# SECTION 6C

# ENGINE FUEL

## CONTENTS



**All new General Motors vehicles are certified by the United States Environmental Protection Agency as conforming to the requirements of the regulations for the control of air pollution from new motor vehicles. This certification is contingent on certain adjustments being set to factory standards. In most cases, these adjustment points either have been permanently sealed and/or made inaccessible to prevent indiscriminate or routine adjustment in the field. For this reason, the factory procedure for temporarily removing plugs, caps, etc., for purposes of servicing the product must be strictly followed and, wherever practicable, returned to the original intent of the design.**

## GENERAL DESCRIPTION

All gasoline engines are designed to use only unleaded gasoline. Unleaded gasoline must be used for proper emission control system operation. Its use will also minimize spark plug fouling and extend engine oil life. Using leaded gasoline can damage the emission control system and could result in loss of emission warranty coverage.

All cars are equipped with an Evaporative Emission System. The purpose of the system is to minimize the escape of fuel vapors to the atmosphere. Information on this system will be found in Section 6E2, or 6E3.

When working on the fuel system, there are several things to keep in mind.

- **Any time fuel system is being worked on, disconnect the negative battery cable except for those tests where battery voltage is required.**
- On MPFI, TPI, SFI and TBI systems, always relieve the line pressure before servicing any fuel system components.
- Do not repair the fuel system until you have read the copy and checked the illustrations relating to that repair.
- Adhere to all Notices and Cautions.
- Always keep a dry chemical (Class B) fire extinguisher near the work area.
- Always use a backup wrench when loosening or tightening a screw couple fitting.
- The torque on a screw fitting is 30 N·m (22 lb. ft.).
- Pipe is used on all MPFI, TPI, SFI, and TBI applications. Fittings require the use of an "O" Ring. Replace all pipe with the same type of pipe and fittings that were removed.
- All fuel pipes must meet GM Specification 124-M, or its equivalent.
- All fuel hoses must meet GM Specification 6163-M, or its equivalent.
- Do not replace fuel pipe with fuel hose.

### Alcohol-In-Fuel

Certain driveability complaints such as hesitation, lack of power, stall, no start, etc., may be caused by an excessive amount of alcohol-in-fuel. The complaints may be due to fuel system corrosion and subsequent fuel filter plugging, deterioration of rubber

components such as the accelerator pumps and/or air-fuel mixture leaning effects.

Various types and concentrations of alcohols are used in commercial gasoline. Some alcohols are more detrimental to fuel system components than others. If an excessive amount of alcohol in the fuel is suspected as the cause of a driveability condition, the following procedure may be used to detect the presence of alcohol in the fuel. In this procedure, water is used to extract the alcohol from the fuel. However, the specific type of alcohol is not determined.

The fuel sample should be drawn from the bottom part of the tank so that any water, if already present, can be detected. The sample should be bright and clear. If the sample appears cloudy or contaminated with water as indicated by a water layer in the bottom part of the sample, this procedure should not be used. The fuel system should then be cleaned (See Fuel System Cleaning).

### Testing Procedure

1. Using a 100 ml cylinder with 1 ml graduation marks, fill with fuel to the 90 ml mark.
2. Add 10 ml of water to bring the total fluid volume to 100 ml and install a stopper.
3. Shake vigorously for 10 to 15 seconds.
4. Carefully loosen stopper to release pressure.
5. Close the stopper and shake vigorously again for 10 to 15 seconds.
6. Carefully loosen stopper to release pressure.
7. Put the graduated cylinder on a level surface for approximately 5 minutes to allow adequate liquid separation.

If alcohol is present in the fuel, the volume of the lower layer, which would now contain alcohol and water will be greater than 10 ml. For example, if the volume of the lower layer is increased to 15 ml, it would indicate at least 5 percent alcohol in fuel. The actual amount of alcohol may be somewhat greater because this procedure does not extract all of the alcohol from the fuel.

## FUEL METERING

### Throttle Body Injection (TBI)

With Throttle Body Injection (TBI), an injection unit is placed on the intake manifold where the carburetor is normally mounted. The TBI unit is computer controlled and supplies the correct amount of fuel during all engine operating conditions. See Section 6E2 for information relative to operation and diagnosis of TBI units.

### Port Fuel Injection

The ECM is in complete control of this fuel delivery system during all driving conditions.

The intake manifold is used only to let air into the engine. Fuel is injected by separate injectors that are mounted over the intake valve.

With the Port Injection System, there is no need for a Thermac, EFE, Map Sensor, Baro Sensor, A.I.R. System, or Dual Bed Converter.

This system provides better cold driveability, lower exhaust emissions and better throttle response.

In Sequential Fuel Injection systems (SFI), injectors turn on at every crankshaft revolution. The ECM controls the injector "on" time so that the correct amount of fuel is metered, depending on driving conditions.

Two interchangeable "O" rings are used on the injector that must be inspected when the injectors are removed. Check "O" rings for cuts or other type of damage and replace as necessary.

The air cleaner is remotely mounted near the radiator. It is connected to the intake manifold by air intake ducting.

Also, mounted between the air cleaner and intake, are the mass air flow sensor and throttle body.

Cold driveability characteristics are greatly improved with the aid of an engine coolant supply to the throttle body for rapid warm up.

The throttle body design uses an integral Idle Air Control to govern idle speed and a Throttle Position Sensor (TPS). The IAC and TPS are both controlled by the ECM.

A large diameter fuel rail is attached to the intake manifold and supplies fuel to all the injectors.

A fuel pressure tap is located on the rail for quick pressure checks.

Fuel is recirculated through the rail continually while the engine is running. This removes air and vapors from the fuel as well as keeping the fuel cool during hot weather operation.

A fuel pressure regulator is mounted on the fuel rail. It maintains a constant 36 psi pressure across the injectors under all operating conditions. It is accomplished by controlling the amount of fuel that is recirculated back to the fuel tank, based on engine demand.

The pressure regulator also uses an "O" ring for attachment. The "O" ring used is the same one that is used for the injectors.

Some engines also have an accumulator that is located in the fuel feed line near the cowl area. It is used to dampen the vibration that is caused by the pressurized fuel and the pulsing of the injector.

See Section 6E3 for more information and diagnosis.

### Fuel Feed and Return Pipe

When replacing fuel feed and return pipes, always replace them with welded steel tubing meeting GM Specification 124M, or its equivalent. The replacement pipe must use the same type of fittings as the original pipes to ensure the integrity of the connection.

**NOTICE:** Do not replace fuel pipe with fuel hose or any other type of tubing such as copper or aluminum. Only tubing meeting the 124M specification is capable of meeting all the pressure and vibration characteristics necessary to ensure the durability standard required.

- Always check and replace any "O" rings or washers that appear damaged.

- Fuel feed and return pipes are secured to the underbody with clamps and screw assemblies. The pipes should be inspected occasionally for leaks, kinks or dents.
- Follow the same routing as the original pipe.
- Pipes must be properly secured to the frame to prevent chafing. A minimum of 6 mm (1/4") clearance must be maintained around a pipe to prevent contact and chafing.

### MPFI Fuel Pipes

Due to the fact that fuel pipes are under high pressure, these systems require special consideration for service.

Many feed and return pipes use screw couplings with "O" Rings. Any time these fittings are loosened to service or replace components, ensure that:

- A backup wrench is used while loosening and tightening the fitting.
- Check all "O" rings at fitting locations (if applicable) for cuts or any damage and replace any that appear worn or damaged.
- Use correct torque when tightening fittings.
- If pipes are replaced always use original equipment parts, or parts that meet GM specifications.

#### Fuel and Vapor Hoses

**NOTICE:** Fuel and vapor hoses are specially manufactured. If replacement becomes necessary, it is important to use only replacement hoses meeting GM Specification 6163-M. These hoses are identified with the words "Fluoroelastomer" on them. Hoses not so marked could cause early failure, or fail to meet emission standards.

- Do not use rubber hose within 4" of any part of the exhaust system, or within 10" of the catalytic converter.

## FUEL PUMP

The electric fuel pump is in the fuel tank. The tank has an outlet for a vapor return system. Any vapor which forms is returned to the fuel tank along with hot fuel through a separate line. This greatly reduces any possibility of vapor lock by keeping cool fuel from the tank constantly circulating through the fuel pump.

## FUEL PUMP RELAY

To control fuel pump operation, a fuel pump relay is used.

When the ignition switch is turned to "RUN" position, the fuel pump relay activates the electric fuel pump for 1.5 to 2.0 seconds to prime the injector(s). If the ECM does not receive reference pulses from the distributor after this time, the ECM signals the relay to turn off the fuel pump. The relay will once again activate the fuel pump when the ECM receives distributor reference pulses.

### Fuel Filter

**CAUTION: To reduce the risk of fire and personal injury, it is necessary to relieve the fuel system pressure before servicing fuel system components. (See Fuel System Pressure Relief.)**

The inline filters can be found on the rear crossmember of the vehicle. Always use a backup wrench any time that the fuel filter is removed or installed. Also make sure that a good "O" Ring is used at all screw couple locations. Torque on fittings is 30 N·m (22 lb. ft.).

## FUEL TANK

The fuel tank is usually located under the rear of the vehicle and a number of shapes and sizes are used depending on the application.

The tank is held in place by two metal straps, hinged (with a bolt through the hinge) and secured at the opposite end with a nut and bolt assembly.

Anti-squeak pieces are used on top of the tank to reduce rattles and other annoying noises.

The fuel tank, cap and lines should be inspected for road damage, whch could cause leakage. Inspect fuel cap for correct sealing and indications of physical damage. Replace any damaged or malfunctioning parts.

Before attempting service of any type on the fuel tank, always (1) remove negative battery cable from battery, (2) place "no smoking" signs near work areas, (3) be sure to have CO2 fire extinguisher handy, (4) wear safety glasses and (5) siphon or pump fuel into an explosion proof container.

### Fuel Filler Cap

The fuel tank filler neck is equipped with a screw-type cap. The threaded part of the cap requires several turns counterclockwise to remove. The long threaded area is designed to allow any remaining fuel tank pressure to escape while the cap is being removed. A built-in torque-limiting device prevents overtightening. To install, turn the cap clockwise until a clicking noise is heard. This signals that the correct torque has been reached and the cap is fully seated.

**NOTICE:** If a fuel filler cap requires replacement, use only a cap with the same features. Failure to use the correct cap can result in a serious malfunction of the system.

Available on some models is an electric locking fuel filler cap. Information on this option will be found in Section 9E.

## FUEL TANK FILLER NECK

To help prevent refueling with leaded gasoline, the fuel filler neck on gasoline engine cars has a built-in restrictor and deflector. The opening in the restrictor will only admit the smaller unleaded gas nozzle spout, which must be fully inserted to bypass the deflector. Attempted refueling with a leaded gas nozzle or failure

to fully insert the unleaded gas nozzle will result in gasoline splashing back out of the filler neck.

### Fuel Gage Sending Unit

The fuel gage sending unit is attached to the top of the fuel tank. It is held in place with a cam lock ring and a gasket is used between the tank and sending unit.

Sending units have three hoses attached. One line is for the fuel feed. The second line is connected to the vapor canister, to keep fuel vapor from getting into the air (see Section 6E). The third line is used as a fuel return line to the tank.

On some sending units a wire is attached to the unit. On others the connectors attach directly to the sender.

When a fuel gage sending unit is removed always make sure to install the gasket and any power or ground leads that were removed.

## DIAGNOSIS

Fuel system diagnostic procedures are located in Section(s) 6E1 thru 6E3.

# SERVICE PROCEDURES

If the fuel system is suspected of delivering an improper amount of fuel, it should be inspected and tested in the vehicle, as follows:

1. Make certain that there is fuel in the tank.
2. With the engine running, inspect for leaks at all fuel feed pipe and hose connections from fuel tank to injection pump. Tighten any loose connections. Inspect all hoses for flattening or kinks which would restrict the flow of fuel. Air leaks or restrictions on suction side of fuel pump will seriously affect pump output.

## FUEL SYSTEM PRESSURE RELIEF

**CAUTION: To reduce risk of fire and personal injury, it is necessary to relieve fuel system pressure before servicing fuel system components. To do this:**

- **Remove "fuel pump" fuse from fuse block in passenger compartment.**
- **Crank engine - engine will start and run until fuel supply remaining in fuel lines is consumed. Engage starter for 3.0 seconds to assure relief of any remaining pressure.**
- **With ignition "OFF", replace fuel pump fuse.**

**Unless this procedure is followed before servicing fuel lines or connections, fuel spray could occur.**

When repair to the fuel system has been completed, start engine and check all connections that were loosened for possible leaks.

Refer to Section 6E for additional diagnosis of engine fuel system.

### Fuel Pump Flow Test

1. Test fuel pump by connecting hose from EFI fuel feed line to a suitable unbreakable container. Apply battery voltage to the fuel pump test terminal (terminal "G" of ALCL).
2. Fuel pump should supply 1/2 pint or more in 15 seconds.
3. If flow is below minimum, check for fuel restriction. If there is no restriction, check pump pressure.

### Fuel System Pressure Test

This test must be performed when diagnosing the fuel system.

**CAUTION: To reduce the risk of fire and personal injury, it is necessary to relieve fuel system pressure before servicing fuel system components on the TBI system. To do this:**

- Remove "Fuel Pump" fuse from fuse block in passenger compartment.
- Crank engine. Engine will start and run until fuel remaining in fuel lines is consumed. Crank the starter for three seconds to assure that any remaining pressure is relieved.
- With the ignition off, replace the "Fuel Pump" fuse.

1. Obtain two sections of 3/8" steel tubing. Each should be about 254 mm (10 inches) long. Double-flare one end of each section.
2. Install a flare nut on each section. Connect each of the above sections of tubing into the "flare nut to flare nut adapters" that are included in J-29658 Gage Adapters.
3. Attach the pipe and adapter assemblies to the J-29658 gage.
4. Hoist the car.
5. Disconnect front fuel feed hose from the fuel pipe on the body.
6. Install a 254 mm (10 inch) length of 3/8" fuel hose onto the fuel feed pipe on the body. Attach the other end of the hose onto one of the sections of pipe mentioned in Step 1. Secure the hose connections with clamps.
7. Attach the front fuel feed hose onto the other section of tubing mentioned in Step 1. Secure the hose connection with a clamp.
8. Start the engine and check for leaks.
9. Observe the fuel pressure reading. It should be 62 to 90 kPa (9 to 13 psi). If not, refer to the appropriate Emissions Section.
10. Depressurize the fuel system and remove the gage with adapters. Reconnect the fuel feed hose to the pipe and torque the clamp to 1.7 N·m (15 lb. in.).
11. Lower the car. Start the engine and check for fuel leaks.

### Fuel System Pressure Test- MPFI

Fuel system diagnosis is in Section 6E3, Chart A-7.

## FUEL TANK

### Draining Fuel Tank

1. Disconnect the negative battery cable. Also have a dry chemical (Class B) fire extinguisher near the work area.
2. Use a hand operated pump device when possible to drain as much fuel through the filler tube as possible.
3. If a hand operated pump device cannot be used to complete the draining process, use a siphon at the main (not return) fuel pipe at the fuel pump or the fuel tank gage unit.

   **CAUTION: Never drain or store gasoline in an open container due to the possibility of fire or explosion.**
4. Reinstall any removed hoses, lines and cap.

#### Removing Fuel Tank

1. Remove all fuel, see "Draining Fuel Tank".
2. Support fuel tank and disconnect the two fuel tank retaining straps.
3. Lower tank enough to disconnect sending unit wire, hoses, and ground strap, if so equipped.
4. Remove tank from vehicle.
5. Remove sending unit.

#### Installing Fuel Tank

1. Reverse removal procedure.
2. Always replace "O" ring when tank unit has been removed.
3. When reinstalling fuel tank, be sure to reinstall anti-squeak pieces on top of the tank to reduce rattles and other annoying noises.
4. Tighten fuel tank retaining strap bolts or screws.

### Fuel System Cleaning

**CAUTION: This procedure will NOT remove all fuel vapor. Do not attempt any repair on tank or filler neck where heat or flame is required, as an explosion resulting in personal injury could occur.**

If trouble is due to contaminated fuel or foreign material that is in the tank, it can usually be cleaned. If tank is rusted internally, it should be replaced.

1. Disconnect negative battery cable.
2. Disconnect ignition engine harness connector. Have dry chemical (Class B) fire extinguisher near the work area.
3. Relieve fuel system pressure.
4. Drain fuel tank (see "Draining Fuel Tank").
5. Remove fuel tank (see "Fuel Tank Removal").
6. Remove external fuel filter and inspect for contamination. If filter is plugged, replace.
7. Locate tank away from heat, flame, or other source of ignition. Remove fuel gage sending unit and fuel pump assembly, if so equipped, and inspect condition of strainer. If strainer is contaminated, a new strainer should be installed.
8. Complete draining of tank by rocking it and allowing fuel to run out of fuel sending unit opening.
9. Flush fuel tank with running hot water for at least five minutes. Pour water out of fuel sending unit opening. (Rock tank to be sure that removal of water is complete.)
10. Disconnect fuel feed pipe and use air pressure to clean fuel line. Apply air pressure in the opposite direction fuel normally flows through the line. On vehicles equipped with a fuel return line, clean line in similar manner. Disconnect pipe at throttle body unit and apply air pressure to clean return line. Reconnect and torque all pipes to 30 N·m (22 lb. ft.).
11. Use low air pressure to clean pipes on fuel gage sending unit.
12. Install new strainer on fuel gage sending unit, if required. Install fuel gage sending unit and fuel pump, with new gasket, into tank and install fuel tank. Connect fuel gage wire harness to body harness. Connect all fuel lines except feed line to external fuel filter.
13. Disconnect fuel feed hose to chassis pipe at front. Connect a hose to front end of chassis fuel feed pipe and insert other end of hose into a one gallon fuel can.
14. Connect battery cable.
15. Put six gallons of clean fuel into fuel tank and apply 12 volts to Terminal "G" of ALCL to operate fuel pump. Pump two quarts of fuel into fuel can. This will purge fuel pump.
16. Remove hose and connect fuel hose to chassis pipe.
17. Check all connections for leaks; tighten all hose clamps.

### Fuel Tank Purging Procedure

The following procedure is used prior to repairing of fuel tank.

1. Remove fuel sending unit and fuel pump and drain all remaining fuel from tank.
2. Visually inspect interior cavity of tank. If any fuel is evident, drain again.
3. Move tank to flushing area (wash rack).
4. Fill tank completely with tap water, agitate vigorously and drain.
5. Add gasoline emulsifying agent to the tank, refill with water, agitate mixture for 10 minutes, and drain tank completely.

   For correct gasoline emulsifying agent-to-water mixture, refer to the manufacturer's specifications. Use an available emulsifying agent, such as "Product-Sol No. 913", or equivalent.
6. When empty, refill the tank to overflowing with water. Completely flush out remaining mixture and empty tank.
7. If available, an explosion meter should be used to check for negative reading.
8. Perform required service work.

### Fuel Tank Leak Test Procedure

Plug all outlets. Before removing a fuel tank for a suspected fuel leak, make sure that it is not one of the fuel hoses that is leaking onto the tank.

#### On-Car Test

If fuel is leaking from tank, replace tank.

#### Off-Car Test

Apply a small amount of air pressure to tank through vent tube (approximately 7 to 10 kPa or 1 to 1-1/2 lbs. of pressure).

**NOTICE:** More than 1-1/2 pounds of pressure will damage tank permanently.

Test repaired area for leaks with soap solution, or by submersion. If leak is noted, replace tank.

## ACCELERATOR CONTROLS

The accelerator control system is cable type. There are no linkage adjustments.

As there are no adjustments, the specific cable for each application must be used. Only the specific replacement part will work.

When work has been performed on accelerator controls, always check to ensure that all components are installed as removed and that all linkage and cables are not rubbing or binding in any manner.

### Accelerator Control Cable

Refer to On-Car Service for removal and installation of accelerator control cable.

When performing service on the accelerator control cable, observe the following:

- Retainer must be installed with tangs secured over head of stud.
- Conduit fitting at both ends of cable must have locking tangs expanded and locked in attaching holes.
- The braided portion of the accelerator cable assembly must not come in contact with the front of dash sealer during assembly, repair or replacement of the assembly.
- Flexible components (hoses, wires, conduits, etc.) must be routed within 50.0mm (2.0 in.) of moving parts of accelerator linkage, outboard of support, unless routing is positively controlled.

Whenever disconnecting or replacing parts, lube pivot points with Accelerator Linkage Lubricant 1052541, or equivalent.

### Accelerator Pedal

When performing service on the accelerator pedal, observe the following:

- The mounting surface between support and dash panel must be free of insulation. The carpet and padding in pedal and tunnel area must be positioned to lay flat and be free of wrinkles and bunches.
- Slip accelerator control cable through slot in rod and then install retainer in rod, being sure it is seated. Care must be utilized in pressing the retainer into hole in rod, to assure the cable is not kinked or damaged in any way.
- After securing all components of the accelerator linkage, linkage must operate freely, without binding, between full closed throttle and full wide open throttle.
- Wire, hoses, cables or other obstructions must not be placed within 13mm (33/64 in.) of cable or rod at any point in their travel.

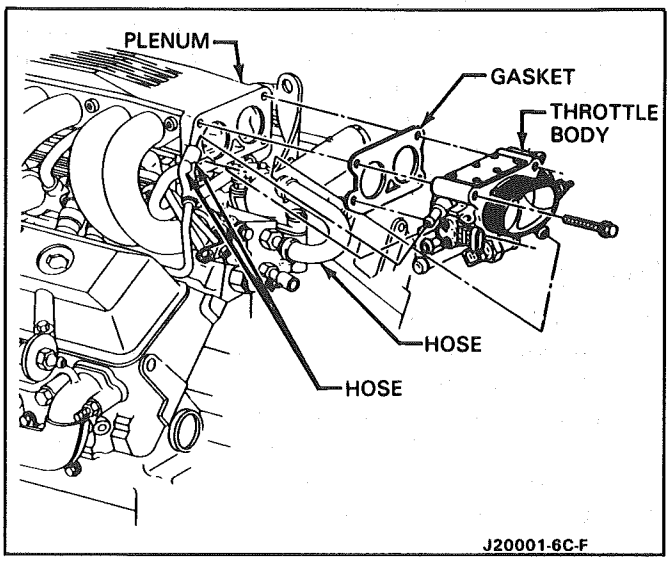



Fig. 1 Throttle Body - LB9 Shown

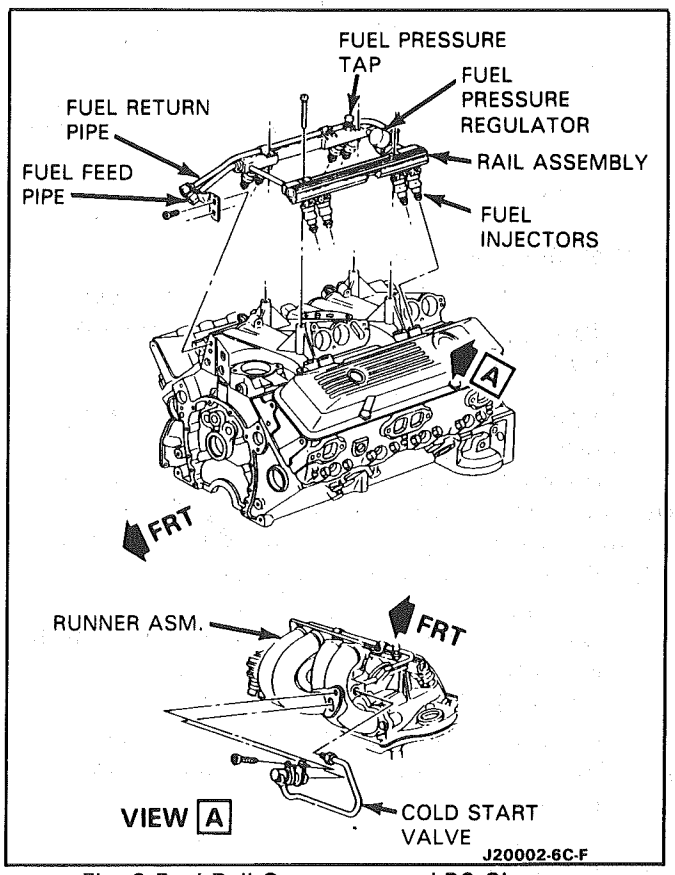



Fig. 2 Fuel Rail Components - LB9 Shown

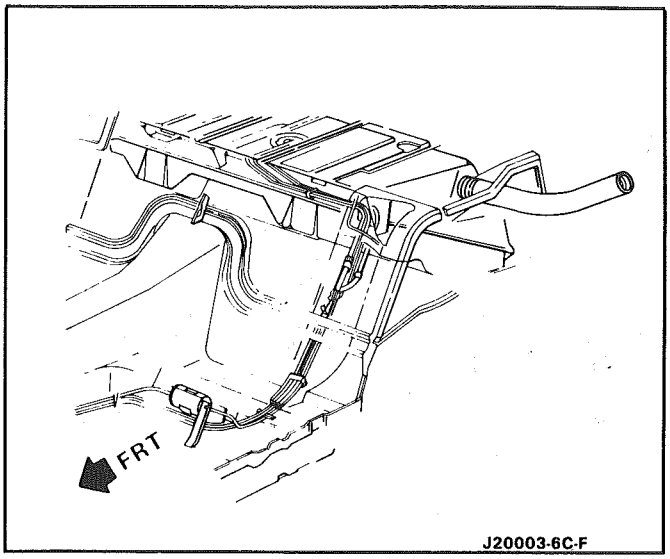



Fig. 3 Fuel Filter Location

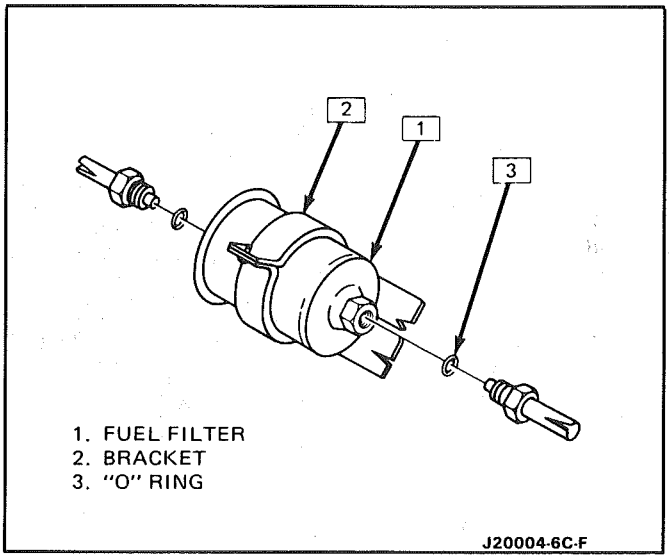



Fig. 4 Fuel Filter

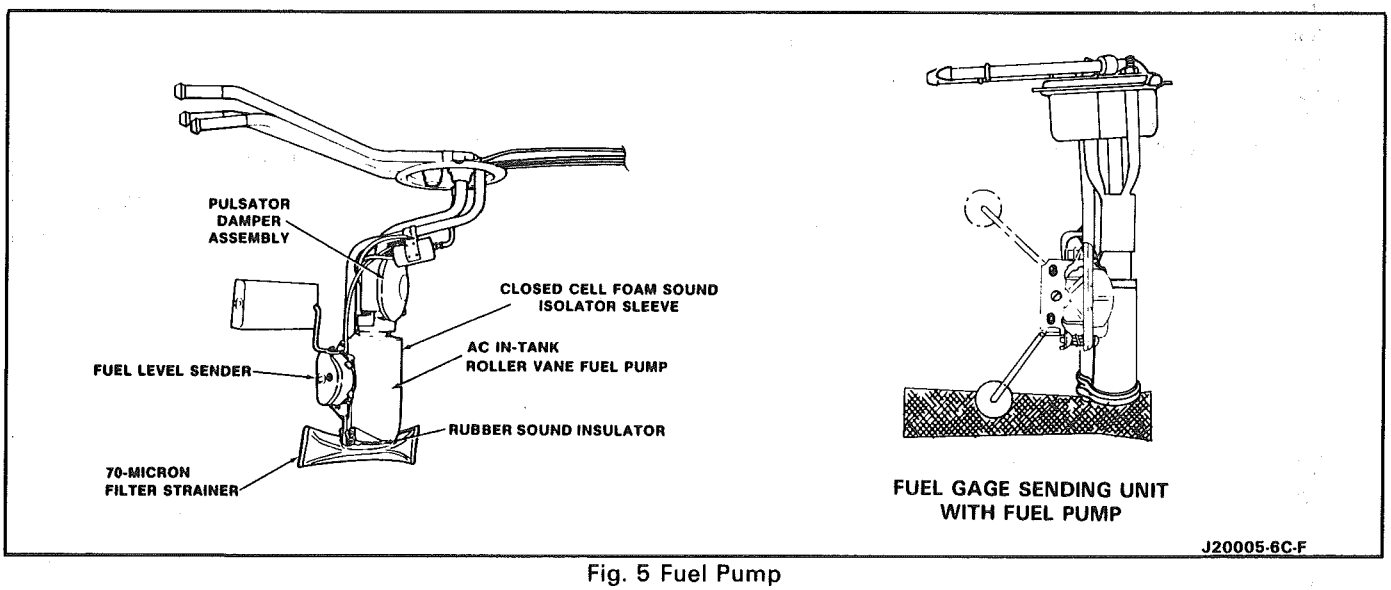



Fig. 5 Fuel Pump

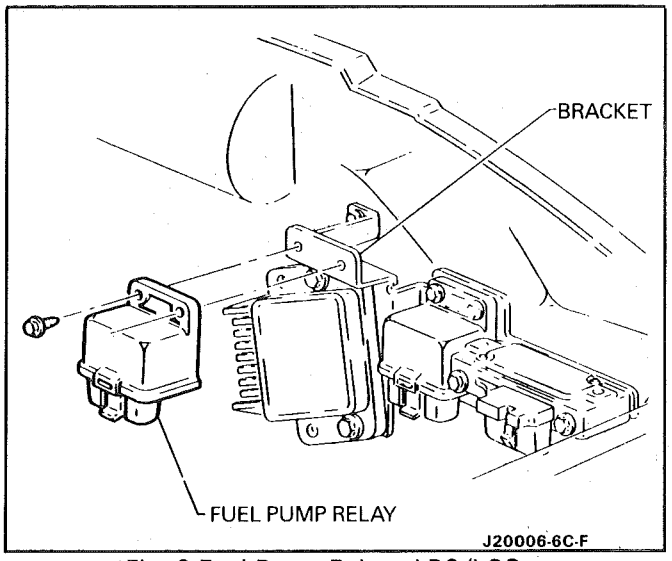



Fig. 6 Fuel Pump Relay - LB8/LO3

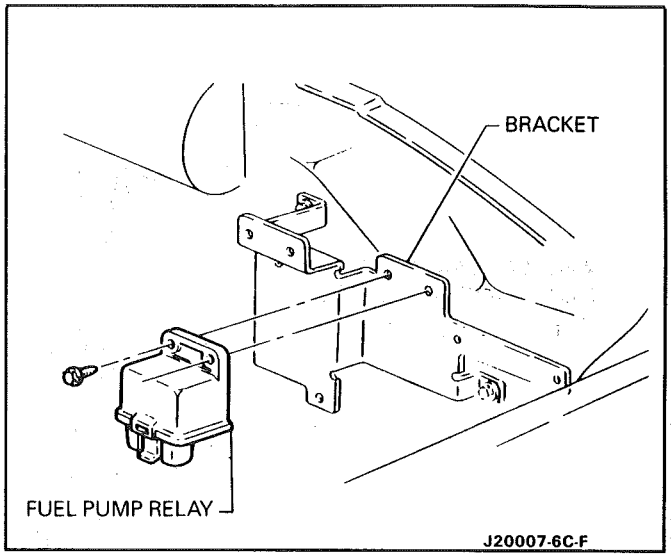



Fig. 7 Fuel Pump Relay - LB9/L98

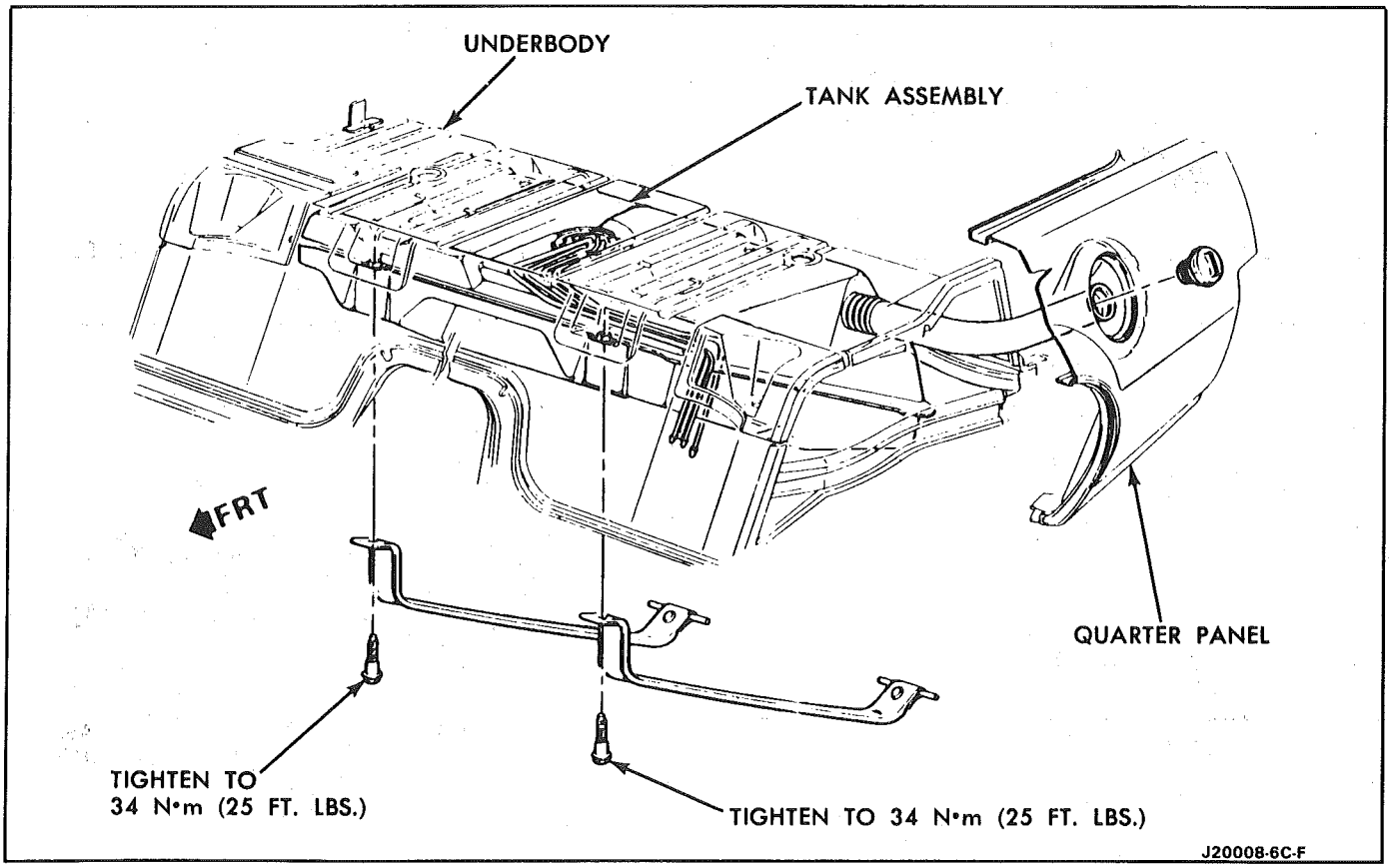



Fig. 8 Strap Attachment

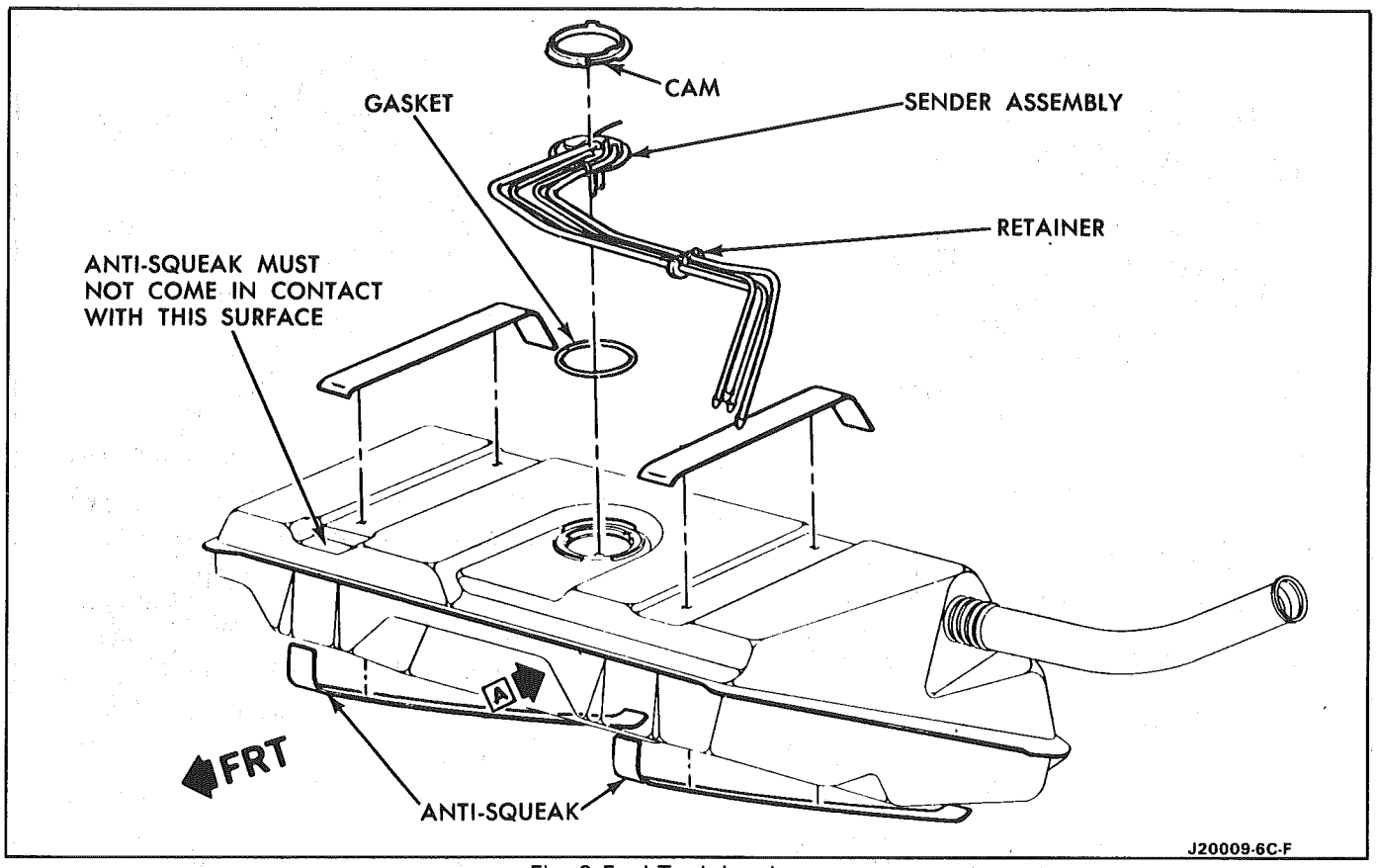



Fig. 9 Fuel Tank Insulator

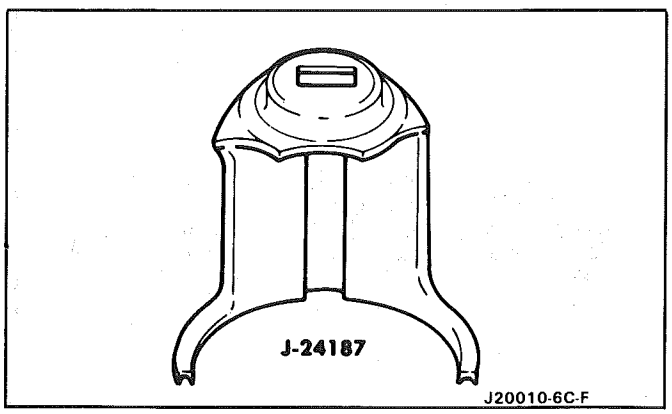



Fig. 10 Locking Cam Tool

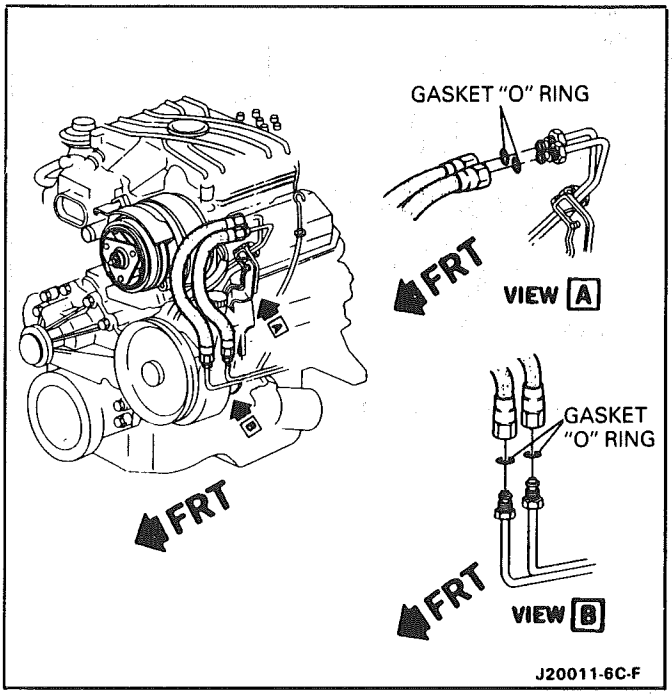



Fig. 11 Fuel Pipes and Hoses - LB8

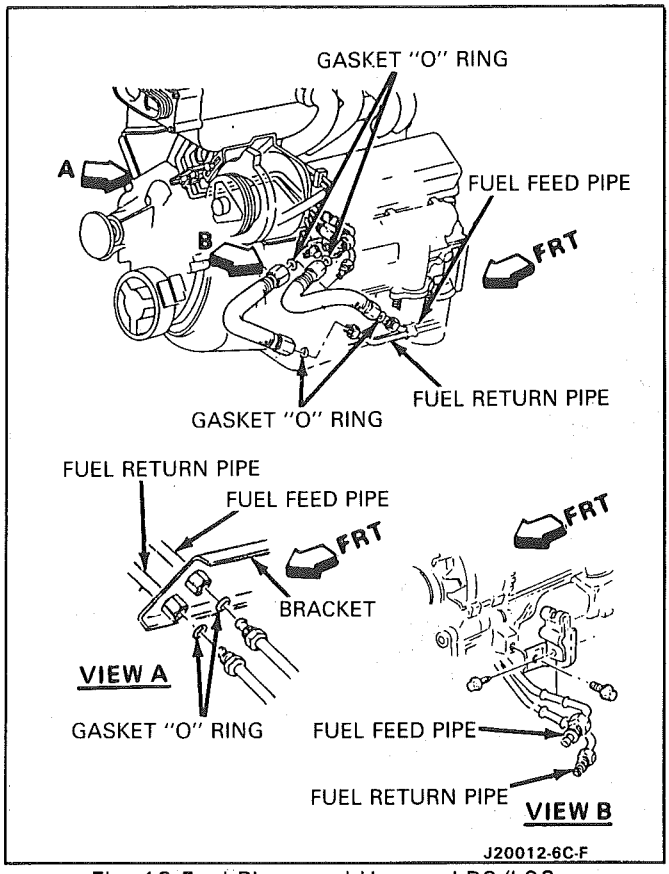



Fig. 12 Fuel Pipes and Hoses - LB9/L98

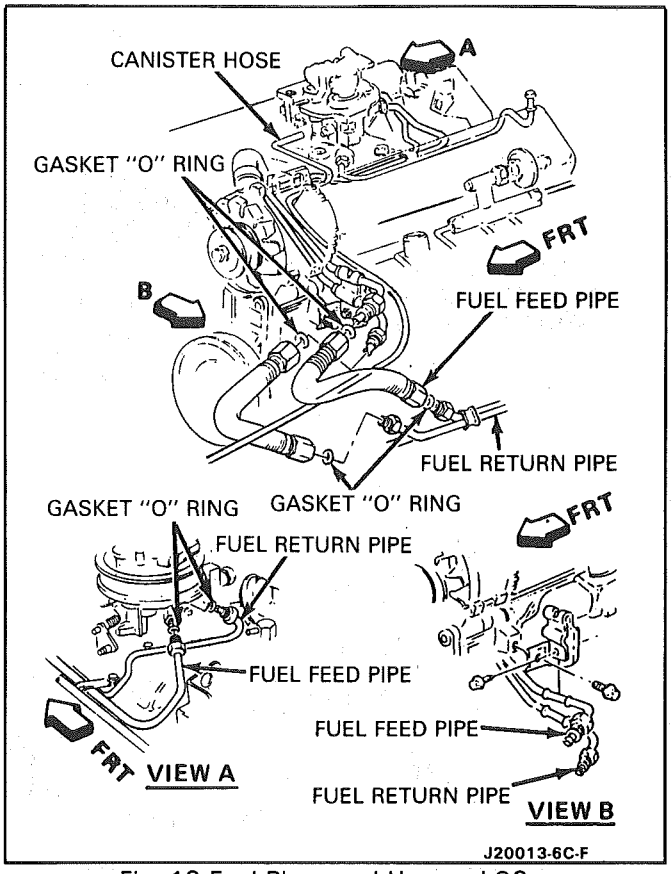



Fig. 13 Fuel Pipes and Hoses - LO3

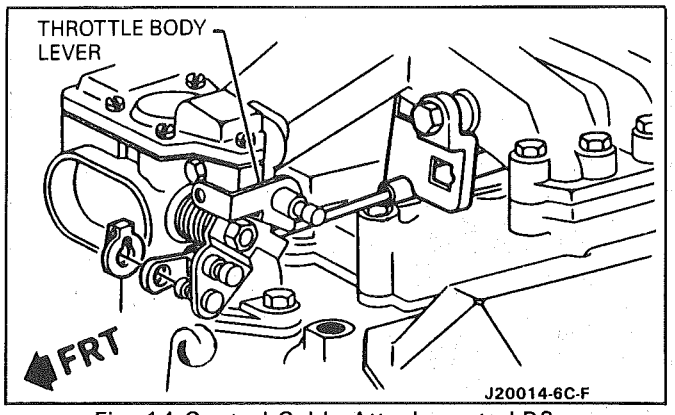



Fig. 14 Control Cable Attachment - LB8

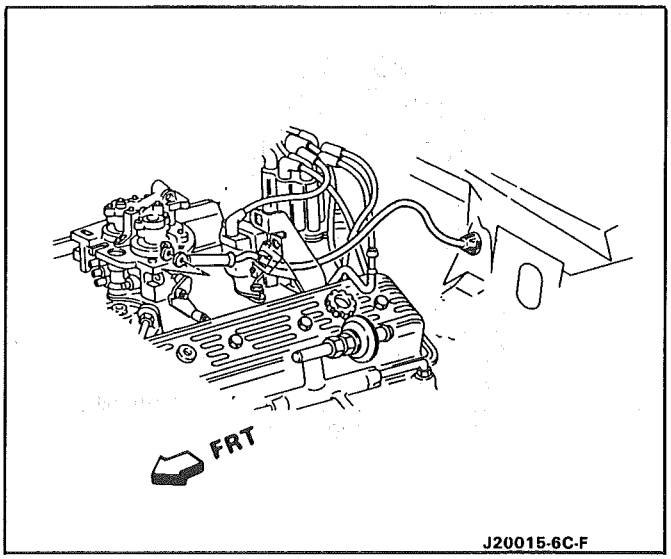



Fig. 15 Control Cable Attachment - LO3

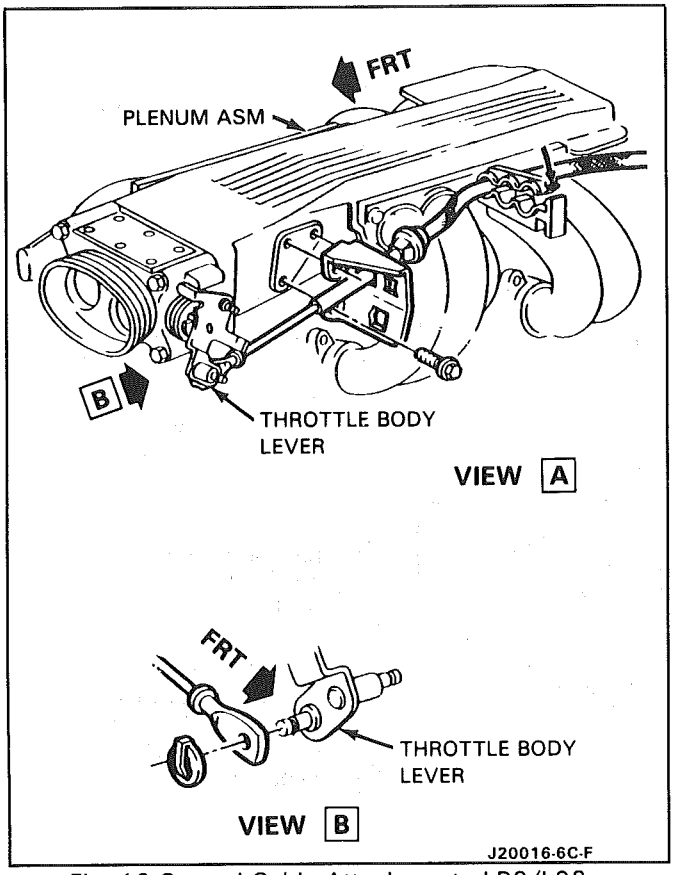



Fig. 16 Control Cable Attachment - LB9/L98

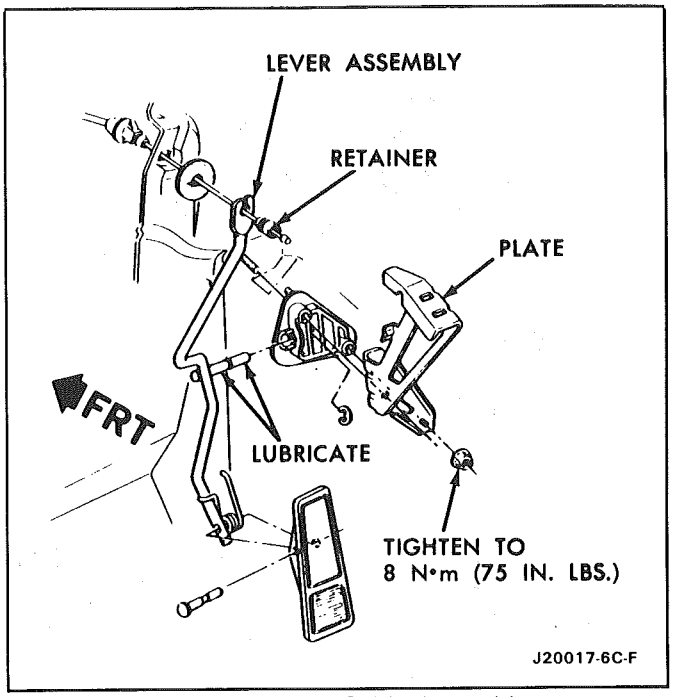



Fig. 17 Accelerator Cable Assembly

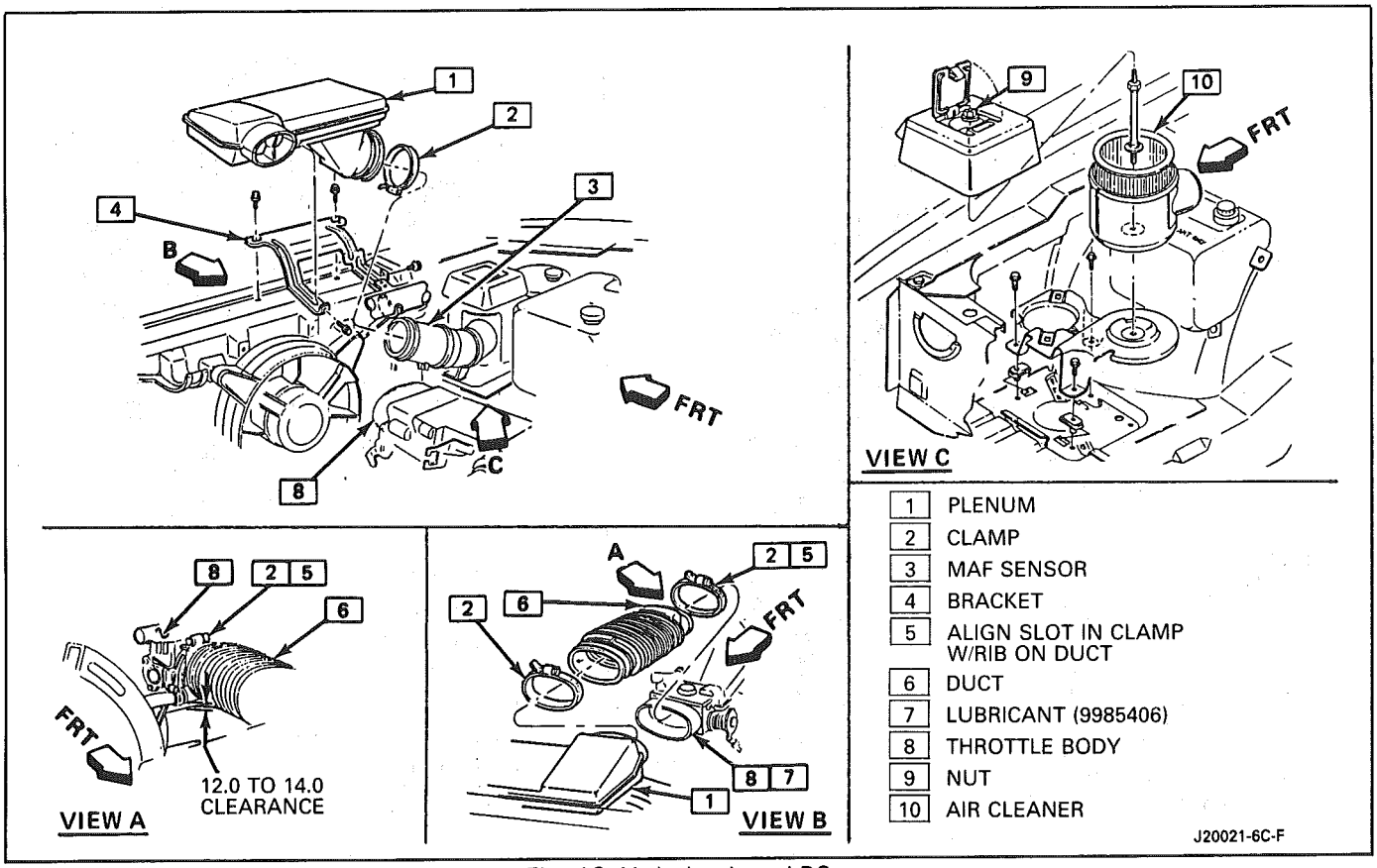



Fig. 18 Air Induction - LB8

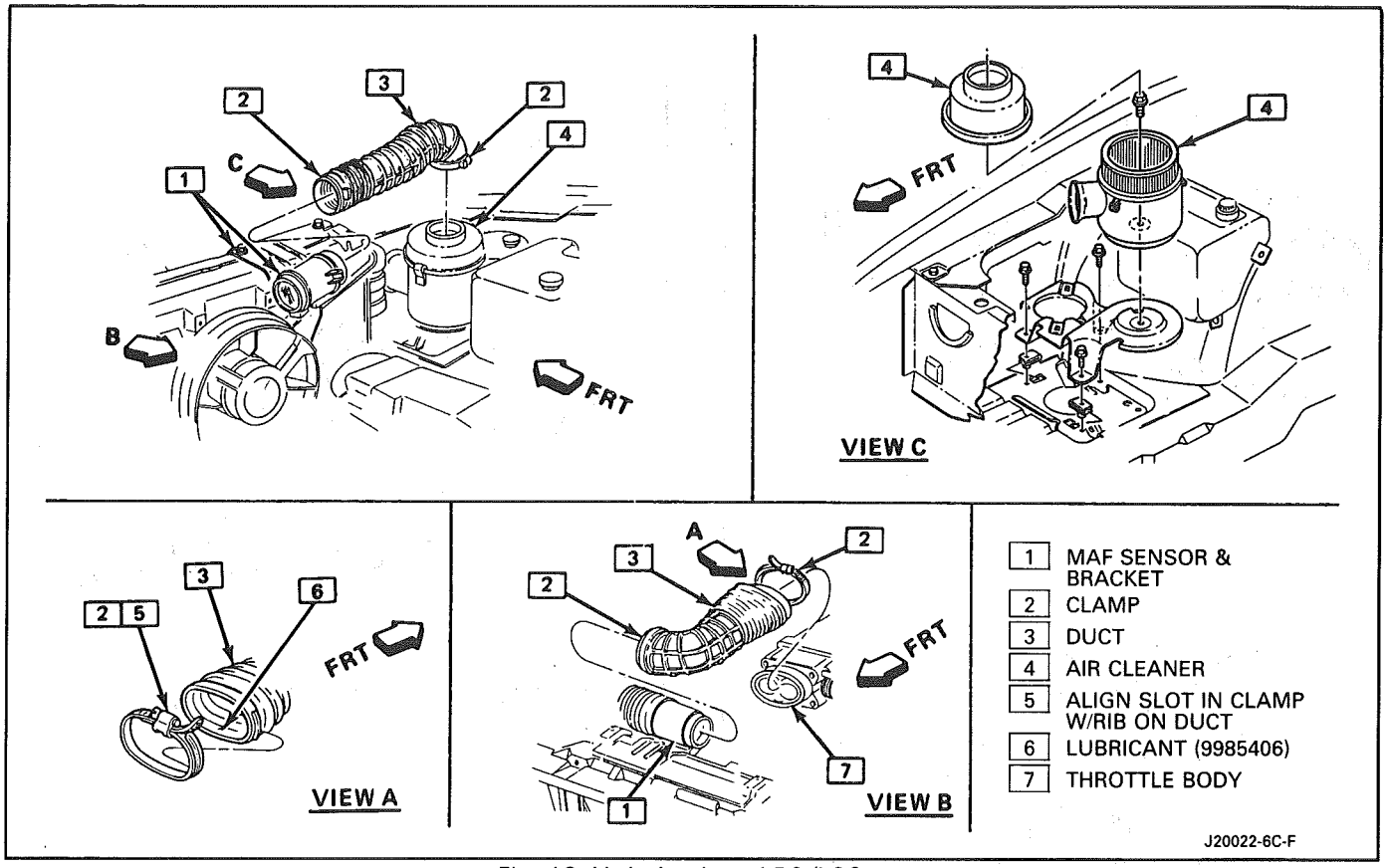



Fig. 19 Air Induction - LB9/L98

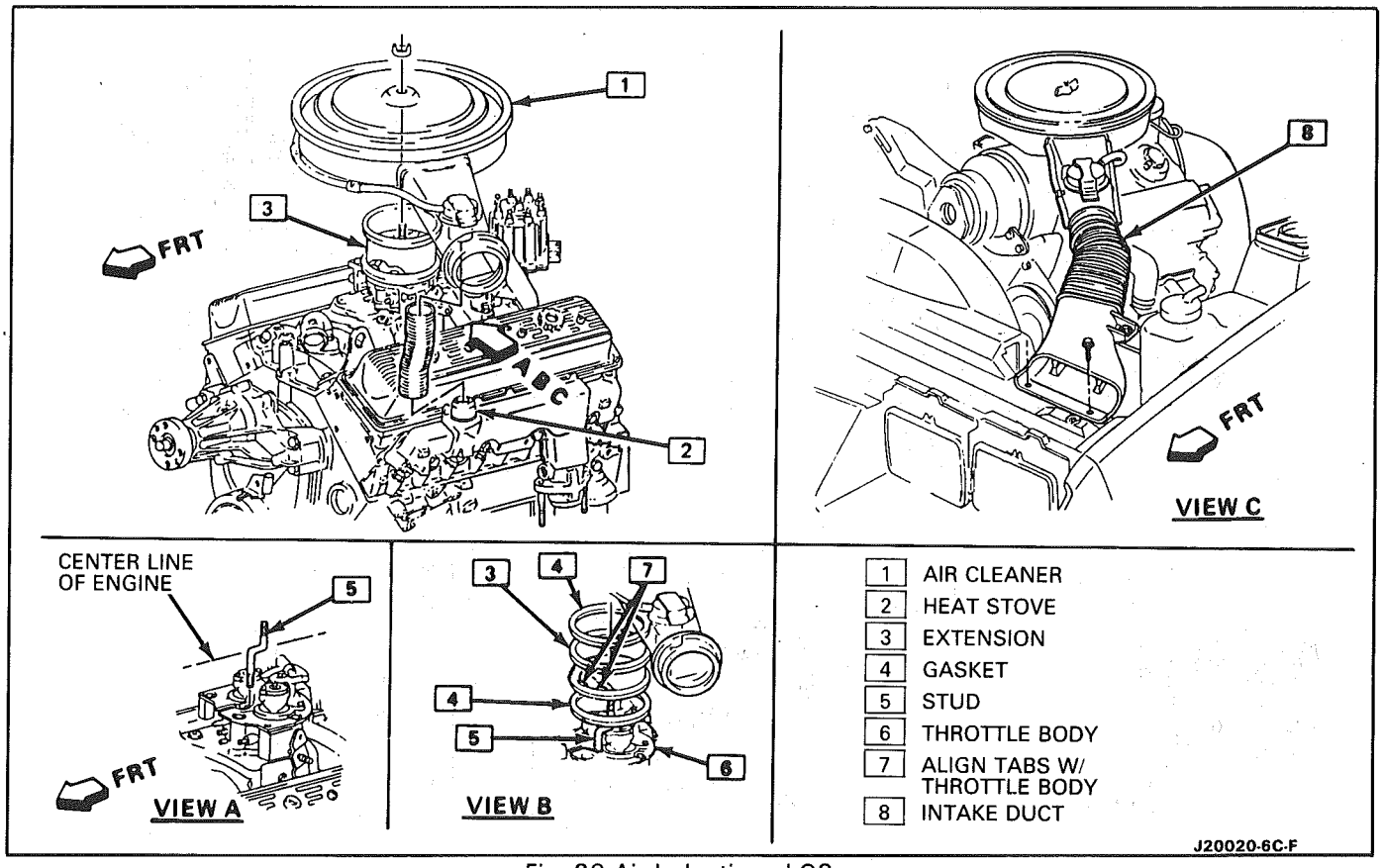



Fig. 20 Air Induction - LO3

# SECTION 6E2
# DRIVEABILITY AND EMISSIONS FUEL INJECTION (TBI)

## THIS SECTION APPLIES TO:
## 5.0L (VIN E) "F" SERIES

## CONTENTS

### INTRODUCTION



### SECTION A - DIAGNOSTIC CHARTS



### SECTION B - SYMPTOMS



### FUNCTIONAL CHECKS/ DIAGNOSTIC CHARTS

## SECTION C - COMPONENT SYSTEMS

# SECTION A
## 5.0L ENGINE

## DIAGNOSTIC CIRCUIT CHECK

The "Diagnostic Circuit Check" verifies the system is functioning correctly. Some special considerations to keep in mind while making the "Diagnostic Circuit Check" are:

### Blocking Drive Wheels

The vehicle drive wheels should always be blocked while checking the system.

### Cold Oxygen Sensor

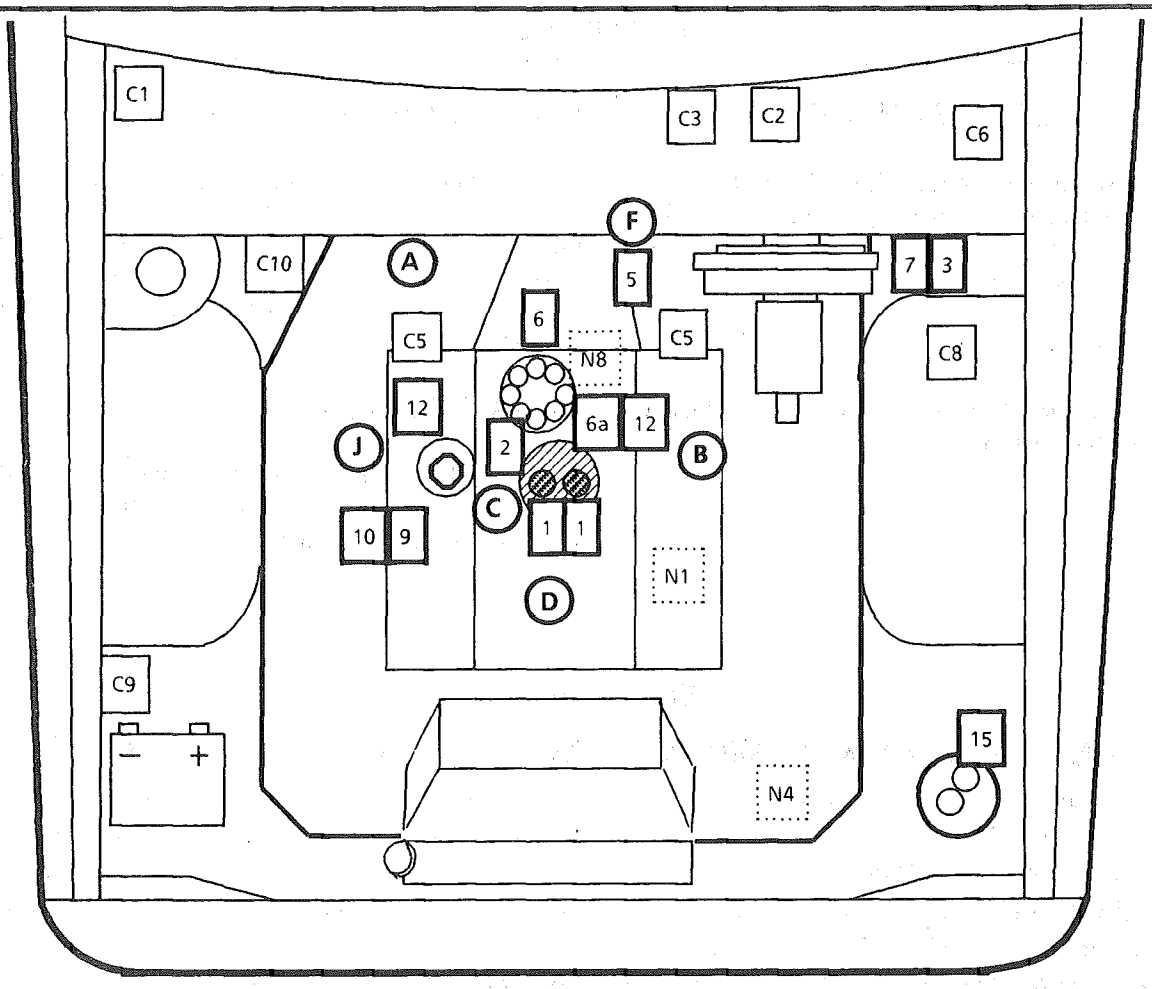
On some engines, the oxygen sensor will cool off after only a short period of operation at idle. This will put the system into "Open Loop". To restore "Closed Loop" operation, run the engine at part throttle several minutes and accelerate from idle to part throttle a few times.

## BASIC PROCEDURE

If you have not reviewed the basic information on how to use the diagnostic procedures, go to the introduction of this section.

## SECTION A
## ENGINE COMPONENTS / WIRING DIAGRAMS / DIAGNOSTIC CHARTS

'F' SERIES RPO: LO3 VIN CODE: E 5.0L V8 TBI




## COMPUTER HARNESS

C1 Electronic Control Module
C2 ALDL diagnostic connector
C3 "SERVICE ENGINE SOON" light
C5 ECM harness grounds
C6 Fuse panel
C8 Fuel pump test connector
C9 Fuel pump fuse & ECM power
C10 Set timing connector

## NOT ECM CONNECTED

N1 Crankcase vent valve (PCV)
N4 P/S Switch
N8 Oil pressure switch

## CONTROLLED DEVICES

1 Fuel injectors
2 Idle air control motor
3 Fuel pump relay
5 Trans. Conv. Clutch connector
6 EST distributor
6a Remote ignition coil
7 Electronic Spark Control module
9 Air injection port solenoid
10 Air injection converter solenoid
12 Exh. Gas Recirc. vacuum solenoid
15 Fuel vapor canister solenoid
Exhaust Gas Recirculation valve

## INFORMATION SENSORS

A Manifold Absolute Pressure
B Exhaust oxygen
C Throttle position
D Coolant temperature
F Vehicle speed
J ESC knock
MAT (on air cleaner)

6-10-87

*8S4419-6E

Figure A-1 - Component Locations 5.0L (VIN E)

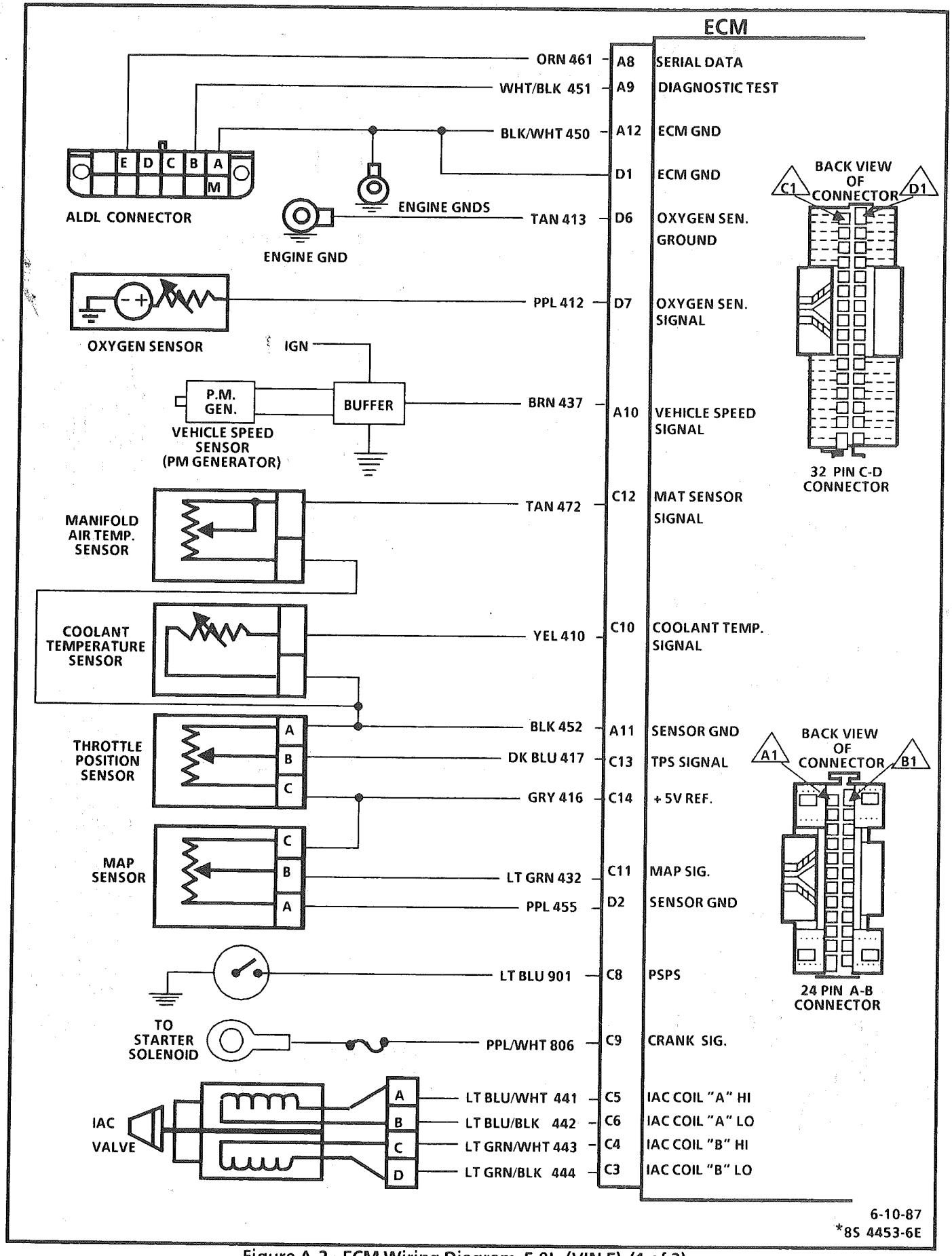



Figure A-2 - ECM Wiring Diagram 5.0L (VIN E) (1 of 3)

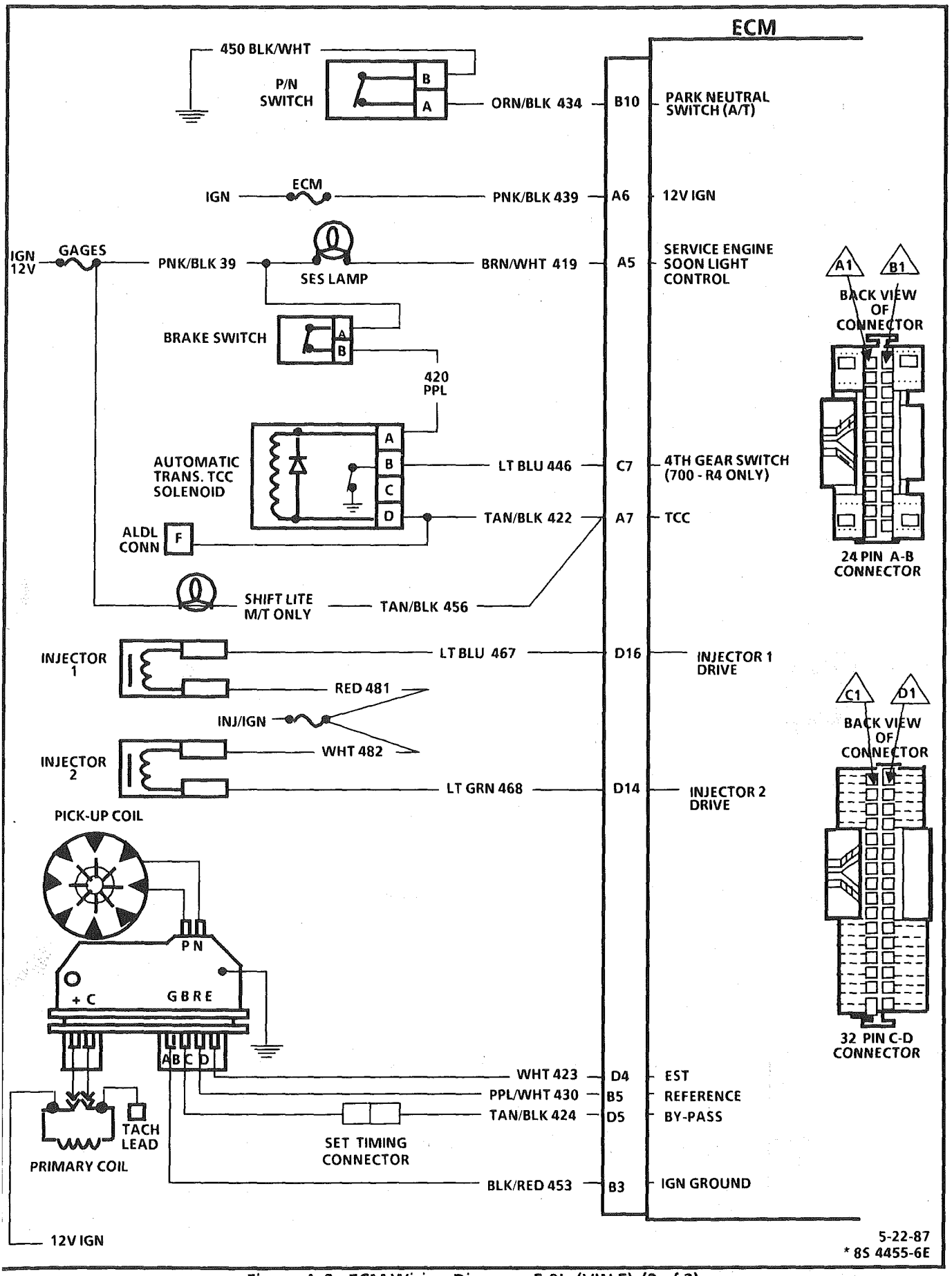



Figure A-3 - ECM Wiring Diagram 5.0L (VIN E) (2 of 3)

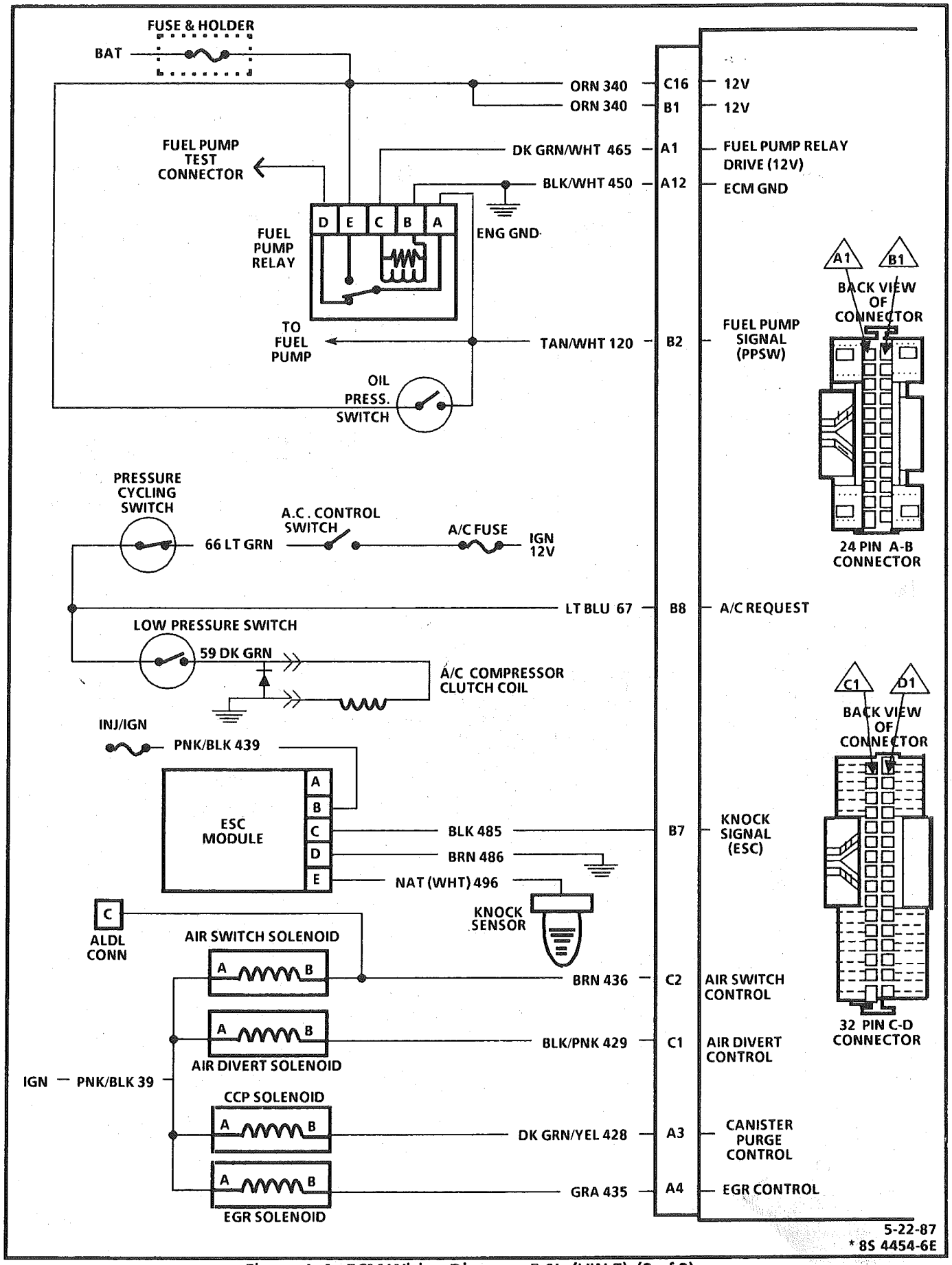
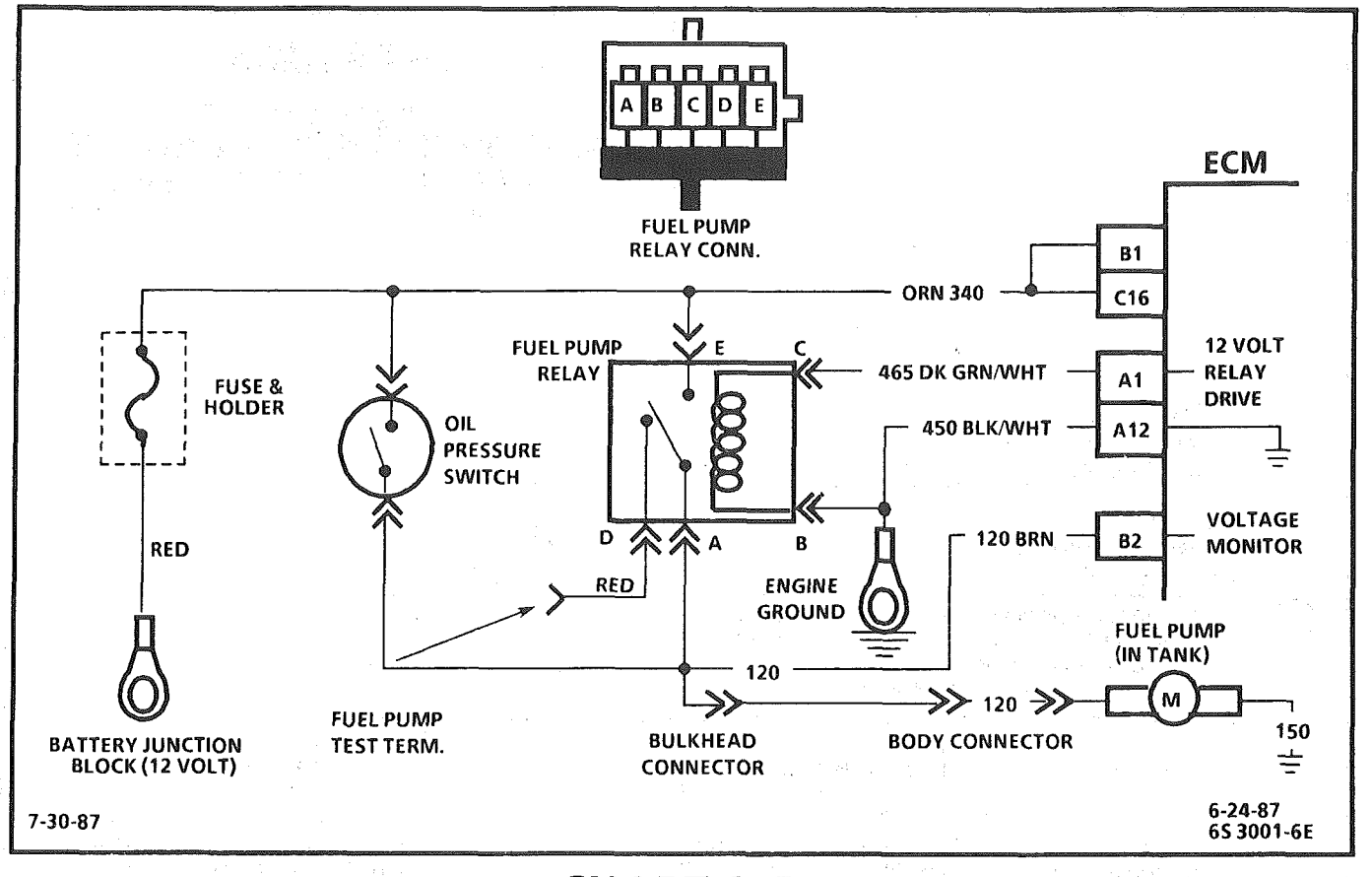



Figure A-4 - ECM Wiring Diagram 5.0L (VIN E) (3 of 3)




# CHART A-7

## (Page 1 of 2)
## FUEL SYSTEM DIAGNOSIS
## 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

When the ignition switch is turned "ON", the electronic control module (ECM) will turn "ON" the in-tank fuel pump. It will remain "ON" as long as the engine is cranking or running, and the ECM is receiving ignition reference pulses.

If there are no reference pulses, the ECM will shut "OFF" the fuel pump within 2 seconds after key "ON".

The pump will deliver fuel to the TBI unit, where the system pressure is controlled to 62 to 90 kPa (9 to 13 psi). Excess fuel is then returned to the fuel tank.

The fuel pump test terminal is located in the left side of the engine compartment. When the engine is stopped, the pump can be turned "ON" by applying battery voltage to the test terminal.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart

1. Fuel pressure should be noted while fuel pump is running. Fuel pressure will drop immediately after fuel pump stops running due to a controlled bleed in the fuel system.

### Diagnostic Aids:

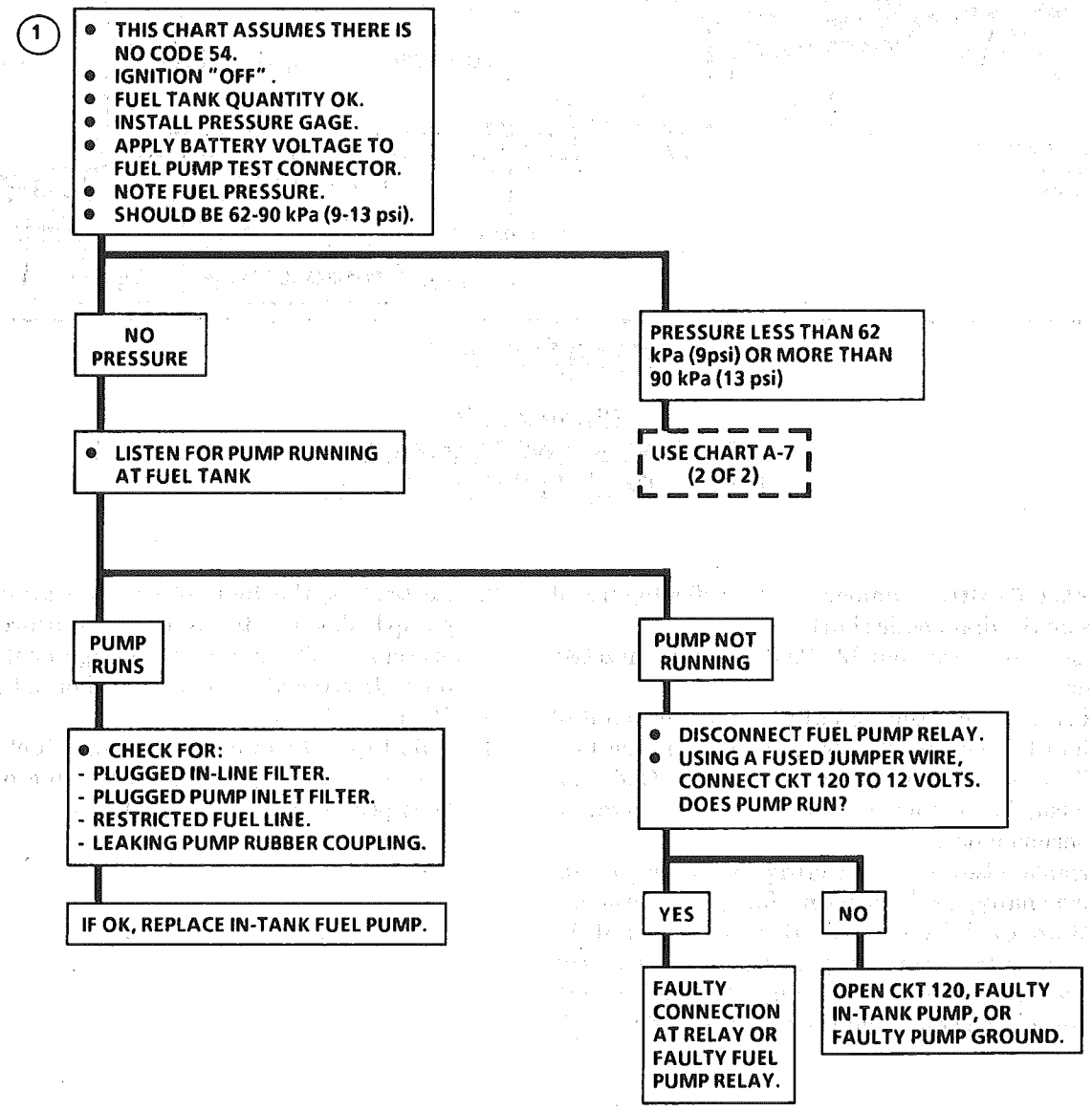
Improper fuel system pressure can result in one of the following symptoms:

- Cranks, but won't run.
- Code 44.
- Code 45.
- Cuts out, may feel like ignition problem.
- Poor fuel economy, loss of power.
- Hesitation.

# CHART A-7

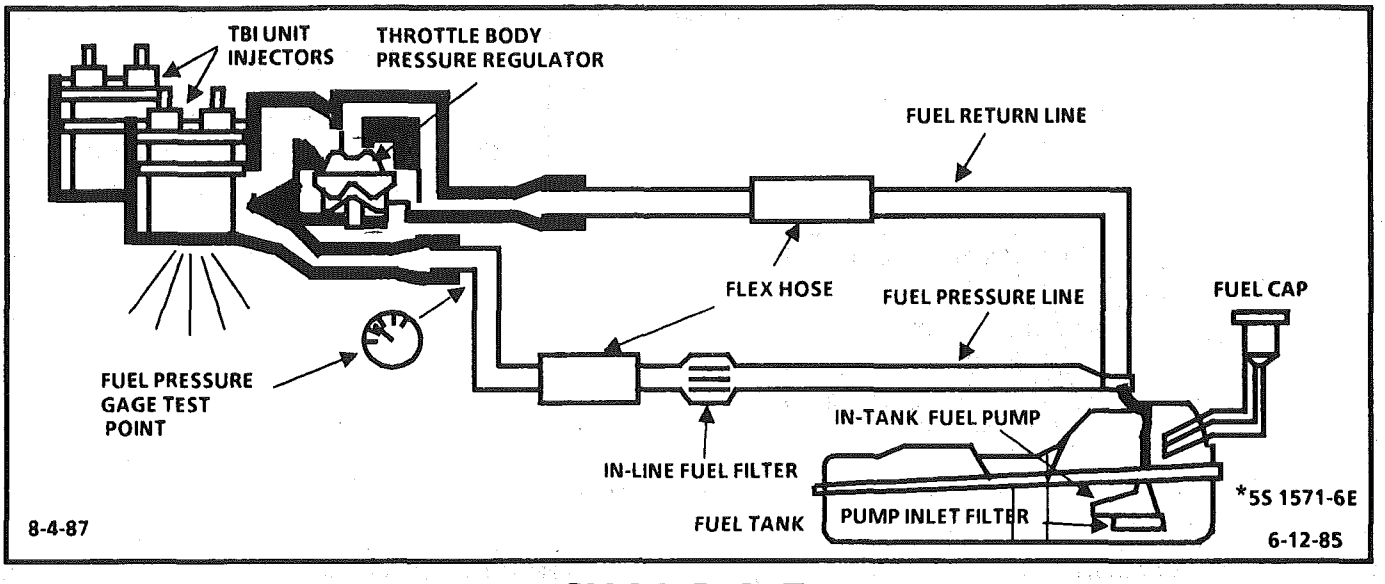
(Page 1 of 2)

## FUEL SYSTEM DIAGNOSIS 5.0L (VIN E) "F" SERIES (TBI)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-27-87
6S 2628-6E




# CHART A-7

## (Page 2 of 2)
## FUEL SYSTEM DIAGNOSIS
## 5.0L (VIN E) "F" SERIES (TBI)

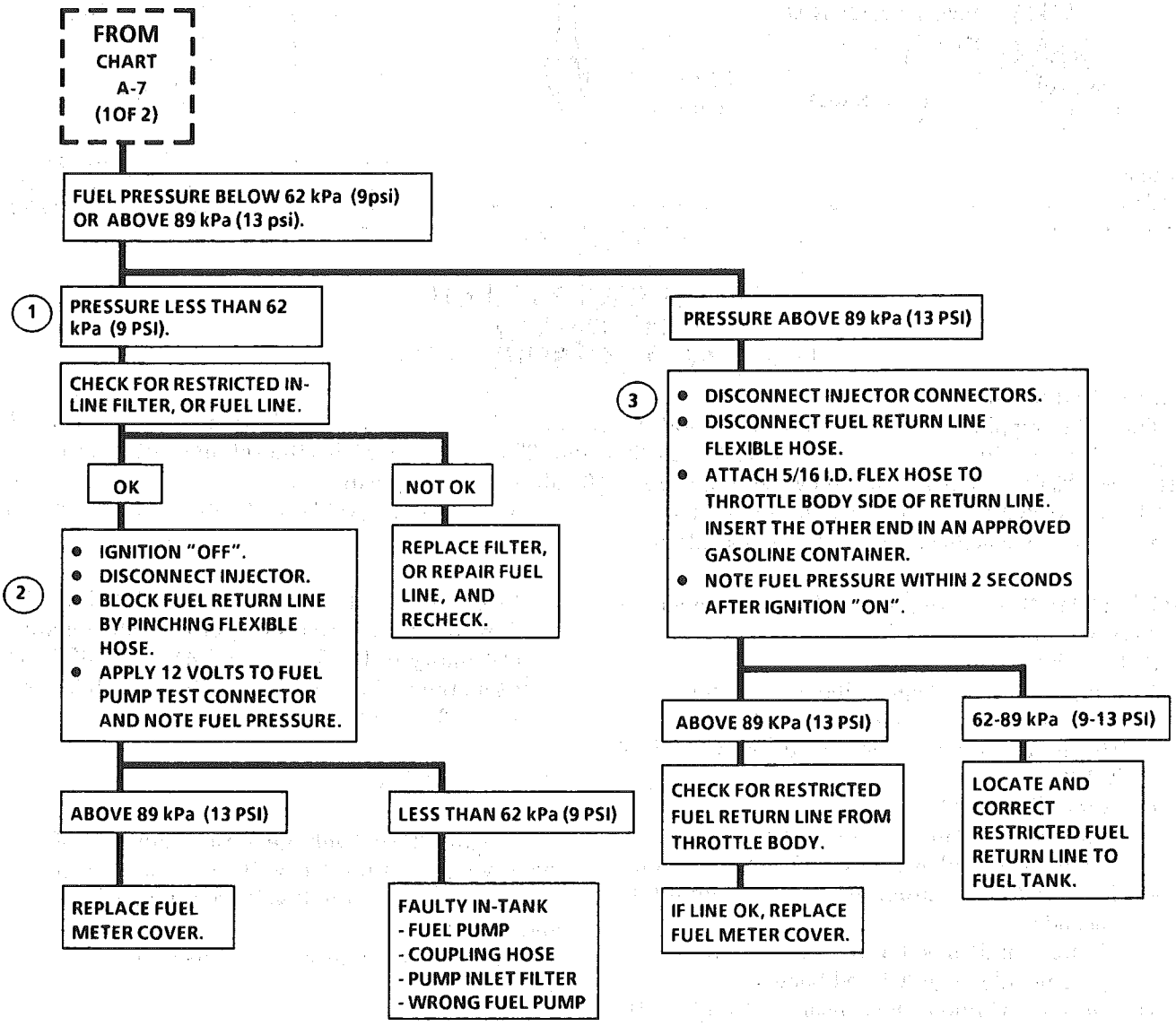
**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Pressure, but less than 62 kPa (9 psi) falls into two areas:
   - Pressure less than 62 kPa (9 psi). Amount of fuel to injectors OK but, pressure is too low. System will be lean and may set Code 44. Also, hard starting cold and poor overall performance.
   - Restricted flow causing pressure drop. Normally, a vehicle with a fuel pressure of less than 62 kPa (9 psi) at idle will not be driveable. However, if the pressure drop occurs only while driving, the engine will surge then stop as pressure begins to drop.
2. Restricting the fuel return line allows the fuel pump to develop its maximum pressure (dead head pressure). When battery voltage is applied to the pump test terminal, pressure should be from 90 to 124 kPa (13 to 18 psi).
3. This test determines if the high fuel pressure is due to a restricted fuel return line or a throttle body pressure regulator problem.

# CHART A-7

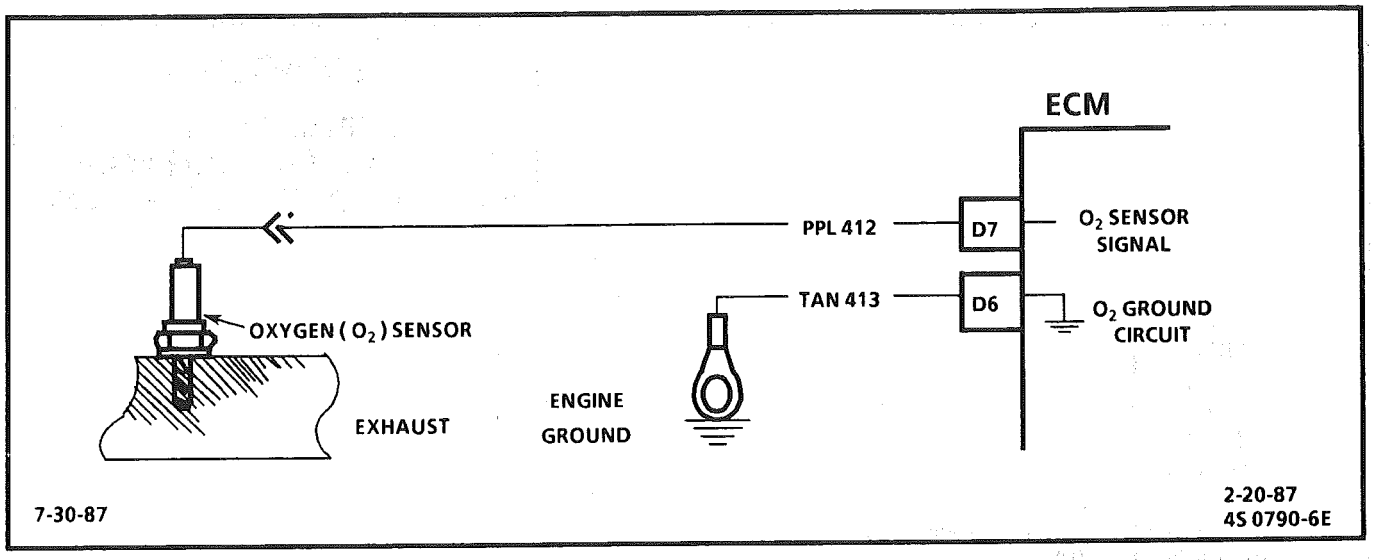
(Page 2 of 2)

## FUEL SYSTEM DIAGNOSIS 5.0L (VIN E) "F" SERIES (TBI)




CLEAR CODES AND CONFIRM "CLOSED LOOP " OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-27-87
5S 1572-6E




# CODE 13

## OXYGEN SENSOR CIRCUIT (OPEN CIRCUIT) 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D7" and "D6". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volts). The $O_2$ sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below 360°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 13 will set:
   - Engine at normal operating temperature.
   - At least 2 minutes engine time after start.
   - $O_2$ signal voltage steady between .35 and .55 volts.
   - Rpm above 1600.
   - Throttle position sensor signal above 5% (about .3 volts above closed throttle voltage).
   - All conditions must be met for about 60 seconds.

   If the conditions for a Code 13 exist, the system will not go "Closed Loop".
2. This will determine if the sensor is at fault or the wiring or ECM is the cause of the Code 13.
3. In doing this test, use only a high impedence digital volt ohmmeter. This test checks the continuity of CKTs 412 and 413. If CKT 413 is open, the ECM voltage on CKT 412 will be over .6 volts (600 mV).

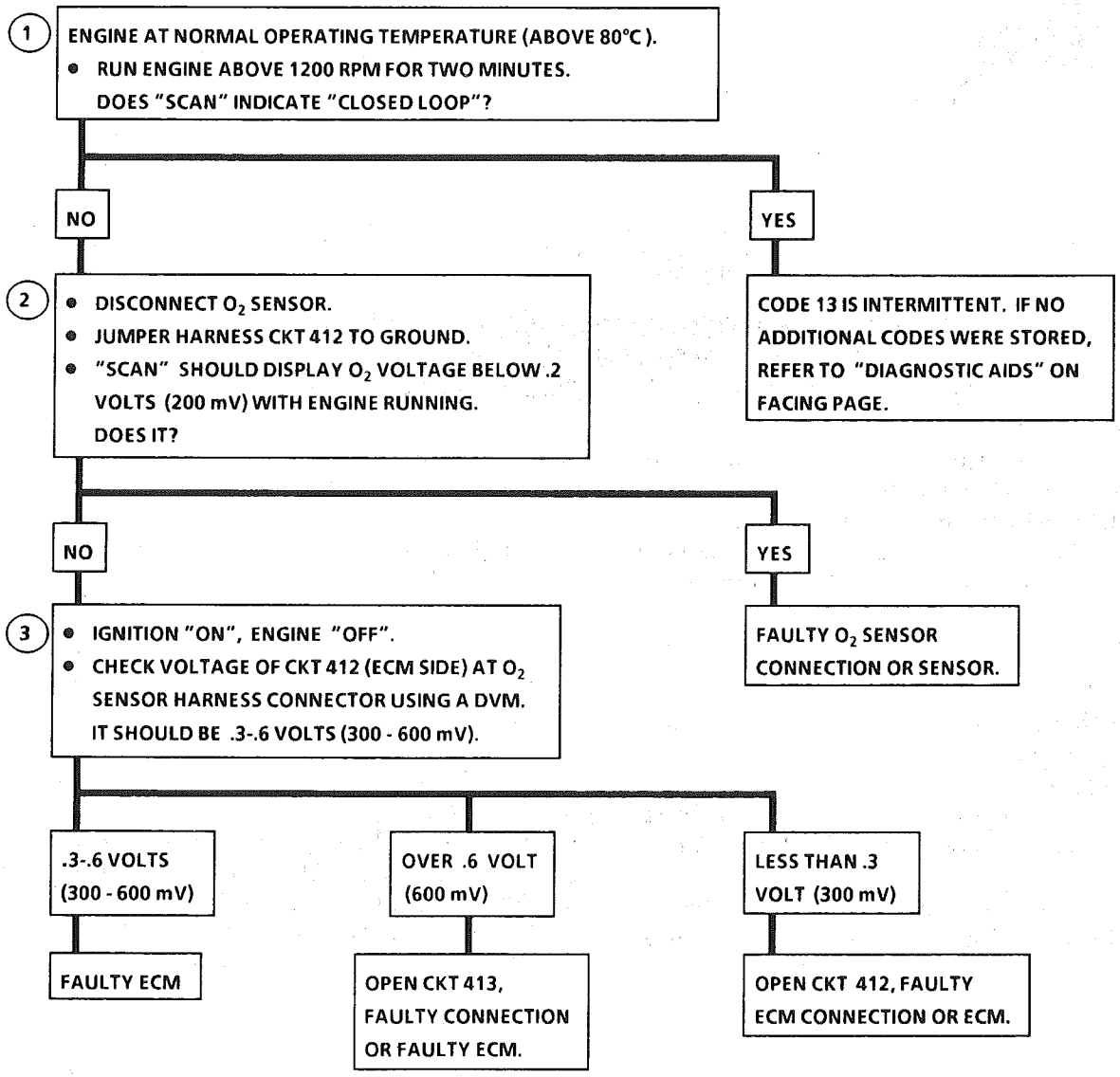
### Diagnostic Aids:

Normal "Scan" voltage varies between 100 mV to 999 mV (.1 and 1.0 volt), while in "Closed Loop". Code 13 sets in one minute, if voltage remains between .35 and .55 volts.

Refer to "Intermittents" in Section "B".

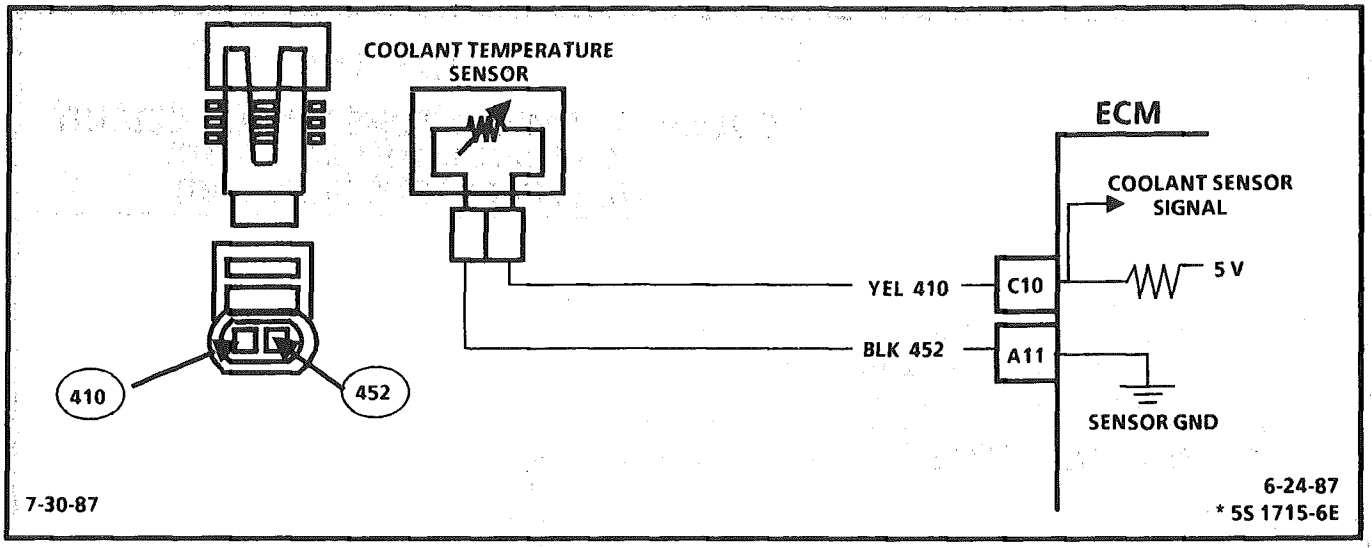
# CODE 13

## OXYGEN SENSOR CIRCUIT (OPEN CIRCUIT) 5.0L (VIN E) "F" SERIES (TBI)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-23-87
• 7S 3054-6E




# CODE 14

## COOLANT TEMPERATURE SENSOR CIRCUIT (HIGH TEMPERATURE INDICATED) 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The coolant temperature sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine is cold the sensor (thermistor) resistance is high, therefore the ECM will see high signal voltage.

As the engine warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (85°C to 95°C) the voltage will measure about 1.5 to 2.0 volts.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 14 will set if:
   - Signal voltage indicates a coolant temperature above 135°C (275°F) for 2 seconds.
2. This test will determine if CKT 410 is shorted to ground which will cause the conditions for Code 14.

### Diagnostic Aids:

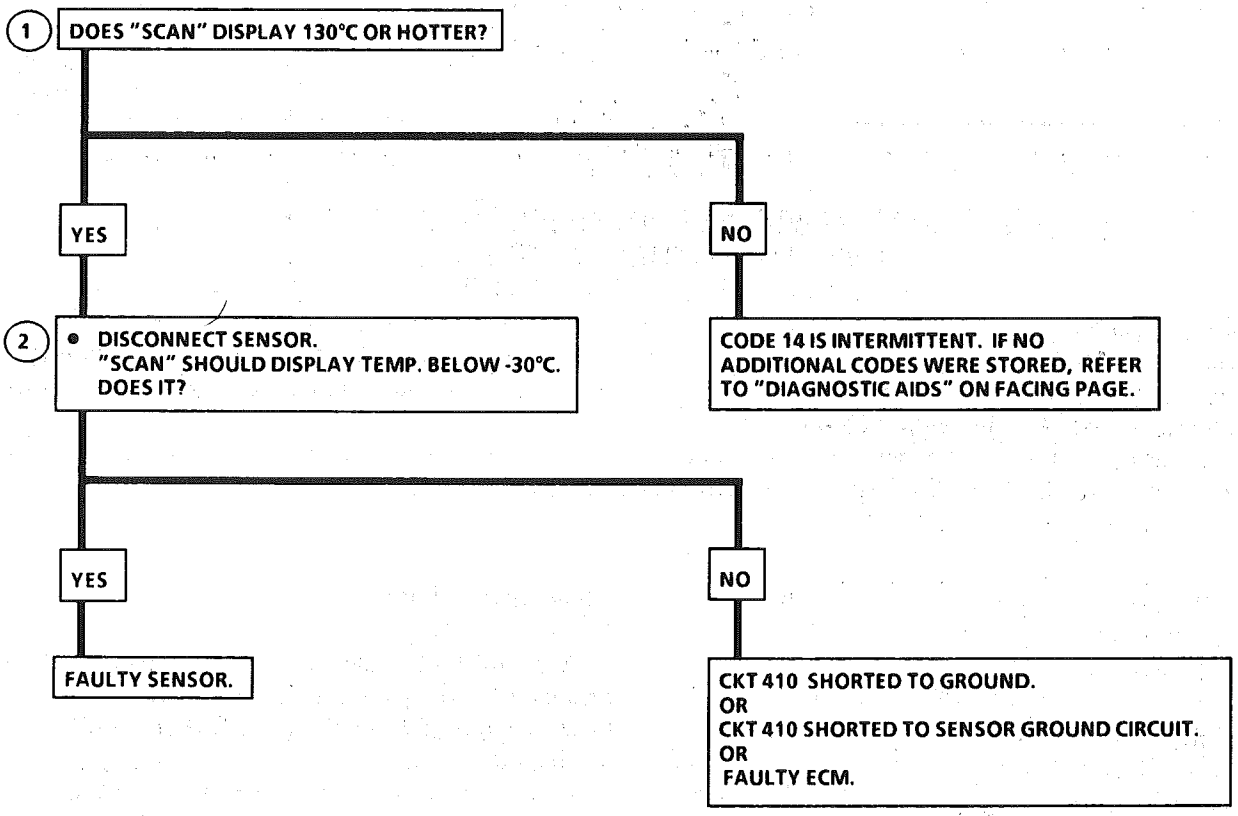
Check harness routing for a potential short to ground in CKT 410.

"Scan" tool displays engine temperature in degrees centigrade. After engine is started, the temperature should rise steadily to about 90°C then stabilize when thermostat opens.

Refer to "Intermittents" in Section "B".

# CODE 14

## COOLANT TEMPERATURE SENSOR CIRCUIT
## (HIGH TEMPERATURE INDICATED)
## 5.0L (VIN E) "F" SERIES (TBI)

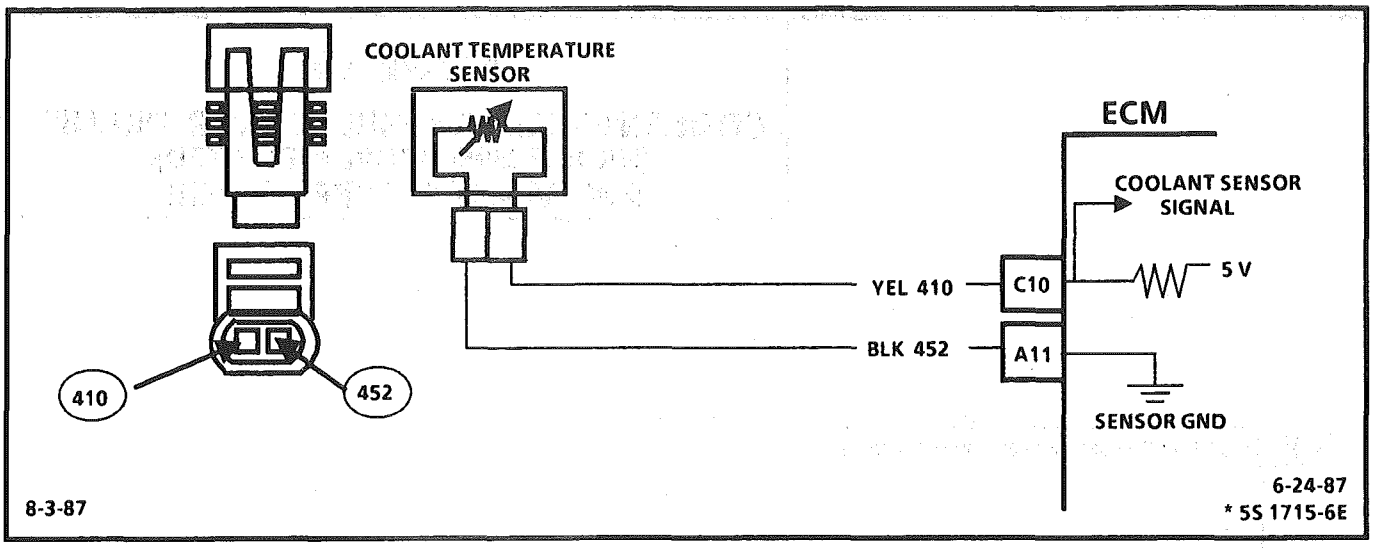



DIAGNOSTIC AID

| COOLANT SENSOR | | |
|---|---|---|
| TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE) | | |
| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

4-28-87
• 7S 3055-6E




# CODE 15

## COOLANT TEMPERATURE SENSOR CIRCUIT
## (LOW TEMPERATURE INDICATED)
## 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The coolant temperature sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine is cold, the sensor (thermistor) resistance is high, therefore the ECM will see high signal voltage.

As the engine warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (85°C to 95°C) the voltage will measure about 1.5 to 2.0 volts at the ECM.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 15 will set if:
   - Engine running longer than 30 seconds.
   - Coolant temperature less than -30°C (-22°F), for 3 seconds.
2. This test simulates a Code 14. If the ECM recognizes the low signal voltage, (high temperature) and the "Scan" reads 130°C or above, the ECM and wiring are OK.
3. This test will determine if CKT 410 is open. There should be 5 volts present at sensor connector if measured with a DVM.

### Diagnostic Aids:

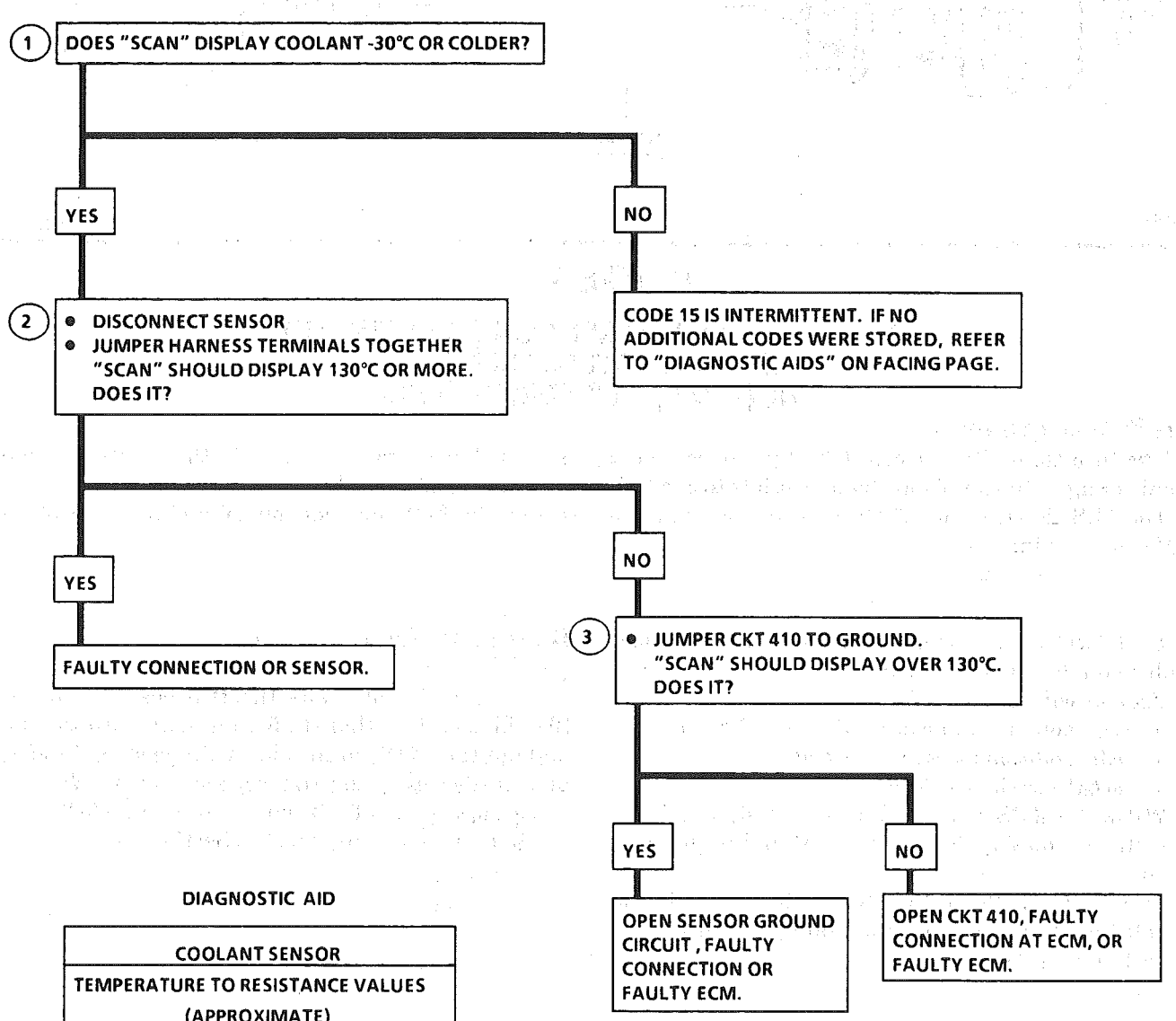
A "Scan" tool reads engine temperature in degrees centigrade. After engine is started the temperature should rise steadily to about 90°C then stabilize when thermostat opens.

If Code 21 is also set, check CKT 452 for faulty wiring or connections. Check terminals at sensor for good contact.

Refer to "Intermittents" in Section "B".

# CODE 15

## COOLANT TEMPERATURE SENSOR CIRCUIT (LOW TEMPERATURE INDICATED) 5.0L (VIN E) "F" SERIES (TBI)



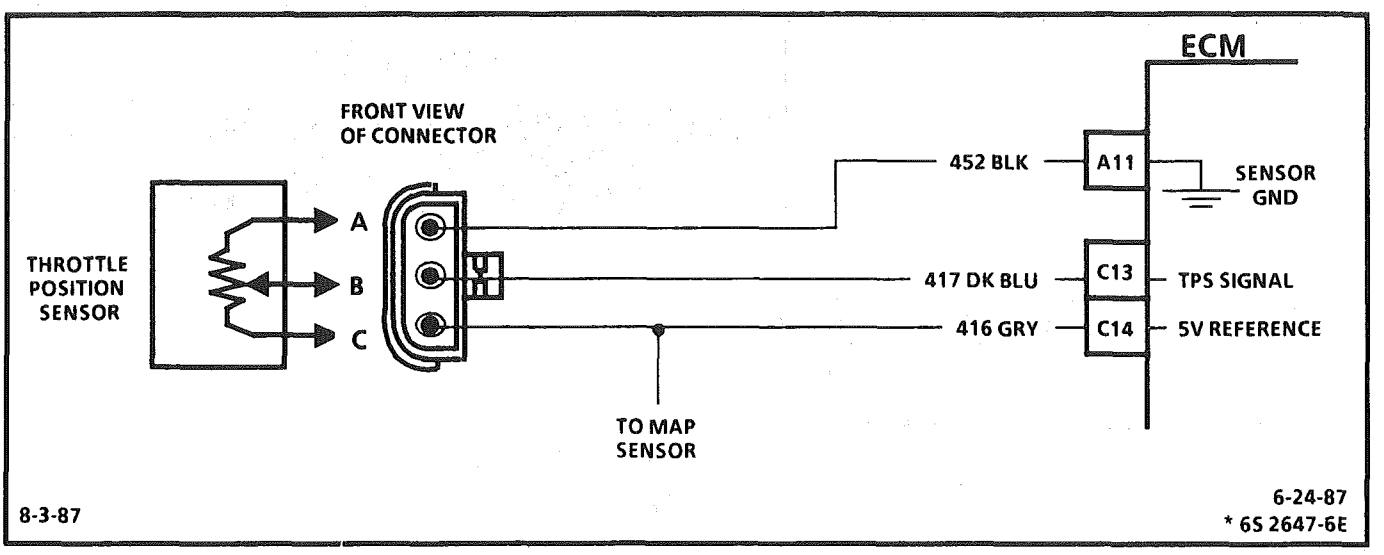

DIAGNOSTIC AID

| COOLANT SENSOR TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE) | | |
|---|---|---|
| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-11-87

• 7S 3261-6E




# CODE 21

## THROTTLE POSITION SENSOR (TPS) CIRCUIT
## (SIGNAL VOLTAGE HIGH)
## 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The throttle position sensor (TPS) provides a voltage signal that changes relative to the throtttle blade. Signal voltage will vary from about .5 at idle to about 5 volts at wide open throttle.

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM control outputs.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 21 will set if:
   - TPS signal voltage is greater than 2.5 volts.
   - All conditions met for 8 seconds.
   - MAP less than 52 kPa.
2. With the TPS sensor disconnected, the TPS voltage should go low if the ECM and wiring are OK.
3. Probing CKT 452 with a test light checks the 5 volt return circuit, because a faulty 5 volt return will cause a Code 21.

### Diagnostic Aids:

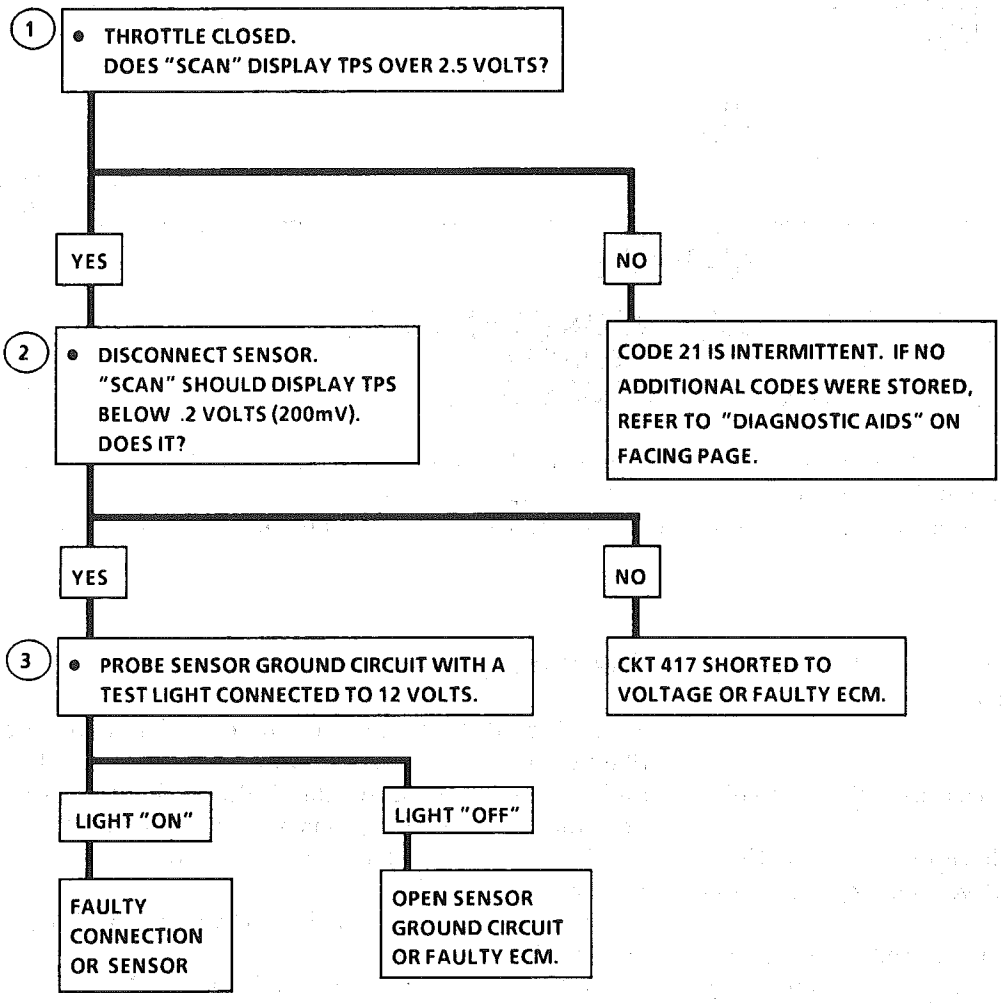
A "Scan" tool reads throttle position in volts. Should read less than 1.25 volts with throttle closed and ignition "ON" or at idle. Voltage should increase at a steady rate as throttle is moved toward WOT.

An open in CKT 452 will result in a Code 21.

Refer to "Intermittents" in Section "B".

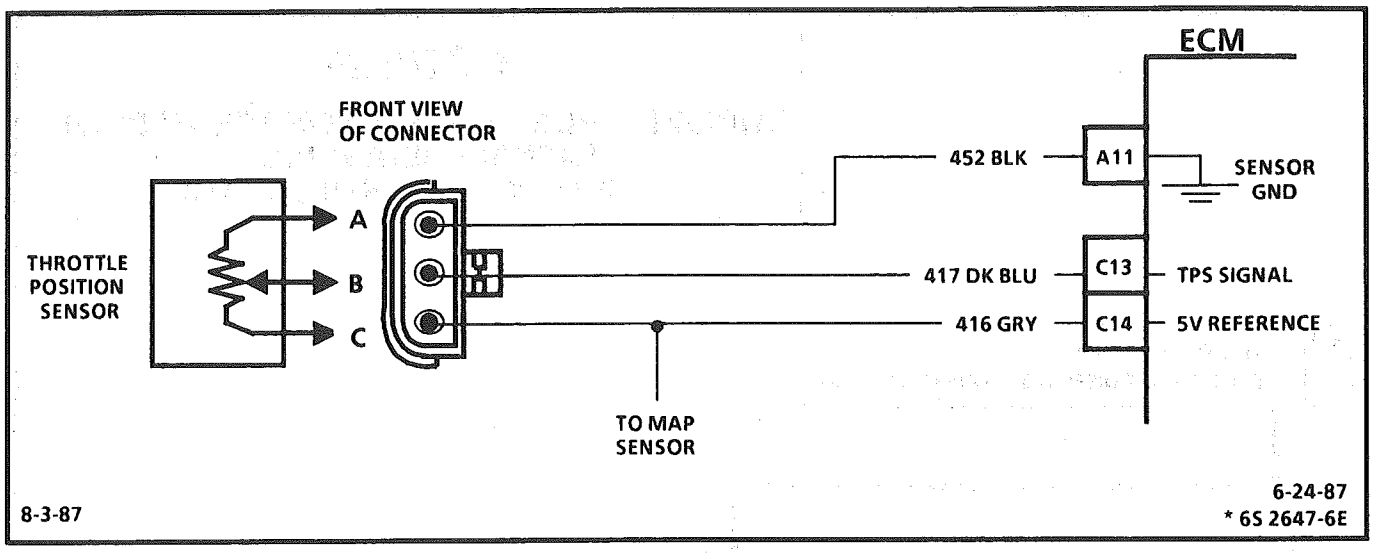
# CODE 21

## THROTTLE POSITION SENSOR (TPS) CIRCUIT
## (SIGNAL VOLTAGE HIGH)
## 5.0L (VIN E) "F" SERIES (TBI)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-24-87
• 7S 3057-6E




# CODE 22

## THROTTLE POSITION SENSOR (TPS) CIRCUIT
## (SIGNAL VOLTAGE LOW)
## 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The throttle position sensor (TPS) provides a voltage signal that changes relative to the throtttle blade. Signal voltage will vary from about .5 at idle to about 5 volts at wide open throttle.

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM control outputs.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 22 will set if:
   - Engine is running
   - TPS signal voltage is less than about .2 volts for 2 seconds.
2. Simulates Code 21: (high voltage) If the ECM recognizes the high signal voltage the ECM and wiring are OK.
3. This simulates a high signal voltage to check for an open in CKT 417. The "Scan" tool will not read up to 12 volts, but what's important is that the ECM recognizes the signal on CKT 417.
4. There should be 5 volts at terminal "C" if measured with a DVM when ignition is "ON".

### Diagnostic Aids:

A "Scan" tool reads throttle position in volts. Should read less than 1.25 volts with throttle closed and ignition "ON" or at idle. Voltage should increase at a steady rate as throttle is moved toward WOT.

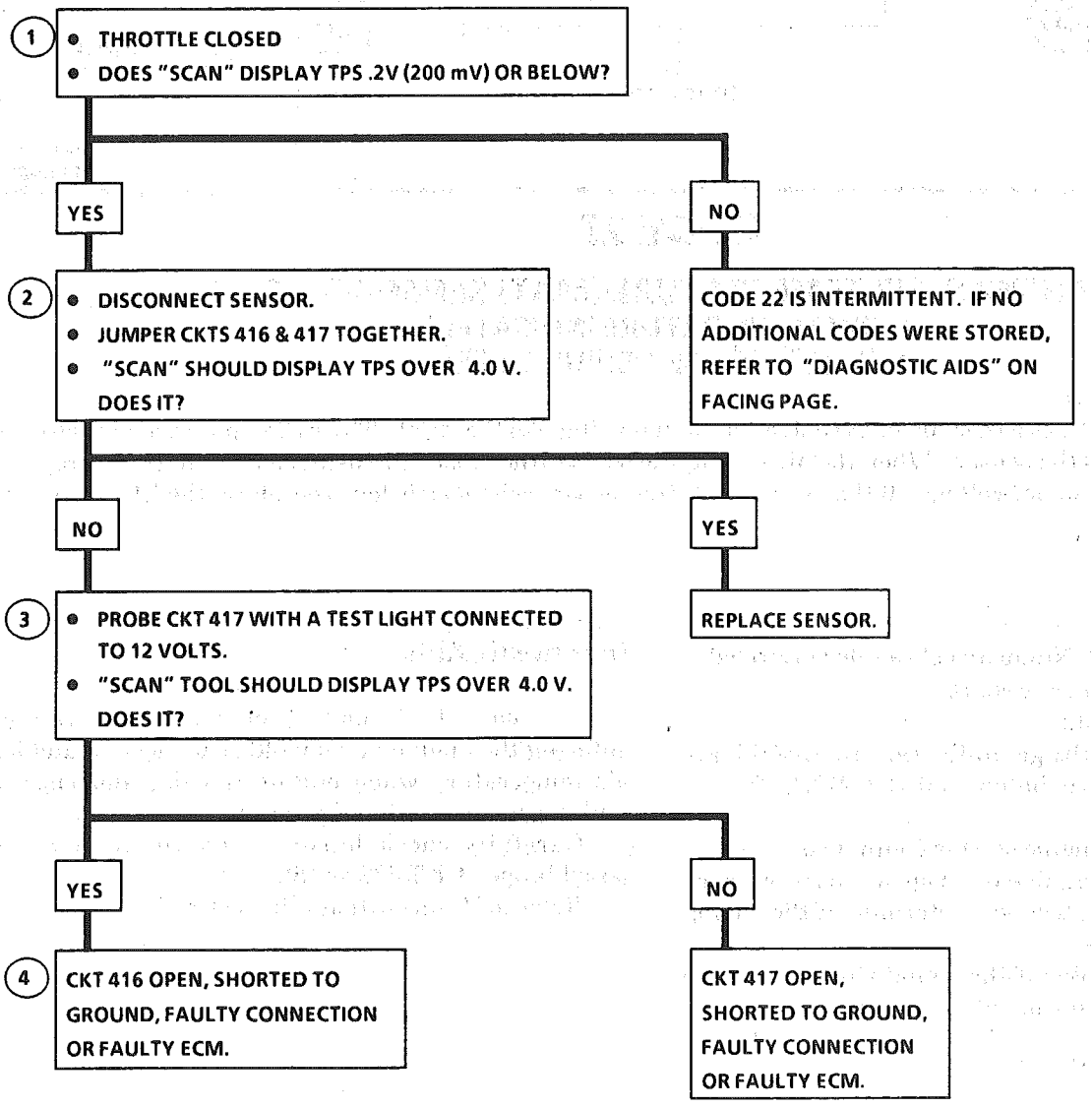
An open or short to ground in CKTs 416 or 417 will result in a Code 22.

If a Code 22 is also set check CKT 416 carefully for open or short to ground.

Refer to "Intermittents" in Section "B".

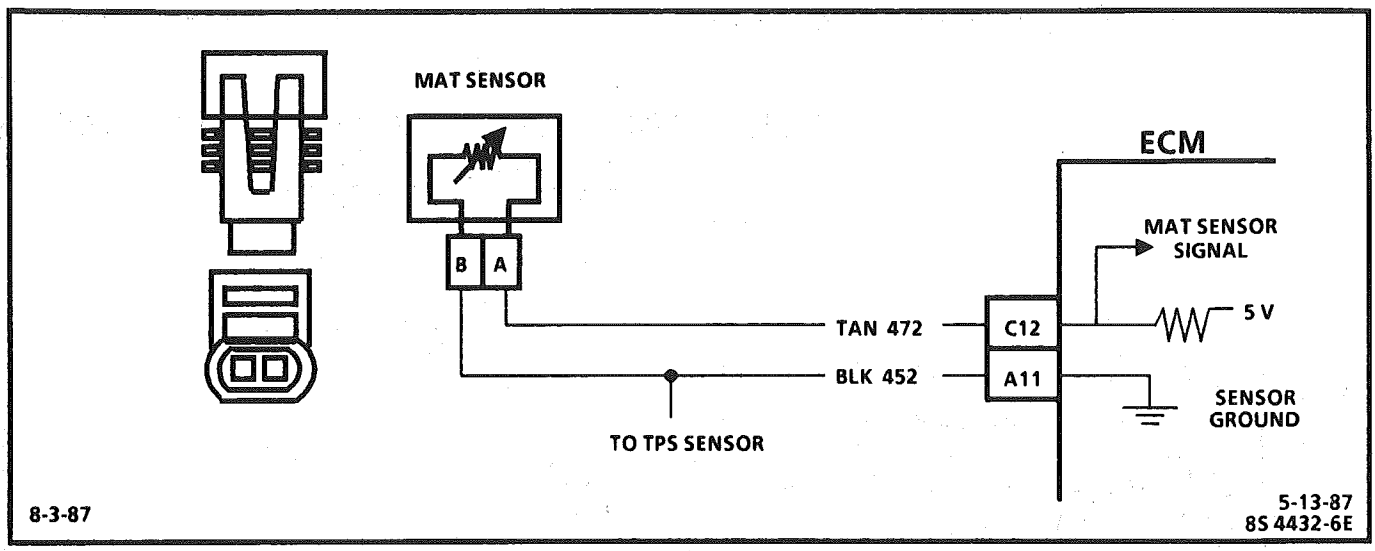
# CODE 22

## THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE LOW)
5.0L (VIN E) "F" SERIES (TBI)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-18-87
*7S 3260-6E




# CODE 23

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
## (LOW TEMPERATURE INDICATED)
## 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The MAT sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage (4-6 volts) on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. If the air is warm, the sensor resistance is low, therefore, the ECM will see a low voltage.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 23 will set if:
   - A signal voltage indicates amanifold air termperature below -30°C (-22°F) for 12 seconds.
   - Time since engine start is 1 minute or longer.
2. A Code 23 will set, due to an open sensor, wire, or connection. This test will determine if the wiring and ECM are OK.
3. This will determine if the signal CKT 472 or the sensor ground is open.

### Diagnostic Aids:

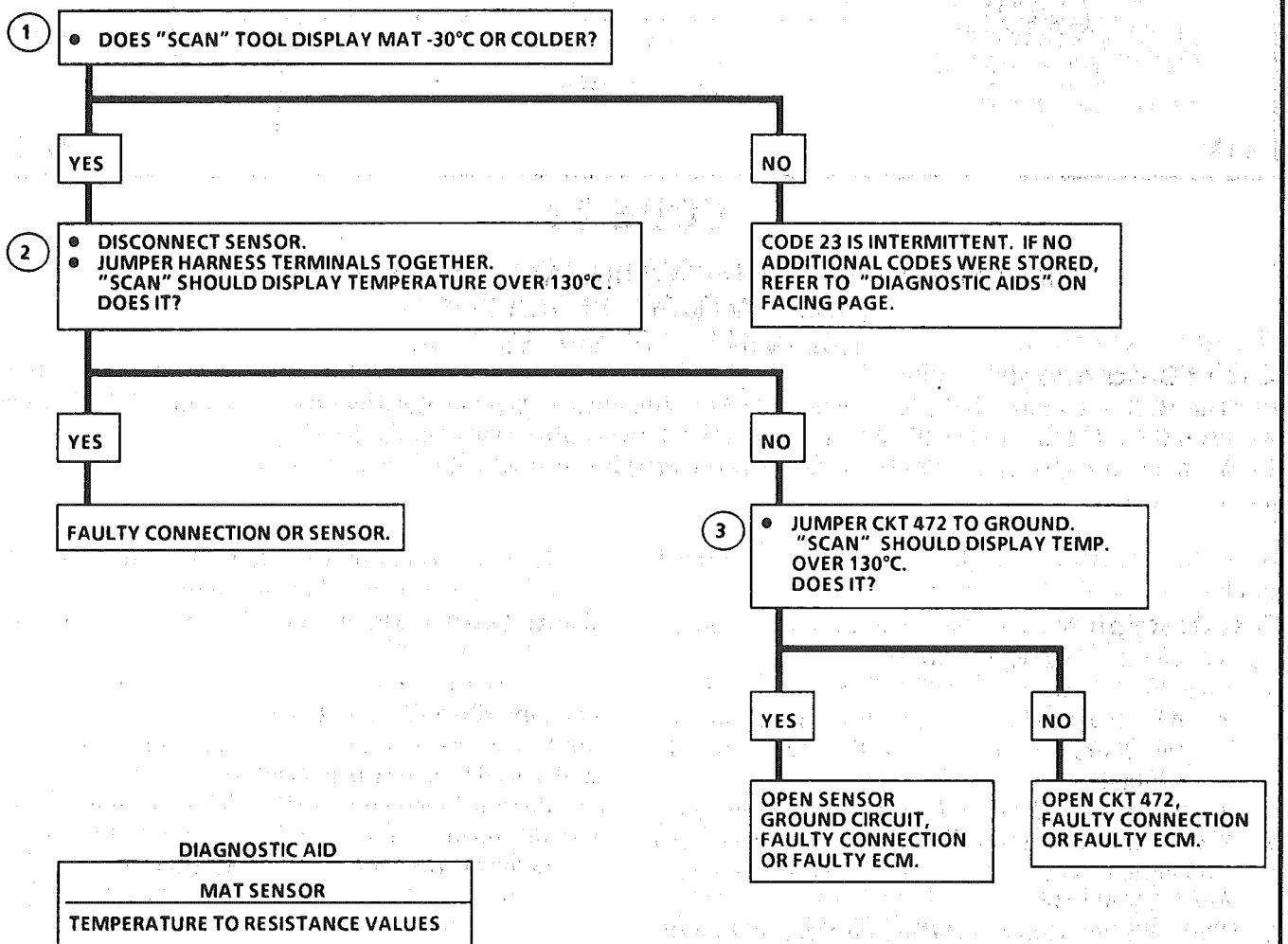
A "Scan" tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rises as underhood temperature increases.

Carefully check harness and connections for possible open CKT 472 or 452.

Refer to "Intermittents" in Section "B".

# CODE 23

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
## (LOW TEMPERATURE INDICATED)
## 5.0L (VIN E) "F" SERIES (TBI)

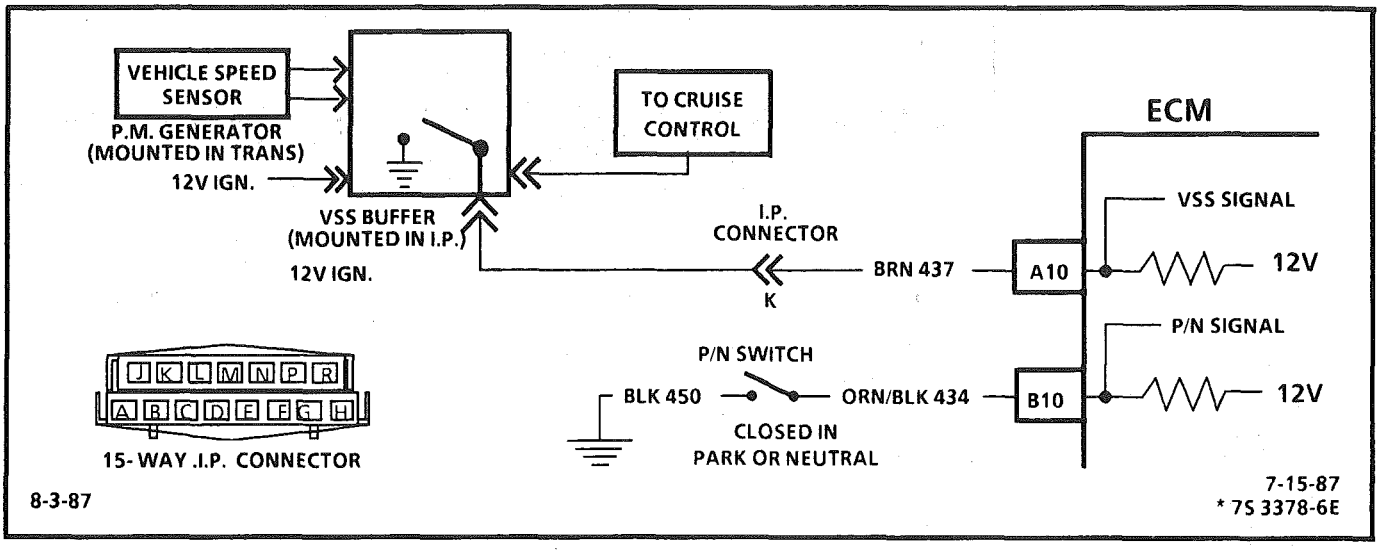



DIAGNOSTIC AID

| MAT SENSOR | | |
|---|---|---|
| TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE) | | |
| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-25-87
• 7S 3285




# CODE 24

## VEHICLE SPEED SENSOR (VSS) CIRCUIT 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The ECM applies and monitors 12 volts on CKT 437. CKT 437 connects to the vehicle speed sensor which alternately grounds CKT 437 when drive wheels are turning. This pulsing action takes place about 2000 times per mile and the ECM will calculate vehicle speed based on the time between "pulses".

A "Scan" reading should closely match with speedometer reading with drive wheels turning.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 24 will set if:
   - CKT 437 voltage is constant.
   - Engine speed is between 1400 and 3600 rpm.
   - Less than 2% throttle opening.
   - Low load condition.
   - Not in park or neutral.
   - All conditions must be met for 4 seconds.

   These conditions are met during a road load deceleration.
2. A voltage of less than 1 volt, at the 15-way connector indicates that the CKT 437 wire may be shorted to ground. Disconnect CKT 437 at the vehicle speed sensor buffer.

   If voltage remains less than 10 volts, then CKT 437 wire is grounded or open. If 437 is not grounded or open, check for a faulty ECM connector or ECM.

### Diagnostic Aids:

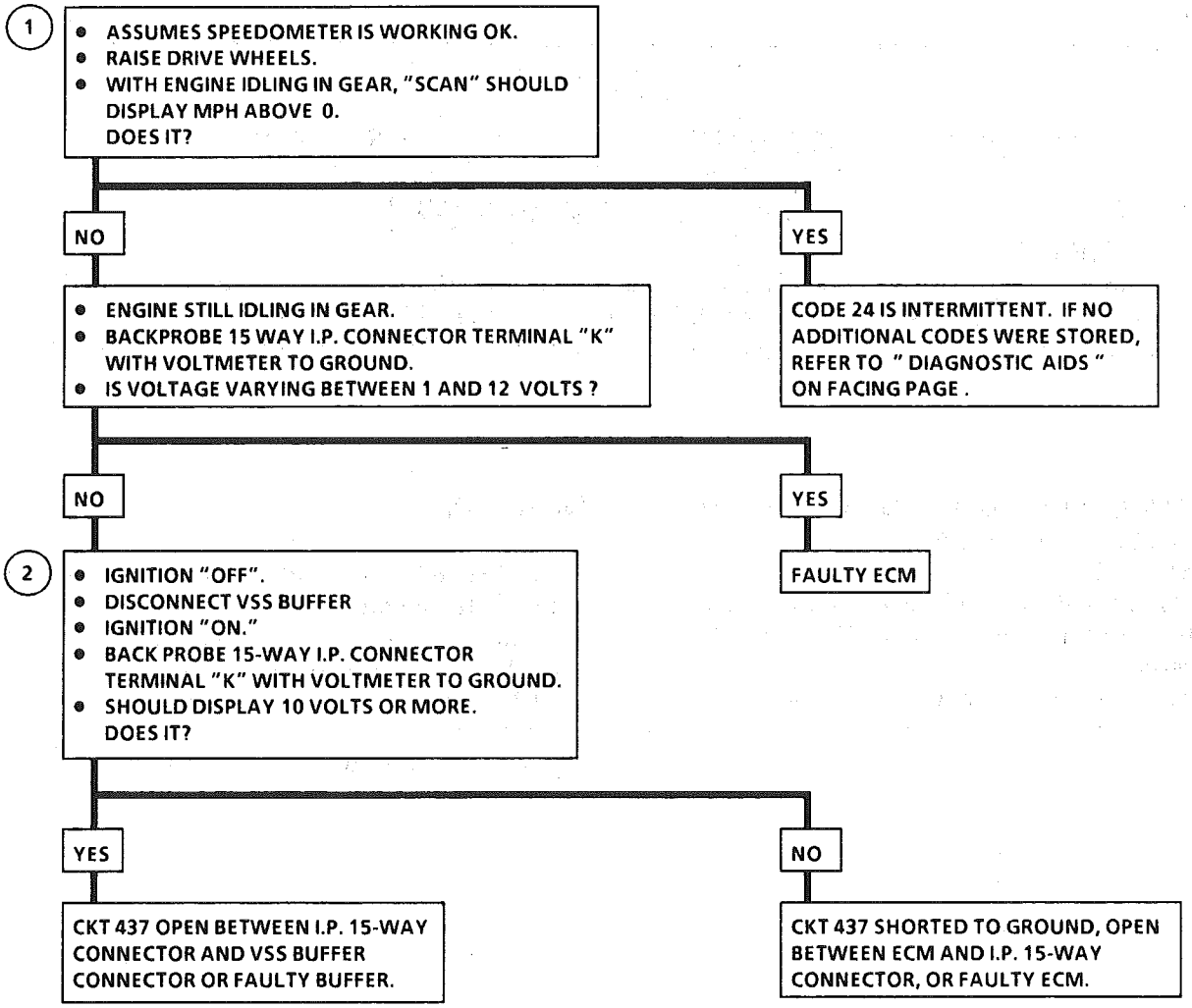
If "Scan" displays vehicle speed, check park/neutral switch CHART C-1A on vehicle with auto trans. If switch is OK, check for intermittent connections. An open or short to ground in CKT 437 will result in a a Code 24. Refer to Section "8A" for complete wiring diagram.

Refer to "Intermittents" in Section "B".

# CODE 24

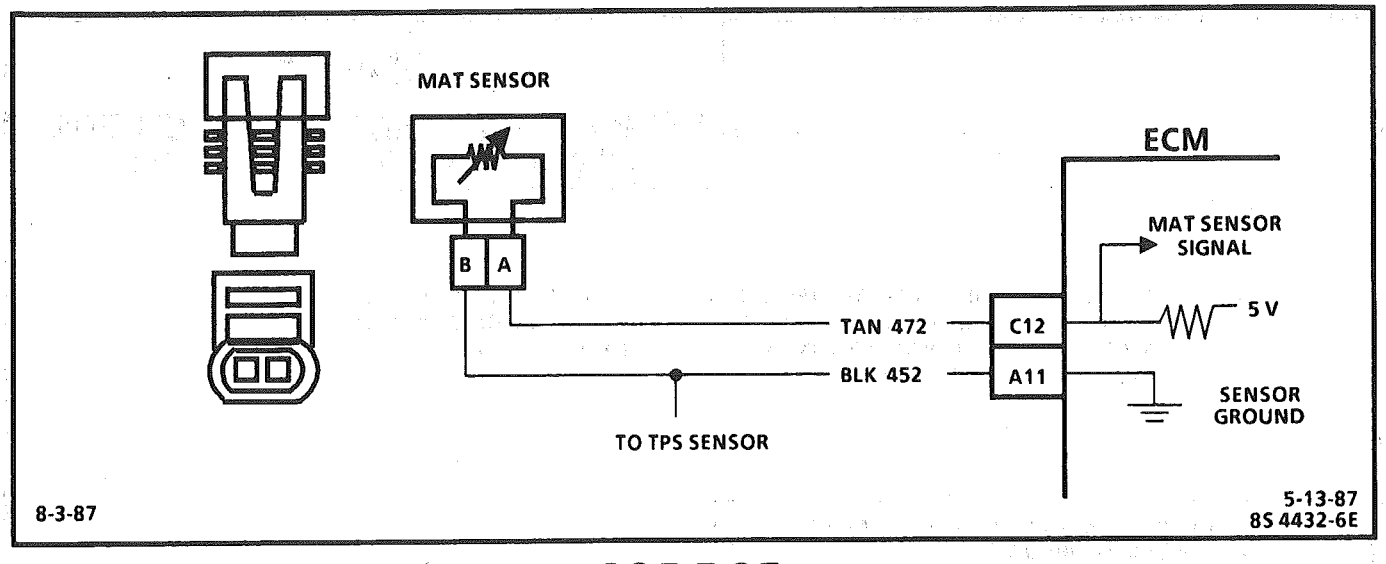
## VEHICLE SPEED SENSOR (VSS) CIRCUIT 5.0L (VIN E) "F" SERIES (TBI)

NOTE: TO PREVENT MISDIAGNOSIS, THE TECHNICIAN SHOULD REVIEW ELECTRICAL SECTION "8A" OR THE ELECTRICAL TROUBLESHOOTING MANUAL AND IDENTIFY THE TYPE OF VEHICLE SPEED SENSOR USED PRIOR TO USING THIS CHART. DISREGARD CODE 24 IF SET WHEN DRIVE WHEELS ARE NOT TURNING.




CLEAR CODES AND CONFIRM "CLOSED LOOP " OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

*8S 4684-6E
7-30-87




# CODE 25

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT (HIGH TEMPERATURE INDICATED) 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The manifold air temperature sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage (4-6) on CKT 472 to the sensor. When manifold air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. As the air warms, the sensor resistance becomes less, and the voltage drops.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 25 will set if:
   - Signal voltage indicates a manifold air temperature greater than 150°C (302°F) for 2 seconds.
   - Time since engine start is 1 minute or longer.

### Diagnostic Aids:

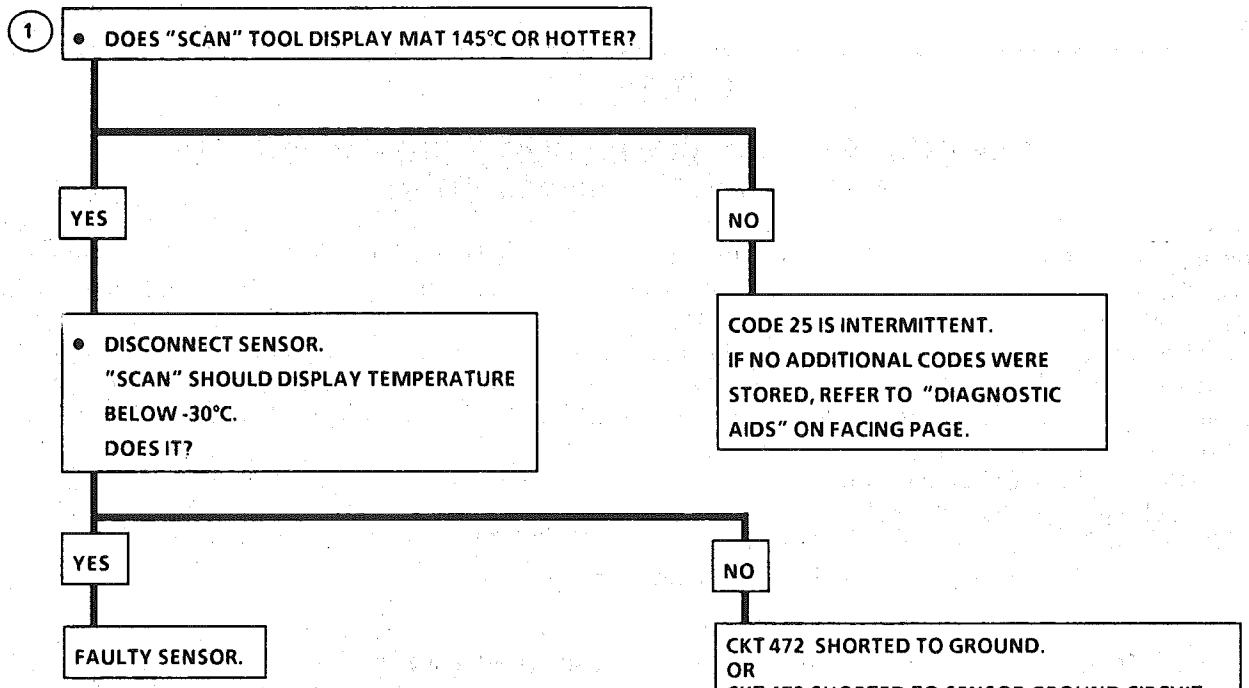
A "Scan" tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rise as underhood temperature increases.

Check harness routing for possible short to ground in CKT 472.

Refer to "Intermittents" in Section "B".

# CODE 25

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
(HIGH TEMPERATURE INDICATED)
5.0L (VIN E) "F" SERIES (TBI)




DIAGNOSTIC AID

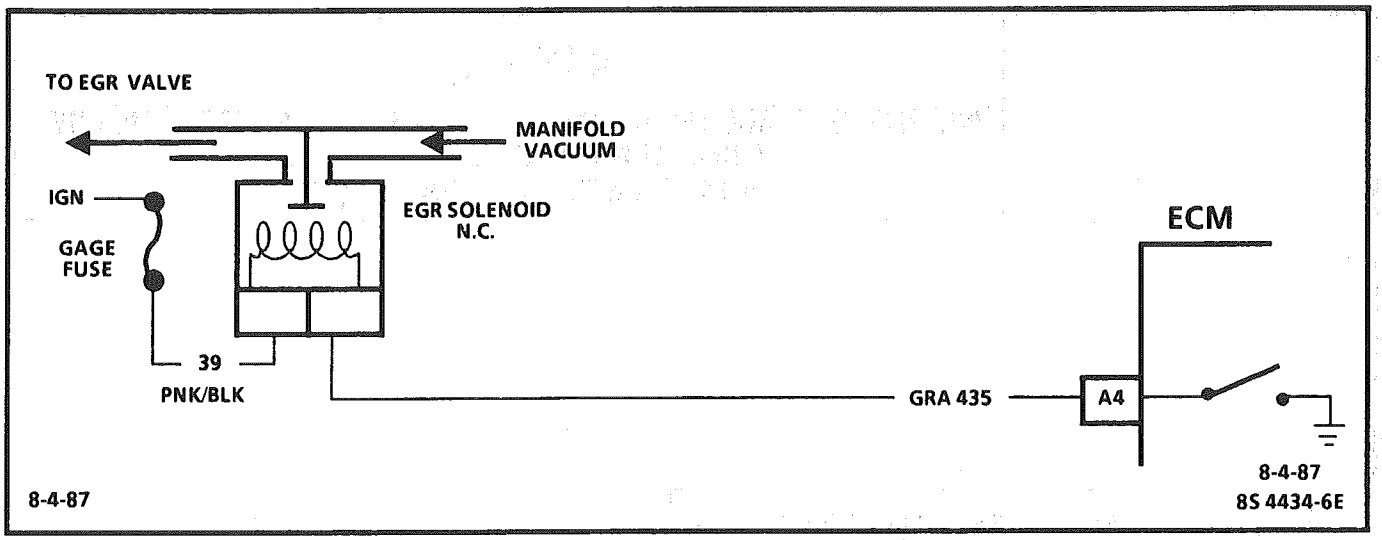
MAT SENSOR

TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)

| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-17-87
• 7S 3190-6E




# CODE 32

## EXHAUST GAS RECIRCULATION (EGR) CIRCUIT 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The ECM operates a solenoid to control the exhaust gas recirculation (EGR) valve. This solenoid is normally closed. By providing a ground path, the ECM energizes the solenoid which then allows vacuum to pass to the EGR valve.

The ECM monitors EGR effectiveness by de-energizing the EGR control solenoid thereby shutting off vacuum to the EGR valve diaphragm. With the EGR valve closed, manifold vacuum will be greater than it was during normal EGR operation and this change will be relayed to the ECM by the MAP sensor. If the change is not within the calibrated window, a Code 32 will be set.

The ECM will check EGR operation when:

- Vehicle speed is above 50 mph.
- Engine vacuum is between 40 and 51 kPa.
- No change in throttle position while test is being run.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Checks for solenoid stuck open.
2. Checks for solenoid always being energized.
3. Grounding test terminal should energize solenoid and vacuum should drop.
4. Negative backpressure valve should hold vacuum with engine "OFF".
5. When engine is started, exhaust backpressure should cause vacuum to bleed off and valve to fully close.
6. 5.0L engines have a manifold vacuum source which should have at least 7" Hg at idle.

### Diagnostic Aids:

Vacuum lines should be thoroughly checked for internal restrictions. The ECM uses the MAP sensor for checking EGR operation. If there is a question of MAP sensor accuracy use CHART C-1D MAP output check in Section "C".

If no problems are found refer to "Intermittents" in Section "B".

# CODE 32

## EXHAUST GAS RECRICULATION (EGR) CIRCUIT 5.0L (VIN E) "F" SERIES (TBI)

BEFORE USING THIS CHART, CHECK FOR MANIFOLD VACUUM TO EGR SOLENOID, ALSO CHECK HOSES FOR LEAKS OR RESTRICTIONS. SHOULD BE AT LEAST (7") HG VACUUM AT 2000 RPM.

**1**
- DISCONNECT EGR SOLENOID VACUUM HARNESS.
- ROTATE HARNESS AND REINSTALL ONLY THE EGR VALVE SIDE,
- IGNITION "ON", ENGINE STOPPED.
- GROUND DIAGNOSTIC TERMINAL.
- INSTALL A HAND HELD VACUUM PUMP WITH GAGE TO MANIFOLD SIDE OF EGR SOLENOID.
- APPLY VACUUM AND OBSERVE EGR VALVE DIAPHRAGM.
- VALVE SHOULD MOVE.

DOES IT?

YES

**2**
- UNGROUND DIAGNOSTIC TERMINAL.
- VACUUM SHOULD BLEED OFF AND VALVE SHOULD CLOSE.

DOES IT?

YES

**4**
- IGNITION "OFF"
- CONNECT A VACUUM PUMP TO EGR VALVE.
- USING A MIRROR, OBSERVE EGR DIAPHRAGM WHILE APPLYING VACUUM.
- DIAPHRAGM SHOULD MOVE FREELY AND HOLD VACUUM FOR AT LEAST 20 SECONDS.

DOES IT?

YES

**5**
- APPLY 10" Hg VACUUM TO EGR VALVE.
- START ENGINE AND IMMEDIATELY OBSERVE VACUUM GAGE ON VACUUM PUMP.
- VALVE IS GOOD IF DIAPHRAGM HAS MOVED TO SEATED POSITION (VALVE CLOSED) AND VACUUM DROPPED WHILE STARTING ENGINE.

VACUUM DROPPED

BE SURE VACUUM HOSE BETWEEN SOLENOID AND EGR VALVE IS OK. (NO LEAKS OR RESTRICTIONS) IF NO PROBLEM IS FOUND, THE EGR CIRCUIT IS OK.

NO

REPLACE EGR VALVE.

NO

DISCONNECT SOLENOID ELECTRICAL CONNECTOR. DOES VACUUM BLEED OFF?

YES

CKT 435 SHORTED TO GROUND OR FAULTY ECM.

NO

REPLACE SOLENOID

NO

- CONNECT VACUUM PUMP TO EGR VALVE SIDE OF HARNESS.
- APPLY VACUUM AND OBSERVE VALVE.
- VALVE SHOULD MOVE.

DOES IT?

YES

**3**
- DISCONNECT EGR ELECTRICAL CONNECTOR.
- CONNECT TEST LIGHT BETWEEN HARNESS CONNECTOR TERMINALS.
- IGNITION "ON", ENGINE "OFF".
- TEST LIGHT SHOULD LIGHT.

DOES IT?

YES

FAULTY SOLENOID CONNECTION OR FAULTY SOLENOID.

NO

CONNECT TEST LIGHT BETWEEN HARNESS TERMINAL "A" AND GROUND.

NO LIGHT

REPAIR OPEN CKT 39.

LIGHT

REPAIR OPEN CKT 435. IF NOT OPEN, IT IS A FAULTY ECM.

NO

FAULTY VACUUM HOSE TO EGR VALVE OR FAULTY VALVE.

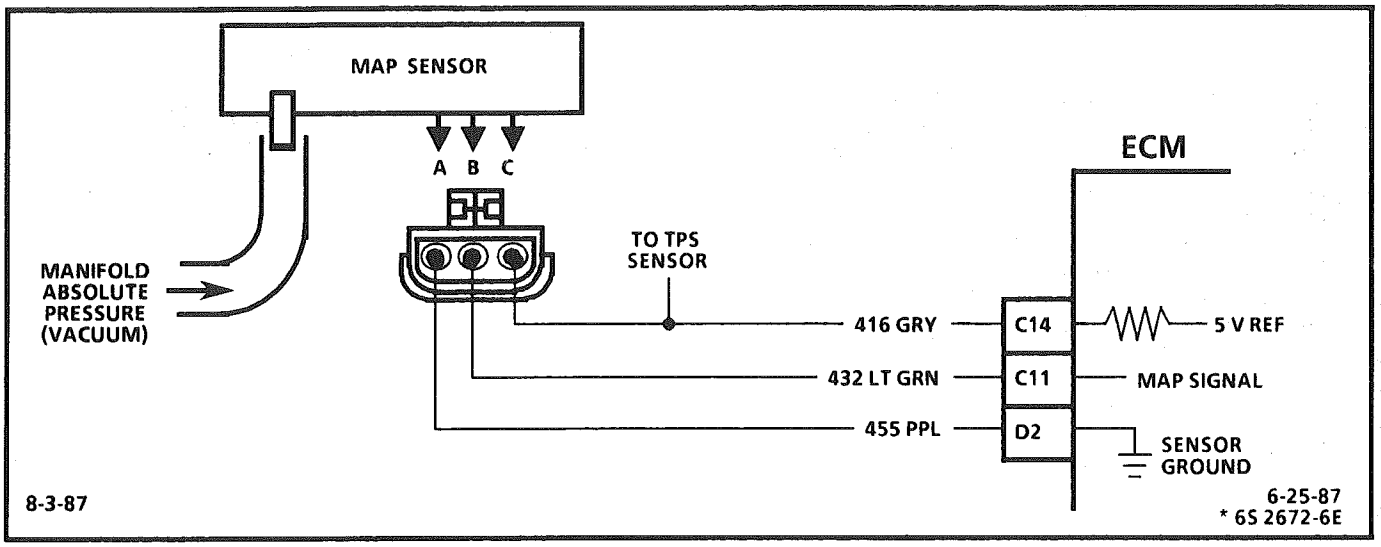
NO VACUUM DROP

- REMOVE EGR VALVE.
- CHECK PASSAGES FOR BEING PLUGGED. IF NOT PLUGGED, REPLACE VALVE,

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-27-87

* 7S 3554-6E




# CODE 33

## MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
## (SIGNAL VOLTAGE HIGH - LOW VACUUM)
## 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The manifold absolute pressure sensor (MAP) responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at idle to 4-4.5 volts at wide open throttle.

A "Scan" displays manifold pressure in volts. Low pressure (high vacuum) reads a low voltage while a high pressure (low vacuum) reads a high voltage.

If the MAP sensor fails the ECM will substitute a fixed MAP value and use the throttle position sensor (TPS) to control fuel delivery.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 33 will set when:
   - Signal is too high, (kPa greater than 68 kPa), for a time greater than 5 seconds.
   - TPS less than 4%.

   Engine misfire or a low unstable idle may set Code 33. Disconnect MAP sensor and system will go into backup mode. If the misfire or idle condition remains, see "Symptoms" in Section "B".
2. If the ECM recognizes the low MAP signal, the ECM and wiring are OK.

An open in CKT 455 will result in a Code 33.

With the ignition "ON" and the engine stopped, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor. Reading should be the same, ± .4 volt.

Also CHART C-1D can be used to test the MAP sensor.

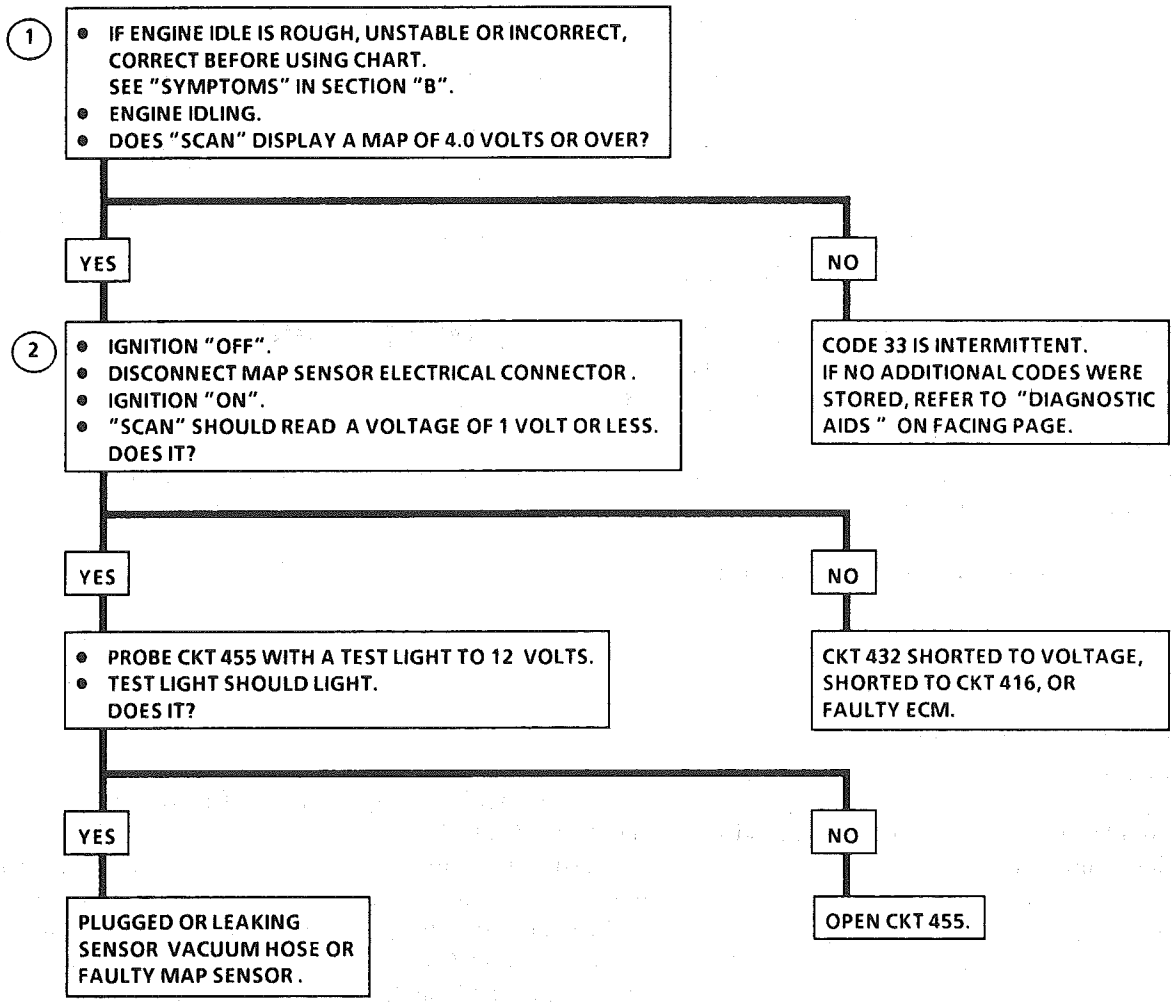
Refer to "Intermittnets" in Section "B".

### Diagnostic Aids:

If idle is rough or unstable refer to "Symptoms" in Section "B" for items which can cause an unstable idle.

# CODE 33

## MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
### (SIGNAL VOLTAGE HIGH - LOW VACUUM)
### 5.0L (VIN E) "F" SERIES (TBI)

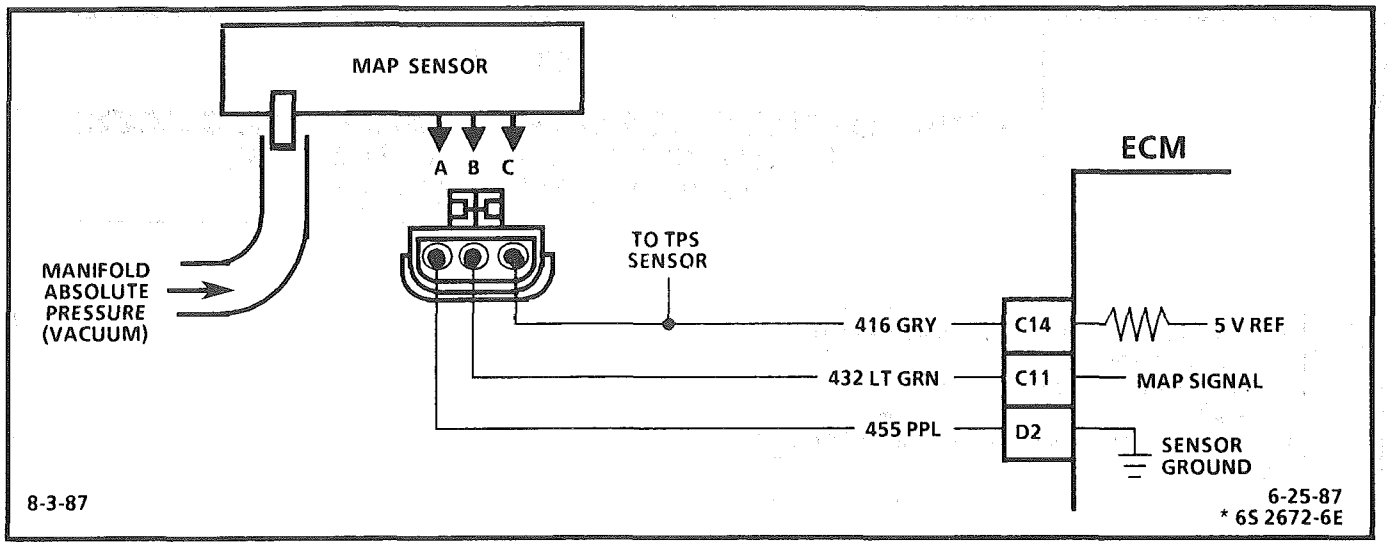



**IGNITION "ON" ENGINE STOPPED VOLTAGES**

| ALTITUDE | | VOLTAGE RANGE |
|---|---|---|
| Meters | Feet | |
| Below 305 | Below 1,000 | 3.8---5.5V |
| 305--- 610 | 1,000--2,000 | 3.6---5.3V |
| 610--- 914 | 2,000--3,000 | 3.5---5.1V |
| 914--1219 | 3,000--4,000 | 3.3---5.0V |
| 1219--1524 | 4,000--5,000 | 3.2---4.8V |
| 1524--1829 | 5,000--6,000 | 3.0---4.6V |
| 1829--2133 | 6,000--7,000 | 2.9---4.5V |
| 2133--2438 | 7,000--8,000 | 2.8---4.3V |
| 2438--2743 | 8,000--9,000 | 2.6---4.2V |
| 2743--3048 | 9,000--10,000 | 2.5---4.0V |

*LOW ALTITUDE = HIGH PRESSURE = HIGH VOLTAGE*

8-3-87
7S 3796-6E




# CODE 34

## MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
## (SIGNAL VOLTAGE LOW - HIGH VACUUM)
## 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The manifold absolute pressure sensor (MAP) responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1-1.5 volts at idle to 4-4.5 volts at wide open throttle.

If the MAP sensor fails the ECM will substitute a fixed MAP value and use the throttle position sensor (TPS) to control fuel delivery.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 34 will set when:
   - Signal is too low (kPa less than 14) and engine running less than 1200 rpm.

   OR
   - Engine running greater than 1200 rpm.
   - Throttle position greater than 21% (over 1.5 volts).
2. If the ECM recognizes the high MAP signal, the ECM and wiring are OK.
3. The "Scan" tool may not display 12 volts. The important thing is that the ECM recognizes the voltage as more than 4 volts, indicating that the ECM and CKT 432 are OK.

### Diagnostic Aids:

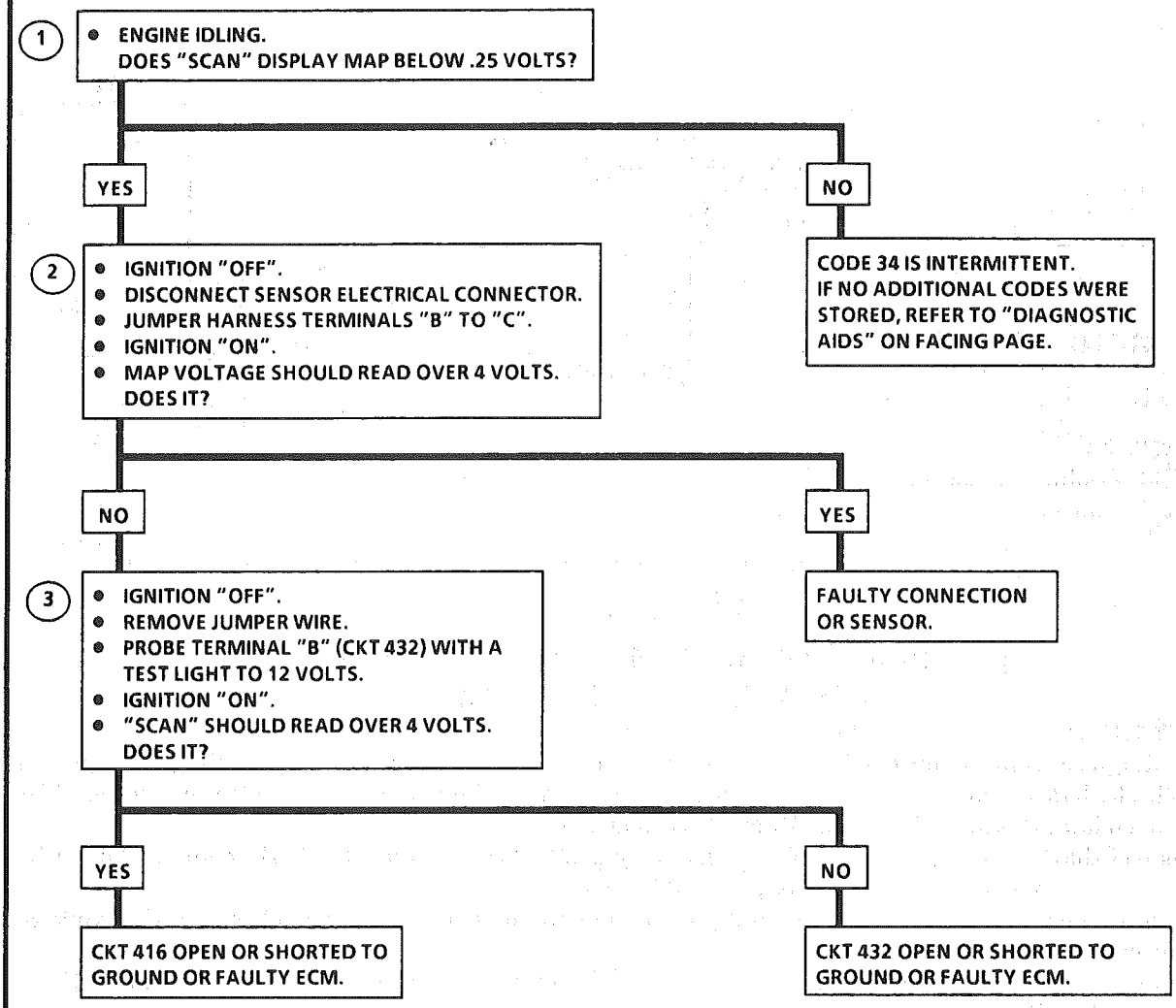
An intermittent open in CKTs 432 or 416 will result in a Code 34.

With the ignition "ON" and engine stopped, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor. Reading should be the same, ± .4 volts.

Refer to "Intermittnets" in Section "B".

# CODE 34

## MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT
## (SIGNAL VOLTAGE LOW - HIGH VACUUM)
## 5.0L (VIN E) "F" SERIES (TBI)

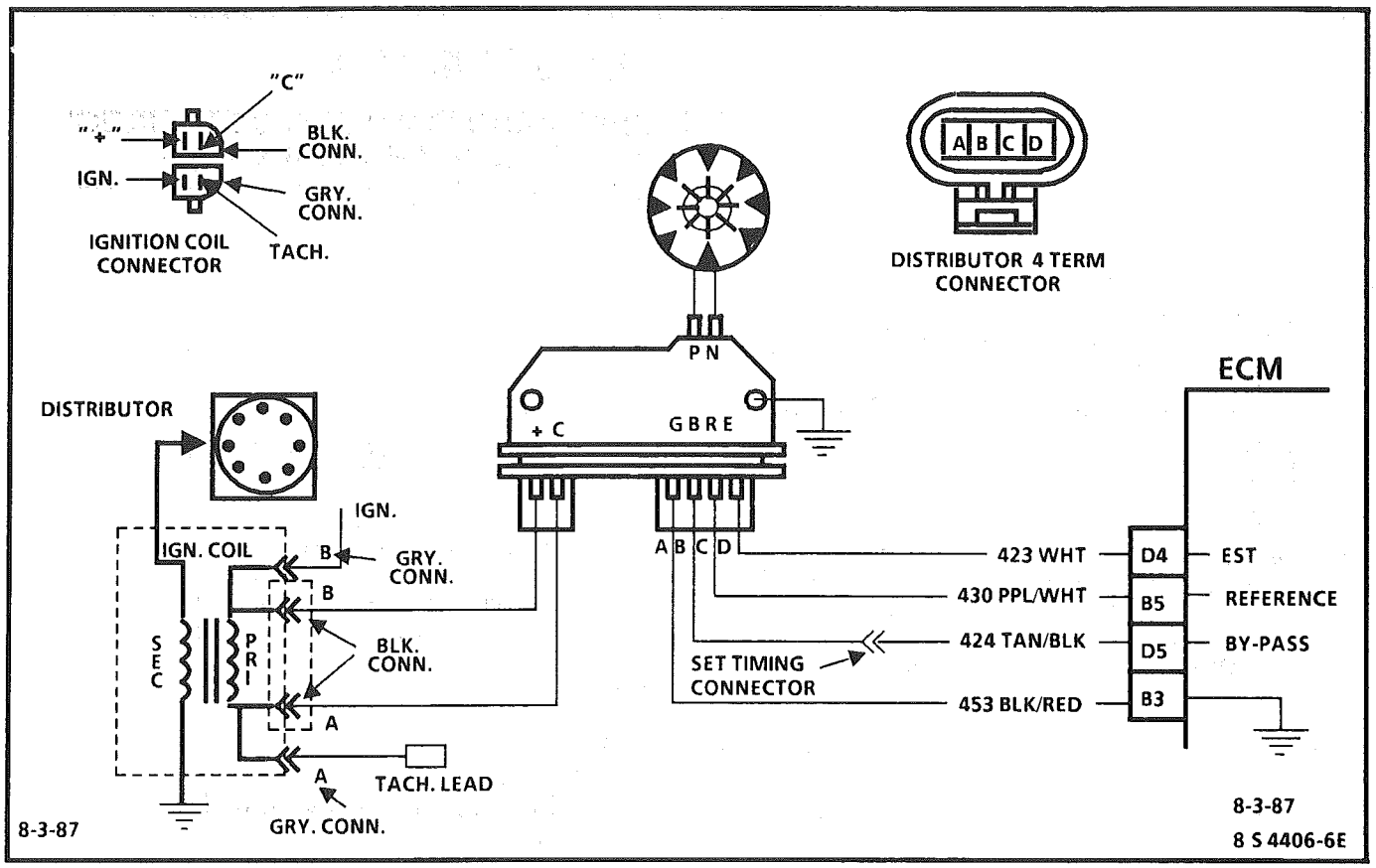



### IGNITION "ON" ENGINE STOPPED VOLTAGES

| ALTITUDE | | VOLTAGE RANGE |
|---|---|---|
| Meters | Feet | |
| Below 305 | Below 1,000 | 3.8---5.5V |
| 305--- 610 | 1,000--2,000 | 3.6---5.3V |
| 610--- 914 | 2,000--3,000 | 3.5---5.1V |
| 914--1219 | 3,000--4,000 | 3.3---5.0V |
| 1219--1524 | 4,000--5,000 | 3.2---4.8V |
| 1524--1829 | 5,000--6,000 | 3.0---4.6V |
| 1829--2133 | 6,000--7,000 | 2.9---4.5V |
| 2133--2438 | 7,000--8,000 | 2.8---4.3V |
| 2438--2743 | 8,000--9,000 | 2.6---4.2V |
| 2743--3048 | 9,000--10,000 | 2.5---4.0V |

*LOW ALTITUDE = HIGH PRESSURE = HIGH VOLTAGE*

6-17-87
7S 3211-6E




# CODE 42

## ELECTRONIC SPARK TIMING (EST) CIRCUIT 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

When the system is running on the ignition module, that is, no voltage on the by-pass line, the ignition module grounds the EST signal. The ECM expects to see no voltage on the EST line during this condition. If it sees a voltage, it sets Code 42 and will not go into the EST mode.

When the rpm for EST is reached (about 400 rpm), and by-pass voltage applied, the EST should no longer be grounded in the ignition module so the EST voltage should be varying.

If the by-pass line is open or grounded, the ignition module will not switch to EST mode so the EST voltage will be low and Code 42 will be set.

If the EST line is grounded, the ignition module will switch to EST, but because the line is grounded there will be no EST signal. A Code 42 will be set.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 42 means the ECM has seen an open or short to ground in the EST or by-pass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Checks for a normal EST ground path through the ignition module. An EST CKT 423 shorted to ground will also read less than 500 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424, the module should switch causing the ohmmeter to "overrange" if the meter is in the 1000-2000 ohms position. Selecting the 10-20,000 ohms position will indicate above 5000 ohms. The important thing is that the module "switched"
4. The module did not switch and this step checks for:
   - EST CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Code 42 is a faulty ECM and not an intermittent in CKTs 423 or 424.

### Diagnostic Aids:

If a Code 42 was stored and the customer complains of a "Hard Start", the problem is most likely a grounded EST line (CKT 423).

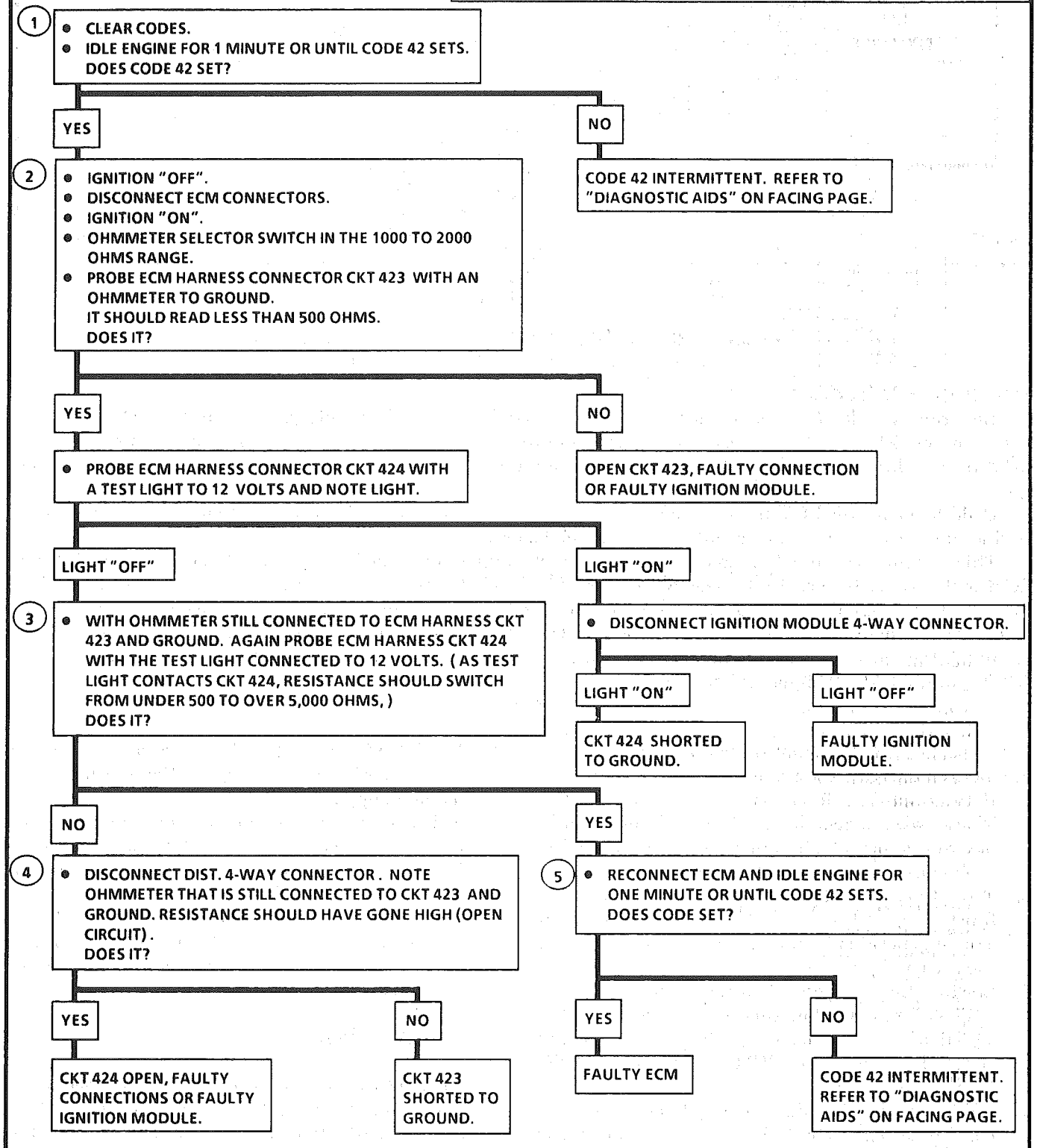
The "Scan" tool does not have any ability to help diagnose a Code 42 problem.

A PROM not fully seated in the ECM can result in a Code 42.

Refer to "Intermittents" in Section "B".

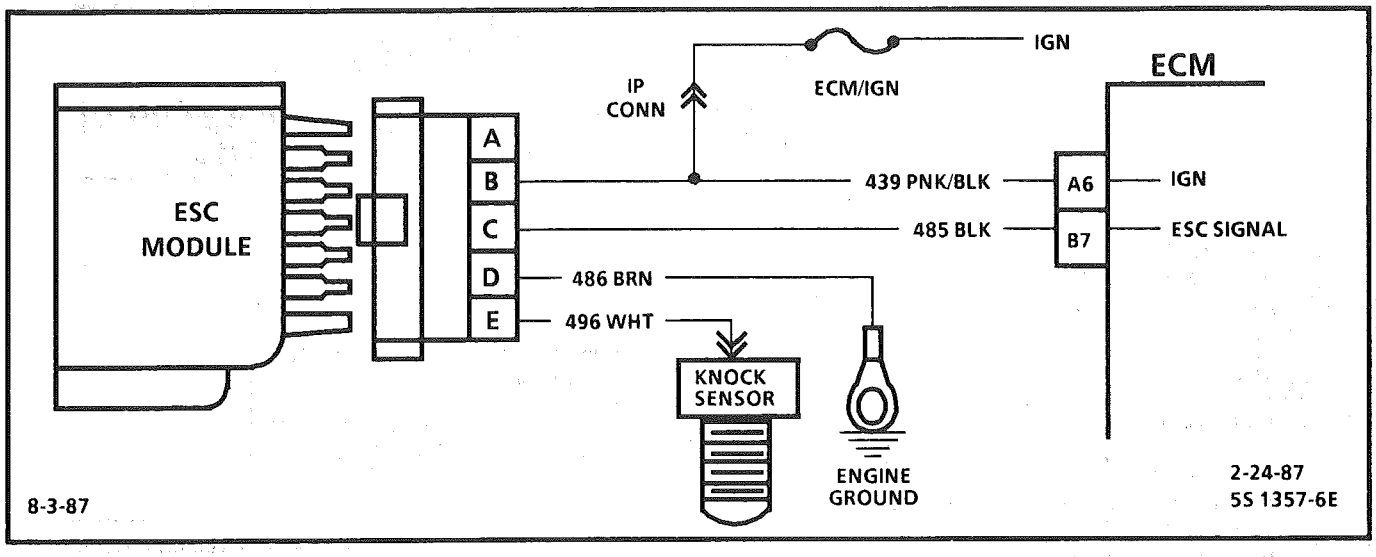
# CODE 42

## ELECTRONIC SPARK TIMING (EST) CIRCUIT 5.0L (VIN E) "F" SERIES (TBI)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-12-87
* 7S 3291-6E




# CODE 43

## ELECTRONIC SPARK CONTROL (ESC) CIRCUIT 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

Electronic spark control is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the ESC module to the ECM drops, and this signals the ECM to retard timing. The ECM will retard the timing when knock is detected and rpm is above about 900 rpm.

Code 43 means the ECM has been low voltage at CKT 485 terminal "B7" for longer than 5 seconds with the engine running or the system has failed the functional check.

This system performs a functional check once per start up to check the ESC system. To perform this test the ECM will advance the spark when coolant is above 95°C and at a high load condition (near W.O.T.). The ECM then checks the signal at "B7" to see if a knock is detected. The functional check is performed once per start up and if knock is detected when coolant is below 95°C (194°F) the test has passed and the functional check will not be run. If the functional check fails, the "Service Engine Soon" light will remain "ON" until ignition is turned "OFF" or until a knock signal is detected.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. If the conditions for a Code 43 are present the "Scan" will always display "yes". There should not be a knock at idle unless an internal engine problem, or a system problem exists.
2. This test will determine if the system is functioning at this time. Usually a knock signal can be generated by tapping on the block close to the area of the sensor.
3. Because Code 43 sets when the signal voltage on CKT 485 remains low this test should cause the signal on CKT 485 to go high. The 12 volts signal should be seen by the ECM as "no knock" if the ECM and wiring are OK.
4. This test will determine if the knock signal is being detected on CKT 496 or if the ESC module is at fault.
5. If CKT 496 is routed to close to secondary ignition wires the ESC module may see the interference as a knock signal.
6. This checks the ground circuit to the module. An open ground will cause the voltage on CKT 485 to be about 12 volts which would cause the Code 43 functional test to fail.
7. Contacting CKT 496 with a test light to 12 volts should generate a knock signal. This will determine if the ESC module is operating correctly.

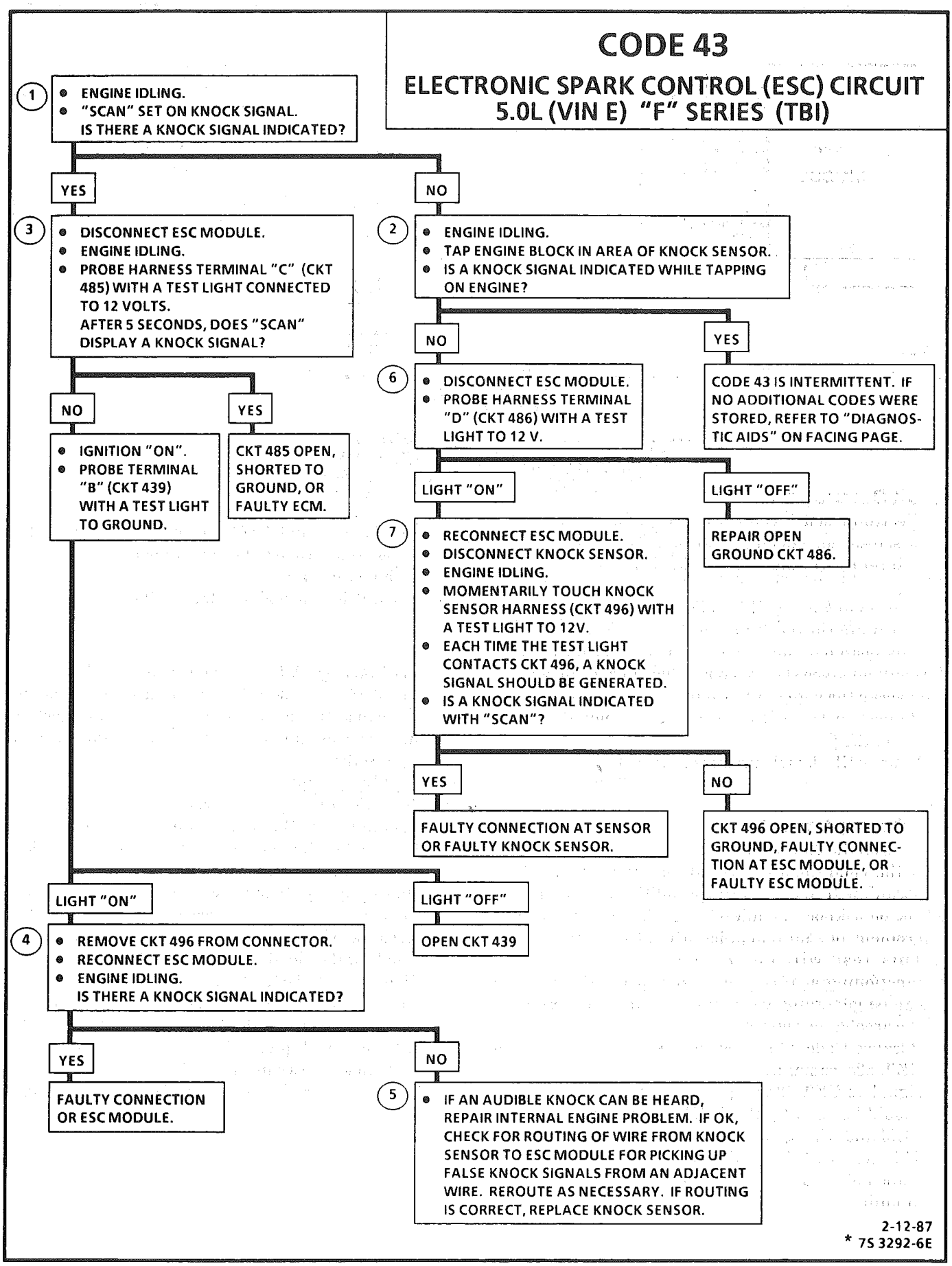
### Diagnostic Aids:

Code 43 can be caused by a faulty connection at the knock sensor at the ESC module or at the ECM. Also check CKT 485 for possible open or short to ground.

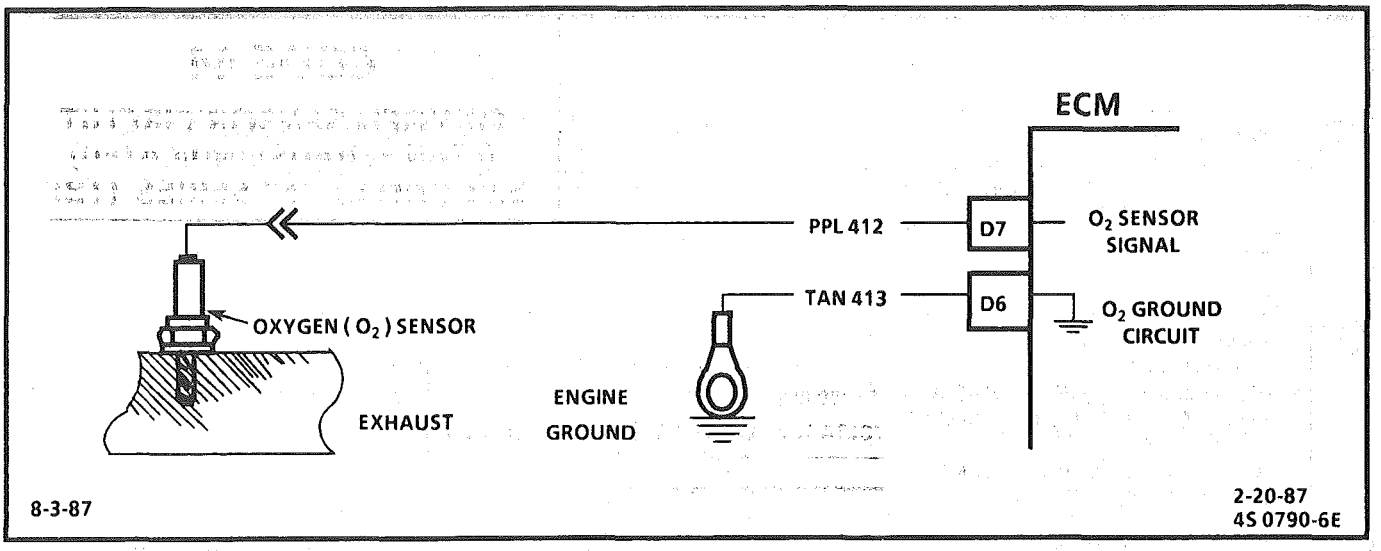
Refer to "Intermittents" in Section "B".

# CODE 43

## ELECTRONIC SPARK CONTROL (ESC) CIRCUIT 5.0L (VIN E) "F" SERIES (TBI)




2-12-87
* 7S 3292-6E




# CODE 44

## OXYGEN SENSOR CIRCUIT
## (LEAN EXHAUST INDICATED)
## 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D6" and "D7". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volts.) The $O_2$ sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 360°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 44 is set when the $O_2$ sensor signal voltage on CKT 412.
   - Remains below .2 volt for 50 seconds,
   - And the system is operating in "Closed Loop".

### Diagnostic Aids:

Using the "Scan", observe the block learn values at different rpm and air flow conditions to determine when the Code 44 may have been set. If the conditions for Code 44 exists the block learn values will be around 150.

- $O_2$ Sensor Wire Sensor pigtail may be mispositioned and contacting the exhaust manifold.
- Check for intermittent ground in wire between connector and sensor.
- MAP Sensor A (MAP) sensor output that causes the ECM to sense a higher than normal vacuum will cause the system to go lean. Disconnect the MAP sensor and if the lean condition is gone, replace the sensor.
- Lean Injector(s)
- Fuel Contamination Water, even in small amounts, near the in-tank fuel pump inlet can be delivered to the injectors. The water causes a lean exhaust and can set a Code 44.
- Fuel Pressure System will be lean if pressure is too low. It may be necessary to monitor fuel pressure while driving the car at various road speeds and/or loads to confirm. See "Fuel System Diagnosis", CHART A-7.
- Exhaust Leaks If there is an exhaust leak, the engine can cause outside air to be pulled into the exhaust and past the sensor. Vacuum or crankcase leaks can cause a lean condition.
- If the above are OK, it is a faulty oxygen sensor.

# CODE 44

## OXYGEN SENSOR CIRCUIT (LEAN EXHAUST INDICATED) 5.0L (VIN E) "F" SERIES (TBI)

- RUN WARM ENGINE (75°C TO 95°C) AT 1200 RPM.
- DOES "SCAN" INDICATE $O_2$ SENSOR VOLTAGE FIXED BELOW .35 VOLTS (350 mV)?

YES

- DISCONNECT $O_2$ SENSOR.
- WITH ENGINE IDLING "SCAN" SHOULD DISPLAY $O_2$ SENSOR BETWEEN .35 VOLTS AND .55 VOLTS (350 mV AND 550 mV).
  DOES IT?

YES

REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE..

NO

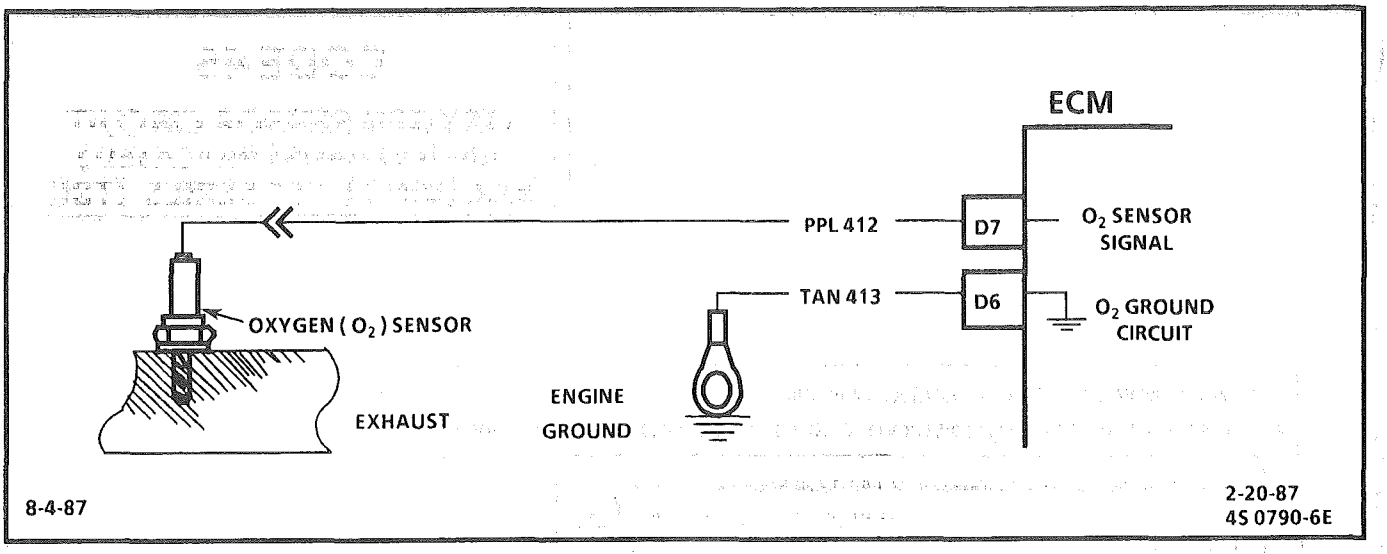
CKT 412 SHORTED TO GROUND OR FAULTY ECM.

NO

CODE 44 IS INTERMITTENT.
IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-30-87
*7S 3191-6E




# CODE 45

## OXYGEN SENSOR CIRCUIT (RICH EXHAUST INDICATED) 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D6" and "D7". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volts.) The $O_2$ sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 360°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 45 is set when the $O_2$ sensor signal voltage or CKT 412.
   - Remains above .7 volts for 50 seconds; and in "Closed Loop".
   - Engine time after start is 1 minute or more.
   - Throttle angle greater than 2% (about .2 volts above idle voltage) but less than 25%.

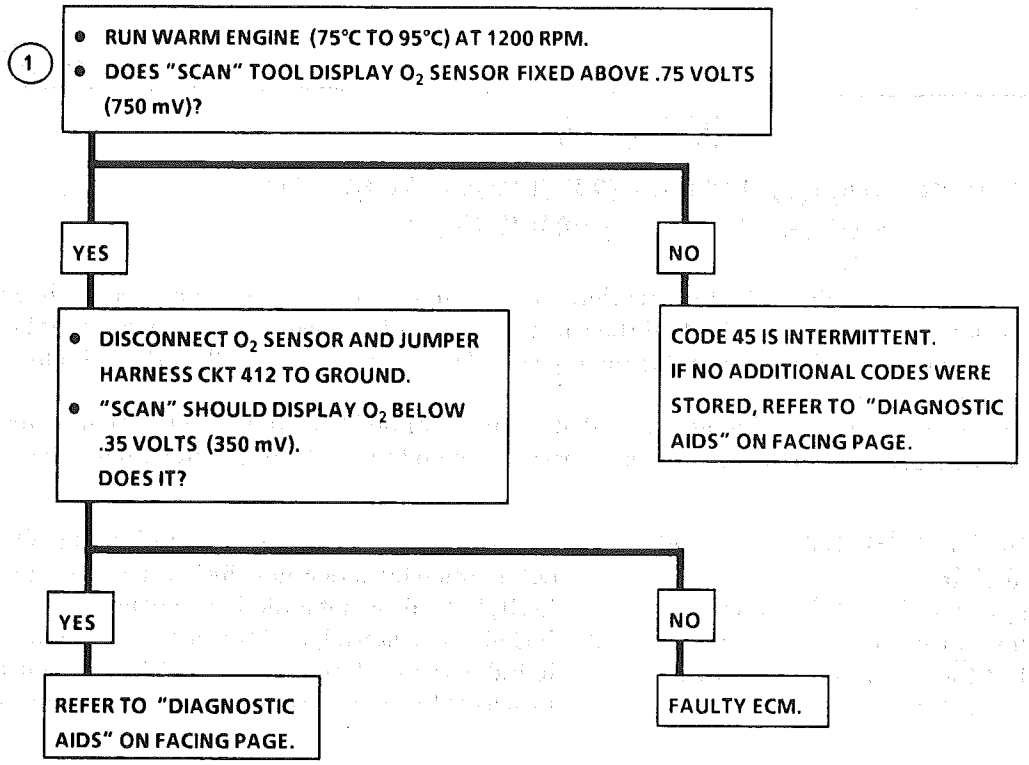
### Diagnostic Aids:

Using the "Scan", observe the block learn values at different rpm conditions to determine when the Code 45 may have been set. If the conditions for Code 45 exists, The block learn values will be around 115.

- Fuel Pressure System will go rich if pressure is too high. The ECM can compensate for some increase. However, if it gets too high, a Code 45 may be set. See "Fuel System Diagnosis", CHART A-7.
- Leaking injector See CHART A-7.
- Check for fuel contaminated oil.
- HEI Shielding An open ground CKT 453 (ignition system ref. low) may result in EMI, or induced electrical "noise". The ECM looks at this "noise" as reference pulses. The additional pulses result in a higher than actual engine speed signal. The ECM then delivers too much fuel, causing system to go rich. Engine tachometer will also show higher than actual engine speed, which can help in diagnosing this problem.
- Canister Purge Check for fuel saturation. If full of fuel, check canister control and hoses. See "Canister Purge", Section "C3".
- MAP Sensor An output that causes the ECM to sense a lower than normal vacuum can cause the system to go rich. Disconnecting the MAP sensor will allow the ECM to set a fixed value for the sensor. Substitute a different MAP sensor if the the rich condition is gone while the sensor is disconnected.
- TPS An intermittent TPS output will cause the system to go rich, due to a false indication of the engine accelerating.

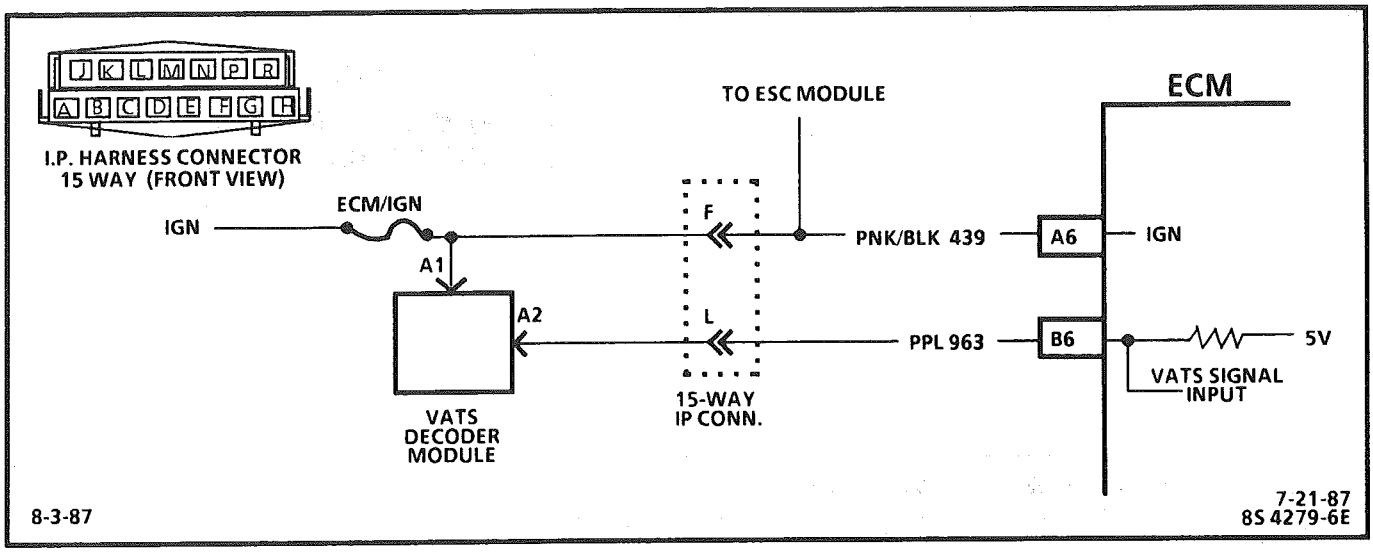
# CODE 45

## OXYGEN SENSOR CIRCUIT (RICH EXHAUST INDICATED) 5.0L (VIN E) "F" SERIES (TBI)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-27-87
*7S 3192-6E




# CODE 53

## VEHICLE ANTI-THEFT SYSTEM (VATS) CIRCUIT 5.0L (VIN E) "F" SERIES (TBI)

### Circuit Description:

The VATS system is designed to disable vehicle operation if the incorrect key or starting procedure is used. The VATS decoder module sends a signal to the ECM if the correct key is being used. If the proper signal does not reach the ECM on CKT 963, the ECM will not pulse the injectors "ON" and thus not allow the vehicle to be started.

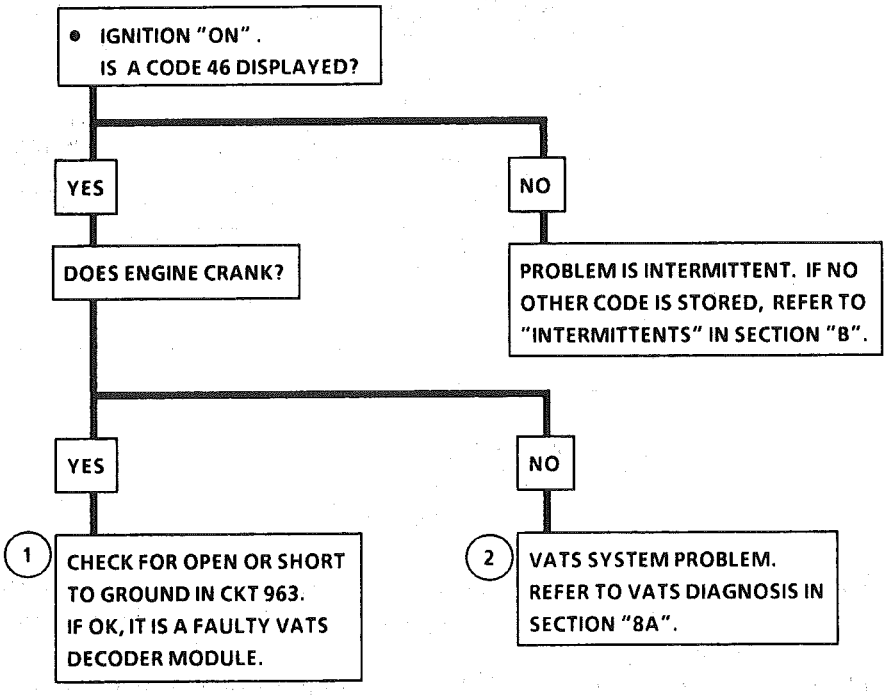
Code 53 will set, if the proper signal is not being received at ECM terminal "B6" when the ignition is turned "ON". Code 53 does not store in the ECM memory but is only present when the conditions stated above are met.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. If the engine cranks, and a Code 53 is stored, it indicates that the portion of the module which generates the signal to the ECM is not operating or CKT 963 is open or shorted to ground. If the decoder module is found to be OK, as determined from Section "8A", the ECM may be at fault, but this is not a likely condition.
2. If Code 53 is stored, and the engine will not crank, it indicates that there is a VATS problem or an incorrect key or starting procedure is being used.

# CODE 53

## VEHICLE ANTI-THEFT SYSTEM (VATS) CIRCUIT 5.0L (VIN E) "F" SERIES (TBI)



## INTERMITTENTS

Problem may or may not turn "ON" the "Service Engine Soon" light, or store a code.

DO NOT use the trouble code charts in Section "A" for intermittent problems. The fault must be present to locate the problem. If a fault is intermittent, use of trouble code charts may result in replacement of good parts.

- Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful check of suspect circuits for:
  - Poor mating of the connector halves, or terminals, not fully seated in the connector body (backed out).
  - Improperly formed or damaged terminals. All connector terminals in problem circuit should be carefully reformed to increase contact tension.
  - Poor terminal to wire connection. This requires removing the terminal from the connector body to check as outlined in the Introduction to Section "6E".
- If a visual (physical) check does not find the cause of the problem, the car can be driven with a voltmeter connected to a suspected circuit or a "Scan" tool may be used. An abnormal voltage reading, when the problem occurs, indicates the problem may be in that circuit. If the wiring and connectors check OK, and a trouble code was stored for a circuit having a sensor, except for Codes 44 and 45, substitute a known good sensor and recheck.
- Loss of trouble code memory. To check, disconnect TPS and idle engine until "Service Engine Soon" light comes "ON". Code 22 should be stored, and kept in memory, when ignition is turned "OFF" for at least 10 seconds. If not, the ECM is faulty.
- An intermittent "SES" light, and no trouble codes, may be caused by:
  - Electrical system interference caused by a defective relay, ECM driven solenoid, or switch. They can cause a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
  - Improper installation of electrical options, such as lights, 2-way radios, etc.
  - EST wires should be routed away from spark plug wires, ignition system components, and generator. Wire for CKT 453 from ECM to ignition system should be a good ground.
  - Ignition secondary shorted to ground.
  - CKTs 419 ("SES" light) or 451 (Diagnostic Test) intermittently shorted to ground.
  - ECM power grounds.

## HARD START

**Definition:** Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.

- **CHECK:**
  - For water contaminated fuel.
  - Fuel system pressure CHART A-7.
  - TPS for sticking or binding should read less than 1.25 volts on a "Scan" tool.
  - No crank signal; see CHART C-1B.
  - EGR operation; CHART C-7.
  - Fuel System - CHART A-7.
  - For a faulty in-tank fuel pump check valve, which would allow the fuel in the lines to drain back to the tank after the engine is stopped. To check for this condition:
    1. Ignition "OFF".
    2. Disconnect fuel line at the filter.
    3. Remove the tank filler cap.
    4. Connect a radiator test pump to the line and apply 103 kPa (15 psi) pressure. If the pressure will hold for 60 seconds, the check valve is OK.
- Check ignition system for:
  - Proper output with ST-125.
  - Worn shaft.
  - Bare and shorted wires.
  - Pickup coil resistance and connections.
  - Loose ignition coil connections.
  - Moisture in distributor cap.
  - Spark plugs, wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits.
- If engine starts but then, immediately stalls, open distributor bypass line. If engine then starts, and runs OK, replace distributor pickup coil.
- Check CKT 423 (EST) for short to ground.

## DETONATION / SPARK KNOCK

**Definition**: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

- CHECK for obvious overheating problems.
  - Low coolant.
  - Loose water pump belt.
  - Restricted air flow to radiator, or restricted water flow thru radiator.
  - Faulty or incorrect thermostat.
  - Coolant sensor, which has shifted in value.
  - Correct coolant solution - should be a 50/50 mix of GM #1052753 anti-freeze coolant (or equiv.) and water.
- **CHECK:**
  - For poor fuel quality, proper octane rating.
  - For correct PROM.
  - Spark plugs for correct heat range.
  - ESC system opeation. See CHART C-5.
  - Ignition timing. See Vehicle Emission Control Information label.
  - Fuel system for low pressure. See CHART A-7.
  - Check EGR system. - CHART C-7.
  - For proper transmission shift points. See Section "7".
  - TCC operation. See CHART C-8.
  - For incorrect basic engine parts such as cam, heads, pistons, etc.
  - Excessive oil entering combustion chamber.
- Remove carbon with top engine cleaner. Follow instructions on can.
- If there is spray from only one injector, then there is a malfunction in the injector assembly, or in the signal to the injector assembly. The malfunction can be isolated by switching the injector connectors. If the problem remains with the original injector, after switching the connector, then the injector is defective. Replace the injector. If the problem moves with the injector connector, then the problem is an improper signal in the injector circuits. See CHART A-3.

## HESITATION, SAG, STUMBLE

**Definition:** Momentary lack of response as the accelerator is pushed down. Can occur at all car speeds. Usually most severe when first trying to make the car move, as from a stop sign. May cause the engine to stall if severe enough.

- Perform careful visual (physical) check, as described at start of Section "B".
- **CHECK:**
  - Fuel pressure. See CHART A-7.
  - Water contaminated fuel.
  - TPS for binding or sticking.
  - Ignition timing. See "Emission Control Information" label.
  - Generator output voltage. Repair if less than 9 or more than 16 volts.
  - For open ignition system ground, CKT 453.
  - Canister purge system for proper operation. See Section "C3".
  - EGR valve operation, CHART C-7.

## CUTS OUT, MISSES

**Definition:** Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

- Perform careful visual (physical) check, as described at start of Section "B".
- If ignition system is suspected of causing a miss at idle or cutting, out under load:
- Check for missing cylinder by:
  1. Disconnect IAC motor. Start engine. Remove one spark plug wire at a time, using insulated pliers.
  2. If there is an rpm drop on all cylinders, (equal to within 50 rpm), go to "Rough, Unstable, Or Incorrect Idle, Or Stalling" symptom. Reconnect IAC motor.
  3. If there is no rpm drop on one or more cylinders, or excessive variation in drop, check for spark, on the suspected cylinder(s) with J 26792 (ST-125) spark tester or equivalent. If no spark, see Section "6D" for "Intermittent Operation or Miss". If there is spark, remove spark plug(s) in these cylinders and check for:
     - Cracks
     - Wear
     - Improper gap
     - Burned electrodes
     - Heavy deposits
     - Perform compression check on questionable cylinder.
- Check wire resistance (should not exceed 30,000 ohms), also, check rotor and distributor cap.

- If the previous checks did not find the problem:
  - Visually inspect ignition system for moisture, dust, cracks, burns, etc. Spray plug wires with fine water mist to check for shorts.
  - Fuel System - Plugged fuel filter, water, low pressure. See CHART A-7.
  - Perform compression check.
  - Valve timing.
  - Remove rocker covers. Check for bent pushrods, worn rocker arms, broken or weak valve springs, worn camshaft lobes. Repair as necessary. See Section "6A".
- If there is spray from only one injector, then, there is a malfunction in the injector assembly, or in the signal to the injector assembly. The malfunction can be isolated by switching the injector connectors. If the problem remains with the original injector, after switching the connector, then the injector is defective. Replace the injector. If the problem moves with the injector connector, then, the problem is an improper signal in the injector circuits. See CHART A-3.

## POOR FUEL ECONOMY

**Definition:** Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, economy is noticeably lower than it was on this car at one time, as previously shown by an actual road test.

- **CHECK:**
  - Engine thermostat for faulty part (always open) or for wrong heat range. See Section "6B".
  - Fuel Pressure. See CHART A-7.
- Check owner's driving habits.
  - Is A/C "ON" full time (Defroster mode "ON")?
  - Are tires at correct pressure?
  - Are excessively heavy loads being carried?
  - Is acceleration too much, too often?
  - Suggest driver read "Important Facts on Fuel Economy" in owner's manual.
- Perform "Diagnostic Circuit Check".
- Check air cleaner element (filter) for dirt or being plugged.
- Check for proper calibration of speedometer.
- Visually (physically) check:
  - Vacuum hoses for splits, kinks, and proper connections, as shown on Vehicle Emission Control Information label.
  - Ignition wires for cracking, hardness, and proper connections.
- Check ignition timing. See Emission Control Information label.
- Remove spark plugs. Check for cracks, wear, improper gap, burned electrodes or heavy deposits. Repair or replace, as necessary.
- Check compression. See Section "6A".
- Check TCC for proper operation. See CHART C-8. Use "Scan" tool if available.
- Check for dragging brakes.
- Suggest owner fill fuel tank and recheck fuel economy.
- Check for exhaust system restriction. See CHART B-1.

## ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

**Definition:** The engine runs unevenly at idle. If bad enough, the car may shake. Also, the idle may vary in rpm (called "hunting"). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.

- **CHECK:**
  - Ignition timing. See Emission Control Information label.
  - P/N switch circuit. See CHART C-1A.
  - For injector(s) leaking. Check fuel pressure, CHART A-7.
  - IAC - See CHART C-2C.
  - If a sticking throttle shaft or binding linkage causes a high TPS voltage (open throttle indication), the ECM will not control idle. Monitor TPS voltage. "Scan" and/or voltmeter should read less than 1.2 volts with throttle closed.
  - Vacuum leaks can cause higher than normal idle.
  - EGR "ON", while idling, will cause roughness, stalling, and hard starting. CHART C-7.
  - Battery cables and ground straps should be clean and secure. Erratic voltage will cause IAC to change its position, resulting in poor idle quality.
  - IAC valve will not move, if system voltage is below 9, or greater than 17.8 volts.
  - Use "Scan" tool to determine if ECM is receiving A/C request signal.

- MAP Sensor - Ignition "ON", engine stopped. Compare MAP voltage with known good vehicle. Voltage should be the same ± 400 mV (.4 volts).

  OR

  Start and idle engine. Disconnect sensor electrical connector. If idle improves, substitute a known good sensor and recheck.
- A/C refrigerant pressure too high. Check for overcharge or faulty pressure switch.
- PCV valve for proper operation by placing finger over inlet hole in valve end several times. Valve should snap back. If not, replace valve.
- Run a cylinder compression check See Section "6".
- Inspect oxygen sensor for silicon contamination from fuel, or use of improper RTV sealant. The sensor will have a white, powdery coating, and will result in a high but false signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem.

## EXCESSIVE EXHAUST EMISSIONS OR ODORS

**Definition:** Vehicle fails an emission test. Vehicle has excessive "rotten egg" smell. Excessive odors do not necessarily indicate excessive emissions.

- Perform "Diagnostic Circuit Check".
- IF TEST SHOWS EXCESSIVE CO AND HC, (or also has excessive odors)
  - Check items that will cause engine to run RICH.
    - Make sure engine is at normal operating temperature.
- **CHECK:**
  - Fuel pressure. See CHART A-7.
  - Incorrect timing. See Vehicle Emission Control Information label.
  - Canister for fuel loading. See CHART C-3.
  - PCV valve for being plugged, stuck or blocked PCV hose or fuel in the crankcase.
  - Spark plugs, plug wires, and ignition components. See Section "6D".
  - Check for lead contamination of catalytic converter (look for removal of fuel filler neck restrictor).
  - Check for properly installed fuel cap.
    - If the system is running rich, (block learn less than 118), refer to "Diagnostic Aids" on facing page of Code 45.
- IF TEST SHOWS EXCESSIVE $NO_X$:
  - Check items which cause car to run LEAN, or to run too hot.
  - EGR valve for not opening. See CHART C-7.
  - Vacuum leaks.
  - Coolant system and coolant fan for proper operation. See CHART C-12.
  - Remove carbon with top engine cleaner. Follow instructions on can.
  - Check ignition timing for excessive base advance. See Emission Control Information label.
- If the system is running lean, (block learn greater than 138) refer to "Diagnostic Aids" on facing page of Code 44.

## DIESELING, RUN-ON

**Definition:** Engine continues to run after key is turned "OFF", but runs very roughly. If engine runs smoothly, check ignition switch and adjustment.

- Check injector for leaking. Apply 12 volts to fuel pump test terminal to turn "ON" fuel pump and pressurize fuel system. Visually check injector and TBI assembly for fuel leakage.

## BACKFIRE

**Definition:** Fuel ignites in intake manifold, making a loud popping noise.

- **CHECK:**
  - EGR operation for being open all the time. See CHART C-7.
  - Output voltage of ignition coil.
  - For crossfire between spark plugs (distributor cap, spark plug wires, and proper routing of plug wires).
  - Engine timing - See Emission Control Information label.
  - For faulty spark plugs and/or plug wires or boots.
  - Faulty A.I.R. check valve.
- Perform a compression check - look for sticking or leaking valves.
  - For proper valve timing.
  - Broken or worn valve train parts.

# SECTION C2
## FUEL CONTROL SYSTEM
## TBI MODEL 220

# CONTENTS



## GENERAL DESCRIPTION

### PURPOSE

The basic function of the fuel control system is to control fuel delivery to the engine. Fuel is delivered to the engine by a throttle body injection (TBI) unit.

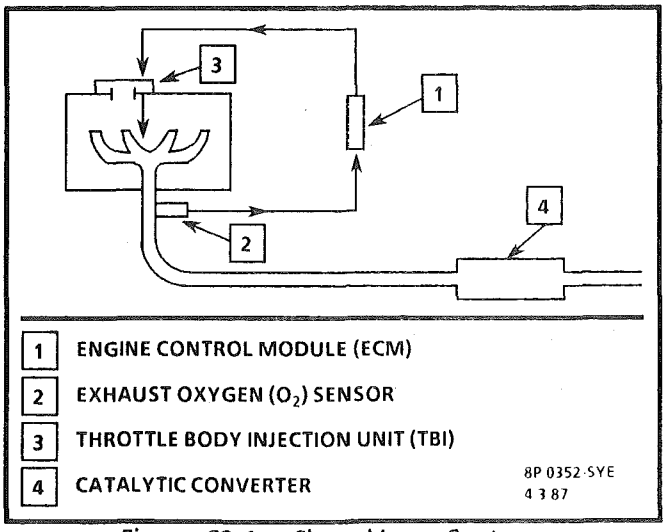



Figure C2-1 - Closed Loop System

The main control sensor is the oxygen ($O_2$) sensor, which is located in the exhaust manifold. The $O_2$ sensor tells the engine control module ECM the amount of oxygen in the exhaust gas, and the ECM changes the air/fuel ratio to the engine by controlling the fuel injector. A 14.7:1 air/fuel ratio is required for efficient catalytic converter operation. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "Closed Loop" System (Figure C2 -1).

### MODES OF OPERATION

The ECM monitors voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called "modes." All the modes are controlled by the ECM.

#### Starting Mode

When the key is first turned "ON", the ECM turns on the fuel pump relay for two seconds, and the fuel pump builds up pressure to the TBI unit. The ECM checks the coolant temperature sensor, throttle position sensor (TPS), manifold absolute pressure (MAP) sensor, and crank signal, then determines the proper air/fuel ratio for starting. This ranges from

Refer to the disassembled view (Figure C2-8) for identification of parts during repair procedures. Service repair of individual components is performed without removing the TBI unit from the engine. If removed, it is essential that care is taken to prevent damage to the throttle valve or sealing surface while performing any service.

Whenever service is performed on the TBI or any of its components, first remove the air cleaner, adapter and air cleaner gaskets. Discard the gaskets and replace them with new ones before replacing the air cleaner after service is complete.

When disconnecting the fuel lines, be sure to use a backup wrench (J-29698-A, or BT8251-A, or equivalent) to keep the TBI nuts from turning.

## Fuel Pressure Relief

The TBI Model 220 on this engine contains a constant bleed feature in the pressure regulator that relieves pressure. Therefore, no special pressure relief procedure is required.

## Fuel System Pressure Test

A fuel system pressure test is part of several of the diagnostic charts and symptom checks. To perform this test, follow this procedure:

1. Turn engine "OFF" to relieve fuel pressure.
2. Remove air cleaner and plug THERMAC vacuum port on TBI.
3. Uncouple fuel supply flexible hose in engine compartment. Install fuel pressure gage J-29658A/BT8205 and adapter 29658A-85 between steel line and flexible hose.
4. Tighten gage in line to ensure no leaks occur during testing.
5. Start car and observe fuel pressure reading. It should be 62-90 kPa (9-13 psi); if not, refer to CHART A-7.
6. Relieve fuel pressure.
7. Remove fuel pressure gage.
8. Reinstall fuel line.
9. Start car and check for fuel leaks.
10. Remove plug from vacuum port and install air cleaner with new gasket.

## Cleaning and Inspection

All TBI component parts, with the exception of those noted below, should be cleaned in a cold immersion cleaner such as Carbon X (X-55) or equivalent.

**NOTICE:** The throttle position sensor (TPS), idle air control (IAC) valve, pressure regulator diaphragm assembly, fuel injectors or other components containing rubber,should NOT be placed in a solvent or cleaner bath. A chemical reaction will cause these parts to swell, harden or distort. Do not soak the throttle body with the above parts attached. If the throttle body assembly requires cleaning, soaking time in the cleaner should be kept to a minimum. Some models have hidden throttle shaft dust seals that could lose their effectiveness by extended soaking.

1. Clean all metal parts thoroughly and blow dry with shop air. Be sure that all fuel and air passages are free of dirt or burrs.
2. Inspect mating casting surfaces for damage that could affect gasket sealing.

## Thread Locking Compound

Service repair kits are supplied with a small vial of thread locking compound with directions for use. If material is not available, use Loctite 262, or GM part number 10522624, or equivalent.

**NOTICE:** Do not use a higher strength locking compound than recommended, since to do so could make removing the screw extremely difficult, or result in damaging the screw head.

## FUEL METER COVER ASSEMBLY Replacement (Figure C2-9)

The fuel meter cover assembly contains the fuel pressure regulator assembly. The regulator has been adjusted at the factory and should only be serviced as a complete preset assembly.

**CAUTION:** **DO NOT remove the four screws securing the pressure regulator to the fuel meter cover. The fuel pressure regulator includes a large spring under heavy compression which, if accidentally released, could cause personal injury. Disassembly might also result in a fuel leak between the diaphragm and the regulator container.**

### Remove or Disconnect

1. Electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
2. Long and short fuel meter cover screw assemblies.
3. Fuel meter cover assembly.

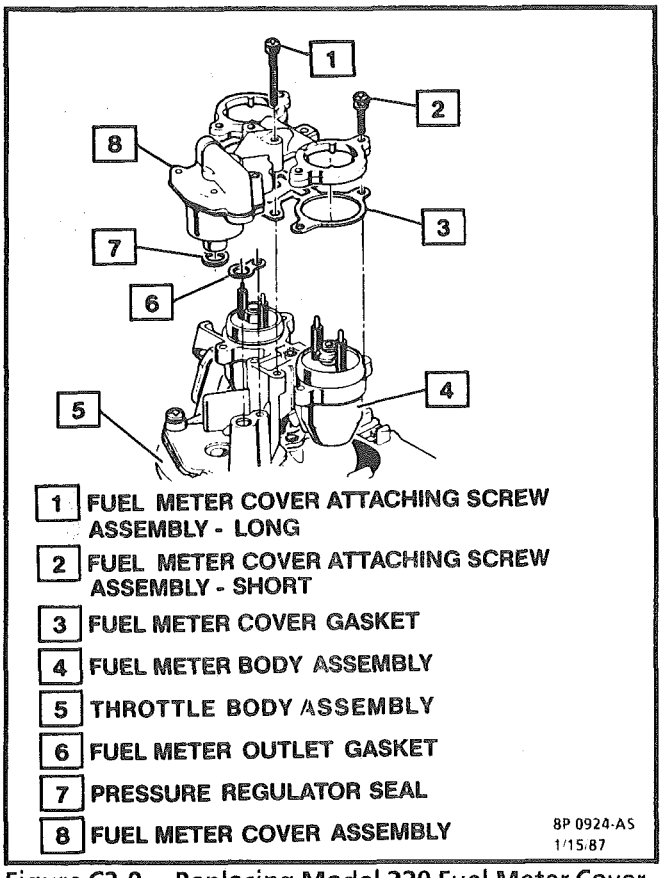



Figure C2-9 - Replacing Model 220 Fuel Meter Cover

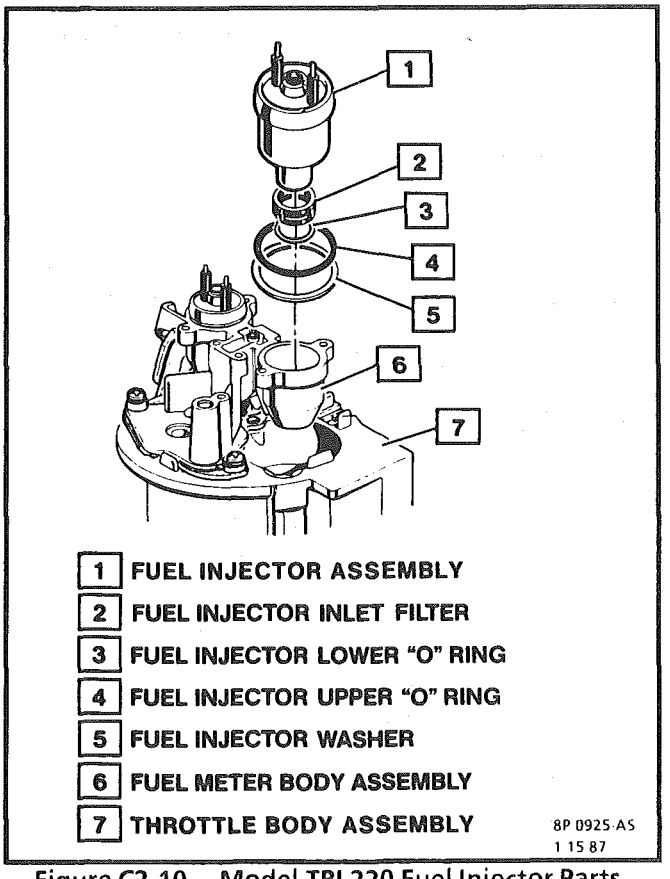



Figure C2-10 - Model TBI 220 Fuel Injector Parts

**NOTICE:** DO NOT immerse the fuel meter cover (with pressure regulator) in cleaner, as damage to the regulator diaphragm and gasket could occur.

4. Fuel meter outlet gasket, cover gasket and pressure regulator seal. Discard gaskets and seal.

### Inspect

- For dirt, foreign material and casting warpage.

### Install or Connect

1. New pressure regulator seal, fuel meter outlet passage gasket, and cover gasket.
2. Fuel meter cover assembly.
3. Attaching screw assemblies, coated with appropriate locking compound to threads. (Short screws are next to injectors.)

### Tighten

- Screw assemblies to 3.0 N·m (28.0 lb. in.).

4. Electrical connectors to fuel injectors.
5. With engine "OFF", and ignition "ON", check for leaks around gasket and fuel line couplings.

## FUEL INJECTOR ASSEMBLIES Replacement (Figure C2-10 to C2-13)

Each fuel injector is serviced as a complete assembly only.

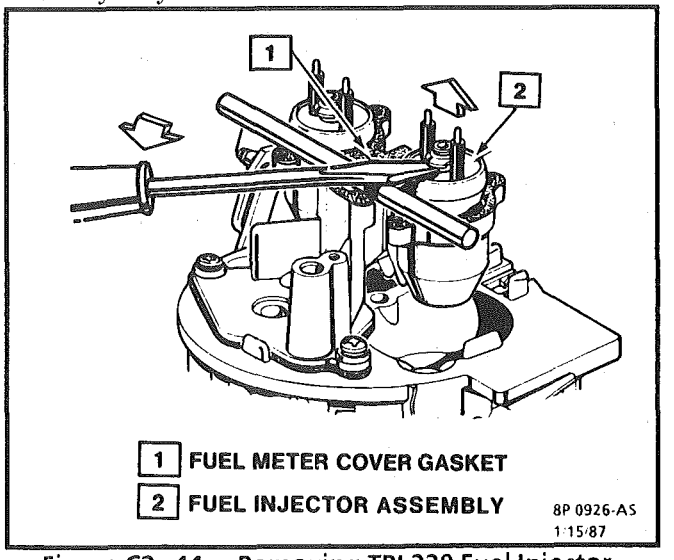



Figure C2 - 11 - Removing TBI 220 Fuel Injector

**NOTICE:** Use care in removing the fuel injectors to prevent damage to the electrical connector terminals, the injector filter, and the fuel nozzle. Also, since the injectors are electrical components, they should not be immersed in any type of liquid solvent or cleaner as damage may occur.

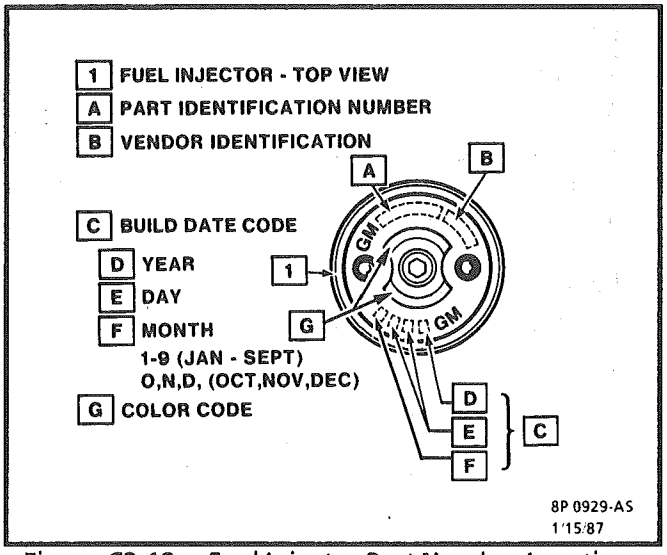



Figure C2-12 - Fuel Injector Part Number Location

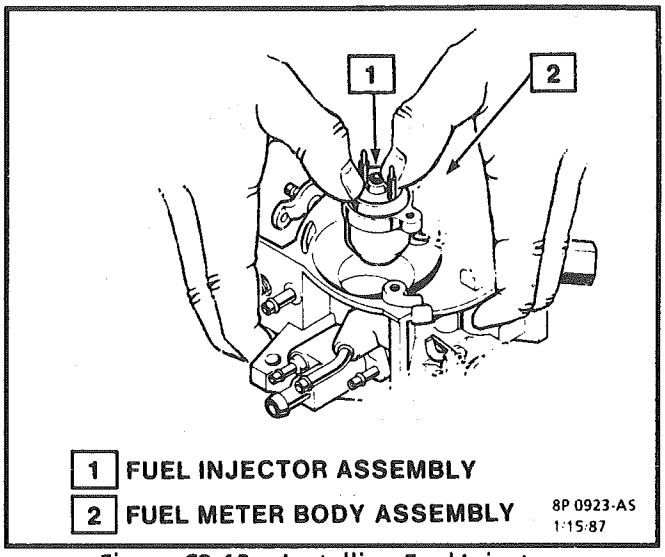



Figure C2-13 - Installing Fuel Injector

### Remove or Disconnect

1. Electrical connectors to fuel injectors. (Squeeze plastic tabs and pull straight up.)
2. Fuel meter cover assembly following above procedure.
3. With fuel meter cover gasket in place to prevent damage to casting, use a screwdriver and fulcrum to carefully lift out each injector (Figure C2-11).
4. Lower (small) o-rings from nozzle of injectors and discard.
5. Fuel meter cover gasket and discard.
6. Upper (large o-rings and steel backup washers from top of each fuel injector cavity and discard.

### Inspect

- Fuel injector filter for evidence of dirt and contamination. If present, check for presence of dirt in fuel lines and fuel tank.

### Important

Be sure to replace the injector with an identical part. Injectors from other models can fit in Model 220 TBI, but are calibrated for different flow rates. (See Figure C2-12 for part number location.)

### Install or Connect

1. Lubricate new lower (small) o-ring with automatic transmission fluid and push on nozzle end of injector until it presses against injector fuel filter.
2. Steel injector backup washer in counterbore of fuel meter body.
3. Lubricate new upper (large) o-ring with automatic transmission fluid and install directly over the backup washer. Be sure o-ring is seated properly and is flush with top of fuel meter body surface.

**NOTICE:** Backup washers and o-rings must be installed before injectors, or improper seating of large o-ring could cause fuel to leak.

4. Injector, aligning raised lug on each injector base with notch in fuel meter body cavity. Push down on injector until it is fully seated in fuel meter body (Figure C2-13). (Electrical terminals of injector should be parallel with throttle shaft.)
5. Fuel meter cover gasket.
6. Fuel meter cover (see above procedure).
7. Fuel meter cover attaching screws, coated with appropriate thread locking compound.
8. Electrical connectors to fuel injectors.
9. With engine "OFF" and ignition "ON", check for fuel leaks.

## FUEL METER BODY ASSEMBLY Replacement (Figure C2-14)

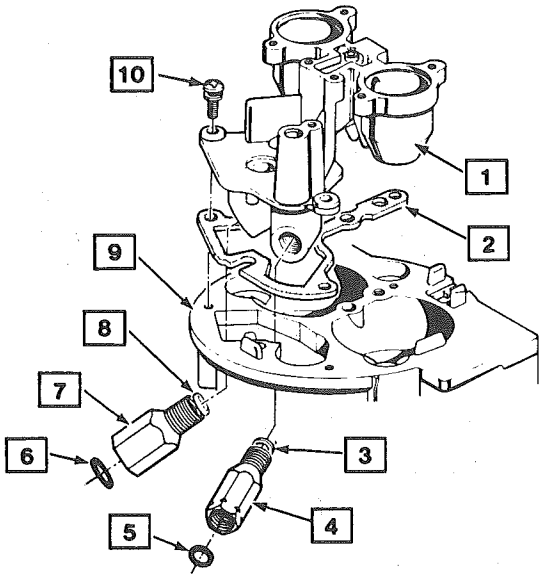
### Remove or Disconnect

1. Electrical connections to fuel injectors. (Squeeze plastic tabs and pull straight up.)
2. Fuel meter cover assembly, (see previous procedure).
3. Fuel meter cover assembly, following above procedure.
4. Fuel injectors, following above procedure.
5. Fuel inlet and return lines. Discard o-rings.
6. Fuel inlet and outlet nuts and gaskets from the fuel meter body assembly. Discard gaskets.

### Important

Note locations of nuts, for proper reassembly later. Inlet nut has a larger passage than outlet nut.

7. Fuel meter body to throttle body attaching screw assemblies.




1 FUEL METER BODY ASSEMBLY
2 THROTTLE BODY TO FUEL METER BODY GASKET
3 FUEL OUTLET NUT GASKET
4 FUEL OUTLET NUT
5 FUEL RETURN LINE "O" RING
6 FUEL INLET LINE "O" RING
7 FUEL INLET NUT
8 FUEL INLET NUT GASKET
9 THROTTLE BODY ASSEMBLY
10 FUEL METER BODY - THROTTLE BODY ATTACHING SCREW ASSEMBLY

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Figure C2-14 - Fuel Meter Body Assembly

8. Fuel meter body assembly from throttle body assembly.
9. Throttle body to fuel meter body gasket and discard.

### Install or Connect

1. New throttle body to fuel meter body gasket. Match cut-out portions in gasket with openings in throttle body.
2. Fuel meter body assembly on throttle body assembly.
3. Fuel meter body-to-throttle body attaching screw assemblies, coated with approriate locking compound.

### Tighten

- Screw assemblies to 4.0 N·m (35.0 lb. in.).

4. Fuel inlet and outlet nuts with new gaskets to fuel meter body assembly.

### Tighten

- Inlet nut to 40.0 N·m (30.0 lb. ft.).
- Outlet nut to 29.0 N·m (21.0 lb. ft.).

5. Fuel inlet and return lines and new o-rings. (Use back-up wrench J-29698-A or BT-8251-A to keep TBI nuts from turning.)

### Tighten

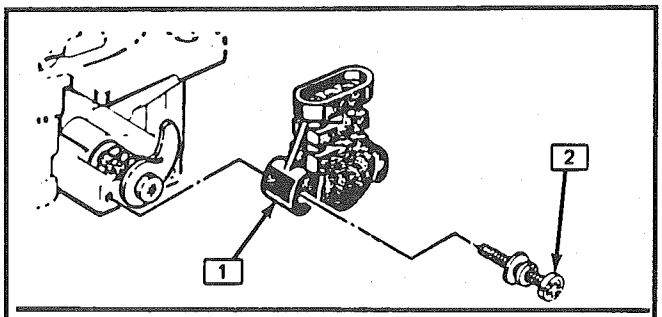
- Fuel lines to 23 N·m ( 17 lb. ft.).

6. Injectors, with new upper and lower o-rings in fuel meter body assembly.
7. Fuel meter cover gasket, fuel meter outlet gasket, and pressure regulator seal.
8. Fuel meter cover assembly.
9. Long and short fuel meter cover attaching screw assemblies, coated with appropriate thread locking compound.

### Tighten

- Screw assemblies to 3.0 N·m (27.0 lb.in.).

10. Electrical connectors to fuel injectors.
11. With engine "OFF," and ignition "ON," check for leaks around fuel meter body, gasket and around fuel line nuts.




1 TPS 2 BOLT (2)

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Figure C2-15 - TPS Service

## THROTTLE POSITION SENSOR (TPS)

### Replacement (Figure C2-15)

### Remove or Disconnect

1. Electrical connector.
2. Two TPS attaching screw assemblies and retainers, (if applicable).
3. TPS from throttle body assembly .

**NOTICE:** The TPS is an electrical component and must not be soaked in any liquid cleaner or solvent, as damage may result.

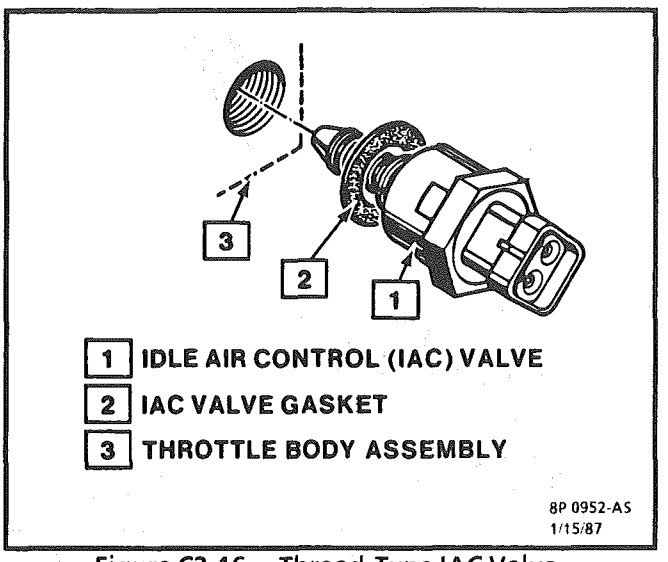



Figure C2-16 - Thread-Type IAC Valve

### Install or Connect

1. TPS on throttle body assembly, while lining up TPS lever with TPS drive lever on throttle body.
2. Two TPS attaching screw assemblies.

### Tighten

- Screw assemblies to 2.0 N·m (18.0 in.lbs.).

3. Electrical connector.
4. Check for TPS output as follows:
   - Use an ALDL scanner to read TPS output voltage.
   - With ignition "ON" and engine stopped, TPS voltage should be less than 1.25 volts. If more than 1.25 volts, replace TPS.

## IDLE AIR CONTROL (IAC) VALVE Replacement (Figure C2-16)

**NOTICE:** The IAC valve is an electrical component and must not be soaked in any liquid cleaner or solvent. Otherwise damage could result.

### Important

All thread-mounted IAC valves on Model 220 TBI units have a dual taper, 10 mm diameter, pintle. Any replacement of an IAC valve must have the correct part number with the appropriate pintle taper and diameter for proper seating of the valve in the throttle body.

### Remove or Disconnect

1. Electrical connector.
2. IAC valve, using 32 mm (1-1/4") wrench.
3. IAC valve gasket and discard.

### Clean

- Old gasket material from surface of throttle body assembly to insure proper seal of new gasket.

**NOTICE:** If the IAC valve has been removed during service, its operation may be tested electrically with the IAC/ISC Motor Tester (Available Tool # J-37027, or BT-8256K). However, if the valve pintle is extended electrically, it must also be retracted electrically. Under no circumstances should the valve pintle be tampered with by hand, screwed, or pushed in, or pulled out, as damage could occur.

### Important

No physical adjustment of the IAC valve assembly is required after installation. The IAC valve is reset by the ECM. When the vehicle is operated at normal engine temperature at approximately 40 mph (64 km/hr.), the ECM causes the valve pintle to seat in the throttle body. The ECM then resets the pintle to the correct position. Proper idle regulation should result.

### Install or Connect

1. IAC valve with new gasket into throttle body.

**NOTICE:** New IAC valves that have been preset at the factory should be installed in the throttle body in an "as is" condition, without any adjustment.

### Tighten

- IAC valve assembly to 18.0 N·m (13.0 lb. ft.) with 32 mm (1-1/4") wrench.

2. Electrical connector to IAC valve.
3. Start engine and allow engine to reach operating temperature.

### Important

When the engine is turned "OFF," the IAC valve will be reset by the ECM.

## THROTTLE BODY ASSEMBLY Replacement (Figure C2-8)

**NOTICE:** Procedures related to replacement of the individual components below have been described previously and should be followed, or damage could occur.

### Remove or Disconnect

1. Throttle body injection unit, described below.
2. Fuel meter body-to-throttle body attaching screw assemblies.

3. Fuel meter body assembly.
4. Throttle body-to-fuel meter body gasket. Discard gasket.

### Disassemble

- TPS from old throttle body, according to previous instructions, for reuse on new throttle body. (New IAC valve comes with new throttle body.)

### Assemble

- TPS onto replacement throttle body assembly, according to previous instructions.

### Install or Connect

1. New throttle body-to-fuel meter body gasket.
2. Fuel meter body assembly on throttle body assembly.
3. Fuel meter body-throttle body attaching screw assemblies that have been coated with locking compound.

### Tighten

- Attaching screw assemblies to 4.0 N·m (35.0 lb. in.).

4. TBI unit onto engine, as described below.

## MINIMUM IDLE SPEED CHECK

The idle stop screw, used in mechanically setting minimum engine idle speed has been set at the factory and should not require further adjustment. However, to check that the setting is correct, proceed as follows:

1. Plug any vacuum ports, as required.
2. If present, remove idle stop screw plug by piercing it with an awl, then applying leverage (Figure C2-17).
3. Connect tachometer to engine.
4. With IAC valve connected, ground the diagnostic terminal (ALDL connector).
5. Turn "ON" ignition, do not start engine. Wait at least 45 seconds (this allows IAC valve pintle to extend and seat in throttle body).
6. With ignition "ON," engine stopped, test terminal still grounded, disconnect IAC valve electrical connector.
7. Remove ground from diagnostic terminal and "start" engine. With transmission in neutral, allow engine rpm to stabilize.
8. The tachometer should read 400 - 450 rpm. If not, adjust the idle stop speed screw accordingly.
9. Turn ignition "OFF" and reconnect IAC valve electrical connector.
10. Use silicon sealant or equivalent to cover minimum idle adjustment screw hole.
11. Unplug any plugged vacuum ports.

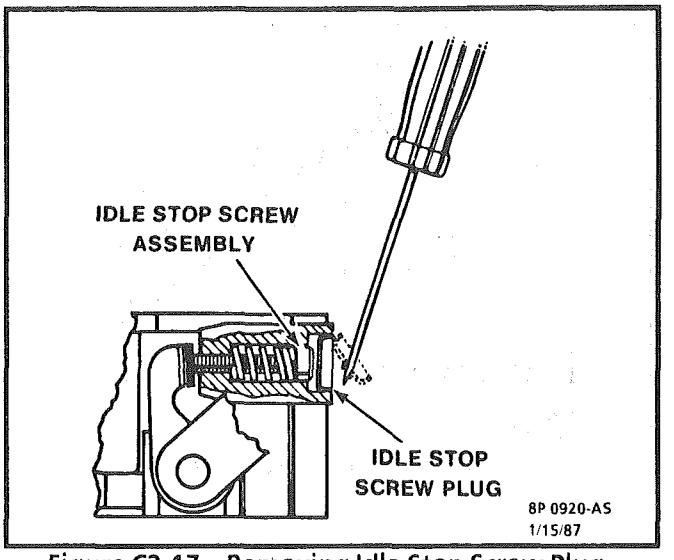



Figure C2-17 - Removing Idle Stop Screw Plug

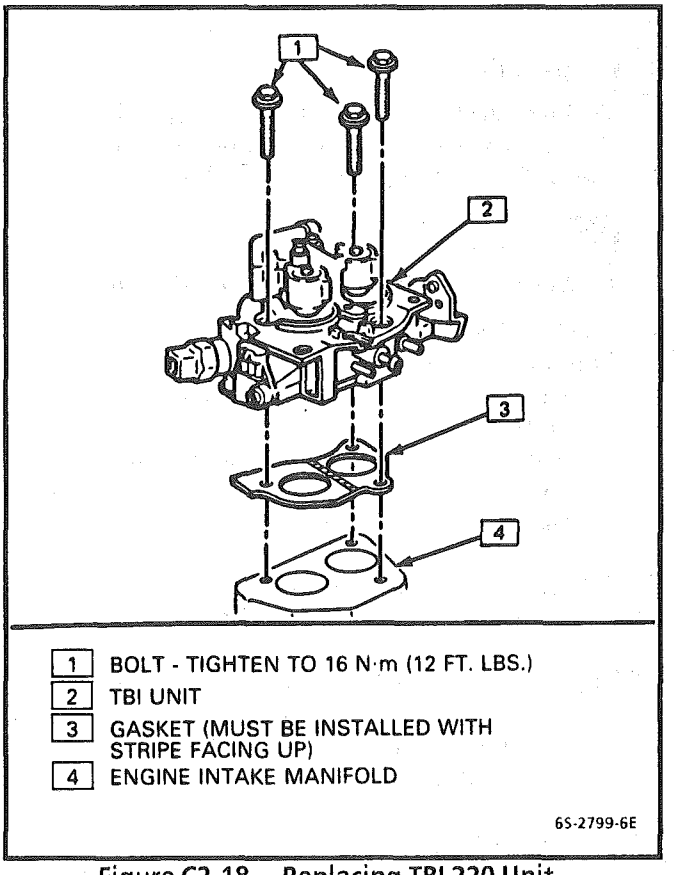



Figure C2-18 - Replacing TBI 220 Unit

# SECTION 6E3
# DRIVEABILITY AND EMISSIONS FUEL INJECTION (PORT)

## THIS SECTION APPLIES TO:
## 2.8L LB8 (VIN S) "F" SERIES
## 5.0L LB9 (VIN F ) "F" SERIES
## 5.7L L98 (VIN 8) "F" SERIES

## CONTENTS

### INTRODUCTION
### 2.8L (VIN S), 5.0L (VIN F) & 5.7L (VIN 8)



### SECTION A - DIAGNOSTIC CHARTS
### 2.8L (VIN S)



### SECTION B - SYMPTOMS
### 2.8L (VIN S)

# SECTION A - DIAGNOSTIC CHARTS
## 5.0L (VIN F) & 5.7L (VIN 8)

**ALL NEW GENERAL MOTORS VEHICLES ARE CERTIFIED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AS CONFORMING TO THE REQUIREMENTS OF THE REGULATIONS FOR THE CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES. THIS CERTIFICATION IS CONTINGENT ON CERTAIN ADJUSTMENTS BEING SET TO FACTORY STANDARDS. IN MOST CASES, THESE ADJUSTMENT POINTS EITHER HAVE BEEN PERMANENTLY SEALED AND/OR MADE INACCESSIBLE TO PREVENT INDISCRIMINATE OR ROUTINE ADJUSTMENT IN THE FIELD. FOR THIS REASON, THE FACTORY PROCEDURE FOR TEMPORARILY REMOVING PLUGS, CAPS, ETC., FOR PURPOSES OF SERVICING THE PRODUCT, MUST BE STRICTLY FOLLOWED AND, WHEREVER PRACTICABLE, RETURNED TO THE ORIGINAL INTENT OF THE DESIGN.**

# INTRODUCTION

## GENERAL DESCRIPTION

This section applies to engines which have a fuel injector in the intake manifold near the intake valve for each cylinder. It is commonly referred to as "Port Fuel Injection".

These engines have controls to reduce exhaust emissions, while maintaining good driveability and fuel economy.

An engine control module (ECM) is the heart of this control system and has sensors used to provide information about engine operation and the various systems it controls. Details of basic operation, diagnosis, functional checks, and on-vehicle service are covered in Section "C", "Component Systems".

The ECM has the ability to do some diagnosis of itself, and of other parts of the system. When it finds a problem, it lights a "Service Engine Soon" light on the instrument panel and a trouble code will be stored in the ECM memory. This does not mean that the engine should be stopped right away, but that the cause of the light coming "ON" should be checked as soon as reasonably possible.

## DIAGNOSIS PROCEDURE

The following sections(s) are written for specific engine applications and are clearly indentified. Be sure to use only the section which applies to the engine family being diagnosed.

Before using this section of the manual, you should be familiar with the information and the proper diagnosing procedures as described in Section "6E". If the proper diagnosis procedures are not followed, as described in Section "6E", it may result in unnecessary replacement of good parts.

Trouble tree charts incorporate diagnosis procedures using an ALDL "SCAN" tool where possible. The "SCAN" tool has the ability to save time in diagnosis and prevent the replacement of good parts. **The key to using the "SCAN" tool successfully for diagnosis lies in the technician's ability to understand the system he is trying to diagnose, as well as an understanding of the "SCAN" tool's limitations. See Section "6E" for more information.**

# SECTION A
## 2.8L ENGINE

## DIAGNOSTIC CIRCUIT CHECK

The "Diagnostic Circuit Check" verifies the system is functioning correctly. Some special considerations to keep in mind while making the "Diagnostic Circuit Check" are:

### Blocking Drive Wheels

The vehicle drive wheels should always be blocked while checking the system.

### Cold Oxygen Sensor

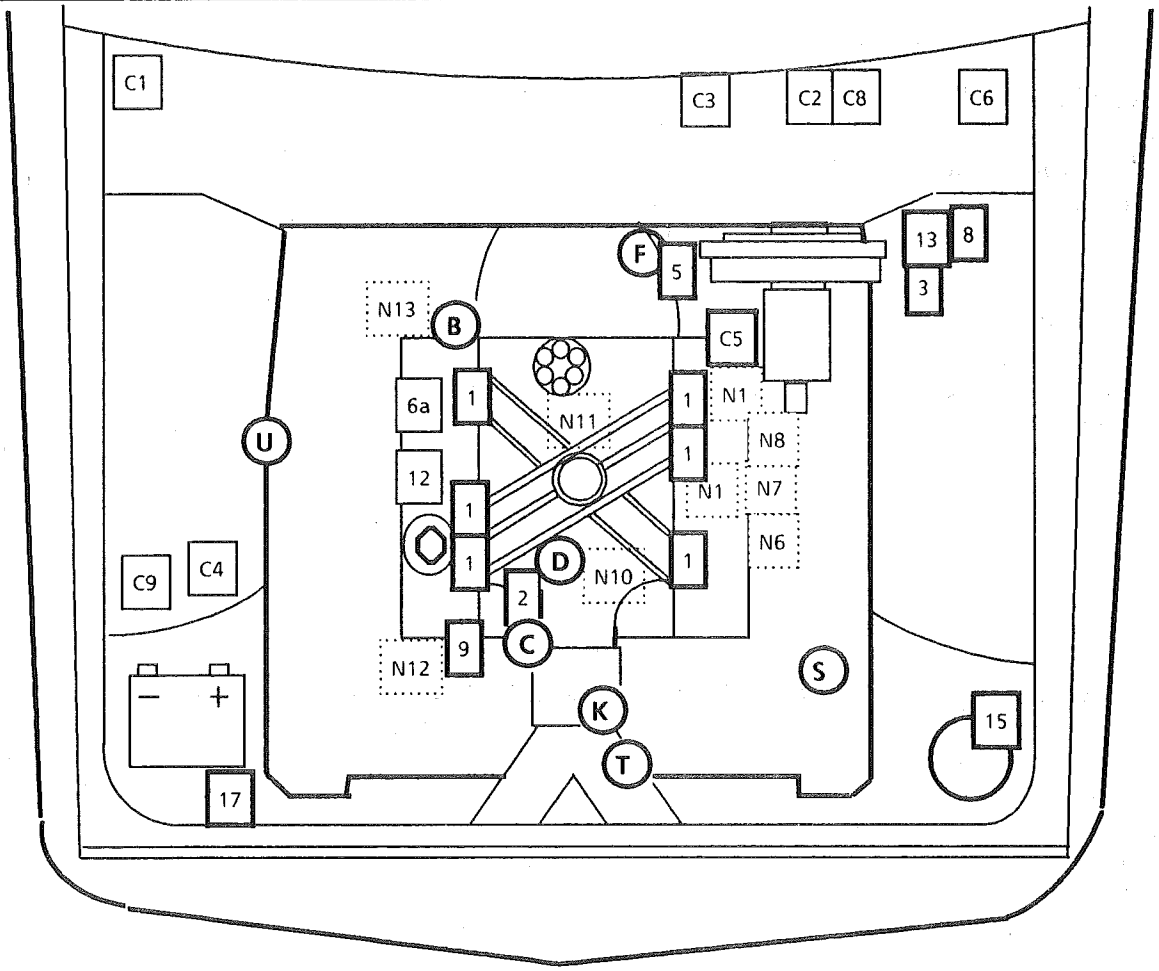
On some engines, the oxygen sensor will cool off after only a short period of operation at idle. This will put the system into "Open Loop". To restore "Closed Loop" operation, run the engine at part throttle several minutes and accelerate from idle to part throttle a few times.

### Basic Procedure

If you have not reviewed the basic information on how to use the diagnostic procedures, go to the introduction of this section.

## SECTION A
## ENGINE COMPONENTS / WIRING DIAGRAMS / DIAGNOSTIC CHARTS

'F' SERIES RPO:LB8 VIN CODE:S 2.8L V6 PFI




## COMPUTER HARNESS

C1 Electronic Control Module (ECM)
C2 ALDL diagnostic connector
C3 "SERVICE ENGINE SOON" light
C4 ECM power/fuel pump fuse
C5 ECM harness ground
C6 Fuse panel
C8 Fuel pump test connector (ALDL"G")
C9 MAF fuse

## NOT ECM CONNECTED

N1 Crankcase vent valve (PCV)
N4 Engine temp. switch (telltale)
N5 Engine temp. sensor (gage)
N6 Oil press. switch (telltale)
N7 Oil press. sensor (gage)
N8 Oil press. swich (fuel pump)
N10 Cold start fuel injection switch
N11 Cold start valve
N12 Deceleration Valve (M/T only)
N13 Fan Override Switch

## CONTROLLED DEVICES

1 Fuel injector
2 Idle air control motor
3 Fuel pump relay
5 Trans. Conv. Clutch connector
6a Remote ignition coil
8 Engine coolant fan relay
9 Air control solenoid (M.T. only)
12 Exhaust Gas Recirculation solenoid
13 A/C compressor relay
15 Fuel vapor canister solenoid
17 Mass air flow sensor relay

Exhaust Gas Recirculation valve

## INFORMATION SENSORS

B Exhaust oxygen
C Throttle position
D Coolant temperature
F Vehicle speed
K Mass Air Flow
S Power steering pressure switch
T Manifold Air Temperature
U A/C pressure fan switch

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Figure A1-1 - Component Locations 2.8L "F" Series

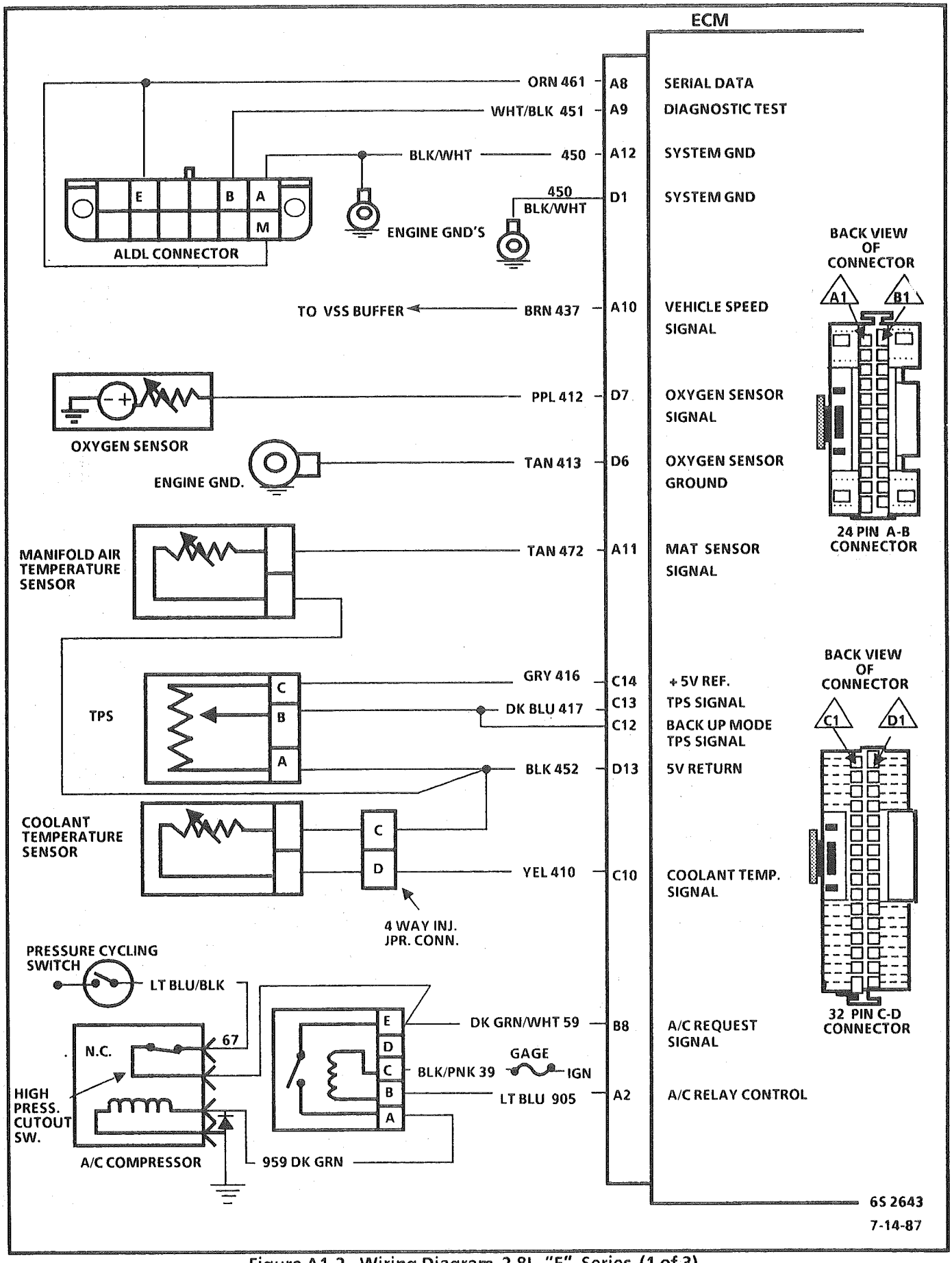



Figure A1-2 - Wiring Diagram 2.8L "F" Series (1 of 3)

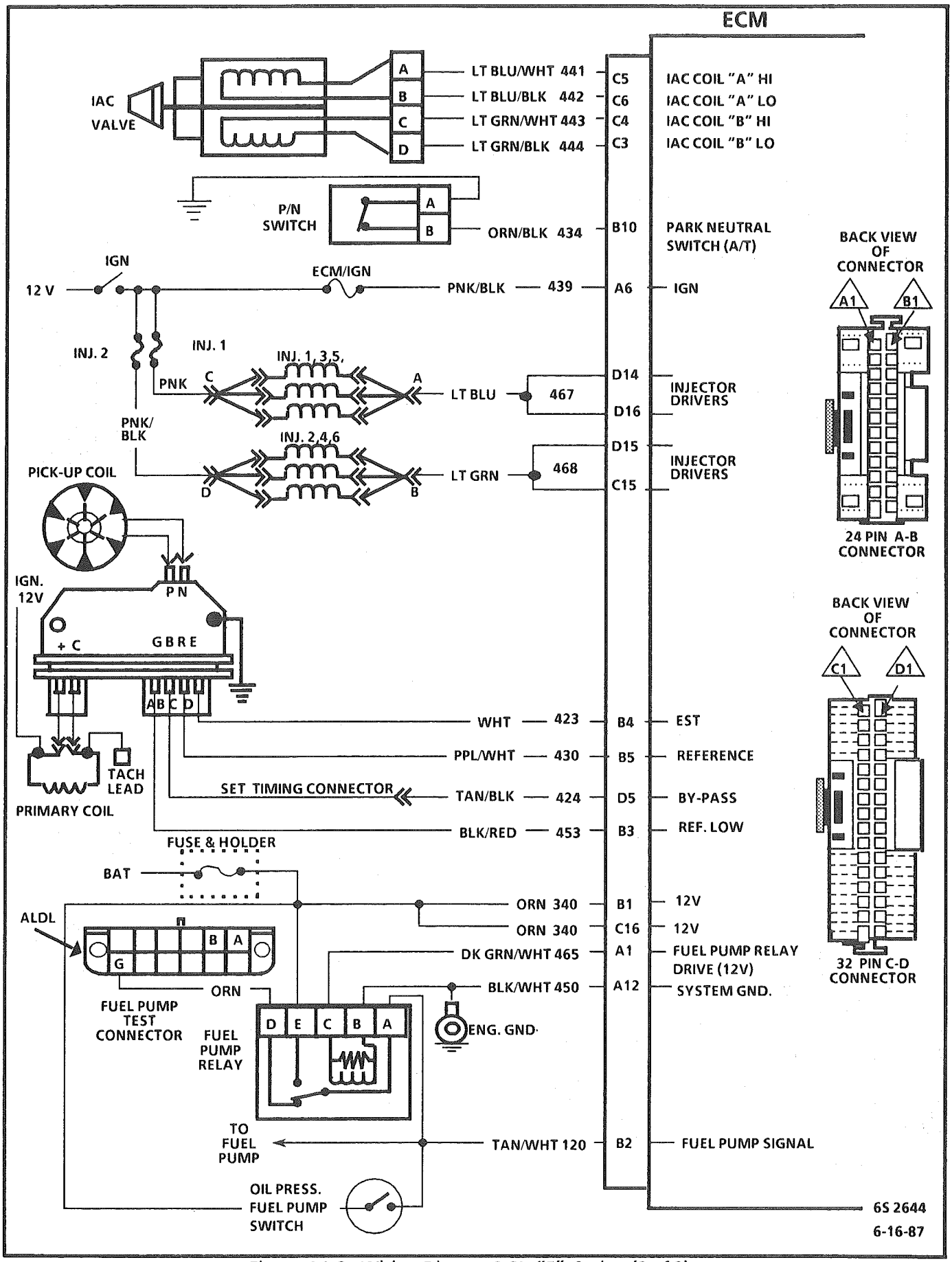



Figure A1-3 - Wiring Diagrm 2.8L "F" Series (2 of 3)

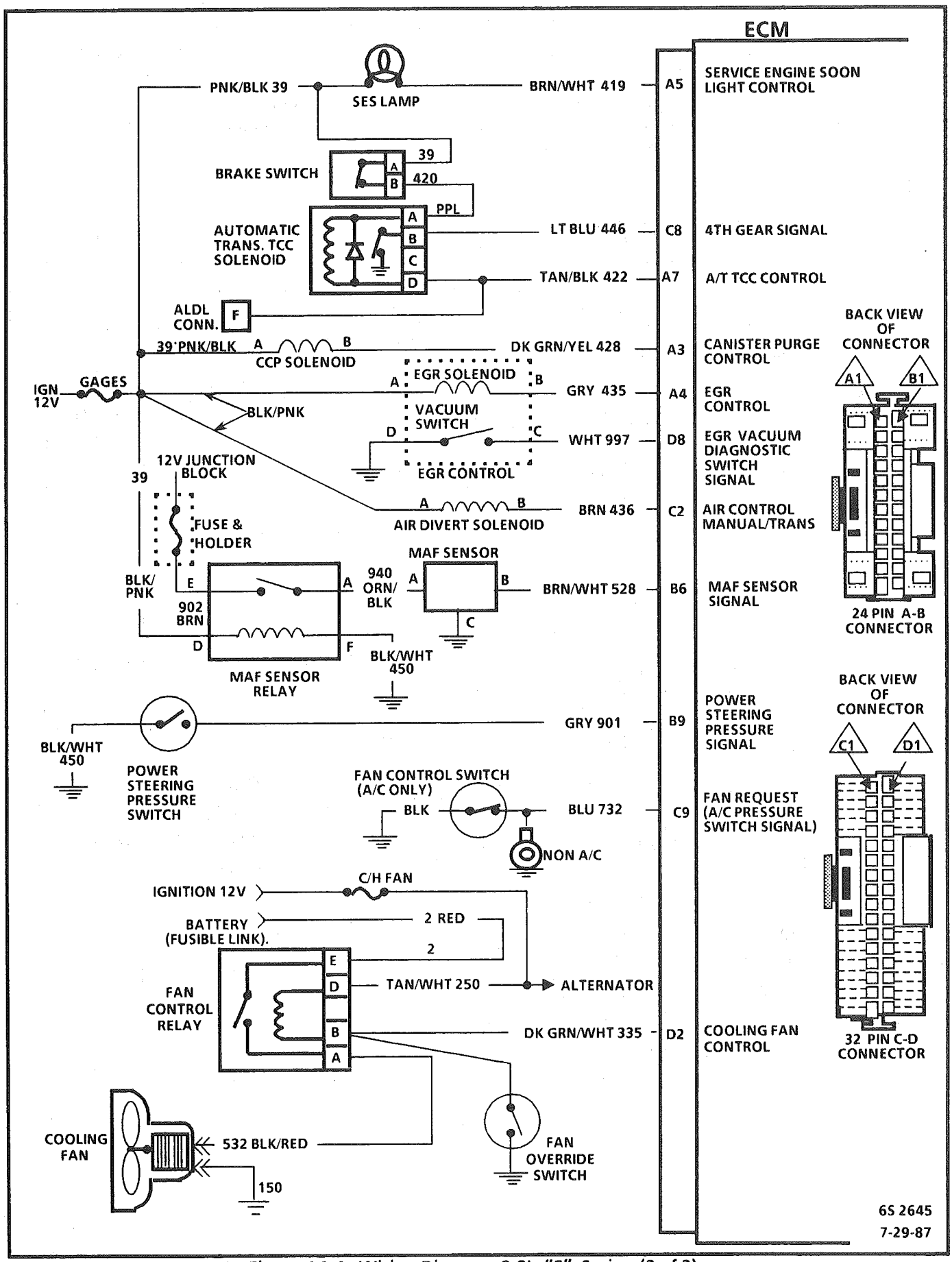



Figure A1-4 - Wiring Diagram 2.8L "F" Series (3 of 3)

# PORT FUEL INJECTION ECM CONNECTOR IDENTIFICATION

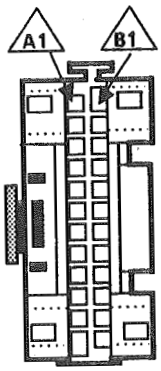
This ECM voltage chart is for use with a digital voltmeter to further aid in diagnosis. The voltages you get may vary due to low battery charge or other reasons, but they should be very close.

**THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:**

- Engine at operating temperature
- Engine idling in closed loop (for "Engine Run" column)
- Test terminal not grounded
- ALDL tool not installed

| | VOLTAGE | | | | |
|---|---|---|---|---|---|
| | KEY "ON" | ENG. RUN | CIRCUIT | PIN | WIRE COLOR |
| (4) | 0 | 14 | FUEL PUMP RELAY | A1 | DK GRN/ WHT |
| | 12 | 14 | A/C CLUTCH CONTROL | A2 | LT BLU |
| | 12 | 14 | CANISTER PURGE CONTROL | A3 | DK GRN/ YEL |
| | 12 | 14 | EGR CONTROL | A4 | GRY |
| | 0 | 14 | "SERVICE ENGINE SOON" CONTROL | A5 | BRN/ WHT |
| | 12 | 14 | IGN - ECM FUSE | A6 | PNK/ BLK |
| | 0 | 0 | TCC CONTROL | A7 | TAN/ BLK |
| | 2-5 | 2.5 | SERIAL DATA | A8 | ORN |
| | 5 | 5 | DIAG. TERM. | A9 | WHT/ BLK |
| (1) | | | SPEED SENSOR SIGNAL | A10 | BRN |
| (2) | | | MAT SIGNAL | A11 | TAN |
| | 0 | 0 | SYSTEM GROUND | A12 | BLK/ WHT |

BACK VIEW OF CONNECTOR

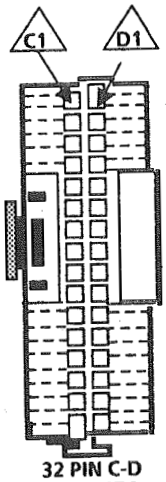



24 PIN A-B CONNECTOR

| | VOLTAGE | | | | |
|---|---|---|---|---|---|
| | WIRE COLOR | PIN | CIRCUIT | KEY "ON" | ENG. RUN |
| | ORN | B1 | BATT.12.VOLTS | 12 | 14 |
| (4) | TAN/ WHT | B2 | FUEL PUMP SIGNAL | 0 | 14 |
| | BLK/ RED | B3 | EST REF LOW | 0 | 0 |
| | WHT | B4 | EST CONTROL | 0 | 1.3 |
| | PPL/ WHT | B5 | REFERENCE | 0 | 1.6 |
| | BRN/WHT | B6 | MASS AIR FLOW SENSOR SIGNAL | 2.5 | 2.5 |
| | | B7 | NOT USED | | |
| | DK GRN/ WHT | B8 | A/C SIGNAL | 0 | 0 |
| | GRY | B9 | P.S.P.S. | 12 | 12 |
| | ORN/ BLK | B10 | PARK/NEUTRAL SW.SIGNAL | 0 | 0 |
| | | B11 | NOT USED | | |
| | | B12 | NOT USED | | |

| | | | | | |
|---|---|---|---|---|---|
| | | | NOT USED | C1 | |
| | 12 | 14 | AIR DIVERT SOL. | C2 | BRN |
| | NOT USEABLE | | IAC "B" LO | C3 | LT GRN/ BLK |
| | NOT USEABLE | | IAC "B" HI | C4 | LT GRN/ WHT |
| | NOT USEABLE | | IAC "A" HI | C5 | LT BLU WHT |
| | NOT USEABLE | | IAC "A" LO | C6 | LT BLU BLK |
| | | | NOT USED | C7 | |
| | 0 | 0 | 4TH GEAR SIGNAL | C8 | LT BLU |
| | 0 | 0 | A/C FAN REQUEST | C9 | BLU |
| (2) | 1.9 | 1.7 | COOLANT TEMP. SIGNAL | C10 | YEL |
| | | | NOT USED | C11 | |
| (5) | 0.35 | ± 0.67 | TPS BACK -UP | C12 | DK BLU |
| (5) | 0.35 | ± 0.67 | TPS SIGNAL | C13 | DK BLU |
| | 5 | 5 | TPS 5 VOLT REFERENCE | C14 | GRY |
| | 12 | 14 | INJ. 2,4,6 | C15 | LT GRN |
| | 12 | 14 | BATTERY 12 VOLTS | C16 | ORN |

BACK VIEW OF CONNECTOR




32 PIN C-D CONNECTOR

| | | | | | |
|---|---|---|---|---|---|
| | BLK/ WHT | D1 | SYSTEM GROUND | | |
| | DK GRN/ WHT | D2 | COOLING FAN CONTROL | 12 | 14 |
| | | D3 | NOT USED | | |
| | | D4 | NOT USED | | |
| | TAN/ BLK | D5 | EST BYPASS | 0 | 4.75 |
| | TAN | D6 | GRN'D. ($0_2$) | 0 | 0 |
| (3) | PPL | D7 | $0^2$ SENSOR SIGNAL | | |
| | WHT | D8 | EGR DIAG. SWITCH | 12 | 14 |
| | | D9 | NOT USED | | |
| | | D10 | NOT USED | | |
| | | D11 | NOT USED | | |
| | | D12 | NOT USED | | |
| | BLK | D13 | COOLANT,TPS,MAT, SENSOR GRD. | 0 | 0 |
| | LT BLU | D14 | INJ. 1,3,5 | 12 | 14 |
| | LT GRN | D15 | INJ 2,4,6 | 12 | 14 |
| | LT BLU | D16 | INJ.1,3,5 | 12 | 14 |

1 Varies from .60 to battery voltage depending on position of drive wheels.

2 Varies with temperature.

3 Varies.

4 12V First two seconds.

5 Measured between terminals C13 and D13.

**ENGINE 2.8L LB8**

**CARLINE "F"**

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Figure A1-5 - ECM Connector Terminal End View 2.8L "F" Series

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# DIAGNOSTIC CIRCUIT CHECK

The diagnostic circuit check is an organized approach to identifying a problem created by an electronic engine control system malfunction. It must be the starting point for any driveability complaint diagnosis, because it directs the service technician to the next logical step in diagnosing the complaint.

The "Scan Data" listed in the table may be used for comparison, after completing the diagnostic circuit check and finding the on-board diagnostics functioning properly and no trouble codes displayed. The "Typical Values" are an average of display values recorded from normally operating vehicles and are intended to represent what a normally functioning system would typically display.

**A "SCAN" TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED, AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY "SCAN" CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.**

Only the parameters listed below are used in this manual for diagnosis. If a "Scan" reads other parameters, the values are not recommended by General Motors for use in diagnosis. For more description on the values and use of the "Scan" to diagnosis ECM inputs, refer to the applicable diagnosis section in Section "C". If all values are within the range illustrated, refer to symptoms in Section "B".

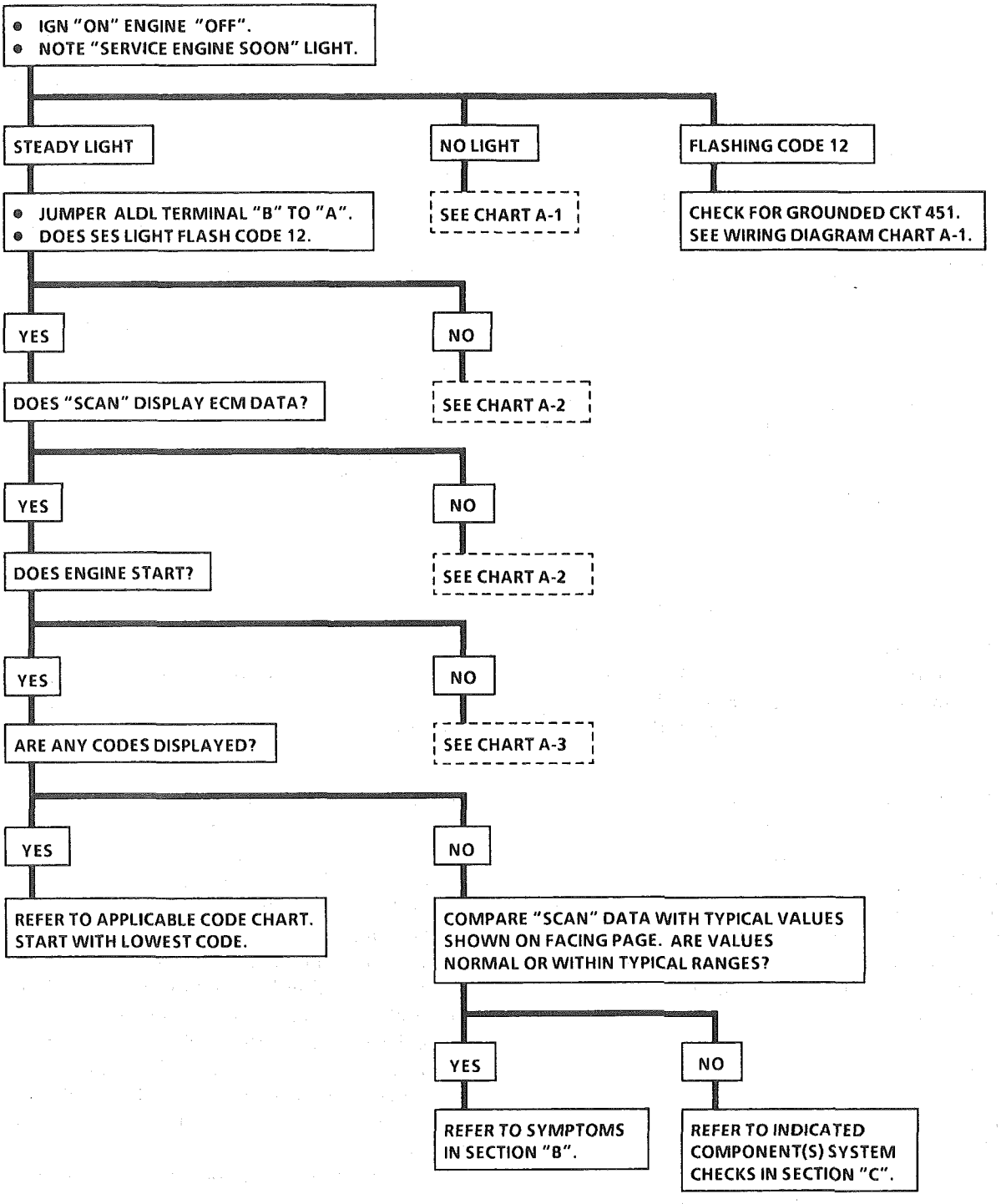
## "SCAN" DATA

Idle / Upper Radiator Hose Hot / Closed Throttle / Park or Neutral / Closed Loop / Acc. off

| "SCAN" Position | Units Displayed | Typical Data Value |
|---|---|---|
| Coolant Temp. | C° | 85° - 105° |
| MAT Temp. | C° | 10° - 60° (depends on underhood temp.) |
| TPS | volts | 0.35 - 0.67 |
| MAF | gm/sec | 4 - 7 |
| INT (Integrator) | Counts | Varies |
| BLM (Block Learn) | Counts | 118 - 138 |
| IAC | Counts (steps) | 5 - 50 |
| rpm | rpm | 1000 ± 50 rpm (depends on temperature) |
| $O_2$ | volts | .1 - 1 and varies |
| Open/Closed Loop | Open/Closed | Closed Loop (may go open with extended idle) |
| Spark Advance | # of Degrees | Varies |
| BPW (base pulse width) | M/Sec | .7 - 2.0 |
| EGR Duty Cycle | 0-100% | 0% (at idle) |
| A/C Request | Yes/No | No (yes, with A/C requested) |
| 4th gear | Yes/No | No (yes, when in 4th gear) |
| A/C Clutch | ON/OFF | OFF (ON, with A/C commanded ON) |
| P/N Switch | P/N and RDL | Park/Neutral (P/N) |
| Power Steering Pressure Switch | Normal/HI pressure | Normal |
| TCC | ON/OFF | OFF/ (ON, with TCC commanded) |
| VSS | mph | 0 |

# DIAGNOSTIC CIRCUIT CHECK

## 2.8L (VIN S) "F" SERIES (PORT)

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**NOTICE:** *FUEL SYSTEM UNDER PRESSURE. TO AVOID FUEL SPILLAGE, REFER TO FIELD SERVICE PROCEDURES FOR TESTING OR MAKING REPAIRS REQUIRING DISASSEMBLY OF FUEL LINES OR FITTINGS.*

# CHART A-3

(Page 1 of 2)

## ENGINE CRANKS BUT WON'T RUN 2.8L (VIN S) "F" SERIES (PORT)

1. FUEL QUANTITY OK.
   - IGN. "ON" - IF "SES" LIGHT IS "OFF", SEE CHART A-1.
   - INSTALL "SCAN" TOOL - IF "NO ALDL", SEE CHART A-2.
   - CHECK THE FOLLOWING:
   - TPS - IF OVER 2.5V AT CLOSED THROTTLE, SEE CODE 21.
   - IF CODE 54 IS SET SEE CODE 54 CHART

2. CONNECT ST-125 (SPARK CHECKER) J-26792 OR EQUIVALENT
   - CHECK FOR SPARK WHILE CRANKING.
   - CHECK AT LEAST TWO WIRES.

- SPARK
- NO SPARK

NO SPARK → CHECK FOR BATTERY VOLTAGE TO IGNITION SYSTEM. IF OK THERE IS A BASIC HEI PROBLEM. REFER TO APPROPRIATE CHART C-4.

3. CHECK EACH BANK OF INJECTORS AS FOLLOWS:
   - DISCONNECT ONE INJECTOR.
   - CONNECT TEST LIGHT J-34730-2 OR EQUIVALENT TO INJECTOR HARNESS CONNECTOR TERMINALS.
   - CHECK FOR BLINKING LIGHT WHILE CRANKING.
   - RECONNECT INJECTOR.
   - REPEAT TEST ON ANOTHER INJECTOR ON THE SAME BANK.
   - LIGHT SHOULD BLINK ON BOTH.

NOTICE: *DO NOT ALLOW INJECTOR, TERMINALS TO SHORT OR TOUCH TOGETHER WHILE CRANKING OR ECM MAY BE DAMAGED.*

- BLINKING LIGHT
- STEADY LIGHT
- NO LIGHT

NO LIGHT → SEE CHART A-3 PAGE 2 OF 2

4. INSTALL FUEL PRESSURE GAGE AND NOTE PRESSURE AFTER IGNITION "ON" AND FUEL PUMP STOPS RUNNING SHOULD BE 34 TO 47 psi (234-325 kPa)

- OK
- NOT OK

NOT OK → SEE FUEL SYSTEM DIAGNOSTIC CHART A-7

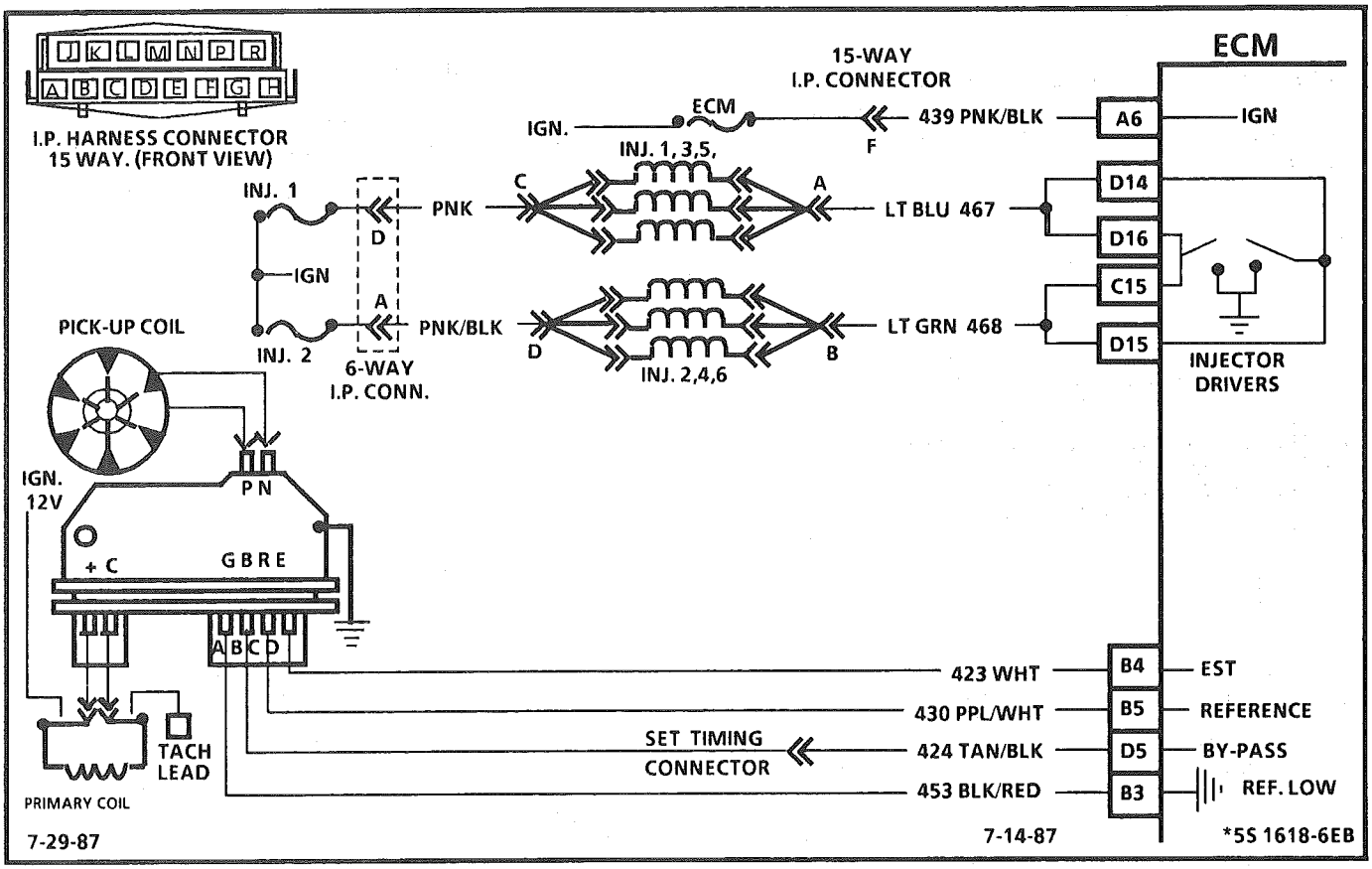
- SEE "DIAGNOSTIC AIDS" ON FACING PAGE FOR ADDITIONAL ITEMS TO CHECK.

IF ALL CHECK OK. THERE IS NO TROUBLE FOUND. REVIEW SYMPTOMS, SECTION "B", "HARD START".

STEADY LIGHT:
- CHECK INJECTOR DRIVER CKT WITH STEADY LIGHT FOR SHORT TO GROUND.
- IF CIRCUIT IS NOT SHORTED, CHECK RESISTANCE ACROSS EACH INJECTOR IN THE CIRCUIT.
- RESISTANCE SHOULD BE GREATER THAN 8 OHMS.

- OK → FAULTY ECM
- NOT OK → REPLACE ECM AND ANY INJECTOR THAT MEASURES UNDER 8 OHMS.

* CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.




# CHART A-3

## (Page 2 of 2)
## ENGINE CRANKS BUT WON'T RUN
## 2.8L (VIN S) "F" SERIES (PORT)

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

5. Checks for 12 volt supply to injectors.
6. This test will determine if the distributor module is not generating the reference pulse or if the wiring or ECM are at fault. By touching CKT 430 with a test light a reference signal is being generated. If the test light (J-34730-2) blinks at the injector, then the ECM and wiring is OK.
7. Each time the test light touches CKT 430, the ECM should turn "ON" the fuel pump for 2 seconds.
8. All checks made to this point would indicate that the ECM is at fault. However, there is a possibility of CKT 467 or 468 being shorted to a voltage source either in the engine harness or in the injector harness.

To test for this condition:

- Disconnect the injector 4-way connector.
- Ignition "ON"
- Probe CKTs 467 and 468 on the ECM side of harness with a test light connected to ground. There should be no light.
- If OK, check the resistance of the injector harness between terminals "A & C", "A & D", "B & D", and "B & C".
- Should be more than 4 ohms
- If less than 4 ohms check harness for wires shorted together and check each injector resistance.
- Resistance should be more than 10 ohms.
- If all OK, replace ECM.

**NOTICE:** *EFI SYSTEM UNDER PRESSURE. TO AVOID FUEL SPILLAGE, REFER TO FIELD SERVICE PROCEDURES FOR TESTING OR MAKING REPAIRS REQUIRING DISASSEMBLY OF FUEL LINES OR FITTINGS*

# CHART A-3

(Page 2 of 2)

## ENGINE CRANKS BUT WON'T RUN 2.8L (VIN S) "F" SERIES (PORT)

FROM CHART A-3 PAGE 1 OF 2

NO LIGHT

(5)
- IGNITION "ON",
- PROBE INJECTOR HARNESS TERMINALS WITH A TEST LIGHT TO GROUND.
- LIGHT SHOULD BE "ON" AT BOTH TERMINALS.

LIGHT "ON" BOTH

(6)
- RECONNECT J-34730-2 OR EQUIVALENT TEST LIGHT TO INJECTOR HARNESS.
- DISCONNECT DISTRIBUTOR 4-WAY CONNECTOR.
- MOMENTARILY TOUCH HARNESS CONNECTOR TERMINAL CKT 430 WITH TEST LIGHT TO 12 VOLTS.

USE A TEST LIGHT ONLY. TOUCH TERMINAL ONLY MOMENTARILY AND NOTE INJECTOR TEST LIGHT. SHOULD "BLINK" EACH TIME THE TEST LIGHT IS REMOVED FROM CKT 430.

INJECTOR LIGHT "BLINKS"

FAULTY IGNITION MODULE OR CONNECTION.

NO BLINKING LIGHT AT INJECTOR

(7) REPEAT TEST AND OBSERVE FOR FUEL PUMP RUNNING FOR 2 SECONDS OR FUEL PUMP RELAY CLICK.

OK

- RECONNECT INJECTOR(S).
- IGNITION "OFF".
- DISCONNECT ECM
- IGNITION "ON".
- PROBE TERMINALS "D15" AND "D16" WITH A TEST LIGHT TO GROUND.

LIGHT

(8) SEE FACING PAGE TEST DESCRIPTION 8.

NO LIGHT

OPEN CKT 467 OR 468

NOT OK

- OPEN OR GROUNDED CKT 430.
- FAULTY CONNECTION AT "B5" OR FAULTY ECM.

LIGHT "ON" ONE

DUE TO INJECTORS WIRED IN PARALLEL THERE SHOULD BE A LIGHT ON BOTH TERMINALS.

IF NOT THE PROBLEM IS IN THE HARNESS TO THE TESTED INJECTOR.

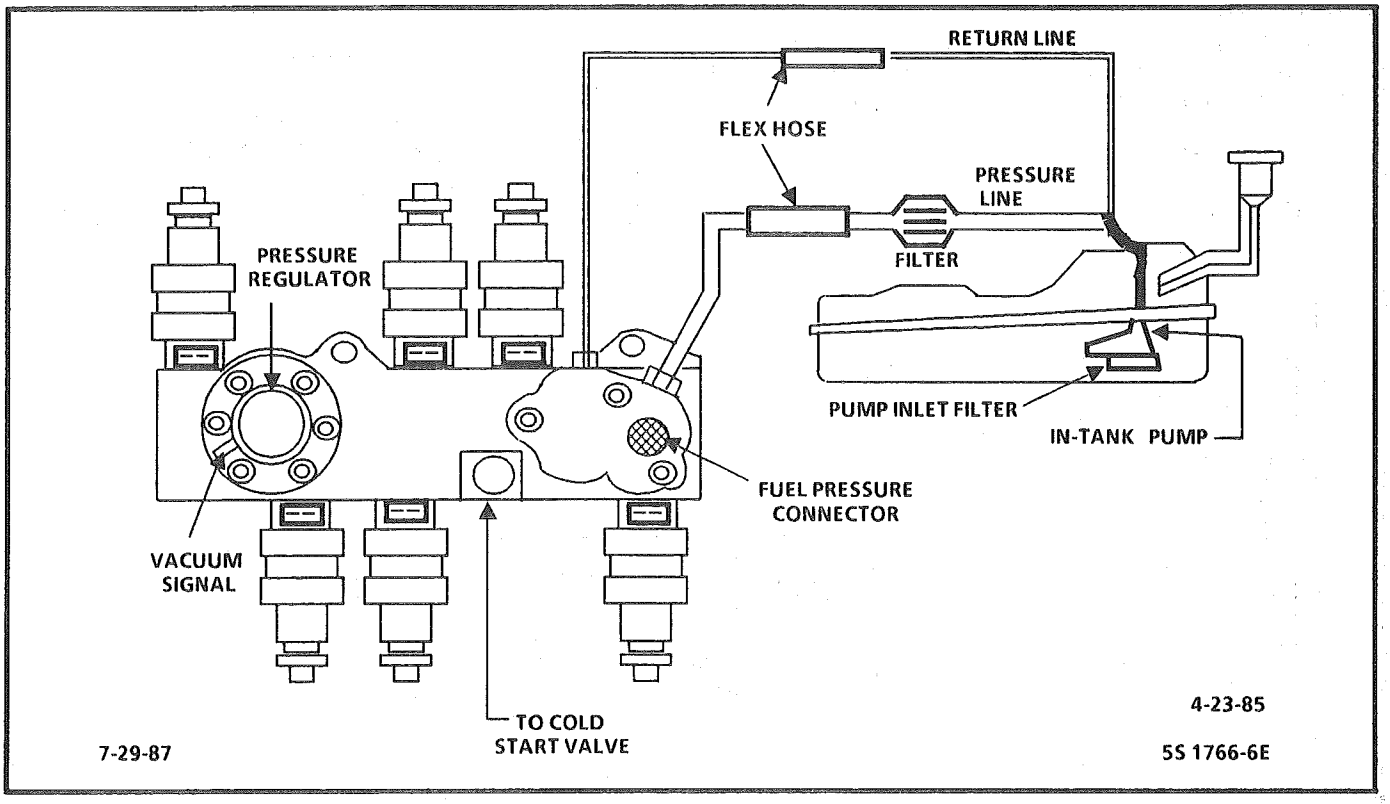
NO LIGHT

REPAIR OPEN IN INJECTOR FEED CIRCUIT.

* CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-29-87

5S 1550-6E




# CHART A-7

(Page 1 of 2)

## FUEL SYSTEM DIAGNOSIS
## 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

When the ignition switch is turned "ON", the electronic control module (ECM) will turn "ON" the in-tank fuel pump. It will remain "ON" as long as the engine is cranking or running, and the ECM is receiving HEI distributor reference pulses.

If there are no reference pulses, the ECM will shut "OFF" the fuel pump within 2 seconds after key "ON" or engine stopped.

The pump will deliver fuel to the fuel rail and injectors, then to the pressure regulator, where the system pressure is controlled to about 234 to 317 kPa (34 to 46 psi). Excess fuel is then returned to the fuel tank.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Use pressure gage J-34730-1. Wrap a shop towel around the fuel pressure tap to absorb any small amount of fuel leakage that may occur when installing the gage.
   Ignition "ON", pump pressure should be 280-325 kPa (40.5-47 psi). This pressure is controlled by spring pressure within the regulator assembly.
2. When the engine is idling, the manifold pressure is low (high vacuum) and is applied to the fuel regulator diaphragm. This will offset the spring and result in a lower fuel pressure. This idle pressure will vary somewhat depending on barometric pressure, however, the pressure idling was less indicating pressure regulator control.
3. Pressure that continues to fall is caused by one of the following:
   - In-tank fuel pump check valve not holding.
   - Pump coupling hose or pulsator leaking.
   - Fuel pressure regulator valve leaking.
   - Injector sticking open.
4. An injector sticking open can best be determined by checking for a fouled or saturated spark plug(s). If a leaking injector can not be determined by a fouled or saturated spark plug the following procedure should be used.
   - Remove Plenum, cold start valve and remove fuel rail bolts. Follow the procedures in the fuel control section of this manual, but leave fuel lines connected.
   - Reconnect cold start valve.
   - Connect a hose to valve nozzle and insert into a gasoline container.
   - Lift fuel rail out just enough to leave injector nozzles in the ports.

   **CAUTION:** ***BE SURE INJECTOR(S) ARE NOT ALLOWED TO SPRAY ON ENGINE AND THAT INJECTOR RETAINING CLIPS ARE INTACT. THIS SHOULD BE CAREFULLY FOLLOWED TO PREVENT FUEL SPRAY ON ENGINE WHICH WOULD CAUSE A FIRE HAZARD.***
   - Pressurize the fuel system.
   - Lift each side of rail up and observe for injector(s) leaking.

THIS CHART ASSUMES THERE IS NO CODE 54

# CHART A-7

(Page 1 of 2)

## FUEL SYSTEM DIAGNOSIS 2.8L (VIN S) "F" SERIES (PORT)

FROM CHART A-3 (1 OF 2)

NOTE: *THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE. ALSO, IT IS NORMAL FOR THE PRESSURE TO DROP SLIGHTLY WHEN THE PUMP STOPS.*

(1)
- INSTALL FUEL PRESSURE GAGE, J-34730-1 OR EQUIVALENT.
- IGNITION 'OFF' FOR 10 SECONDS. A/C "OFF".
- IGNITION "ON". FUEL PUMP WILL RUN FOR ABOUT 2 SECONDS.
- NOTE FUEL PRESSURE, WITH PUMP RUNNING SHOULD BE 280-325 kPa (40.5-47 psi) AND HOLD STEADY WHEN PUMP STOPS.

OK

(2)
- START AND IDLE ENGINE AT NORMAL OPERATING TEMPERATURE.
- PRESSURE SHOULD BE LOWER BY 21-69 kPa (3-10 psi).

OK

NO TROUBLE FOUND. REVIEW SYMPTOMS SECTION "B".

NOT OK

- APPLY 10 INCHES OF VACUUM TO PRESSURE REGULATOR.
- FUEL PRESSURE SHOULD DROP 21-69 kPa (3-10 psi).

OK

REPAIR VACUUM SOURCE TO REGULATOR.

NOT OK

REPLACE REGULATOR. ASSEMBLY

NOT OK

(3)

PRESSURE, BUT NOT HOLDING

- IGNITION "OFF" FOR 10 SECONDS.
- IGNITION "ON"
- BLOCK FUEL PRESSURE LINE BY PINCHING FLEX HOSE. PRESSURE SHOULD HOLD.

NOT HOLDING

- IGNITION "OFF" FOR 10 SECONDS.
- IGNITION "ON".
- BLOCK FUEL RETURN LINE BY PINCHING HOSE.
- RECHECK PRESSURE.

HOLDS

FAULTY FUEL PRESSURE REGULATOR.

NOT HOLDING

(4) LOCATE AND CORRECT LEAKING INJECTOR(S).

HOLDS

CHECK :
- LEAKING PUMP COUPLING HOSE OR PULSATOR.
- FAULTY IN-TANK PUMP.

PRESSURE, BUT LESS THAN 280 kPa (40.5 psi).

ABOVE 325 kPa (47 psi).

SEE CHART A-7 (2 of 2)

NO PRESSURE

- IGNITION "OFF".
- APPLY 12 VOLTS TO FUEL PUMP TEST TERMINAL.
- LISTEN FOR FUEL PUMP RUNNING.

PUMP RUNS

CHECK FOR :
- PLUGGED IN-LINE FILTER.
- PLUGGED PUMP INLET FILTER.
- RESTRICTED FUEL LINE.
- DISCONNECTED COUPLING HOSE OR PULSATOR.

IF OK

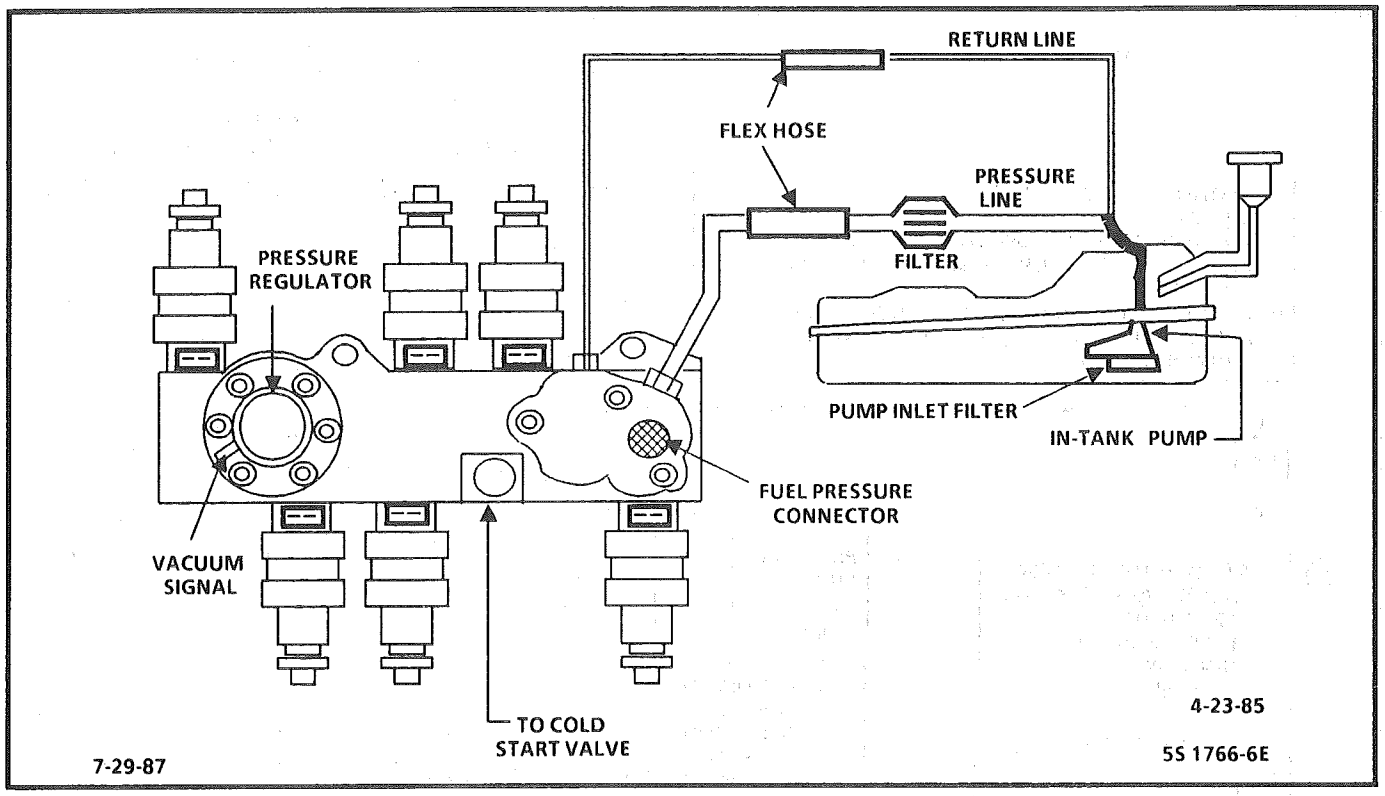
PUMP NOT RUNNING

CHECK FOR :
- OPEN WIRE IN CKT 120.
- OPEN PUMP. GROUND CKT 150.

IF OK

REPLACE IN-TANK FUEL PUMP

7-23-87
8S 4693-6E




# CHART A-7

## (Page 2 of 2)
## FUEL SYSTEM DIAGNOSIS
## 2.8L (VIN S) "F" SERIES (PORT)

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Pressure but less than 280 kPa (40.5 psi) falls into two areas:
   - Regulated pressure, but less than 280 kPa (40.5 psi). Amount of fuel to injectors OK but pressure is too low. System will be lean running and may set Code 44. Also, hard starting cold and overall poor performance.
   - Restricted flow causing pressure drop - Normally, a vehicle with a fuel pressure of less than 165 kPa (24 psi) at idle will not be driveable. However, if the pressure drop occurs only while driving, the engine will normally surge then stop as pressure begins to drop rapidly.
2. Restricting the the fuel return line allows the fuel pump to develop its maximum pressure (dead head pressure). When battery voltage is applied to the pump test terminal, pressure should be above 414 kPa (60 psi).
3. This test determines if the high fuel pressure is due to a restricted fuel return line or a pressure regulator problem.

NOTICE: *FUEL SYSTEM UNDER PRESSURE. TO AVOID FUEL SPILLAGE, REFER TO FIELD SERVICE PROCEDURES FOR TESTING OR MAKING REPAIRS REQUIRING DISASSEMBLY OF FUEL LINES OR FITTINGS.*

# CHART A-7

(Page 2 of 2)

## FUEL SYSTEM DIAGNOSIS 2.8L (VIN S) "F" SERIES (PORT)

FROM CHART A-7 (1 of 2)

(1) HAS PRESSURE BUT LESS THAN 280 kPa (40.5 psi ).

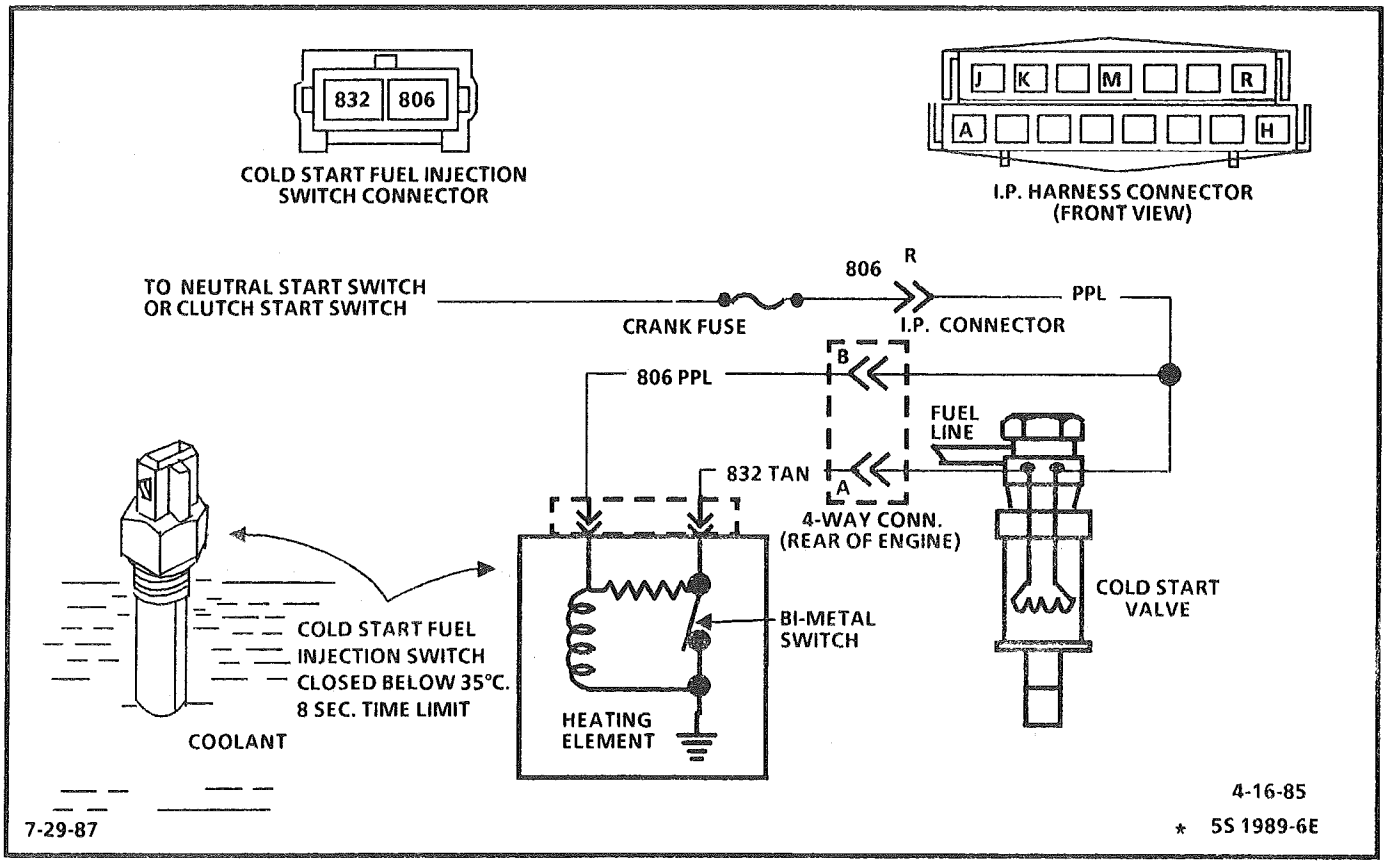
- CHECK FOR RESTRICTED FUEL LINES OR IN-LINE FILTER.
  - OK
    - (2)
      - IGNITION "OFF".
      - BLOCK FUEL RETURN LINE .
      - APPLY 12 VOLTS TO FUEL PUMP RELAY HARNESS TERMINAL "A" OR FUEL PUMP TEST CONNECTOR AND NOTE PRESSURE .
        - ABOVE 325 kPa (47 psi ).
          - FAULTY PRESSURE REGULATOR.
        - PRESSURE BUT LESS THAN 280 kPa (40.5 psi ).
          - FAULTY IN-TANK
            - FUEL PUMP
            - COUPLING HOSE OR PULSATOR
            - INLET FILTER
            - WRONG FUEL PUMP
  - NOT OK
    - REPLACE FILTER OR REPAIR FUEL LINE AND RECHECK.

ABOVE 325 kPa (47 psi).

(3)

- DISCONNECT FUEL RETURN LINE FLEXIBLE HOSE.
- ATTACH $^{5}/_{16}$ I.D. FLEX HOSE TO PRESSURE REGULATOR SIDE OF RETURN LINE. INSERT THE OTHER END IN AN APPROVED GASOLINE CONTAINER.
  NOTE FUEL PRESSURE WITHIN 2 SECONDS AFTER IGNITION "ON".
  - ABOVE 325 kPa ( 47 psi )
    - CHECK FOR RESTRICTED FUEL RETURN LINE FROM FUEL PRESSURE REGULATOR TO POINT WHERE FUEL LINE WAS DISCONNECTED.
      - IF LINE OK REPLACE FUEL PRESSURE REGULATOR.
  - 280-325 kPa (40.5-47 psi )
    - LOCATE AND CORRECT RESTRICTED FUEL RETURN LINE TO FUEL TANK.

CLEAR CODES AND CONFIRM "CLOSED LOOP " OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.




# CHART A-9

## COLD START VALVE
## 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The cold start valve is used to provide additional fuel during the crank mode to improve cold start-ups. This circuit is important when engine coolant temperature is low because the other injectors are not pulsed "ON" long enough to provide the needed amount of fuel to start.

The circuit is activated only in the crank mode. The power is supplied directly from the starter solenoid and is protected by a fuse. The system is controlled by a cold start fuel injection switch which provides a ground path for the valve during cranking when engine coolant is below 95°F (35°C).

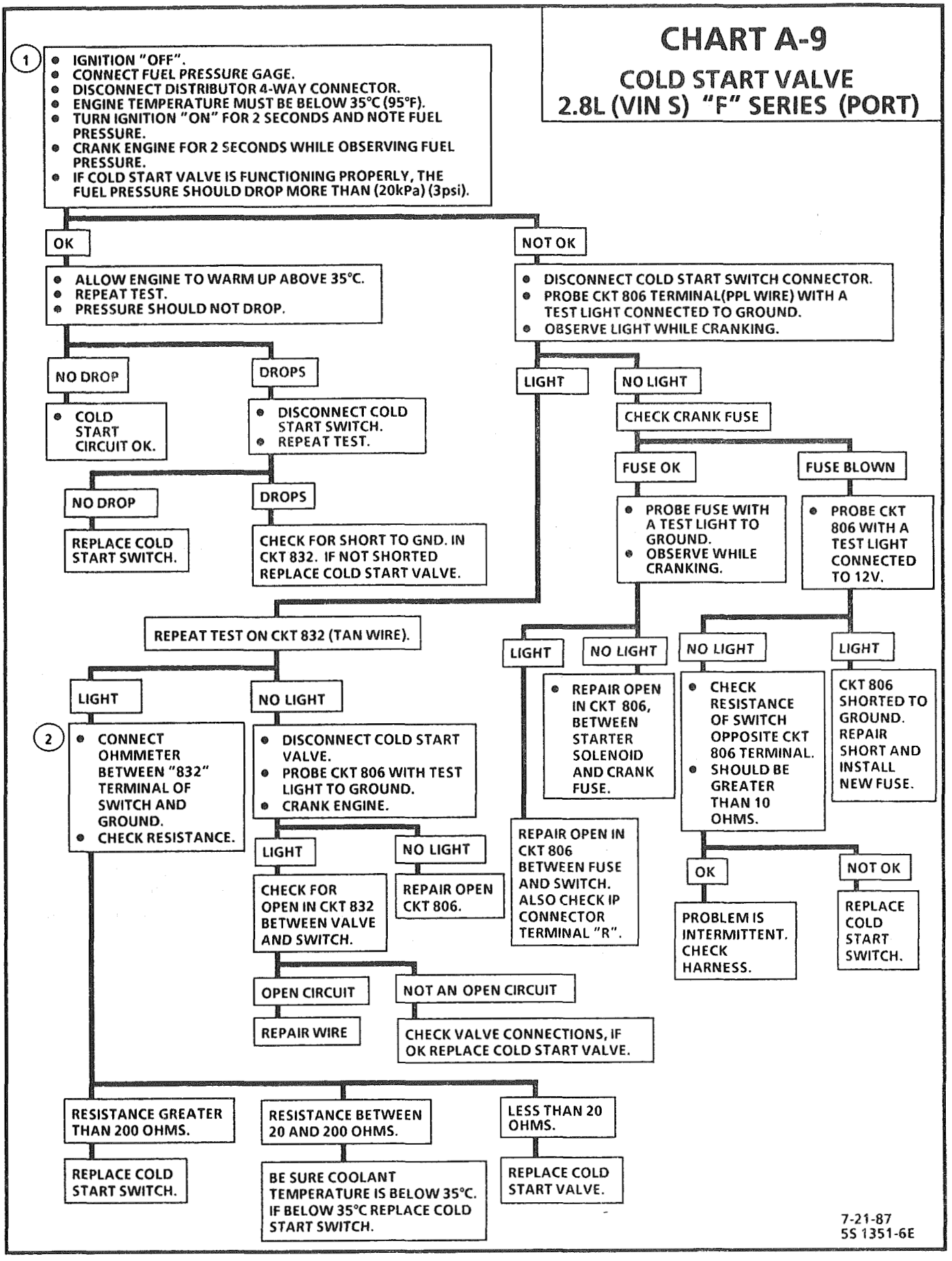
The cold start fuel injection switch consists of a bimetal material which opens at a specified coolant temperature. This bimetal is also heated by the winding in the switch which allows the valve to stay "ON" for 8 seconds at -20°C (-5°F) coolant. The time the switch will stay closed varies inversely with coolant temperature. In other words, as the coolant temperature goes up, the cold start valve "ON" time goes down.

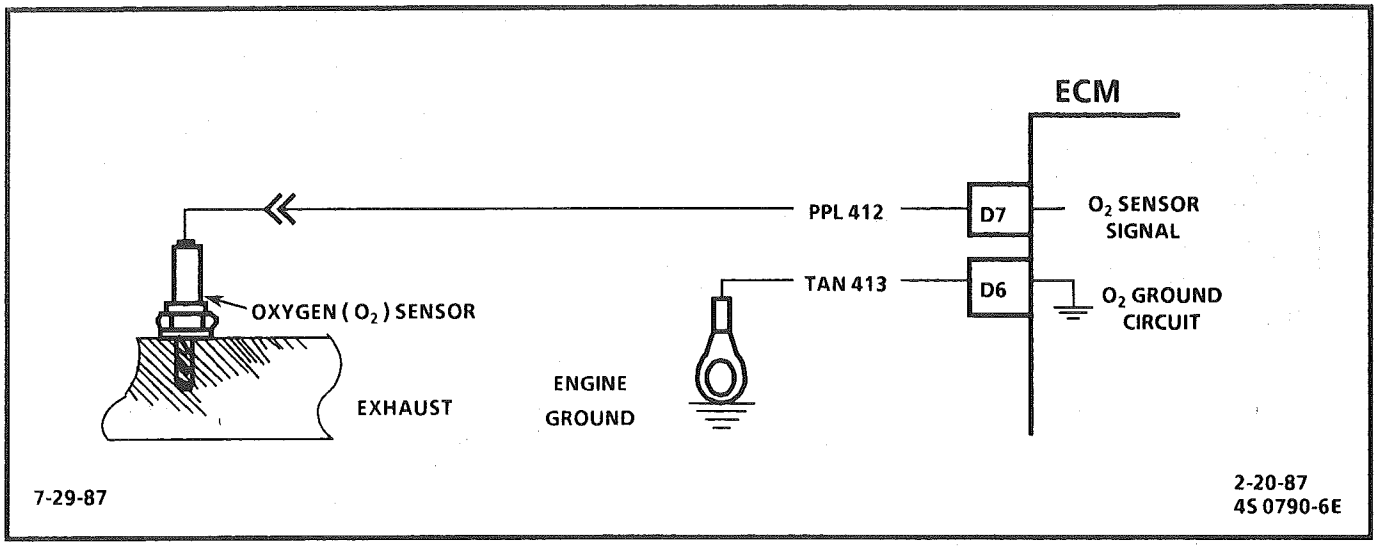
**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Disconnecting the distributor 4-way connector will disable the other injectors. The amount of pressure drop depends on the temperature of the engine.
2. This test will determine the continuity through the switch to ground.

# CHART A-9

## COLD START VALVE 2.8L (VIN S) "F" SERIES (PORT)






# CODE 13

## OXYGEN SENSOR CIRCUIT (OPEN CIRCUIT) 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D6" and "D7". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volts.) The $O_2$ sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below 315° C (600° F). An open sensor circuit or cold sensor causes "Open Loop" operation.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 13 will set:
   - Engine at normal operating temperature.
   - At least 2 minutes engine time after start.
   - $O_2$ signal voltage steady between .35 and .55 volts.
   - Throttle position sensor signal above 4%.
   - All conditions must be met for about 60 seconds.

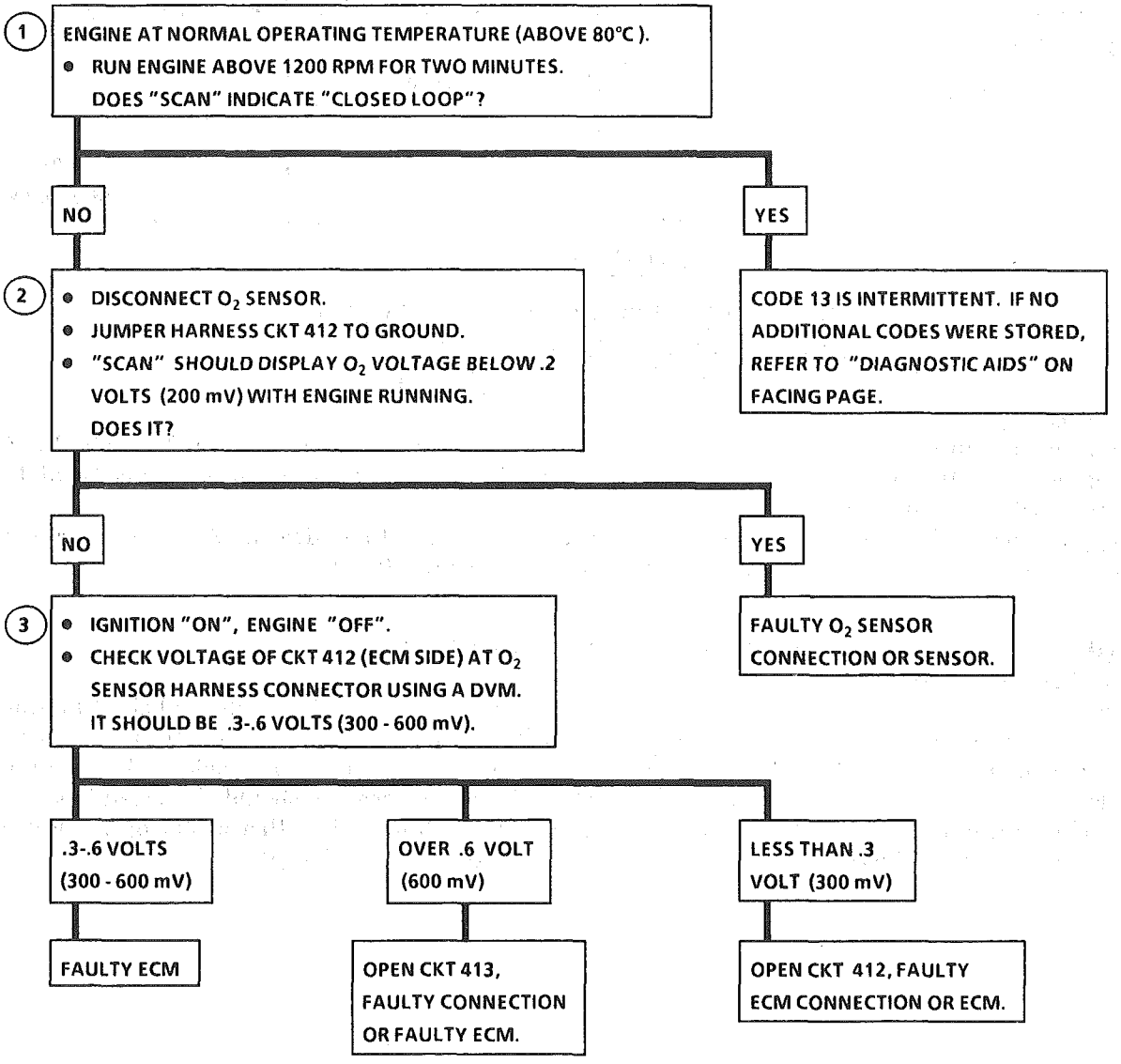
   If the conditions for a Code 13 exist the system will not go "Closed Loop".
2. This will determine if the sensor is at fault or the wiring or ECM is the cause of the Code 13.
3. In doing this test use only a high impedence digital volt ohmmeter. This test checks the continuity of CKTs 412 and 413 because if CKT 413 is open the ECM voltage on CKT 412 will be over .6 volts (600 mV).

### Diagnostic Aids:

Normal "Scan" voltage varies between 100mV to 999mV (.1 and 1.0 volt) while in "Closed Loop". Code 13 sets in one minute if voltage remains between .35 and .55 volts, but the system will go "Open Loop" in about 15 seconds. Refer to "Intermittents" in Section "B".

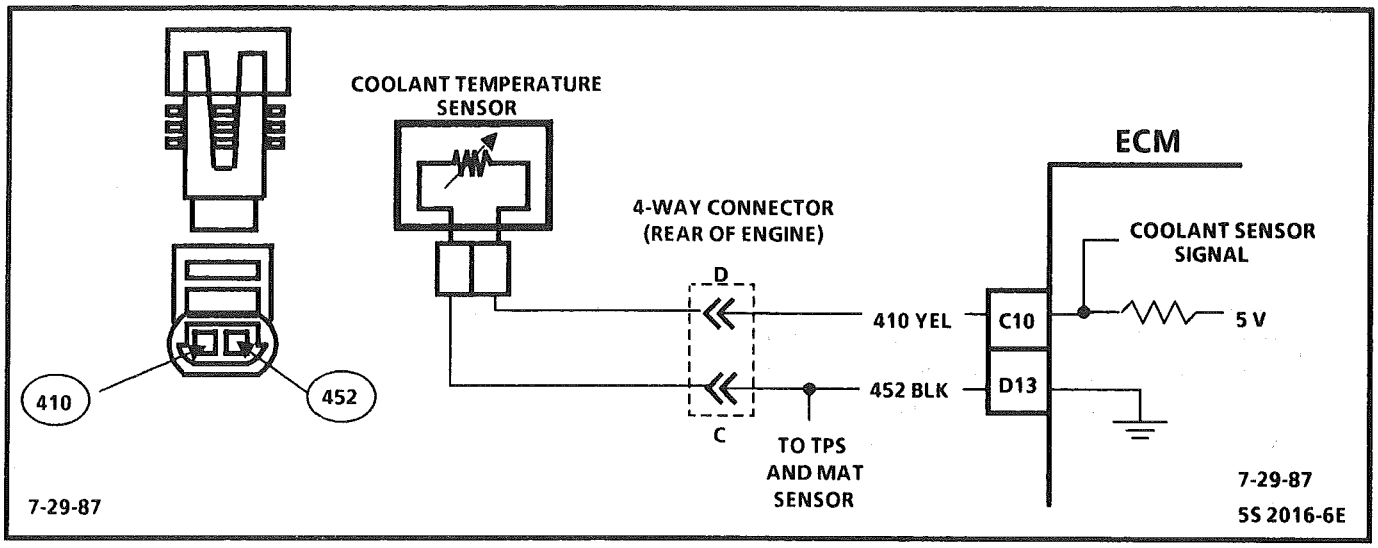
# CODE 13

## OXYGEN SENSOR CIRCUIT (OPEN CIRCUIT) 2.8L (VIN S) "F" SERIES (PORT)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-23-87
• 7S 3054-6E




# CODE 14

## COOLANT TEMPERATURE SENSOR CIRCUIT (HIGH TEMPERATURE INDICATED) 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The coolant temperature sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine is cold the sensor (thermistor) resistance is high, therefore the ECM will see high signal voltage.

As the engine warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (85°C to 95°C) the voltage will measure about 1.5 to 2.0 volts.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

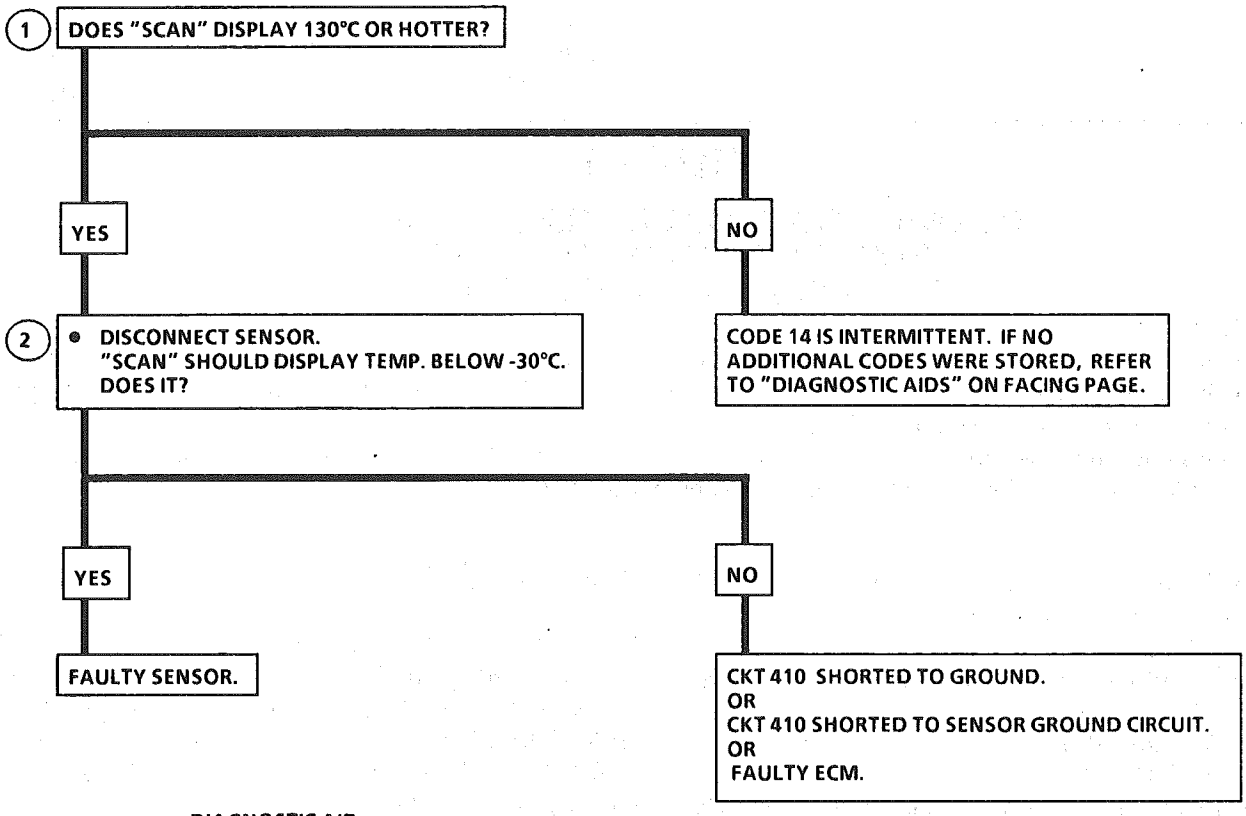
1. Code 14 will set if:
   - Signal voltage indicates a coolant temperature above 135°C (275°F) for 3 seconds.
2. This test will determine if CKT 410 is shorted to ground, which will cause the conditions for Code 14.

### Diagnostic Aids:

Check harness routing for a potential short to ground in CKT 410. "SCAN" tool displays engine temperature in degrees centigrade. After engine is started, the temperature should rise steadily to about 90°C then stabilize when thermostat opens. Refer to "Intermittents" in Section "B".

# CODE 14

## COOLANT TEMPERATURE SENSOR CIRCUIT
## (HIGH TEMPERATURE INDICATED)
## 2.8L (VIN S) "F" SERIES (PORT)



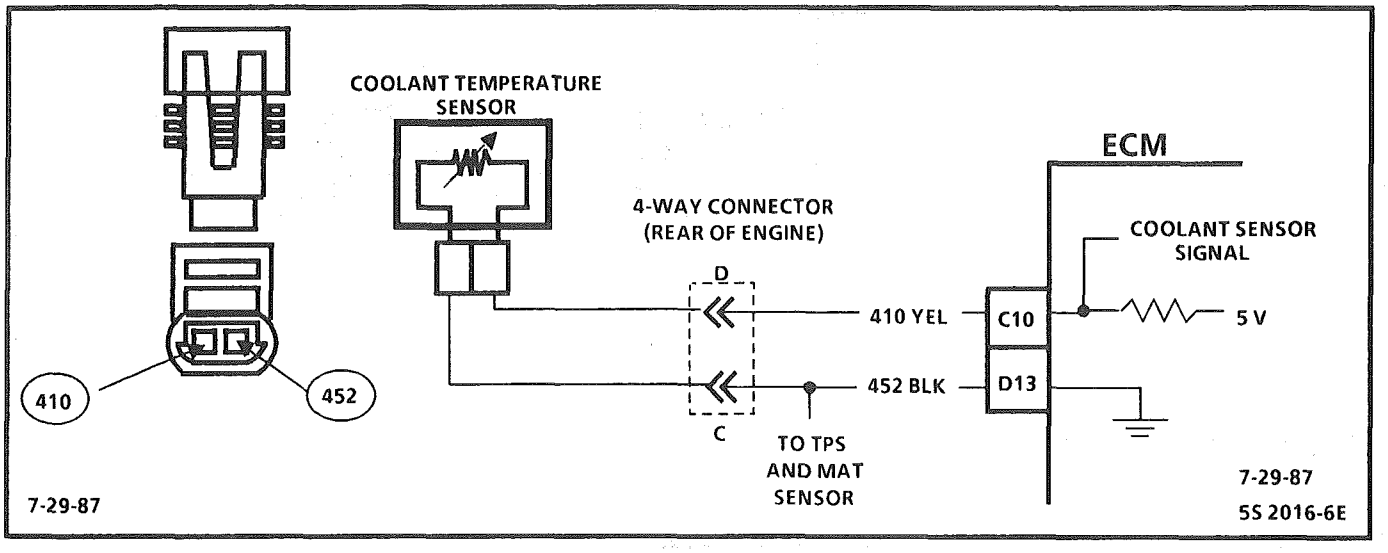

DIAGNOSTIC AID

| COOLANT SENSOR | | |
|---|---|---|
| TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE) | | |
| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

4-28-87

• 7S 3055-6E




# CODE 15

## COOLANT TEMPERATURE SENSOR CIRCUIT (LOW TEMPERATURE INDICATED) 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The coolant temperature sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine is cold the sensor (thermistor) resistance is high, therefore the ECM will see high signal voltage.

As the engine warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (85°C to 95°C) the voltage will measure about 1.5 to 2.0 volts at the ECM.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 15 will set if:
   - Signal voltage indicates a coolant temperature less than -44° C (-47° F) for 3 seconds.
2. This test simulates a Code 14. If the ECM recognizes the low signal voltage, (high temperature) and the "Scan" reads 130°C, the ECM and wiring are OK.
3. This test will determine if CKT 410 is open. There should be 5 volts present at sensor connector if measured with a DVM.

### Diagnostic Aids:

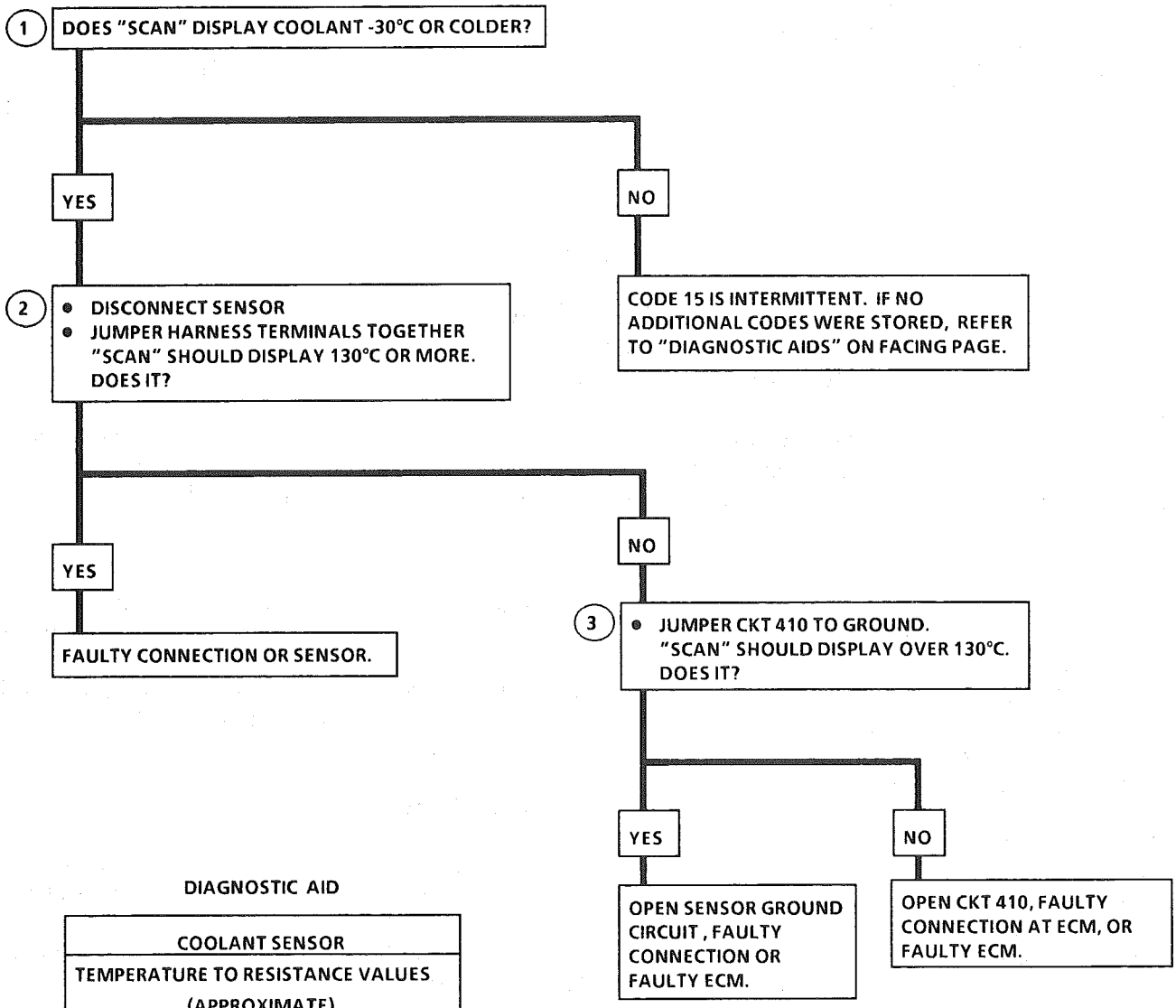
A "SCAN" tool reads engine temperature in degrees centigrade. After engine is started the temperature should rise steadily to about 90°C then stabilize when thermostat opens.

A faulty connection, or an open in CKT 410 or 452 will result in a Code 15.

If Code 23 or 63 is also set, check CKT 452 for faulty wiring or connections. Check terminals at sensor for good contact. Refer to "Intermittents" in Section "B".

# CODE 15

## COOLANT TEMPERATURE SENSOR CIRCUIT
## (LOW TEMPERATURE INDICATED)
## 2.8L (VIN S) "F" SERIES (PORT)

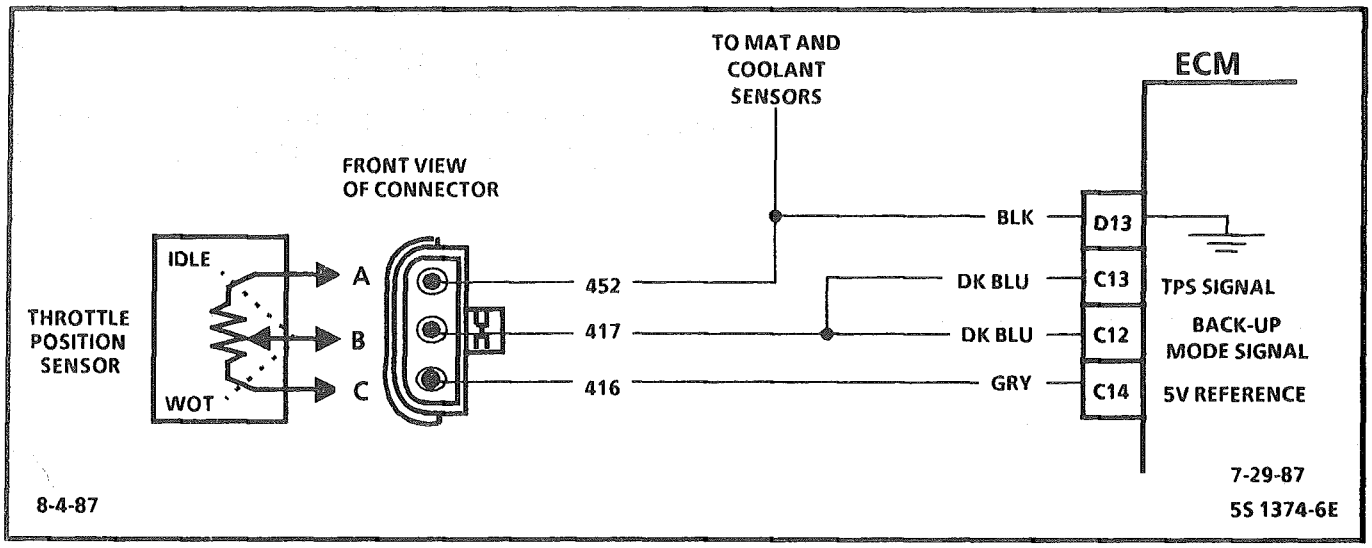



DIAGNOSTIC AID

| COOLANT SENSOR | | |
|---|---|---|
| TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE) | | |
| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-11-87
• 7S 3261-6E




# CODE 21

## THROTTLE POSITION SENSOR (TPS) CIRCUIT
### (SIGNAL VOLTAGE HIGH)
### 2.8L (VIN S) "F" SERIES (PORT)

**Circuit Description:**

The throttle position sensor (TPS) provides a voltage signal that changes relative to the throttle blade. Signal voltage will vary from about .5 at idle to about 5 volts at wide open throttle.

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM control outputs.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 21 will set if:
   - Engine is running
   - TPS signal voltage is greater than 2.5 volts
   - Air flow is less than 12 gm/sec.
   - All conditions met for 5 seconds.

   OR

   - TPS signal voltage over 4.5 volts with ignition "ON".

   The TPS has an auto zeroing feature. If the voltage reading is within the range of 0.35 to 0.7 volts, the ECM will use that value as closed throttle. If the voltage reading is out of the auto zero range at closed throttle, refer to "TPS Adjustment" in Section "6E3-C1".
2. With the TPS sensor disconnected, the TPS voltage should go low if the ECM and wiring is OK.
3. Probing CKT 452 with a test light checks the 5volt return circuit, because a faulty 5volt return will cause a Code 21.

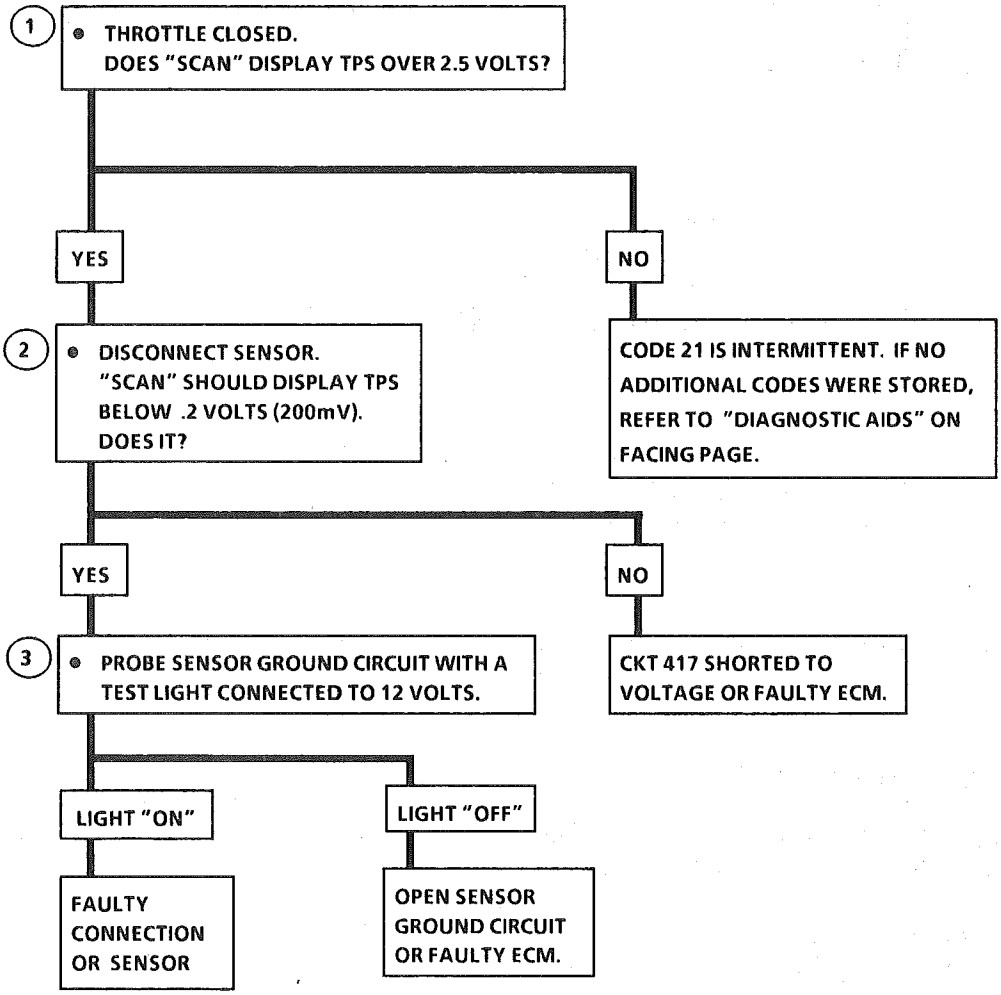
**Diagnostic Aids:**

A "SCAN" tool reads throttle position in volts. Voltage should increase at a steady rate as throttle is moved toward WOT.

An open in CKT 452 will result in a Code 21. Refer to "Intermittents" in Section "B".

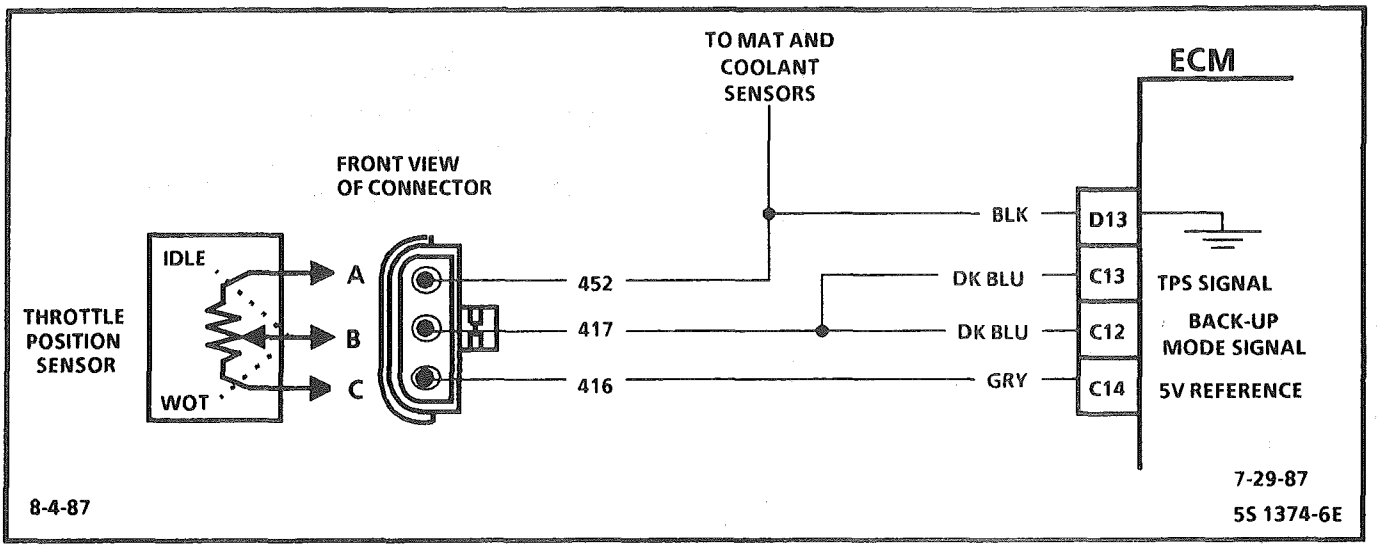
# CODE 21

## THROTTLE POSITION SENSOR (TPS) CIRCUIT
## (SIGNAL VOLTAGE HIGH)
## 2.8L (VIN S) "F" SERIES (PORT)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-24-87
• 7S 3057-6E




# CODE 22

## THROTTLE POSITION SENSOR (TPS) CIRCUIT (SIGNAL VOLTAGE LOW) 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The throttle position sensor (TPS) provides a voltage signal that changes relative to the throttle blade. Signal voltage will vary from about .5 at idle to about 5 volts at wide open throttle.

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM control outputs.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 22 will set if:
   - Engine running
   - TPS signal voltage is less than about .2 volt for 3 seconds.
2. Simulates Code 21: (high voltage) If the ECM recognizes the high signal voltage the ECM and wiring are OK.
3. The TPS has an auto zeroing feature. If the voltage reading is within the range of 0.35 to 0.7 volts, the ECM will use that value as closed throttle. If the voltage reading is out of the auto zero range at closed throttle, refer to "TPS Adjustment" in Section "6E3-C1".
4. This simulates a high signal voltage to check for an open in CKT 417.

### Diagnostic Aids:

A "Scan" tool reads throttle position in volts. Voltage should increase at a steady rate as throttle is moved toward WOT.

An open or short to ground in CKTs 416 or 417 will result in a Code 22.

Refer to "Intermittents" in Section "B".

# CODE 22

## THROTTLE POSITION SENSOR (TPS) CIRCUIT (SIGNAL VOLTAGE LOW) 2.8L (VIN S) "F" SERIES (PORT)

(1) • THROTTLE CLOSED
DOES "SCAN" DISPLAY TPS .2V (200 mV) OR BELOW?

YES

(2) • DISCONNECT TPS SENSOR.
• JUMPER CKTS 416 & 417 TOGETHER.
"SCAN" SHOULD DISPLAY TPS OVER 4.0 V (4000 mV).
DOES IT?

NO

(4) • PROBE CKT 417 WITH A TEST LIGHT CONNECTED TO 12 VOLTS.
"SCAN" TOOL SHOULD DISPLAY TPS OVER 4.0V (4000 mV)
DOES IT?

YES

CKT 416 OPEN.
OR
SHORTED TO GROUND.
OR
FAULTY CONNECTION.
OR
FAULTY ECM.

NO

CKT 417 OPEN.
OR
SHORTED TO GROUND.
OR
SHORTED TO SENSOR GROUND CIRCUIT.
OR
FAULTY ECM CONNECTION.
OR
FAULTY ECM.

NO

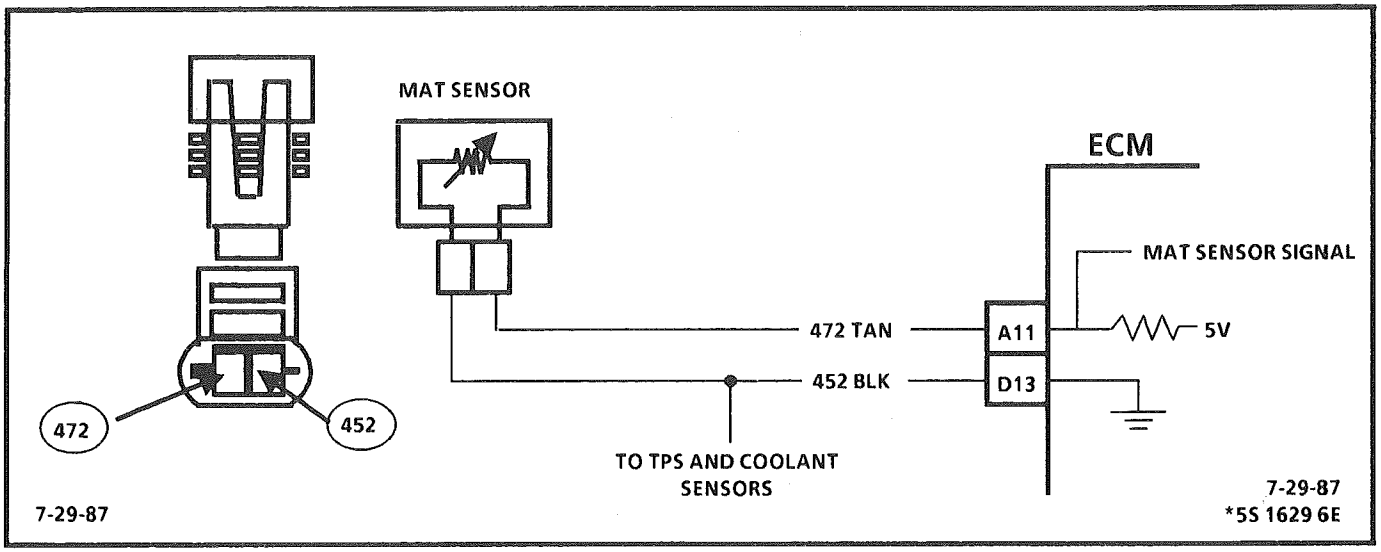
• CODE 22 IS INTERMITTENT.
IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

YES

(3) • REFER TO FACING PAGE FOR SPECIFIC INSTRUCTIONS.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-25-87
• 7S 3365-6E




# CODE 23

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
## (LOW TEMPERATURE INDICATED)
## 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The MAT sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When the air is cold the sensor (thermistor) resistance is high, therefore the ECM will see a high signal voltage. If the air is warm the sensor resistance is low, therefore, the ECM will see a low voltage.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 23 will set if:
   - A signal voltage indicates a manifold air temperature below −35°C (-31°F) for 3 seconds.
   - Time since engine start is 8 minutes or longer.
   - No VSS.
2. A Code 23 will set, due to an open sensor, wire, or connection. This test will determine if the wiring and ECM are OK.
3. This will determine if the signal CKT 472 or the 5V return CKT 452 is open.

### Diagnostic Aids:

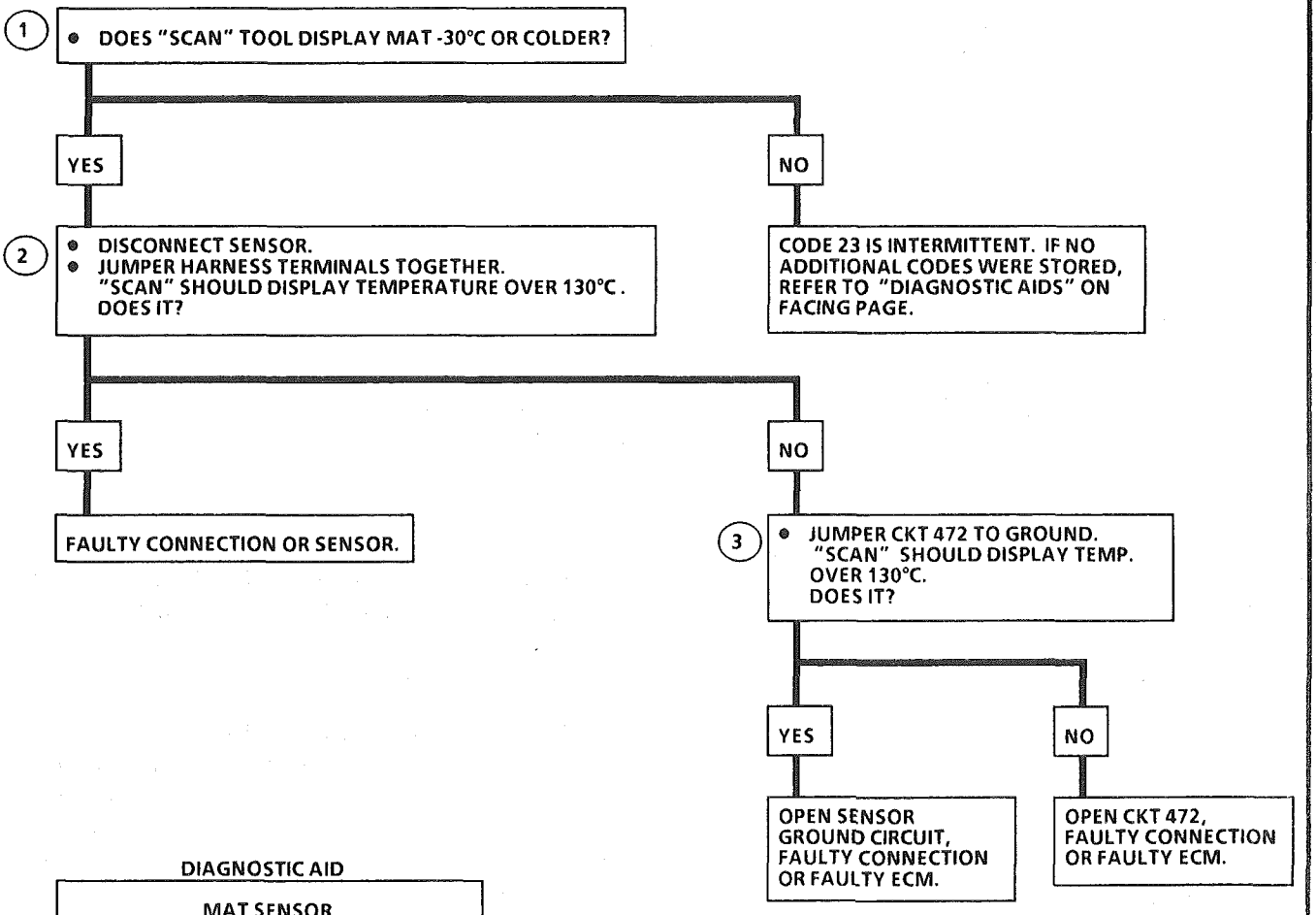
A "SCAN" tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rises as underhood temperature increases.

A faulty connection, or an open in CKT 472 or 452 will result in a Code 23.

Refer to "Intermittents" in Section "B".

# CODE 23

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
## (LOW TEMPERATURE INDICATED)
## 2.8L (VIN S) "F" SERIES (PORT)




DIAGNOSTIC AID

MAT SENSOR

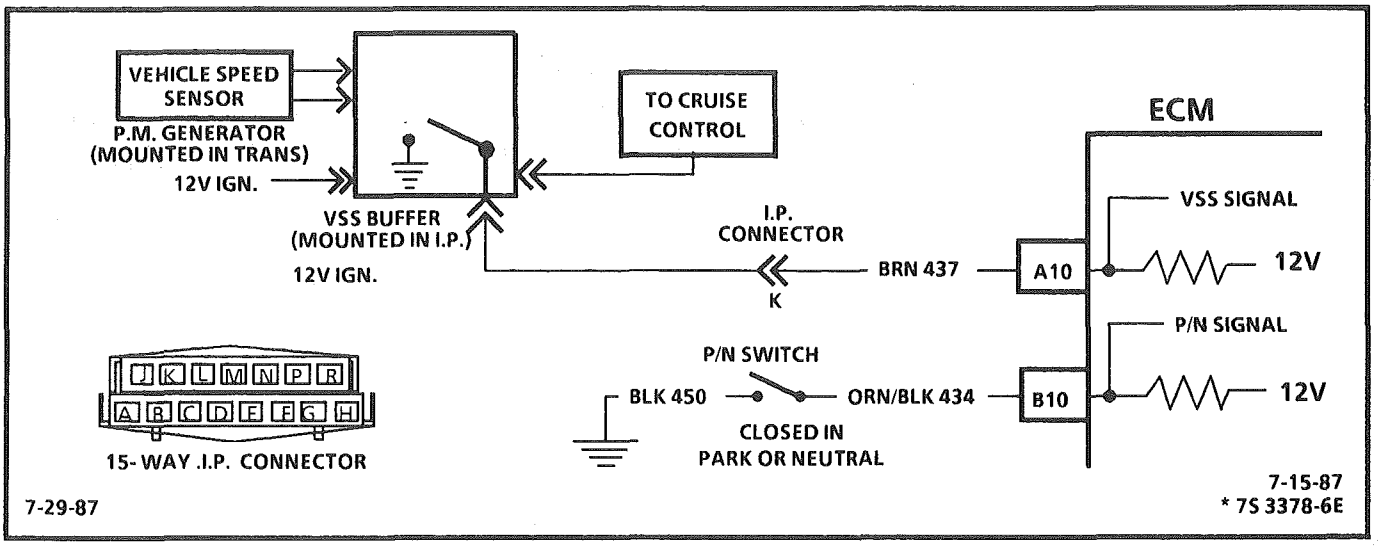
TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)

| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-25-87

• 7S 3285




# CODE 24

## VEHICLE SPEED SENSOR (VSS) CIRCUIT 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The ECM applies and monitors 12 volts on CKT 437. CKT 437 connects to the vehicle speed sensor buffer which alternately grounds CKT 437 when drive wheels are turning. This pulsing action takes place about 2000 times per mile and the ECM will calculate vehicle speed based on the time between "pulses".

A "SCAN" tool reading should closely match with speedometer reading with drive wheels turning.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 24 will set if:
   - CKT 437 voltage is constant.
   - Engine speed between 1400 and 3600 rpm.
   - Less than 2% throttle opening.
   - Low load condition (low air flow).
   - Not in park or neutral.
   - All conditions must be met for 3 seconds.

   These conditions are met during a road load deceleration.
2. A voltage of less than 1 volt at the 15-way connector indicates that the CKT 437 wire may be shorted to ground. Disconnect CKT 437 at the VSS buffer. If voltage now reads above 10 volts, the VSS buffer is faulty.

   If voltage remains less than 10 volt, then CKT 437 wire is grounded or open. If 437 is not grounded or open, check for a faulty ECM connector or ECM.

### Diagnostic Aids:

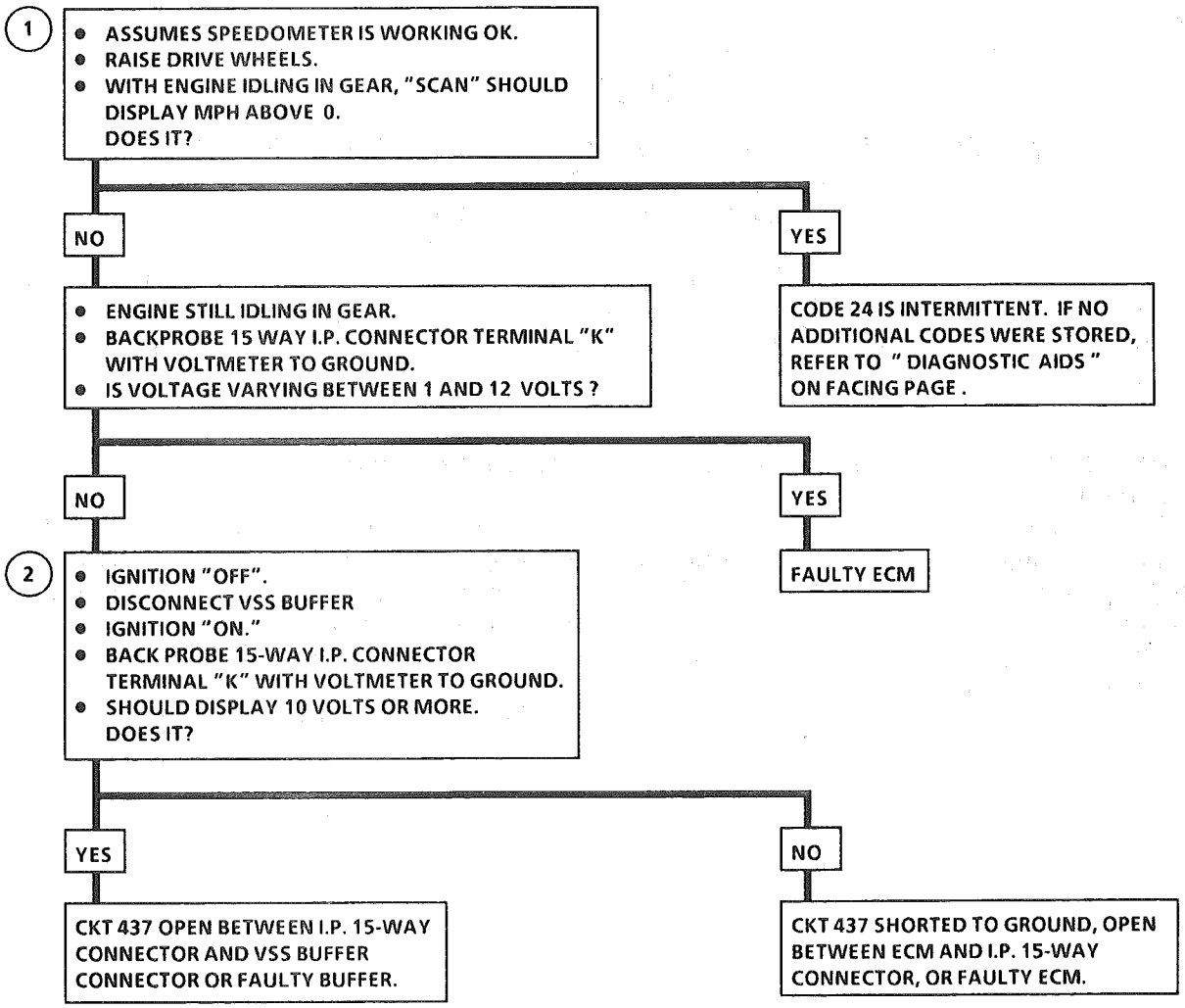
If "Scan" displays vehicle speed, check park/neutral switch CHART C-1A on vehicle with auto trans. If switch is OK, check for intermittent connections. An open or short to ground in CKT 437 will result in a Code 24. If the customer also complained about a loss of mph on the I.P., check the P.M. generator circuit. Refer to Section "8A" for complete wiring diagram.

Refer to "Intermittents" in Section "B".

# CODE 24

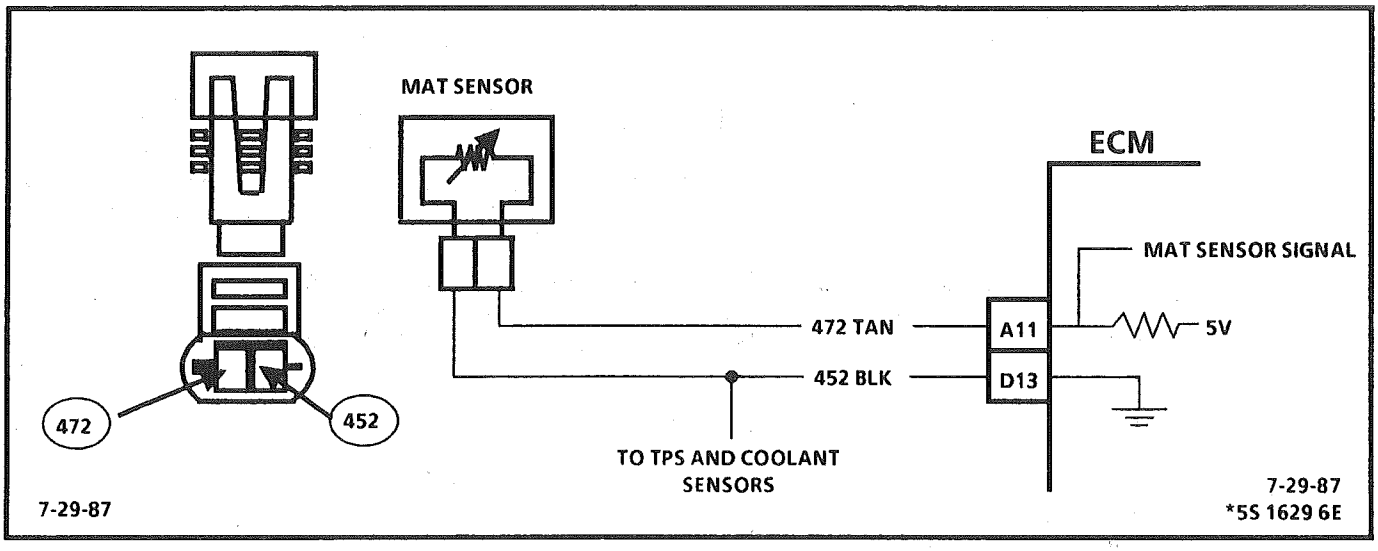
## VEHICLE SPEED SENSOR (VSS) CIRCUIT 2.8L (VIN S) "F" SERIES (PORT)

NOTE: TO PREVENT MISDIAGNOSIS, THE TECHNICIAN SHOULD REVIEW ELECTRICAL SECTION "8A" OR THE ELECTRICAL TROUBLESHOOTING MANUAL AND IDENTIFY THE TYPE OF VEHICLE SPEED SENSOR USED PRIOR TO USING THIS CHART. DISREGARD CODE 24 IF SET WHEN DRIVE WHEELS ARE NOT TURNING.




CLEAR CODES AND CONFIRM "CLOSED LOOP " OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

*8S 4684-6E
7-30-87




# CODE 25

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
## (HIGH TEMPERATURE INDICATED)
## 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The manifold air temperature sensor uses a thermistor to control the signal-voltage to the ECM. The ECM applies a voltage (about 5 volts) on CKT 472 to the sensor. When manifold air is cold, the sensor (thermistor) resistance is high, therefore the ECM will see a high signal voltage. As the air warms, the sensor resistance becomes less, and the voltage drops.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 25 will set if:
   - Signal voltage indicates a manifold air temperature greater than 145°C (293° F) for 3 seconds.
   - Time since engine start is 8 minutes or longer.
   - A vehicle speed is present.

### Diagnostic Aids:

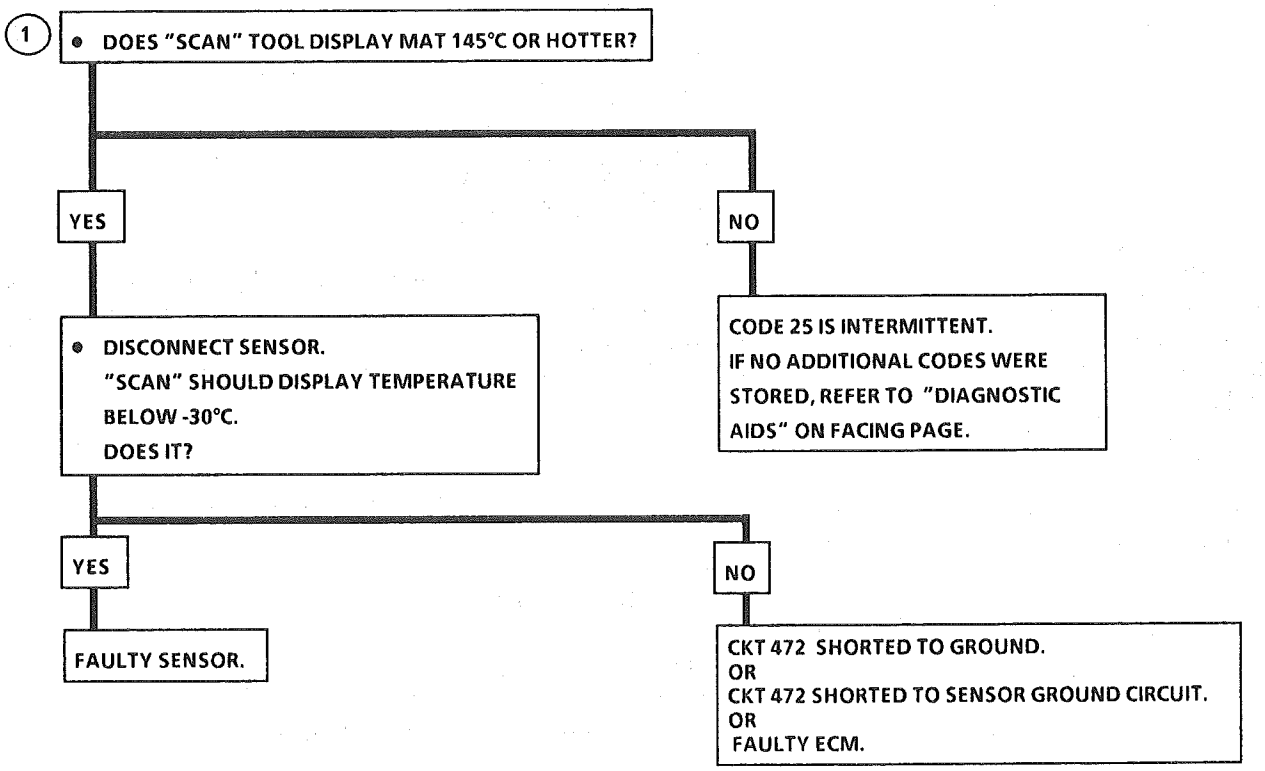
A "SCAN" tool reads temperature of the air entering the engine and should read close to ambient air temperature, when engine is cold, and rises as underhood temperature increases.

A short to ground in CKT 472 will result in a Code 25.

Refer to "Intermittents" in Section "B".

# CODE 25

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
## (HIGH TEMPERATURE INDICATED)
## 2.8L (VIN S) "F" SERIES (PORT)



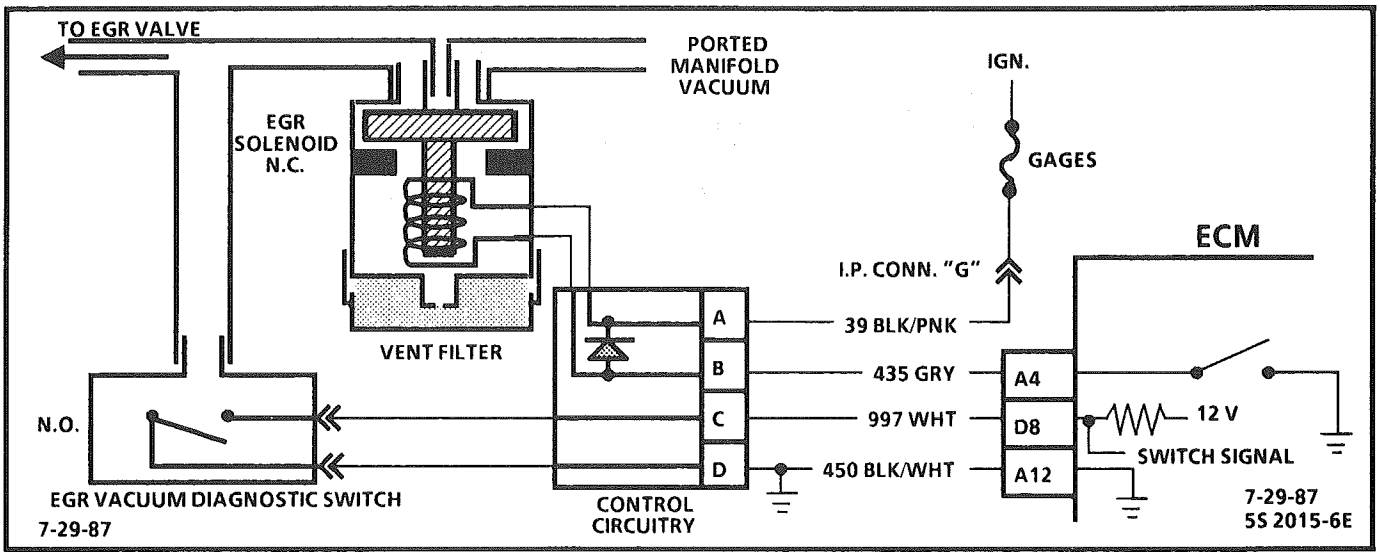

DIAGNOSTIC AID

| MAT SENSOR | | |
|---|---|---|
| TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE) | | |
| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-17-87

• 7S 3190-6E




# CODE 32

## EGR SYSTEM FAILURE
## 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The EGR vacuum control uses an ECM controlled solenoid. The solenoid is normally closed and the vacuum source is a ported signal. The ECM will turn the EGR "ON" and "OFF" (Duty Cycle) by grounding CKT 435. The duty cycle is calculated by the ECM based on information from the coolant and mass airflow sensor and engine rpm. The duty cycle should be 0% (no EGR) when in park or neutral, TPS input below a specified value, or TPS indicating WOT.

With the ignition "ON", engine stopped, the EGR solenoid is de-energized unless the diagnostic terminal is grounded.

Code 32 means that the EGR vacuum diagnostic switch was closed during start-up, or that the switch was not detected closed under the following conditions.

- Coolant temperature greater than 80° C (176°F).
- EGR duty cycle commanded by the ECM is greater than 55%.
- TPS less than half throttle, but not at idle.
- All conditions above must be met for 5 seconds.

If the switch is detected closed during start-up, or , if the switch is detected open when the above conditions are met, the "Service Engine Soon" light will remain "ON" unless the switch changes state.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. If the first step caused Code 32 to set, then the ECM has recognized a closed vacuum switch on start-up. This test will determine whether the EGR vacuum diagnostic switch is the cause or if the wiring or the ECM is the cause.
2. With the ignition "ON", the solenoid should not be energized and vacuum should not pass to the EGR valve.
3. To this point the EGR solenoid and valve are OK and the following check will check the diagnostic vacuum switch portion of the system.
4. The diagnostic switch should close at about 2" of vacuum. With vacuum applied, the switch should close and resistance go to near zero ohms and the vacuum should hold.

# CODE 32

## EGR SYSTEM FAILURE
## 2.8L (VIN S) "F" SERIES (PORT)

*BEFORE USING THIS CHART, CHECK FOR PORTED VACUUM TO EGR SOLENOID, ALSO CHECK HOSES FOR LEAKS OR RESTRICTIONS. SHOULD BE AT LEAST 23.64 kPa (7") HG VACUUM AT 2000 RPM.*

- IGNITION "OFF", CLEAR CODES.
- START ENGINE. AND IDLE FOR 30 SECONDS OR UNTIL CODE 32 SETS.

**NO CODE 32**

(2)
- DISCONNECT EGR SOLENOID VACUUM HARNESS.
- ROTATE HARNESS AND REINSTALL ONLY THE EGR VALVE SIDE.
- IGNITION "ON", ENGINE STOPPED.
- INSTALL A HAND HELD VACUUM PUMP WITH GAGE TO MANIFOLD SIDE OF EGR SOLENOID.
- APPLY VACUUM AND OBSERVE EGR VALVE.
- VALVE SHOULD NOT MOVE.

**VALVE DOES NOT MOVE**
- GROUND DIAGNOSTIC TERMINAL.
- REPEAT TEST.

**VALVE MOVES**
- DISCONNECT EGR SOLENOID ELECTRICAL CONNECTOR.
- REPEAT TEST.

**VALVE MOVES**

(3)
- DISCONNECT EGR 4-WAY CONNECTOR.
- CONNECT VOLTMETER BETWEEN "C" & "D".
- IGNITION "ON".

**OVER 10 VOLTS**

(4)
- CONNECT OHMMETER ACROSS TERMINALS "C" & "D" OF SOLENOID.
- APPLY 23.64 kPa (7") VACUUM TO VACUUM DIAGNOSTIC SWITCH.
- NOTE RESISTANCE.

**LOW RESISTANCE (SWITCH CLOSED)**

PROBLEM IS INTERMITTENT, CHECK ALL CONNECTIONS AND TERMINALS.

**HIGH RESISTANCE (SWITCH OPEN)**

FAULTY SWITCH, WIRING OR CONNECTIONS.

**UNDER 10 VOLTS**

CONNECT VOLTMETER BETWEEN TERMINAL "C" AND CHASSIS GROUND.

**VALVE DOES NOT MOVE**
- DISCONNECT EGR 4-WAY CONNECTOR
- CONNECT TEST LIGHT BETWEEN HARNESS TERMINALS "A" & "B".

**LIGHT "ON"**
- CONNECT VACUUM PUMP TO EGR VALVE.
- APPLY VACUUM AND OBSERVE VALVE.

**VALVE MOVES**

FAULTY HOSE OR CONNECTION BETWEEN EGR SOLENOID AND EGR VALVE OR FAULTY EGR SOLENOID.

**OVER 10 VOLTS**

REPAIR OPEN GROUND CKT 450.

**VALVE DOES NOT MOVE**

REPLACE EGR VALVE

**UNDER 10 VOLTS**

CHECK CKT 997 FOR OPEN. IF NOT OPEN, IT IS A FAULTY ECM. SEE ECM QUAD DRIVER CHECK (CHART C-1).

**LIGHT "OFF"**

CONNECT TEST LIGHT BETWEEN "A" AND GROUND.

**NO LIGHT**

REPAIR OPEN CKT 39.

**LIGHT**

REPAIR OPEN CKT 435. IF NOT OPEN, IT IS A FAULTY ECM. SEE ECM QUAD DRIVER CHECK (CHART C-1).

**CODE 32**

(1)
- CLEAR CODES.
- DISCONNECT EGR SOLENOID 4-WAY CONNECTOR.
- REPEAT TEST.

**NO CODE 32**

CHECK FOR A STUCK CLOSED SWITCH. IF NOT CLOSED, IT IS FAULTY WIRING OR CONNECTIONS.

**VALVE MOVES**

FAULTY EGR SOLENOID

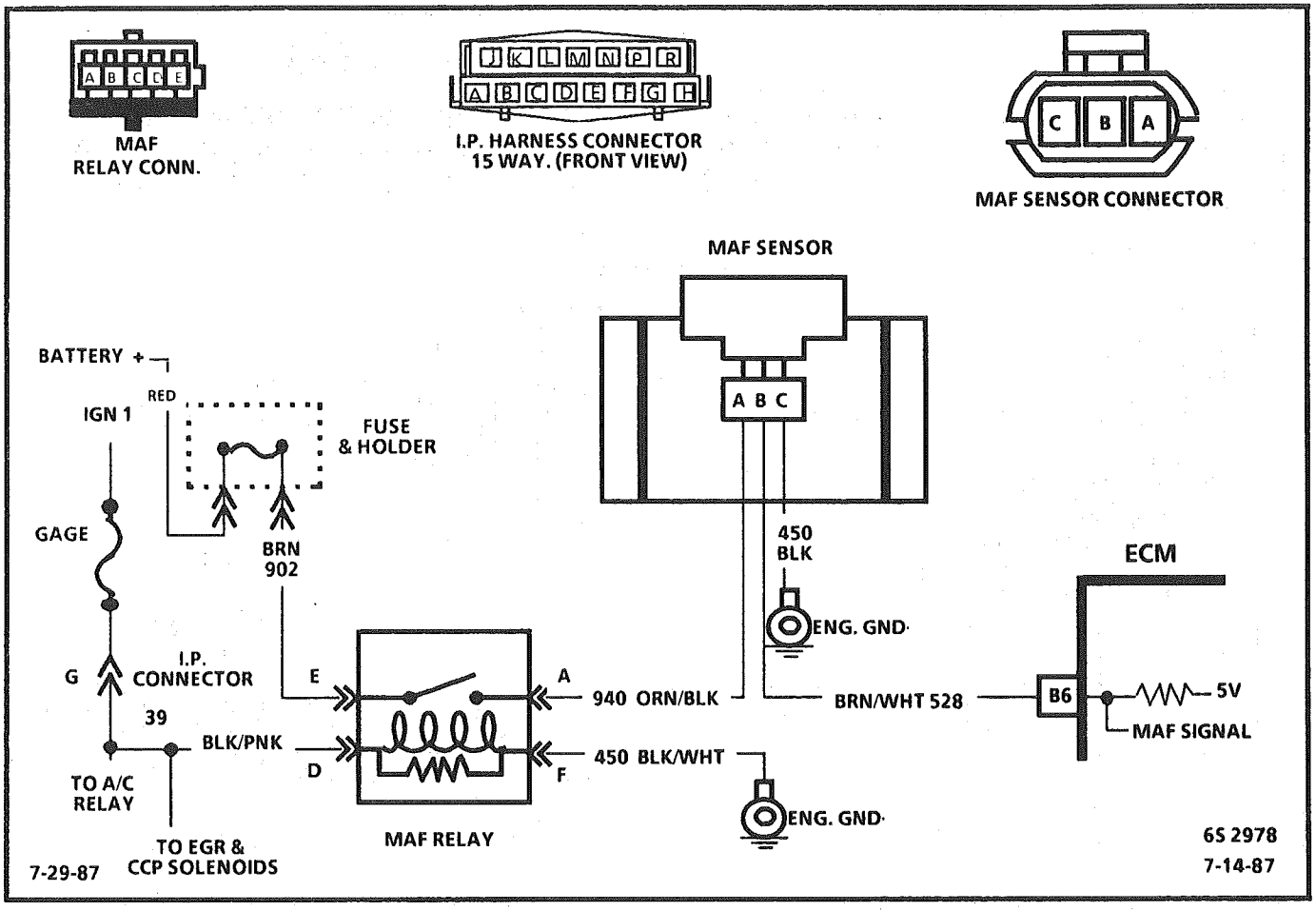
**CODE 32**

CHECK CKT 997 FOR SHORT TO GROUND. IF NOT SHORTED IT IS A FAULTY ECM.

**VALVE DOES NOT MOVE**

CHECK CKT 435 FOR SHORT TO GROUND. IF OK, IT IS A FAULTY ECM. SEE ECM QUAD DRIVER CHECK (CHART C-1).

7-29-87
5S 1602-6E




# CODE 33

## MASS AIR FLOW (MAF) SENSOR CIRCUIT
## (GM/SEC HIGH)
## 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The MAF sensor measures the flow of air entering the engine. The sensor produces a frequency output between 32 and 150 hertz (3gm/sec to 150gm/sec). A large quantity (high frequency) indicates acceleration, and a small quantity (low frequency) indicates deceleration or idle. This information is used by the ECM for fuel control and is converted by a "Scan" tool to read out the air flow in grams per second. A normal reading is about 4-7 grams per second at idle and increases with rpm.

The MAF sensor is powered up by the MAF sensor relay and the sensor should have power supplied to it anytime the ignition is "ON".

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 33 will set if:
   - Ign. "ON" and air flow exceeds 20gm/sec.
     OR
   - Engine is running less than 1300 rpm.
   - TPS is 8% or less.
   - Air flow greater than 20 grams per second (high frequency).
   - All of the above are met for 2 seconds.

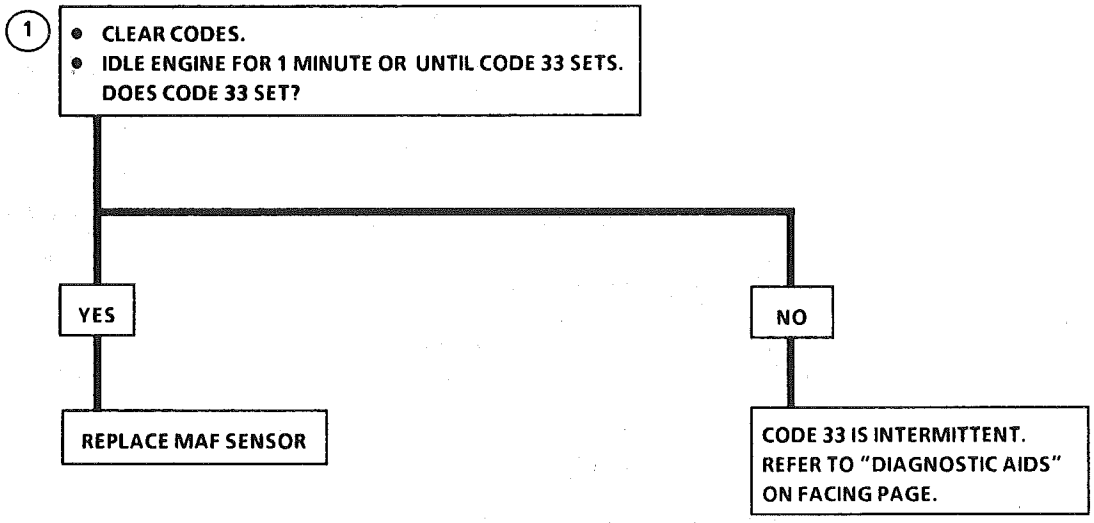
### Diagnostic Aids:

The "Scan" tool is not of much use in diagnosing this code because when the code sets gm/sec will be displaying the default value. However, the "Scan" may be useful in comparing the signal of a problem vehicle with that of a known good running one.

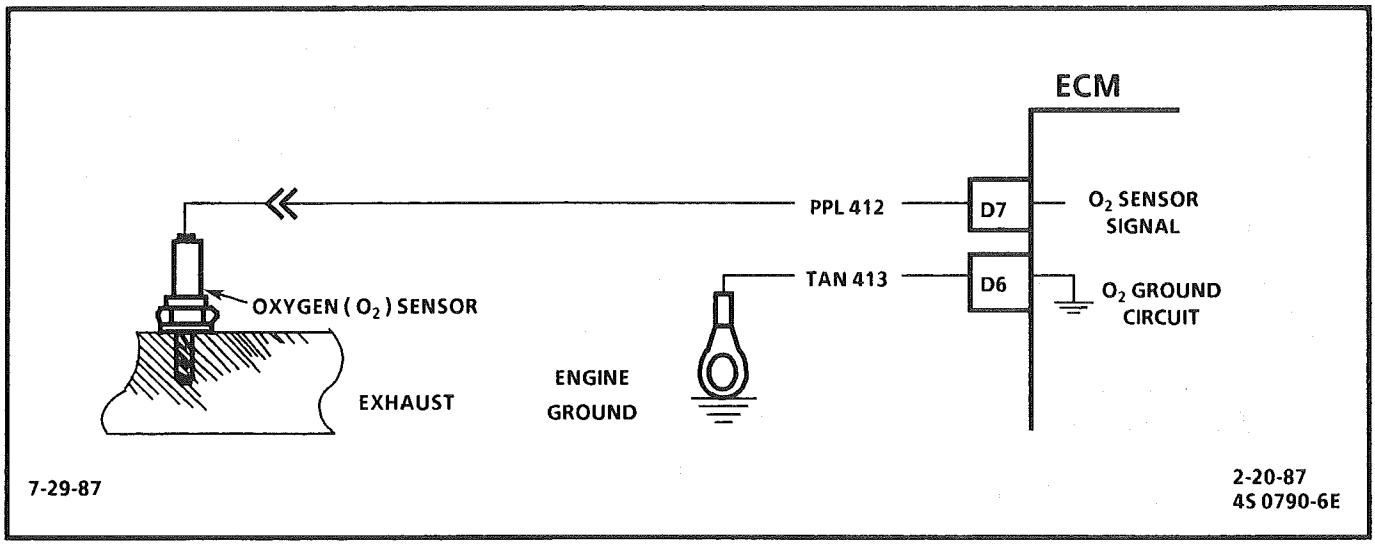
Refer to "Intermittents" in Section "B".

# CODE 33

## MASS AIR FLOW (MAF) SENSOR CIRCUIT
## (GM/SEC HIGH)
## 2.8L (VIN S) "F" SERIES (PORT)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.




# CODE 44

## OXYGEN SENSOR CIRCUIT
## (LEAN EXHAUST INDICATED)
## 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D6" and "D7". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volts.) The $O_2$ sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 360°C (600°F) An open sensor circuit or cold sensor causes open loop operation.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 44 is set when the $O_2$ sensor signal voltage on CKT 412.
   - Remains below .2 volt for 60 seconds or more:
   - And the system is operating in "Closed Loop".

### Diagnostic Aids:

Using the "Scan", observe the block learn values at different rpm and air flow conditions. If the conditions for Code 44 exists the block learn values will be around 150.

- $O_2$ Sensor Wire Sensor pigtail may be mispositioned and contacting the exhaust manifold.
- Check for intermittent ground in wire between connector and sensor.
- MAF Sensor A mass air flow (MAF) sensor output that causes the ECM to sense a lower than normal air flow will cause the system to go lean. Disconnect the MAF sensor and if the lean condition is gone, check for a Code 34.
- Lean Injector(s) Perform injector balance test, CHART C-2A.
- Fuel Contamination Water, even in small amounts, near the in-tank fuel pump inlet can be delivered to the injectors. The water causes a lean exhaust and can set a Code 44.
- Fuel Pressure System will be lean if pressure is too low. It may be necessary to monitor fuel pressure while driving the car at various road speeds and/or loads to confirm. See "Fuel System Diagnosis", CHART A-7.
- Exhaust Leaks If there is an exhaust leak, the engine can cause outside air to be pulled into the exhaust and past the sensor. Vacuum or crankcase leaks can cause a lean condition.
- Air System (manual trans only)
  Be sure air is not being directed to the exhaust ports while in "Closed Loop". If the block learn value goes down while squeezing air hose to exhaust ports , refer to CHART C-6.
- If the above are OK, it is a faulty oxygen sensor.

# CODE 44

## OXYGEN SENSOR CIRCUIT (LEAN EXHAUST INDICATED) 2.8L (VIN S) "F" SERIES (PORT)

- RUN WARM ENGINE (75°C TO 95°C) AT 1200 RPM.
- DOES "SCAN" INDICATE $O_2$ SENSOR VOLTAGE FIXED BELOW .35 VOLTS (350 mV)?

YES

- DISCONNECT $O_2$ SENSOR.
- WITH ENGINE IDLING "SCAN" SHOULD DISPLAY $O_2$ SENSOR BETWEEN .35 VOLTS AND .55 VOLTS (350 mV AND 550 mV).
  DOES IT?

YES

REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE..

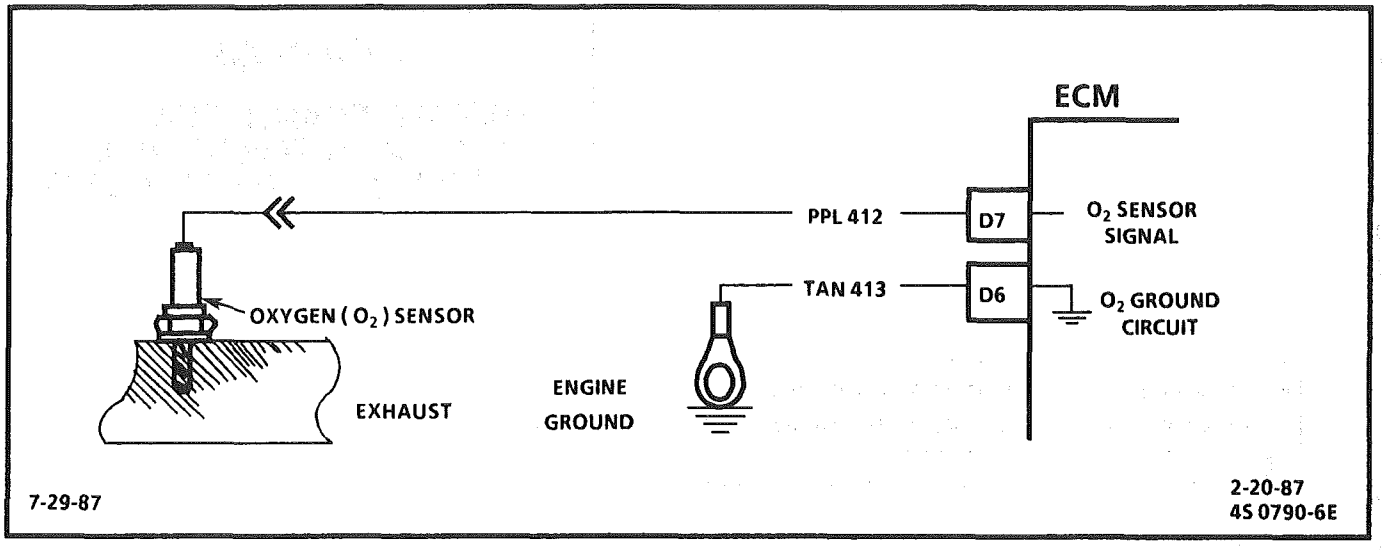
NO

CKT 412 SHORTED TO GROUND OR FAULTY ECM.

NO

CODE 44 IS INTERMITTENT.
IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.




# CODE 45

## OXYGEN SENSOR CIRCUIT
## (RICH EXHAUST INDICATED)
## 2.8L (VIN S) "F" SERIES (PORT)

### Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D6" and "D7". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volts.) The $O_2$ sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 315°C (600°F). An open sensor circuit or cold sensor causes open loop operation.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 45 is set when the $O_2$ sensor signal voltage or CKT 412.
   - Remains above .7 volt for 30 seconds; and in "Closed Loop".
   - Engine time after start is 1 minute or more.
   - Throttle less than 1/2 open but not at idle.

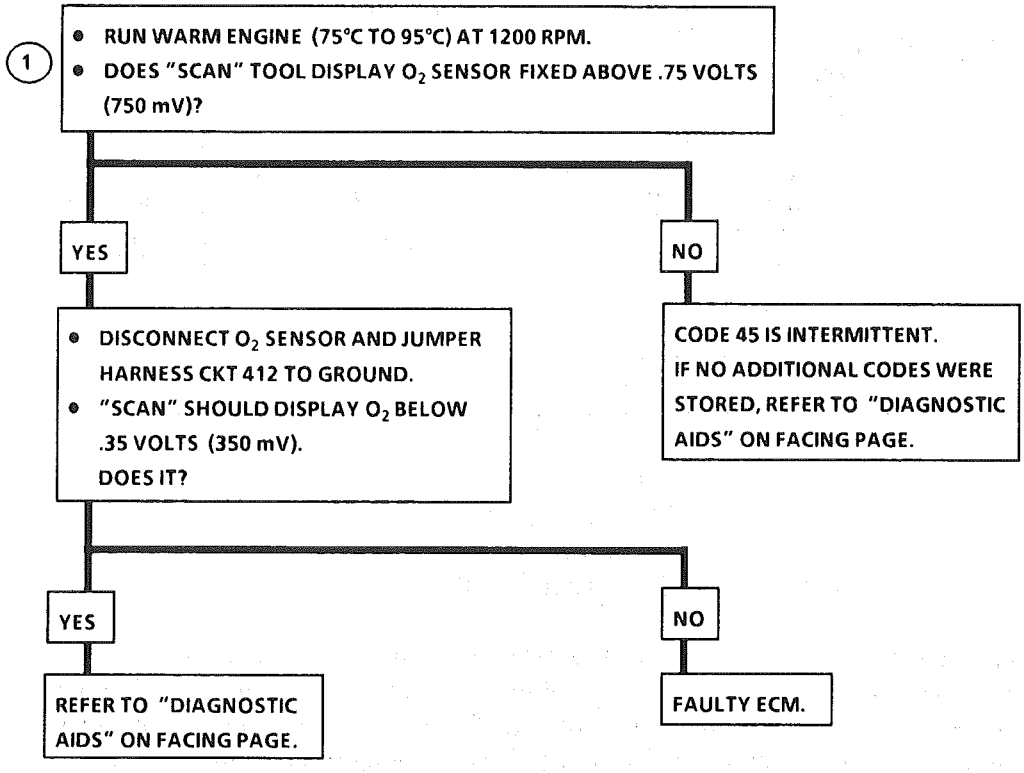
### Diagnostic Aids:

Using the "Scan", observe the block learn values at different rpm and air flow conditions. If the conditions for Code 45 exists, the block learn values will be around 115.

- Fuel Pressure System will go rich if pressure is too high. The ECM can compensate for some increase. However, if it gets too high, a Code 45 may be set. See "Fuel System Diagnosis", CHART A-7.
- Rich Injector Perform injector balance test CHART C-2A.
- Leaking Injector See CHART A-7.
- Check for fuel contaminated oil.
- HEI Shielding An open ground CKT 453 (ignition system reflow) may result in EMI, or induced electrical "noise". The ECM looks at this "noise" as reference pulses. The additional pulses result in a higher than actual engine speed signal. The ECM then delivers too much fuel, causing system to go rich. Engine tachometer will also show higher than actual engine speed, which can help in diagnosing this problem.
- Canister Purge Check for fuel saturation. If full of fuel, check canister control and hoses. See "Canister Purge", Section "C3".
- MAF Sensor An output that causes the ECM to sense a higher than normal airflow can cause the system to go rich. Disconnecting the MAF sensor will allow the ECM to set a fixed value for the sensor. Substitute a different MAF sensor if the the rich condition is gone while the sensor is disconnected. Check for a Code 34.
- Check for leaking fuel pressure regulator diaphragm by checking vacuum line to regulator for fuel.
- TPS An intermittent TPS output will cause the system to go rich, due to a false indication of the engine accelerating.
- EGR An EGR staying open (especially at idle) will cause the $O_2$ sensor to indicate a rich exhaust.

# CODE 45

## OXYGEN SENSOR CIRCUIT
## (RICH EXHAUST INDICATED)
## 2.8L (VIN S) "F" SERIES (PORT)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-27-87
*7S 3192-6E

- A faulty in-tank fuel pump check valve will allow the fuel in the lines to drain back to the tank after the engine is stopped. To check for this condition:
  Perform Fuel System Diagnosis, CHART A-7.
- Remove spark plugs. Check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- If engine starts but then immediately stalls, open distributor by-pass line. If engine then starts and runs OK, replace pickup coil.
- If engine starts and stalls, disconnect MAF sensor. If engine then runs and sensor connections are OK, replace the sensor.

## HESITATION, SAG, STUMBLE

**Definition:** Momentary lack of response as the accelerator is pushed down. Can occur at all car speeds. Usually most severe when first trying to make the car move, as from a stop sign. May cause the engine to stall if severe enough.

- Perform careful visual check as described at start of Section "B".
- **CHECK:**
  - Fuel pressure. See CHART A-7. Also check for water contaminated fuel.
  - Air leaks at air duct between MAF sensor and throttle body.
  - Spark plugs for being fouled or faulty wiring.
  - PROM (2.8L) or MEM-CAL (5.0L & 5.7L) number. Also check service bulletins for latest MEM-CAL or PROM.
  - TPS for binding or sticking. Voltage should increase at a steady rate as throttle is moved toward WOT.
  - Ignition timing. See Emission Control Information label.
  - Generator output voltage. Repair if less than 9 or more than 16 volts.
  - HEI ground, CKT 453.
  - Canister purge system for proper operation. See CHART C-3.
  - EGR - See CHART C-7.
- Perform injector balance test CHART C-2A.

## SURGES AND/OR CHUGGLE

**Definition:** Engine power variation under steady throttle or cruise. Feels like the car speeds up and slows down with no change in the accelerator pedal.

- Be sure driver understands transmission converter clutch and A/C compressor operation in Owner's Manual.
- Perform careful visual inspection as described at start of Section "B".
- **CHECK:**
  - TCC and 4th gear switch operation - See CHART C-8A.
  - Loose or leaking air duct between MAF sensor and throttle body.
  - Generator output voltage. Repair if less than 9 or more than 16 volts.
  - EGR - There should be no EGR at idle. See CHART C-7. Also check for plugged EGR solenoid filter.
  - Vacuum lines for kinks or leaks.
  - Ignition timing. See Emission Control Information label.
  - In-line fuel filter. Replace if dirty or plugged.
  - Fuel pressure while condition exists. See CHART A-7.
- Inspect oxygen sensor for silicone contamination from fuel, or use of improper RTV sealant. The sensor may have a white, powdery coating and result in a high but false signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem.
- Remove spark plugs. Check for cracks, wear, improper gap, burned electrodes, or heavy deposits. Also check condition of distributor cap, rotor, and spark plug wires.
- To help determine if the condition is caused by a rich or lean system, the car should be driven at the speed of the complaint. Monitoring block learn at the complaint speed will help identify the cause of the problem. If the system is runnig lean (block learn greater than 138), refer to "Diagnostic Aids" on facing page of Code 44. If the system is running rich (block learn less than 118), refer to "Diagnostic Aids" on facing page of Code 45.

## LACK OF POWER, SLUGGISH, OR SPONGY

**Definition:** Engine delivers less than expected power. Little or no increase in speed when accelerator pedal is pushed down part way.

- Perform careful visual check as described at start of Section "B".
- Compare customer's car to similar unit. Make sure the customer's car has an actual problem.
- Remove air cleaner and check air filter for dirt, or for being plugged. Replace as necessary.
- **CHECK:**
  - For loose or leaking air duct between MAF Sensor and throttle body.
  - Ignition timing. See Emission Control Information label.
  - Restricted fuel filter, contaminated fuel or improper fuel pressure. See CHART A-7.
  - ECM ground circuits - See ECM wiring diagrams.
  - EGR operation for being open or partly open all the time - CHART C-7.
  - Exhaust system for possible restriction: See CHART B-1.
    - Inspect exhaust system for damaged or collapsed pipes.
    - Inspect muffler for heat distress or possible internal failure.
  - Generator output voltage. Repair if less than 9 or more than 16 volts.
  - Engine valve timing and compression.
  - Engine for proper or worn camshaft. See Section "6A".
  - Secondary voltage using a shop ocilliscope or a spark tester J-26792 (ST-125) or equivalent.

## DETONATION /SPARK KNOCK

**Definition:** A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening. Sounds like popcorn popping.

- Check for obvious overheating problems:
  - Low coolant.
  - Loose water pump belt.
  - Restricted air flow to radiator, or restricted water flow thru radiator.
  - Inoperative electric cooling fan circuit. See CHART C-12.
- **CHECK:**
  - Ignition timing. See Vehicle Emission Control Information label.
  - EGR system for not opening - CHART C-7.
  - TCC operation - CHART C-8.
  - Fuel system pressure. See CHART A-7.
  - PROM or MEM-CAL - Be sure it's the correct one. (See Service Bulletins)
  - Valve oil seals for leaking.
- Check for incorrect basic engine parts such as cam, heads, pistons, etc.
- Check for poor fuel quality.
- Remove carbon with top engine cleaner. Follow instructions on can.
- Check ESC system (5.0L & 5.7L) See CHART C-5
- To help determine if the condition is caused by a rich or lean system, the car should be driven at the speed of the complaint. Monitoring block learn at the complaint speed will help identify the cause of the problem. If the system is runnig lean (block learn greater than 138), refer to "Diagnostic Aids" on facing page of Code 44. If the system is running rich (block learn less than 118), refer to "Diagnostic Aids" on facing page of Code 45.

## CUTS OUT, MISSES

**Definition:** Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

- Perform careful visual check as described at start of Section "B".
- Check for missing cylinder by:
  1. Disconnect IAC valve. Start engine. Remove one spark plug wire at a time using insulated pliers.
  2. If there is an rpm drop on all cylinders (equal to within 50 rpm), go to "ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING" symptom. Reconnect IAC valve.
  3. If there is no rpm drop on one or more cylinders, or excessive variation in drop, check for spark on the suspected cylinder(s) with J 26792 (ST-125) Spark Gap Tool or equivalent. If no spark, see Section "6D" for intermittent operation or miss. If there is spark, remove spark plug(s) in these cylinders and check for:
     - Cracks
     - Wear
     - Improper gap
     - Burned electrodes
     - Heavy deposits
- Perform compression check on questionable cylinder(s) found above. If compression is low, repair as necessary. See Section "6".
- Disconnect all injector harness connectors. Connect J-34730-2 injector test light or equivalent 6 volt test light between the harness terms, of each injector connector and note light while cranking. If test light fails to blink at any connector, it is a faulty injector drive circuit harness, connector, or terminal.
- Perform the injector balance test. See CHART C-2A.
- **CHECK:**
  - Spark plug wires by connecting ohmmeter to ends of each wire in question. If meter reads over 30,000 ohms, replace wire(s).
  - Fuel System - Plugged fuel filter, water, low pressure. See CHART A-7.
  - Valve timing.
  - Secondary voltage using a shop ocilliscope or a spark tester J-26792 (ST-125) or equivalent.
- Visually inspect distributor cap and rotor for moisture, dust, cracks, burns, etc. Spray cap and plug wires with fine water mist to check for shorts.
- A miss condition can be caused by EMI (Electromagnetic Interference) on the reference circuit. EMI can usually be detected by monitoring engine rpm with a "Scan" tool. A sudden increase in rpm with little change in actual engine rpm change, indicates EMI is present.
  If the problem exists, check routing of secondary wires, check all distributor ground circuits.
- Remove rocker covers. Check for bent pushrods, worn rocker arms, broken valve springs, worn camshaft lobes. Repair as necessary. See Section "6A".

## BACKFIRE

**Definition:** Fuel ignites in intake manifold, or in exhaust system, making a loud popping noise.

- **CHECK:**
  - Loose wiring connector or air duct at MAF sensor.
  - Compression - Look for sticking or leaking valves.
  - EGR operation for being open all the time. See CHART C-7.
  - EGR gasket for faulty or loose fit .
  - Valve timing.
  - Output voltage of ignition coil using a shop ocilliscope or spark tester J-26792 (ST-125) or equivalent.
  - Spark plugs for crossfire also inspect (distributor cap, spark plug wires, and proper routing of plug wires).
  - Ignition system for intermittent condition. (See Section "6D").
  - Engine timing - see Emission Control Information label.
  - Perform fuel system diagnosis check, CHART A-7A.
  - Perform injector balance test, CHART C-2A.
  - Deceleration valve (2.8L manual/trans) - See Section "C6".
  - A.I.R. system check valves - See Section "C-6".

The ECM supplies a 5-volt signal to the sensor thru a resistor in the ECM and measures the voltage. The voltage will be high when the manifold air is cold, and low when the air is hot. By measuring the voltage, the ECM knows the manifold air temperature.

The 2.8L uses the signal to slightly retard the timing during high ambient air temperatures and to help compensate the MAF sensor based on air temperature.

A failure in the MAT sensor circuit should set either a Code 23 or Code 25.

## Oxygen ($O_2$) Sensor (Fig. C1-4)

The exhaust oxygen sensor ($O_2$) is mounted in the exhaust system where it can monitor the oxygen content of the exhaust gas stream. The oxygen content in the exhaust reacts with the sensor to produce a voltage output. This voltage ranges from approximately .1 volt (high $O_2$ - lean mixture) to .9 volts (low $O_2$ - rich mixture). This voltage can be measured with a digital voltmeter having at least 10 megohms input impedance. Use of standard shop type voltmeters will result in very inaccurate readings.

By monitoring the voltage output of the $O_2$ sensor, the ECM will know what fuel mixture command to give to the Injector (lean mixture-low $O_2$ voltage = rich command, rich mixture-high $O_2$ voltage = lean command).

The $O_2$ sensor, if open, should set a Code 13. A low voltage in the sensor circuit should set a Code 44. A high voltage in the circuit should set a Code 45. Codes 44 and 45 could also be set as a result of fuel system problems. See code charts.

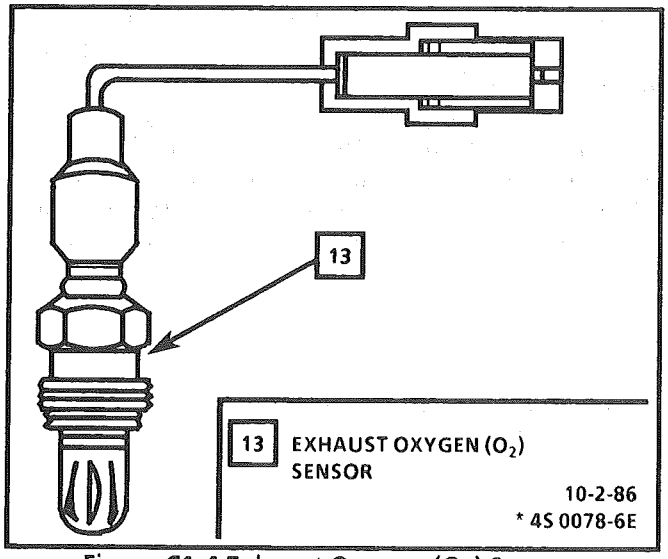



Figure C1-4 Exhaust Oxygen ($O_2$) Sensor

## Throttle Position Sensor (TPS) (Fig. C1-5)

The throttle position sensor (TPS) is connected to the throttle shaft on the throttle body. It is a potentiometer with one end connected to 5 volts from the ECM and the other to ECM ground. A third wire is connected to the ECM to measure the voltage from the TPS. As the throttle valve angle is changed (accelerator pedal moved), the output of the TPS also changes. At a closed throttle position, the output of the TPS is low (approximately .5 volts). As the throttle valve opens, the output increases so that, at wide open throttle, the output voltage should be approximately 5 volts.

By monitoring the output voltage from the TPS, the ECM can determine fuel delivery based on throttle valve angle (driver demand). A broken or loose TPS can cause intermittent bursts of fuel from the injector, and an unstable idle, because the ECM thinks the throttle is moving. A problem in any of the TPS circuits will set either a Code 21 or 22. Once a trouble code is set, the ECM will use an artificial default value for TPS, and some vehicle performance will return.

See "On-Car Service" for replacement or adjustment of TPS.

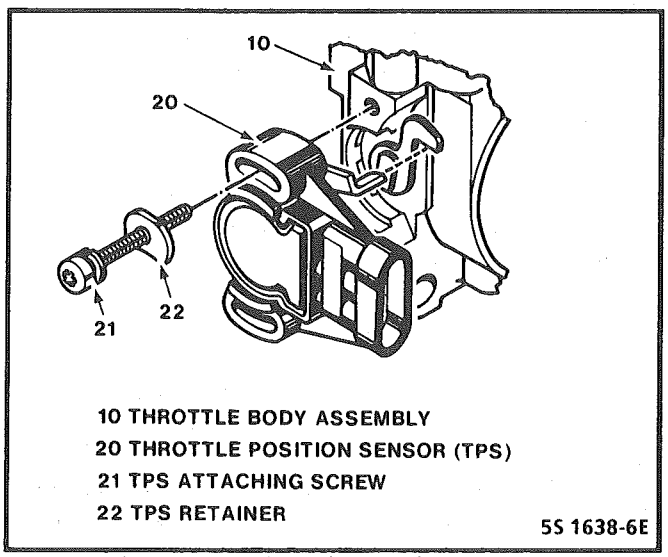



Figure C1-5 Throttle Position Sensor

## Vehicle Speed Sensor

The vehicle speed sensor (VSS) sends a pulsing voltage signal to the ECM, which the ECM converts to miles per hour. This sensor mainly controls the operation of the TCC system. See "TCC System" for more information.

### ECM Inputs

All of the sensors and input switches can be diagnosed by the use of a "Scan" tool. Following is a short description of how the sensors and switches can be diagnosed by the use of "Scan". The "Scan" can also be used to compare the values for a normal running engine with the engine you're diagnosing.

### Coolant Temperature Sensor

A "Scan" tool displays engine temperature in degrees centigrade. After engine is started, the temperature should rise steadily to about 90°C then stabilize when thermostat opens. If the engine has not been run for several hours (overnight) the coolant temperature and MAT temperatures should read close to each other. A fault in the coolant sensor circuit should set a Code 14 or 15. The code charts also contain a chart to check for sensor resistance values relative to temperature.

### MAF Sensor

A "Scan" tool reads the MAF value and displays it in grams per second. Should read between 4-7 on a fully warmed up idling engine. Values should change rather quickly on acceleration, but values should remain fairly stable at any given RPM. Most "Scan" tools will have 2 positions for reading MAF sensor values. (MAF & Air Flow). Both values should read the same if no Code 33 or 34 is set, but if a code is set, the MAF values will be the default value and the Air Flow parameter will lock in on the value to which the ECM recognized the fault. A failure in the MAF sensor or circuit should set a Code 33 or 34.

### MAT Sensor

A "Scan" tool displays temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rise as underhood temperature increases. If the engine has not been run for several hours (overnight) the MAT sensor temperature and coolant temperature should read close to each other. A failure in the MAT sensor circuit should set a Code 23 or 25. The code charts also contain a chart to check for sensor resistance values relative to temperature.

### $O_2$ Sensor

The "Scan" has several positions that will indicate the state of the exhaust gases, $O_2$ voltage, integrator, and block learn. See "Scan" position information in "Introduction," Section "6E".

A problem in the $O_2$ sensor circuit, or fuel system, should set a Code 13 (open circuit), Code 44 (lean indication), Code 45 (rich indication). Refer to applicable chart if any of these codes were stored in memory.

### TPS

A "Scan" tool displays throttle position in volts. You should read .55V ± .08V, with throttle closed and ignition on, or at idle. Voltage should increase at a steady rate as throttle is moved toward WOT.

The ECM has the ability to Auto-Zero the TPS voltage if it is below about .7V (700 mV). This means that any voltage less than .7 volts will be determined by the ECM to be 0% throttle. A failure in the TPS or circuit should set a Code 21 or 22.

### VSS

A "Scan" tools reading should closely match with speedometer reading with drive wheels turning. A failure in the VSS circuit should set a Code 24.

### P/N Switch

A "Scan" tool should read P/N when in Park, or Neutral, and R-D, L, when in Drive or Overdrive. This reading may vary with different makes of tools. Refer to CHART C-1A for P/N switch diagnosis.

### A/C Request Signal

"Scan" tool should indicate A/C request "ON," when A/C is requested and the pressure cycling switch is closed.

### Power Steering Pressure Switch

A "Scan" tool should read "OFF" normally and "ON" with high pressure. This reading may vary with different make of tools. Refer to CHART C-1E for PSPS diagnosis.

### Reference Signal

A "Scan" tool will read this signal and is displayed in rpm.

## ON-CAR SERVICE

### ELECTRONIC CONTROL MODULE (ECM)

Service of the ECM should normally consist of either replacement of the ECM or a PROM change.

If the diagnostic procedures call for the ECM to be replaced, the engine calibrator (PROM) and ECM should be checked first to see if they are the correct parts. If they are, remove the PROM from the faulty ECM and install it in the new service ECM. THE SERVICE ECM WILL NOT CONTAIN A PROM or CALPAK. Trouble Code 51 indicates the PROM is installed improperly or has malfunctioned. When Code 51 is obtained, check the PROM installation for bent pins or pins not fully seated in the socket. If it is installed correctly and Code 51 still shows, replace the PROM.

## Fuel Cutoff Mode

No fuel is delivered by the injector when the ignition is "OFF". This prevents dieseling. Also, fuel is not delivered if no reference pulses are seen from the distributor, which means the engine is not running. This prevents flooding.

## Fuel Control System Components

The fuel control system is made up of the following parts:

- Fuel Injectors
- Throttle Body
- Fuel pump relay
- Fuel Pressure Regulator
- Fuel Rail

## Basic System Operation

The fuel system (Figure C2-3) starts with the fuel in the fuel tank. An electric fuel pump, located in the fuel tank with the gage sending unit, pumps fuel to the fuel rail through an in-line fuel filter. The pump is designed to provide fuel at a pressure above the pressure needed by the injectors. A pressure regulator in the fuel rail keeps fuel available to the injectors at a constant pressure. Unused fuel is returned to the fuel tank by a separate line. For further information on the fuel tank, in-line filter , and fuel lines , see Section "6C".

The injectors, are controlled by the ECM. They deliver fuel in one of several modes, as described above.

In order to properly control the fuel supply, the fuel pump is operated by the ECM thru the fuel pump relay and oil pressure switch (see "Fuel Pump Electrical Circuit", Code 54).

## THROTTLE BODY UNIT

The throttle body has a throttle valve to control the amount of air delivered to the engine. The TPS and IAC valve are also mounted on the throttle body.

The throttle body contains vacuum ports located at, above, or below the throttle valve. These ports generate the vacuum signals needed by various components.

## FUEL RAIL

The fuel rail is mounted to the top of the engine. It distributes fuel to the individual injectors. Fuel is delivered to the input end of the rail by the fuel lines, goes thru the rail, then to the pressure regulator. Remaining fuel is then returned to the fuel tank.

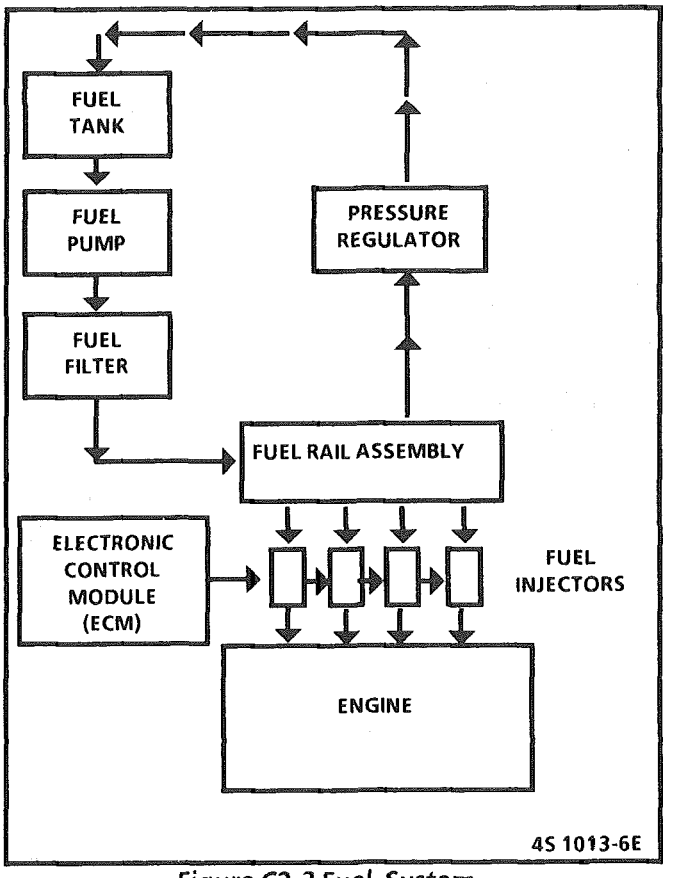



Figure C2-3 Fuel System

## FUEL INJECTOR

The fuel injector is a solenoid operated device controlled by the ECM (See Figure C2-4). The ECM turns "ON" the solenoid, which opens a valve to allow fuel delivery. The fuel, under pressure, is injected in a conical spray pattern at the opening of the intake valve. The fuel which is not used by the injectors passes through the pressure regulator before being returned to the fuel tank.

An injector which is stuck partly open will cause loss of pressure after engine shut down, so long crank times would be noticed on some engines. Also, dieseling could occur because some fuel could be delivered to the engine after the ignition is turned "OFF".

## PRESSURE REGULATOR

The pressure regulator is a diaphragm-operated relief valve with injector pressure on one side and manifold pressure on the other. The function of the regulator is to maintain a constant pressure at the injector at all times. The pressure regulator compensates for engine load, by increasing fuel pressure when it sees low engine vacuum.

As a backup system to the fuel pump relay, the fuel pump can also be turned "ON" by the oil pressure switch. The oil pressure switch is a normally open switch which closes when oil pressure reaches about 28 kPa (4 psi). If the fuel pump relay fails, the oil pressure switch will close and run the fuel pump.

An inoperative fuel pump relay can result in long cranking times, particularly if the engine is cold.

An inoperative fuel pump would cause a no start condition. A fuel pump which does not provide enough pressure can result in poor performance.

# DIAGNOSIS

## FUEL CONTROL SYSTEM

Some failures of this system will result in an "Engine Cranks But Won't Run". If this condition exists, see CHART A-3. This chart will determine if the problem is caused by the ignition system, ECM or fuel pump circuit. If it's determined to be a fuel problem, CHART A-7 will be used. This includes the injectors, pressure regulator, fuel pump and fuel pump relay. The fuel system wiring schematic is covered on the facing page of Code CHART 54.

If a malfunction occurs in the fuel control system it usually results in either a rich or a lean exhaust condition. This condition is sensed by the oxygen sensor and the ECM will change the fuel calculation (injector pulse width) based on the $O_2$ sensor reading. The change made to the fuel calculation will be indicated by a change in the block learn values which can be monitored by a "Scan" tool. The normal block learn values are around 128 and if the $O_2$ sensor is sensing a lean condition, the ECM will add fuel and this will result in a block learn value above 128. If the $O_2$ sensor is sensing a rich exhaust the ECM will reduce fuel to the engine and this will result in block learn values below 128. Some variations in block learn values are normal because all engines are not exactly the same. However, if the block learn values are $\pm$ 10 counts from 128, a system problem exists. If the block learn values are greater than 138, see Code 44 for items which can cause a lean system.

If the block learn values are less than 118, see Code 45 for items which can cause the system to run rich. If a driveability symptom exists, refer to the particular symptom in Section "B" for additional items to check.

## IDLE AIR CONTROL VALVE

A "Scan" tool will read IAC position in steps (counts). "0" steps indicates the ECM is commanding the IAC to be driven all the way in, to a fully seated position, and this is usually caused by a vacuum leak. The higher the number of counts the more air being allowed to pass the IAC valve. CHART C-2C can be used to diagnosis the IAC valve. Also refer to "Rough, Unstable, or Incorrect Idle, Stalling" in "Symptoms," Section "B" for other possibilities for the cause of idle problems.

# ON-CAR SERVICE

## PORT FUEL INJECTION COMPONENTS

**CAUTION: Before servicing an injector, fuel rail, or pressure regulator, it is necessary to relieve the pressure in the fuel system, to minimize the risk of fire and personal injury. (See "Fuel Pressure Relief Procedure" below). To reduce the chance of personal injury, cover the fuel line with a shop cloth to collect the fuel, and then place the cloth in an approved container.**

## FUEL PRESSURE RELIEF PROCEDURE

1. Connect fuel gage J 34730-1 or equivalent to fuel pressure valve. Wrap a shop towel around fitting while connecting gage to avoid spillage.
2. Install bleed hose into an approved container and open valve to bleed system pressure.

### Plenum

#### Remove or Disconnect

1. Negative battery cable.
2. Air inlet duct at throttle body.
3. Throttle body retaining bolts (2).
4. EGR pipe bolts (2).
5. Throttle cable bracket.
6. Plenum bolts (8).

#### Install or Connect

1. Plenum and gaskets.
2. Plenum bolts. See Figure C2-6.
3. Throttle cable bracket.
4. EGR pipe bolts.
5. Throttle body and bolts.
6. Air inlet duct
7. Negative battery cable.

### Fuel Rail and Pressure Regulator Assembly

#### Important

When servicing the fuel rail assembly, precautions must be taken to prevent dirt and other contaminants from entering the fuel passages. It is recommended that fittings be capped and holes be plugged during servicing.

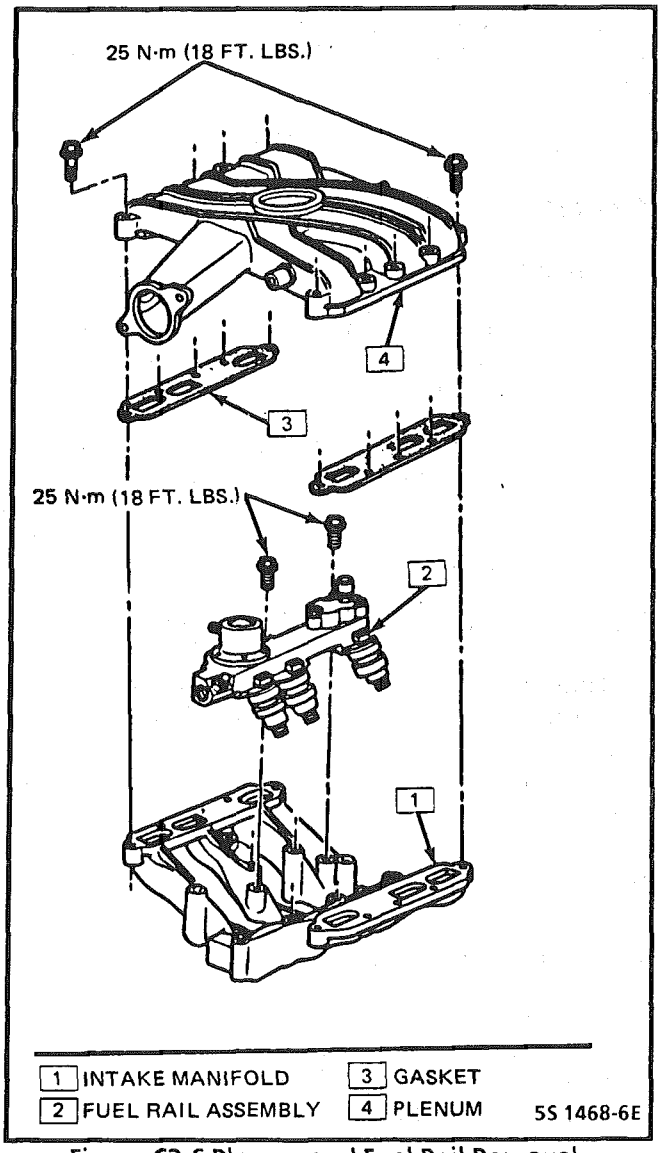



Figure C2-6 Plenum and Fuel Rail Removal

## Important

At any time the fuel system is opened for service, the O-ring seals used with the related component(s) should be replaced.

## Remove or Disconnect

1. Negative battery cable.
2. Plenum.
3. Fuel lines.
4. Cold start valve.
5. Vacuum line at pressure regulator.
6. Fuel rail retaining bolts
7. Injector harness connectors.
8. Rail and injectors.

## Install or Connect

1. Coat injector "O"-rings with engine oil.
2. Rail and injectors.
3. Injector harness.
4. Fuel rail retaining bolt.
5. Vacuum line at pressure regulator.
6. Cold start valve.
7. Fuel lines.
8. Plenum.
9. Negative cable
10. Cycle the ignition on and off several times and inspect fuel system for leaks.

## FUEL RAIL SERVICE

Names of component parts will be found on the numbered list that accompanies the exploded view (Figure C2-9). Numbers used to identify parts on the exploded view will identify the same parts in other illustrations of this section.

An eight digit identification number is stamped on the side of the fuel rail assembly, as shown in Figure C2-7. Refer to this number if servicing or part replacement is required.

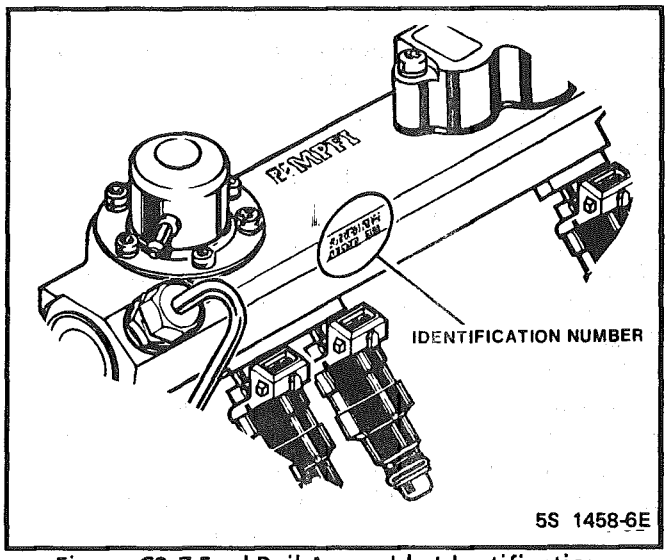



Figure C2-7 Fuel Rail Assembly Identification

## UNIT SERVICE PROCEDURES

## Important

When servicing the fuel rail assembly, precautions must be taken to prevent dirt and other contaminants from entering the fuel passages. It is recommended that fittings be capped, and holes be plugged, during servicing.

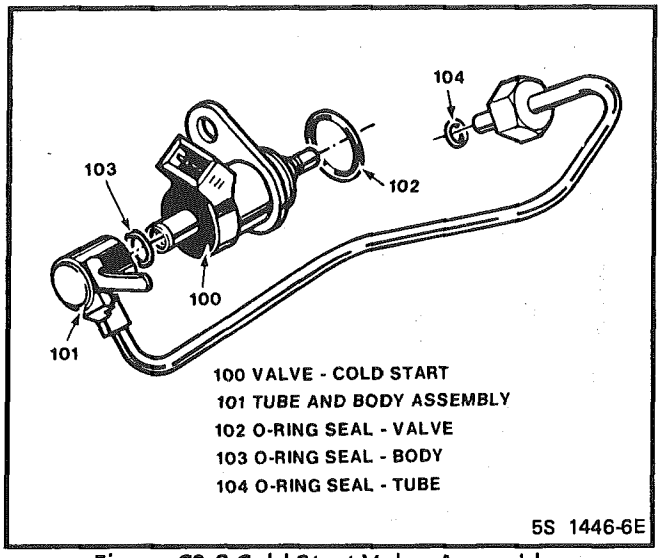



Figure C2-8 Cold Start Valve Assembly

### Important

At any time the fuel system is opened for service, the O-ring seals used with related component(s) should be replaced.

### Cleaning and Inspection

Before disassembly, the fuel rail assembly may be cleaned with a spray type engine cleaner, such as AC Delco X-30A or equivalent, following package instructions. The fuel rail should not be immersed in liquid solvent.

## COLD START TUBE AND VALVE ASSEMBLY (Figure C2-8)

### Remove or Disconnect

1. Negative battery cable.
2. Plenum.
3. Distributor cap.
4. Cold start valve retaining bolts.
5. Tube from rail.

### Clean

- Areas around valve and connection with AC Delco X-30A or equivalent.
- Valve from tube and body assembly (101).
- Bend tab back to permit unscrewing of valve.

### Adjust

1. Turn valve completely into body.
2. Turn valve back one full turn, until electrical connector is at top position.
3. Bend tang of body forward to limit rotation of valve to less than a full turn.

### Install or Connect

1. New valve O-ring seal (102) and body O-ring seal (103), on cold start valve (100).
2. Tube O-ring seal (104) on tube and body assembly (101).
3. Cold start valve in body assembly.
4. Distributor cap.
5. Plenum.
6. Negative battery cable.

## FUEL PRESSURE CONNECTION ASSEMBLY (Figure C2-10)

### Remove or Disconnect

1. Negative battery terminal.

### Clean

- Area around valve and connection with AC Delco X-30A or equivalent.

2. Fuel pressure connection assembly (26) and seal (27). Discard seal.

### Install or Connect

1. New seal (27) on fuel pressure connection assembly (26).
2. Fuel pressure connection assembly in fuel rail.

### Tighten

- Fuel pressure connection assembly to 10.0 N·m (88.0 in lbs.)

3. Negative battery terminal.

### Inspect

- Energize fuel pump and check for leaks.

| Part # | Part Name |
|---|---|
| 1 | O-ring—Fuel Inlet Line |
| 2 | O-ring—Fuel Return Line |
| 11 | Fuel Rail and Pressure Regulator Assembly |
| 26 | Fuel Pressure Connection Assembly |
| 27 | Seal—Fuel Pressure Connection Assembly |
| 28 | Cap—Fuel Pressure Connection |
| 55 | Fuel Block |
| 56 | Seal—Fuel Block |
| 57 | Screw Assembly—Fuel Block Attaching |
| 85 | Injector—Port |
| 86 | Seal—O-ring—Injector |
| 87 | Clip—Injector Retainer |
| 100 | Valve—Cold Start |
| 101 | Tube and Body Assembly |
| 102 | O-Ring Seal—Valve |
| 103 | O-Ring Seal—Body |
| 104 | O-Ring Seal—Tube |
| 105 | Fitting—Cold Start |

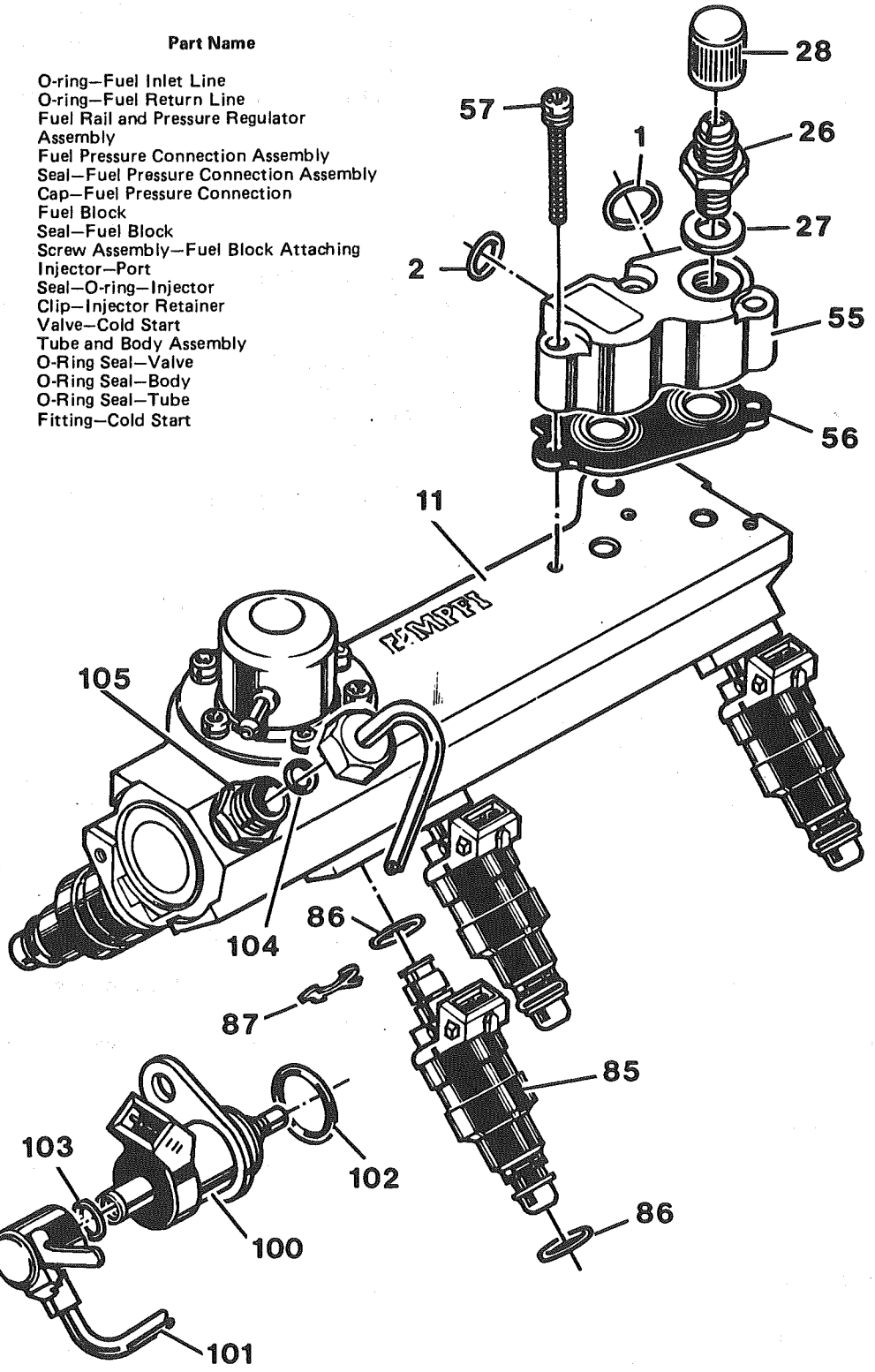



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Figure C2-9 Fuel Rail Assembly

# SECTION A
## 5.0L & 5.7L ENGINE

## DIAGNOSTIC CIRCUIT CHECK

The "Diagnostic Circuit Check" verifies the system is functioning correctly. Some special considerations to keep in mind while making the "Diagnostic Circuit Check" are:

### Blocking Drive Wheels

The vehicle drive wheels must be blocked while checking the system.

### Cold Oxygen Sensor

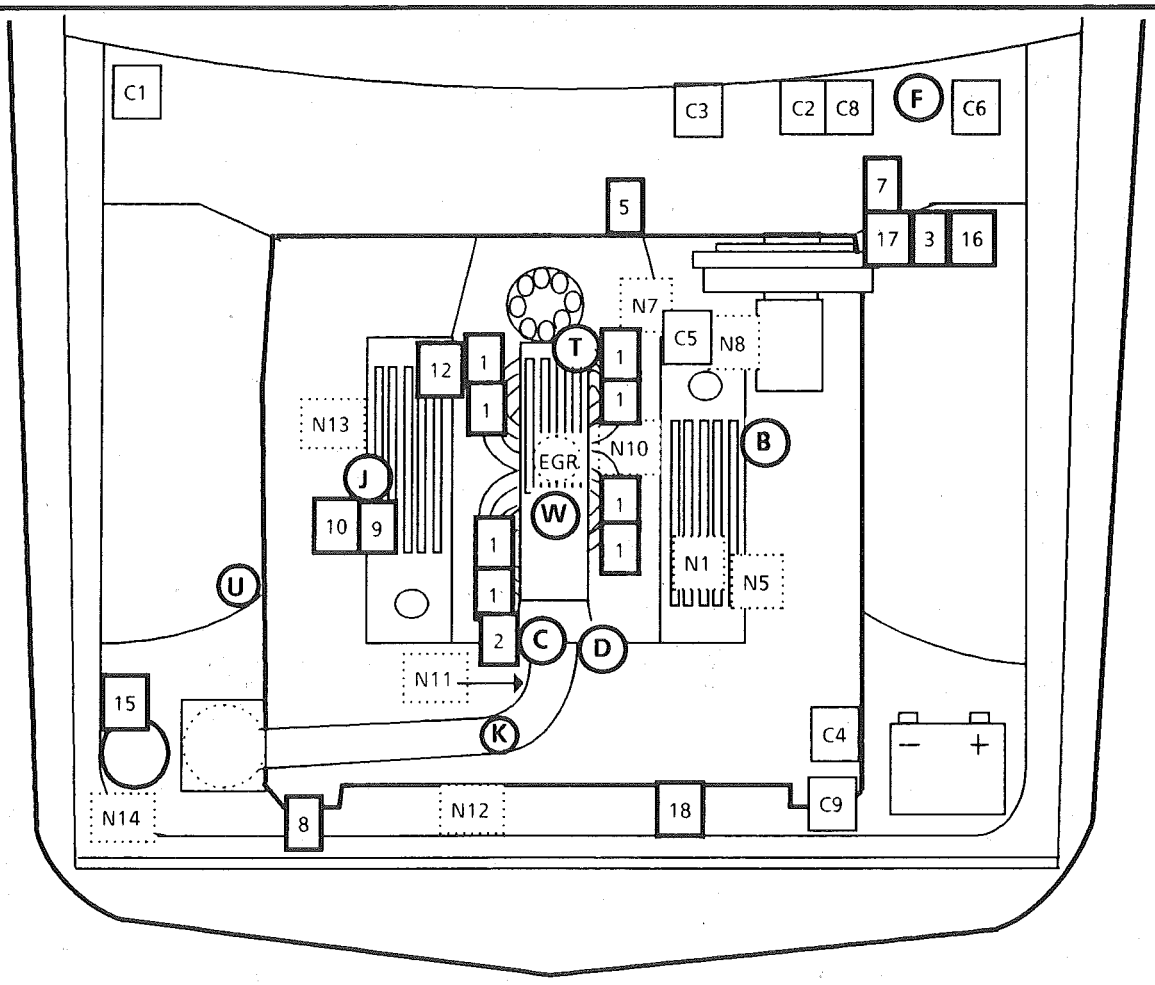
On some engines, the Oxygen Sensor will cool off after only a short period of operation at idle. This will put the system into "Open Loop". To restore "Closed Loop" operation, run the engine at part throttle several minutes and accelerate from idle to part throttle a few times.

### Basic Procedure

If you have not reviewed the Basic Information on how to use the Diagnostic Procedures, go to the Introduction of this section.

## SECTION A
## ENGINE COMPONENTS / WIRING DIAGRAMS / DIAGNOSTIC CHARTS

## 'F' SERIES RPO: LB9 & L98 VIN CODE: F & 8 5.0L, 5.7L V8 PFI




### COMPUTER HARNESS

- C1 Electronic Control Module (ECM)
- C2 ALDL diagnostic connector
- C3 "SERVICE ENGINE SOON" light
- C4 ECM power
- C5 ECM harness ground
- C6 Fuse panel
- C8 Fuel pump test connector (ALDL "G")
- C9 Fuel pump/ECM fuse

### NOT ECM CONNECTED

- N1 Crankcase vent valve (PCV)
- N5 Engine temp. sensor (gage overheat)
- N7 Oil pressure sensor (gage)
- N8 Oil pressure switch (fuel pump)
- N10 Cold start valve
- N11 Cold start fuel injection switch
- N12 Secondary cooling fan
- N13 Cooling fan temperature switch
- N14 Secondary cooling fan relay

### CONTROLLED DEVICES

- 1 Fuel injector
- 2 Idle air control motor
- 3 Fuel pump relay
- 5 Trans. Converter Clutch connector
- 7 Electronic Spark Control module
- 8 Primary cooling fan relay
- 9 Air injection converter/divert solenoid
- 10 Air injection port solenoid
- 12 EGR vacuum solenoid
- 15 Fuel vapor canister solenoid
- 16 MAF sensor power relay
- 17 MAF sensor burn-off relay
- 18 Primary cooling fan

### INFORMATION SENSORS

- B Exhaust oxygen
- C Throttle position
- D Coolant temperature
- F Vehicle speed
- J ESC knock
- K Mass Air Flow
- T Manifold Air Temperature
- U A/C pressure fan switch
- W EGR temp. diagnostic switch

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Figure A-1 - Component Locations - 5.0L (VIN F) & 5.7L (VIN 8) "F" Series

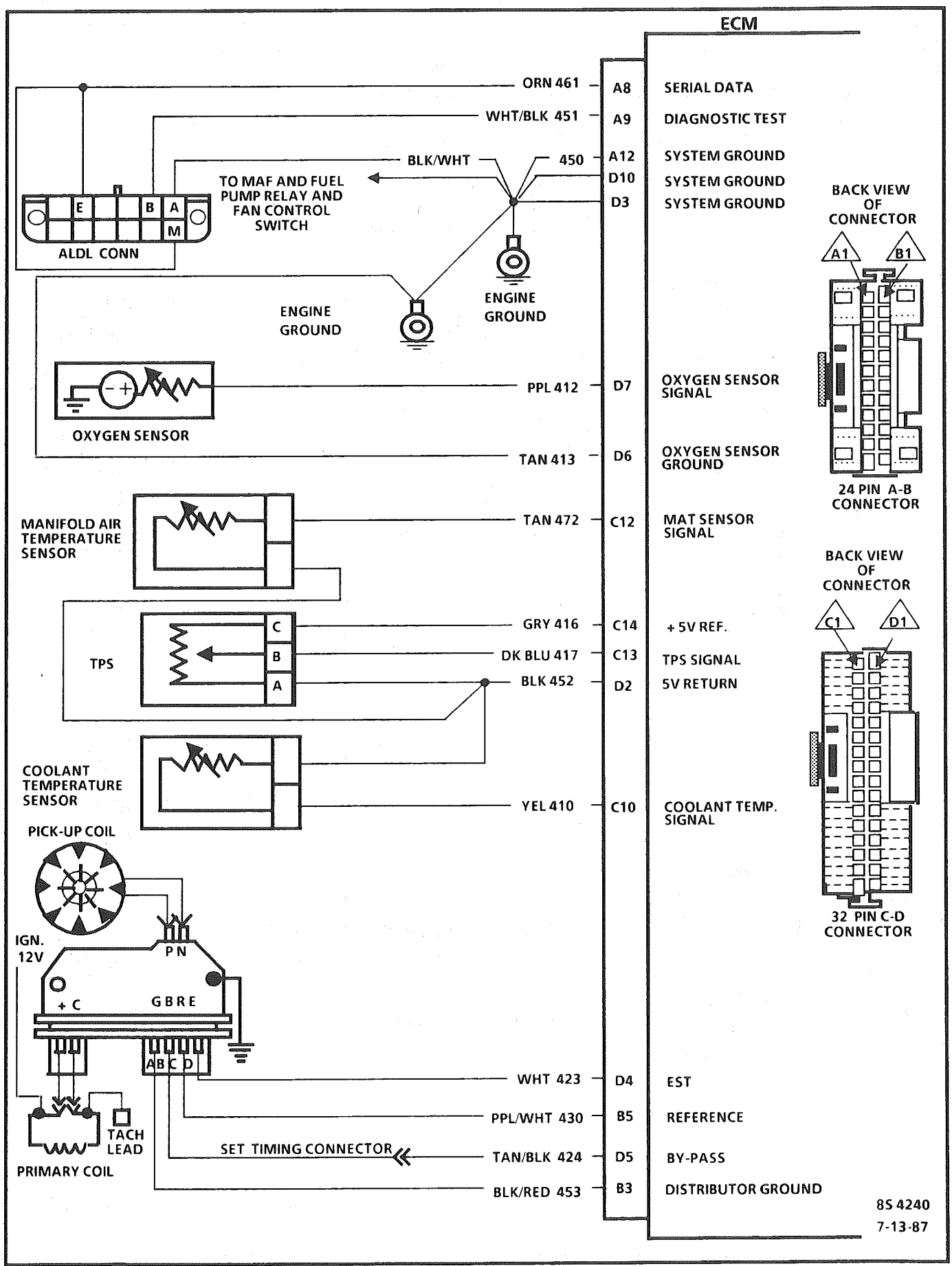



Figure A-2 - Wiring Diagram - 5.0L (VIN F) & 5.7L (VIN 8) "F" Series (1 of 4)

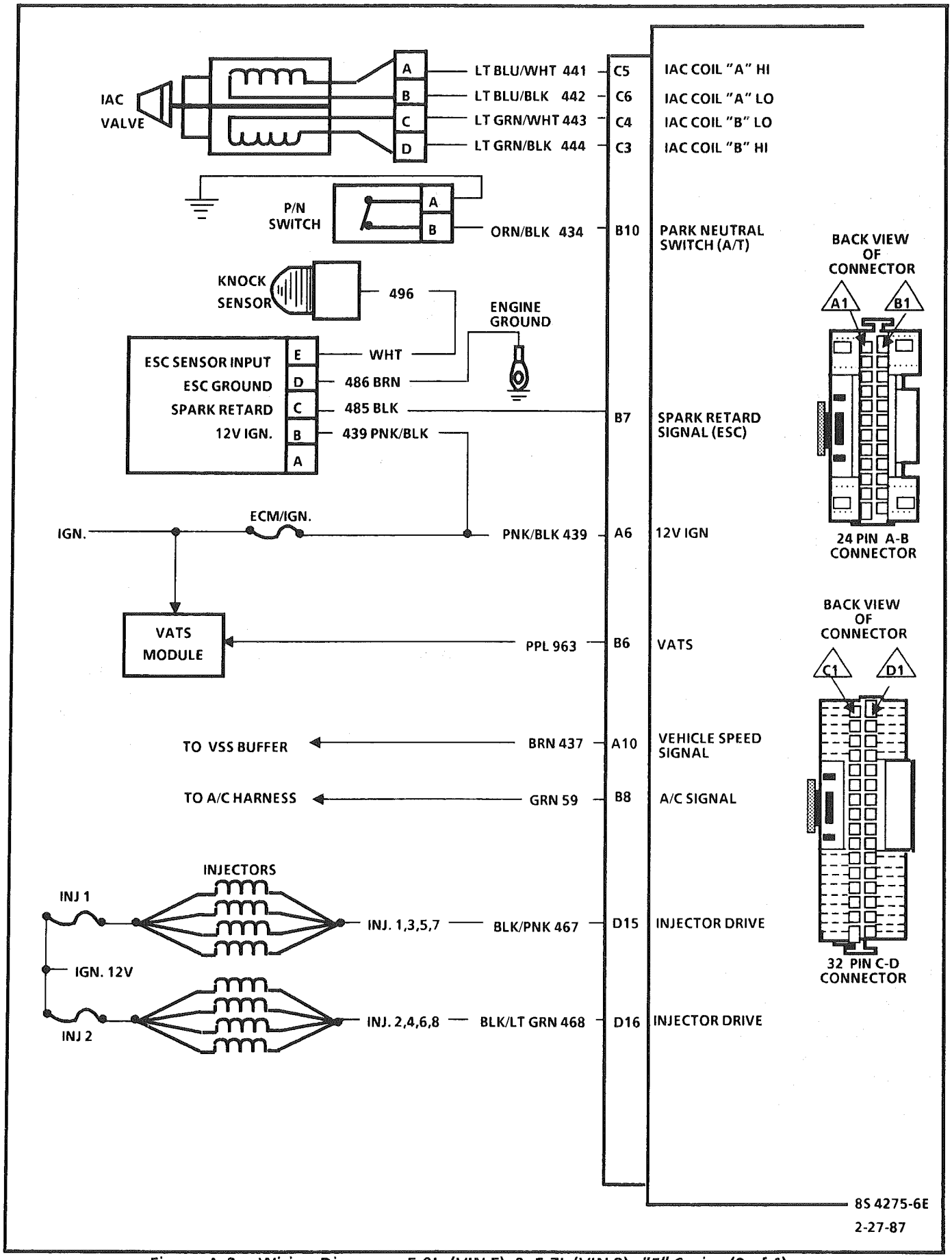



Figure A-3 - Wiring Diagram - 5.0L (VIN F) & 5.7L (VIN 8) "F" Series (2 of 4)

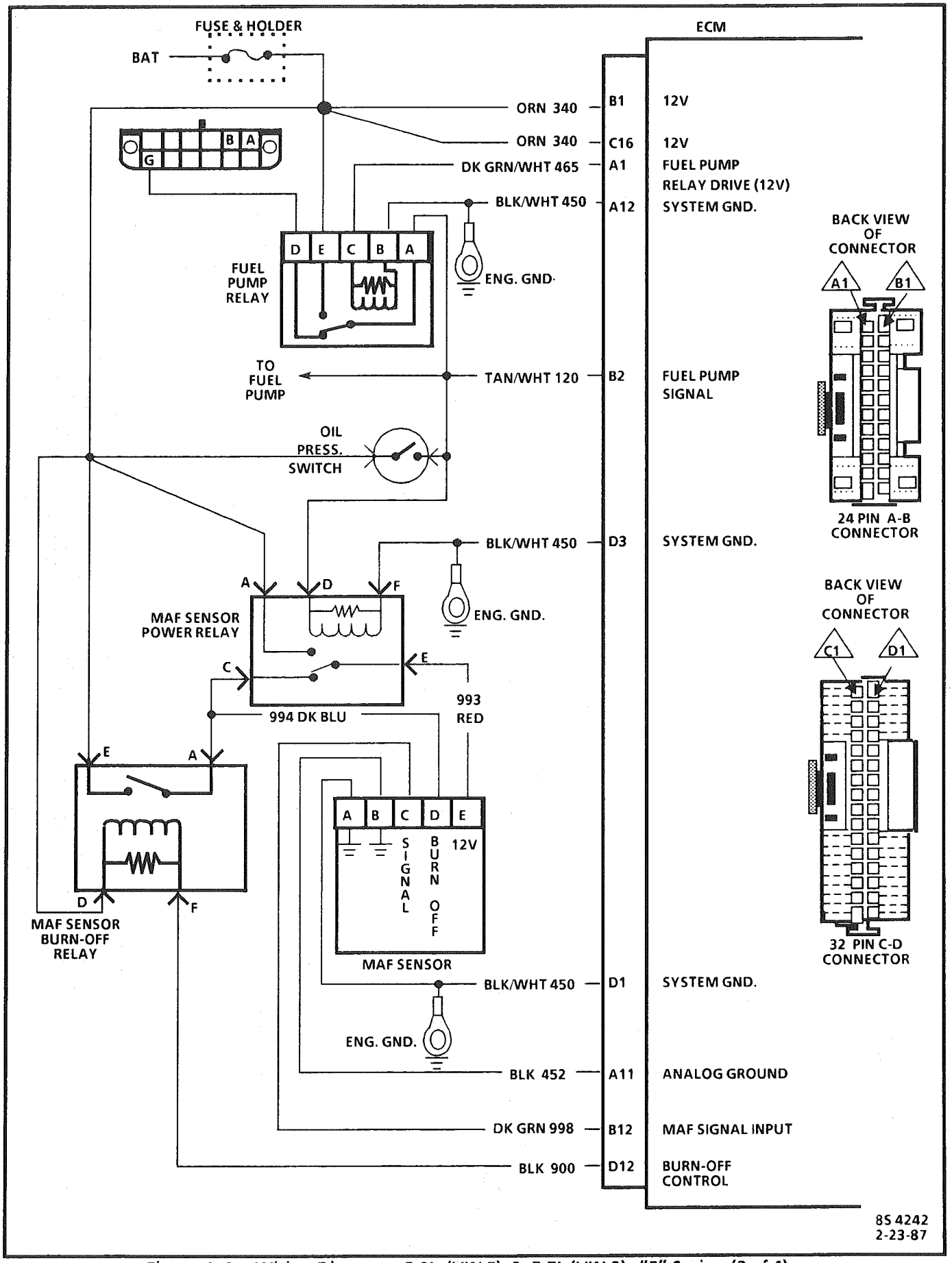



Figure A-4 - Wiring Diagram - 5.0L (VIN F) & 5.7L (VIN 8) "F" Series (3 of 4)

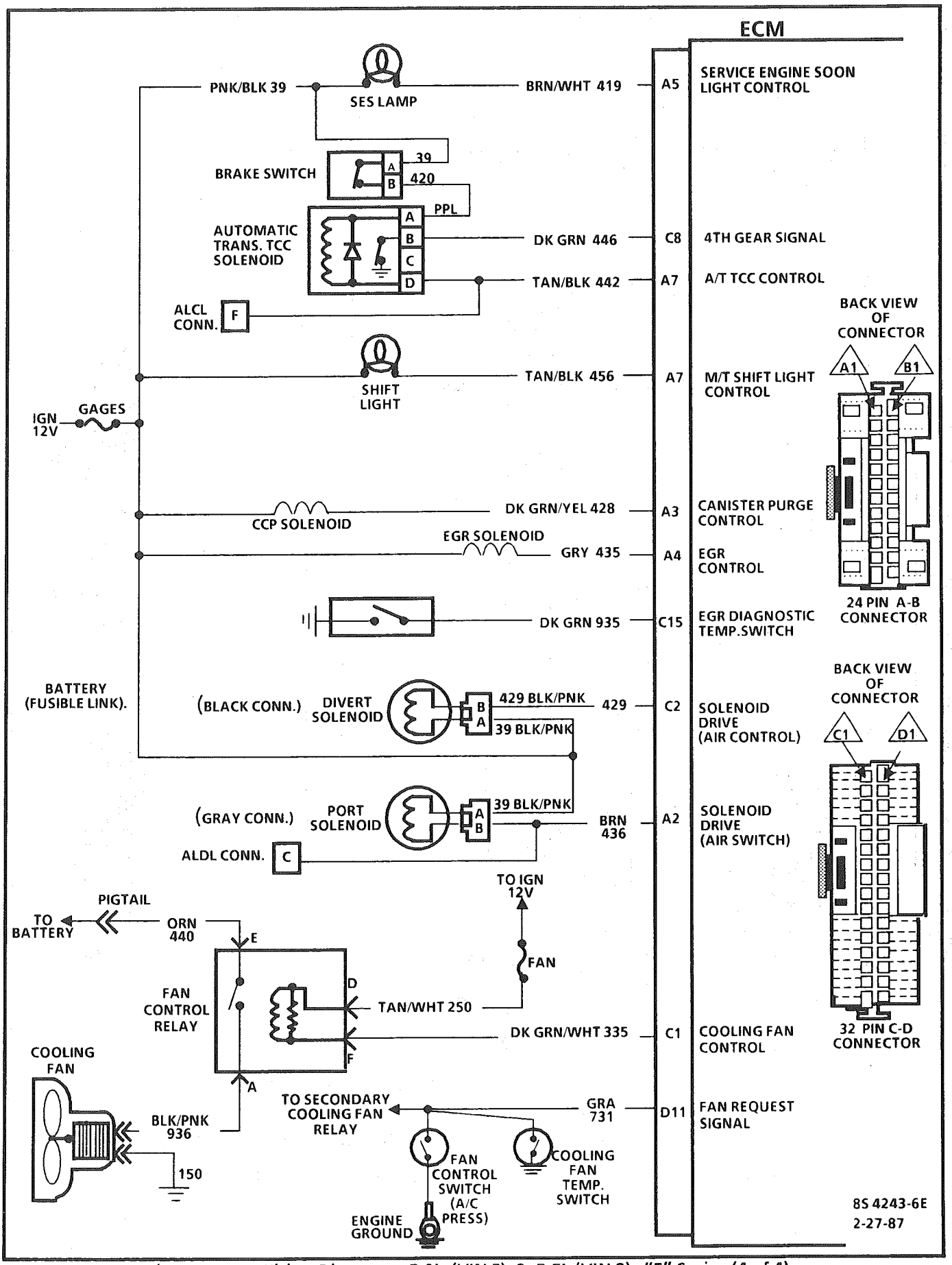
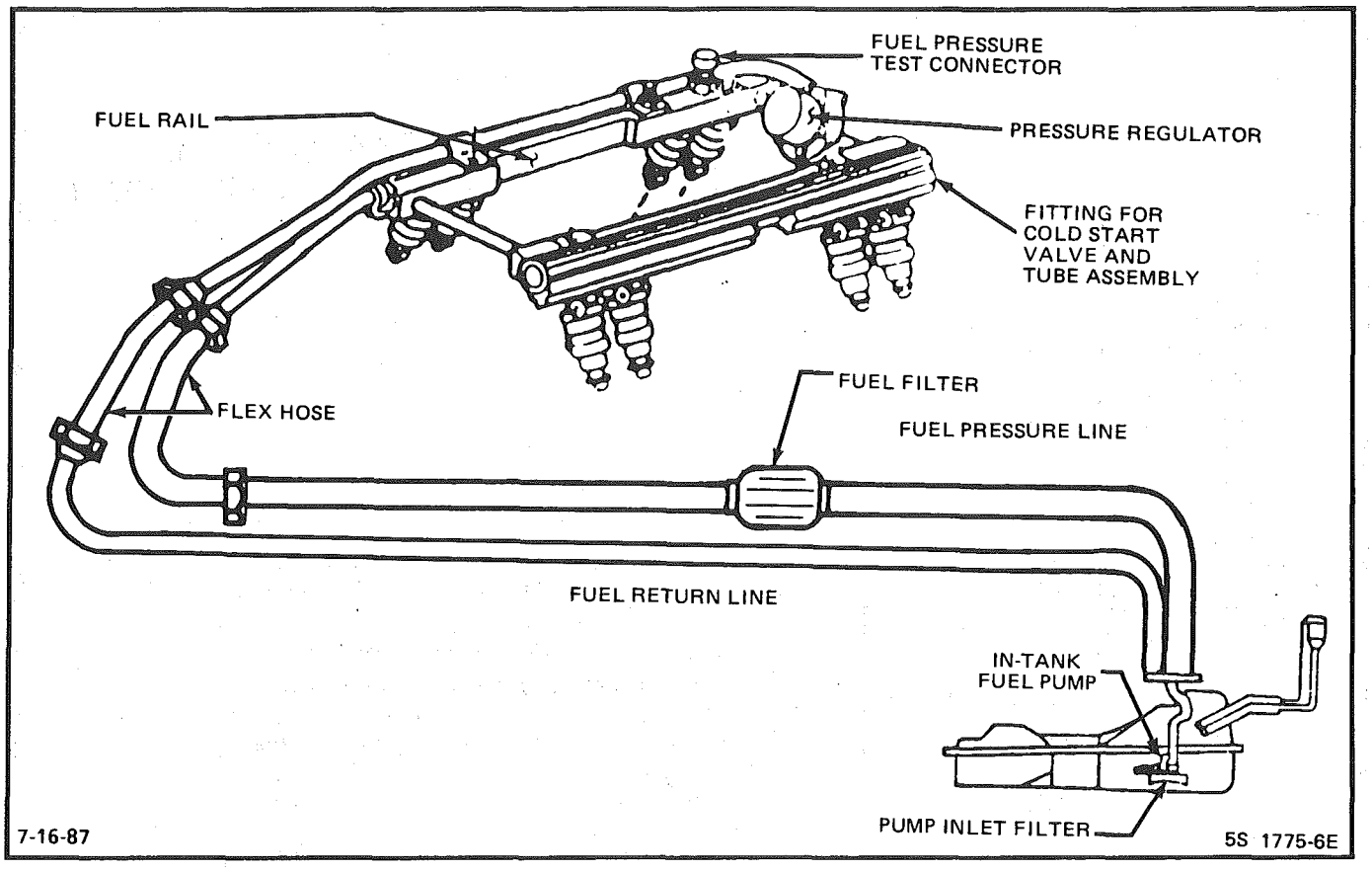



Figure A-5 - Wiring Diagram - 5.0L (VIN F) & 5.7L (VIN 8) "F" Series (4 of 4)




# CHART A-7

(Page 1 of 2)

## FUEL SYSTEM DIAGNOSIS
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

When the ignition switch is turned "ON", the electronic control module (ECM) will turn "ON" the in-tank fuel pump. It will remain "ON" as long as the engine is cranking or running, and the ECM is receiving reference pulses. If there are no reference pulses, the ECM will shut "OFF" the fuel pump within 2 seconds after ignition "ON" or engine stops.

The pump will deliver fuel to the fuel rail and injectors, then to the pressure regulator, where the system pressure is controlled at 234 to 325 kPa (34 to 47 psi). Excess fuel is then returned to the fuel tank.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Wrap a shop towel around the fuel pressure connector to absorb any small amount of fuel leakage that may occur when installing the gage. Ignition "ON", pump pressure should be 280-325 KPa (40.5-47 psi). This pressure is controlled by spring pressure within the regulator assembly.
2. When the engine is idling, the manifold pressure is low (high vacuum) and is applied to the fuel regulator diaphragm. This will offset the spring and result in a lower fuel pressure.This idle pressure will vary somewhat depending on barometric pressure; however, the pressure idling should be less, indicating pressure regulator control.
3. Pressure that continues to fall is caused by one of the following:
   - In-tank fuel pump check valve not holding.
   - Pump coupling hose or pulsator leaking.
   - Fuel pressure regulator valve leaking.
   - Injector(s) sticking open.
4. An injector sticking open can best be determined by checking for a fouled or saturated spark plug(s). If a leaking injector cannot be determined by a fouled or saturated spark plug, the following procedure should be used:
   - Remove Plenum, and remove fuel rail bolts. Follow the procedures in the Fuel Control Section of this manual, but leave fuel lines connected.
   - Lift fuel rail out just enough to observe injector nozzles in the ports.

CAUTION: ***BE SURE INJECTOR(S) ARE NOT ALLOWED TO SPRAY ON ENGINE AND THAT INJECTOR RETAINING CLIPS ARE INTACT. THIS SHOULD BE CAREFULLY FOLLOWED TO PREVENT FUEL SPRAY ON ENGINE WHICH WOULD CAUSE A FIRE HAZARD.***

   - Pressurize the fuel system and observe injector nozzles.

FROM CHART A-3 PAGE 1.

THIS CHART ASSUMES THERE IS NO CODE 54

# CHART A-7
(Page 1 of 2)
## FUEL SYSTEM DIAGNOSIS
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

**1**
- INSTALL FUEL PRESSURE GAGE, J-34730-1 OR EQUIVALENT.
- IGNITION "OFF" FOR 10 SECONDS. A/C "OFF".
- IGNITION "ON". FUEL PUMP WILL RUN FOR ABOUT 2 SECONDS.
- NOTE FUEL PRESSURE, WITH PUMP RUNNING SHOULD BE 280-325 kPa (40.5-47 psi) AND HOLD STEADY WHEN PUMP STOPS.

NOTE:
*THE IGNITION MAY HAVE TO BE CYCLED "ON" MORE THAN ONCE TO OBTAIN MAXIMUM PRESSURE.*
*ALSO, IT IS NORMAL FOR THE PRESSURE TO DROP SLIGHTLY WHEN THE PUMP STOPS.*

- OK
- NOT OK

**2**
- START AND IDLE ENGINE AT NORMAL OPERATING TEMPERATURE.
- PRESSURE SHOULD BE LOWER BY 21-69 kPa (3-10 psi).

- OK
- NOT OK

NO TROUBLE FOUND. REVIEW SYMPTOMS SECTION "B".

- USING AN EXTERNAL VACUUM SOURCE, APPLY 10 INCHES OF VACUUM TO FUEL PRESSURE REGULATOR.
- FUEL PRESSURE SHOULD DROP 21-69 kPa (3-10 psi).

- OK
- NOT OK

REPAIR VACUUM SOURCE TO REGULATOR.

REPLACE REGULATOR ASSEMBLY

**3**
- PRESSURE BUT NOT HOLDING
- PRESSURE BELOW 280 kPa (40.5 psi)
- PRESSURE ABOVE 325 kPa (47 psi)
- NO PRESSURE

- IGNITION "OFF" FOR 10 SECONDS.
- IGNITION "ON"
- BLOCK FUEL PRESSURE LINE BY PINCHING FLEX HOSE. PRESSURE SHOULD HOLD.

- NOT HOLDING
- HOLDS

- IGNITION "OFF" FOR 10 SECONDS.
- IGNITION "ON".
- BLOCK FUEL RETURN LINE BY PINCHING HOSE.
- RECHECK PRESSURE.

- HOLDS
- NOT HOLDING

FAULTY FUEL PRESSURE REGULATOR.

**4** LOCATE AND CORRECT LEAKING INJECTOR(S).

SEE CHART A-7 (2 of 2)

CHECK :
- LEAKING PUMP COUPLING HOSE OR PULSATOR.
- FAULTY IN-TANK PUMP.

- IGNITION "OFF".
- APPLY 12 VOLTS TO FUEL PUMP TEST TERMINAL.
- LISTEN FOR FUEL PUMP RUNNING.

- PUMP RUNS
- PUMP NOT RUNNING

CHECK FOR :
- PLUGGED IN-LINE FILTER.
- PLUGGED PUMP INLET FILTER.
- RESTRICTED FUEL LINE.
- DISCONNECTED COUPLING HOSE OR PULSATOR.

CHECK FOR :
- OPEN WIRE IN CKT 120
- OPEN PUMP. GROUND CKT 150

- IF OK
- IF OK

REPLACE IN-TANK FUEL PUMP

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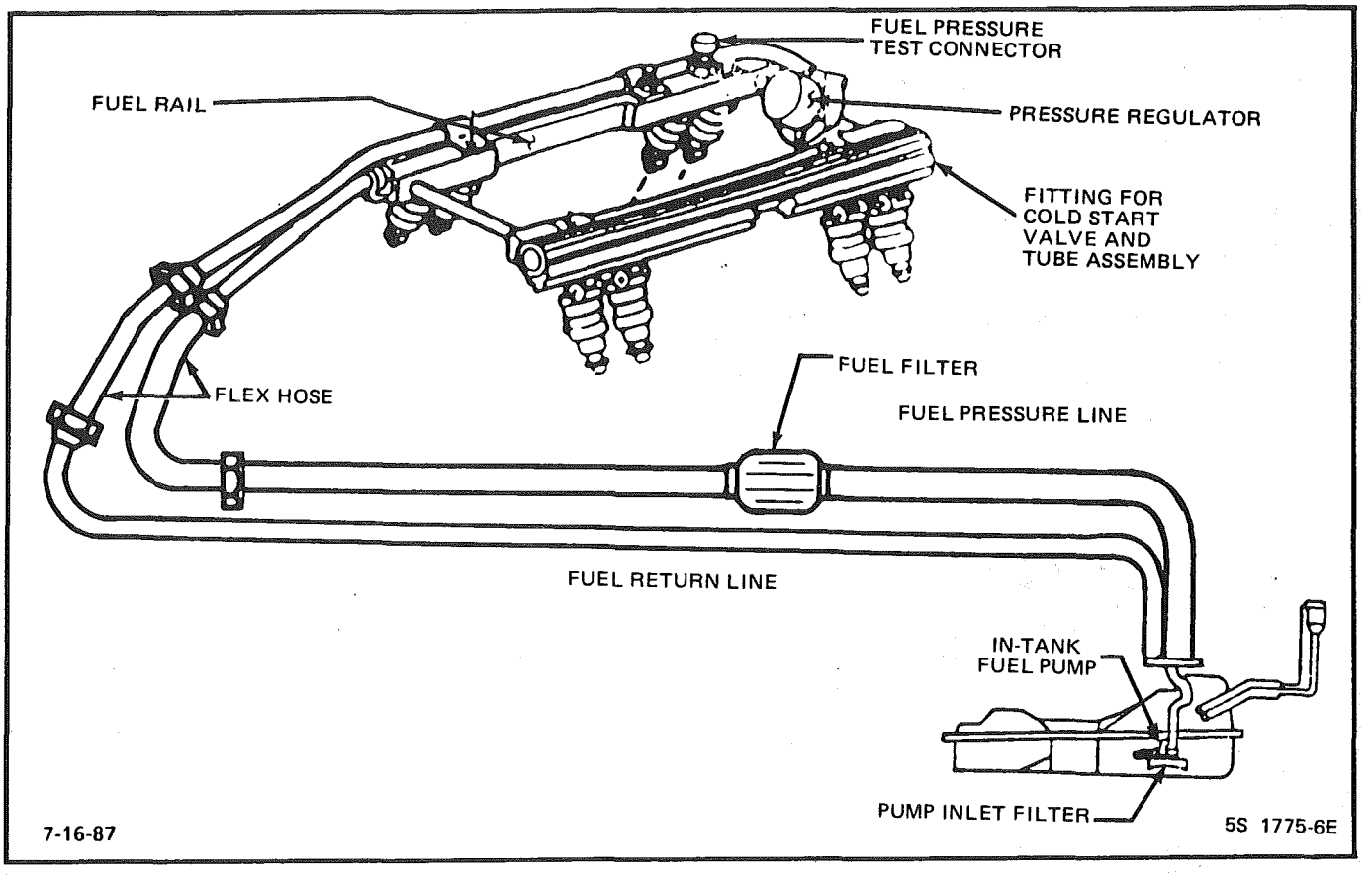



# CHART A-7

## (Page 2 of 2)
## FUEL SYSTEM DIAGNOSIS
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Fuel pressure less than 280 kPa (40.5 psi) falls into two areas:
   - Regulated pressure less than 280 kPa (40.5 psi) - Amount of fuel to injectors OK but pressure is too low. System will be lean and may set Code 44. Also, hard starting cold and overall poor performance.
   - Restricted flow causing pressure drop - Normally, a vehicle with a fuel pressure of less than 165 kPa (24 psi) at idle will not be driveable. However, if the pressure drop occurs only while driving, the engine will normally surge then stop running as pressure begins to drop rapidly. This is most likely caused by a restricted fuel line or plugged filter.
2. Restricting the the fuel return line allows the fuel pump to develop its maximum pressure (dead head pressure). When battery voltage is applied to the pump test terminal, pressure should be above 414 kPa (60 psi ).
3. This test determines if the high fuel pressure is due to a restricted fuel return line or a pressure regulator problem.

# CHART A-7

(Page 2 of 2)

## FUEL SYSTEM DIAGNOSIS 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

NOTICE: *THE FUEL SYSTEM IS UNDER PRESSURE. TO AVOID FUEL SPILLAGE, REFER TO FIELD SERVICE PROCEDURES IN SECTION "C2" FOR TESTING OR MAKING REPAIRS REQUIRING DISASSEMBLY OF FUEL LINES OR FITTINGS.*

FROM CHART A-7 (1 of 2)

(1) PRESSURE LESS THAN 280 kPa (40.5 psi ).

CHECK FOR RESTRICTED FUEL LINES OR IN-LINE FILTER.

- OK
- NOT OK → REPLACE FILTER OR REPAIR FUEL LINE AND RECHECK.

(2)
- IGNITION "OFF".
- BLOCK FUEL RETURN LINE .
- APPLY 12 VOLTS TO FUEL PUMP RELAY HARNESS TERMINAL "A" OR TO THE FUEL PUMP TEST CONNECTOR, AND NOTE FUEL PRESSURE .

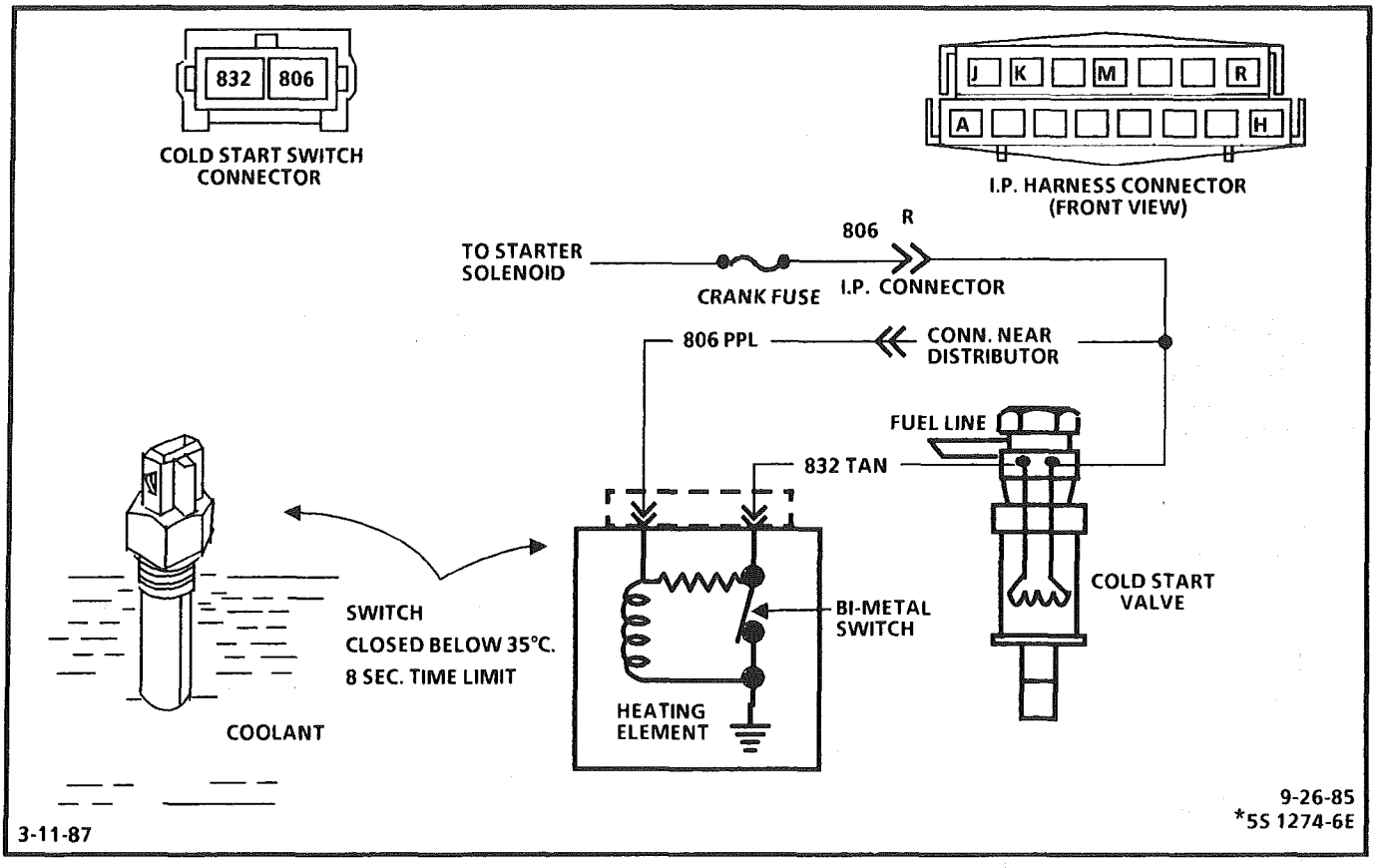
- PRESSURE ABOVE 325 kPa (47 psi ). → FAULTY PRESSURE REGULATOR.
- PRESSURE LESS THAN 280 kPa (40.5 psi ). → FAULTY IN-TANK
  - FUEL PUMP
  - COUPLING HOSE OR PULSATOR
  - INLET FILTER
  - WRONG FUEL PUMP.

PRESSURE ABOVE 325 kPa (47 psi).

(3)
- DISCONNECT FUEL RETURN LINE FLEXIBLE HOSE.
- ATTACH $^{5}/_{16}$ I.D. FLEX HOSE TO PRESSURE REGULATOR SIDE OF RETURN LINE. INSERT THE OTHER END IN AN APPROVED GASOLINE CONTAINER.
  NOTE FUEL PRESSURE WITHIN 2 SECONDS AFTER IGNITION "ON".

- PRESSURE ABOVE 325 kPa ( 47 psi ) → CHECK FOR RESTRICTED FUEL RETURN LINE FROM FUEL PRESSURE REGULATOR TO POINT WHERE FUEL LINE WAS DISCONNECTED. → IF LINE IS OK, REPLACE THE FUEL PRESSURE REGULATOR.
- PRESSURE BETWEEN 280-325 kPa (40.5-47 psi ) → LOCATE AND CORRECT RESTRICTED FUEL RETURN LINE TO FUEL TANK.

CLEAR CODES AND CONFIRM "CLOSED LOOP " OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.




# CHART A-9

## COLD START VALVE CIRCUIT TEST
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The cold start valve is used to provide additional fuel during the crank mode to improve cold start-ups. This circuit is important when engine coolant temperature is low because the other injectors are not pulsed "ON" long enough to provide the needed amount of fuel to start.

The circuit is activated only in the crank mode. The power is supplied directly from the starter solenoid and is protected by a fuse. The system is controlled by a cold start fuel injection switch which provides a ground path for the valve during cranking when engine coolant is below 35°C (95°F).

The cold start fuel injection switch consists of a bimetal material which opens at a specified coolant temperature. This bimetal is also heated by the winding in the thermal switch which allows the valve to stay "ON" for 8 seconds at -20°C (-4°F) coolant. The time the switch will stay closed varies inversely with coolant temperature. In other words, as the coolant temperature goes up, the cold start valve "ON" time goes down.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Disconnecting the distributor 4-way connector will disable the other injectors. The amount of pressure drop depends on the temperature of the engine. This test could also be performed by removing the two injector fuses.
2. This test will determine the continuity through the switch to ground.

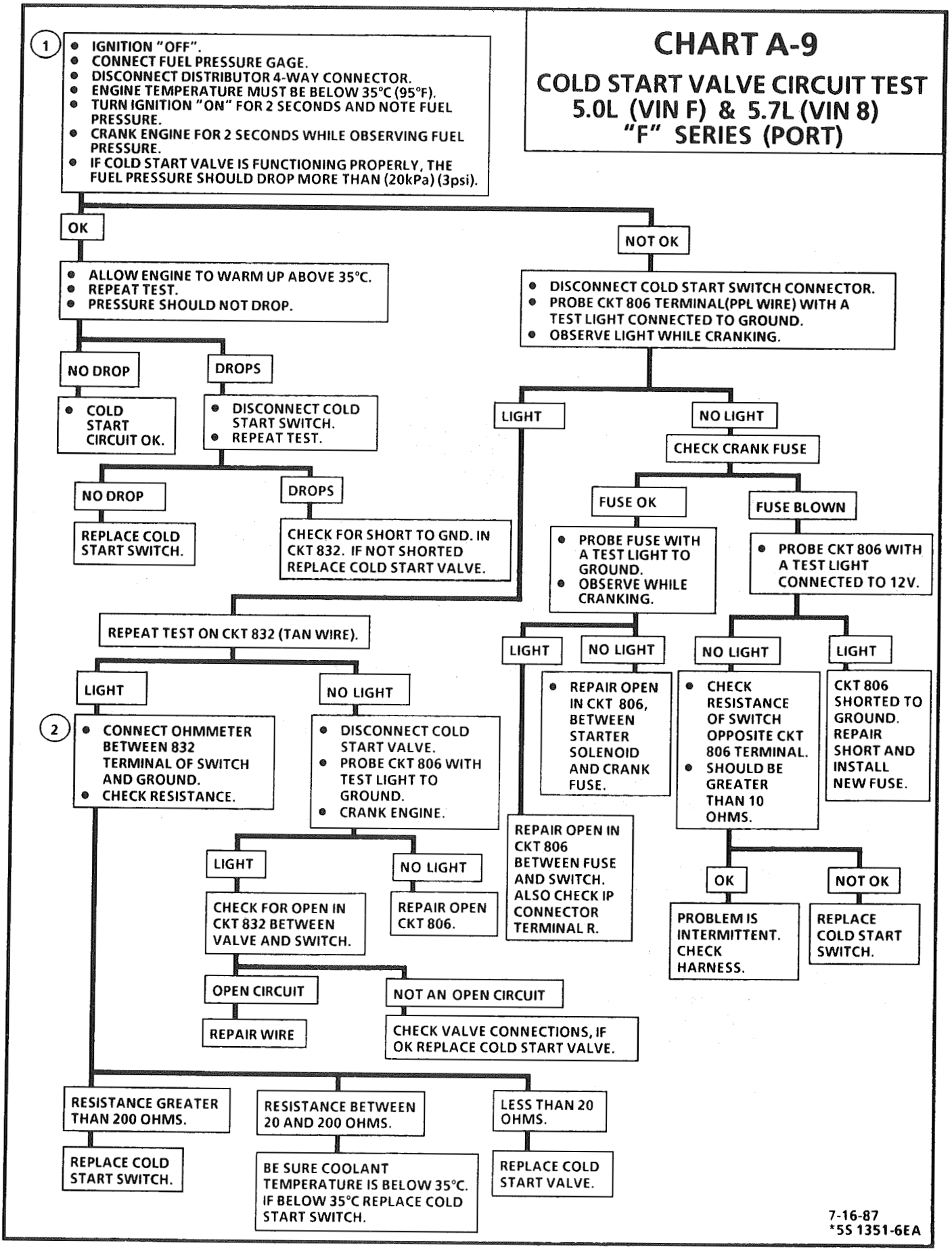


CHART A-9
COLD START VALVE CIRCUIT TEST
5.0L (VIN F) & 5.7L (VIN 8)
"F" SERIES (PORT)
1
IGNITION "OFF".
CONNECT FUEL PRESSURE GAGE.
DISCONNECT DISTRIBUTOR 4-WAY CONNECTOR.
ENGINE TEMPERATURE MUST BE BELOW 35°C (95°F).
TURN IGNITION "ON" FOR 2 SECONDS AND NOTE FUEL PRESSURE.
CRANK ENGINE FOR 2 SECONDS WHILE OBSERVING FUEL PRESSURE.
IF COLD START VALVE IS FUNCTIONING PROPERLY, THE FUEL PRESSURE SHOULD DROP MORE THAN (20kPa) (3psi).
OK
NOT OK
ALLOW ENGINE TO WARM UP ABOVE 35°C.
REPEAT TEST.
PRESSURE SHOULD NOT DROP.
NO DROP
DROPS
COLD START CIRCUIT OK.
DISCONNECT COLD START SWITCH.
REPEAT TEST.
NO DROP
DROPS
REPLACE COLD START SWITCH.
CHECK FOR SHORT TO GND. IN CKT 832. IF NOT SHORTED REPLACE COLD START VALVE.
DISCONNECT COLD START SWITCH CONNECTOR.
PROBE CKT 806 TERMINAL(PPL WIRE) WITH A TEST LIGHT CONNECTED TO GROUND.
OBSERVE LIGHT WHILE CRANKING.
LIGHT
NO LIGHT
CHECK CRANK FUSE
FUSE OK
FUSE BLOWN
PROBE FUSE WITH A TEST LIGHT TO GROUND.
OBSERVE WHILE CRANKING.
PROBE CKT 806 WITH A TEST LIGHT CONNECTED TO 12V.
REPEAT TEST ON CKT 832 (TAN WIRE).
LIGHT
NO LIGHT
LIGHT
NO LIGHT
NO LIGHT
LIGHT
REPAIR OPEN IN CKT 806, BETWEEN STARTER SOLENOID AND CRANK FUSE.
CKT 806 SHORTED TO GROUND. REPAIR SHORT AND INSTALL NEW FUSE.
2
CONNECT OHMMETER BETWEEN 832 TERMINAL OF SWITCH AND GROUND.
CHECK RESISTANCE.
DISCONNECT COLD START VALVE.
PROBE CKT 806 WITH TEST LIGHT TO GROUND.
CRANK ENGINE.
CHECK RESISTANCE OF SWITCH OPPOSITE CKT 806 TERMINAL.
SHOULD BE GREATER THAN 10 OHMS.
REPAIR OPEN IN CKT 806 BETWEEN FUSE AND SWITCH. ALSO CHECK IP CONNECTOR TERMINAL R.
LIGHT
NO LIGHT
OK
NOT OK
CHECK FOR OPEN IN CKT 832 BETWEEN VALVE AND SWITCH.
REPAIR OPEN CKT 806.
PROBLEM IS INTERMITTENT. CHECK HARNESS.
REPLACE COLD START SWITCH.
OPEN CIRCUIT
NOT AN OPEN CIRCUIT
REPAIR WIRE
CHECK VALVE CONNECTIONS, IF OK REPLACE COLD START VALVE.
RESISTANCE GREATER THAN 200 OHMS.
RESISTANCE BETWEEN 20 AND 200 OHMS.
LESS THAN 20 OHMS.
REPLACE COLD START SWITCH.
BE SURE COOLANT TEMPERATURE IS BELOW 35°C. IF BELOW 35°C REPLACE COLD START SWITCH.
REPLACE COLD START VALVE.
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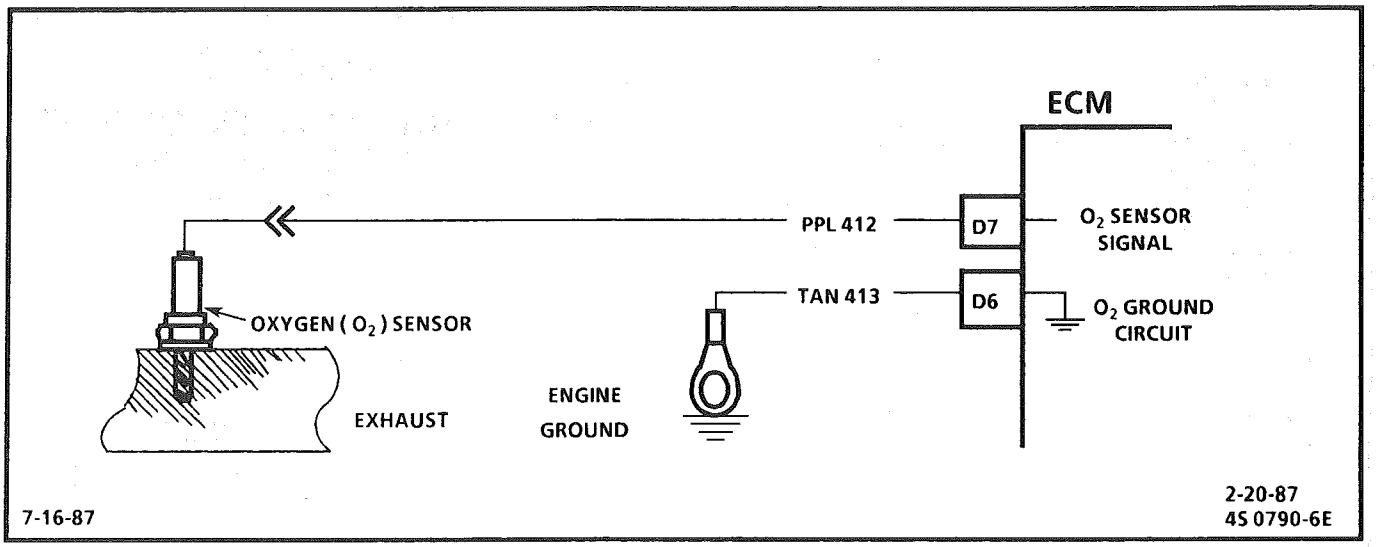



# CODE 13

## OXYGEN SENSOR CIRCUIT (OPEN CIRCUIT) 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D7" and "D6". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volts.) The $O_2$ sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below 360 ° C(600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 13 WILL SET:
   - Engine at normal operating temperature (above 70°C)
   - At least 2 minutes engine time after start.
   - $O_2$ signal voltage steady between .35 and .55 volts.
   - Throttle position sensor signal above 5%. (about .3 volts above closed throttle voltage).
   - All conditions must be met for about 60 seconds.

   If the conditions for a Code 13 exist, the system will not go "Closed Loop".
2. This will determine if the sensor is at fault or the wiring or ECM is the cause of the Code 13.
3. For this test use only a high impedance digital voltohm meter. This test checks the continuity of CKTs 412 and 413. If CKT 413 is open, the ECM voltage on CKT 412 will be over .6 volts (600 mV).

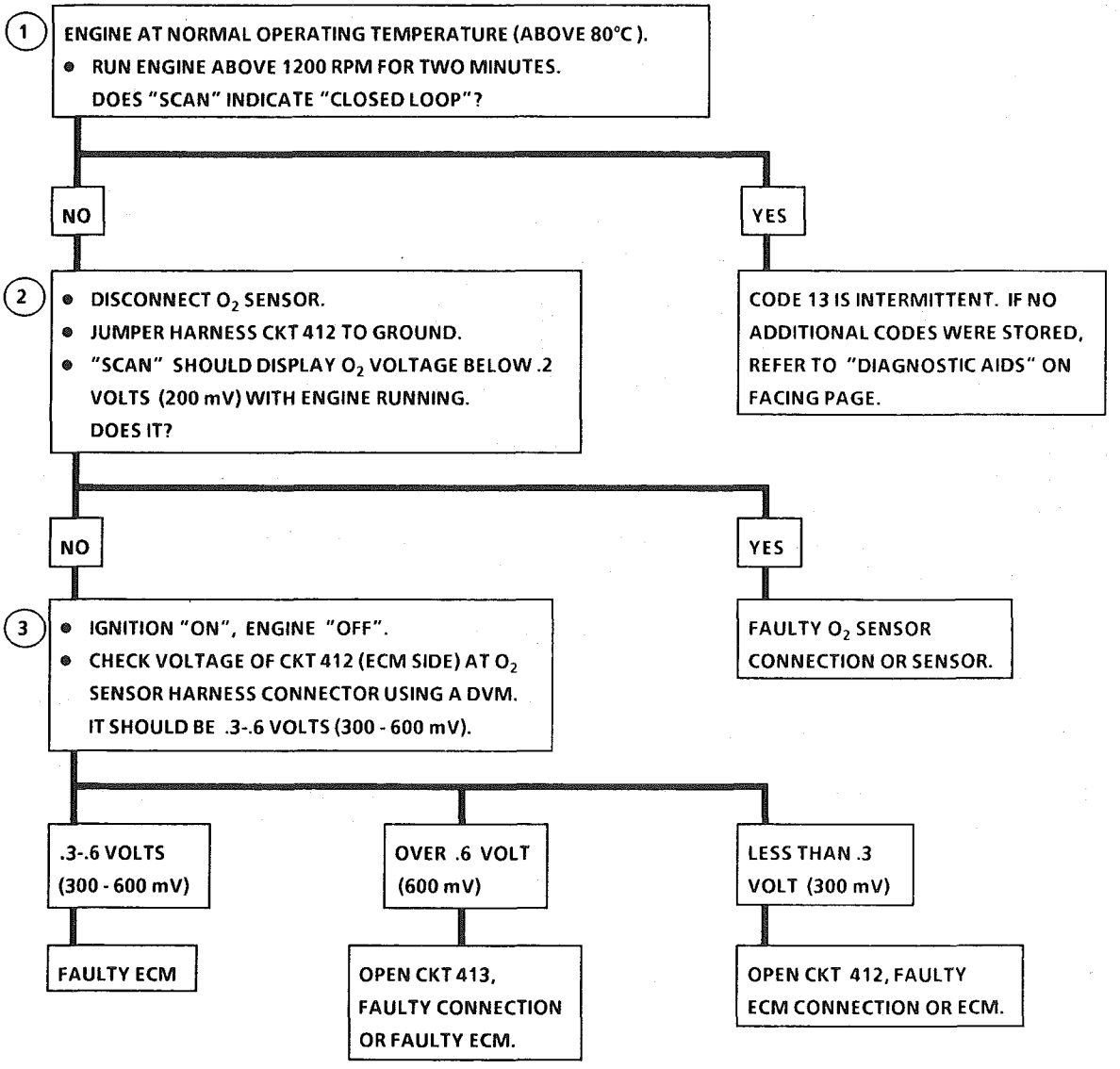
### Diagnostic Aids:

Normal "Scan" voltage varies between 100mV to 999mV (.1 and 1.0 volt) while in "Closed Loop". Code 13 sets in one minute if voltage remains between .35 and .55 volts, but the system will go "Open Loop" in about 15 seconds.

Refer to "Intermittents" in Section "B".

# CODE 13

## OXYGEN SENSOR CIRCUIT
## (OPEN CIRCUIT)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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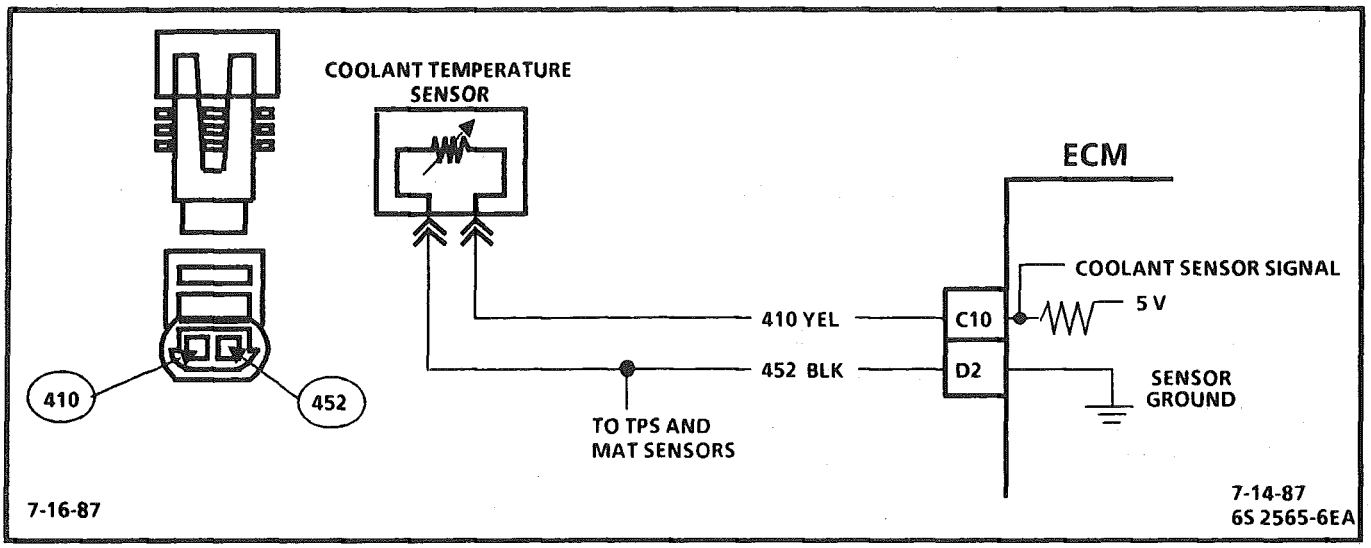
• 7S 3054-6E




# CODE 14

## COOLANT TEMPERATURE SENSOR CIRCUIT
## (HIGH TEMPERATURE INDICATED)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The coolant temperature sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage.

As the engine warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (85°C to 95°C), the voltage will measure about 1.5 to 2.0 volts.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 14 will set if:
   - signal voltage indicates a coolant temperature above 130°C (266°F) for 3 seconds
2. This test will determine if CKT 410 is shorted to ground which will cause the conditions for Code 14.

### Diagnostic Aids:

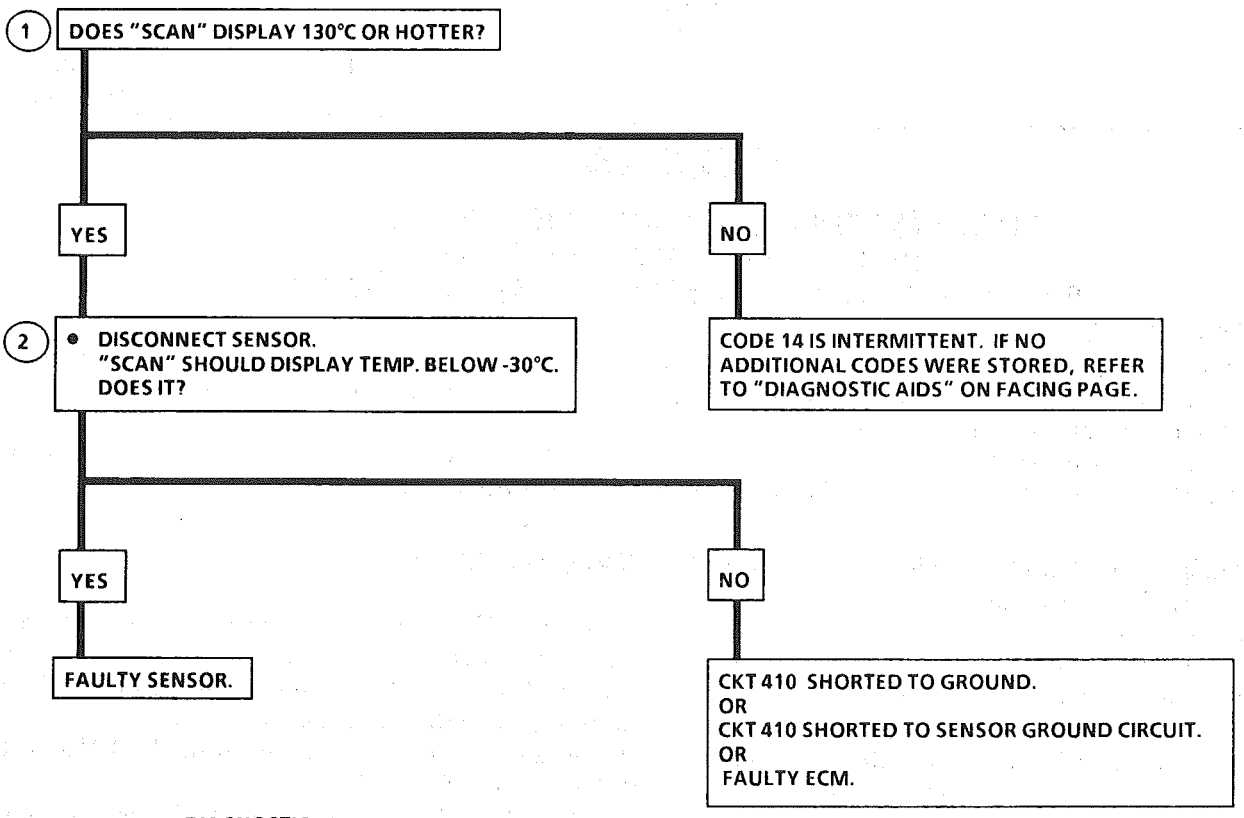
Check harness routing for a potential short to ground in CKT 410.

"SCAN" tool displays engine temp. in degrees centigrade. After engine is started, the temperature should rise steadily to about 90°C, then stabilize when thermostat opens.

Refer to "Intermittents" in Section "B".

# CODE 14

## COOLANT TEMPERATURE SENSOR CIRCUIT
(HIGH TEMPERATURE INDICATED)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)




DIAGNOSTIC AID

| COOLANT SENSOR | | |
|---|---|---|
| TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE) | | |
| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

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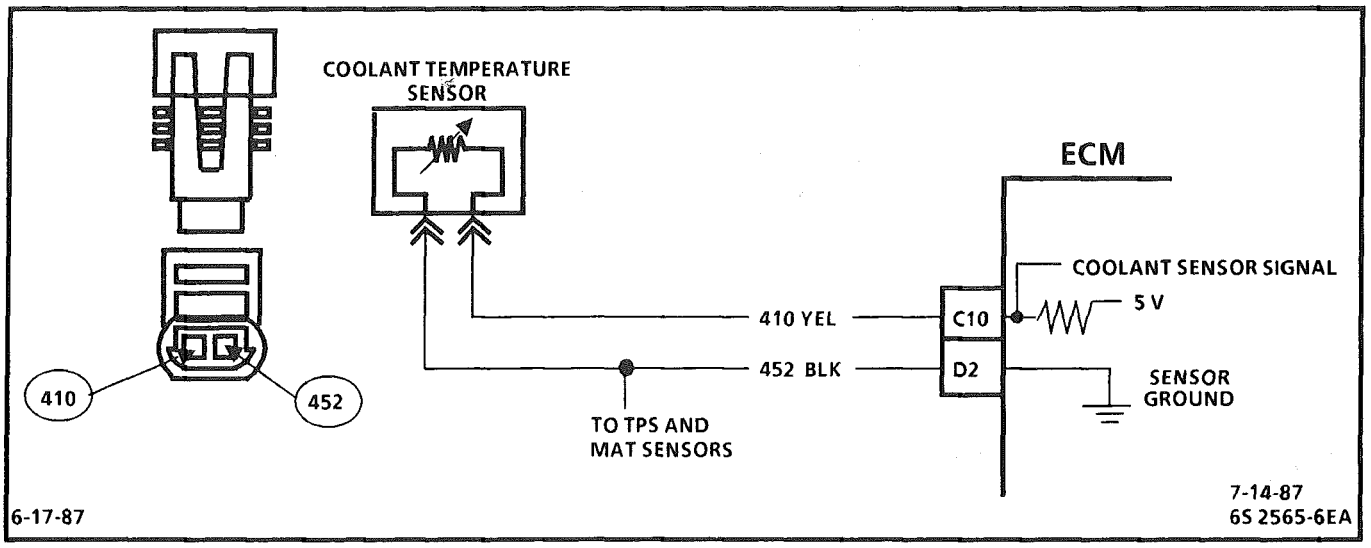
• 7S 3055-6E




# CODE 15

## COOLANT TEMPERATURE SENSOR CIRCUIT
### (LOW TEMPERATURE INDICATED)
### 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

**Circuit Description:**

The coolant temperature sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage on CKT 410 to the sensor. When the engine is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see high signal voltage.

As the engine warms, the sensor resistance becomes less, and the voltage drops. At normal engine operating temperature (85°C to 95°C), the voltage will measure about 1.5 to 2.0 volts at the ECM.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 15 will set if:
   - signal voltage indicates a coolant temperature less than -44° C (-47° F) for 3 seconds.
2. This test simulates a Code 14. If the ECM recognizes the low signal voltage, (high temp.) and the "Scan" reads 130°C or above, the ECM and wiring are OK.
3. This test will determine if CKT 410 is open. There should be 5 volts present at sensor connector if measured with a DVM.

**Diagnostic Aids:**

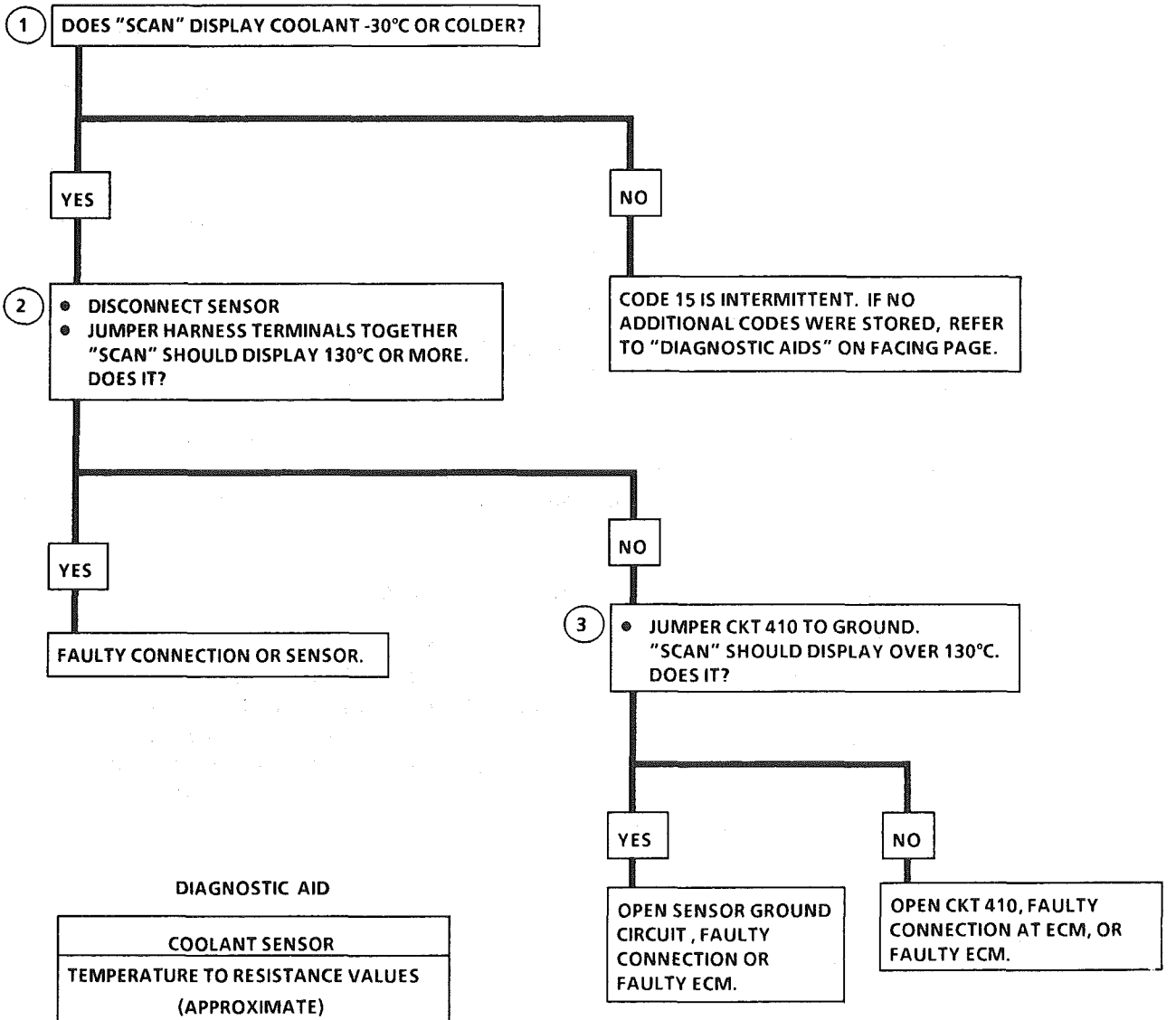
A "SCAN" tool reads engine temperature in degrees centigrade. After engine is started the temperature should rise steadily to about 90°C then stabilize when thermostat opens.

A faulty connection, or an open in CKT 410 or 452 will result in a Code 15.

If Code 22 or 23 is also set, check CKT 452 for faulty wiring or connections. Check terminals at sensor for good contact. Refer to "Intermittents" in Section "B".

# CODE 15

## COOLANT TEMPERATURE SENSOR CIRCUIT
(LOW TEMPERATURE INDICATED)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

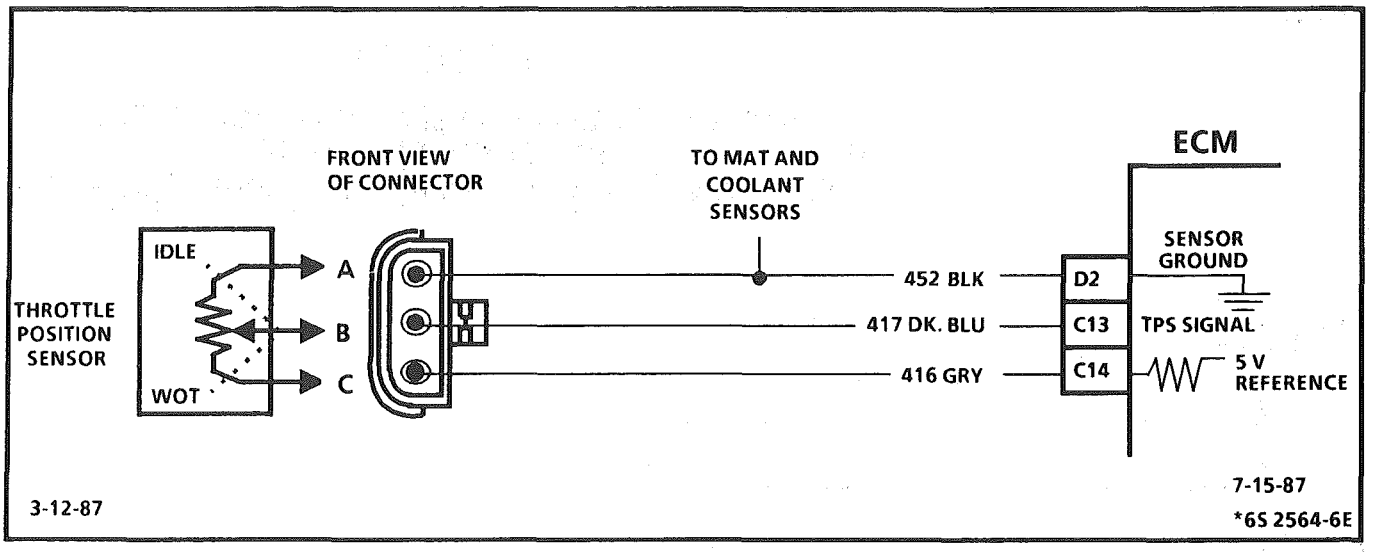



DIAGNOSTIC AID

| COOLANT SENSOR | | |
|---|---|---|
| TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE) | | |
| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-11-87
• 7S 3261-6E




# CODE 21

## THROTTLE POSITION SENSOR (TPS) CIRCUIT
## (SIGNAL VOLTAGE HIGH)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The throttle position sensor (TPS) provides a voltage signal that changes relative to the throttle blade. Signal voltage will vary from about .5 at idle to about 5 volts at wide open throttle.

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM control outputs.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 21 will set if:
   - TPS signal voltage is greater than 2.5 volts
   - Engine is running
   - Air flow is less than 12 GM/sec.
   - All conditions met for 3 seconds.

   OR
   - TPS signal voltage over about 4.8 volts with ignition "ON".

   With throttle closed, the TPS should read less than .62 volts. If it doesn't check adjustment.
2. With the TPS sensor disconnected, the TPS voltage should go low if the ECM and wiring is OK.
3. Probing CKT 452 with a test light checks the 5V return CKT, because a faulty 5V return will cause a Code 21.

### Diagnostic Aids:

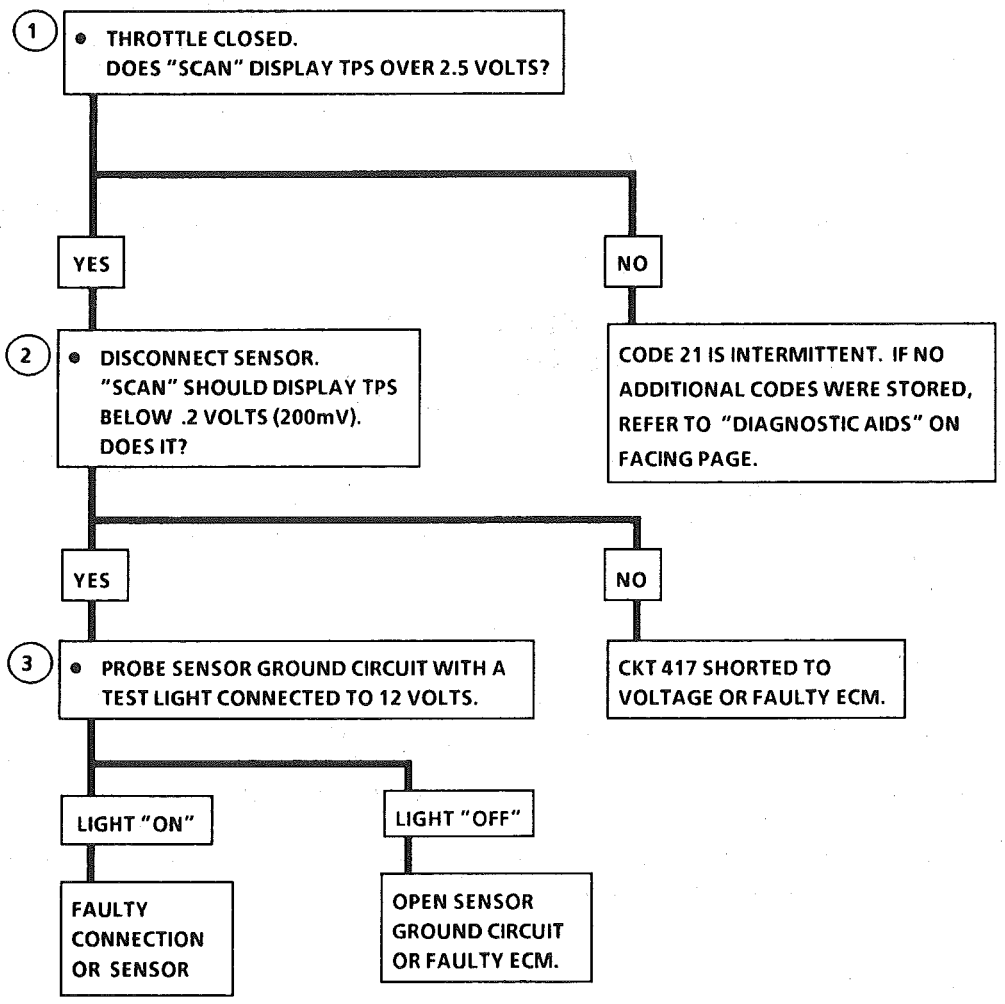
A "SCAN" tool reads throttle position in volts. Should read .54V ± .08V with throttle closed and ignition "ON" or at idle. Voltage should increase at a steady rate as throttle is moved toward WOT.

An open in CKT 452 will result in a Code 21.

Refer to "Intermittents" in Section "B".

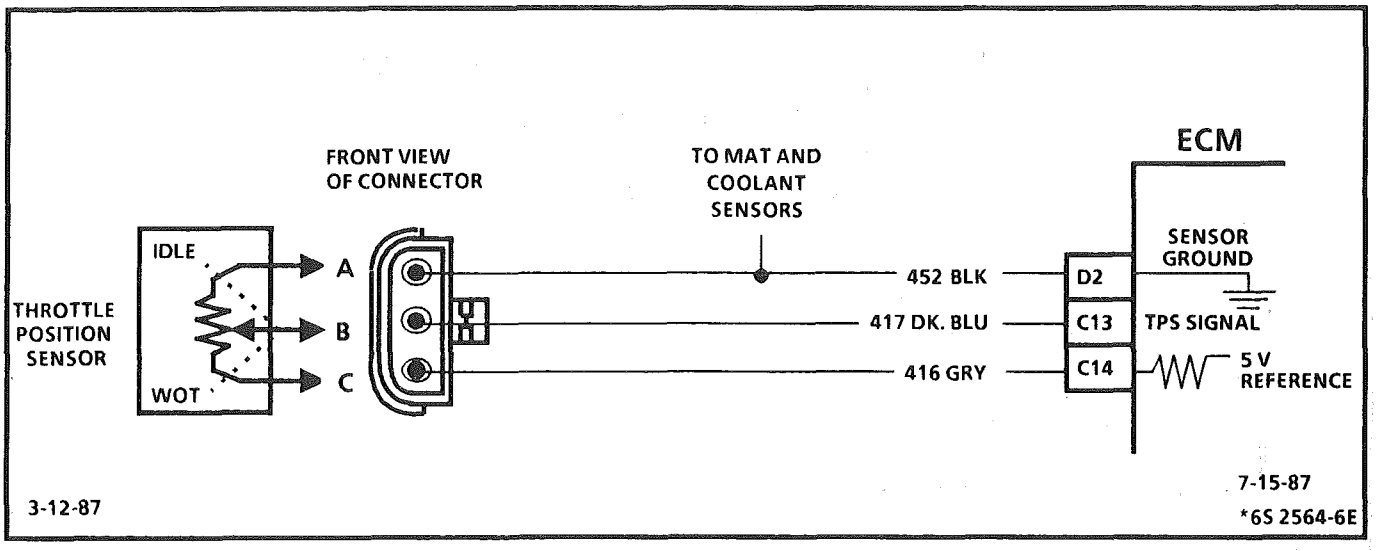
# CODE 21

## THROTTLE POSITION SENSOR (TPS) CIRCUIT
(SIGNAL VOLTAGE HIGH)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-24-87
• 7S 3057-6E




# CODE 22

## THROTTLE POSITION SENSOR (TPS) CIRCUIT
## (SIGNAL VOLTAGE LOW)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The throttle position sensor (TPS) provides a voltage signal that changes relative to the throttle blade. Signal voltage will vary from about .5 at idle to about 5 volts at wide open throttle.

The TPS signal is one of the most important inputs used by the ECM for fuel control and for most of the ECM control outputs.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 22 will set if:
   - Engine running
   - TPS signal voltage is less than about .2 volt for 3 seconds.
2. Simulates Code 21: (high voltage) If the ECM recognizes the high signal voltage the ECM and wiring are OK.
3. TPS adjustment: With throttle closed, the TPS voltage reading should be .54V ± .08V.
4. This simulates a high signal voltage to check for an open in CKT 417.

### Diagnostic Aids:

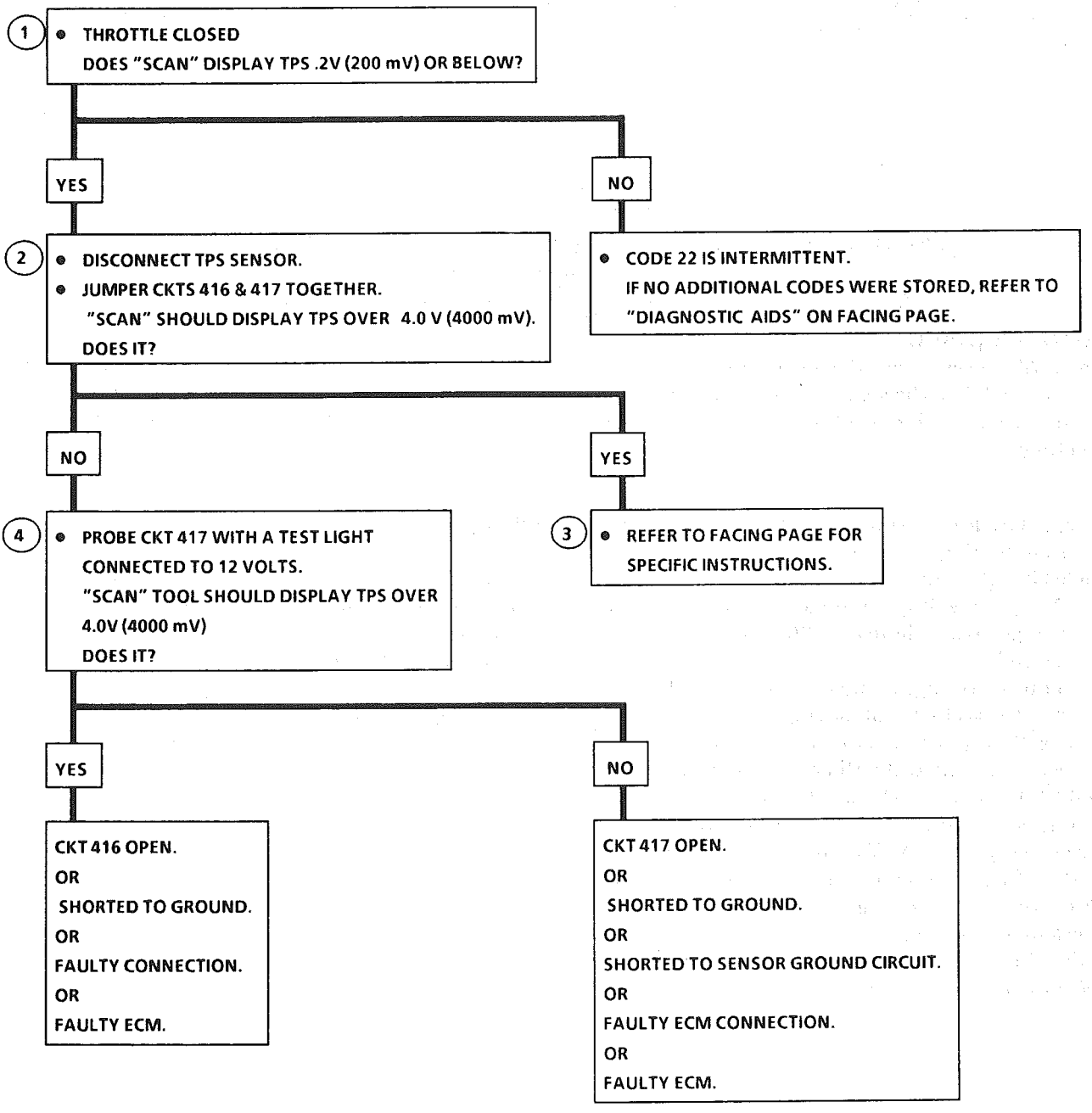
A "Scan" tool reads throttle position in volts. Should read .54V ± .08V with throttle closed and ignition "ON" or at idle. Voltage should increase at a steady rate as throttle is moved toward WOT.

An open or short to ground in CKTs 416 or 417 will result in a Code 22.

Refer to "Intermittents" in Section "B".

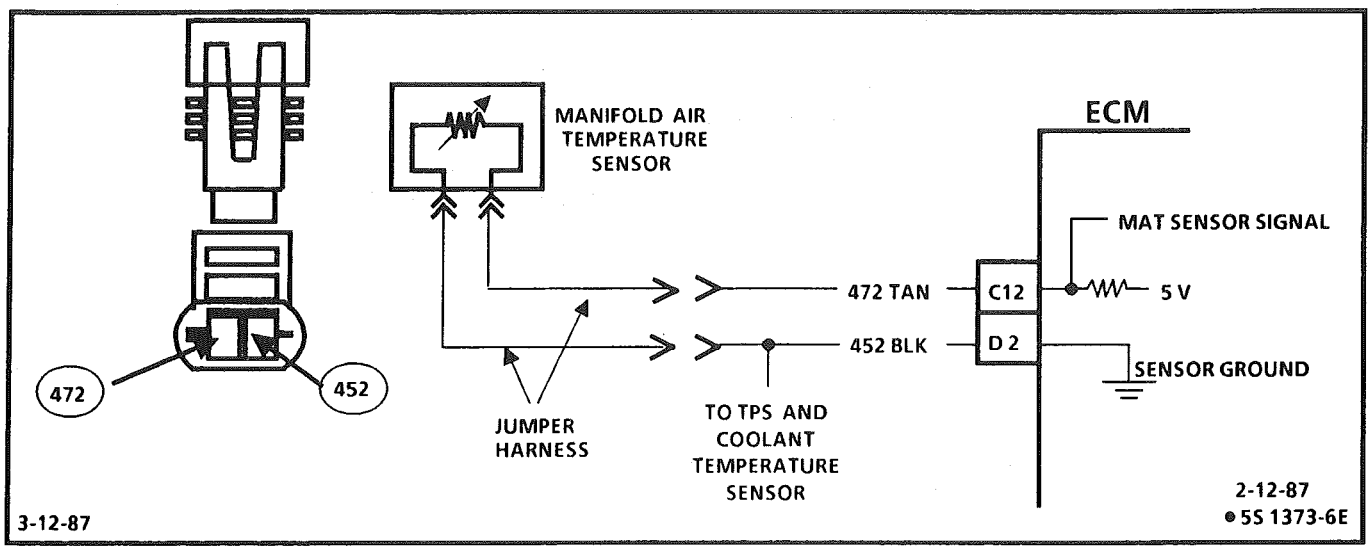
# CODE 22

## THROTTLE POSITION SENSOR (TPS) CIRCUIT
## (SIGNAL VOLTAGE LOW)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-25-87
• 7S 3365-6E




# CODE 23

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
## (LOW TEMPERATURE INDICATED)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The MAT sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a voltage (4-6 volts) on CKT 472 to the sensor. When the air is cold, the sensor (thermistor) resistance is high, therefore, the ECM will see a high signal voltage. If the air is warm, the sensor resistance is low, therefore, the ECM will see a low voltage.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 23 will set if:
   - A signal voltage indicates a manifold air temperature below −30°C (-22°F) for 12 seconds.
   - Time since engine start is 1 minute or longer.
   - No VSS (vehicle not moving)
2. A Code 23 will set, due to an open sensor, wire, or connection. This test will determine if the wiring and ECM are OK. The MAT sensor is difficult to reach and this test can be performed by disconnecting the MAT jumper harness connector. If the "Scan" indicates a temperature of over 130°C the jumper harness to the sensor should be checked before replacing the sensor.
3. This will determine if the signal CKT 472 or the 5V return CKT 452 is open.

### Diagnostic Aids:

A "SCAN" tool reads temperature of the air entering the 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 CKT 472 or 452.

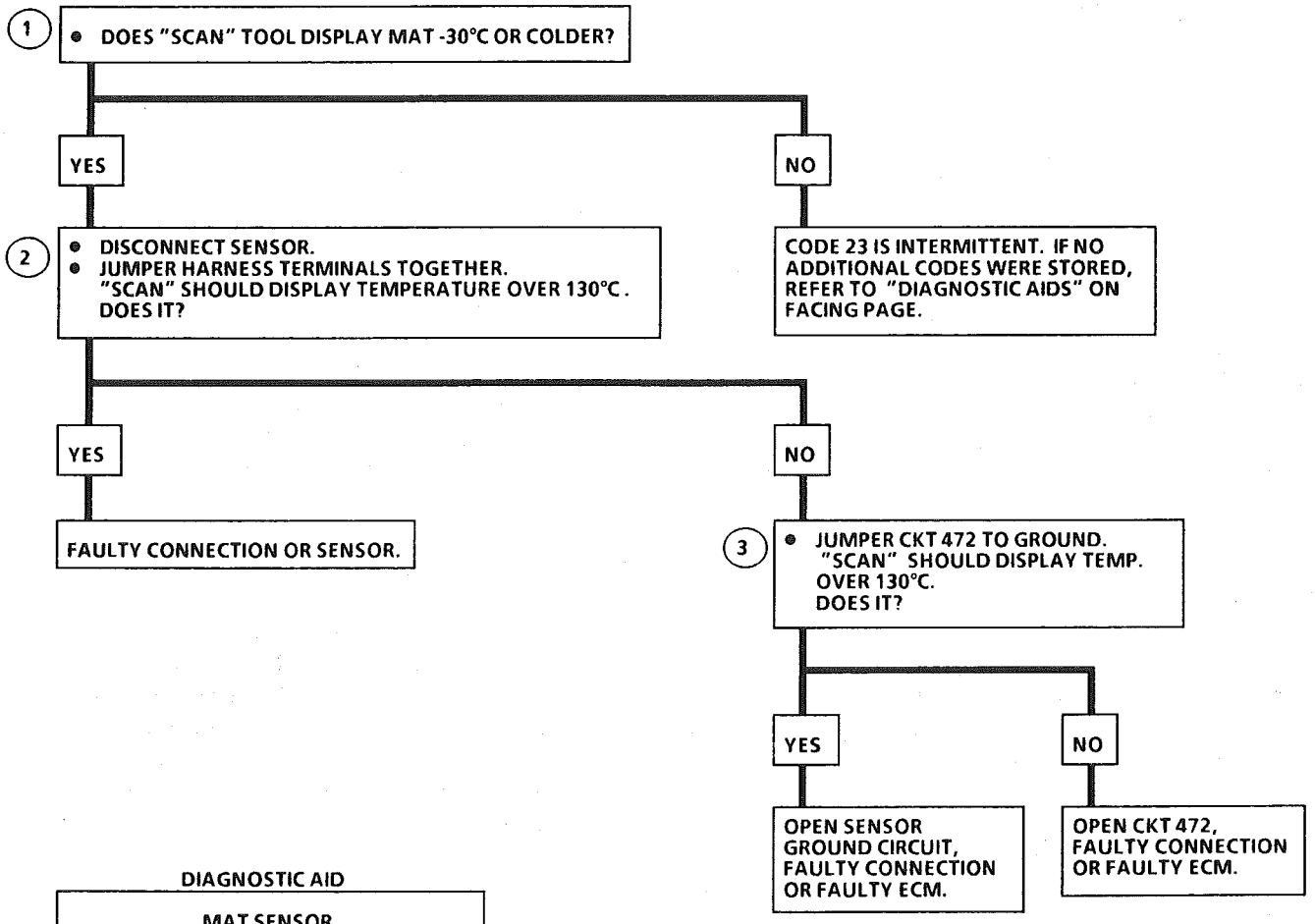
Refer to "Intermittents" in Section "B".

# CODE 23

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT

### (LOW TEMPERATURE INDICATED)

### 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)



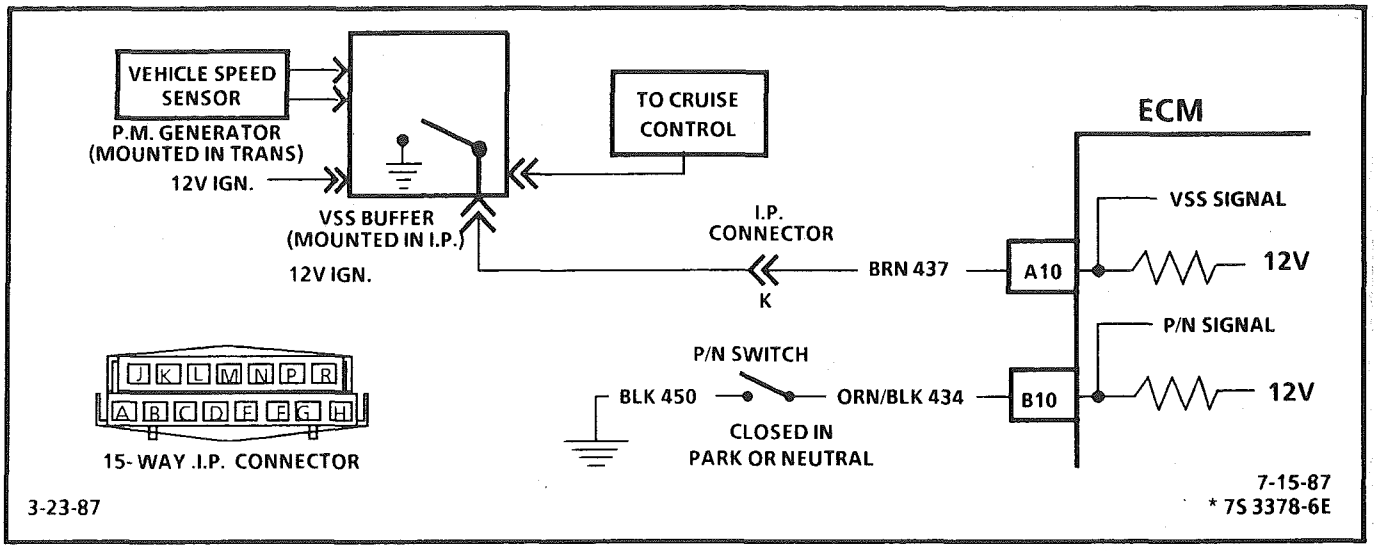

DIAGNOSTIC AID

| MAT SENSOR | | |
|---|---|---|
| TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE) | | |
| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-25-87

• 7S 3285




# CODE 24

## VEHICLE SPEED SENSOR (VSS) CIRCUIT
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The ECM applies and monitors 12 volts on CKT 437. CKT 437 connects to the vehicle speed sensor buffer which alternately grounds CKT 437 when drive wheels are turning. This pulsing action takes place about 2000 times per mile and the ECM will calculate vehicle speed based on the time between "pulses".

A "SCAN" tool reading should closely match with speedometer reading with drive wheels turning.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 24 will set if:
   - CKT 437 voltage is constant.
   - Engine speed between 1400 and 3600 rpm.
   - Less than 2% throttle opening, about .10V (100mV) above close throttle.
   - Low load condition (low air flow).
   - Not in park or neutral.
   - All conditions must be met for 4 seconds.

   These conditions are met during a road load deceleration.
2. A voltage of less than 1 volt at the 15-way connector indicates that the CKT 437 wire may be shorted to ground. Disconnect CKT 437 at the VSS buffer. If voltage now reads above 10 volts, the VSS buffer is faulty. If voltage remains less than 10 volt, then CKT 437 wire is grounded or open. If 437 is not grounded or open, check for a faulty ECM connector or ECM.

### Diagnostic Aids:

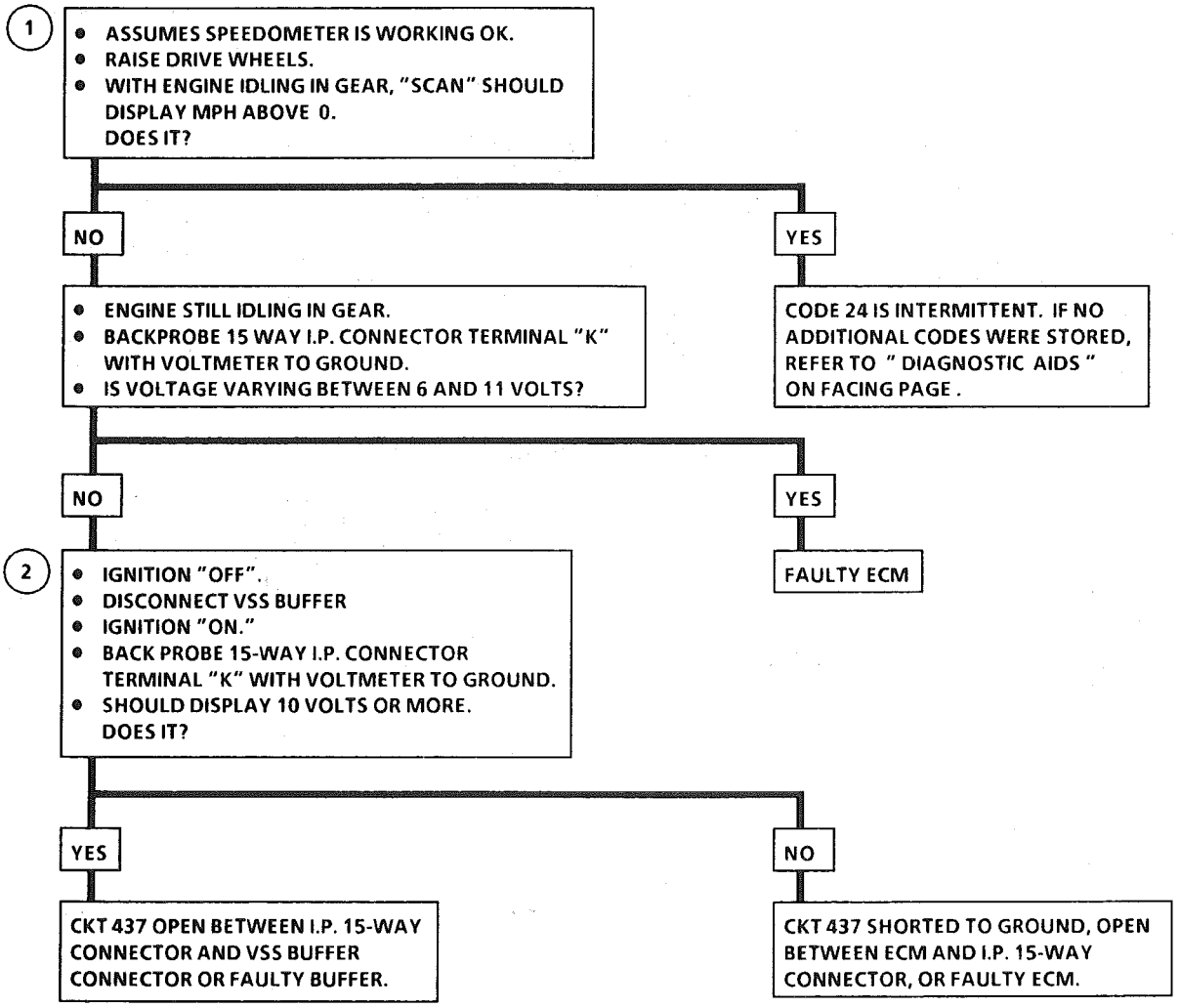
If "Scan" displays vehicle speed, check park/neutral switch CHART C-1A on vehicle with auto trans. If switch is OK check for intermittent connections. An open or short to ground in CKT 437 will result in a Code 24. If the customer also complained about a loss of mph on the I.P., check the P.M. generator circuit. Refer to Section "8A" for complete wiring diagram.

Refer to "Intermittents" in Section "B".

# CODE 24

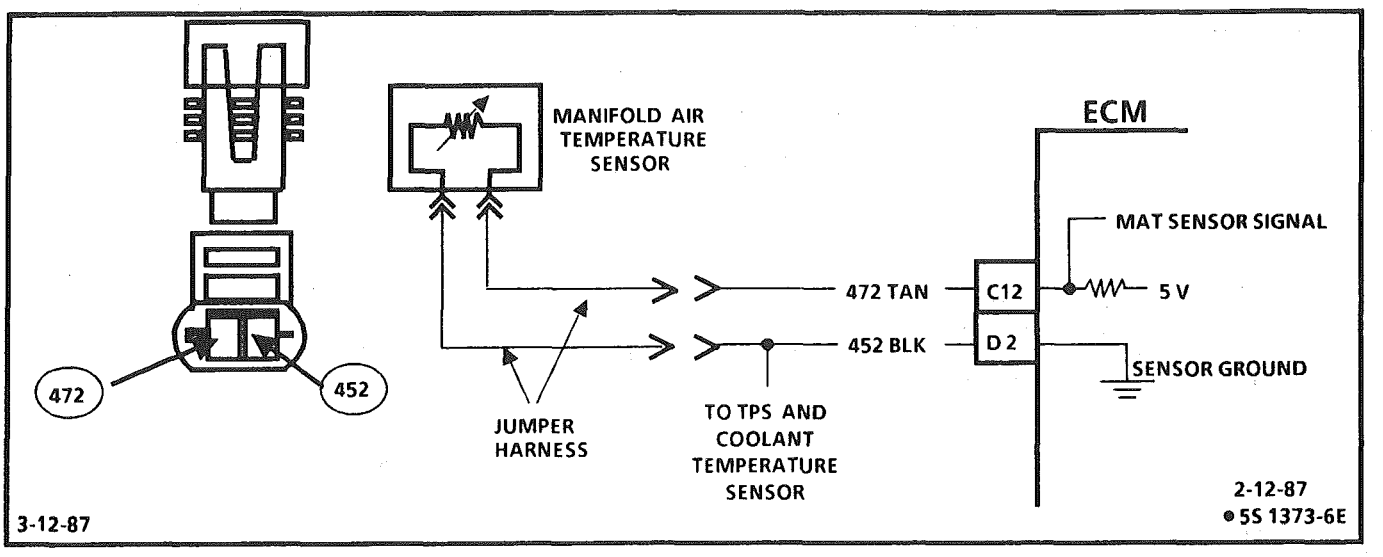
## VEHICLE SPEED SENSOR (VSS) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

NOTE: TO PREVENT MISDIAGNOSIS, THE TECHNICIAN SHOULD REVIEW ELECTRICAL SECTION "8A" OR THE ELECTRICAL TROUBLESHOOTING MANUAL AND IDENTIFY THE TYPE OF VEHICLE SPEED SENSOR USED PRIOR TO USING THIS CHART. DISREGARD CODE 24 IF SET WHEN DRIVE WHEELS ARE NOT TURNING.




CLEAR CODES AND CONFIRM "CLOSED LOOP " OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

*8S 4684-6E
7-16-87




# CODE 25

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT (HIGH TEMPERATURE INDICATED) 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The manifold air temperature sensor uses a thermistor to control the signal-voltage to the ECM. The ECM applies a voltage (4-6) on CKT 472 to the sensor. When manifold air is cold, the sensor (Thermistor) resistance is high, therefore, the ECM will see a high signal voltage. As the air warms, the sensor resistance becomes less, and the voltage drops.

### Test Description:

Numbers below refer to circled numbers on the diagnostic chart.

1. Code 25 will set if:
   - Signal voltage indicates a manifold air temperature greater than 150°C (302° F) for 2 seconds.
   - Time since engine start is 1 minute or longer.
   - A vehicle speed is present.

### Diagnostic Aids:

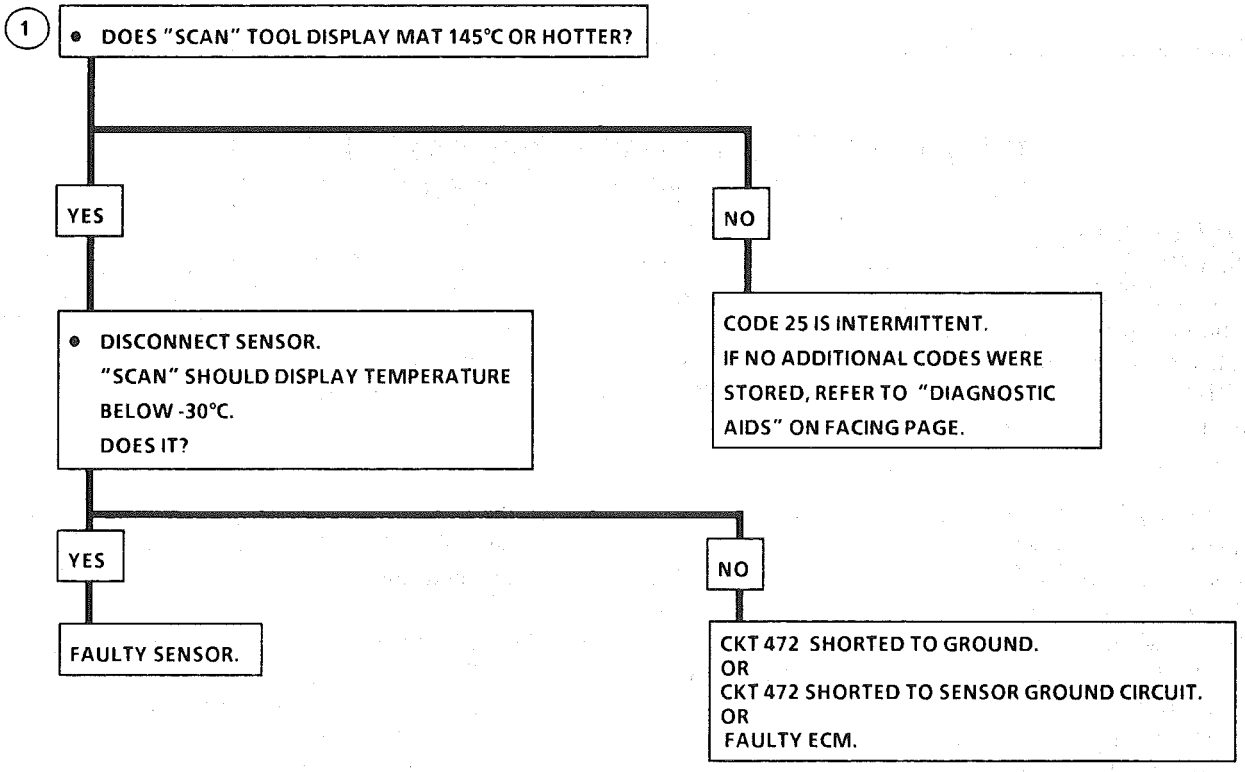
A "SCAN" tool reads temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rise as underhood temperature increases.

Check harness routing for possible short to ground in CKT 472.

Refer to "Intermittents" in Section "B".

# CODE 25

## MANIFOLD AIR TEMPERATURE (MAT) SENSOR CIRCUIT
## (HIGH TEMPERATURE INDICATED)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)




DIAGNOSTIC AID

MAT SENSOR

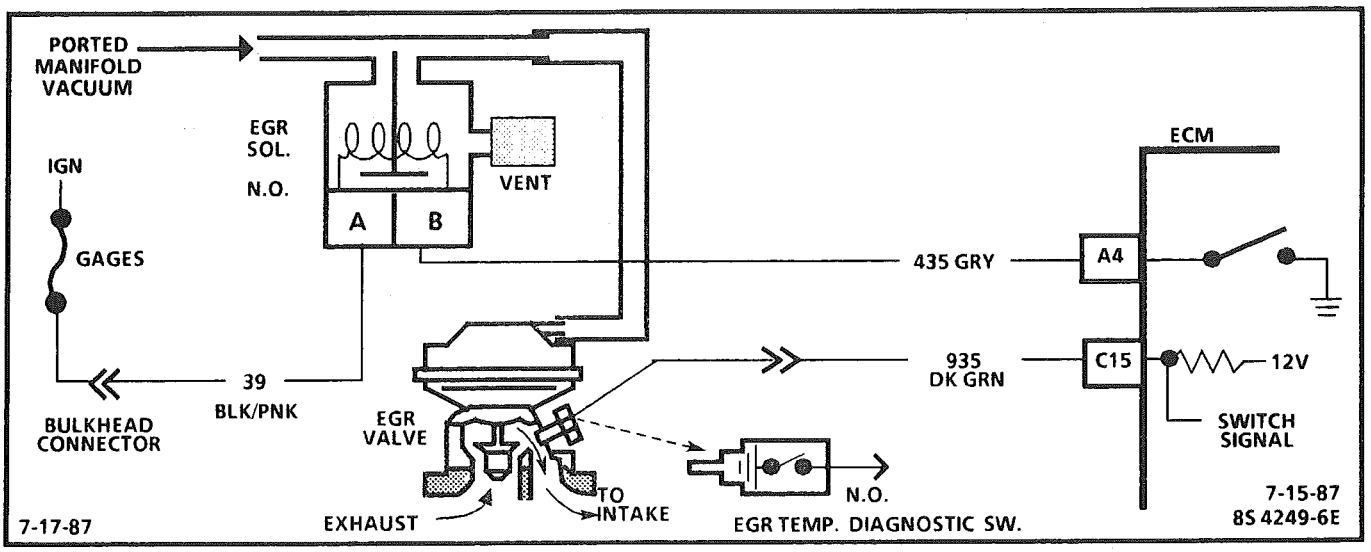
TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)

| °F | °C | 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 |

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

6-17-87

• 7S 3190-6E




# CODE 32

## EXHAUST GAS RECIRCULATION (EGR) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The EGR valve vacuum is controlled by an ECM controlled solenoid. The ECM will turn the EGR "ON" and "OFF" (Duty Cycle) by grounding CKT 435. The duty cycle is calculated by the ECM, based on information from the coolant and mass air flow sensor and engine RPMs. There should be (NO EGR) when in park or neutral, TPS input below a specified value or TPS indicating wide open throttle (WOT).

With the ignition "ON", engine stopped, the EGR solenoid is de-energized and, by grounding the diagnostic terminal, the solenoid is energized.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

Code 32 means that the EGR diagnostic switch was closed during start-up or that the switch was not detected closed under the following conditions:

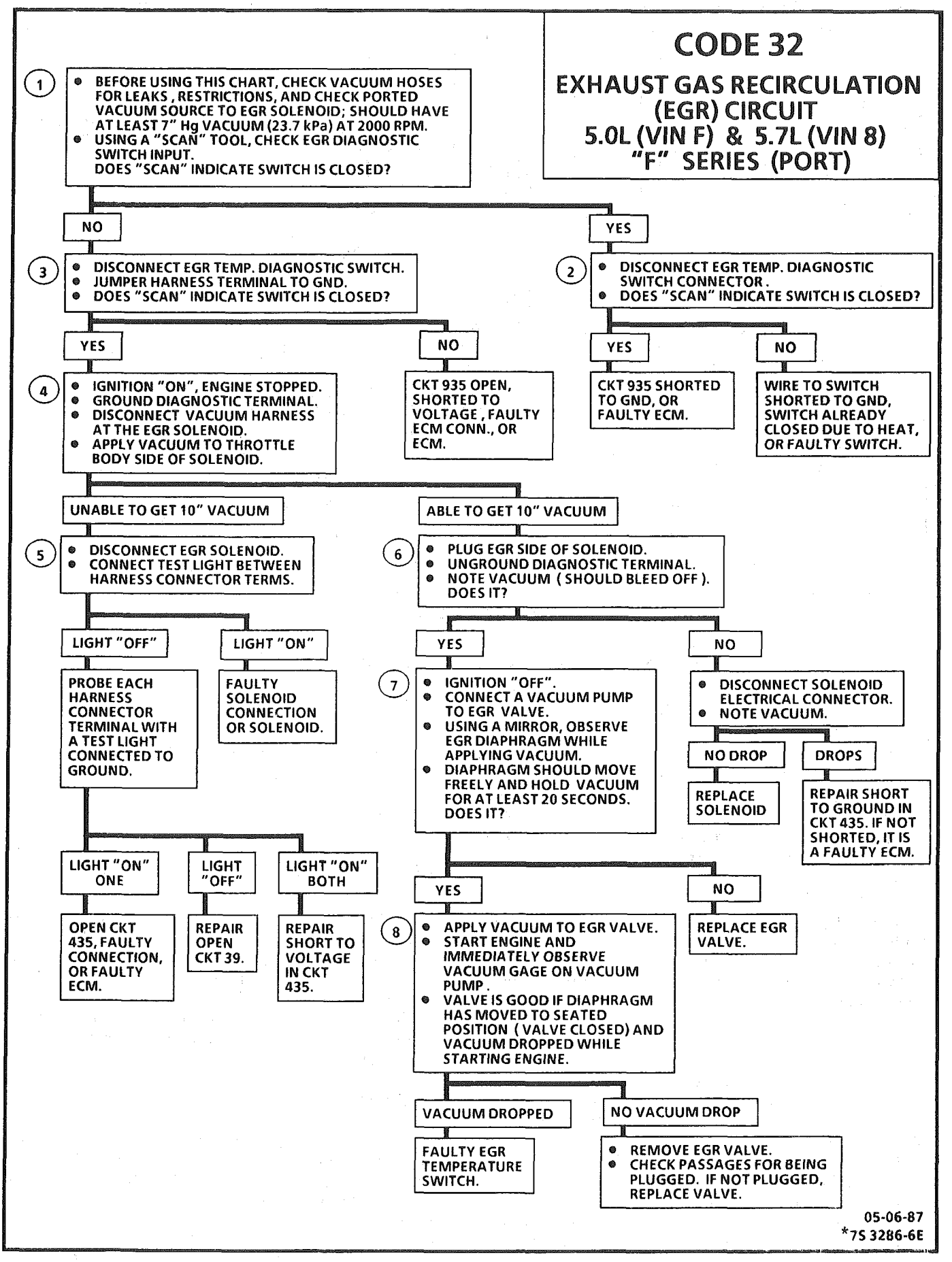
- Coolant temperature greater than 80°C (176°F).
- EGR duty cycle commanded by the ECM is greater than 48%.
- TPS less than wide open throttle (WOT), but not at idle.
- Codes 21,22,33,34 not present.
- All conditions above must be met for about 4 minutes.

If the switch is detected closed during start-up, or if the switch is detected open when the above conditions are met, the "Service Engine Soon" light will remain "ON" unless the switch changes state.

1. This test will determine if the ECM set the code due to CKT 935 being grounded on start-up. If the "Scan" does not indicate the switch is closed but the customer complained of a "Service Engine Soon" light after start-up, then this circuit should be checked carefully for an intermittent grounded condition.
2. If the "Scan" indicates the switch is no longer closed after disconnecting it, be sure the switch is not closed due to heat. (EGR being "ON" prior to test).
3. This test will check for a possible open in CKT 935. The ECM supplies 9-12 volts to CKT 935 and the "Scan" should indicate switch being closed when CKT 935 is grounded.
4. By grounding the diagnostic terminal, the EGR solenoid should close, and allow vacuum to be applied and the vacuum should hold.
5. This test will determine if the electrical control part of the system is at fault or if the connector or solenoid are at fault.
6. By plugging the EGR valve side and ungrounding the diagnostic terminal, the solenoid valve should open and allow vacuum to bleed off through the vent.
7. With the engine not running and vacuum is applied to the valve, the valve should move to the fully open position.
8. This engine uses a negative back pressure valve and the valve should close when the engine is cranked over.

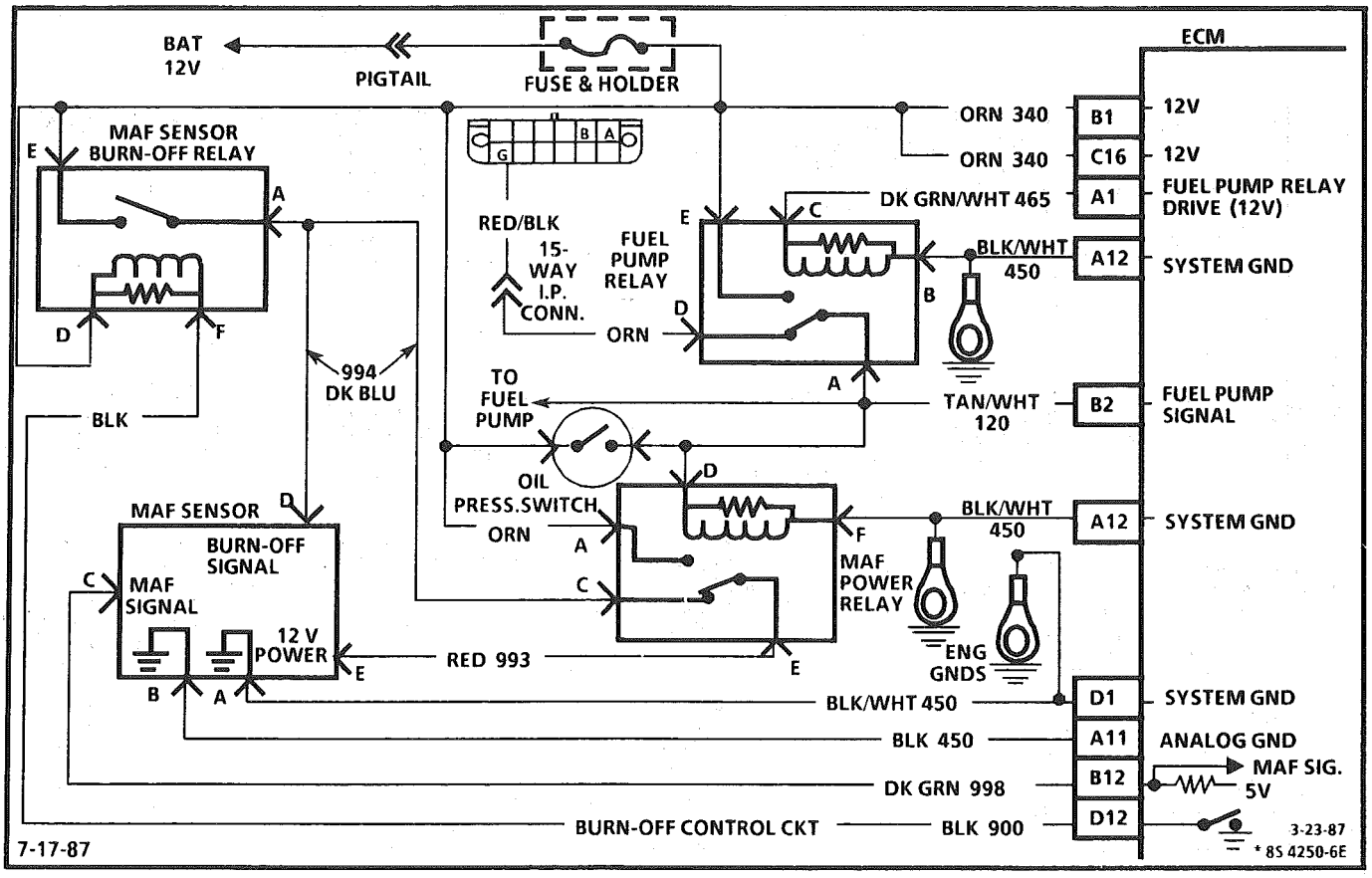
# CODE 32

## EXHAUST GAS RECIRCULATION (EGR) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)




05-06-87

*7S 3286-6E




# CODE 33

## MASS AIR FLOW (MAF) SENSOR CIRCUIT (GM/SEC HIGH) 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The mass air flow (MAF) sensor measures the amount of air which passes through it. The ECM uses this information to determine the operating condition of the engine to control fuel delivery. For a detailed description of the MAF sensor operation refer to Section "C".

The oil pressure switch or the ECM, through control of the fuel pump relay, will provide 12 volts for the MAF power relay which provides the 12 volts needed by the MAF sensor.

The ECM provides a current limiting 5V on the signal line (CKT 998). The MAF sensor then changes the signal by dropping the voltage, so that with low air flow the ECM sees a low voltage and a high air flow will cause the ECM to see near the 5 volt supply.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

Code 33 indicates: ECM has seen flow in excess of 45 grams per second (above about 2.2 volts) for one second when:

- Engine is first started
  OR
- TPS is less than $\frac{1}{4}$ throttle.
- RPM is less than 2000.

Due to the 5 volt pull-up resistor in the ECM if CKT 998 becomes open, the ECM will see a high voltage signal and set a Code 33.

1. This test will determine if the conditions to set the code still exist.
2. With the ALDL terminal "G" jumpered to 12 volts, there should be 12 volts at the sensor. If no voltage is present, make sure that the fuel pump is running. If not, repair fuel pump circuit.
3. If a burn-off signal is present at the MAF sensor with the engine running, a Code 33 will set. Be sure no voltage is present on CKT 994 for the first 2 seconds after the ignition is turned "ON", or after the 2 second period.
4. The ECM sources a voltage (4-6 volts) to the MAF sensor on CKT 998. This test checks for that voltage.

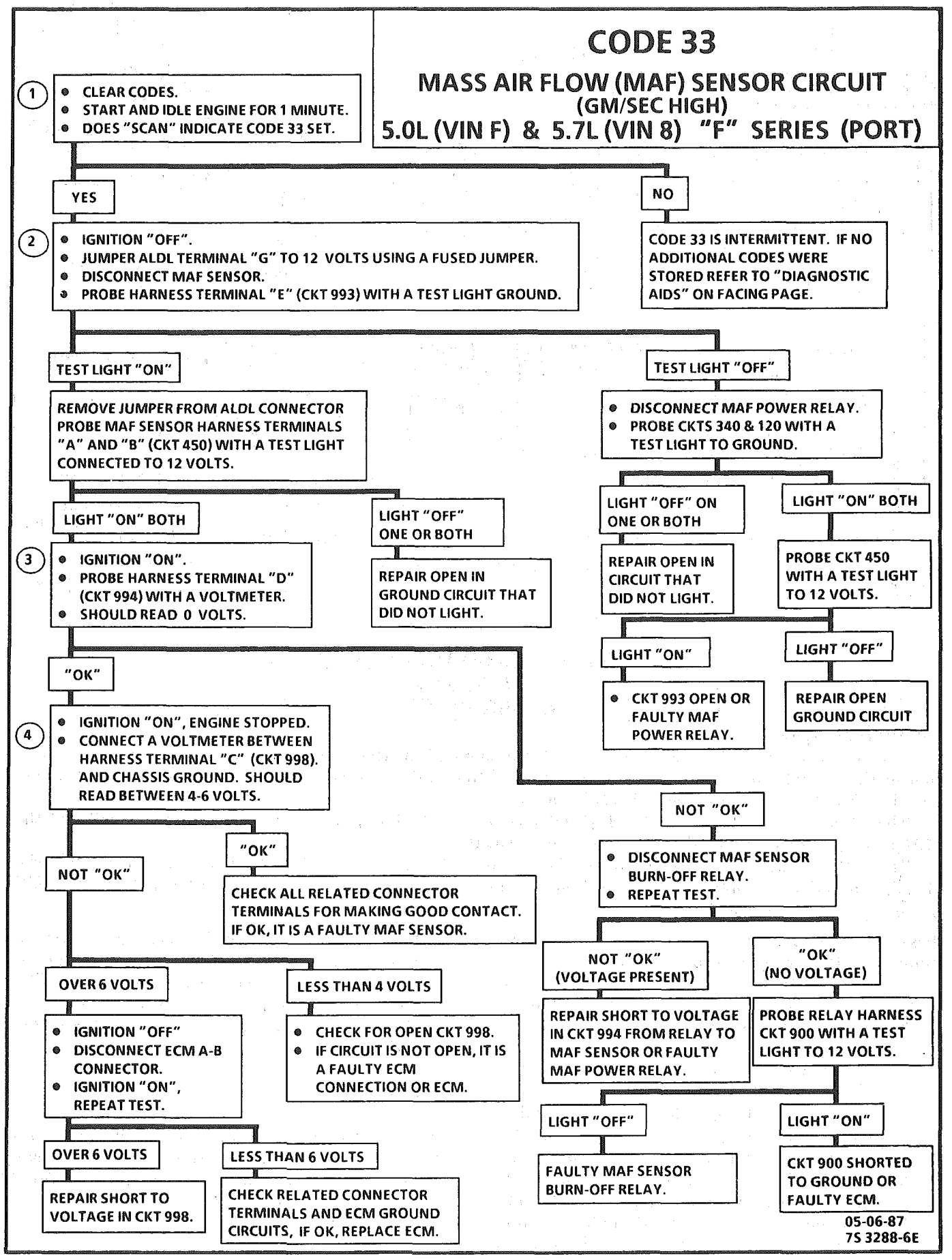
### Diagnostic Aids:

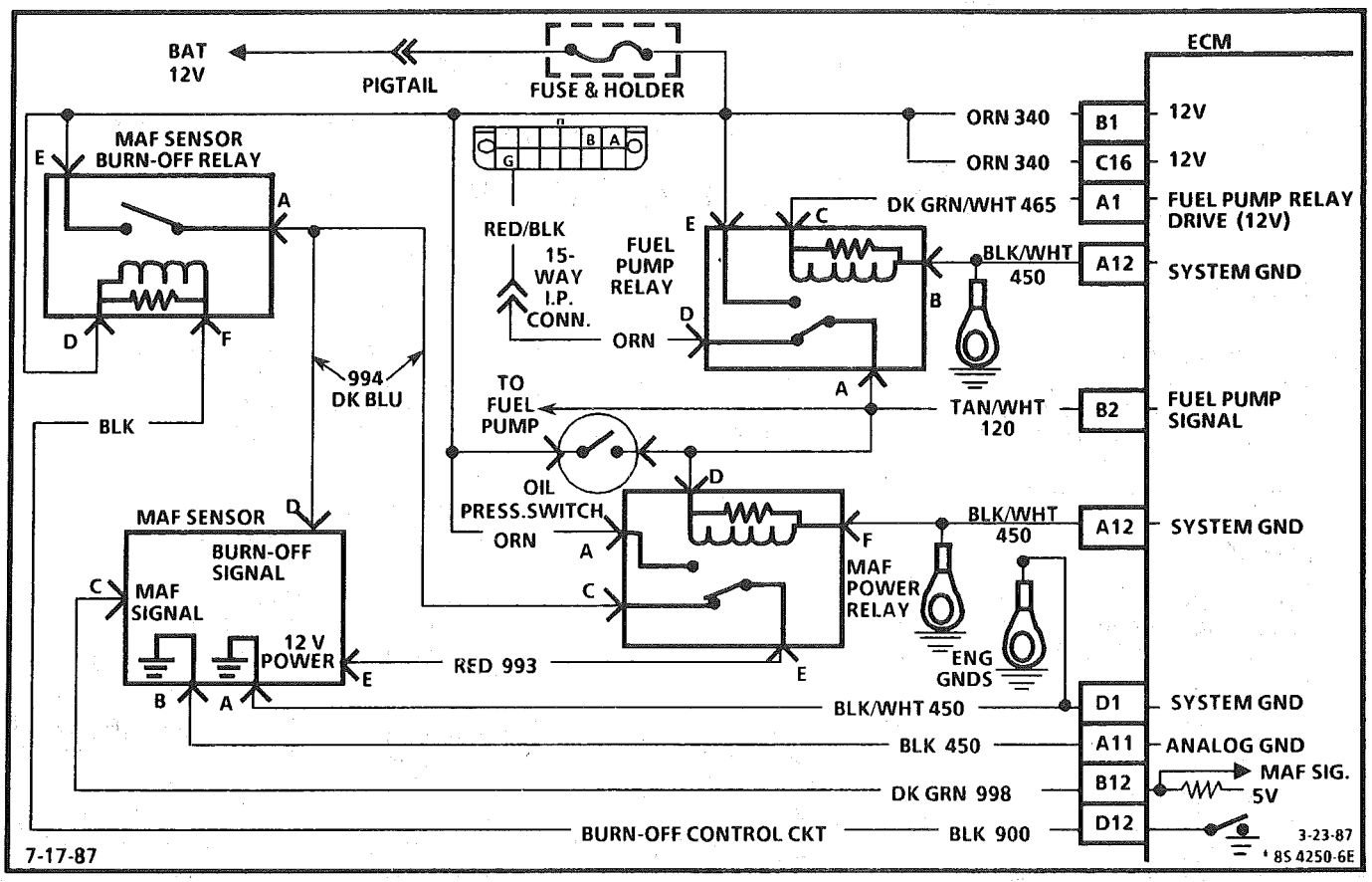
Intermittent: By jumpering the fuel pump test terminal (G term. of ALDL) to 12 volts, the MAF sensor will stay powered up and the signal line should see a low voltage, less than 250 mv or low grams per second on a "SCAN" tool. By wiggling the related wiring the intermittent may be detected. Also, an erratic signal with the engine running may indicate faulty wiring or components.

# CODE 33

## MASS AIR FLOW (MAF) SENSOR CIRCUIT (GM/SEC HIGH)

## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)






# CODE 34

## MASS AIR FLOW (MAF) SENSOR CIRCUIT (GM/SEC LOW) 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The mass air flow (MAF) sensor measures the amount of air which passes through it. The ECM uses this information to determine the operating condition of the engine, to control fuel delivery. For a detailed description of the MAF sensor operation refer to Section C.

The oil pressure switch or the ECM, through control of the fuel pump relay, will provide 12 volts for the MAF power relay which provides the 12 volts needed by the MAF sensor.

The ECM provides a current limiting 5V on the signal line (CKT 998). The MAF sensor then changes the signal by dropping the voltage so that with low air flow the ECM sees a low voltage and a high air flow will cause the ECM to see near the 5 volt supply.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

Code 34 indicates: ECM has seen low air flow less than 2.5 gm/sec. (low voltage) for one second when:

- Engine is first started
  OR
- RPM above 600
- TPS above 6%. To obtain 6%, the engine has to be running at about 2300 rpm in neutral.

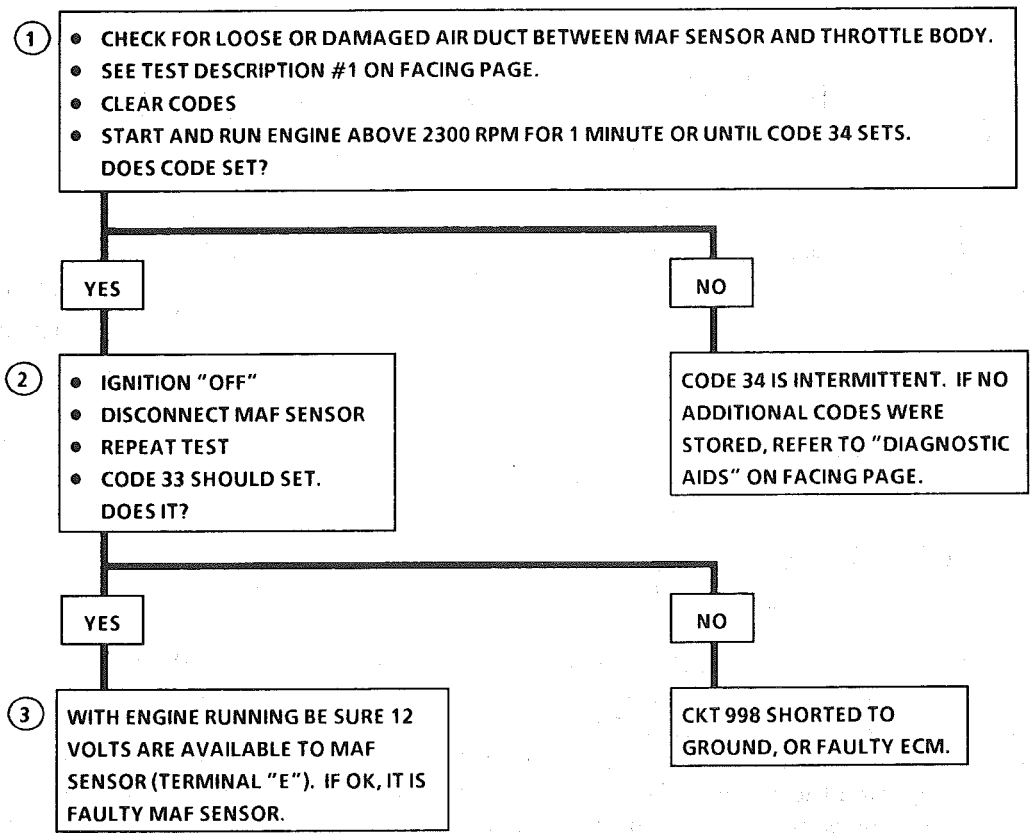
1. A Code 34 may be caused by an engine that exhibits a low, rough, unstable or incorrect idle problem. If this condition exists, disconnect the MAF sensor. If the unstable idle still exists, refer to Symptoms in Section "B". (Rough, unstable, incorrect idle, or stalling.) If the idle improved with the sensor disconnected, replace it.
2. This test will determine if the conditions still exist to set a code or if the problem is intermittent.
3. With the MAF sensor disconnected, the ECM should see a high signal voltage and set a Code 33. If a Code 34 resets then the wiring or the ECM is at fault.

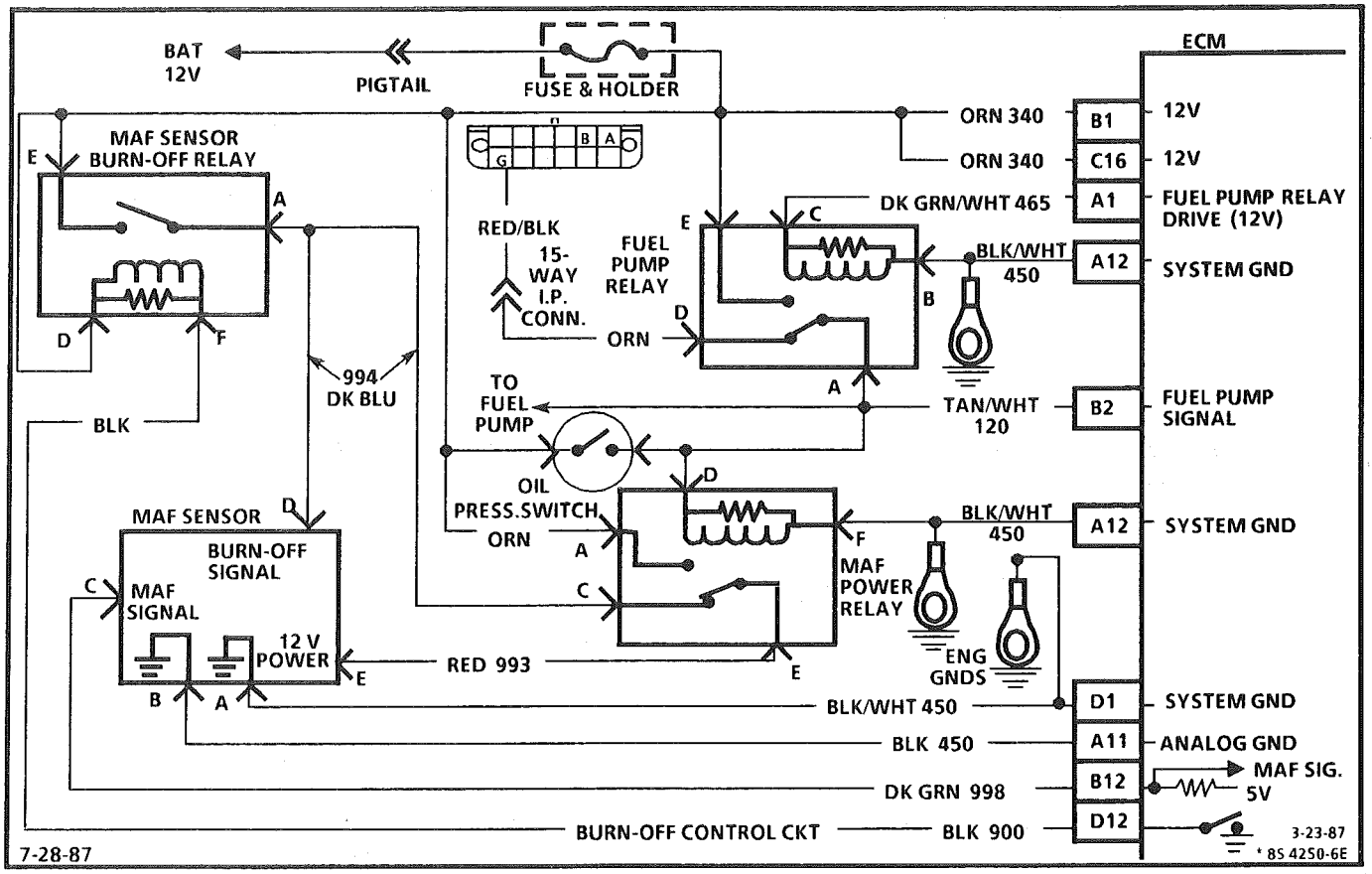
### Diagnostic Aids:

A low, rough or unstable idle could result in a Code 34. Also be sure air ducts are tight and not cracked. Check CKT 998 for short to ground. Refer to "Intermittents" in Section "B".

# CODE 34

## MASS AIR FLOW (MAF) SENSOR CIRCUIT
## (GM/SEC LOW)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)






# CODE 36

## MASS AIR FLOW (MAF) BURN-OFF CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The mass air flow (MAF) sensor measures the amount of air which passes through it. The ECM uses this information to determine the operating condition of the engine, to control fuel delivery. For a detailed description of the MAF sensor operation see Section "C".

Due to contaminates in the atmosphere, a residue may build up on the MAF sensor sensing wire. To maintain an accurate reading from the sensor, a "burn-off" cycle will occur when the ignition is turned "OFF" after the engine had been running a specified amount of time and engine warmed up. The burn-off function is enabled when the ECM grounds CKT 900 which energizes the MAF sensor burn-off relay. With the MAF sensor burn-off relay energized, voltage will be supplied to the MAF sensor terminal "D". Voltage will also be supplied through the normally closed set of contacts in the MAF power relay which will supply 12 volts to terminal "E" of the MAF sensor.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. This test will determine if the burn-off function is operative or if the Code was set due to an intermittent condition.
2. Check for continuous 12 volt supply to burn-off relay.
3. Grounding CKT 900 should energize the relay and close the contacts. CKT 900 should be grounded by using a jumper wire at ECM connector "D12". If the test light is dim, check for corroded or faulty connections. If OK, replace relay.
4. With the burn-off relay energized there should be 12 volts supplied to the MAF sensor on terminal "D" & "E" (CKTs 993 and 994). If the test light is dim, check for corroded or faulty connections. If OK, replace relay.

### Diagnostic Aids:

The Code 36 could have been set due to a poor connection at any of the relays or the MAF sensor. Be sure that these connections and terminals are OK. A faulty MAF sensor should not be considered as the cause if Code 36 is set.

Refer to "Intermittents" in Section "B".

# CODE 36

## MASS AIR FLOW (MAF) BURN-OFF CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

1. • IGNITION "OFF", CLEAR CODES.
   • START ENGINE AND RUN UNTIL SYSTEM GOES "CLOSED LOOP".
   • TURN IGNITION "OFF" AND WAIT 20 SECONDS.
   • START AND IDLE ENGINE FOR 30 SECONDS OR UNTIL S.E.S. LIGHT COMES "ON".
   IS CODE 36 SET?

- NO → CODE 36 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.
- YES

2. • DISCONNECT MAF SENSOR BURN-OFF RELAY.
   • PROBE BOTH 340 CKTS WITH A TEST LIGHT TO GROUND.

- LIGHT "OFF" ON ONE OR BOTH → REPAIR OPEN IN CIRCUIT THAT DID NOT LIGHT.
- LIGHT "ON" BOTH

3. • RECONNECT RELAY.
   • DISCONNECT MAF SENSOR.
   • GROUND BURN-OFF RELAY CKT 900.
   • PROBE MAF SENSOR HARNESS TERMINAL "D" WITH A TEST LIGHT TO GROUND.

- LIGHT "OFF" → CKT 900 OPEN, CKT 994 OPEN OR SHORTED TO GROUND, OR FAULTY CONNECTION OR FAULTY RELAY.
- LIGHT "ON"

4. • CKT 900 STILL GROUNDED.
   • PROBE TERMINAL "E" (CKT 993) WITH A TEST LIGHT TO GROUND.

- LIGHT "OFF" → • OPEN CKT 993, OPEN CIRCUIT BETWEEN MAF SENSOR RELAY AND THE BURN-OFF RELAY, FAULTY CONNECTION, OR FAULTY MAF SENSOR POWER RELAY.
- LIGHT "ON"

• DISCONNECT BURN-OFF RELAY.
• IGNITION "ON".
• PROBE CKT 900 WITH A TEST LIGHT TO GROUND.

- LIGHT "OFF" → FAULTY ECM CONNECTION OR ECM. CODE 36 CAN SET DUE TO A POOR CONNECTION AT ANY OF THE RELAYS OR THE MAF SENSOR, OR COULD BE CAUSED BY HIGH RESISTANCE IN THE RELAY CONTACTS OR CONNECTIONS. BE SURE THAT THESE CONNECTIONS AND TERMINALS ARE OK BEFORE REPLACING ECM.
- LIGHT "ON" → REPAIR SHORT TO VOLTAGE IN CKT 900

2-12-87
* 7S 3290-6E

# CODE 41

## CYLINDER SELECT ERROR
## (FAULTY OR INCORRECT MEM-CAL)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. The ECM used for this engine can also be used for other engines, and the difference is in the Mem-Cal. If a Code 41 sets, the incorrect Mem-Cal has been installed, may not be installed properly, or it is faulty and it must be replaced.

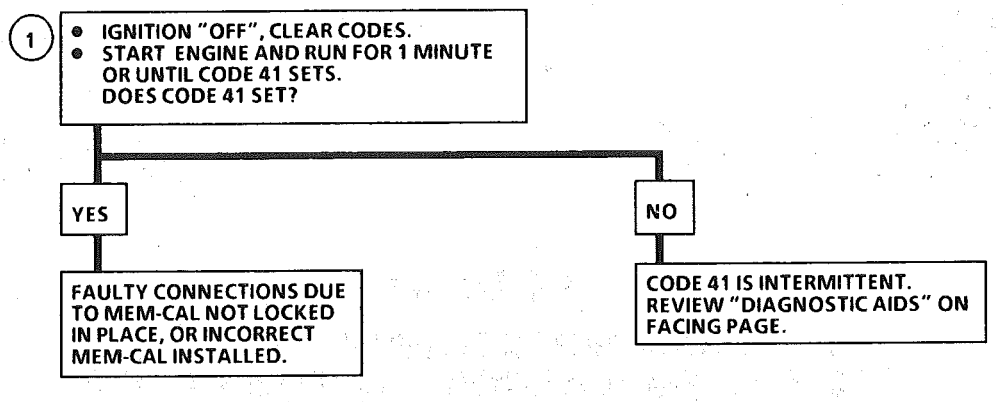
**Diagnostic Aids:**

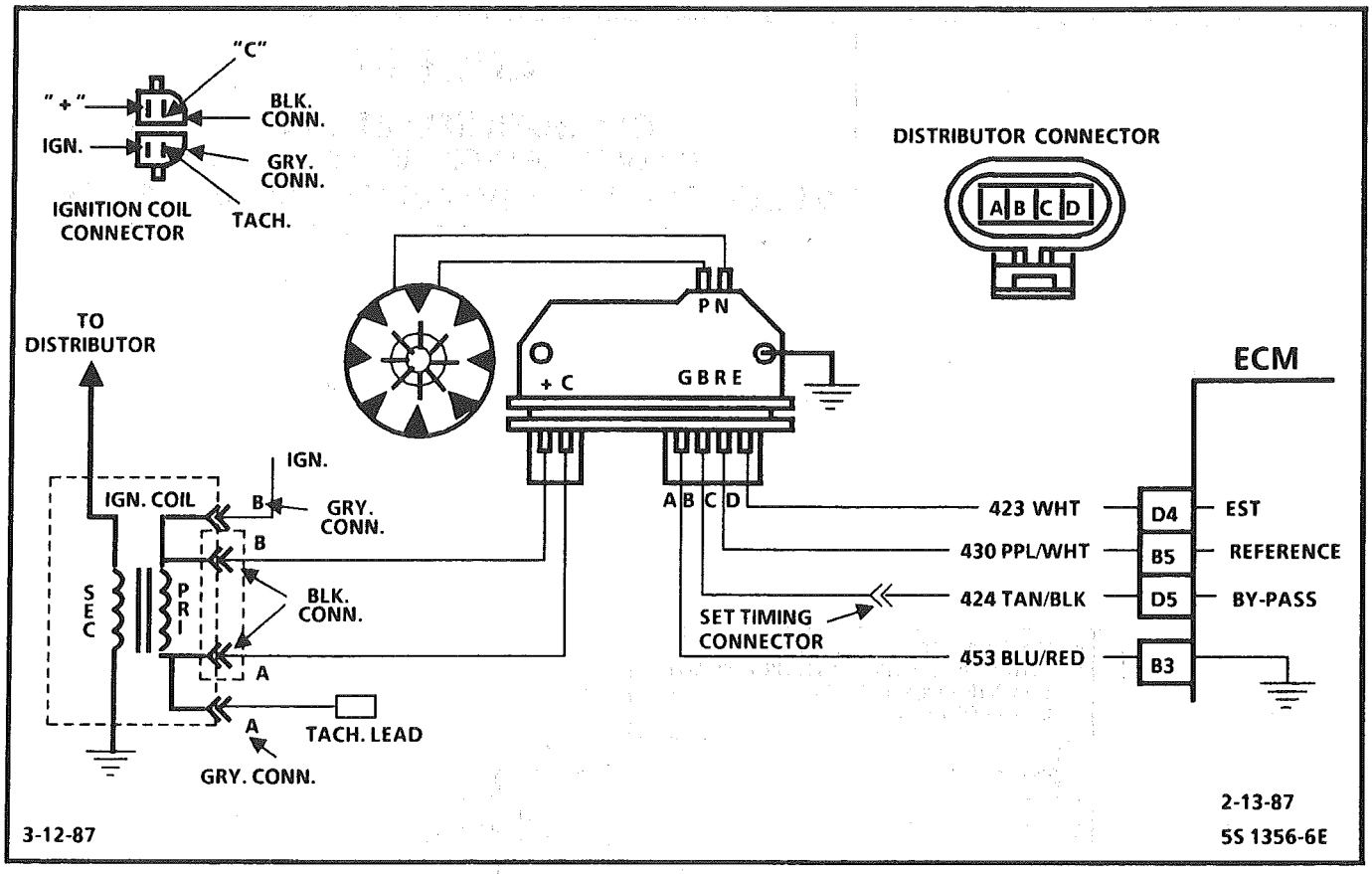
Check mem-cal to be sure locking tabs are secure.

Also check the pins on both the Mem-Cal and ECM to assure they are making proper contact. Check the Mem-Cal part number to assure it is the correct part. If the Mem-Cal is faulty, it must be replaced. It is also possible that the ECM is faulty, however, it should not be replaced until all of the above have been checked. For additional information, refer to "Intermittents" in Section "B".

# CODE 41

## CYLINDER SELECT ERROR
## (FAULTY OR INCORRECT MEM-CAL)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)






# CODE 42

## ELECTRONIC SPARK TIMING (EST) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

When the system is running on the ignition module, that is, no voltage on the bypass line, the ignition module grounds the EST signal. The ECM expects to see no voltage on the EST line during this condition. If it sees a voltage, it sets Code 42 and will not go into the EST mode.

When the rpm for EST is reached (about 400 rpm), and bypass voltage applied, the EST should no longer be grounded in the ignition module, so the EST voltage should be varying.

If the bypass line is open or grounded, the ignition module will not switch to EST mode so the EST voltage will be low and Code 42 will be set.

If the EST line is grounded, the ignition module will switch to EST but, because the line is grounded, there will be no EST signal. A Code 42 will be set.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 42 means the ECM has seen an open or short to ground in the EST or bypass circuits. This test confirms Code 42 and that the fault causing the code is present.
2. Checks for a normal EST ground path through the ignition module. An EST CKT 423 shorted to ground will also read less than 500 ohms; however, this will be checked later.
3. As the test light voltage touches CKT 424 the module should switch, causing the ohmmeter to "overrange" if the meter is in the 1000-2000 ohms position. Selecting the 10-20,000 ohms position will indicate above 5000 ohms. The important thing is that the module "switched".
4. The module did not switch and this step checks for:
   - EST CKT 423 shorted to ground.
   - Bypass CKT 424 open.
   - Faulty ignition module connection or module.
5. Confirms that Code 42 is a faulty ECM and not an intermittent in CKTs 423 or 424.

### Diagnostic Aids:

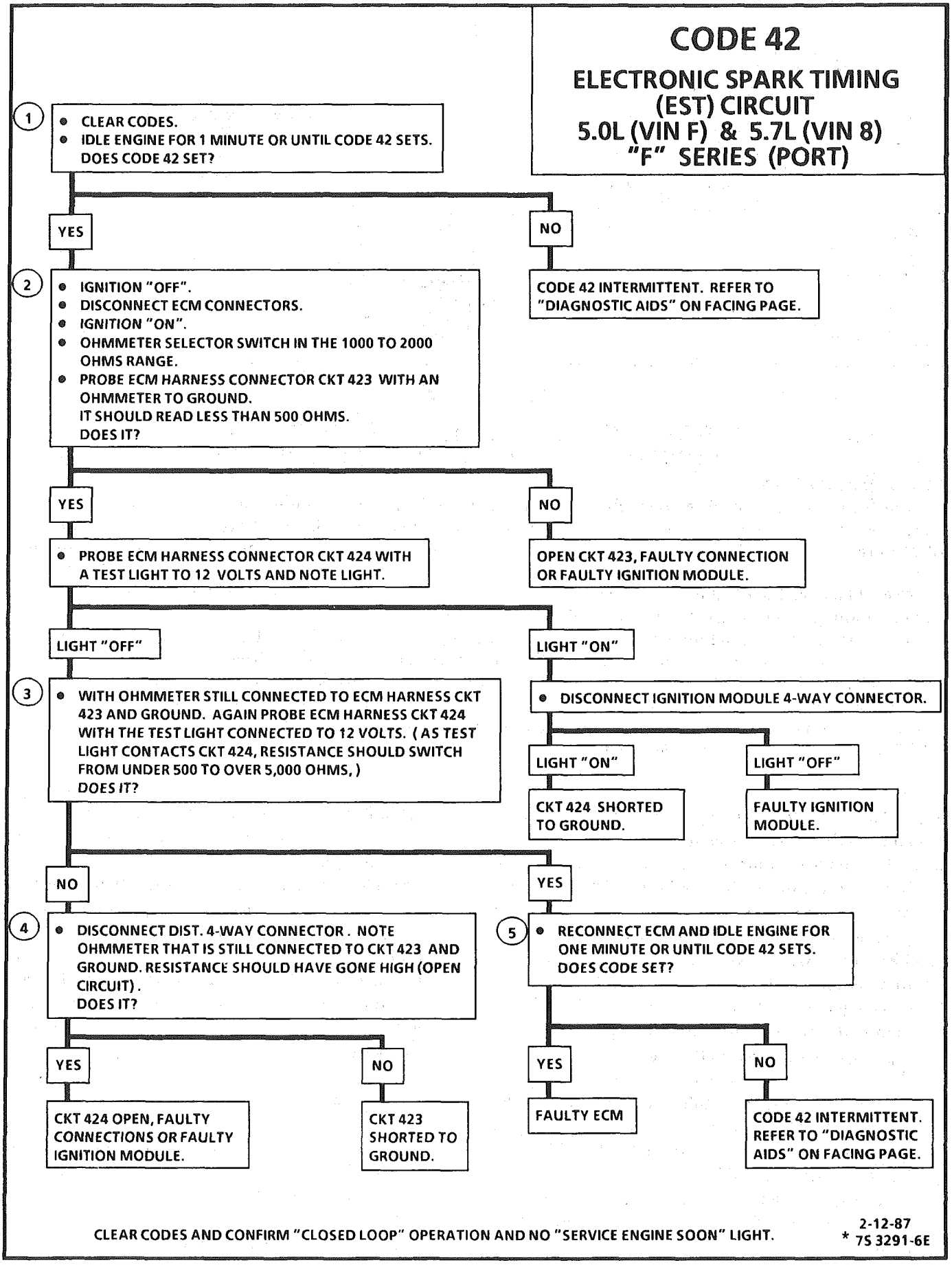
The "Scan" tool does not have any ability to help diagnose a Code 42 problem.

A Mem-Cal not fully seated in the ECM can result in a Code 42.

Refer to "Intermittents" in Section "B".

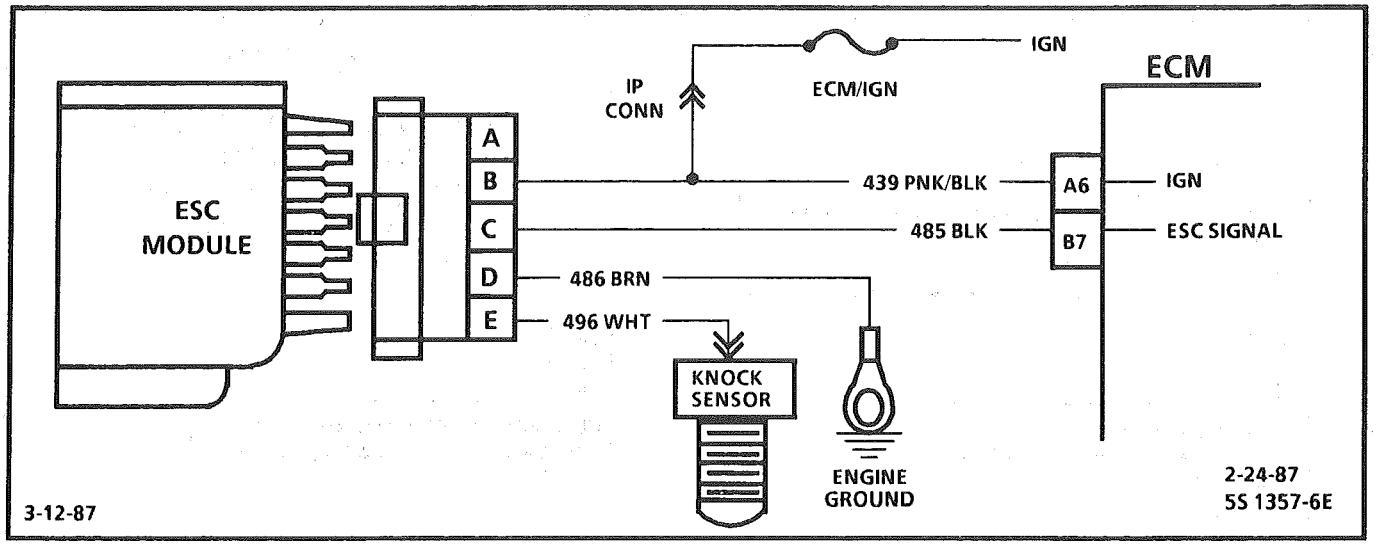
# CODE 42

## ELECTRONIC SPARK TIMING (EST) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

2-12-87
* 7S 3291-6E




# CODE 43

## ELECTRONIC SPARK CONTROL (ESC) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

Electronic spark control is accomplished with a module that sends a voltage signal to the ECM. As the knock sensor detects engine knock, the voltage from the ESC module to the ECM drops, and this signals the ECM to retard timing. The ECM will retard the timing when knock is detected and rpm is above about 900 rpm.

Code 43 means the ECM has been low voltage at CKT 485 terminal "B7" for longer than 5 seconds, with the engine running, or the system has failed the functional check.

This system performs a functional check once per start up to check the ESC system. To perform this test the ECM will advance the spark when coolant is above 95°C and at a high load condition (near WOT). The ECM then checks the signal at "B7" to see if a knock is detected. The functional check is performed once per start up and if knock is detected when coolant is below 95°C (194°F) the test has passed and the functional check will not be run. If the functional check fails, the "Service Engine Soon" light will remain "ON" until ignition is turned "OFF", or until a knock signal is detected.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. If the conditions for a Code 43 are present, the "Scan" will always display "yes". There should not be a knock at idle unless an internal engine problem, or a system problem exists.
2. This test will determine if the system is functioning at this time. Usually a knock signal can be generated by tapping on the right exhaust manifold. If no knock signal is generated try tapping on block close to the area of the sensor.
3. Because Code 43 sets when the signal voltage on CKT 485 remains low, this test should cause the signal on CKT 485 to go high. The 12 volts signal should be seen by the ECM as "no knock" if the ECM and wiring are OK.
4. This test will determine if the knock signal is being detected on CKT 496 or if the ESC module is at fault.
5. If CKT 496 is routed to close to secondary ignition wires, the ESC module may see the interference as a knock signal.
6. This checks the ground circuit to the module. An open ground will cause the voltage on CKT 485 to be about 12 volts, which would cause the Code 43 functional test to fail.
7. Contacting CKT 496 with a test light to 12 volts should generate a knock signal. This will determine if the ESC module is operating correctly.

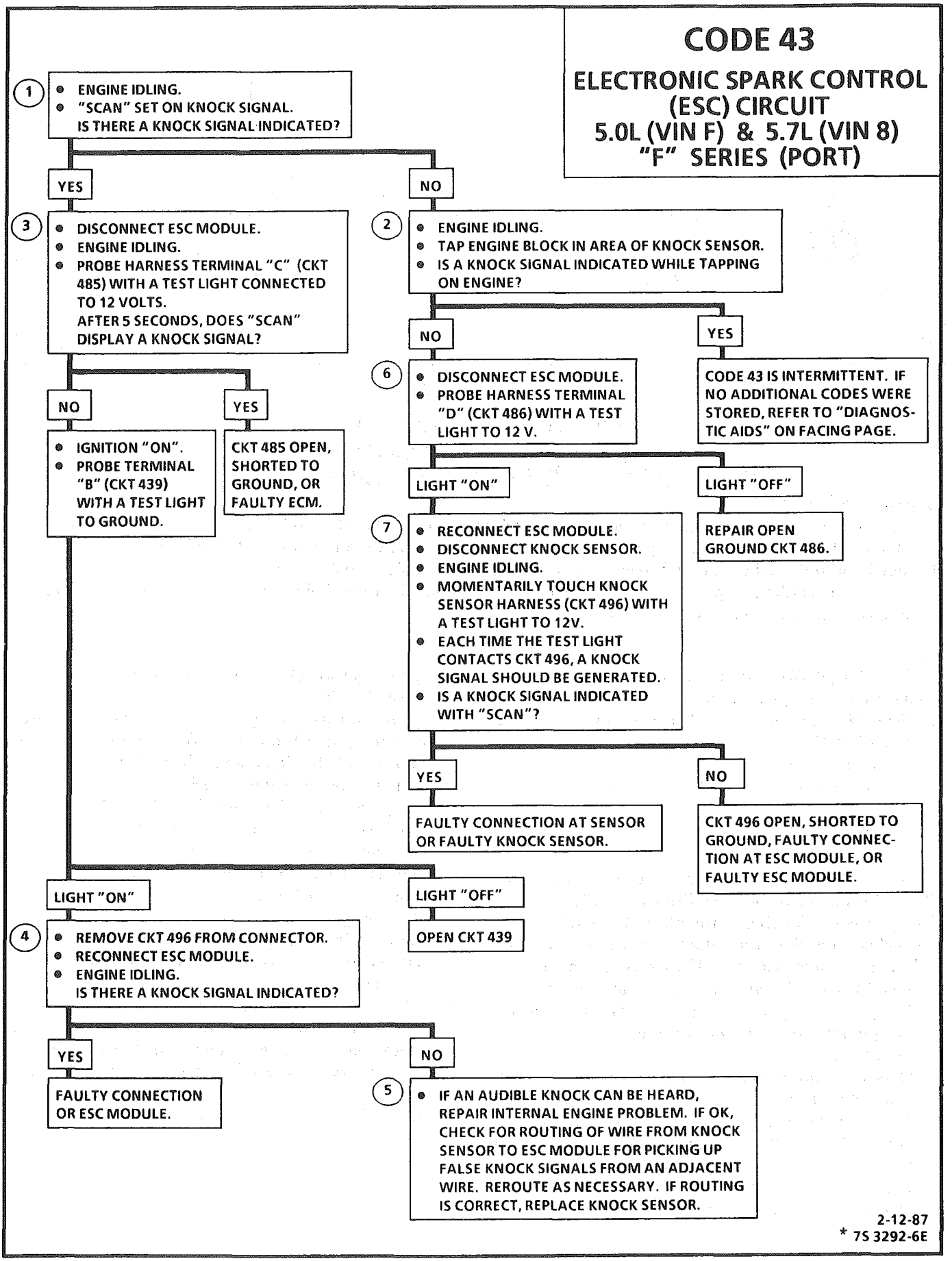
### Diagnostic Aids:

Code 43 can be caused by a faulty connection at the knock sensor at the ESC module or at the ECM. Also check CKT 485 for possible open or short to ground.

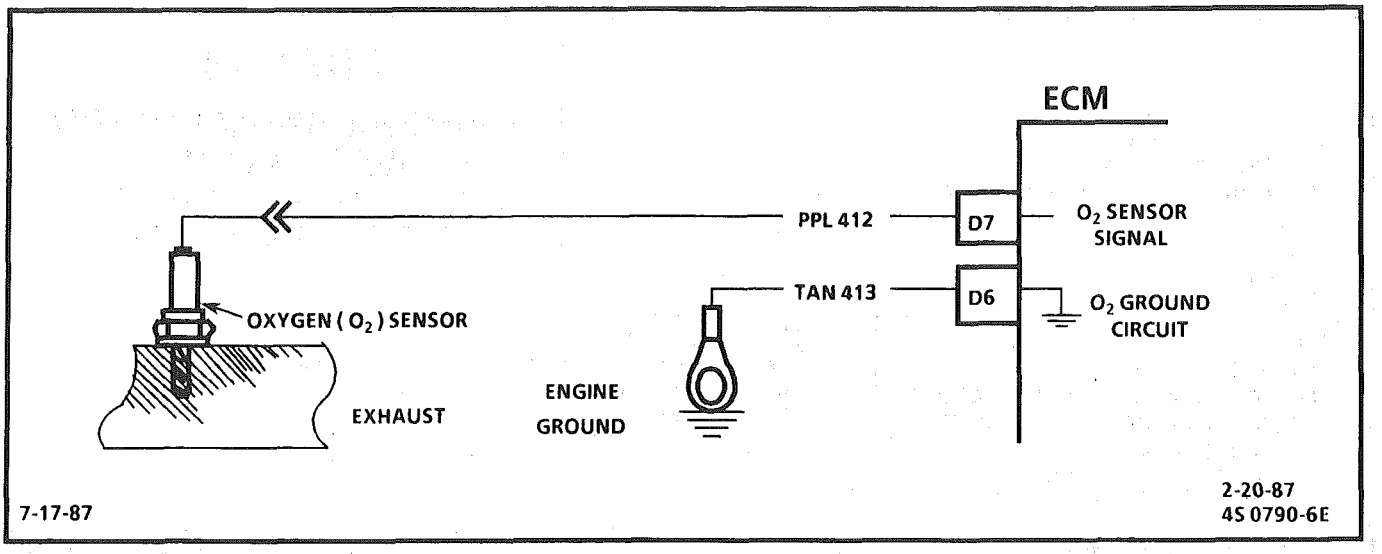
Refer to "Intermittents" in Section "B".

# CODE 43

## ELECTRONIC SPARK CONTROL (ESC) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)




2-12-87
* 7S 3292-6E




# CODE 44

## OXYGEN SENSOR CIRCUIT
## (LEAN EXHAUST INDICATED)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D6" and "D7". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volts.) The $O_2$ sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 360°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 44 is set when the $O_2$ sensor signal voltage on CKT 412.
   - Remains below .2 volt for 50 seconds.
   - And the system is operating in "Closed Loop".

### Diagnostic Aids:

Using the "Scan", observe the block learn values at different rpm and air flow conditions. The "Scan" also displays the block cells, so the block learn values can be checked in each of the cells to determine when the Code 44 may have been set. If the conditions for Code 44 exist, the block learn values will be around 150.

- $O_2$ sensor wire. Sensor pigtail may be mispositioned and contacting the exhaust manifold.
- Check for intermittent ground in wire between connector and sensor.
- MAF Sensor. A mass air flow (MAF) sensor output that causes the ECM to sense a lower than normal air flow will cause the system to go lean. Disconnect the MAF sensor and, if the lean condition is gone, replace the MAF sensor.
- Lean Injector(s). Perform injector balance test CHART C-2A.
- Fuel Contamination. Water, even in small amounts, near the in-tank fuel pump inlet can be delivered to the injectors. The water causes a lean exhaust and can set a Code 44.
- Fuel Pressure. System will be lean if pressure is too low. It may be necessary to monitor fuel pressure while driving the car at various road speeds and/or loads to confirm. See Fuel System diagnosis CHART A-7.
- Exhaust Leaks. If there is an exhaust leak, outside air can be pulled into the exhaust and past the sensor. Vacuum or crankcase leaks can cause a lean condition.
- AIR System. Be sure air is not being directed to the exhaust ports while in "Closed Loop". If the block learn value goes down while squeezing air hose to left side exhaust ports, refer to CHART C-6.
- If the above are OK, it is a faulty oxygen sensor.

# CODE 44

## OXYGEN SENSOR CIRCUIT
## (LEAN EXHAUST INDICATED)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

- RUN WARM ENGINE (75°C TO 95°C) AT 1200 RPM.
- DOES "SCAN" INDICATE $O_2$ SENSOR VOLTAGE FIXED BELOW .35 VOLTS (350 mV)?

YES

- DISCONNECT $O_2$ SENSOR.
- WITH ENGINE IDLING "SCAN" SHOULD DISPLAY $O_2$ SENSOR BETWEEN .35 VOLTS AND .55 VOLTS (350 mV AND 550 mV).

DOES IT?

YES

REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE..

NO

CKT 412 SHORTED TO GROUND OR FAULTY ECM.

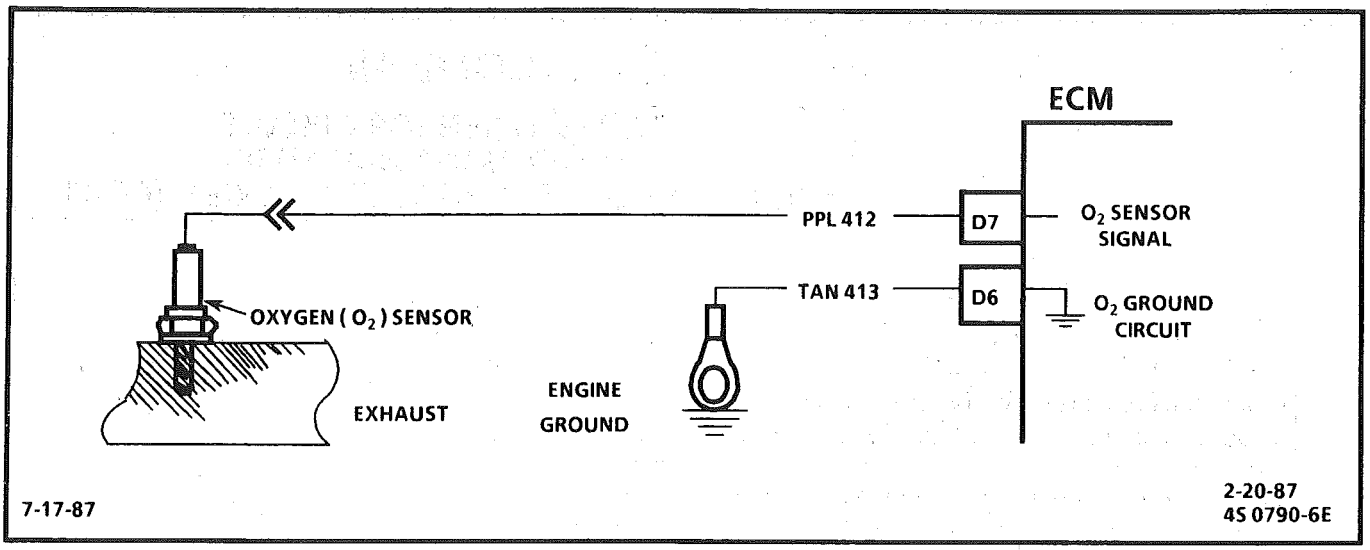
NO

CODE 44 IS INTERMITTENT. IF NO ADDITIONAL CODES WERE STORED, REFER TO "DIAGNOSTIC AIDS" ON FACING PAGE.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-27-87

*7S 3191-6E




# CODE 45

## OXYGEN SENSOR CIRCUIT
## (RICH EXHAUST INDICATED)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The ECM supplies a voltage of about .45 volt between terminals "D6" and "D7". (If measured with a 10 megohm digital voltmeter, this may read as low as .32 volts.) The $O_2$ sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down through about .10 volt if exhaust is lean.

The sensor is like an open circuit and produces no voltage when it is below about 360°C (600°F). An open sensor circuit or cold sensor causes "Open Loop" operation.

**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. Code 45 is set when the $O_2$ sensor signal voltage or CKT 412.
   - Remains above .7 volt for 50 seconds; and in "Closed Loop".
   - Engine time after start is 1 minute or more.
   - Throttle angle greater than 2% (about .2 volts above idle voltage)

### Diagnostic Aids:

Using the "Scan", observe the block learn values at different rpm and air flow conditions. The "Scan" also displays the block cells, so the block learn values can be checked in each of the cells to determine when the Code 45 may have been set. If the conditions for Code 45 exists, the block learn values will be around 115.

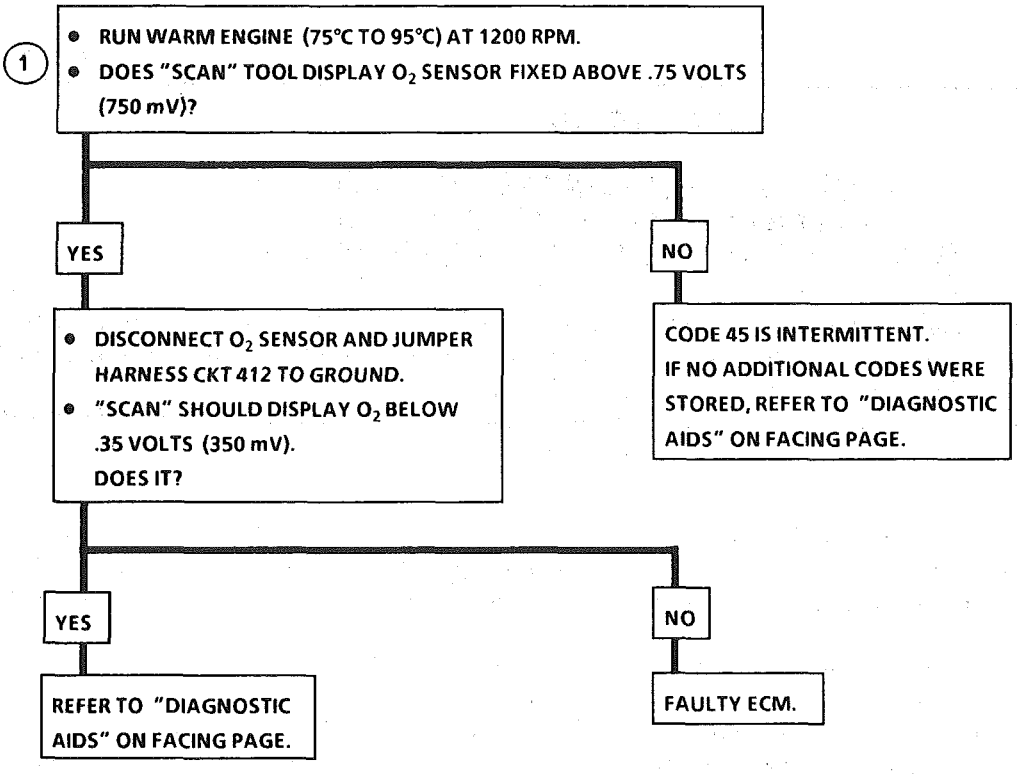
- Fuel Pressure. System will go rich if pressure is too high. The ECM can compensate for some increase. However, if it gets too high, a Code 45 may be set.

Use the Fuel System diagnosis CHART A-7.

- Rich injector. Perform injector balance test CHART C-2A.
- Leaking injector. See CHART A-7.
- Check for fuel contaminated oil.
- HEI Shielding. An open ground CKT 453 (ignition system reflow) may result in EMI, or induced electrical "noise". The ECM looks at this "noise" as reference pulses. The additional pulses result in a higher than actual engine speed signal. The ECM then delivers too much fuel, causing system to go rich. Engine tachometer will also show higher than actual engine speed, which can help in diagnosing this problem.
- Canister purge. Check for fuel saturation. If full of fuel, check canister control and hoses. See canister purge Section "C3".
- MAF sensor. An output that causes the ECM to sense a higher than normal airflow can cause the system to go rich. Disconnecting the MAF sensor will allow the ECM to set a fixed value for the sensor. Substitute a different MAF sensor if the the rich condition is gone while the sensor is disconnected.
- Check for leaking fuel pressure regulator diaphram by checking vacuum line to regulator for fuel.
- TPS. An intermittent TPS output will cause the system to go rich, due to a false indication of the engine accelerating.

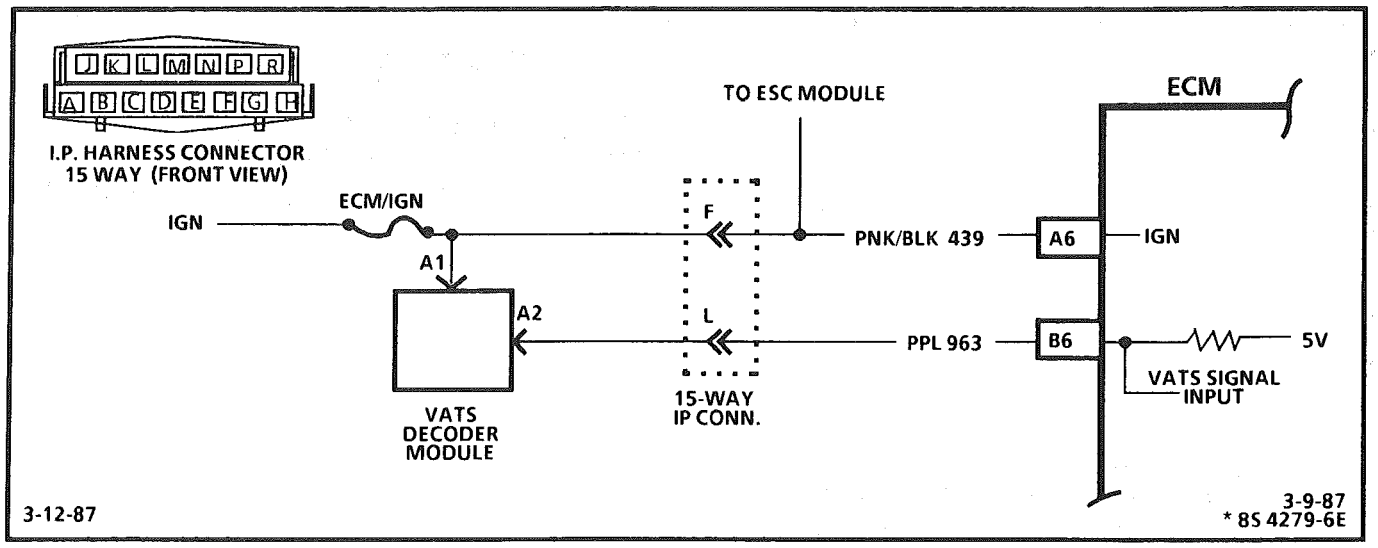
# CODE 45

## OXYGEN SENSOR CIRCUIT
(RICH EXHAUST INDICATED)
5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)




CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

5-27-87
*7S 3192-6E




# CODE 46

## VEHICLE ANTI-THEFT SYSTEM (VATS) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

**Circuit Description:**

The VATS system is designed to disable vehicle operation if the incorrect key or starting procedure is used. The VATS decoder module sends a signal to the ECM if the correct key is being used. If the proper signal does not reach the ECM on CKT 963, the ECM will not pulse the injectors "ON" and thus not allow the vehicle to be started.

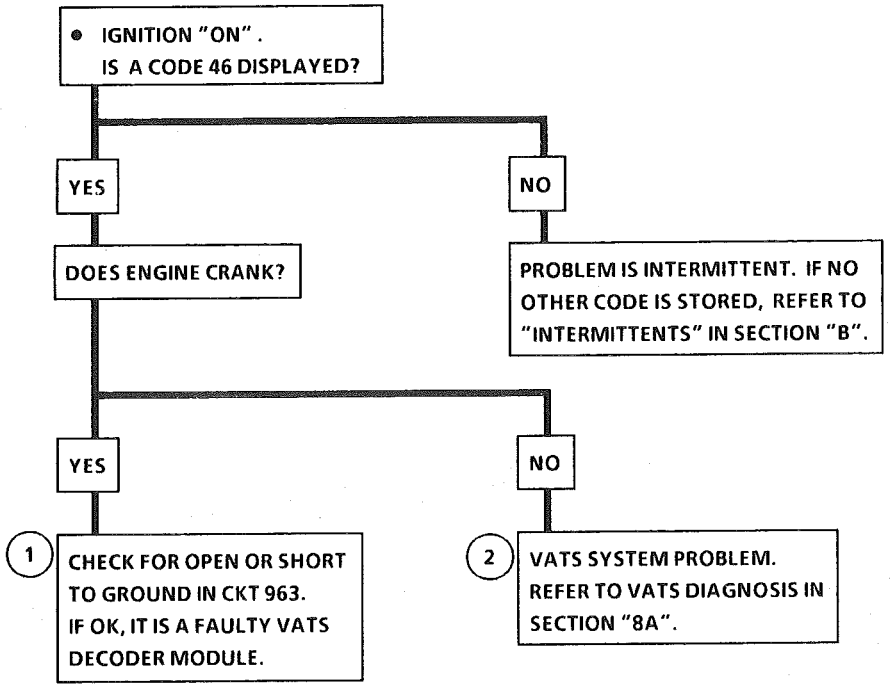
Code 46 will set, if the proper signal is not being received at ECM terminal "B6" when the ignition is turned "ON". Code 46 does not store in the ECM memory but is only present when the conditions stated above are met.

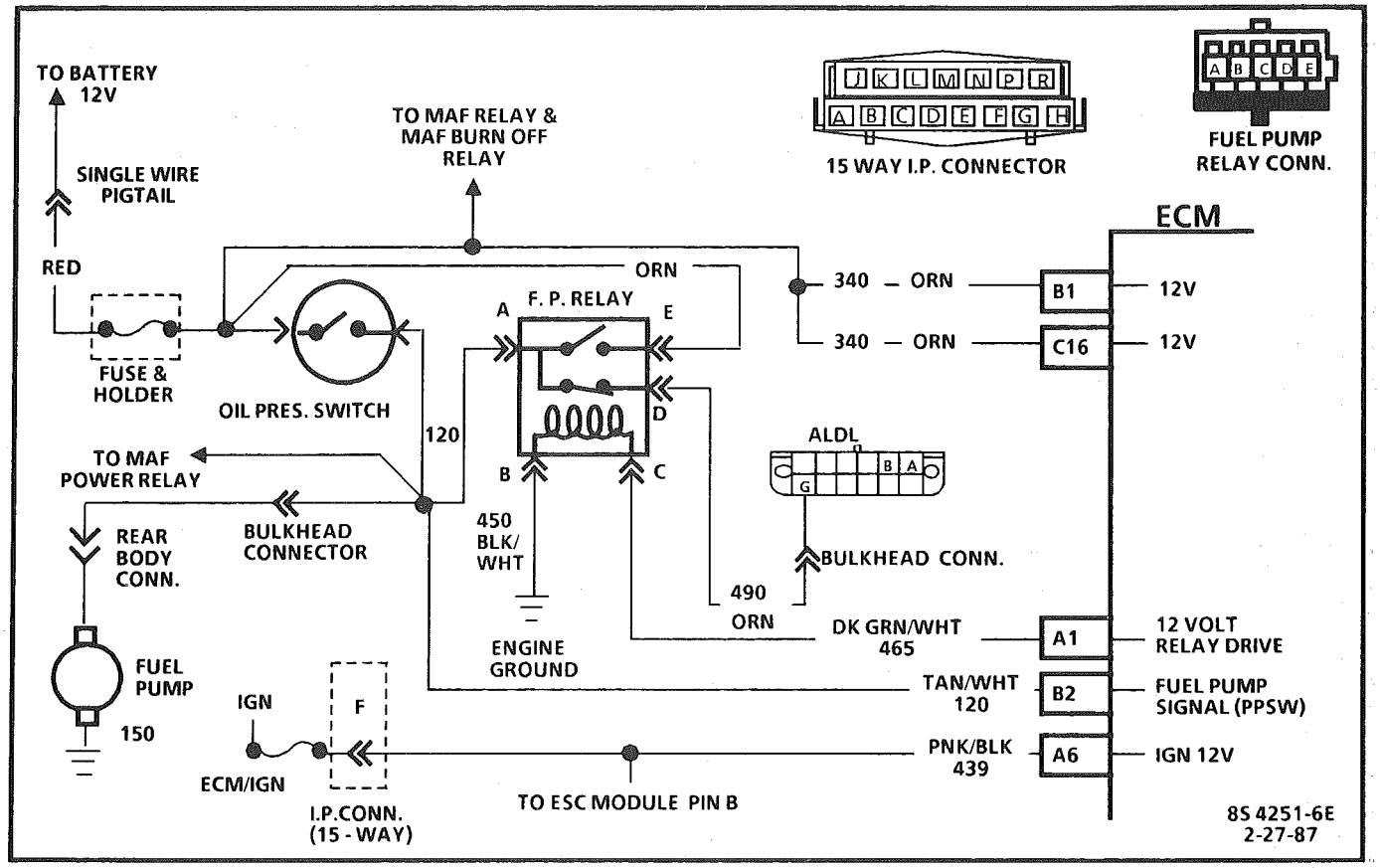
**Test Description:** Numbers below refer to circled numbers on the diagnostic chart.

1. If the engine cranks, and a Code 46 is stored, it indicates that the portion of the module which generates the signal to the ECM is not operating or CKT 963 is open or shorted to ground. If the decoder module is found to be OK, as determined from Section "8A", the ECM may be at fault, but this is not a likely condition.
2. If Code 46 is stored, and the engine will not crank, it indicates that there is a VATS problem or an incorrect key or starting procedure is being used.

# CODE 46

## VEHICLE ANTI-THEFT SYSTEM (VATS) CIRCUIT 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)






# CODE 54

## FUEL PUMP CIRCUIT
## (LOW VOLTAGE)
## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

### Circuit Description:

The status of the fuel pump CKT 120 (PPSW) is monitored by the ECM at terminal "B2" and is used to compensate fuel delivery based on system voltage. This signal is also used to store a trouble code if the fuel pump relay is defective or fuel pump voltage is lost while the engine is running. There should be about 12 volts on CKT 120 for 2 seconds after the ignition is turned "ON", or any time references pulses are being received by the ECM.

Code 54 will set, if the voltage at terminal "B2" is less than 2 volts for 1.5 seconds since the last reference pulse was received. This code is designed to detect a faulty relay, causing extended crank time, and the code will help the diagnosis of an engine that "CRANKS BUT WILL NOT RUN".

If a fault is detected during start-up, the "Service Engine Soon" light will stay "ON" until the ignition is cycled "OFF". However, if the voltage is detected below 2 volts, with the engine running, the light will only remain "ON" while the condition exists.

# CODE 54

## FUEL PUMP CIRCUIT (LOW VOLTAGE) 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

- IGNITION "OFF" FOR 10 SECONDS.
- IGNITION "ON".
- LISTEN FOR IN-TANK FUEL PUMP.
- PUMP SHOULD RUN FOR 2 SECONDS AFTER IGNITION "ON". DOES IT?

**NO**

- IGNITION "OFF".
- USING A FUSED JUMPER WIRE, CONNECT FUEL PUMP TEST CONNECTOR TO 12 VOLTS.
- DOES PUMP RUN?

**YES**

- IGNITION "OFF".
- USING A FUSED JUMPER WIRE, CONNECT FUEL PUMP TEST CONN. TO 12 VOLTS.
- DOES PUMP RUN?

**LIGHT "ON"**

CONNECT TEST LIGHT BETWEEN CKTS 340 & 450

**LIGHT "OFF"**

REPAIR OPEN IN CKT 340

**NO**

- DISCONNECT FUEL PUMP RELAY.
- USING THE FUSED JUMPER WIRE, CONNECT CKT 120 TO 12 VOLTS. DOES PUMP RUN?

**YES**

FAULTY RELAY

**NO**

OPEN CKT 120, FAULTY IN-TANK PUMP OR FAULTY PUMP GROUND.

**LIGHT "ON"**

- CONNECT TEST LIGHT BETWEEN HARNESS CKT 465 AND GROUND.
- IGNITION "OFF" FOR 10 SECONDS.
- NOTE TEST LIGHT WITHIN 2 SECONDS AFTER IGNITION "ON".

**LIGHT "ON"**

- FAULTY RELAY.

NOTE: IF ORIGINAL COMPLAINT WAS "CRANKS BUT WILL NOT RUN" MAKE THE FOLLOWING ADDITIONAL CHECKS:

- ENGINE IDLING AT NORMAL OPERATING TEMPERATURE.
- OIL PRESSURE NORMAL.
- DISCONNECT FUEL PUMP RELAY.
- ENGINE SHOULD CONTINUE TO RUN.
- DOES IT?

**YES**

FUEL PUMP CIRCUIT OK

**NO**

FAULTY OIL PRESSURE SWITCH

**LIGHT "OFF"**

CKT 465 OPEN, SHORTED TO GROUND, OR FAULTY ECM.

**LIGHT "OFF"**

REPAIR OPEN CKT 450

**YES**

- CLEAR CODES.
- START AND RUN ENGINE FOR 30 SECONDS OR UNTIL CODE 54 SETS. DOES CODE SET?

**YES**

- AT THE ECM, BACK PROBE CKT 120 WITH A TEST LIGHT TO GROUND.
- IGNITION "OFF" FOR 10 SECONDS.
- NOTE LIGHT WITHIN 2 SECONDS AFTER IGNITION "ON".

**LIGHT "ON"**

FAULTY CONNECTION AT ECM OR FAULTY ECM.

**LIGHT "OFF"**

OPEN CKT 120 TO ECM.

**NO**

CODE 54 IS INTERMITTENT. REFER TO "INTERMITTENTS" IN SECTION "B".

7-16-87
*7S 3155-6E

# CODE 51
# CODE 52
# CODE 53

## 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

## CODE 51

### MEM-CAL ERROR
### (FAULTY OR INCORRECT MEM-CAL)

CHECK THAT ALL PINS ARE FULLY INSERTED IN THE SOCKET AND THAT MEM-CAL IS PROPERLY LATCHED. IF OK, REPLACE MEM/CAL, CLEAR MEMORY, AND RECHECK. IF CODE 51 REAPPEARS, REPLACE ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

## CODE 52

### CALPAK ERROR
### (FAULTY OR INCORRECT CALPAK)

CHECK THAT THE MEM-CAL IS FULLY SEATED AND LATCHED INTO THE MEM-CAL SOCKET. IF OK, REPLACE MEM-CAL, CLEAR MEMORY, AND RECHECK. IF CODE 52 REAPPEARS, REPLACE ECM.

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

## CODE 53

### SYSTEM OVER VOLTAGE

THIS CODE INDICATES THERE IS A BASIC GENERATOR PROBLEM .

- CODE 53 WILL SET, IF VOLTAGE AT ECM IGNITION INPUT PIN IS GREATER THAN 17.1 VOLTS FOR 2 SECONDS.
- CHECK AND REPAIR CHARGING SYSTEM. REFER TO SECTION "6D".

CLEAR CODES AND CONFIRM "CLOSED LOOP" OPERATION AND NO "SERVICE ENGINE SOON" LIGHT.

7-17-87
*6S 2652-6E

- A faulty in-tank fuel pump check valve will allow the fuel in the lines to drain back to the tank after the engine is stopped. To check for this condition:
  Perform Fuel System Diagnosis, CHART A-7.
- Remove spark plugs. Check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary.
- If engine starts but then immediately stalls open distributor by-pass line. If engine then starts and runs OK, replace pickup coil.
- If engine starts and stalls disconnect MAF sensor. If engine then runs and sensor connections are OK, replace the sensor.
- Basic engine problem.

## HESITATION, SAG, STUMBLE

**Definition:** Momentary lack of response as the accelerator is pushed down. Can occur at all car speeds. Usually most severe when first trying to make the car move, as from a stop sign. May cause the engine to stall if severe enough.

- Perform careful visual check as described at start of Section "B".
- **CHECK:**
  - Fuel pressure. See CHART A-7. Also, check for water contaminated fuel.
  - Air leaks at air duct between MAF sensor and throttle body.
  - Spark plugs for being fouled or faulty wiring.
  - Mem-Cal number. Also check service bulletins for latest Mem-Cal.
  - TPS for binding or sticking. Voltage should increase at a steady rate as throttle is moved toward WOT.
  - Ignition timing. See emission control information label.
  - Generator output voltage. Repair if less than 9 or more than 16 volts.
  - HEI ground, CKT 453.
  - Canister purge system for proper operation. See CHART C-3.
  - EGR - See CHART C-7.
- Perform injector balance test CHART C-2A.

## SURGES AND/OR CHUGGLE

**Definition:** Engine power variation under steady throttle or cruise. Feels like the car speeds up and slows down with no change in the accelerator pedal.

- Be sure driver understands transmission converter clutch and A/C compressor operation in owner's manual.
- Perform careful visual inspection as described at start of Section "B".
- **CHECK:**
  - Loose or leaking air duct between MAF sensor and throttle body.
  - Generator output voltage. Repair if less than 9 or more than 16 volts.
  - EGR - There should be no EGR at idle. See CHART C-7.
  - Vacuum lines for kinks or leaks.
  - Ignition timing. See emission control information label.
  - In-line fuel filter. Replace if dirty or plugged.
  - Fuel pressure while condition exists. See CHART A-7.
- Inspect oxygen sensor for silicon contamination from fuel, or use of improper RTV sealant. The sensor may have a white, powdery coating and result in a high but false signal voltage (rich exhaust indication). The ECM will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem.
- Remove spark plugs. Check for cracks, wear, improper gap, burned electrodes, or heavy deposits. Also check condition of distributor cap, rotor, and spark plug wires.
- To help determine if the condition is caused by a rich or lean system, the car should be driven at the speed of the complaint. Monitoring block learn at the complaint speed will help identify the cause of the problem. If the system is lean (block learn greater than 138), refer to "Diagnostic Aids" on facing page of Code 44. If the system is running rich (block learn less than 118), refer to "Diagnostic Aids" on facing page of Code 45.

## LACK OF POWER, SLUGGISH, OR SPONGY

**Definition:** Engine delivers less than expected power. Little or no increase in speed when accelerator pedal is pushed down part way.

- Perform careful visual check as described at start of Section "B".
- Compare customer's car to similar unit. Make sure the customer's car has an actual problem.
- Remove air cleaner and check air filter for dirt, or for being plugged. Replace as necessary.
- **CHECK:**
  - For loose or leaking air duct between MAF sensor and throttle body.
  - Ignition timing. See emission control information label.
  - Restricted fuel filter, contaminated fuel or improper fuel pressure. See CHART A-7.
  - ECM Ground circuits - See ECM wiring diagrams.
  - EGR operation for being open, or partly open all the time - CHART C-7.
  - Exhaust system for possible restriction: See CHART B-1.
    - Inspect exhaust system for damaged or collapsed pipes.
    - Inspect muffler for heat distress or possible internal failure.
  - For possible plugged catalytic convertor by comparing exhaust system backpressure on each side at engine. Check backpressure by removing A.I.R check valves near exhaust manifolds. See CHART B-1 for procedure.
  - Generator output voltage. Repair if less than 9 or more than 16 volts.
  - Engine valve timing and compression.
  - Engine for proper or worn camshaft. See Section "6A".
  - Secondary voltage using a shop ocilliscope or a spark tester J-26792 (ST-125) or equivalent.
  - Check for excessive knock retard. See CHART C-5.

## DETONATION /SPARK KNOCK

**Definition:** A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening. Sounds like popcorn popping.

- Check for obvious overheating problems:
  - Low coolant.
  - Loose water pump belt.
  - Restricted air flow to radiator, or restricted water flow thru radiator.
  - Inoperative electric cooling fan circuit. See CHART C-12.
- **CHECK:**
  - Ignition timing. See vehicle emission control information label.
  - EGR system for not opening - CHART C-7.
  - TCC operation - CHART C-8.
  - Fuel system pressure. See CHART A-7.
  - Mem-Cal - Be sure it's the correct one. (See "Service Bulletins").
  - Valve oil seals for leaking.
- Check for incorrect basic engine parts such as cam, heads, pistons, etc.
- Check for poor fuel quality.
- Remove carbon with top engine cleaner. Follow instructions on can.
- Check ESC system
  See CHART C-5
- To help determine if the condition is caused by a rich or lean system, the car should be driven at the speed of the complaint. Monitoring block learn at the complaint speed will help identify the cause of the problem. If the system is runnig lean (block learn greater than 138), refer to "Diagnostic Aids" on facing page of Code 44. If the system is running rich (block learn less than 118), refer to "Diagnostic Aids" on facing page of Code 45.

## CUTS OUT, MISSES

**Definition:** Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

- Perform careful visual check as described at start of Section "B".
- Check for missing cylinder by:
  1. Disconnect IAC valve. Start engine. Remove one spark plug wire at a time using insulated pliers.
  2. If there is an rpm drop on all cylinders (equal to within 50 rpm), go to "ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING" symptom. Reconnect IAC valve.
  3. If there is no rpm drop on one or more cylinders, or excessive variation in drop, check for spark on the suspected cylinder(s) with J 26792 (ST-125) Spark Gap Tool or equivalent. If no spark, see Section 6D for Intermittent Operation or Miss. If there is spark, remove spark plug(s) in these cylinders and check for:
     - Cracks
     - Wear
     - Improper Gap
     - Burned Electrodes
     - Heavy Deposits
- Perform compression check on questionable cylinder(s) found above. If compression is low, repair as necessary. See Section "6".
- Disconnect all injector harness connectors. Connect J-34730-2 Injector Test Light or equivalent 6 volt test light between the harness terms, of each injector connector and note light while cranking. If test light fails to blink at any connector, it is a faulty injector drive circuit harness, connector, or terminal.
- Perform the Injector Balance Test. See CHART C-2A.
- **CHECK:**
  - Spark plug wires by connecting ohmmeter to ends of each wire in question. If meter reads over 30,000 ohms, replace wire(s).
  - Fuel System - Plugged fuel filter, water, low pressure. See CHART A-7.
  - Valve timing.
  - Secondary voltage using a shop ocilliscope or a spark tester J-26792 (ST-125) or equivalent.
- Visually inspect distributor cap and rotor for moisture, dust, cracks, burns, etc. Spray cap and plug wires with fine water mist to check for shorts.
- A miss condition can be caused by EMI (Electromagnetic Interference) on the reference circuit. EMI can usually be detected by monitoring engine rpm with a "Scan" tool. A sudden increase in rpm with little change in actual engine rpm change, indicates EMI is present.
  If the problem exists, check routing of secondary wires, check all distributor ground circuits.
- Remove rocker covers. Check for bent pushrods, worn rocker arms, broken valve springs, worn camshaft lobes. Repair as necessary. See Section "6A".

## BACKFIRE

**Definition:** Fuel ignites in intake manifold, or in exhaust system, making a loud popping noise.

- **CHECK:**
  - Loose wiring connector or air duct at MAF sensor.
  - Compression - Look for sticking or leaking valves.
  - EGR operation for being open all the time. See CHART C-7.
  - EGR gasket for faulty or loose fit.
  - Valve timing.
  - Output voltage of ignition coil using a shop ocilliscope or spark tester J-26792 (ST-125) or equivalent.
  - Spark plugs for crossfire also inspect (distributor cap, spark plug wires, and proper routing of plug wires).
  - Ignition system for intermittent condition. (See Section "6D").
  - Engine timing - see emission control information label.
  - Perform fuel system diagnosis check, CHART A-7A.
  - Perform injector balance test CHART C-2A.
  - A.I.R. system check valves - See Section "C-6".

The MAT sensor signal is used by the ECM to delay EGR until the manifold air temperature reaches about 5°C (40°F).

A failure in the MAT sensor circuit should set either a Code 23 or Code 25.

## Oxygen ($O_2$) Sensor (Figure C1-4)

The exhaust oxygen sensor ($O_2$) is mounted in the exhaust system, where it can monitor the oxygen content of the exhaust gas stream. The oxygen content in the exhaust reacts with the sensor to produce a voltage output. This voltage ranges from approximately .1 volt (high $O_2$ - lean mixture) to .9 volts (low $O_2$ - rich mixture). This voltage can be measured with a digital voltmeter having at least 10 meg ohms input impedance. Use of standard shop type voltmeters will result in very inaccurate readings.

By monitoring the voltage output of the $O_2$ sensor, the ECM will know what fuel mixture command to give to the Injector (lean mixture-low $O_2$ voltage = rich command, rich mixture-high $O_2$ voltage = lean command).

The $O_2$ sensor, if open, should set a Code 13. A low voltage in the sensor circuit should set a Code 44. A high voltage in the circuit should set a Code 45. Codes 44 and 45 could also be set as a result of fuel system problems. See Code Charts.

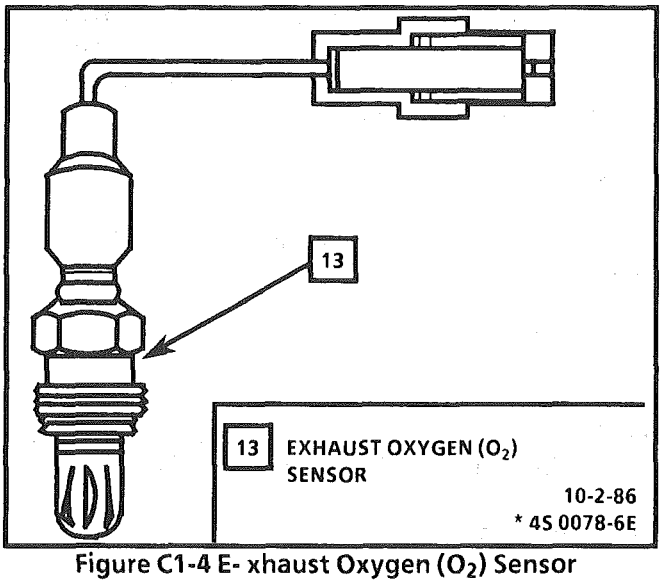



Figure C1-4 E- xhaust Oxygen ($O_2$) Sensor

## Throttle Position Sensor (TPS) (Figure C1-5)

The throttle position sensor (TPS) is connected to the throttle shaft on the throttle body. It is a potentiometer with one end connected to 5 volts from the ECM and the other to ECM ground. A third wire is connected to the ECM to measure the voltage from the TPS. As the throttle valve angle is changed (accelerator pedal moved), the output of the TPS also changes. At a closed throttle position, the output of the TPS is low (approximately .5 volts). As the throttle valve opens, the output increases so that, at wide-open throttle, the output voltage should be approximately 5 volts.

By monitoring the output voltage from the TPS, the ECM can determine fuel delivery based on throttle valve angle (driver demand). A broken or loose TPS can cause intermittent bursts of fuel from the injector and an unstable idle, because the ECM thinks the throttle is moving. A problem in any of the TPS circuits will set either a Code 21 or 22. Once a trouble code is set, the ECM will use an artificial default value for TPS, and some vehicle performance will return.

See "On-Car Service" for replacement or adjustment of TPS.

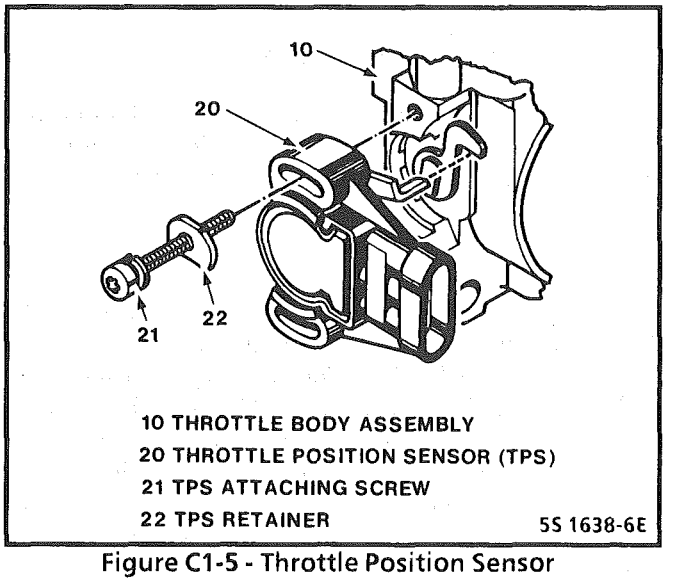



Figure C1-5 - Throttle Position Sensor

## Knock Sensor

This sensor is used to control engine detonation. Refer to Section "C5", for description.

## Vehicle Speed Sensor

The vehicle speed sensor (VSS), part of the digital cluster, sends a pulsing voltage signal to the ECM, which the ECM converts to miles per hour. This sensor mainly controls the operation of the TCC system. See Code 24 or Section "C8" for more information.

## Park/Neutral Switch (Auto Only)

The park/neutral (P/N) switch indicates to the ECM when the transmission is in park or neutral. This information is used for the TCC and the IAC valve operation.

**Important**

Vehicle should not be driven with park/neutral switch disconnected, as idle quality will be affected and a possible false Code 24 (VSS).

### Coolant Temperature Sensor

A "Scan" tool displays engine temperature in degrees centigrade. After engine is started, the temperature should rise steadily to about 90°C then stabilize when thermostat opens. If the engine has not been run for several hours (overnight), the coolant temperature and MAT temperatures should read close to each other. A fault in the coolant sensor circuit should set a Code 14 or 15. The code charts also contain a chart to check for sensor resistance values relative to temperature.

### MAF Sensor

A "Scan" tool reads the MAF value and displays it in grams per second and should read between 4-7 on a fully warmed up idling engine. Values should change rather quickly on acceleration, but values should remain fairly stable at any given rpm. Most "Scan" tools will have 2 positions for reading MAF sensor values (MAF & air flow). Both values should read the same if no Code 33 or 34 is set, but if a code is set, the MAF values will be the default value and the air flow parameter will lock on the value at which the ECM recognized the fault. A failure in the MAF sensor or circuit should set a Code 33 or 34.

### MAT Sensor

A "Scan" tool displays temperature of the air entering the engine and should read close to ambient air temperature when engine is cold, and rise as underhood temperature increases. If the engine has not been run for several hours (overnight) the MAT sensor temperature and coolant temperature should read close to each other. A failure in the MAT sensor circuit should set a Code 23 or 25. The code charts also contain a chart to check for sensor resistance values relative to temperature.

### $O_2$ Sensor

The "Scan" has several positions that will indicate the state of the exhaust gases, $O_2$ voltage, integrator, and block learn. See "Scan" position information in introduction, Section "6E".

A problem in the $O_2$ sensor circuit or fuel system should set a Code 13 (open circuit), Code 44 (lean indication), Code 45 (rich indication). Refer to applicable chart if any of these codes were stored in memory.

### TPS

A "Scan" tool displays throttle position in volts. The value should read .54volts ± .08 (.46V-.62V), with throttle closed and ignition "ON", or at idle. Voltage should increase at a steady rate as throttle is moved toward WOT (about 4.6 volts).

The ECM has the ability to auto-zero the TPS voltage if it is below about .7V (700 mV). This means that any voltage less than .7 volts will be determined by the ECM to be 0% throttle. A failure in the TPS or circuit should set a Code 21 or 22.

### VSS

A "Scan" tools reading should closely match with speedometer reading with drive wheels turning. A failure in the VSS circuit should set a Code 24.

### P/N Switch

A "Scan" tool should read "P/N" when in park or neutral and "R.D.L." when in Drive. This reading may vary with different makes of tools. Refer to CHART C-1A for P/N switch diagnosis.

### A/C Request Signal

"Scan" tool should indicate A/C "ON", when A/C is requested and the pressure cycling switch is closed.

### Reference Signal

A "Scan" tool will read this signal and is displayed in rpm. See Section "C4" for more information on the ignition system.

## ON-CAR SERVICE

### ELECTRONIC CONTROL MODULE (ECM)

Service of the ECM should, normally, consist of either replacement of the ECM or a Mem-Cal change.

If the diagnostic procedures call for the ECM to be replaced, the engine calibrator (Mem-Cal) and ECM should be checked first to see if they are the correct parts. If they are, remove the Mem-Cal from the faulty ECM and install it in the new service ECM. THE SERVICE ECM WILL NOT CONTAIN A MEM-CAL. Trouble Code 51 indicates the Mem-Cal is installed improperly or has malfunctioned. When Code 51 is obtained, check the Mem-Cal installation for bent pins or pins not fully seated in the socket. If it is installed correctly and Code 51 still shows, replace the Mem-Cal.

**Important**

When replacing the production ECM with a service ECM (controller), it is important to transfer the broadcast code and production ECM number to the service ECM label.

# SECTION C2
## FUEL CONTROL SYSTEM
## CONTENTS



## GENERAL DESCRIPTION

### PURPOSE

The basic function of the fuel control system is to control fuel delivery to the engine.

Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder.

The main control sensor is the oxygen ($O_2$) sensor, which is located in the exhaust manifold. The $O_2$ sensor tells the electronic control module (ECM) how much oxygen is in the exhaust gas. The ECM changes the air/fuel ratio to the engine by controlling the fuel injectors. The best mixture to minimize exhaust emissions is 14.7 to 1, which allows the catalytic converter to operate the most efficiently. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "Closed Loop" system (shown in Figure C2-1).

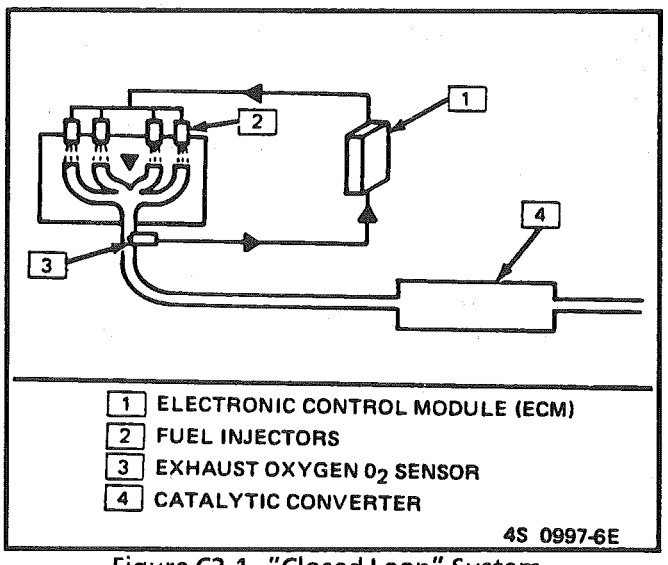



Figure C2-1 "Closed Loop" System

## MODES OF OPERATION

The ECM looks at voltages from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called "modes". All the modes are controlled by the ECM and are described below.

### Starting Mode

When the ignition is first turned "ON", the ECM will turn "ON" the fuel pump relay for two seconds, and the fuel pump will build up pressure. The ECM then checks the coolant temperature sensor, throttle position sensor, and determines the proper air/fuel ratio for starting. This ranges from 1.5 : 1 at -36°C (-33°F) to 14.7:1 at 94°C (201°F). The ECM controls the amount of fuel delivered in the starting mode by changing how long the injectors are pulsed "ON".

The cold start valve (Figure C2-2), not controlled by the ECM, is used to provide additional fuel during the starting mode to improve cold start-ups. This circuit is important, when the engine coolant temperature is very low, because the other injectors would not be pulsed "ON" long enough to provide the needed amount of fuel to start. The cold start valve is somewhat different from the other injectors in that it causes the fuel to be vaporized for a better combustible mixture.

The circuit is activated only in the crank mode. The power is supplied directly from the starter solenoid and is protected by the crank fuse. The system is controlled by a cold start fuel injection switch which provides a ground path for the valve during cranking whenever engine coolant is below 35° C (95°F).

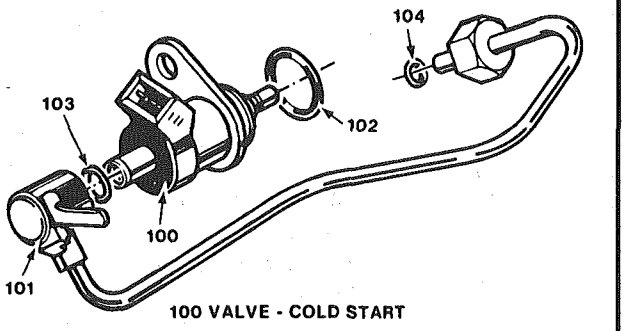



Figure C2-2 Cold Start Valve

The cold start fuel injection switch contains a bimetal switch which opens the circuit at specified coolant temperature. This bimetal is also heated by the winding in the switch, which would allow the valve to stay "ON" 8 seconds at -20° C or below. The time the switch stays closed varies inversely with coolant temperature. In other words, as the coolant temperature goes up the maximum cold start valve "ON" time goes down.

### Clear Flood Mode

If the engine floods, clear it by pushing the accelerator pedal down all the way. The ECM then pulses the injectors at an air/fuel ratio of 20:1. The ECM holds this injector rate as long as the throttle stays wide open, and the engine rpm is below 600. If the throttle position becomes less than 80%, the ECM returns to the starting mode.

### Run Mode

The RUN mode has two conditions called "Open Loop" and "Closed Loop".

When the engine is first started, and rpm is above 400 rpm, the system goes into "Open Loop" operation. In "Open Loop", the ECM will ignore the signal from the Oxygen ($O_2$) sensor, and calculate the air/fuel ratio based on inputs from the coolant and MAF sensors.

The system will stay in "Open Loop" until the following conditions are met:

1. The $O_2$ sensor has varying voltage output, showing that it is hot enough to operate properly. (This depends on temperature.)
2. The coolant sensor is above a specified temperature about 40°C (104°F).
3. A specific amount of time has elapsed after starting the engine.

The specific values for the above conditions vary with different engines, and are stored in the mem-cal. When these conditions are met, the system goes into "Closed Loop" operation. In "Closed Loop", the ECM will calculate the air/fuel ratio (injector on-time) based on the signal from various sensors but mainly the $O_2$ sensor. This allows the air / fuel ratio to stay very close to 14.7:1 .

### Acceleration Mode

The ECM looks at rapid changes in throttle position and air flow, and provides extra fuel.

## Deceleration Mode

The ECM looks at changes in throttle position and air flow to reduce the amount of fuel. When deceleration is very fast, the ECM may shut off fuel completely for short periods.

## Battery Voltage Correction Mode

When battery voltage is low, the ECM can compensate for the weak spark delivered by the distributor by:

- Increasing the amount of fuel delivered;
- Increasing the idle rpm; and
- Increasing ignition dwell time.

## Fuel Cutoff Mode

No fuel is delivered by the injector when the ignition is "OFF". This prevents dieseling. Also, fuel is not delivered if no reference pulses are seen from the distributor, which means the engine is not running. This prevents flooding.

# FUEL CONTROL SYSTEM

## Basic System Operation

The fuel system (Figure C2-3) starts with the fuel in the fuel tank.

An electric fuel pump, located in the fuel tank with the gage sending unit, pumps fuel to the fuel rail through an in-line fuel filter. The pump is designed to provide fuel at a pressure above the pressure needed by the injectors. A pressure regulator in the fuel rail keeps fuel available to the injectors at a constant pressure, depending on manifold pressure. Unused fuel is returned to the fuel tank by a separate line. For further information on the fuel tank, in-line filter, and fuel lines, see Section "6C".

The injectors are controlled by the ECM. They deliver fuel in one of several modes, as described above.

In order to properly control the fuel supply, the fuel pump is operated by the ECM through the fuel pump relay and oil pressure switch (see Fuel Pump Electrical Circuit Code 54).

## Throttle Body Unit

The throttle body has a throttle valve to control the amount of air delivered to the engine. The TPS and the IAC valve are also mounted on the throttle body.

The throttle body contains vacuum ports located at, above, or below the throttle valve. These ports generate the vacuum signals needed by various

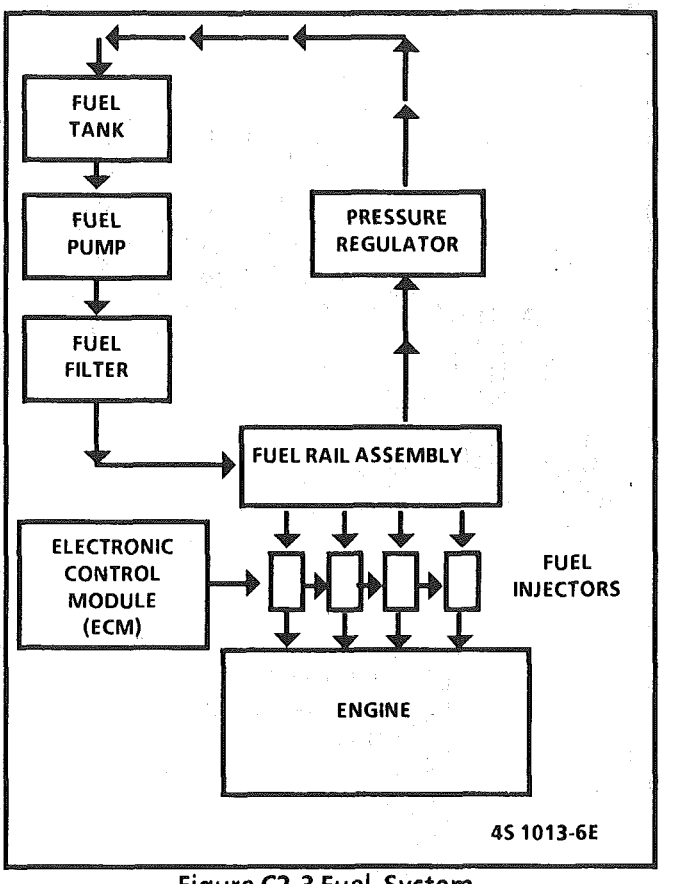



Figure C2-3 Fuel System

components. Engine coolant is directed through the coolant cavity, on the bottom of the throttle body, to warm the throttle valve and prevent icing.

## Fuel Rail

The fuel rail is mounted to the top of the engine. It distributes fuel to the individual injectors. Fuel is delivered to the input end of the rail by the fuel lines, goes through the rail, then to the pressure regulator. Remaining fuel is then returned to the fuel tank.

## Fuel Injectors

The fuel injector is a solenoid operated device controlled by the ECM (see Figure C2-4). The ECM turns "ON" the solenoid, which opens a valve to allow fuel delivery. The fuel, under pressure, is injected in a conical spray pattern at the opening of the intake valve. The fuel, which is not used by the injectors, passes through the pressure regulator before being returned to the fuel tank.

An injector which is stuck partly open will cause loss of pressure after engine shut down, so long crank times would be noticed on some engines. Also, dieseling could occur because some fuel could be delivered to the engine after the ignition is turned "OFF".

### Fuel Pump Electrical Circuit

When the ignition is first turned "ON", without the engine running, the ECM will turn the fuel pump relay "ON" for two seconds. This builds up the fuel pressure quickly. If the engine is not started within two seconds, the ECM will shut the fuel pump "OFF" and wait until the engine is cranking. As soon as the engine is cranked, the ECM will turn the relay "ON" and run the fuel pump.

As a backup system to the fuel pump relay, the fuel pump can also be turned "ON" by the oil pressure switch. The oil pressure switch is a normally open switch which closes when oil pressure reaches about 28 kPa (4 psi). If the fuel pump relay fails, the oil pressure switch will close, and run the fuel pump.

An inoperative fuel pump relay can result in long cranking times, particularly if the engine is cold but should result in a Code 54.

An inoperative fuel pump would cause a no start condition. A fuel pump which does not provide enough pressure can result in poor performance.

## DIAGNOSIS

### FUEL CONTROL SYSTEM

Some failures of this system will result in an "Engine Cranks But Won't Run". If this condition exists see CHART A-3. This chart will determine if the problem is caused by the ignition system, ECM, or fuel pump circuit. If it's determined to be a fuel problem CHART A-7 will be used. This includes the injectors, pressure regulator, fuel pump, and fuel pump relay. The fuel system wiring schematic is covered on the facing page of Code CHART 54.

If a malfunction occurs in the fuel control system, it usually results in either a rich or a lean exhaust condition. This condition is sensed by the oxygen sensor and the ECM will change the fuel calculation (injector pulse width) based on the $O_2$ sensor reading. The change made to the fuel calculation will be indicated by a change in the block learn values, which can be monitored by a "Scan" tool. The normal block learn values are around 128, and if the $O_2$ sensor is sensing a lean condition, the ECM will add fuel which will result in a block learn value above 128. If the $O_2$ sensor is sensing a rich exhaust the ECM will reduce fuel to the engine and this will result in block learn values below 128. Some variations in block learn values are normal because all engines are not exactly the same. However, if the block learn values are ± 10 counts from 128 a system problem exists. If the block learn values are greater than 138 see Code 44, for items which can cause a lean system.

If the block learn values are less than 118 see Code 45 for items which can cause the system to run rich.

If a driveability symptom exists, refer to the particular symptom in Section "B" for additional items to check.

### IDLE AIR CONTROL VALVE

A"Scan" tool will read IAC position in steps (counts). "0" steps indicates the ECM is commanding the IAC to be driven all the way in, to a fully seated position, and this is usually caused by a vacuum leak. The higher the number of counts the more air being allowed to pass the IAC valve. CHART C-2C can be used to diagnosis the IAC valve. Also refer to "Rough, Unstable, or Incorrect Idle, Stalling" in symptoms, Section "B" for other possibilities for the cause of idle problems.

### FUEL SYSTEM PRESSURE TEST

A fuel system pressure test is part of several of the diagnostic charts and symptom checks. To perform this test, use the procedure in CHART A-7.

## ON-CAR SERVICE

### PORT FUEL INJECTION COMPONENTS

**CAUTION: Before servicing an injector, fuel rail, or pressure regulator, it is necessary to relieve the pressure in the fuel system, to minimize the risk of fire and personal injury. (See "Fuel Pressure Relief Procedure" below). To reduce the chance of personal injury, cover the fuel line with a shop cloth to collect the fuel, and then place the cloth in an approved container.**

### FUEL PRESSURE RELIEF PROCEDURE

1. Connect fuel gage J 34730-1 or equivalent to fuel pressure valve. Wrap a shop towel around fitting while connecting gage to avoid spillage.
2. Install bleed hose into an approved container and open valve to bleed system pressure.

### Plenum (Figure C2-6)

#### Remove or Disconnect

1. Negative battery cable.
2. Throttle, T.V., and cruise control cable.
3. Cable retaining bracket.
4. Throttle body retaining bolts (4).
5. TPS and IAC valve electrical connectors.
6. Vacuum hoses.

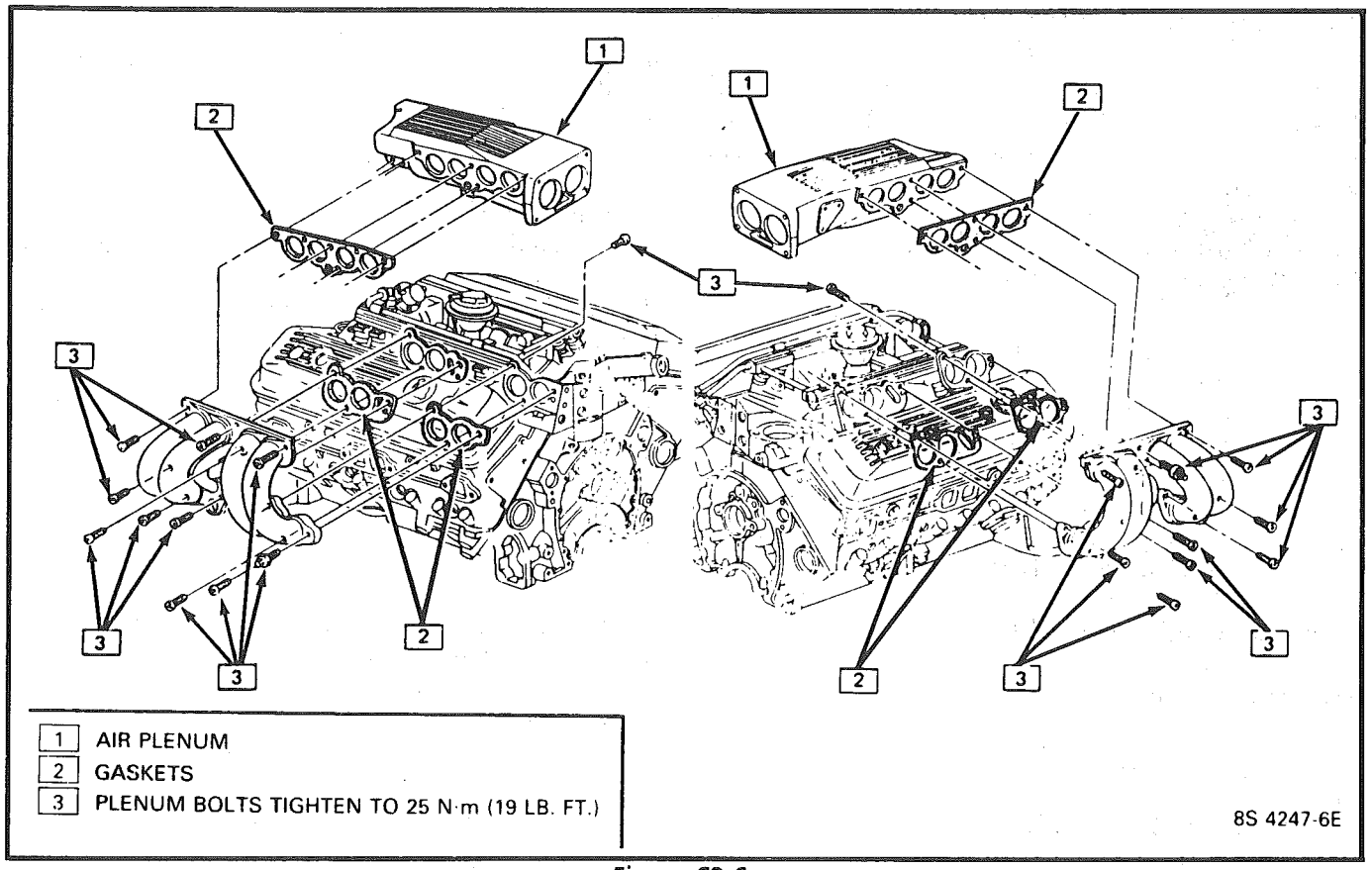



Figure C2-6

7. Right runners.
8. Plenum retaining bolts.
9. Plenum and gaskets (discard gaskets).

### Install or Connect

1. New gaskets.
2. Reverse removal procedures. See Figure C2-6 for bolt torque specifications.

## FUEL RAIL ASSEMBLY

### Fuel Rail (Figure C2-7)

### Remove or Disconnect

1. Negative battery cable.
2. Fuel system pressure following "Fuel Pressure Relief procedure".
3. Plenum. (Refer to Plenum Removal).
4. Cold start valve line.
5. Runners.
6. Cold start valve.
7. Fuel lines and injector harness connectors.
8. Loosen rail retaining bolts and raise rail.
9. Rail and injectors.
10. Injector O-ring seal (86) (Figure C2-9) from each injector spray tip and discard.

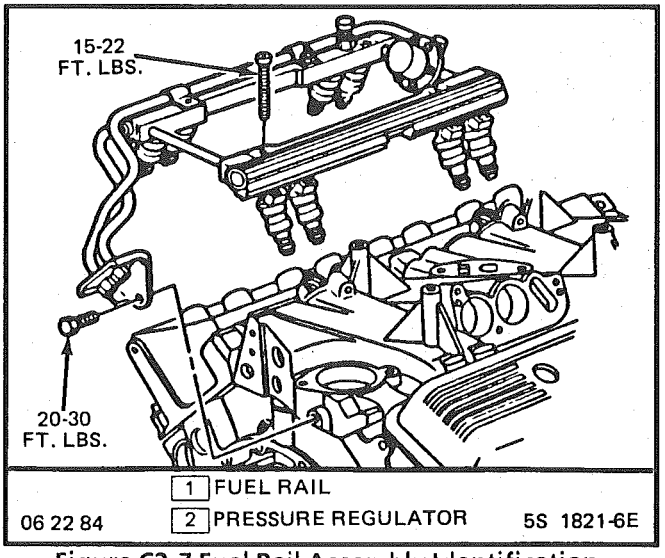



Figure C2-7 Fuel Rail Assembly Identification

### Install or Connect

1. New injector O-rings.
2. Coat injector O-rings with engine oil.
3. Reverse removal instructions.
   Refer to Figure C2-7 for torque specifications.

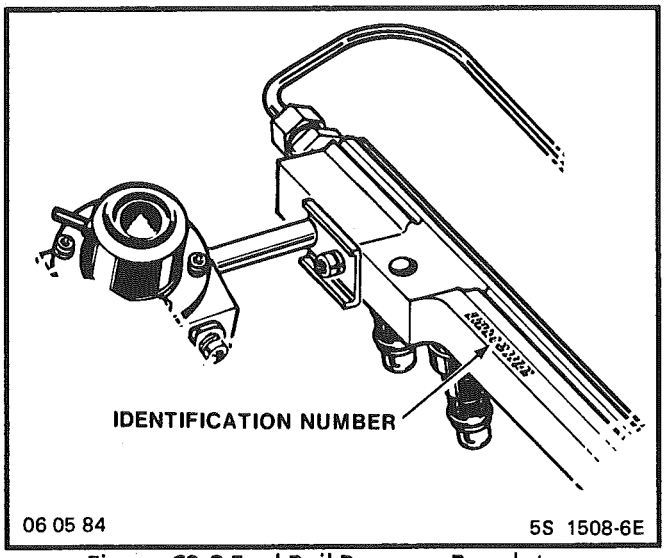



Figure C2-8 Fuel Rail Pressure Regulator

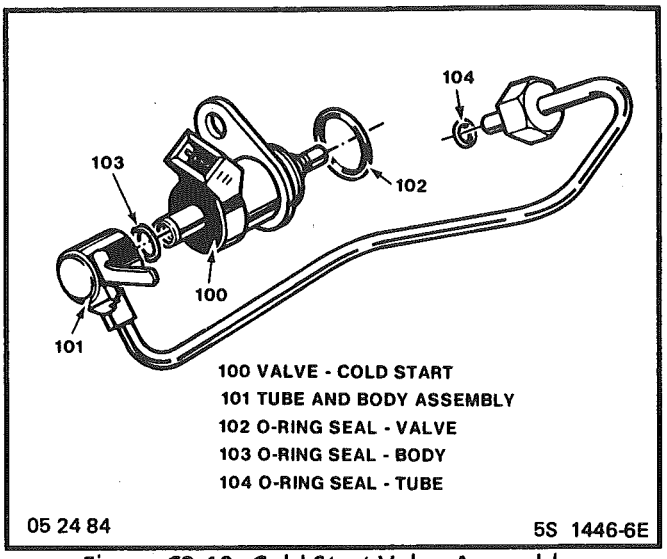



Figure C2-10 Cold Start Valve Assembly

# FUEL RAIL SERVICE

## IDENTIFICATION

An eight digit identification number is stamped on the fuel rail assembly, as shown in Figure C2-8. Refer to this model identification number if servicing or part replacement is required.

Names of component parts will be found on the numbered list that accompanies the dis-assembled view, (Figure C2-9). Numbers used to identify parts there will be used to identify the same parts in other illustrations of this section of the manual.

## UNIT SERVICE PROCEDURES

### Important

When servicing the fuel rail assembly, precautions must be taken to prevent dirt and other contaminants from entering the fuel passages. It is recommended that fittings be capped, and holes be plugged during servicing.

### Important

At any time the fuel system is opened for service, the O-ring seals used with the related component(s) should be replaced.

### Cleaning and Inspection

Before disassembly, the fuel rail assembly may be cleaned with a spray type engine cleaner, such as AC Delco X-30A or equivalent, following package instructions. The fuel rail should not be immersed in liquid solvent.

## COLD START TUBE AND VALVE ASSEMBLY (Figure C2-10)

### Remove or Disconnect

1. Negative battery cable.
2. Relieve fuel system pressure, following "Fuel Pressure Relief Procedure".
3. Plenum, per previous instructions.
4. Brake booster line.
5. Tube and body assembly (101) at fitting on fuel rail.
6. Electrical connector from cold start valve (100).
7. PVC hose.
8. Cold start valve retaining bolt.
9. Cold start valve assembly from fuel rail and intake manifold.

### Disassemble

1. Raise tab on tube and body assembly (101) to clear electrical connector and unscrew cold start valve (100).
2. O-ring seals (102, 103, and 104) from tube and body assembly (101), cold start valve (100), and fuel rail fitting. Discard seals.

### Assemble

1. Lubricate new O-ring seals (102, 103, and 104) with engine oil and install at following locations:
   - O-ring seal (102) goes on end of cold start valve (100).
   - O-ring seal (103) goes inside body of tube and body assembly (101).
   - O-ring seal (104) goes up against collar of tube and body assembly.

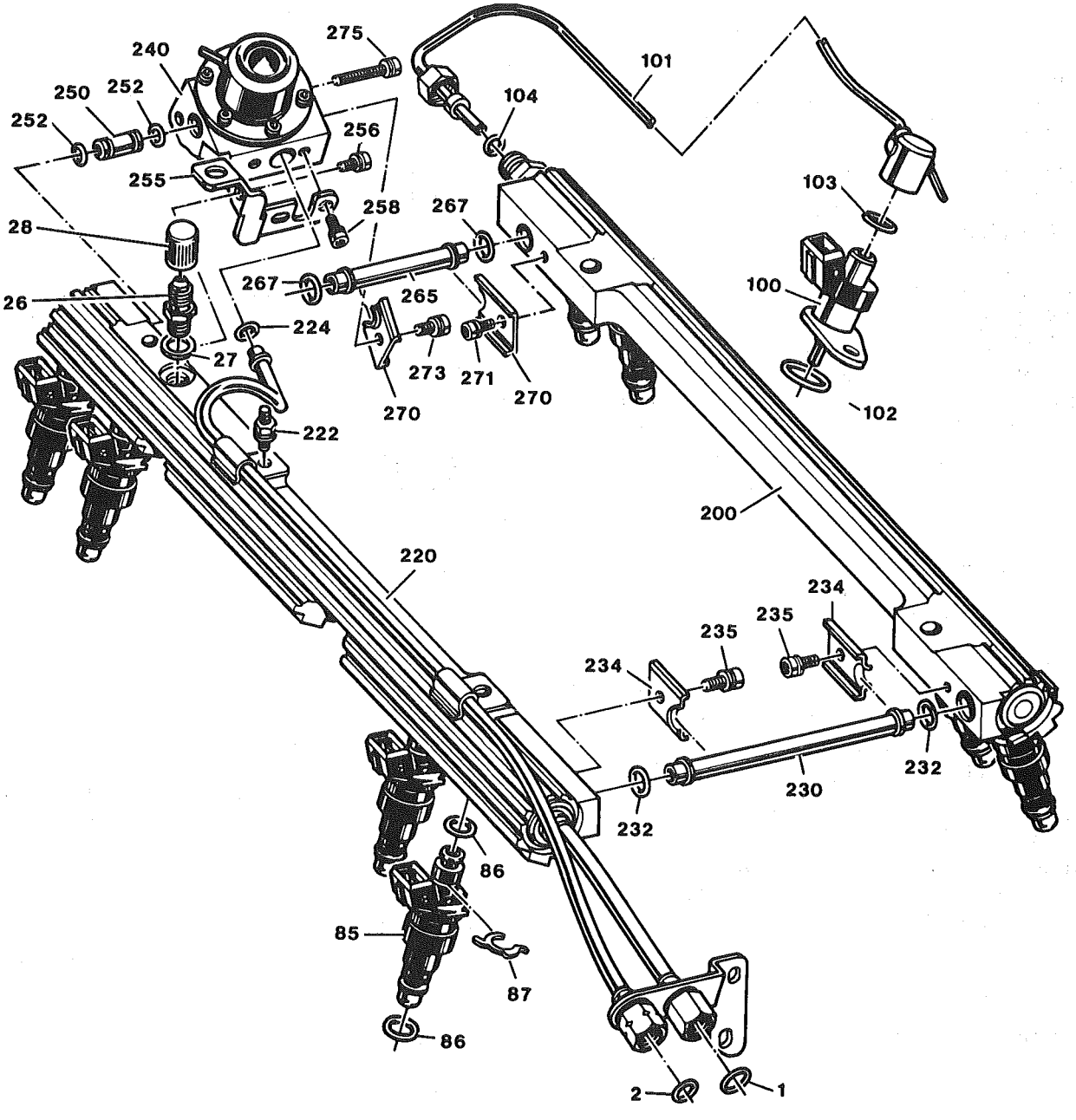



Figure C2-9 Fuel Rail Assembly

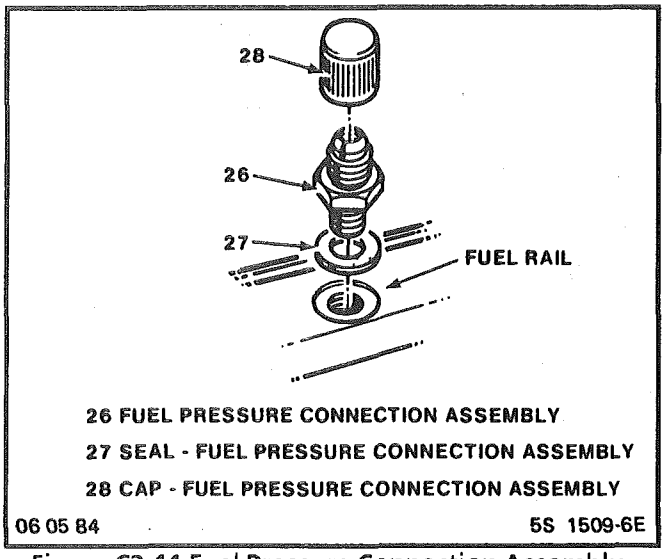



Figure C2-11 Fuel Pressure Connection Assembly

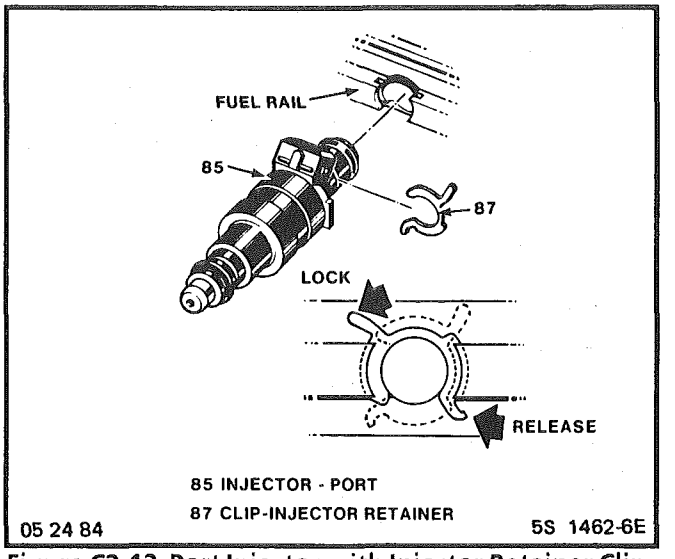



Figure C2-12 Port Injector with Injector Retainer Clip

## FUEL PRESSURE CONNECTION ASSEMBLY (Figure C2-11)

### Remove or Disconnect

1. Negative battery cable.
2. Relieve fuel system pressure following "Fuel Pressure Relief" procedure.

### Clean

- Area around valve and connection with AC Delco X-30A or equivalent.

3. Fuel pressure connection assembly (26) and seal (27). Discard seal

### Install or Connect

1. New seal (27) on fuel pressure connection assembly (26).
2. Fuel pressure connection assembly (26)in fuel rail.

### Tighten

- Fuel pressure connection assembly to 10.0 N·m (88.0 in. lbs. )

3. Negative battery cable.

### Inspect

- Energize fuel pump and check for leaks.

## FUEL INJECTORS (With Fuel Rail Removed)

Each port injector is located and held in position by a retainer clip that must be rotated to release and/or lock the injector in place, as shown in Figure C2-12.

### Remove or Disconnect

1. Rotate injector retaining clip(s) (87) to unlocked position.
2. Injectors (85).

### Disassemble

1. Injector O-ring seals (86) from both ends of injectors (85) and discard.

### Assemble

- New O-ring seals (86) and install on injectors (85).

### Install or Connect

1. Injectors to fuel rail and pressure regulator assembly (11).
2. Rotate injector retainer clips (87) to locking position (Figure C2-12).

## PRESSURE REGULATOR (With Fuel Rail Removed)

### Important

The pressure regulator is factory adjusted and is not serviceable. Do not attempt to remove regulator cover.

### Remove or Disconnect

1. Front crossover tube retainer attaching screw assembly (235) and crossover tube retainer (234) on right hand rail side.
2. Retainer to base screw assembly (273) and rear crossover tube retainer (270) at pressure regulator and base assembly (240).

3. Separate left hand fuel rail and plug assembly (200) from right hand fuel rail and plug assembly (220).
4. Bracket-to-rail attaching screw assembly (256), two bracket-to-base attaching screw assemblies (258) and pressure regulator and base assembly bracket (255).
5. Screw assembly (235), which attaches fuel outlet tube to right hand rail (220).
6. Base to right hand rail screw assembly (275).
7. Pressure regulator and base assembly (240) from right hand rail assembly (220).
8. Rotate regulator and base assembly to remove from fuel outlet tube.
9. Base to rail connector (250).
10. O-ring seals and discard:
    - Connector (252).
    - Fuel outlet tube (224).
    - Rear crossover tube (267).
    - Front crossover tube (232).

### Important

When removing O-ring seals, note locations and sizes, to assure correct replacement and re-assembly.

### Inspect

- O-rings and sealing surfaces, for damage that could prevent proper sealing.
  - Replace any damaged O-ring seals.

### Install or Connect

1. Lubricate with engine oil, and install O-ring seals:
    - Connector (252).
    - Fuel outlet tube (224).
    - Rear crossover tube (267).
    - Front crossover tube (232).
2. Base-to-rail connector (250) in pressure regulator and base assembly (240).
3. Regulator and base assembly on fuel outlet tube.
4. Rotate the regulator and base assembly to install base to rail connector (250) into right hand rail assembly (220).
5. Base to right hand rail screw assembly (275).
6. Pressure regulator and base assembly bracket (255), two brackets to base attaching screw assembly (258) and bracket to rail attaching screw assembly (256).
7. Rear bracket attaching screw assembly (235).
8. Left hand rail and plug assembly (200), with front and rear crossover tubes (230) and 265), to right hand rail and tube assembly (220).
9. Rear crossover tube retainer (270) and retainer to base screw assembly (273).

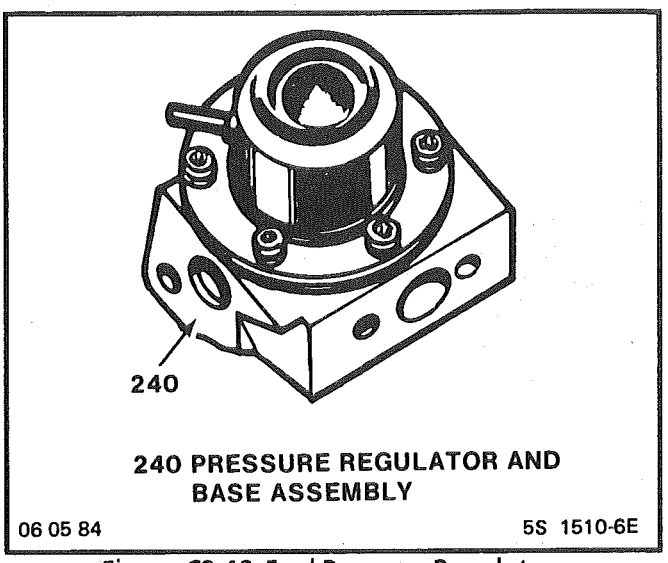



Figure C2-13 Fuel Pressure Regulator

10. Front crossover tube retainer (234) and retainer attaching screw assembly (235).

### Tighten

- Above mentioned seven assemblies to 5 N·m (44 in. lbs.).

## COLD START FUEL INJECTION SWITCH

### Remove or Disconnect

1. Air inlet duct.
2. Alternator bracket.
3. Electrical connector.
4. Switch.

### Install or Connect

1. Coat threads with pipe sealant.
2. Reverse removal procedure to reinstall.

## THROTTLE BODY

### Remove or Disconnect

1. Air inlet duct.
2. IAC and TPS connectors.
3. Vacuum lines.
4. Coolant hoses (2).
5. Throttle, TV, and cruise control cables.
6. Throttle body retaining bolts.

### Install or Connect

1. Reverse procedure to reinstall.
2. Refill radiator with lost coolant. Refer to Figure C2-14 for torque specifications.

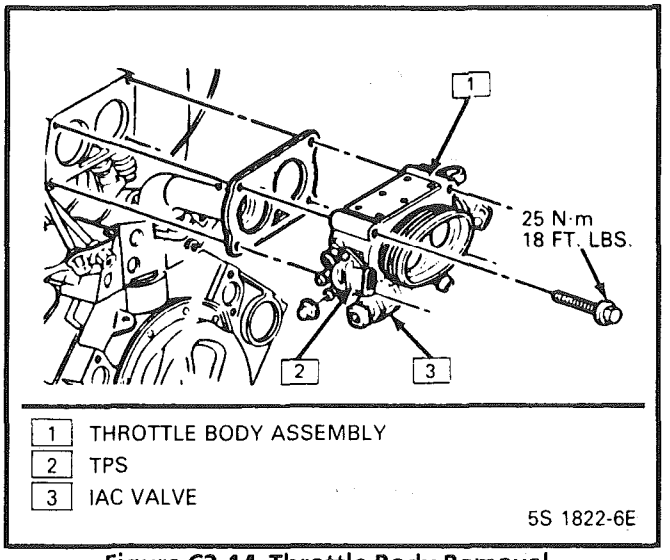



Figure C2-14 Throttle Body Removal

## THROTTLE BODY SERVICE IDENTIFICATION

An eight digit identification number is stamped on the throttle body casting, next to the coolant cover, as shown in Figure C2-15. Refer to this model identification number if servicing or part replacement is required.

Names of component parts will be found on the numbered list that accompanies the exploded view (Figure C2-18). Numbers used to identify parts in the exploded views also are used to identify the same parts in other illustrations of this manual.

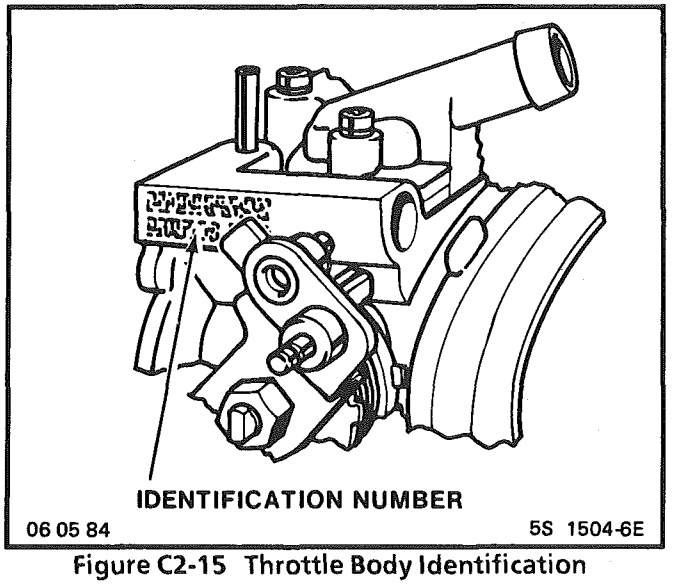



Figure C2-15 Throttle Body Identification

## UNIT REPAIR PROCEDURES

### TPS Adjustment

Refer to Section "C-1" for TPS replacement or adjustment.

The unit repair procedures cover component replacement with the unit on the vehicle. However, throttle body replacement requires that the complete unit be removed from the engine. If removed, it may be placed on a holding fixture, such as J-9789-118, BT-3553, or equivalent, to prevent damage to the throttle valve.

### Cleaning and Inspection

Throttle body parts, except as noted below, may be cleaned in a cold immersion-type cleaner such as AC Delco X-55 or equivalent.

**NOTICE:** The throttle position sensor (TPS), idle air control (IAC) valve, throttle body with cover and seals or gaskets in place, should NOT be soaked in liquid solvent or cleaner, as they may be damaged. If TPS or IAC valve is still mounted in the throttle body, do not immerse throttle body.

1. Clean all metal parts throughly and blow dry with shop air. Be sure all air passages are free of burrs and dirt.
2. Inspect mating casting surfaces for damage that could affect gasket sealing.

## MINIMUM IDLE SPEED CHECK

The idle stop screw (16), used to regulate minimum idle speed of the engine, is adjusted at the factory, then is covered with a plug (15) to discourage unnecessary readjustment. However, if it is necessary to gain access to the idle stop screw assembly, proceed as shown in Figure C2-16.

Before checking minimum idle speed, be sure ignition timing is correct and, before making any idle speed adjustments, be sure throttle body is clean around the throttle plates.

### Adjust

1. Pierce the idle stop screw plug (15) with an awl, and apply leverage to remove it.
2. Adjust idle stop screw assembly (16) as required.

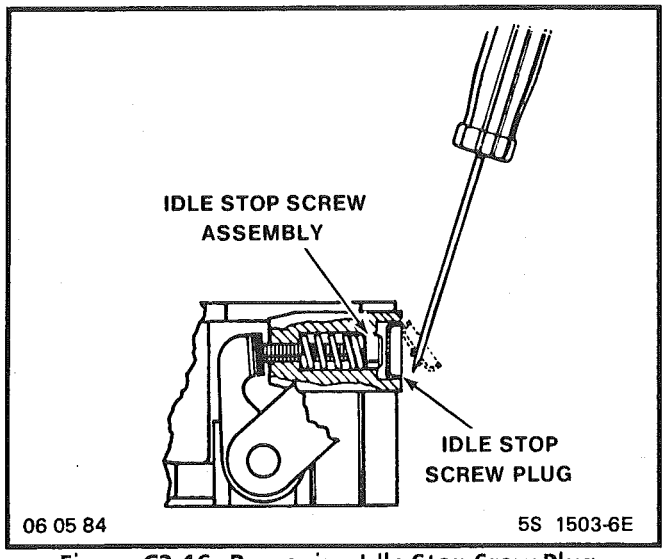



Figure C2-16 Removing Idle Stop Srew Plug

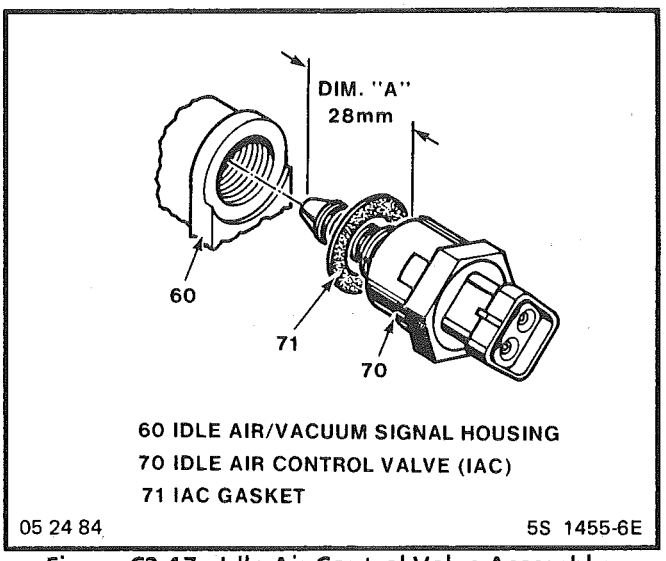



Figure C2-17 Idle Air Control Valve Assembly

3. With IAC motor connected, ground diagnostic terminal.
4. Turn "ON" ignition, do not start engine. Wait at least 30 seconds.
5. With ignition "ON", disconnect IAC electrical connector.

### Important

6. Disconnect the distributor set-timing connector.
7. Start engine and allow to go "Closed Loop".
8. Remove ground from diagnostic terminal.
9. Adjust idle stop screw to 400 rpm 5.0L, 450 rpm 5.7L in neutral for manual or automatic transmission vehicles.
10. Turn ignition "OFF" and reconnect connector at IAC motor.
11. Adjust TPS, if necessary:
    - With ignition "ON", use a "Scan" tool or 3 jumper wires and adjust TPS to obtain .54 volt $\pm$ .08 volt.
    - Tighten screws, then recheck reading to insure adjustment has not changed.
12. Start engine and inspect for proper idle operation.

## IDLE AIR CONTROL VALVE ASSEMBLY AND GASKET

### Remove or Disconnect

1. Electrical connector at idle air control valve assembly (70).
2. IAC valve assembly from IACV/coolant cover assembly.
3. IAC valve assembly gasket (71) and discard.

**NOTICE:** Before installing new idle air control valve assembly, the position of its pintle MUST be checked. If pintle is extended too far, damage to the assembly may occur.

### Measure

- Distance from gasket mounting surface of IAC valve assembly (70) to tip of pintle, (Dimension "A" in Figure C2-17).

### Adjust

If distance is greater that 28 mm (1 1/8 in.), reduce it as follows:

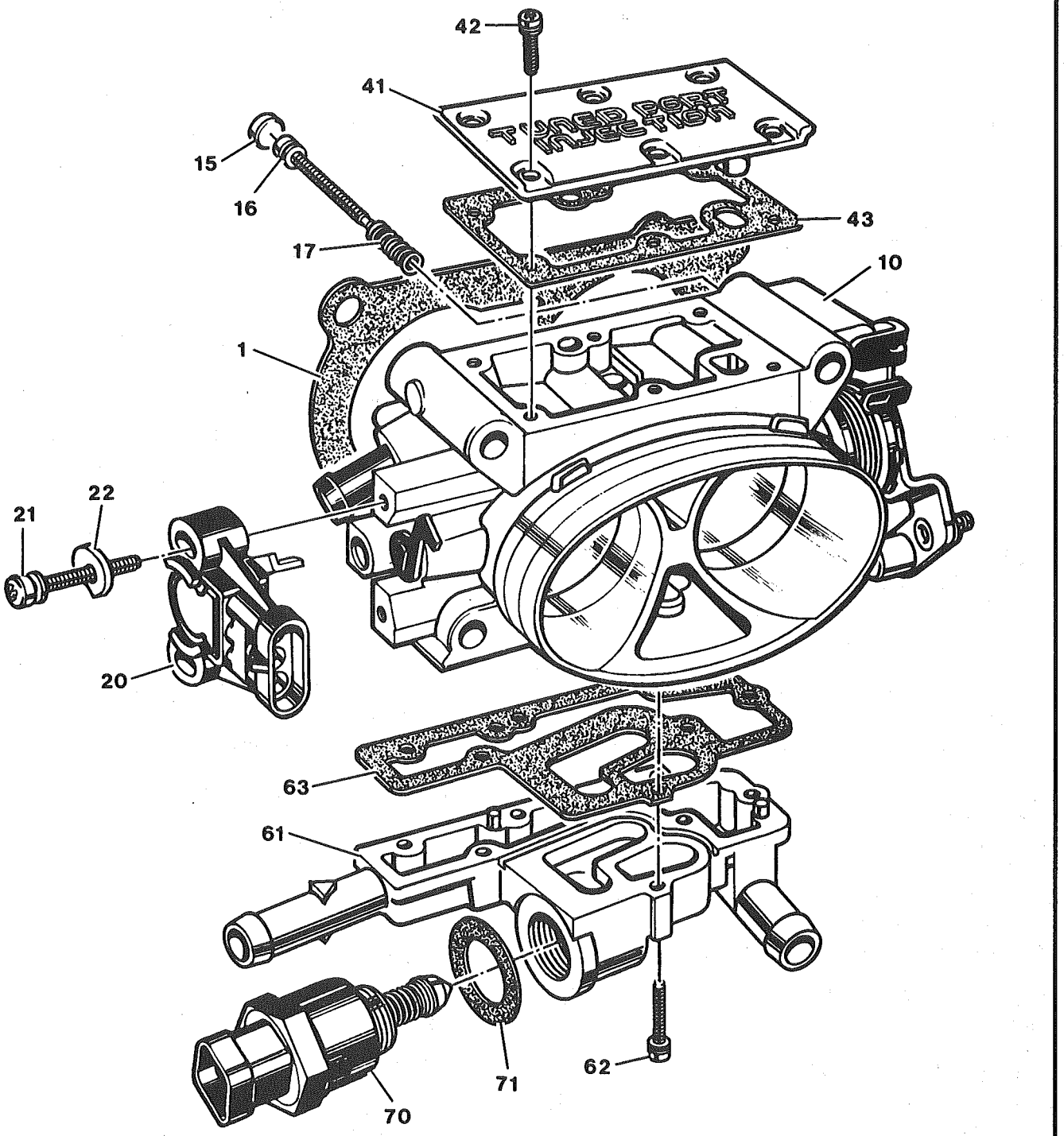
a. If IAC valve assembly has a "collar" around electrical connector end, use firm hand pressure on pintle to retract it. (A slight side-to-side motion may help.)
b. If IAC valve assembly has no "collar", compress pintle-retaining spring toward body of IAC valve and try to turn pintle clockwise.
    - If pintle will turn, continue turning until 28mm (1 1/8 in.) is reached. Return spring to original position, with straight part of spring end lined up with flat surface under pintle head.
    - If pintle will not turn, use firm hand pressure to retract it.

### Install or Connect

1. New IAC valve assembly gasket (71) on IAC valve assembly (70).
2. IAC valve assembly in IACV/coolant cover assembly (61).

### Tighten

- IAC valve assembly to 18N·m (13 ft. lbs.), with wrench on hex surface only.
3. Electrical connector at IAC valve assembly (70).

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5S 1505-6E

Figure C2-18 Throttle Body

### Important

No physical adjustment is made to the IAC assembly after installation. IAC valve resetting occurs after reinstallation on the vehicle, and is reset after the engine is started and then the ignition turned "OFF".

## THROTTLE BODY PARTS INFORMATION FIGURE C2-18

| PART NAME | PART # |
|---|---|
| Gasket - Flange | 1 |
| Throttle Body Assembly | 10 |
| Plug - Idle Stop Screw | 15 |
| Screw Assembly - Idle Stop | 16 |
| Spring - Idle Stop Screw | 17 |
| Sensor - Throttle Position (TPS) | 20 |
| Screw Assembly - TPS Attaching | 21 |
| Retainer - TPS Attaching Screw | 22 |
| Cover - Clean Air | 41 |
| Screw Assembly - Clean Air Cover Attaching | 42 |
| Gasket - Clean Air Cover | 43 |
| IACV/Coolant Cover Assembly | 61 |
| Screw Assembly - IACV Cover Assembly to Throttle Body | 62 |
| Gasket - IACV/Coolant Cover to Throttle Body | 63 |
| Valve Assembly - Idle Air Control (IAC) | 70 |
| Gasket - IAC Valve Assembly | 71 |

## CLEAN AIR COVER AND GASKET

### Remove or Disconnect

1. Clean air cover attaching screw assemblies (42).
2. Clean air cover (41).
3. Clean air cover gasket (43).

### Clean

- Cover mounting surface to ensure a good seal.

### Install and Connect

1. New clean air cover gasket (43) on throttle body assembly (10).
2. Clean air cover (41).
3. Clean air cover attaching screw assemblies (42).

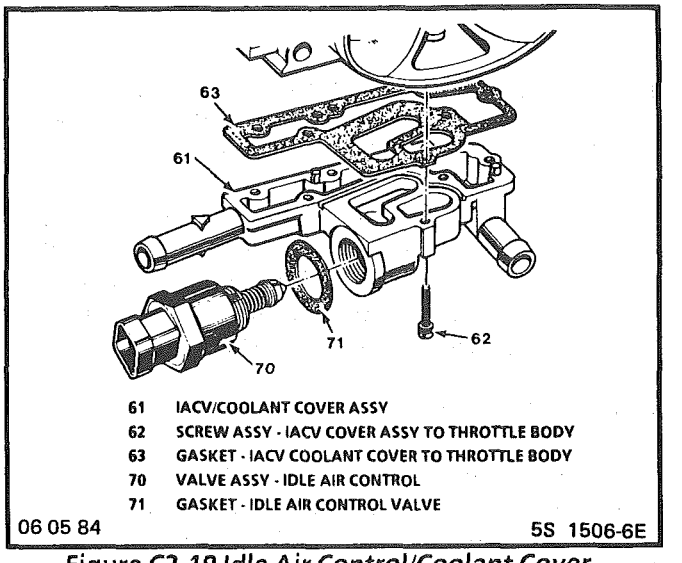



Figure C2-19 Idle Air Control/Coolant Cover Assembly

## IDLE AIR CONTROL/COOLANT COVER ASSEMBLY (Figure C2-19) (With Throttle Body Removed From Engine)

### Remove or Disconnect

1. Idle air control (IAC) valve assembly (70) from IACV/coolant cover assembly. (See "Idle Air Control Valve and Gasket" instructions.)
2. IACV cover assembly to throttle body screw assemblies (62).
3. Cover assembly (61).
4. Cover assembly to throttle body gasket (63) and discard.

### Install or Connect

#### Clean

- Throttle body gasket mounting surface to ensure a good seal.
- Sealing surface for damage that could prevent sealing properly or cause coolant leak.

#### Install and Connect

1. New IACV/coolant cover assembly to throttle body gasket (63).
2. IACV/coolant cover assembly (61).
3. IACV cover assembly to throttle body screw assemblies (62).

### Tighten

- Screw assemblies to 3.0 N•m (27.0 in. lbs.).

4. IAC valve assembly (70). (See "Idle Air Control Valve and Gasket" instructions).

**NOTICE:** Before installing the IAC valve assembly, the position of its pintle MUST be checked. If pintle is extended too far, damage to the assembly may occur. (See "Idle Air Control Valve and Gasket" instructions.)

## FUEL PUMP RELAY

The fuel pump relay is mounted in the engine compartment (see Figure C2-20). Other than checking for loose connectors, the only service possible is replacement.

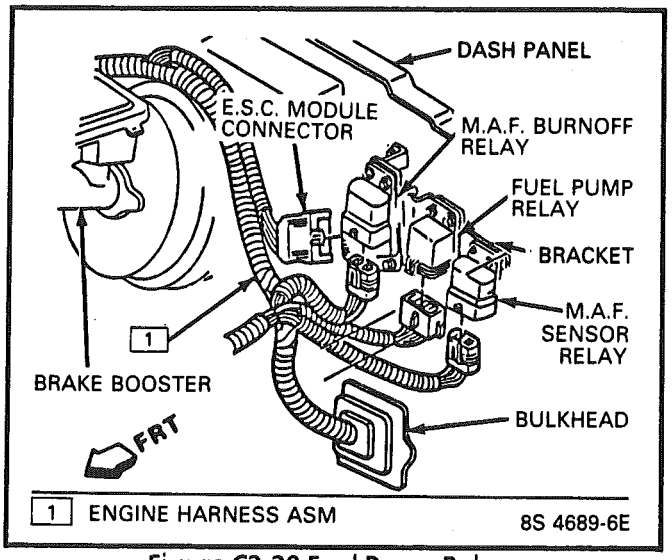



Figure C2-20 Fuel Pump Relay

## OIL PRESSURE SWITCH

The oil pressure switch is mounted as shown in Figures C2-21.

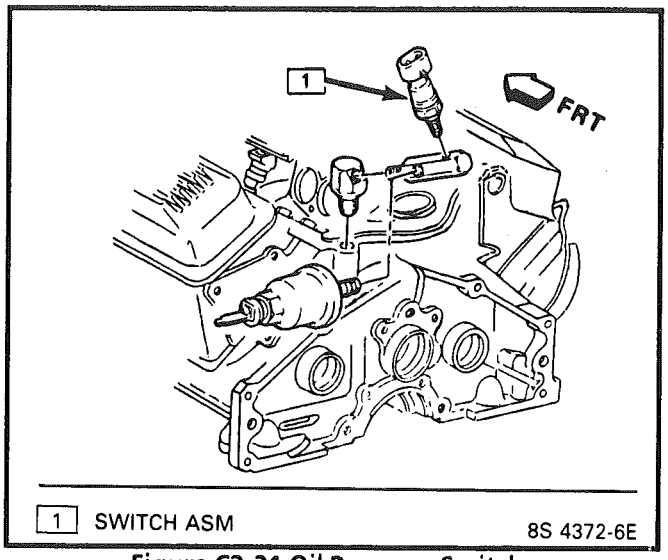



Figure C2-21 Oil Pressure Switch

### Remove or Disconnect

1. Electrical connector.
2. Oil pressure switch.

### Install or Connect

1. Make sure fittings (41) are properly aligned to allow switch installation.
2. Oil pressure switch.
3. Electrical connector.

## PARTS INFORMATION

| PART NAME | GROUP |
|---|---|
| Injector, fuel | 3.300 |
| Pump, Fuel (In-Tank) | 3.900 |
| Relay, Fuel Pump | 3.900 |
| Switch, Oil Pressure | 1.800 |
| Valve Asm, Idle Air Control: Part Of Control Kit, Idle Air Valve | 3.820 |
| Regulator, Fuel Pressure | 3.164 |
| Rail, Fuel Feed | 3.330 |

BLANK

# CHART C-2A

## INJECTOR BALANCE TEST

The injector balance tester is a tool used to turn the injector on for a precise amount of time, thus spraying a measured amount of fuel into the manifold. This causes a drop in fuel rail pressure that we can record and compare between each injector. All injectors should have the same amount of pressure drop (± 10 kPa). Any injector with a pressure drop that is 10 kPa (or more) greater or less than the average drop of the other injectors should be considered faulty and replaced.

### STEP 1

Engine "cool down" period (10 minutes) is necessary to avoid irregular readings due to "Hot Soak" fuel boiling. With ignition "OFF" connect fuel gauge J347301 or equivalent to fuel pressure tap. Wrap a shop towel around fitting while connecting gage to avoid fuel spillage.

Disconnect harness connectors at all injectors, and connect injector tester J-34730-3, or equivalent, to one injector. On turbo equipped engines, use adaptor harness furnished with injector tester to energize injectors that are not accessible. Follow manufacturers instructions for use of adaptor harness. Ignition must be "OFF" at least 10 seconds to complete ECM shutdown cycle. Fuel pump should run about 2 seconds after ignition is turned "ON". At this point, insert clear tubing attached to vent valve into a suitable container and bleed air from gauge and hose to insure accurate gauge operation. Repeat this step until all air is bled from gauge.

### STEP 2

Turn ignition "OFF" for 10 seconds and then "ON" again to get fuel pressure to its maximum. Record this initial pressure reading. Energize tester one time and note pressure drop at its lowest point (Disregard any slight pressure increase after drop hits low point.). By subtracting this second pressure reading from the initial pressure, we have the actual amount of injector pressure drop.

### STEP 3

Repeat step 2 on each injector and compare the amount of drop. Usually, good injectors will have virtually the same drop. Retest any injector that has a pressure difference of 10kPa, either more or less than the average of the other injectors on the engine. Replace any injector that also fails the retest. If the pressure drop of all injectors is within 10kPa of this average, the injectors appear to be flowing properly. Reconnect them and review symptoms, section "B".

**NOTE:** ***The entire test should not be repeated more than once without running the engine to prevent flooding. (This includes any retest on faulty injectors).***

**NOTE:** If injectors are suspected of being dirty, they should be cleaned using an approved tool and procedure prior to performing this test. The fuel pressure test in section "A", CHART A-7, should be completed prior to this test.

# CHART C-2A

## INJECTOR BALANCE TEST 5.0L (VIN F) & 5.7L (VIN 8) "F" SERIES (PORT)

Step 1. If engine is at operating temperature, allow a 10 minute "cool down" period then connect fuel pressure gauge and injector tester.

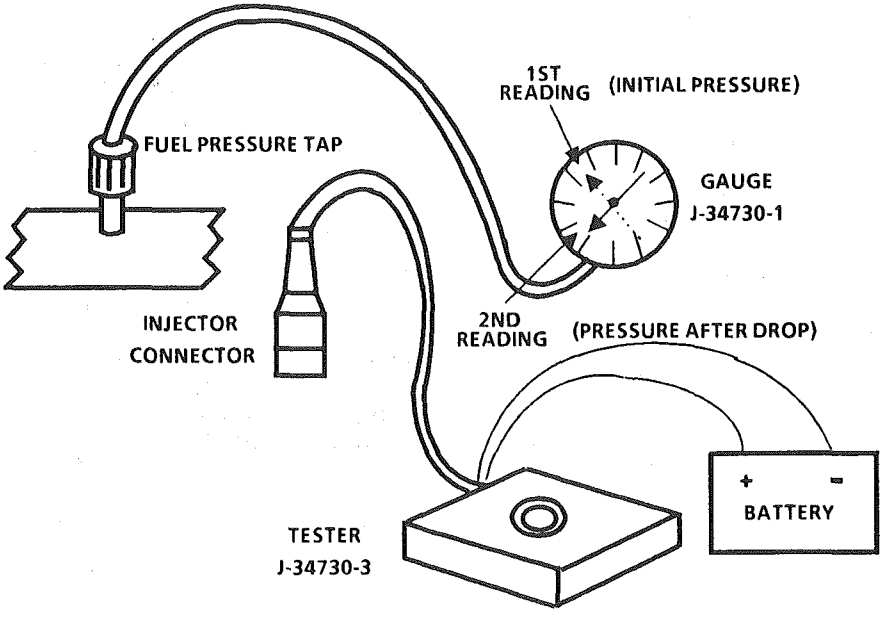
1. Ignition "OFF".
2. Connect fuel pressure gauge and injector tester.
3. Ignition "ON".
4. Bleed off air in gauge. Repeat until all air is bled from gauge.

Step 2. Run test:

1. Ignition "OFF" for 10 seconds.
2. Ignition "ON". Record gauge pressure. (Pressure must hold steady, if not see the fuel system diagnosis, CHART A-7, in section "A").
3. Turn injector "ON", by depressing button on injector tester, and note pressure at the instant the gauge needle stops.

Step 3.

1. Repeat step 2 on all injectors and record pressure drop on each. Retest injectors that appear faulty (any injectors that have a 10 kPa difference, either more or less, in pressure from the average). If no problem is found, review symptoms, section "B".




— EXAMPLE —

| CYLINDER | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1ST READING | 225 | 225 | 225 | 225 | 225 | 225 |
| 2ND READING | 100 | 100 | 100 | 90 | 100 | 115 |
| AMOUNT OF DROP | 125 | 125 | 125 | 135 | 125 | 110 |
| | OK | OK | OK | FAULTY, RICH (TOO MUCH) (FUEL DROP) | OK | FAULTY, LEAN (TOO LITTLE) (FUEL DROP) |

# SECTION 6E
# DRIVEABILITY AND EMISSIONS
# CONTENTS

## General Information - Section 6E
## Driveability and Emissions - Fuel Injected (TBI) - Section 6E2
## Driveability and Emissions - Fuel Injected (PORT) - Section 6E3

## 6E CONTENTS



## DRIVEABILITY

The driveability diagnosis procedures apply to various systems in current GM vehicles. The procedures assume that the vehicle worked right at one time and the problem is due to time, wear, dirt or other causes. Start with the introduction that follows. This will describe a systematic diagnostic procedure.

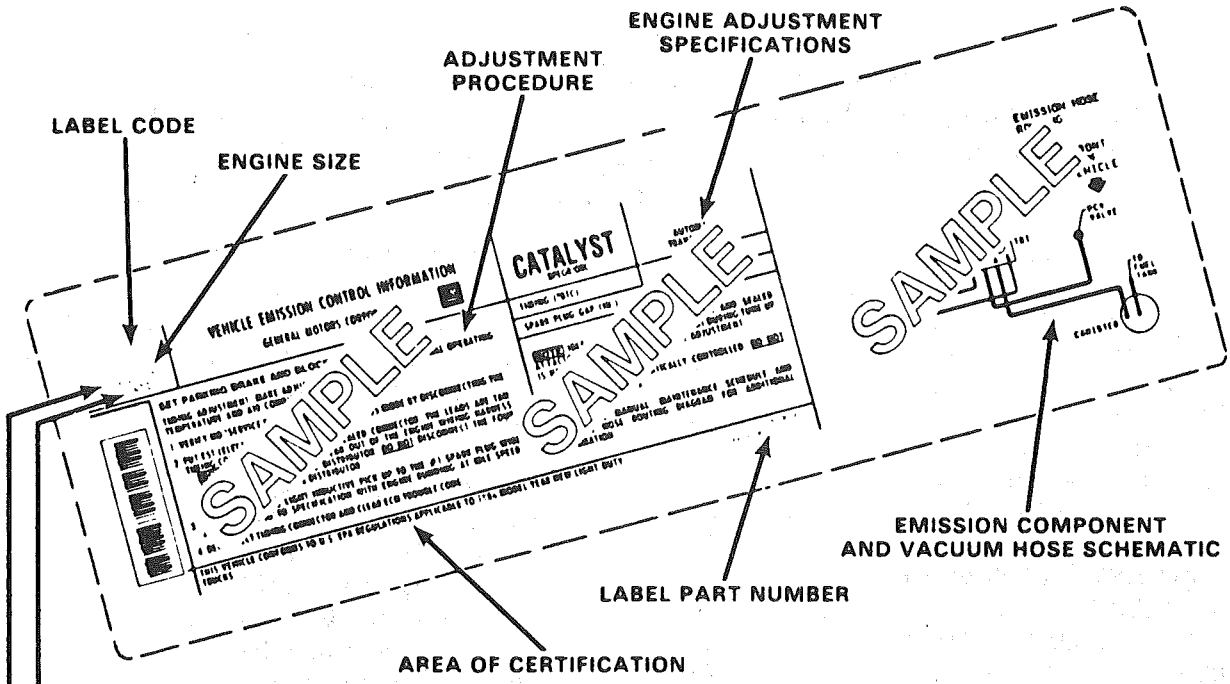
Any system disconnected during diagnosis should be reconnected. This includes wires, hoses, linkage, etc. When removing air cleaner, plug hose fittings that could cause an air leak.

## EMISSIONS

The exhaust emission control systems used on General Motors engines perform a specific function to lower exhaust emissions while maintaining good fuel economy and driveability.

## MAINTENANCE SCHEDULE

Refer to the General Motors Maintenance Schedule in Section "0B" of the Chassis Service Manual for the maintenance service that should be performed to retain emission control performance.




"ALWAYS REFER TO THE VEHICLE EMISSION CONTROL INFORMATION LABEL FOR THE CORRECT AND MOST CURRENT SPECIFICATIONS".

EVAPORATIVE EMISSION SYSTEM

EXHAUST EMISSION SYSTEM

H 1G 4.3 T 5 TM G 9

CERT YEAR
H = 1987

DIVISION
1G = Chevrolet
2G = Pontiac
3G = Oldsmobile
4G = Buick
6G = Cadillac

DISPLACEMENT
Liters - Largest if more than one

VEHICLE CLASS AND STANDARDS
V = Gasoline Vehicle
W = Calif. Std Gasoline Vehicle
T = Gasoline Truck
D = Diesel Vehicle
E = 100K Calif. Std. Diesel Vehicle
K = Diesel Truck

FUEL METERING
1 = 1bbl
2 = 2bbl
4 = 4bbl
5 = TBI
7 = MFI
8 = PFI
9 = PFI Turbo

CATALYST DESCRIPTION

Engine Family Suffix Code (Describes Emission System)

CHECK SUM DIGIT

753395-6E

Figure 1 - Vehicle Emission Control Information Label

## VEHICLE EMISSION CONTROL INFORMATION LABEL

The Vehicle Emission Control Information label (Figure 1) contains important emission specifications and setting procedures. In the upper left corner is exhaust emission information which identifies the year, the manufacturing division of the engine, the displacement in liters of the engine, the class of vehicle and type of fuel metering. Also there is an illustrated emission component and vacuum hose schematic. A similar label is located in the engine compartment of every General Motors Corporation vehicle. If the label has been removed, it can be ordered from the parts division. (WDDGM)

## INTRODUCTION

### Electronic Engine Control

Each engine has an electronic engine control module (ECM) to control the fuel system. The ECM varies the air/fuel ratio by controlling the fuel flow through the injector(s).

In addition, the ECM controls the ignition timing as well as the fuel pump and other systems.

It is important to review the component sections and wiring diagrams in Section "6E2" and "6E3" for a specific engine, to determine what is controlled by the ECM and what systems are non-ECM controlled.

### What This Section Contains

Each General Motors engine has system controls to reduce exhaust emissions while maintaining good driveability and fuel economy. This section explains:

- How to use the Driveability and Emission Sections "6E2" for TBI, and "6E3" for Port Fuel engines.
- A brief description of systems used to control fuel and emissions.
- Abbreviations that are used in "Driveability and Emissions".
- Wiring harness service information for harnesses used with the ECM.
- Special tools used to diagnosis and repair a system.

Before checking the system, observe the following:

### Blocking Drive Wheels

The vehicle drive wheels always should be blocked, and parking brake firmly set, while checking the system.

### Cold Oxygen Sensor

On some engines, the oxygen sensor will cool off after only a short period of operation at idle. This will put the system into "Open Loop". To restore "Closed Loop" operation, run the engine at part throttle and accelerate from idle to part throttle a few times until the system goes "Closed Loop".

## VISUAL/PHYSICAL UNDERHOOD INSPECTION

<u>One of the most important checks that must be done as part of any diagnostic procedures or finding the cause of, an emissions test failure is a careful visual/physical underhood inspection</u>. This can often lead to fixing a problem without further steps. Inspect all vacuum hoses for correct routing, pinches, cuts, or disconnects. Be sure to inspect hoses that are difficult to see beneath the air cleaner, compressor, generator, etc. Inspect all the wires in the engine compartment for correct and good connections, burned or chafed spots, pinched wires, or contact with sharp edges or hot exhaust manifolds. This visual/physical inspection is very important. It must be done carefully and thoroughly.

## BASIC KNOWLEDGE REQUIRED

Before using this section of the service manual, there are some areas that you should be familiar with. Without this basic knowledge, you will have trouble using the diagnostic procedures contained in this section.

### Basic Electric Circuits

You should understand the basic theory of electricity, and know the meaning of voltage, amps,

**ALL NEW GENERAL MOTORS VEHICLES ARE CERTIFIED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AS CONFORMING TO THE REQUIREMENTS OF THE REGULATIONS FOR THE CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES. THIS CERTIFICATION IS CONTINGENT ON CERTAIN ADJUSTMENTS BEING SET TO FACTORY STANDARDS. IN MOST CASES, THESE ADJUSTMENT POINTS EITHER HAVE BEEN PERMANENTLY SEALED AND/OR MADE INACCESSIBLE TO PREVENT INDISCRIMINATE OR ROUTINE ADJUSTMENT IN THE FIELD. FOR THIS REASON, THE FACTORY PROCEDURE FOR TEMPORARILY REMOVING PLUGS, CAPS, ETC., FOR PURPOSES OF SERVICING THE PRODUCT, MUST BE STRICTLY FOLLOWED AND, WHEREVER PRACTICABLE, RETURNED TO THE ORIGINAL INTENT OF THE DESIGN.**

and ohms. You should understand what happens in a circuit with an open or a shorted wire. You should be able to read and understand a wiring diagram. A short to ground is referred to as a ground to distinguish it from a short between wires.

### Use of Circuit Testing Tools

You should know how to use a test light, how to connect and use a tachometer, and how to use jumper wires to by-pass components to test circuits. Care should be taken to not deform the terminal when testing.

### Use of Digital Volt-Ohm Meter (DVM)

You should be familiar with the digital volt-ohm Meter, particularly essential tool J-29125-A, J34029A or equivalent. You should be able to measure voltage, resistance, and current, and know how to use the meter correctly.

The digital volt-ohm meter is covered in the "Special Tools"portion of this section.

## DIAGNOSTIC INFORMATION

The electronic control module (ECM) is equipped with a self-diagnosis system which detects system failure and aids the technician by identifying the circuit at fault via a trouble code. Below is information about the way the ECM displays a problem and how this corresponds to a trouble code in the ECM. The ECM can also indicate an "Open Loop" or "Closed Loop" mode.

### "Service Engine Soon" Light

This light is on the instrument panel, and has two functions:

- It is used to tell the driver that a problem has occurred, and that the vehicle should be taken for service as soon as reasonably possible.
- It is used by the technician to read out "Trouble Codes" to help diagnose system problems.

As a bulb and system check, the light will come "ON" with the key "ON" and the engine not running. When the engine is started, the light will turn "OFF". If the light remains "ON", the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after 10 seconds, but a Trouble Code will remain stored in the ECM.

### Intermittent "Service Engine Soon" Light

The diagnostic charts in Section "A" are set up to check whether or not a stored trouble code is "intermittent" or "hard".

An "intermittent" code is one which does not always reset when the code setting parameters are met, or is not present while you are working on the vehicle. This is often caused by a loose connection. The facing page will contain diagnostic aids to help in detecting intermittents.

A "hard" code is one which is present when you are working on the vehicle and the condition still exists while working on the vehicle. The chart with the stored trouble code number will lead you to the cause of the problem.

### Trouble Codes

The engine control module (ECM) is really a computer. It uses sensors to look at many engine operating conditions. It has a memory and it knows what certain sensor readings should be under certain conditions. These conditions are described on the facing page of each Trouble Code chart. If a sensor reading is not what the ECM thinks it should be, the ECM will turn "ON" the "Service Engine Soon" light on the instrument panel, and will store a Trouble Code in the memory. The Trouble Code tells which circuit the trouble is in. A circuit consists of a sensor (such as coolant temperature), the wiring and connectors to it, and the ECM.

To get a Trouble Code out of the ECM, we use the assembly line diagnostic link (ALDL) connector.

### ALDL Connector

The assembly line diagnostic link (ALDL) is a diagnostic connector located in the passenger compartment (Figure 2). It has terminals which are used in the assembly plant to check that the engine is operating properly before it leaves the plant.

*Terminal "B" is the Diagnostic terminal, and it can be connected to terminal "A", or ground, to enter the Diagnostic mode, or the Field Service Mode.*

The ALDL connector is also used by "Scan" tools to read information from the ECM via the Serial Data Line. Serial Data information is used extensively throughout the manual.

### Diagnostic Mode

If the Diagnostic terminal is grounded with the ignition "ON" and the engine stopped, the system will enter the Diagnostic Mode. In this mode the ECM will:

1. Display a Code 12 by flashing the "Service Engine Soon" light (indicating the system is operating). A Code 12 consists of one flash, followed by a short pause, then two flashes in quick succession. This code will be flashed three times. If no other codes

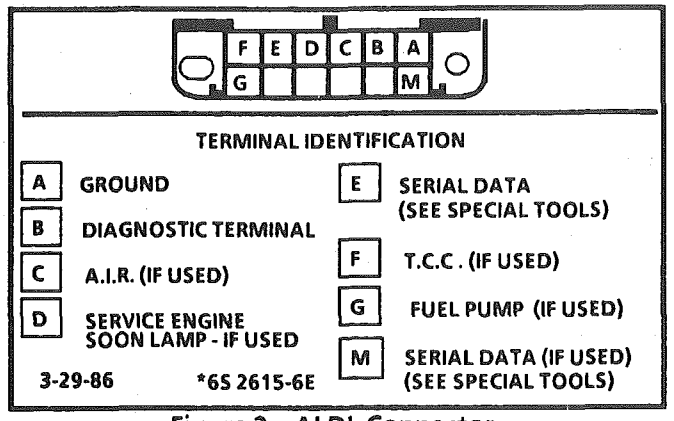


Figure 2 - ALDL Connector

are stored, Code 12 will continue to flash until the Diagnostic terminal is ungrounded.

Codes can only be obtained with the engine stopped. Grounding the Diagnostic terminal with the engine running gives the "field service mode".

2. Display any stored trouble codes by flashing the "Service Engine Soon" light. Each code will be flashed three times, then Code 12 will be flashed again.

   If a trouble code is displayed, the memory is cleared, then the engine is run to see if the code is a "hard" or "intermittent" failure. If it is a "hard" failure, a Diagnostic Code chart is used to find the problem. If it is an intermittent failure, the charts are not used. Diagnostic aids are usually included on the facing page. Section "B" also covers the topic of "Intermittents". A physical inspection of the applicable system most often will resolve the problem.
3. Energize all ECM controlled relays and solenoids except fuel pump relay .
4. The IAC valve on most models also moves to the fully extended position.

## Field Service Mode

If the Diagnostic terminal is grounded with the engine running, the system will enter the Field Service mode. In this mode, the "Service Engine Soon" light will show whether the system is in "Open" or "Closed Loop".

In "Open Loop" the "Service Engine Soon" light flashes two and one-half times per second.

In "Closed Loop", the light flashes once per second: Also, in "Closed Loop", the light will stay OUT most of the time if the system is too lean. It will stay "ON" most of the time if the system is too rich.

While the system is in Field Service Mode, the ECM will be in the following mode:

1. New trouble codes cannot be stored in the ECM.
2. The "Closed Loop" timer is bypassed.

## Clearing Trouble Codes

When the ECM sets a trouble code, the "Service Engine Soon" light will come "ON" and a trouble code will be stored in memory. If the problem is intermittent, the light will go out 10 seconds after the fault goes away. However, the trouble code will stay in the ECM memory until the battery voltage to the ECM is removed. Removing battery voltage for 30 seconds will clear all stored trouble codes.

Trouble Codes should be cleared after repairs have been completed. Also, some diagnostic charts will tell you to clear the codes before using the chart. This allows the ECM to set the code while going thru the chart, which will help to find the cause of the problem more quickly.

**NOTICE: To prevent ECM damage, the key must be "OFF" when disconnecting or reconnecting power to ECM (for example battery cable, ECM pigtail, ECM fuse, jumper cables, etc.).**

## ECM Learning Ability

The ECM has a "learning" ability which allows it to make corrections for minor variations in the fuel system to improve driveability. If the battery is disconnected to clear diagnostic codes, or for repair, the "learning" process has to begin all over again. A change may be noted in the vehicle's performance. To "teach" the vehicle, make sure the engine is at operating temperature, and drive at part throttle, with moderate acceleration and idle conditions, until normal performance returns.

## DRIVEABILITY AND EMISSIONS

## SECTIONS 6E2 and 6E3 SUMMARY

The Driveability and Emissions sections are subdivided into three sub-sections:

**SECTION A: STARTING POINT AND CODE CHARTS**
- Diagnostic circuit check (Starting Point)
- No-start and fuel system check charts
- Code Charts

**SECTION B: SYMPTOMS**
- Based on driveability symptoms, when no codes, or intermittent codes, are stored.

**SECTION C: COMPONENT SYSTEMS**
- Circuit descriptions
- On-car service
- Functional check/Diagnosis charts

## SECTION A

### Diagnostic Procedure Summary

This is the starting point for the diagnostic procedures or an emissions test failure. The diagnostic charts are related to the ECM and will determine if the ECM is working properly. This section diagnoses the fuel system controlled by the ECM and has charts to diagnose a circuit when the ECM has displayed a trouble code.

The way to approach a problem is to follow three basic steps (shown in Figure 3):

1. Are the On-Vehicle Diagnostics working? We find this out by performing the "Diagnostic Circuit Check". Since this is the starting point for the diagnostic procedures or finding the cause of an emissions test failure, always begin here. If the On-Vehicle Diagnostics aren't working, the "Diagnostic Circuit Check" will lead you to a chart in Section "A" to correct the problem. If the On-Vehicle Diagnostics are OK, the next step is:
2. Is there a Trouble Code stored? If a trouble code is stored, go directly to the numbered code chart in Section "A". This will determine if the fault is still present. If no trouble code is stored, then:
3. "Scan" Serial Data. This involves reading the various pieces of information available on the Serial Data Stream with one of the tools available for that purpose. Information on these tools and the meaning of the various displays can be found in the succeeding paragraphs. Expected readings can be found on the facing page for the Diagnostic Circuit Check.

This short procedure will help lead you to repair the problem in the least amount of time.

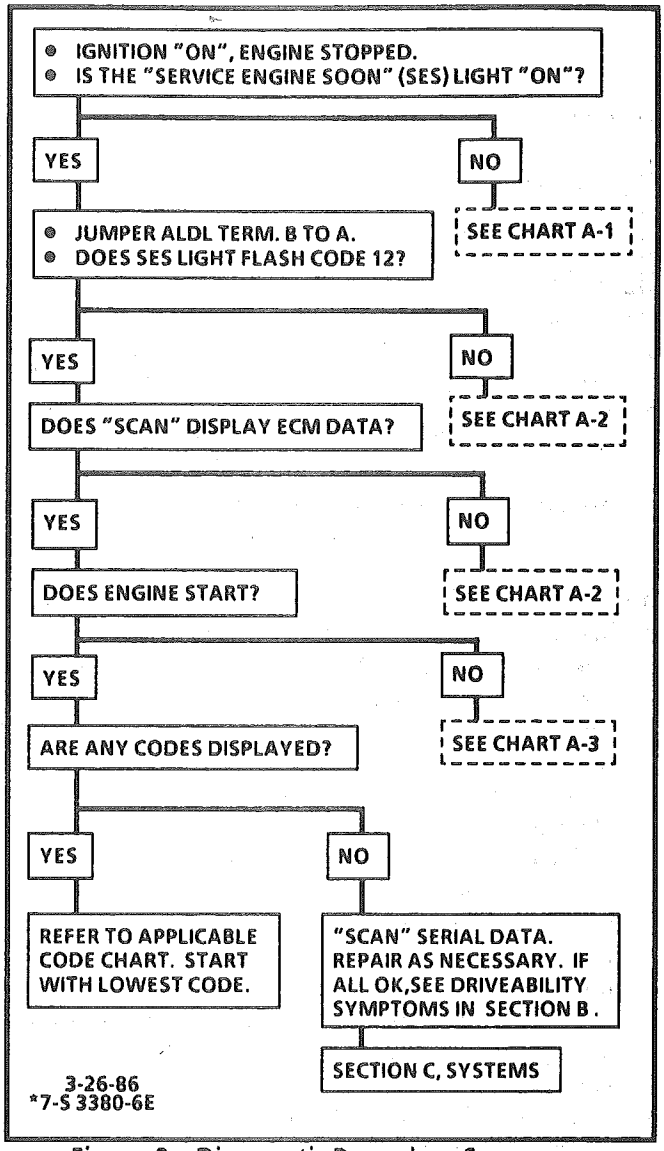



Figure 3 - Diagnostic Procedure Summary

## ALDL "SCAN" TOOLS

The ALDL connector under the dash has a variety of information available on terminal "E" or "M" (depending on engine). There are several tools on the market for reading this information.

"Scan" tools do not make the use of diagnostic charts unnecessary. They do not tell exactly where a problem is in a given circuit. However, with an understanding of what each position on the equipment measures, and knowledge of the circuit involved, the tools can be very useful in getting information which would be more time consuming to get with other equipment.

In some cases, "Scan" tools will provide information that is either extremely difficult or impossible to get with other equipment.

**A "SCAN" TOOL THAT DISPLAYS FAULTY DATA SHOULD NOT BE USED AND THE PROBLEM SHOULD BE REPORTED TO THE MANUFACTURER. THE USE OF A FAULTY "SCAN" TOOL CAN RESULT IN MISDIAGNOSIS AND UNNECESSARY PARTS REPLACEMENT.**

Trouble Tree Charts incorporate diagnosis procedures using an ALDL "Scan" tool where possible. Most charts require use of a "Scan" tool when it is applicable. Unless instructed otherwise, code charts in "6E" Section "A" should not be used for diagnosis unless the fault is still present (a "hard" failure).

Some ECM's have three modes for transmitting information but some only read data in the open mode.

The following information will describe each of the three modes where applicable and the effects they may cause.

### Normal (Open) Mode

Not all engines and ECM families will transmit information on the Serial Data Line while in this mode.

On engines that can be monitored in the open mode, it allows certain parameters to be obtained without changing the engine operating characteristics. The parameters capable of being read vary from engine family to engine family. Most "Scan" tools are programmed so that the system will go directly into the special mode if the "open" mode is not available.

### ALDL (10K, or Special) Mode (not used on all engines)

In this mode, all information incorporated into a specific engine and ECM is obtainable. However, in this mode the system operating characteristics are modified as follows.

- "Closed Loop" timers are bypassed
- EST (spark) is advanced
- IAC will control engine idle to 1000 rpm ± 50 rpm (if applicable)
- On some engines, canister purge solenoid will be enabled
- P/N restrict functions will be disabled.

### Factory Test (Back-up or 3.9 K) Mode (TBI, Port)

In this mode, the ECM is operating on the fuel back-up logic and is calibrated by the Calpak or Memcal. These are used to control the fuel delivery if the ECM fails. This mode verifies that the back-up feature is OK. The parameters that can be read on a "Scan" tool in this mode are not of much use for service.

## "SCAN" TOOL LIMITATIONS AND USE

The "Scan" tool allows a quick check of sensors and switches which are inputs to the ECM. However, on some applications the data update rate makes the tool less effective as a voltmeter when trying to detect an intermittent which lasts for a very short time. However, the "Scan" tool allows one to manipulate wiring harnesses or components under the hood while observing the "Scan" readout. This helps in locating intermittents with the engine not running.

### Intermittent Conditions

The "Scan" tool is helpful in cases of intermittent operation. The tool can be plugged in and observed while driving the vehicle under the condition where the light comes "ON" momentarily, or the engine driveability is poor momentarily. If the problem seems to be related to certain areas that can be checked on the "Scan" tool, then those are the positions that should be checked while driving the vehicle. If there does not seem to be any correlation between the problem and any specific circuit, the "Scan" tool can be checked on each position, watching for a period of time to see if there is any change in the readings that indicates intermittent operation.

The "Scan" tool is also a useful and quick way of comparing operating parameters of a poorly operating engine with a known good one. For example; A sensor may shift in value but not set a code. Comparing with a known good vehicle may uncover the problem.

The "Scan" tool has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the "Scan" tool successfully for diagnosis lies in the technician's ability to understand the system he is trying to diagnose as well as an understanding of the "Scan" tool's limitations. Therefore, the technician should read the tool manufacturer's operating manual to become familiar with the operation. The following information will describe most of the "Scan" tool positions and how they can be helpful in diagnosis.

## "SCAN" TOOL POSITIONS

The following positions may not be applicable to all engines. See the facing page of the diagnostic circuit check for a particular engine to decide which positions apply to that engine.

### Mode

Check with the manufacturer to determine what the function of this mode is. In most cases it allows the user to place the ECM in different operating modes.

### Injector Pulse Width

In this position, the reading is given in milliseconds, which is the "ON" time that the ECM is commanding to the injector(s).

### Closed Loop/Open Loop

This position will indicate whether the engine control system is operating in "Open Loop" or "Closed Loop". Most systems go "Closed Loop" after a certain amount of running time, when coolant temperature is high enough, and the oxygen sensor becomes active.

### Exhaust (Rich/Lean Indicator)

This indicates the $O_2$ sensor voltage at the instant that the data stream is sampled. If voltage is less than 350 mv, the value will be lean. If above 550 mv, a rich exhaust is indicated.

### Trouble Codes

This will display any trouble codes stored in the ECM memory.

### Throttle Position Sensor (TPS)

Values read will be the voltage as seen by the ECM. The voltage should be the TPS specification with the throttle closed and go up to about 5 volts with throttle wide open (WOT).

### Throttle Angle

Displayed, in percent, is the amount the throttle is open. 0% is closed throttle, 100% is wide open throttle.

### Oxygen ($O_2$) Sensor

The reading will be read out in millivolts (mv) with a range from 1 to 999 mv. If the reading is consistently below 350 (350 mv), the fuel system is running lean as seen by the ECM; and if the reading is consistently above 550 (550 mv), the system is running rich.

### PROM ID

In this position, information is used for assembly verification only. PROM ID is useful only when the vehicle is equipped with the original ECM and PROM or Mem-Cal.

### RPM

Reading displays engine rpm. It is often useful if extra reference pulses are suspected. A sudden high rpm indication while at a steady throttle would indicate electrical interference (EMI) in the reference circuit. This interference is usually caused by ECM wires too close to ignition secondary wires or an open distributor ground circuit.

### MPH

Displayed is vehicle speed, useful in checking TCC application speed or speedometer accuracy.

### MAF

This displays the amount of air passing the Mass Air Flow (MAF) sensor, in grams per second. It is useful when comparing the airflow between a problem vehicle and a known good one. Normal readings at idle are about 4 to 8 grams. If a MAF code is set, this reading will display the ECM default value.

### Airflow

This display should be the same as MAF when there are no failures in the MAF sensor circuit. When an MAF code is set, however, this value will not change, and will indicate the gm/sec that the failure has detected.

### Coolant Temperature

Engine temperature is displayed in Celsius degrees. After the engine is started, temperature should rise steadily to about 85-95° C, then stabilize when the thermostat opens.

### Manifold Air Temperature (MAT) Sensor

This displays temperature of the intake manifold air. It should read close to ambient air temperature when the engine is cold, and rise as underhood and engine temperatures increase.

### Manifold Absolute Pressure (MAP)

The MAP sensor produces a low signal voltage when manifold pressure is low (high vacuum) and a high voltage when the pressure is high (low vacuum).

With the ignition "ON" and the engine stopped, the manifold pressure is equal to atmospheric pressure, and the signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same sensor is a good way to check accuracy of a "suspect" sensor *. Readings should be the same ±.4 volt.

* A MAP sensor has a colored plastic insert visible in the connector cavity. Sensors with the same insert color are identical in calibration. The harness electrical connector color also should be the same as the sensor insert color.

### Vacuum (Differential Pressure) Sensor

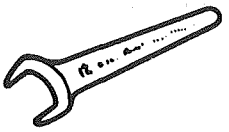
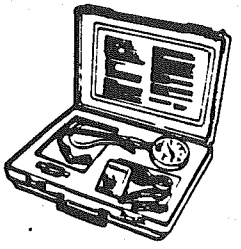
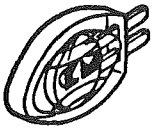
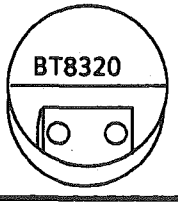
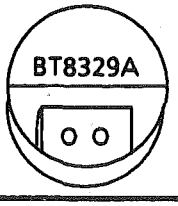
The vacuum sensor produces a low signal voltage when manifold vacuum is low, and a high voltage when the vacuum is high .

With the ignition "ON" and the engine stopped, there is no vacuum, so the voltage is low (under 1 volt). With the engine idling the vacuum is high so the voltage is high (over 3 volts).

A vacuum sensor has a colored plastic insert visible in the connector cavity. Sensors with the same insert color are identical in calibration. The harness electrical connector color also should be the same as the sensor insert color.

### Baro

This displays barometric pressure. The ECM uses this information to adjust for altitude and pressure. This value will vary depending on barometric pressure and altitude. Some vehicles use a dedicated baro sensor, while others take a MAP reading before the engine is started, and at various times during engine operation.

| | |
|---|---|
|  J29533A/BT8127 | **OXYGEN SENSOR WRENCH**<br>Used to remove or install the oxygen sensor. |
|  J33031/BT8130 | **IDLE AIR CONTROL WRENCH**<br>Used to remove or install IAC valve on throttle body. |
|  J34730-A | **PORT FUEL INJECTION DIAGNOSTIC KIT**<br>Used to diagnose port fuel injection systems.<br>The kit includes:<br>• Fuel Pressure Gage - to check fuel pump pressure and compare injector pressure drop for equal fuel distribution.<br>• Injector Test Light - to check electrical circuit to an injector.<br>• Injector Tester - to energize each fuel injector for a precise amount of time to perform injector balance test in CHART C-2A by checking each injector's pressure drop using pressure gage. |
|  J34730-1 | **FUEL PRESSURE GAGE**<br>Used to check and monitor fuel line pressure of port fuel system.<br>Part of Diagnostic Kit J34730-A |
|  J34730-2 | **INJECTOR TEST LIGHT**<br>Used to check electrical circuit to a port fuel injector<br>Part of Diagnostic Kit J34730-A |
|   BT8320 | **INJECTOR TEST LIGHT**<br>Used to check electrical circuit to a TBI fuel injector (except TBI 700) |
|   BT8329A | **INJECTOR TEST LIGHT**<br>Used to check electrical circuit to a TBI 700 fuel injector and a port fuel injector. 5-2-86<br>7S 3396-6E |

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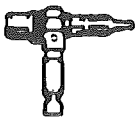
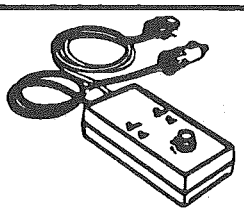
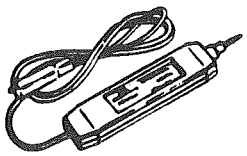
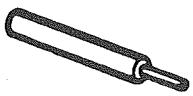
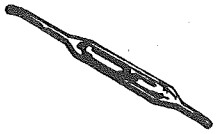
|  J26792/BT7220-1 | **SPARK TESTER**<br>Use to check available secondary ignition voltage . Also called an ST125. |
|  J36101 | **MASS AIR FLOW (MAF) SENSOR TESTER**<br>Used for static test of MAF Sensor on vehicles equipped with an A/C type MAF Sensor. |
|  J36179 | **CRANKSHAFT SENSOR ALIGNMENT TOOL (C3I SYSTEMS)**<br>Used to properly align crank or combination sensor to harmonic balancer interrupter. |
|  J35616 | **CONNECTOR TEST ADAPTER KIT**<br>Used to make electrical test connections in current Weather Pack, Metri - Pack and Micro-Pack style terminals. |
|  J34636 | **CIRCUIT TESTER**<br>Used to check all relays and solenoids before connecting them to a new ECM. Measures the circuit resistance and indicates pass or fail via green or red LED. Amber LED indicates current polarity. Can also be used as a non-powered continuity checker. |
|  J28687-A/BT8220 | **OIL PRESSURE TRANSDUCER WRENCH**<br>Used to remove or install oil pressure transducer on engine. |
|  J35689 | **METRI-PACK TERMINAL REMOVER**<br>Used to remove 150 series Metri-Pack "pull-to-seat " terminals from connectors. Refer to wiring harness service in Section 6E for removal procedure. |
|  J28742/BT8234-A | **WEATHER PACK TERMINAL REMOVER**<br>Used to remove Terminals from Weather Pack connectors. Refer to wiring harness service in Section 6E for removal procedure. |
|  J33095/BT8234-A | **ECM CONNECTOR TERMINAL REMOVER**<br>Used to remove terminal from Micro-Pack connectors. Refer to wiring harness service Section 6E for removal procedure.<br>5-2-86<br>7S 3384-6E |

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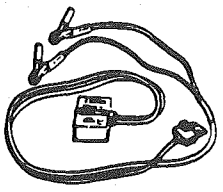
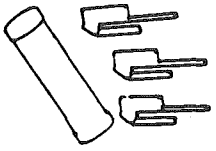
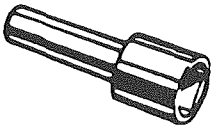
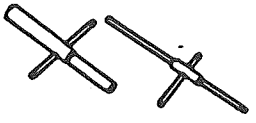
|---|---|
|  J29607/BT8022 | **ISC ADJUSTING WRENCH**<br>Used to adjust ISC on carburetor to obtain maximum specification RPM.. |
|  J34025/BT8256A | **ISC MOTOR TESTER**<br>Used to test operation of ISC Motor on carburetor in either direction, and condition of the internal switch. |
|  J9789-135/BT8104 | **FLOAT LEVEL GAGE SET**<br>Used to check float level on 2SE or E2SE carburetor. |
|  J34935/BT8420A | **FLOAT LEVEL GAGE**<br>Used to check float level or M/C Solenoid travel on E2ME or E4ME carburetor. |
|  J29030-B/BT7610B | **IDLE MIXTURE SOCKET**<br>Used to adjust idle mixture needle on an E2SE carburetor. |
|  J28696-B/BT7928 | **MIXTURE ADJUSTMENT TOOL**<br>Used to adjust lean mixture and rich mixture stop screws on E2SE, E2ME, and E4ME carburetors. |
|  J22646-02 | **CARBURETOR ADJUSTMENT WRENCH**<br>Used to adjust idle mixture on carburetor |
|  J33815-1/BT8253-A | **M/C SOLENOID GAGING TOOL**<br>Used to adjust the Mixture Control Solenoid plunger on E2ME, and E4ME carburetors. |

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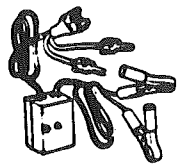
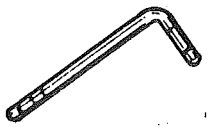
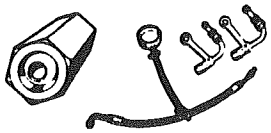
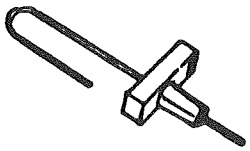
| | |
|---|---|
|  J34730-3 | **INJECTOR TESTER**<br>Used to energize each fuel injector for a precise amount of time to perform injector balance test in CHART C-2A by checking each injector's pressure drop using pressure gage. Part of Diagnostic Kit J34730-A. |
|  J29698-A/BT8251 | **FUEL LINE WRENCH**<br>Used to disconnect or connect fuel lines at Throttle Body Unit by holding fuel nut at throttle body. |
|  J33179-20 | **MINIMUM AIR RATE ADJUSTING WRENCH**<br>Used to adjust throttle stop screw on TBI unit. |
|  J29658/BT8205 | **FUEL PRESSURE GAGE**<br>Used to check and monitor fuel line pressure of port fuel system. |
|  J33815-2/BT8253-A | **AIR BLEED VALVE GAGING TOOL**<br>Used to adjust Idle Air Bleed Valve on E2ME, and E4ME carburetors. |
|  J25322/BT7523 | **PUMP LEVER PIN PUNCH**<br>Used to drive pump lever pin inward to allow removal of the pump lever on E2ME carburetor. |

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# GENERAL SPECIFICATIONS

Many of the specifications used in this section are located on the Vehicle Emission Control Information label under the hood.

Listed on the chart below are locations of specifications used in this Section.

| SPECIFICATION | LOCATION OF INFORMATION |
|---|---|
| Engine Timing | Vehicle Emission Control information label. |
| Idle Speed, ECM Controlled | Not adjustable. ECM controls idle. |
| Spark Plug Type | See Owner's Manual, Section "7". |
| Spark Plug Gap | Vehicle Emission Control Information Label. |
| Engine Code | 8th digit of VIN number. See Section "OA". Also Owner's Manual, Section "7". |
| Engine Family | Vehicle Emission Control Information label. |
| Filter Part Numbers | See Owner's Manual, Section "7". |
| Part Numbers of Major Components | WDD-GM Parts Book. |
| Replacement of Vehicle Emission Control Information Label | WDD-GM Label Catalog. |