Chapter 11

Servicing

Contents

TABLES

1. Introduction

In the previous chapter you've seen how to use tools such as scan tools to look for trouble codes and to run a Quick Test of the engine control system. In this chapter you'll see how to:

- Check specifics on the fuel system, ignition system and idle-air system
- Run typical specific tests of components that are indicated by trouble codes or Quick Test
- Observe and measure details of sensors and actuators, so that you can apply this using the electrical tests in Chapter 12

When testing components, owners and shops without the necessary BreakOut Box (BOB), may choose to backprobe. Backprobers push a straight pin in through the back of a connector, probing for a contact that allows making an electrical test (voltage/ground/resistance) on that circuit.

CAUTION —
- *Be very careful when backprobing connectors. Backprobing can destroy the waterproofing of a connector. Moisture entering the opening can corrode the contacts inside the connector. If in doubt, don't backprobe.*
- *When backprobing connectors, insert pins from the harness side.*
- *Never force the probe into a female connector. On the male pin side, probe the pin. Be sure you do not short between the pins.*

Fig. 1-1. Backprobing gives you access to circuit signals without breakout box. Checking VPWR to Mass Air Flow (MAF) sensor shown. Take care not to damage connector or terminals.

CAUTION —
- *Connect or disconnect multiple connectors and test leads only with the ignition off. Switch multimeter functions or measurement ranges only with the test leads disconnected.*
- *Do not use a test lamp that has a normal incandescent bulb to test circuits containing electronic components. Use only an LED (light emitting diode) test lamp.*
- *Do not use an analog (swing-needle) meter to check circuit resistance or continuity on electronic (solid state) components. Use only a high quality digital multimeter having high input impedance (at least 10 megohm).*

1.1 Electrical Troubleshooting

Four things are required for current to flow in any electrical circuit: a voltage source, wires or connections to transport the voltage, a consumer or device that uses the electricity, and a connection to ground.

For trouble-free operation of the engine control systems, the ground connections, including the negative battery cable and the body ground strap, must remain clean and free from corrosion. Most problems can be found using only a multimeter (volt/ohm/amp meter) to check for voltage, for resistance, for breaks in the wiring (infinite resistance/no continuity), or for a path to ground that completes the circuit.

Electric current is logical in its flow, always moving from the voltage source toward ground. Keeping this in mind, electrical faults can be located through a process of elimination. When troubleshooting a complex circuit, separate the circuit into smaller parts. The general tests outlined here may be helpful in finding electrical problems. The information is most helpful when used with the electrical tests and wiring diagrams provided in **Chapter 12**.

Testing for Voltage and Ground

The most useful and fundamental electrical troubleshooting technique is checking for voltage and ground. A voltmeter or a test light should be used for this test. For example, for a code 74/536 Brake On/Off (BOO) circuit failure, checking for voltage will determine if the problem is in the circuit or the switch. See Fig. 1-2 and Fig. 1-3.

NOTE —
A test light only determines if voltage or ground is present. It does not determine how much voltage or how good the path to ground is. If the voltage reading is important, use a digital voltmeter. To check the condition of the ground connection, check voltage drop on the suspected connection as described below.

To check for positive (+) battery voltage using a test light, connect the test light wire to a clean, unpainted metal part of

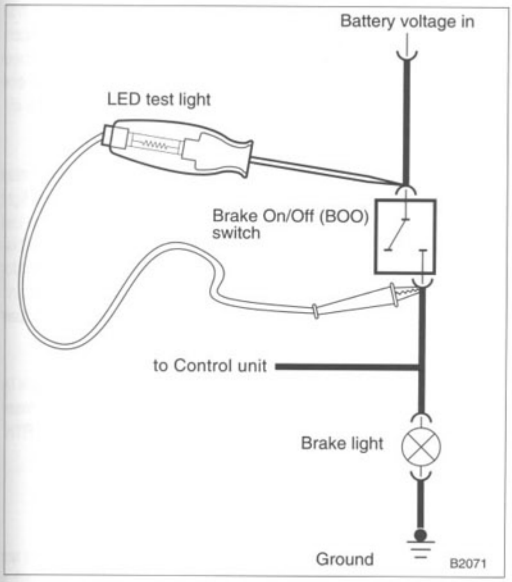

Fig. 1-2. How to use a test light for checking voltage in BOO circuit. A test light is the quickest way to check for voltage and ground.

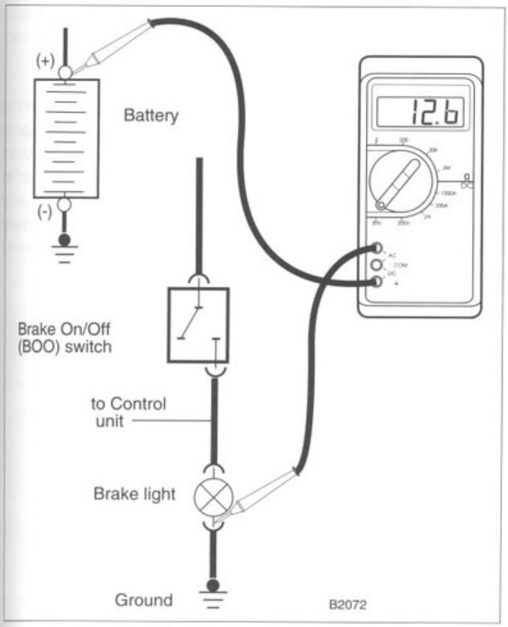

Fig. 1-3. How to use a voltmeter to check for ground.

the car or a known good ground. Use the pointed end of the light to probe the positive (+) connector or socket. To check for continuity to ground, connect the test light wire to the positive (+) battery post or a battery source. Use the pointed end of the light to probe the connector or socket leading to ground. In either case, the test light should light up.

To check for voltage using a voltmeter, set the meter to the correct scale. Connect the negative (–) test lead to the negative (–) battery terminal or known good ground. Touch the positive (+) test lead to the positive wire or connector. To check for ground, connect the positive (+) test lead to the positive (+) battery terminal or voltage source. Touch the negative (–) test lead to the wire leading to ground. The meter should read battery voltage.

Continuity Test

The continuity test can be used to check a circuit or switch. Because most automotive circuits are designed to have little or no resistance, a circuit can be easily checked for faults using an ohmmeter. An open circuit or a circuit with high resistance will not allow current to flow. A circuit with little or no resistance allows current to flow easily. See Fig. 1-4.

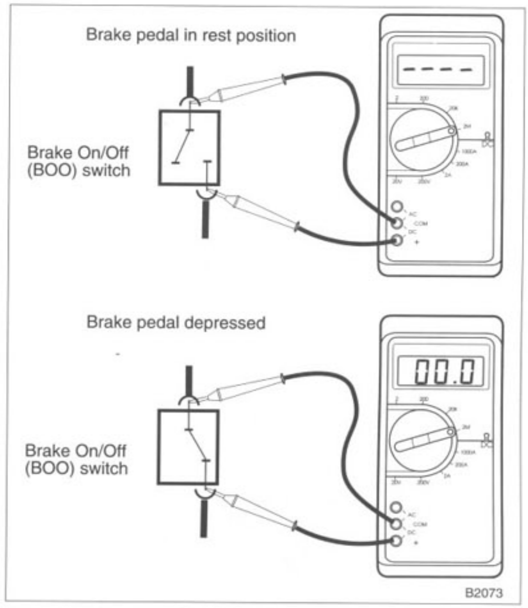

Fig. 1-4. How to test BOO switch for continuity. With brake pedal in rest position (switch open) there is no continuity. With brake pedal depressed (switch closed) there is continuity.

When checking continuity, keep the ignition off. On circuits that are powered at all times, disconnect the battery. Using the appropriate wiring diagram, you can test a circuit for faulty connections, wires, switches, relays, and engine sensors by checking for continuity.

On the BOO code, for example, you could check wiring continuity from the battery to the switch, from the switch to ground, or from the switch to the control module. You could also check continuity across the switch.

Short Circuit Test

A short circuit is exactly what the name implies. The circuit takes a shorter path than it was designed to take. The most common short that causes problems is a short to ground where the insulation on a positive (+) wire wears away and the metal wire is exposed. If the exposed wire is live (positive battery voltage), a fuse will blow and the circuit may possibly be damaged.

> ***CAUTION —***
> *On circuits protected with large fuses (25 amp and greater), the wires or circuit components may be damaged before the fuse blows. Always check for damage before replacing fuses of this rating. Always use replacement fuses of the same rating.*

Shorts to ground can be located with a voltmeter, a test light, or an ohmmeter. Short circuits are often difficult to locate. Therefore, it is important that the correct wiring diagram is available. Short circuits can be found using a logical approach based on the current path. See Fig. 1-5.

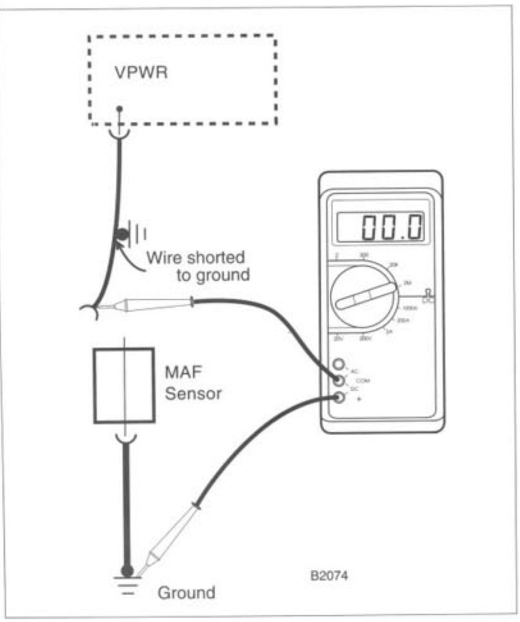

Fig. 1-5. How to use an ohmmeter to check for short circuit to ground On Mass Air Flow (MAF) sensor power supply.

To check for a short circuit to ground, disconnect the harness connector from the circuit's load or consumer. If necessary, remove the blown fuse from the circuit and disconnect the cables from the battery. Using an ohmmeter, connect one test lead to the load side terminal (terminal leading to the circuit) and the other test lead to ground.

Working from the wire harness nearest to the fuse/relay panel, move or wiggle the wires while observing the test light or the meter. Continue to move down the harness until the test light blinks or the meter displays a reading. This is the location of the short. Visually inspect the wire harness at this point for any faults. If no faults are visible, carefully slice open the harness cover or the wire insulation for further inspection. Repair any faults found.

You can also check for a short circuit to the control module by disconnecting both the component and control module harness connectors and probing two terminals, say MAF and MAF RTN. If there is continuity, then there is a short in the harness.

Voltage Drop Test

The wires, connectors, and switches that carry current are designed with very low resistance so that current flows with a minimum loss of voltage. A voltage drop is caused by higher than normal resistance in a circuit. This additional resistance actually decreases or stops the flow of current. A voltage drop can be noticed by problems ranging from dim headlights to rough running. Some common sources of voltage drops are faulty wires or switches, dirty or corroded connections or contacts, and loose or corroded ground wires and ground connections.

Voltage drop can only be checked when current is running through the circuit, such as by operating the starter motor or turning on the ignition. Making a voltage drop test requires measuring the voltage in the circuit and comparing it to what the voltage should be. Since these measurements are usually small, a digital voltmeter should be used to ensure accurate readings. If a voltage drop is suspected, turn the circuit on and measure the voltage at the circuit's load.

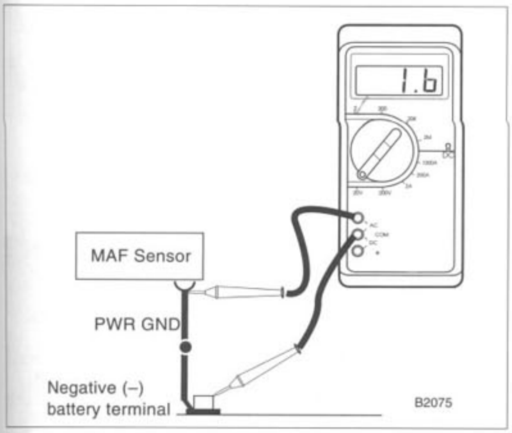

Fig. 1-6. How to test voltage drop on MAF sensor ground. Voltmeter showed 1.6-volt drop between PWR GND at MAF connector and battery ground. After removing and cleaning battery ground, voltage drop returned to normal.

NOTE —
- A voltage drop test is generally more accurate than a simple resistance check because the resistances involved are often too small to measure with most ohmmeters. For example, a resistance as small as 0.02 ohms results in a 3 volt drop in a typical 150 amp starter circuit. (150 amps x 0.02 ohms = 3 volts).

- Keep in mind that voltage with the key on and voltage with the engine running are not the same. With the ignition on and the engine off, battery voltage should be approximately 12.6 volts. With the engine running (charging voltage), voltage should be approximately 14.5 volts. Measure voltage at the battery with the ignition on and then with the engine running to get exact measurements.

- The maximum voltage drop, as recommended by the Society of Automotive Engineers (SAE), is: 0 volt for small wire connections; 0.1 volt for high-current connections; 0.2 volt for high-current cables; and 0.3 volt for switch or solenoid contacts. On longer wires or cables, the drop may be slightly higher. In any case, a voltage drop of more than 1.0 volt usually indicates a problem.

2. CHECKING FUEL SYSTEM

You may have noticed that codes do not show when the fuel system is not operating properly. The engine does not have a sensor for low fuel pressure or fuel flow. But your Diagnostic Routines often consider fuel delivery as a possible cause of a driving complaint.

If you've come to this section from the Diagnostic Routines, you're specifically looking for a problem that would cause fuel flow through the injectors to be incorrect. Your fuel delivery checks will look for answers to four questions:

1. Is the pressure regulator controlling the pressure?
2. Is the fuel pump creating enough pressure?
3. Is the fuel pump delivering enough volume?
4. Are the injectors operating correctly?

If you suspect fuel system problems, first listen to make sure the pump runs when you turn on the ignition. If not, check the system relay, the fuel pump relay, (or the Integrated Relay Control Module if fitted), the inertia switch, and the anti-theft system. You'll be looking for power to the relay, ground from the relay, and relay switching when power is applied.

Also make sure the control module is receiving the signal indicating the engine is turning over. On EEC systems (and on MECS-II), it comes from the ignition system (PIP signal). On most MECS-I, this comes from the air-flow sensor. If the pump runs, continue to check basic system pressures, fuel delivery, and operation of the fuel injectors.

WARNING —
- *Remember that Ford port-injection systems operate at high pressures, typically about 40 psi (270kPa).*
- *Fuel lines are usually pressurized even when the engine is not running. If you open a line under pressure, that can spray gasoline which is a severe fire hazard.*

2.1 Pre-checks

Start by checking over the complete fuel-delivery system. You're looking for leakage in fuel lines or at fuel line connections, loose wiring connectors, cracks, pinching, kinking, corrosion, grounding abrasion. Check around all components:

- Fuel tank
- Filter
- Pump(s)
- Injectors and fuel rail
- Pressure regulator

Check that the battery is fully charged and the fuel tank has fuel. (I know, that's an oldie, but it's easy to overlook an empty tank.) Check the fuses controlling the fuel-delivery system.

2.2 Pressure Tests

Excess fuel pressure may enrichen the mixture, while insufficient pressure may lean the mixture. Why? Because injection times are calculated on the basis of specified fuel pressure. You'll be checking three pressures:

- Engine off, to check pump pressure
- Engine running, to check pressure-regulator response to manifold pressure
- Rest (or residual) pressure to check leakage in the system

To check engine off/engine running fuel pressure (all except MECS systems):

1. Attach the fuel-pressure gauge. Look for a fitting on the fuel rail. See Fig. 2-1. Be sure to tighten the gauge onto the valve.

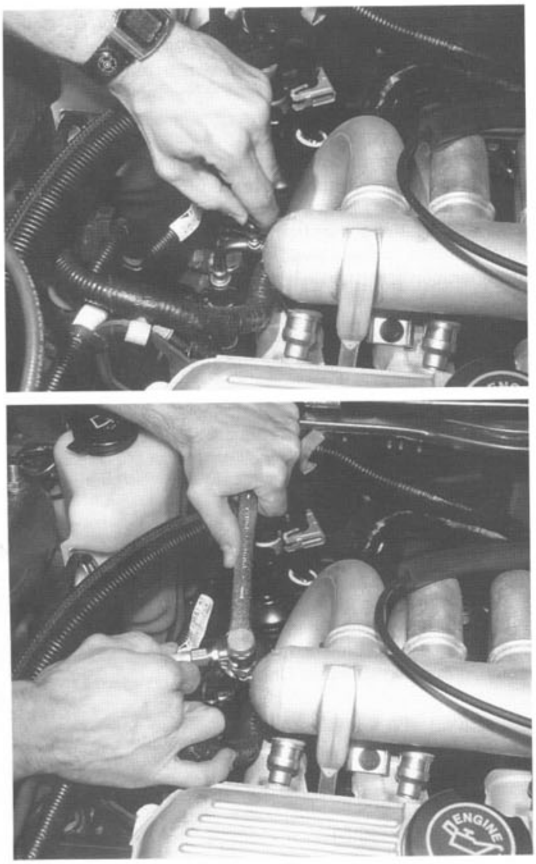

Fig. 2-1. Fuel pressure gauge attachment to EEC systems is easy. Look for Schrader valve fitting on fuel rail. Attach gauge to fitting and tighten.

2. With the key OFF, ground the fuel pump (FP) lead of the Self-Test Connector (STC). See Fig. 2-2.

NOTE —
For short tests without grounding the fuel-pump lead in the STC connector, you can build engine-OFF fuel pressure by turning the key ON several times. This runs the pump for about one second at a time until pressure builds.

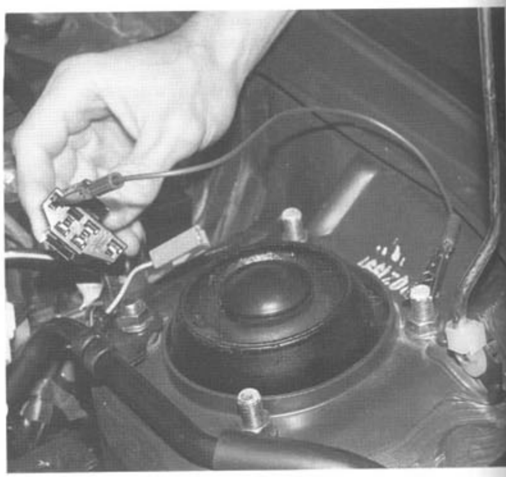

Fig. 2-2. Grounding Fuel Pump (FP) lead of Self-Test Connector to run fuel pump with engine off.

3. Turn the key ON to run pump (Do not start the engine).
4. Check the Engine Off fuel pressure according to the specifications. See **Table a** or **Table b**. Turn the key OFF and remove the jumper wire when done.
5. Start the engine and check Engine Running pressure.

To check engine off/engine running fuel pressure (MECS systems):

1. Relieve the fuel pressure, open the supply line and with an adapter, T-in the gauge. Here's how:
   - With engine idling, remove fuel-pump relay
   - After engine stalls, turn ignition OFF
   - Install fuel-pump relay
   - Use rag when opening fittings to prevent spray
   - Install gauge with hose clamps
2. After fuel-pressure release, prime the pump before starting the engine:
   - Ground pump at test connector
   - Ignition ON for 10 seconds
   - Check for leaks
   - Ignition OFF
   - Remove jumper wire

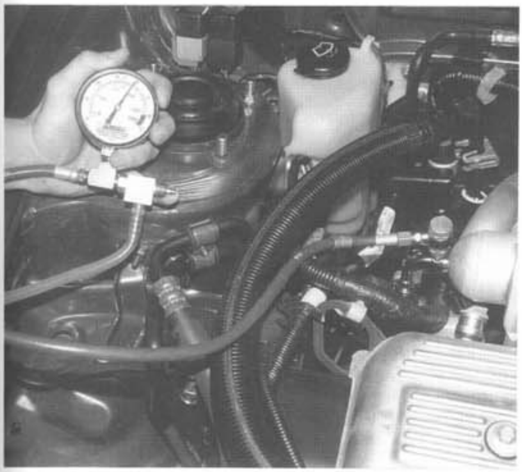

Fig. 2-3. Fuel pressure, pump running, engine off. See tables below for correct values.

Table a. EEC-IV Fuel Pressure Specifications

	Key On Engine Off		Engine Running (ER) Idle	
Engine	**psi**	**kPa**	**psi**	**kPa**
1.9L, 2.3L OHC, 2.9L 3.0L, 3.8L, 5.0L	35–45	240–310	30–45	210–310
2.3L HSC, 4.9L	50–60	345–415	45–60	310–415
SHO and other cars not listed	30–45	210–310	28–33	193–227
3.8L SC	35–40	240–280	30–40	210–280
4.6L	35–40	240–280	30–45	210–310
Trucks not listed	35–45	240–310	30–45	210–310

Table b. MECS Fuel Pressure Specifications

	Key On Engine Off		Engine Running (ER) Idle	
Engine	**psi**	**kPa**	**psi**	**kPa**
1.3L	35–40	240–280	25–31	175–215
1.6L	37–41	255–290	28–31	195–215
1.8L	38–45	265–315	30–37	205–255
2.2L	34–40	235–275	27–33	185–225
'93 2.0L	37–46	260–320	30–38	210–260
'93 2.5L	37–46	260–320	30–36	210–250

To check leakdown pressure (residual):

1. Begin with the engine idling, with the fuel-pressure gauge connected, as above. Get ready to time the leakdown.
2. Turn off engine, then turn Key ON, but do not start. Observe the KOEO pressure.
3. Turn the key OFF and measure pressure for one minute after turning key off.
4. At the end of that time, fuel pressure should hold within the KOEO specification.

If the car passes, but still has a start problem, recheck to a tighter limit—say, it should lose no more than 2 psi per hour. Incorrect fuel pressures indicate a problem either with fuel delivery from the pump, with the pressure regulator or with the fuel lines.

Checking for Causes of Incorrect Fuel Pressures

If KOEO pressure is too low, first check for a clogged fuel filter. Also check for a bad pump, or a bad pressure regulator. Why? These parts affect how much fuel reaches the pressure gauge. If reduced, you'll see less gauge pressure.

If KOEO pressure is too high, the problem is either a clogged return-line or a faulty regulator. Why? These parts affect how much fuel returns to the tank. If return is reduced, you'll see more gauge pressure.

Low residual pressure could be caused by leakage at the fuel-pump check valve or the fuel pressure regulator. Or look for leaking injectors. See **2.6 Checking Injectors** for more information.

If there is no change in ER pressure, check the vacuum supply and hose to the pressure regulator. Fix if faulty. If the vacuum and hose are OK, then the regulator is probably faulty.

On port-injected engines, notice the difference between the Key On, Engine Off (KOEO) pressure and the Engine Running (ER) pressures. With the engine OFF, Manifold Absolute Pressure (MAP) is higher than it would be with the engine running. See Chapter 7 for additional information.

- ER, idle fuel pressure is lower than KOEO because the fuel pressure regulator compensates for the lower MAP.
- ER, wide-open-throttle fuel pressure is usually about the same as KOEO because MAP is about the same as it would be Engine OFF.
- ER, idle fuel pressure with the vacuum hose removed from the fuel pressure regulator is also the same as KOEO. (Fuel-pressure gauge is operating at barometric pressure, both cases.)

To check for causes of low fuel pressure:

1. Check voltage and ground at the high-pressure fuel-pump terminals. Voltage should be within 0.5v. of battery voltage. Continuity to ground should be less than 1 ohm. If not, check the wiring and check for corrosion.
2. Remember, some Ford trucks use a low-pressure pump in the tank and a high-pressure pump in the line. Verify low-pressure pump operation by listening at the fuel tank through the open filler pipe. You may have to check delivery of the low-pressure pump.
3. On MECS-I, verify operation of the VAF fuel-pump switch and VAF ground. See **Chapter 12**.
4. Check fuel volume delivery as described below.
5. If all of the above ar O.K., then the fuel pressure regulator is probably faulty.

To check for causes of excess fuel pressure:

1. Remove the fuel return line from the regulator. Attach a hose and direct the fuel return into an unbreakable container. See Fig. 2-4.

> ***WARNING —***
> *This test delivers gasoline into the open, with attendant vapors. Know what you are doing and be extra careful. You can expect fuel to leak or gush out. Do not smoke or cause sparks. Have an approved fire extinguisher handy.*

Fig. 2-4. Check return flow from regulator. Fuel-pressure gauge fitted to Schrader valve has drain valve.

2. Re-run the fuel-system pressure test. If pressures are now within spec, clean or replace the fuel return line. If pressures are still high, replace the regulator.

To check leakage in the regulator or at the pump:

1. Disconnect the fuel-return line from the engine. Plug it.
2. Build up normal fuel pressure by cycling key ON and OFF.
3. In 30 seconds, fuel-pressure drop should be less than 5 psi (34 kPa).

If the drop is still more than spec, fuel is probably leaking past the fuel-pump check valve. Why? Because with the return line plugged, the regulator could not be causing the drop in pressure. If the drop is now in spec, a faulty pressure regulator caused the drop you observed in the first test. Why? Because blocking off the regulator cured the pressure drop.

To check pressure regulator diaphragm:

1. Start the engine and run for about 10 seconds.
2. Stop the engine for about 10 seconds.
3. Run the engine for another 10 seconds. Stop the engine.
4. Remove the vacuum hose from the regulator. See Fig. 2-5. If the diaphragm is leaking, you will see evidence of fuel at the vacuum port. Replace the regulator.

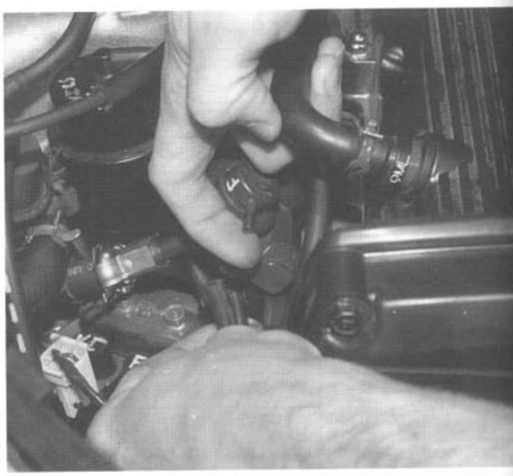

Fig. 2-5. Check for evidence of fuel at regulator vacuum port. If it is dry, the diaphragm is not leaking.

2.3 Fuel Volume Delivered

The latest service manuals do not call for this test, relying on other checks to verify proper operation of the fuel system. On the other hand, if you are faced with loss of power at high revs or if there seems to be no other reason for low fuel pressure, this test could verify if pump delivery as the problem.

> **NOTE —**
> If you wonder why you check fuel delivery from the return line instead of the supply line, I did too, at first. Then I learned that what counts is the delivery amount against the regulated pressure, and that measuring the supply line against zero pressure gives a higher, misleading delivery volume.

To measure delivery:

1. Disconnect the fuel-return line at the engine.
2. Slip a hose over the return line and place the other end in a container holding about 1 qt. (1 L). Use a plastic or metal container; if a glass container breaks, the spilled gasoline would be a real fire hazard. See Fig. 2-4 above.
3. Connect a jumper to the FP lead of the STC. See Fig. 2-2 above.
4. Get ready to measure time as you turn ignition ON for just 10 seconds. **Table c** gives delivery specs.

Table c. Fuel Delivery Specifications

System	Time	Fuel Delivered
EEC-IV	10 sec	170 ml (5oz.)
MECS 1.8L	10 sec	170 ml (5oz.)
MECS other	10 sec	220-380 ml (7.5–13 oz.)

If fuel delivery is low, replace the filter, and blow air through the supply line to be sure it is open. If delivery is still low, check voltage and ground at the high-pressure fuel-pump terminals. See Fig. 2-6. Voltage should be within 0.5v. of battery voltage. Continuity to ground should be less than 1 ohm. If not, check the wiring and check for corrosion. If there is no other problem and the pump electricals are OK, replace the pump.

2.4 Relieving Fuel Pressure

The fuel system is under pressure even when the engine is not running. The fuel-pump check valve holds pressure in the system for many hours after the engine is turned off. To prevent fuel from spraying over yourself and the engine when opening a fuel line, always relieve pressure in the lines.

Fig. 2-6. Check voltage at fuel-pump relay. On the '91 1.9L Escort, it is under the center console.

First, remove the gas tank cap. Why? Although most people don't realize it, gasoline vapor-pressure builds in fuel tanks. If you open a fuel-return line with the gas-tank cap in place, the small pressure can force fuel out of the line. Normal tank pressure is controlled by the valve in the cap at about 1.6 psi (11 kPa).

Fig. 2-7. Ford sets relief valve in the fuel tank cap at 1.6 psi (11 kPa). That small pressure can force fuel out of an open return line.

Next, release the pressure in the lines. The old way was to wrap the fuel fitting in a shop cloth and loosen it, but that can be messy and dangerous if a lot of fuel is spilled. I'm going to tell you two ways applicable to Ford engines.

1. EEC engines: With the fuel-pressure gauge attached to the Schrader valve as shown previously, gradually open the drain valve and catch the pressurized fuel in a container.
2. EEC or MECS engines: Open the inertia switch reset button (or disconnect the inertia switch connector) to disable the fuel-pump circuit. See Fig. 2-8. Run the engine until it stalls. Using a rag, disconnect the hose as necessary. Be sure to reset inertia switch.

Fig. 2-8. Inertia switch in trunk.

On MECS engines there's a third way. Disconnect power to the fuel pump, then crank/run the engine dry. On all except the 2.2L Turbo engine, disconnect the VAF connector to cut pump power. On the 2.2L Turbo, remove fuel-pump relay. After the engine stops, reconnect the circuit.

2.5 Opening EEC Fuel Lines

Generally, Ford fuel line connections use special couplings. See Fig. 2-9. Although you can make fuel connections simply by pushing them together, you'll need a special tool to open the fuel lines. In most engines, a $\frac{1}{2}$" tool opens the larger supply lines. A $\frac{3}{8}$" tool opens the return lines. See Fig. 2-10.

Here are four special points to remember:

1. Relieve fuel pressure before separating the spring-clip connectors. Twist the fittings to aid their release.
2. Use only the specified O-rings, made of special material for these couplings. Other O-rings may leak later, even if they seem at first to seal.
3. In reassembly, lubricate O-rings and both fittings with clean engine oil.
4. The color of the safety clip identifies the type. The larger, black clip identifies the supply line; the smaller, gray clip identifies the return line.

Fig. 2-9. A garter spring inside a circular cage holds safety-clip push-connect fittings with push-lock couplings together.

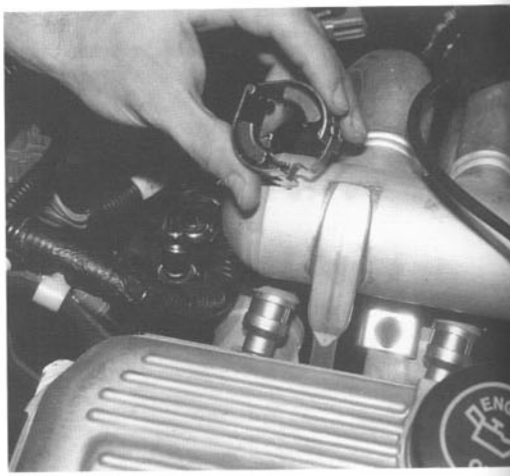

Fig. 2-10. You'll need special Ford tool to open fuel lines.

Whatever the coupling, always use new gaskets, O-rings and seals when reconnecting lines or installing components. Many of these seals crush on tightening. If a crushed seal is reused, it may leak immediately, or worse, it may develop a leak later as you drive.

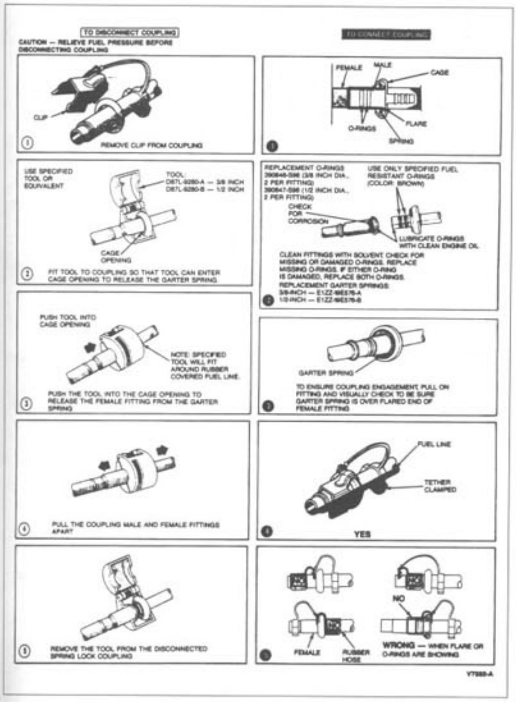

Fig. 2-11. Fuel line disconnect and connect procedure.

2.6 Checking Injectors

You have several methods to check the operation of the fuel injectors. In addition to those listed here, don't forget to check wiring continuity to the control module. Note: while the injectors may appear to be operating correctly, even a small amount of injector clogging can affect engine performance. This can lead to hard starting, rough idle, stumbles and surges, and gas smell from leaking.

> ***CAUTION —***
> *Do not apply voltage to the fuel injectors in an attempt to test them. Remember, injectors receive voltage from the computer and are grounded by the computer. Excessive voltage will burn out the injectors.*

Injector Operation

You can usually check injector operation by the vibration—indicating that they are opening and closing—while the engine is idling. If they're too hot to touch with your fingertips, use a mechanic's stethoscope or a screwdriver as shown in Fig. 2-12. You should hear a buzzing or clicking sound. Remember that each SFI injector fires individually once every two crankshaft-revolutions, a rate only half as fast as MFI injectors, which fire in gangs every crankshaft revolution.

Fig. 2-12. You can check injector operation with a stethoscope or by placing screwdriver tip against injector body and listening for clicking sound.

No vibration indicates a bad injector or harness. A different pitch of vibration in one versus the others can also indicate a bad injector or injector clogging. Interchange injectors (MFI on the same circuit). If the same injector is still faulty, then replace the injector. If the injector now works, check the wiring.

Injector Electrical Tests

To check resistance of an individual injector, disconnect the harness connector and use an ohmmeter across the injector terminals. See Fig. 2-13. See **Table d** for specifications.

Fig. 2-13. Checking injector resistance.

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Table d. Single Injector Resistances

Engine	Ohms
Most Late Model Engines	13.0–16.0
2.3L OHC & 3.0L	15.0–18.0
up to '90 1.9L MFI	2.0–2.7
1.9L & 2.5L CFI	1.0–2.0
2.3L TC MFI	2.0–3.0
5.0L SFI	13.5–19.0
'89 TRUCK	13.5–18.0
MECS-I (except 2.2L T)	12.0–16.0
MECS 2.2L Turbo	11.0–15.0
MECS-II 2.0L	12.0–17.0
MECS-II 2.5L V-6	12.0–16.0

For MECS 2.5L V-6, measure resistance of individual injectors at the harness terminals as shown in Fig. 2-14 .

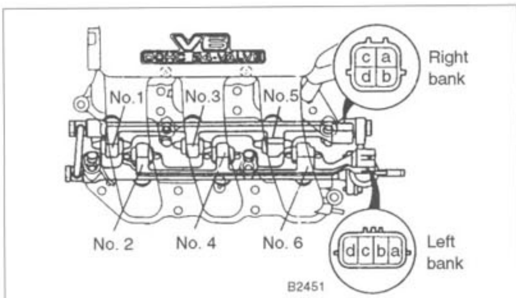

Fig. 2-14. MECS 2.5L V-6: Measure individual injector resistances at the connectors. Use the terminals shown in the table below.

Harness	Terminals	Injector No.
Right bank	a—b	1
	a—c	5
	a—d	3
Left bank	d—c	2
	d—b	4
	d—a	6

Notice the real differences in resistances of some injectors. Substituting a low-resistance injector for a high-resistance one (or vice versa) would cause real trouble.

To check the signal from the control module, use an LED test light across the harness connector terminals. Special injector test lights that plug into the connector are available from auto supply stores. When the engine is cranked the test light should flash. If it doesn't, there's a problem with either the wiring or the power and ground circuit from the control module. Remember, the injectors are supplied power with the key on, and the control module grounds the circuit to open the injectors.

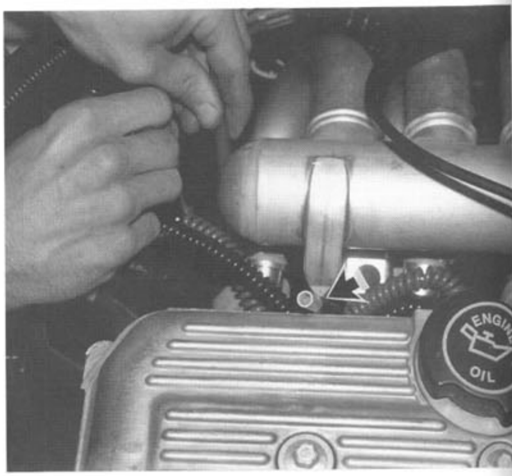

Fig. 2-15. Checking injector triggering by control module using a Light Emitting Diode (LED) test light (arrow).

RPM Drop Test

Sometimes you can identify an injector that is not carrying its load by looking for rpm drop as you disconnect, one at a time. Disable idle speed control by removing the connector. With the engine idling, and with a shop tach connected (the instrument-panel tach is not adequate), disconnect each injector by pulling its connector.

If any injector does not cause a drop of about 100 rpm, pull the injector and check it out. Check its circuit also. Remember, for SFI engines, the computer Quick Test does the RPM Drop Test for you.

Injector Leakage

Fuel injector leaks can occur at the seams around the fuel injector body and bleed off residual fuel pressure. Clean off the injector and look closely. Injectors usually leak most when they are cold. Replace an injector that leaks this way.

Also check the injector pintle for leakage. On some port systems, you can remove the fuel rail with the injectors and fuel lines still attached, then build up fuel pressure as in the pressure test and watch the injector(s) for drips. If you see more than 1 drop in two minutes, clean and retest. If not OK, replace the injector.

WARNING —
A leaking injector may spray vaporized gasoline, the most hazardous form. Keep a fire extinguisher handy.

Injector Clogging

Symptoms of a clogged fuel injector are a rough idle, a stumble or hesitation during acceleration, or a failed emissions test. A buildup of carbon and other deposits on the injector pintle causes fuel-injector clogging. This reduces the flow of gasoline through the injectors and results in a poor spray pattern. See Fig. 2-16.

> **NOTE —**
> Injector clogging is seldom a problem with side-feed injectors used in MECS 2.5L V-6, or in deposit-resistant injectors, used in most late-model EEC systems.

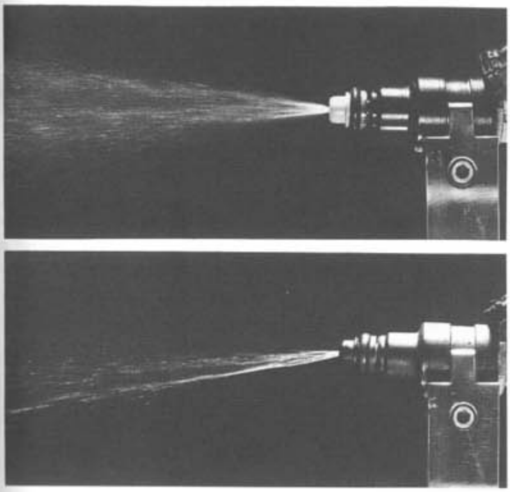

Fig. 2-16. New injector (top) has good spray pattern. Clogged injector (bottom) has poor pattern and flow rate of 50% less.

Causes of Clogging

Clogging is the result of the combination of a number of factors:

- High underhood temperatures on smaller cars
- Fuel being metered at the tip of the port injector
- Short driving cycles followed by hot-soak periods
- Low-detergent fuels with a high carbon content and low hydrogen content

The worst clogging seems to occur with driving cycles where the car is driven for at least 15 minutes, ensuring full warm-up, then parking for about 45 minutes or more. While the engine runs, the fuel flow cools the injector tips. After shut-down the engine acts as a heat sink and temperatures climb, particularly at the valves and manifolds. Injector-tip temperature climbs equally high, and the small amount of fuel that is in the tip of the injector breaks down and causes the deposit. Considering the small quantities of fuel that the injector meters, and the tiny orifice of the injector tip, it doesn't take much to restrict the flow, as shown in Fig. 2-17.

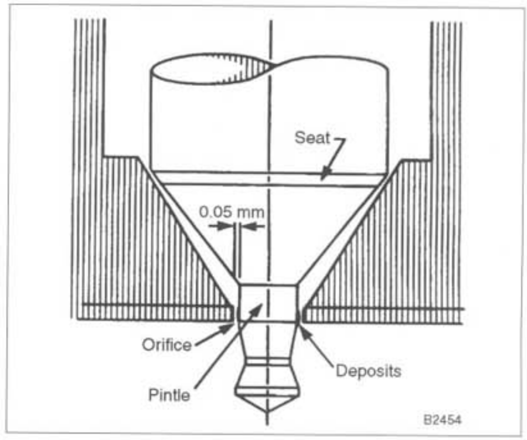

Fig. 2-17. Very small amounts of deposits will affect engine performance.

Normally, one injector clogs before the others, reducing its delivery so that one cylinder runs lean. The oxygen sensor compensates by enriching the mixture for other cylinders, which is in turn too rich for the cylinders with unclogged injectors. The result is a rough idle. The engine will most likely fail an emission test, and will send you to the gas pump more often, because it can lose as much as 25% fuel economy.

Solving the Clogging Problem

The first step towards solving the problem of fuel injector clogging is to determine whether one or more injectors are indeed clogged. You may use the special Ford Rotunda tester that checks the flow of each injector without removing them.

> **NOTE —**
> Test all multi-port injectors at 40 psi (270 kPa) regardless of the operating pressure specified for the vehicle.

Without the tester there are other ways to check for clogging. On SFI systems you can run a Cylinder Balance Test as described in Chapter 10. On other MFI systems, you can try an rpm drop test as described above.

Here's a tip from the field: read the plugs. If one looks OK and the others read rich, what could cause that? The OK plug is from the clogged injector. The other plugs are dark because the control module is adding extra fuel to compensate for the lean-mixture signal from the oxygen sensor. You can also read the plugs on a scope firing line. The plugged-injector cylinder will read normal, while the others will read low.

The tendency to form injector deposits varies considerably depending on the fuel. Many cases of injector clogging can be cured by using premium fuels advertised as containing more detergent additive. Most regular unleaded fuels probably have enough detergent to keep unclogged injectors clean, but they probably won't dissolve deposits on clogged injectors.

Pour a separate additive in your gas tank to clean injectors in a short time as shown in Fig. 2-18. In some cases, this may free other deposits that can clog the fuel system. Be aware that some gasoline additives that cure clogging can cause carbon deposits on the intake valves. These fluffy deposits absorb fuel and cause rough idle and hesitation, especially in cold running conditions. Check with your dealer for a recommended gasoline or additive.

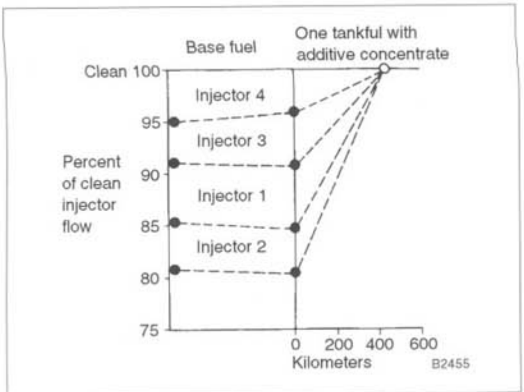

Fig. 2-18. Effect of adding fuel-injector cleaning additive to one tank of gas.

Change your driving cycle if you still get clogged injectors with all fuels. If you can't get good fuel, or if you want the best protection, it may be possible to install deposit-resistant injectors. Check with your dealer.

Cleaning Injectors

There are a number of special repair kits available that hook up to the fuel system to flush out deposits. Often they attach to the pressure test fitting. Ford dealers test and clean injectors with the Rotunda tester. I'll briefly list the steps. In any case, I suggest you follow the instructions of the specific cleaner you use.

- Install the tester/cleaner to the fuel lines
- Run the engine on gasoline/solvent mixture
- Reinstall fuel lines and check for leaks

Many cars may need to have their injectors cleaned on a regular basis. But with widespread distribution of fuels of increased quality, the great injector-clogging problem may pass into history.

3. Air Flow (Load) Measurement

Here are four different basic procedures for making Pinpoint tests of the components that measure air flow into the engine. Generally, you would make these when you see trouble codes during Quick Test (for example: codes 08, 22, 26, or 159). See also the electrical tests in Chapter 12 for terminal identification, tests specifications, and wiring diagrams.

> ***CAUTION —***
> *Check your DVOM for compatibility. Do not use a True DVOM for these measurements. See the Caution at the beginning of Chapter 12.*

> **NOTE —**
> These electrical tests are called for by the Trouble Codes from Quick Test. That indicates the sensor is out of self-test range. Ordinarily, these sensors do not call for routine checking.

3.1 Mass Air Flow (MAF) Sensor

The MAF signal may be affected by the air-cleaner element, the inlet air duct and the throttle body. In addition, it can be affected by the service garage-ventilation system. If you get a code signal, rerun the Self-Test vented to the outside atmosphere. The following procedure gives the basic steps for troubleshooting a code.

> **NOTE —**
> With 2-digit trouble codes, look for 66 in memory, indicating a MAF sensor problem. This is the only signal like this.

To check MAF sensor:

1. Check power and ground to MAF:
   - Key OFF
   - Disconnect MAF sensor
   - DVOM on 20v. scale
   - Key ON
   - Measure between VPWR and PWR GND at the MAF sensor connector
   - Look for: 10.5v. or more

   > **NOTE —**
   > This test can also be made with the harness connector connected. See Fig. 1-1 earlier.

2. If not OK, there is a fault either with the VPWR circuit or with the ground circuit to the battery. Check wiring continuity. Check VPWR as described in Chapter 12.
3. Next check MAF circuit output. With the MAF sensor reconnected, backprobe connector as shown in Fig. 3-1.
   - DVOM on 20v. scale, Start engine
   - Look for: 0.2 to 1.5v. MAF sensor output varies with engine load, also with temperature. See Chapter 12 for full specs

Fig. 3-1. Checking Mass Air Flow (MAF) sensor output with engine running.

4. If not OK then either there is a problem with the wiring to the control module, the control module, or the MAF sensor. Go to the next step.

5. Check wiring continuity from the control module to the MAF sensor connector.
   - Backprobe at the control module connector as shown in Fig. 3-2. See the wiring diagrams in Chapter 12 for connector terminal identification
   - DVOM on resistance scale
   - Look for: 5.0 ohms or less in each test
   - If not, fix wiring faults

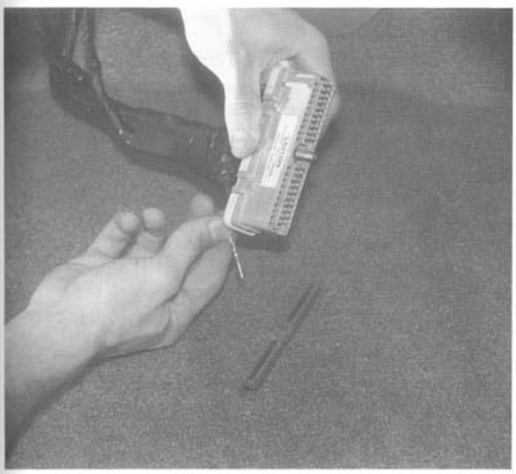

Fig. 3-2. Control module harness connector being backprobed to test pins (or use BreakOut Box).

6. Check the control module for an internal short.
   - Control module connector connected
   - MAF connector disconnected
   - DVOM on resistance scale
   - Check resistance between MAF SIG and MAF RTN, and between MAF SIG and PWR GND
   - Look for: 10,000 ohms or greater
   - If not, then the control module is probably faulty

7. If the wiring and the control module are OK, then the MAF sensor is most likely faulty.

3.2 Manifold Absolute Pressure (MAP) Sensor

Recall that the Manifold Absolute Pressure (MAP) sensor outputs a frequency signal. That does not show on your DVOM. There are four ways to measure MAP output:

1. BreakOut box (BOB) to read SIGRTN, MAP/BP SIG, and VREF.
2. Ford MAP/BP Tester, shown in Fig. 3-3.
3. Oscilloscope voltage pattern.
4. MAP frequency using a frequency tester. See Chapter 12.

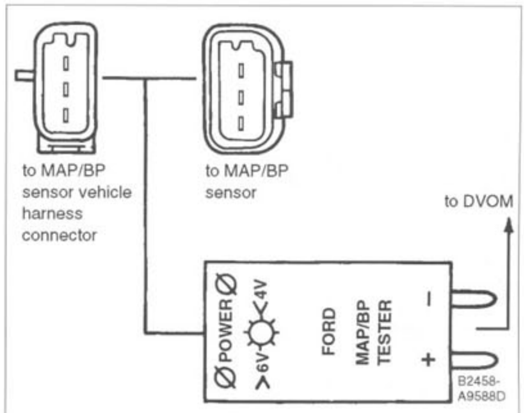

Fig. 3-3. Measure MAP/BP voltages at the BreakOut Box, or at the plugs of the Ford MAP/BP tester.

The following tests are for when you receive a typical MAP trouble code during Quick Test. For example: 22, 29, 126 or 129.

NOTE —
Engine Running (ER) trouble codes generated during ER Self-Test may be due to a faulty vacuum hose or to excess EGR flow. The latter causes the sensor to "see" pressure beyond its normal compensation. Continuous memory codes may be due to a MAP sensor leak.

To check MAP/BP sensor with MAP/BP tester:

1. With Key OFF, disconnect MAP/BP sensor.
2. Connect tester between vehicle harness connector and sensor.
3. Insert tester plugs into DVOM, set to 20v. scale.
4. Key ON.
   - Look for: Green light
   - If not, red light indicates VREF is either too high or too low
   - Disconnect MAP/BP sensor
   - Look for: green light. If yes, replace MAP/BP sensor. If not, check wiring to control module, and check VREF circuit as described in Chapter 12, then retest
5. If green light in Step 4 above indicates VREF OK, test sensor output. Voltage output changes with altitude as shown in chart below. See also Chapter 12.

Table e. MAP/BP Output

Approx. Altitude	Output v.
Sea level	1.55–1.63
1,000 ft. (300m)	1.52–1.60
2,000 ft. (600m)	1.49–1.57
3,000 ft. (900m)	1.46–1.54
4,000 ft. (1200m)	1.43–1.51
5,000 ft. (1500m)	1.40–1.48

If MAP sensor voltage is OK but a trouble code is still generated, check the wiring to the control module for continuity and for shorts to ground or power. If the wiring is OK, the control module may be faulty.

To check MAP/BP sensor with oscilloscope:

1. Connect center wire to scope, set scope to "Voltage Pattern"
2. Apply vacuum to sensor port with vacuum pump.
   - Look for: time from one square wave pattern to the next
   - With 1000 ms in one second, dividing the time of one pulse will tell you the frequency of the pulses—how many per second
   - No vacuum: 6.25ms; 1000 divided by 6.25 = about 155 Hz frequency
   - Full vacuum: 10.8ms; 1000 divided by 10.8 = about 93 Hz frequency

If necessary, correct readings for altitude above sea level. Remember, other factors can cause faulty MAP output. If excess EGR is delivered into the intake manifold the sensor "sees" pressure beyond its normal compensation.

> **NOTE —**
> Tip from the field: This is the only place where "try a known good part" may diagnose a bad MAP sensor. They're almost interchangeable. Try a replacement if the MAP tests OK but the problem persists.

3.3 Volume Air Flow (VAF) Sensor

Be particularly aware of "false air," unmeasured air that enters the engine without passing through the VAF, causing lean mixtures. Check ducting between the VAF and the throttle body, vacuum leaks from vacuum-operated devices, and engine sealing, PCV, CANP, valve-cover seal, even the seating of the dipstick. The following procedure gives the basic steps for troubleshooting a code. See also Chapter 12.

To check VAF sensor:

1. Key OFF, wait 10 seconds.
2. Remove the air cleaner ducting so you can see the VAF inlet.
3. Press on the vane with your finger, full open and release slowly to close.
   - Look for: smooth free movement, with just a light touch. Your fingertip will sense if the vane is binding
   - If the interior is dirty, spray carburetor cleaner on a cloth and pass it through the VAF to remove oily film buildup. Do not spray carb cleaner in the VAF. Retest for freedom of movement. If you still feel binding, replace the VAF
4. Check VAF Output.
   - Backprobe or install BOB and connect control module
   - Place a unsharpened pencil as shown in Fig. 3-4
   - DVOM on 20 scale
   - Key ON. Do not run engine
   - Measure voltage between VAF and SIG RTN
   - Look for: 2.8 to 3.7v
5. If not, check VAF connector pins and VREF to sensor. If still not OK, replace VAF.

Fig. 3-4. Place a pencil through the VAF to deflect the vane. Measure the voltage output. Shown is 2.2L Turbo.

3.4 Measuring-Core Volume Air Flow (MC-VAF) Sensor (2.5L V-6)

To check MC-VAF sensor:

1. Check the sensor for cracks and damage.
2. Gently push back the sliding core; verify smooth motion.
3. Measure resistance across terminals shown in Fig. 3-5. See **Table f** for test values.

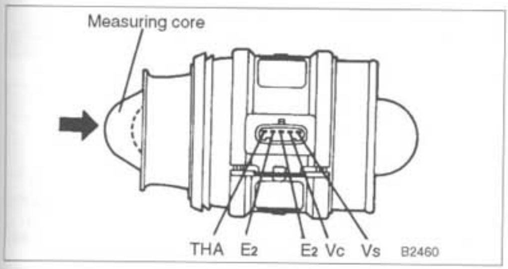

Fig. 3-5. Measuring-core air flow sensor. Measure resistance values at about room temperature, 70°F.

Table f. MC-VAF Sensor Test Values

Terminals	Resistance (Ohms)
E_2 and Vs	20–600 Closed 20–1,000 Open
E_2 and Vc	200–400 Open or Closed
E_2 and THA (Intake Air Temp)	2,000–3,000 at room temp.

4. Checking Ignition System

With electronic ignitions such as Thick Film Ignition (TFI), we got rid of points and condensers. With Distributorless and Electronic Distributorless Ignition Systems (DIS/EDIS), we got rid of distributors. With fewer moving parts and virtually nothing to wear or change tolerances, these ignition systems give less trouble.

That doesn't mean that things don't go wrong. Early TFI-IV modules fail. DIS and EDIS Hall magnets break when the vane strikes the magnet. DIS modules loosen and vibrate in the mounting. A few EDIS modules and VRS have been known to break. On EDIS engines, water can get into the connector and short the pins, the VRS can become disconnected or dislodged, or the module can fail.

In addition, some traditional parts need routine checking, such as ignition coil resistance, or replacement, such as plug wires, or the distributor cap and rotor (TFI-IV only). And there can be occasional problems with the other system components. So just in case, I'll show you examples of several troubleshooting tests for Ford systems. Additional diagnostics tests are given in Chapter 12.

On the Vehicle Emission Control Information (VECI) decal, you'll read about the list of items not adjustable, including ignition timing. But the VECI decal will list the base, or initial timing. In troubleshooting, you can check initial timing and computed timing advance to see if timing is responsible for a complaint, and what you should replace if it is.

4.1 Pre-checks

Your first job is to verify which system is on the car you are servicing.

- Most Ford EEC systems of the 1980's use the TFI-IV, and many of those use Computer-Controlled Dwell (CCD). I'll describe two simple tests for TFI-CCD
- Beginning recently, you'll find coil packs on EEC engines but no distributor. These are classed as DIS
- Beginning in the '90s, in the newer engines, you'll find EDIS

Begin with a visual inspection. Check that all plug wires are properly routed and secure. Be sure plug wires are not lying directly together but are separate and secure in their clamps.

Check spark plug condition. If you have one or more wet plugs, in addition to checking for leaking injectors, check spark quality. Hook up your spark tester or engine analyzer/scope.

Check wiring harnesses and connectors for insulation damage, loose connections, burned or broken connectors. Check that the battery charge indicator shows OK. All accessories OFF, engine at normal temperature, Transmission in P (automatic) or N.

4.2 Thick Film Ignition (TFI-IV)

If you receive trouble codes relating to the TFI-IV ignition system, basic questions you might want to ask are:

- Is the Hall sender in the distributor generating a Profile Ignition Pickup (PIP) signal? See Fig. 4-1. If not, check that the Hall sender in the distributor has power and ground. If so, then the sender is probably faulty
- Is the control module receiving the PIP signal? Check for wiring continuity from the TFI module to the control module
- Is the control module generating the correct Spark Output (SPOUT) signal to control ignition timing? If not, then either the wiring or the control module is likely faulty

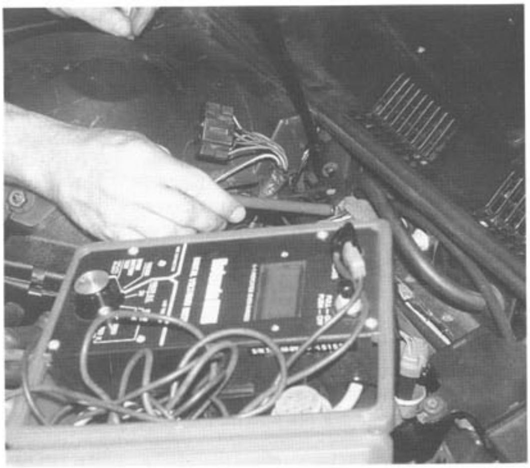

Fig. 4-1. Check for cranking and running PIP signal at the TFI-IV module (some modules are mounted on the distributor, some are mounted on the engine cowl).

The tests below check basic timing and timing advance control by the EEC module (SPOUT). See Chapter 12 for additional TFI-IV electrical tests of PIP, SPOUT, and the TFI module.

To check initial timing:

1. Connect a timing light.
2. Disconnect the in-line SPOUT connector near the TFI module.
3. Check initial timing using a timing light. It should be within 3 degrees of base timing value on the VECI decal. If base timing is specified as 10 deg. BTDC, 7 to 13 is OK.
4. If not, adjust timing of TFI-IV distributor:
   - Loosen distributor mounting-bolts
   - Rotate distributor to correct timing
   - Tighten bolts

To check spark-timing advance:

1. Key OFF.
2. Disconnect the in-line SPOUT connector near the TFI module.
3. Attach negative (–) lead of VOM to the distributor base.
4. Start the engine.
5. Measure battery voltage with engine running.
6. Measure voltage on test-pin side of the in-line TFI connector. See Fig. 4-2.
   - Look for: voltage 30–60 percent (4.2–8.4v) of battery voltage measured in previous step

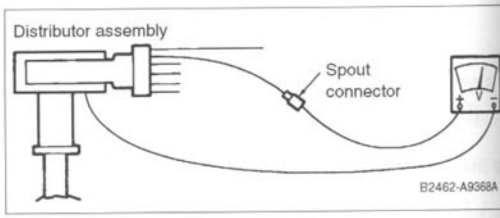

Fig. 4-2. Checking TFI-IV timing signal at SPOUT connector.

7. If not, check the wiring to the TFI module. See Fig. 4-3.
   - Look for: less than 5 ohms indicating wiring is OK
   - If not, fix wiring and retest
   - If wiring OK, the TFI module is internally damaged

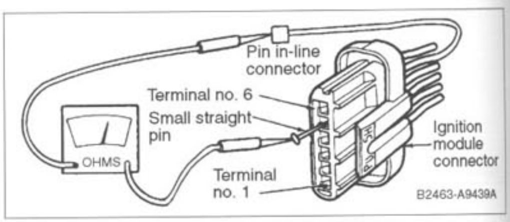

Fig. 4-3. Checking wiring continuity of SPOUT circuit.

To check computed timing in Self-Test:

1. If code 18/213 appears in ER Self-Test, SPOUT circuit is open.

NOTE —
Self-Test locks computed timing at base timing plus about 20 (17 to 23) degrees for 2 minutes after last code output. During those 2 minutes, check computed timing with timing light.

2. Disconnect in-line SPOUT/SAW connector.
3. Engine idling. Reconnect SPOUT/SAW connector.
   - Look for: Timing change when connection is replaced
   - If not, then either the wiring or the control module is faulty

4.3 Distributorless Ignition System (DIS/EDIS)

Procedures for checking DIS timing are similar to TFI. Use the right coil pack, on the exhaust side of the engine. Locate the Spark Output/Spark Angle Word (SPOUT/SAW) disconnect next to the Ignition Diagnostic Monitor (IDM) at the coil.

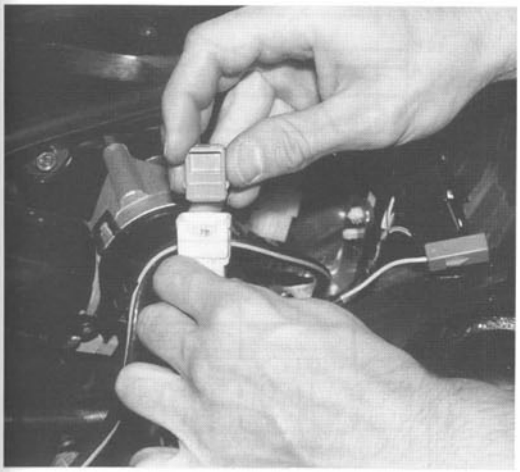

Fig. 4-4. Spark Output/Spark Angle Word (SPOUT/SAW) connector for DIS/EDIS) is located near the coil.

If you receive trouble codes relating to DIS ignition, basic questions you might want to ask are:

- Is the crankshaft sensor generating a Profile Ignition Pickup (PIP) signal? If not, check that the sensor has power and ground. If so, then the sensor is probably faulty
- Is the control module receiving the PIP signal? Check for wiring continuity from the crankshaft sensor to the control module. See Fig. 4-5
- Is the control module generating the correct Spark Output (SPOUT) signal to control ignition timing? If not, then either the wiring or the control module is likely faulty
- Is the control module receiving the IDM signal? If not, then either the DIS module or the wiring is faulty
- Does the DIS module have power and ground?
- Is the DIS module providing power to the ignition coil(s)?

For example, Code 18 Engine Running or 18/212 Continuous indicates a SPOUT/SAW failure (IDM circuit failure or SPOUT circuit grounded). Basically, the control module is indicating that it lost IDM input. Possible causes are: open circuit, shorted circuit, damaged DIS/EDIS module, or a damaged control module.

See Chapter 12 for DIS/EDIS electrical tests of PIP, SPOUT, IDM and the DIS/EDIS module.

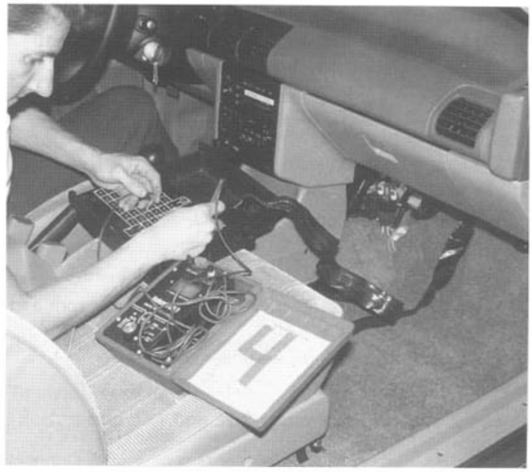

Fig. 4-5. Check DIS/EDIS inputs to EEC control module (PIP, IDM) at control module connector using BreakOut Box (BOB).

4.4 Mazda Engine Control System (MECS) Ignition

Mazda Engine Control System (MECS) equipped vehicles use an ignition system similar to TFI-IV. On some models, advance is handled by flyweights and a vacuum diaphragm at the distributor.

If you receive trouble codes relating to the MECS ignition system, basic questions you might want to ask are:

- Is the Crankshaft Position Sender in the distributor generating a Profile Ignition Pickup (PIP) signal? If not, check that the sender in the distributor has power and ground. If so, then the sender is probably faulty
- Is the control module receiving the PIP signal? Check for wiring continuity from the ignition module to the control module

- Is the control module generating the correct Spark Output (SPOUT) signal to the ignition module (not all models)? If not, then either the wiring or the control module is likely faulty

The tests below check basic timing and timing advance control. See Chapter 12 for additional MECS electrical tests of PIP, SPOUT, and IDM.

2.2L Non-Turbo and 1.6L Turbo and Non-Turbo

To check timing:

1. Check vacuum supply. Remove vacuum-delay valve. Apply 25 in.Hg. to green side.
   - Look for: vacuum-delay valve holds vacuum for 10–20 seconds. If not, replace valve
2. Check base timing.
   - Plug vacuum hoses
   - Ground STI connector.
   - At idle, all loads OFF, check base timing
   - Look for: 2.2L turbo 5–7° BTDC,
     1.6L non-turbo 1–3° BTDC
     1.6L turbo 11–13° BTDC
3. Check centrifugal advance. Slowly advance rpm and note timing per Fig. 4-6.
   - If not OK, centrifugal weights may be faulty

To check vacuum diaphragm (2.2L and 1.6L non-turbo):

1. Check vacuum advance/retard, engine idle. Connect vacuum tester to vacuum diaphragm. Apply vacuum to Chamber A, and note timing. See Fig. 4-7.
2. Apply vacuum to Chamber B, and note timing.
   - If not OK, replace vacuum diaphragm

To check vacuum diaphragm (1.6L Turbo):

1. Apply vacuum to advance diaphragm and note timing. See Fig. 4-8.
2. Apply pressure (10 psi MAX) to advance diaphragm and note timing.

If not OK, replace vacuum diaphragm.

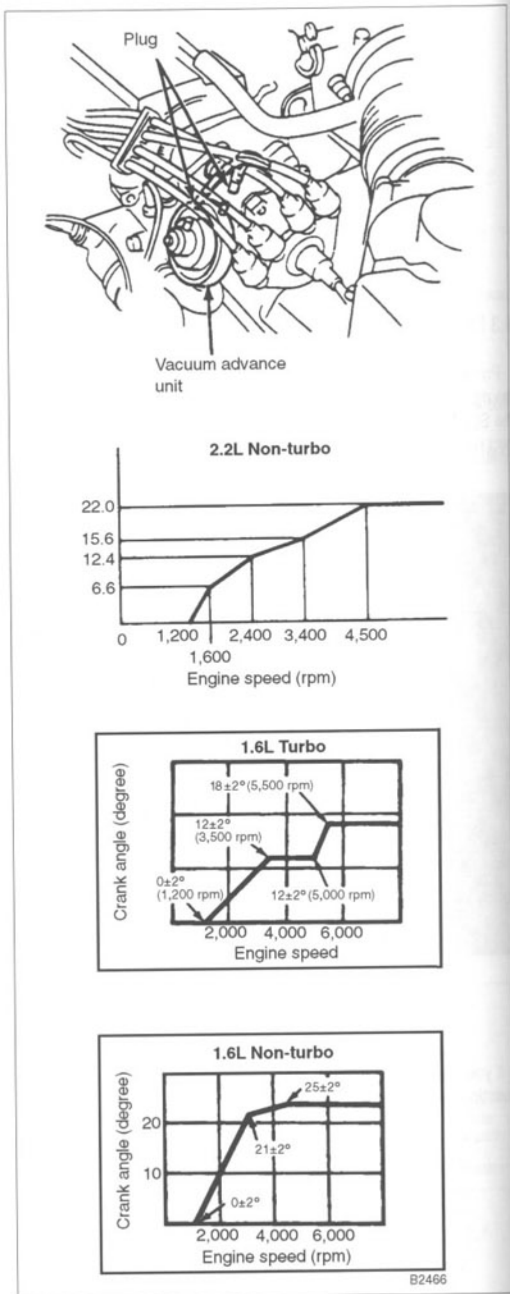

Fig. 4-6. Check centrifugal advance.

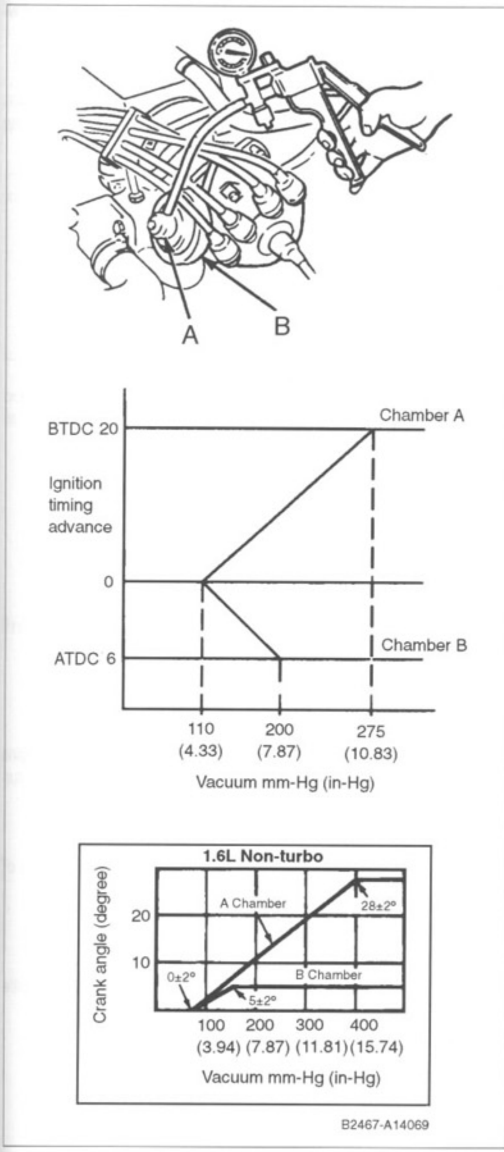

Fig. 4-7. Check vacuum diaphragm, 2.2L Turbo and non-Turbo, 1.6L non-Turbo.

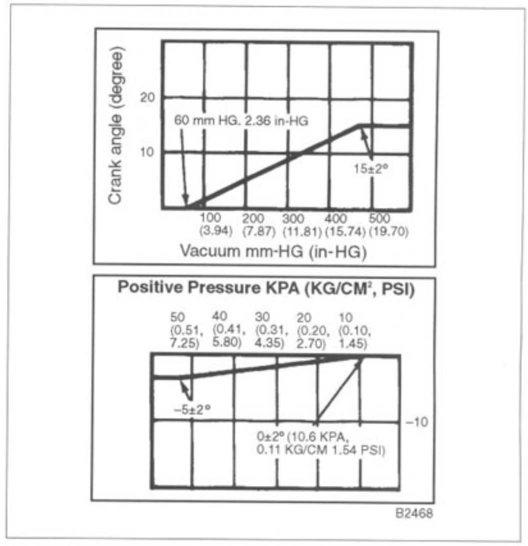

Fig. 4-8. Check vacuum diaphragm, 1.6L Turbo.

1.3L, 1.8L, 2.2L Turbo

These MECS engines feature Electronic Spark Advance (ESA) controlled by the computer.

To check base timing:

1. Warm engine, idle.
2. Ground Self-Test Input (STI) connector. See Chapter 10 for location.
   - Look for: base timing 9–11°, except 2.2L Turbo, 8–10°

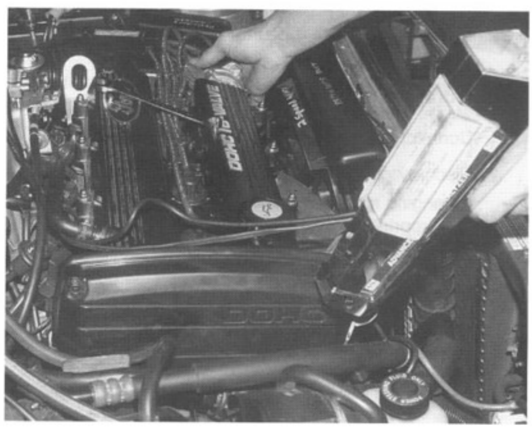

Fig. 4-9. Check timing on MECS 1.8L with Electronic Spark Advance (ESA).

5. CHECKING IDLE RPM (THROTTLE-AIR BYPASS–ISC)

Idle rpm is controlled by a bypass valve that allows air to bypass the closed throttle plate. See Chapter 12 for additional Idle Speed Control (ISC) tests.

5.1 Idle Speed (EEC-IV)

Pre-checks

Improper idle rpm can be the result of non-EEC problems, including: Engine cool, or too hot, A/C input, throttle sticking, linkage binding, Speed Control linkage.

The following Throttle-Air Bypass Pinpoint tests will help diagnose:

- RPM in Self-Test
- ISC solenoid
- Harness circuits, ISC and VPWR
- Control module

Self-Test RPM Limit Codes

An Upper Limit trouble code (12/412) indicates that engine rpm could not be controlled within the Self-Test upper limit during ER test. Possible causes include:

- Open or shorted circuit
- Throttle linkage binding
- Improper idle set
- Contamination of throttle body or bypass–ISC (throttle body sludge)
- Faulty ISC solenoid
- Faulty control module

Begin checking with an rpm drop test.

To rpm drop test:

1. Connect a shop tachometer and start the engine.
2. Disconnect the ISC-BPA harness connector.
   - If engine rpm drops, check for EGR codes, and run appropriate tests by symptom
   - If engine rpm does not drop, and no EGR codes, check for other EEC codes, and see appropriate tests by symptom
   - If no EGR or EEC codes, see Step 3
3. Measure ISC-BPA solenoid resistance as shown in Fig. 5-1.
   - Look for: 7–13 ohms
   - If not, replace the ISC-BPA
   - If OK, continue with additional checks outlined below

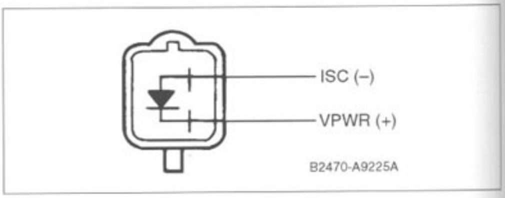

Fig. 5-1. Check ISC-BPA solenoid resistance. Solenoid has a diode, so measurement should be as shown, with DVOM (+) lead on VPWR pin.

4. Check for internal short to ISC solenoid case.
5. Check VPWR circuit voltage.
6. Check ISC circuit continuity.
7. Check ISC circuit for short to ground.
8. Check ISC circuit for short to power.
9. Check for ISC signal from the control module.
10. Check base idle as described below.

A Lower Limit trouble code (13/411) indicates that engine rpm could not be controlled within the Self-Test lower limit during ER test. Possible causes include:

- Improper idle set
- Vacuum leaks
- Throttle linkage binding
- Throttle plates open
- Improper ignition timing (TFI vehicles)
- Contamination of throttle body or bypass-ISC (throttle body sludge)
- ISC circuit short to ground
- Faulty ISC solenoid

Tests for this condition include:

1. Check idle rpm.
2. Check for internal short to ISC solenoid case.
3. Check ISC circuit for short to ground.
4. Check control module output signal.

Setting Idle Speed (EEC-IV)

Under normal use, the idle speed will not need adjustment. If, as a result of parts replacement, idle rpm is out of spec, the idle-speed stop screw may need adjustment. You may also be setting idle speed from a diagnosis of rough idle, or fast idle.

Remember that idle rpm can be affected by several factors outside the EEC system:

- Contamination within throttle bore, or within Throttle-Air Bypass-ISC (sludge)
- Oxygen sensor
- Throttle sticking
- Vacuum leaks
- Ignition timing

NOTE —
To reduce intake sludge in the throttle body, a sealant/coating covers the inside of the throttle bore and the throttle plate(s) on all '92 and later vehicles and some previous models. Look for the black/yellow attention sticker. DO NOT CLEAN inside a coated throttle body. The ByPass Air valve is not coated and may need cleaning.

Pre-checks

- Engine warm, transmission in P or neutral
- Parking brake applied and wheels chocked
- Heater and all accessories off
- Throttle lever resting on the throttle-plate stop screw
- Quick Test, all codes serviced
- KAM cleared: disconnect battery for 5 minutes

To check idle speed:

1. Idle engine 2 minutes.
2. Goose engine, return to idle.
3. Gently press accelerator and release.

NOTE —
If electric cooling fan comes on, wait until it shuts off; otherwise, the generator load may affect the idle rpm.

- Look for: idle rpm to spec as shown on Vehicle Emission Control Information (VECI) decal
- If engine does not idle properly, follow procedures according to vehicle model

NOTE —
- Some vehicles have provisions for Self-Test Idle-Speed check. These include: 2.3L car, 3.0L (except SHO), 3.8L, 3.8L SC, 4.0L, 4.6L, 4.9L, 5.0L E4OD, 5.0L HO (T-Bird or Cougar), 5.8L. For these, your scan-tool output will guide you to the need to adjust base rpm. See Procedure A for typical steps.

- Some vehicles have no provision for Self-Test Idle-Speed Check. These include: 2.3L truck, 2.9L, 3.0L SHO, 3.2L SHO, 3.0L truck, 5.0L non-E4OD, 5.0L Mustang or Mark VII. See Procedure B for typical steps.

- In some vehicles, idle rpm is not adjustable. These include: 1.9L SFI Escort/Tracer (730–830 rpm), 3.2L SFI Taurus SHO (720–780 rpm), 4.0L MFI Aerostar/Ranger/Explorer, 4.6L 4V Mark VIII.

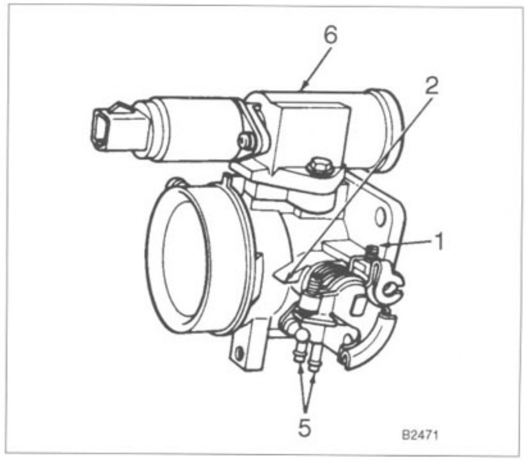

Fig. 5-2. Typical throttle body showing idle speed adjustment screw (**1**).

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The following is the typical procedure for setting idle speed using a scan tool. The procedure for a specific engine may differ slightly.

To set base idle speed (Procedure A):

1. Using your scan tool, activate Engine Running Self-Test as described in Chapter 10.
2. After code 11 is displayed, quickly (within 4 seconds) latch and unlatch the tester button.
   - Look for: constant tone/solid light/STO LO indicating base idle OK

3. If not OK, check for problems listed under **Self-Test RPM Limit Codes** above.
4. Next, adjust idle speed by turning the throttle stop screw shown in Fig. 5-2 above until tone/light/STO LO is correct.
5. Open throttle to 1500 rpm for 10 seconds, then recheck base idle speed.

To set idle speed (Procedure B):

Below is the typical procedure for a 5.0L HO Mustang or Mark VII (idle speed specified to be 625–725 rpm). The procedure for other engines may differ slightly.

> ***CAUTION —***
> *Do not use this procedure with 5.0L HO in Thunderbird or Cougar.*

1. Disconnect the negative battery terminal for 5 minutes to clear KAM, then reconnect.
2. With engine OFF, install feeler gauge 0.025" between the throttle plate idle stop-screw and the throttle lever. See Fig. 5-2 above.
3. Run engine at 2500 for about 30 seconds.
   - If rpm too low, check for plate orifice-plug
   - If plug in from previous service, remove plug
4. Turn screw to adjust to 650–700 rpm.
   - If rpm too high, turn engine off and disconnect air-cleaner hose
5. Block off orifice in throttle plate. See Fig. 5-3.
   - If no plug, reattach hose from MAF and recheck rpm
   - If engine stalls, crack open plate with stop screw
   - If throttle plate has orifice plug, remove the plate and install plug with proper color code, depending on orifice size

> **NOTE —**
> Select the proper plug by using the Go/NoGo gauge pegs in the service kit FOPZ-9F652-A.

6. Recheck rpm to 650–700 rpm. Turn plate stop screw only clockwise. If you turn counterclockwise, throttle plate may stick at idle.
7. Remove feeler gauge. Key OFF, restart, Idle for 2 minutes.
8. Engine off. Disconnect battery for 10 minutes.
9. Run KOEO Self-Test for proper TPS output code.
10. Start engine. Run 2 minutes. Goose engine, return to idle. Gently press accelerator. Return to idle. Recheck to verify that idle problem is cured, and rpm is within spec.

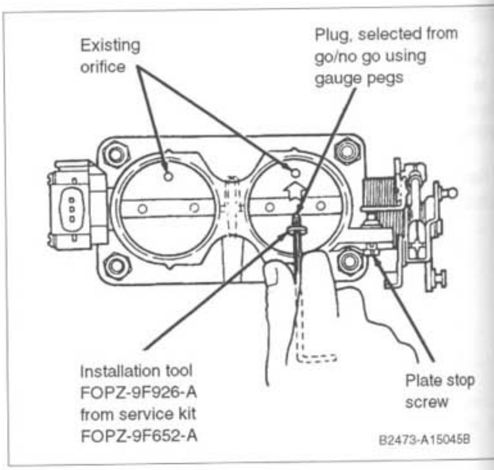

Fig. 5-3. If necessary, install plug in throttle plate orifice. (Dual throttle plates shown.) Notice plate stop-screw.

This should result in proper EEC operation for idle rpm; if not, check other causes listed above. If rpm is not within limits, Neutral, A/C OFF, look for other possible causes. If none, replace the throttle body.

5.2 Idle Speed (MECS)

Remember, Mazda Engine Control (MEC) systems increase idle rpm with two bypasses: one "warm-up" bypass is directly dependent on engine coolant temperature. The other "engine-load" ISC bypass is computer-controlled for engine load changes that affect idle rpm. Checking improper idle rpm is a two-part process. I'll look first at the BPA that functions for warm-up. It is controlled only by coolant flow so you will not see trouble codes. The BPA valve is packaged with the ISC valve, except on 1.8L engines, where it is separate. See also Chapter 12 for additional ISC electrical tests.

Coolant-Controlled BPA

Consider three possibilities that could cause idle problems:

1. The cold engine starts hard, then stalls, but runs OK once warm. The BPA coolant-controlled valve could be stuck closed.
2. The warm engine races at idle. The valve could be stuck open, or the warm coolant flow could be clogged.
3. The cold engine stalls and the warm engine races. The valve could be stuck in the middle.

First, visually inspect the coolant and air hoses. Be sure the engine warms up. Check the base-idle speed as described in the VECI decal.

To check for cold-engine stall:

1. Remove the BPA valve; If it is warm from the engine, cool it in cold water.
2. Blow through the air passage.
   - If you cannot blow through, the valve is stuck closed. Replace the valve

To check for warm-engine fast-idle:

1. Remove the BPA valve, and cool it in cold water, if necessary.
2. Blow through the air passage.
   - If you can blow through, the valve is not stuck closed. But it may be stuck part-way open
3. Run hot water through the coolant passages, at least 55°C (130°F).
4. Blow through the air passages.
   - If it's easier to blow through warm than cold, the valve is not stuck. If the valve is not stuck, check the ISC solenoid

ISC Valve Solenoid

1. Disconnect the ISC valve connector.
2. Measure the resistance of the solenoid.
   - Look for: resistance between 6.3–9.9 ohms
   - If not, replace the solenoid
   - If OK, the problem is probably incorrect input from a temperature sensor. It may also be incorrect processing in the control module

Setting Idle Speed (MECS)

To set idle speed:

1. Warm engine. All accessories off. Connect tachometer.
2. Check ignition timing to spec, 11–13° BTDC.
3. Ground Self-Test Input (STI) (TEN pin on engines with Data Link Connector).
   - Look for: 650–750 rpm
   - If not, adjust by turning air-adjusting screw, as in Fig. 5-4

NOTE —
Adjustment screw for 2.2L trims air flow rather than acting as adjustable hard stop.

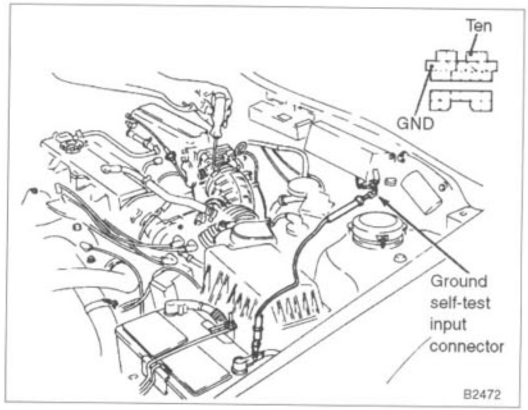

Fig. 5-4. Adjust MECS idle by turning adjusting screw next to throttle body. 2.2L shown; others similar.

6. Checking Temperature Sensors

Engine Coolant Temperature (ECT), Air Charge Temperature (ACT), and Vane Air Temperature (VAT) sensors provide an important input for calculation of the air-fuel mixture. If they're out of whack, you may have serious driveability, or even starting problems in cold weather. These thermistor sensors are quite similar and can be tested the same way. With this test, I'll show you the typical way to check the sensors, the harness circuit and the control module. Full specifications are given in Chapter 12.

Pre-checks

Be sure you have an engine control problem, indicated by Quick-Test trouble codes. Codes usually mean the sensor is outside its Self-Test range, normally 0.3 to 3.7 v.

Remember that the problem may not be with the sensor. You may get a code because of engine underheat/overheat. Don't forget to check engine coolant level, engine temperature, and the thermostats.

You would think you could just measure the resistance at any temperature. But Ford wants you to check these things reasonably warm:

- ACT or VAT in the KOEO test, more than 10°C (50°F)
- ECT in the KOEO test, more than 10°C (50°F)
- ECT in the ER test, more than 85°C (180°F)

The ACT and ECT temperature sensors connect through a common SIG RTN.

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Check VREF Voltage

One of the first possibilities to consider is that the sensor is not supplied with the proper reference voltage (VREF). A convenient place to check is the Throttle Position Sensor (TPS).

1. After the key has been OFF at least 10 seconds, disconnect the TPS.
2. Key ON, measure voltage between VREF and SIG RTN at the TPS connector. See Chapter 12 for specifications.

Check Resistance—Engine Off

ECT/ACT resistances vary with temperature. Calculated from Ford specs, allow 15% variation for sensors.

1. After the key has been OFF for at least 10 seconds, disconnect the sensor you think is the problem.
2. Measure the resistance between the sensor signal circuit and SIG RTN. See Chapter 12 for Specifications.
   - If sensor is out of spec, replace the sensor. Reconnect the harness and re-run the Quick Test
   - If sensor is in spec for KOEO, check resistance with Engine Running

Check Resistance—Engine Running

Remember, coolant temp above 85°C (180°F).

1. With suspect sensor disconnected, run engine for 2 minutes at 2000 rpm.
2. Measure resistance as in step 2 above.
   - If sensor is out of spec, replace the sensor
   - If sensor is in spec, check wiring continuity to the control module. If the wiring is OK, replace the control module and re-run Quick Test