specified.

Cooling Fan System & Quad-Driver Check

1. Connect a test light to battery voltage. Touch test light probe to the cooling fan control driver terminal of the PCM. See **Fig. 6** - **Fig. 11** . Disconnect coolant temperature sensor. This should set a code, causing PCM to engage cooling fan through relay. On some models, it may be necessary to jumper the coolant temperature sensor harness connectors. On some models, grounding the DLC with the ignition on and engine off will cause the PCM to activate the cooling fan control driver (ground circuit).
2. If test light illuminates and cooling fan does not come on, check cooling fan relay, power circuits, cooling fan motor, and relay and fan motor ground circuits. If test light does not illuminate, problem is a faulty PCM connector or PCM. Clear diagnostic trouble code(s) from PCM memory after testing.
3. If cooling fan functions normally during testing but fails to operate under normal conditions, check PCM monitored inputs which affect cooling fan operation. These include the following: coolant temperature sensor, A/C request signal from A/C control switch and A/C pressure sensor, or pressure/temperature switch signals (if equipped).

Cooling Fan Relay

1. Disconnect cooling fan relay harness connector. Using an ohmmeter, check continuity of relay winding. See **Fig. 6** - **Fig. 11** . Continuity should exist. Check continuity across power delivery terminals of relay. With relay not energized, no continuity should exist.
2. With ohmmeter still attached to power delivery terminals of relay, apply battery voltage and ground to energize relay winding. Continuity should now be present between cooling fan relay power delivery terminals. Replace cooling fan relay if readings are not as specified.

Cooling Fan Motor

Disconnect cooling fan motor harness connector. Apply battery voltage to one of the fan motor terminals and jumper the other terminal to ground. Fan motor should activate. If fan motor does not activate, replace faulty fan motor.

NOTE: For a more specific system testing, refer to the following C-10 or C-12 diagnostic charts. If any chart other than a C-10 or C-12 chart is referenced, REFER TO appropriate TESTS W/CODES - 4.3L article in the ENGINE PERFORMANCE section.

DIAGNOSTIC CHARTS

NOTE: In following charts, the terms ECM and PCM can be used interchangeably.

CHART C-12A, COOLING FAN CKT DIAGNOSIS

Cooling fans are controlled by Powertrain Control Module (PCM) based on various inputs. Battery voltage is supplied to terminal C4 of primary fan relay and terminal C1 of secondary fan relay. Ignition voltage is supplied to terminal B4 of primary fan relay and terminal B1 of secondary fan relay. Grounding circuit No. 335 will energize primary cooling fan relay and supply battery voltage to primary cooling fan motor. Grounding circuit No. 473 will energize secondary cooling fan relay and supply battery to secondary cooling fan motor. When certain Diagnostic Trouble Codes (DTC) are set, PCM will energize cooling fans.

NOTE: Test numbers refer to numbers on diagnostic charts.

1. With output/field service enable terminal grounded at DLC, cooling fan control driver(s) will close, energizing fan control relay(s).
2. Cooling fans should come on anytime A/C system is operating. Engine coolant temperature must be less than 212°F (100°C) when performing this step.
3. Comparing Tech 1 scan tester pressure and manifold gauge set pressure will determine if A/C refrigerant pressure sensor is out of range. An out-of-range A/C pressure sensor can cause cooling fans to operate at the wrong times.

Diagnostic Aids

If an overheating condition is suspected, check if it is caused by an actual boilover. If gauge or light indicates an overheat condition and boilover is not evident, inspect gauge circuit for malfunction.

If vehicle is overheating and gauge or light indicates so but cooling fan is not coming on, check Engine Coolant Temperature (ECT) sensor temperature using a scan tester. ECT sensor may have shifted out of calibration and should be replaced. If engine is overheating and cooling fan is on, check cooling system. PCM will command primary cooling fan on at 225°F (107°C) and off at 217°F (103°C). PCM will command secondary cooling fan on at 232°F (111°C) and off at 224°F (107°C).

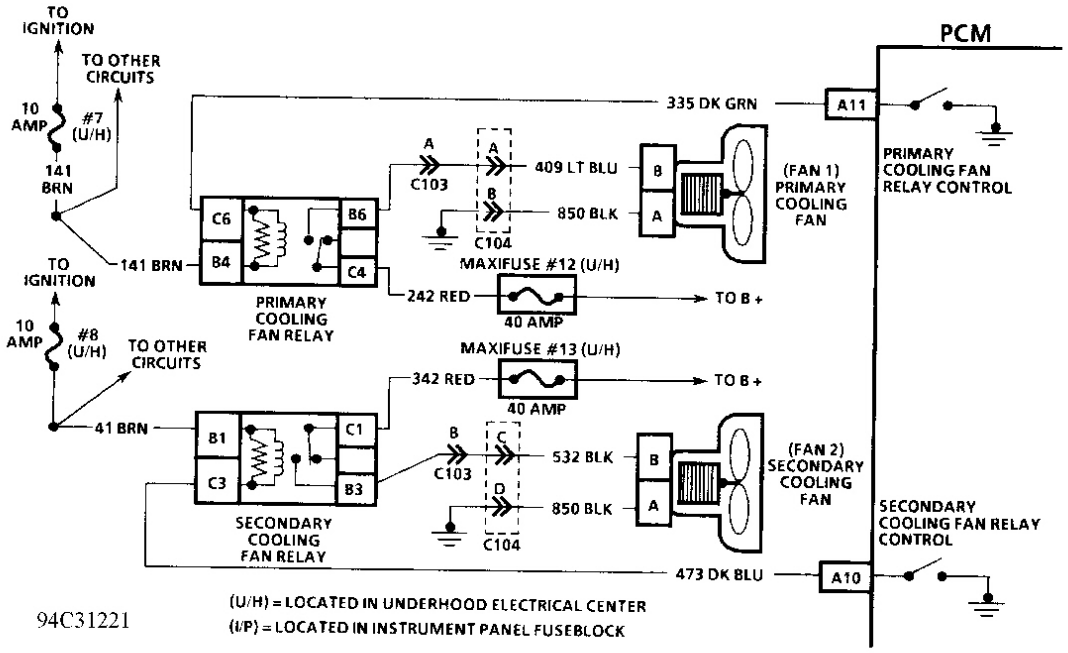


Fig. 6: Cooling Fan Ckt. Schematic (4.3L)
Courtesy of GENERAL MOTORS CORP.

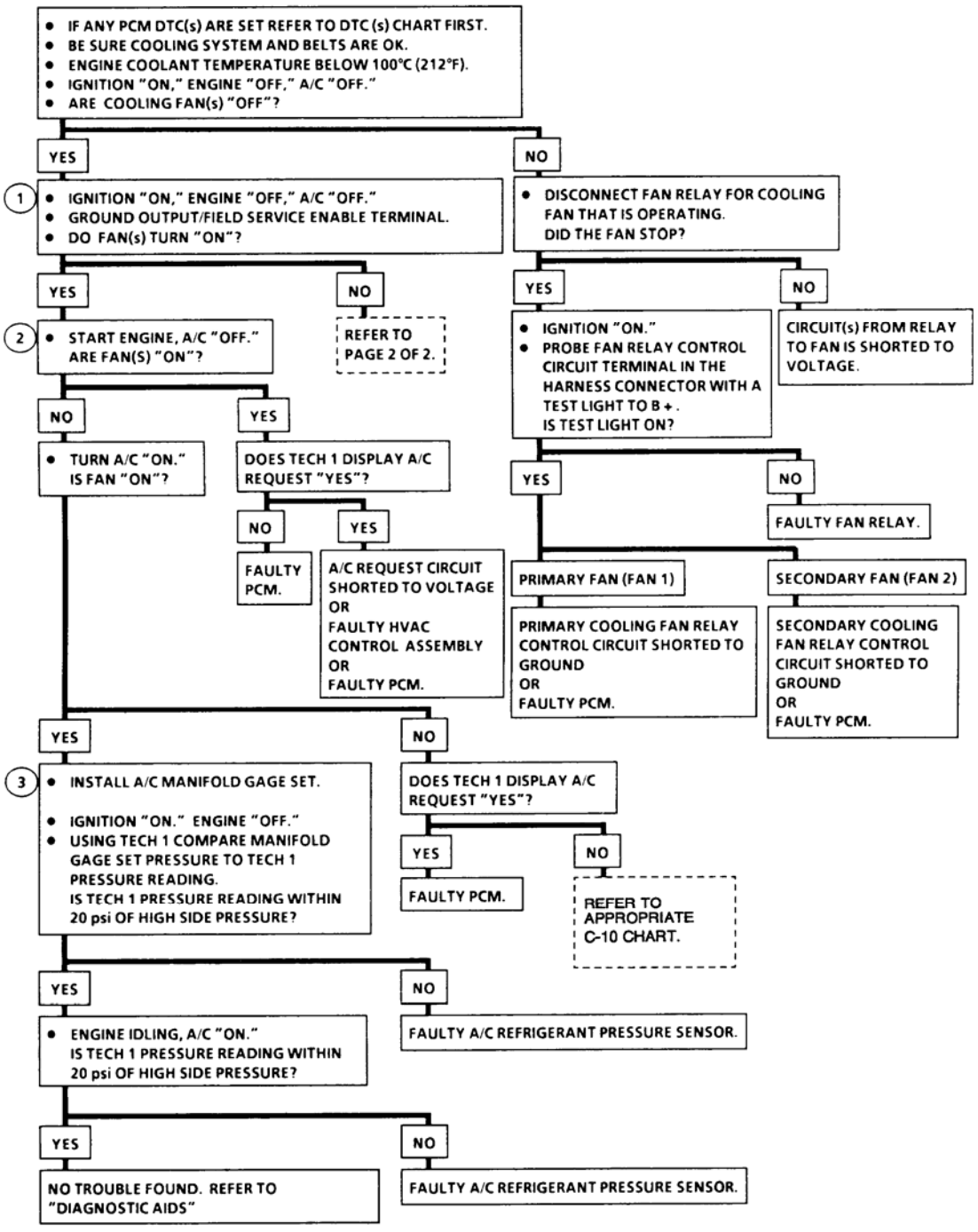


Fig. 7: Cooling Fan Circuit Diagnostic Flow Chart (4.3L - 1 Of 2)
Courtesy of GENERAL MOTORS CORP.

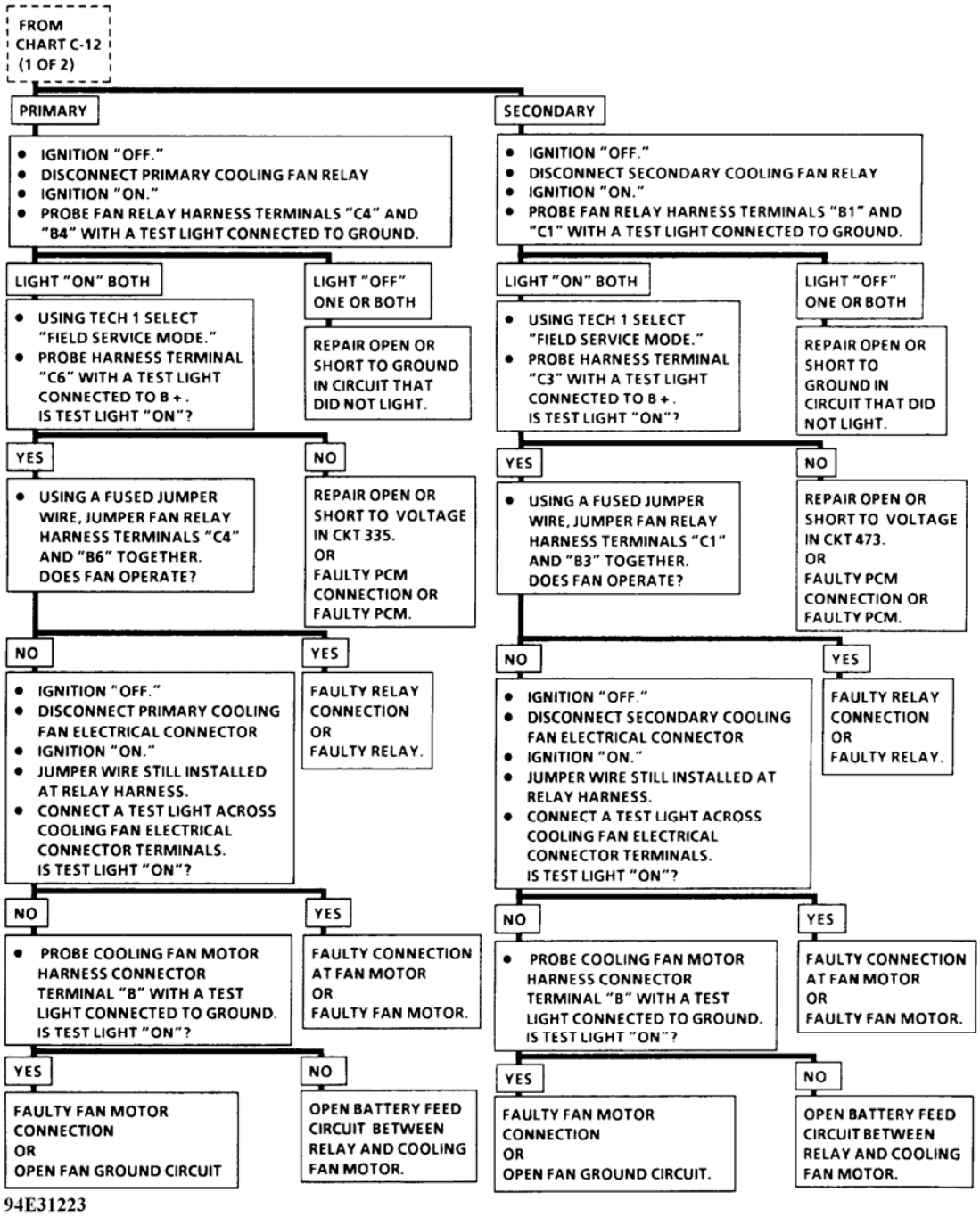


Fig. 8: Cooling Fan Circuit Diagnostic Flow Chart (4.3L - 2 Of 2)
Courtesy of GENERAL MOTORS CORP.

CHART C-10, A/C COMPRESSOR CLUTCH CIRCUIT DIAGNOSIS (1 OF 2)

Powertrain Control Module (PCM) delays A/C compressor clutch engagement momentarily after A/C is turned on. This delay allows PCM time to adjust engine RPM before A/C compressor clutch engages.

PCM will temporarily disengage A/C compressor clutch for a precalibrated time during one or more of the following conditions: Wide Open Throttle (WOT), high engine RPM, high engine coolant temperature or A/C refrigerant pressure too high or too low.

An A/C refrigerant pressure sensor is used to monitor A/C system pressure. If A/C refrigerant pressure is greater than 429 psi (30.2 kg/cm^2) or less than zero, A/C compressor clutch will not engage. If A/C refrigerant pressure sensor signal wire becomes open, shorted to ground or shorted to voltage, a Diagnostic Trouble Code (DTC) 66 will set.

If A/C compressor clutch engages and no refrigerant pressure change is detected, DTC 67 will set. When A/C request is detected by PCM, cooling fan(s) will be turned on unless vehicle speed is too high.

NOTE: Test numbers refer to numbers on diagnostic chart.

1. Checks PCM's ability to control A/C compressor clutch relay.
2. Before replacing A/C system control components, check basic A/C-heater system.
3. Checks for a grounded circuit No. 459 to PCM.

Diagnostic Aids

Before diagnosing vehicle using C-10 chart, ensure no DTCs are stored. PCM will not activate A/C compressor clutch if any DTC is stored.

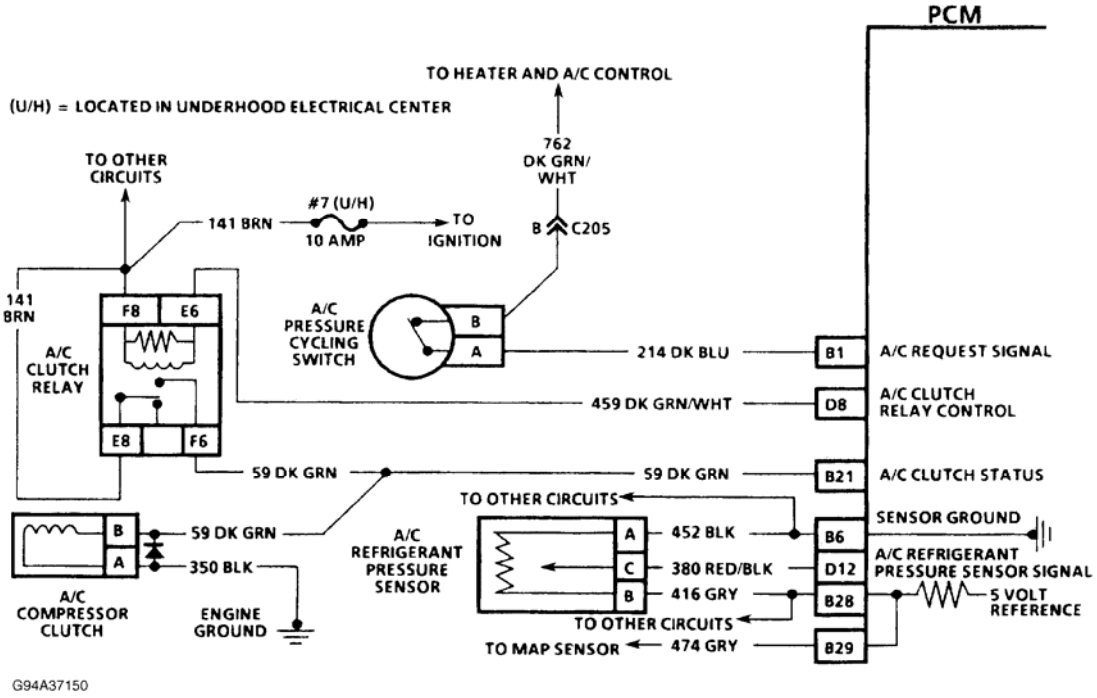


Fig. 9: A/C Clutch Control Circuit Schematic (4.3L)
Courtesy of GENERAL MOTORS CORP.

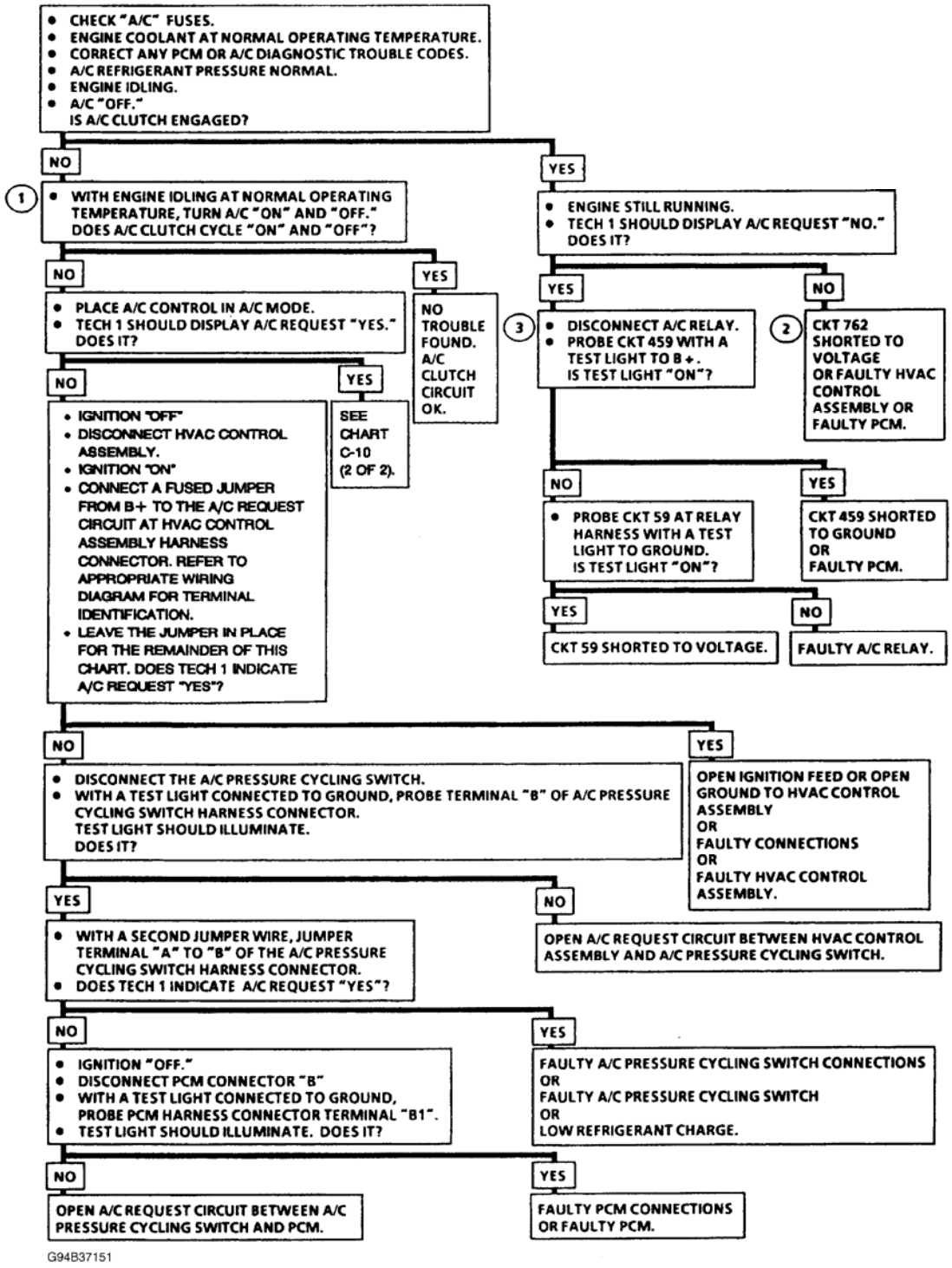


Fig. 10: A/C Clutch Control Circuit Diagnostic Flow Chart (4.3L - 1 Of 2)
Courtesy of GENERAL MOTORS CORP.

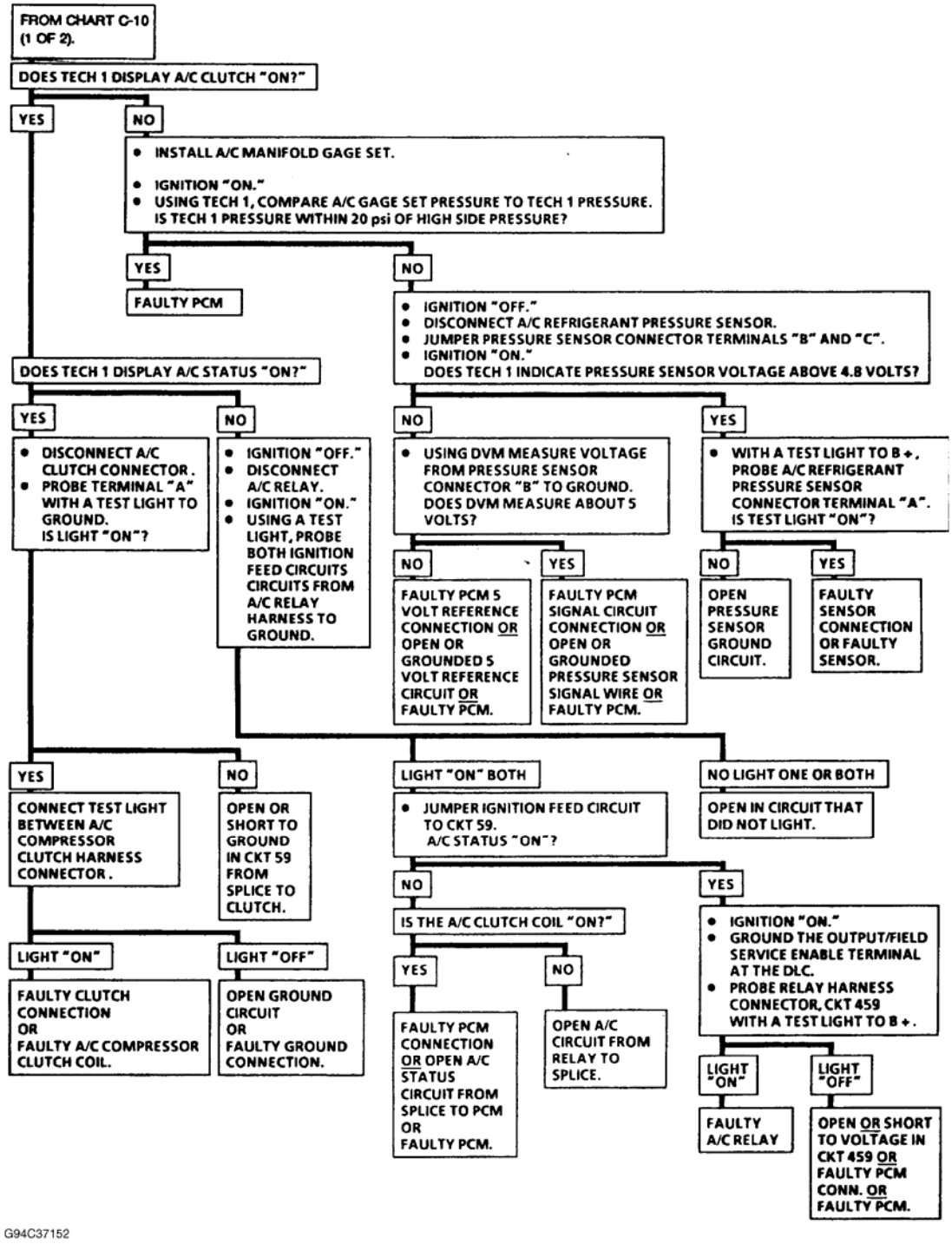


Fig. 11: A/C Clutch Control Circuit Diagnostic Flow Chart (4.3L - 2 Of 2)
Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATIONS

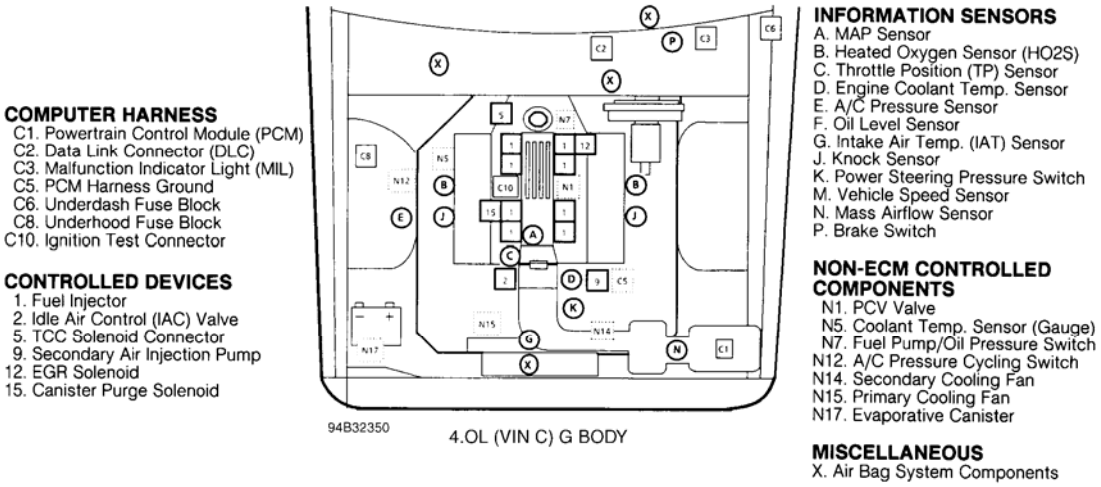


Fig. 12: Component Locations (4.3L VIN W)
Courtesy of GENERAL MOTORS CORP.

WIRING DIAGRAMS

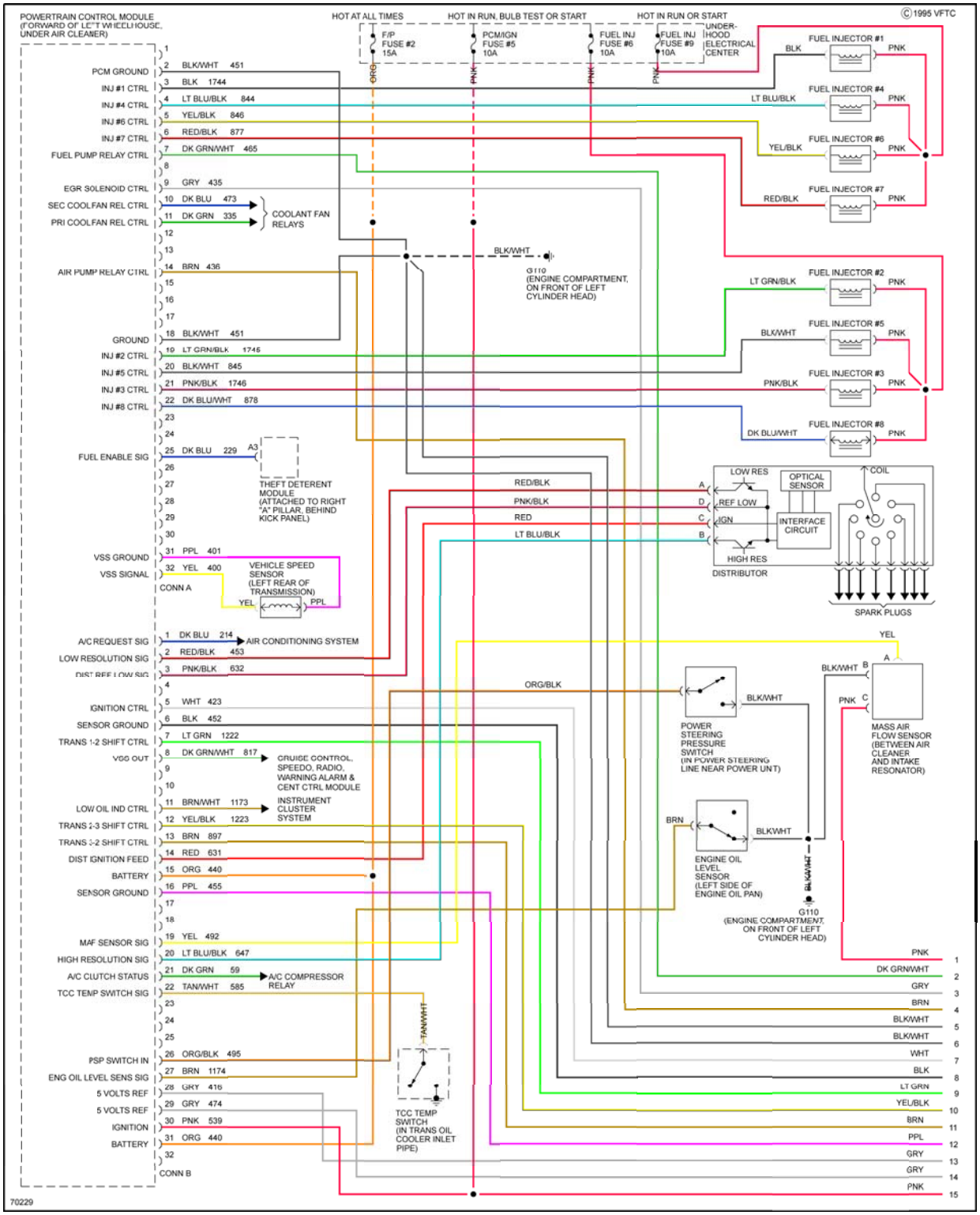


Fig. 13: 4.3L (VIN W) PCM Wiring Diagram (1 Of 3)

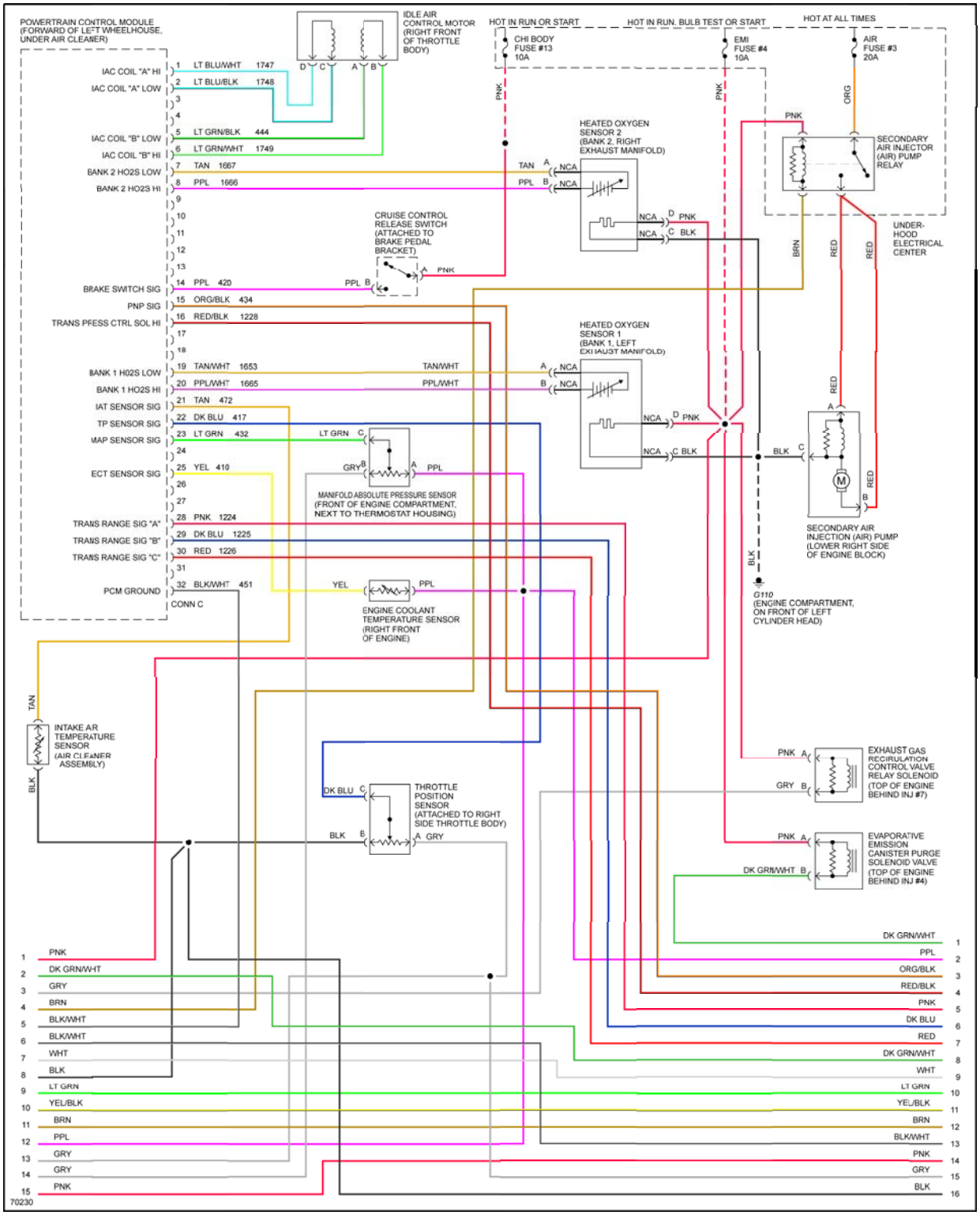


Fig. 14: 4.3L (VIN W) PCM Wiring Diagram (2 Of 3)

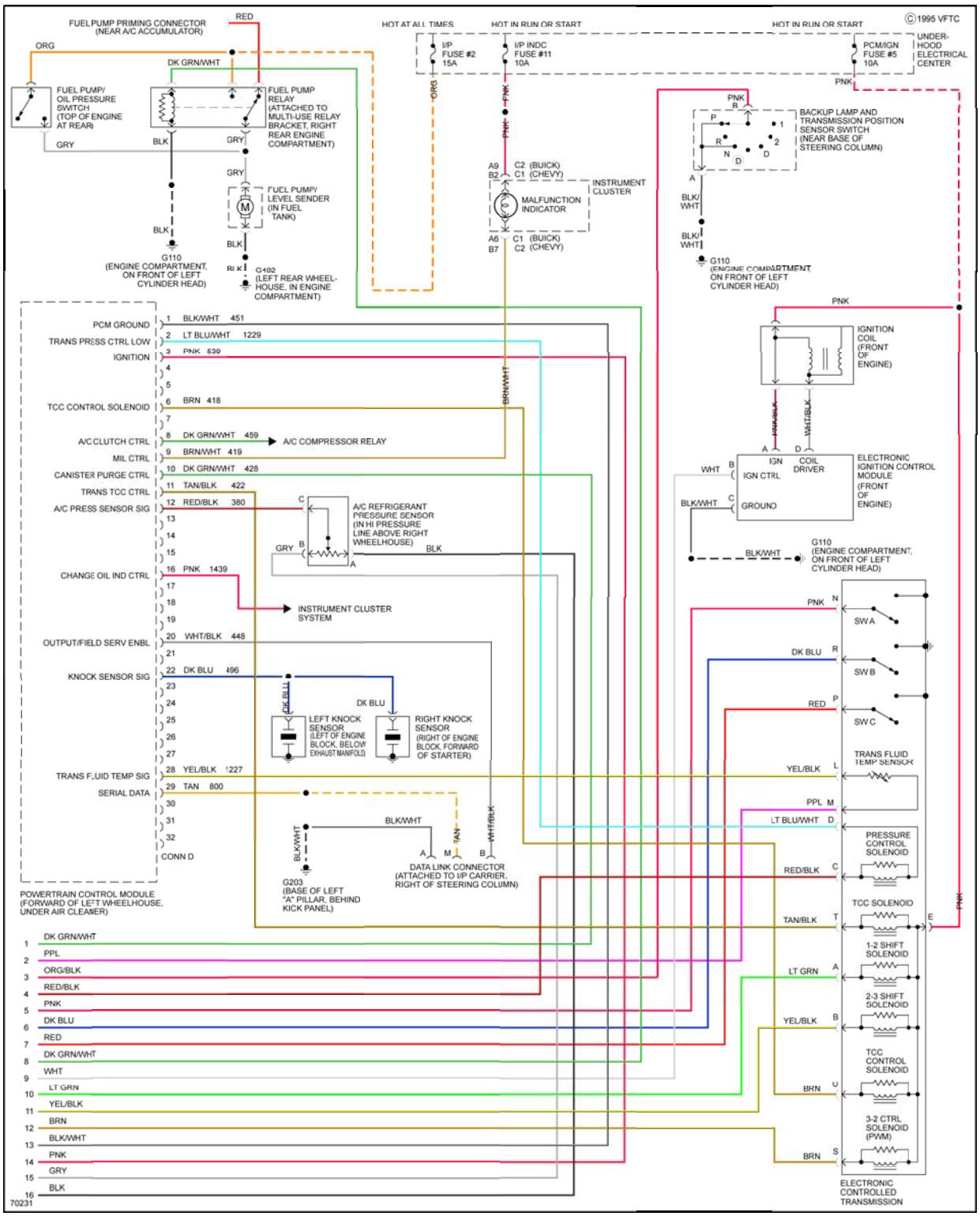


Fig. 15: 4.3L (VIN W) PCM Wiring Diagram (3 Of 3)

System Wiring Diagrams

Chevrolet - Caprice

DEFOGGERS

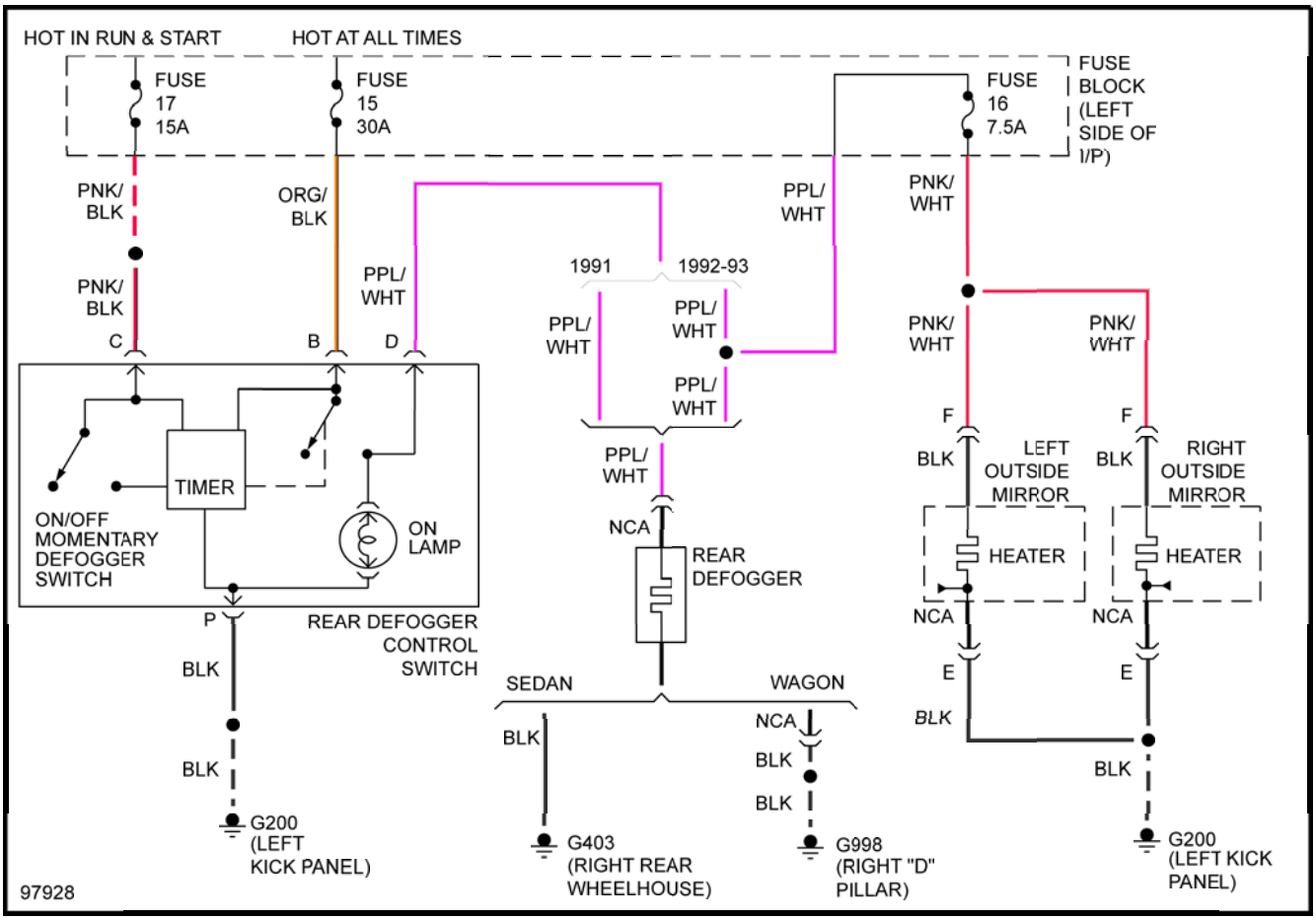


Fig. 1: Defogger Circuit

HORN

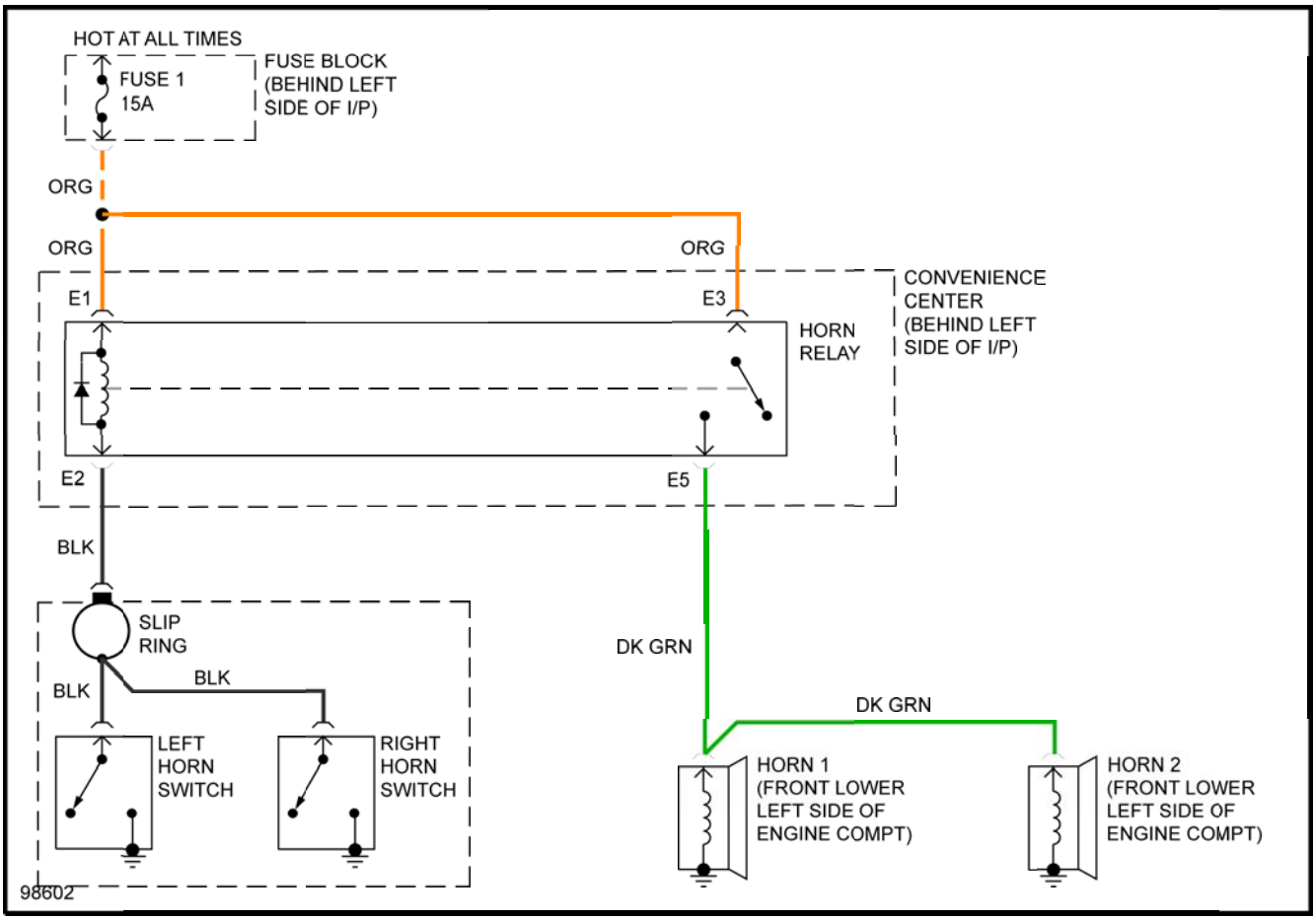


Fig. 2: Horn Circuit

POWER ANTENNA

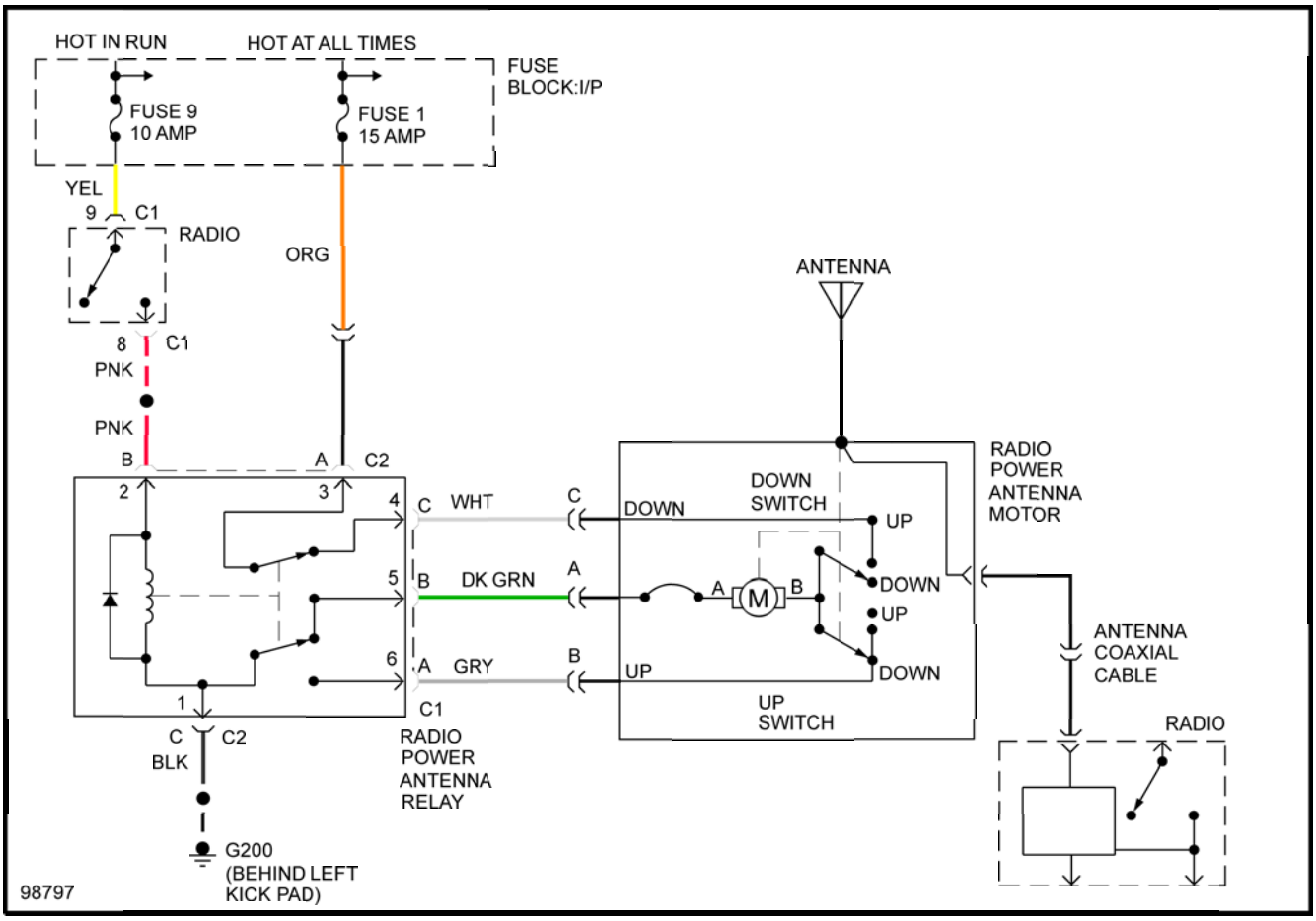


Fig. 3: Power Antenna Circuit

POWER DOOR LOCKS

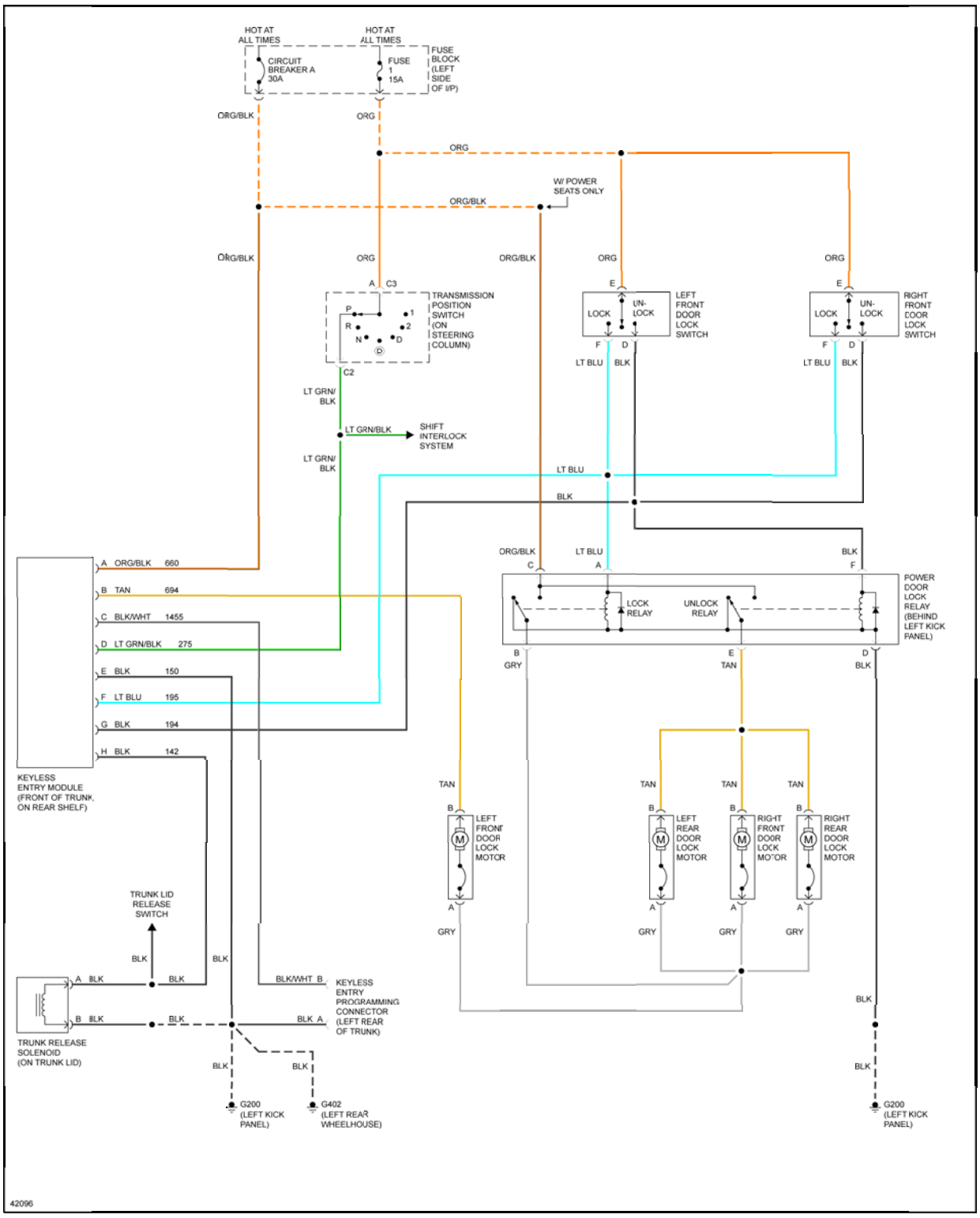


Fig. 4: Keyless Entry Circuit

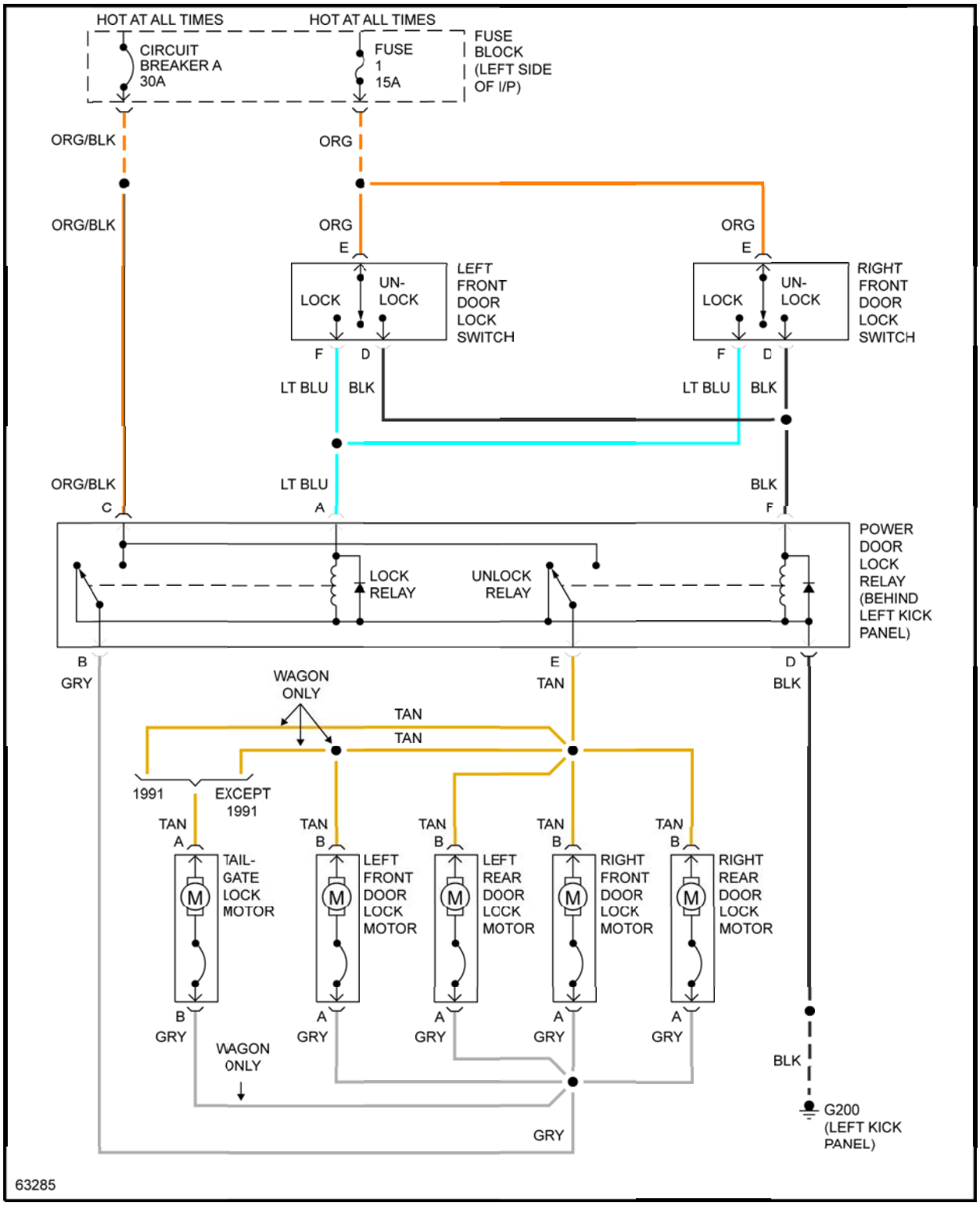


Fig. 5: Power Door Locks Circuit

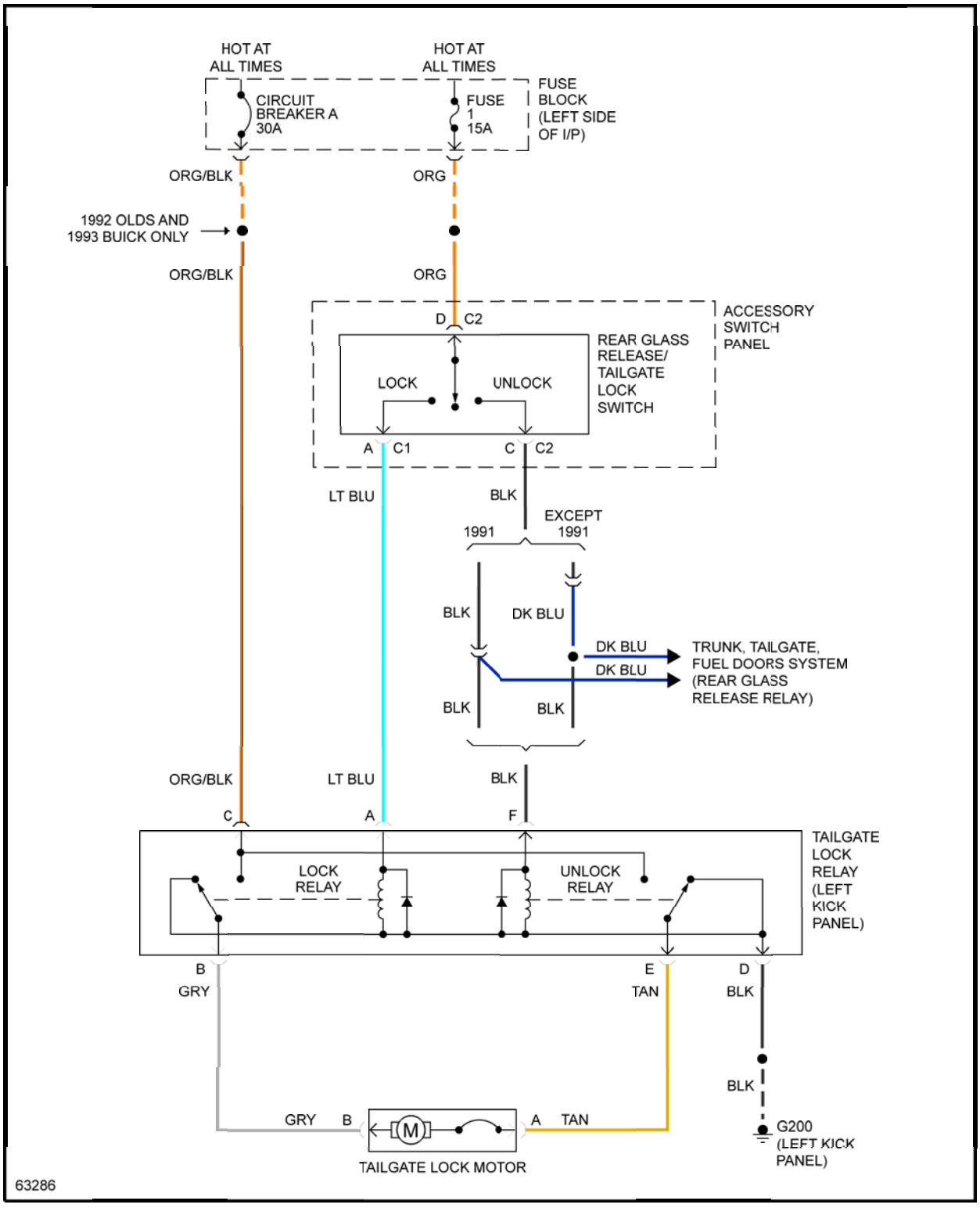


Fig. 6: Power Tailgate Lock Circuit

POWER MIRRORS

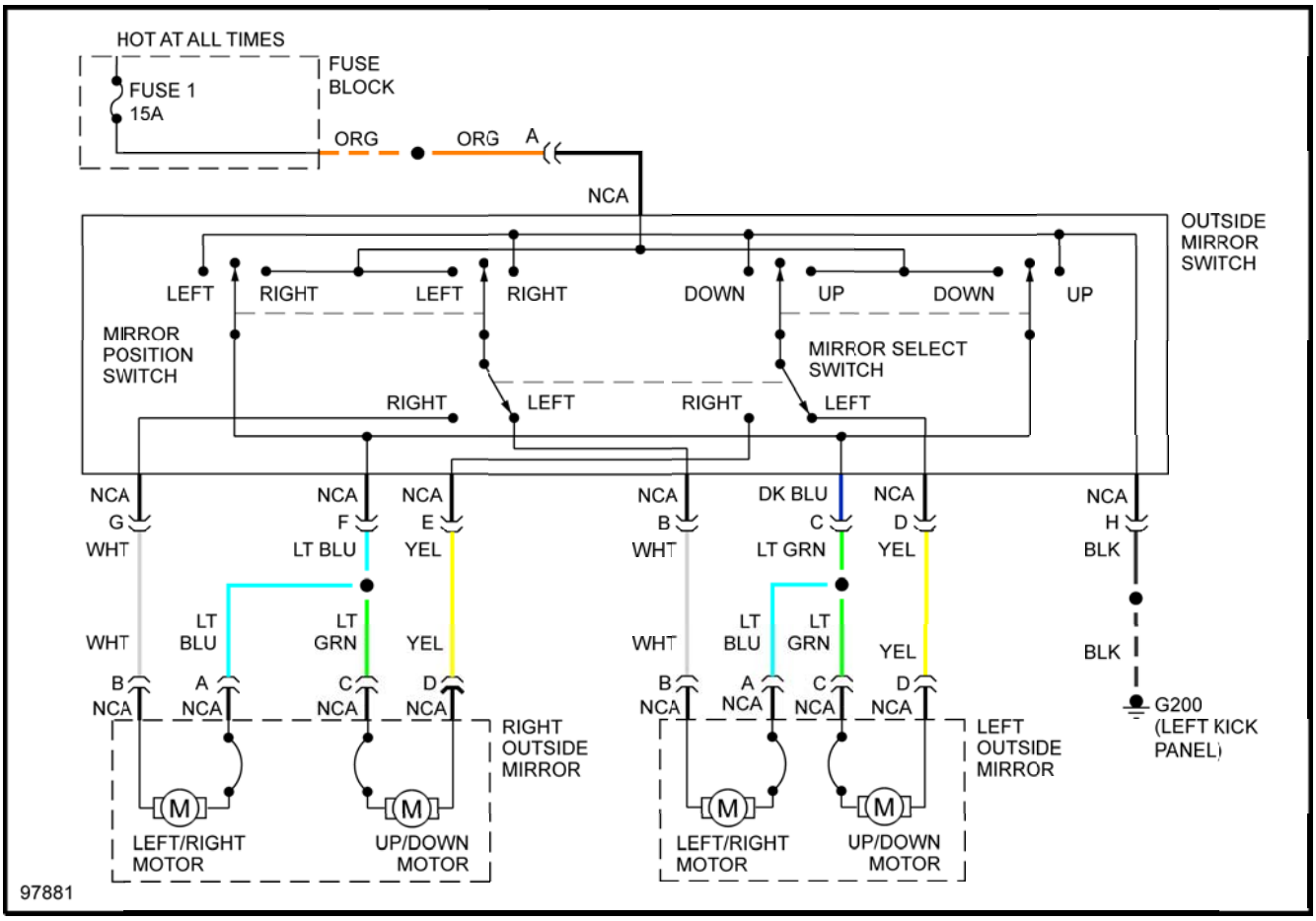


Fig. 7: Power Mirror Circuit

POWER SEATS

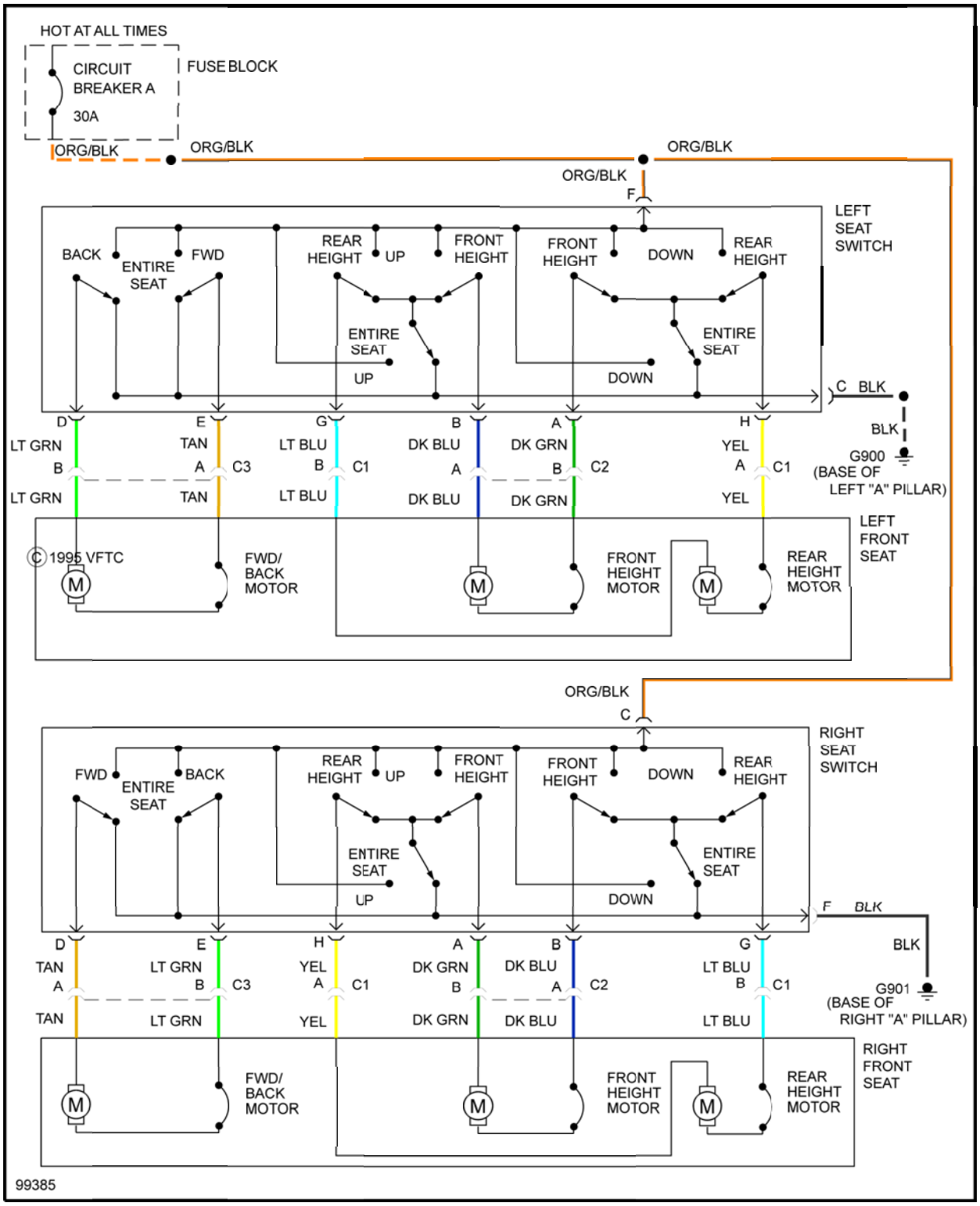


Fig. 8: 6-Way Power Seat Circuit

POWER WINDOWS

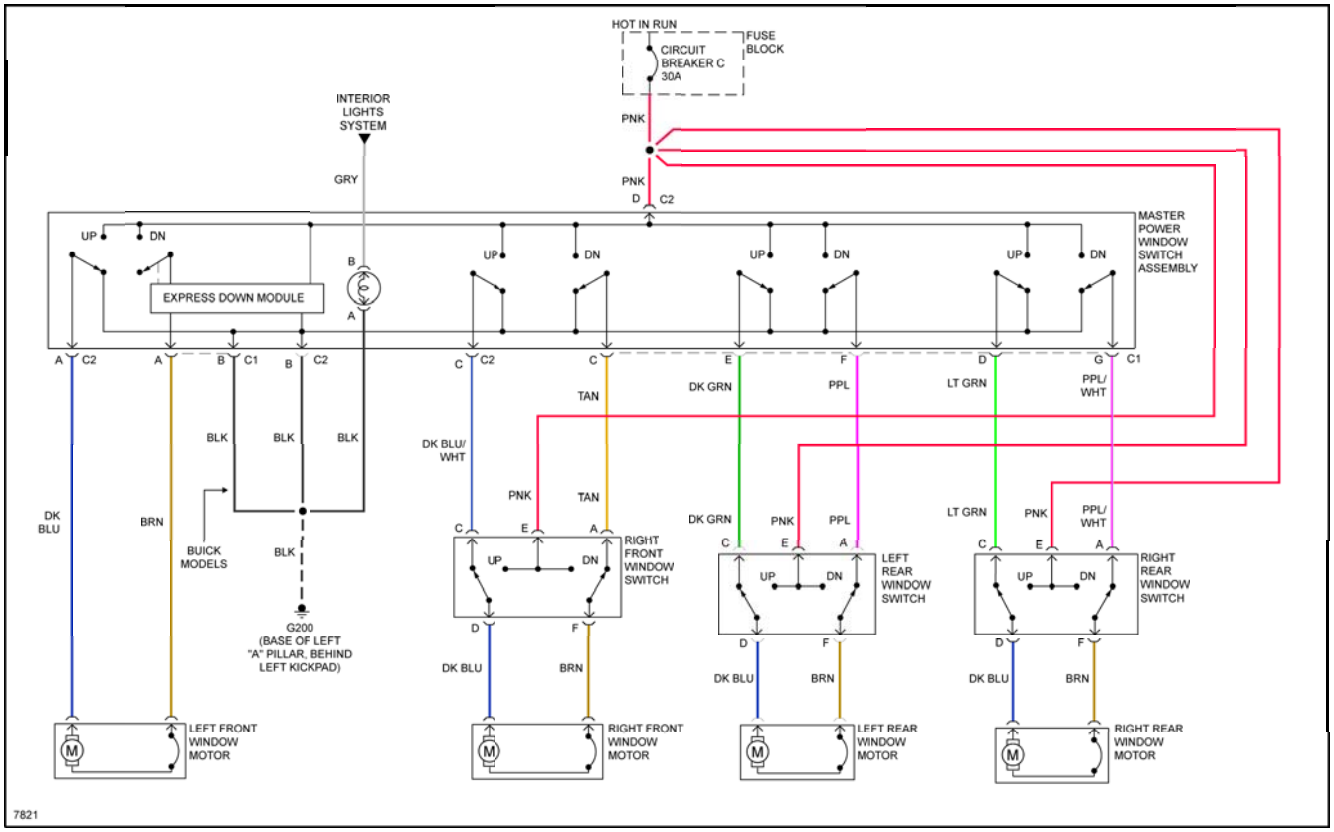


Fig. 9: Power Window Circuit

RADIO

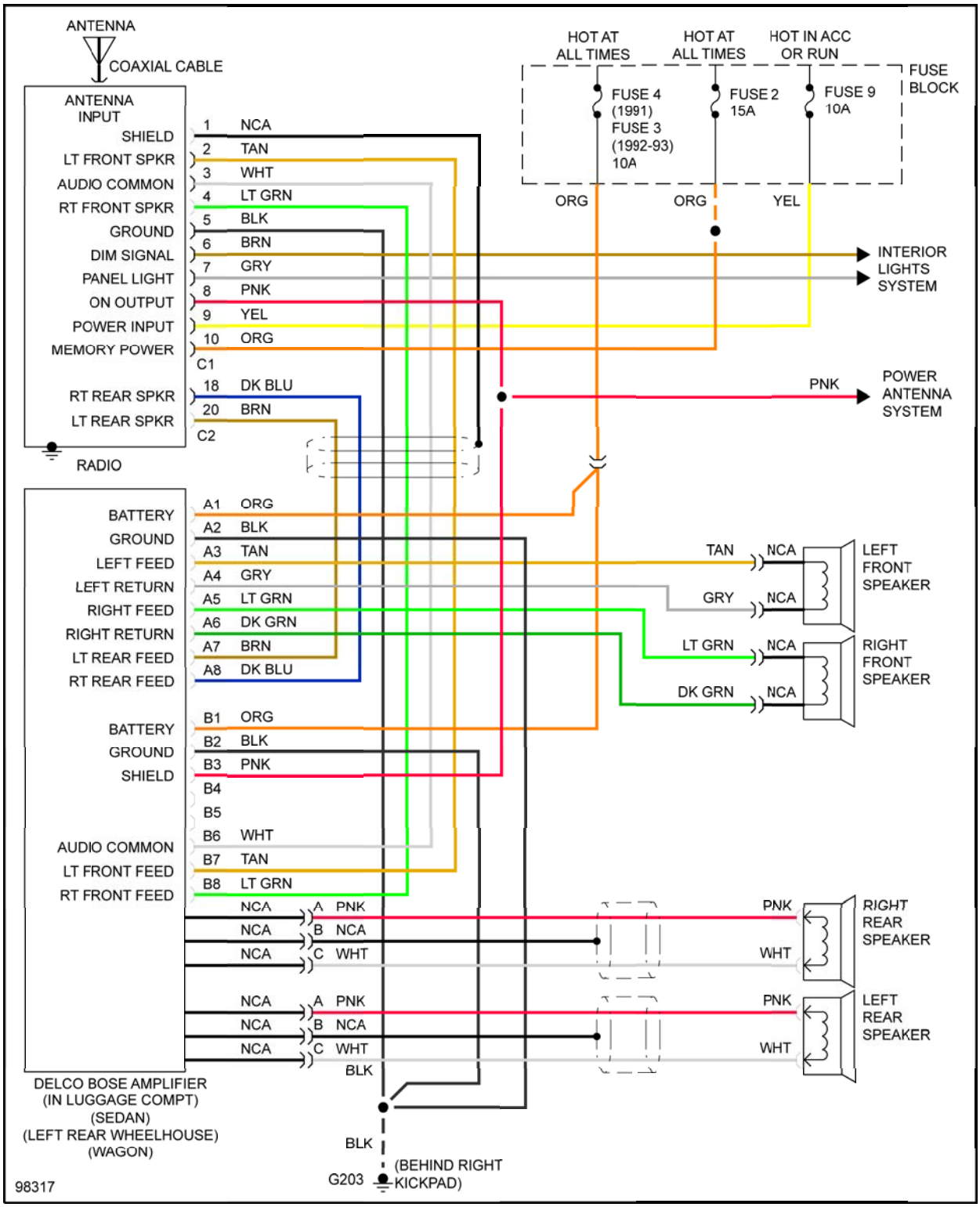


Fig. 10: Radio Circuits, W/ Delco Bose

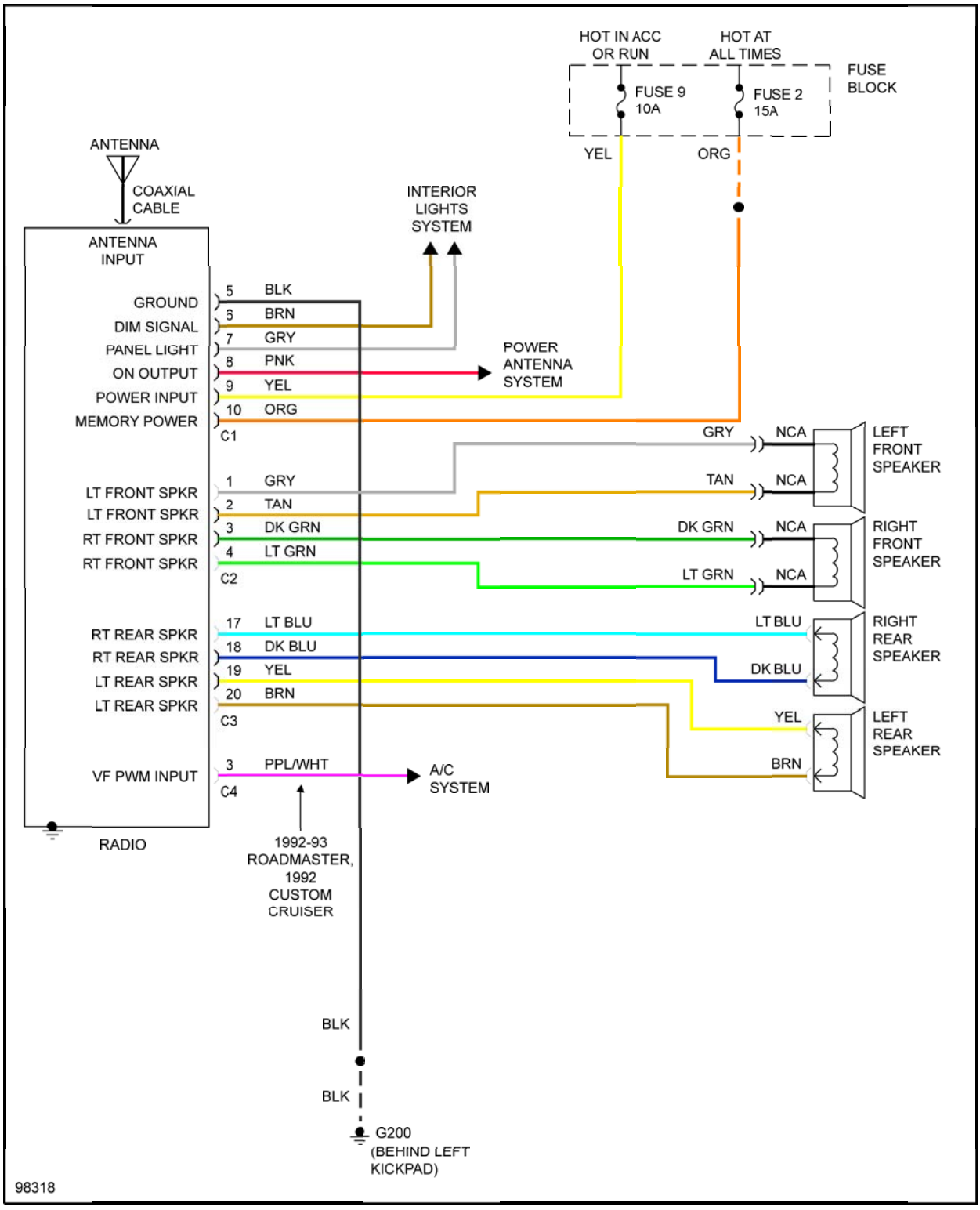


Fig. 11: Radio Circuits, W/O Delco Bose

STARTING/CHARGING

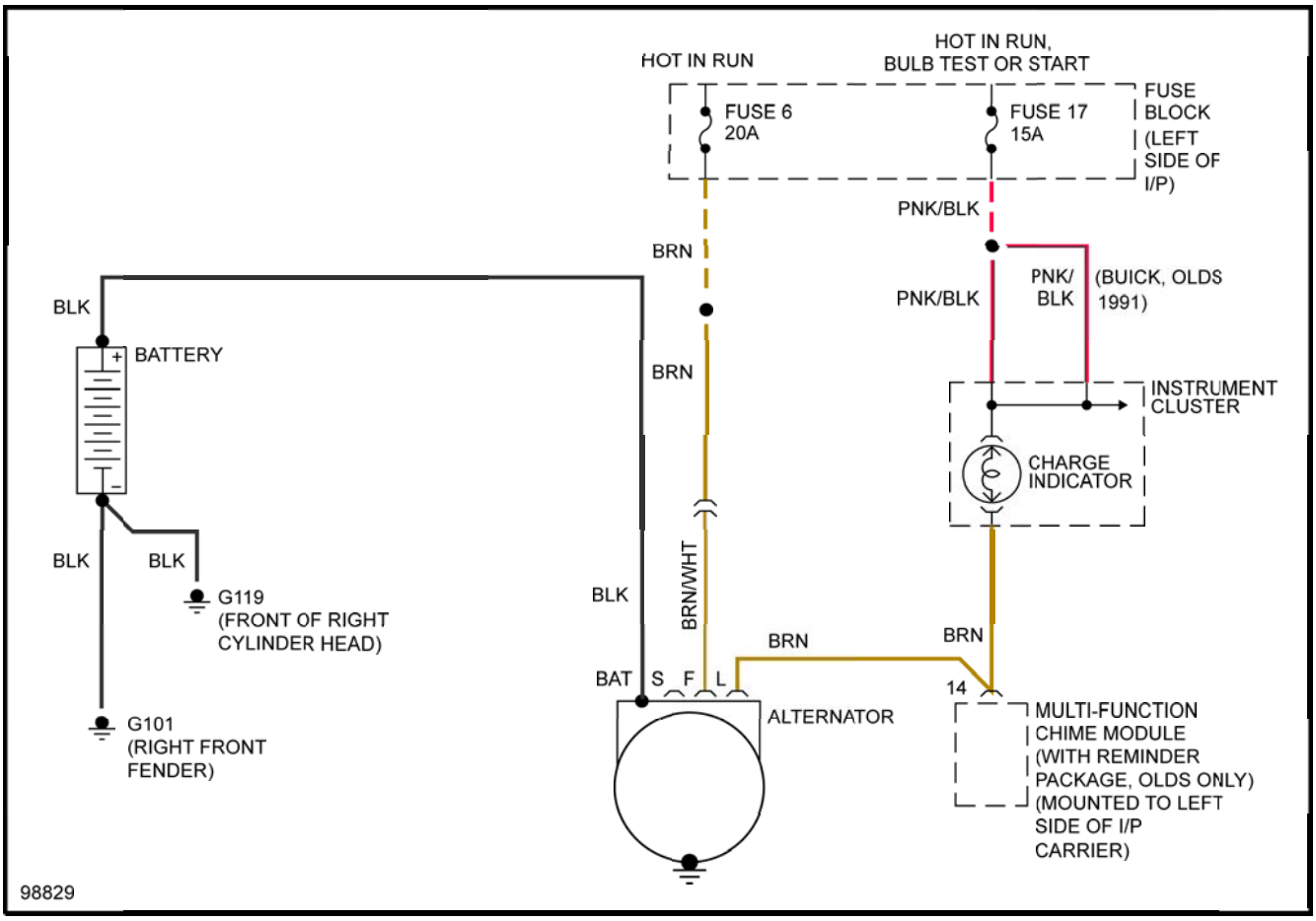


Fig. 12: Charging Circuit

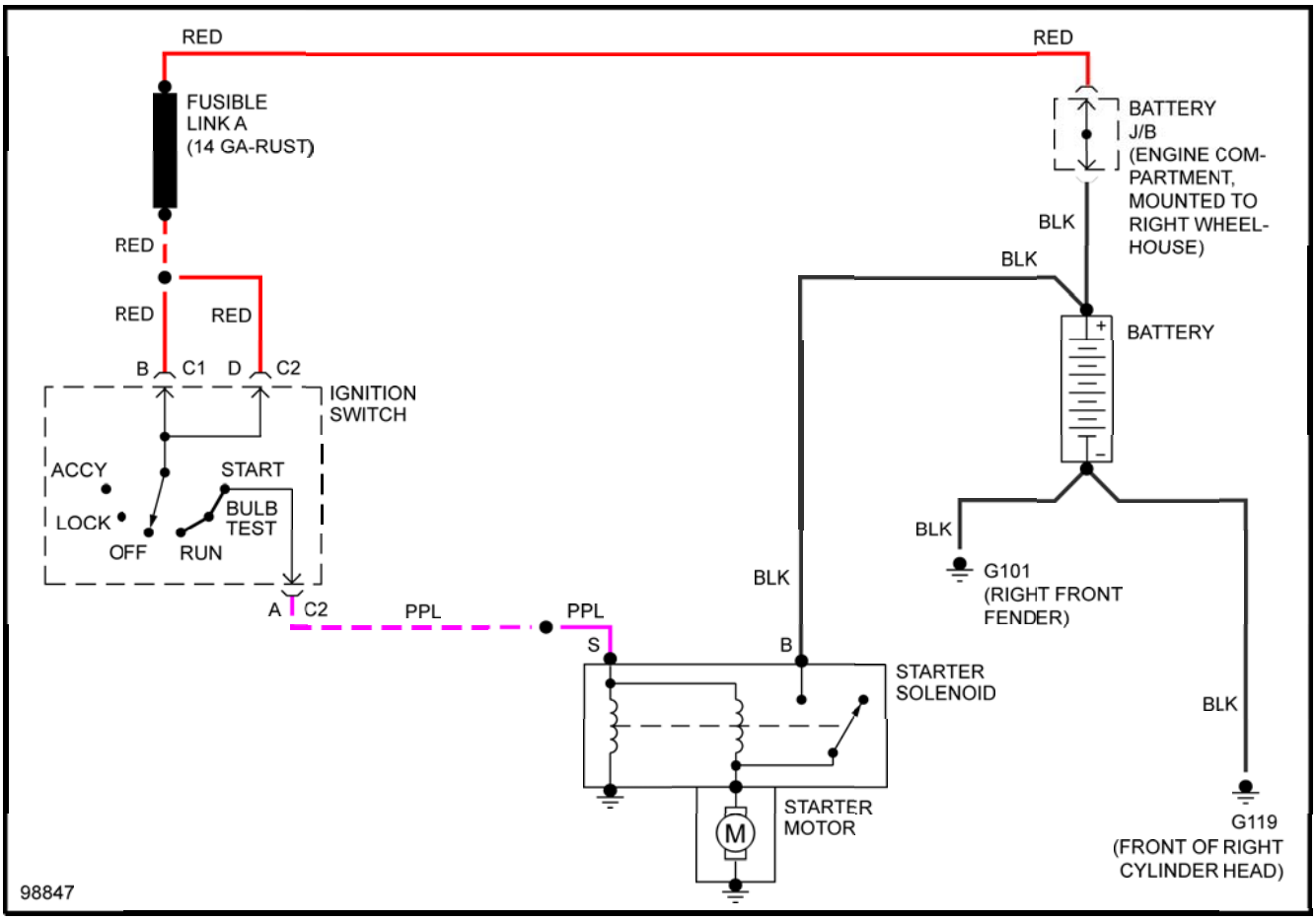


Fig. 13: Starting Circuit

TRUNK, TAILGATE, FUEL DOOR

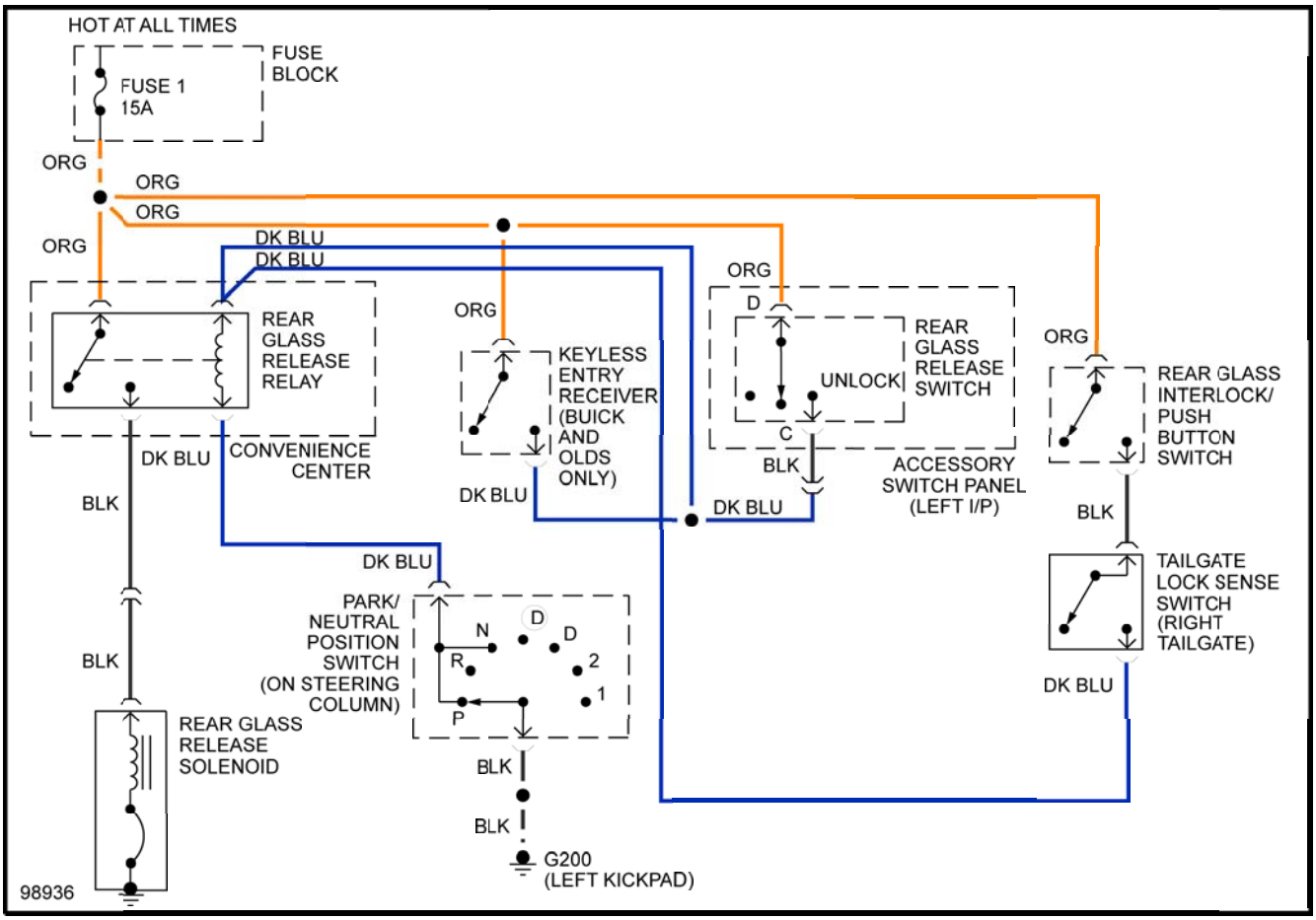


Fig. 14: Rear Glass Release Circuit, W/ Power Door Locks

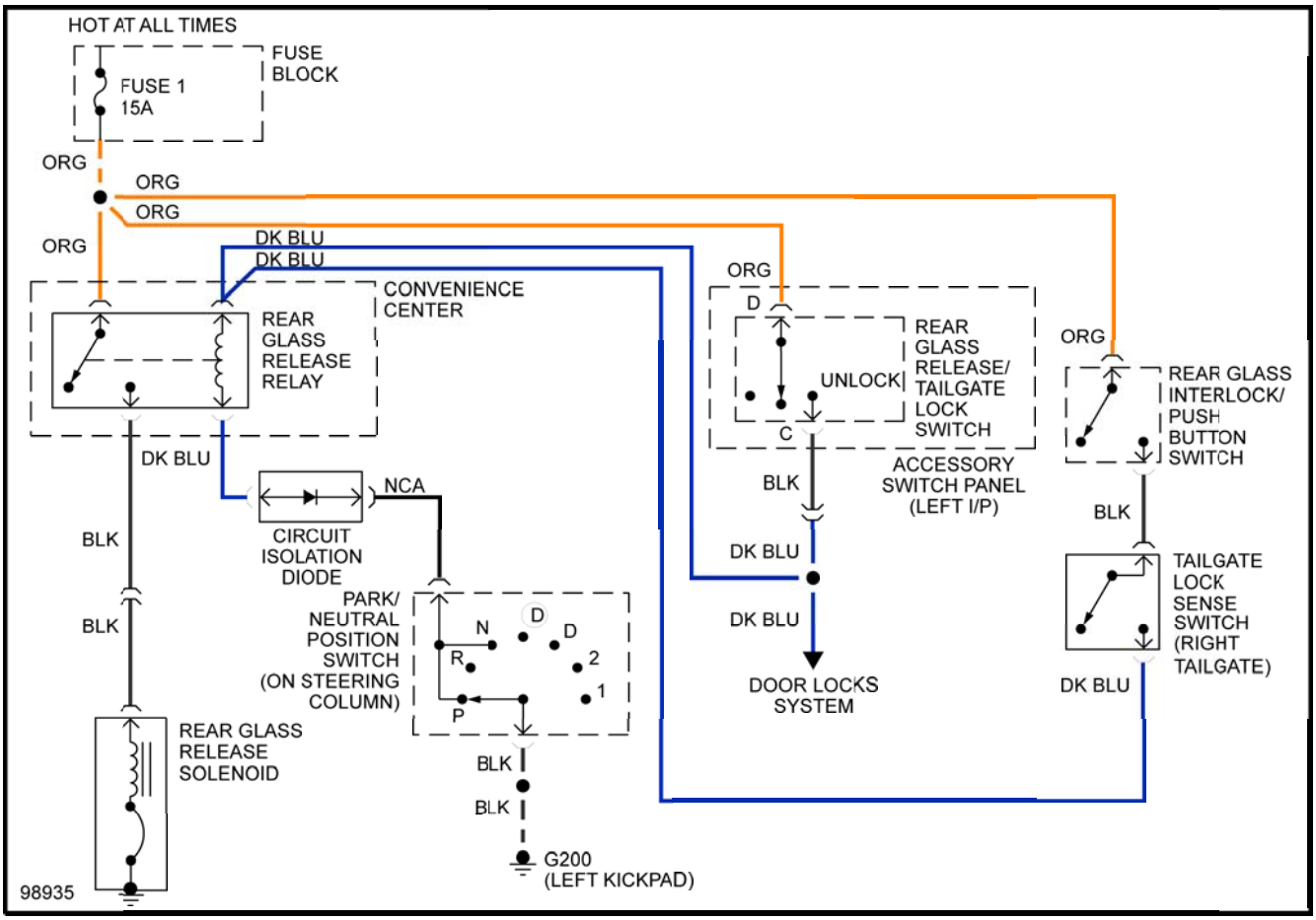


Fig. 15: Rear Glass Release Circuit, W/O Power Door Locks

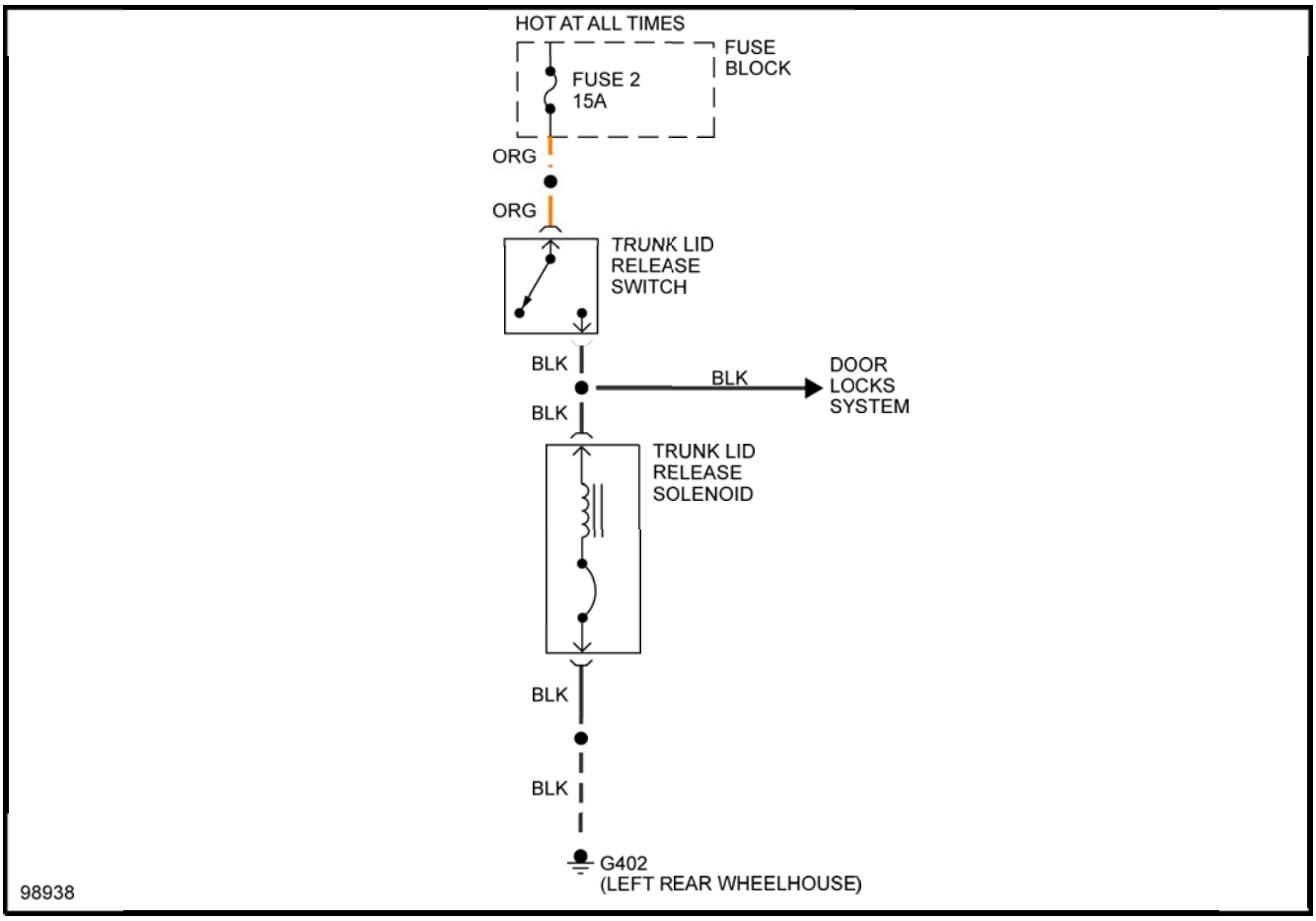


Fig. 16: Trunk Release Circuit

WIPER/WASHER

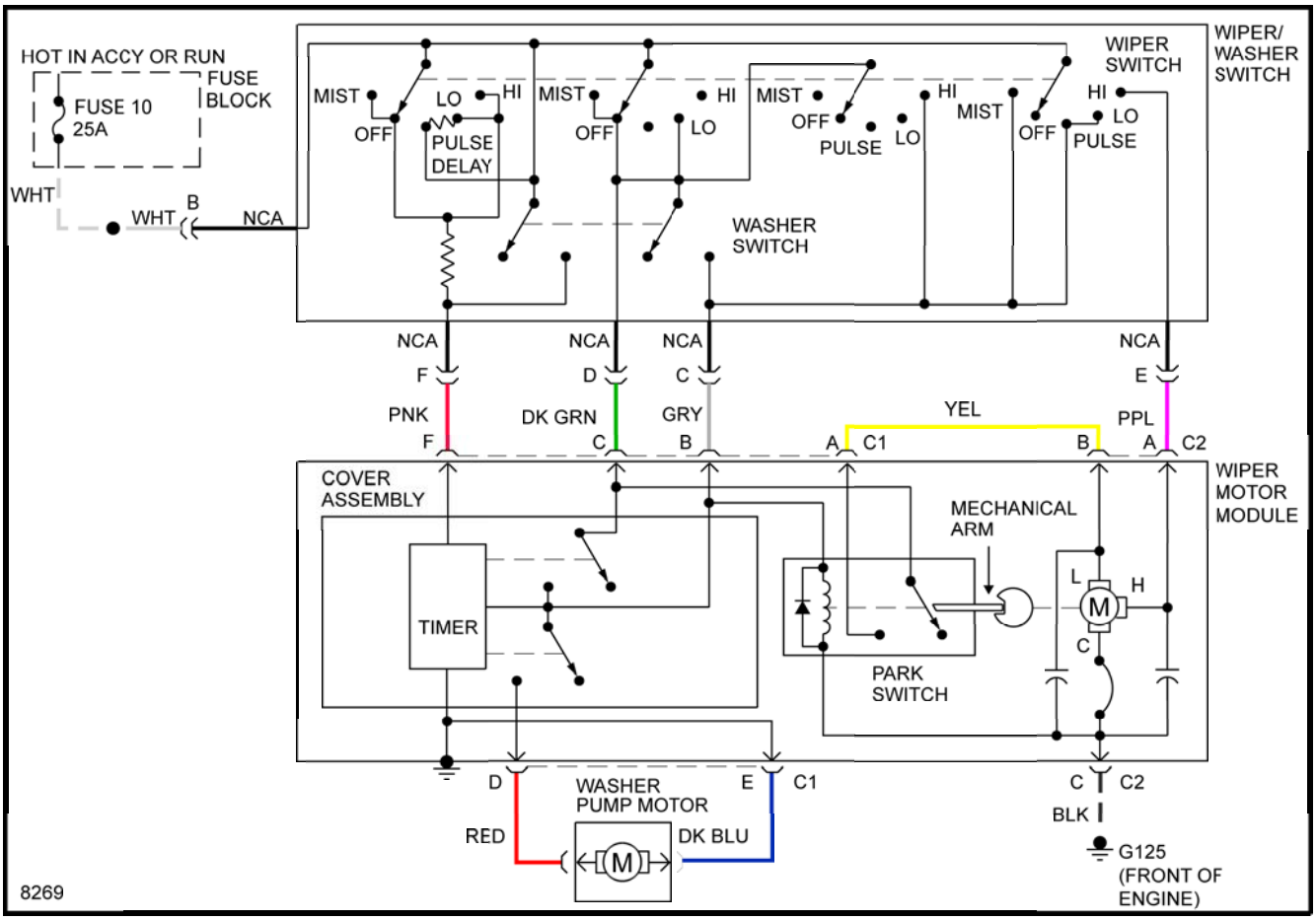


Fig. 17: Interval Wiper/Washer Circuit

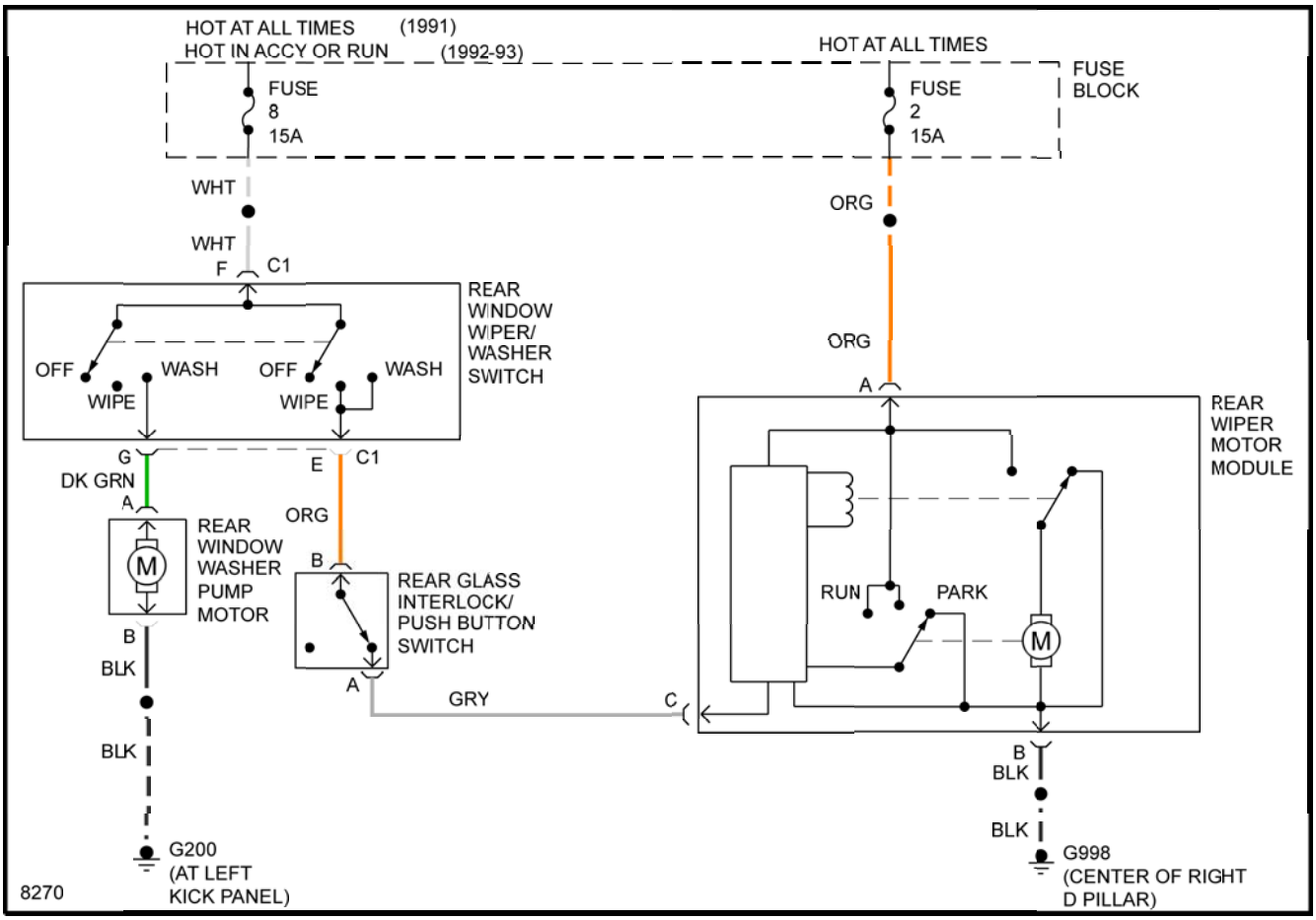


Fig. 18: Rear Wiper/Washer Circuit

System Wiring Diagrams

Chevrolet - Impala SS

AIR CONDITIONING

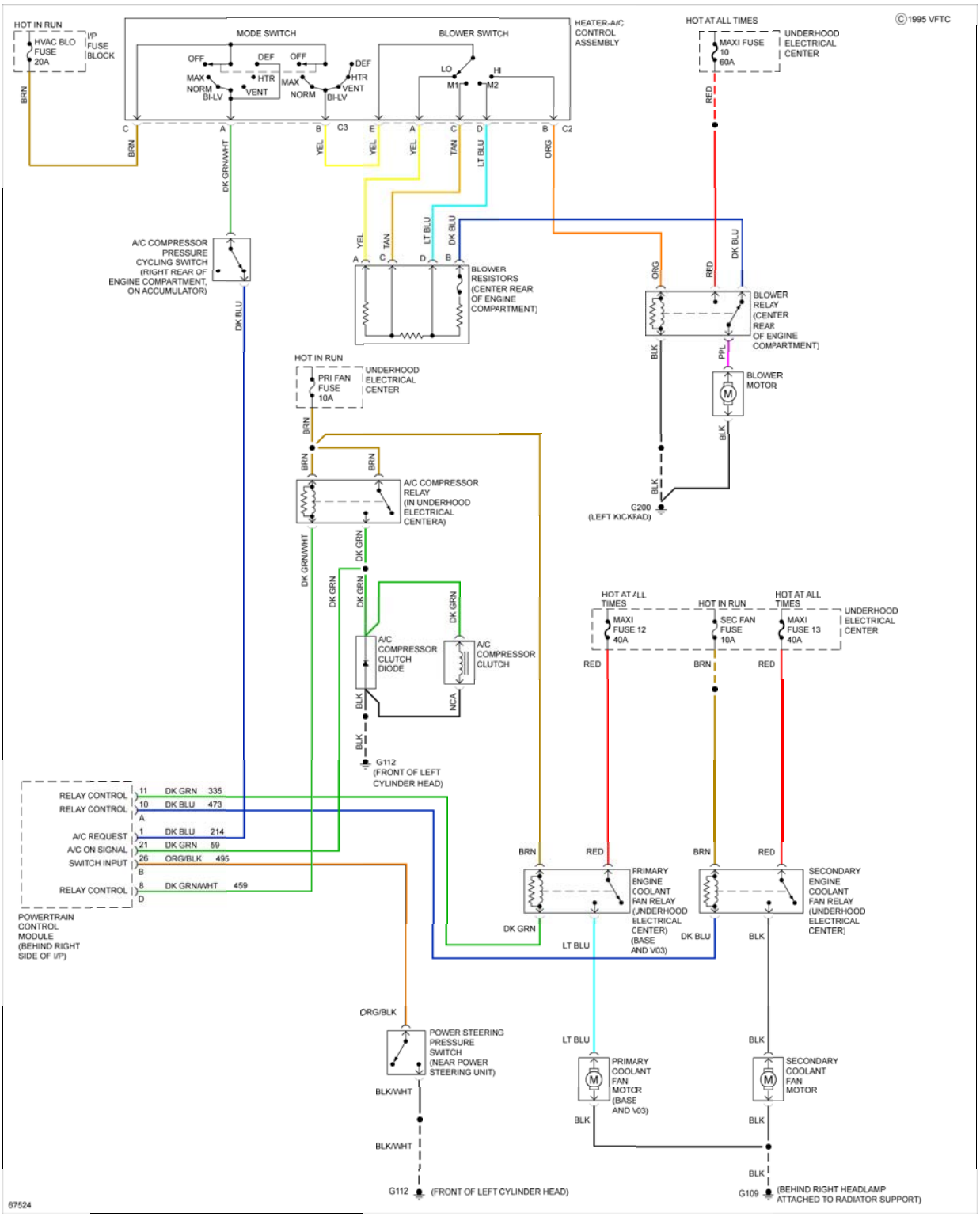


Fig. 1: Air Conditioning Circuits

ANTI-LOCK BRAKES

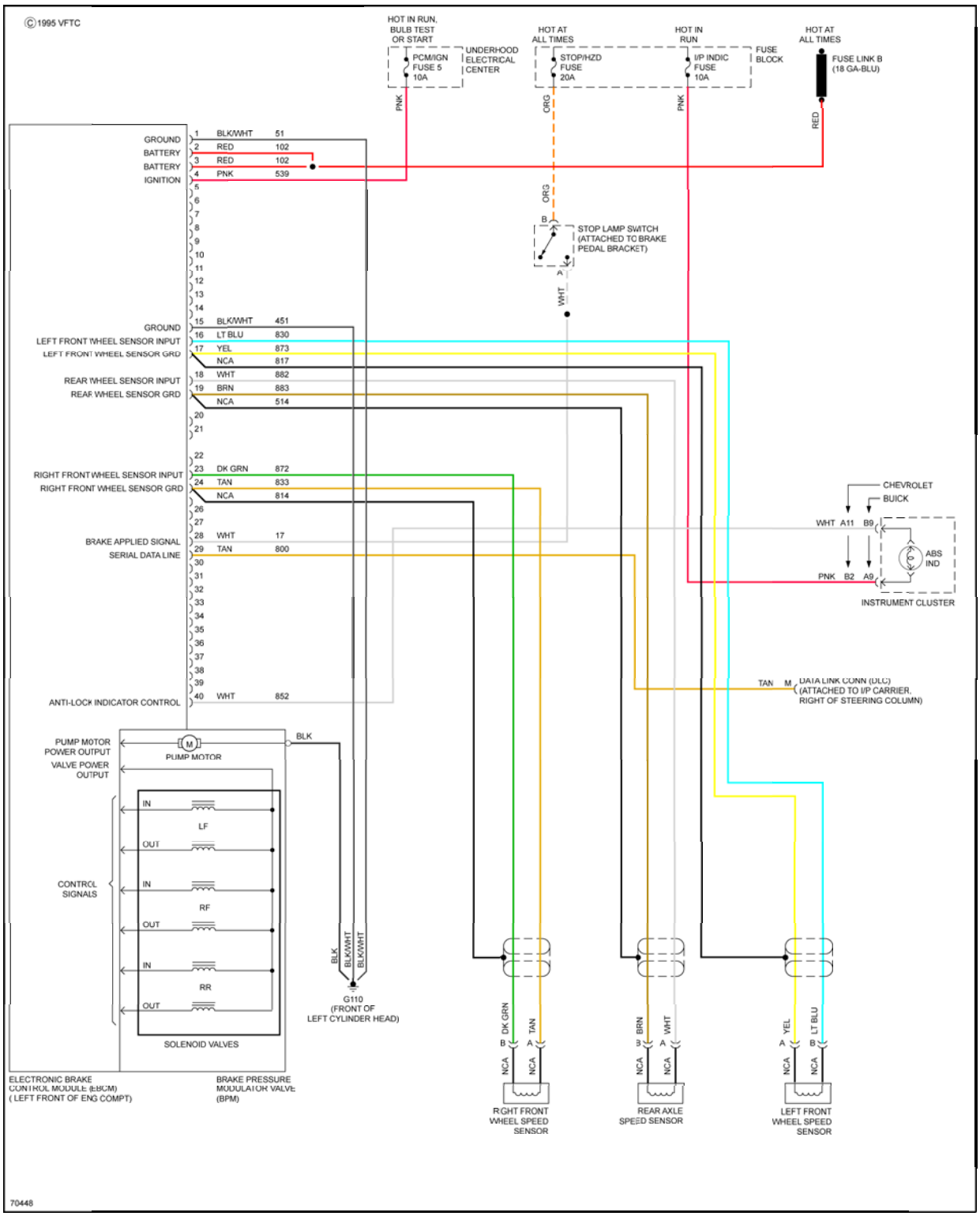


Fig. 2: Anti-lock Brake Circuits

ANTI-THEFT

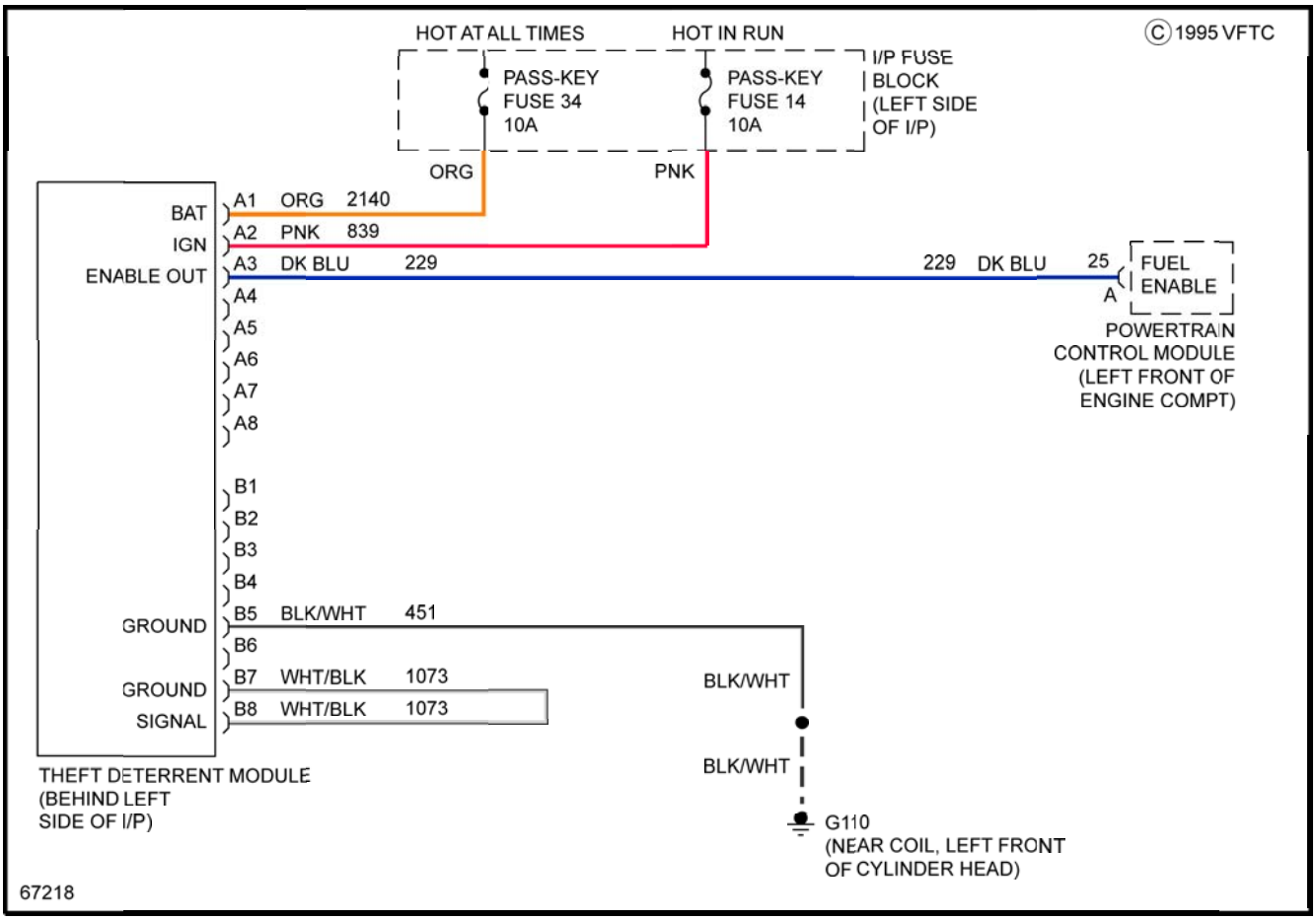


Fig. 3: Pass-Key Circuit, W/ SEO

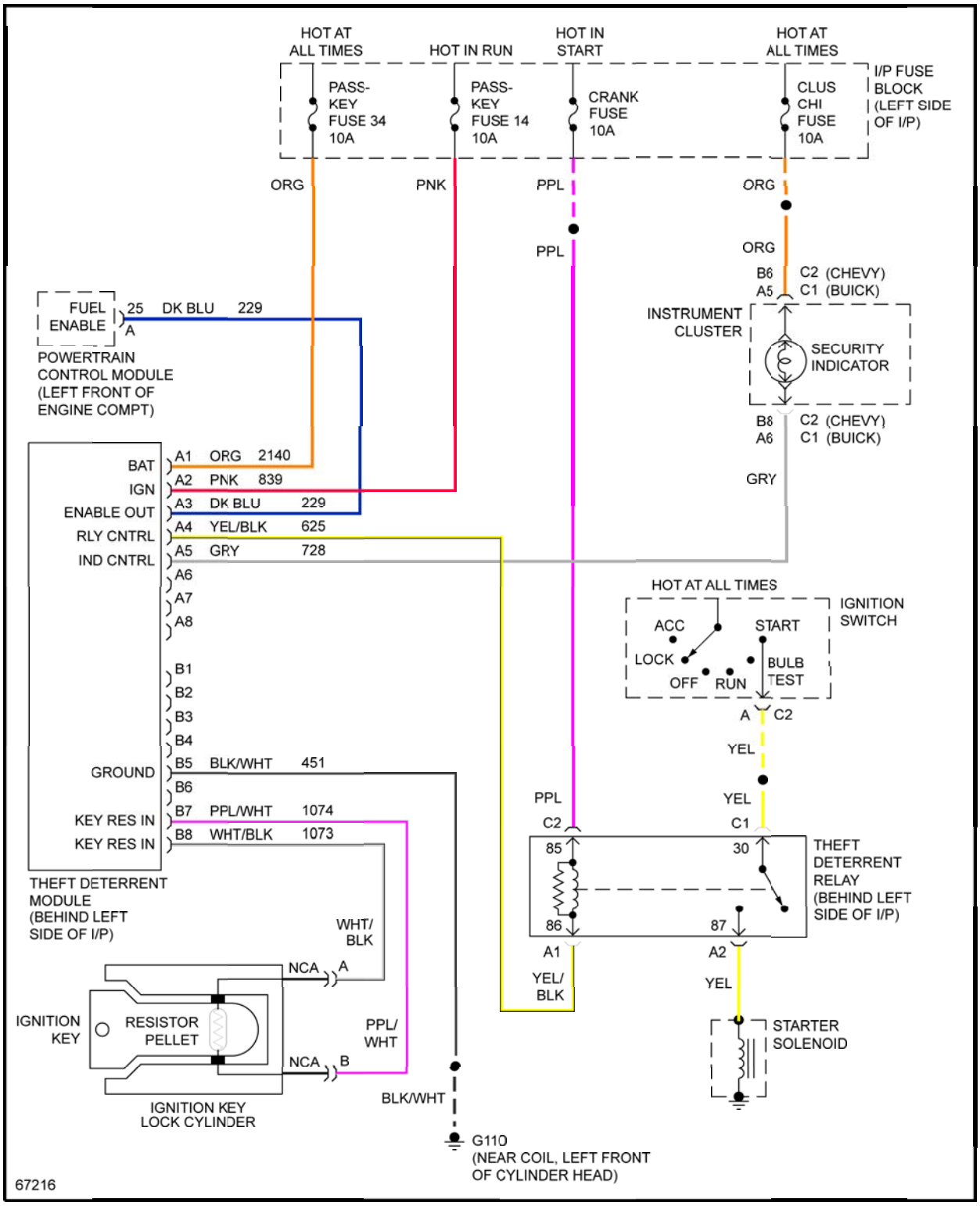


Fig. 4: Pass-Key Circuit, W/O SEO

COMPUTER DATA LINES

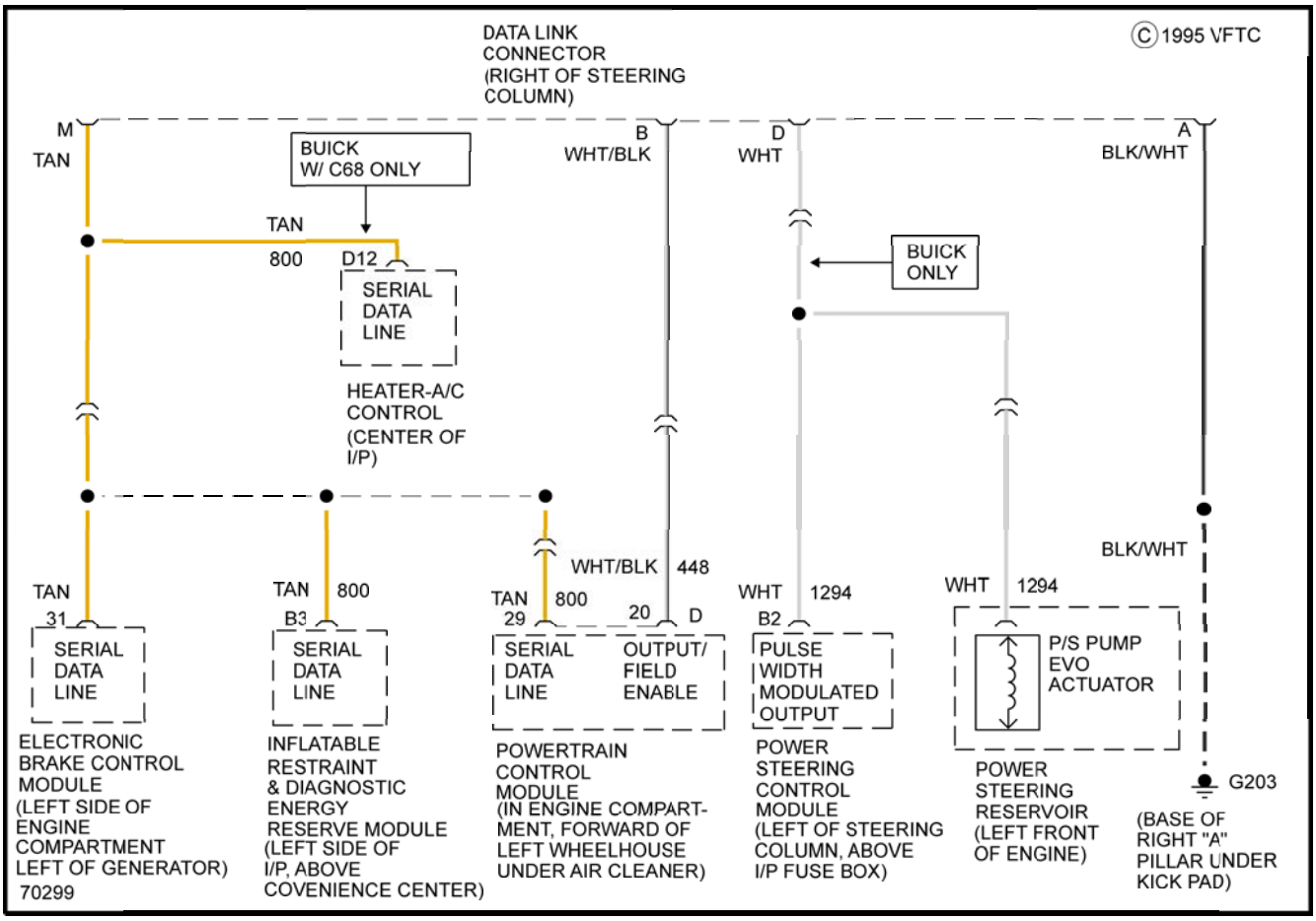


Fig. 5: Data Link Connector Circuit

COOLING FAN

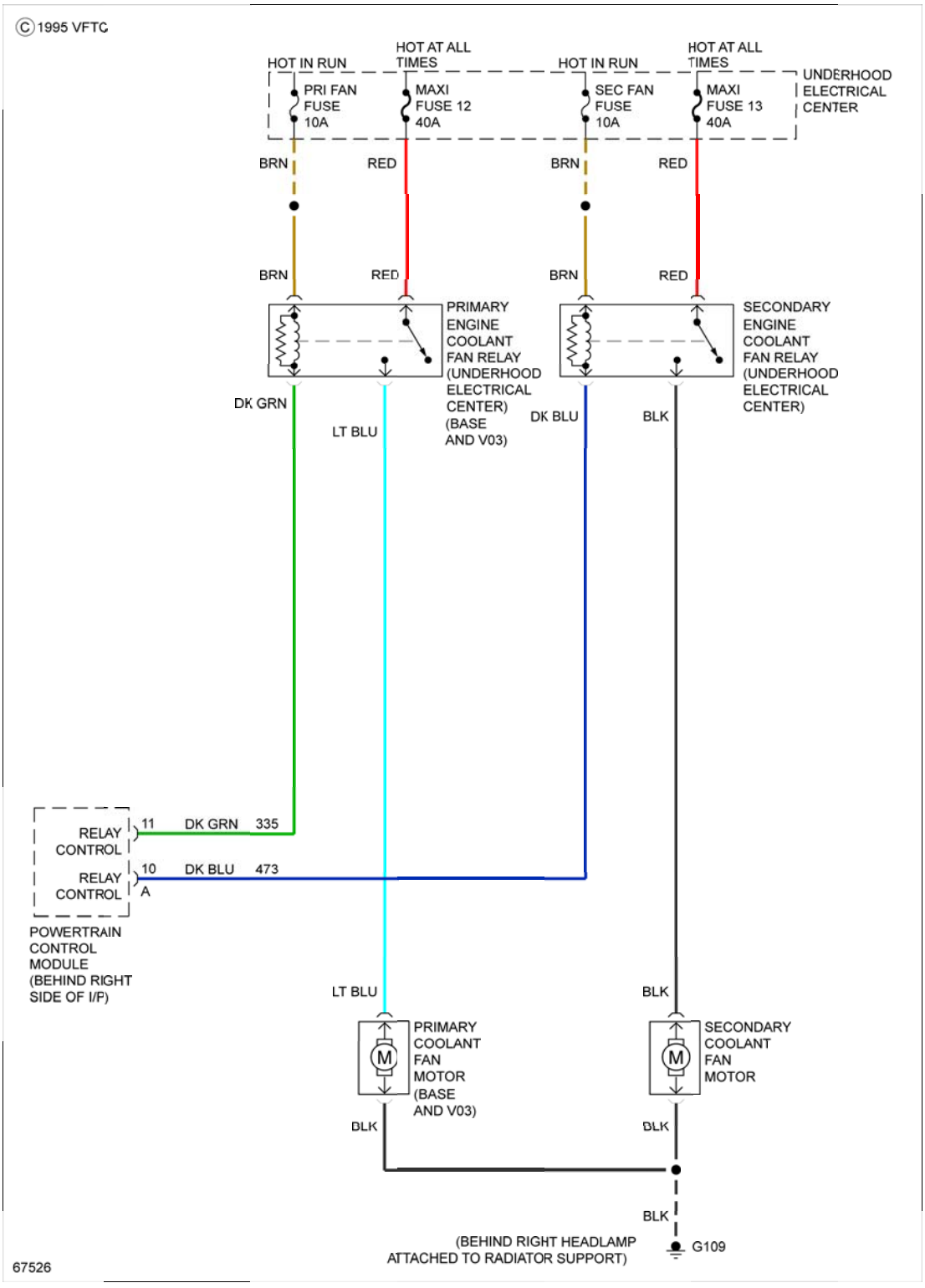


Fig. 6: Cooling Fan Circuit

CRUISE CONTROL

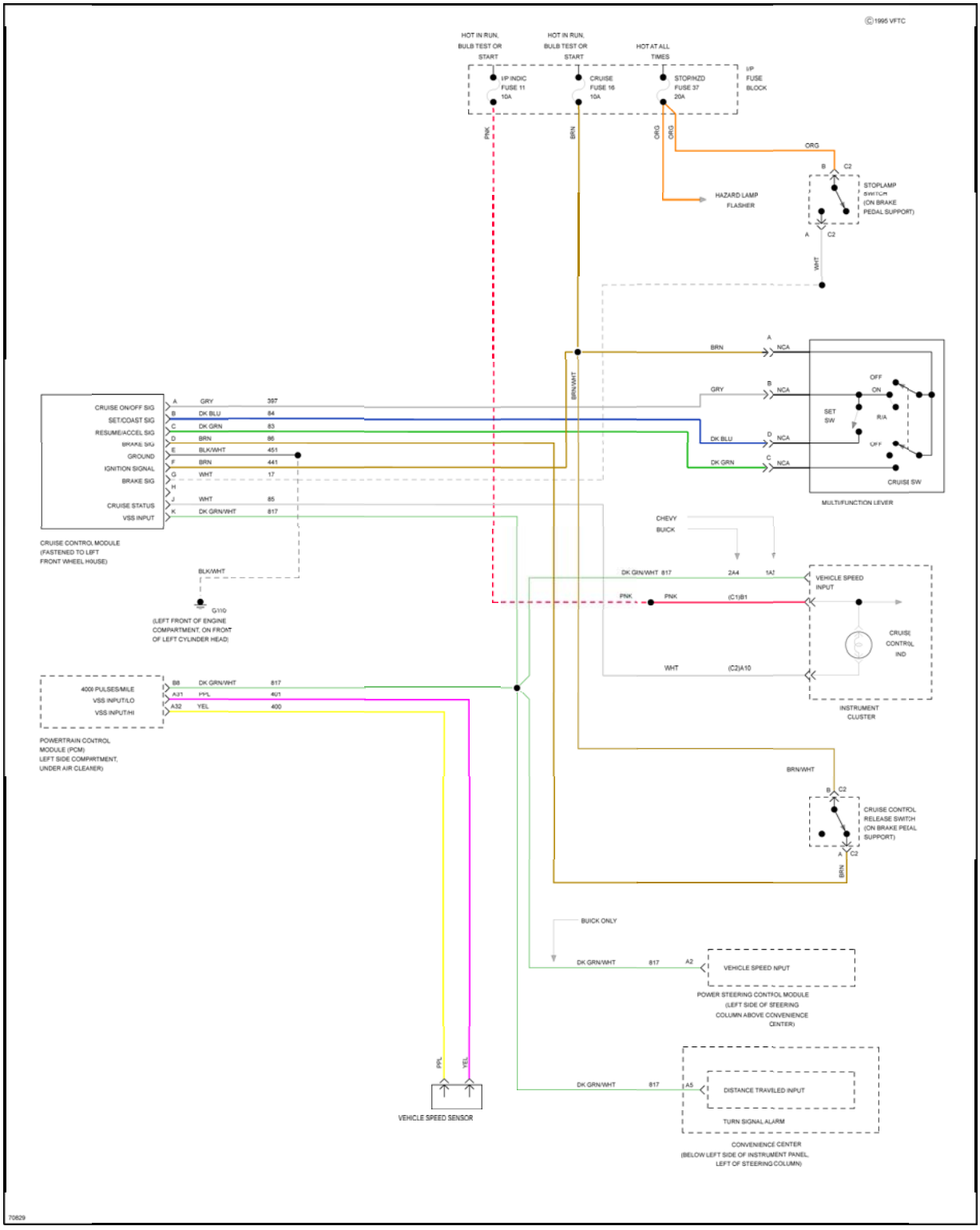


Fig. 7: Cruise Control Circuit

DEFOGGERS

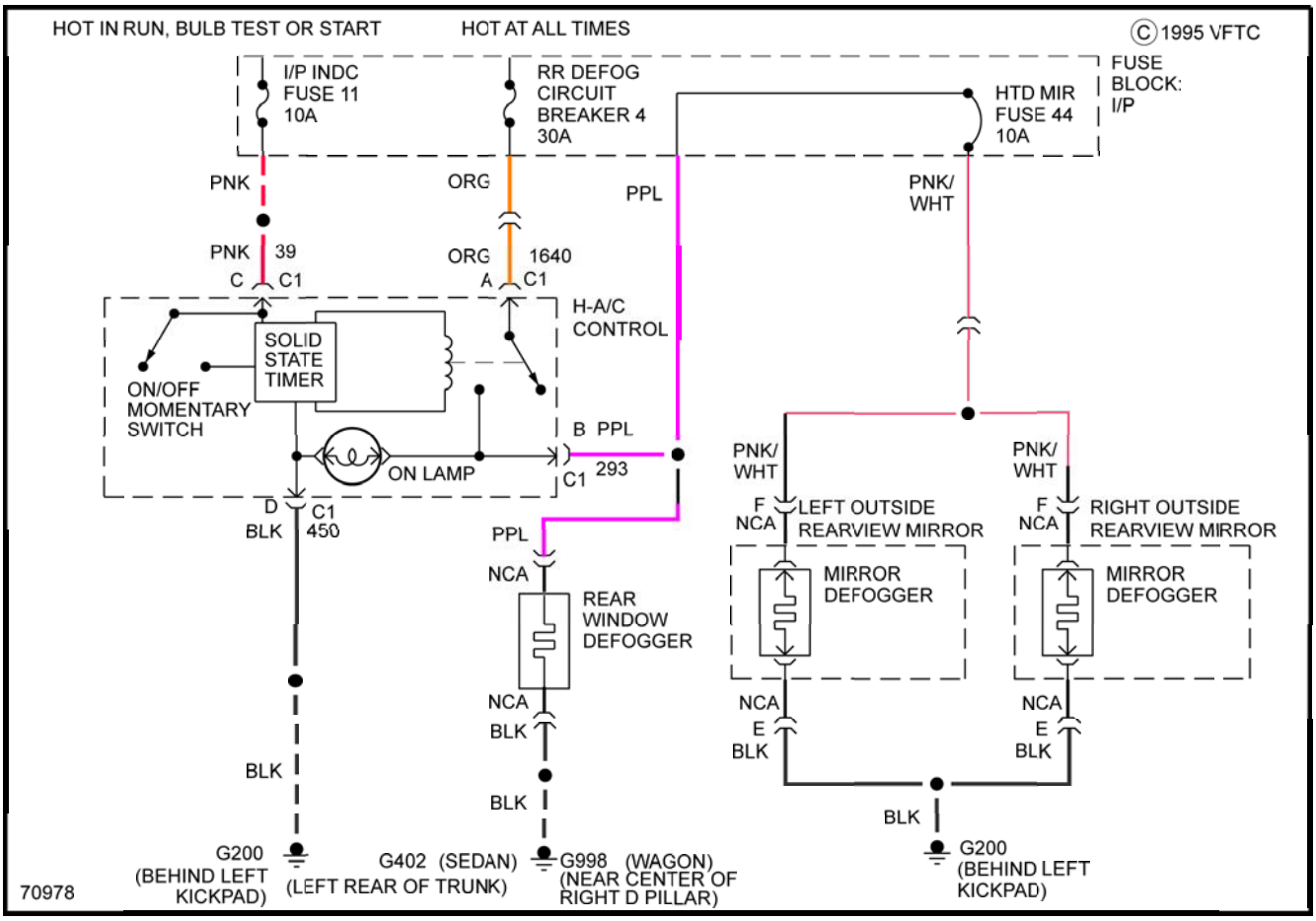


Fig. 8: Defogger Circuit

ELECTRONIC POWER STEERING

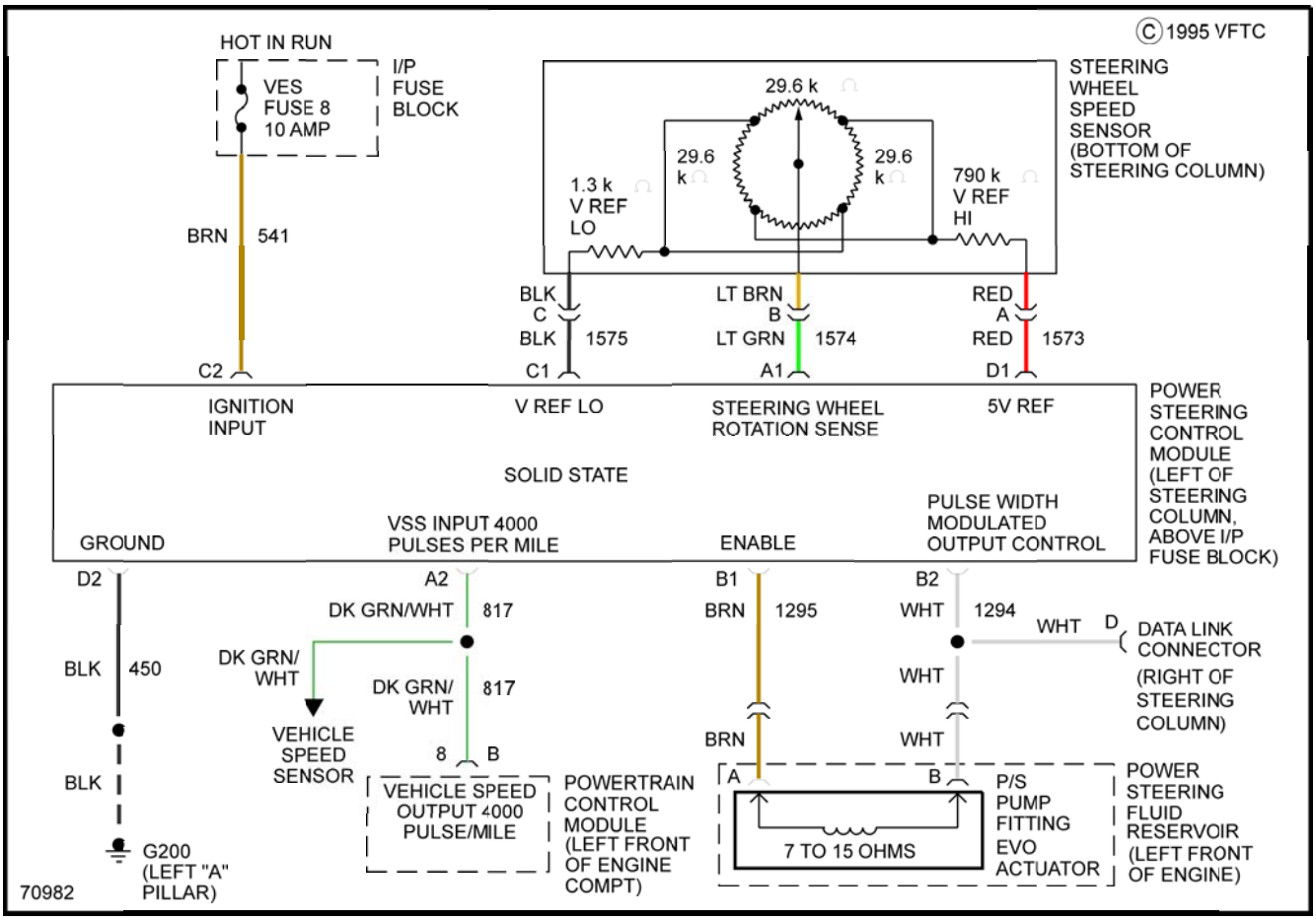


Fig. 9: Electronic Power Steering Circuit

ENGINE PERFORMANCE

5.7L

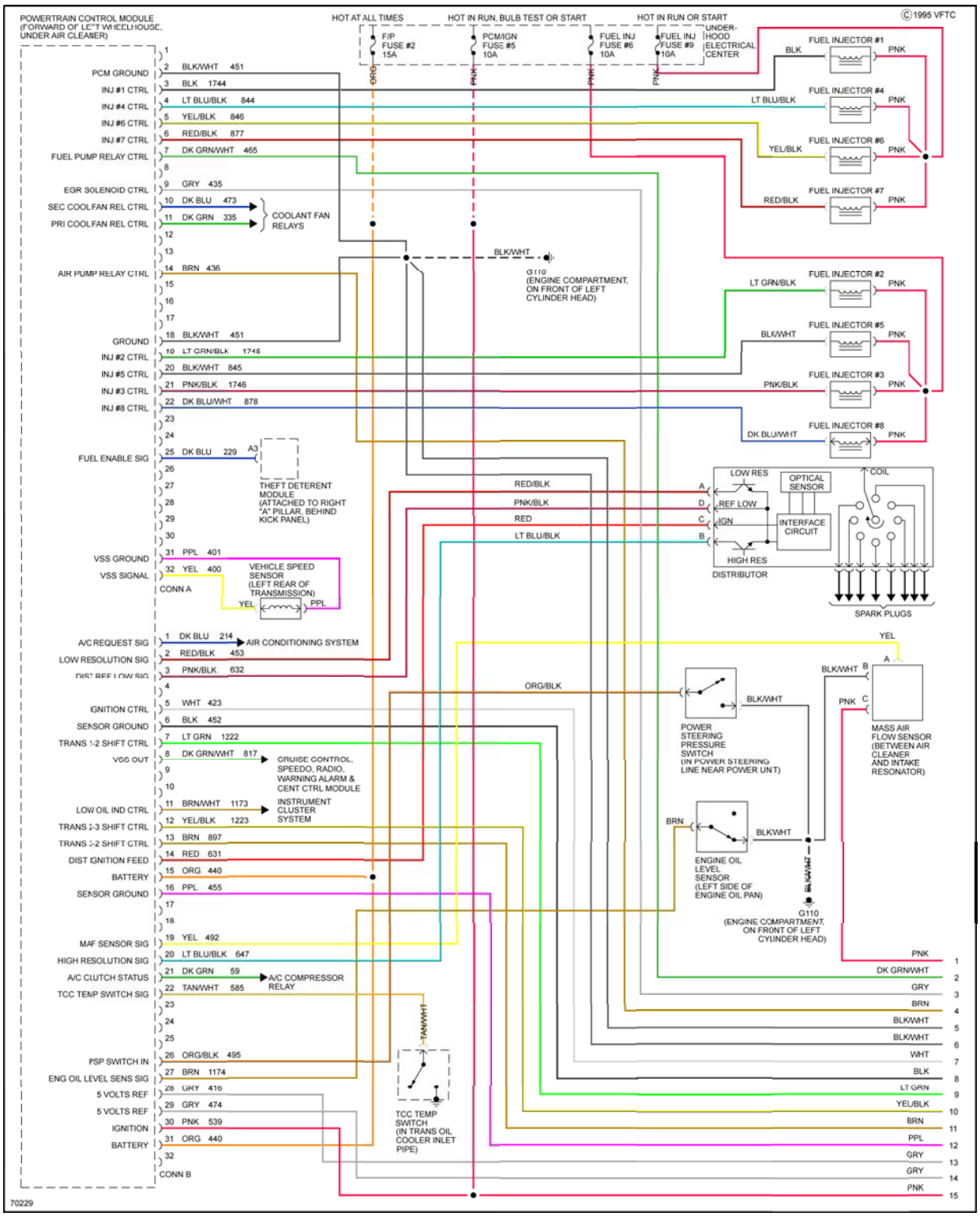


Fig. 10: 5.7L (VIN P), Engine Performance Circuits (1 of 3)

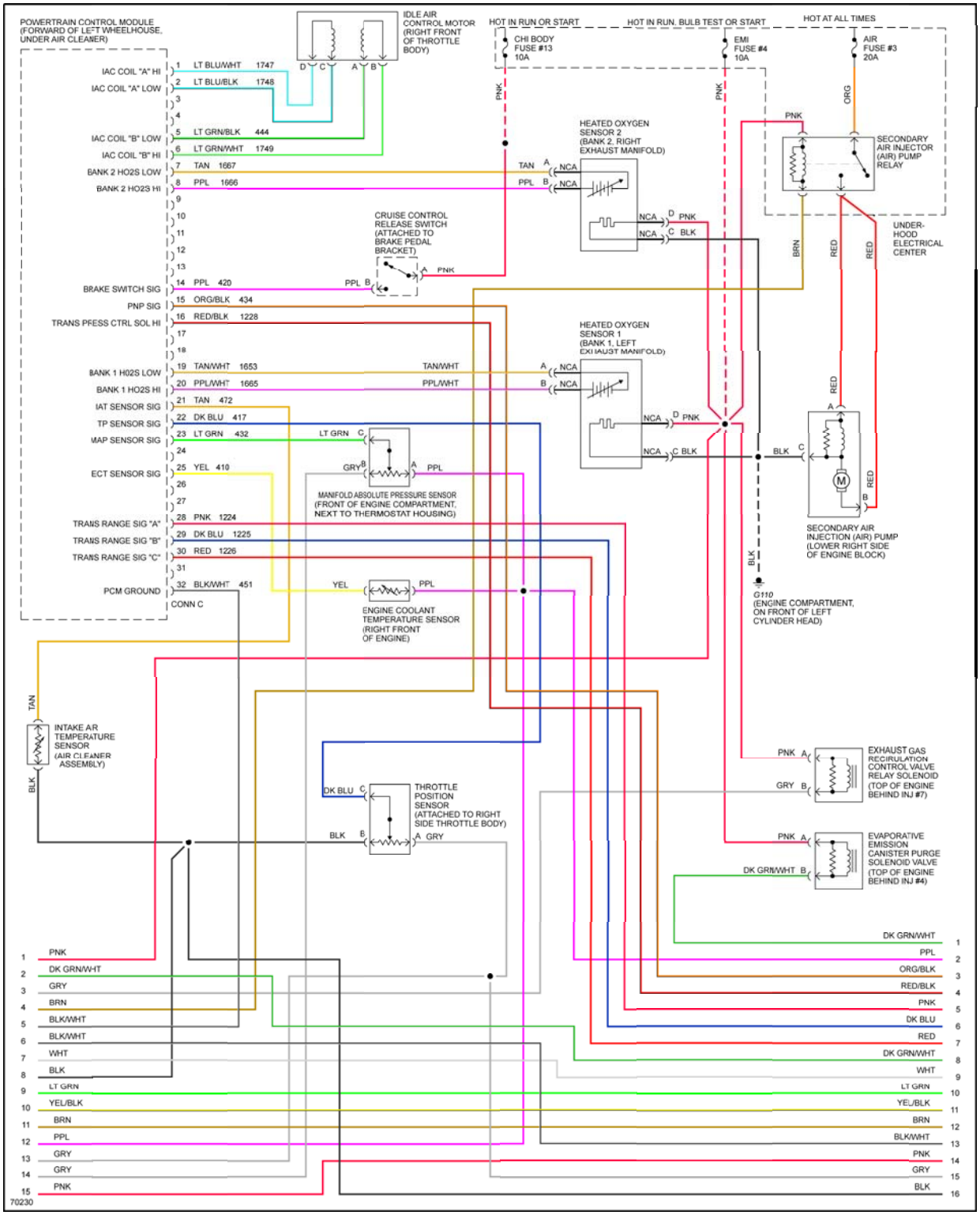


Fig. 11: 5.7L (VIN P), Engine Performance Circuits (2 of 3)

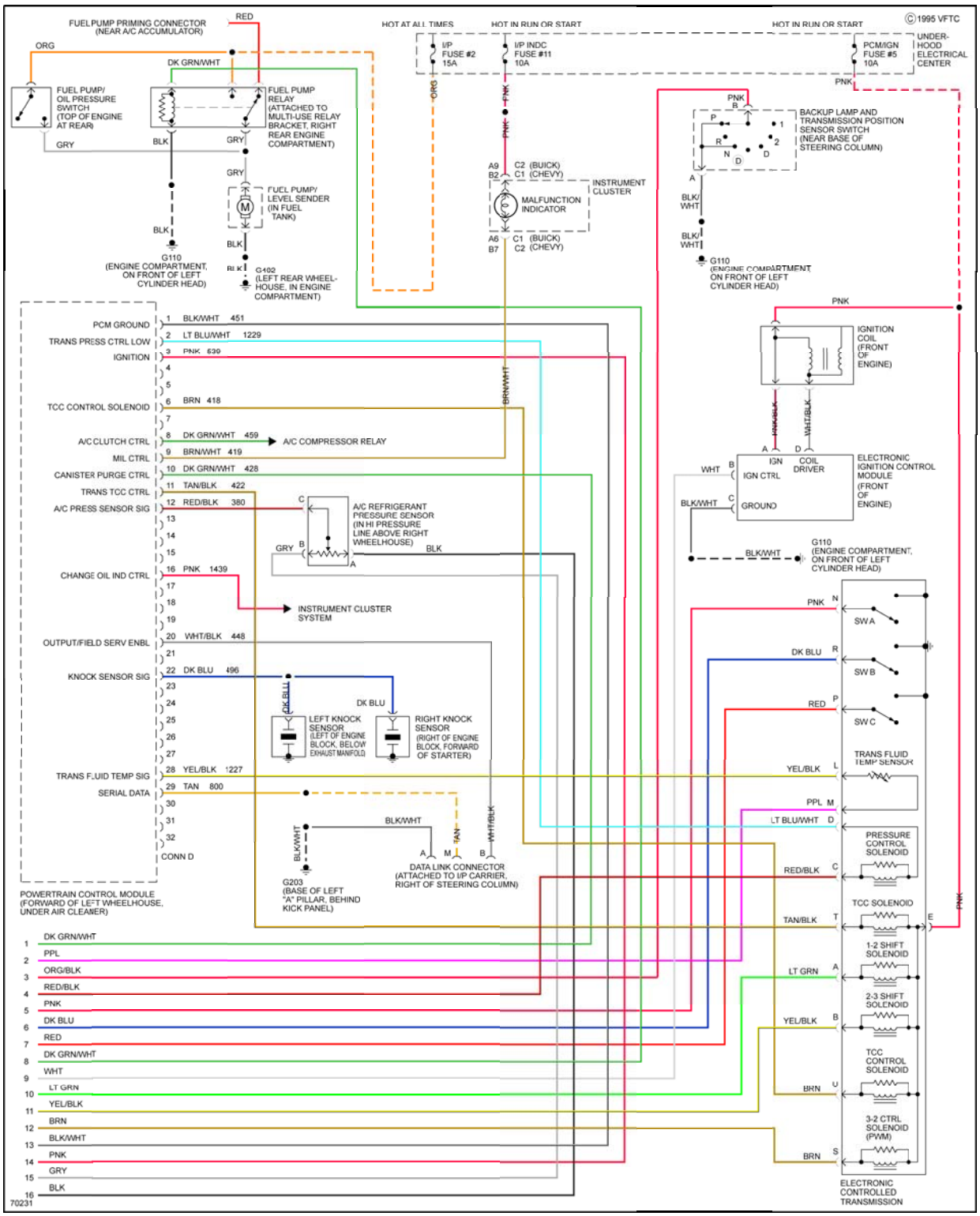


Fig. 12: 5.7L (VIN P), Engine Performance Circuits (3 of 3)

EXTERIOR LIGHTS

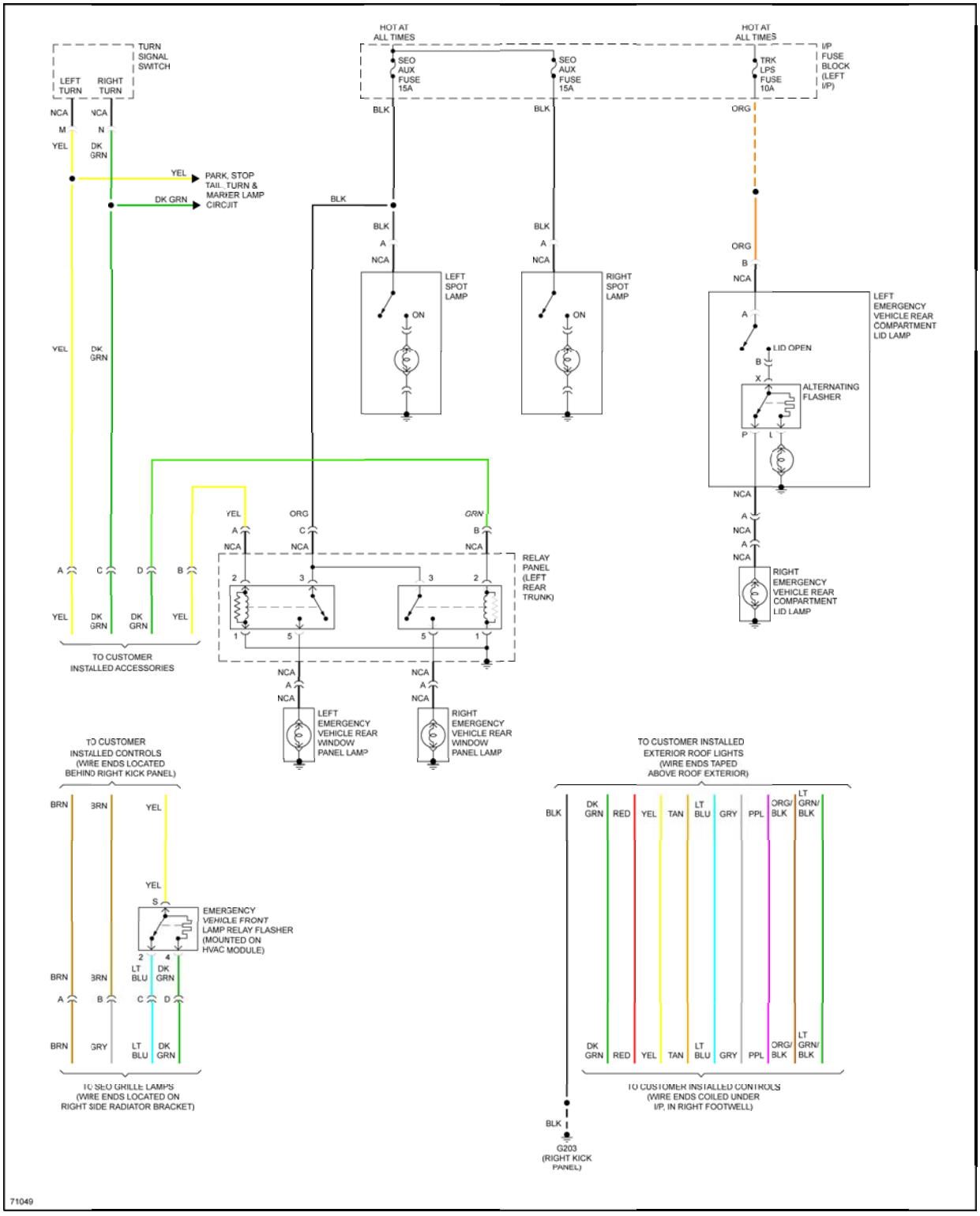


Fig. 13: Accessory Lamps Circuit

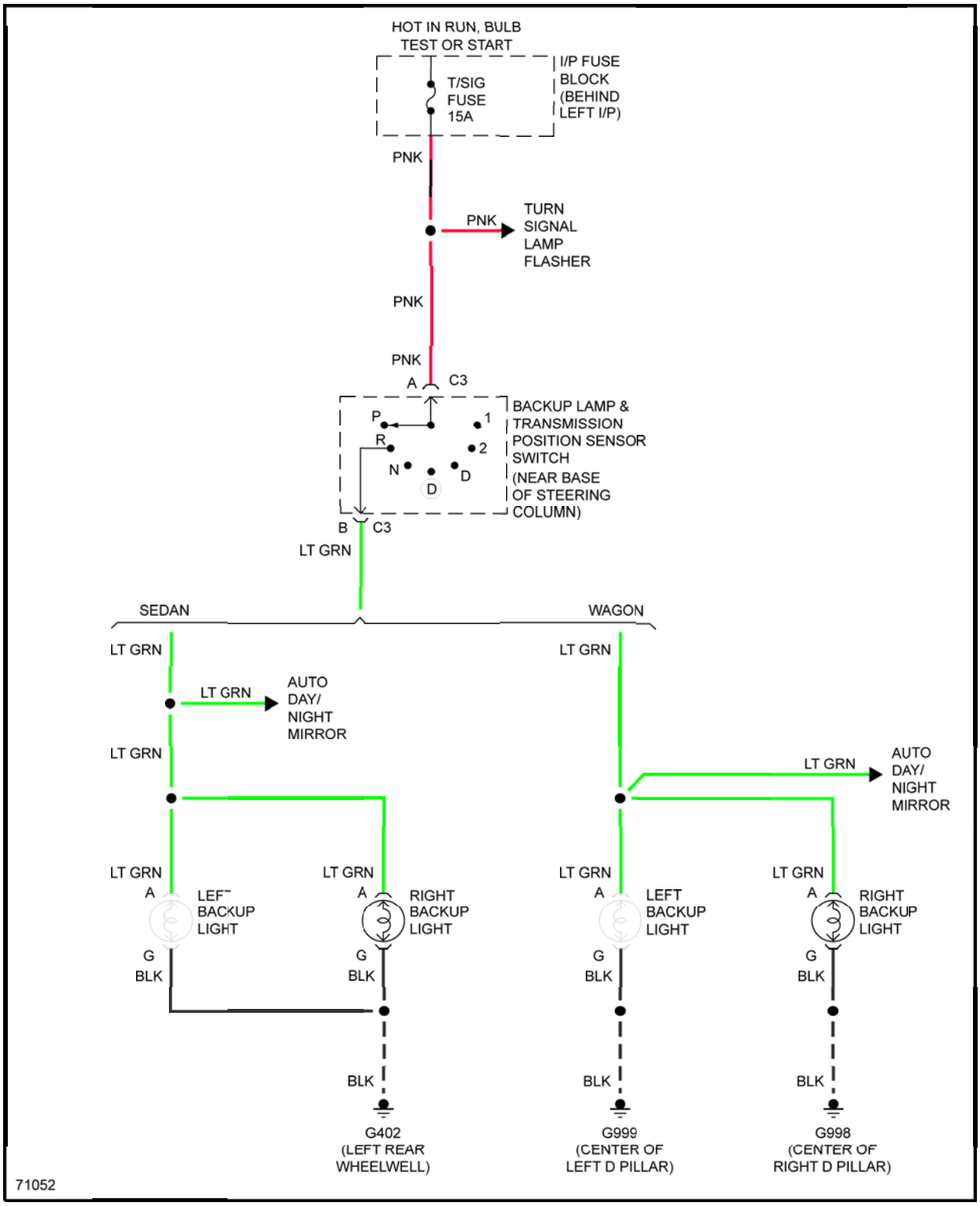


Fig. 14: Back-up Lamps Circuit

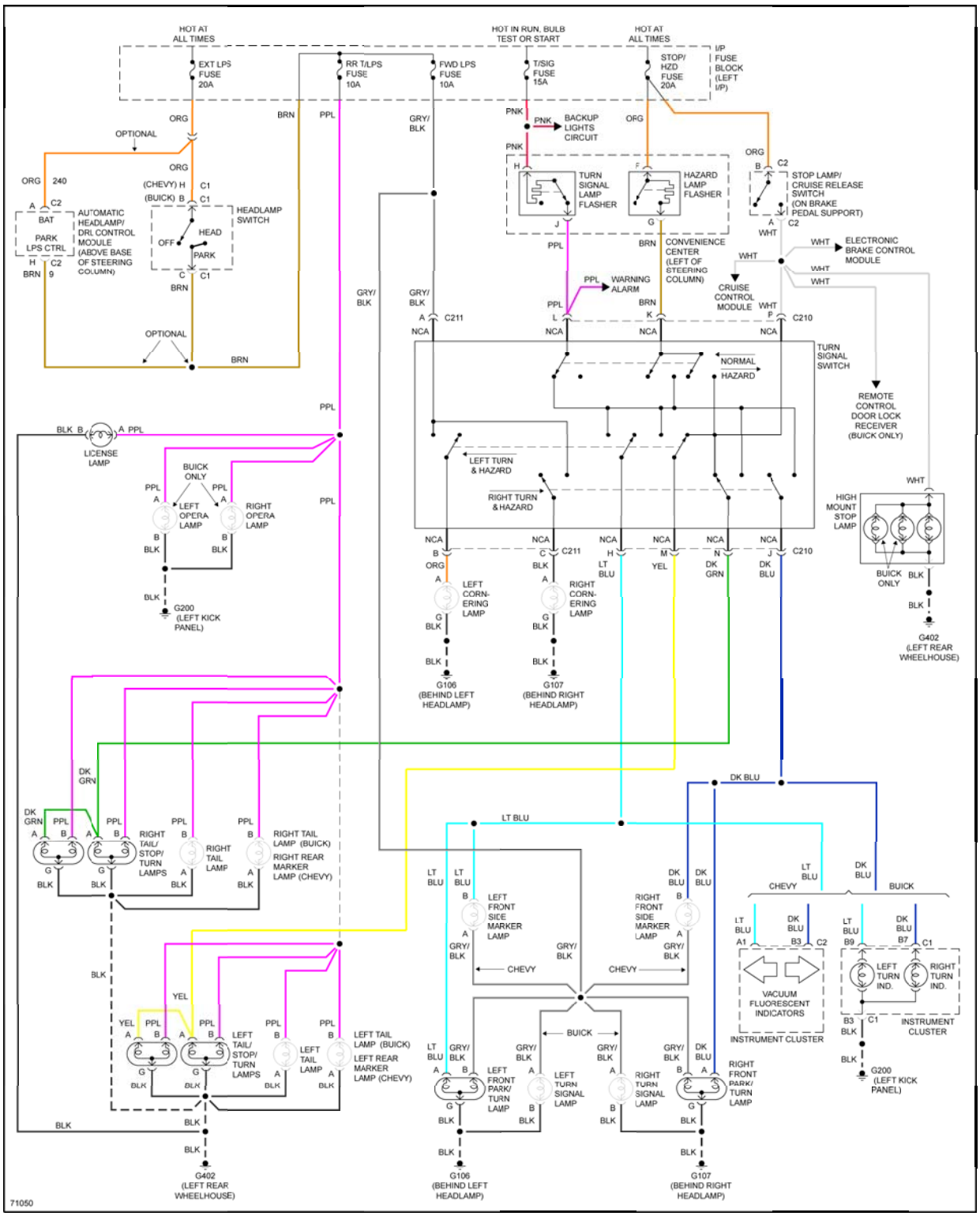


Fig. 15: Exterior Light Circuit, Sedan

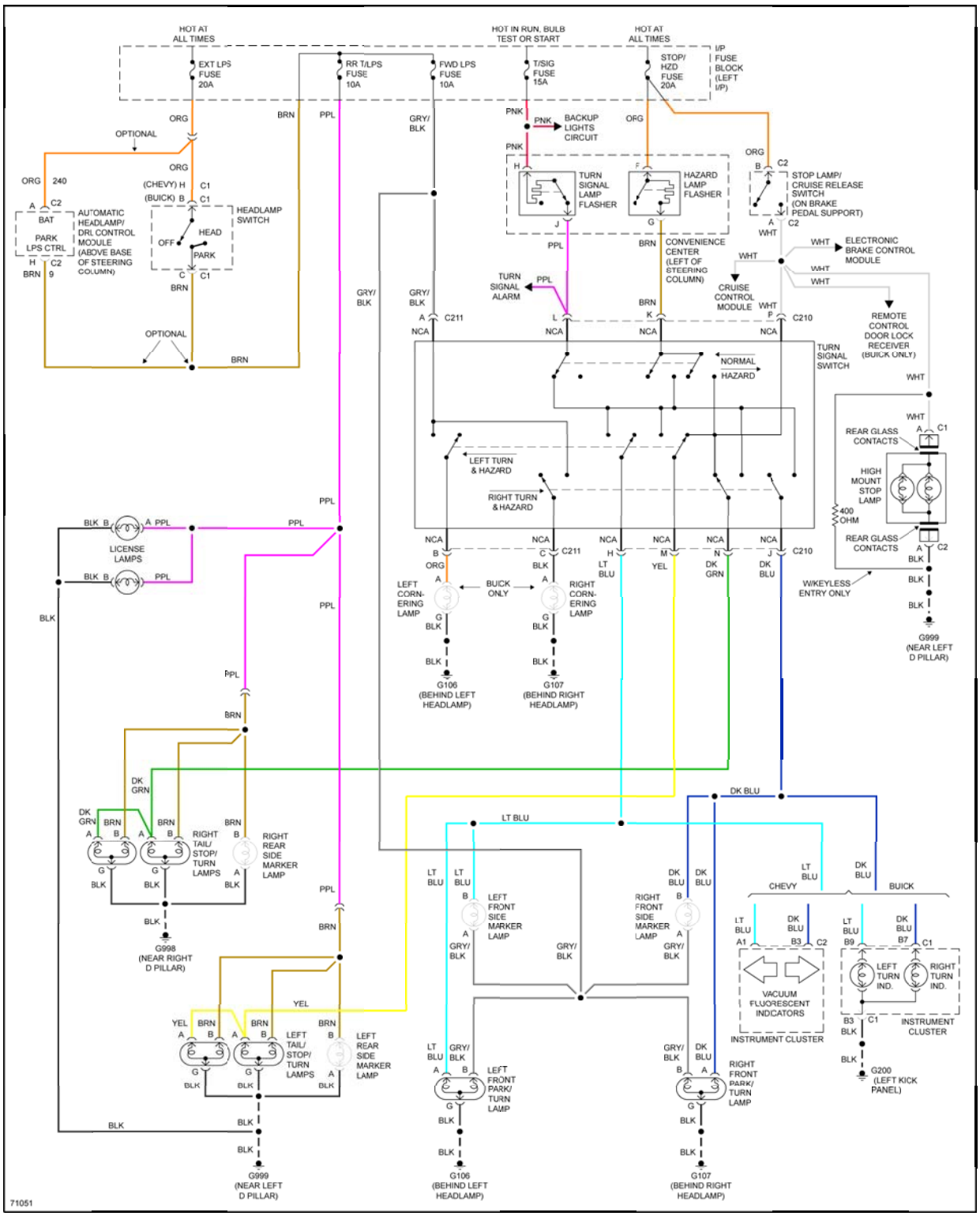


Fig. 16: Exterior Light Circuit, Wagon

GROUND DISTRIBUTION

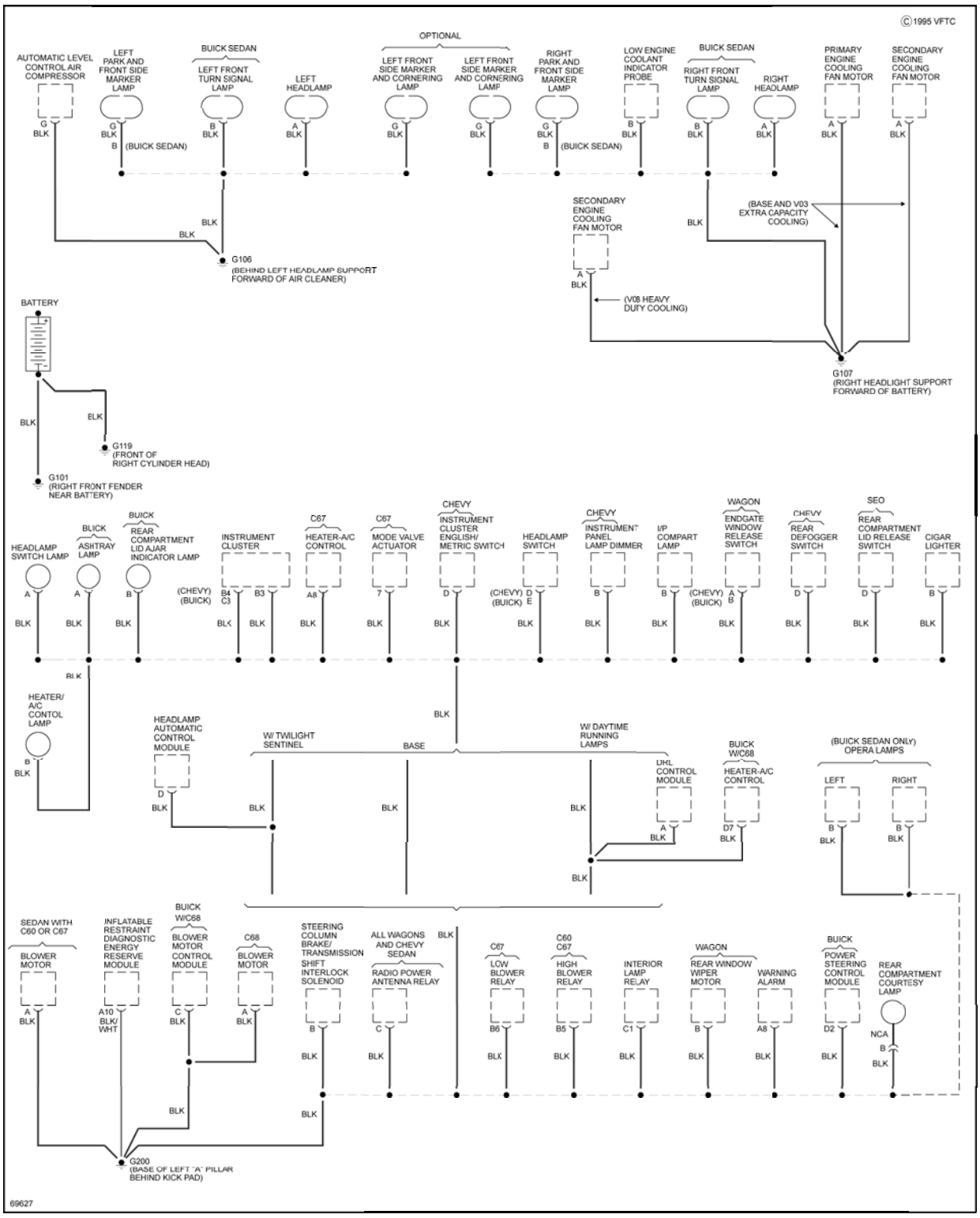


Fig. 17: Ground Distribution Circuit (1 of 3)

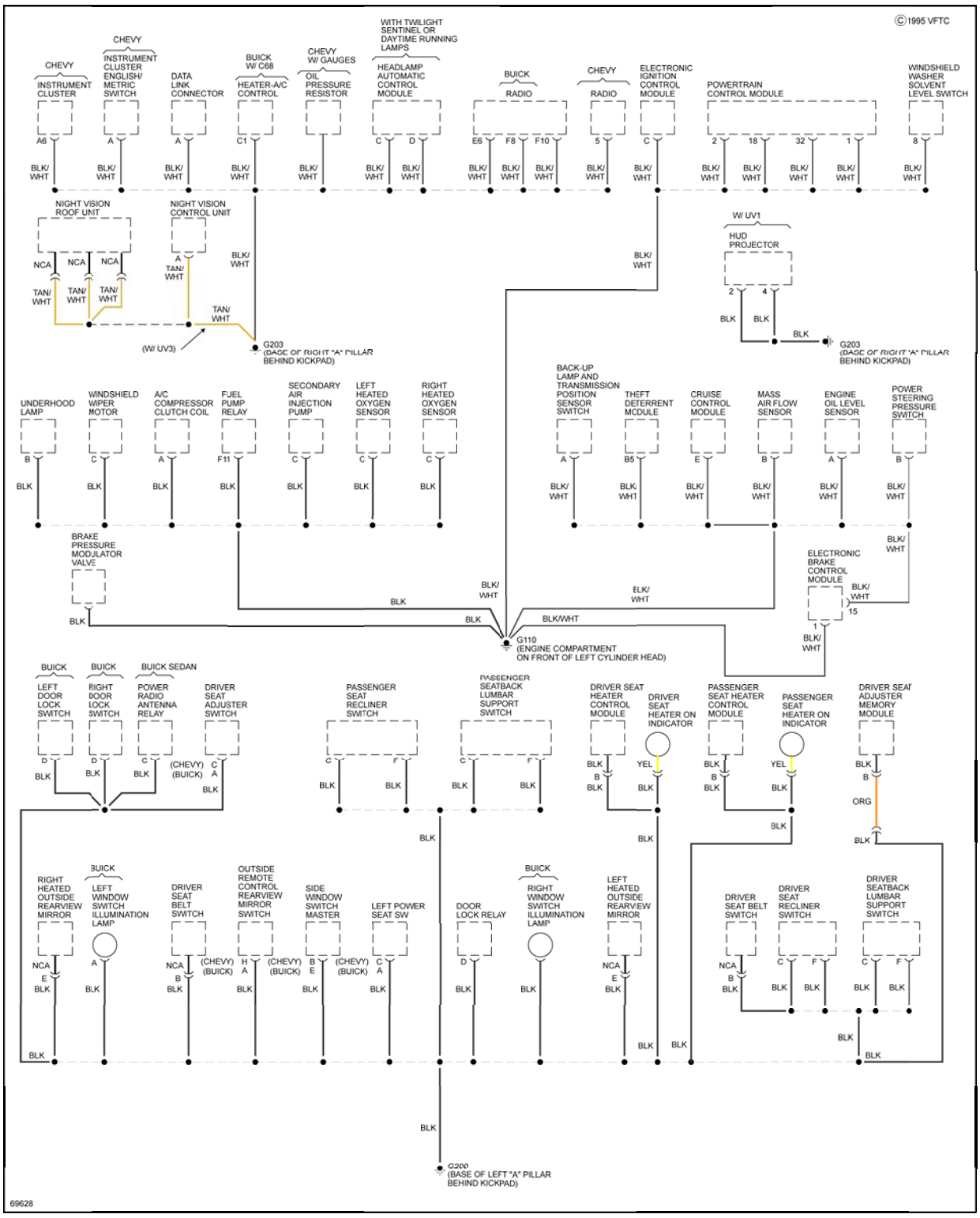


Fig. 18: Ground Distribution Circuit (2 of 3)

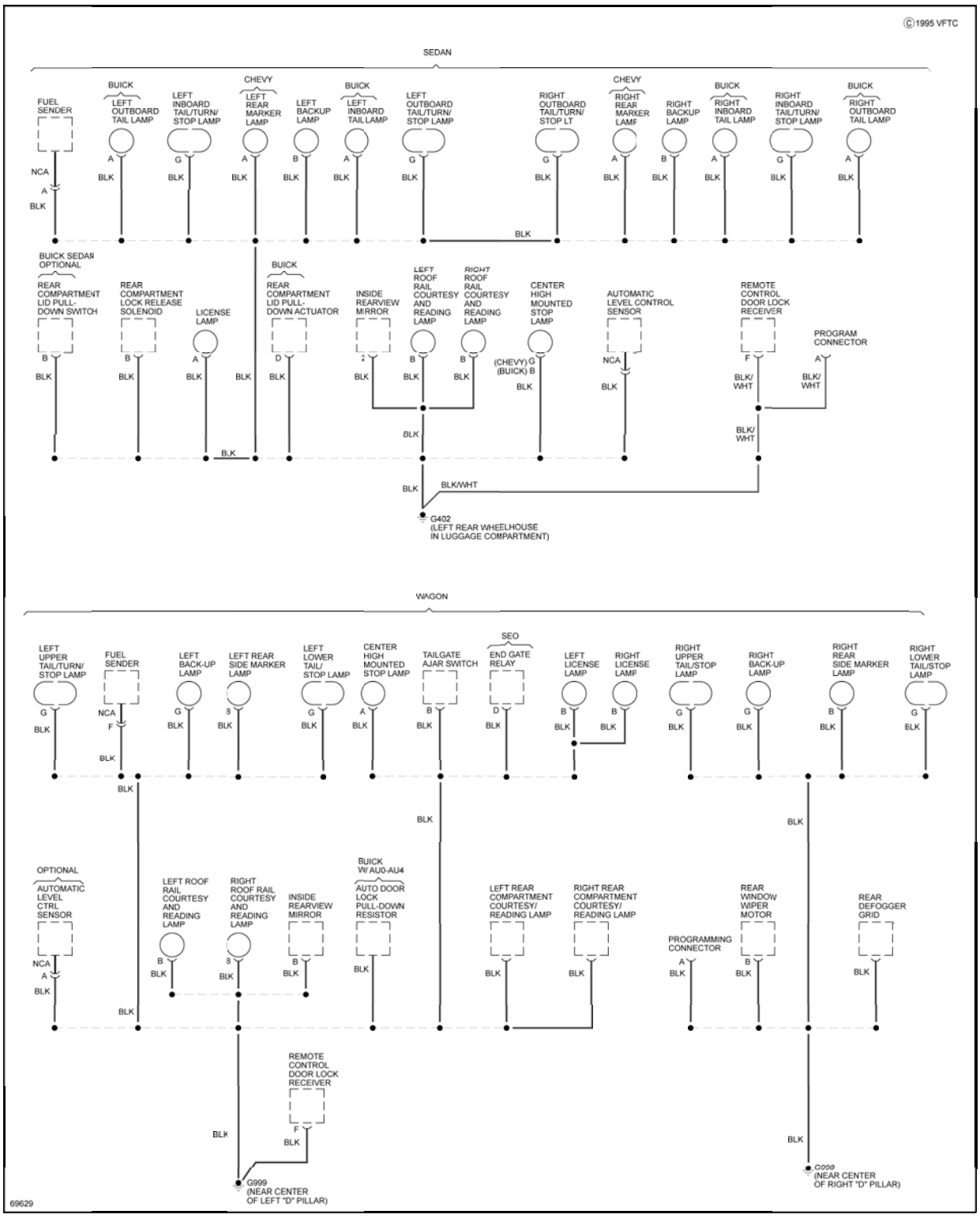


Fig. 19: Ground Distribution Circuit (3 of 3)

HEADLIGHTS

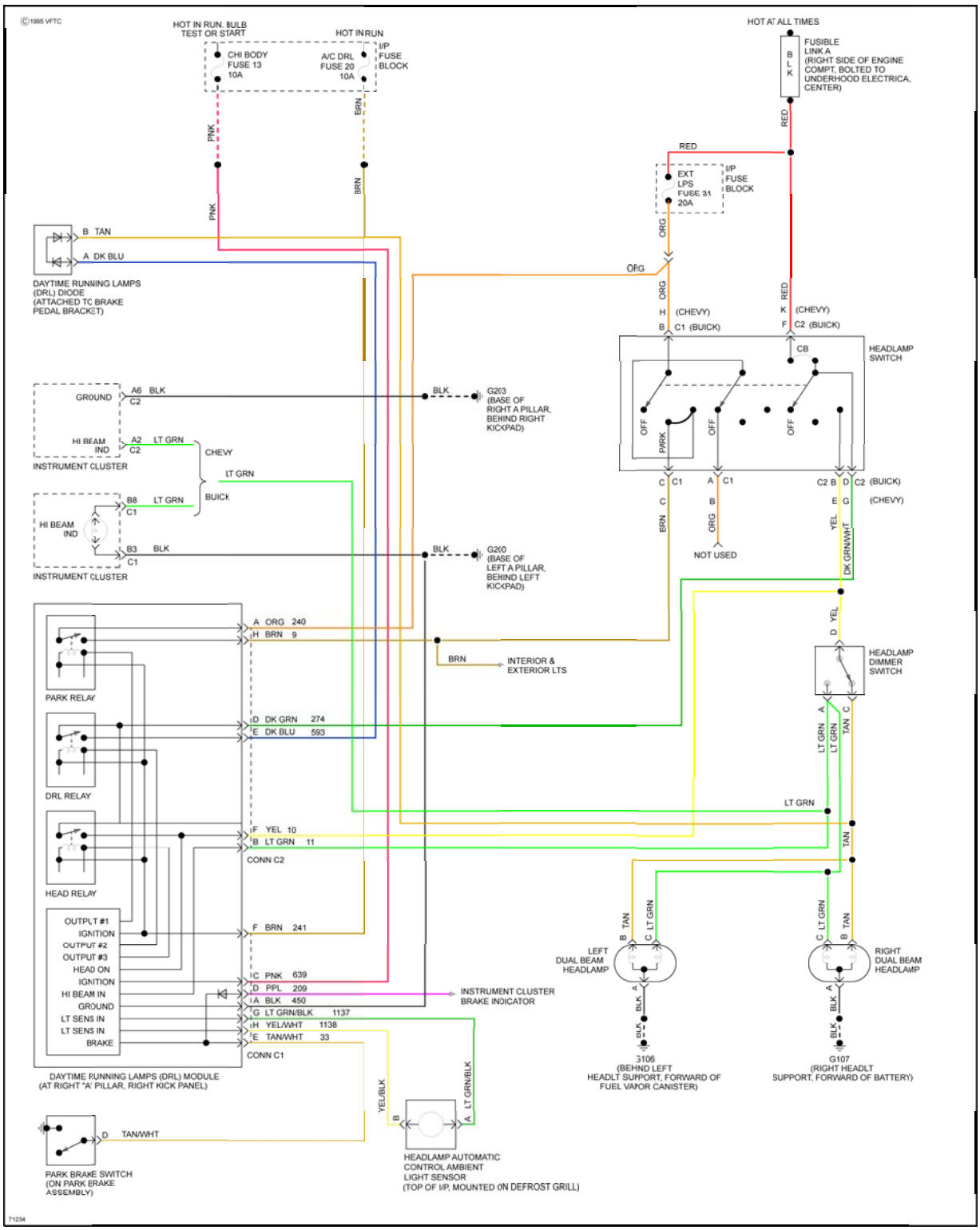


Fig. 20: Headlight Circuit, W/ DRL

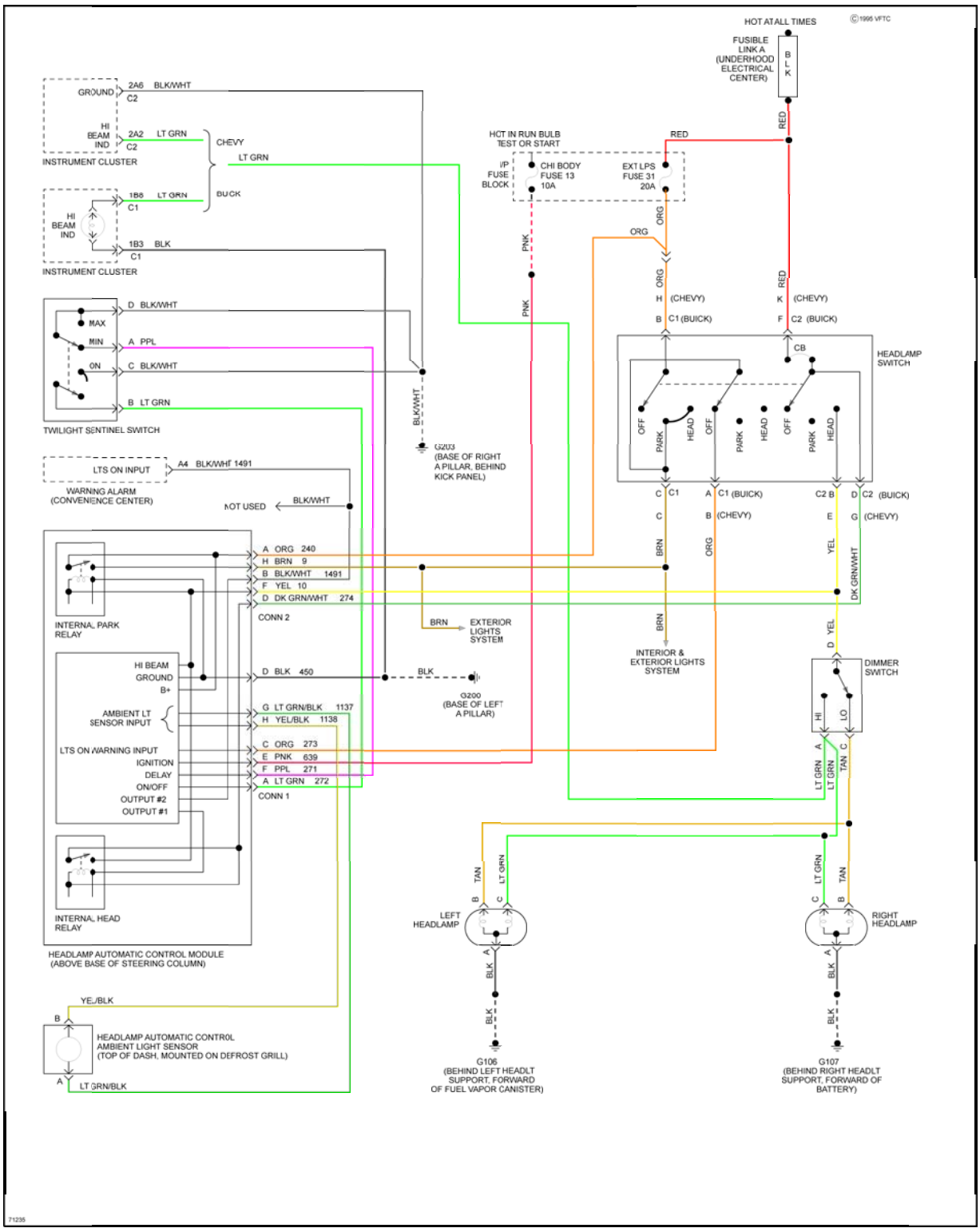


Fig. 21: Headlight Circuit, W/O DRL, W/ Twilight Sentinel

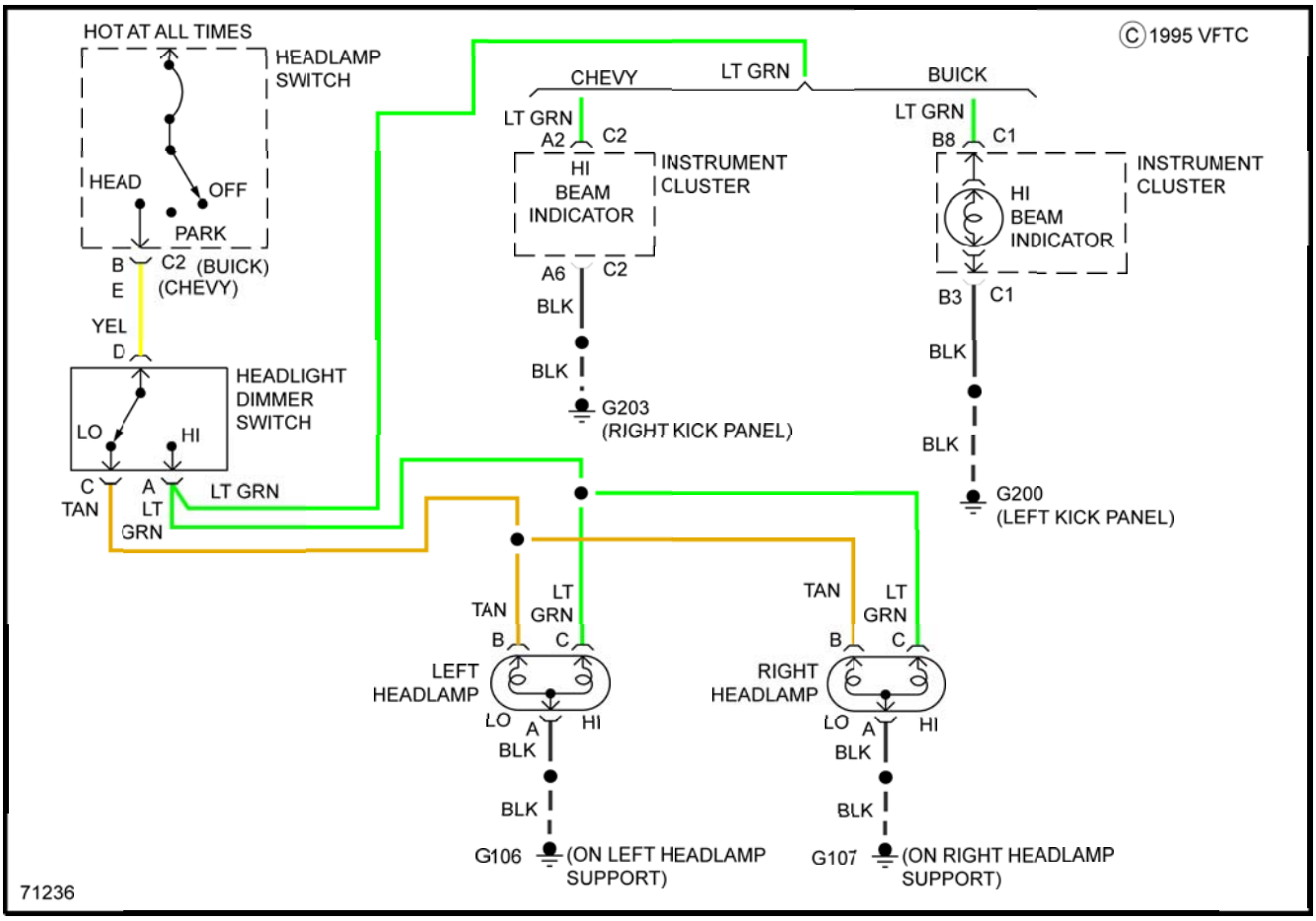


Fig. 22: Headlight Circuit, W/O DRL, W/O Twilight Sentinel

HORN

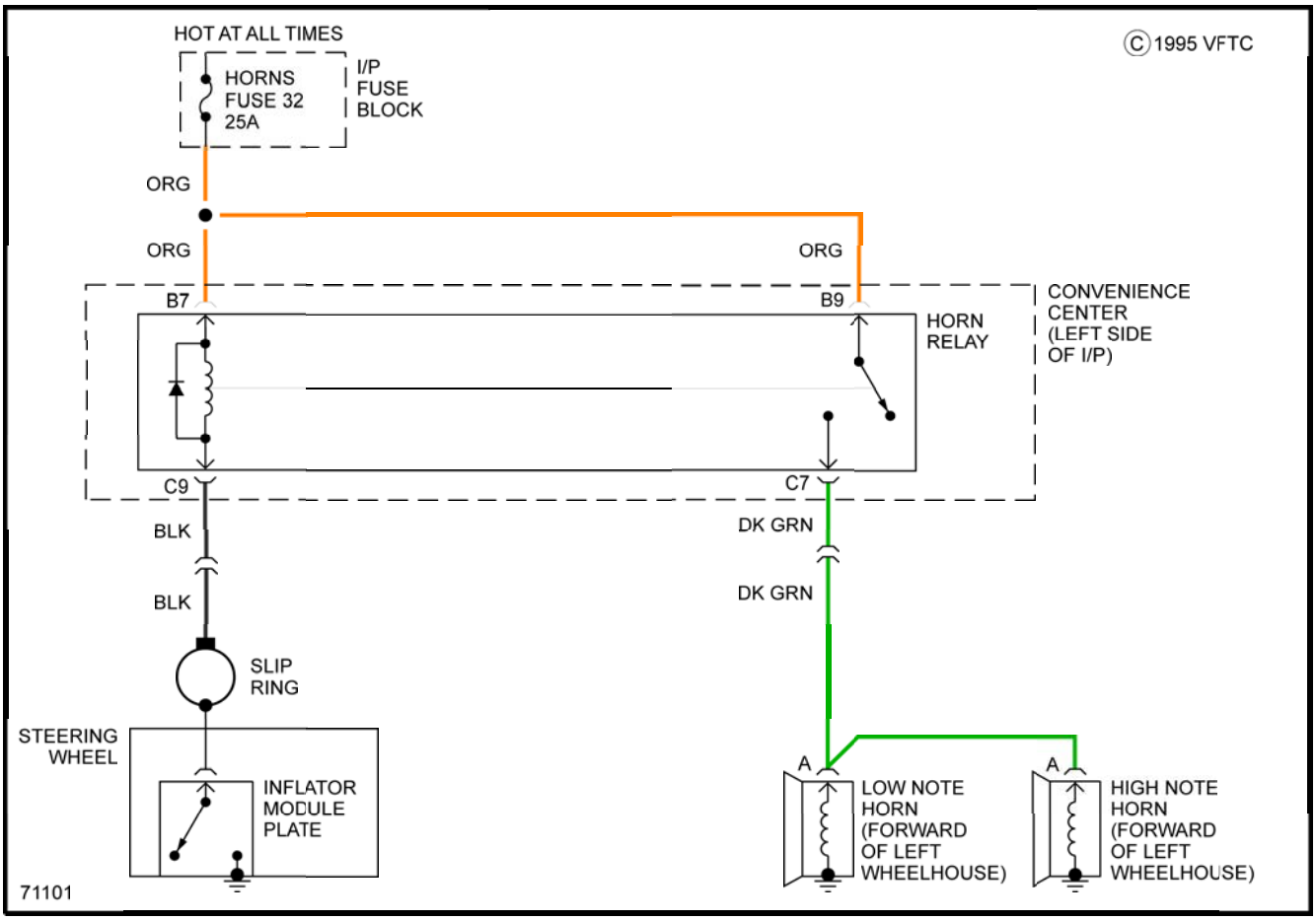


Fig. 23: Horn Circuit

INSTRUMENT CLUSTER

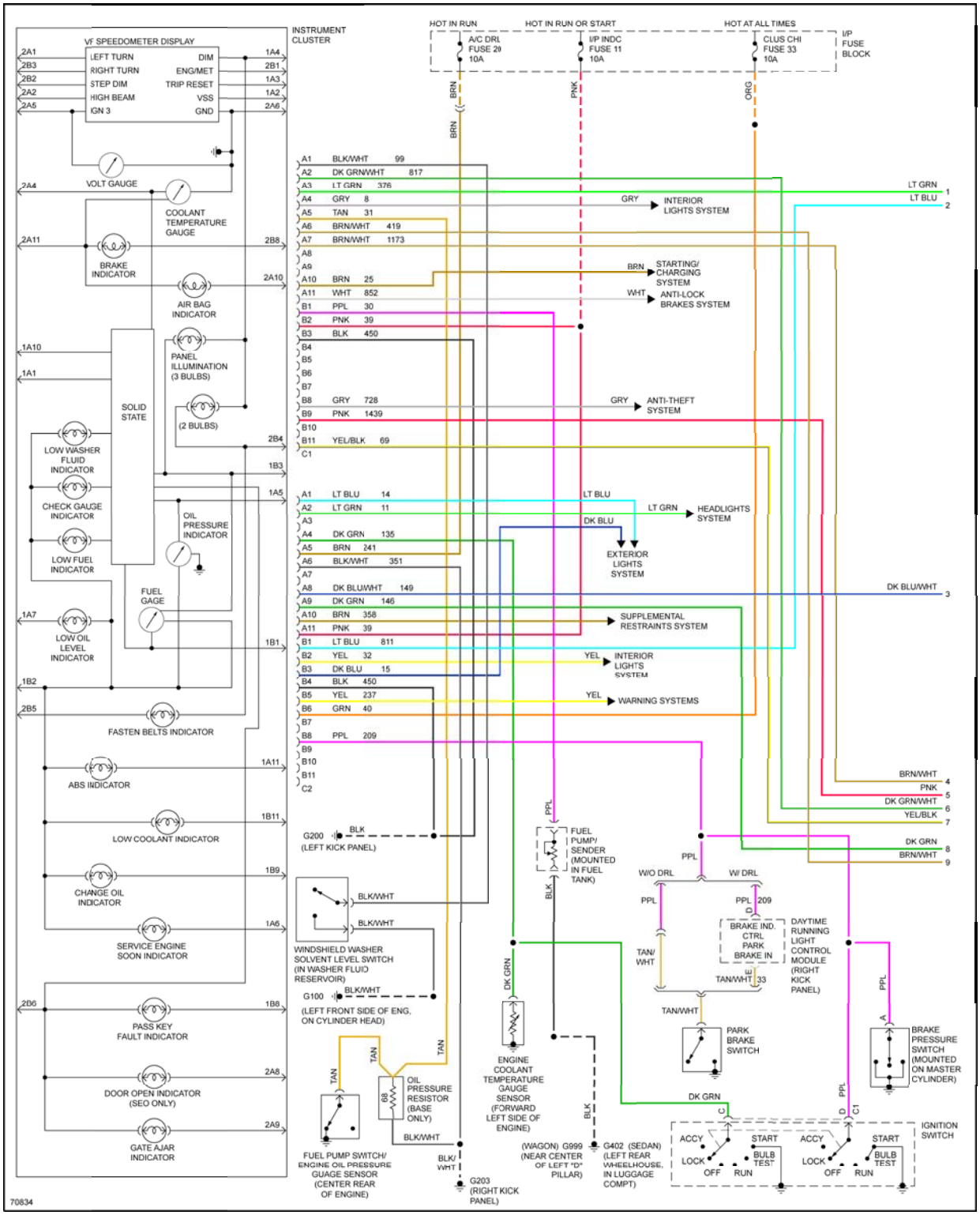


Fig. 24: Instrument Cluster Circuit (1 of 2)

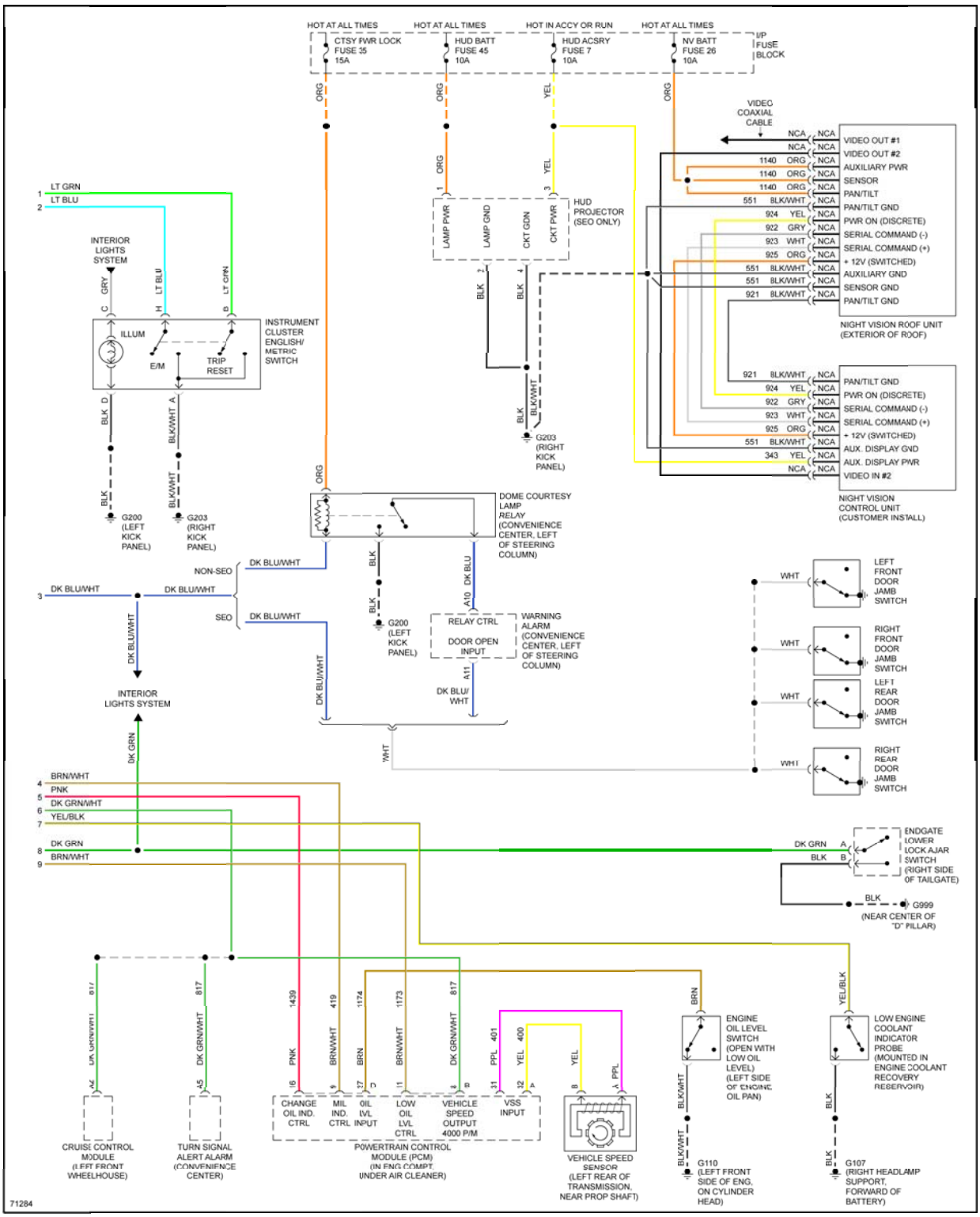


Fig. 25: Instrument Cluster Circuit (2 of 2)

INTERIOR LIGHTS

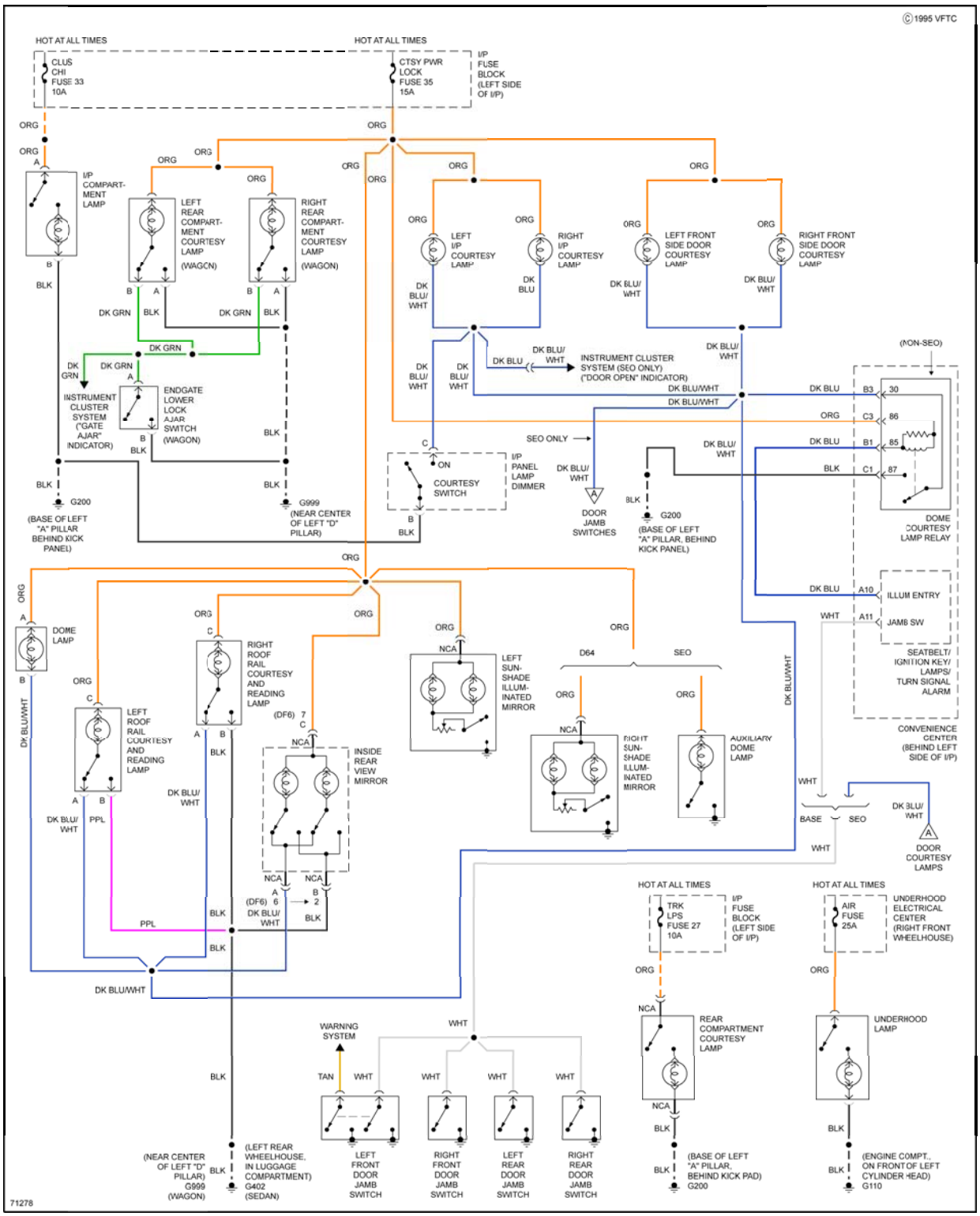


Fig. 26: Courtesy Lamps Circuit

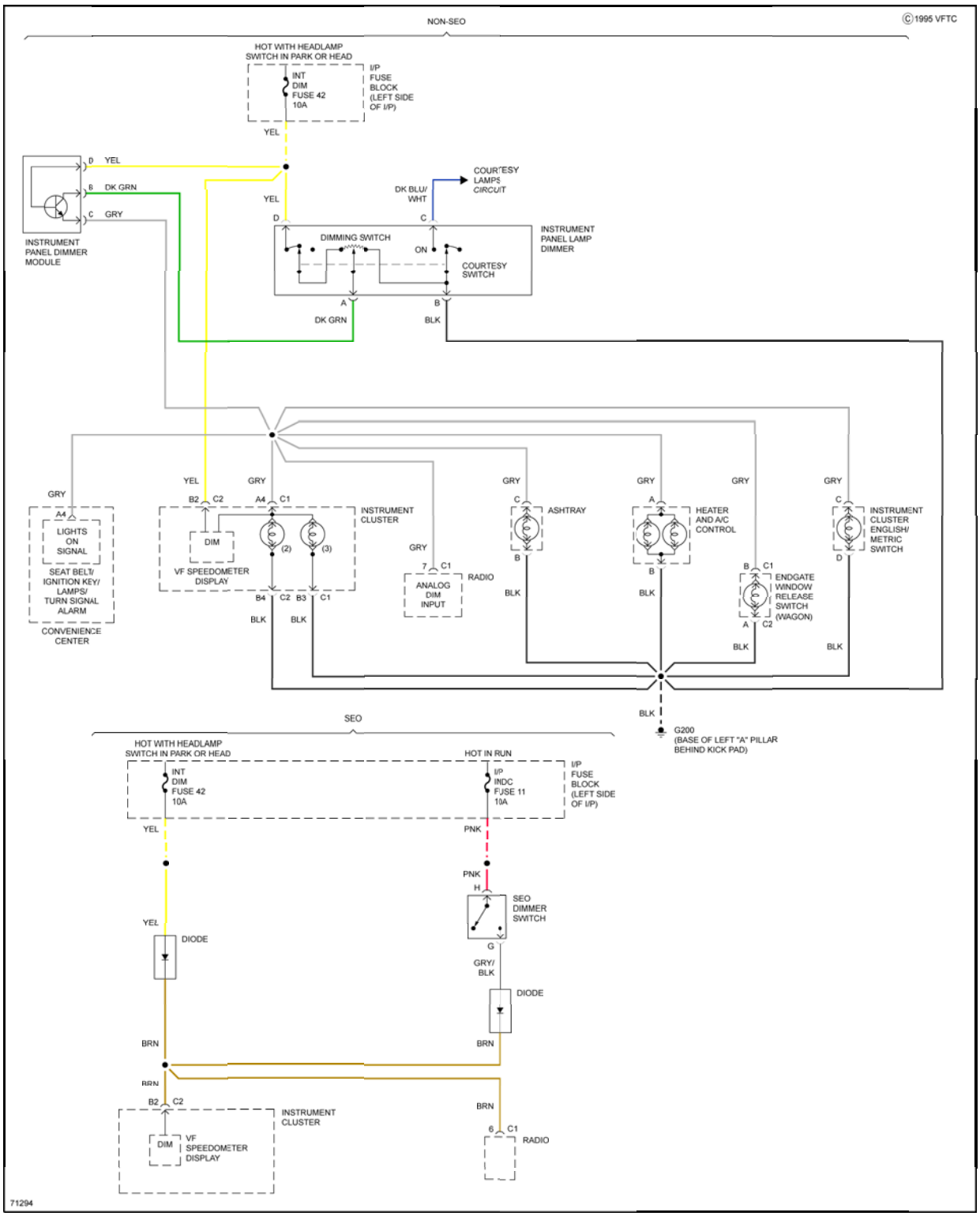


Fig. 27: Instrument Illumination Circuit

POWER ANTENNA

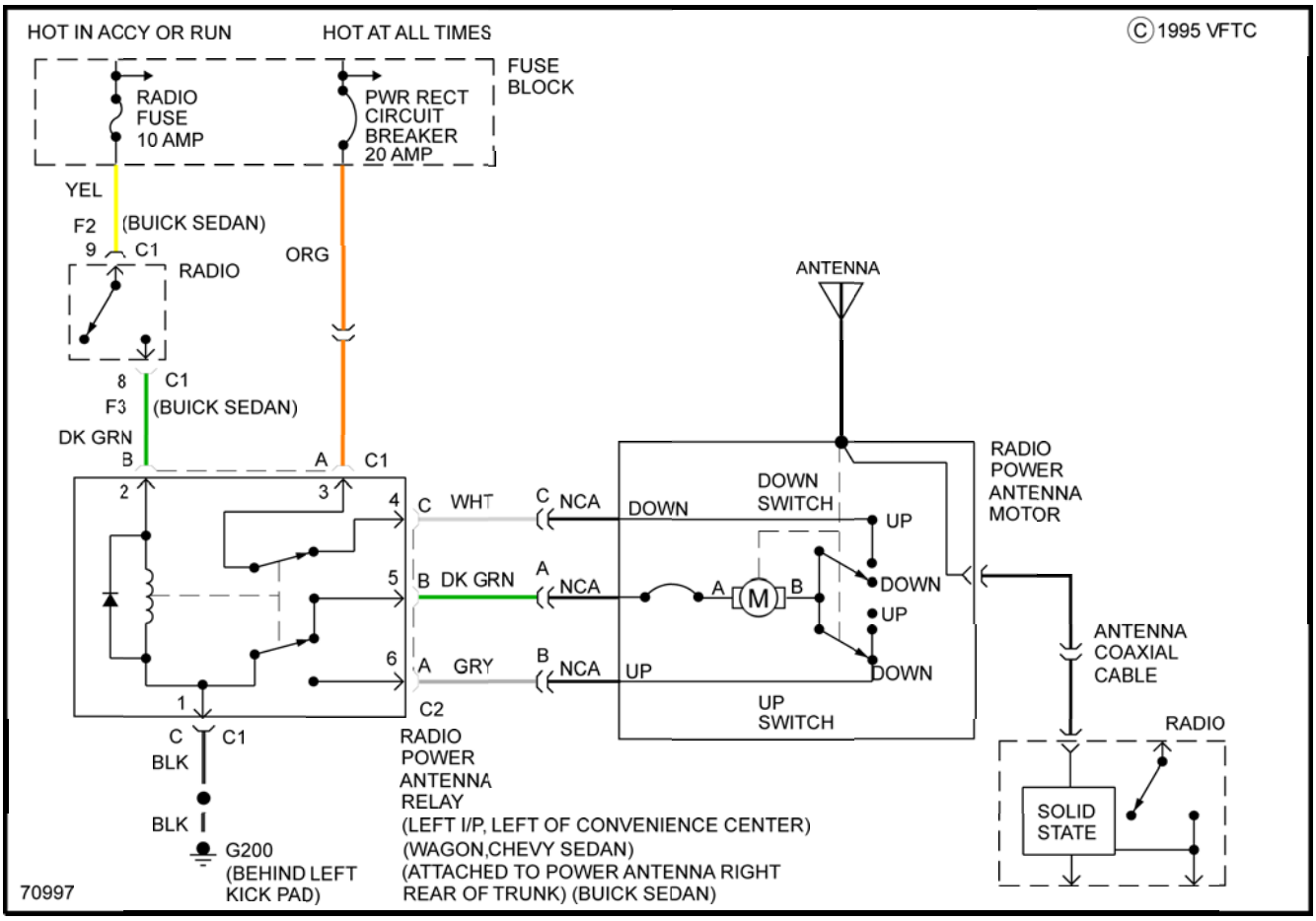


Fig. 28: Power Antenna Circuit

POWER DISTRIBUTION

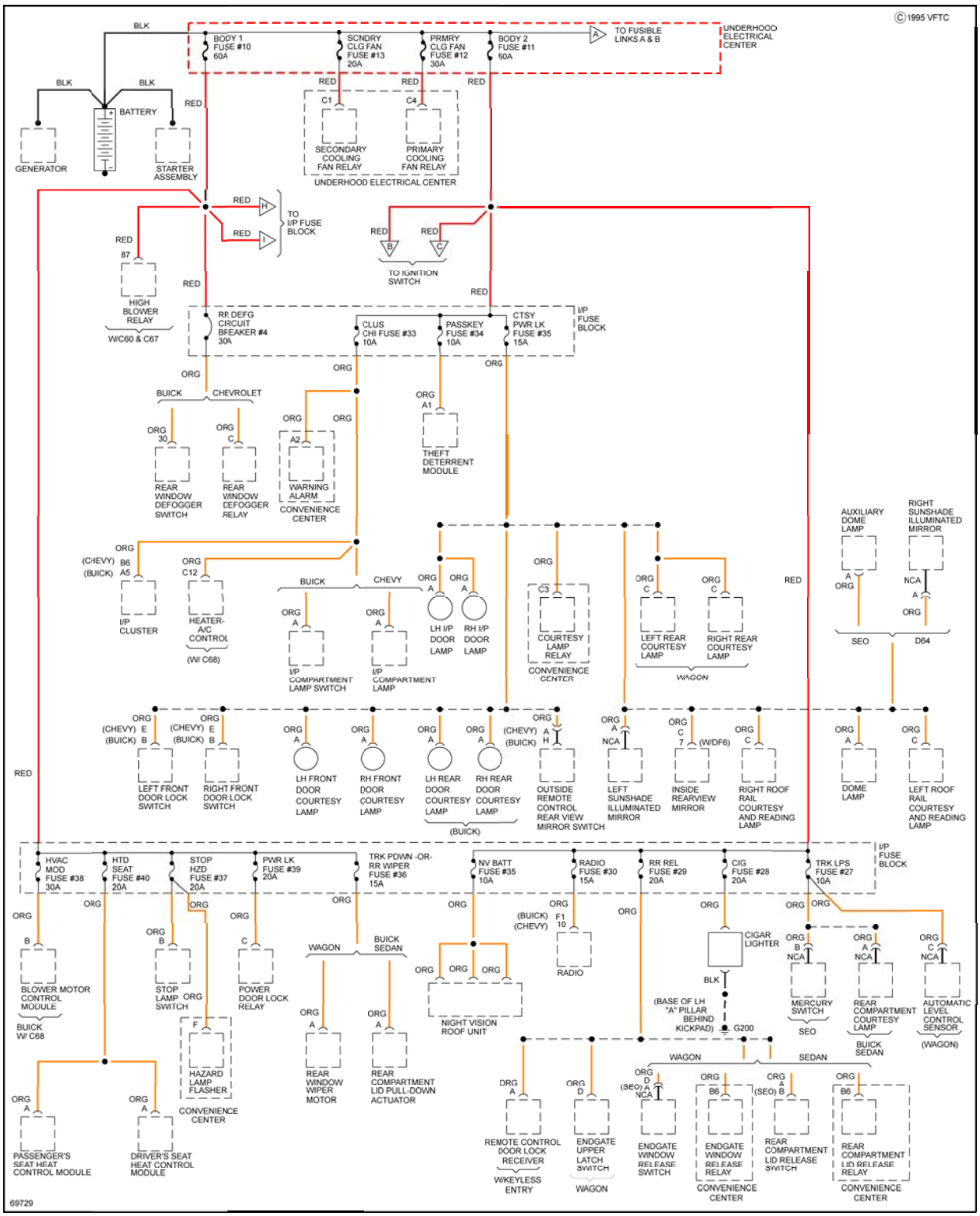


Fig. 29: Power Distribution Circuit (1 of 4)

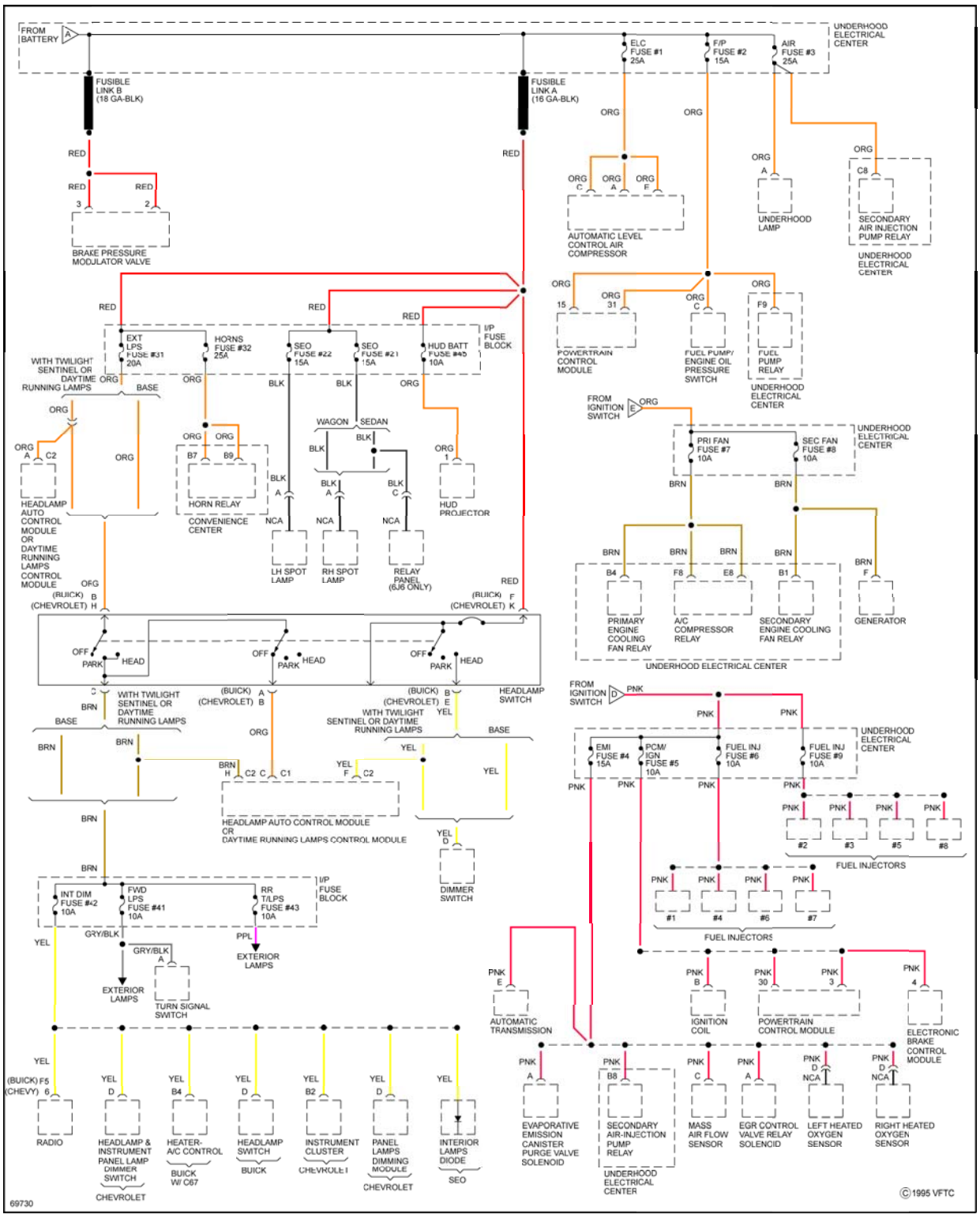


Fig. 30: Power Distribution Circuit (2 of 4)

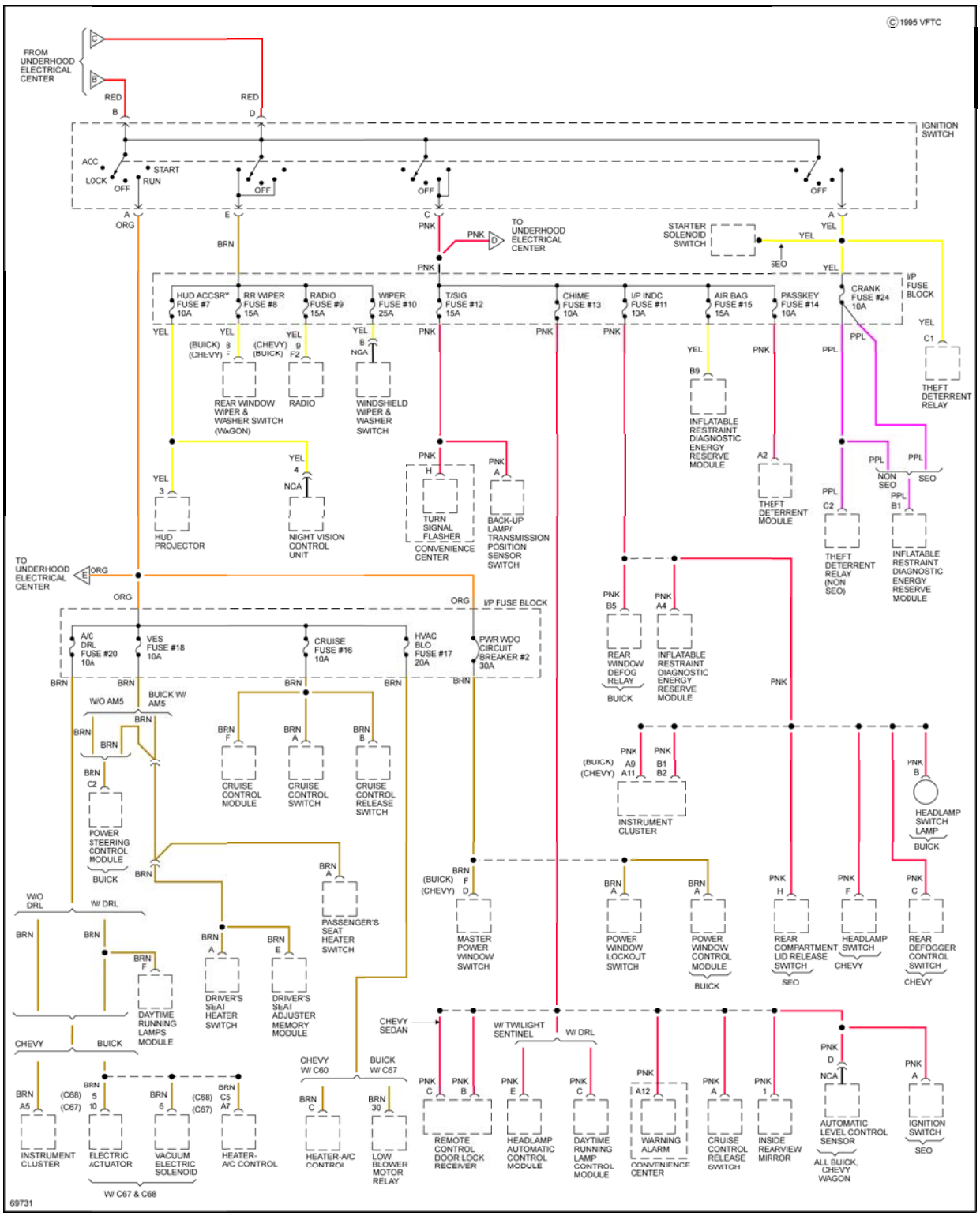


Fig. 31: Power Distribution Circuit (3 of 4)

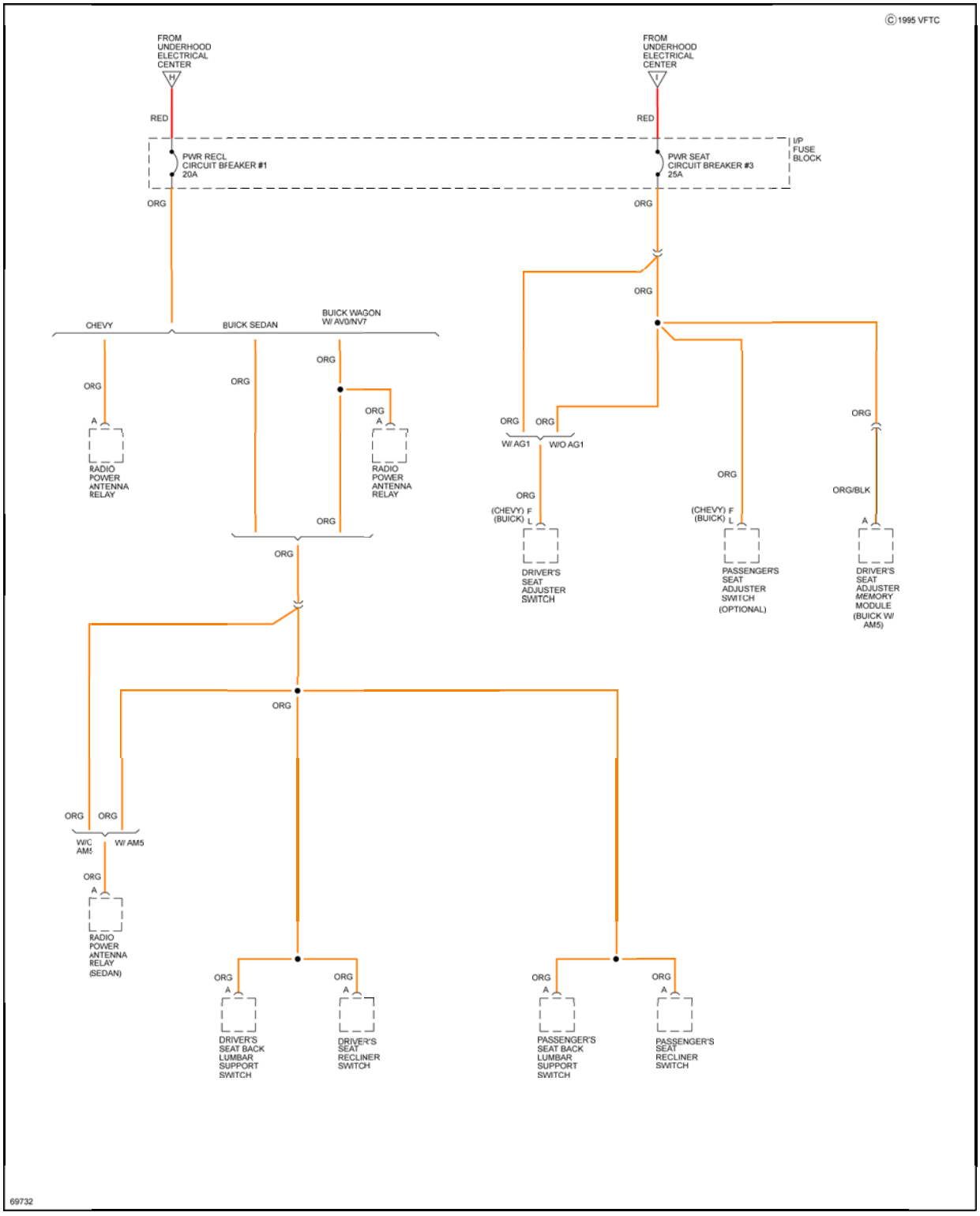


Fig. 32: Power Distribution Circuit (4 of 4)

POWER DOOR LOCKS

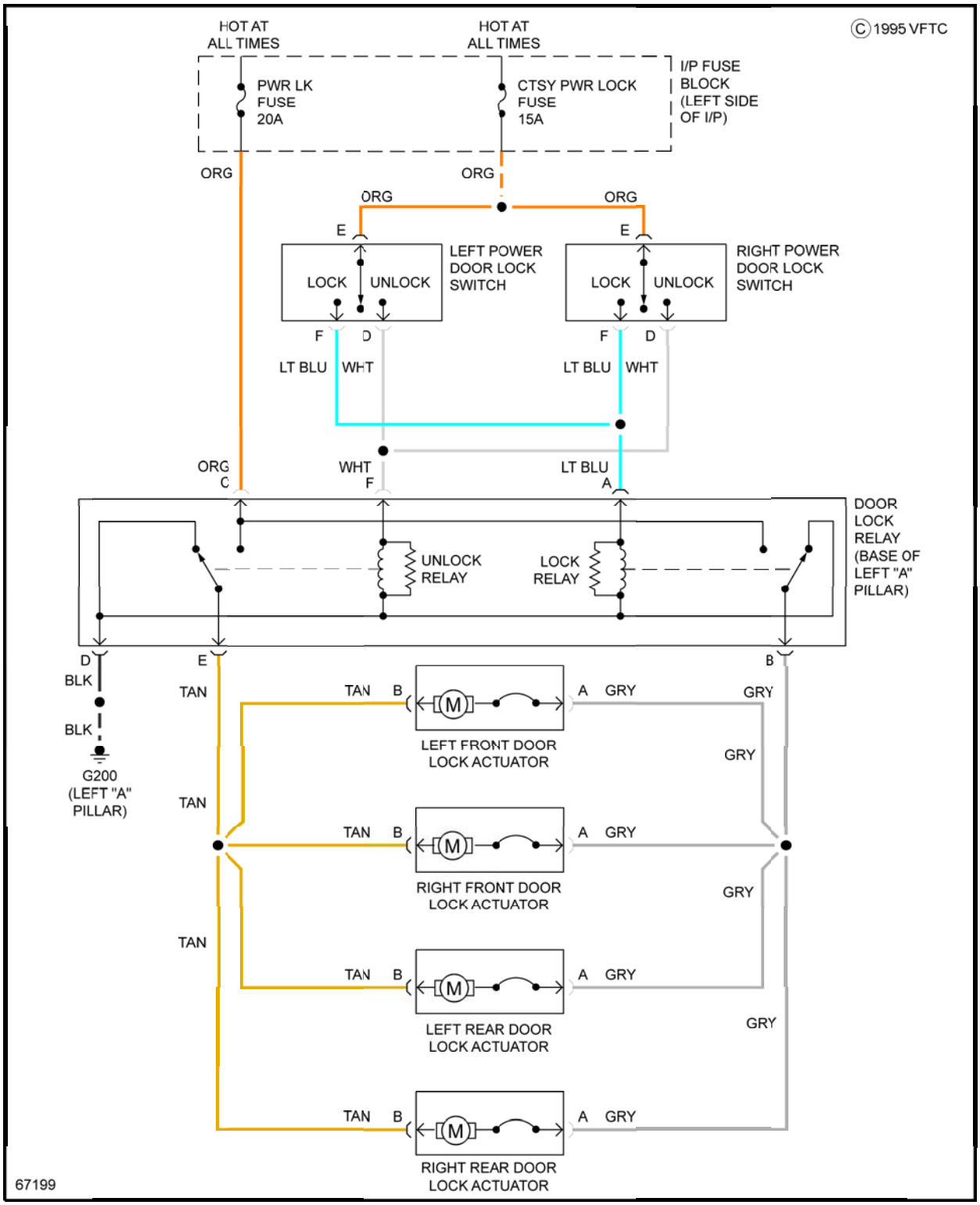


Fig. 33: Door Lock Circuit

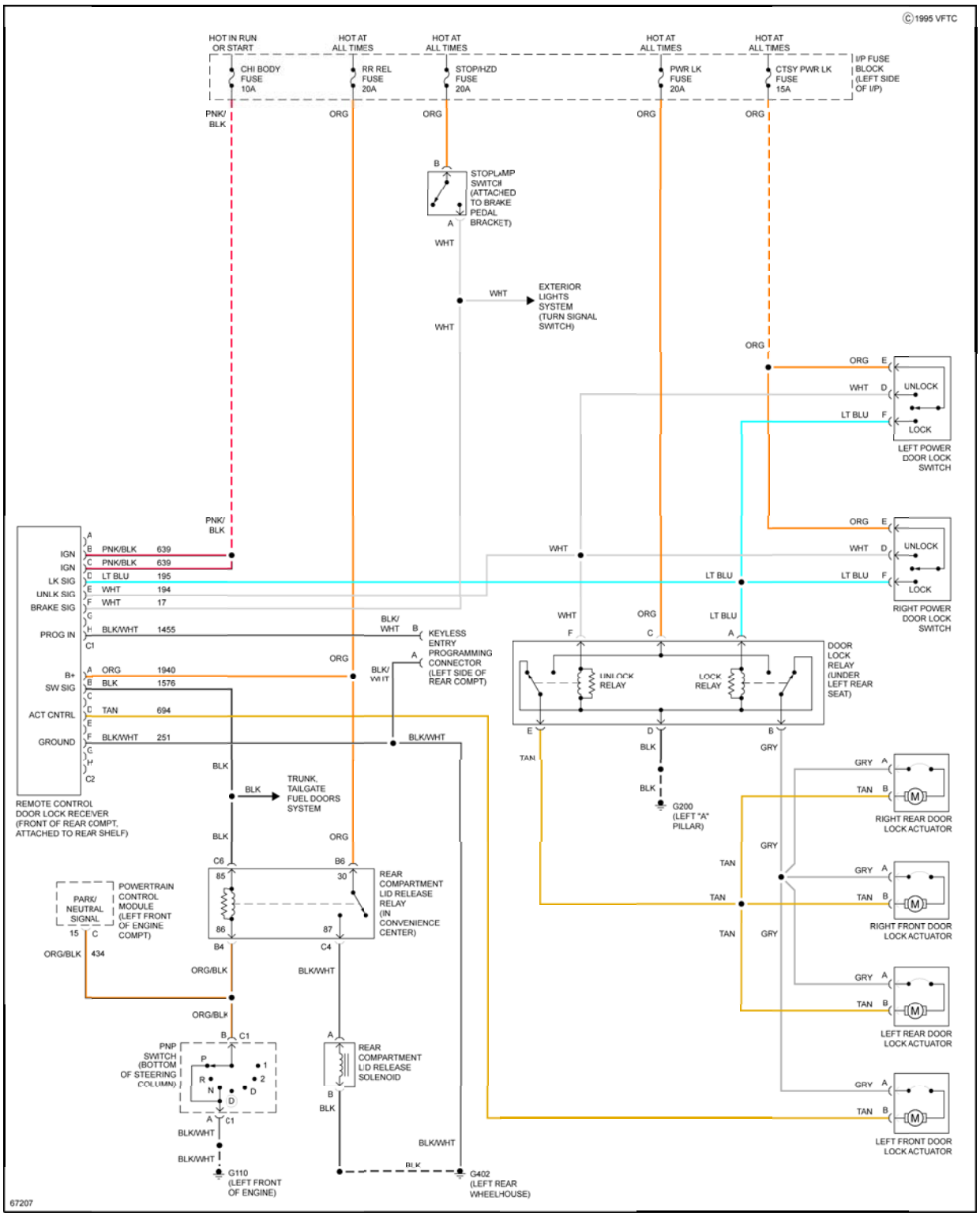


Fig. 34: Keyless Entry Circuit

POWER MIRRORS

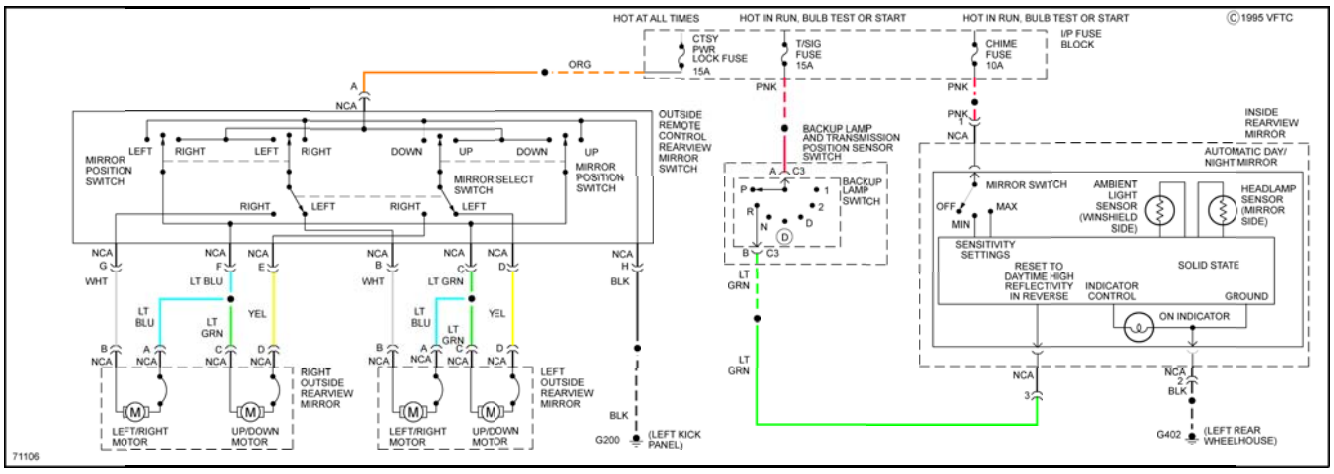


Fig. 35: Power Mirror Circuit

POWER SEATS

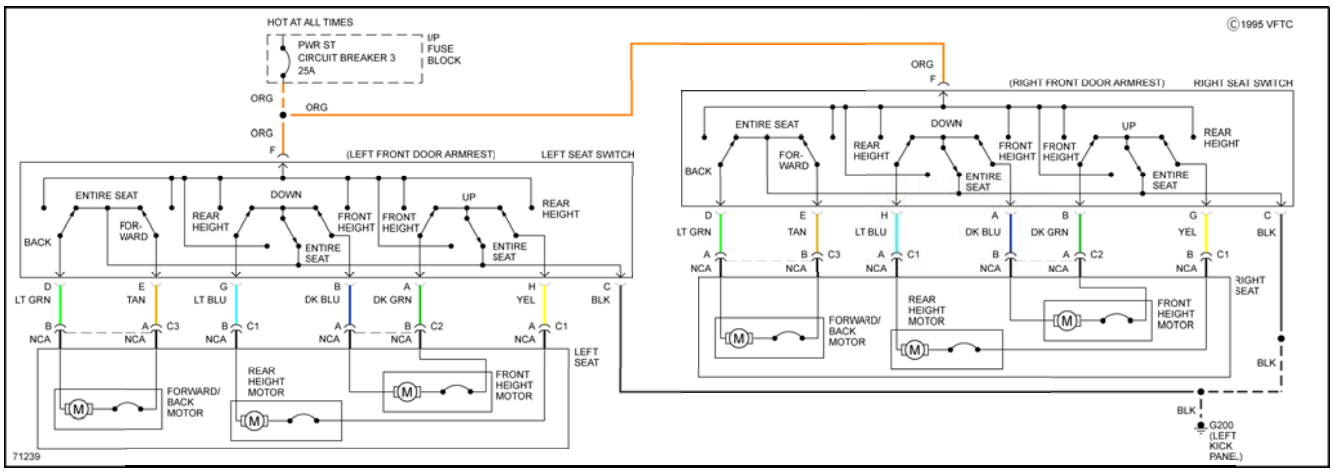


Fig. 36: 6-Way Power Seat Circuit

POWER WINDOWS

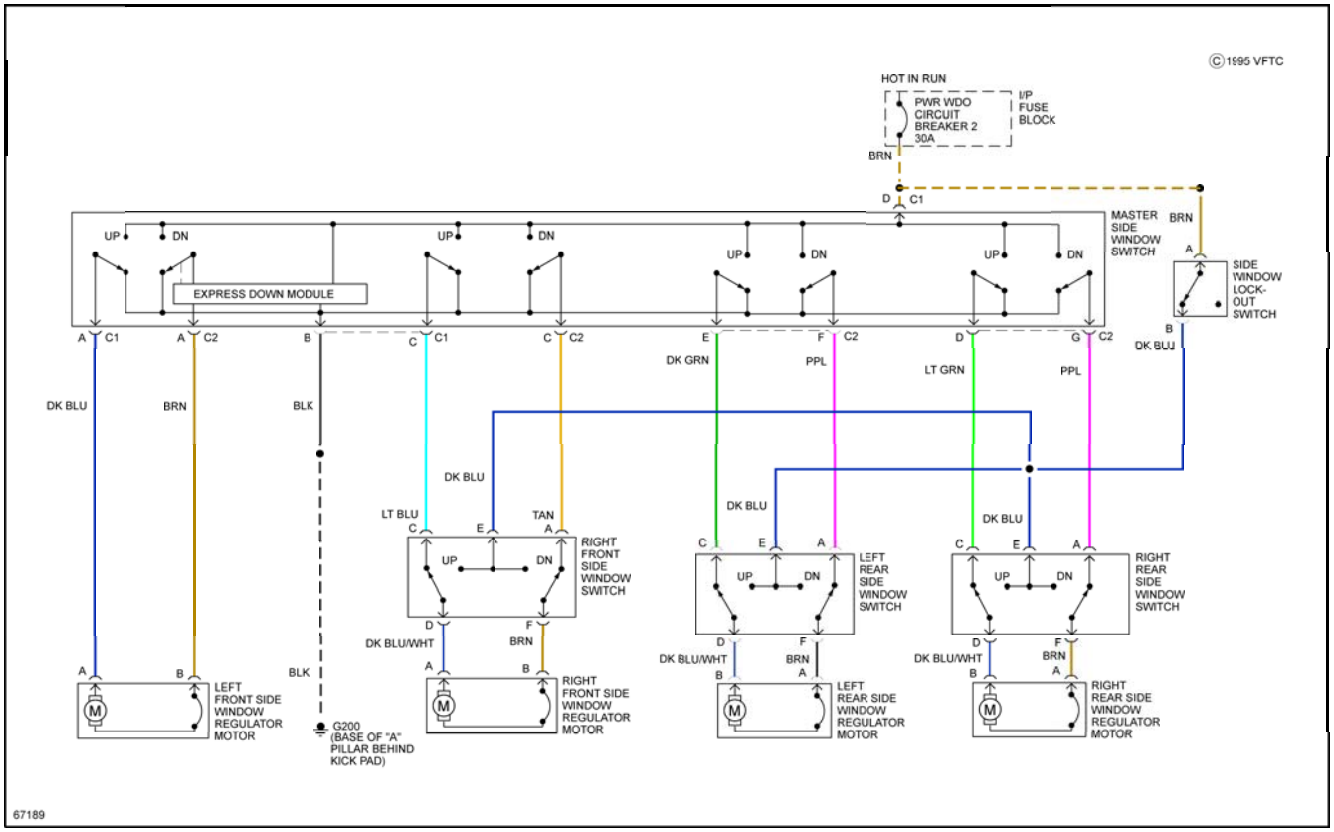


Fig. 37: Power Window Circuit

SHIFT INTERLOCKS

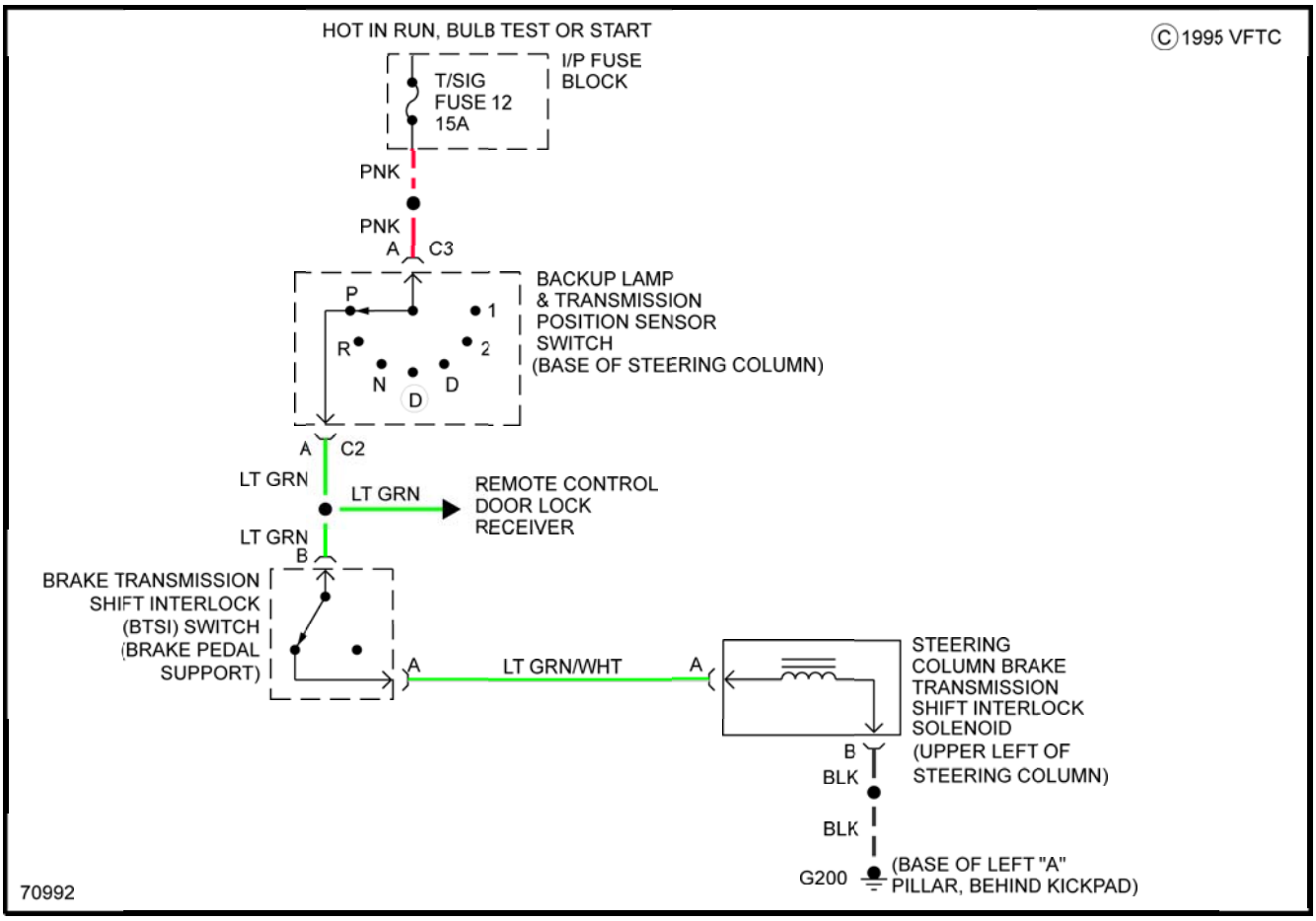


Fig. 38: Shift Interlock Circuit

STARTING/CHARGING

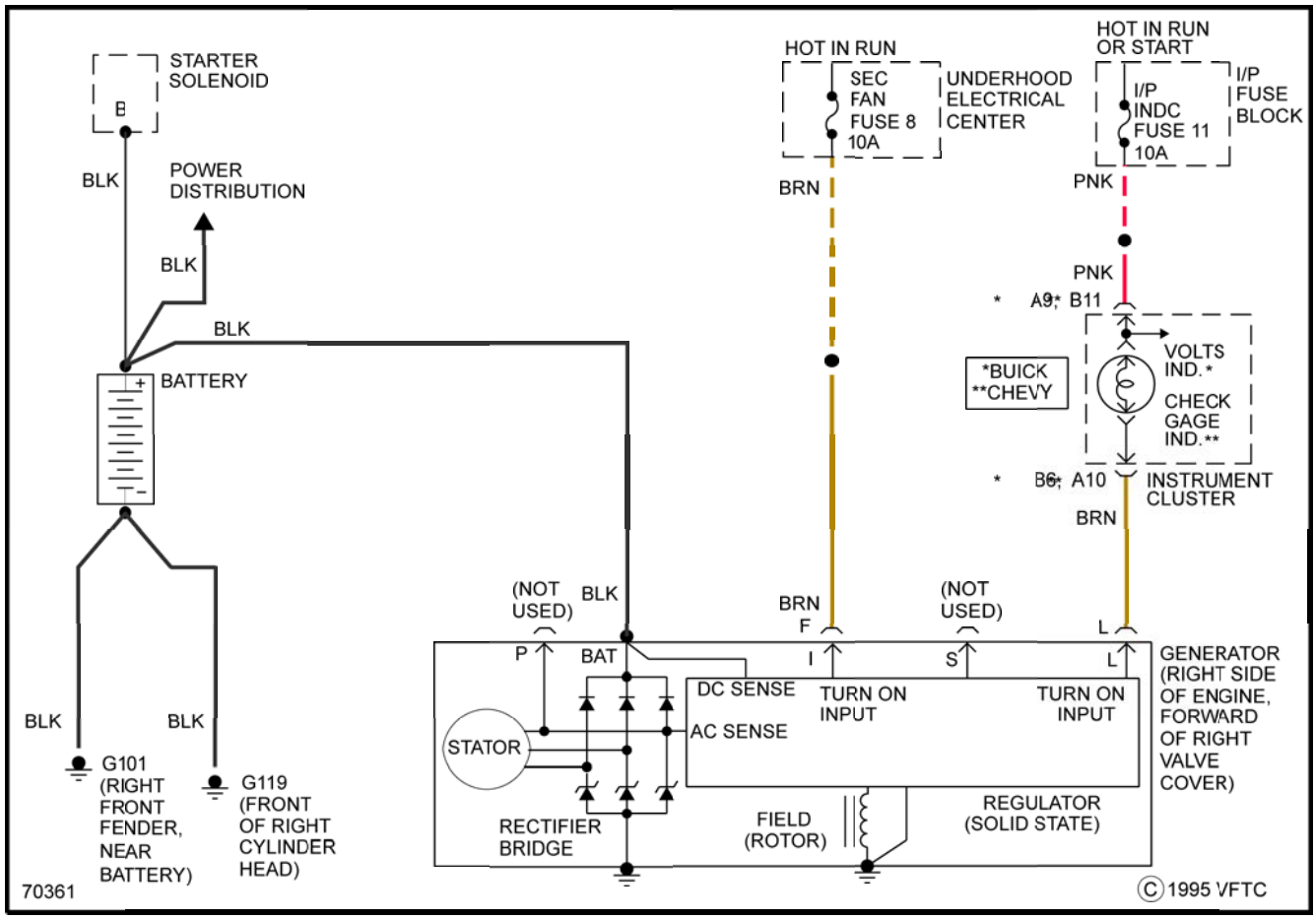


Fig. 39: Charging Circuit

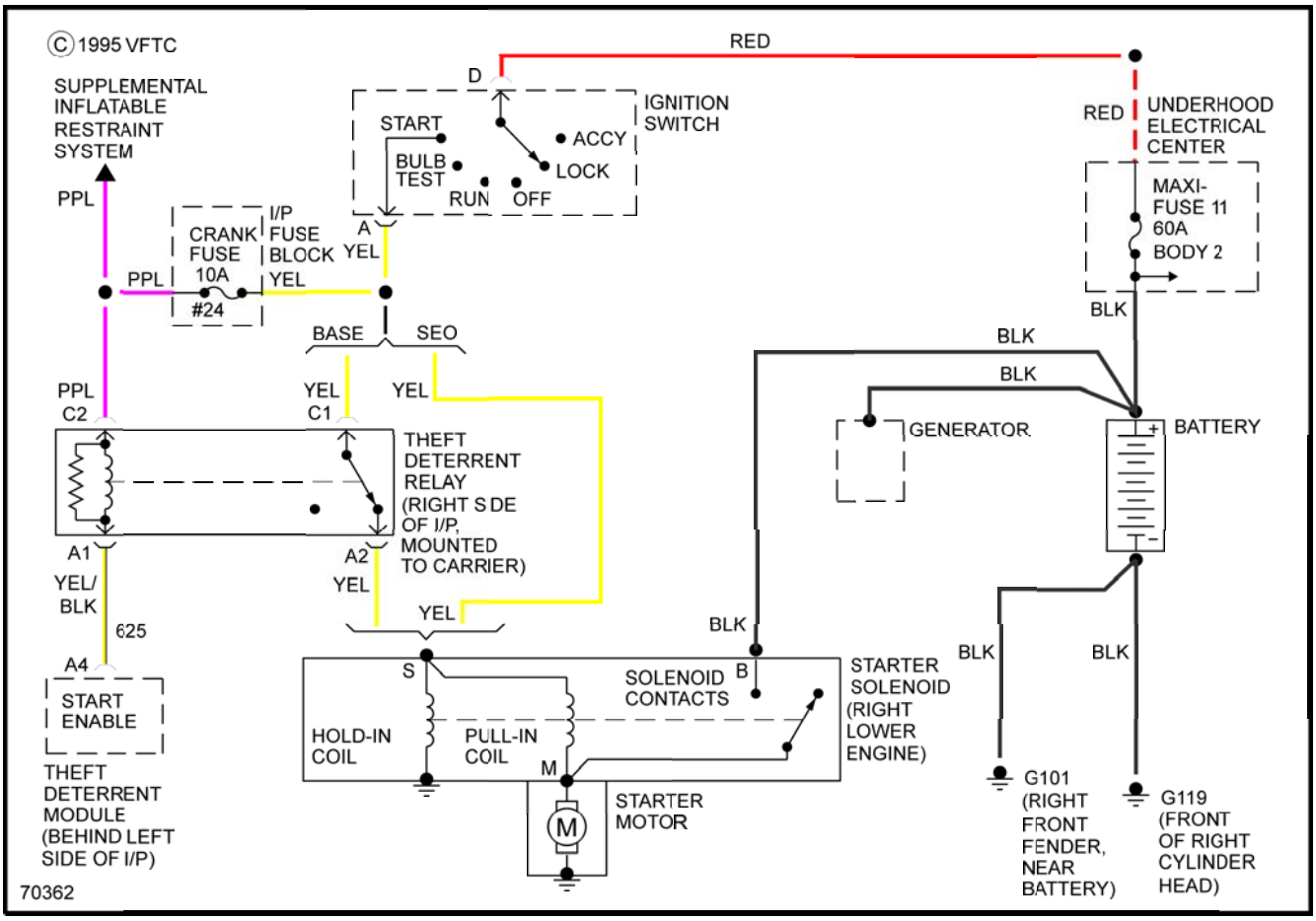


Fig. 40: Starting Circuit

SUPPLEMENTAL RESTRAINTS

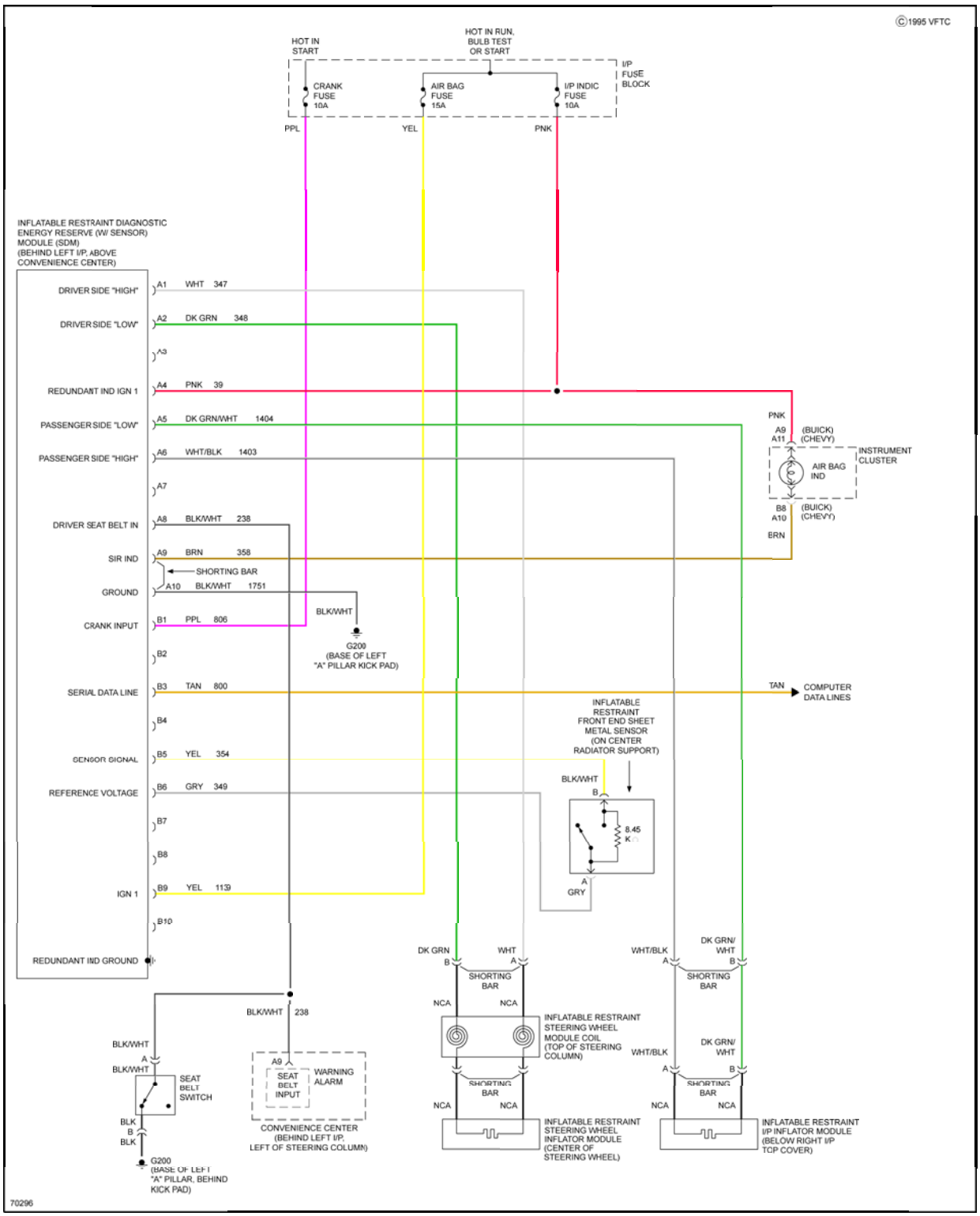


Fig. 41: Supplemental Restraint Circuit

TRANSMISSION

5.7L

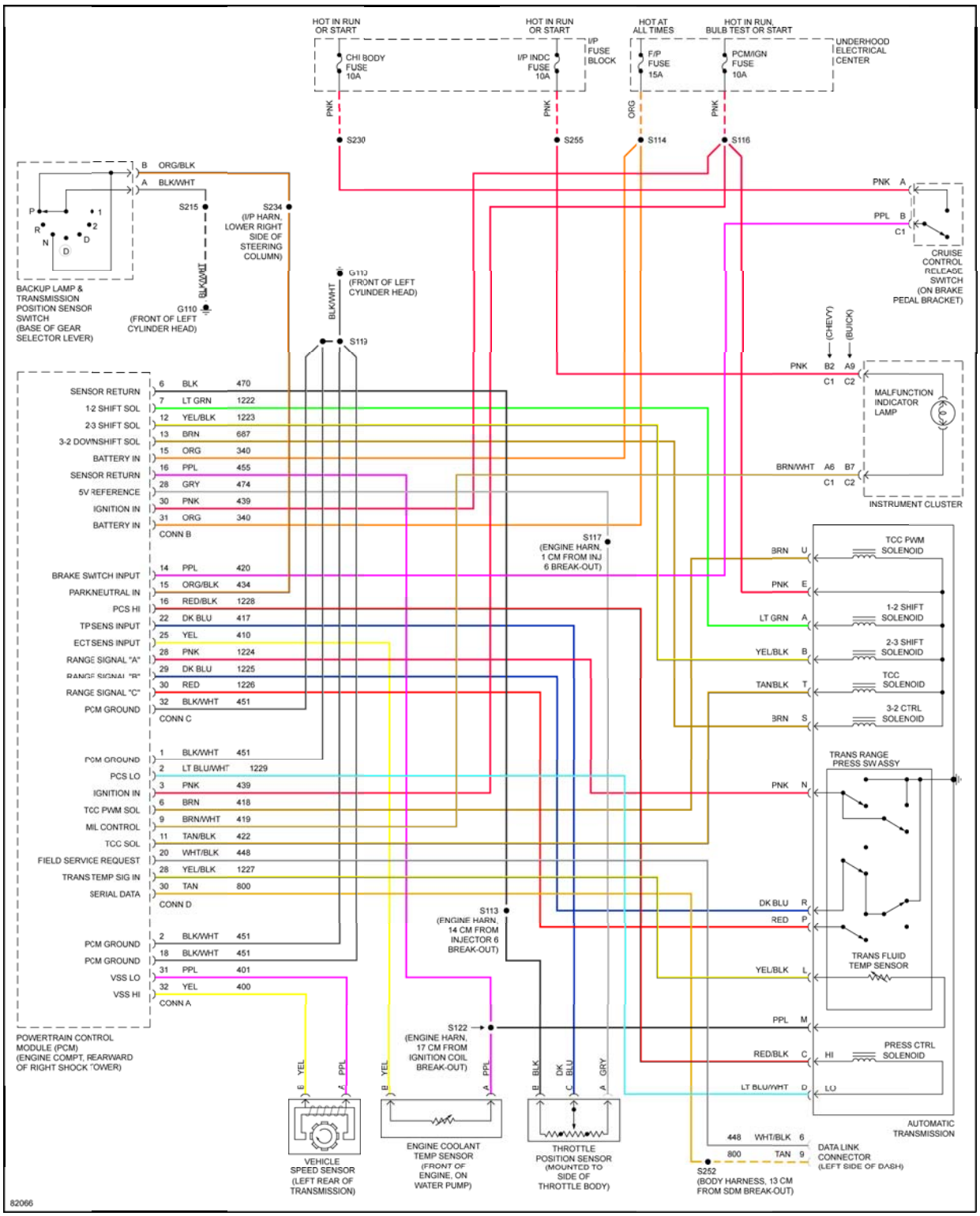


Fig. 42: 5.7L (VIN P), Transmission Circuit

TRUNK, TAILGATE, FUEL DOOR

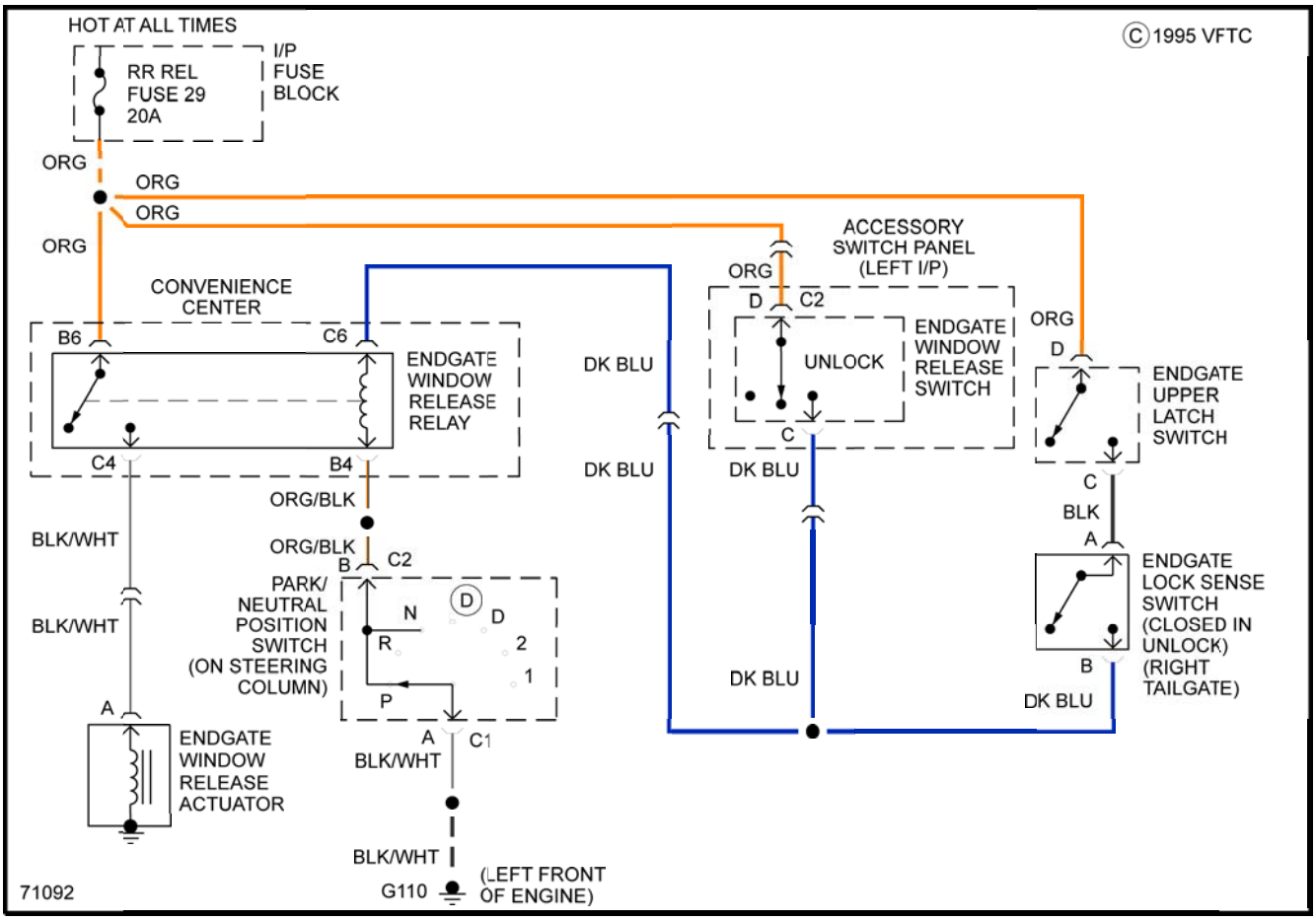


Fig. 43: Rear Glass Release Circuit, W/O Keyless Entry

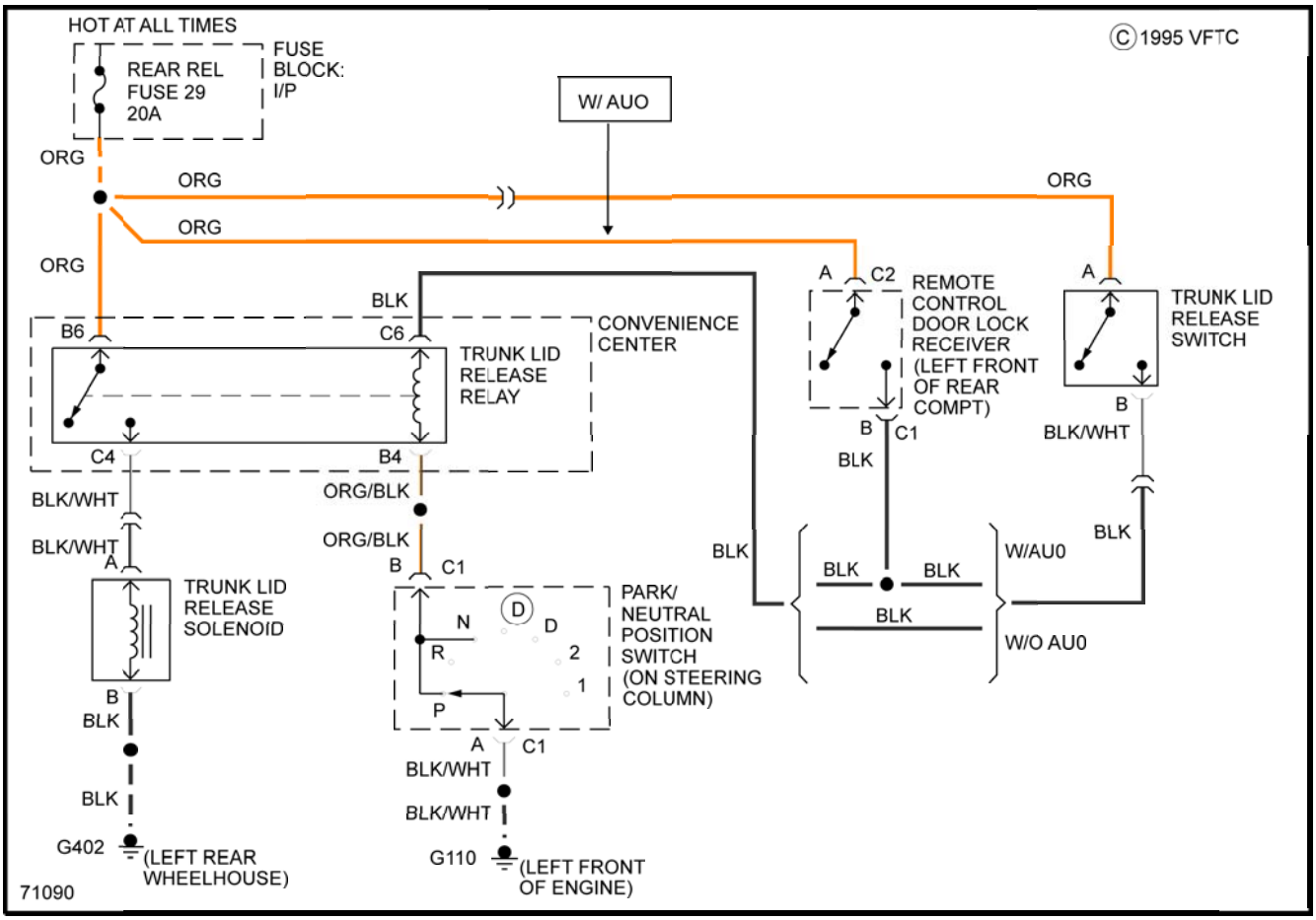


Fig. 44: Trunk Release Circuit, W/ Keyless Entry & SEO

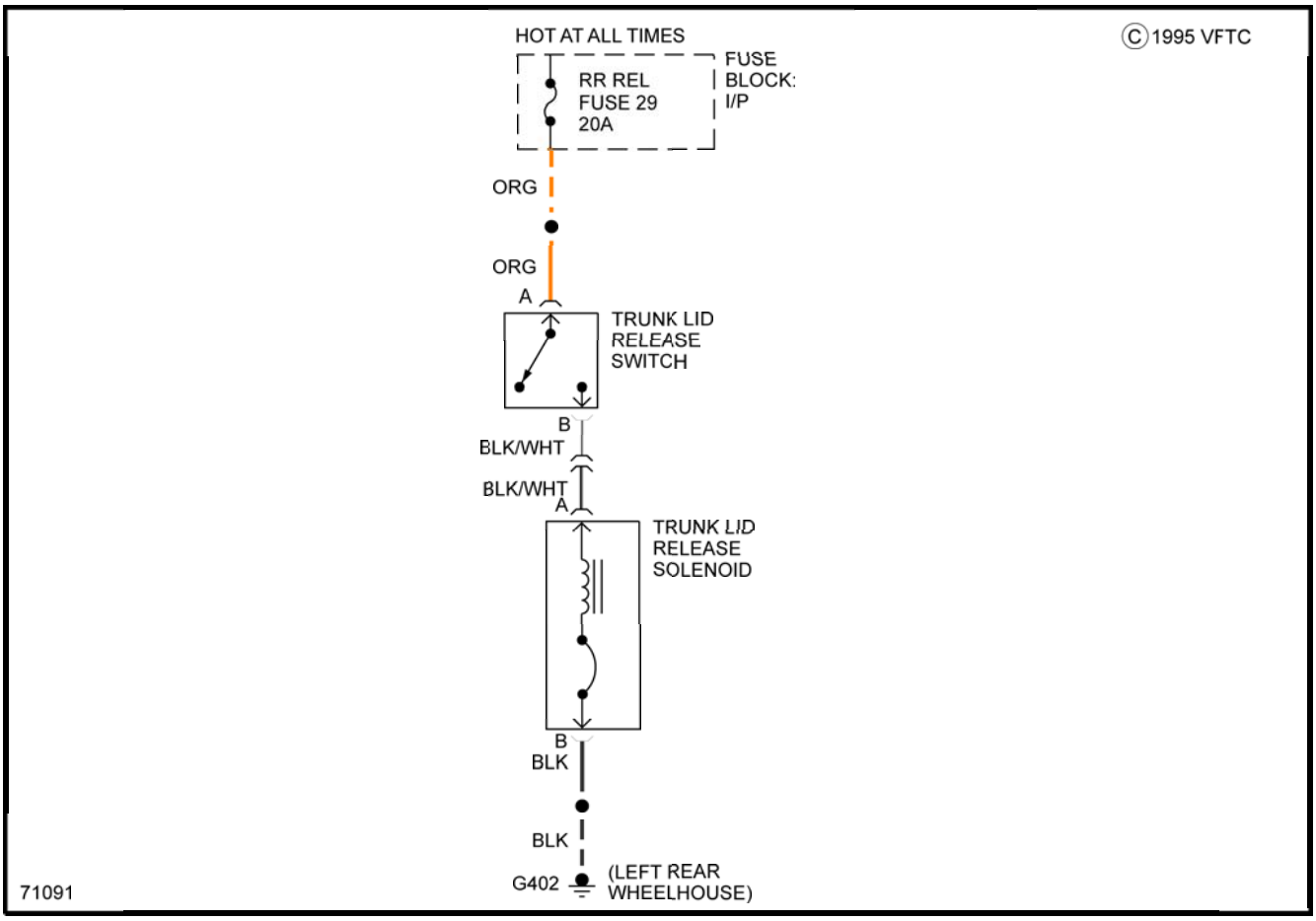


Fig. 45: Trunk Release Circuit, W/O Keyless Entry & SEO

WARNING SYSTEMS

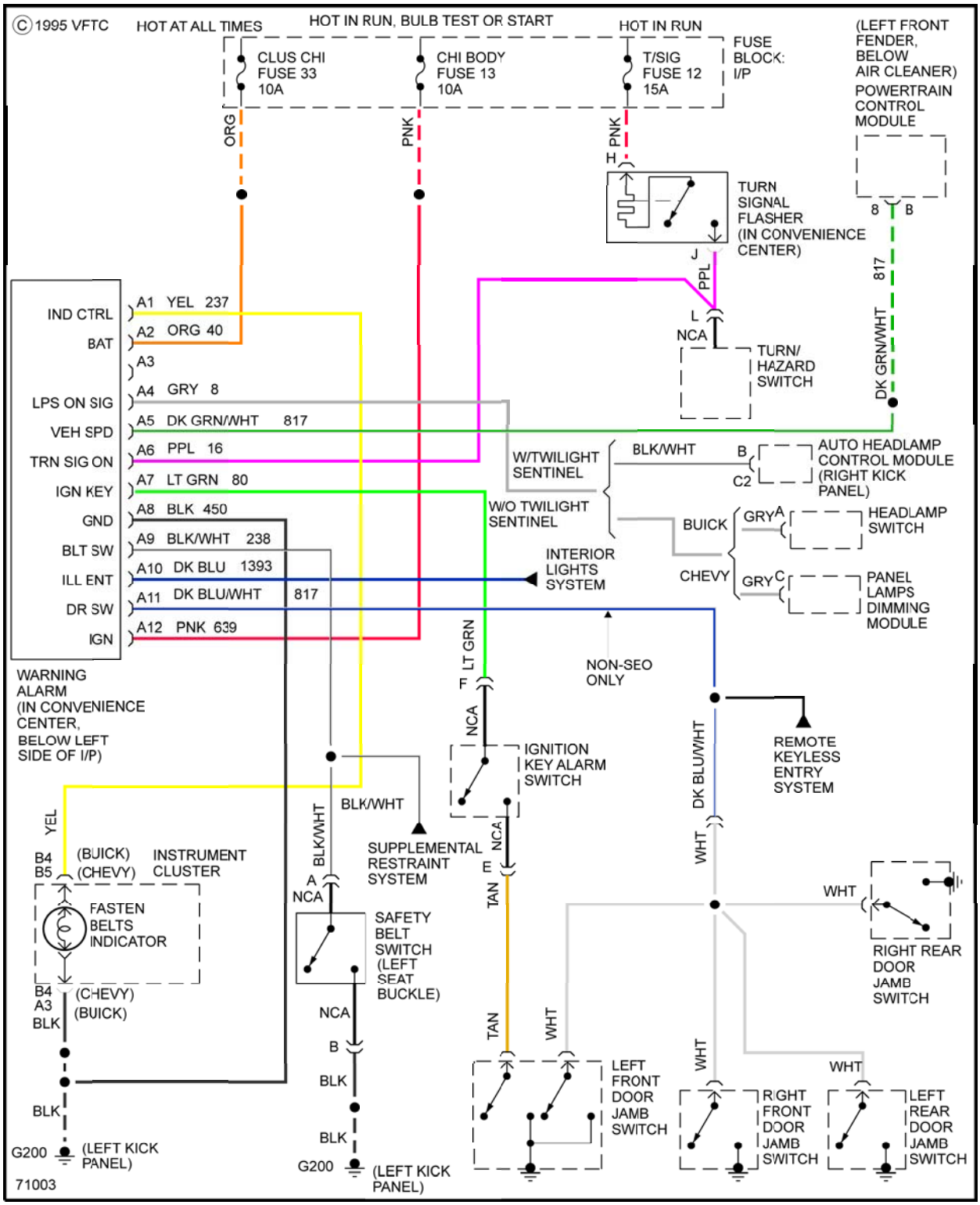


Fig. 46: Warning System Circuits

WIPER/WASHER

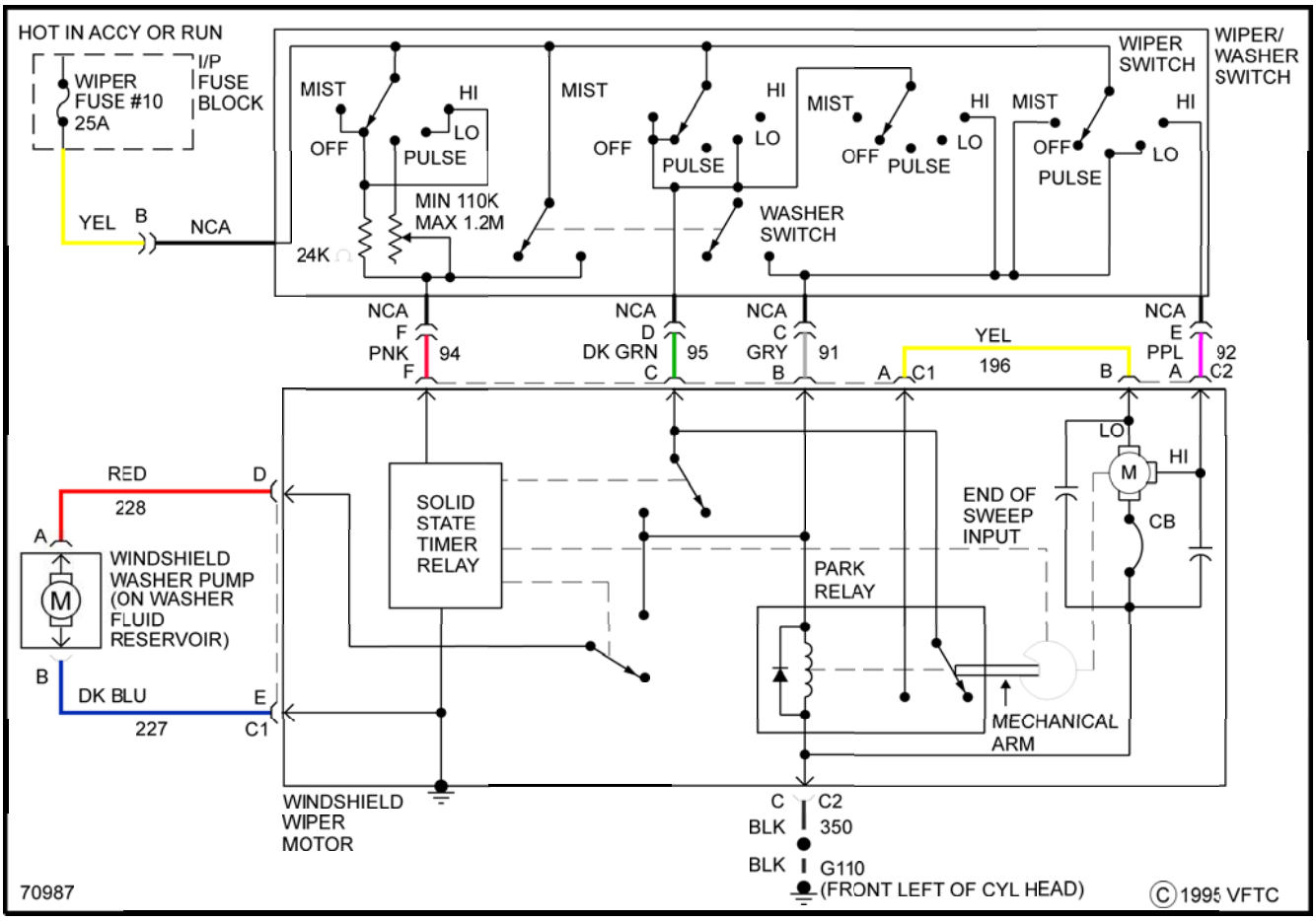


Fig. 47: Front Wiper/Washer Circuit

System Wiring Diagrams

Chevrolet - Caprice

AIR CONDITIONING

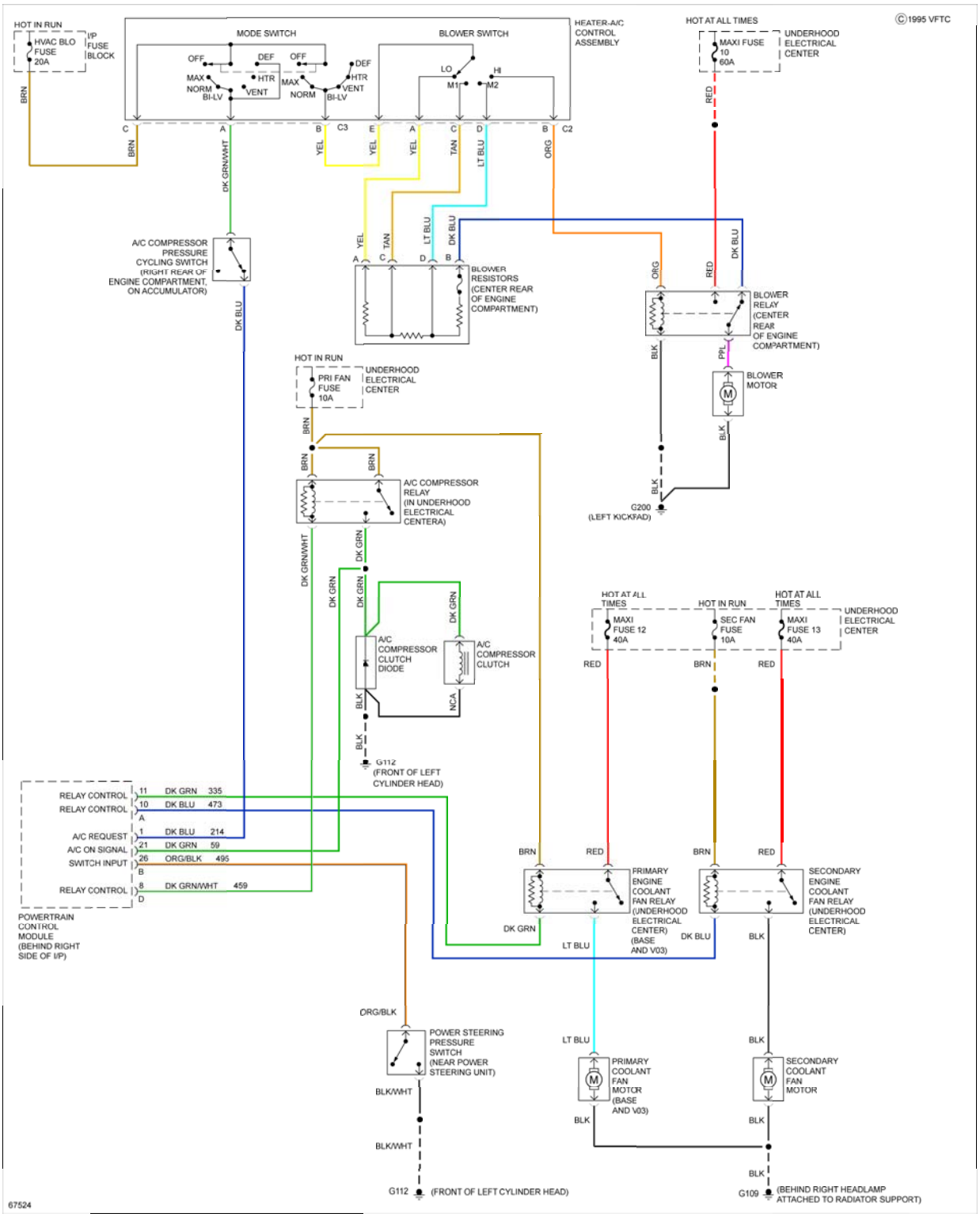


Fig. 1: Air Conditioning Circuits

ANTI-LOCK BRAKES

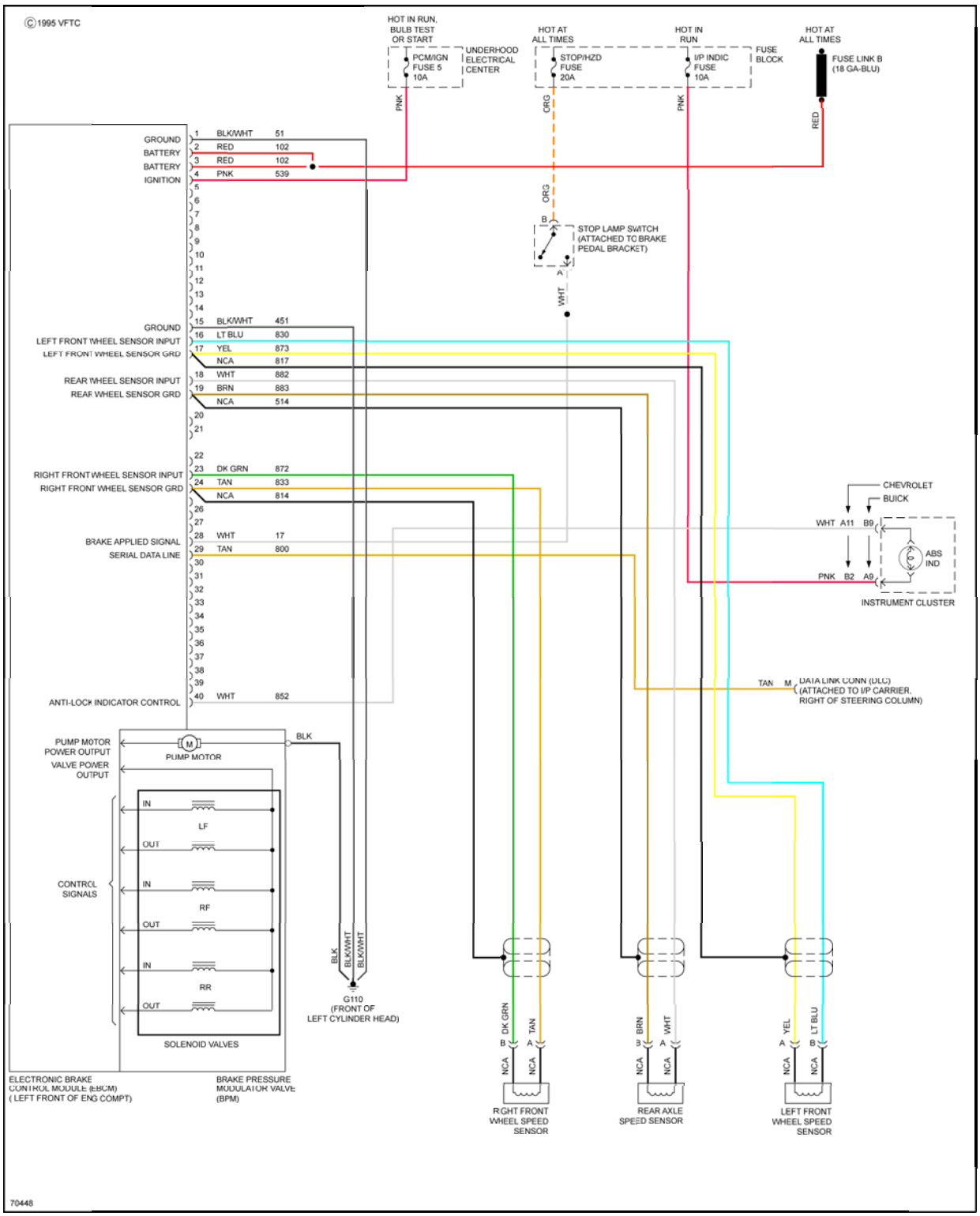


Fig. 2: Anti-lock Brake Circuits

ANTI-THEFT

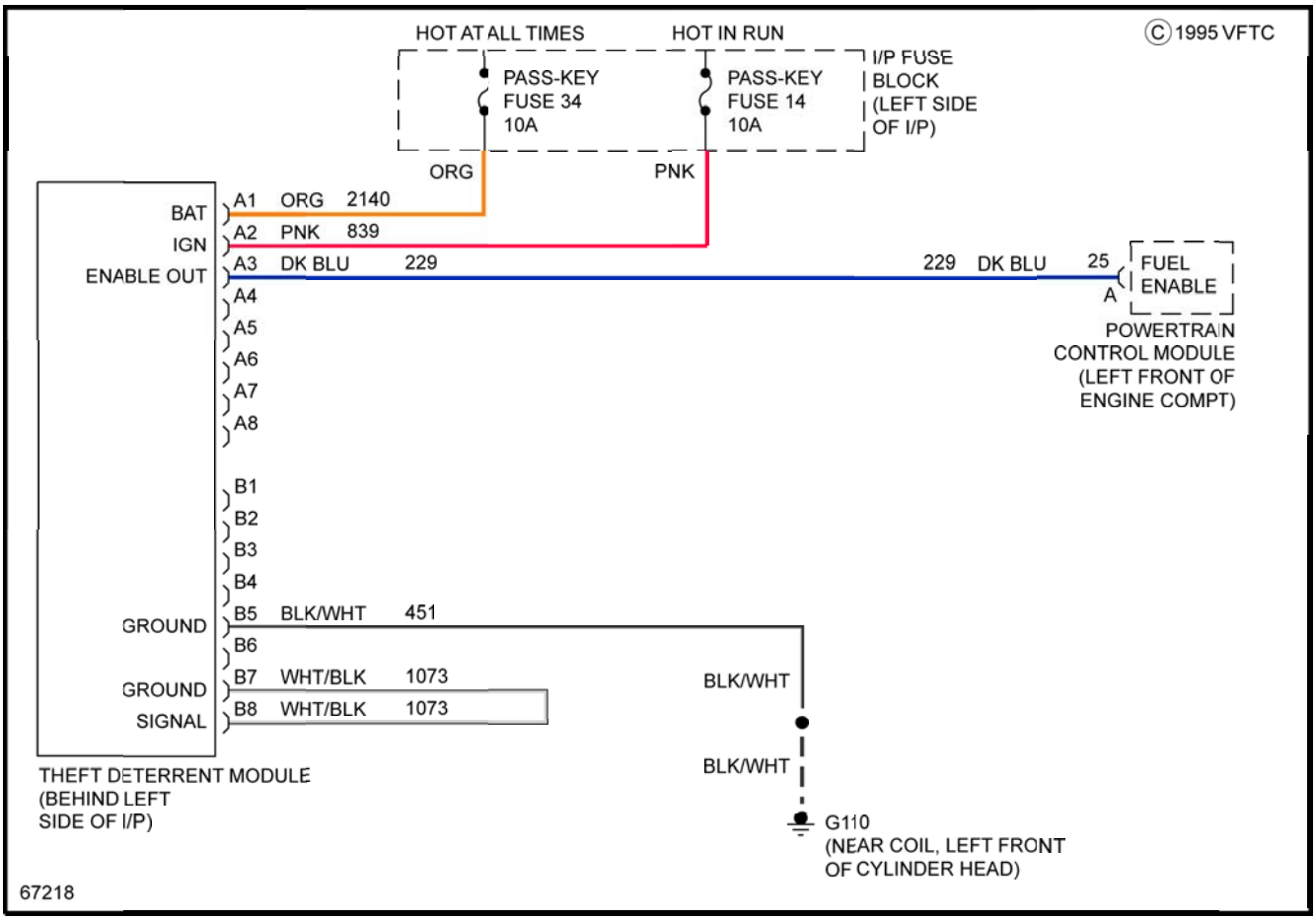


Fig. 3: Pass-Key Circuit, W/ SEO

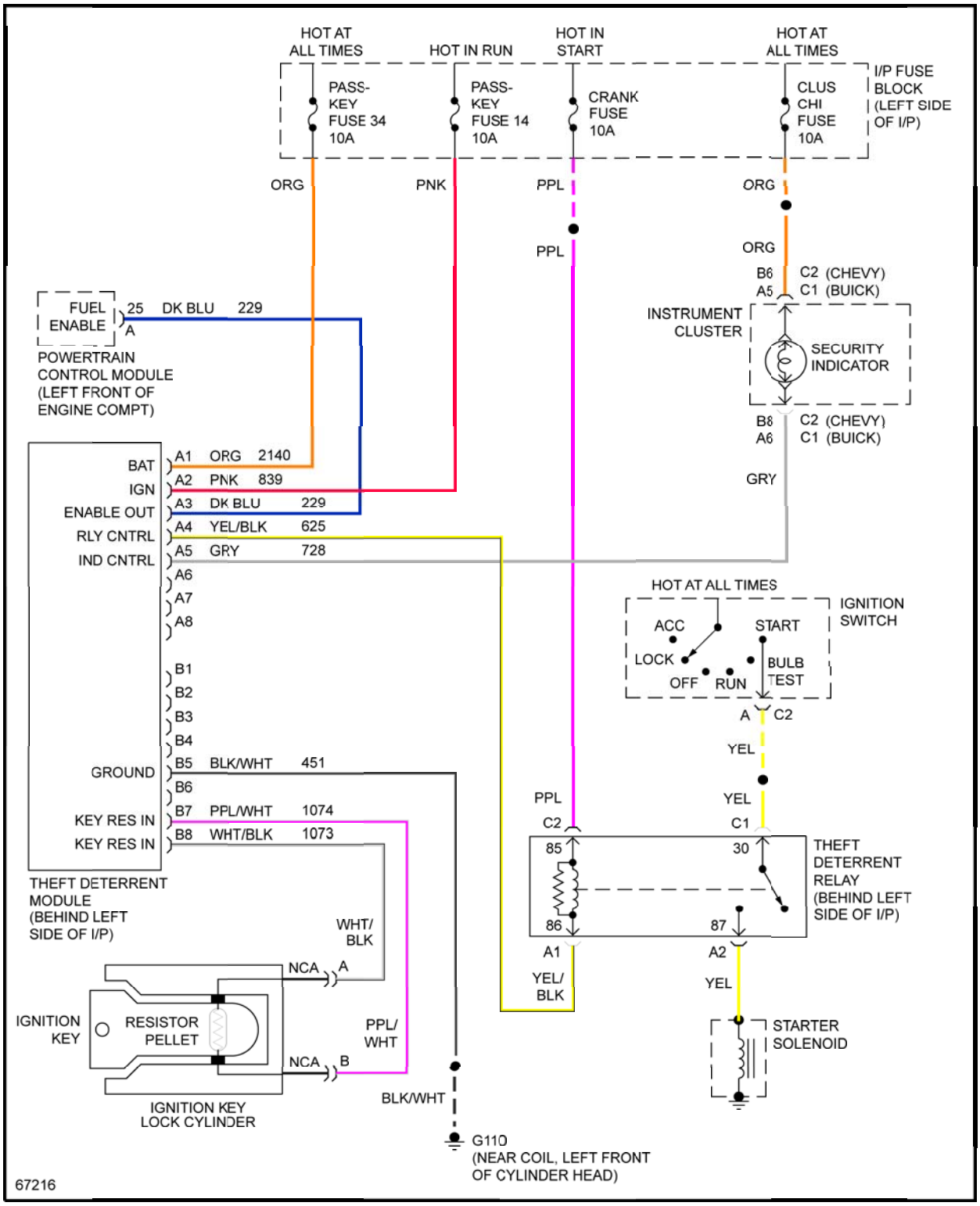


Fig. 4: Pass-Key Circuit, W/O SEO

COMPUTER DATA LINES

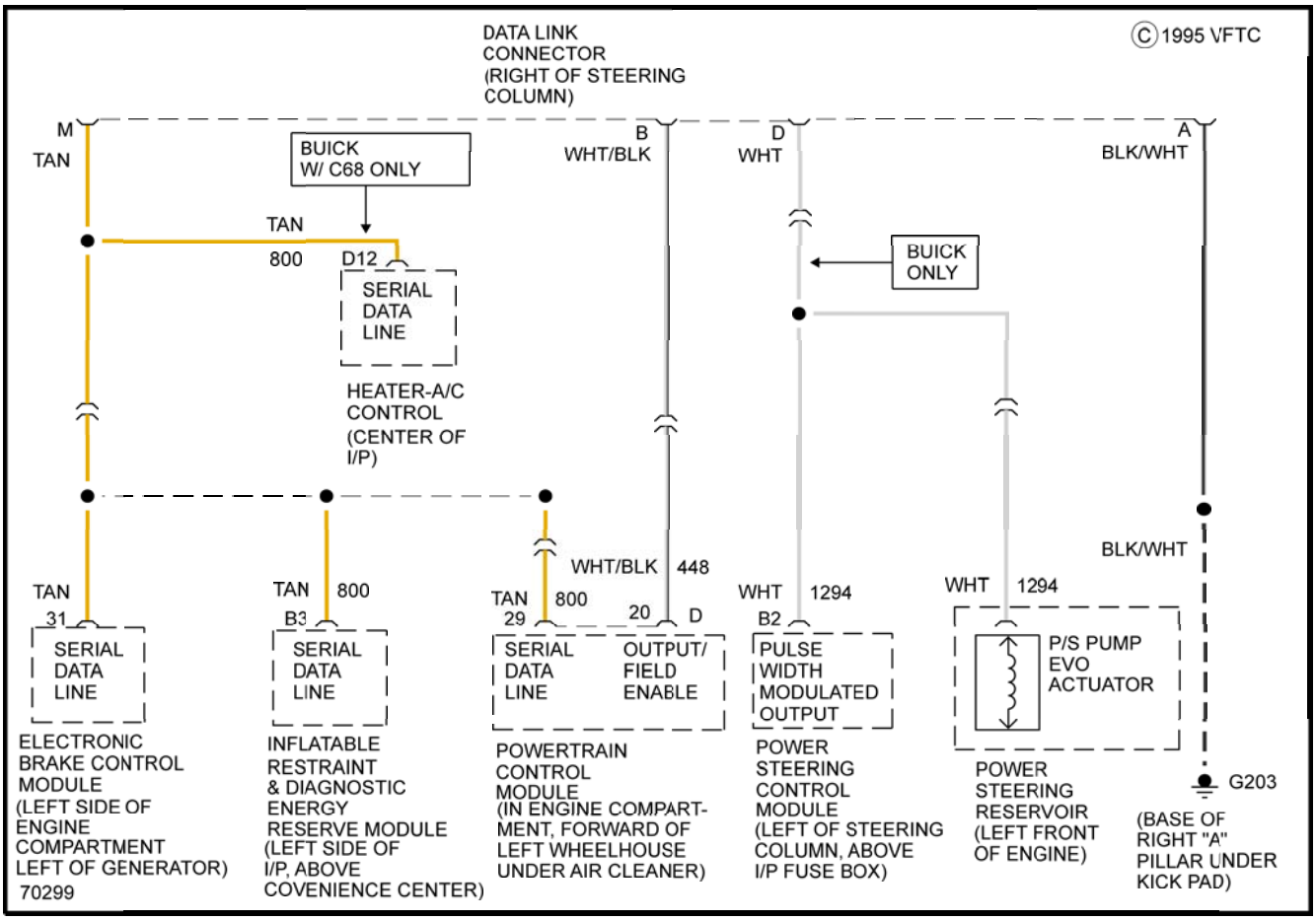


Fig. 5: Data Link Connector Circuit

COOLING FAN

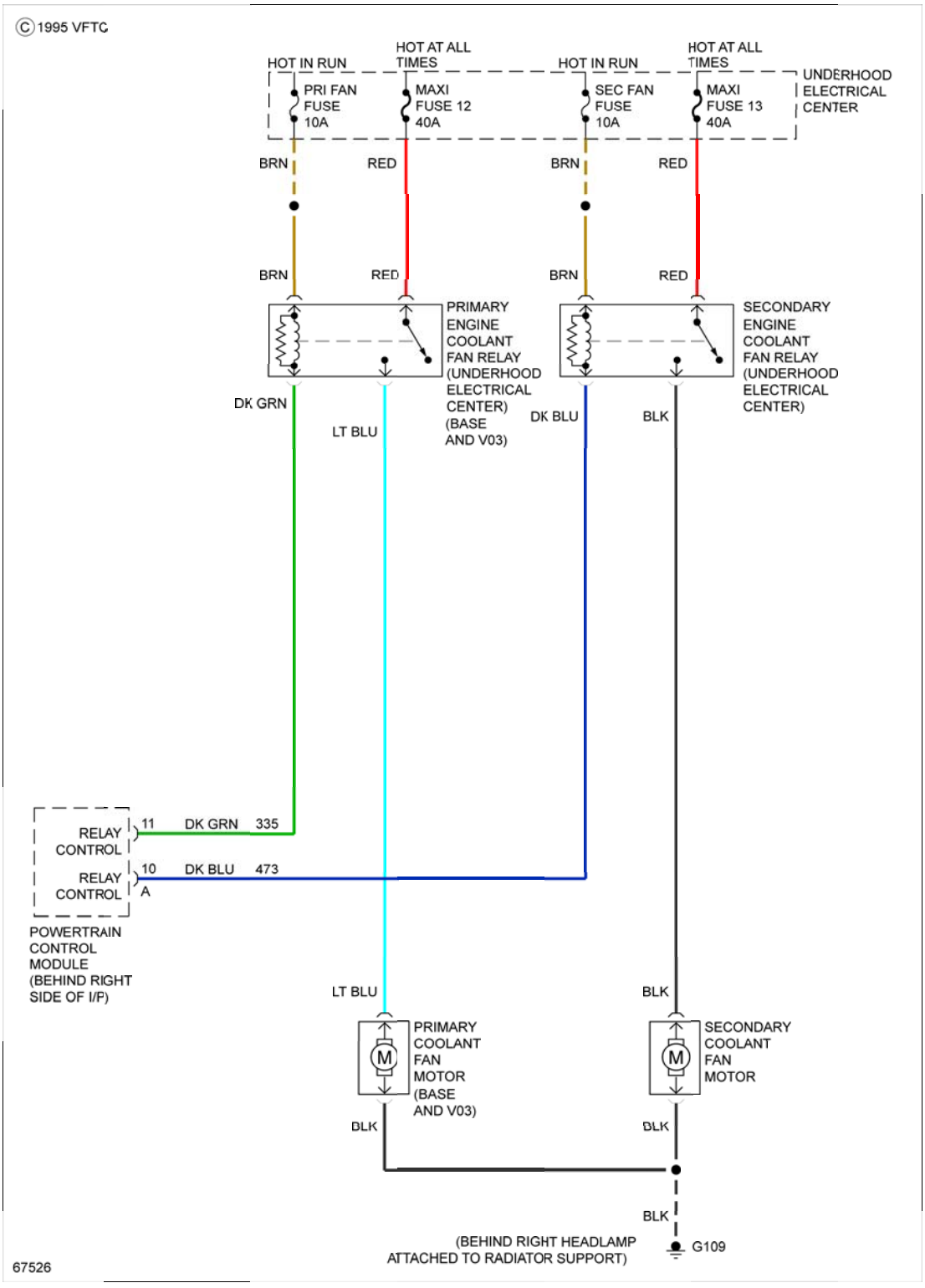


Fig. 6: Cooling Fan Circuit

CRUISE CONTROL

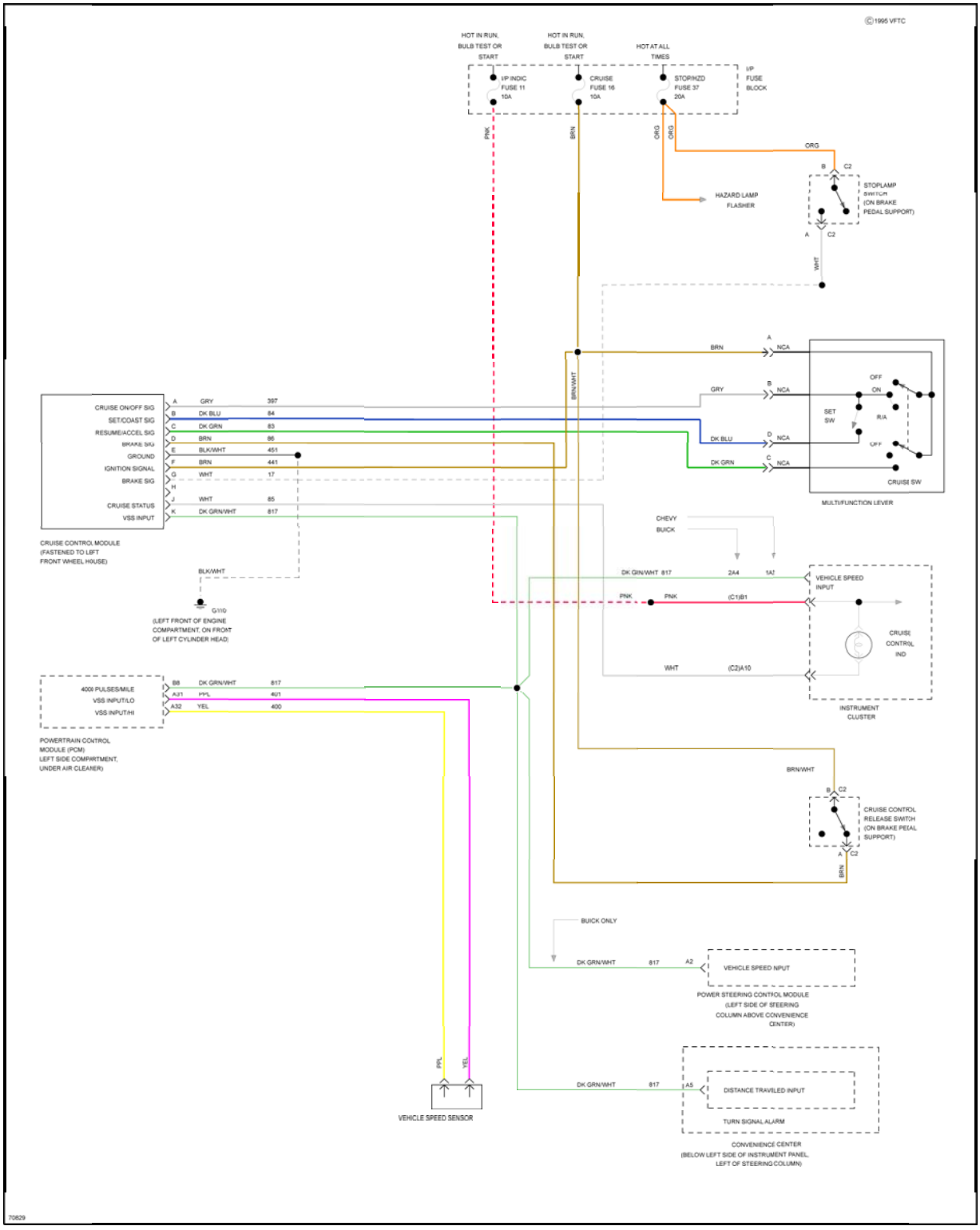


Fig. 7: Cruise Control Circuit

DEFOGGERS

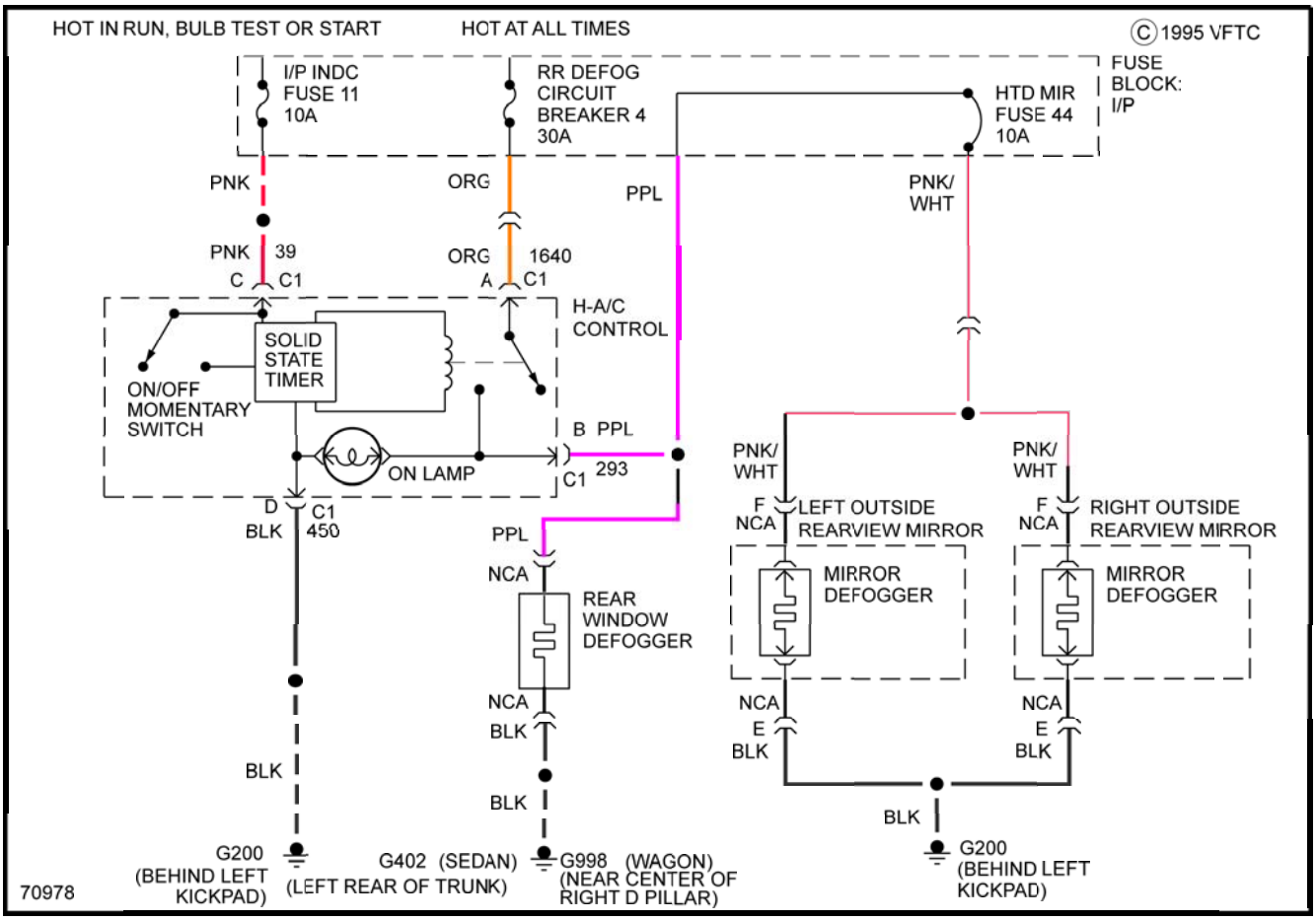


Fig. 8: Defogger Circuit

ELECTRONIC POWER STEERING

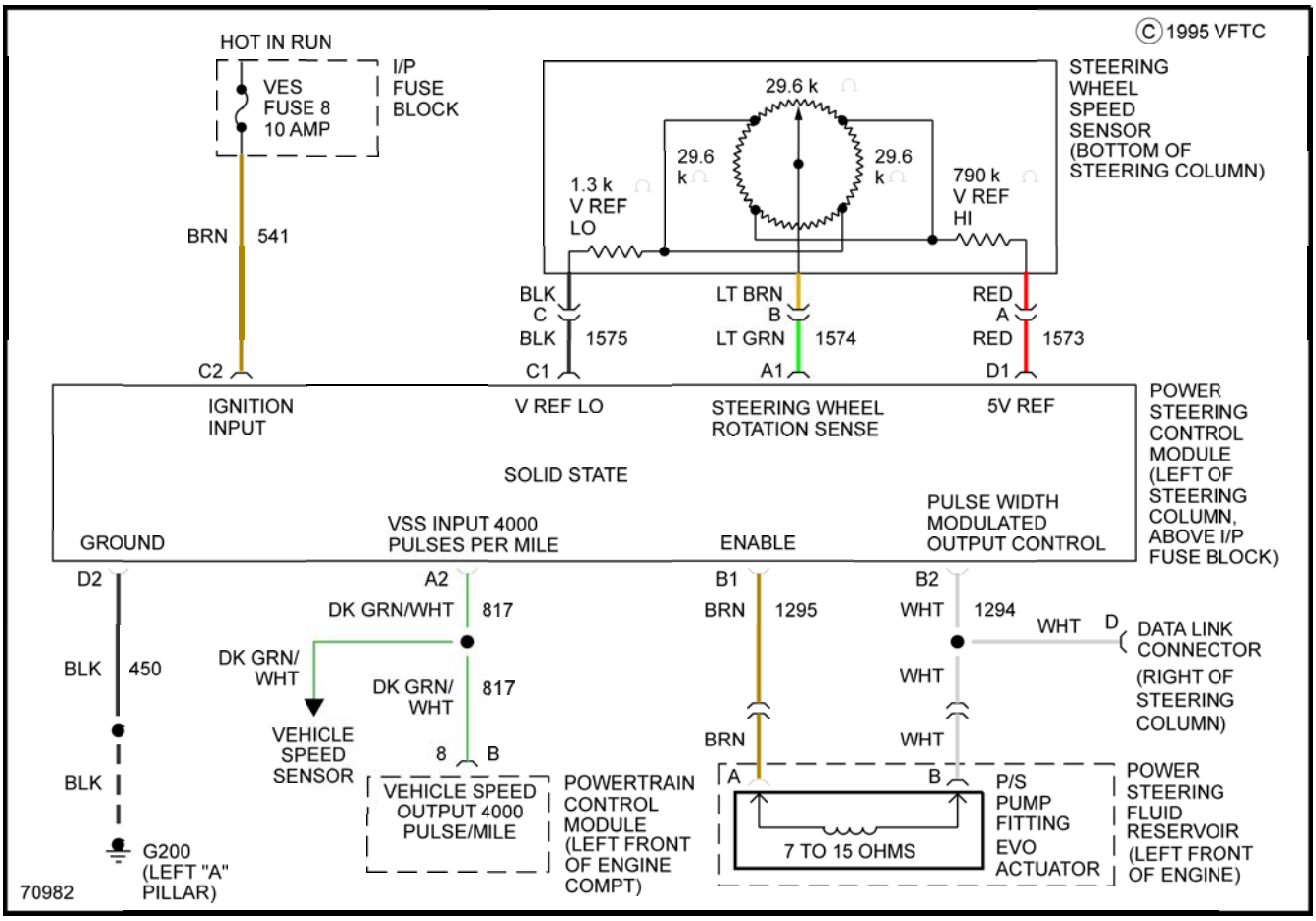


Fig. 9: Electronic Power Steering Circuit

ENGINE PERFORMANCE

4.3L

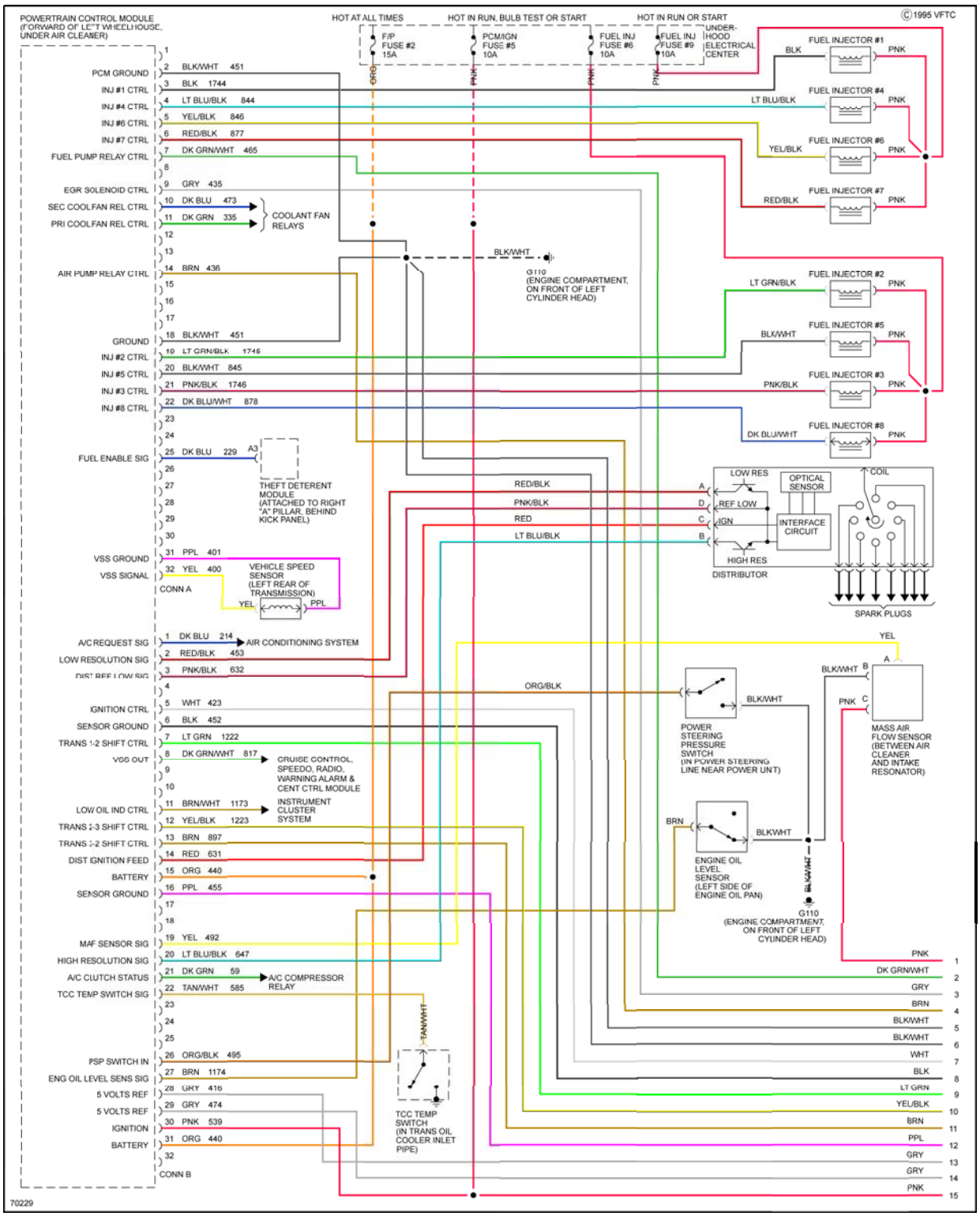


Fig. 10: 4.3L (VIN W), Engine Performance Circuits (1 of 3)

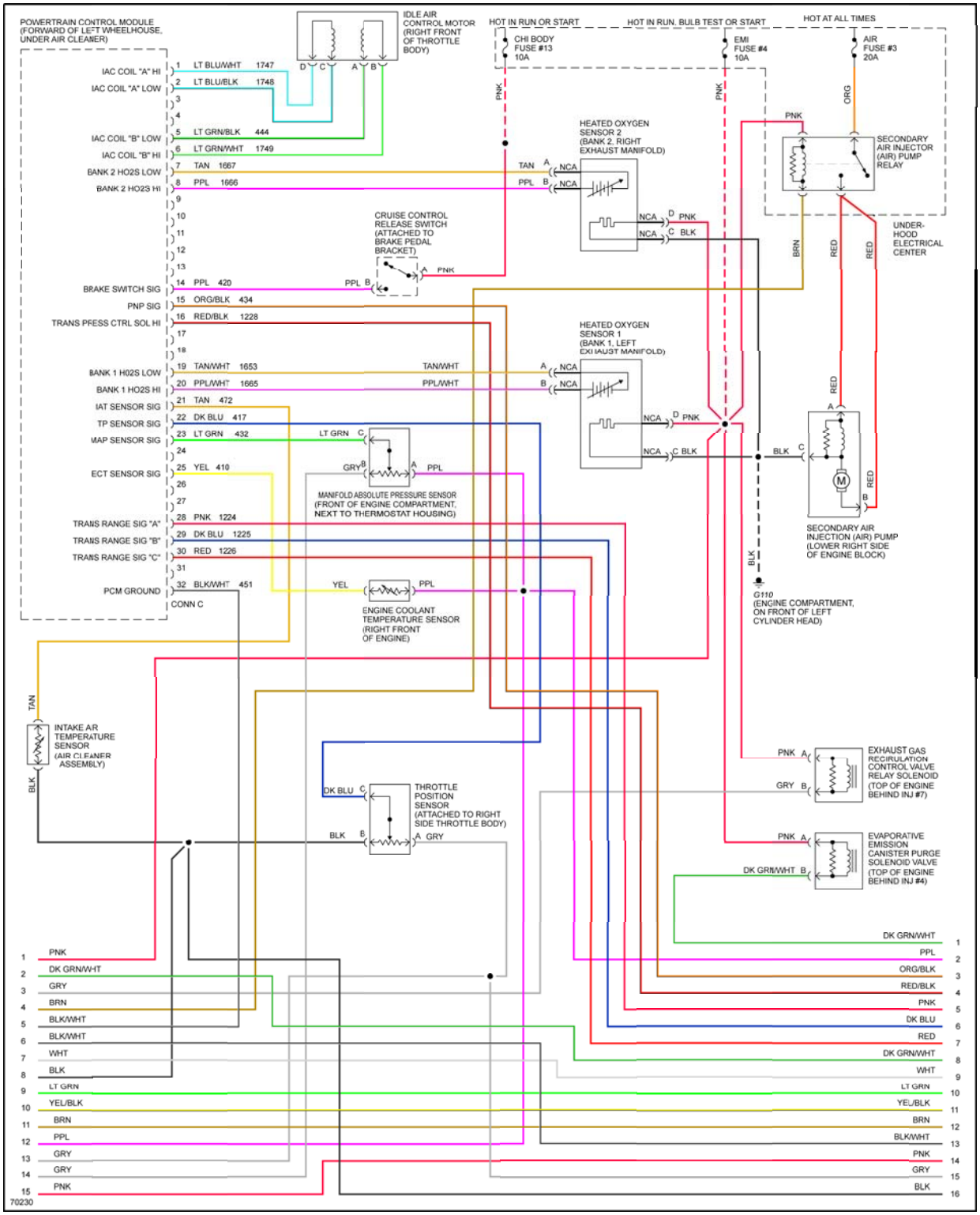


Fig. 11: 4.3L (VIN W), Engine Performance Circuits (2 of 3)

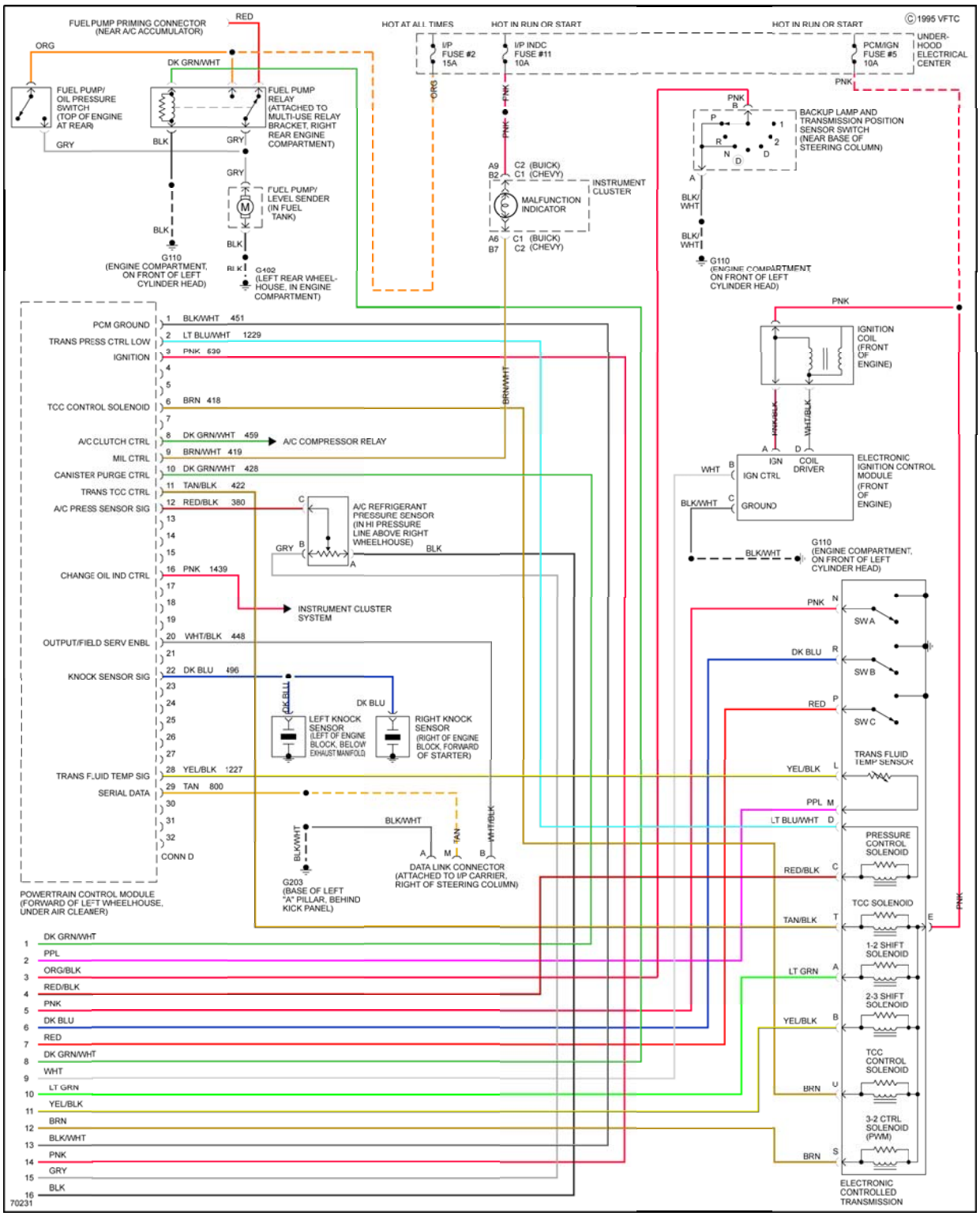


Fig. 12: 4.3L (VIN W), Engine Performance Circuits (3 of 3)

5.7L

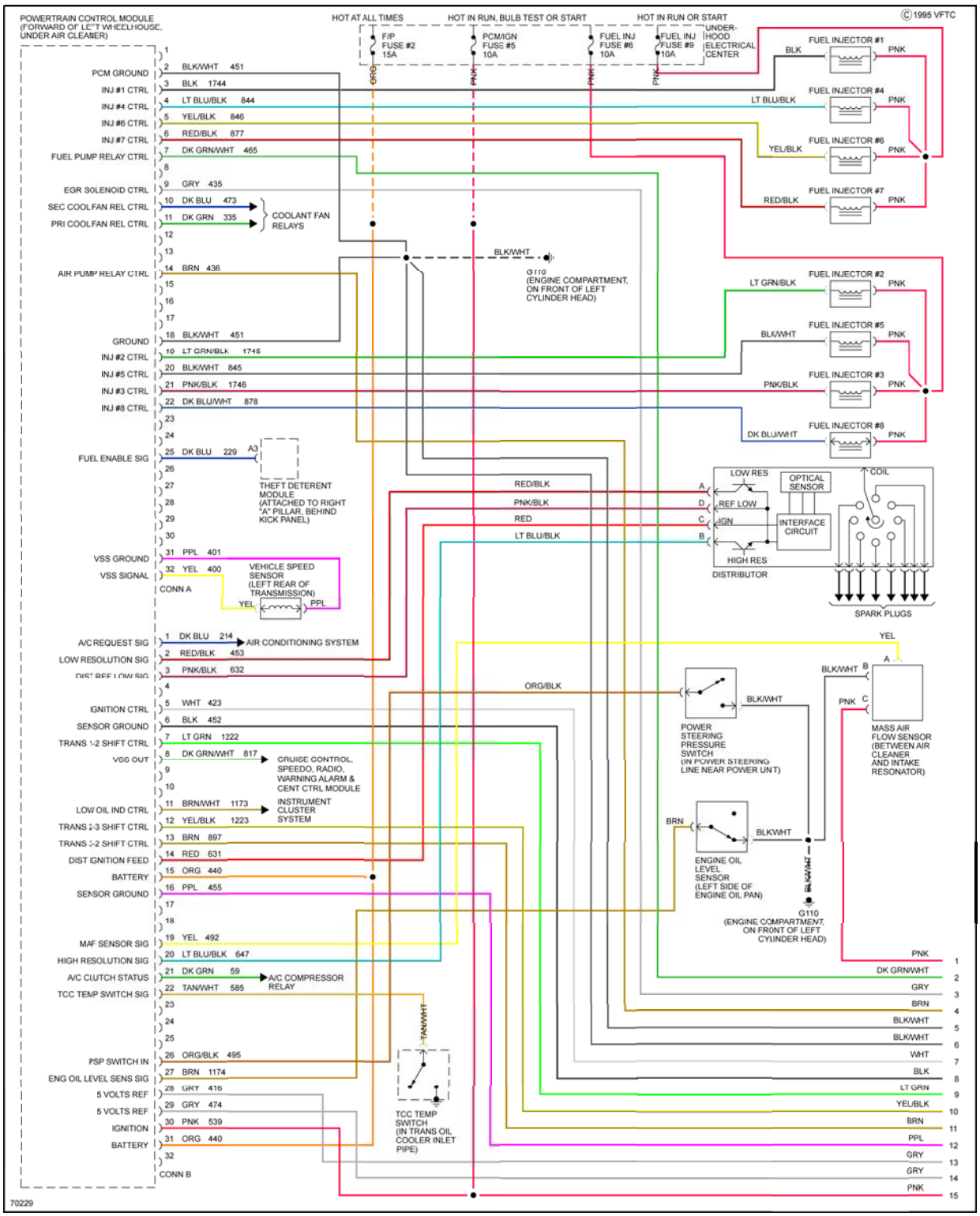


Fig. 13: 5.7L (VIN P), Engine Performance Circuits (1 of 3)

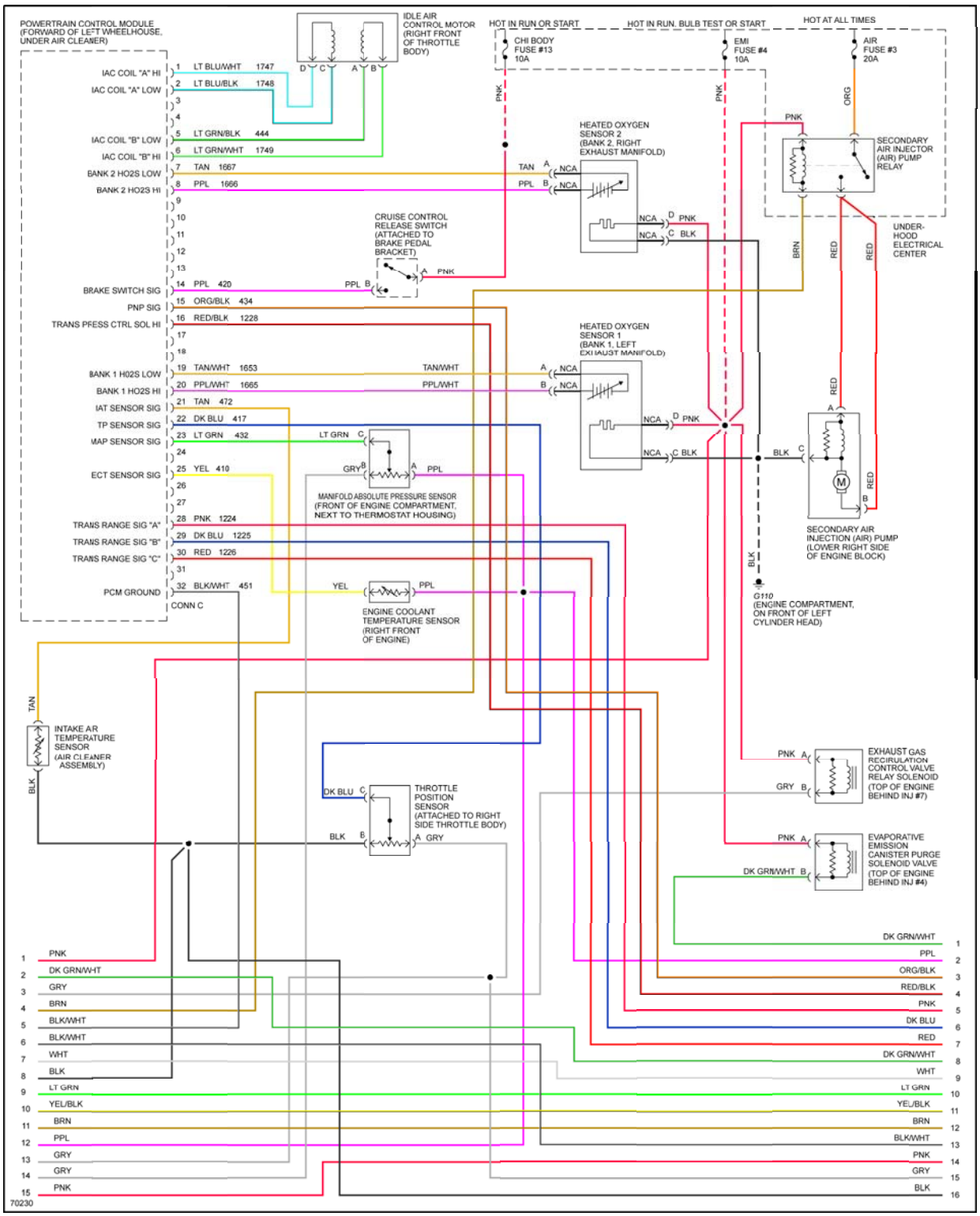


Fig. 14: 5.7L (VIN P), Engine Performance Circuits (2 of 3)

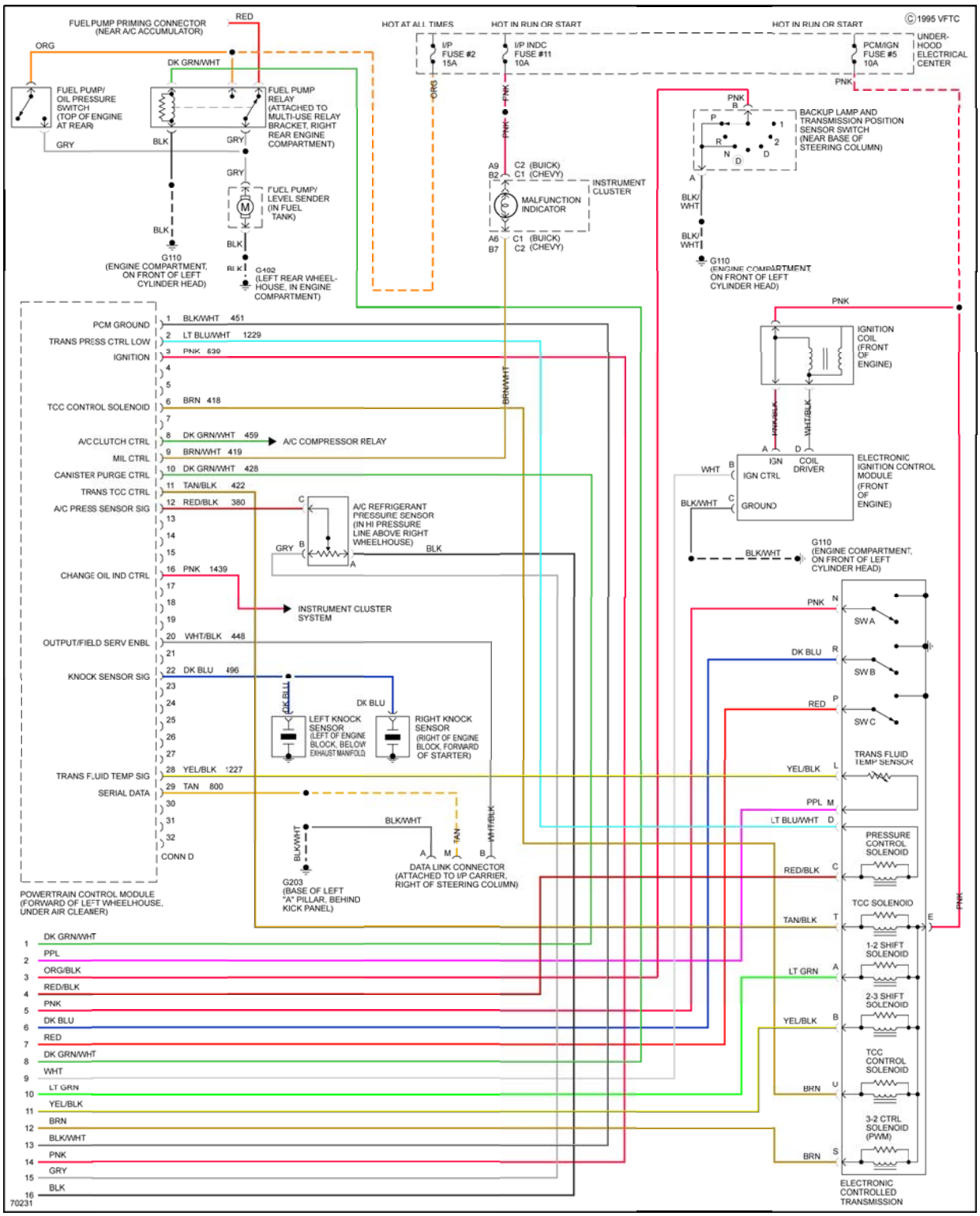


Fig. 15: 5.7L (VIN P), Engine Performance Circuits (3 of 3)

EXTERIOR LIGHTS

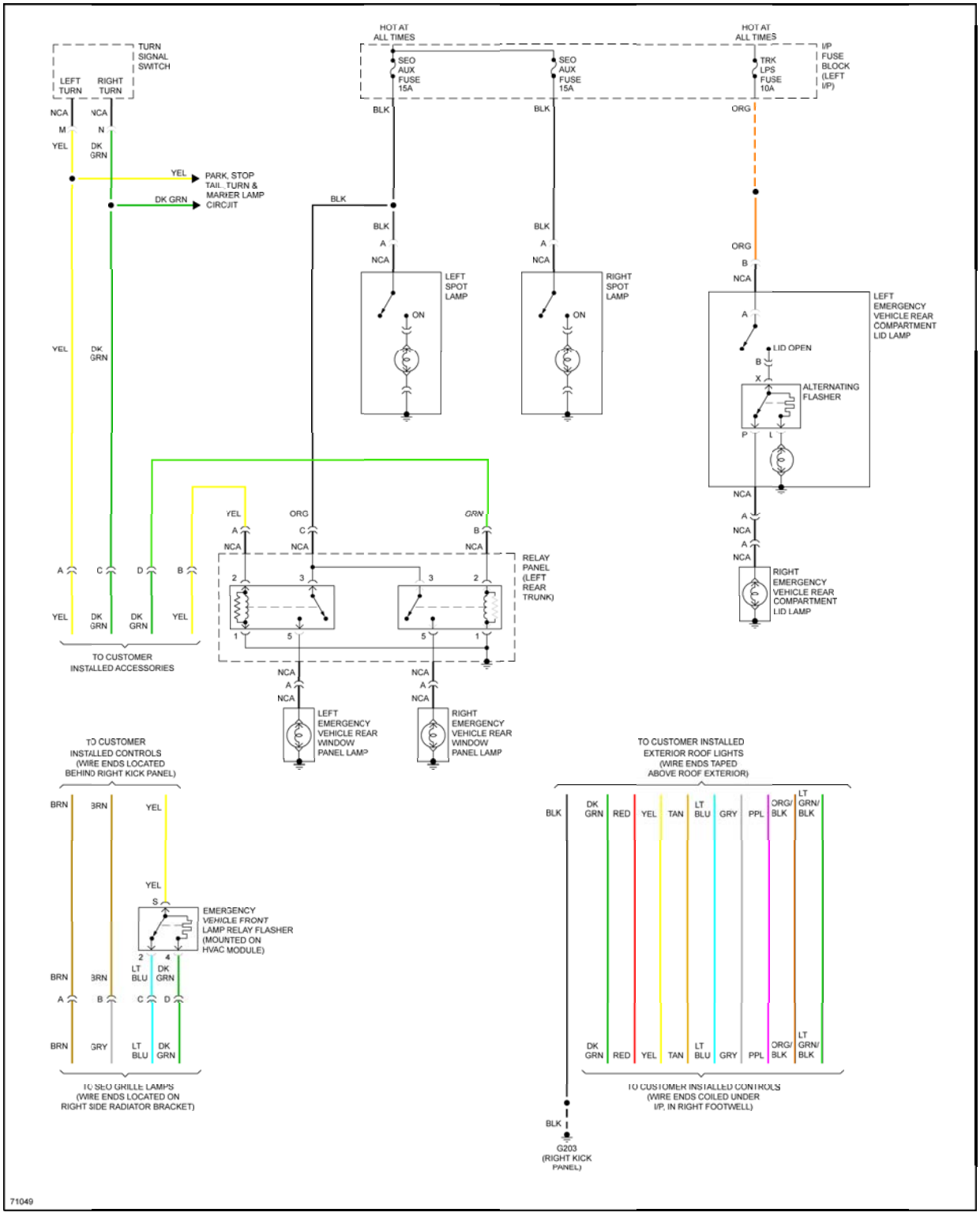


Fig. 16: Accessory Lamps Circuit

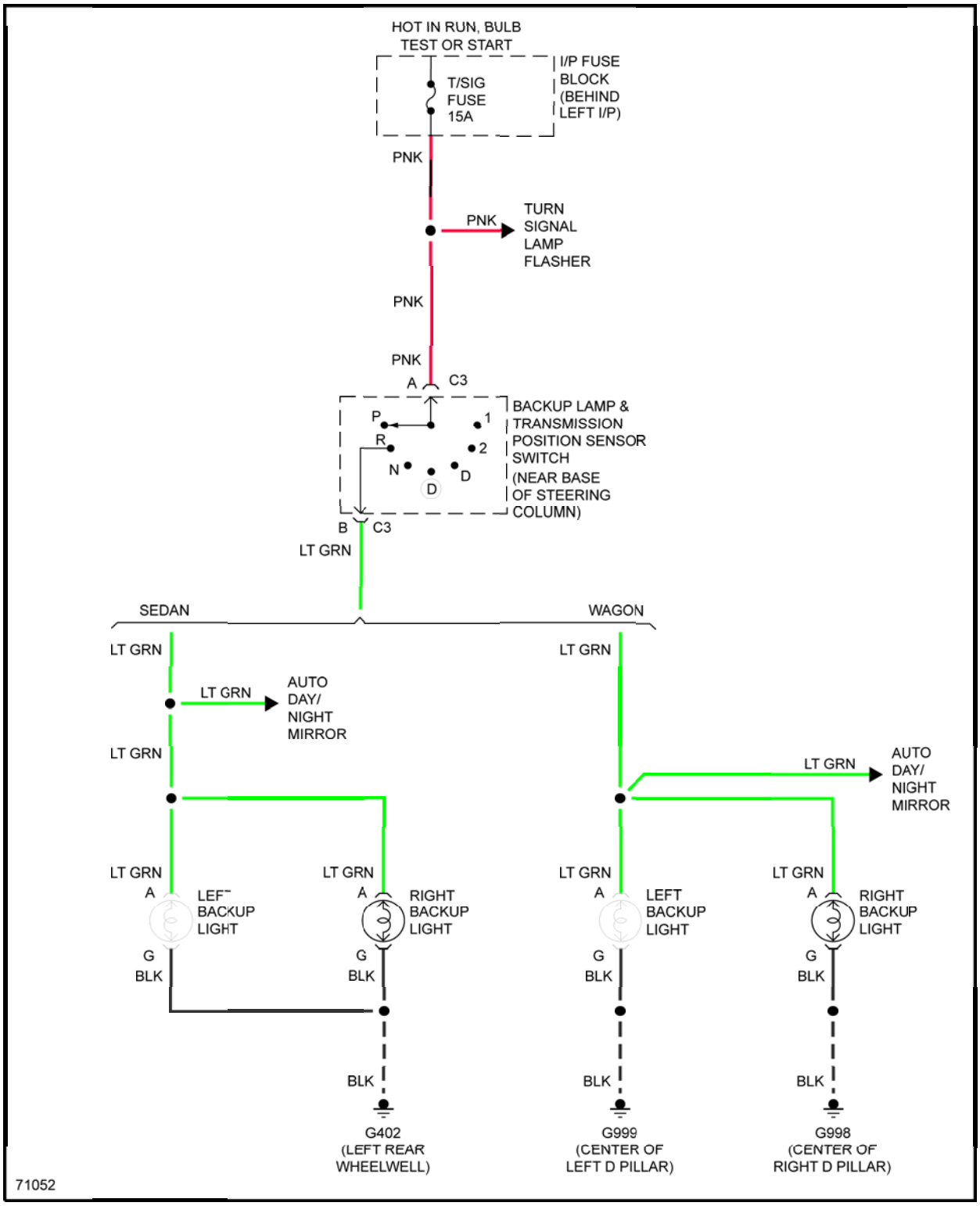


Fig. 17: Back-up Lamps Circuit

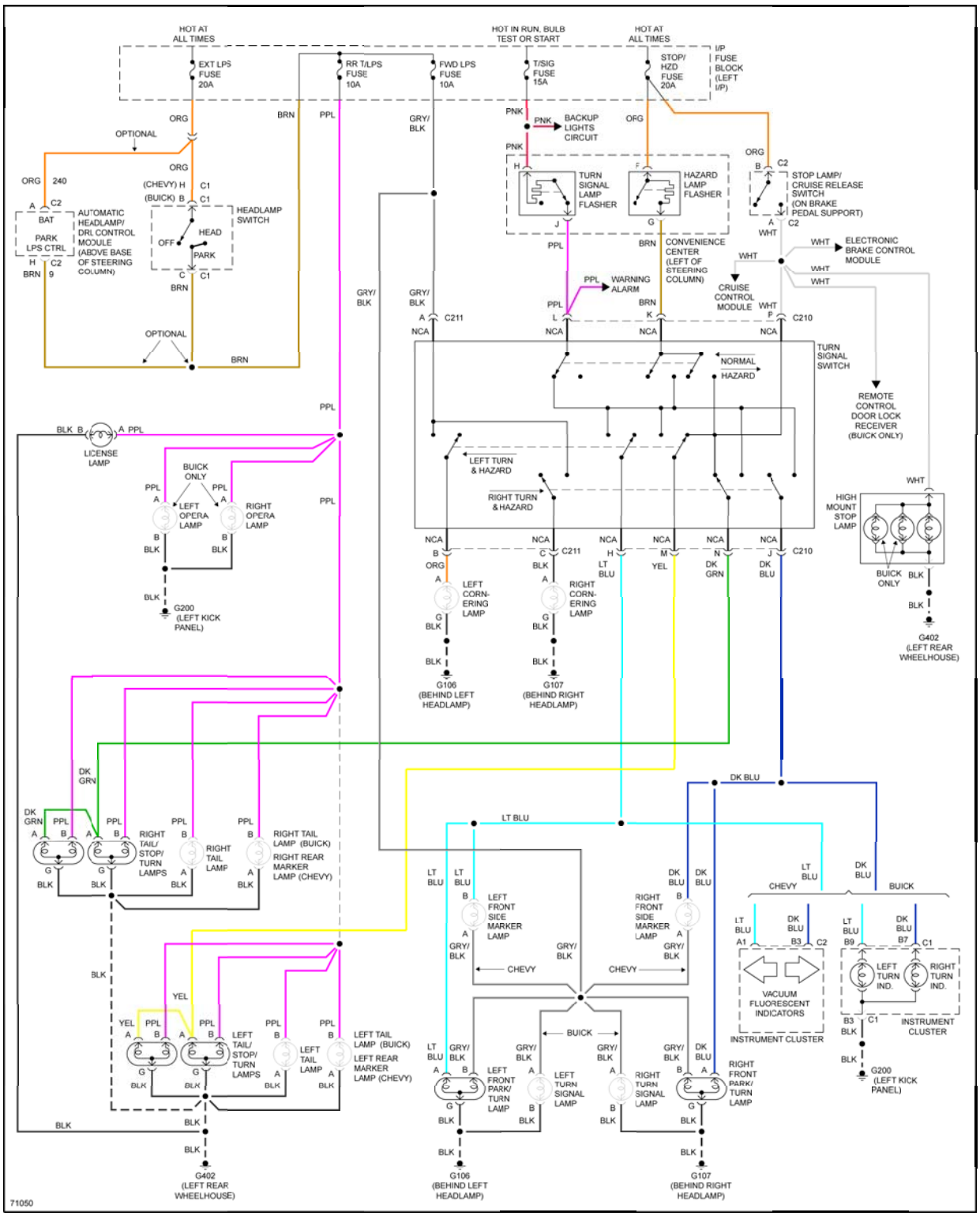


Fig. 18: Exterior Light Circuit, Sedan

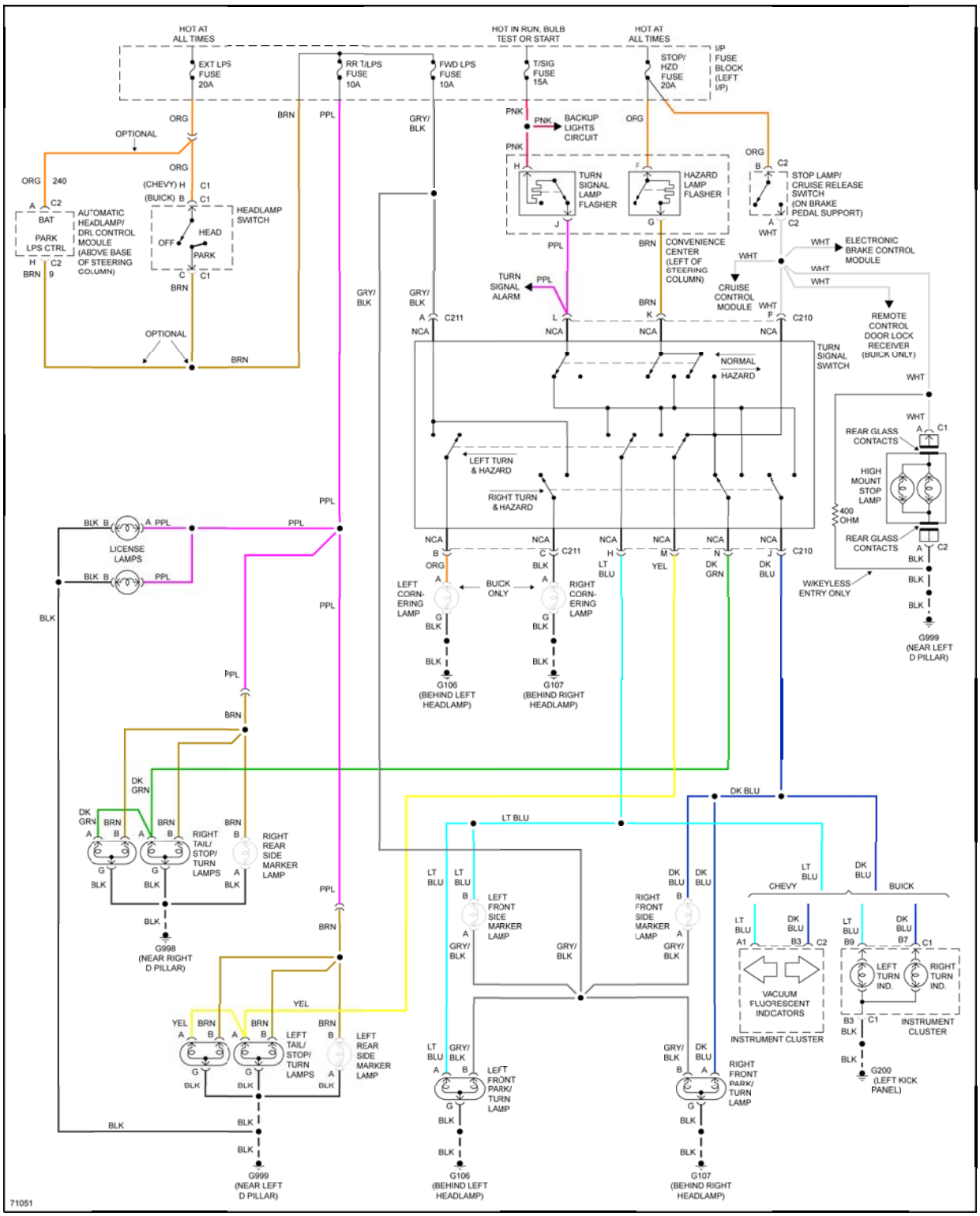


Fig. 19: Exterior Light Circuit, Wagon

GROUND DISTRIBUTION

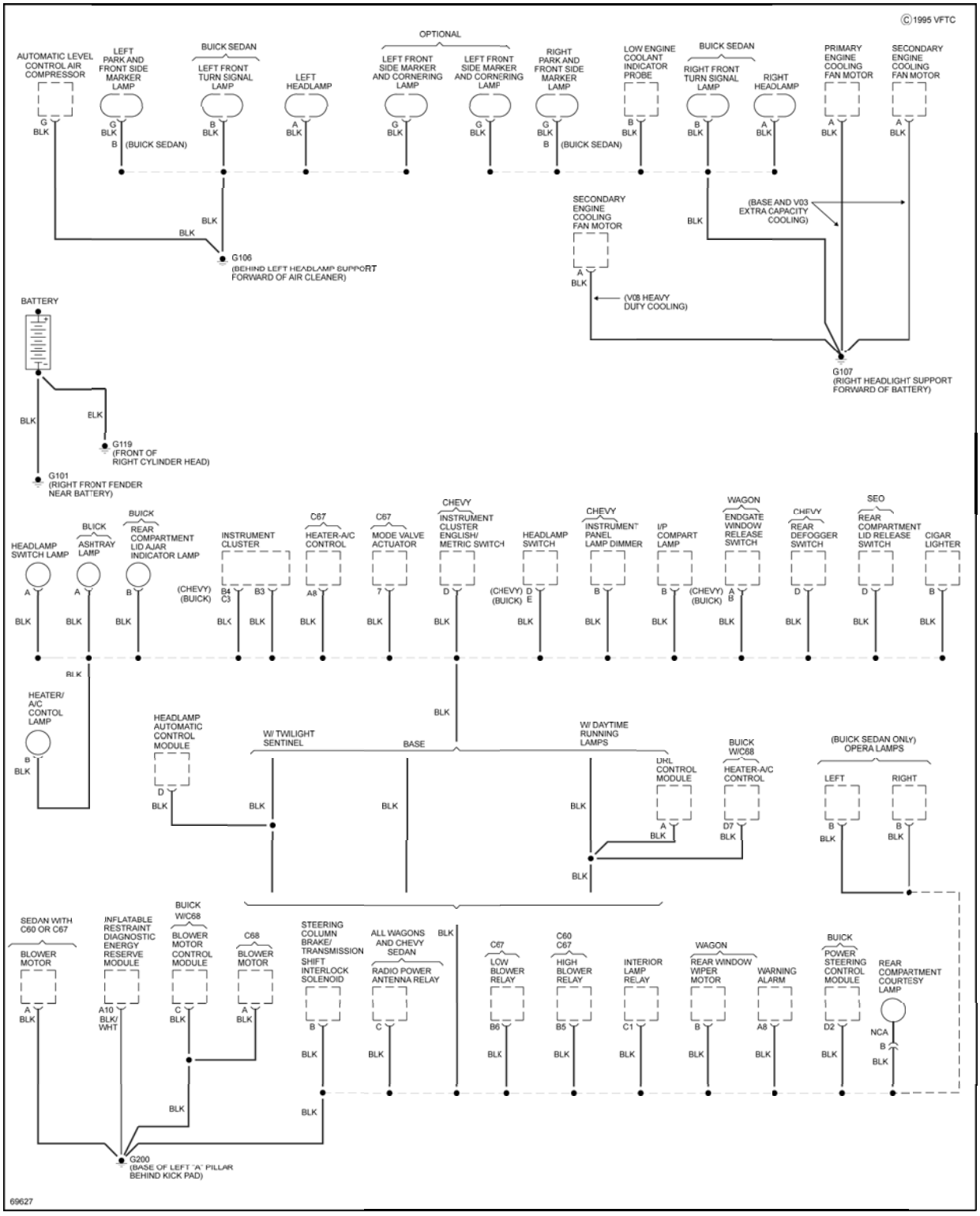


Fig. 20: Ground Distribution Circuit (1 of 3)

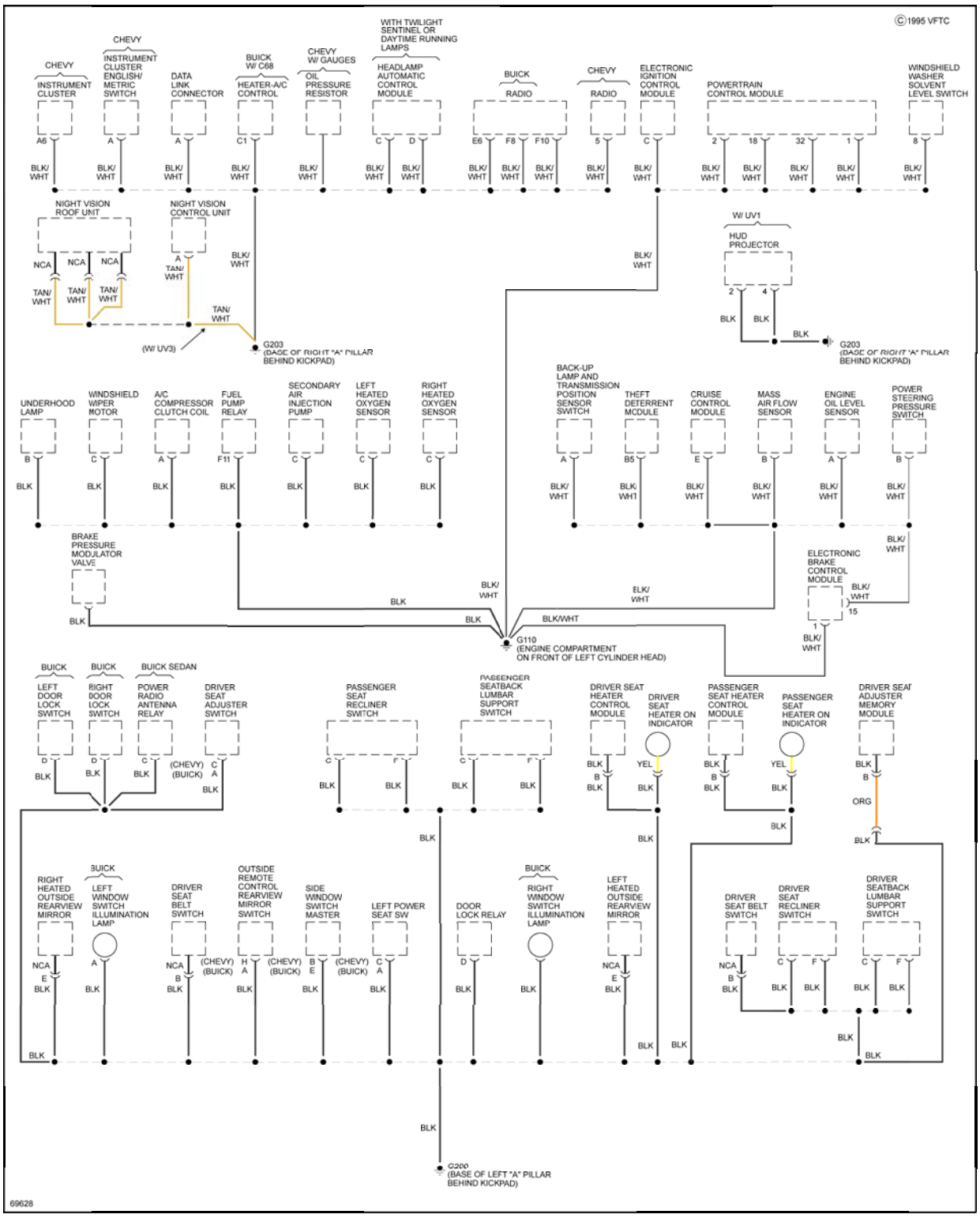


Fig. 21: Ground Distribution Circuit (2 of 3)

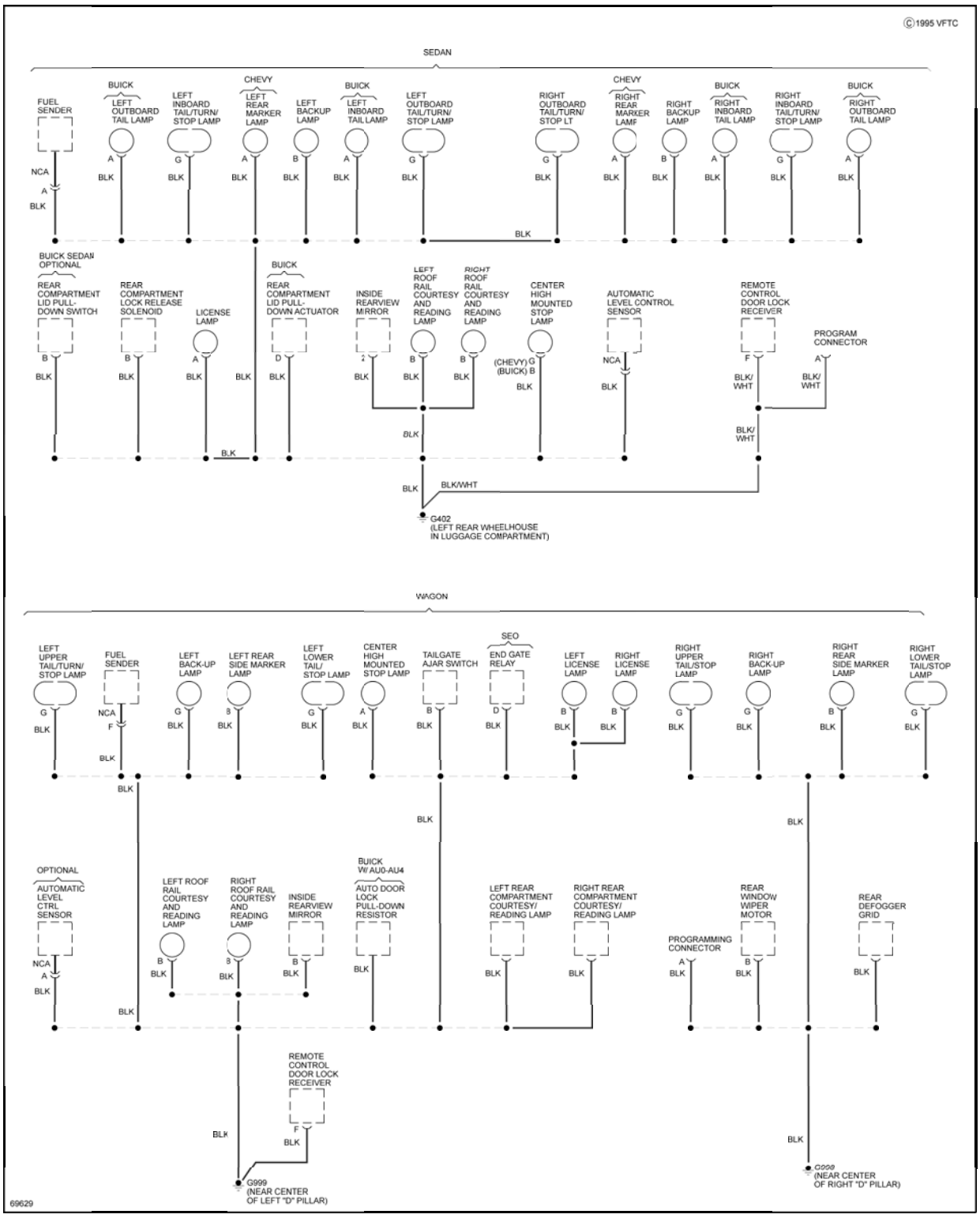


Fig. 22: Ground Distribution Circuit (3 of 3)

HEADLIGHTS

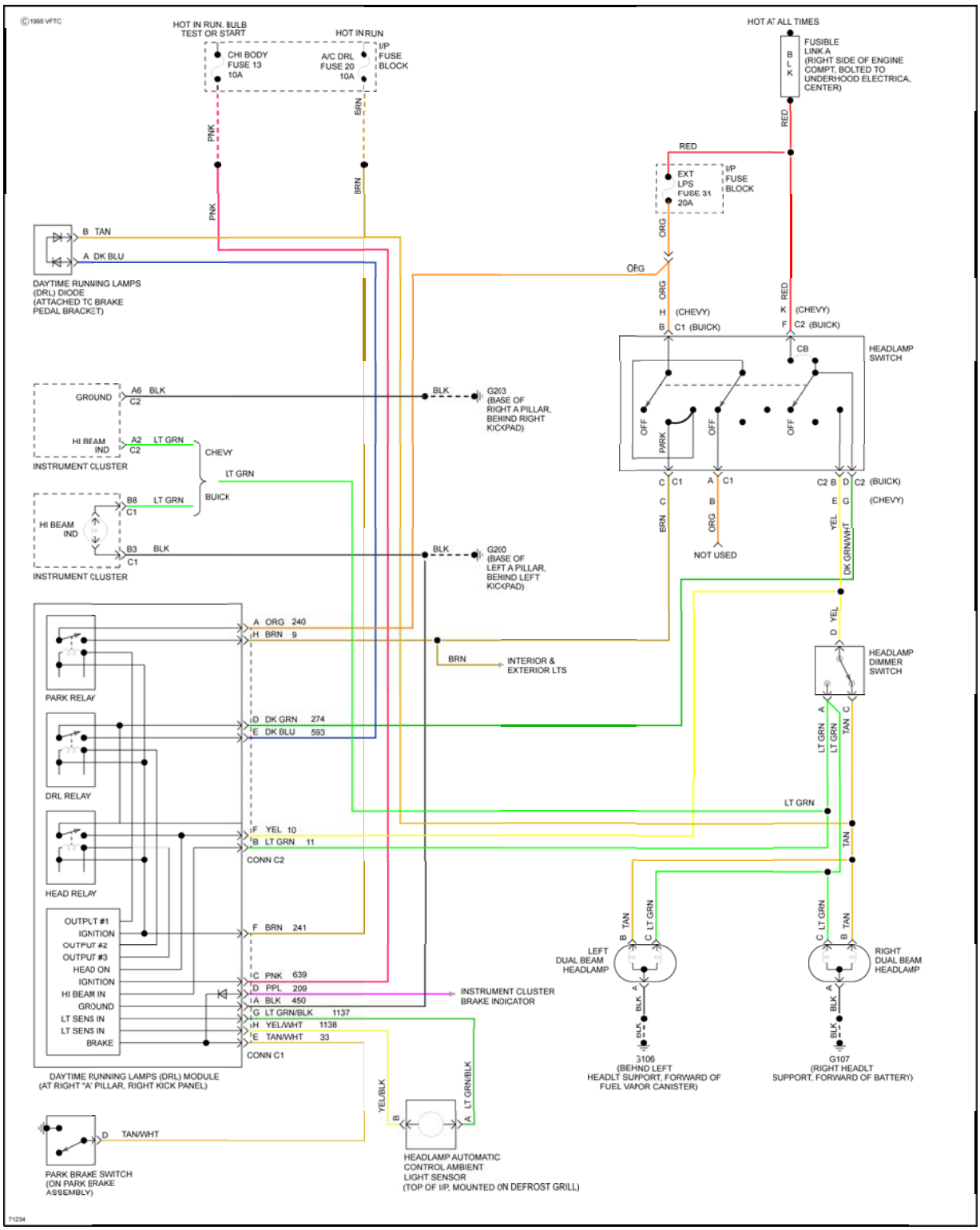


Fig. 23: Headlight Circuit, W/ DRL

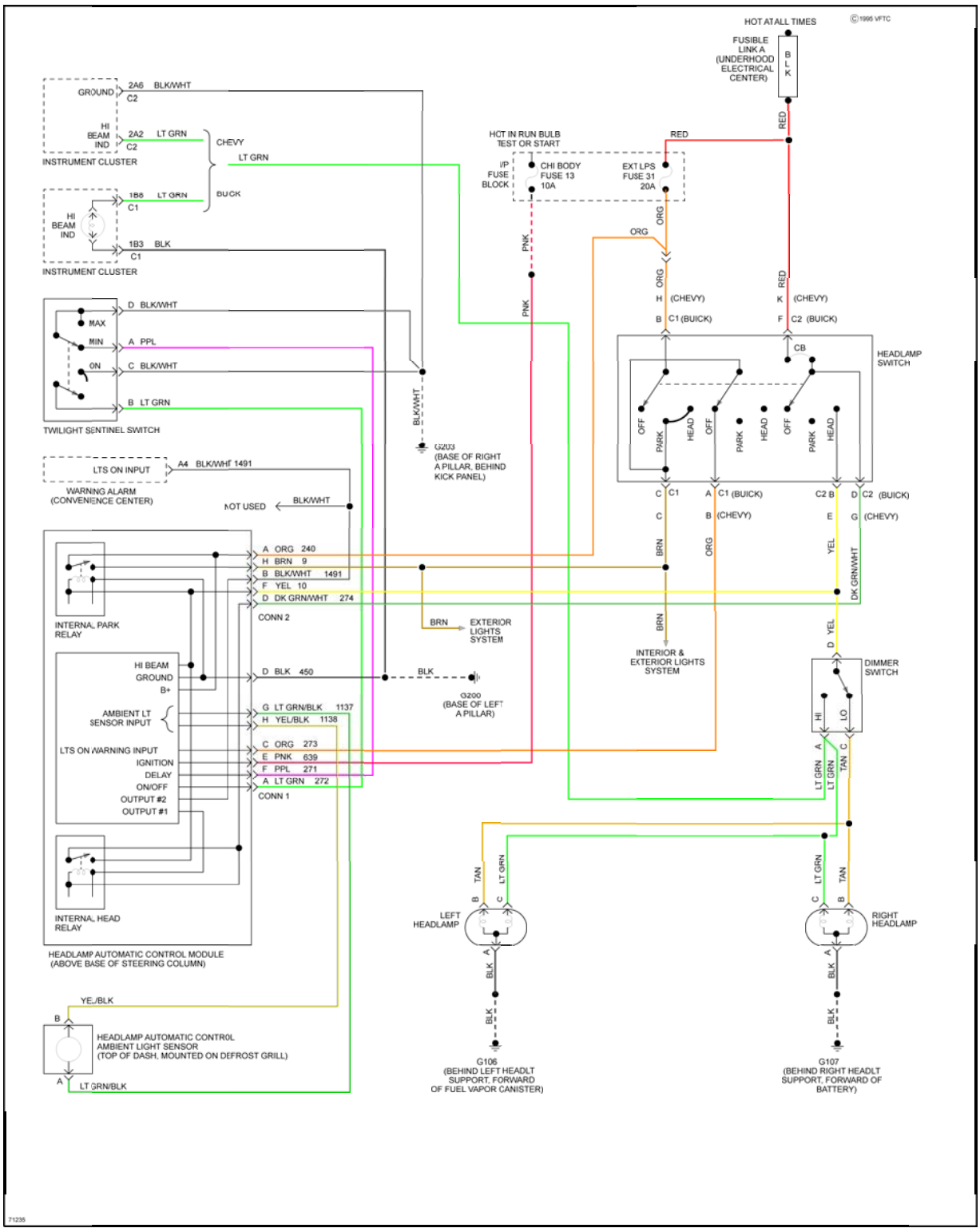


Fig. 24: Headlight Circuit, W/O DRL, W/ Twilight Sentinel

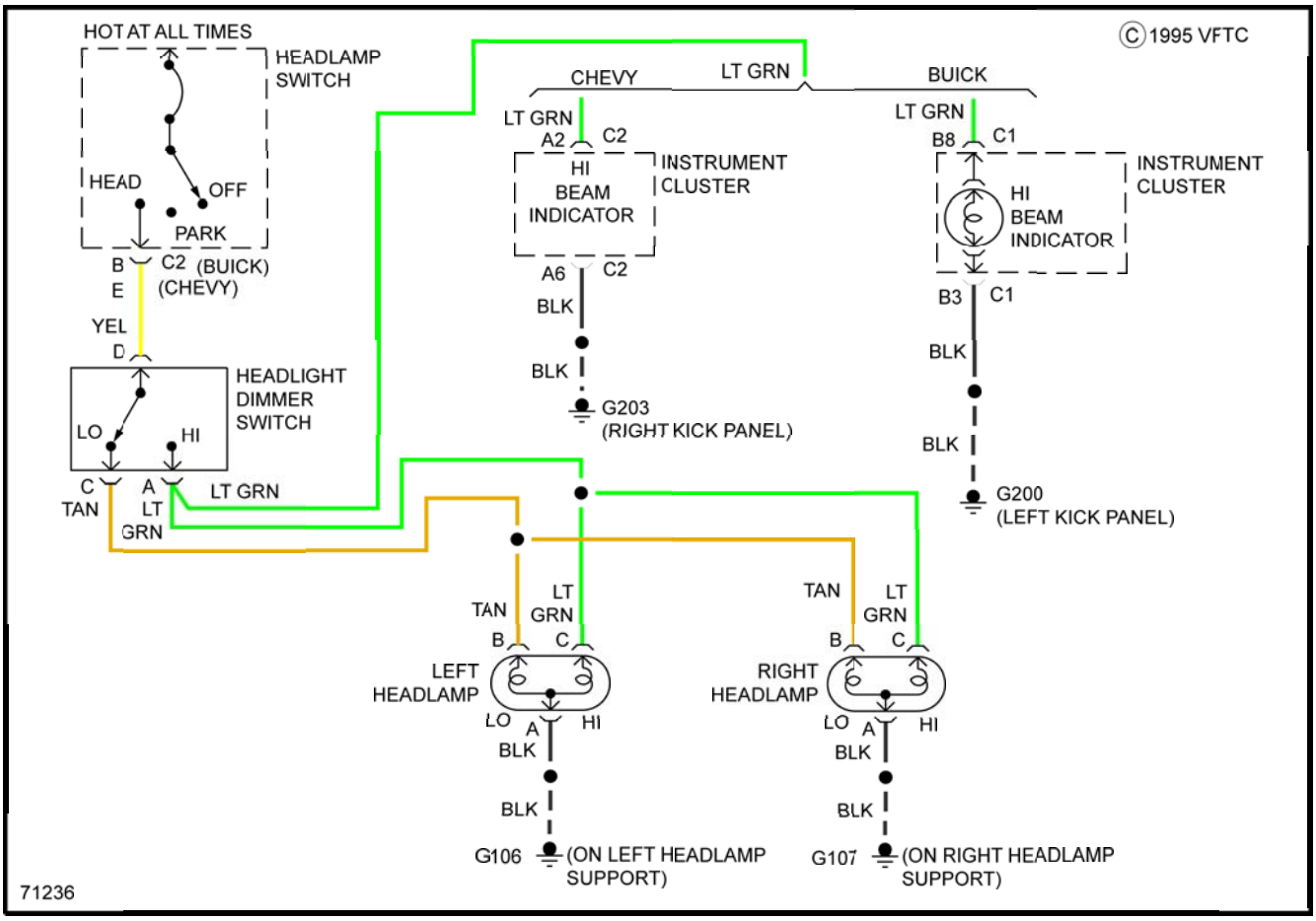


Fig. 25: Headlight Circuit, W/O DRL, W/O Twilight Sentinel

HORN

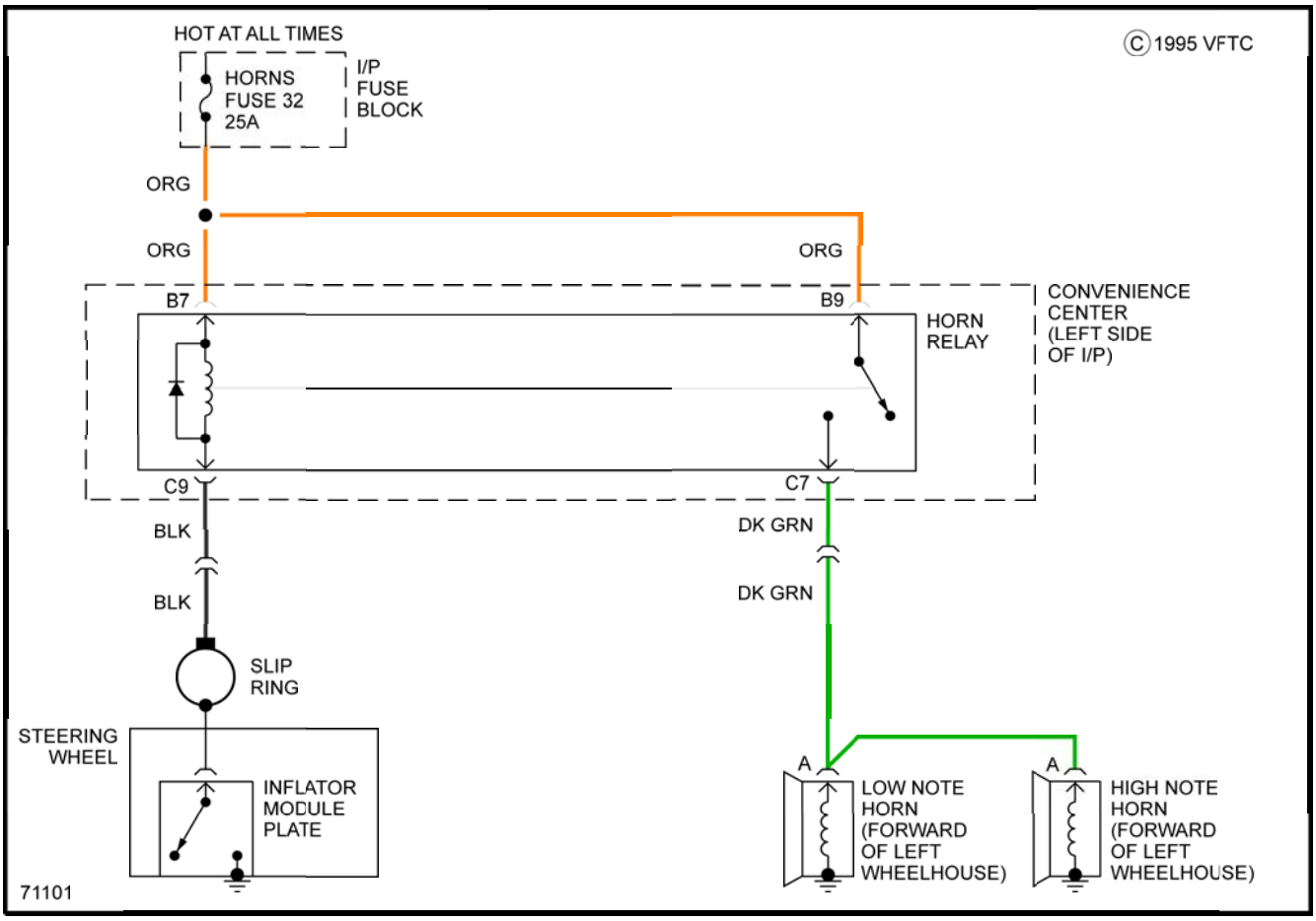


Fig. 26: Horn Circuit

INSTRUMENT CLUSTER

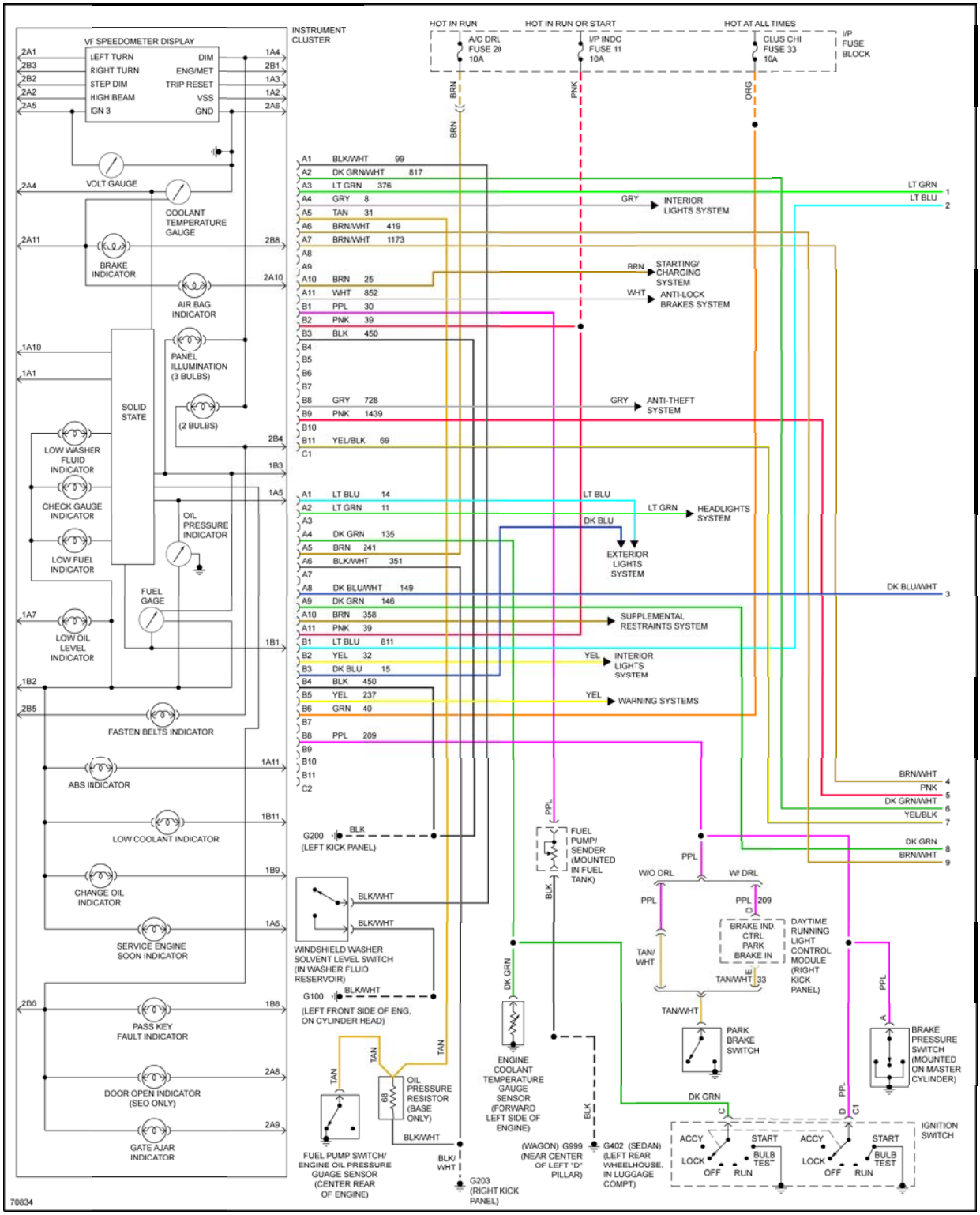


Fig. 27: Instrument Cluster Circuit (1 of 2)

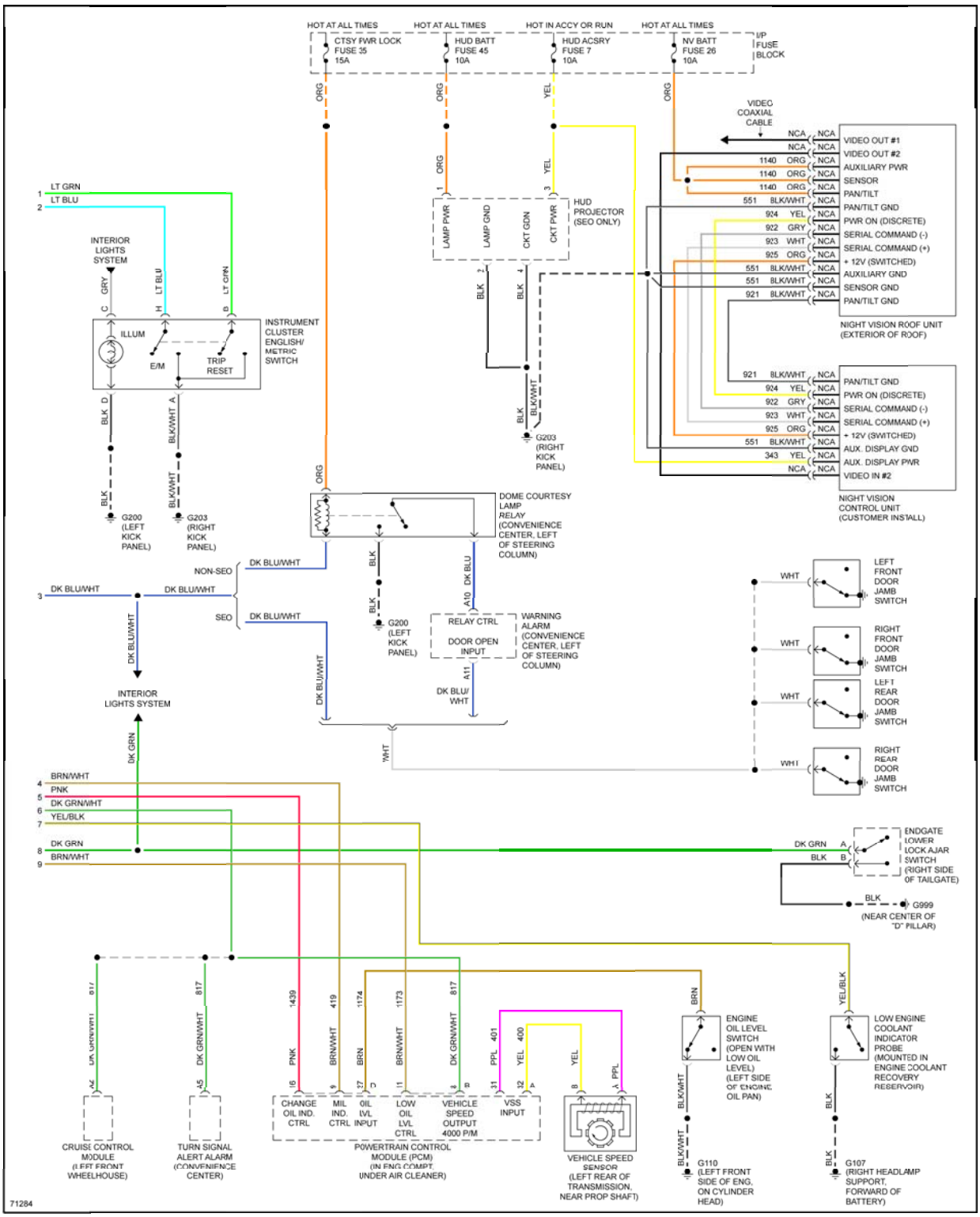


Fig. 28: Instrument Cluster Circuit (2 of 2)

INTERIOR LIGHTS

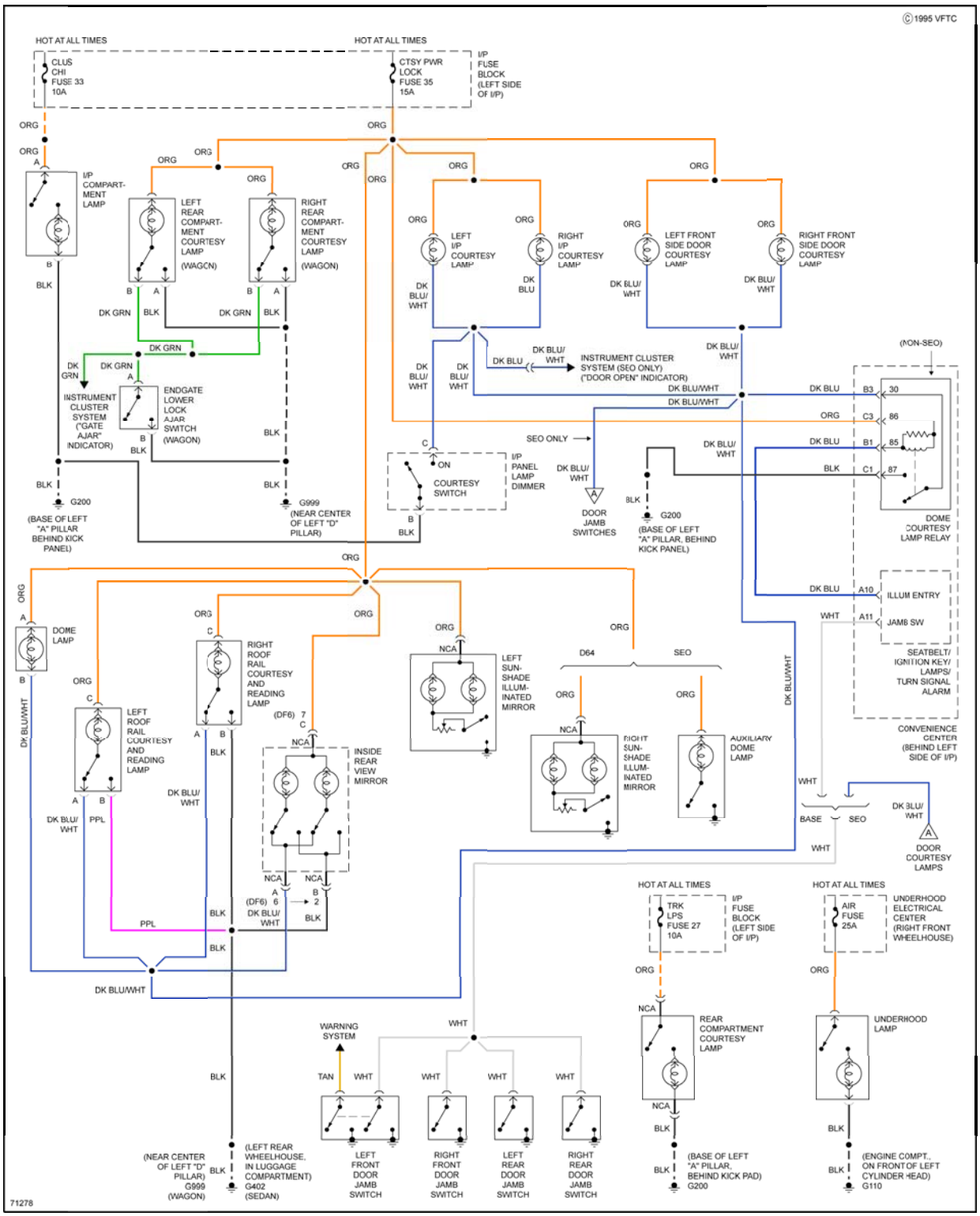


Fig. 29: Courtesy Lamps Circuit

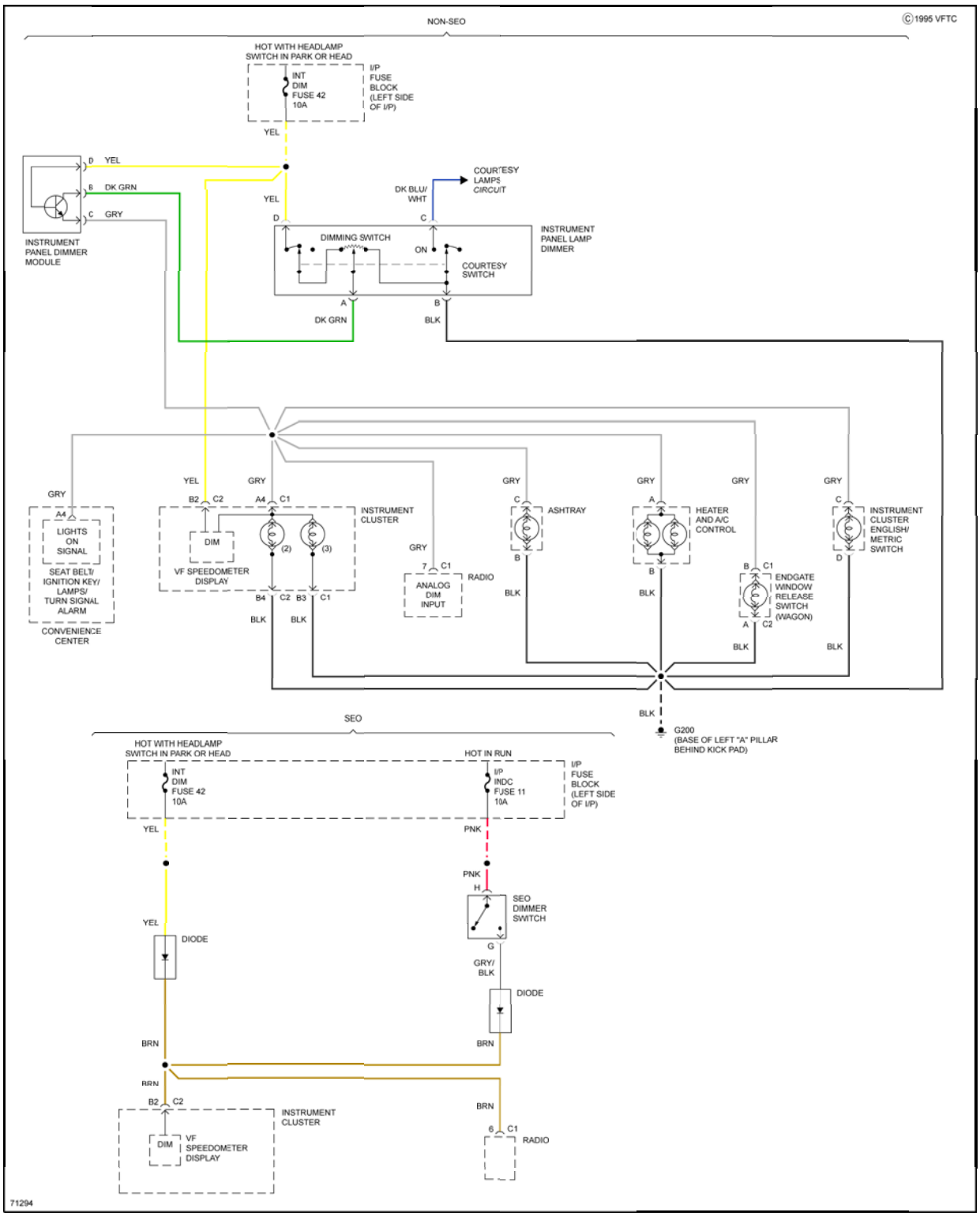


Fig. 30: Instrument Illumination Circuit

POWER ANTENNA

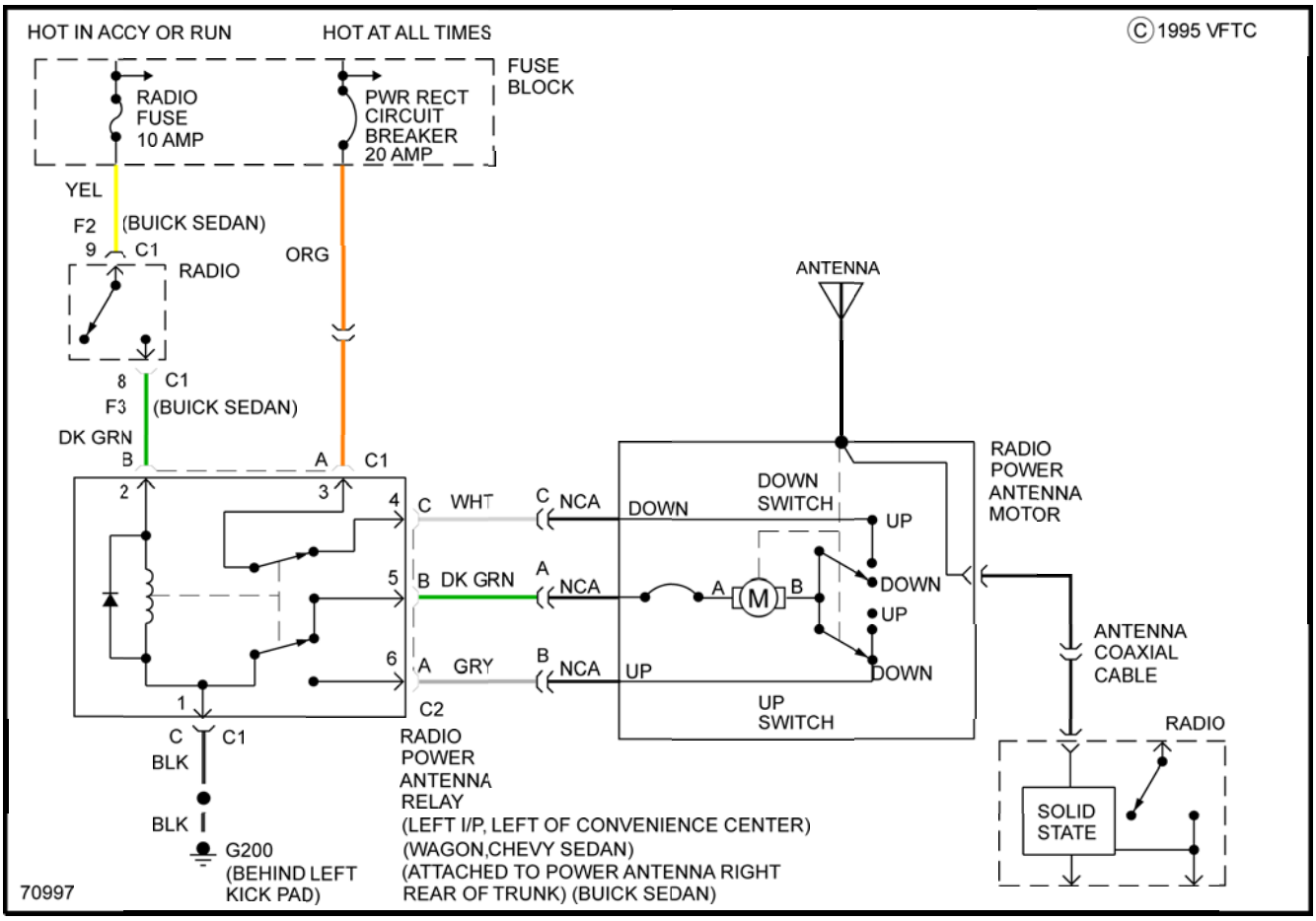


Fig. 31: Power Antenna Circuit

POWER DISTRIBUTION

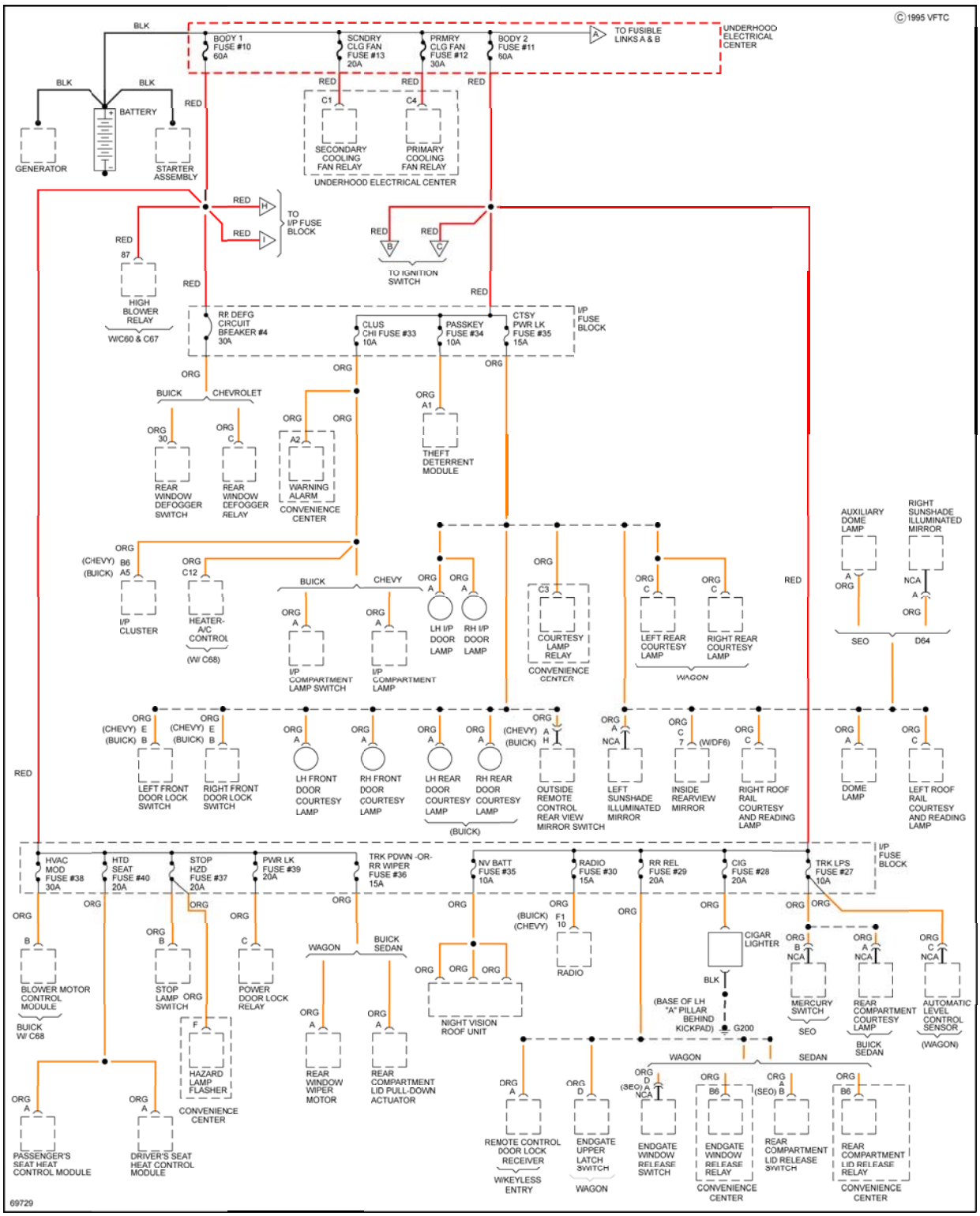


Fig. 32: Power Distribution Circuit (1 of 4)

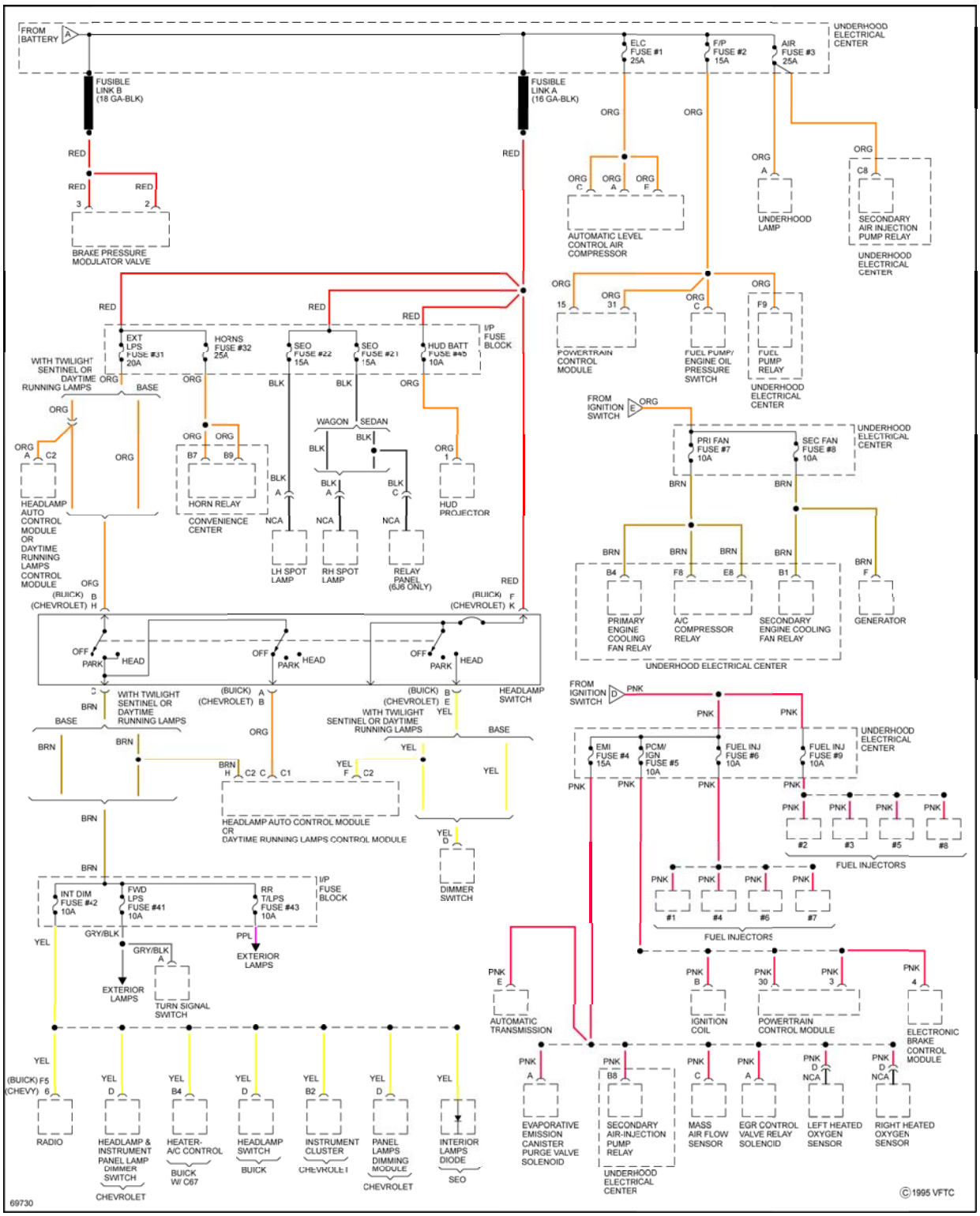


Fig. 33: Power Distribution Circuit (2 of 4)

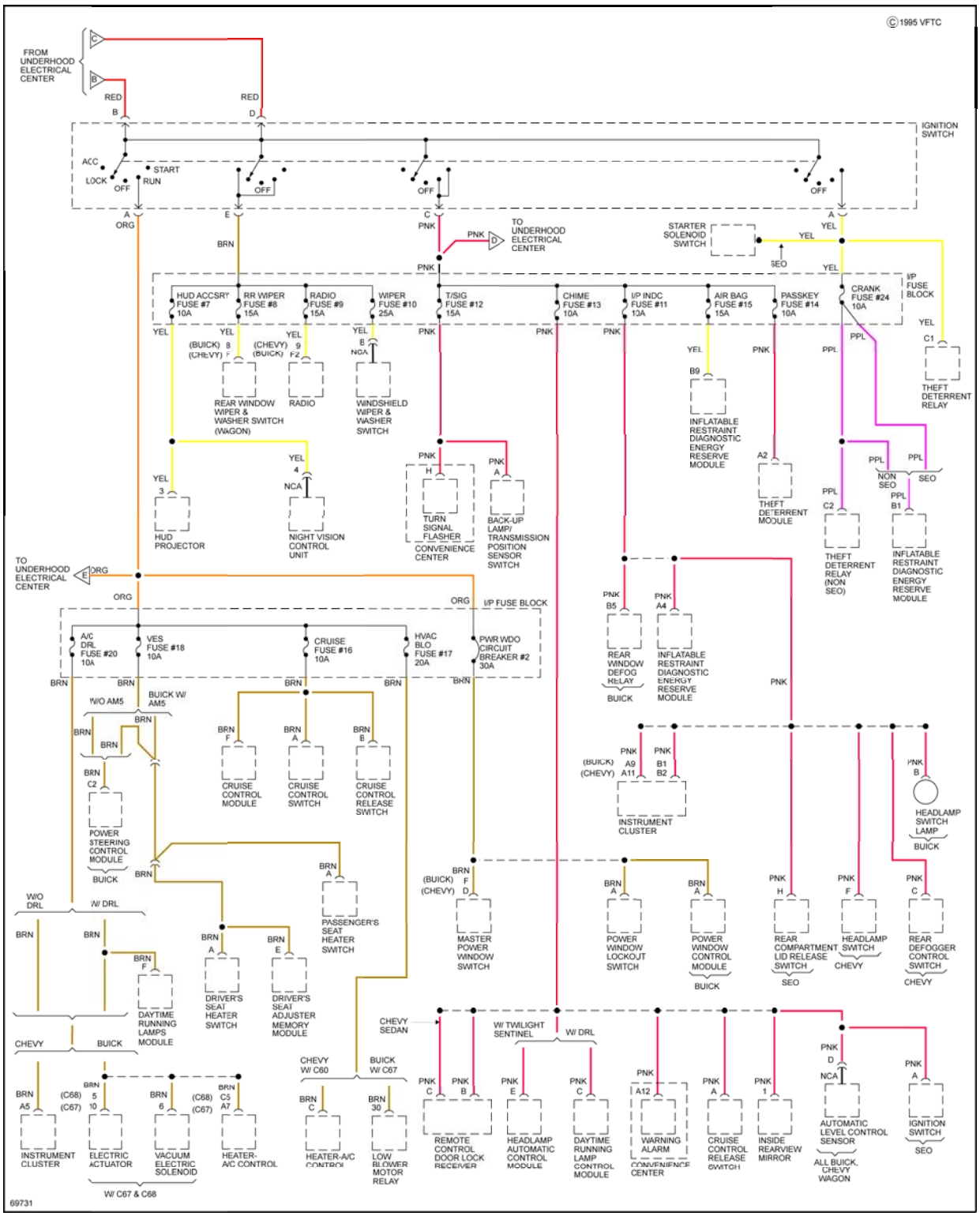


Fig. 34: Power Distribution Circuit (3 of 4)

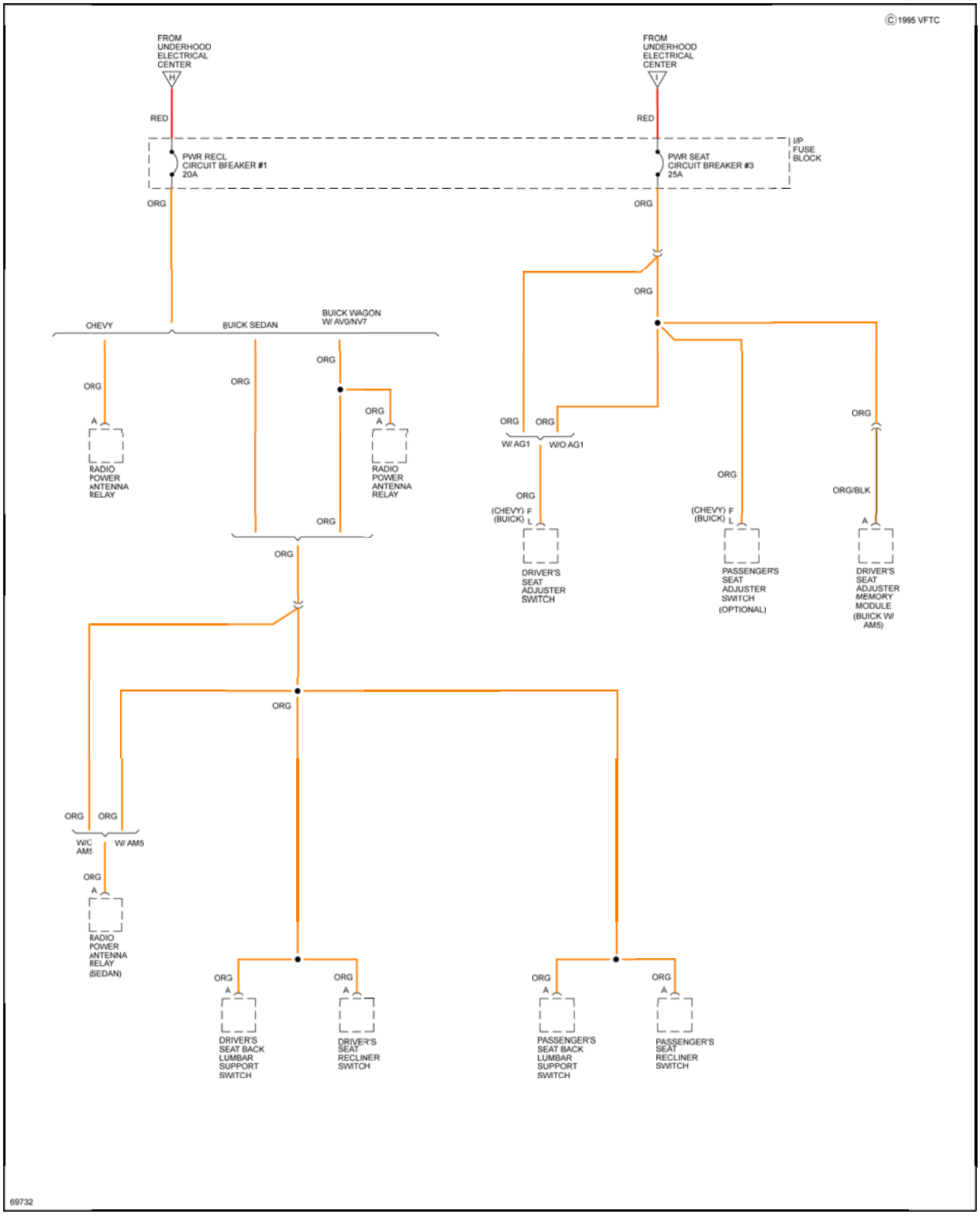


Fig. 35: Power Distribution Circuit (4 of 4)

POWER DOOR LOCKS

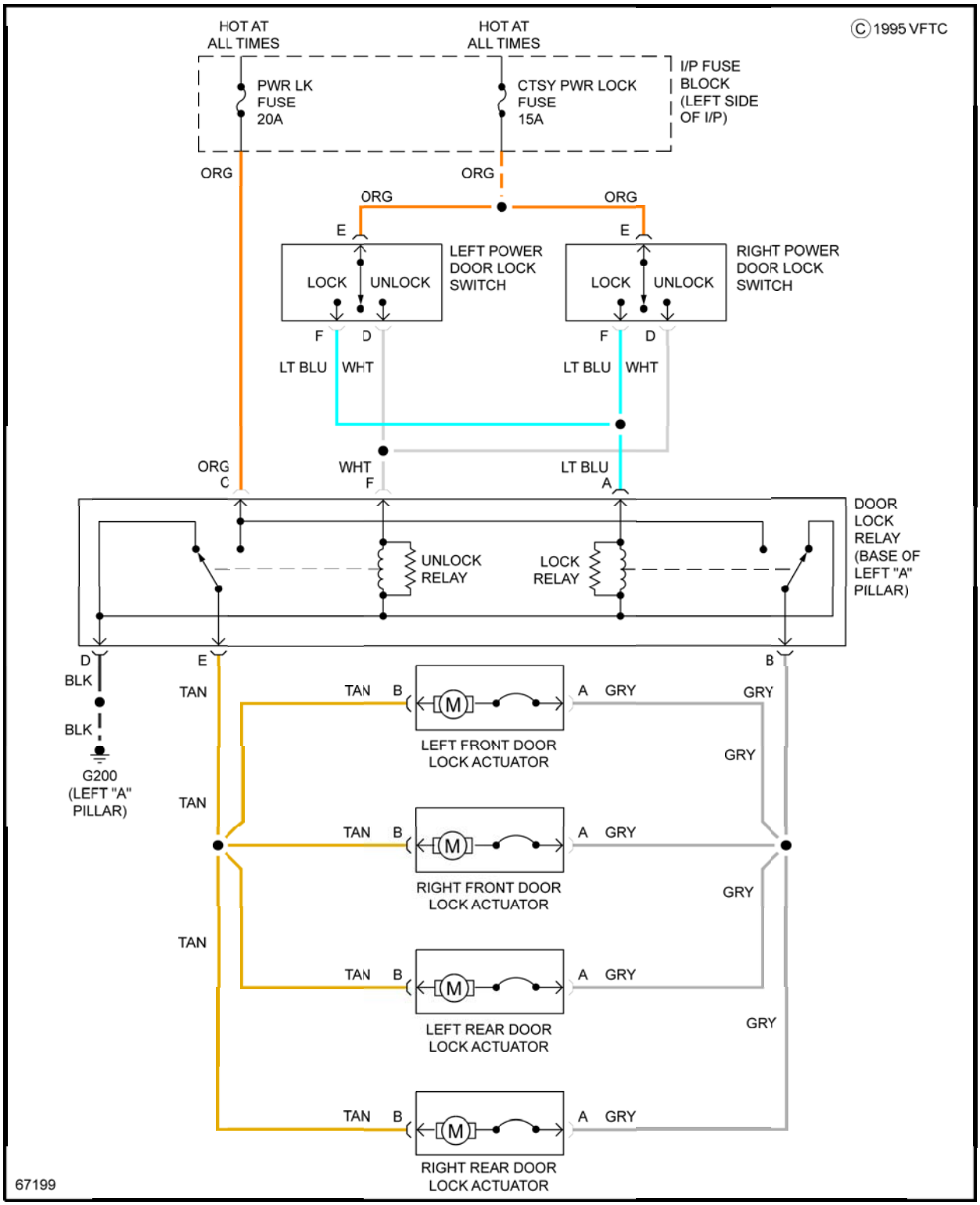


Fig. 36: Door Lock Circuit

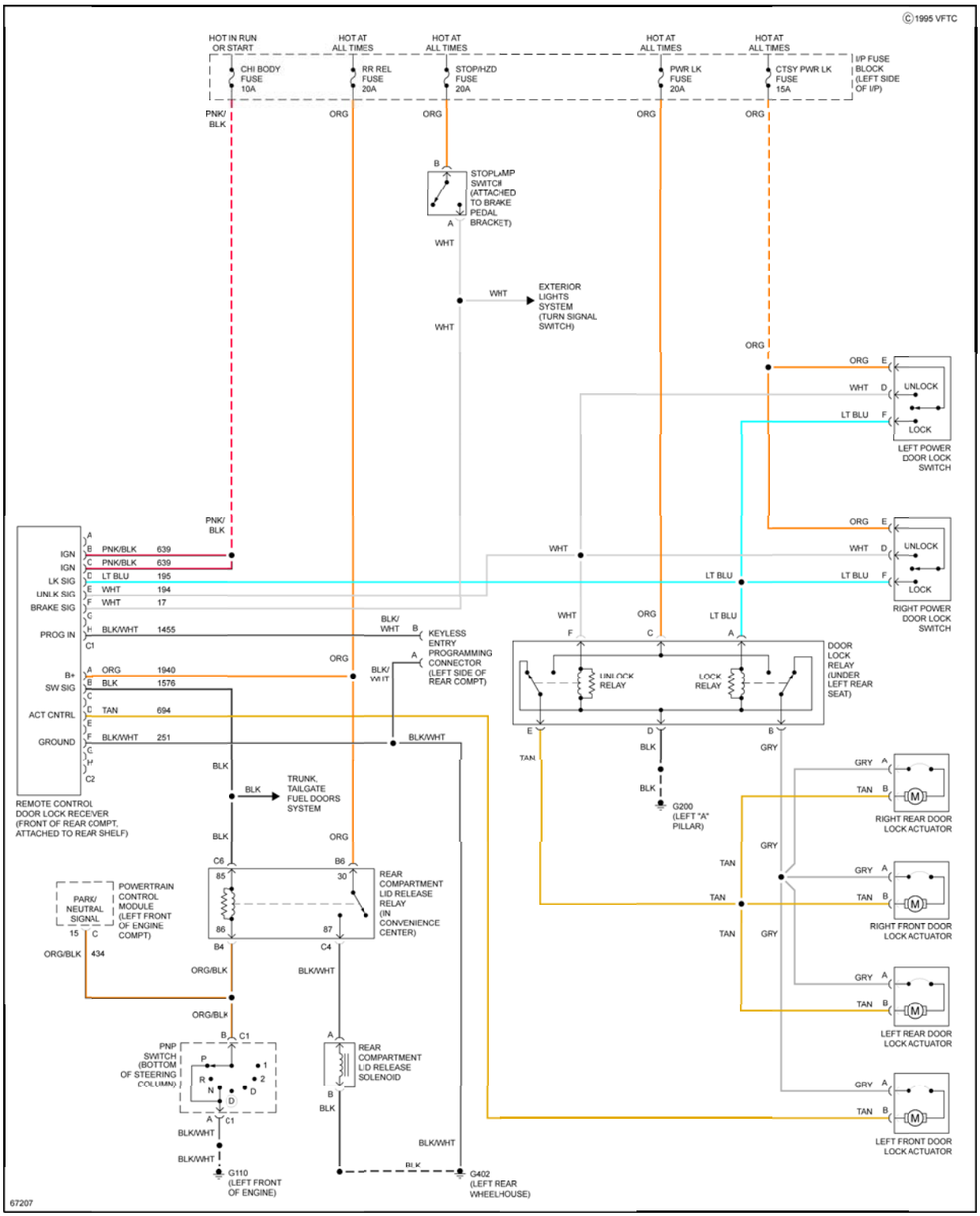


Fig. 37: Keyless Entry Circuit

POWER MIRRORS

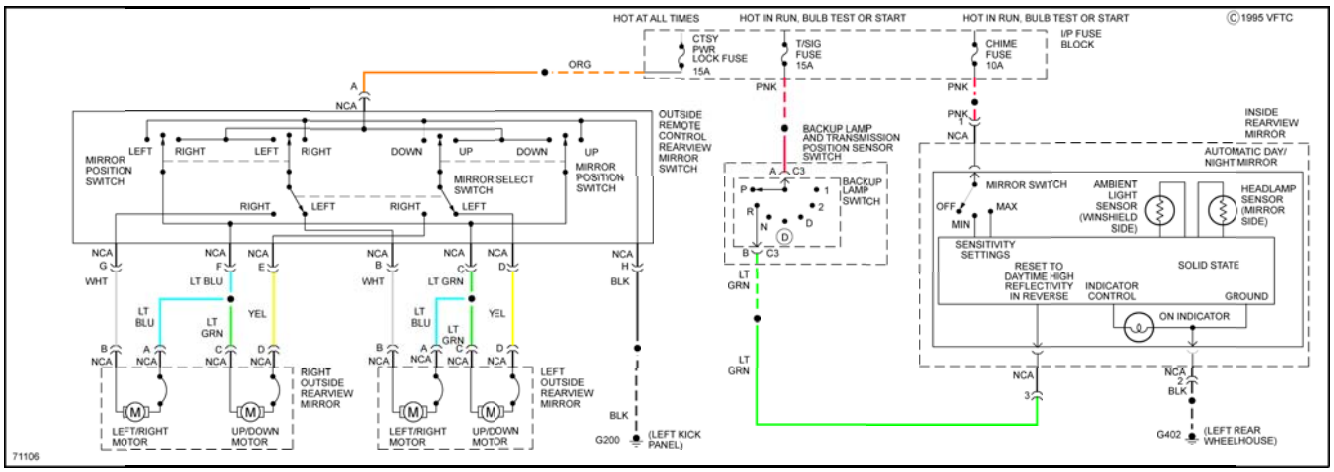


Fig. 38: Power Mirror Circuit

POWER SEATS

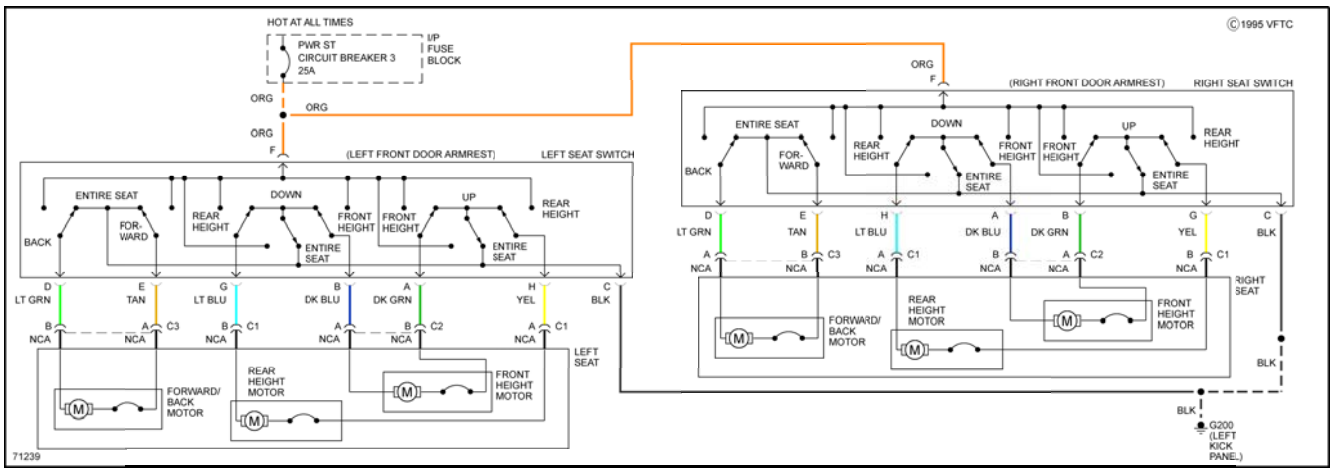


Fig. 39: 6-Way Power Seat Circuit

POWER WINDOWS

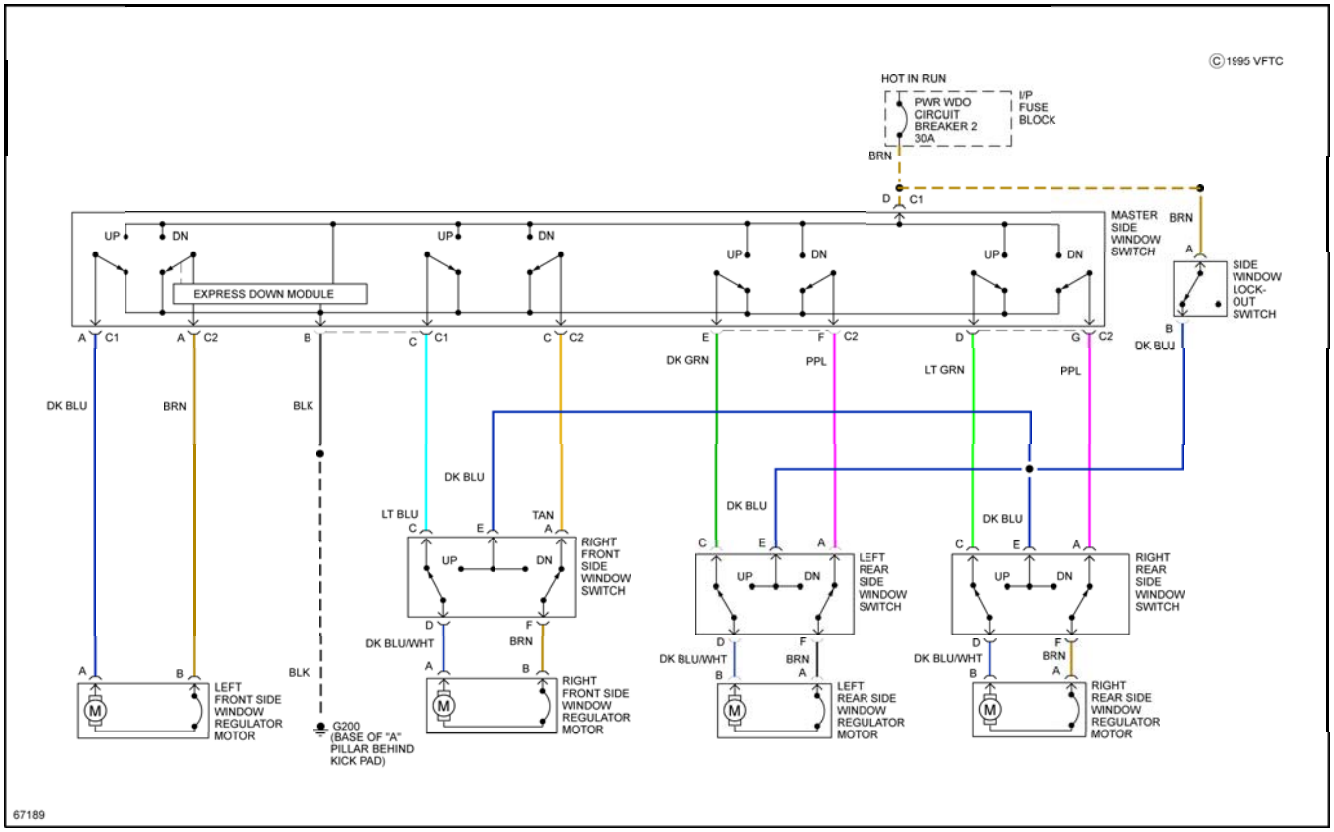


Fig. 40: Power Window Circuit

RADIO

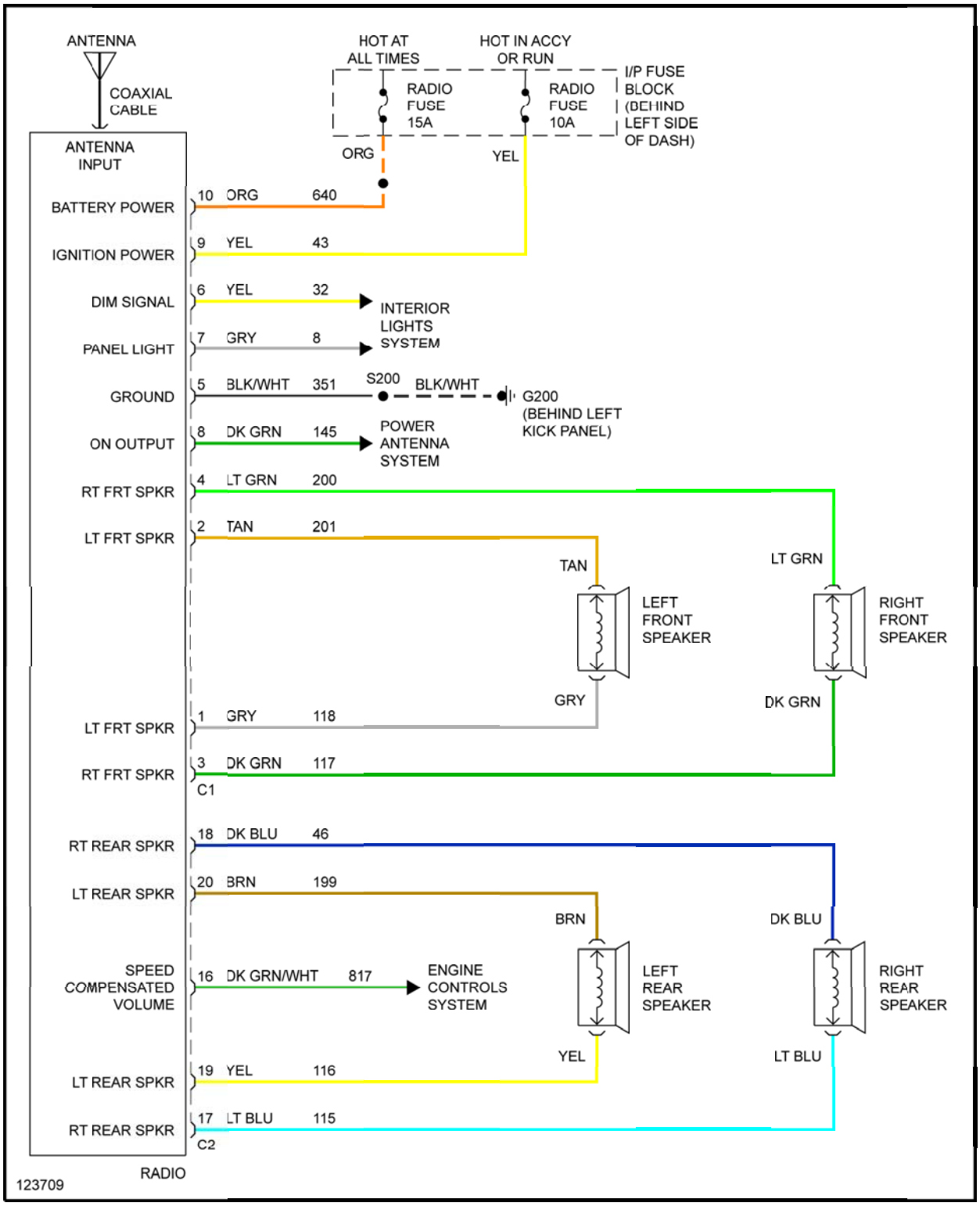


Fig. 41: Radio Circuits

SHIFT INTERLOCKS

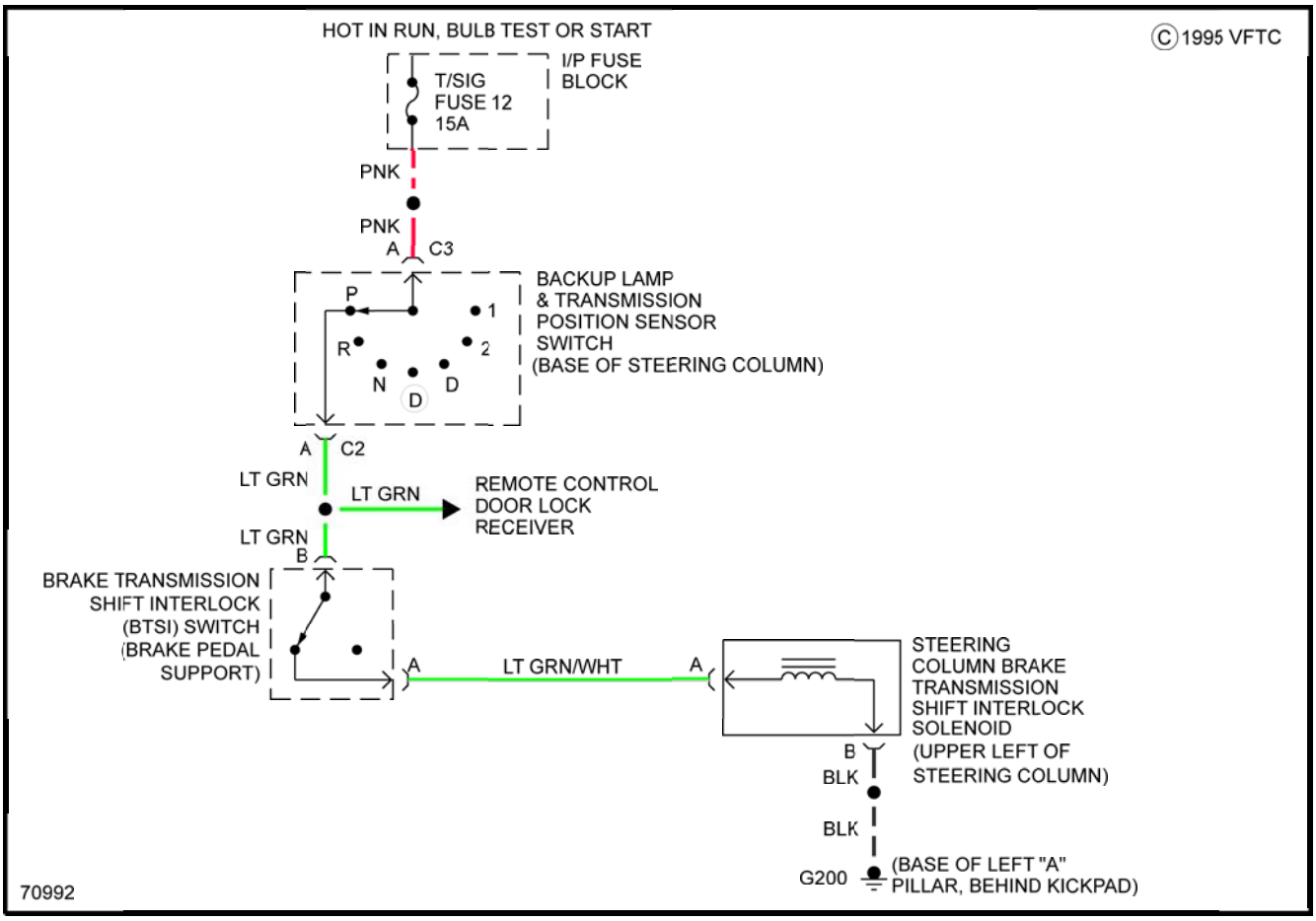


Fig. 42: Shift Interlock Circuit

STARTING/CHARGING

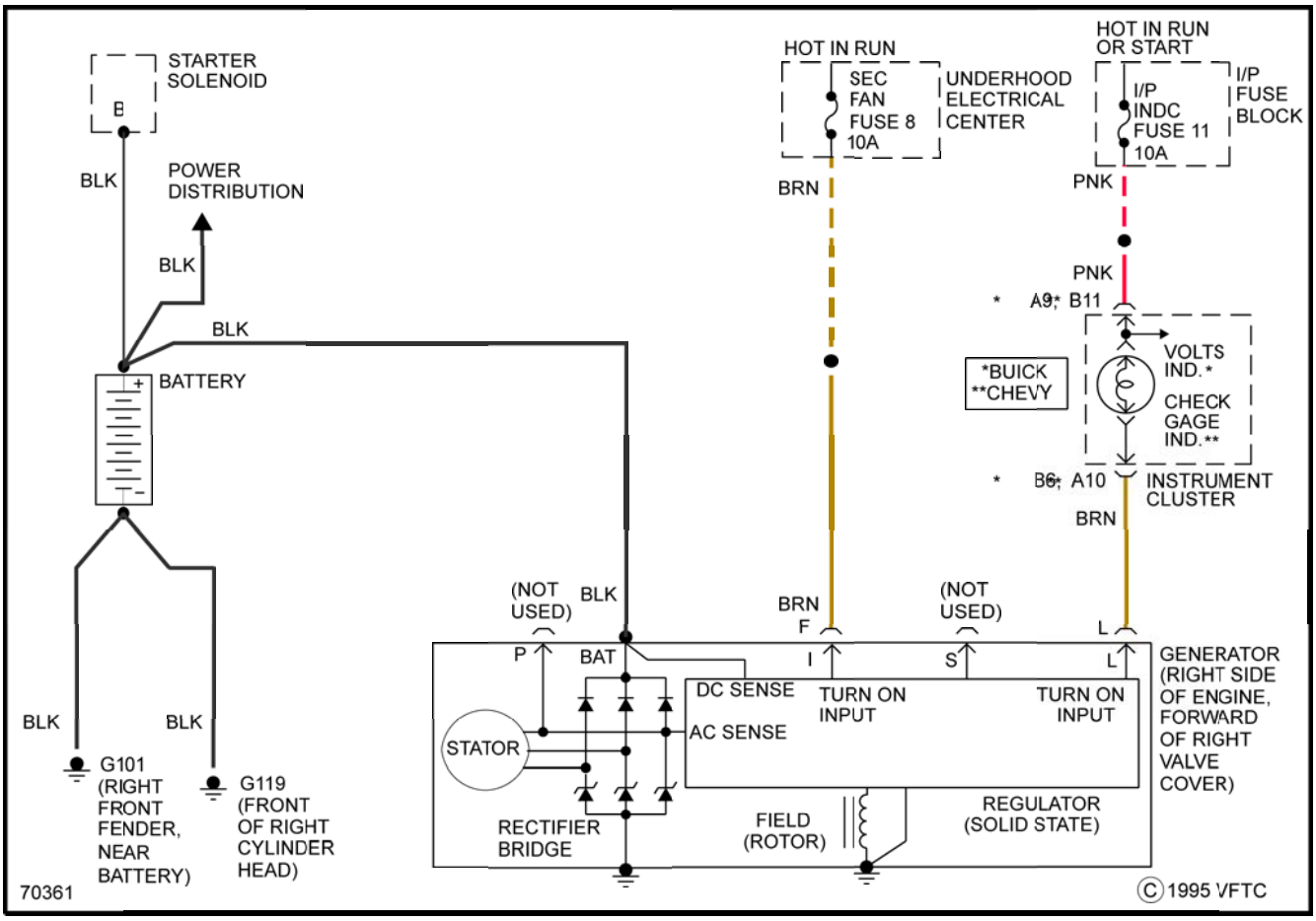


Fig. 43: Charging Circuit

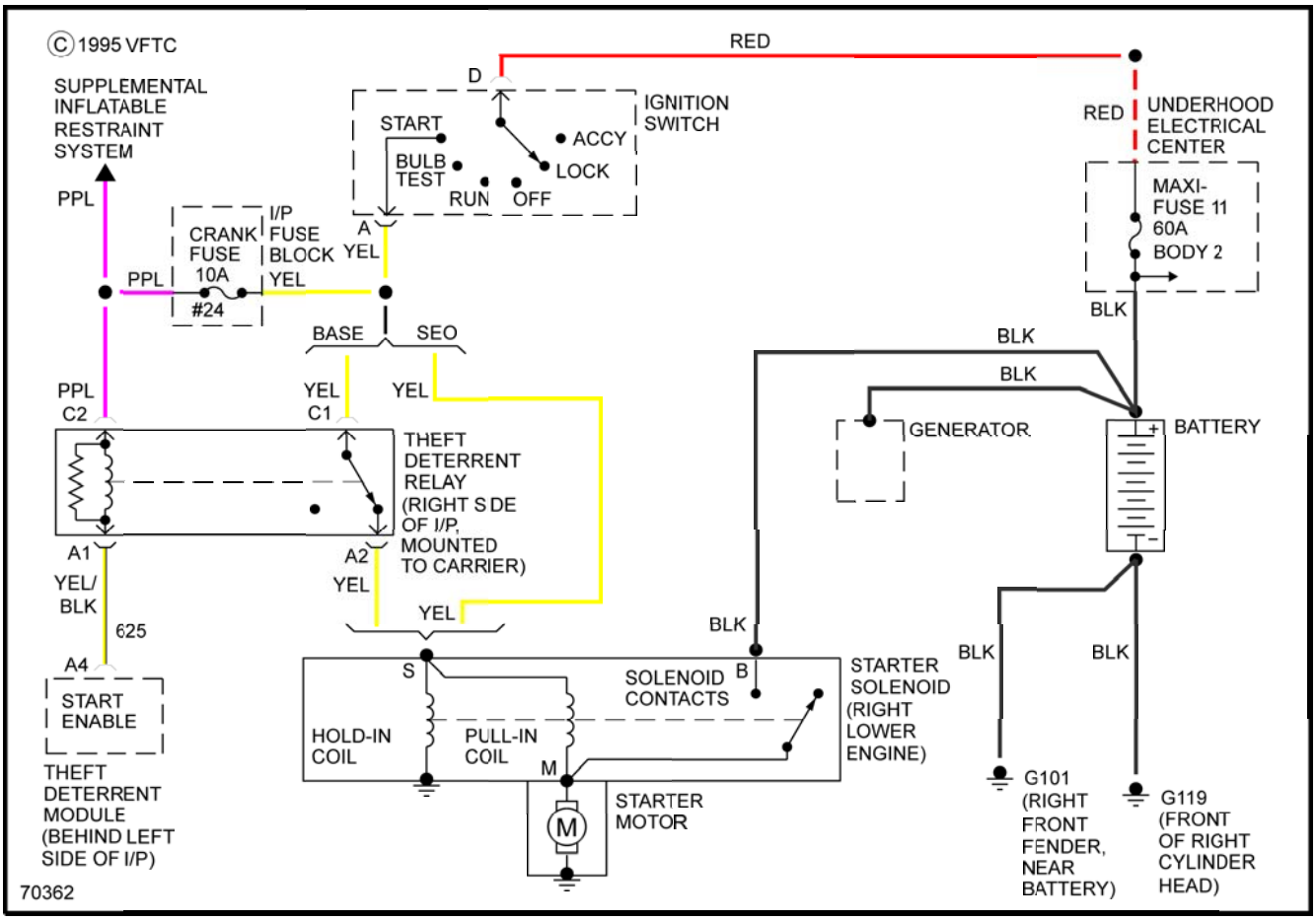


Fig. 44: Starting Circuit

SUPPLEMENTAL RESTRAINTS

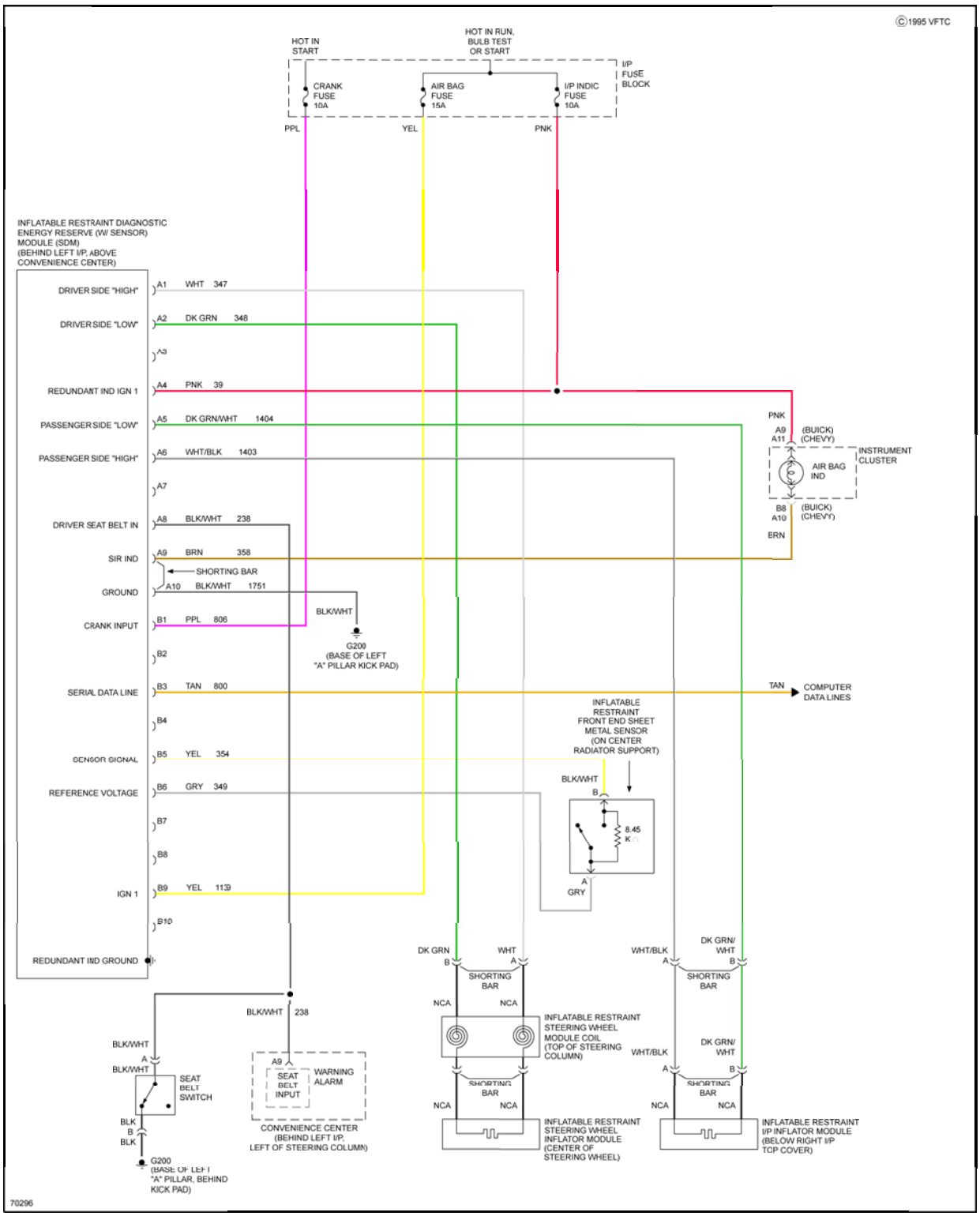


Fig. 45: Supplemental Restraint Circuit

TRANSMISSION

4.3L

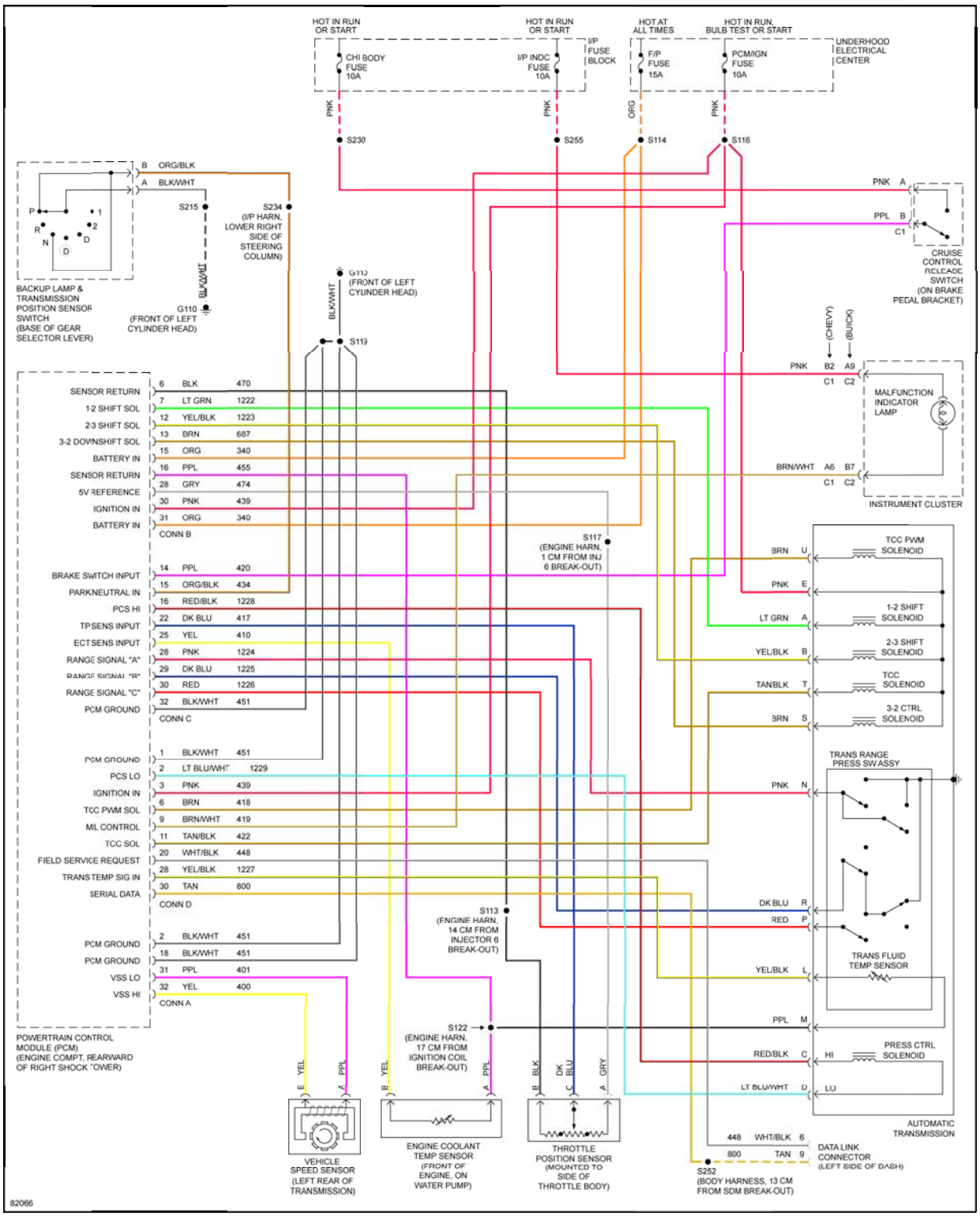


Fig. 46: 4.3L (VIN W), Transmission Circuit

5.7L

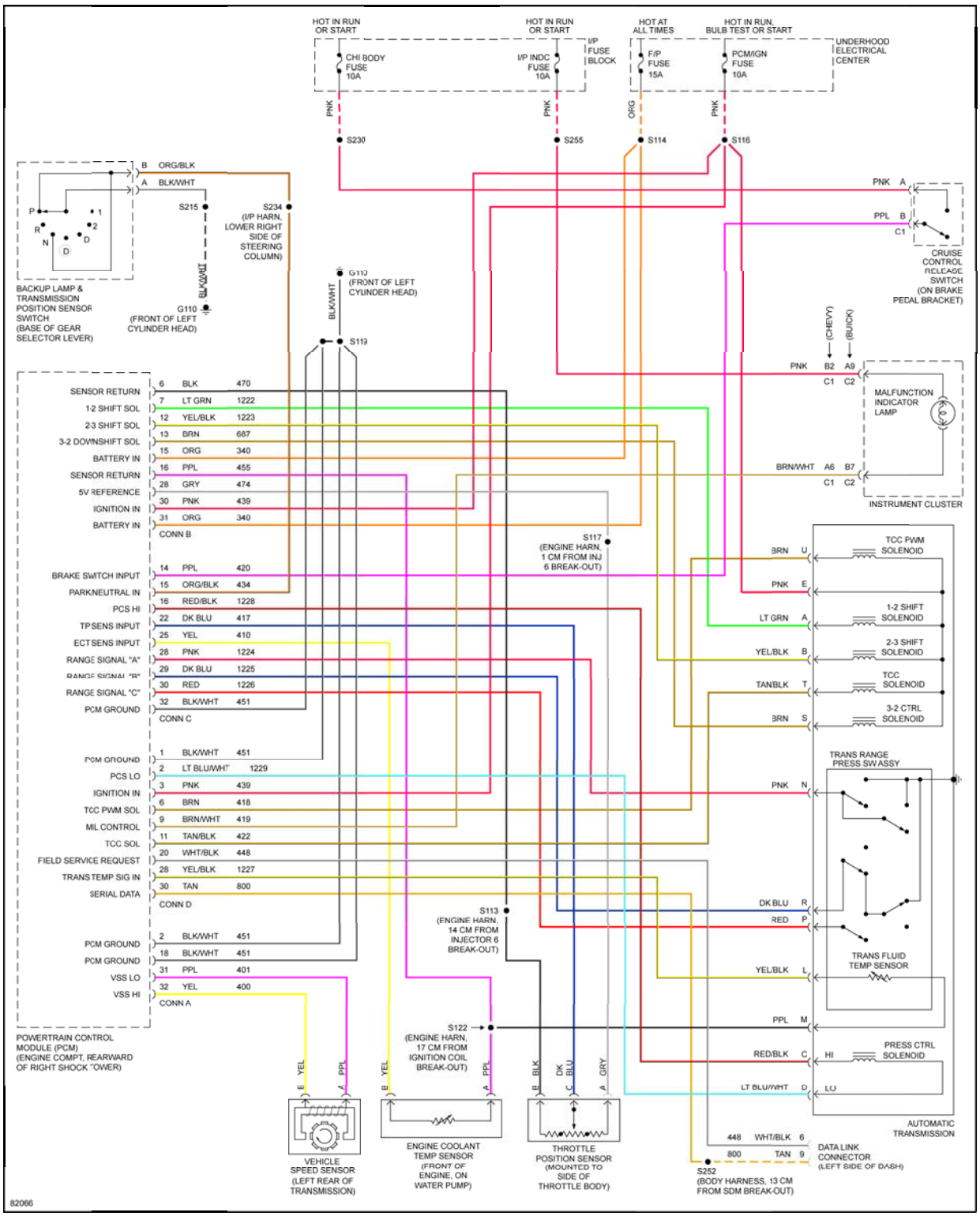


Fig. 47: 5.7L (VIN P), Transmission Circuit

TRUNK, TAILGATE, FUEL DOOR

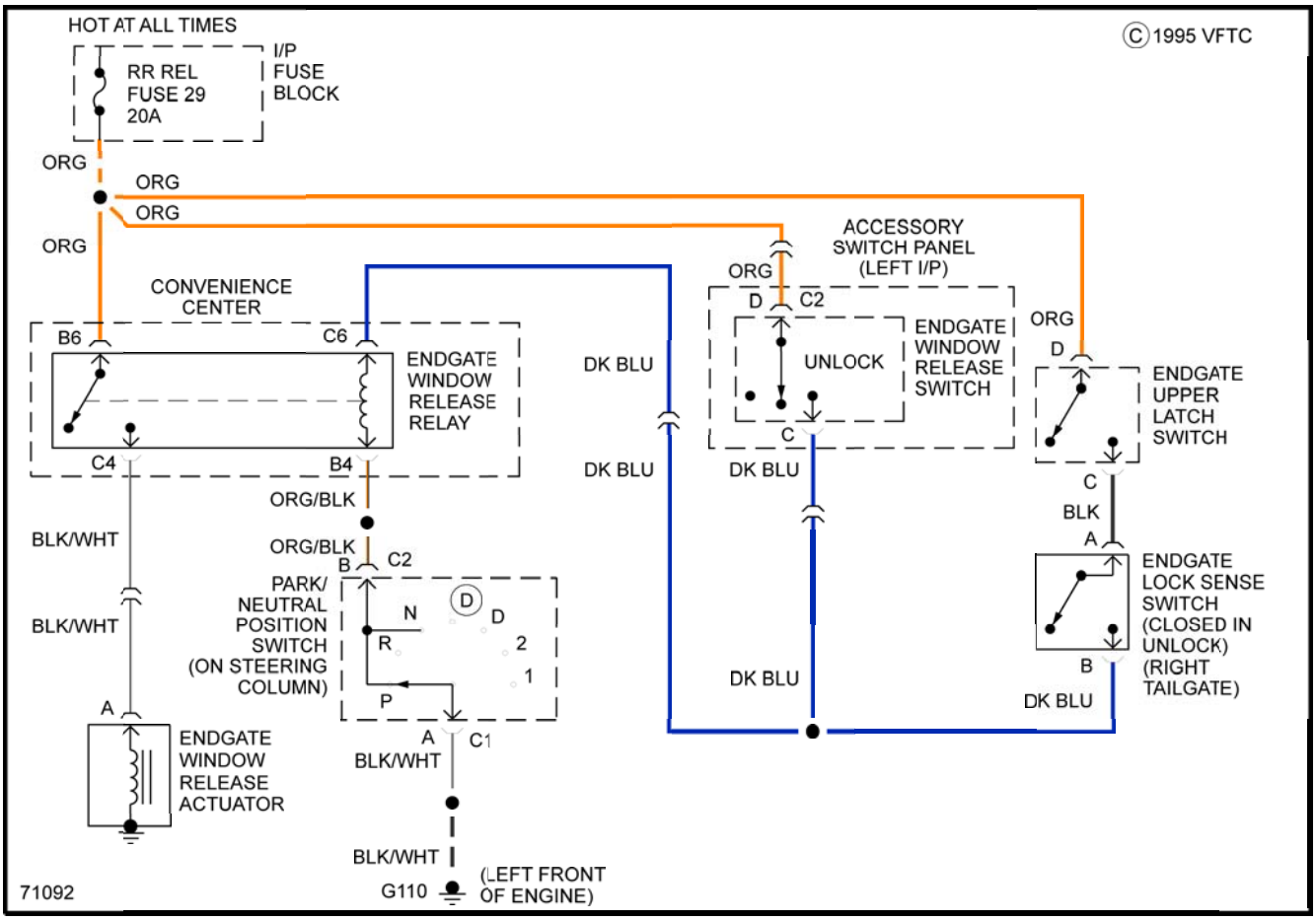


Fig. 48: Rear Glass Release Circuit, W/O Keyless Entry

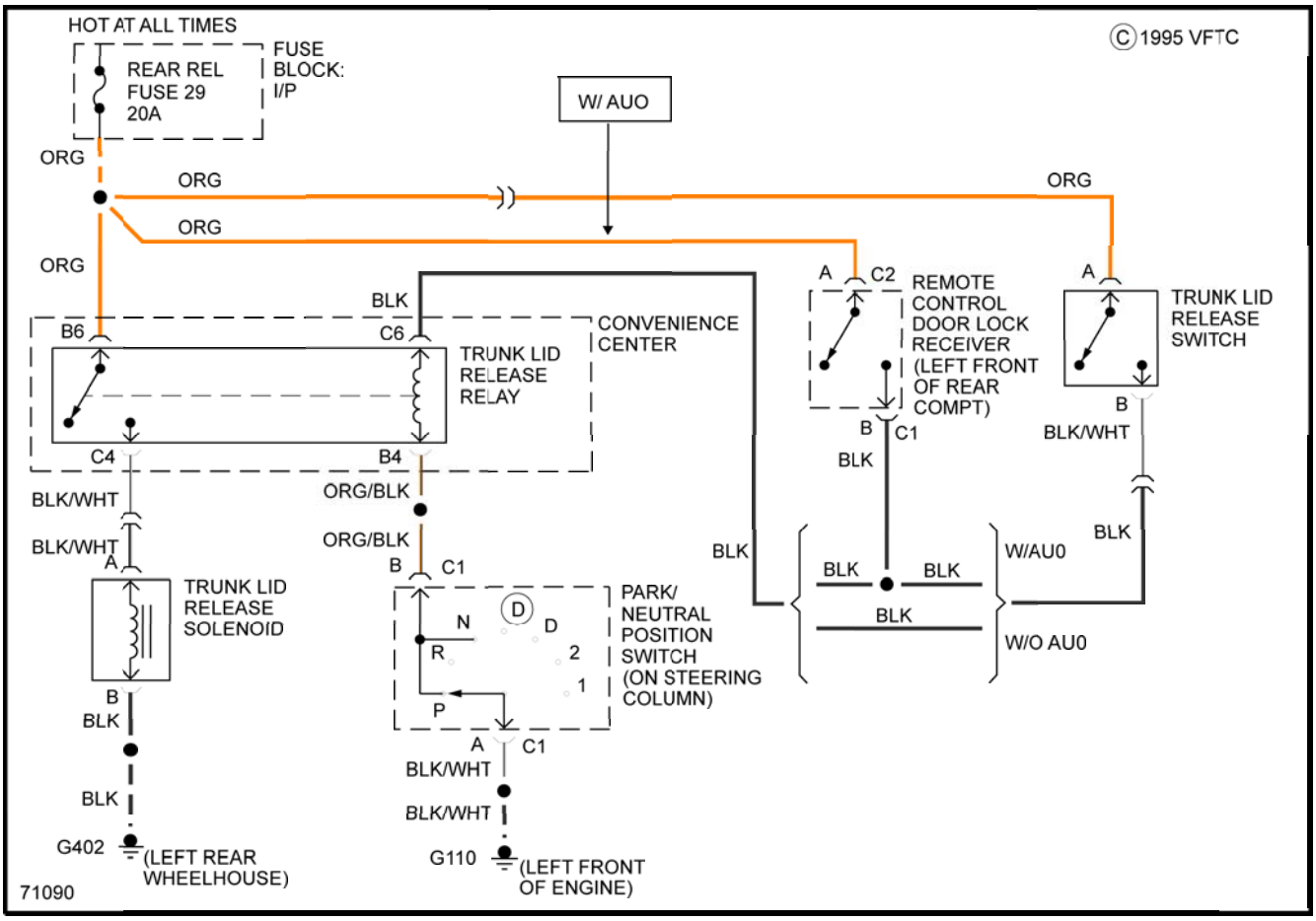


Fig. 49: Trunk Release Circuit, W/ Keyless Entry & SEO

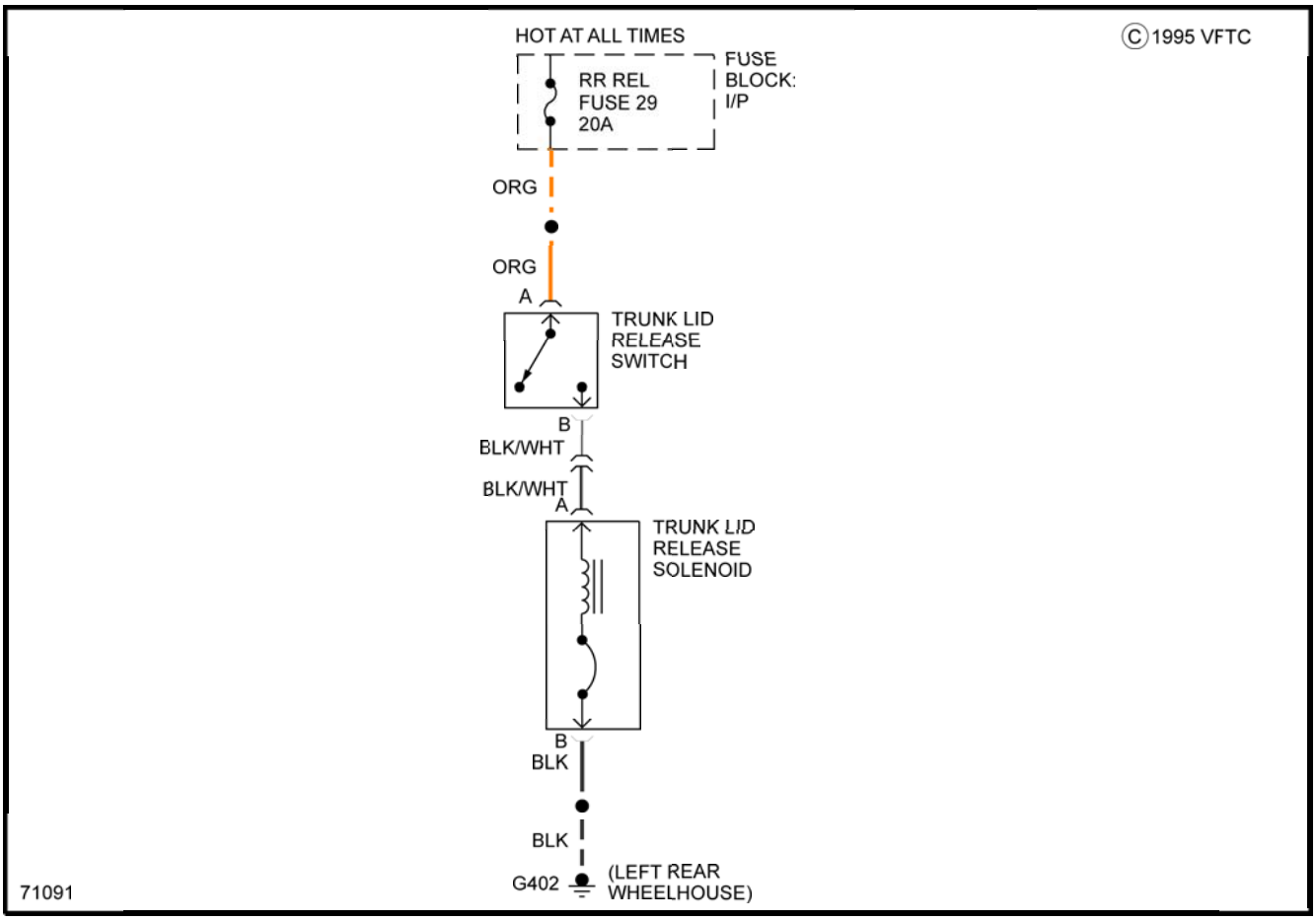


Fig. 50: Trunk Release Circuit, W/O Keyless Entry & SEO

WARNING SYSTEMS

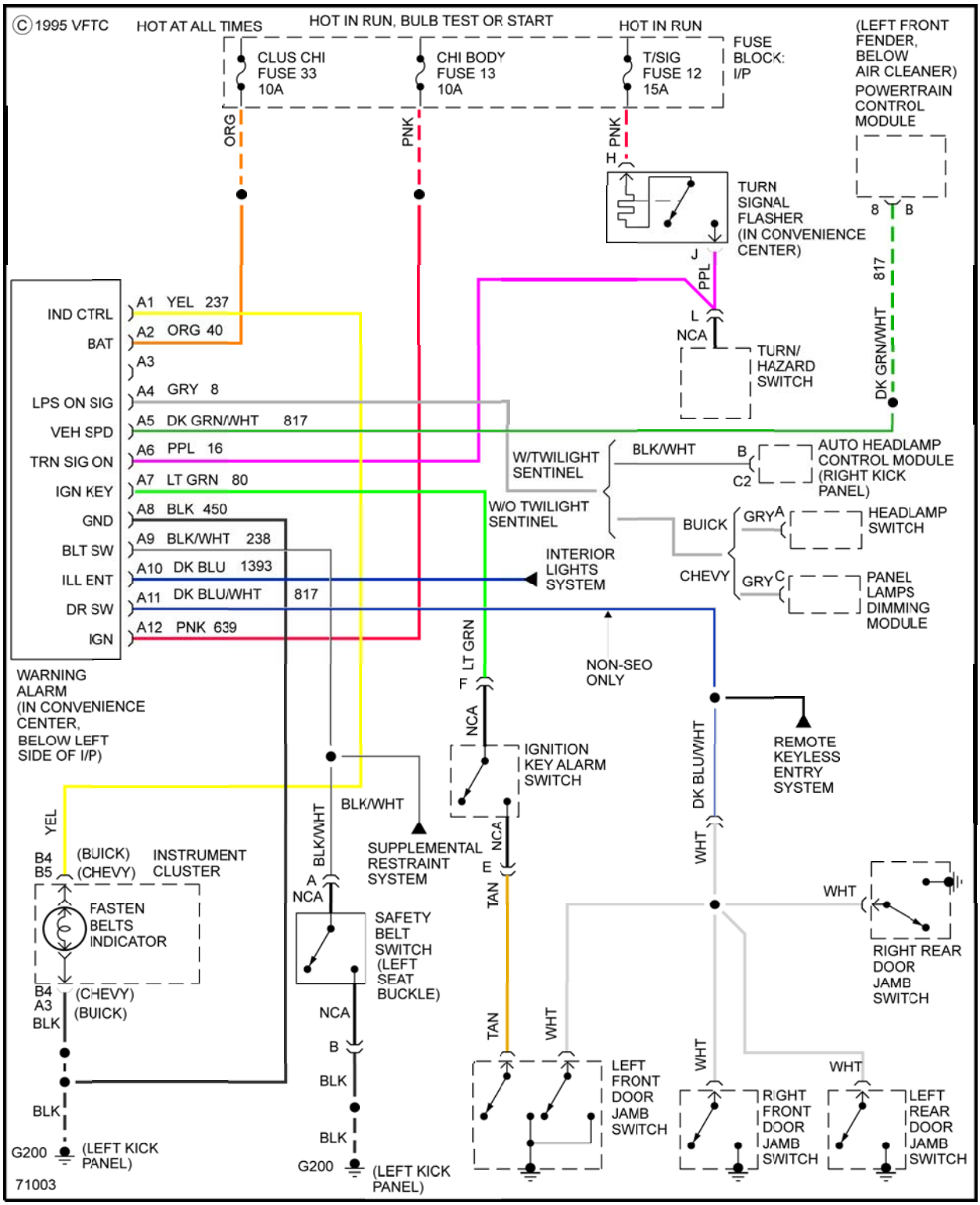


Fig. 51: Warning System Circuits

WIPER/WASHER

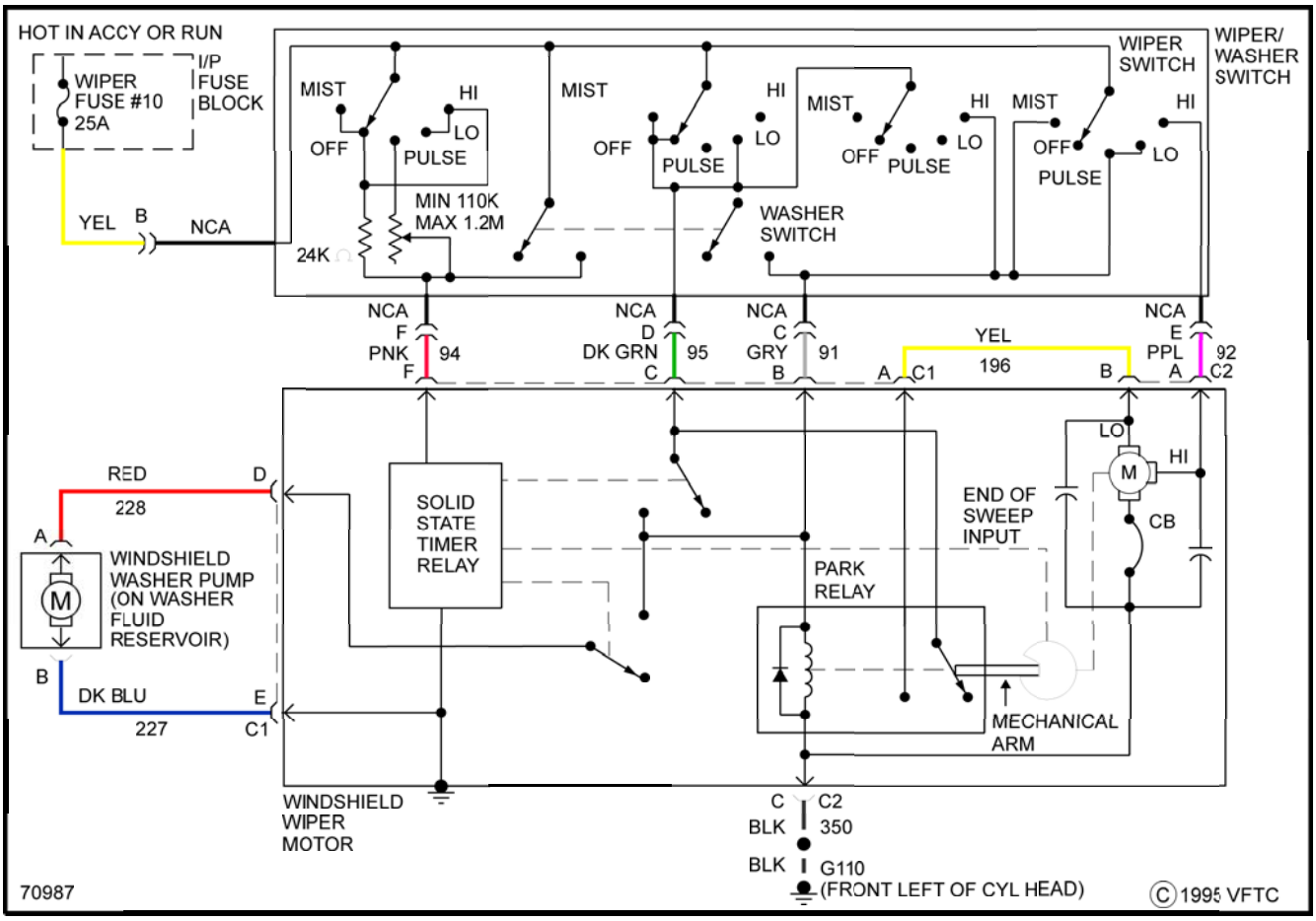


Fig. 52: Front Wiper/Washer Circuit

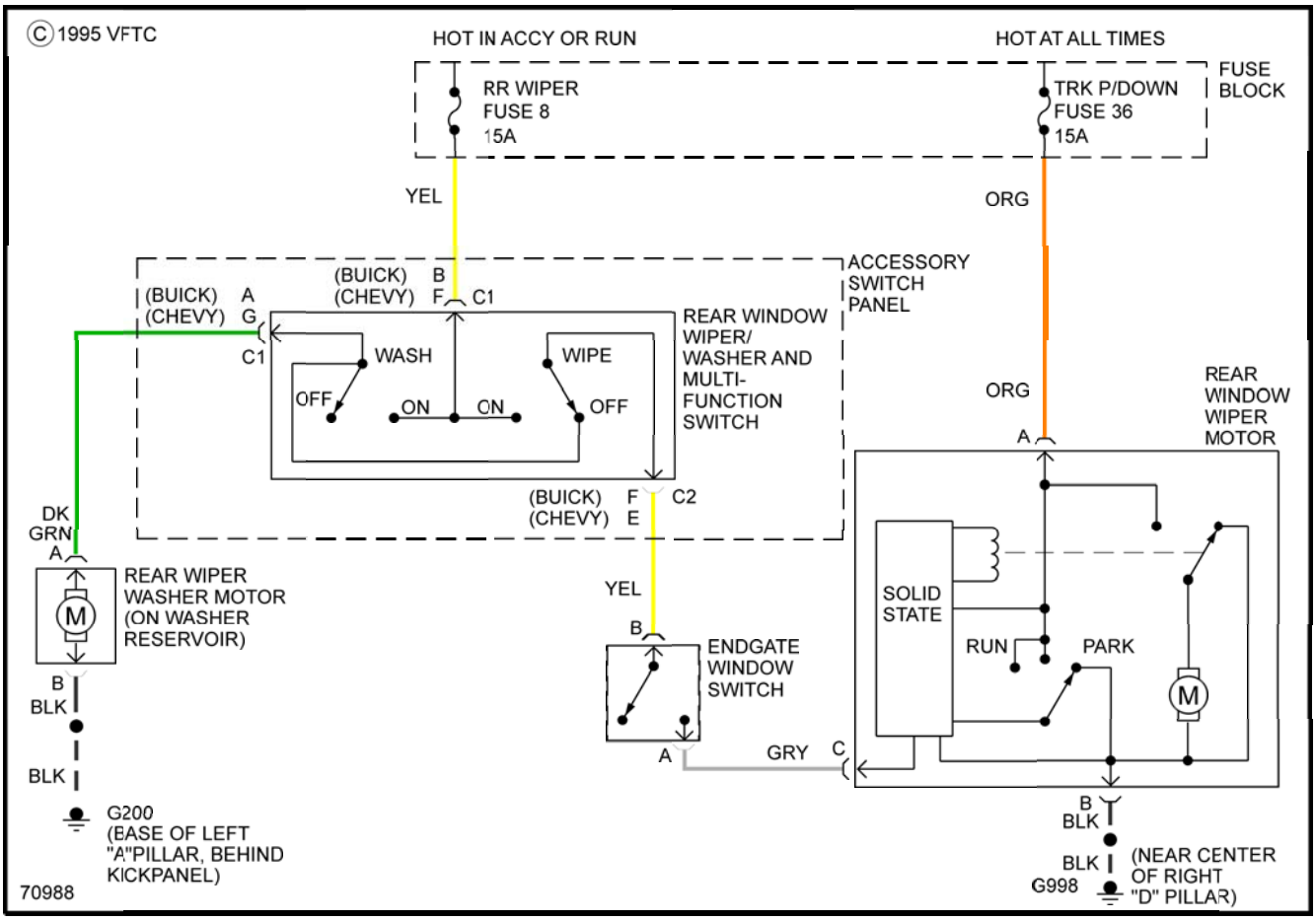


Fig. 53: Rear Wiper/Washer Circuit

H - TESTS W/O CODES

ENGINE PERFORMANCE General Motors Corp. Trouble Shooting - No Codes

INTRODUCTION

Before diagnosing symptoms or intermittent faults, perform steps in **BASIC TESTING** and appropriate TESTS W/CODES articles in the ENGINE PERFORMANCE section below. Use this article to diagnose driveability problems existing when a hard diagnostic trouble code is not present.

- **TESTS W/CODES - 4.3L** (for Caprice Only)
- **TESTS W/CODES - 5.7L** (for All Models)

Symptom checks are intended to direct the technician to malfunctioning component(s) so that further diagnosis may be performed. A symptom should lead to further testing of specific components or systems, or verification of adjustment specifications.

Use intermittent test procedures to locate intermittent driveability problems that do not occur when the vehicle is being tested. These problems may cause a noticeable driveability problem or cause the Malfunction Indicator Light (MIL) to illuminate on some vehicles.

It is also possible that certain driveability concerns have been rectified by the manufacturer through substitution of a revised PROM or Powertrain Control Module (PCM). Check with manufacturer for latest information on updated PROMs and PCMs.

NOTE: For specific testing procedures, see appropriate SYSTEM/COMPONENT TESTING article in the ENGINE PERFORMANCE section below. To verify specifications, see ADJUSTMENTS or SPECIFICATIONS article in the ENGINE PERFORMANCE section.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

SYMPTOMS

Before proceeding with any symptom diagnosis, perform all steps under PRELIMINARY CHECKS.

PRELIMINARY CHECKS

- Verify the on-car diagnostics are working by performing ON -BOARD DIAGNOSTIC (OBD) SYSTEM CHECK chart in **BASIC TESTING** article in the ENGINE PERFORMANCE section.
- Ensure the PCM and Malfunction Indicator Light (MIL) are functioning properly.
- Ensure there are no diagnostic trouble codes stored, or only intermittent codes are present.
- Ensure the fuel control system is operating properly. See **BASIC TESTING** article in the ENGINE PERFORMANCE section.

- Perform fuel system pressure test in **BASIC TESTING** article in the ENGINE PERFORMANCE section.
- Perform a careful visual inspection of all systems.

After all checks have been performed, verify customer complaint and locate correct symptom. Check items indicated under that symptom. Not all items listed under each symptom apply to all models and systems. These procedures will normally recommend testing of a system or component on vehicle, such as EGR, ignition control, TCC, etc. See appropriate SYSTEM/COMPONENT TESTING article in the ENGINE PERFORMANCE section below for test procedures.

- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)

NOTE: If PCM displays data but engine fails to start, proceed to NO START - ENGINE CRANKS OKAY in BASIC TESTING article in the ENGINE PERFORMANCE section.

SYMPTOM DIAGNOSIS

Symptom checks cannot be used properly unless problem occurs while vehicle is being tested. To reduce diagnostic time, ensure steps in **BASIC TESTING** and appropriate TESTS W/CODES articles in the ENGINE PERFORMANCE section below were performed before diagnosing a symptom. Symptoms available for diagnosis include:

- **TESTS W/CODES - 4.3L** (for Caprice Only)
- **TESTS W/CODES - 5.7L** (for All Models)
- Hard Start
- Hesitation, Sag Or Stumble
- Vehicle Surges Or Chuggles
- Lack Of Power, Sluggish Or Spongy
- Engine Backfires
- Cuts Out, Misses
- Rough, Unstable Or Incorrect Idle, Stalling
- Poor Fuel Economy
- Engine Dieseling/Run-On
- Detonation/Spark Knock
- Excessive Exhaust Emissions Or Odors

HARD START

Symptom Definition

Engine cranks okay, but does not start for a long time. Engine eventually starts, and may die immediately or run

okay.

Possible Cause & Correction

Check the following items:

- Check fuel pump relay by connecting test light between fuel pump relay connector ignition feed circuit and ground. Turn ignition on. Light should illuminate for 2 seconds. If light does not illuminate for 2 seconds, see FUEL PUMP RELAY under FUEL SYSTEM in appropriate SYSTEM/COMPONENT TESTING article in the ENGINE PERFORMANCE section below. For location of fuel pump test connector, see COMPONENT LOCATIONS in appropriate SYSTEM/COMPONENT TESTING article in the ENGINE PERFORMANCE section below. Check for blown injector fuse.
- Check for poor quality or water contaminated fuel.
- Visually inspect injector fuse(s).
- Check for a binding or sticking TP sensor, or high TP sensor voltage with throttle closed.
- Check EGR operation.
- Check for a leaking injector.
- Ensure resistance of engine coolant sensor circuit or engine coolant sensor is within specification. Refer to **SENSOR RANGE CHARTS** article in the ENGINE PERFORMANCE section.
- Check for proper ignition voltage output using Spark Tester (ST-125).
- Check for shorts by spraying plug wires with a fine mist of water.
- Remove spark plugs and check for wet plugs, cracks, improper gap, burned electrodes or heavy carbon deposits.
- Check fuel pressure.
- Check for loose ignition coil ground. Also check ignition coil fuse.
- Check for faulty in-tank fuel pump check valve (if equipped). A faulty in-tank fuel pump check valve will allow fuel in lines to drain back to tank after engine is stopped. To check this condition, turn ignition off, disconnect fuel pressure line at fuel rail and remove filler cap. Connect a radiator test pump and apply 15 psi (1.0 kg/cm^2) pressure. If pressure will hold for 60 seconds, check valve is okay.
- Ensure the installed PROM is correct for that particular vehicle. Check with dealer for latest application information.
- Check for restricted exhaust system.
- Check Idle Air Control (IAC) system. Check for vacuum leak at high idle. Check for binding of throttle blade or linkage. Check for foreign material in IAC bore of throttle body. Check for proper connection of IAC valve electrical connector. Check for failure of A/C compressor or relay.
- Check MAP or MAF sensor.
- Inspect crankshaft sensor clearance and resistance. Check harmonic balancer interrupter rings for bent or missing vanes.
- Check if crankcase ventilation valve is stuck open.
- Check basic engine mechanical problems (i.e. compression, valves).
- Check distributor vent system (if equipped).

HESITATION, SAG OR STUMBLE

Symptom Definition

Momentary lack of response when accelerator is pushed down. Condition occurs at all vehicle speeds or usually occurs when taking off from a stop. If severe enough, may cause engine to stall.

Possible Cause & Correction

Check the following items:

- Visually check vacuum hoses for splits, kinks and proper connections as shown on Vehicle Emission Control Information label.
- Check ignition wires for cracking, hardness and proper connections at both distributor cap and spark plugs.
- Check wires for pinches, cuts and proper connections.
- Check fuel pressure.
- Check for poor quality or water contaminated fuel.
- Check for fouled spark plugs.
- Ensure the installed PROM is correct for that particular vehicle. Check with dealer for latest application information.
- Check for a binding or sticking TP sensor. Voltage should increase steadily as throttle is moved toward Wide Open Throttle (WOT).
- Ensure PCM-controlled idle speed is correct.
- Check EGR operation.
- Check engine cooling system thermostat for proper operation and heat range.
- Check ignition control system ground circuit.
- Check canister purge system for proper operation.
- Check charging system output. Repair charging system if voltage is less than 9 or more than 17 volts.
- Check fuel injectors. Perform INJECTOR BALANCE TEST in SYSTEM/COMPONENT TESTS article in the ENGINE PERFORMANCE section below.
- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)
- Check injector harness locations. Ensure injectors are connected to correct injector/cylinder according to firing order.
- Check heated oxygen sensor ground (corroded threads in exhaust manifold).
- Check for air leaks between MAF sensor and throttle body.
- Check air induction system for restrictions.
- Check for intake valve deposits.
- Check MAP or MAF sensor.
- Check distributor vent system (if equipped).

VEHICLE SURGES OR CHUGGLES

Symptom Definition

Engine power varies under steady throttle or cruise. Vehicle speeds up and slows down without changing position of accelerator pedal.

Possible Cause & Correction

Check the following items:

- Visually check vacuum hoses for splits, kinks and proper connections as shown on Vehicle Emission Control Information label.
- Ensure Park/Neutral Position (PNP) switch is properly adjusted.
- Check for intermittent open or short to ground in Torque Converter Clutch (TCC) or HEI by-pass circuits.
- Check canister purge system for proper operation.
- Check ignition control system for proper operation.
- Check EGR system for proper operation.
- Ensure the installed PROM is correct for that particular vehicle. Check with dealer for latest application information.
- Check for adequate ignition voltage output using Spark Tester (ST-125).
- Check oxygen sensor for contamination. This will cause a false high voltage signal to PCM. PCM will respond by leaning air/fuel ratio.
- Check in-line fuel filter, and replace if dirty or clogged.
- Check fuel pressure while condition exists.
- Check for poor quality or water contaminated fuel.
- Remove spark plugs and check for wet plugs, cracks, improper gap, burned electrodes or heavy carbon deposits. Also, check condition of distributor cap, rotor and spark plug wires.
- Check charging system output. Repair charging system if voltage is less than 9 volts or more than 17 volts.
- Check A/C for excessive charge.
- Check for restricted exhaust system.
- Check injector harness locations. Ensure injectors are connected to correct injector/cylinder according to firing order.
- Ensure driver understands operation of TCC and A/C. See owner's manual.
- Check speedometer calibration.
- Check for rich or lean conditions. Drive vehicle at speed when complaint occurs.
- Check for plugged injectors. Perform INJECTOR BALANCE TEST in appropriate SYSTEM/COMPONENT TESTING article in the ENGINE PERFORMANCE section below.
- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)
- Ensure PCM grounds are clean and tight.

- Check for excessive use of additives in fuel.
- Check distributor vent system (if equipped).

LACK OF POWER, SLUGGISH OR SPONGY

Symptom Definition

Engine delivers less power than expected. Little or no increase in speed when accelerator is pushed down.

Possible Cause & Correction

Check following items:

- Ensure air filter and fuel filter are not plugged. Replace if necessary. Check for incorrect fuel pressure. Also check for contaminated fuel.
- Check shift solenoid system and TCC system for proper operation.
- Check knock sensor system for excessive retard.
- Check ignition control system for proper operation.
- Ensure EGR valve is not open all the time.
- Check exhaust system for restrictions, such as a damaged or collapsed pipe, muffler or catalytic converter.
- Check charging system output. Repair charging system if voltage is less than 9 volts or more than 17 volts.
- Check for A/C clutch cutout at wide open throttle.
- Check MAP sensor.
- Using Spark Tester (ST-125), check for available secondary voltage.
- Check air induction system for restrictions.
- Check engine valve timing and compression.
- Ensure the installed PROM is correct for that particular vehicle. Check with dealer for latest application information.
- Check PCM grounds for clean, tight connections.
- Check for incorrect or worn camshaft.
- Check for excessive fuel additives.
- Check for binding accelerator cable.
- Check distributor vent system (if equipped).
- Check engine supercharger (if equipped).
- Check if engine is operating in power management mode (if equipped).
- Check boost control system components and connections (if equipped).

ENGINE BACKFIRES

Symptom Definition

Fuel ignites in intake manifold or in exhaust system, making a loud popping noise.

Possible Cause & Correction

Check following items:

- Check for proper valve timing.
- Check for engine vacuum leaks and/or engine not tuned to specifications.
- Check secondary air injection system.
- Check EGR valve for leaking base gasket or valve hanging open.
- Check engine for sticking or leaking valves.
- Check for fuel or water in vacuum hose to MAP sensor. Also check for restricted hose.
- Check fuel injectors. Perform INJECTOR BALANCE TEST in appropriate SYSTEM/COMPONENT TESTING article in the ENGINE PERFORMANCE section below.
- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)
- Check fuel system. Perform BASIC FUEL SYSTEM CHECKS in **BASIC TESTING** article in the ENGINE PERFORMANCE section.
- Using Spark Tester (ST-125), check available output voltage of ignition coil.
- Check for crossfire between spark plugs, distributor cap and spark plug wires.
- Remove spark plugs and check for wet plugs, cracks, improper gap, burned electrodes or heavy carbon deposits. Also, check condition of distributor cap, rotor and spark plug wires.
- Check for an intermittent ignition system problem.
- Check intake and exhaust manifold passages for casting flash.
- Check distributor vent system (if equipped).
- Check harmonic balancer interrupter rings for missing, broken or bent vanes.

CUTS OUT, MISSES

Symptom Definition

Cuts out or misses is a steady pulsation or jerking that follows engine speed and is usually more pronounced as engine load increases. Exhaust may have a steady spitting sound at idle or low speed. Perform a careful visual inspection as described in **BASIC TESTING** article in the ENGINE PERFORMANCE section.

Possible Cause & Correction

Check following items:

- Check ignition wires for short or faulty insulation.
- Check distributor cap (if equipped) for moisture, dust or cracks. Spray spark plug wires with a fine mist of water to check for shorts.
- Using Spark Tester (ST-125), check for available secondary voltage.

- Check ignition system for faulty grounds.
- Ensure ignition control wiring harness is not routed too close to wiring which may cause induced voltage signals.
- Check ignition coil connections.
- Remove spark plugs and check for correct heat range, wear, cracks, wetness, improper gap or heavy deposits.
- Check for poor quality or water contaminated fuel.
- Check for improper fuel pressure. Check for restricted fuel filter.
- Check for plugged injectors. See INJECTOR BALANCE TEST in appropriate SYSTEM/COMPONENT TESTING article in the ENGINE PERFORMANCE section below.
- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)
- Check PCM for proper ground circuits. Check for internal PCM intermittents.
- Check for bent push rods, broken valve springs or worn camshaft lobes.
- Check for EGR valve sticking open.
- Check TP sensor for sticking and binding. TP sensor voltage should be less than 1.25 volts at idle.
- Check for proper crank angle sensor (DIS and IDI) or pick-up coil (HEI distributor) resistance.
- Check for restricted exhaust system.
- Check injector drivers by disconnecting all injector harness connectors and connecting a 6-volt test light to each injector's harness terminal. Light should blink while cranking.
- Check engine compression. Check for incorrect valve timing.
- Check intake and exhaust manifold passages for casting flash.
- Check distributor vent system (if equipped).

Misfire Isolation

1. Start engine. Disconnect IAC motor. Using insulated pliers, remove one spark plug wire from a spark plug and ground it against the engine.
2. Note engine RPM as wire is grounded. Reconnect spark plug wire. Repeat procedure for all cylinders. Stop engine and reconnect IAC motor.
3. If engine speed dropped equally (within 50 RPM) on all cylinders, see ROUGH, UNSTABLE OR INCORRECT IDLE, STALLING symptom. If there is no engine RPM drop or if there is excessive variation on one or more cylinder, check spark on the respective cylinder(s).

ROUGH, UNSTABLE OR INCORRECT IDLE, STALLING

Symptom Definition

Engine runs unevenly at idle. If bad enough, vehicle will shake. Idle may vary in RPM. Either problem may cause stalling. Engine idles at incorrect RPM.

Possible Cause & Correction

Check following items:

- Ensure throttle linkage and/or TP sensor is not sticking or binding. Ensure throttle bore is free of foreign material.
- Check for vacuum leaks.
- Check engine idle speed (both base idle and PCM idle).
- Check Idle Air Control (IAC) system. Check for vacuum leak or high idle. Check for water contaminated fuel, correct fuel pressure or a restricted injector. Check for foreign material in IAC bore of throttle body. Check for proper connection of IAC valve electrical connector. Check for failure of A/C compressor or relay.
- Check for proper operation of EGR system.
- Check Park/Neutral Position (PNP) switch circuit. Ensure PNP switch is properly adjusted.
- Check power steering pressure switch operation.
- Check charging system output. Repair charging system if voltage is less than 9 volts or more than 17 volts.
- Check for fuel in pressure regulator hose. If fuel is present, replace regulator.
- Check evaporative emission control system.
- Check for proper spark plug gap, and check engine compression.
- Check PCM grounds for clean and tight connections.
- Check A/C signal to PCM. If problem exists only when A/C is on, check A/C system operation and pressures.
- Check for broken motor mounts.
- Ensure the installed PROM is correct for that particular vehicle. Check with dealer for latest application information.
- Check MAP or MAF sensor for proper operation.
- Check oxygen sensor operation. Check for silicone contamination or incorrect RTV sealant.
- Check for excessive fuel additives.
- Check for shorted or open injector windings.
- Check for leaking injectors. Perform INJECTOR BALANCE TEST in appropriate SYSTEM/COMPONENT TESTING article in the ENGINE PERFORMANCE section.
- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)
- Check injector harness locations. Ensure injectors are connected to correct injector/cylinder according to firing order.
- If rough idle only occurs when engine is hot, check crankcase ventilation valve operation. Check for manifold vacuum at inlet end of crankcase vent tube assembly with engine idling.
- Check ignition system. Check for moisture, dust, cracks, burns, etc. Check for shorts by spraying spark plug wires with a fine water mist. Check ignition wires for shorts and faulty insulation.
- Check to see if condition is caused by engine running either rich or lean.
- Check air injection system.
- Check for worn camshaft or weak valve springs.

- Check engine coolant temperature sensor for proper temperature-to-resistance values.
- Check distributor vent system (if equipped).
- Check exhaust system for restrictions, such as a damaged or collapsed pipe, muffler or catalytic converter.

POOR FUEL ECONOMY

Symptom Definition

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Fuel economy is noticeably lower than was on this vehicle at one time.

Possible Cause & Correction

Check the following items:

- Visually check vacuum hoses for splits, kinks and proper connections as shown on Vehicle Emission Control Information label.
- Check for dirty or clogged air filter.
- Check coolant level. Check engine cooling system thermostat for proper heat range and operation.
- Check engine coolant sensor for shift in calibration. See **SENSOR RANGE CHARTS** article in the ENGINE PERFORMANCE section.
- Check A/C for "full time" operation.
- Ensure initial ignition timing is properly set, and check for proper operation of ignition control and knock sensor systems.
- Check TCC for proper operation.
- Check air intake system and crankcase for air leaks.
- Check exhaust system for restrictions, such as a damaged or collapsed pipe, muffler or catalytic converter.
- Check oxygen sensor for silicone or lead contamination.
- Remove spark plugs and check for wet plugs, cracks, improper gap, burned electrodes or heavy carbon deposits.
- Ensure speedometer is properly calibrated.
- Check fuel pressure.
- Check EGR valve for proper operation.
- Check boost control system (if equipped).
- Check engine compression.
- Check for dragging brakes.
- Check distributor vent system (if equipped).
- Check for correct tire pressure. Check with operator to see if vehicle is operated under excessive acceleration or is heavily loaded.

ENGINE DIESELING/RUN-ON

Symptom Definition

Engine continues to run after ignition is turned off but runs very rough. If engine runs smoothly, check ignition switch.

Possible Cause & Correction

Check the following items:

- Check for binding throttle linkage.
- Check for leaking injectors. Perform INJECTOR BALANCE TEST in appropriate SYSTEM/COMPONENT TESTING article in the ENGINE PERFORMANCE section below.
- **SYSTEM/COMPONENT TESTS - 4.3L** (Caprice Only)
- **SYSTEM/COMPONENT TESTS - 5.7L** (All Models)
- Check Idle Air Control (IAC) system. Check for vacuum leak or high idle. Check for water contaminated fuel, correct fuel pressure or a restricted injector. Check for foreign material in IAC bore of throttle body. Check for proper connection of IAC valve electrical connector. Check for faulty crankcase ventilation valve. Check for failure of A/C compressor or relay.
- Check engine for overheating.
- Check for excessive use of fuel additives.

DETONATION/SPARK KNOCK

Symptom Definition

A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with amount of acceleration.

Possible Cause & Correction

Check the following items:

- Check for obvious overheating problems.
- Check TP sensor adjustment and operation.
- Check fuel pressure.
- Check knock sensor system for no retard.
- Check EGR system for not opening.
- Check TCC system operation, applying too soon.
- Remove carbon from engine with top engine cleaner.
- If excessive carbon exists in combustion chamber, check for excessive oil burning due to leaking valve guide seals.
- Check for incorrect basic engine parts such as camshaft, cylinder heads and pistons.

- Ensure the installed PROM is correct for that particular vehicle. Check with dealer for latest application information.
- Check engine coolant sensor for shift in calibration. See **SENSOR RANGE CHARTS** article in the ENGINE PERFORMANCE section.
- Check for rich or lean running conditions.
- Check spark plugs for proper application and heat range.
- Check engine compression.
- Check Park/Neutral Position (PNP) switch or trans range switch. Ensure scan tester indicates proper gear selection with gear in proper position.
- Check distributor vent system (if equipped).
- Check for contaminated or poor quality fuel. Check vehicle operation using a higher octane fuel.

EXCESSIVE EXHAUST EMISSIONS OR ODORS

Symptom Definition

Vehicle fails emission test. Vehicle may also have excessive "rotten egg" smell (hydrogen sulfide) being emitted from tail pipe. Excessive odors DO NOT necessarily indicate exhaust emissions are high.

Possible Cause & Correction

Check the following items:

- Check for lead contamination of catalytic converter. Look for removal/tampering at restrictor in fuel filler neck.
- Check coolant level. Check cooling system thermostat for proper operation and application.
- Check cooling fan for proper operation.
- If emission test shows excessive carbon monoxide (CO) and hydrocarbons (HC) emissions, and vehicle is also emitting excessive odor, check all systems and components that could cause engine to run rich. See DIAGNOSTIC AIDS in CODE 45/65/P0132 chart in appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section below.
- **TESTS W/CODES - 4.3L** (for Caprice Only)
- **TESTS W/CODES - 5.7L** (for All Models)
- Ensure the installed PROM is correct for that particular vehicle. Check with dealer for latest application information.
- If emission test shows excessive oxides of nitrogen (NOx) emissions, check all systems and components that could cause engine to run lean or to run too hot. See DIAGNOSTIC AIDS in CODE 44/64/P0131 chart in appropriate TESTS W/CODES article in the ENGINE PERFORMANCE section. Check EGR system or for an inoperative cooling fan.
- **TESTS W/CODES - 4.3L** (for Caprice Only)
- **TESTS W/CODES - 5.7L** (for All Models)
- Ensure fuel filler cap is properly installed.
- Check fuel pressure.

- Perform INJECTOR BALANCE TEST in appropriate SYSTEM/COMPONENT TESTING article in the ENGINE PERFORMANCE section below.
- Check EVAP fuel canister for fuel loading.
- Check spark plugs, plug wires and ignition components.
- Check for plugged or stuck crankcase ventilation valve. Check for fuel in crankcase.
- Check for vacuum leaks.
- Check for excessive carbon build-up. Remove with top engine cleaner.
- Check EGR valve for not opening.
- Check injector harness locations. Ensure injectors are connected to correct injector/cylinder according to firing order.
- Check distributor vent system (if equipped).
- Check for use of excessive fuel additives.

INTERMITTENTS

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION section before disconnecting battery.

INTERMITTENT PROBLEM DIAGNOSIS

Intermittent fault testing requires duplicating circuit or component failure to identify fault. These procedures may lead to computer setting a diagnostic trouble code which may help in diagnosis.

If problem vehicle does not produce diagnostic trouble codes, monitor voltage or resistance values using a DVOM while attempting to reproduce conditions causing the intermittent fault. A status change on DVOM indicates a fault has been located.

Use DVOM to pinpoint faults. When monitoring voltage, ensure ignition is in ON position or engine is running. When monitoring resistance, ensure ignition switch is in the OFF position or negative battery cable is disconnected. A status change on DVOM while performing TEST PROCEDURES indicates area of fault.

TEST PROCEDURES

Intermittent Simulation

To reproduce the conditions causing intermittent fault, use the following methods:

- Lightly vibrate component.
- Heat component.
- Wiggle or bend wiring harness.
- Spray component with water.

- Remove/apply vacuum source.

Monitor circuit/component voltage or resistance while simulating intermittent. If engine is running, monitor for diagnostic trouble codes. Use test results to identify a faulty component or circuit.

INTERMITTENT TROUBLE SHOOTING

Intermittent Symptom Definition

Malfunction Indicator Light (MIL) illuminates but does not remain on. A stored diagnostic trouble code may or may not exist.

Possible Cause & Correction

To track down possible causes of an intermittent MIL, check the following items:

- Check for poor mating of one connector to another. Terminals may not be fully seated. Check for improperly formed or damaged terminals. Check wire to terminal connections.
- Check for poor connection from ignition coil to ground or arcing at spark plug wires or plugs.
- Check wire from MIL to PCM for short to ground.
- Check wire from test terminal "B" of Data Link Connector (DLC) for intermittent short to ground (if equipped).
- Check for poor connections in PCM ground terminals.
- Check for loss of diagnostic trouble code memory. To check code memory on fuel injected models, disconnect TP sensor and run engine at idle until MIL comes on. TP sensor code should be stored and retained in memory when ignition is turned off. If code is not stored, PCM is faulty.
- Check for electrical system interference caused by a defective relay, or an PCM-driven solenoid or switch which may cause sharp electrical surge. This type of problem will normally occur when faulty component is operated.
- Check for aftermarket parts which may not have been produced to manufacturer's specifications.
- Check for any open diodes in A/C or engine wiring.
- Check for improper installation of electrical accessories such as auxiliary lights or 2-way radios.
- Ensure ignition control wires are kept away from spark plug wires, distributor wires, distributor housing, ignition coil and generator. Ensure ground wire from PCM to distributor or ignition control module is connected to a good ground.

TRUNK & HATCH RELEASE - POWER

ACCESSORIES & SAFETY EQUIPMENT General Motors Corp. Trunk/Hatch Release - Power

DESCRIPTION & OPERATION

Description

The trunk lid or hatchback release system allows trunk lid or hatchback to be opened using a remote release switch. Release switch is located in glove box, on instrument panel or on console. On models with Remote Keyless Entry (RKE) systems, trunk/hatchback can also be opened using RKE transmitter.

Some station wagon models also have a rear window glass release that allows rear window to be opened using remote release switch or RKE system.

Trunk/Hatchback Release

Trunk lid and hatchback release system consists of a release switch, release solenoid, release relay, valet switch (if equipped), connectors and necessary wiring. Wiring harness is routed from switch to trunk/hatchback lid and solenoid. When switch is pressed, release solenoid coil is energized. Release is pulled back, unlatching trunk/hatchback lid lock, and lid is opened.

On models with Remote Keyless Entry (RKE), the same action takes place except release solenoid is energized by RKE transmitter. Release solenoid is part of trunk lid on sedan models, and at latch assembly in hatchback models. Some models with automatic transmission also use a transmission position switch that allows trunk/hatchback to only be opened with transmission in Park or Neutral. On some manual transmission models, parking brake must be applied before release will operate.

Rear Window Glass Release

Rear window glass release switch is located in accessory panel in instrument panel or glove box. When switch is pressed, release relay is energized and voltage is applied to release solenoid. Release solenoid then releases glass latch and glass is opened. On models with Remote Keyless Entry (RKE), the same action takes place except RKE transmitter energizes release solenoid. Release solenoid is located at inside center of tailgate. Some models with automatic transmission also use a transmission position switch that allows rear glass to only be opened in Park or Neutral.

TROUBLE SHOOTING

TRUNK/HATCHBACK WILL NOT RELEASE

Check lock and release mechanism for mechanical interference. Check solenoid connectors. Check release relay and circuits. Check park/neutral position switch (A/T) or parking brake switch (M/T) for open. Check Daytime Running Light (DRL) module for open. Check for fuse block open. Check valet and security switch connections. Check system grounds. Check release switch connections.

TRUNK/HATCHBACK WILL NOT RELEASE WITH IGNITION ON

Check convenience center connections. Check circuit between transmission position switch and convenience center. Check for open in fuse block circuit.

TRUNK/HATCHBACK RELEASES WHEN VEHICLE NOT IN PARK OR NEUTRAL

Check convenience center connections. Check circuit between transmission position switch and convenience center. Check for open in fuse block circuit.

TRUNK/HATCHBACK DOES NOT LATCH

Check lock and release mechanism for mechanical interference. Check for short in circuit between security switch and release switch. Check for short in circuit between security switch and solenoid.

REAR GLASS RELEASE INOPERATIVE FROM BOTH SWITCHES

Check for open fuse. Check for short to ground in fuse circuit. Check for open in ground circuit or poor ground. Check for poor connections at transmission switch connector and hatch release switch. Check for open in circuit between convenience center and transmission switch. Check isolation diode. Check for open in release relay circuit.

REAR GLASS RELEASE INOPERATIVE FROM TAILGATE REAR GLASS

SWITCH

Check for open fuse. Check for open in circuit between tailgate lock sense switch and convenience center. Check for poor connections at push button switch and tailgate lock sense switch.

REAR GLASS WILL NOT LATCH

Check convenience center ground connection. Check for short in circuit between convenience center and glass release solenoid. Check for mechanical interference preventing glass from latching. Check rear glass release relay. Check for short in circuit between accessory switch panel and rear glass switch.

TESTING

NOTE: On models with Remote Keyless Entry (RKE) systems, see the KEYLESS ENTRY SYSTEM article for specific testing of trunk/hatchback release system.

Always check following items for possible causes of system malfunction before performing any test on trunk/hatchback or rear glass release system:

- Faulty fuses or circuit breakers.
- Loose or corroded connectors.
- Low battery charge.

- Poor ground connections.
- Inoperative lock or latch mechanism.

REMOVAL & INSTALLATION

NOTE: Vehicles are equipped with Supplemental Inflatable Restraint (SIR) system. To disarm system, see AIR BAG RESTRAINT SYSTEM article.

CAUTION: When battery is disconnected, vehicle computer and memory systems may lose memory data. Driveability problems may exist until computer systems have completed a relearn cycle. See the COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section before disconnecting battery.

TRUNK/HATCHBACK RELEASE SWITCH

Removal & Installation

Remove switch trim cover or filler panel, if equipped. Gently pry switch mounting assembly from instrument panel or console. Disconnect electrical connector and remove switch. To install, reverse removal procedure.

TRUNK LID RELEASE SOLENOID

Removal & Installation

Open trunk lid. Disconnect electrical connector from release solenoid. Remove solenoid attaching screws. Lift solenoid tab from notch in lock assembly and remove solenoid. To install, reverse removal procedure.

HATCHBACK RELEASE SOLENOID

Removal & Installation

Open hatchback. Remove inside rear compartment trim assembly. Remove lock retainer from release solenoid. Disconnect electrical connector from solenoid. Remove solenoid attaching screws and remove solenoid from latch assembly. To install, reverse removal procedure.

GLASS RELEASE SOLENOID

Removal & Installation

Open rear glass and tailgate. Remove tailgate lock cylinder. Remove release solenoid bumper, if equipped. Disconnect electrical connectors. Loosen nuts on striker locator and move it aside. Remove solenoid attaching nuts and remove solenoid. To install, reverse removal procedure.

WIRING DIAGRAMS

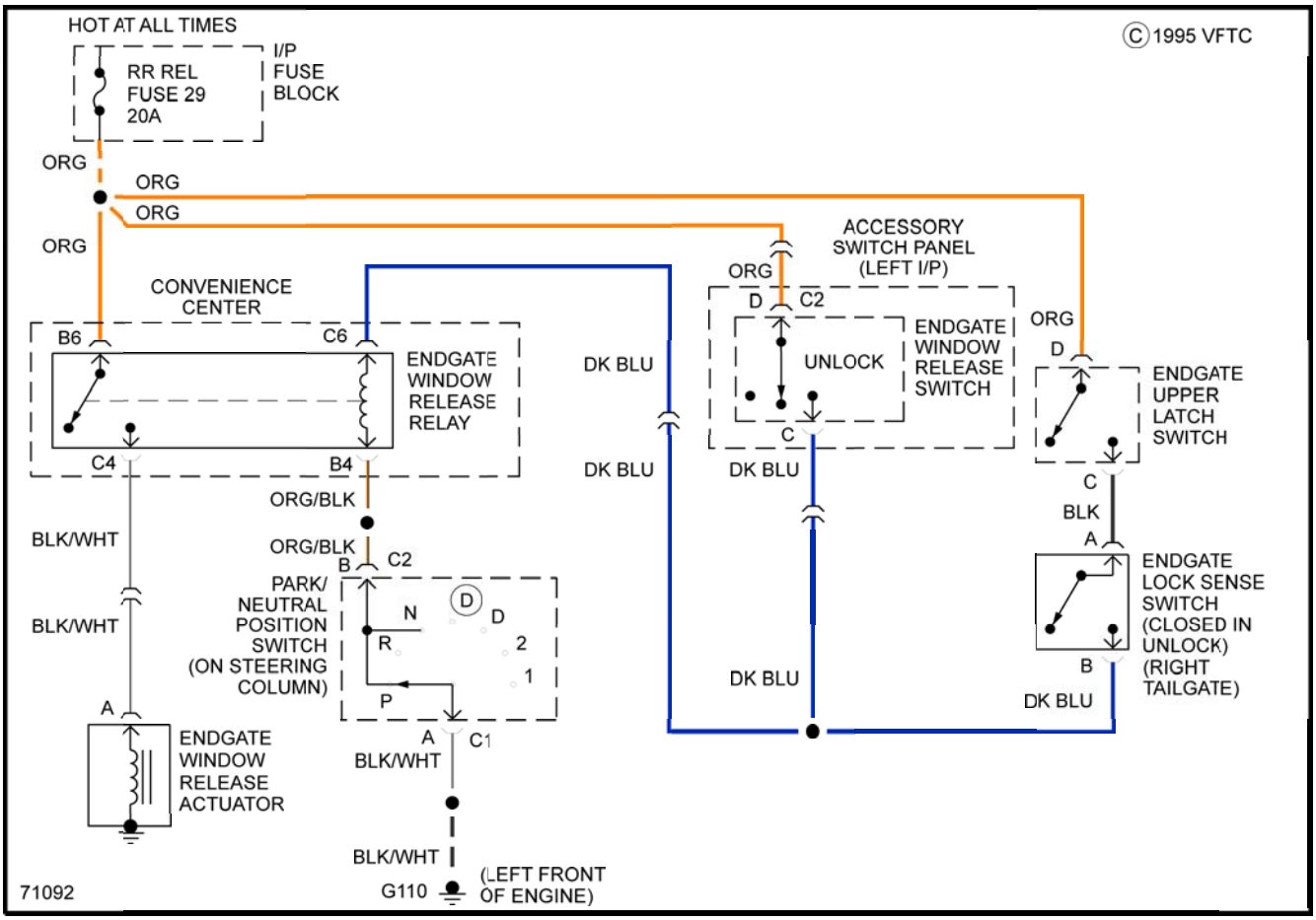


Fig. 1: Tailgate Glass Release Wiring Diagram (Caprice Wagon)

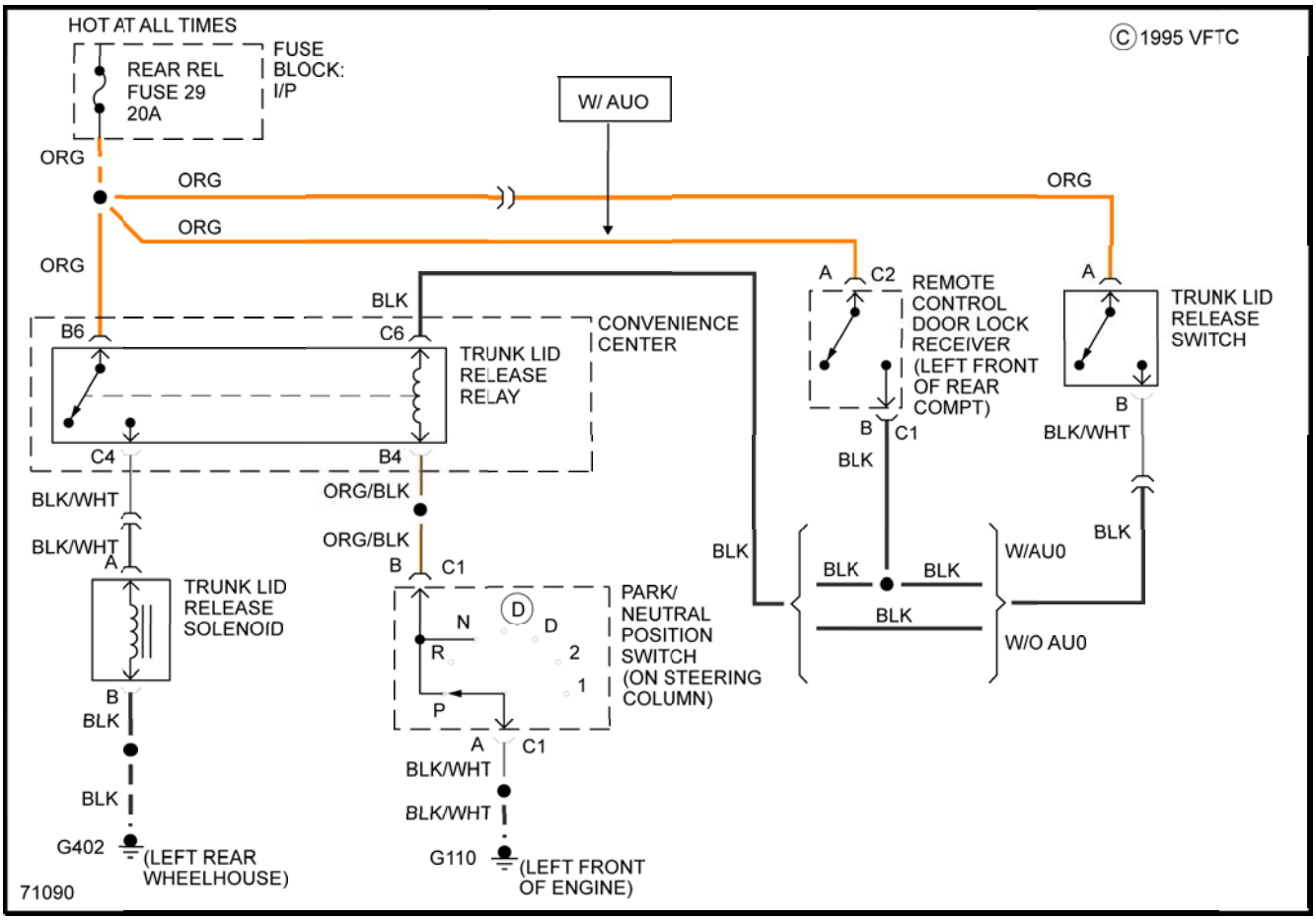


Fig. 2: Power Trunk Release Wiring Diagram (Caprice & Impala SS With Keyless Entry)

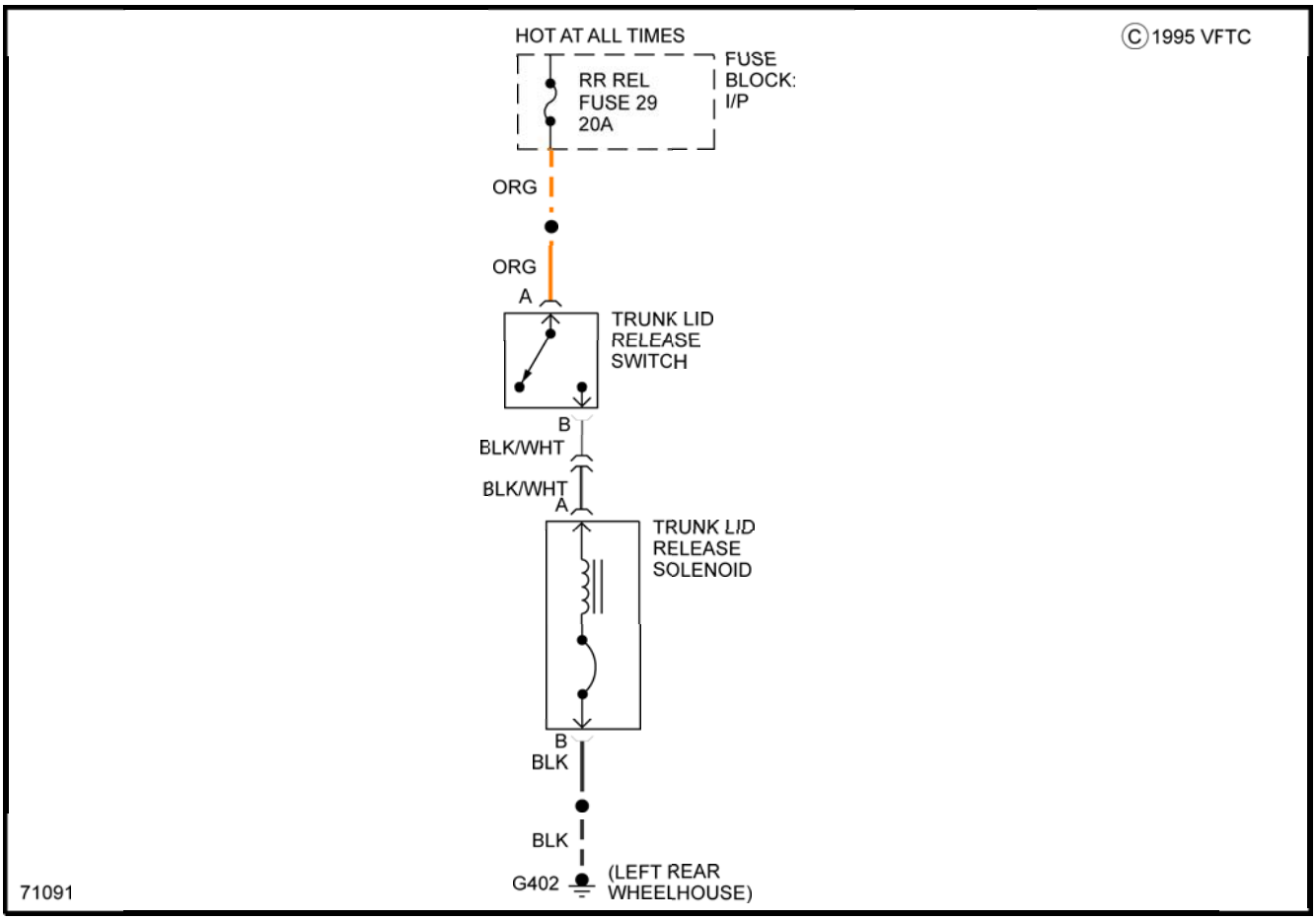


Fig. 3: Power Trunk Release Wiring Diagram (Caprice & Impala SS Without Keyless Entry)

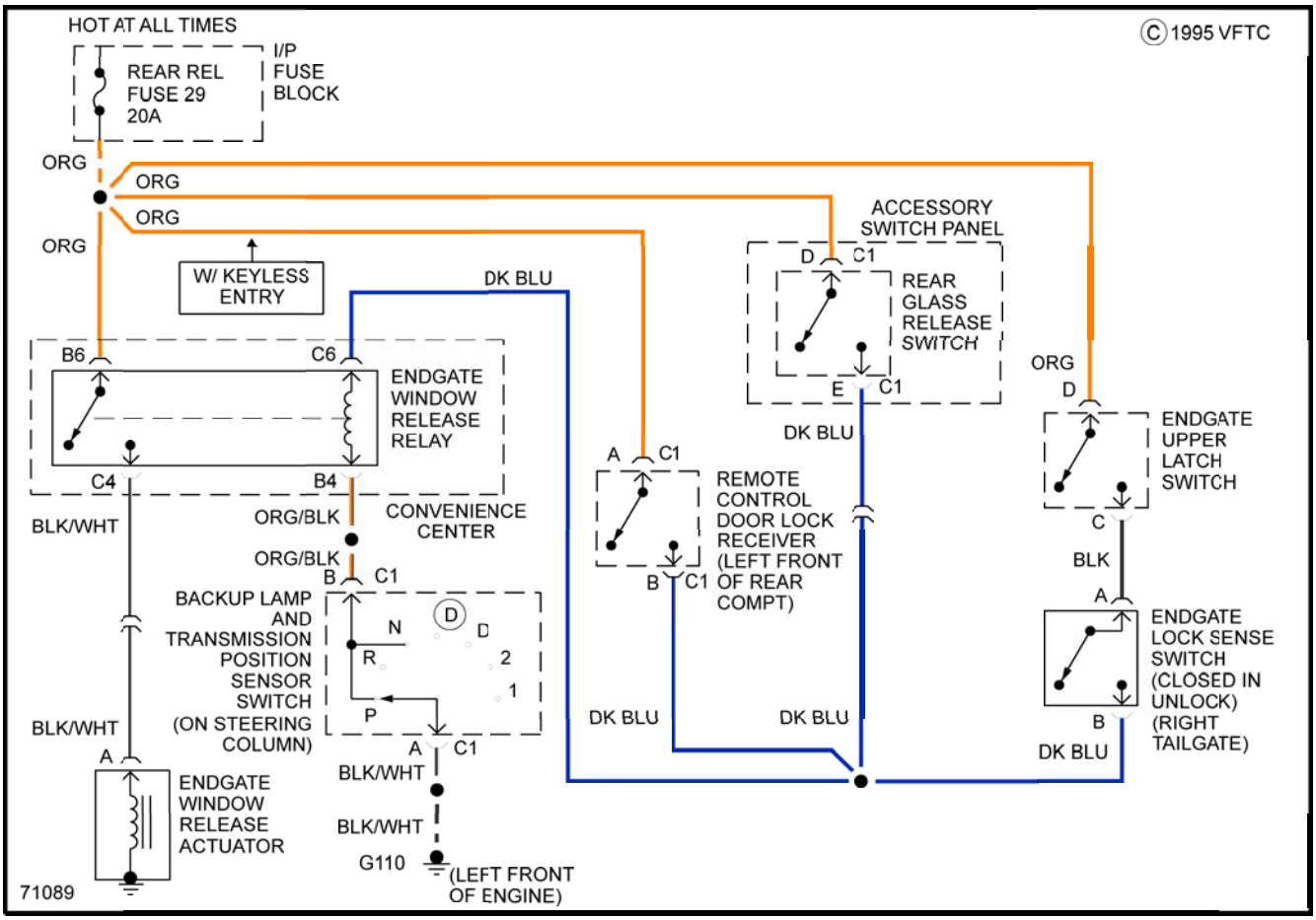


Fig. 4: Power Tailgate Glass Release Wiring Diagram (Roadmaster Wagon)

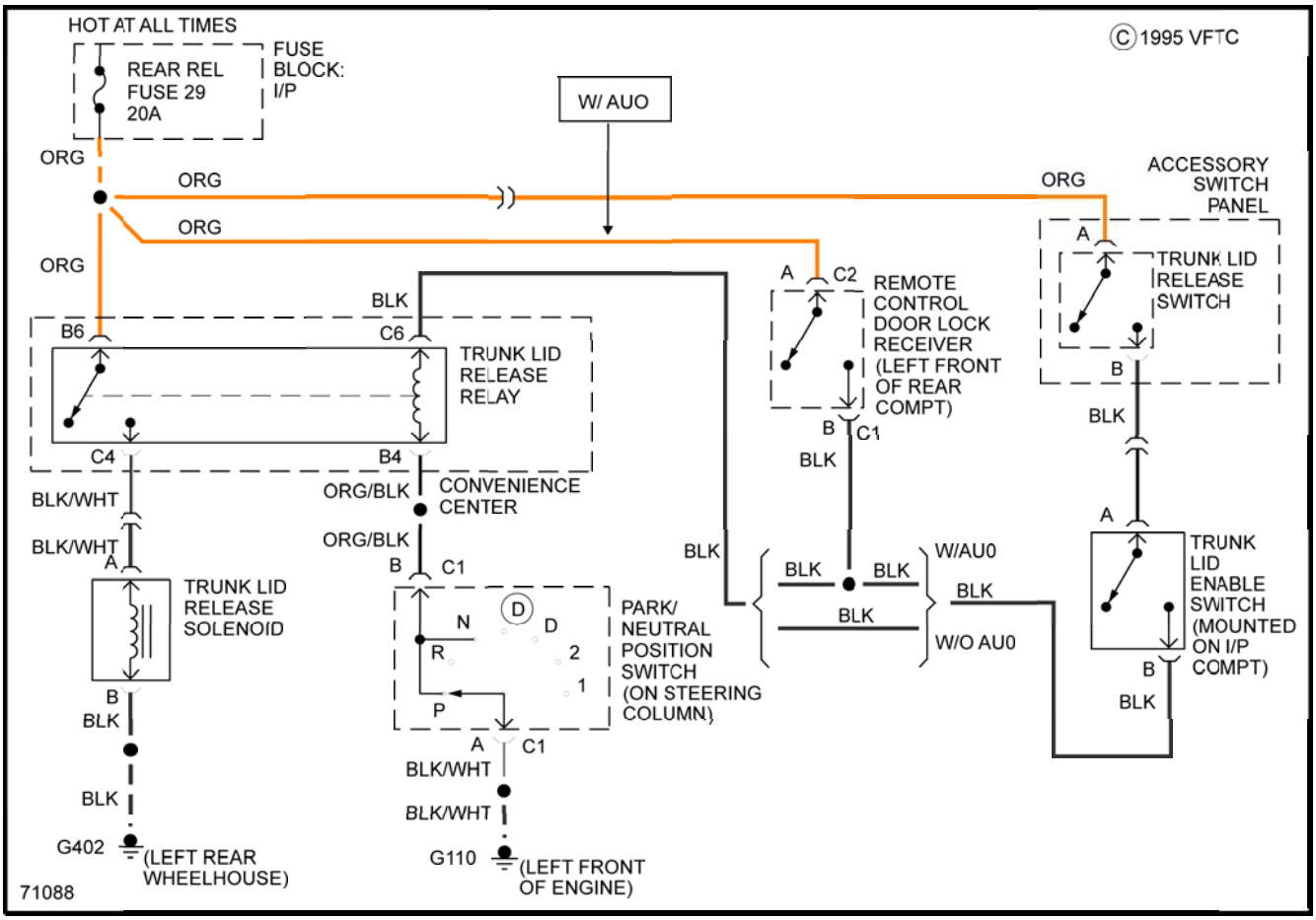


Fig. 5: Power Trunk Release Wiring Diagram (Roadmaster)

M - VACUUM DIAGRAMS

ENGINE PERFORMANCE General Motors Corp. Vacuum Diagrams VACUUM

HOSE DIAGRAM(S)

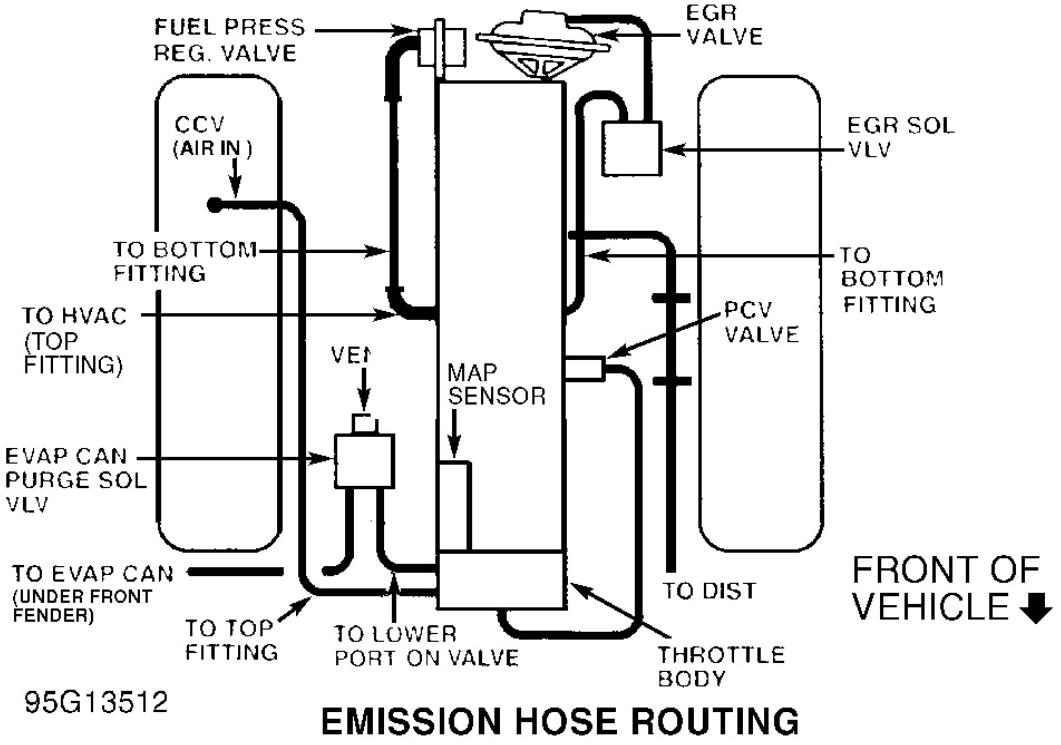


Fig. 1: 4.3L SFI (VIN W) Caprice & 5.7L SFI (VIN P) Caprice, Impala SS & Roadmaster
Courtesy of GENERAL MOTORS CORP.

ADJUSTMENTS

PRE-ALIGNMENT INFORMATION

NOTE: Prior to performing wheel alignment, perform visual and mechanical inspection of wheels, tires and suspension components. See the PRE-ALIGNMENT CHECKS article in this section. For basic wheel alignment theory, refer to WHEEL ALIGNMENT THEORY/OPERATION article in the GENERAL INFORMATION section.

ORDER OF ALIGNMENT

To ensure accurate alignment, align wheels in the following order:

- Rear Camber
- Rear Toe-In
- Front Caster
- Front Camber
- Front Toe-In

CAMBER ADJUSTMENT (REAR)

Rear camber is not adjustable. If rear camber is not as specified, repair or replace worn or damaged components.

TOE-IN ADJUSTMENT (REAR)

Rear toe-in is not adjustable. If rear toe-in is not as specified, repair or replace worn or damaged components.

CASTER ADJUSTMENT

Remove, add or transfer shims at bolts securing upper control arm shaft to frame. See **Fig. 1** . One shim pack can be thicker than the other, but not by more than .40" (10.2 mm).

CAMBER ADJUSTMENT (FRONT)

Remove, add or transfer shims at bolts securing upper control arm shaft to frame. See **Fig. 1** . One shim pack can be thicker than the other, but not by more than .40" (10.2 mm).

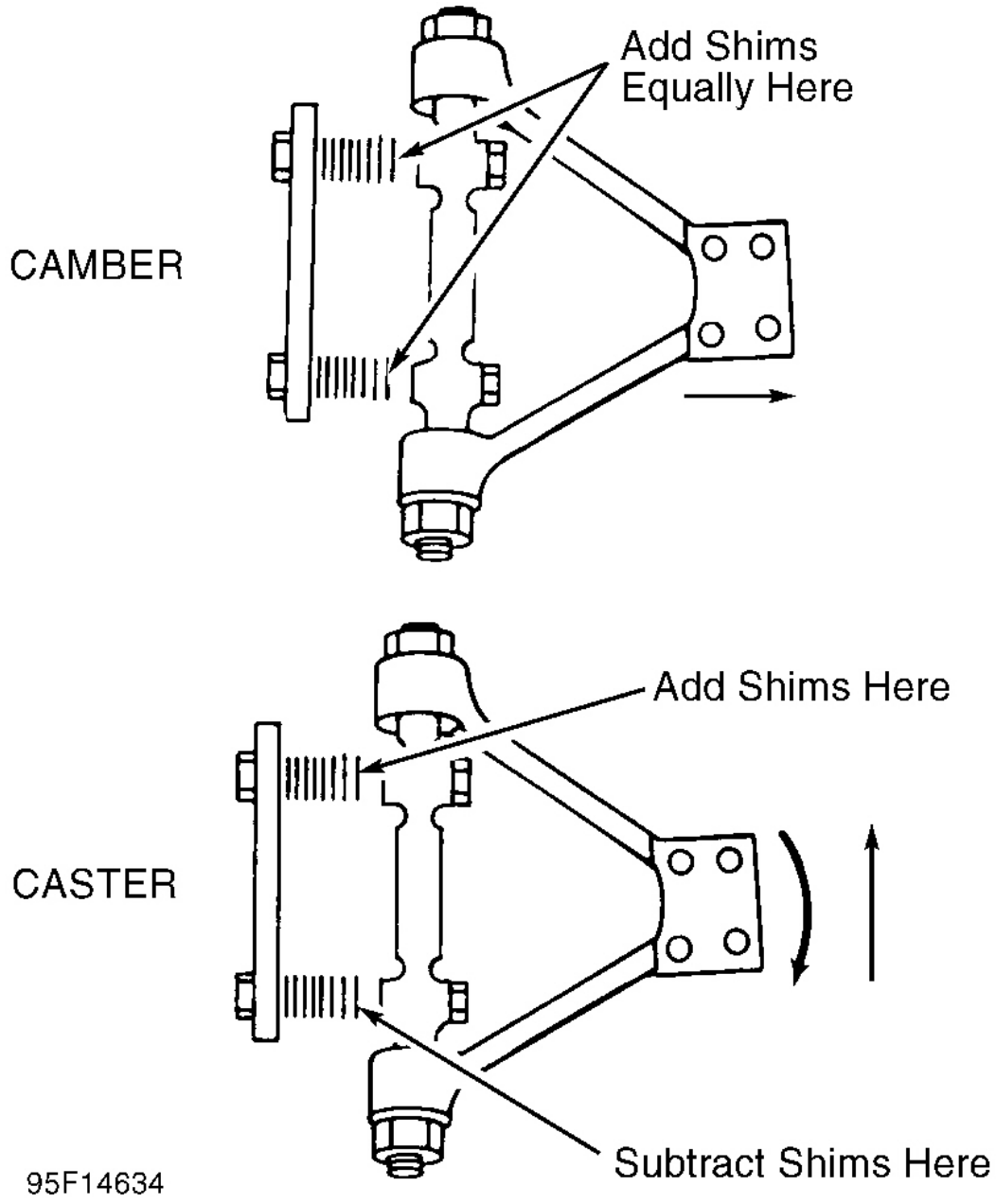


Fig. 1: Adjusting Front Camber & Caster ("B" & "D" Bodies)
Courtesy of GENERAL MOTORS CORP.

TOE-IN ADJUSTMENT (FRONT)

1. Center steering wheel and keep it centered throughout procedure. Loosen adjusting sleeve clamps. See **Fig. 2** . Rotate adjusting sleeve until threaded part of both tie rod ends is covered by adjusting sleeve (no

threads are showing).

2. Turn adjusting sleeve until toe-in is as specified. See **ALIGNMENT SPECIFICATIONS** . Ensure slot in adjusting sleeve is NOT aligned with gap in clamp. Ensure angle of clamp bolt (in relation to horizontal line) is as illustrated. See **Fig. 2** . Ensure bolt head is facing rearward. Tighten clamp bolts to specification. See **TORQUE SPECIFICATIONS** .

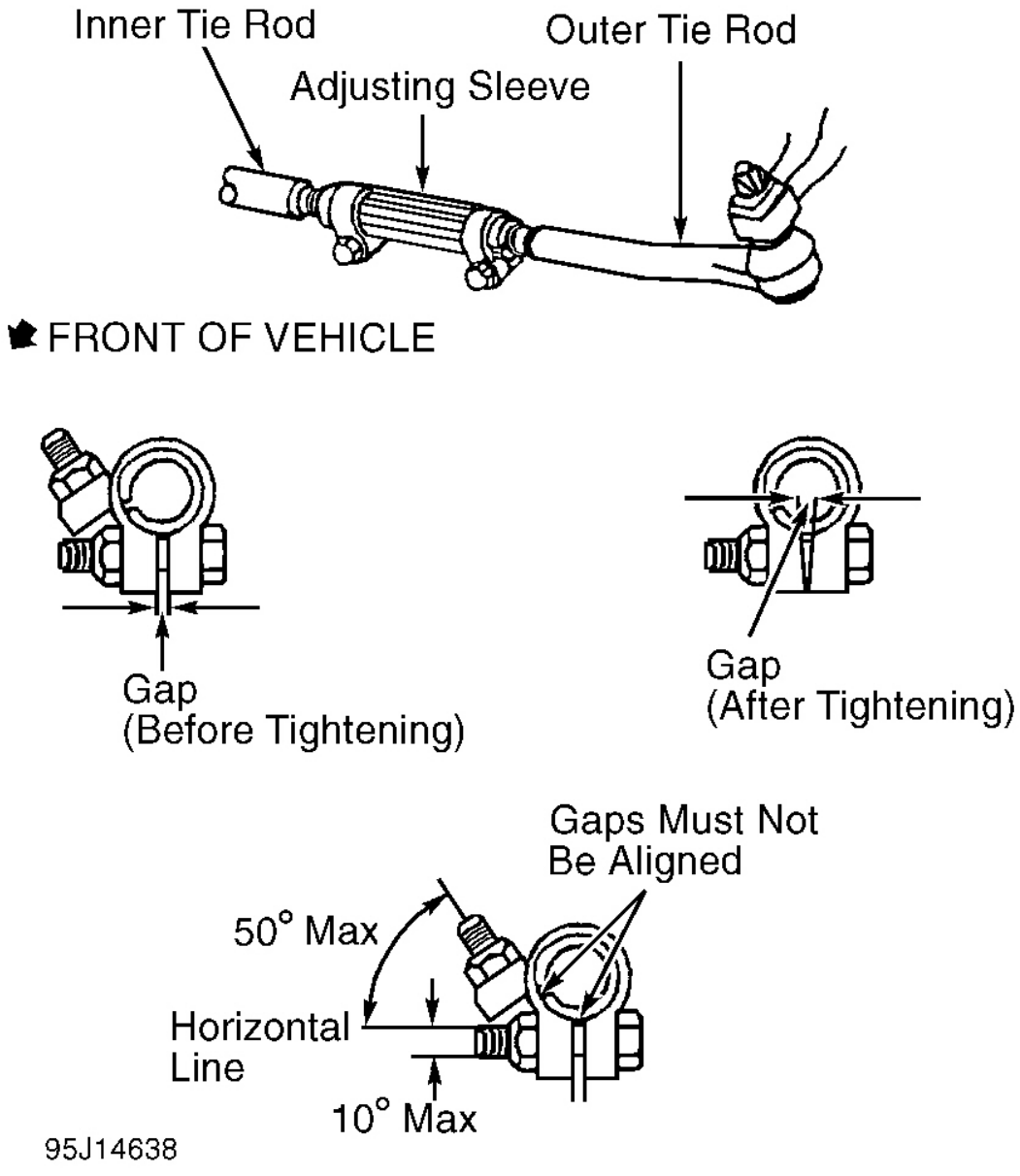


Fig. 2: Adjusting Front Toe-In
Courtesy of GENERAL MOTORS CORP.

ALIGNMENT SPECIFICATIONS

WHEEL ALIGNMENT SPECIFICATIONS

Application	Preferred	Range
Camber (Degrees) Front	0	-1 to 1
Camber (Degrees) Rear	N/A	N/A
Caster (Degrees) Front Right	3.75	2.75 to 4.75
Caster (Degrees) Front Left	3.25	2.25 to 4.25
Caster (Degrees) Rear	N/A	N/A
Toe-In (Inches) Front	0.08	-0.02 to 0.18
Toe-In (Inches) Rear	N/A	N/A
Toe-In (Millimeters) Front	2	0.5 to 4.5
Toe-In (Millimeters) Rear	N/A	N/A
Toe-In (Degrees) Front	0.16	-0.04 to 0.36
Toe-In (Degrees) Rear	N/A	N/A
Wheelbase (Inches)	115.9	N/A
Wheelbase (Millimeters)	2944	N/A

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	Ft. Lbs. (N.m)
Front Suspension	
Lower Ball Joint Nut	79 (109)
Lower Control Arm Bushing Nut	95 (125)
Shock Absorber Lower Bolt	20 (27)
Tie Rod Nut	35 (47)
Upper Ball Joint Nut	60 (82)
Upper Control Arm	
Bushing Nut	72 (98)
Pivot Shaft Nut	85 (115)
Wheel Lug Nut	100 (140)
Rear Suspension	
Lower Control Arm Bushing	
Bolt	74 (100)
Nut	91 (123)
Shock Absorber	
Lower Nut	48 (65)
Upper Bolt	20 (27)
Upper Nut	12 (16)
Upper Control Arm	

Front Bushing	
Bolt	114 (155)
Nut	91 (123)
Rear Bushing	
Bolt	80 (108)
Nut	70 (95)

POWER WINDOWS

ACCESSORIES & EQUIPMENT General Motors Corp. - Power Windows

DESCRIPTION & OPERATION

DESCRIPTION

Power window system uses a permanent magnet motor to operate each window. Motor operation is controlled by a master switch assembly alone or in combination with individual window switches. Window is lifted or lowered depending on polarity of current applied to window motor.

Some models use a control module to access an express mode of operation. When left front window switch is held in down position for .3 second, module activates relay to apply full battery voltage to window motor. This provides current to quickly and fully open window.

OPERATION

When ignition switch is in RUN position, power for window system is supplied to master switch assembly through fuse block 30-amp circuit breaker. When any master switch is operated, power is applied through related window switch to motor, driving drive motor in either direction to either raise or lower window. Each motor is protected by an internal circuit breaker which will reset after switch is released (voltage removed).

TROUBLE SHOOTING

SYSTEM CHECK

1. Before beginning system check, turn ignition on. Ensure there is battery voltage from POWER WINDOW (30-amp) circuit breaker, located in fuse block. Ensure master switch ground circuit is complete.
2. With all windows closed, turn ignition switch to RUN position. Briefly (less than .3 second) press left front window switch down. Window should descend a small distance, then stop.
3. Press left front window switch down and release (more than .3 second). Window should descend completely (express mode).
4. Press left front window switch up. Window should raise as long as switch is held up, then stop when switch is released (no express). Repeat step 3). While window is moving down in express mode, press switch upward. Window should stop express decent.
5. Lower and raise other windows from master switch. All windows should operate quietly and smoothly through full range of travel.
6. Lower and raise each window from window switches. All windows should operate quietly and smoothly through full range of travel. Note any symptoms and proceed to **SYMPTOM DIAGNOSIS** .

SYMPTOM DIAGNOSIS

None Of The Windows Operate

Go to **TEST 1** under TESTING.

Left Front Window Does Not Operate

Go to **TEST 2** under TESTING.

Right Front Window Does Not Operate

Go to **TEST 3** under TESTING.

Left Rear Window Does Not Operate

Go to **TEST 4** under TESTING.

Right Rear Window Does Not Operate

Go to **TEST 5** under TESTING.

Window(s) Do Not Operate From Individual Switch But Operate

From Master Switch

Go to **TEST 6** under TESTING.

Left Front Window Operates But With No Express Mode

On models without power window control module, replace master switch assembly. On models with power window control module, check for open in power feed to control module (Brown wire) circuit. If circuit is okay, replace power window control module.

Window(s) Operate From Individual Switches But Do Not Operate

From Master Switch

Replace Master Switch Assembly.

TESTING

NOTE: To identify specific circuits, see WIRING DIAGRAMS .

TEST 1

1. With ignition switch in RUN position, connect a test light between master switch Brown wire connector terminal and ground. If light comes on, go to step 2). If light does not come on, check for poor connection at master switch. If connection is okay, repair open in Brown wire between POWER WINDOW (30-amp) circuit breaker and master switch.
2. Connect a test light between master switch Brown wire connector terminal and master switch Black wire

(ground) connector terminal. If light comes on, check for poor connections at master switch. If connections are okay, replace master switch. If light does not come on, check for poor connections at master switch. If connections are okay, repair open in Black wire between master switch and ground.

TEST 2

1. With ignition switch in RUN position, connect a test light between master switch Dark Blue wire connector terminal and Brown wire connector terminal (Gray wire on models with power window control module). Press left front window switch (on master switch) up then down.
2. If light does not come on in both directions, replace master switch. If light comes on in both directions, on models with power window control module, go to step 3). On models without power window control module, check for open in Dark Blue and Brown wires between master switch and left front window motor. If wires are okay, replace motor.
3. Disconnect power window control module connector. Connect a test light between master switch Brown wire connector terminal and ground. If light comes on, go to step 4). If light does not come on, repair open in Brown wire between POWER WINDOW (30-amp) circuit breaker and master switch.
4. Connect a test light between master switch Gray wire connector terminal and ground. Press left front window switch (on master switch) down. If light comes on, go to step 5). If light does not come on, repair open in Gray wire between master switch and power window control module.
5. Connect a test light between master switch Dark Blue wire connector terminal and ground. Press left front window switch (on master switch) up. If light comes on, go to step 6). If light does not come on, repair open in Dark Blue wire between master switch and power window control module.
6. Reconnect power window control module. Disconnect left front window motor connector. Connect a test light between left front window motor Brown wire connector terminal and ground. Press left front window switch (on master switch) down. If light comes on, go to step 7). If light does not come on, check for open in Brown wire between power window control module and left front window motor. If wire is okay, replace power window control module.
7. Connect a test light between left front window motor Dark Blue wire connector terminal and ground. Press left front window switch (on master switch) up. If light comes on, replace left front power window motor. If light does not come on, repair open in Dark Blue wire between power window control module and left front window motor.

TEST 3

1. Disconnect right front window switch connector. With ignition switch in RUN position, connect a test light between right front window switch Light Blue wire connector terminal and Tan wire connector terminal. Press right front window switch (on master switch) up then down.
2. If light comes on in both directions, go to step 3). If light does not come on in both directions, check for open in Light Blue and Tan wires between master switch and right front window switch. If wires are okay, replace master switch.
3. Connect a jumper wire between right front window switch connector Light Blue wire and Dark Blue wire (going to right front window motor). Connect a jumper wire between right front window switch connector Tan wire and Brown wire.
4. Press right front window switch (on master switch) up and down. If window motor operates, replace right front window switch. If window motor does not operate, check for open in Dark Blue and Brown wires between right front window switch and right front window motor. If wires are okay, replace motor.

TEST 4

1. Disconnect left rear window switch connector. With ignition switch in RUN position, connect a test light between left rear window switch Dark Green wire connector terminal and Purple wire connector terminal. Press left rear window switch (on master switch) up then down.
2. If light comes on in both directions, go to step 3). If light does not come on in both directions, check for open in Dark Green and Purple wires between master switch and left rear window switch. If wires are okay, replace master switch.
3. Connect a jumper wire between left rear window switch connector Dark Green wire and Dark Blue wire (going to left rear window motor). Connect a jumper wire between left rear window switch connector Purple wire and Brown wire.
4. Press left rear window switch (on master switch) up and down. If window motor operates, replace left rear window switch. If window motor does not operate, check for open in Dark Blue and Brown wires between left rear window switch and left rear window motor. If wires are okay, replace motor.

TEST 5

1. Disconnect right rear window switch connector. With ignition switch in RUN position, connect a test light between right rear window switch Light Green wire connector terminal and Purple wire connector terminal. Press right rear window switch (on master switch) up then down.
2. If light comes on in both directions, go to step 3). If light does not come on in both directions, check for open in Light Green and Purple wires between master switch and right rear window switch. If wires are okay, replace master switch.
3. Connect a jumper wire between right rear window switch connector Light Green wire and Dark Blue wire (going to right rear window motor). Connect a jumper wire between right rear window switch connector Purple wire and Brown wire.
4. Press right rear window switch (on master switch) up and down. If window motor operates, replace right rear window switch. If window motor does not operate, check for open in Dark Blue and Brown wires between right rear window switch and right rear window motor. If wires are okay, replace motor.

TEST 6

1. Disconnect suspect individual switch connector. Ensure passenger window lockout switch is off. With ignition switch in RUN position, connect a test light between suspect window switch Dark Blue wire (from master switch) connector terminal and ground.
2. If light comes on, replace suspect individual switch. If light does not come on, check for open in Dark Blue wire between master switch and suspect switch. If wire is okay, replace master switch.

REMOVAL & INSTALLATION

WINDOW MOTOR

Removal

1. Raise window to full up position and secure in place. Remove door panel covering and insulator. Window may be disengaged from regulator and removed from vehicle. If motor is held to door and regulator with

nuts and bolts, remove nuts and bolts as necessary.

2. If motor is held to door and regulator with rivets, punch out center of regulator-to-door rivets and drill out rivets using a 1/4" drill bit. Disconnect window from regulator.
3. Move regulator and motor assembly rearward to access motor-to-regulator rivets. Punch out center of motor-to-regulator rivets and drill out rivets using a 3/16" drill bit. On all models, disconnect electrical connector and remove motor from door.

Installation

To install, reverse removal procedure. On models attached with rivets, use Rivet Installer (J-34940) with 3/16" rivets for motor-to-regulator attachment and 1/4" rivets for regulator-to-door attachment.

WINDOW SWITCH

Removal & Installation

Using a thin-blade screwdriver, probe between switch and door panel for spring clip (if equipped). Press down on clip to release switch and pry outward. Disconnect electrical connector and remove switch. To install, reverse removal procedure.

WIRING DIAGRAMS

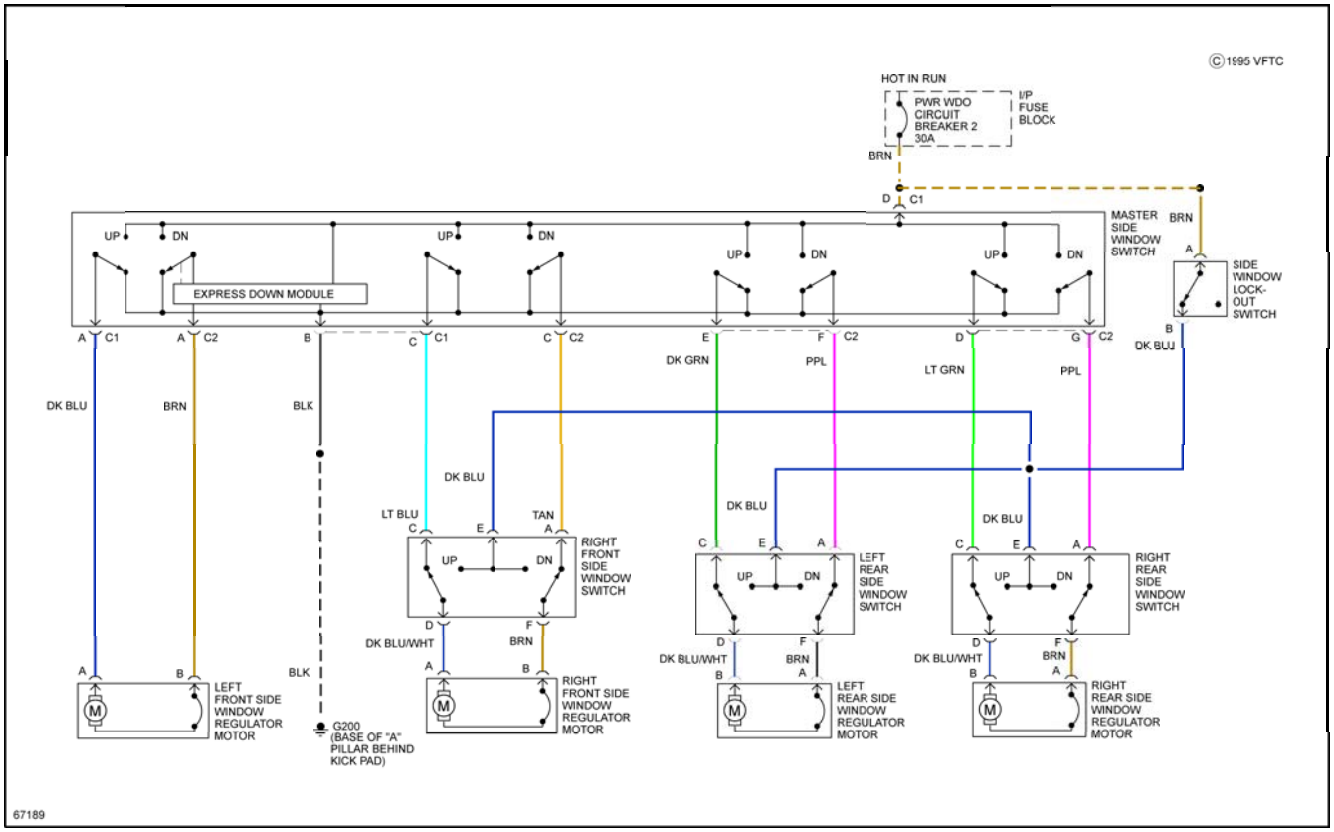


Fig. 1: Power Window System Wiring Diagram (Caprice & Impala SS)

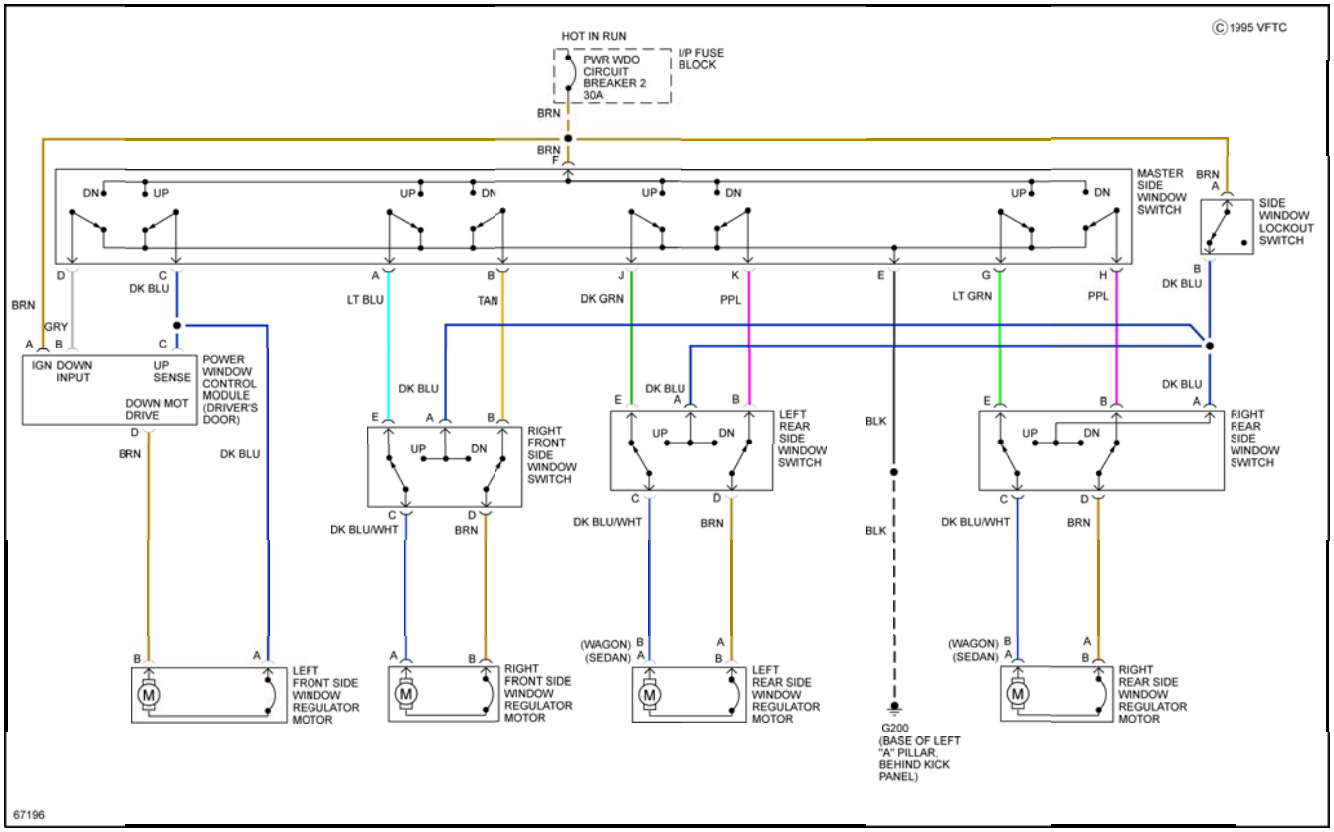


Fig. 2: Power Window System Wiring Diagram (Roadmaster)

WIPER/WASHER SYSTEM - REAR

ACCESSORIES & EQUIPMENT General Motors Corp. - Rear Wiper/Washer Systems

DESCRIPTION & OPERATION

System uses a one-speed permanent magnet motor and an autopark module that returns wiper to park position. See **Fig. 1** . Washer pump is on washer fluid reservoir in engine compartment. The system can only be operated with ignition switch in RUN or ACCY position. When wiper switch is turned on, the autopark module senses battery voltage on the wiper request input. See **WIRING DIAGRAM** . A switch in the autopark module closes, allowing current to flow through wiper motor to ground.

When wiper switch is turned off, the wiper motor continues to operate until the wiper blade reaches the park position. At this point, a cam inside of the wiper motor housing opens the park switch.

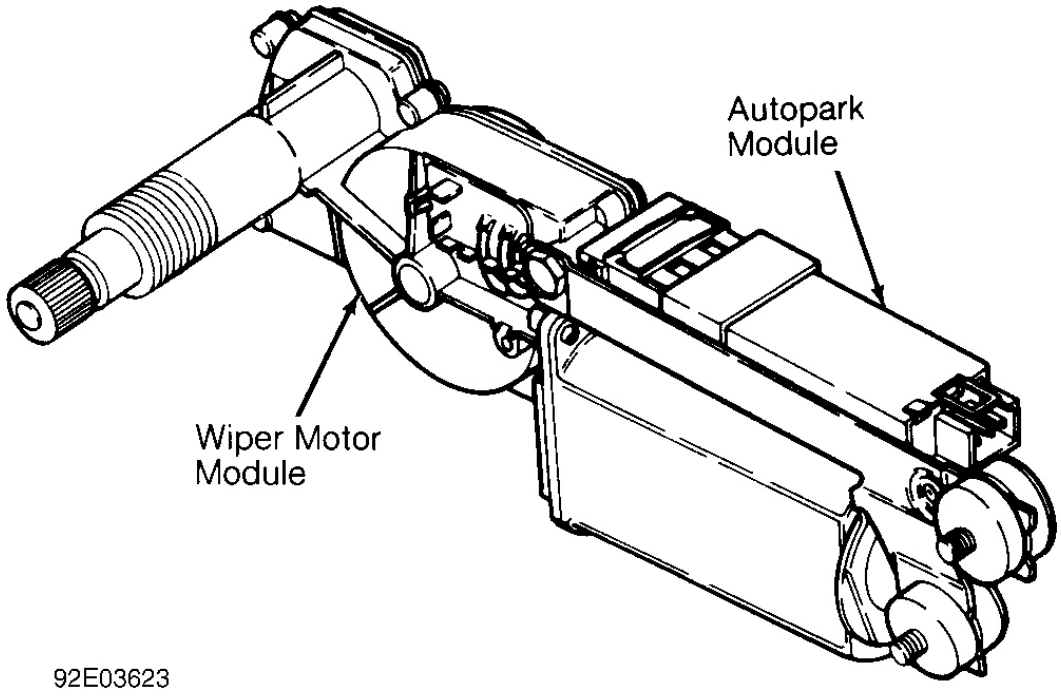


Fig. 1: Identifying Rear Window Wiper Motor
Courtesy of GENERAL MOTORS CORP.

TROUBLE SHOOTING

WIPER

Before going to SYMPTOM DIAGNOSIS table, check for:

- Open fuse or circuit breaker.
- Poor connection at wiper motor ground.

WASHER

Before going to SYMPTOM DIAGNOSIS table, check for:

- Empty washer fluid reservoir.
- Incorrectly attached hoses.
- Cut, kinked, or pinched hoses, and clogged nozzles.
- Open fuse.
- Damaged or missing seal at washer pump.
- Poor connection at washer motor ground.

SYMPTOM DIAGNOSIS

Symptom	Perform Test No.
Wiper Intermittent, Washer Okay	1
Wiper Never Operates	2
Washer Does Not Operate, Wiper Okay	3
Wiper & Washer Do Not Operate	4
Wiper Does Not Turn Off	5
Washer Does Not Turn Off	(1)
(1) Check for short to battery voltage in Dark Green wire between washer switch and washer motor. If Dark Green wire is okay, replace washer switch.	

TESTING

TEST NO. 1

Wiper Intermittent (Washer Okay)

Replace autopark module.

TEST NO. 2

Wiper Never Operates (Washer Is Okay)

1. Turn ignition switch to RUN position. Leave 3-pin wiper motor connector attached. Connect test light between body ground and Orange wire terminal of 3-pin wiper motor connector. If test light does not come on, replace fuse and/or repair Orange wire. If test light comes on, connect test light between Orange wire and Black wire terminals of 3-pin wiper motor connector.
2. If test light does not come on, repair Black wire. If test light comes on, turn wiper switch to ON position. Connect test light between body ground and Gray wire terminal of 3-pin wiper motor connector. If test

light comes on, go to next step. If test light does not come on, check for poor wiring connection at 3-pin wiper motor connector. If connection is okay, replace wiper motor.

3. Connect test light between body ground and Yellow wire terminal (White wire terminal) of liftgate window switch connector. If test light comes on, go to next step. If test light does not come on, check for open circuit between wiper switch and liftgate window switch. If circuit is okay, replace wiper switch.
4. Check for open Gray wire between liftgate window switch and wiper motor. If Gray wire is okay, connect test light between ground and terminal "D" (unidentified by manufacturer) of 4-pin wiper motor connector. If test light comes on, replace wiper motor. If test light does not come on, replace autopark module.

TEST NO. 3

Washer Does Not Operate, Wiper Okay

1. Disconnect washer motor connector. Turn ignition switch to RUN position. Connect test light between body ground and Dark Green wire terminal of washer motor connector. Turn washer switch to ON position.
2. If test light comes on, go to next step. If test light does not come on, check for open Dark Green wire between washer switch and washer motor. If Dark Green wire is okay, replace washer switch.
3. Connect test light between terminals of washer motor connector. Turn washer switch to ON position. If test light does not come on, repair Black wire. If test light comes on, check for poor wiring connection at washer motor. If connection is okay, replace washer motor.

TEST NO. 4

Wiper & Washer Do Not Operate

Turn ignition switch to RUN position. Connect test light between body ground and Yellow wire terminal of washer switch connector. If test light does not come on, replace fuse and/or repair wire. If test light comes on, check for poor wiring connection at washer switch. If connection is okay, replace washer switch.

TEST NO. 5

Wiper Does Not Turn Off

1. Turn ignition switch to RUN position. Turn wiper switch to ON position. Open liftgate window.
2. If wiper turns off, go to next step. If wiper does not turn off, check for short to voltage in Gray wire between liftgate window switch and wiper motor. If Gray wire is okay, replace autopark module.
3. Check for short to voltage in circuit between wiper switch and liftgate window switch. If circuit is okay, replace wiper switch.

REMOVAL & INSTALLATION

WIPER MOTOR ASSEMBLY

Removal

Remove wiper arm and blade. Remove nut on wiper linkage transmission shaft. Remove liftgate window upper finishing molding. Disconnect 3-pin wiper motor connector. Remove screws securing wiper motor. Remove wiper motor.

Installation

Install motor. Tighten screws to specification. See TORQUE SPECIFICATIONS. Reconnect wiring connector. Install upper finishing molding. Install nut on wiper transmission shaft linkage. Tighten nut to specification. See **TORQUE SPECIFICATIONS** . Install wiper arm.

AUTOPARK MODULE

Removal & Installation

Remove wiper motor assembly. See **WIPER MOTOR ASSEMBLY** . Drill out rivet attaching autopark module to wiper motor assembly bracket. See **Fig. 1** . Remove autopark module. To install, reverse removal procedure. Attach autopark module to wiper motor assembly bracket with NEW screw and nut.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Application	INCH Lbs. (N.m)
Wiper Motor Screw	53 (6)
Transmission Shaft Linkage Nut	62 (7)

WIRING DIAGRAM

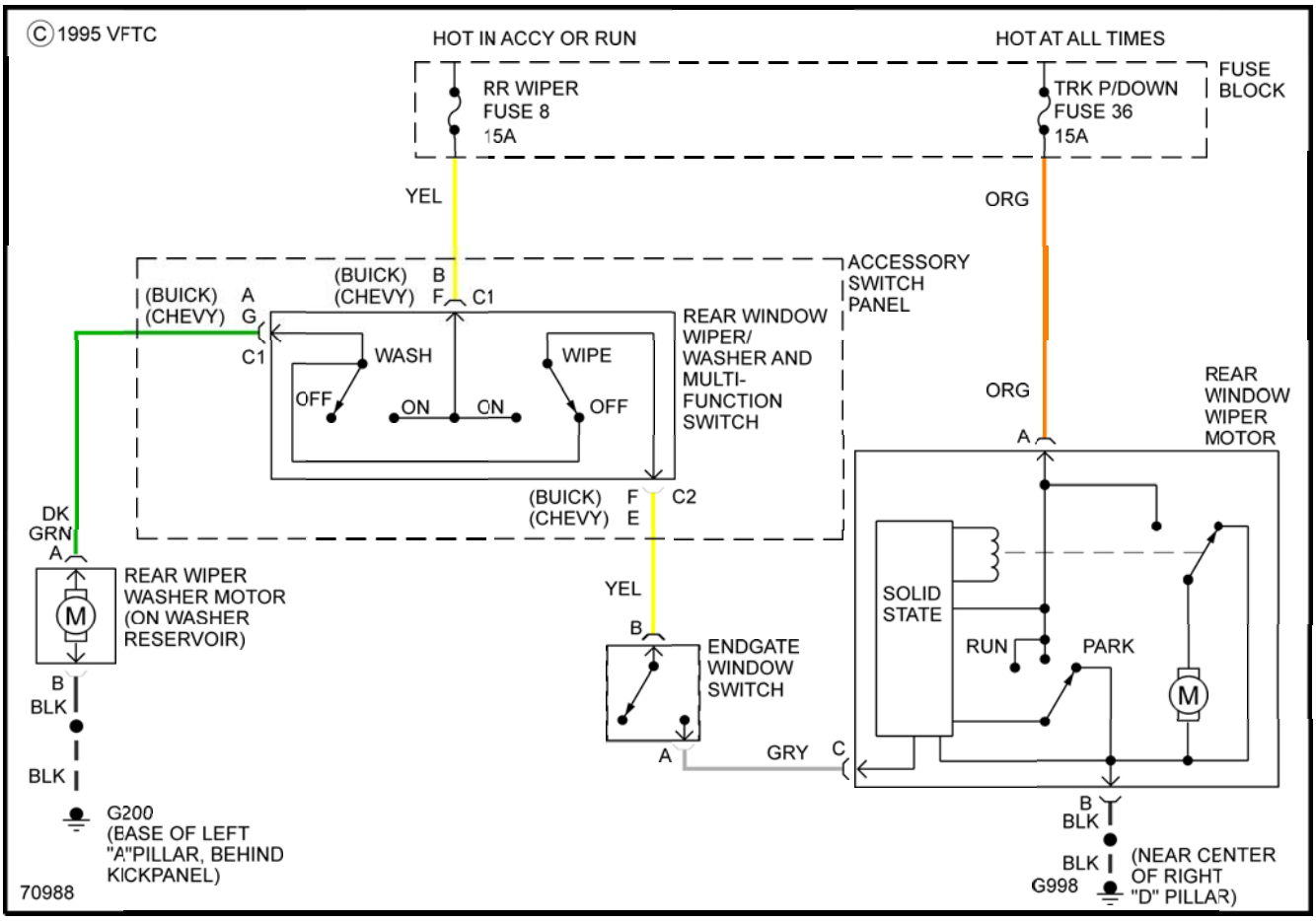


Fig. 2: Rear Wiper/Washer System Wiring Diagram

IDENTIFICATION

COMPONENT LOCATION MENU

COMPONENT LOCATIONS

Component	Figure No. (Location)
A/C & HEATER CONTROL ASSEMBLY LIGHTS	9 (D 33)
A/C/HEATER SYSTEM	6 (A 20-23)
ACCESSORY SWITCH PANEL LIGHT	9 (D 33)
ALDL CONNECTOR (4.3L)	2 (E 4)
ALDL CONNECTOR (5.0L & 5.7L)	3 (E 8)
ALTERNATOR	1 (A-B 3)
ARMING SENSOR	5 (C 19)
ASHTRAY LIGHT	9 (D 33)
AUDIO ALARM MODULE	7 (A 24)
AUTO TRANS TCC SOLENOID (4.3L)	2 (D 4)
AUXILIARY FUSE BLOCK	4 (E 14-15)
BATTERY	1 (A 2)
BATTERY J/B	1 (B 3)
BEAM SELECT SWITCH	7 (B 27)
BRAKE/CRUISE RELEASE SWITCH	7 (E 27)
CIGAR LIGHTER	9 (E 34)
COOLANT TEMP SENSOR	2 (C 7)
CRUISE CONTROL SYSTEM	5 (D-E 16)
DEFOGGER CONTROL SYSTEM	10 (E 36)
DIAGNOSTIC ENERGY RESERVE MODULE (DERM)	5 (C-D 16)
DIRECTIONAL FLASHER	7 (A 24)
DIRECTIONAL/HAZARD SWITCH	7 (C-E 24)
DOME LIGHT	9 (B 35)
DOOR COURTESY LIGHTS	9 (D 35)
DOOR LOCK SWITCHES	10 (C 38)
DOOR SWITCHES	9 (C-D 34)
ELECTRONIC BRAKE CONTROL MODULE	4 (A-B 16)
ELECTRONIC CONTROL MODULE (ECM)(4.3L)	2 (A 4-7)
ELECT CONTROL MODULE (5.0L & 5.7L)	3 (A 8-11)
ELECTRONIC SPARK CONTROL MODULE	2 (D 4)
ELECTRONIC LEVEL CONTROL COMPRESSOR ASSEMBLY	1 (C 2)

EST DISTRIBUTOR	2 (D-E 6-7)
FLUID WARNING CENTER	7 (A 27)
FUEL CONTROL IN-LINE FUSE (4.3L)	2 (C 5)
FUEL CONTROL IN-LINE FUSE (5.0L & 5.7L)	3 (C 9)
FUEL INJECTORS (4.3L)	2 (B 7)
FUEL INJECTORS (5.0L & 5.7L)	3 (B 11)
FUEL PUMP RELAY (4.3L)	2 (B 4)
FUEL PUMP RELAY (5.0L & 5.7L)	3 (B 8)
FUEL TANK UNIT	8 (A 28, D 28)
FUSE BLOCK	4 (C-D 13-14)
GEAR SELECT SWITCH	4 (E 12)
HAZARD FLASHER	7 (A 24)
HEIGHT SENSOR ASSEMBLY	1 (C 3)
HI LEVEL STOP LIGHT	10 (C 39)
HORN RELAY	7 (B 24)
HYDRAULIC MODULATOR	5 (A-B 19)
I/P COMPARTMENT LIGHT	9 (E 34)
I/P COURTESY LIGHTS	9 (B 34)
IGNITION COIL (4.3L)	2 (E 6)
IGNITION COIL (5.0L & 5.7L)	3 (E 10)
IGNITION SWITCH	4 (A 12-15)
INSIDE MIRROR READING LIGHTS	9 (B 35)
INSTRUMENT CLUSTER DIMMER SWITCH	9 (C 33)
INSTRUMENT CLUSTER (DIGITAL)	8 (C-E 30-31)
INSTRUMENT CLUSTER (INDICATOR)	8 (A-B 31)
KEYLESS ENTRY MODULE	10 (B 38)
LIGHT SWITCH	7 (C 27)
LIGHT SWITCH LIGHT	9 (E 34)
LOW COOLANT MODULE	7 (B 27)
LOW OIL MODULE	7 (B 27)
MIRROR HEATERS	10 (B 36-37)
O2 SENSOR (4.3L)	2 (B 7)
OIL LEVEL SWITCH	7 (A 26)
POWER ANTENNA RELAY	10 (A 36)
POWER DOOR LOCKS RELAY	10 (C 36)
POWER MIRRORS SWITCH	9 (C 32)
POWER SEAT SWITCH	9 (D-E 32-33)
POWER WINDOW SWITCH LIGHT	9 (D 33)
POWER WINDOW SYSTEM	9 (A-B 32-33)
REAR COURTESY LIGHTS	9 (A 35)
REAR GLASS RELEASE/TAILGATE LOCK SYSTEM	5 (B-E 21-23)
REAR WIPER MODULE	

	6 (C 20)
REAR WIPER/WASHER SWITCH	6 (B 20)
SEAT BELT SWITCH	5 (A 25)
SHIFT INHIBIT SOLENOID	7 (E 27)
STARTER	1 (A 3)
TAILGATE AJAR SWITCH	9 (A 34)
TCC CRUISE RELEASE SWITCH	5 (E 18)
TRUNK LIGHT	9 (E 34)
TRUNK RELEASE SWITCH	10 (A 37)
TWILIGHT SENTINEL CONTROL	7 (C-D 25-27)
UNDERHOOD LIGHT	9 (E 34)
VANITY MIRROR	9 (E 34)
VEHICLE SPEED SENSOR	5 (D-E 18)
WASHER FLUID LEVEL SWITCH	7 (A 26)
WIPER/WASHER MOTOR	1 (D-E 3)
WIPER/WASHER SWITCH	6 (D-E 20)

GROUND LOCATION MENU

GROUND LOCATIONS

Component	Figure No. (Location)
GROUND**A:** (BOLTED TO RIGHT FRONT FENDER NEAR BATTERY)	1 (A 2)
GROUND**B:** (BOLTED TO FRONT OF RIGHT CYLINDER HEAD)	1 (A 2)
GROUND**C:** (BOLTED TO RIGHT HEADLIGHT SUPPORT FORWARD OF BATTERY)	1 (B 1)
GROUND**D:** (BOLTED BEHIND LEFT HEADLIGHT SUPPORT FORWARD OF FUEL VAPOR CANISTER)	1 (D 1)
GROUND**E:** (4.3L) (REAR OF RIGHT CYLINDER HEAD BELOW EXHAUST MANIFOLD)	2 (D 5)
GROUND**E:** (5.0L & 5.7L) (REAR OF RIGHT CYLINDER HEAD BELOW EXHAUST MANIFOLD)	3 (D 9)
GROUND**F:** (FRONT OF ENGINE AT THERMOSTAT HOUSING)	5 (B 19)
GROUND**G:** (BASE OF LEFT "A" PILLAR BEHIND LEFT KICK PAD)	6 (C 22)
GROUND**H:** (BEHIND RIGHT KICK PAD AT BASE OF RIGHT "A" PILLAR)	9 (B 32)
GROUND**I:** (NEAR CENTER OF RIGHT "D" PILLAR)	10 (A 38)
GROUND**J:** (NEAR CENTER OF LEFT "D" PILLAR)	10 (B 38)
GROUND**K:** (ABOVE GROUND G)	10 (B 38)
GROUND**L:** (IN LUGGAGE COMPARTMENT BOLTED TO BRACE ATTACHED TO LEFT WHEELHOUSE)	10 (E 37)

GROUND**M:** (ABOVE GROUND G)	10 (E 38)
GROUND**N:** (BOLTED TO BRACE ATTACHED TO RIGHT WHEELHOUSE)	10 (E 37)

WIRING DIAGRAMS

Fig. 1: Engine Compartment & Headlights (Grid 1-3)

Fig. 2: Electronic Engine Control (4.3L) (Grid 4-7)

Fig. 3: Electronic Engine Control (5.0L & 5.7L) (Grid 8-11)

Fig. 4: Fuse Block, Ignition Switch (Grid 12-15)

Fig. 5: DERM, Elect Brake, Cruise Control (Grid 16-19)

Fig. 6: A/C-Heat, Wipers Switch (Grid 20-23)

Fig. 7: Instrument Cluster, Conven Center, Twilight (Grid 24-27)



Fig. 8: Instrument Cluster Fuel Pump/Oil Pressure Sw (Grid 28-31)



Fig. 9: Power Window/Mirror/Seat (Grid 32-35)



Fig. 10: Power Door, Defog, Keyless Entry, Taillights (Grid 36-39)

WIRING DIAGRAMS

4.3L VIN W (CAPRICE)

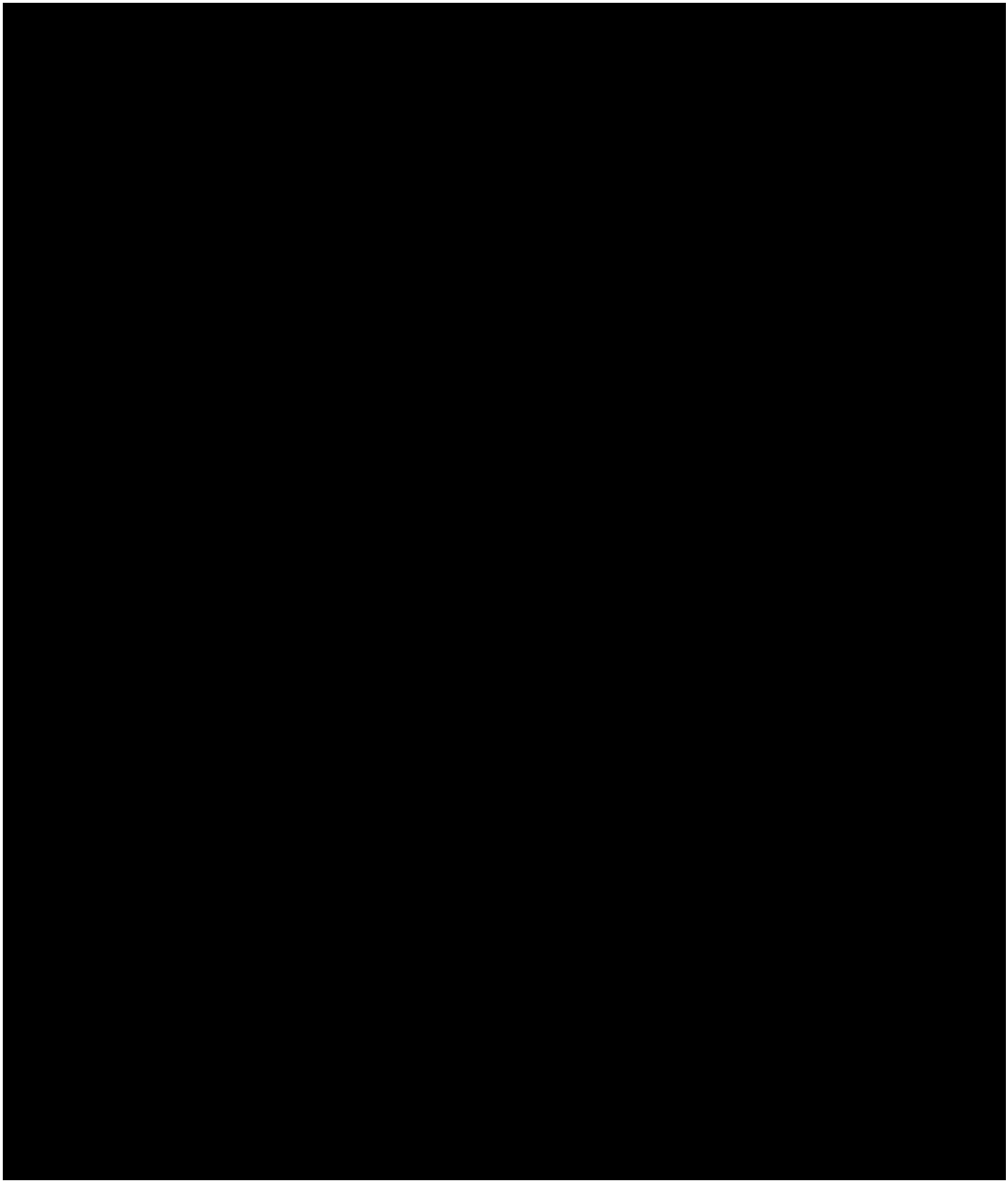


Fig. 1: 4.3L (VIN W) PCM Wiring Diagram (Caprice - 1 Of 3)

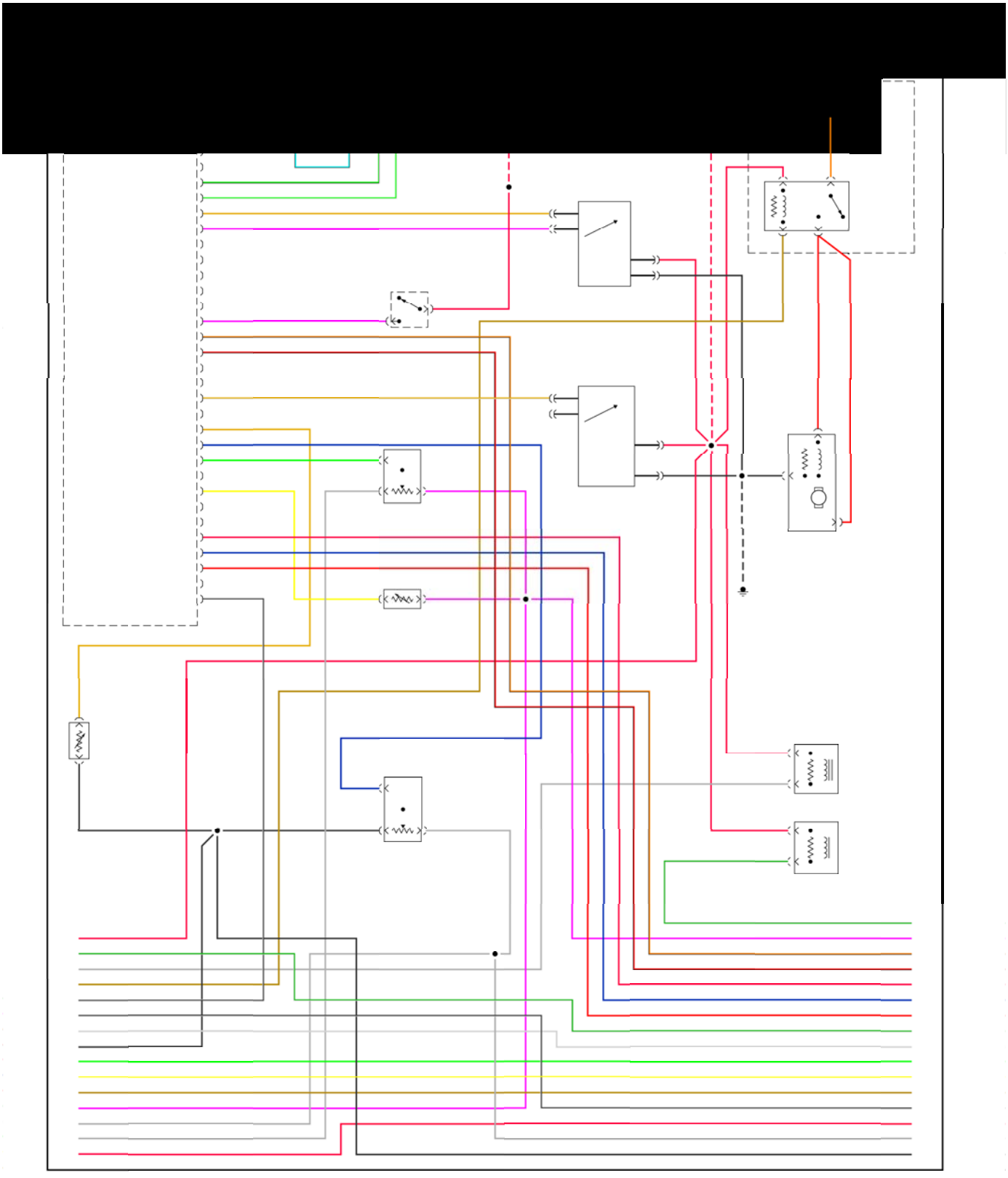


Fig. 2: 4.3L (VIN W) PCM Wiring Diagram (Caprice - 2 Of 3)

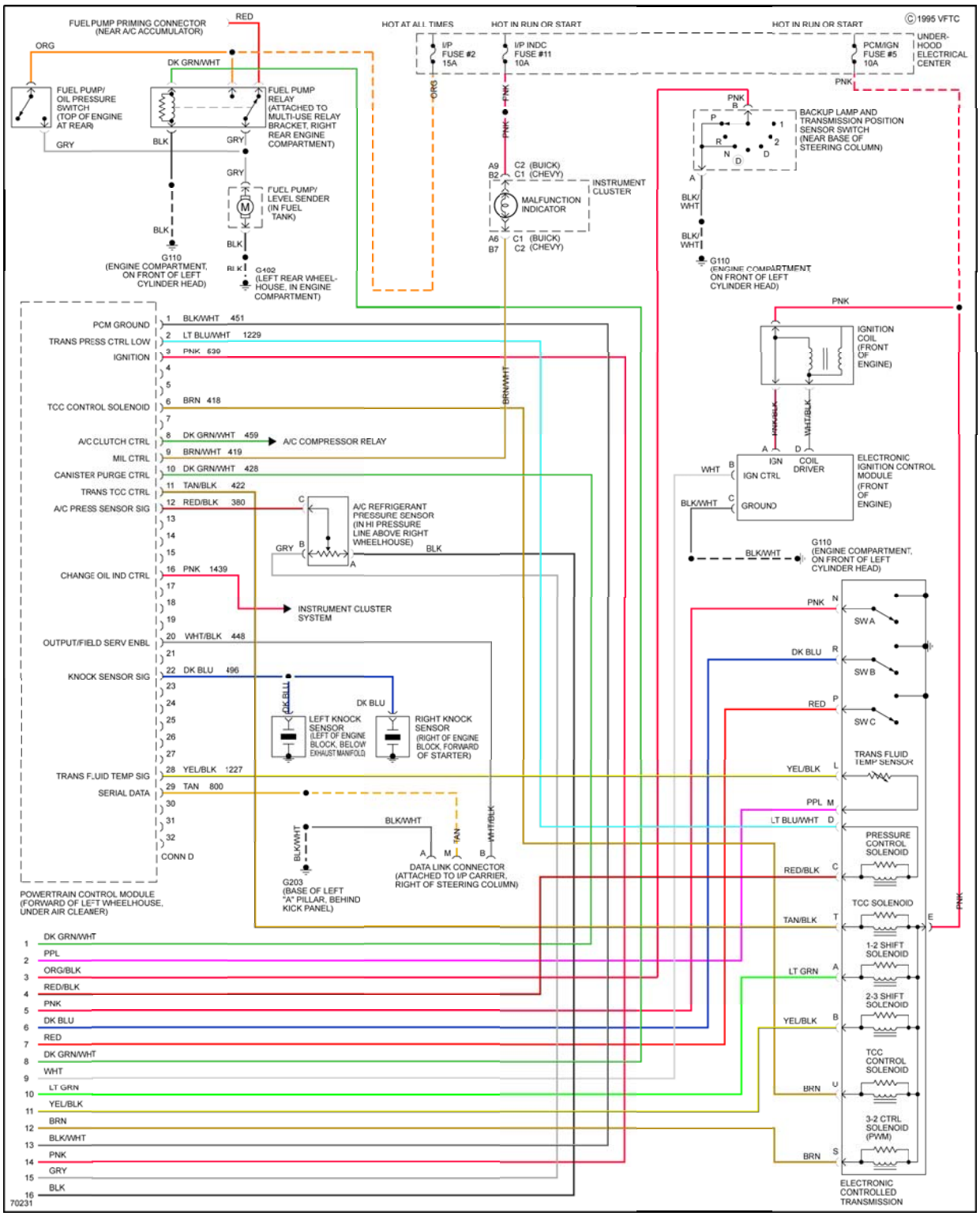


Fig. 3: 4.3L (VIN W) PCM Wiring Diagram (Caprice - 3 Of 3)

5.7L VIN P (ALL MODELS)

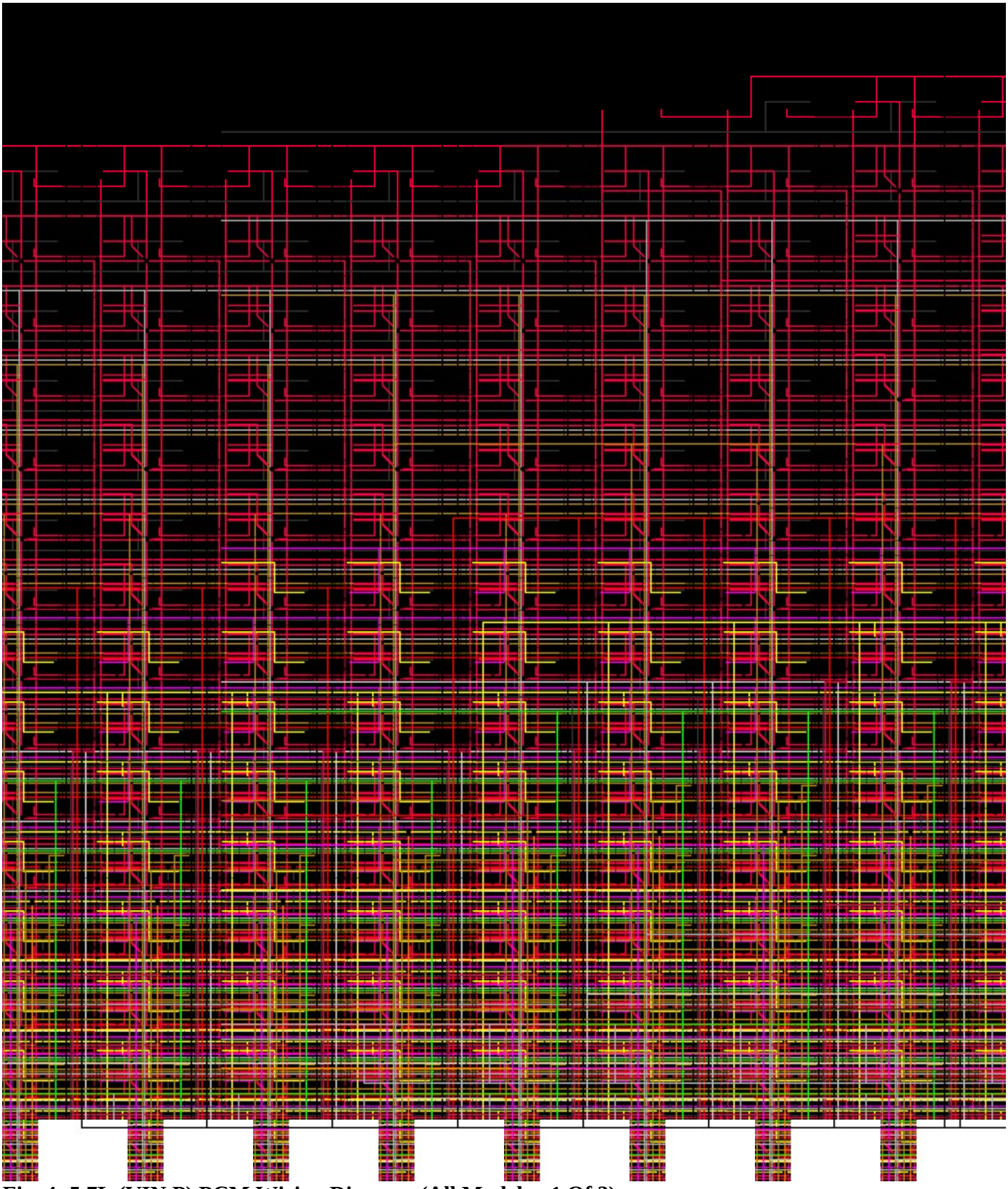


Fig. 4: 5.7L (VIN P) PCM Wiring Diagram (All Models - 1 Of 3)

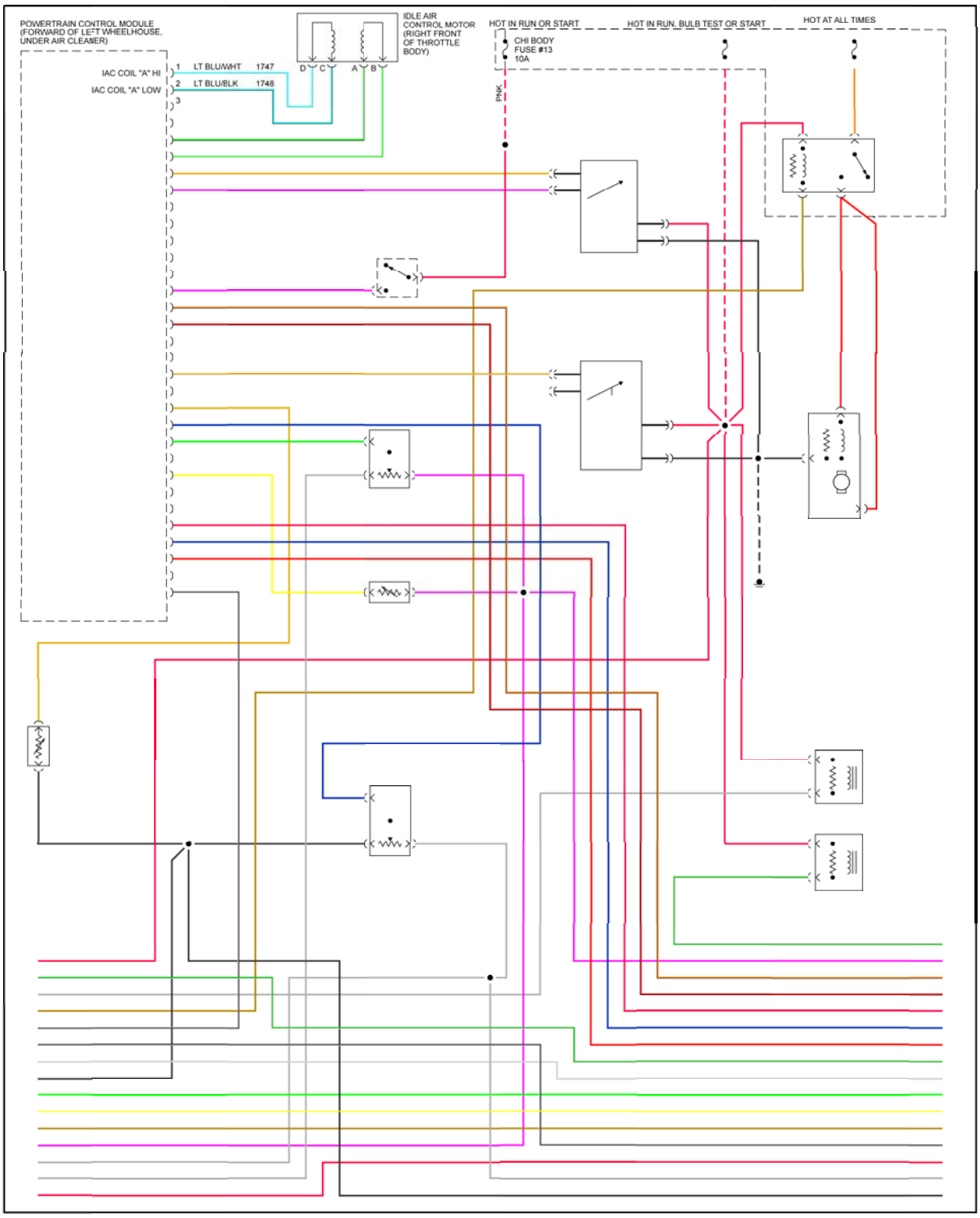


Fig. 5: 5.7L (VIN P) PCM Wiring Diagram (All Models - 2 Of 3)

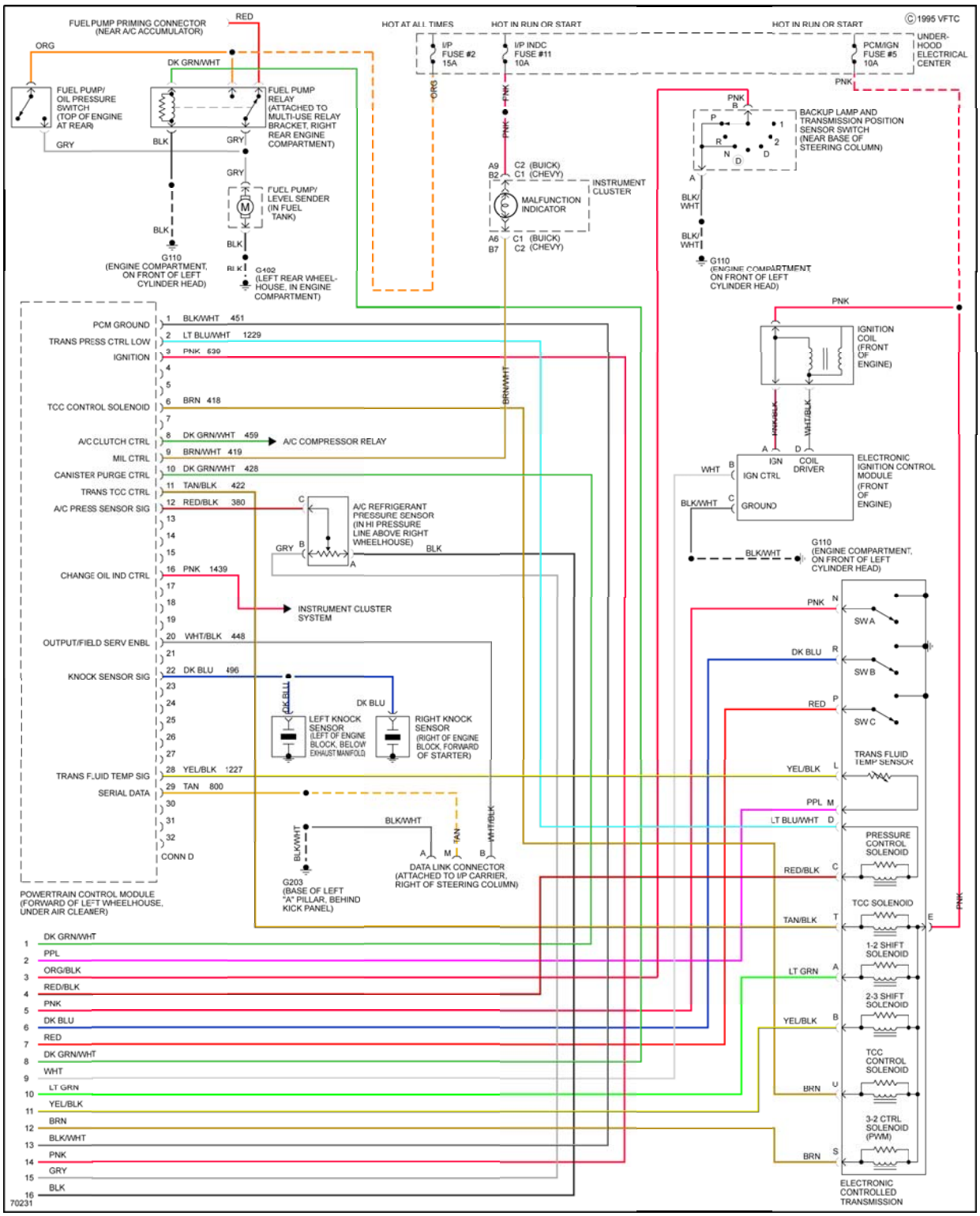


Fig. 6: 5.7L (VIN P) PCM Wiring Diagram (All Models - 3 Of 3)