FUEL SYSTEM

CONTENTS

GENERAL INFORMATION

Throughout this group, references are made to particular vehicle models by alphabetical designation or by the particular vehicle nameplate. A chart showing a breakdown of the alphabetical designations is included in the Introduction section at the beginning of this manual.

The **Fuel System** consists of: the fuel tank, an electric (fuel tank mounted) fuel pump and fuel filter. It also consists of fuel tubes/lines/hoses, vacuum hoses, throttle body and fuel injectors.

The **Fuel Delivery System** consists of: the electric fuel pump, fuel filter, fuel tubes/lines/hoses, fuel rail, fuel injectors and fuel pressure regulator.

A **Fuel Return System** is used on all vehicles. The system consists of: the fuel tubes/lines/hoses that route fuel back to the fuel tank.

The **Fuel Tank Assembly** consists of: the fuel tank, filler tube, fuel gauge sending unit/electric fuel pump module, a pressure relief/rollover valve and a pressure-vacuum filler cap.

Also to be considered part of the fuel system is the **Evaporation Control System.** This is designed to reduce the emission of fuel vapors into the atmosphere. The description and function of the Evaporative Control System is found in Group 25, Emission Control Systems.

FUEL USAGE STATEMENT

Your vehicle was designed to meet all emission regulations and provide excellent fuel economy using high quality unleaded gasoline. Only use unleaded gasolines having a minimum posted octane of 87.

If your vehicle develops occasional light spark knock (ping) at low engine speeds, this is not harmful. However, **continued heavy knock at high speeds can cause damage and should be reported to your dealer immediately.** Engine damage as a result of heavy knock operation may not be covered by the new vehicle warranty.

In addition to using unleaded gasoline with the proper octane rating, **those that contain detergents, corrosion and stability additives are recommended.** Using gasolines that have these additives will help improve fuel economy, reduce emissions and maintain vehicle performance. Generally, premium unleaded gasolines contain more additive than regular unleaded gasolines.

Poor quality gasoline can cause problems such as hard starting, stalling and stumble. If you experience these problems, use another brand of gasoline before considering service for the vehicle.

GASOLINE/OXYGENATE BLENDS

Some fuel suppliers blend unleaded gasoline with materials that contain oxygen such as alcohol, MTBE and ETBE. The type and amount of oxygenate used in the blend is important. The following are generally used in gasoline blends:

ETHANOL

Ethanol (Ethyl or Grain Alcohol) properly blended, is used as a mixture of 10 percent ethanol and 90 percent gasoline. **Gasoline with ethanol may be used in your vehicle.**

METHANOL

CAUTION: DO NOT USE GASOLINES CONTAINING METHANOL. Use of methanol/gasoline blends may result in starting and driveability problems. In addition, damage may be done to critical fuel system components.

Methanol (Methyl or Wood Alcohol) is used in a variety of concentrations blended with unleaded gasoline. You may encounter fuels containing 3 percent or more methanol along with other alcohols called cosolvents.

Problems that are the result of using methanol/gasoline blends are not the responsibility of Chrysler Corporation. They may not be covered by the vehicle warranty.

MTBE/ETBE

Gasoline and MTBE (Methyl Tertiary Butyl Ether) blends are a mixture of unleaded gasoline and up to 15 percent MTBE. Gasoline and ETBE (Ethyl Tertiary Butyl Ether) are blends of gasoline and up to 17 percent ETBE. Gasoline blended with MTBE or ETBE may be used in your vehicle.

CLEAN AIR GASOLINE

Many gasolines are now being blended that contribute to cleaner air, especially in those areas of the country where air pollution levels are high. These new blends provide a cleaner burning fuel and some are referred to as **Reformulated Gasoline**.

In areas of the country where carbon monoxide levels are high, gasolines are being treated with oxygenated materials such as MTBE, ETBE and ethanol.

Chrysler Corporation supports these efforts toward cleaner air and recommends that you use these gasolines as they become available.

FUEL DELIVERY SYSTEM

INDEX

FUEL PUMP MODULE

The fuel pump module (Fig. 1) is installed in the top of the fuel tank. The fuel pump module contains the following components:

- Electric fuel pump
- Fuel pump reservoir
- In-tank fuel filter
- Fuel gauge sending unit
- Fuel supply and return tube connections

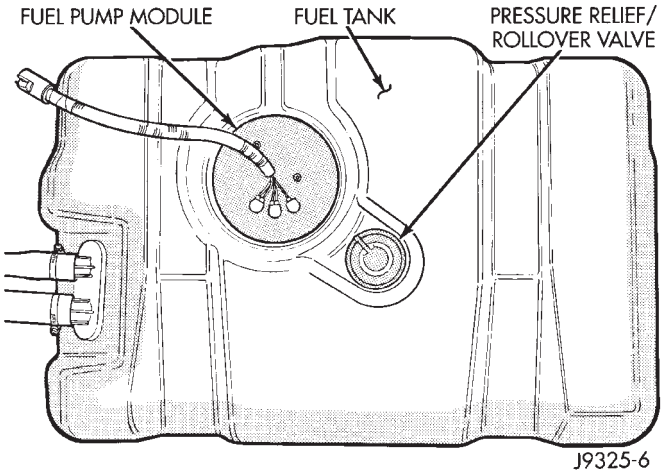

Fig. 1 Fuel Pump Module

The fuel pump used on all vehicles is a gear/rotor type pump. It is driven by a permanent magnet 12 volt electric motor that is immersed in the fuel tank. The electrical pump is integral with the fuel sender unit. The pump/sender assembly is installed inside the fuel tank.

The fuel pump has a check valve at the outlet end that consists of a ball held against a seat by force applied from a spring. When the pump is operating, fuel pressure overcomes spring pressure and forces the ball off its seat, allowing fuel to flow. When the pump is not operating, spring pressure forces the ball back against the seat preventing fuel backflow through the pump.

Fuel system pressure is maintained at approximately 214 kPa (31 psi). This is when the pump is operating and vacuum is supplied to the fuel pressure regulator. If vacuum is not supplied to the pressure regulator, fuel pressure will be approximately 55-69 kPa (8-10 psi) higher. This may be due to a broken or clogged vacuum line. When the fuel pump is not operating, system fuel pressure of 131-269 kPa (19-39 psi) is maintained. This is done by the fuel pump outlet check valve and the vacuum assisted fuel pressure regulator.

REMOVAL

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING THE FUEL PUMP MODULE, THE FUEL SYSTEM PRESSURE MUST BE RELEASED. REFER TO THE FUEL PRESSURE RELEASE PROCEDURE IN THIS GROUP.

(1) Drain and remove the fuel tank. Refer to Fuel Tank removal and installation in the Fuel Tank section of this group.

(2) The fuel pump module locknut is threaded onto the fuel tank. Remove the fuel pump module locknut (Fig. 2). The fuel pump module will spring up from the fuel tank after the locknut has been removed.

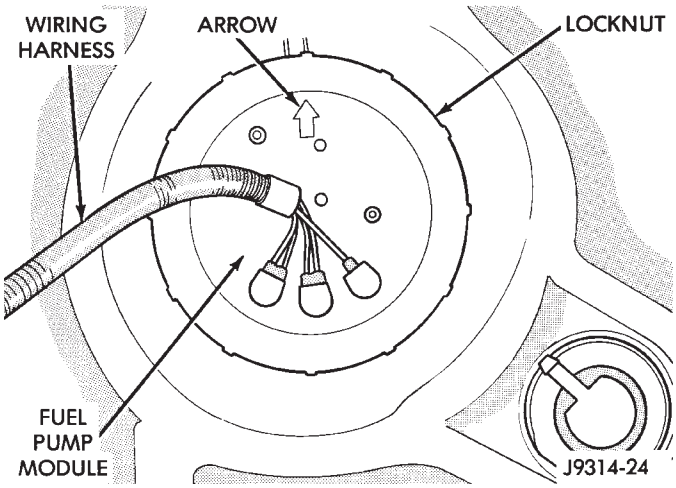

Fig. 2 Top View of Fuel Pump Module

(3) Remove module from fuel tank.

INSTALLATION

CAUTION: Whenever the fuel pump module is serviced, the rubber gasket must be replaced.

(1) Clean the fuel tank at the module opening.

(2) Using a new gasket on the fuel tank (Fig. 3), position fuel pump module into opening in fuel tank.

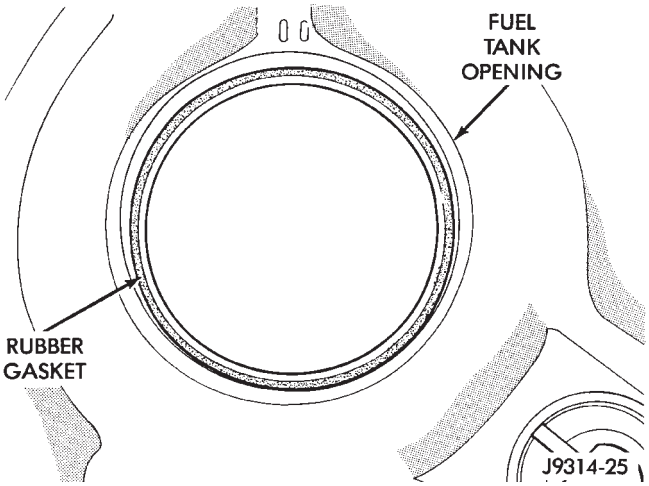

Fig. 3 Rubber Gasket

CAUTION: The arrow on the top of the fuel pump module must be facing in the direction shown in Figure 2.

(3) Tighten locknut.

(4) Install fuel tank. Refer to Fuel Tank Installation in this group.

FUEL PUMP REPLACEMENT

The electric fuel pump is not serviceable. If the fuel pump needs replacement, the complete fuel pump module must be replaced. Refer to the previous procedure.

FUEL GAUGE SENDING UNIT REPLACEMENT

The fuel gauge sending unit is not serviceable. If the unit needs replacement, the complete fuel pump module must be replaced.

FUEL PUMP CONTROL

The Powertrain Control Module (PCM) computer energizes the fuel pump through the Fuel Pump Relay. Battery voltage is applied to the relay from the ignition switch. The coil in the relay is energized when a ground is provided by the PCM. The relay is located in the Power Distribution Center (PDC) next to the battery (Fig. 4). For location of relay within the PDC, refer to label under PDC cover. The ballast resistor and ballast resistor bypass relay (as used with 4.0L engines of previous years), is no longer used to control fuel pump operation.

FUEL PRESSURE RELEASE PROCEDURE

WARNING: THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE (EVEN WITH THE ENGINE OFF) OF APPROXIMATELY 131-269 KPA (19-39 PSI). THIS PRESSURE MUST BE RELEASED BEFORE SERVICING ANY FUEL SUPPLY OR FUEL RETURN SYSTEM COMPONENT.

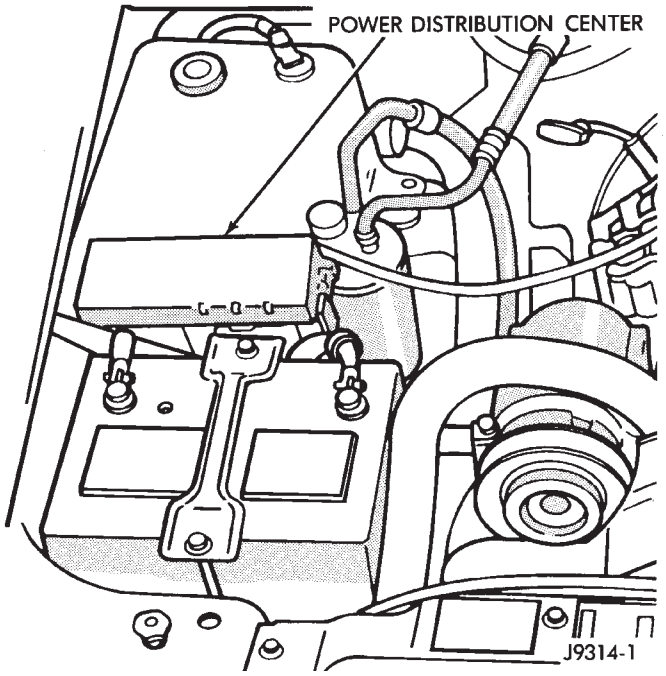

Fig. 4 Power Distribution Center

(1) Disconnect negative battery cable.

(2) Remove fuel tank filler neck cap to release fuel tank pressure.

WARNING: DO NOT ALLOW FUEL TO SPILL ONTO THE ENGINE INTAKE OR EXHAUST MANIFOLDS. PLACE SHOP TOWELS UNDER AND AROUND THE PRESSURE PORT TO ABSORB FUEL WHEN THE PRESSURE IS RELEASED FROM THE FUEL RAIL.

WARNING: WEAR PROPER EYE PROTECTION WHEN RELEASING FUEL SYSTEM PRESSURE.

(3) Remove protective cap from pressure test port on the fuel rail (Figs. 5 or 6).

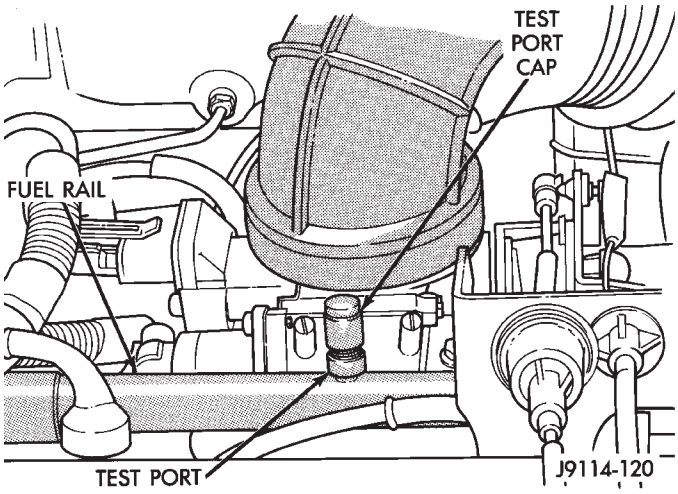

Fig. 5 Pressure Test Port—4.0L Engine

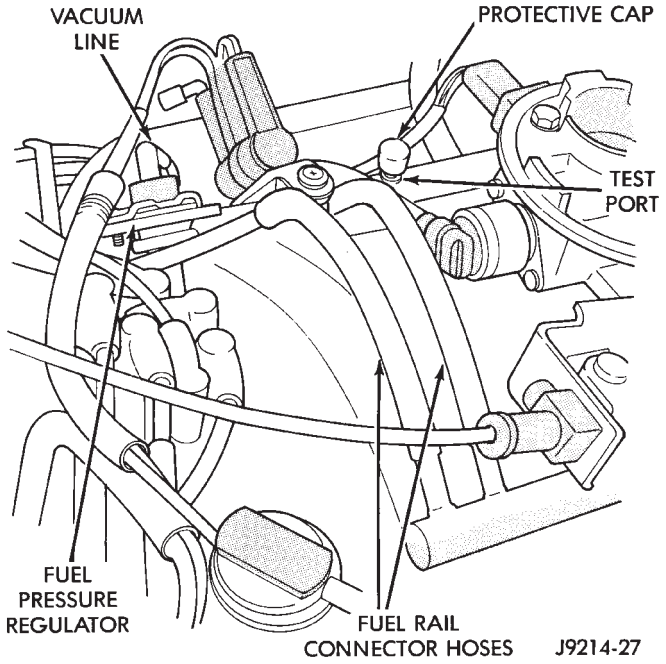

Fig. 6 Pressure Test Port—5.2L Engine

(4) Obtain the fuel pressure gauge/hose assembly from fuel pressure gauge tool set 5069. Remove the gauge from the hose.

(5) Place one end of hose (gauge end) into an approved gasoline container.

(6) Place a shop towel under the test port.

(7) To release fuel pressure, screw the other end of hose onto the fuel pressure test port.

(8) After fuel pressure has been released, remove the hose from the test port.

(9) Install protective cap to fuel test port.

FUEL SYSTEM PRESSURE TEST

The fuel system is equipped with a vacuum assisted fuel pressure regulator (Figs. 7 or 8). With engine at idle speed, system fuel pressure should be approximately 214 kPa (31 psi) with the vacuum line connected to the regulator. With the vacuum line disconnected from the regulator, fuel pressure should be approximately 269 kPa (39 psi). This is 55-69 kPa (8-10 psi) higher.

(1) Remove the protective cap at the fuel rail (Figs. 5 or 6). Connect the 0-414 kPa (0-60 psi) fuel pressure gauge (from Gauge Set 5069) to test port pressure fitting on fuel rail (Figs. 9 or 10).

(2) Note pressure gauge reading. Fuel pressure should be approximately 214 kPa (31 psi) at idle.

(3) Disconnect vacuum line at fuel pressure regulator (Figs. 7 or 8). Note gauge reading. With vacuum line disconnected, fuel pressure should rise to approximately 269 kPa (39 psi).

Fuel pressure should be approximately 55-69 kPa (8-10 psi) higher with vacuum line removed from regulator. If not, inspect pressure regulator vacuum line for leaks, kinks or blockage. If vacuum line

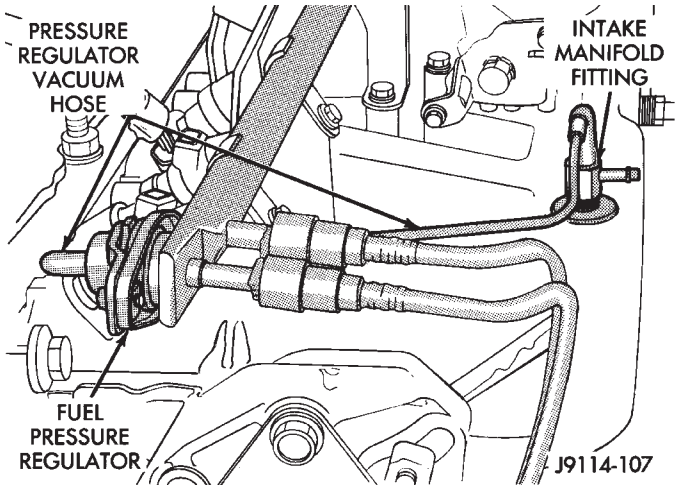

Fig. 7 Fuel Pressure Regulator—4.0L Engine

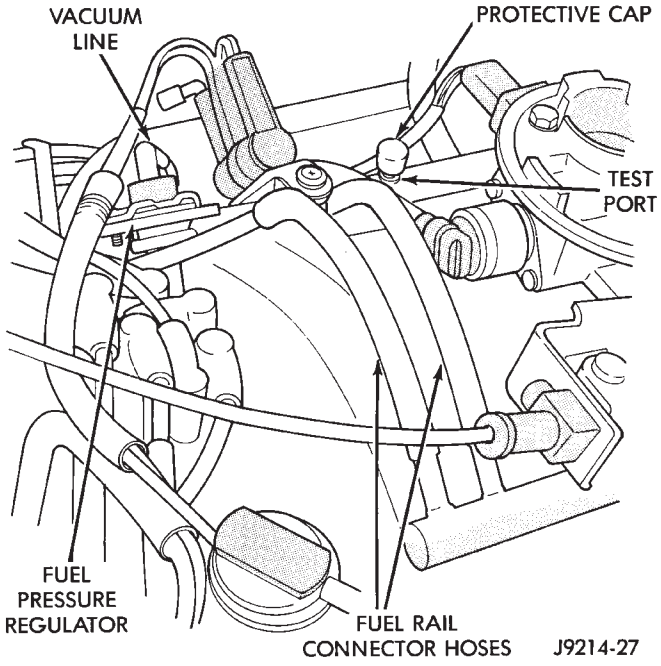

Fig. 8 Fuel Pressure Regulator—5.2L Engine

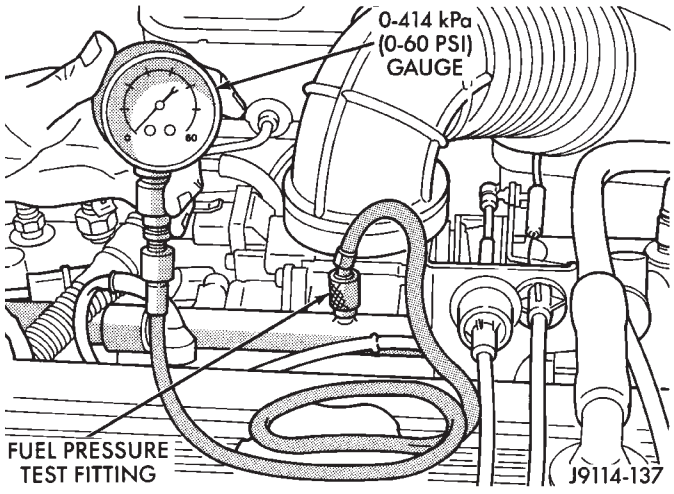

Fig. 9 Fuel Pressure Test Connection—4.0L Engine

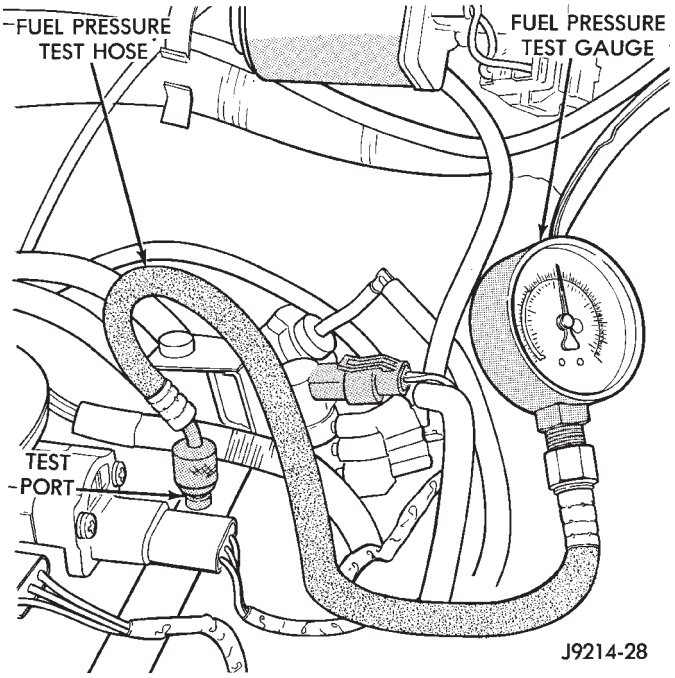

Fig. 10 Fuel Pressure Test Connection—5.2L Engine

checks OK and fuel pressure does not rise approximately 8-10 psi after disconnecting vacuum line, replace fuel pressure regulator.

The fuel pressure regulator is **not adjustable**.

(4) If fuel pressure exceeds 45 psi, check fuel return line for kinks or obstructions.

If the previous tests checked good, fuel pump pressure is correct. If pump pressure was low, proceed as follows:

(5) Release fuel system pressure. Refer to the previous Fuel Pressure Release Procedure in this group.

(6) Disconnect the 5/16 inch fuel return line quick-connect fitting at fuel rail as follows:

(a) 4.0L Engine: To disconnect quick-connect fitting from fuel rail, press on both tabs located on sides of fitting (Fig. 11) and remove fitting at fuel rail.

(b) 5.2L Engine: To disconnect the quick-connect fitting from the fuel rail, push in the spring loaded plastic retainer ring into the fitting (Fig. 12). With the plastic ring depressed, pull the fitting from fuel rail. After disconnection, the plastic retainer ring will remain on the fitting.

Connect Fuel Line Pressure Test Adapter Tool number 6539 (5/16 in.) between the disconnected fuel return line and fuel rail (Fig. 13).

WARNING: THE FUEL SYSTEM PRESSURE IN THE FOLLOWING TEST MAY EXCEED 100 PSI. BEFORE STARTING TEST, VERIFY GOOD CONNECTIONS AT ENDS OF ADAPTER TOOL 6539. BE SURE TOOL IS LOCKED ONTO FUEL RAIL AND FUEL RETURN LINE. PULL FIRMLY ON ENDS OF TOOL TO VERIFY.

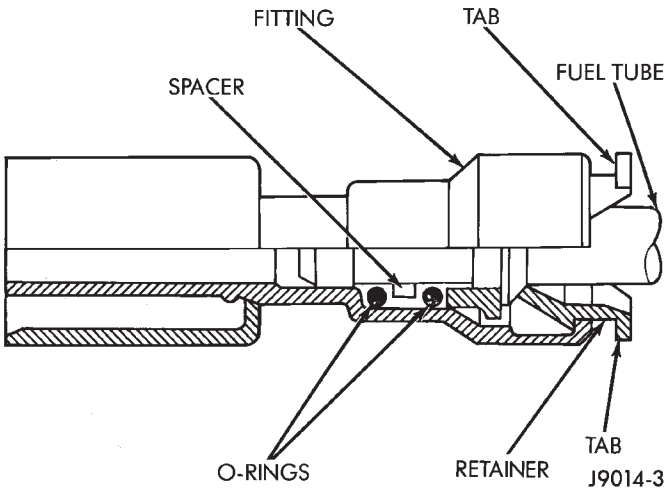

Fig. 11 Removing Quick-Connect Fitting—4.0L Engine

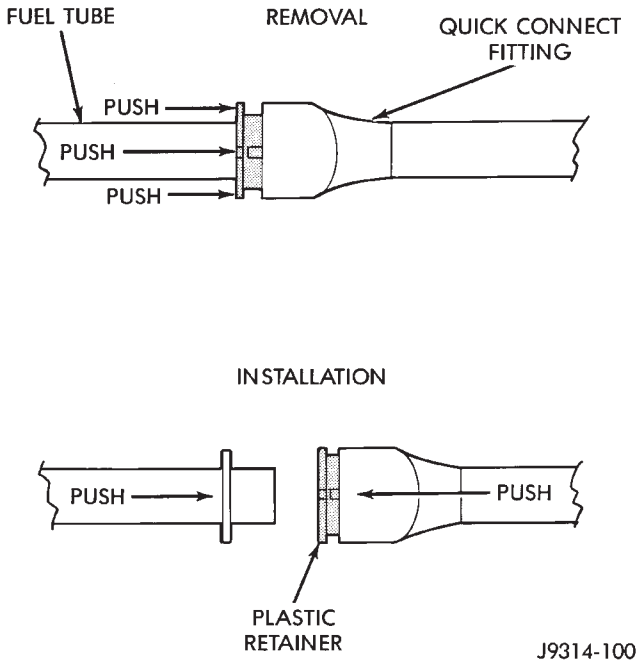

Fig. 12 Removing Quick-Connect Fitting—5.2L Engine

(7) To activate the fuel pump and pressurize the system, obtain the DRB II scan tool. Refer to the appropriate Powertrain Diagnostic Procedures service manual for DRB II operation.

(8) **MOMENTARILY** pinch the rubber hose portion of adapter tool 6539. Pressure should rise to approximately 75 psi within two (2) seconds. **DO NOT** pinch hose for longer than three seconds.

If fuel pump pressure rises to approximately 75 psi within two seconds, pressure is operating at its maximum and is correct.

If fuel pump pressure does not rise to approximately 75 psi within two seconds, proceed as follows:

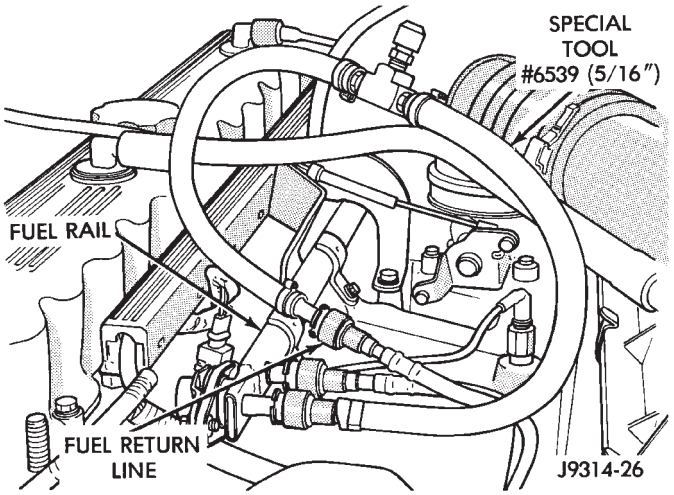

Fig. 13 Adapter Tool—Typical Connection

(9) Release fuel system pressure. Refer to the previous Fuel Pressure Release Procedure in this group.

(10) Raise and support vehicle.

(11) Disconnect fuel supply line at inlet (fuel tank side) of fuel filter. Connect Fuel Line Pressure Test Adapter Tool number 6631 (3/8 in.) between fuel filter and fuel supply line.

WARNING: THE FUEL SYSTEM PRESSURE IN THE FOLLOWING TEST MAY EXCEED 100 PSI. BEFORE STARTING TEST, VERIFY GOOD CONNECTIONS AT ENDS OF ADAPTER TOOL 6631. BE SURE TOOL IS LOCKED ONTO FUEL FILTER AND FUEL SUPPLY LINE. PULL FIRMLY ON ENDS OF TOOL TO VERIFY.

(12) To activate the fuel pump and pressurize the system, obtain the DRB II scan tool. Refer to the appropriate Powertrain Diagnostic Procedures service manual for DRB II operation.

MOMENTARILY pinch the rubber hose portion of adapter tool 6631. Pressure should rise to approximately 75 psi within two (2) seconds. **DO NOT** pinch hose for longer than three seconds.

If fuel pump pressure now rises to approximately 75 psi within two seconds, but this pressure could not be met at the fuel rail, check for a plugged or restricted fuel filter. Also check the fuel supply line between fuel filter and fuel rail for kinks or obstructions. Proceed to the following Fuel Pump Capacity Test.

FUEL PUMP CAPACITY TEST

Before performing this test, verify fuel pump pressure by performing the previous tests.

(1) Release the fuel system pressure from fuel system. Refer to the previous Fuel Pressure Release Procedure in this group.

(2) Disconnect the fuel supply line at fuel rail near pressure regulator.

(3) Connect Fuel Line Pressure Test Adapter Tool number 6631 (3/8 in.) into the disconnected fuel supply line. Insert the other end of tool 6631 into an approved gasoline container.

(4) To activate the fuel pump and pressurize the system, obtain the DRB II scan tool. Refer to the appropriate Powertrain Diagnostic Procedures service manual for DRB II operation.

(5) A good fuel pump will deliver at least 1 liter of fuel per minute.

FUEL PRESSURE LEAK DOWN TEST

ENGINE OFF

Abnormally long periods of cranking to restart a hot engine that has been shut down for a short period of time may be caused by:

- Fuel pressure bleeding past the fuel pressure regulator.
- Fuel pressure bleeding past the check valve in the outlet end of the fuel tank mounted fuel pump.

(1) Remove protective cap at fuel rail test port (Figs. 14 or 15). With the engine off, connect an accurate 0-689 kPa (0-100 psi) fuel gauge to the pressure test port fitting on the fuel rail. The fitting on the pressure tester must be in good condition and free of any leaks before performing this test.

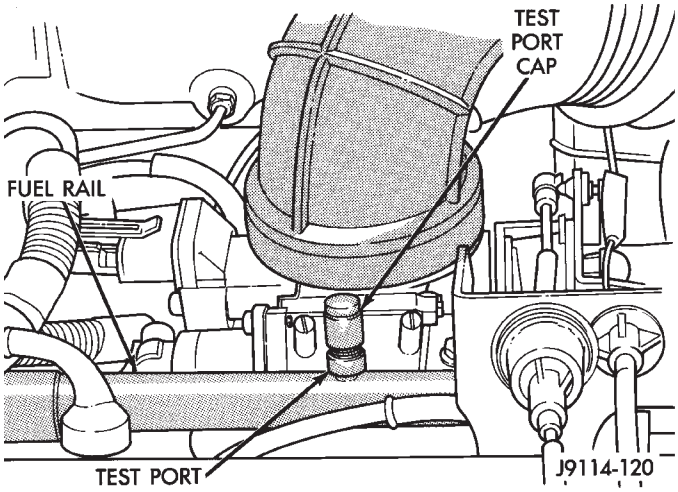

Fig. 14 Fuel Pressure Test Port—4.0L Engine

(2) Start the vehicle and let engine idle. Check fuel pressure reading on gauge. Fuel pressure should be within specifications. Refer to the previous Fuel System Pressure Tests.

(3) Shut engine off. Observe and record fuel pressure reading on gauge. Leave fuel pressure gauge connected. Allow engine to set for 30 minutes and then compare the fuel pressure reading on the gauge with the reading taken when engine was shut down. A pressure drop of up to 138 kPa (20 psi) within 30 minutes is within specifications.

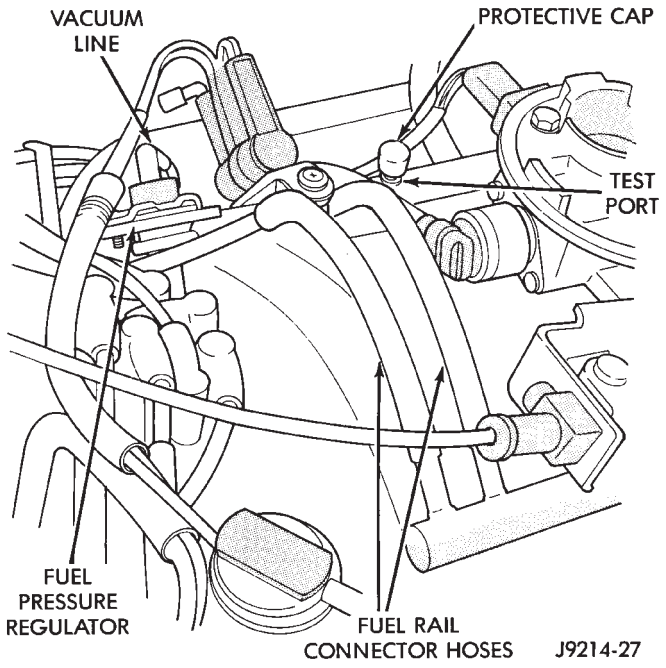

Fig. 15 Fuel Pressure Test Port—5.2L Engine

(4) If the fuel pressure drop is within specifications, the fuel pump outlet check valve and fuel pressure regulator are both operating normally.

(5) If fuel pressure drop is greater than 138 kPa (20 psi), it must be determined if this drop is being caused by (in-tank mounted) fuel pump outlet check valve or fuel pressure regulator. Proceed to next step.

(6) Release the fuel system pressure from fuel system. Refer to the previous Fuel Pressure Release Procedure in this group.

(7) Disconnect both fuel lines at fuel rail near fuel pressure regulator.

(8) Connect Fuel Line Pressure Test Adapter Tool number 6631 (3/8 in.) between the disconnected fuel supply line and fuel rail (Fig. 16).

(9) Connect Fuel Line Pressure Test Adapter Tool number 6539 (5/16 in.) between the disconnected fuel return line and fuel rail (Fig. 16).

(10) Start engine. Observe and record fuel system pressure.

(11) Shut engine off.

(12) Clamp off the rubber hose portion of adapter tool number 6539 connected to the fuel return line. Allow engine to set for 30 minutes. If pressure has dropped more than 138 kPa (20 psi) in 30 minutes, pressure is bleeding past the (in-tank mounted) fuel pump outlet check valve. Replace Fuel Pump Module assembly. Refer to Fuel Pump Module removal and installation in this group. If pressure drop is within specifications, proceed to next step.

(13) Clamp off the rubber hose portion of adapter tool number 6631 connected to the fuel supply line. Allow engine to set for 30 minutes. If pressure has dropped more than 138 kPa (20 psi) in 30 minutes,

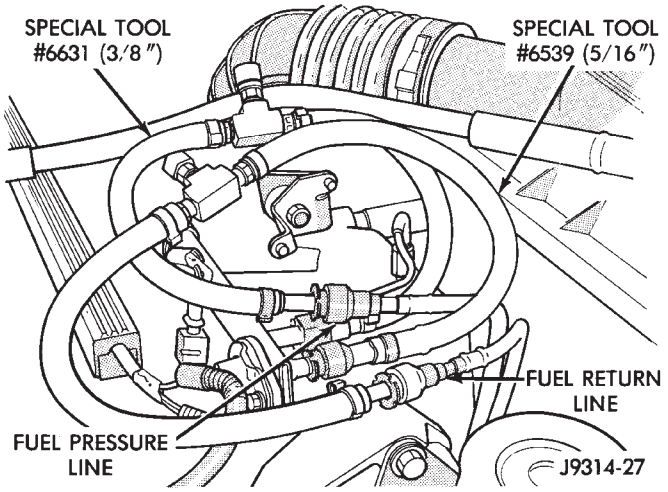

Fig. 16 Adapter Tools—Typical Connections

pressure is bleeding past the fuel pressure regulator. Replace fuel pressure regulator. Refer to Fuel Pressure Regulator removal and installation in the Component Removal/Installation section of this group.

MECHANICAL MALFUNCTIONS

Mechanical malfunctions are more difficult to diagnose with this system. The Powertrain Control Module (PCM) has been programmed to compensate for some mechanical malfunctions such as incorrect cam timing, vacuum leaks, etc. If engine performance problems are encountered and diagnostic trouble codes are not displayed, the problem may be mechanical rather than electronic.

FUEL FILTER

The fuel filter protects the fuel injectors and fuel pressure regulator from dirt, water and other foreign matter. The filter is located under the vehicle near front of fuel tank (Fig. 17). Replace fuel filter at intervals specified in the Lubrication and Maintenance Schedule chart found in Group 0, Lubrication and Maintenance.

REMOVAL

WARNING: THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE (EVEN WITH THE ENGINE OFF) OF APPROXIMATELY 131-269 KPA (19-39 PSI). THIS PRESSURE MUST BE RELEASED BEFORE SERVICING THE FUEL FILTER.

(1) Disconnect negative battery cable. Remove fuel filler cap.

(2) Release fuel system pressure. Refer to the previous Fuel Pressure Release Procedure in this section.

(3) Raise and support vehicle.

(4) Place shop towels under fuel filter.

(5) Disconnect fuel lines at filter by pressing on two tabs located on fuel line (Fig. 18).

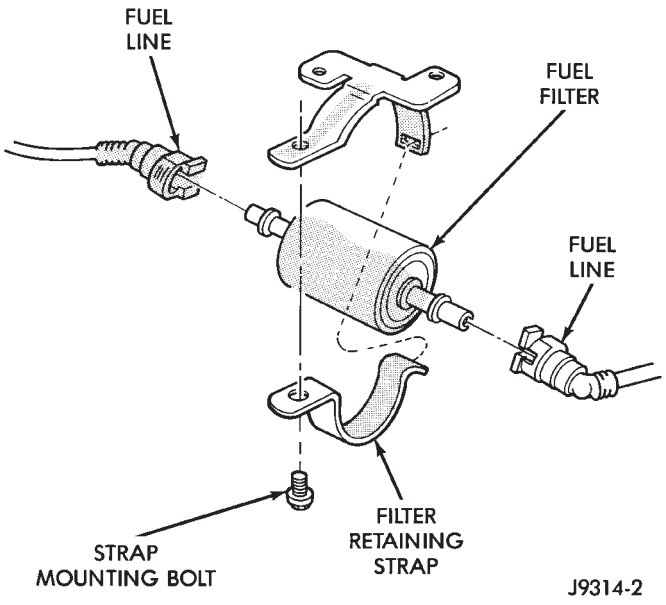

Fig. 17 Fuel Filter

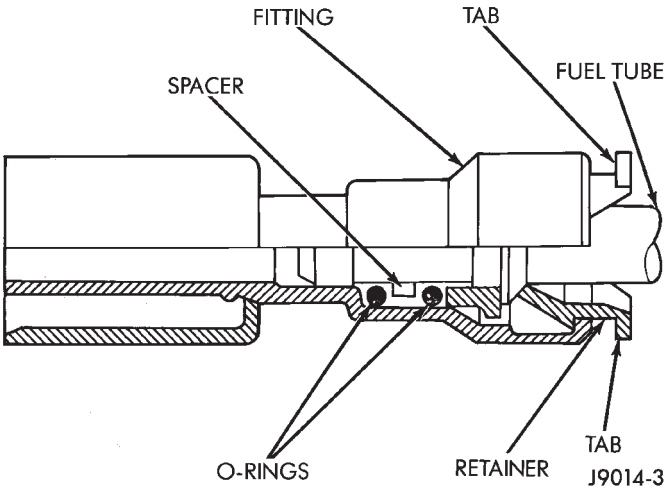

Fig. 18 Quick-Connect Fitting Removal

(6) Remove retaining strap mounting bolt (Fig. 17).
(7) Remove filter retaining strap (Fig. 17).
(8) Remove filter from mounting bracket.

INSTALLATION

CAUTION: The ends of the fuel filter are marked for correct installation. Install filter with the end marked IN towards fuel tank and the end marked OUT towards engine.

(1) Place fuel filter in retaining strap with the marked ends in the correct position.
(2) Install retaining strap bolt. Tighten to 7 N•m (66 in. lbs.) torque.
(3) Install fuel lines to filter. Refer to Fuel Tubes/Lines/Hoses and Clamps in this group.
(4) Lower vehicle.
(5) Connect negative battery cable.
(6) Start engine and check for leaks.

FUEL TUBES/LINES/HOSES AND CLAMPS

Also refer to Quick-Connect Fittings in this section.

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF). BEFORE SERVICING ANY FUEL SYSTEM HOSES, FITTINGS OR LINES, THE FUEL SYSTEM PRESSURE MUST BE RELEASED. REFER TO THE FUEL PRESSURE RELEASE PROCEDURE IN THIS GROUP.

Inspect all hose connections such as clamps, couplings and fittings to make sure they are secure and leaks are not present. The component should be replaced immediately if there is any evidence of degradation that could result in failure.

Avoid contact of any fuel tubes/hoses with other vehicle components that could cause abrasions or scuffing. Be sure that the plastic fuel tubes are properly routed to prevent pinching and to avoid heat sources.

CAUTION: The tubes/hoses used on fuel injected vehicles are of a special construction. This is due to the higher fuel pressures and the possibility of contaminated fuel in this system. If it is necessary to replace these tubes/hoses, only tubes/hoses marked EFM/EFI may be used.

CAUTION: The hose clamps used on fuel injected vehicles are of a special rolled edge construction to prevent the edge of the clamp from cutting into the hose. Only these rolled edge type clamps may be used in this system. All other types of clamps may cut into the hoses and cause high pressure fuel leaks.

Use new original equipment type hose clamps. Tighten hose clamps to 1 N•m (10 in. lbs.) torque.

QUICK-CONNECT FITTINGS

Also refer to the previous Fuel Tubes/Lines/Hoses and Clamps.

Two different types of Quick-Connect fittings are used at several fuel system connections. One type of fitting will be referred to as a Tab Type Fitting. The other will be referred to as a Plastic Ring Type Fitting.

CAUTION: The Plastic Ring Type Fittings are not serviced separately. Do not attempt to repair damaged Plastic Ring Type quick-connect fittings or fuel tubes. Replace the complete fuel tube/quick-connect fitting assembly.

PLASTIC RING TYPE FITTING

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE DISCONNECTING A QUICK-CONNECT FITTING. REFER TO THE FUEL PRESSURE RELEASE PROCEDURE.

This type of fitting contains non-serviceable sealed O-rings.

(1) Disconnect negative cable from the battery.

(2) Perform the Fuel Pressure Release Procedure. Refer to the Fuel Pressure Release Procedure in this section.

(3) To release the fuel tube from the fitting, push in on the tube while pushing the spring loaded plastic retainer ring into the fitting (Fig. 19). With the plastic ring depressed, pull the tube from fitting. After disconnection, the plastic retainer ring will remain on the fitting.

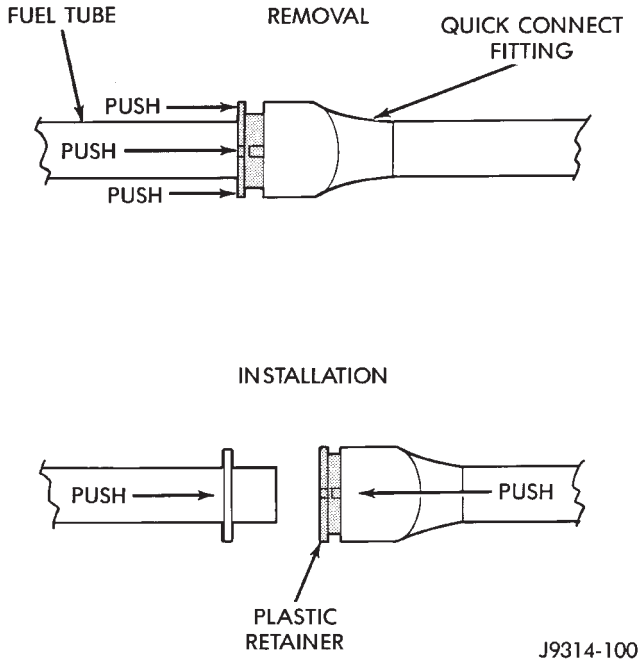

Fig. 19 Plastic Ring Type Fitting

(4) Inspect fitting connector body and plastic retainer ring (Fig. 19) for damage. Replace as necessary.

(5) Prior to connecting fuel tube to quick-connect fitting, check condition of tube and clean the fuel tube nipple and fitting with a lint-free cloth. Lubricate it with clean engine oil.

(6) Insert the fuel tube into quick-connect fitting (Fig. 19) until a click is felt. Pull back on fuel tube and fitting to be sure of a complete connection.

(7) Connect negative cable to battery.

TAB TYPE FITTING

CAUTION: The O-ring and spacer assembly must be replaced when ever the tab type quick-connect fittings are disassembled.

Tab type fittings consist of two O-rings, a spacer (installed between O-rings) and an O-ring retainer (Fig. 20).

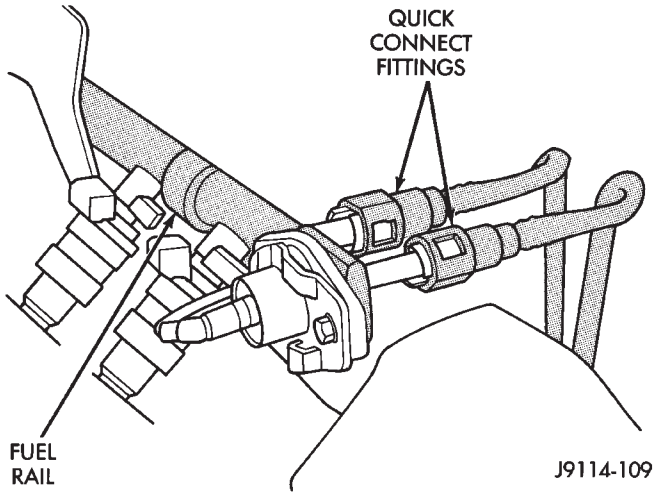

Fig. 20 Tab Type Quick-Connect Fittings—Typical

DISASSEMBLY

WARNING: THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE (EVEN WITH THE ENGINE OFF) OF APPROXIMATELY 131-269 KPA (19-39 PSI). THIS PRESSURE MUST BE RELEASED BEFORE SERVICING ANY FUEL SUPPLY OR FUEL RETURN SYSTEM COMPONENT.

The retainer has two tabs. To disconnect the fitting, squeeze the tabs against the fuel tube. Pull the fitting off of the quick-connect fitting/tube assembly. The retainer will stay on the fuel tube when the tube is disconnected. The O-rings and spacer will remain in the connector.

CAUTION: When ever a tab type quick-connect fitting is disconnected, the O-rings, spacer and retainer MUST be replaced.

The O-rings and spacer must be removed with the bent end of an L-shaped paper clip.

O-RING REPLACEMENT

A repair kit consisting of replacement O-rings, spacer and retainer is available through the parts department. The replacement parts are installed on a disposable plastic plug. Install the replacement kit as follows:

(1) Push the kit/disposable plug assembly into the fitting until an audible click sound is heard (Fig. 21).

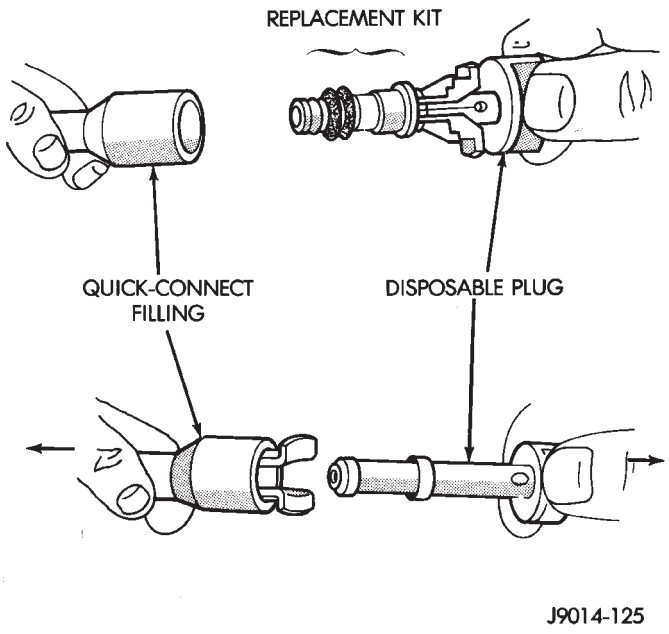

Fig. 21 Repair Kit Installation

(2) Grasp end of disposable plug and pull outward to remove it from fitting.

ASSEMBLY

(1) Push fuel tube into quick-connect fitting until an audible click is heard (Fig. 22).

(2) Verify that connection is secure by firmly pulling back on fuel tube (Fig. 22). The tube should be locked in place.

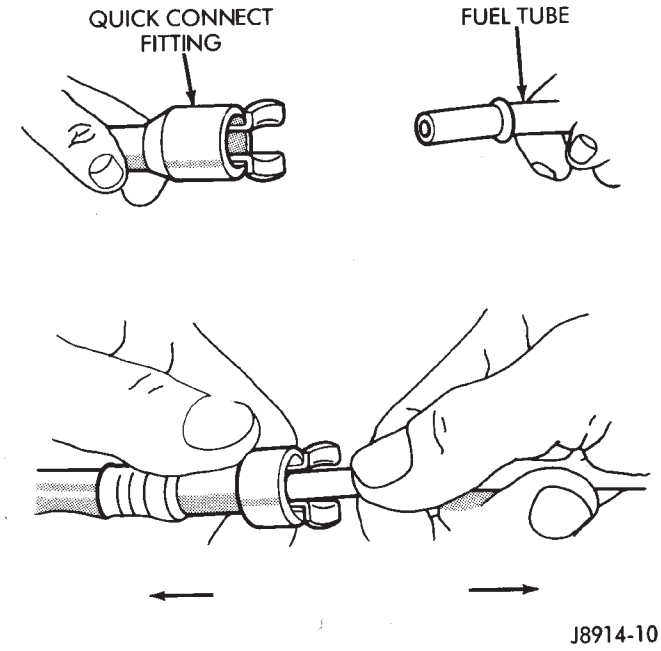

Fig. 22 Fuel Tube-to-Fitting Connection

FUEL TANKS

INDEX

GENERAL INFORMATION

These vehicles pass a full 360 degree rollover test without fuel leakage. To accomplish this, fuel and vapor flow controls are required for all fuel tank connections.

All models are equipped with a pressure relief/rollover valve mounted in the top of the fuel pump module. The return line from the fuel pump to the fuel tank contains a one-way check valve.

An evaporative control system prevents raw fuel vapor from escaping into the atmosphere. Fuel vapors from the fuel tank are collected in the EVAP canister. When the engine is operating, the vapors are drawn into the intake manifold to be used in combustion. Refer to Group 25, Emission Control System for more information.

Inspect all hose/tube connections for completeness. Be sure that leaks are not present. Replace any hose that is cracked, scuffed, swelled, has rubbed against other vehicle components or shows any other sign of wear that could lead to failure. If it is necessary to replace a hose, only hose marked EFM/EFI may be used.

When installing hoses, be sure that they are routed away from contact with other vehicle components.

The hose clamps used on fuel injected vehicles are of a special rolled edge construction to prevent the edge of the clamp from cutting into the hose. Only these rolled edge type clamps may be used on this system. Other types of clamps may cut into the hoses and cause high pressure fuel leaks.

NO-LEAD FUEL TANK FILLER TUBE

These vehicles are designed to operate using Unleaded fuels. The diameter of the opening in the fuel tank filler neck is sized to only accept unleaded fuel nozzles. Gasoline station pumps for unleaded and leaded fuels have different size nozzles. Leaded fuel nozzles are larger in diameter than unleaded nozzles. The fuel tank filler neck opening is also equipped with a deflector, which the smaller unleaded nozzle pushes back upon entering the filler neck. The deflector will prevent the larger diameter leaded fuel nozzles from entering the filler neck and will deflect fuel away from the filler neck. This happens if filling of the tank with leaded fuel is attempted.

A label is attached to the instrument panel under the fuel gauge that reads UNLEADED FUEL ONLY as a reminder to the driver. A similar label is located near the fuel tank filler.

FUEL TANK FILLER TUBE CAP

The loss of any fuel or vapor out of the filler neck is prevented by the use of a safety filler cap. This will release only under pressure of 10.9 to 13.45 kPa (1.58 to 1.95 psi). The vacuum release is between .97 and 2.0 kPa (.14 and .29 psi). This cap must be replaced by a similar unit if replacement is necessary.

CAUTION: Remove fuel tank filler tube cap prior to removing or repairing fuel lines to relieve fuel tank pressure.

HEAT SHIELDS

The sheet metal heat shields may have to be removed when servicing the fuel tank, fuel lines or vapor vent line. The heat shields must be installed to protect the lines and tank from the heat of the exhaust system. Refer to Group 11, Exhaust System and Intake Manifold for proper installation.

FUEL TANK

WARNING: THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE (EVEN WITH THE ENGINE OFF) OF APPROXIMATELY 131-269 KPA (19-39 PSI). THIS PRESSURE MUST BE RELEASED BEFORE SERVICING FUEL TANK.

REMOVAL

(1) Disconnect negative battery cable at battery.

(2) Release fuel system pressure. Refer to the Fuel Pressure Release Procedure in the Fuel Delivery section of this Group.

(3) Raise and support vehicle.

(4) Remove the fuel tank filler hose and vent hose retaining clamps (Fig. 1). Remove both tubes at fuel filler tube (Fig. 1).

(5) Remove the rear tow hooks (if equipped).

(6) Remove the fuel tank skid plate mounting nuts/bolts and remove skid plate (Fig. 2) (if equipped).

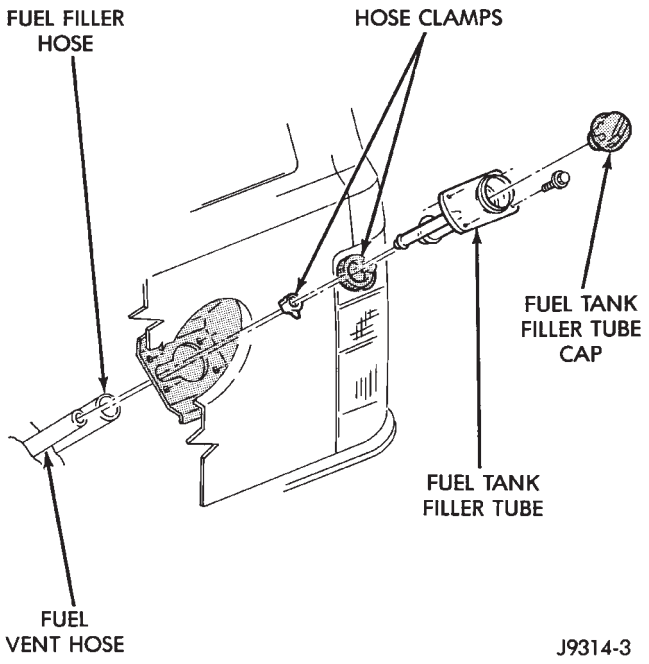

Fig. 1 Fuel Filler Tube and Hoses

(7) Remove the optional trailer hitch (if equipped).

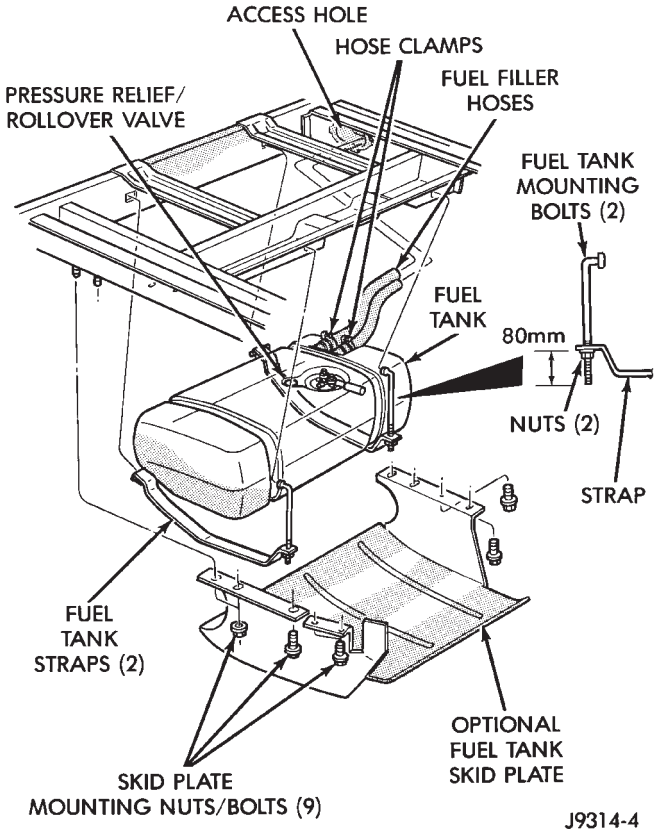

Fig. 2 Fuel Tank Mounting

(8) Remove the exhaust tailpipe heat shield mounting bolts and remove shield.

CAUTION: To protect the fuel tank from exhaust heat, this shield must reinstalled after tank installation.

(9) Place a hydraulic jack to bottom of fuel tank.

WARNING: PLACE A SHOP TOWEL AROUND FUEL LINES TO CATCH ANY EXCESS FUEL. REFER TO FUEL TUBES/LINES/HOSES AND CLAMPS IN THIS GROUP.

(10) Disconnect fuel supply line at fuel filter. Disconnect fuel return line and fuel vent line near front of tank.

(11) Disconnect fuel pump module electrical connector near front of tank.

CAUTION: The right (passenger side) of the fuel tank must be lowered first to gain access to the two fuel filler hose clamps located on the left side of tank (Fig. 2).

(12) Remove the two fuel tank strap nuts (Fig. 2). Position both tank support straps away from tank.

(13) Carefully lower right side of tank while feeding fuel hoses through access hole in body (Fig. 2) until fuel tank filler hose clamps can be removed.

(14) Before removing fuel filler hoses (Fig. 2) from tank, mark their rotational position in relation to tank. Remove both hose clamps and hoses at tank (Fig. 2). Insert the drain hose (from an approved gasoline draining station) into either of the hose openings. Drain tank until empty.

(15) Continue lowering tank and remove from vehicle.

(16) If tank is to be replaced, disconnect fuel tank pressure relief/rollover valve (Fig. 2) from tank. For valve removal, refer to Fuel Tank Pressure Relief/Rollover Valve in this section. Remove fuel pump module from tank. Refer to Fuel Pump Module Removal/Installation in the Fuel Delivery section of this group.

INSTALLATION

(1) Install fuel filler hoses and hose clamps (Fig. 2) to tank noting their previously marked position.

(2) Position fuel tank to hydraulic jack.

(3) Raise tank into position while guiding the fuel filler hoses into and through the access hole (Fig. 2) in body.

(4) Continue raising tank until positioned to body.

(5) Attach two fuel tank mounting straps and mounting nuts.

CAUTION: The two mounting nuts must be tightened until 80 mm (3.149 in.) is attained between the end of the mounting bolt and bottom of strap. See insert (Fig. 2). Do not over tighten nuts.

(6) Connect pump module electrical connector and three fuel lines near front of tank.

(7) Install exhaust tailpipe heat shield.

(8) Install the fuel tank skid plate (Fig. 2) and trailer hitch (if equipped).

(9) Install the rear tow hooks (if equipped).

(10) Install the fuel tank filler hose and vent hose to tank necks. Tighten both retaining clamps (Fig. 1).

(11) Lower vehicle and connect battery cable to battery.

FUEL PUMP—REMOVAL/INSTALLATION

The fuel pump is not serviceable. If the fuel pump needs replacement, the complete fuel pump module must be replaced. Refer to Fuel Pump Module in the Fuel Delivery System section of this group.

FUEL GAUGE SENDING UNIT

The fuel gauge sending unit is attached to the fuel pump module. Refer to Fuel Delivery System in this group for fuel gauge sending unit service.

FUEL TANK PRESSURE RELIEF/ROLLOVER VALVE

The fuel tank is equipped with a pressure relief/rollover valve (Fig. 3). The dual function valve will relieve fuel tank pressure and prevent fuel flow through the fuel tank vent tubes in the event of accidental vehicle rollover.

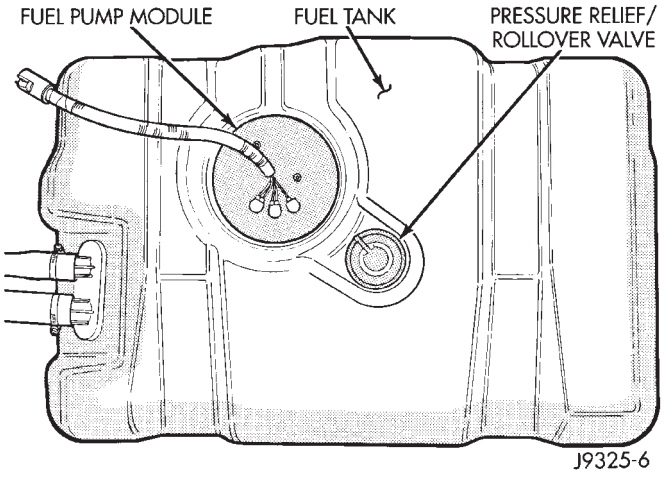

Fig. 3 Pressure Relief/Rollover Valve Location

The valve consists of a plunger, spring and orifice/guide plate (Fig. 4). The valve is normally open allowing fuel vapor to vent to the EVAP canister. Here it is stored until it can be consumed by the engine (under controlled conditions). The plunger seats in the guide plate at the orifice preventing liquid fuel from reaching the EVAP canister. This is done if bottom of plunger is contacted by fuel sloshing in tank when vehicle is cornering.

In the event of accidental vehicle rollover, the valve is inverted. In this position the plunger is forced against the guide plate and raw fuel is prevented from flowing through the valve orifice into the fuel tank vent tube.

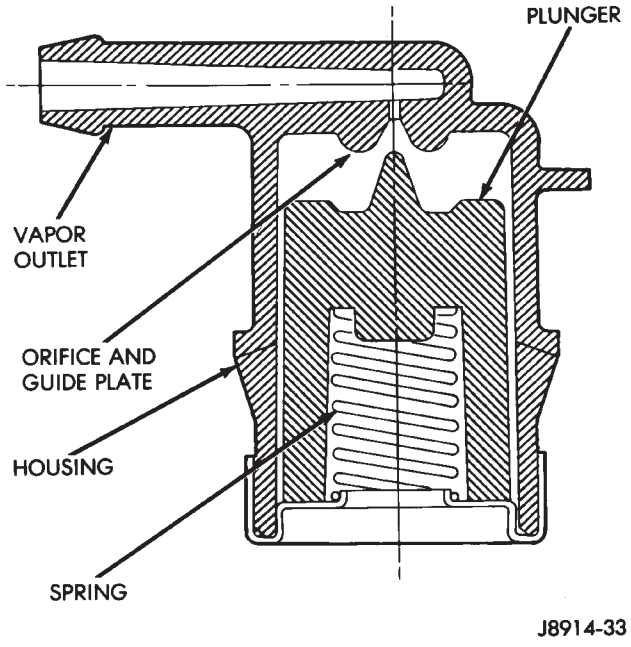

Fig. 4 Pressure Relief/Rollover Valve Operation

REMOVAL

(1) Disconnect negative battery cable.

(2) Drain and remove the fuel tank. Refer to Fuel Tank removal and installation in the Fuel Tank section of this group.

(3) The valve is seated in a grommet. Remove by prying one side upward and then roll the grommet out of tank.

INSTALLATION

(1) Start one side of grommet into opening in fuel tank. Using finger pressure only, press valve/grommet into place.

(2) Install fuel tank. Refer to Fuel Tank Installation.

(3) Fill fuel tank. Install fuel tank filler cap.

(4) Connect negative battery cable.

(5) Start vehicle and check for leaks.

ACCELERATOR PEDAL AND THROTTLE CABLE

INDEX

GENERAL INFORMATION

The accelerator pedal is connected to the throttle body linkage by the throttle cable. The cable is protected by a plastic sheathing and is connected to the throttle body linkage by a ball socket. It is connected to the accelerator pedal arm by a plastic retainer (clip) (Fig. 1). This retainer (clip) snaps into the top of the accelerator pedal arm. Retainer tabs (built into the cable sheathing) (Fig. 1) fasten the cable to the dash panel.

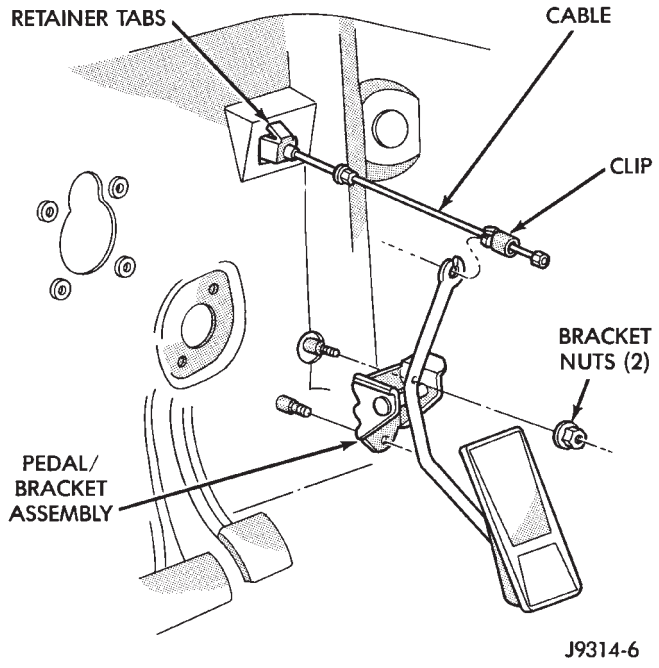

Fig. 1 Accelerator Pedal Mounting—Typical

Dual throttle return springs (attached to the throttle shaft) are used to close the throttle.

CAUTION: Never attempt to remove or alter these springs.

ACCELERATOR PEDAL

CAUTION: Be careful not to damage or kink the cable core wire (within the cable sheathing) while servicing accelerator pedal or throttle cable.

REMOVAL

(1) From inside the vehicle, hold up accelerator pedal. Remove plastic cable retainer (clip) and throttle cable core wire from upper end of pedal arm (Fig. 1). Plastic cable retainer (clip) snaps into pedal arm.

(2) Remove accelerator pedal bracket nuts. Remove accelerator pedal assembly (Fig. 1).

INSTALLATION

(1) Place accelerator pedal assembly over studs protruding from floor pan. Tighten mounting nuts to 10 N●m (92 in. lbs.) torque.

(2) Slide throttle cable into opening in top of pedal arm. Push plastic cable retainer (clip) into pedal arm opening until it snaps into place.

(3) Before starting engine, operate accelerator pedal to check for any binding.

THROTTLE CABLE

REMOVAL

(1) From inside the vehicle, hold up accelerator pedal. Remove plastic cable retainer (clip) and throttle cable core wire from upper end of pedal arm (Fig. 1). Plastic cable retainer (clip) snaps into pedal arm.

(2) Remove the cable core wire at pedal arm.

(3) From inside the vehicle, pinch both sides of the cable housing retainer tabs (Fig. 1) at the dash panel. Remove cable housing from dash panel and pull into the engine compartment.

(4) 4.0L Engine: Remove cable from clip on engine valve cover (Fig. 2) and clip at dash panel.

(5) Remove the throttle cable ball end socket at throttle body linkage (Figs. 2 or 3) (snaps off).

(6) 4.0L Engine: Remove throttle cable from throttle body mounting bracket by compressing retainer tabs and pushing cable through hole in bracket. Remove throttle cable from vehicle.

(7) 5.2L Engine: Remove cable housing at throttle body mounting bracket by pressing forward on release tab with a small screwdriver (Fig. 4). **To prevent cable housing breakage, press on the tab only enough to release the cable from the bracket.** Lift the cable housing straight up from bracket while pressing on release tab. Remove throttle cable from vehicle.

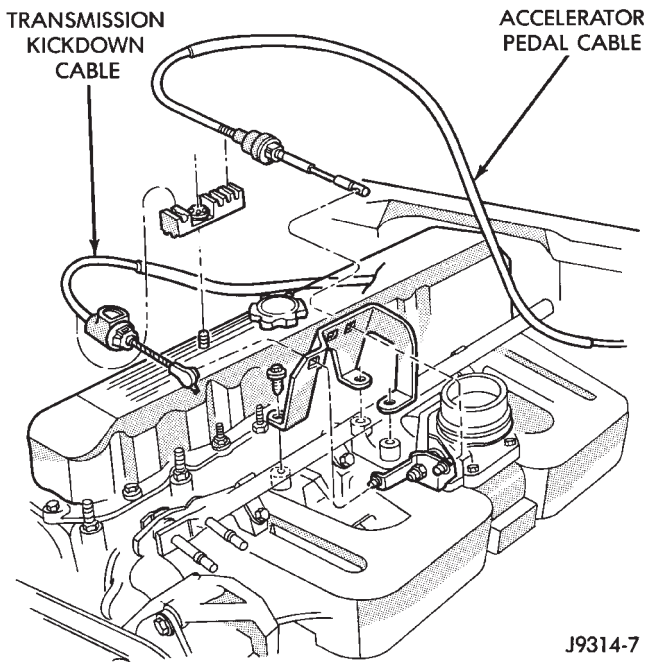

Fig. 2 Throttle Cable—4.0L Engine

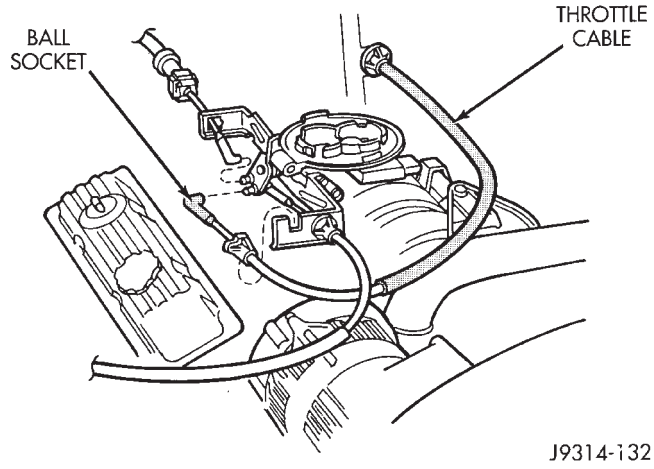

Fig. 3 Throttle Cable—5.2L Engine

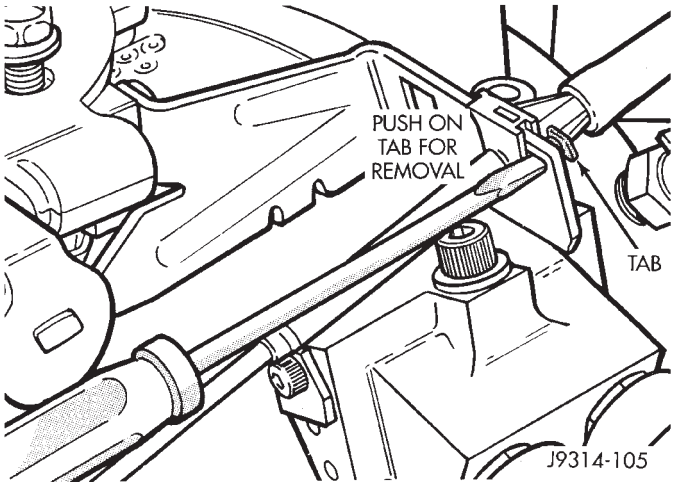

Fig. 4 Cable Release Tab—5.2L Engines—Typical

INSTALLATION

(1) 4.0L Engine: Slide throttle cable through hole in throttle body bracket until retainer tabs lock into bracket. Connect cable ball end to throttle body linkage ball (snaps on).

(2) 5.2L Engine: Connect cable end to throttle body linkage ball (snaps on). Connect cable to throttle body bracket (push down and lock).

(3) 4.0L Engine: Snap cable into clip on engine valve cover and clip at dash panel.

(4) Push other end of cable through opening in dash panel until retaining tabs lock into panel.

(5) From inside drivers compartment, slide throttle cable core wire into opening in top of pedal arm. Push cable retainer (clip) into pedal arm opening until it snaps in place.

(6) Before starting engine, operate accelerator pedal to check for any binding.

MPI SYSTEM—4.0L ENGINE—COMPONENT DESCRIPTION/SYSTEM OPERATION

INDEX

GENERAL INFORMATION

All 4.0L engines are equipped with sequential Multi-Port Fuel Injection (MPI). The MPI system (Fig. 1) provides precise air/fuel ratios for all driving conditions.

The Powertrain Control Module (PCM) operates the fuel system. The PCM was formerly referred to as the SBEC or engine controller. The PCM is a pre-programmed, dual microprocessor digital computer. It regulates ignition timing, air-fuel ratio, emission control devices, charging system, speed control, air conditioning compressor clutch engagement and idle speed. The PCM can adapt its programming to meet changing operating conditions.

Powertrain Control Module (PCM) Inputs represent the instantaneous engine operating conditions. Air-fuel mixture and ignition timing calibrations for various driving and atmospheric conditions are pre-programmed into the PCM. The PCM monitors and analyzes various inputs. It then computes engine fuel and ignition timing requirements based on these inputs. Fuel delivery control and ignition timing will then be adjusted accordingly.

Other inputs to the PCM are provided by the brake light switch, air conditioning select switch and the speed control switches. All inputs to the PCM are converted into signals.

Electrically operated fuel injectors spray fuel in precise metered amounts into the intake port directly above the intake valve. The injectors are fired in a specific sequence by the PCM. The PCM maintains an air/fuel ratio of 14.7 to 1 by constantly adjusting injector pulse width. Injector pulse width is the length of time that the injector opens and sprays fuel into the chamber. The PCM adjusts injector pulse width by opening and closing the ground path to the injector.

Manifold absolute pressure (air density) and engine rpm (speed) are the primary inputs that determine fuel injector pulse width. The PCM also monitors other inputs when adjusting air-fuel ratio.

Inputs That Effect Fuel Injector Pulse Width

- Exhaust gas oxygen content
- Coolant temperature
- Manifold absolute pressure (MAP)
- Engine speed
- Throttle position
- Battery voltage
- Air conditioning selection
- Transmission gear selection (automatic transmissions only)
- Speed control

The powertrain control module (PCM) adjusts ignition timing by controlling ignition coil operation. The ignition coil receives battery voltage when the ignition key is in the run or starter position. The PCM provides a ground for the ignition coil. The coil discharges when the PCM supplies a ground. By switching the ground path on and off, the PCM regulates ignition timing.

The sensors and switches that provide inputs to the Powertrain control module (PCM) comprise the Engine Control System. It is also comprised of the PCM Outputs (engine control devices that the are operated by the PCM).

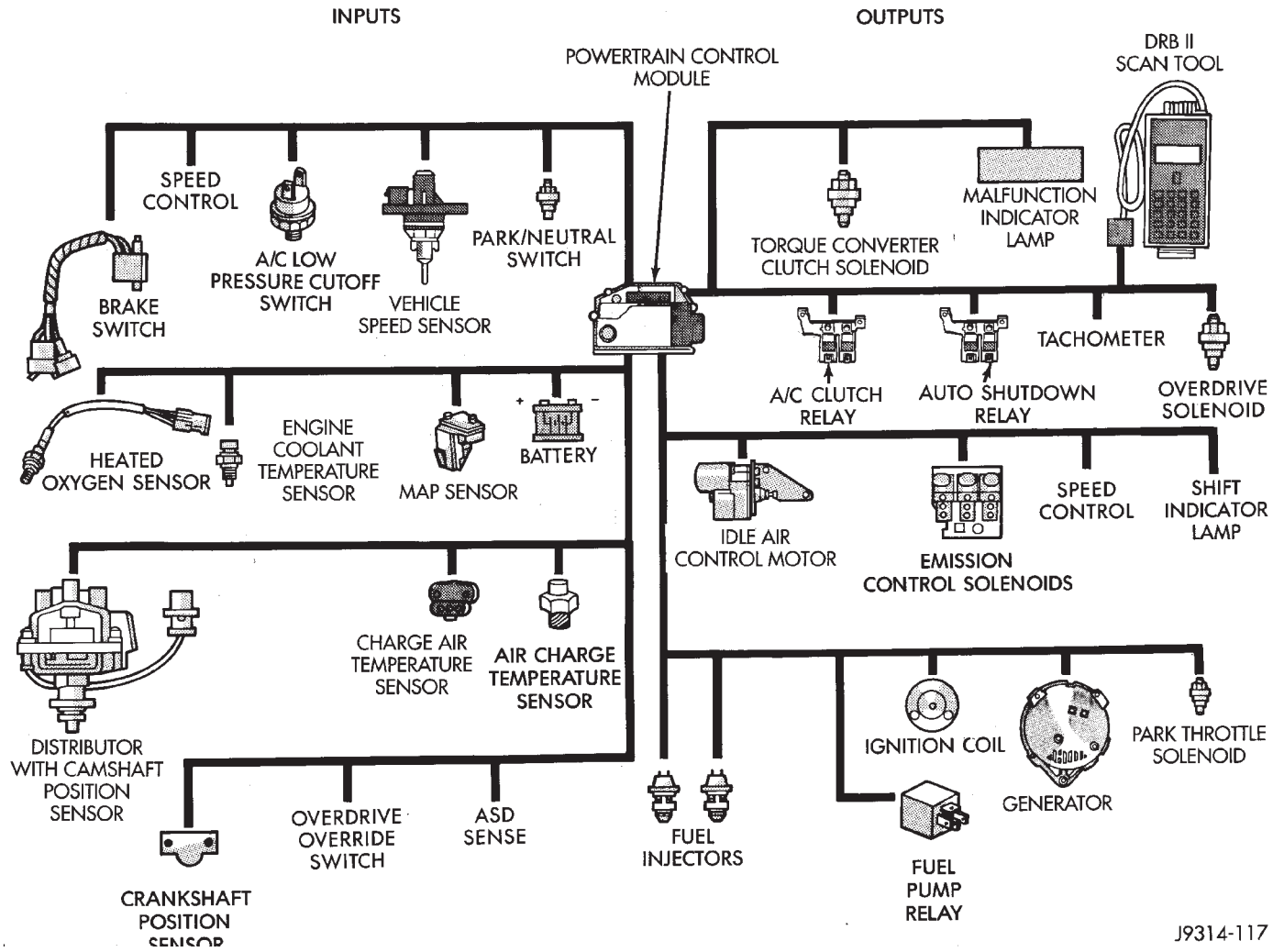

Fig. 1 Multi-Port Fuel Injection Components—4.0L Engine

SYSTEM DIAGNOSIS

The Powertrain Control Module (PCM) tests many of its own input and output circuits. If a Diagnostic Trouble Code (DTC) is found in a major system, this information is stored in the PCM memory. Refer to On-Board Diagnostics in the MPI System—4.0L Engine—General Diagnosis section of this group for DTC information.

POWERTRAIN CONTROL MODULE (PCM)

The Powertrain Control Module (PCM) (Fig. 2) operates the fuel system. The PCM was formerly referred to as the SBEC or engine controller. The PCM is a pre-programmed, dual microprocessor digital computer. It regulates ignition timing, air-fuel ratio, emission control devices, charging system, speed control, air conditioning compressor clutch engagement and idle speed. The PCM can adapt its programming to meet changing operating conditions.

The PCM receives input signals from various switches and sensors. Based on these inputs, the PCM regulates various engine and vehicle operations through different system components. These components are referred to as Powertrain Control Module (PCM) Outputs. The sensors and switches that provide inputs to the PCM are considered Powertrain Control Module (PCM) Inputs.

The PCM adjusts ignition timing based upon inputs it receives from sensors that react to: engine rpm, manifold absolute pressure, coolant temperature, throttle position, transmission gear selection (automatic transmission), vehicle speed and the brake switch.

The PCM adjusts idle speed based on inputs it receives from sensors that react to: throttle position, vehicle speed, transmission gear selection, coolant temperature and from inputs it receives from the air conditioning clutch switch and brake switch.

Based on inputs that it receives, the PCM adjusts ignition coil dwell. The PCM also adjusts the generator charge rate through control of the generator field and provides speed control operation.

Powertrain Control Module (PCM) Inputs:

- Generator output

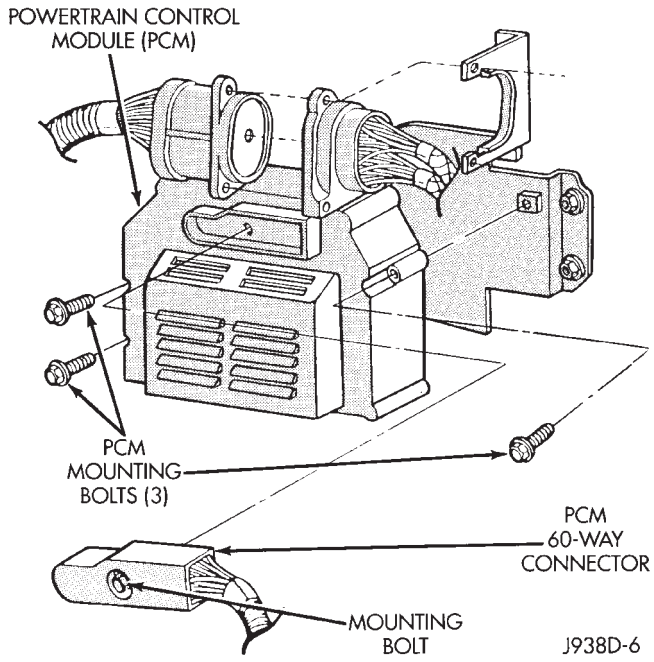

Fig. 2 Powertrain Control Module (PCM)

- A/C request (if equipped with factory A/C)
- A/C select (if equipped with factory A/C)
- Auto shut down (ASD) sense
- Charge air temperature sensor
- Battery voltage
- Brake switch
- Coolant temperature sensor
- Crankshaft position sensor
- Ignition circuit sense (ignition switch in run position)
- Manifold absolute pressure sensor
- Overdrive/override switch
- Oxygen sensor
- Park/neutral switch (auto. trans. only)
- SCI receive (DRB II connection)
- Speed control resume switch
- Speed control set switch
- Speed control on/off switch
- Camshaft position sensor signal
- Throttle position sensor
- Vehicle speed sensor
- Sensor return
- Power ground
- Signal ground

Powertrain Control Module (PCM) Outputs

- A/C clutch relay
- Idle air control (IAC) motor
- Auto shut down (ASD) relay
- Generator field
- Malfunction Indicator lamp
- Fuel injectors
- Fuel pump relay
- Ignition coil
- SCI transmit (DRB II connection)
- Shift indicator lamp (manual transmission only)
- Speed control vacuum solenoid
- Speed control vent solenoid
- Tachometer (on instrument panel, if equipped)

The powertrain control module (PCM) contains a voltage convertor. This converts battery voltage to a regulated 8.0 volts. It is used to power the crankshaft position sensor and camshaft position sensor. The PCM also provides a five (5) volt supply for the Manifold Absolute Pressure (MAP) sensor and Throttle Position Sensor (TPS).

AIR CONDITIONING (A/C) CONTROLS—PCM INPUT

The A/C control system information applies to factory installed air conditioning units.

A/C SELECT SIGNAL: When the A/C switch is in the ON position and the A/C low pressure switch is closed, an input signal is sent to the powertrain control module (PCM). The signal informs the PCM that the A/C has been selected. The PCM adjusts idle speed to a pre-programmed rpm through the idle air control (IAC) motor to compensate for increased engine load.

A/C REQUEST SIGNAL: Once A/C has been selected, the powertrain control module (PCM) receives the A/C request signal from the evaporator switch. The input indicates that the evaporator temperature is in the proper range for A/C application. The PCM uses this input to cycle the A/C compressor clutch (through the A/C relay). It will also determine the correct engine idle speed through the idle air control (IAC) motor position.

If the A/C low pressure switch opens (indicating a low refrigerant level), the PCM will not receive an A/C select signal. The PCM will then remove the ground from the A/C relay. This will deactivate the A/C compressor clutch.

If the evaporator switch opens, (indicating that evaporator is not in proper temperature range), the PCM will not receive the A/C request signal. The PCM will then remove the ground from the A/C relay, deactivating the A/C compressor clutch.

AUTOMATIC SHUT DOWN (ASD) SENSE—PCM INPUT

A 12 volt signal at this input indicates to the PCM that the ASD has been activated. The ASD relay is located in the Power Distribution Center (PDC) in the engine compartment. It is used to connect oxygen sensor heater element, ignition coil, generator field winding and fuel injectors to 12 volt + power supply.

This input is used only to sense that the ASD relay is energized. If the powertrain control module (PCM) does not see 12 volts at this input when the ASD should be activated, it will set a Diagnostic Trouble Code (DTC).

BATTERY VOLTAGE—PCM INPUT

The battery voltage input provides power to the powertrain control module (PCM). It also informs the PCM what voltage level is supplied to the ignition coil and fuel injectors.

If battery voltage is low, the PCM will increase injector pulse width (period of time that the injector is energized). This is done to compensate for the reduced flow through injector caused by the lowered voltage.

BRAKE SWITCH—PCM INPUT

When the brake light switch is activated, the powertrain control module (PCM) receives an input indicating that the brakes are being applied. After receiving this input, the PCM maintains idle speed to a scheduled rpm through control of the idle air control (IAC) motor. The brake switch input is also used to operate the speed control system.

CAMSHAFT POSITION SENSOR—PCM INPUT

A sync signal is provided by the camshaft position sensor located in the ignition distributor (Fig. 3). The sync signal from this sensor works in conjunction with the crankshaft position sensor to provide the powertrain control module (PCM) with inputs. This is done to establish and maintain correct injector firing order.

Refer to Camshaft Position Sensor in Group 8D, Ignition System for more information.

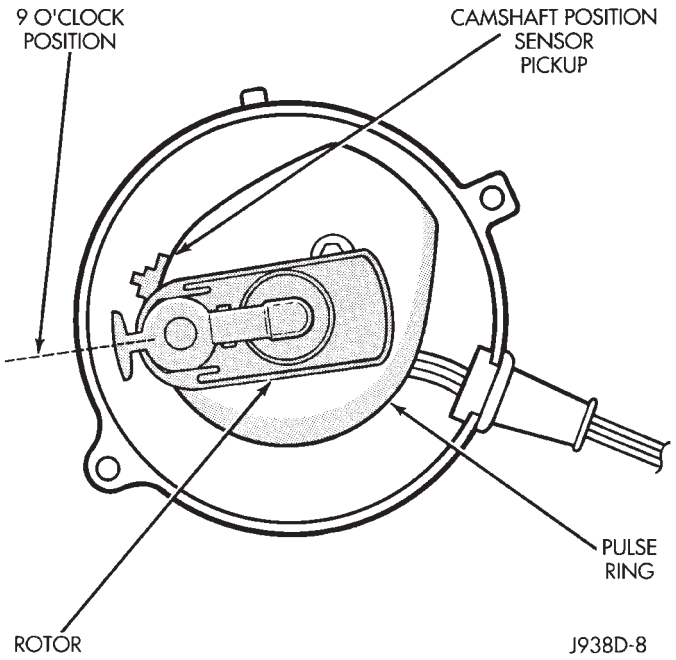

Fig. 3 Camshaft Position Sensor

CHARGE AIR TEMPERATURE SENSOR—PCM INPUT

The intake manifold charge air temperature sensor is installed in the intake manifold with the sensor element extending into the air stream (Fig. 4). The sensor provides an input voltage to the powertrain control module (PCM) indicating intake manifold air temperature. The input is used along with inputs from other sensors to determine injector pulse width. As the temperature of the air-fuel stream in the manifold varies, the sensor resistance changes. This results in a different input voltage to the PCM.

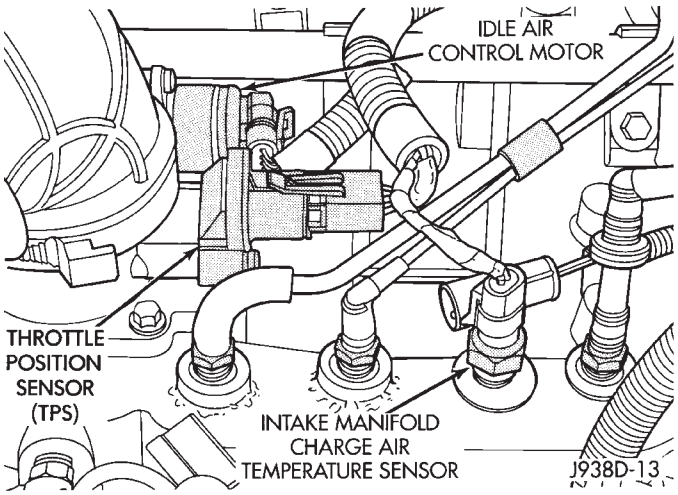

Fig. 4 Charge Air Temperature Sensor

CRANKSHAFT POSITION SENSOR—PCM INPUT

This sensor is a Hall Effect device that detects notches in the flywheel (manual transmission), or flexplate (automatic transmission).

This sensor is used to indicate to the powertrain control module (PCM) that a spark and or fuel injection event is to be required. The output from this sensor, in conjunction with the camshaft position sensor signal, is used to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

The sensor is bolted to the transmission housing near the rear of the cylinder head (Fig. 5).

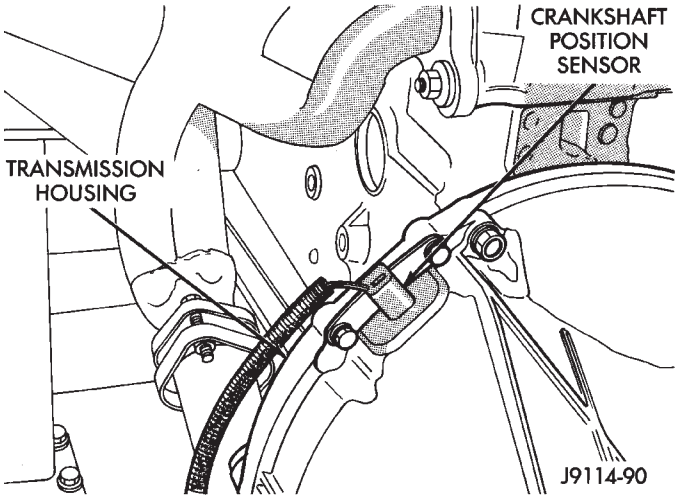

Fig. 5 Crankshaft Position Sensor

Refer to Group 8D, Ignition System for more crankshaft position sensor information.

The engine will not operate if the PCM does not receive a crankshaft position sensor input.

ENGINE COOLANT TEMPERATURE SENSOR—PCM INPUT

The coolant temperature sensor is installed in the thermostat housing (Fig. 6) and protrudes into the water jacket. The sensor provides an input voltage to the powertrain control module (PCM) relating coolant temperature. The PCM uses this input along with inputs from other sensors to determine injector pulse width and ignition timing. As coolant temperature varies, the coolant temperature sensor's resistance changes. The change in resistance results in a different input voltage to the PCM.

When the engine is cold, the PCM will operate in Open Loop cycle. It will demand slightly richer air-fuel mixtures and higher idle speeds. This is done until normal operating temperatures are reached.

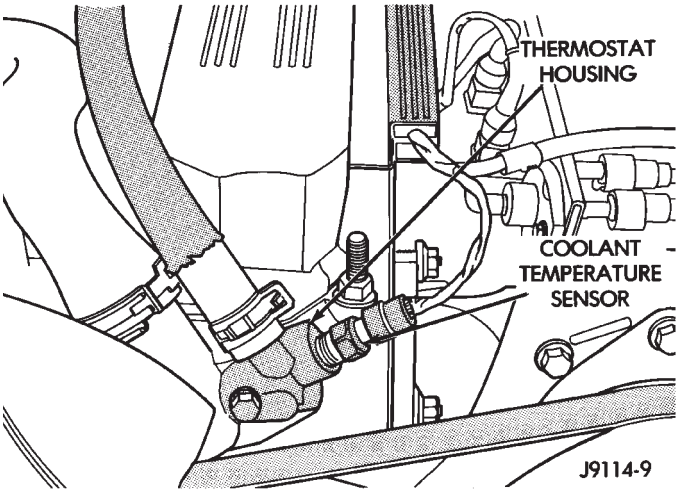

Fig. 6 Coolant Temperature Sensor

IGNITION CIRCUIT SENSE—PCM INPUT

The ignition circuit sense input tells the powertrain control module (PCM) the ignition switch has energized the ignition circuit. Refer to the wiring diagrams for circuit information.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—PCM INPUT

The MAP sensor reacts to absolute pressure in the intake manifold. It provides an input voltage to the powertrain control module (PCM). As engine load changes, manifold pressure varies. The change in manifold pressure causes MAP sensor voltage to change. The change in MAP sensor voltage results in a different input voltage to the PCM. The input voltage level supplies the PCM with information about ambient barometric pressure during engine start-up (cranking) and engine load while the engine is running. The PCM uses this input along with inputs from other sensors to adjust air-fuel mixture.

The MAP sensor is mounted on the dash panel (Fig. 7). The sensor is connected to the throttle body with a vacuum hose and to the PCM electrically.

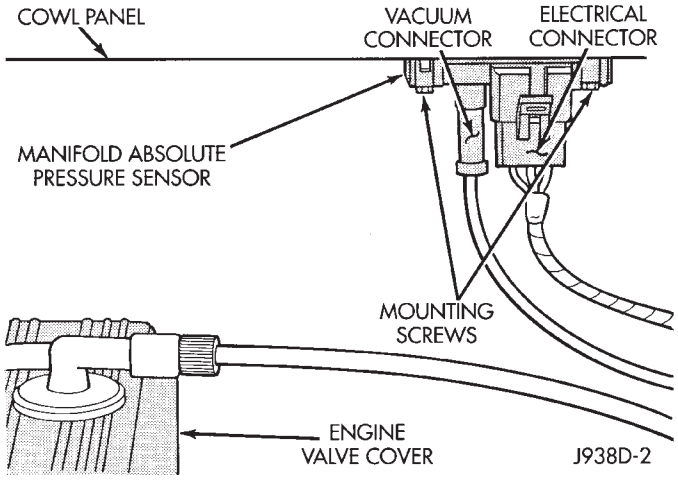

Fig. 7 Manifold Absolute Pressure (MAP) Sensor

OXYGEN (O_2) SENSOR—PCM INPUT

The O_2 sensor is located in the exhaust down pipe (Fig. 8). It provides an input voltage to the powertrain control module (PCM) relating the oxygen content of the exhaust gas. The PCM uses this information to fine tune the air-fuel ratio by adjusting injector pulse width.

The O_2 sensor produces voltages from 0 to 1 volt. This voltage will depend upon the oxygen content of the exhaust gas in the exhaust manifold. When a large amount of oxygen is present (caused by a lean air-fuel mixture), the sensor produces a low voltage. When there is a lesser amount present (rich air-fuel mixture) it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensor acts as a rich-lean switch.

The oxygen sensor is equipped with a heating element that keeps the sensor at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner.

In Closed Loop operation, the powertrain control module (PCM) monitors the O_2 sensor input (along with other inputs). It then adjusts the injector pulse width accordingly. During Open Loop operation, the PCM ignores the O_2 sensor input and adjusts injector pulse width to a preprogrammed value (based on other sensor inputs).

OVERDRIVE/OVERRIDE SWITCH

On vehicles equipped with overdrive, the powertrain control module (PCM) regulates the 3-4 overdrive up-shift and down-shift through the overdrive solenoid.

Refer to Group 21 for more information.

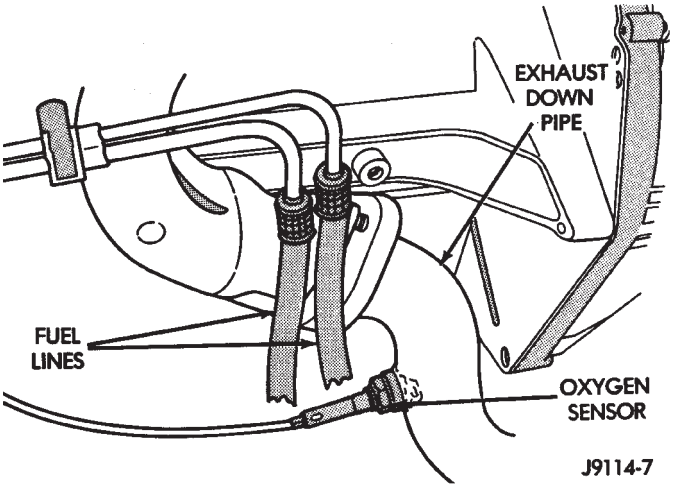

Fig. 8 Heated Oxygen Sensor Location

PARK/NEUTRAL SWITCH—PCM INPUT

The park/neutral switch is located on the transmission housing and provides an input to the powertrain control module (PCM). This will indicate that the automatic transmission is in Park, Neutral or a drive gear selection. This input is used to determine idle speed (varying with gear selection), fuel injector pulse width and ignition timing advance. Refer to Group 21, Transmissions, for testing, replacement and adjustment information.

POWER GROUND

The power ground is used to control ground circuits for the following powertrain control module (PCM) loads:

- Generator Field Winding
- 8 volt (PCM) power supply
- Fuel Injectors
- Ignition Coil

SCI RECEIVE—PCM INPUT

SCI Receive is the serial data communication receive circuit for the DRB II scan tool. The powertrain control module (PCM) receives data from the DRB II through the SCI Receive circuit.

SPEED CONTROL—PCM INPUT

The speed control system provides three separate inputs to the powertrain control module (PCM); On/Off, Set and Resume. The On/Off input informs the PCM that the speed control system has been activated. The Set input informs the PCM that a fixed vehicle speed has been selected. The Resume input indicates to the PCM that the previous fixed speed is requested.

The speed control operating range is from 50 km/h to 142 km/h (35 to 85 mph). Inputs that effect speed control operation are:

- Park/neutral switch
- Vehicle speed sensor
- Throttle position sensor

Refer to Group 8H for further speed control information.

SENSOR RETURN—PCM INPUT

Sensor Return provides a low noise ground reference for all system sensors.

THROTTLE POSITION SENSOR (TPS)—PCM INPUT

The Throttle Position Sensor (TPS) is mounted on the throttle body (Fig. 9). The TPS is a variable resistor that provides the powertrain control module (PCM) with an input signal (voltage) that represents throttle blade position. The sensor is connected to the throttle blade shaft. As the position of the throttle blade changes, the resistance of the TPS changes.

The PCM supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the PCM) represents the throttle blade position. The PCM receives an input signal voltage from the TPS. This will vary in an approximate range of from 1 volt at minimum throttle opening (idle), to 4 volts at wide open throttle. Along with inputs from other sensors, the PCM uses the TPS input to determine current engine operating conditions. In response to engine operating conditions, the PCM will adjust fuel injector pulse width and ignition timing.

VEHICLE SPEED SENSOR—PCM INPUT

The speed sensor (Fig. 10) is located in the extension housing of the transmission (2WD) or on the transfer case extension housing (4WD). The sensor input is used by the powertrain control module (PCM) to determine vehicle speed and distance traveled.

The speed sensor generates 8 pulses per sensor revolution. These signals, in conjunction with a closed throttle signal from the throttle position sensor, indicate a closed throttle deceleration to the PCM. When the vehicle is stopped at idle, a closed throttle signal is received by the PCM (but a speed sensor signal is not received).

Under deceleration conditions, the PCM adjusts the idle air control (IAC) motor to maintain a desired

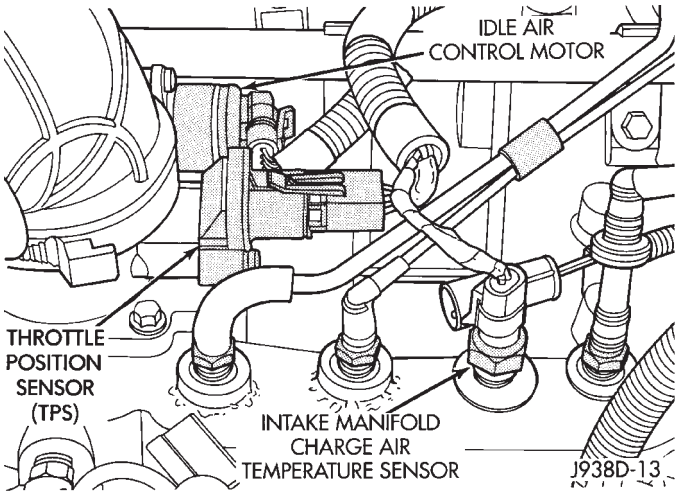

Fig. 9 Throttle Position Sensor

MAP value. Under idle conditions, the PCM adjusts the IAC motor to maintain a desired engine speed.

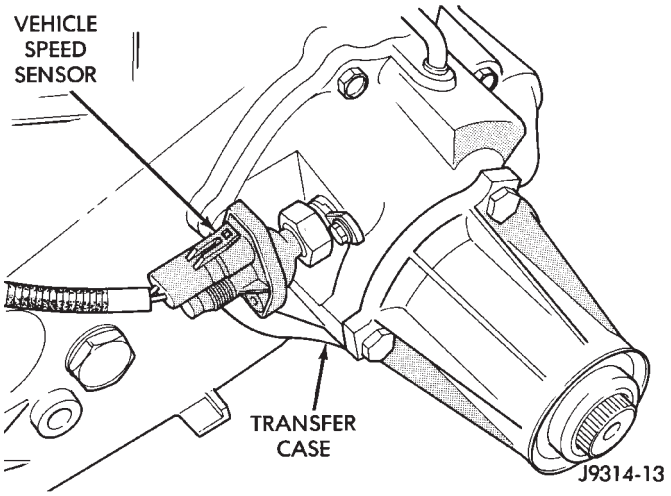

Fig. 10 Vehicle Speed Sensor—Typical

AIR CONDITIONING (A/C) CLUTCH RELAY—PCM OUTPUT

The powertrain control module (PCM) activates the A/C compressor through the A/C clutch relay. The PCM regulates A/C compressor operation by switching the ground circuit for the A/C clutch relay on and off. The relay is located in the Power Distribution Center (PDC) (Fig. 11). For the location of the relay within the PDC, refer to label under PDC cover.

When the PCM receives a request for A/C from A/C evaporator switch, it will adjust idle air control (IAC) motor position. This is done to increase idle speed. The PCM will then activate the A/C clutch through the A/C clutch relay. The PCM adjusts idle air control (IAC) stepper motor position to compensate for increased engine load from the A/C compressor.

By switching the ground path for the relay on and off, the PCM is able to cycle the A/C compressor clutch. This is based on changes in engine operating conditions. If, during A/C operation, the PCM senses

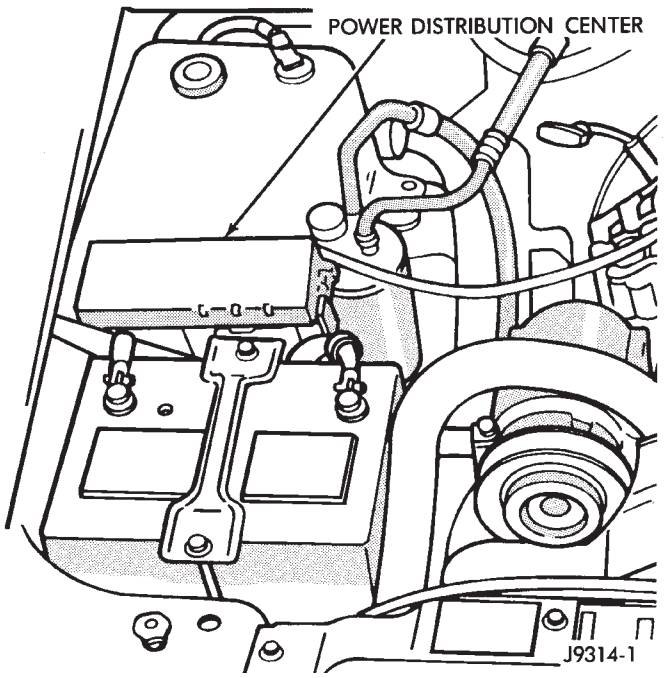

Fig. 11 Power Distribution Center (PDC)

low idle speeds or a wide open throttle condition, it will de-energize the relay. This prevents A/C clutch engagement. The relay will remain de-energized until the idle speed increases or the wide open throttle condition exceeds 15 seconds or no longer exists. The PCM will also de-energize the relay if coolant temperature exceeds 125°C (257°F).

IDLE AIR CONTROL (IAC) MOTOR—PCM OUTPUT

The IAC motor is mounted on the throttle body (Fig. 12) and is controlled by the powertrain control module (PCM).

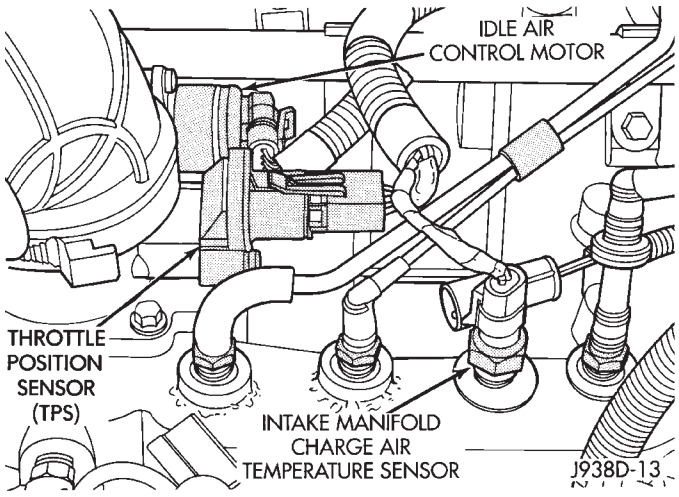

Fig. 12 IAC Motor

The throttle body has an air control passage that provides air for the engine at idle (the throttle plate is closed). The IAC motor pintle protrudes into the

air control passage and regulates air flow through it. Based on various sensor inputs, the powertrain control module (PCM) adjusts engine idle speed by moving the IAC motor pintle in and out of the air control passage. The IAC motor is positioned when the ignition key is turned to the On position.

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

AUTO SHUT DOWN (ASD) RELAY—PCM OUTPUT

The ASD relay is located in the Power Distribution Center (PDC) (Fig. 11). For the location of this relay within the PDC, refer to label under PDC cover.

The ASD supplies battery voltage to the fuel pump, fuel injector, ignition coil, generator field winding and oxygen (O_2) sensor heating element. The ground circuit for the coil in the ASD relay is controlled by the powertrain control module (PCM). The PCM operates the relay by switching the ground circuit on and off.

The fuel pump relay is controlled by the PCM through same circuit that the ASD relay is controlled.

GENERATOR FIELD—PCM OUTPUT

The powertrain control module (PCM) regulates the charging system voltage within a range of 12.9 to 15.0 volts. Refer to Group 8A for charging system information.

GENERATOR LAMP—PCM OUTPUT

If the powertrain control module (PCM) senses a low charging condition in the charging system, it will illuminate the generator lamp on the instrument panel. For example, during low idle with all accessories turned on, the light may momentarily go on. Once the PCM corrects idle speed to a higher rpm, the light will go out. Refer to Group 8A for charging system information.

EMR LAMP—PCM OUTPUT

The EMR lamp is not used for the 1993 model year.

FUEL INJECTORS—PCM OUTPUT

Six fuel injectors are attached to the fuel rail (Fig. 13).

The nozzle ends of the injectors are positioned into openings in the intake manifold just above the intake valve ports of the cylinder head. The engine wiring harness connector for each fuel injector is equipped with an attached numerical tag (INJ 1, INJ 2 etc.). This is used to identify each fuel injector.

The injectors are energized individually in a sequential order by the powertrain control module (PCM). The PCM will adjust injector pulse width by switching the ground path to each individual injector on and off. Injector pulse width is the period of time that the injector is energized. The PCM will adjust injector pulse width based on various inputs it receives.

During start up, battery voltage is supplied to the injectors through the ASD relay. When the engine is operating, voltage is supplied by the charging system. The PCM determines injector pulse width based on various inputs.

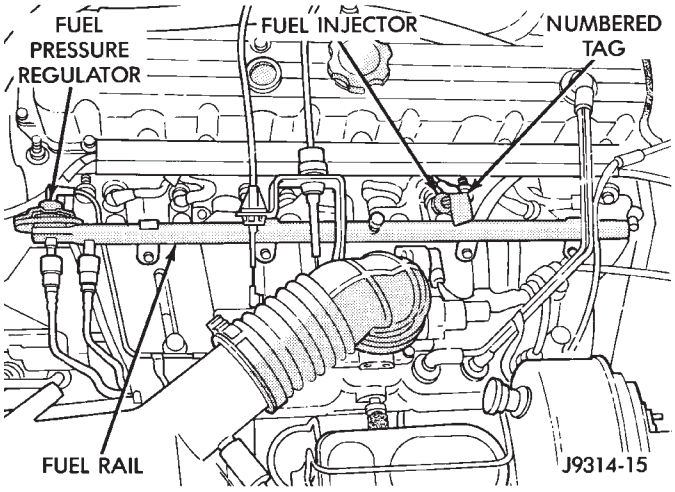

Fig. 13 Fuel Injectors—Typical

MALFUNCTION INDICATOR LAMP—PCM OUTPUT

The Malfunction Indicator Lamp (formerly referred to as the Check Engine Lamp) illuminates on the instrument panel each time the ignition key is turned on. It will stay on for three seconds as a bulb test.

If the powertrain control module (PCM) receives an incorrect signal, or no signal from certain sensors or emission related systems, the lamp is turned on. This is a warning that the PCM has recorded a system or sensor malfunction. In some cases, when a problem is declared, the PCM will go into a limp-in mode. This is an attempt to keep the system operating. It signals an immediate need for service.

The lamp can also be used to display a Diagnostic Trouble Code (DTC). Cycle the ignition switch On-Off-On-Off-On within three seconds and any codes stored in the PCM memory will be displayed. This is done in a series of flashes representing digits. Refer to On-Board Diagnostics in the General Diagnosis section of this group for more information.

IGNITION COIL—PCM OUTPUT

System voltage is supplied to the ignition coil positive terminal. The powertrain control module (PCM) operates the ignition coil. **Base (initial) ignition timing is not adjustable.** The PCM adjusts ignition timing to meet changing engine operating conditions.

The ignition coil is located near the ignition distributor (Fig. 14).

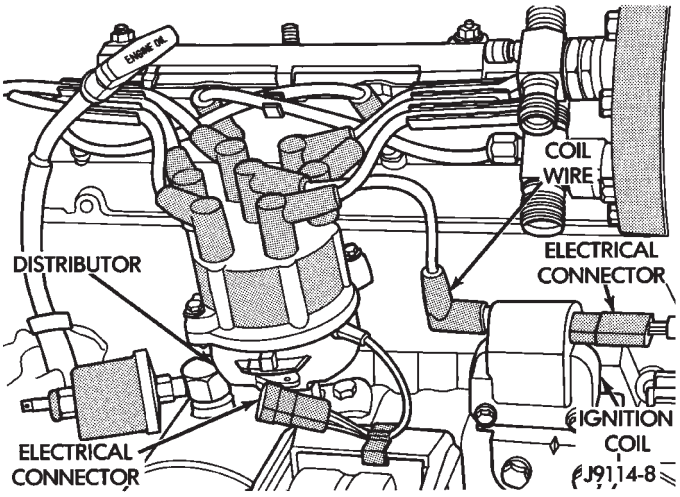

Fig. 14 Ignition Coil

SCI TRANSMIT—PCM OUTPUT

SCI Transmit is the serial data communication transmit circuit for the DRB II scan tool. The powertrain control module (PCM) transmits data to the DRB II through the SCI Transmit circuit.

SHIFT INDICATOR—PCM OUTPUT

Vehicles equipped with manual transmissions have an Up-Shift indicator lamp. The lamp is controlled by the powertrain control module (PCM). The lamp illuminates on the instrument panel to indicate when the driver should shift to the next highest gear for best fuel economy. The PCM will turn the lamp OFF after 3 to 5 seconds if the shift of gears is not performed. The up-shift light will remain off until vehicle stops accelerating and is brought back to range of up-shift light operation. This will also happen if vehicle is shifted into fifth gear.

The indicator lamp is normally illuminated when the ignition switch is turned on and it is turned off when the engine is started up. With the engine running, the lamp is turned on/off depending upon engine speed and load.

SPEED CONTROL—PCM OUTPUT

Speed control operation is regulated by the powertrain control module (PCM). The PCM controls the vacuum to the throttle actuator through the speed control vacuum and vent solenoids. Refer to Group 8H for Speed Control Information.

TACHOMETER—PCM OUTPUT

The powertrain control module (PCM) supplies engine rpm values to the instrument cluster tachometer. Refer to Group 8E for tachometer information.

OPEN LOOP/CLOSED LOOP MODES OF OPERATION

As input signals to the powertrain control module (PCM) change, the PCM adjusts its response to the output devices. For example, the PCM must calculate different injector pulse width and ignition timing for idle than it does for wide open throttle (WOT). There are several different modes of operation that determine how the PCM responds to the various input signals.

MODES

- Open Loop
- Closed Loop

During Open Loop modes, the powertrain control module (PCM) receives input signals and responds only according to preset PCM programming. Input from the oxygen (O_2) sensor is not monitored during Open Loop modes.

During Closed Loop modes, the PCM will monitor the oxygen (O_2) sensor input. This input indicates to the PCM whether or not the calculated injector pulse width results in the ideal air-fuel ratio. This ratio is 14.7 parts air-to-1 part fuel. By monitoring the exhaust oxygen content through the O_2 sensor, the PCM can fine tune the injector pulse width. This is done to achieve optimum fuel economy combined with low emission engine performance.

The fuel injection system has the following modes of operation:

- Ignition switch ON
- Engine start-up (crank)
- Engine warm-up
- Idle
- Cruise
- Acceleration
- Deceleration
- Wide open throttle (WOT)
- Ignition switch OFF

The ignition switch On, engine start-up (crank), engine warm-up, acceleration, deceleration and wide open throttle modes are Open Loop modes. The idle and cruise modes, (with the engine at operating temperature) are Closed Loop modes.

IGNITION SWITCH (KEY-ON) MODE

This is an Open Loop mode. When the fuel system is activated by the ignition switch, the following actions occur:

- The powertrain control module (PCM) pre-positions the idle air control (IAC) motor.
- The PCM determines atmospheric air pressure from the MAP sensor input to determine basic fuel strategy.
- The PCM monitors the engine coolant temperature sensor input. The PCM modifies fuel strategy based on this input.
- Intake manifold charge air temperature sensor input is monitored
- Throttle position sensor (TPS) is monitored
- The auto shut down (ASD) relay is energized by the PCM for approximately three seconds.

• The fuel pump is energized through the fuel pump relay by the PCM. The fuel pump will operate for approximately one second unless the engine is operating or the starter motor is engaged.
• The O_2 sensor heater element is energized through the fuel pump relay. The O_2 sensor input is not used by the PCM to calibrate air-fuel ratio during this mode of operation.
• The up-shift indicator light is illuminated (manual transmission only).

ENGINE START-UP MODE

This is an Open Loop mode. The following actions occur when the starter motor is engaged.

The powertrain control module (PCM) receives inputs from:
• Battery voltage
• Engine coolant temperature sensor
• Crankshaft position sensor
• Intake manifold charge air temperature sensor
• Manifold absolute pressure (MAP) sensor
• Throttle position sensor (TPS)
• Starter motor relay
• Camshaft position sensor signal

The PCM monitors the crankshaft position sensor. If the PCM does not receive a crankshaft position sensor signal within 3 seconds of cranking the engine, it will shut down the fuel injection system.

The fuel pump is activated by the PCM through the fuel pump relay.

Voltage is applied to the fuel injectors with the PCM. The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.

The PCM determines the proper ignition timing according to input received from the crankshaft position sensor.

ENGINE WARM-UP MODE

This is an Open Loop mode. During engine warm-up, the powertrain control module (PCM) receives inputs from:
• Battery voltage
• Crankshaft position sensor
• Engine coolant temperature sensor
• Intake manifold charge air temperature sensor
• Manifold absolute pressure (MAP) sensor
• Throttle position sensor (TPS)
• Camshaft position sensor signal (in the distributor)
• Park/Neutral Switch (Gear indicator signal—auto. trans. only)
• Air conditioning select signal (if equipped)
• Air conditioning request signal (if equipped)

Based on these inputs the following occurs:
• Voltage is applied to the fuel injectors with the powertrain control module (PCM). The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.
• The PCM adjusts engine idle speed through the idle air control (IAC) motor and adjusts ignition timing.
• The PCM operates the A/C compressor clutch through the clutch relay. This is done if A/C has been selected by the vehicle operator and requested by the A/C thermostat.
• If the vehicle has a manual transmission, the up-shift light is operated by the PCM.
• When engine has reached operating temperature, the PCM will begin monitoring O_2 sensor input. The system will then leave the warm-up mode and go into closed loop operation.

IDLE MODE

When the engine is at operating temperature, this is a Closed Loop mode. At idle speed, the powertrain control module (PCM) receives inputs from:
• Air conditioning select signal (if equipped)
• Air conditioning request signal (if equipped)
• Battery voltage
• Crankshaft position sensor
• Engine coolant temperature sensor
• Intake manifold charge air temperature sensor
• Manifold absolute pressure (MAP) sensor
• Throttle position sensor (TPS)
• Camshaft position sensor signal (in the distributor)
• Battery voltage
• Park/Neutral Switch (Gear indicator signal—Auto. trans. only)
• Oxygen sensor

Based on these inputs, the following occurs:
• Voltage is applied to the fuel injectors with the powertrain control module (PCM). The PCM will then control injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.
• The PCM monitors the O_2 sensor input and adjusts air-fuel ratio by varying injector pulse width. It also adjusts engine idle speed through the idle air control (IAC) motor.
• The PCM adjusts ignition timing by increasing and decreasing spark advance.
• The PCM operates the A/C compressor clutch through the clutch relay. This happens if A/C has been selected by the vehicle operator and requested by the A/C thermostat.

CRUISE MODE

When the engine is at operating temperature, this is a Closed Loop mode. At cruising speed, the powertrain control module (PCM) receives inputs from:
• Air conditioning select signal (if equipped)
• Air conditioning request signal (if equipped)
• Battery voltage

- Engine coolant temperature sensor
- Crankshaft position sensor
- Intake manifold charge air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Park/Neutral switch (gear indicator signal—auto. trans. only)
- Oxygen (O_2) sensor

Based on these inputs, the following occurs:

- Voltage is applied to the fuel injectors with the PCM. The PCM will then adjust the injector pulse width by turning the ground circuit to each individual injector on and off.
- The PCM monitors the O_2 sensor input and adjusts air-fuel ratio. It also adjusts engine idle speed through the idle air control (IAC) motor.
- The PCM adjusts ignition timing by turning the ground path to the coil on and off.
- The PCM operates the A/C compressor clutch through the clutch relay. This happens if A/C has been selected by the vehicle operator and requested by the A/C thermostat.

ACCELERATION MODE

This is an Open Loop mode. The powertrain control module (PCM) recognizes an abrupt increase in throttle position or MAP pressure as a demand for increased engine output and vehicle acceleration. The PCM increases injector pulse width in response to increased throttle opening.

DECELERATION MODE

When the engine is at operating temperature, this is an Open Loop mode. During hard deceleration, the powertrain control module (PCM) receives the following inputs.

- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)
- Battery voltage
- Engine coolant temperature sensor
- Crankshaft position sensor
- Intake manifold charge air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Park/Neutral switch (gear indicator signal—auto. trans. only)

If the vehicle is under hard deceleration with the proper rpm and closed throttle conditions, the PCM will ignore the oxygen sensor input signal. The PCM will enter a fuel cut-off strategy in which it will not supply battery voltage to the injectors. If a hard deceleration does not exist, the PCM will determine the proper injector pulse width and continue injection.

Based on the above inputs, the PCM will adjust engine idle speed through the idle air control (IAC) motor.

The PCM adjusts ignition timing by turning the ground path to the coil on and off.

The PCM opens the ground circuit to the A/C clutch relay to disengage the A/C compressor clutch. This is done until the vehicle is no longer under deceleration (if the A/C system is operating).

WIDE OPEN THROTTLE MODE

This is an Open Loop mode. During wide open throttle operation, the powertrain control module (PCM) receives the following inputs.

- Battery voltage
- Crankshaft position sensor
- Engine coolant temperature sensor
- Intake manifold charge air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)

During wide open throttle conditions, the following occurs:

- Voltage is applied to the fuel injectors with the powertrain control module (PCM). The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off. The PCM ignores the oxygen sensor input signal and provides a predetermined amount of additional fuel. This is done by adjusting injector pulse width.
- The PCM adjusts ignition timing by turning the ground path to the coil on and off.
- The PCM opens the ground circuit to the A/C clutch relay to disengage the A/C compressor clutch. This will be done for approximately 15 seconds (if the air conditioning system is operating).

If the vehicle has a manual transmission, the upshift light is operated by the PCM.

IGNITION SWITCH OFF MODE

When ignition switch is turned to OFF position, the PCM stops operating the injectors, ignition coil, ASD relay and fuel pump relay.

THROTTLE BODY

Filtered air from the air cleaner enters the intake manifold through the throttle body (Fig. 15). Fuel does not enter the intake manifold through the throttle body. Fuel is sprayed into the manifold by the fuel injectors. The throttle body is mounted on the intake manifold. It contains an air control passage controlled by an Idle Air Control (IAC) motor. The air control passage is used to supply air for idle conditions. A throttle valve (plate) is used to supply air for above idle conditions.

The throttle position sensor (TPS) and idle air control (IAC) motor are attached to the throttle body. The accelerator pedal cable, speed control cable and transmission control cable (when equipped) are connected to the throttle arm.

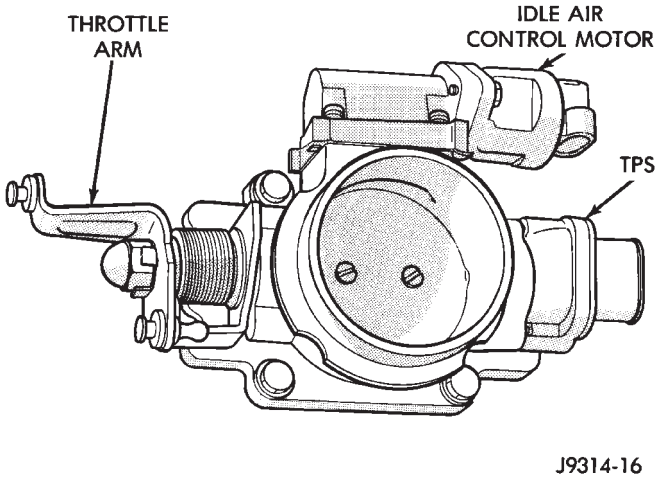

Fig. 15 Throttle Body—Typical

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

FUEL RAIL

The fuel rail supplies fuel to the injectors and is mounted to the intake manifold (Fig. 16). The fuel pressure regulator is attached to the rail and the fuel pressure test port is integral with the rail. The fuel rail is not repairable.

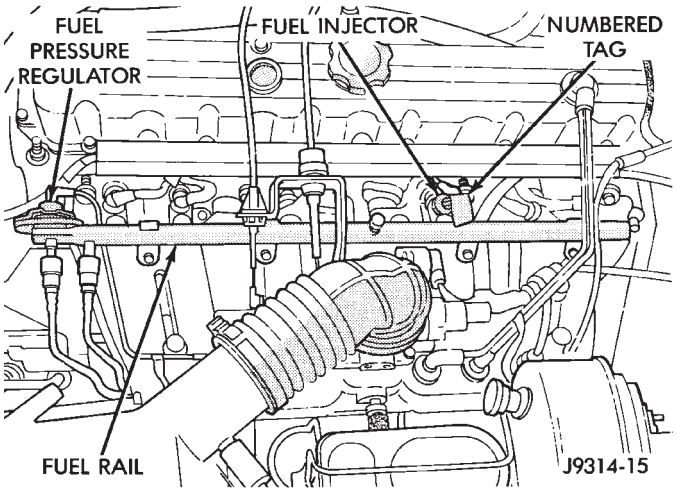

Fig. 16 Fuel Rail—Typical

FUEL PRESSURE REGULATOR

The fuel pressure regulator (Fig. 17) is a mechanical device that is not controlled by the powertrain control module (PCM).

The fuel pressure regulator used is a vacuum balanced, nonadjustable type. The regulator is mounted on the output end of the fuel rail and is connected to intake manifold vacuum. The fuel return tube (to the fuel tank) is connected to the fuel pressure regulator.

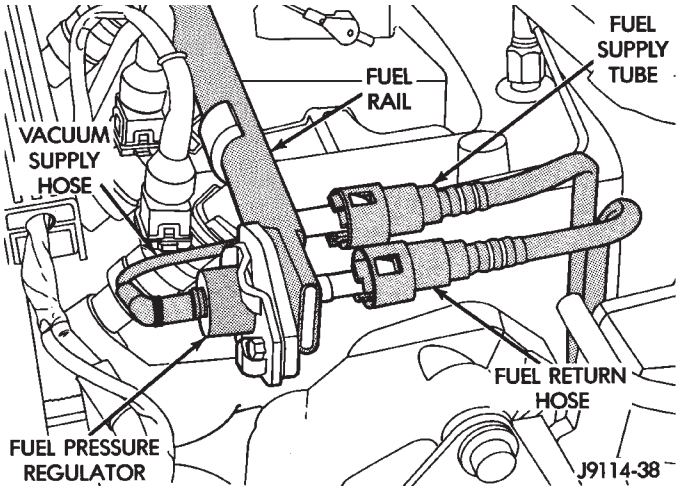

Fig. 17 Fuel Pressure Regulator—Typical

The regulator is calibrated to maintain fuel system pressure at approximately 214 kPa (31 psi). This is with vacuum applied while the engine is at idle. Fuel pressure will be 55-69 kPa (8-10 psi) higher if vacuum is not applied to the regulator.

The pressure regulator contains a diaphragm, calibrated spring and a fuel return valve (Fig. 18). Fuel pressure operates on one side of the regulator, while spring pressure and intake manifold vacuum operate on the other side. Spring pressure on one side of the diaphragm tries to force the return valve closed. Fuel pressure on other side of diaphragm, with assistance from manifold vacuum on spring side of diaphragm, act against spring pressure to open the return valve. System fuel pressure is the amount of fuel pressure required to force against spring pressure and unseat the return valve.

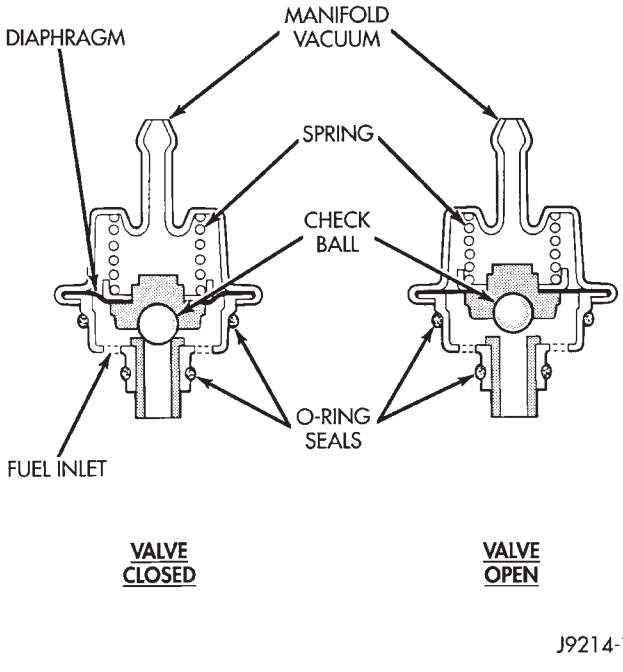

Fig. 18 Fuel Pressure Regulator Operation—Typical

Without vacuum applied to the spring side of the regulator, the spring is calibrated to open the fuel return outlet. This happens when the pressure differential between the fuel injectors and the intake manifold reaches approximately 269 kPa (39 psi). Since manifold vacuum varies with engine operating conditions, the amount of vacuum applied to the spring side of the diaphragm varies. For this reason, fuel pressure varies, depending upon intake manifold vacuum. With low vacuum, such as during wide open throttle conditions, minimal vacuum assistance is available. Full spring pressure is exerted to seal the fuel outlet. This causes the system pressure to increase. With high vacuum, such as at engine idle or during vehicle deceleration, fuel pressure on one side of the diaphragm is balanced by intake manifold pressure. This is done on the spring side of the diaphragm and results in lower system fuel pressure.

MPI SYSTEM—4.0L ENGINE—GENERAL DIAGNOSIS

INDEX

GENERAL INFORMATION

All 4.0L engines are equipped with sequential Multi-Port Fuel Injection (MPI). The MPI system provides precise air/fuel ratios for all driving conditions.

VISUAL INSPECTION

A visual inspection for loose, disconnected, or incorrectly routed wires and hoses should be made. This should be done before attempting to diagnose or service the fuel injection system. A visual check will help spot these faults and save unnecessary test and diagnostic time. A thorough visual inspection will include the following checks:

(1) Verify that the 60-way connector is fully inserted into the connector of the Powertrain Control Module (PCM) (Fig. 1). Verify that the connector mounting screw is tightened to 4 N•m (35 in. lbs.) torque.

(2) Inspect the battery cable connections. Be sure that they are clean and tight.

(3) Inspect fuel pump relay, air conditioning compressor clutch relay (if equipped) and ASD relay. These are located in the Power Distribution Center (Fig. 2). Inspect starter motor relay connections. Inspect relays for signs of physical damage and corrosion.

(4) Inspect ignition coil connections. Look for bent or spread pins in the connector. Verify that coil secondary cable is firmly connected to coil (Fig. 3).

(5) Verify that distributor cap is correctly attached to distributor. Be sure that spark plug cables are firmly connected to the distributor cap and the spark

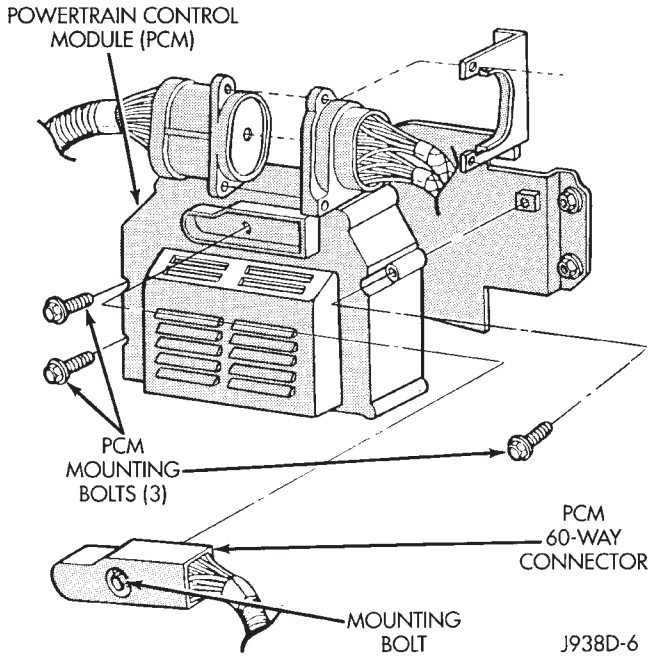

Fig. 1 Powertrain Control Module (PCM) Connector

plugs are in their correct firing order. Be sure that coil cable is firmly connected to distributor cap and coil. Be sure that camshaft position sensor wire connector (from in the distributor) is firmly connected to main harness connector (Fig. 4). Inspect spark plug condition. Refer to Group 8D, Ignition System. Connect vehicle to an oscilloscope and inspect spark events for fouled or damaged spark plugs or cables.

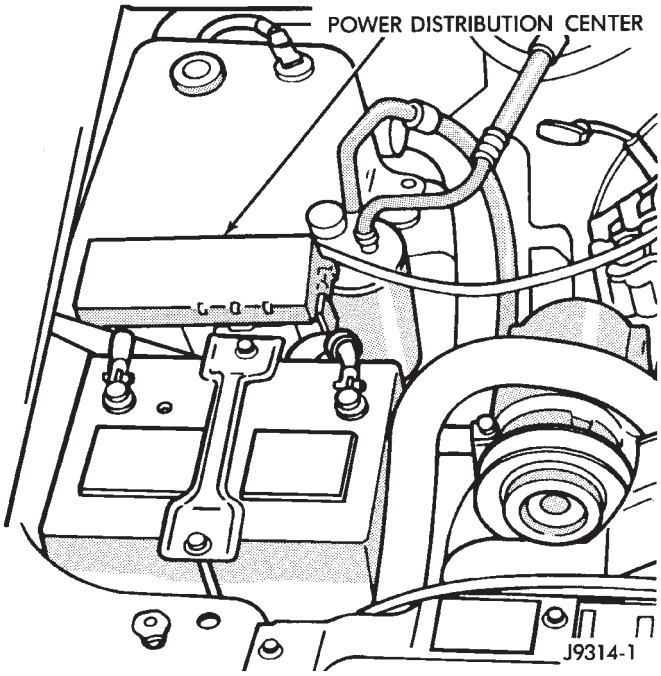

Fig. 2 Power Distribution Center

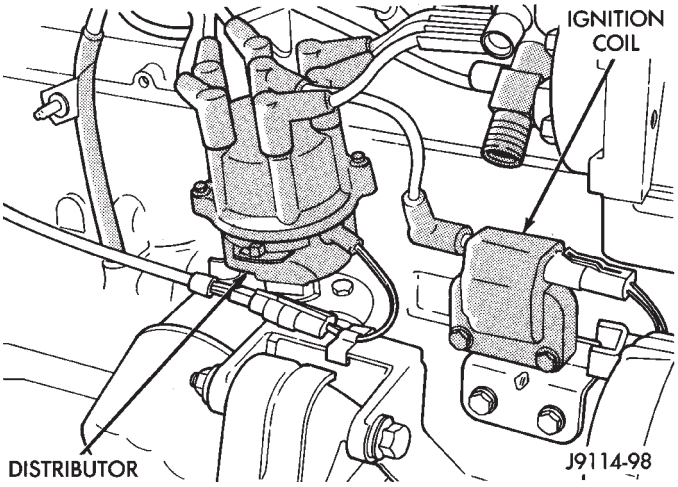

Fig. 3 Ignition Coil—Typical

(6) Verify that generator output wire, generator connector and ground wire are firmly connected to the generator (Fig. 5).

(7) Inspect the system ground connections at the right inner fender next to the battery. Be sure the bolt is tight and the ground terminals are clean. The Powertrain Control Module (PCM) is grounded directly (and plugged individually) to the negative battery cable with a small jumper harness.

(8) Verify that crankcase ventilation (CCV) fresh air hose is firmly connected to cylinder head and air cleaner covers. Refer to Group 25, Emission Control System for information.

(9) Verify that vacuum hose is firmly connected to fuel pressure regulator and manifold fitting (Fig. 6).

(10) Inspect fuel tube quick-connect fitting-to-fuel rail connections (Fig. 7).

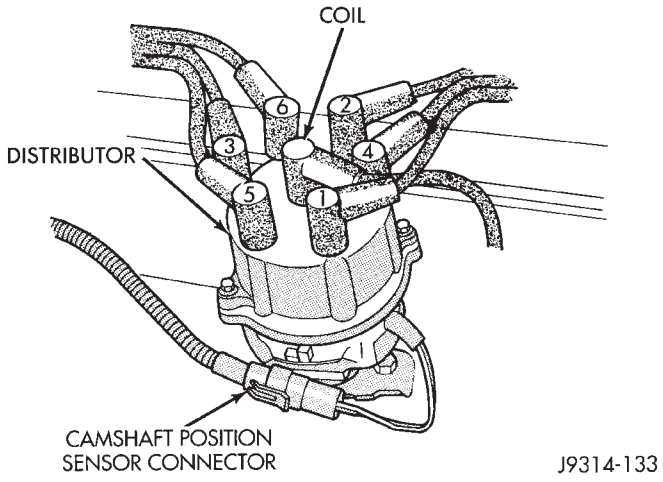

Fig. 4 Distributor Cap, Spark Plug Cables and Camshaft Position Sensor Connector

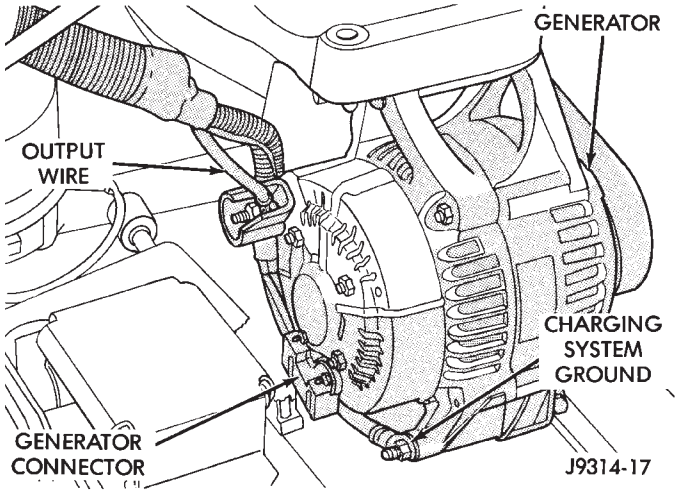

Fig. 5 Generator Connector and Output Wire Connections—Typical

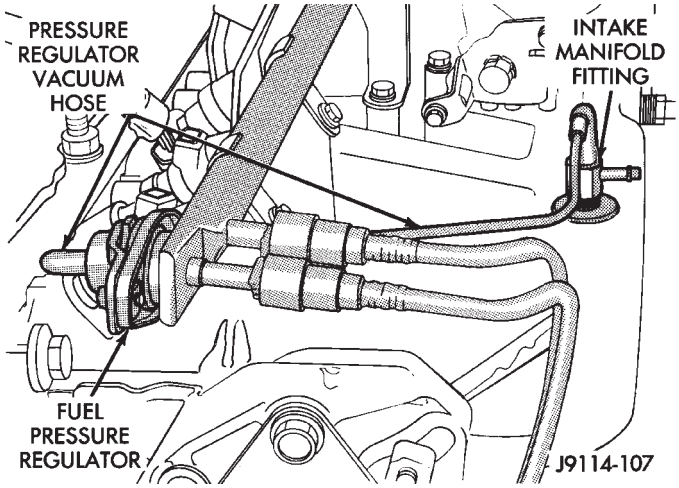

Fig. 6 Fuel Pressure Regulator Vacuum Hose—Typical

(11) Verify that hose connections to all ports of vacuum fittings on intake manifold are tight and not leaking.

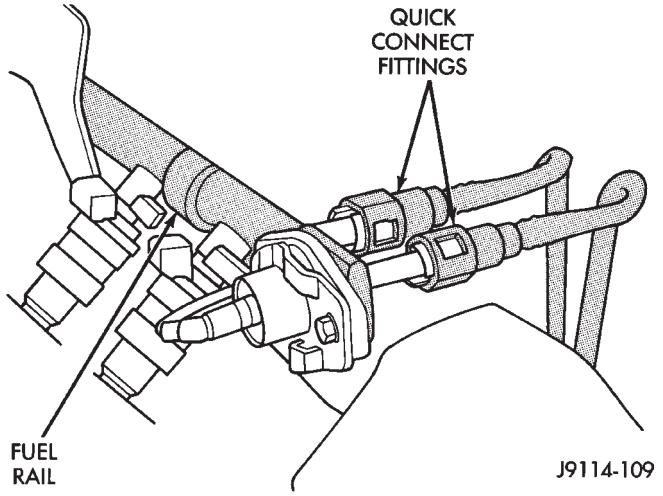

Fig. 7 Fuel Supply Tube—Typical

(12) Inspect accelerator cable, transmission throttle cable (if equipped) and cruise control cable connections (if equipped). Check their connections to the throttle arm of throttle body for any binding or restrictions (Fig. 8).

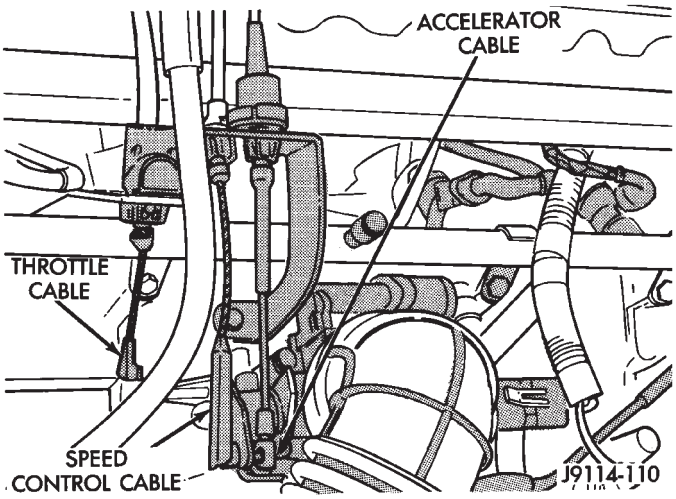

Fig. 8 Accelerator Cable, Throttle Cable and Speed Control Cable

(13) Verify that brake vacuum booster hose is firmly connected to fitting on intake manifold. Also check connection to brake vacuum booster.

(14) Inspect the air cleaner inlet and air filter element for restrictions.

(15) Inspect radiator grille area, radiator fins and air conditioning condenser for restrictions.

(16) Verify that intake manifold air temperature sensor wire connector is firmly connected to harness connector (Fig. 9).

(17) Verify that MAP sensor electrical connector is firmly connected to MAP sensor (Fig. 10). Verify that vacuum hose is firmly connected to MAP sensor and to the intake manifold.

(18) Verify that fuel injector wire harness connectors are firmly connected to the fuel injectors in the

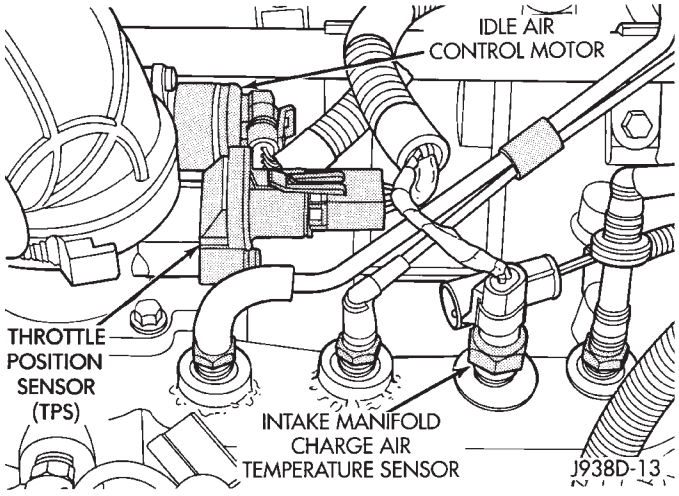

Fig. 9 Sensor Connectors

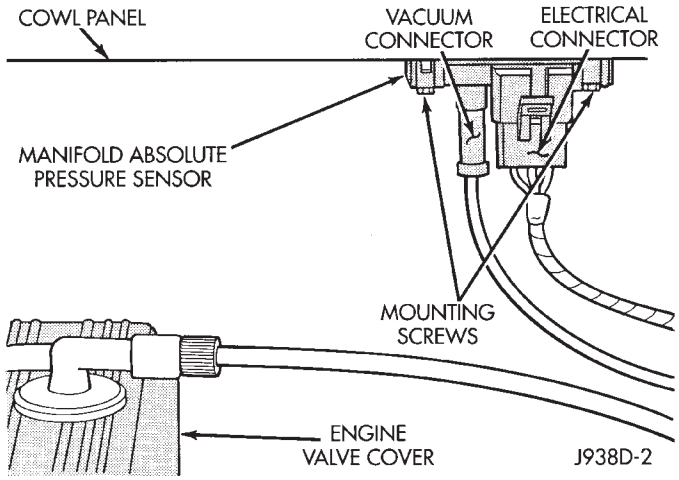

Fig. 10 Manifold Absolute Pressure (MAP) Sensor

correct firing order. Each harness connector is tagged with the number of its corresponding fuel injector (Fig. 11).

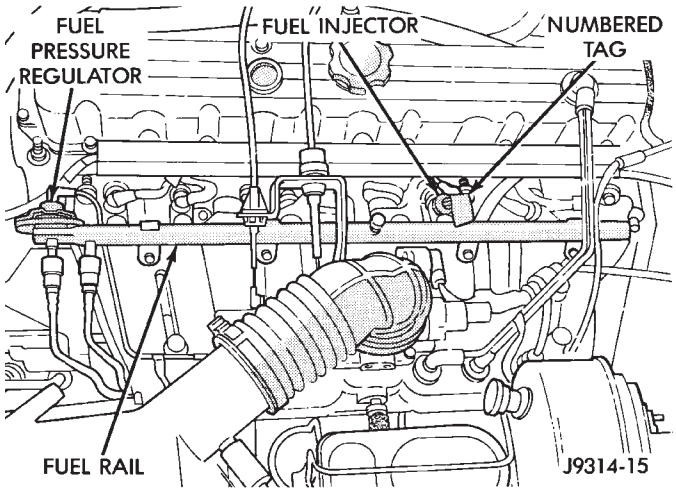

Fig. 11 Fuel Injector Wire Harness—Typical

(19) Verify that harness connectors are firmly connected to idle air control motor and throttle position sensor.

(20) Verify that wire harness connector is firmly connected to the engine coolant temperature sensor (Fig. 12).

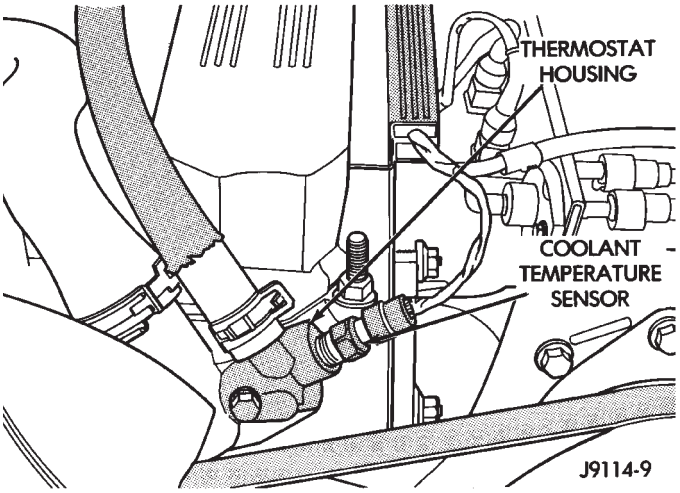

Fig. 12 Engine Coolant Temperature Sensor—Typical

(21) Verify that Oxygen Sensor wire connector is firmly connected to the sensor. Inspect sensor and connector for damage (Fig. 13).

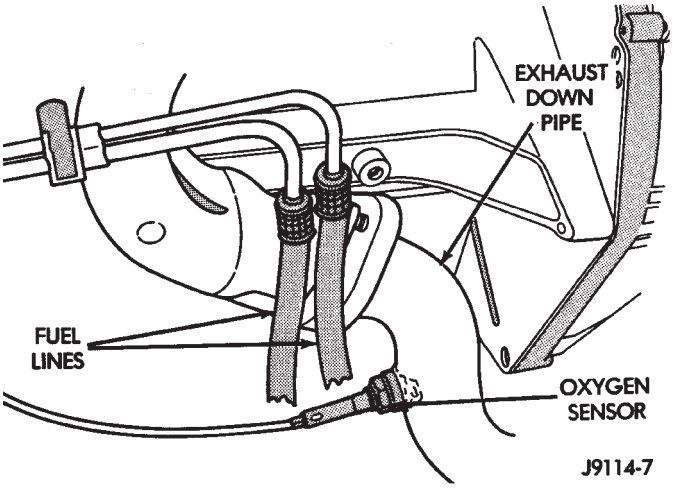

Fig. 13 Oxygen Sensor Location—Typical

(22) Raise and support the vehicle.

(23) Inspect for pinched or leaking fuel tubes. Inspect for pinched cracked or leaking fuel lines.

(24) Inspect for exhaust system restrictions such as pinched exhaust pipes, collapsed muffler or plugged catalytic convertor.

(25) If equipped with automatic transmission, verify that electrical harness is firmly connected to neutral safety switch. Refer to the Automatic Transmission section of Group 21.

(26) Verify that the harness connector is firmly connected to the vehicle speed sensor (Fig. 14).

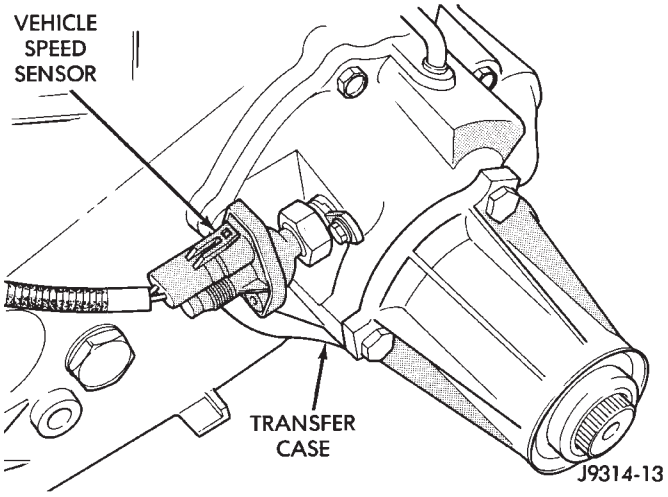

Fig. 14 Vehicle Speed Sensor—Typical

(27) Verify that fuel pump/gauge sender unit wire connector (located near front of fuel tank) is firmly connected to harness connector.

(28) Inspect fuel lines at front of fuel tank for cracks or leaks.

(29) Inspect transmission torque convertor housing (automatic transmission) or clutch housing (manual transmission) for damage to timing ring on drive plate/flywheel.

(30) Verify that battery cable and solenoid feed wire connections to the starter solenoid are tight and clean. Inspect for chaffed wires or wires rubbing up against other components (Fig. 15).

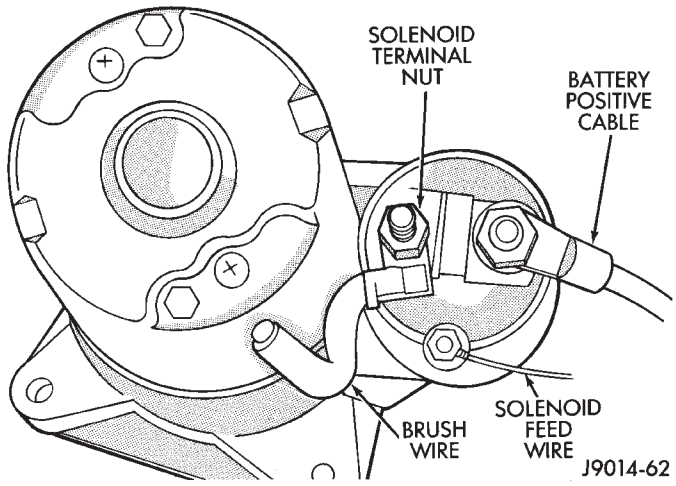

Fig. 15 Starter Solenoid Connection—Typical

POWERTRAIN CONTROL MODULE (PCM) 60-WAY CONNECTOR

Terminal identification and specific circuit applications for the 4.0L six-cylinder engine are detailed in the PCM connector chart (Fig. 16).

SYSTEM SCHEMATICS

Fuel system schematics for fuel injected 4.0L engines are shown in figure 17.

CAV	WIRE COLOR	DESCRIPTION
1	RD/WT	MANIFOLD ABSOLUTE PRESSURE SENSOR SIGNAL
2	TN/BK*	ENGINE COOLANT TEMPERATURE SENSOR
3	RD	DIRECT BATTERY VOLTAGE
4	BK/LB*	SENSOR GROUND (PCM II)
5	BK/TN	POWER GROUND
6	VT/WT	+ 5 VOLT OUTPUT
7	WT/BK	+ 8 VOLT OUTPUT
8		
9	LB/RD	IGNITION (START AND RUN)
10		
11	BK/TN*	POWER GROUND
12	BK/TN*	POWER GROUND
13	LB/BR*	INJECTOR NO. 4
14	YL/WT*	INJECTOR NO. 3
15	TN	INJECTOR NO. 2
16	WT/LB	INJECTOR NO. 1
17		
18		
19	GY/WT	DISTRIBUTOR IGNITION COIL (-)
20	DG	GENERATOR FIELD CONTROL
21	BK/RD*	INTAKE (MANIFOLD) AIR TEMPERATURE SENSOR
22	OR/DB*	THROTTLE POSITION SENSOR
23		
24	RD/LG	CRANKSHAFT POSITION SENSOR (CPS)
25	BK	DIAGNOSTIC CONNECTOR
26	VT/BR*	CHRYSLER COLLISION DETECTION BUS (+)
27	DB/OR	A/C LOW PRESSURE SWITCH
28	LG	A/C SELECT
29	BR	BRAKE SWITCH (-)
30	BK/WT	PARK/NEUTRAL SWITCH (AUTO TRANS. ONLY)
31		
32	BK/PK*	CHECK ENGINE LAMP
33	TN/RD*	SPEED CONTROL VACUUM SOLENOID
34	DB/RD	A/C CLUTCH RELAY
35		
36		
37		
38	GY	INJECTOR NO. 5
39	YL/BK	IDLE AIR CONTROL MOTOR (4)
40	BR/WT*	IDLE AIR CONTROL MOTOR (2)
41	BK/OR	OXYGEN SENSOR
42		
43	GY/LB*	TACH SIGNAL OUTPUT (VEHICLE W/TACHOMETER)
44	GY/BL	CAMSHAFT POSITION SENSOR (FUEL SYNC)
45	BK/YL	DIAGNOSTIC CONNECTOR
46	WT/GY	CHRYSLER COLLISION DETECTION BUS (-)
47	WT/OR*	VEHICLE SPEED (DISTANCE) SENSOR
48	BR/RD*	SPEED CONTROL COAST/SET
49	YL/RD*	SPEED CONTROL ON/OFF
50	WT/LG*	SPEED CONTROL RESUME/ACCEL
51	PK	FUEL PUMP RELAY
52		
53	LG/RD*	SPEED CONTROL VENT SOLENOID
54		
55		
56	GY/PK*	SERVICE REMINDER INDICATOR
57	DG/BK	AUTOMATIC SHUTDOWN RELAY (SENSE)
58	BR/YL	INJECTOR NO. 6
59	GY/RD	IDLE AIR CONTROL MOTOR (1)
60	VT/BK	IDLE AIR CONTROL MOTOR (3)

WIRE COLOR CODES					
		LB	LIGHT BLUE	VT	VIOLET
BK	BLACK	LG	LIGHT GREEN	WT	WHITE
BR	BROWN	OR	ORANGE	YL	YELLOW
DB	DARK BLUE	PK	PINK	*	WITH TRACER
DG	DARK GREEN	RD	RED		
GY	GRAY	TN	TAN		

CONNECTOR TERMINAL SIDE SHOWN

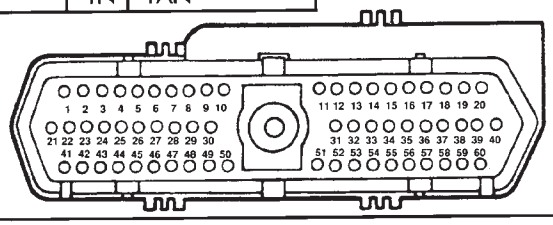

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Fig. 16 PCM Connector—4.0L Engine

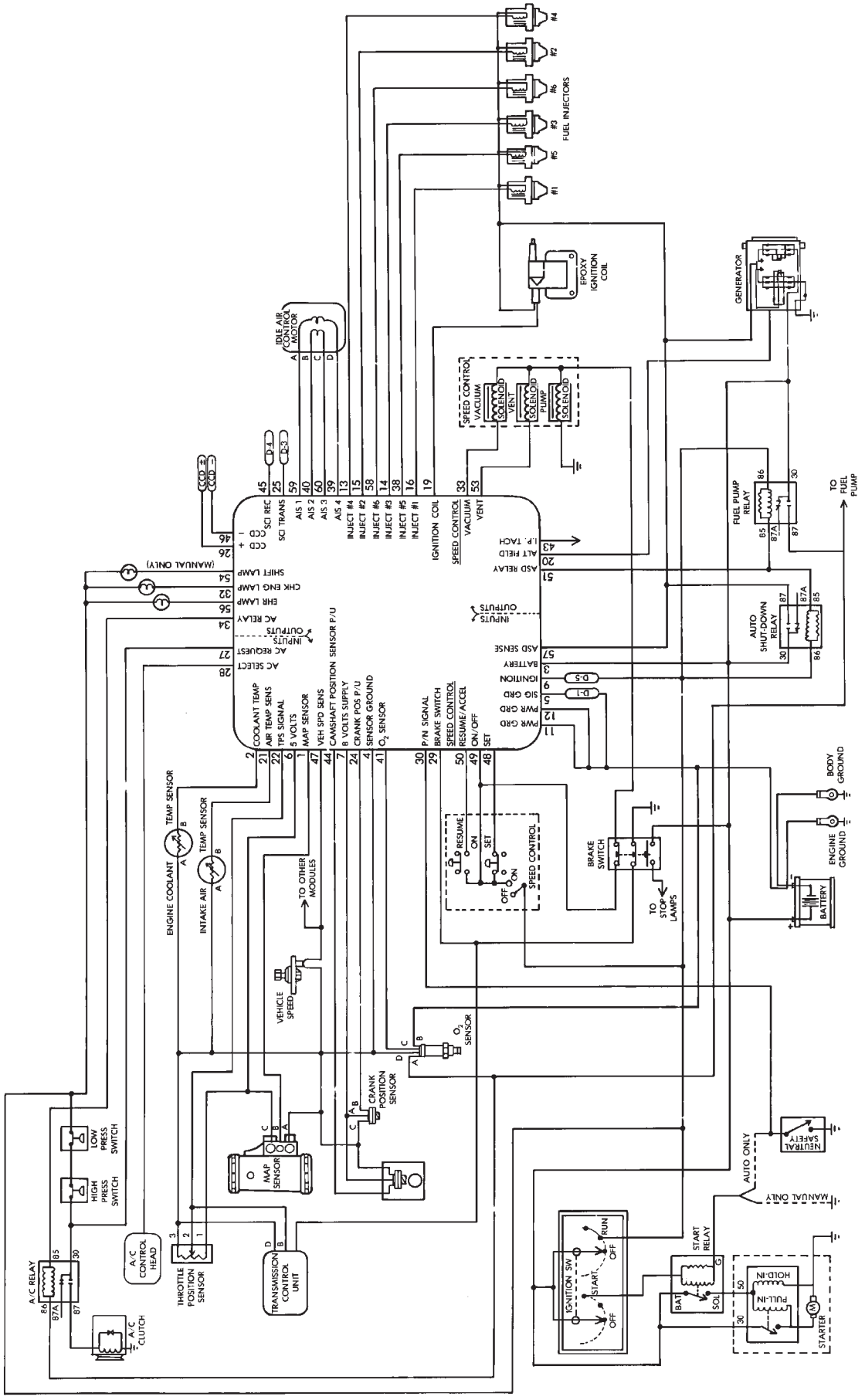

Fig. 17 System Schematic—4.0L Engine

CAMSHAFT POSITION SENSOR TEST

Refer to Group 8D, Ignition Systems, for Camshaft Position Sensor testing.

COOLANT TEMPERATURE SENSOR TEST

Disconnect wire harness connector from engine coolant temperature sensor (Fig. 18).

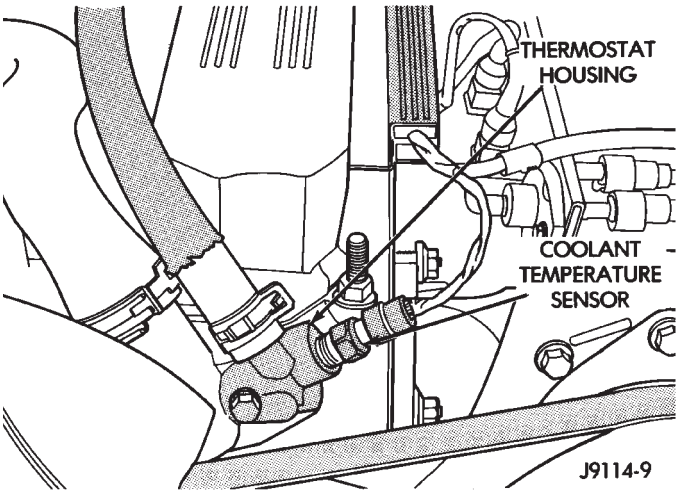

Fig. 18 Coolant Temperature Sensor—Typical

Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter. The resistance should be less than 1000 ohms with the engine at its correct operating temperature. Refer to the Coolant Temperature Sensor/Manifold Air Temperature Sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

Test continuity of the wire harness. Do this between the Powertrain Control Module (PCM) wire harness connector terminal 2 and the sensor connector terminal. Also test continuity of wire harness terminal 4 to the sensor connector terminal. Repair the wire harness if an open circuit is indicated.

CHARGE AIR TEMPERATURE SENSOR TEST

Disconnect the wire harness connector from the intake manifold charge air temperature sensor (Fig. 19).

Test the resistance of the sensor with an input impedance (digital) volt-ohmmeter. The resistance should be less than 4000 ohms with the engine at operating temperature. The longer the engine idles, the warmer the intake manifold temperature will become. Refer to the Coolant Temperature Sensor/Manifold Air Temperature Sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

Test the resistance of the wire harness. Do this between the Powertrain Control Module (PCM) wire harness connector terminal 2 and the sensor connector terminal. Also test terminal 4 to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

SENSOR RESISTANCE (OHMS)—COOLANT TEMPERATURE SENSOR/MANIFOLD AIR TEMPERATURE

TEMPERATURE		RESISTANCE (OHMS)	
C	F	MIN	MAX
−40	−40	291,490	381,710
−20	−4	85,850	108,390
−10	14	49,250	61,430
0	32	29,330	35,990
10	50	17,990	21,810
20	68	11,370	13,610
25	77	9,120	10,880
30	86	7,370	8,750
40	104	4,900	5,750
50	122	3,330	3,880
60	140	2,310	2,670
70	158	1,630	1,870
80	176	1,170	1,340
90	194	860	970
100	212	640	720
110	230	480	540
120	248	370	410

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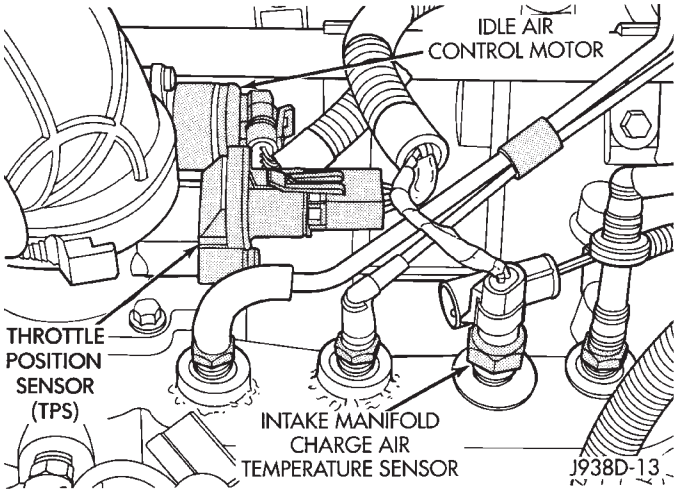


Fig. 19 Air Temperature Sensor

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST

Inspect the MAP sensor vacuum hose connections at the throttle body and sensor. Repair as necessary.

CAUTION: When testing, do not remove the electrical connector from MAP sensor (Fig. 20). Be sure that the MAP sensor harness wires are not damaged by the test meter probes.

Test the MAP sensor output voltage at the MAP sensor connector between terminals A and B (as marked on the sensor body) (Fig. 21). With the ignition switch ON and the engine OFF, output voltage

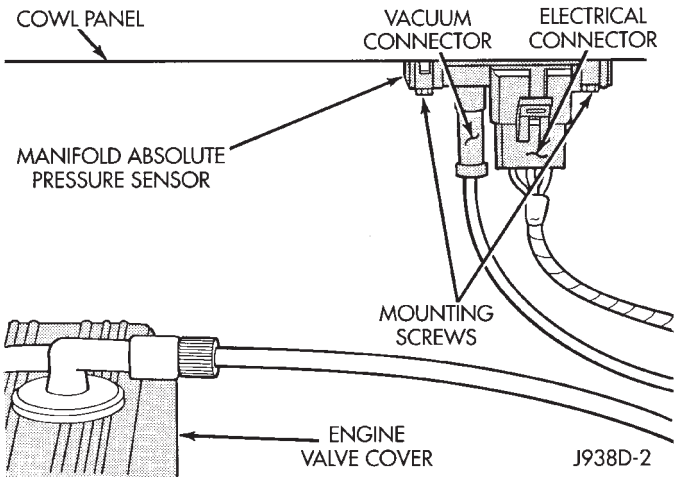


Fig. 20 MAP Sensor Location

should be 4-to-5 volts. The voltage should drop to 1.5-to-2.1 volts with a neutral-hot idle speed condition.

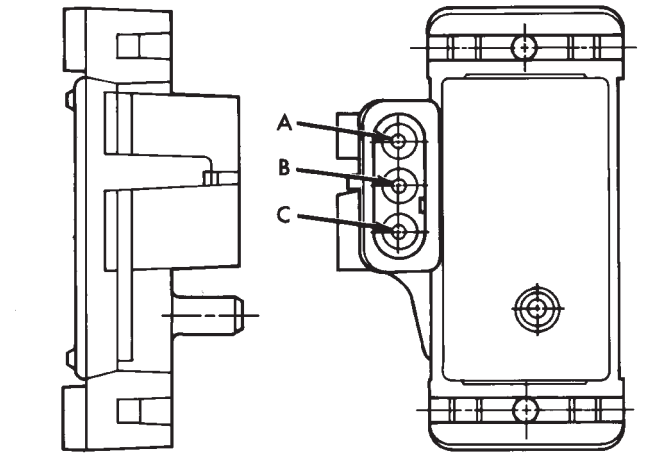


Fig. 21 MAP Sensor Connector Terminals—Typical

Test Powertrain Control Module (PCM) (terminal 5) for the same voltage described above to verify the wire harness condition. Repair as necessary.

Test MAP sensor supply voltage at sensor connector between terminals A and C (Fig. 21) with the ignition ON and engine OFF. The voltage should be approximately 5 volts (±0.5V). Five volts (±0.5V) should also be at terminal 6 of the PCM wire harness connector. Repair or replace the wire harness as necessary.

Test the MAP sensor ground circuit at sensor connector terminal A (Fig. 21) and PCM connector terminal 4. Repair the wire harness if necessary.

Test the MAP sensor ground circuit at the PCM connector between terminal 4 and terminal 11 with an ohmmeter. If the ohmmeter indicates an open circuit, inspect for a defective sensor ground connection. Refer to Group 8W, Wiring for location of engine grounds. If the ground connection is good, replace the PCM. If terminal 4 has a short circuit to 12 volts, correct this condition before replacing the PCM.

CRANKSHAFT POSITION SENSOR TEST

Refer to Group 8D, Ignition Systems for test procedures.

THROTTLE POSITION SENSOR (TPS) TEST

The throttle position sensor (TPS) can be tested with a digital voltmeter. The center terminal of the TPS is the output terminal (Fig. 22).

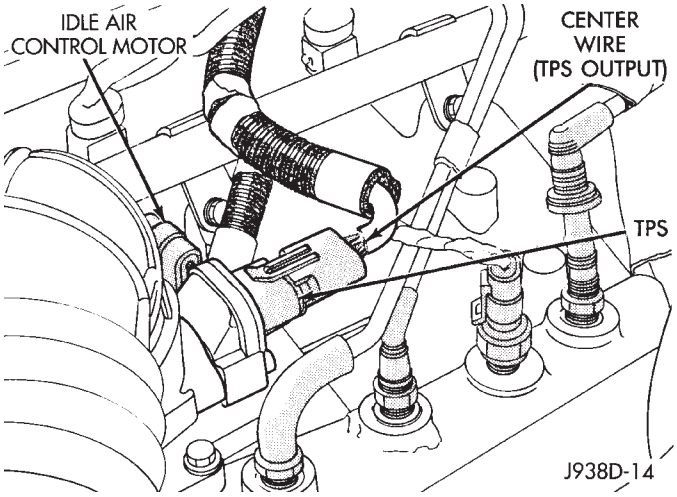


Fig. 22 Throttle Position Sensor (TPS) Testing—Typical

With the ignition key in the ON position, backprobe the TPS connector. Check the TPS output voltage at the center terminal wire of the connector. Check this at idle (throttle plate closed) and at wide open throttle (WOT). At idle, TPS output voltage should must be greater than 200 millivolts. At wide open throttle, TPS output voltage must be less than 4.8 volts. The output voltage should increase gradually as the throttle plate is slowly opened from idle to WOT.

OXYGEN SENSOR (O_2) HEATING ELEMENT TEST

The oxygen sensor heating element can be tested with an ohmmeter as follows:

With the sensor at room temperature 25 degrees C (77 degrees F), disconnect the O_2 sensor connector (Fig. 23). Connect the ohmmeter test leads across the white wire terminals of the sensor connector. Resistance should be between 5 and 7 ohms. Replace the sensor if the ohmmeter displays an infinity (open) reading.

IDLE AIR CONTROL MOTOR TEST

Idle Air Control Motor operation can be tested using special exerciser tool number 7558 (Fig. 24).

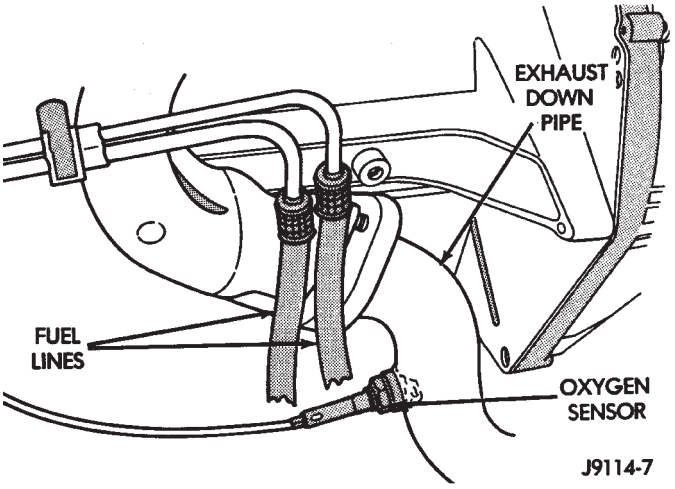


Fig. 23 Oxygen Sensor—Typical

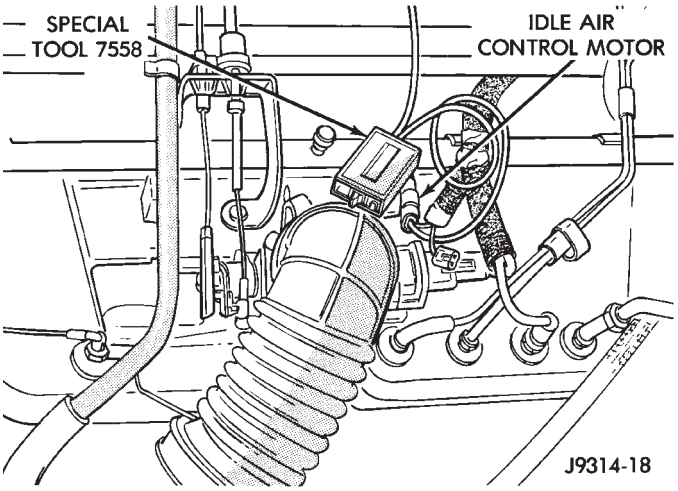


Fig. 24 Idle Air Control Motor Testing

CAUTION: Proper safety precautions must be taken when testing the Idle Air Control Motor:

- Set the parking brake and block the drive wheels
- Route all tester cables away from the cooling fans, drive belt, pulleys and exhaust components
- Provide proper ventilation while operating the engine
- Always return the engine idle speed to normal before disconnecting the exerciser tool

(1) With the ignition OFF, disconnect the Idle Air Control Motor wire connector at throttle body (Fig. 24).

(2) Plug the exerciser tool number 7558 harness connector into the Idle Air Control Motor.

(3) Connect the red clip of exerciser tool 7558 to battery positive terminal. Connect the black clip to negative battery terminal. The red light on the exerciser tool will flash when the tool is properly connected.

(4) Start engine.

When the switch on the tool is in the HIGH or LOW position, the light on the tool will flash. This indicates that voltage pulses are being sent to the Idle Air Control stepper motor.

(5) Move the switch to the HIGH position. The engine speed should increase. Move the switch to the LOW position. The engine speed should decrease.

(a) If the engine speed changes while using the exerciser tool, the Idle Air Control Motor is functioning properly. Disconnect the exerciser tool and connect the Idle Air Control Motor wire connector to the stepper motor.

(b) If the engine speed does not change, turn the ignition OFF and proceed to step (6). Do not disconnect exerciser tool from the Idle Air Control Motor.

(6) Remove the Idle Air Control Motor from the throttle body. Do not remove Idle speed motor housing from throttle body.

CAUTION: When checking Idle Air Control Motor operation with the motor removed from the throttle body, do not extend the pintle (Fig. 25) more than 6.35 mm (.250 in). If the pintle is extended more than this amount, it may separate from the Idle Air Control Motor. The Idle Air Control Motor must be replaced if the pintle separates from the motor.

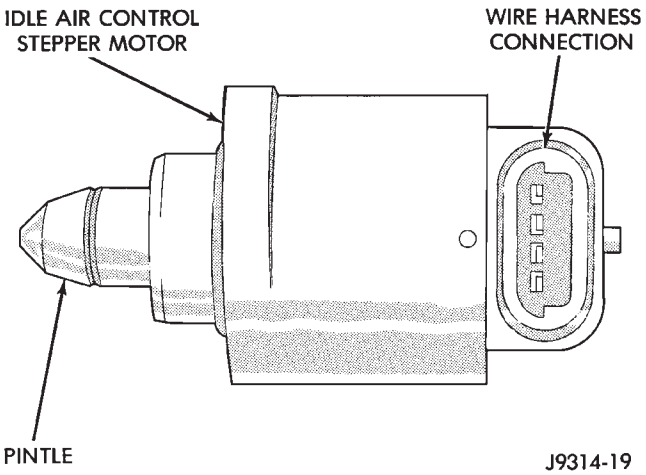


Fig. 25 Idle Air Control Motor Pintle

(7) With the ignition OFF, cycle the exerciser tool switch between the HIGH and LOW positions. Observe the pintle. The pintle should move in-and-out of the motor.

(a) If the pintle does not move, replace the Idle Air Control Motor. Start the engine and test the replacement motor operation as described in step (5).

(b) If the pintle operates properly, check the Idle Air Control Motor bore in the throttle body bore for blockage and clean as necessary. Reinstall the Idle Air Control Motor and retest. If blockage is not found, refer to the DRB II Scan Tool and the appropriate Powertrain Diagnostics Procedures service manual.

RELAYS—OPERATION/TESTING

OPERATION

The following operations/tests apply to these relays only: Automatic Shutdown (ASD) and Fuel Pump. For operations/tests on all other relays, refer to the appropriate section of this service manual.

The relay terminal numbers from (Fig. 26) can be found on the bottom of the relay:

- Terminal number 30 is connected to battery voltage and can be switched or B+ (hot) at all times.
- Terminal number 87A is connected (a circuit is formed) to terminal 30 in the de-energized (normally OFF) position.
- Terminal number 87 is connected (a circuit is formed) to terminal 30 in the energized (ON) position. Terminal number 87 then supplies battery voltage to the component being operated.
- Terminal number 86 is connected to a switched (+) power source.
- Terminal number 85 is grounded by the Powertrain Control Module (PCM).

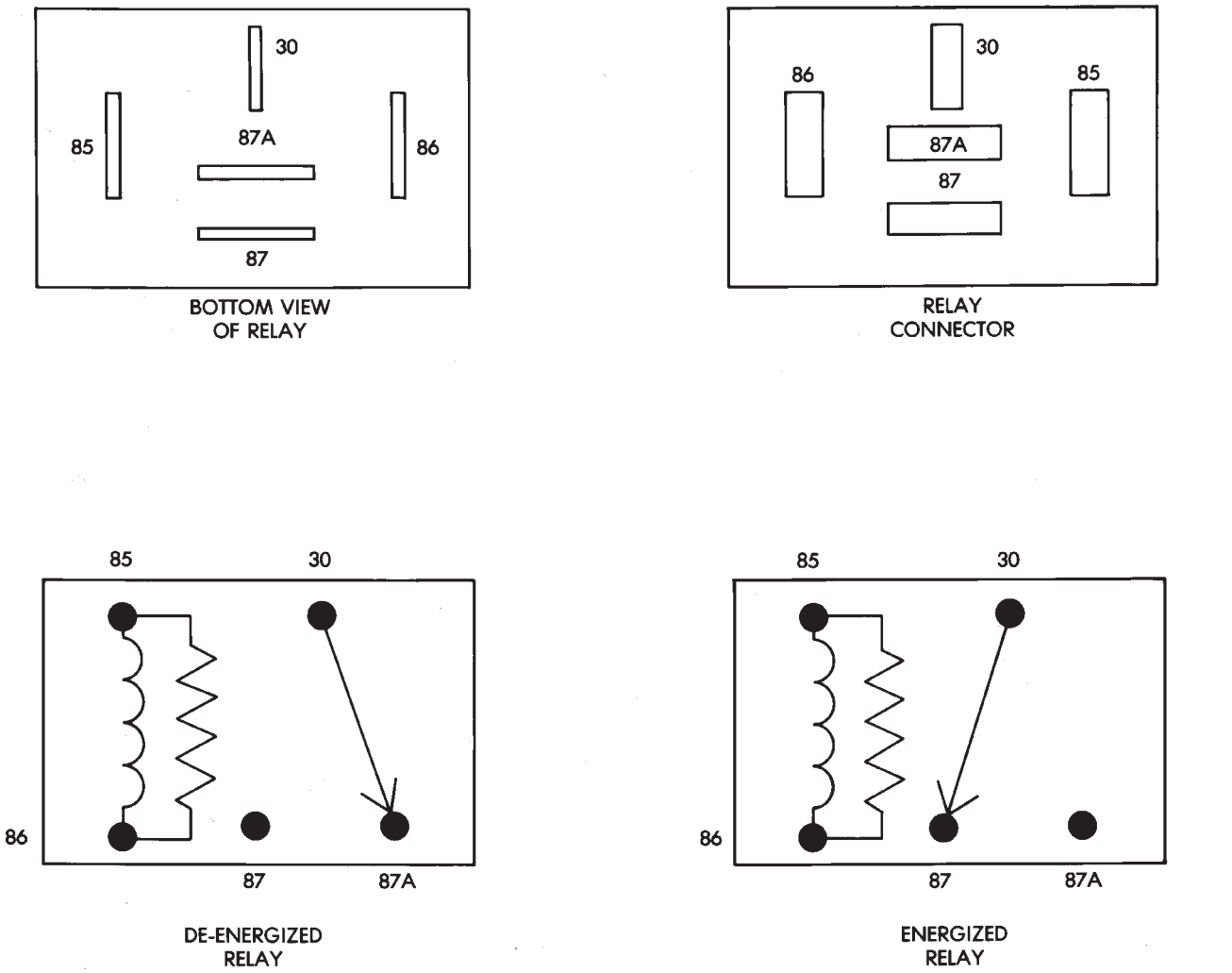


Fig. 26 Relay Terminals

TESTING

(1) Remove relay before testing.

(2) Using an ohmmeter, perform a resistance test between terminals 85 and 86. Resistance value (ohms) should be 75 ±5 ohms for resistor equipped relays.

(3) Connect the ohmmeter between terminals number 87A and 30. Continuity should be present at this time.

(4) Connect the ohmmeter between terminals number 87 and 30. Continuity should not be present at this time.

(5) Use a set of jumper wires (16 gauge or smaller). Connect one jumper wire between terminal number 85 (on the relay) to the ground side (-) of a 12 Volt power source.

(6) Attach the other jumper wire to the positive side (+) of a 12V power source. Do not connect the jumper wire to relay at this time.

CAUTION: DO NOT ALLOW THE OHMMETER TO CONTACT TERMINALS 85 OR 86 DURING THESE TESTS. DAMAGE TO OHMMETER MAY RESULT.

(7) Attach the other jumper wire (12V +) to terminal number 86. This will activate the relay. Continuity should now be present between terminals number 87 and 30. Continuity should not be present between terminals number 87A and 30.

(8) Disconnect jumper wires from relay and 12 Volt power source.

If continuity or resistance tests did not pass, replace relay. If tests passed, refer to (Fig. 17) for (fuel system) relay wiring schematics. Also refer to Group 8W, Wiring Diagrams for additional circuit information.

STARTER MOTOR RELAY TEST

Refer to Group 8A, Battery/Starting/ Charging/ System Diagnostics, for starter motor relay testing.

INJECTOR TEST

Disconnect the injector wire connector from the injector. Place an ohmmeter on the injector terminals. Resistance reading should be approximately 14.5 ohms ±1.2 ohms at 20°C (68°F). Proceed to following Injector Diagnosis chart.

FUEL SYSTEM PRESSURE TEST

Refer to the Fuel Delivery System section of this group.

ON-BOARD DIAGNOSTICS (OBD)

The Powertrain Control Module (PCM) has been programmed to monitor many different circuits of the fuel injection system. If a problem is sensed in a monitored circuit often enough to indicate an actual problem, a Diagnostic Trouble Code (DTC) is stored. The DTC will be stored in the PCM memory for eventual display to the service technician. If the problem is repaired or ceases to exist, the PCM cancels the DTC after 51 engine starts.

Certain criteria must be met for a diagnostic trouble code (DTC) to be entered into PCM memory. The criteria may be a specific range of engine rpm, engine temperature and/or input voltage to the PCM.

It is possible that a DTC for a monitored circuit may not be entered into memory even though a malfunction has occurred. This may happen because one of the DTC criteria for the circuit has not been met. Example: assume that one of the criteria for the MAP sensor circuit is that the engine must be operating between 750 and 2000 rpm to be monitored for a DTC. If the MAP sensor output circuit shorts to ground when the engine rpm is above 2400 rpm, a 0 volt input will be seen by the PCM. A DTC will not be entered into memory because the condition does not occur within the specified rpm range.

A DTC indicates that the powertrain control module (PCM) has recognized an abnormal signal in a circuit or the system. A DTC may indicate the result of a failure, but never identify the failed component directly.

There are several operating conditions that the PCM does not monitor and set a DTC for. Refer to the following Monitored Circuits and Non-Monitored Circuits in this section.

MONITORED CIRCUITS

The powertrain control module (PCM) can detect certain problems in the fuel injection system.

Open or Shorted Circuit - The PCM can determine if sensor output (which is the input to PCM) is within proper range. It also determines if the circuit is open or shorted.

Output Device Current Flow - The PCM senses whether the output devices are hooked up.

If there is a problem with the circuit, the PCM senses whether the circuit is open, shorted to ground (-), or shorted to (+) voltage.

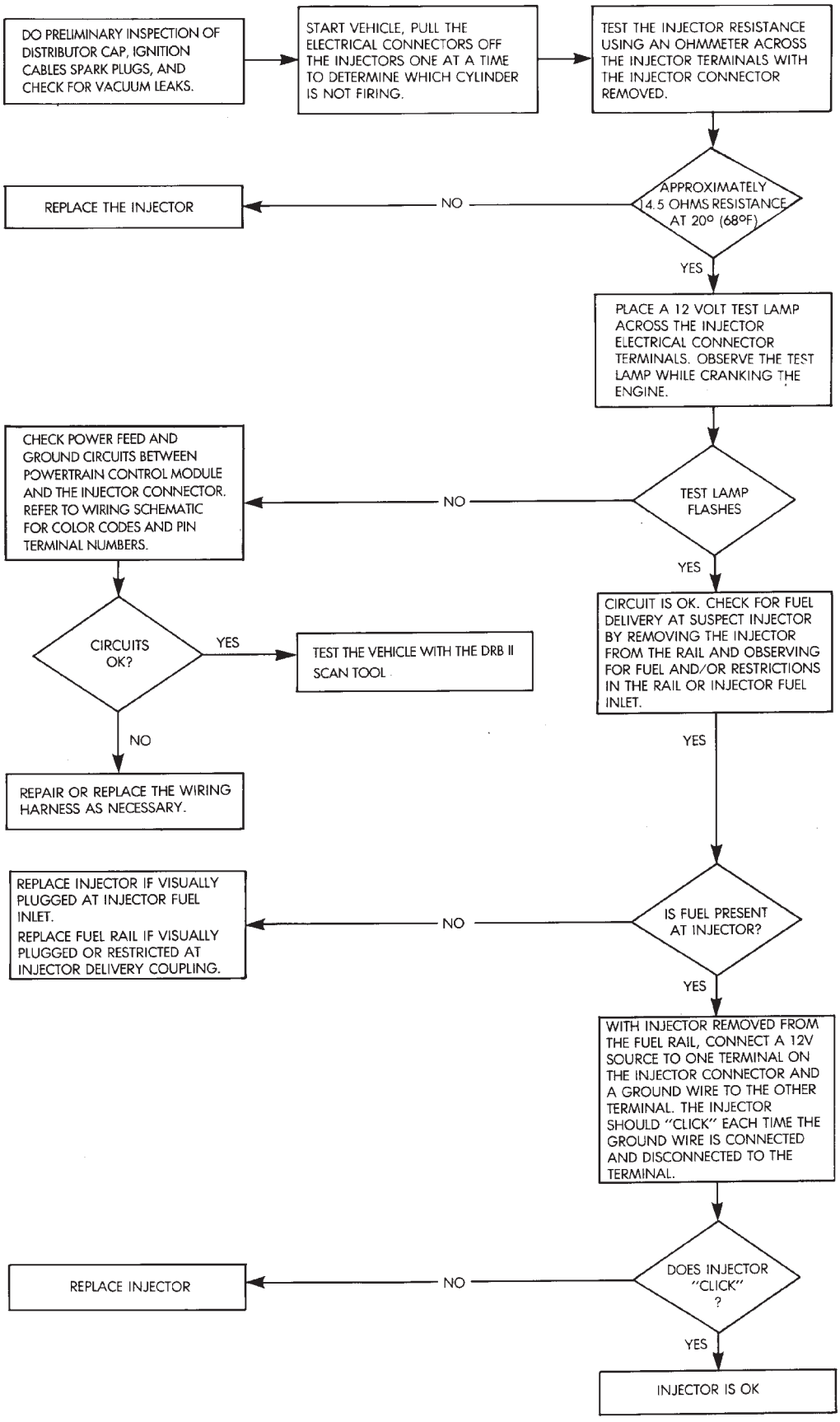
Oxygen Sensor - The PCM can determine if the oxygen sensor is switching between rich and lean. This is, once the system has entered Closed Loop. Refer to Open Loop/Closed Loop Modes Of Operation in the Component Description/System Operation section for an explanation of Closed (or Open) Loop operation.

NON-MONITORED CIRCUITS

The PCM does not monitor the following circuits, systems or conditions that could have malfunctions that result in driveability problems. A Diagnostic Trouble Code (DTC) may not be displayed for these conditions.

Fuel Pressure: Fuel pressure is controlled by the vacuum assisted fuel pressure regulator. The PCM cannot detect a clogged fuel pump inlet filter, clogged

INJECTOR DIAGNOSIS—VEHICLE RUNS ROUGH AND/OR HAS A MISS



in-line fuel filter, or a pinched fuel supply or return line. However, these could result in a rich or lean condition causing an oxygen sensor DTC to be stored in the PCM.

Secondary Ignition Circuit: The PCM cannot detect an inoperative ignition coil, fouled or worn spark plugs, ignition cross firing, or open circuited spark plug cables.

Engine Timing: The PCM cannot detect an incorrectly indexed timing chain, camshaft sprocket or crankshaft sprocket. The PCM also cannot detect an incorrectly indexed distributor. However, these could result in a rich or lean condition causing an oxygen sensor DTC to be stored in the PCM.

Cylinder Compression: The PCM cannot detect uneven, low, or high engine cylinder compression.

Exhaust System: The PCM cannot detect a plugged, restricted or leaking exhaust system.

Fuel Injector Malfunctions: The PCM cannot determine if the fuel injector is clogged, or the wrong injector is installed. However, these could result in a rich or lean condition causing an oxygen sensor DTC to be stored in the PCM.

Excessive Oil Consumption: Although the PCM monitors exhaust stream oxygen content through oxygen sensor (closed loop), it cannot determine excessive oil consumption.

Throttle Body Air Flow: The PCM cannot detect a clogged or restricted air cleaner inlet or air filter element.

Evaporative System: The PCM will not detect a restricted, plugged or loaded EVAP canister.

Vacuum Assist: Leaks or restrictions in the vacuum circuits of vacuum assisted engine control system devices are not monitored by the PCM. However, a vacuum leak at the MAP sensor will be monitored and a diagnostic trouble code (DTC) will be generated by the PCM.

Powertrain Control Module (PCM) System Ground: The PCM cannot determine a poor system ground. However, a DTC may be generated as a result of this condition.

Powertrain Control Module (PCM) Connector Engagement: The PCM cannot determine spread or damaged connector pins. However, a DTC may be generated as a result of this condition.

HIGH AND LOW LIMITS

The powertrain control module (PCM) compares input signal voltages from each input device. It will establish high and low limits that are programmed into it for that device. If the input voltage is not within specifications and other Diagnostic Trouble Code (DTC) criteria are met, a DTC will be stored in memory. Other DTC criteria might include engine rpm limits or input voltages from other sensors or switches. The other inputs might have to be sensed by the PCM when it senses a high or low input voltage from the control system device in question.

ACCESSING DIAGNOSTIC TROUBLE CODES

A stored Diagnostic Trouble Code (DTC) can be displayed by cycling the ignition key On-Off-On-Off-On within three seconds and observing the Malfunction Indicator Lamp. This lamp was formerly referred to as the Check Engine Lamp. The lamp is located on the instrument panel.

They can also be displayed through the use of the Diagnostic Readout Box II (DRB II scan tool). The DRB II connects to the data link connector in the vehicle (Fig. 27). For operation of the DRB II, refer to the appropriate Powertrain Diagnostic Procedures service manual.

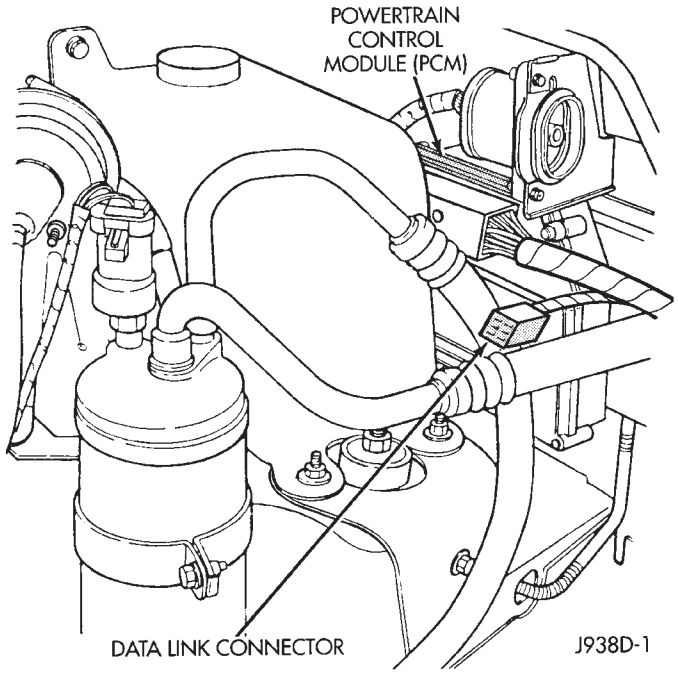


Fig. 27 Data Link Connector—Typical

EXAMPLES

- If the lamp flashes 4 times, pauses and flashes 1 more time, a Diagnostic Trouble Code (DTC) number 41 is indicated.
- If the lamp flashes 4 times, pauses and flashes 6 more times, a Diagnostic Trouble Code (DTC) number 46 is indicated.

Refer to the Diagnostic Trouble Code (DTC) charts for DTC identification.

If the problem is repaired or ceases to exist, the Powertrain Control Module (PCM) cancels the DTC after 51 engine starts.

Diagnostic Trouble Codes indicate the results of a failure, but never identify the failed component directly.

The circuits of the data link connector are shown in (Fig. 28).

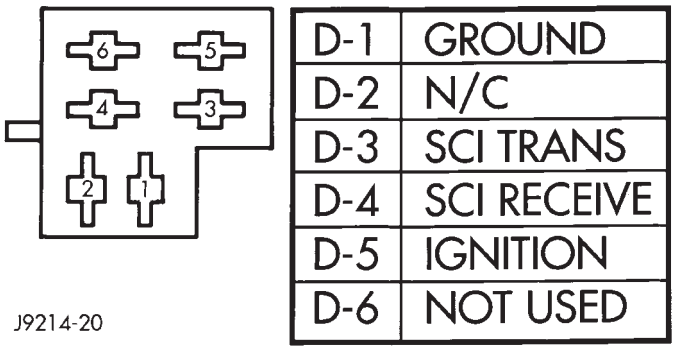


Fig. 28 Data Link Connector Schematic

ERASING TROUBLE CODES

The DRB II scan tool must be used to erase a Diagnostic Trouble Code (DTC). Refer to the appropriate Powertrain Diagnostic Procedures service manual for operation of the DRB II scan tool.

DRB II SCAN TOOL

For operation of the DRB II scan tool, refer to the appropriate Powertrain Diagnostic Procedures service manual.

DIAGNOSTIC TROUBLE CODE (DTC)

On the following pages, a list of diagnostic trouble codes is provided for the 4.0L six-cylinder engine. A DTC indicates that the powertrain control module (PCM) has recognized an abnormal signal in a circuit or the system. A DTC may indicate the result of a failure, but never identify the failed component directly.

DIAGNOSTIC TROUBLE CODE DESCRIPTION

DIAGNOSTIC TROUBLE CODE	DRBII DISPLAY	DESCRIPTION OF CONDITION
11	No Reference (Crank) Signal at PCM	No distributor reference signal detected during engine cranking from the crankshaft position sensor.
13+**	No change in MAP from Start to Run	No difference is recognized between the engine MAP reading and the barometric pressure reading at engine start-up.
14+**	MAP Voltage too Low MAP Voltage too high	MAP sensor input below minimum acceptable voltage.
15	No vehicle speed sensor signal.	No speed sensor signal detected during road load conditions.
17	Engine is cold too long	Engine coolant temperature remains below normal operating temperatures during vehicle travel (thermostat).
21**	O_2S Shorted to Voltage	Neither rich nor lean condition is detected from the oxygen sensor input. Oxygen sensor input voltage maintained above normal operating range.
22+**	ECT Voltage too High or ECT Voltage too Low	Coolant temperature sensor input below the minimum acceptable voltage. Coolant temperature sensor input above the maximum acceptable voltage.
23+**	Intake Air Temp Sensor Voltage High or Intake Air Temp Sensor Voltage Low	Intake Manifold Air Temperature Sensor input above the maximum acceptable voltage. Intake Manifold Air Temperature Sensor input below the minimum acceptable voltage.
24+**	Throttle Position Sensor Voltage High or Throttle Position Sensor Voltage Low	Throttle position sensor (TPS) input below the minimum acceptable voltage. Throttle position sensor (TPS) input above the maximum acceptable voltage.

+ Check Engine Lamp On
* * Check Engine Lamp On (California Only)

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DIAGNOSTIC TROUBLE CODE DESCRIPTION—CONTINUED

DIAGNOSTIC TROUBLE CODE	DRBII DISPLAY	DESCRIPTION OF CONDITION
25**	Idle Air Control Motor Circuits	A shorted or open circuit detected in one or more of the Idle Air Control motor circuits.
27+**	Injector #1, #2, #3, #4, #5 or #6 Circuits	Injector output driver does not respond properly to the control signal.
33	A/C Clutch Relay Circuit	An open or shorted condition detected in the A/C clutch relay circuit.
34	Speed Control Solenoid Circuits	An open or shorted condition detected in the speed control vacuum or vent solenoid circuits.
41+**	Generator Field Not Switching Properly	Generator field not switching properly.
42	Auto Shutdown Relay Control Circuit or No ASD Relay Voltage Sense at PCM	An open or shorted condition detected in the ASD relay control circuit. No ASD voltage sensed at PCM.
44	Battery Temp Sensor Voltage out of limit	Battery temperature sensor voltage out of limit.
46+**	Charging System Voltage too High	Charging system voltage too high.
47+**	Charging System Voltage too Low	Charging system voltage too low.
51**	O_2S stays below center (lean)	O_2 sensor signal stays lean.
52**	O_2S stays above center (rich)	O_2 sensor signal stays rich.
53	Internal PCM Failure or PCM Failure SPI Communication	Internal Powertrain Control Module (PCM) fault condition detected. No internal communication between co-processors.
54	No Cam Sync Signal at PCM	No sync pickup signal from camshaft position sensor.
62	PCM Failure SRI miles not stored	Powertrain Control Module (PCM) failure—Service Reminder Indicator (SRI) miles not stored.

+ Check Engine Lamp On
* * Check Engine Lamp On (California Only)

J9314-135

DIAGNOSTIC TROUBLE CODE DESCRIPTION—CONTINUED

DIAGNOSTIC TROUBLE CODE	DRBII DISPLAY	DESCRIPTION OF CONDITION
63	PCM Failure EEPROM Write Denied	Powertrain Control Module (PCM) failure—EEPROM write denied.
76		
55	NA	Completion of diagnostic trouble code display on the Malfunction Indicator Lamp (Check Engine Lamp).

+ Check Engine Lamp On
* * Check Engine Lamp On (California Only)

J9314-22

MPI SYSTEM—4.0L ENGINE—COMPONENT REMOVAL/INSTALLATION

INDEX

ACCELERATOR PEDAL AND THROTTLE CABLE

Refer to the Accelerator Pedal and Throttle Cable section of this group for removal/installation procedures.

AIR CONDITIONING (A/C) CLUTCH RELAY

The A/C clutch relay is located in the Power Distribution Center (PDC) (Fig. 1). For location of this relay within the PDC, refer to label attached to bottom of PDC cover.

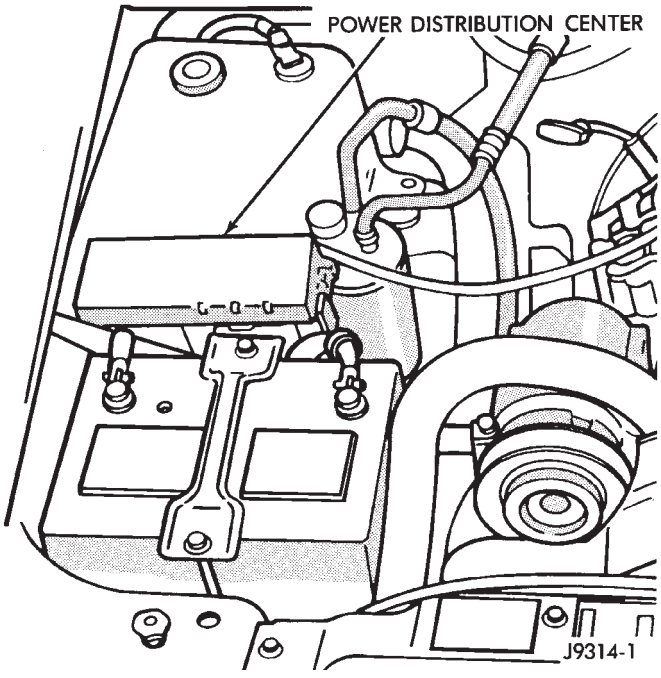


Fig. 1 Power Distribution Center (PDC)

AIR CLEANER HOUSING

Refer to Group 25, Emission Control System.

AIR FILTER

Refer to Group 25, Emission Control System.

AUTOMATIC SHUT DOWN (ASD) RELAY

The ASD relay is located in the Power Distribution Center (Fig. 1) (PDC). For location of this relay within the PDC, refer to label attached to bottom of PDC cover.

BRAKE SWITCH

Refer to Group 5, Brakes for removal/installation procedures.

CAMSHAFT POSITION SENSOR

For removal/installation procedures, refer to Group 8D, Ignition System. See Camshaft Position Sensor.

CHARGE AIR TEMPERATURE SENSOR

The intake manifold charge air temperature sensor is installed into the intake manifold plenum (Fig. 2).

REMOVAL

(1) Disconnect the electrical connector from the sensor.

(2) Remove the sensor from the intake manifold.

INSTALLATION

(1) Install the sensor into the intake manifold. Tighten the sensor to 28 N•m (20 ft. lbs.) torque.

(2) Connect the electrical connector to the sensor.

CRANKSHAFT POSITION SENSOR

The crankshaft position sensor is mounted in the transmission bellhousing at the left/rear side of the engine block (Fig. 3).

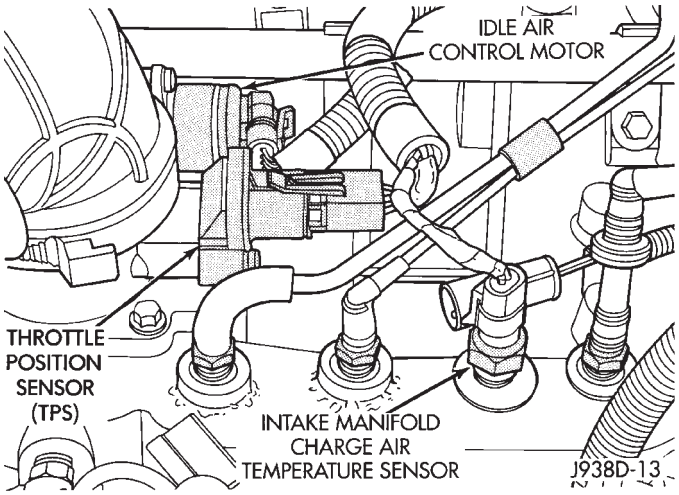


Fig. 2 Sensor Location

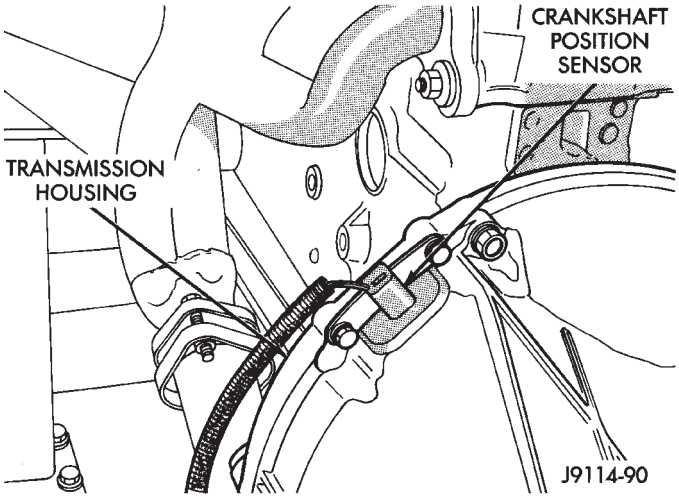


Fig. 3 Crankshaft Position Sensor

REMOVAL

(1) Near the rear of the intake manifold, disconnect the pigtail harness (on the sensor) from the main electrical harness.

(2) Remove the two sensor mounting bolts (Fig. 3).

(3) Remove the sensor.

(4) Remove clip from sensor wire harness.

INSTALLATION

(1) Install the sensor flush against the opening in the transmission housing.

(2) Install and tighten the two sensor mounting bolts to 17-to-21 N•m (13-to-16 ft. lbs.) torque.

CAUTION: The two bolts used to secure the sensor to the transmission are specially machined to correctly space the unit to the flywheel. Do not attempt to install any other bolts.

(3) Connect the electrical connector to the sensor.

(4) Install clip on sensor wire harness.

ENGINE COOLANT TEMPERATURE SENSOR

The coolant temperature sensor is installed in the thermostat housing (Fig. 4).

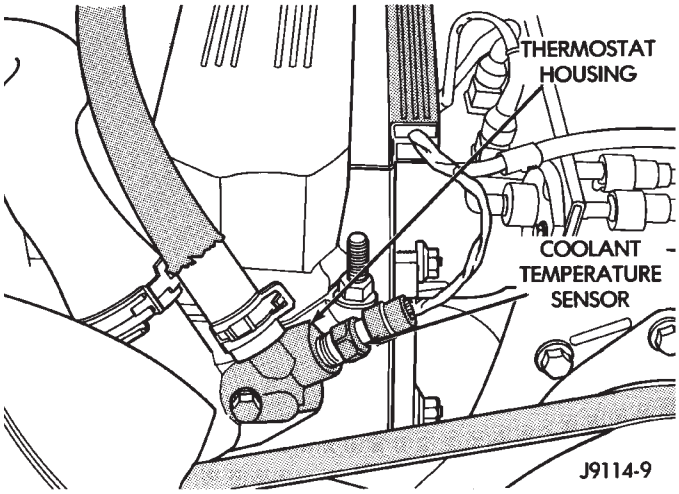


Fig. 4 Engine Coolant Temperature Sensor—Typical

REMOVAL

(1) Drain cooling system until the coolant level is below the cylinder head. Observe the **WARNINGS** in Group 7, Cooling.

(2) Disconnect the coolant temperature sensor wire connector.

(3) Remove the sensor from the thermostat housing (Fig. 4).

INSTALLATION

(1) Install coolant temperature sensor into the cylinder block. Tighten to 28 N•m (21 ft. lbs.) torque.

(2) Connect the wire connector.

(3) Fill the cooling system.

FUEL FILTER

Refer to the Fuel Delivery System section of this group for removal/installation procedures.

FUEL INJECTOR

REMOVAL

(1) Remove the fuel rail. Refer to Fuel Rail Removal in this section.

(2) Remove the clip(s) that retain the fuel injector(s) to the fuel rail (Fig. 5).

INSTALLATION

(1) Install the fuel injector(s) into the fuel rail assembly and install retaining clip(s).

(2) Install fuel rail. Refer to Fuel Rail Installation in this section.

(3) Start engine and check for fuel leaks.

FUEL PUMP MODULE

Refer to the Fuel Delivery System section of this group for removal/installation procedures.

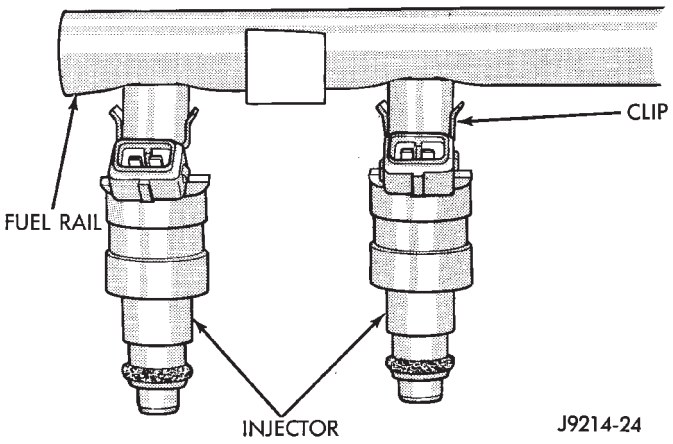


Fig. 5 Injector Retaining Clips

FUEL PUMP RELAY

The Fuel Pump relay is located in the Power Distribution Center (PDC) (Fig. 6). For location of this relay within the PDC, refer to label attached to bottom of PDC cover.

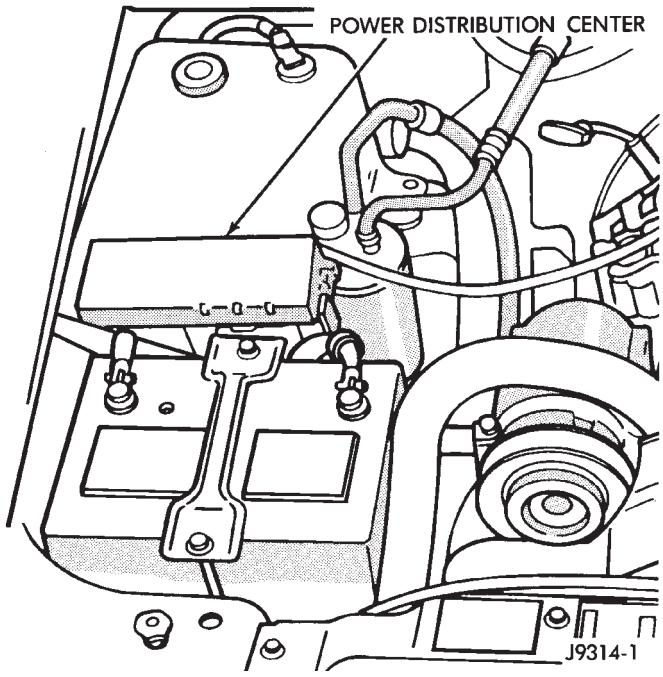


Fig. 6 Power Distribution Center (PDC)

FUEL RAIL ASSEMBLY

REMOVAL

WARNING: THE FUEL SYSTEM IS UNDER CONSTANT FUEL PRESSURE (EVEN WITH THE ENGINE OFF) OF APPROXIMATELY 131-269 KPA (19-39 PSI). THIS PRESSURE MUST BE RELEASED BEFORE SERVICING THE FUEL RAIL.

(1) Remove fuel tank filler tube cap.

(2) Disconnect the negative battery cable from battery.

(3) Perform the Fuel System Pressure Release Procedure as described in the Fuel Delivery System section of this Group.

(4) Remove and numerically attach a tag (if fuel injector is not already tagged), the injector harness connectors. Do this at each injector (Fig. 7).

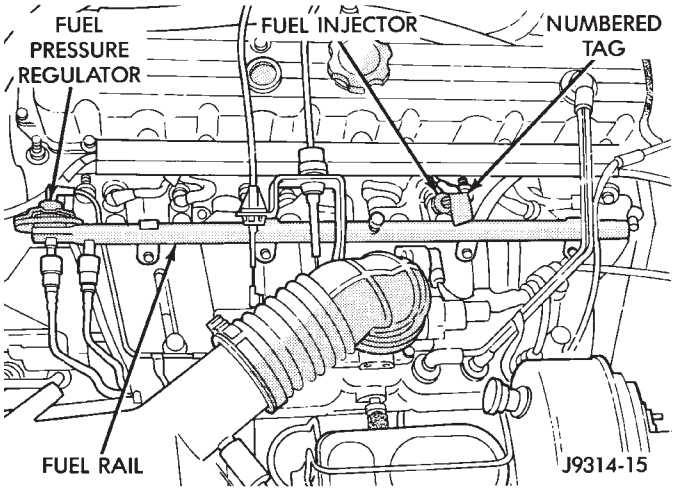


Fig. 7 Fuel Injector Harness—Typical

(5) Disconnect vacuum line from fuel pressure regulator (Fig. 7).

(6) Disconnect fuel supply tube from fuel rail and the fuel return tube from fuel pressure regulator (Fig. 7). Refer to Fuel Tubes/Lines/Hoses and Clamps, or Quick-Connect Fittings. These can both be found in the Fuel Delivery section of this group.

(7) Remove fuel rail mounting bolts.

On models with automatic transmissions, it may be necessary to remove automatic transmission throttle line pressure cable (and bracket). This will aid in fuel rail assembly removal.

(8) Remove fuel rail by gently rocking until all the fuel injectors are out of the intake manifold.

INSTALLATION

(1) Position tips of all fuel injectors into the corresponding injector bore in the intake manifold. Seat injectors into manifold.

(2) Tighten fuel rail mounting bolts to 27 N•m (20 ft. lbs.) torque.

(3) Connect injector harness connectors to appropriate (tagged) injector.

(4) Connect both fuel lines to fuel rail.

(5) Connect vacuum supply line to fuel pressure regulator.

(6) Install protective cap to pressure test port fitting.

(7) Install fuel tank cap.

(8) Connect negative battery cable to battery.

(9) Start engine and check for fuel leaks.

FUEL SYSTEM PRESSURE RELEASE PROCEDURE

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE OFF) OF APPROXIMATELY 100 KPA (14.5 PSI). BEFORE SERVICING THE FUEL PUMP, FUEL LINES, FUEL FILTER, THROTTLE BODY OR FUEL INJECTOR, THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

Refer to the Fuel Delivery System section of this group. See Fuel Pressure Release procedure.

FUEL TANKS

Refer to the Fuel Tank section of this group for removal/installation procedures.

FUEL TANK PRESSURE RELIEF/ROLLOVER VALVE

Refer to the Fuel Tank section of this group for removal/installation procedures.

FUEL TUBES/LINES/HOSES AND CLAMPS

Refer to the Fuel Delivery System section of this group for removal/installation procedures. Also refer to Quick-Connect Fittings in the Fuel Delivery section of this group.

IDLE AIR CONTROL (IAC) MOTOR

The Idle Air Control Motor is mounted to the throttle body adjacent to the throttle position sensor (Fig. 8).

REMOVAL

(1) Disconnect the electrical connector from the Idle Air Control Motor.

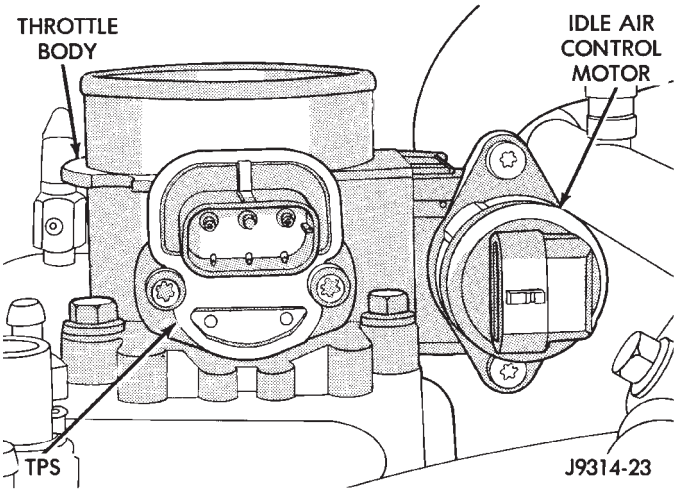


Fig. 8 Idle Air Control Motor—Removal/Installation

(2) Remove Idle Air Control Motor torx head mounting screws.

(3) Remove Idle Air Control Motor.

INSTALLATION

(1) Install Idle Air Control Motor into throttle body and tighten retaining screws.

(2) Connect electrical connector to Idle Air Control Motor.

IGNITION COIL

Refer to Group 8D, Ignition Systems for removal/installation procedures.

INTAKE MANIFOLD

Refer to Group 11, Exhaust System and Intake Manifold for removal/installation procedures.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The MAP sensor is located on the dash panel near the rear of the engine cylinder head cover (Fig. 9).

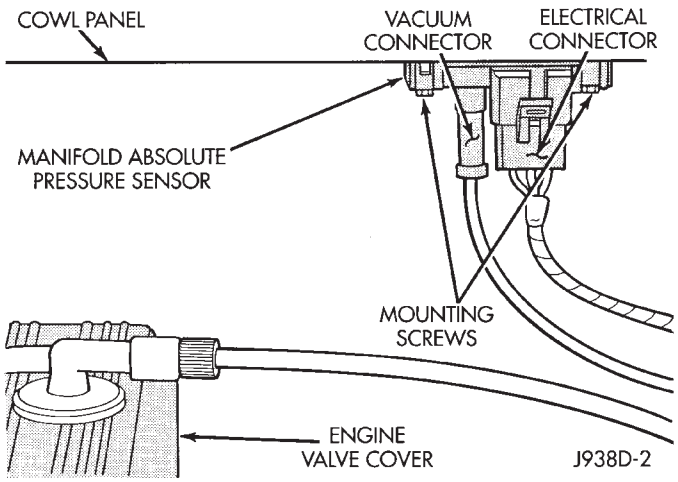


Fig. 9 MAP Sensor

REMOVAL

(1) Disconnect the MAP sensor electrical connector (Fig. 9).

(2) Disconnect the MAP sensor vacuum supply hose (Fig. 9).

(3) Remove the MAP sensor mounting screws and remove MAP sensor.

INSTALLATION

(1) Install MAP sensor to dash panel and secure with mounting screws.

(2) Install the MAP sensor vacuum supply hose.

(3) Connect the MAP sensor electrical connector.

OXYGEN (O_2) SENSOR

The O_2 sensor is installed in the exhaust down pipe just below the exhaust manifold flange (Fig. 10).

REMOVAL

WARNING: THE EXHAUST MANIFOLD BECOMES VERY HOT DURING ENGINE OPERATION. ALLOW ENGINE TO COOL BEFORE REMOVING OXYGEN SENSOR.

(1) Raise and support the vehicle.
(2) The sensors electrical connector clip is pushed over an oil pan mounting stud. Pull the connector clip from the mounting stud.
(3) Separate the electrical connectors.
(4) Remove the O_2 sensor from the exhaust manifold.

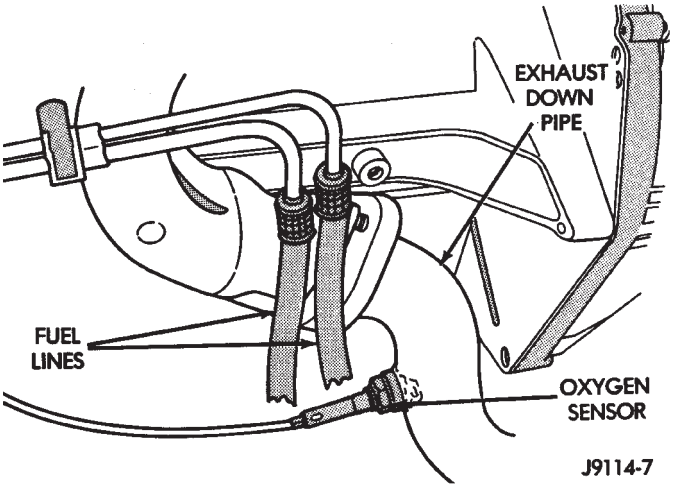


Fig. 10 Oxygen Sensor—Typical

INSTALLATION

Threads of new factory oxygen sensors are coated with anti-seize compound to aid in removal.
(1) Install the O_2 sensor into the exhaust manifold and tighten to 30 N●m (22 ft. lbs.) torque.
(2) Connect the O_2 sensor wire connector to the main harness.
(3) Push the sensor clip on firmly at the oil pan stud.
(4) Lower the vehicle.

PARK NEUTRAL SWITCH

Refer to Group 21, Transmissions for park neutral switch service.

POWERTRAIN CONTROL MODULE (PCM)

The PCM is located on the cowl panel in the right/rear side of the engine compartment (Fig. 11).

REMOVAL

(1) Disconnect the negative battery cable at the battery.
(2) Remove the coolant reserve/overflow bottle (one bolt and two nuts) (Fig. 12)
(3) Loosen the 60-Way connector mounting bolt (Fig. 13).
(4) Remove the electrical connector by pulling straight back.
(5) Remove the three PCM mounting bolts (Fig. 13).
(6) Remove PCM.

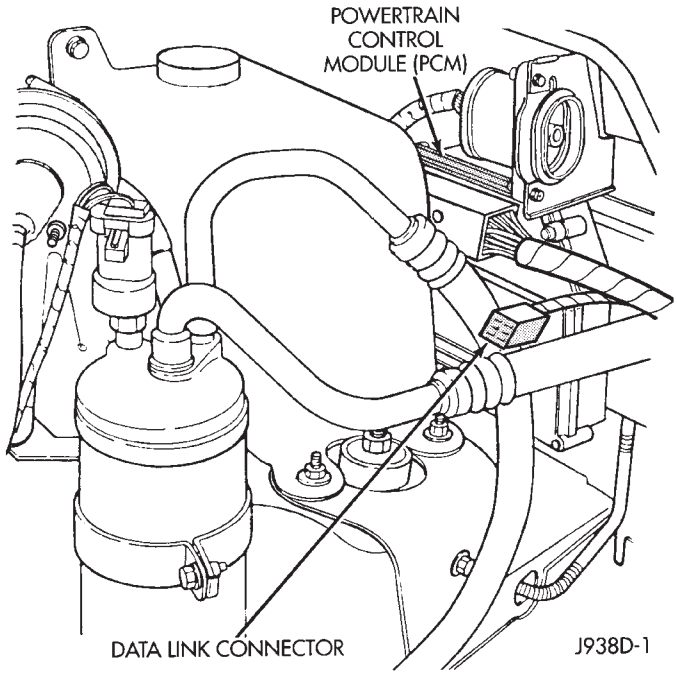


Fig. 11 Powertrain Control Module (PCM) Location

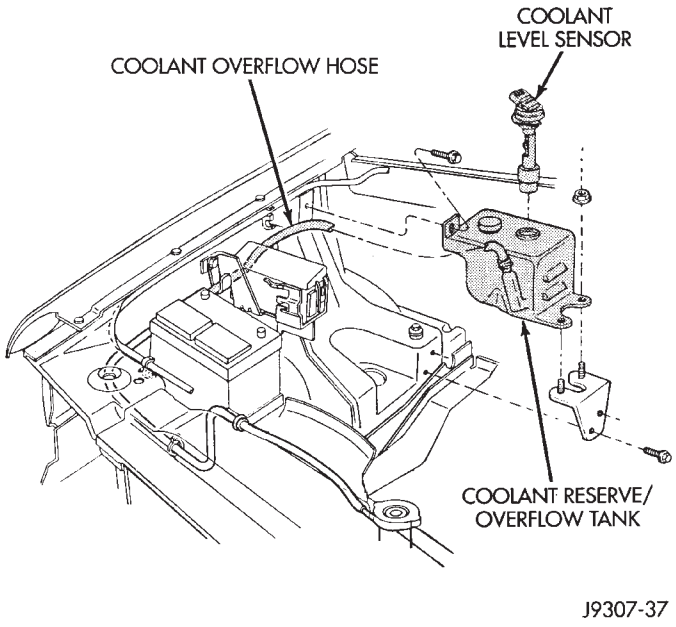


Fig. 12 Coolant Reserve/Overflow Bottle Mounting

INSTALLATION

(1) Check the pins in 60-way electrical connector for damage. Repair as necessary.
(2) Install PCM. Tighten three mounting bolts to 1 N●m (9 in. lbs.) torque.
(3) Engage 60-way connector into PCM. Tighten connector mounting bolt to 4 N●m (35 in. lbs.) torque.
(4) Install coolant reserve/overflow bottle.
(5) Connect negative cable to battery.

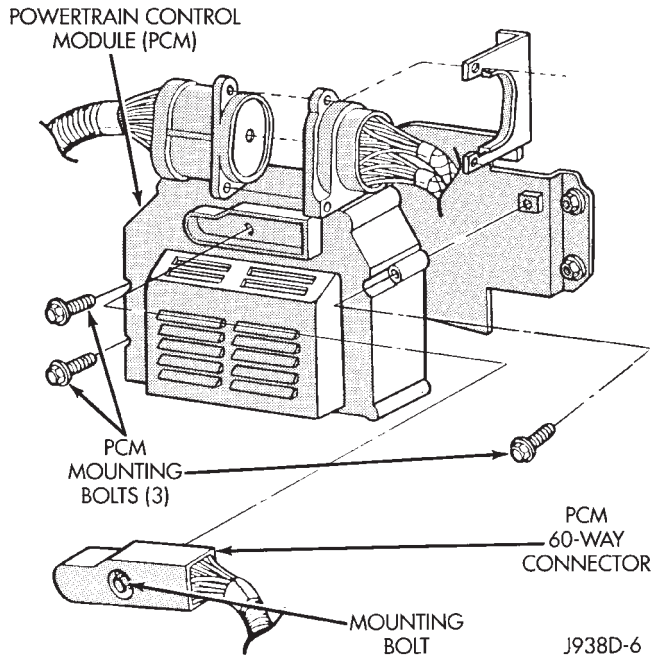


Fig. 13 Powertrain Control Module (PCM) Mounting

QUICK-CONNECT FITTINGS

Refer to the Fuel Delivery System section of this group for removal/installation procedures.

THROTTLE BODY

REMOVAL

(1) Disconnect the negative battery cable.

(2) Disconnect air cleaner hose from throttle body.

(3) Disconnect Idle Air Control Motor and throttle position sensor wire connectors.

(4) Disconnect accelerator cable, throttle cable (automatic transmission) and speed control cable (if equipped) from throttle arm (Fig. 14).

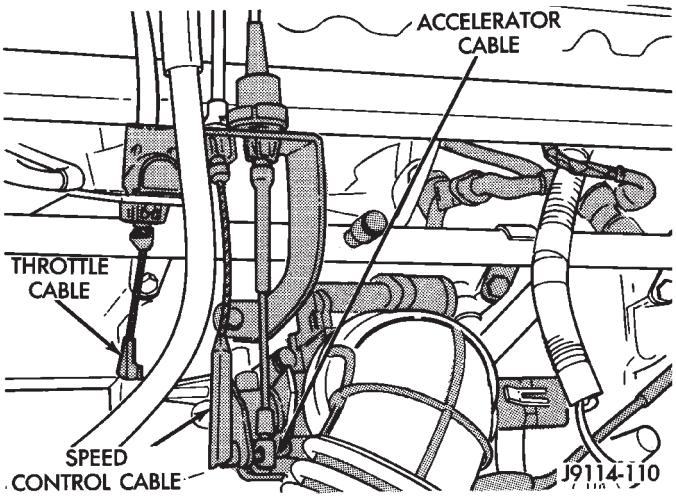


Fig. 14 Accelerator, Throttle and Speed Control Cables

(5) Remove throttle body mounting bolts, throttle body and gasket. Discard old gasket (Fig. 15).

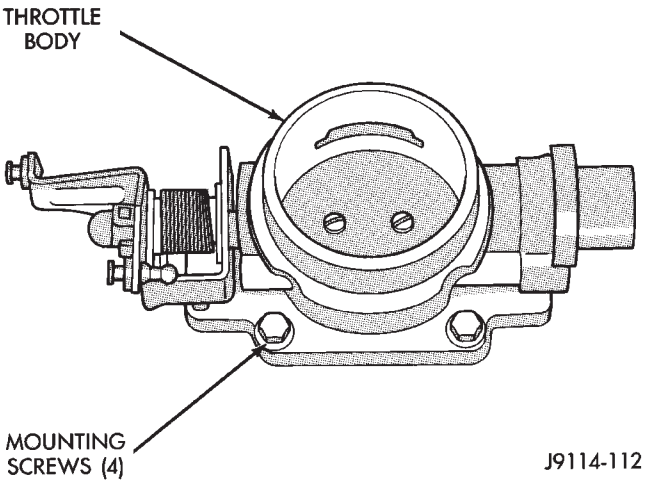


Fig. 15 Throttle Body—Removal/Installation

INSTALLATION

(1) Install throttle body and new gasket. Tighten throttle body mounting bolts to 12 N●m (9 ft. lbs.) torque.

(2) Connect Idle Air Control Motor and throttle position sensor wire connectors.

(3) Connect throttle linkage to throttle arm.

CAUTION: When the automatic transmission throttle cable is connected, it MUST be adjusted.

(4) If equipped with an automatic transmission, connect and adjust the transmission line pressure cable. Refer to Group 21, Transmissions for adjustment procedure.

(5) Install air cleaner hose to throttle body.

(6) Connect negative battery cable to battery.

THROTTLE POSITION SENSOR (TPS)

REMOVAL

(1) Disconnect TPS electrical connector.

(2) Remove TPS mounting screws.

(3) Remove TPS.

INSTALLATION

The throttle shaft end of the throttle body slides into a socket in the TPS (Fig. 16). The TPS must be installed so that it can be rotated a few degrees. (If the sensor will not rotate, install the sensor with the throttle shaft on the other side of the socket tangs). The TPS will be under slight tension when rotated.

(1) Install the TPS and retaining screws.

(2) Connect TPS electrical connector to TPS.

(3) Manually operate the throttle (by hand) to check for any TPS binding before starting the engine.

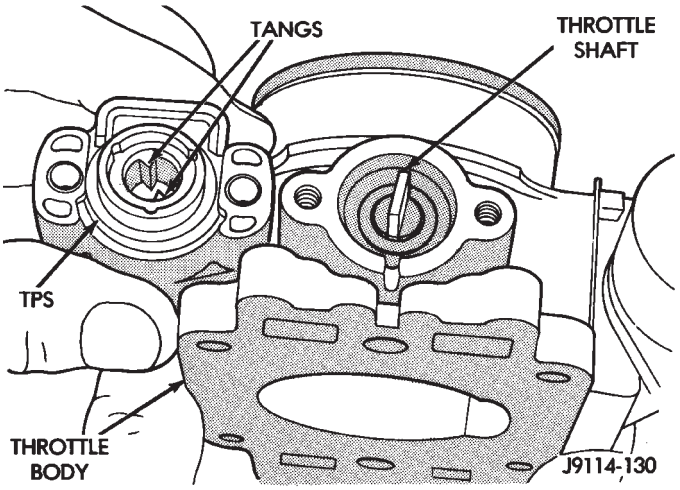


Fig. 16 Throttle Position Sensor—Installation

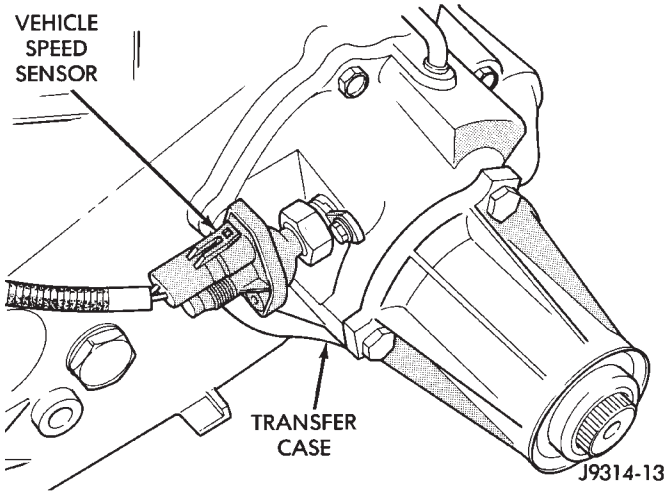


Fig. 17 Vehicle Speed Sensor—Typical

VEHICLE SPEED SENSOR

The vehicle speed sensor (Fig. 17) is located on the extension housing of the transmission on 2WD models. It is located on the transfer case on 4WD models.

REMOVAL

(1) Raise and support vehicle.

(2) Disconnect the electrical connector from the sensor.

(3) Remove (unscrew) the speedometer cable from the sensor (Fig. 18).

(4) Loosen the sensor mounting nut (Fig. 18).

(5) Remove the sensor.

INSTALLATION

(1) Install new sensor into speedometer adapter.

(2) Tighten sensor mounting nut.

(3) Connect electrical connector to sensor.

(4) Connect the speedometer cable.

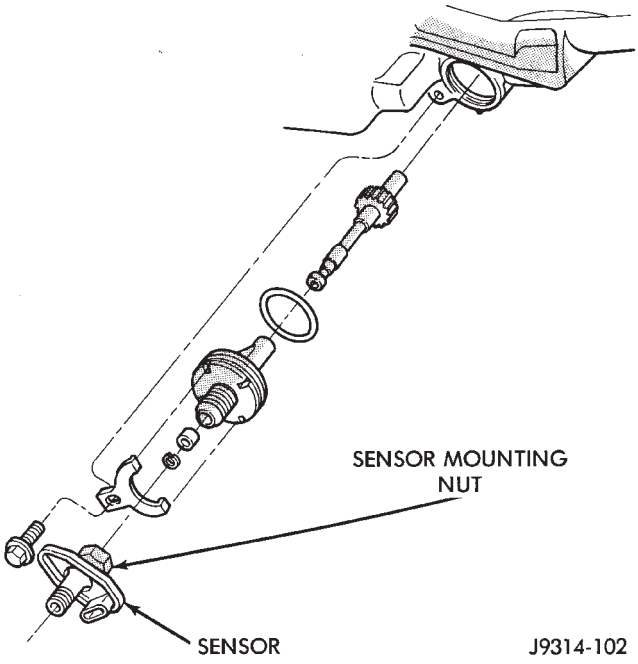


Fig. 18 Sensor and Components

MPI SYSTEM—5.2L ENGINE—COMPONENT DESCRIPTION/SYSTEM OPERATION

INDEX

GENERAL INFORMATION

All 5.2L engines are equipped with sequential Multi-Port Fuel Injection (MPI). The MPI system (Fig. 1) provides precise air/fuel ratios for all driving conditions.

The Powertrain Control Module (PCM) operates the fuel system. The PCM was formerly referred to as the SBEC or engine controller. The PCM is a preprogrammed, dual microprocessor digital computer. It regulates ignition timing, air-fuel ratio, emission control devices, charging system, speed control, air conditioning compressor clutch engagement and idle speed. The PCM can adapt its programming to meet changing operating conditions.

Powertrain Control Module (PCM) Inputs represent the instantaneous engine operating conditions. Air-fuel mixture and ignition timing calibrations for various driving and atmospheric conditions are preprogrammed into the PCM. The PCM monitors and analyzes various inputs. It then computes engine fuel and ignition timing requirements based on these inputs. Fuel delivery control and ignition timing will then be adjusted accordingly.

Other inputs to the PCM are provided by the brake light switch, air conditioning select switch and the speed control switches. All inputs to the PCM are converted into signals.

Electrically operated fuel injectors spray fuel in precise metered amounts into the intake port directly above the intake valve. The injectors are fired in a specific sequence by the PCM. The PCM maintains an air/fuel ratio of 14.7 to 1 by constantly adjusting injector pulse width. Injector pulse width is the length of time that the injector opens and sprays fuel into the chamber. The PCM adjusts injector pulse width by opening and closing the ground path to the injector.

Manifold absolute pressure (air density) and engine rpm (speed) are the primary inputs that determine fuel injector pulse width. The PCM also monitors other inputs when adjusting air-fuel ratio.

Inputs That Effect Fuel Injector Pulse Width

- Exhaust gas oxygen content
- Coolant temperature
- Manifold absolute pressure (MAP)
- Engine speed
- Throttle position
- Battery voltage
- Air conditioning selection
- Transmission gear selection (automatic transmissions only)
- Speed control

The powertrain control module (PCM) adjusts ignition timing by controlling ignition coil operation. The ignition coil receives battery voltage when the ignition key is in the run or starter position. The PCM provides a ground for the ignition coil. The coil discharges when the PCM supplies a ground. By switching the ground path on and off, the PCM regulates ignition timing.

The sensors and switches that provide inputs to the Powertrain control module (PCM) comprise the En-

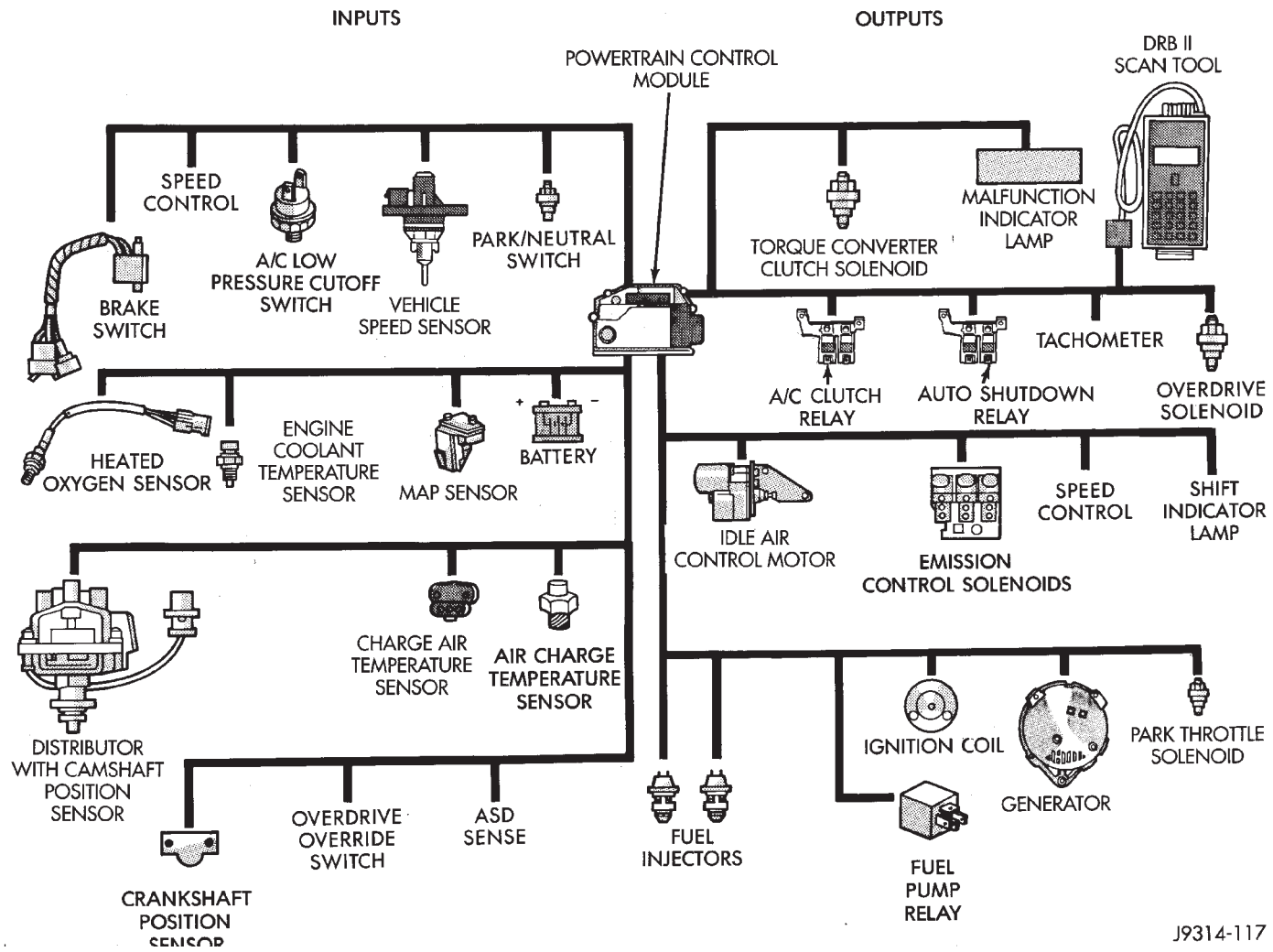


Fig. 1 Multi-Port Fuel Injection Components—5.2L Engine

gine Control System. It is also comprised of the PCM Outputs (engine control devices that the are operated by the PCM).

SYSTEM DIAGNOSIS

The Powertrain Control Module (PCM) tests many of its own input and output circuits. If a Diagnostic Trouble Code (DTC) is found in a major system, this information is stored in the PCM memory. Refer to On-Board Diagnostics in the Multi-Port Fuel Injection—General Diagnosis—5.2L Engine section of this group for DTC information.

POWERTRAIN CONTROL MODULE (PCM)

The Powertrain Control Module (PCM) (Fig. 2) operates the fuel system. The PCM was formerly referred to as the SBEC or engine controller. The PCM is a pre-programmed, dual microprocessor digital computer. It regulates ignition timing, air-fuel ratio, emission control devices, charging system, speed control, air conditioning compressor clutch engagement and idle speed. The PCM can adapt its programming to meet changing operating conditions.

The PCM receives input signals from various switches and sensors. Based on these inputs, the PCM regulates various engine and vehicle operations through different system components. These components are referred to as Powertrain Control Module (PCM) Outputs. The sensors and switches that provide inputs to the PCM are considered Powertrain Control Module (PCM) Inputs.

The PCM adjusts ignition timing based upon inputs it receives from sensors that react to: engine rpm, manifold absolute pressure, coolant temperature, throttle position, transmission gear selection (automatic transmission), vehicle speed and the brake switch.

The PCM adjusts idle speed based on inputs it receives from sensors that react to: throttle position, vehicle speed, transmission gear selection, coolant temperature and from inputs it receives from the air conditioning clutch switch and brake switch.

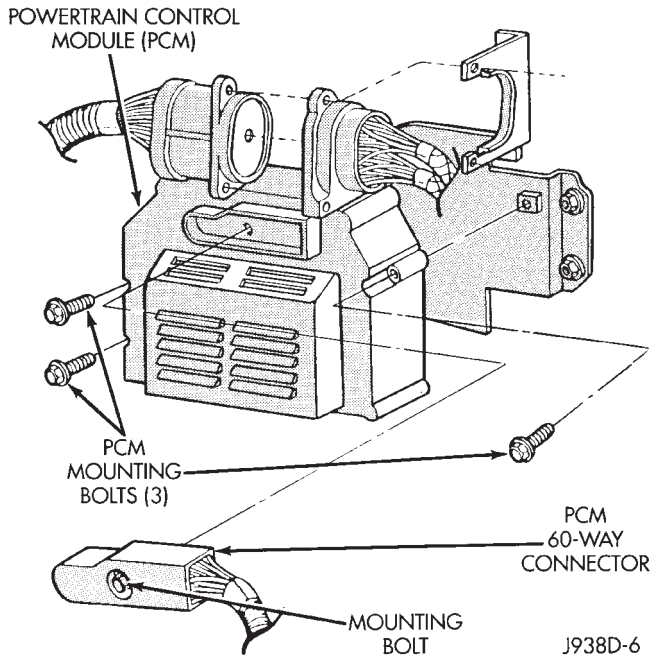


Fig. 2 Powertrain Control Module (PCM) Location

Based on inputs that it receives, the PCM adjusts ignition coil dwell. The PCM also adjusts the generator charge rate through control of the generator field and provides speed control operation.

Powertrain Control Module (PCM) Inputs:

- Generator output
- A/C request (if equipped with factory A/C)
- A/C select (if equipped with factory A/C)
- Auto shut down (ASD) sense
- Charge air temperature sensor
- Battery voltage
- Brake switch
- Coolant temperature sensor
- Crankshaft position sensor
- Ignition circuit sense (ignition switch in run position)
- Manifold absolute pressure sensor
- Overdrive/override switch
- Oxygen sensor
- Park/neutral switch (auto. trans. only)
- SCI receive (DRB II connection)
- Speed control resume switch
- Speed control set switch
- Speed control on/off switch
- Camshaft position sensor signal
- Throttle position sensor
- Vehicle speed sensor
- Sensor return
- Power ground
- Signal ground

Powertrain Control Module (PCM) Outputs

- A/C clutch relay
- Idle air control (IAC) motor
- Auto shut down (ASD) relay
- Generator field
- Malfunction Indicator lamp
- EGR valve control solenoid
- Fuel injectors
- Fuel pump relay
- Ignition coil
- EVAP canister purge solenoid
- SCI transmit (DRB II connection)
- Shift indicator lamp (manual transmission only)
- Speed control vacuum solenoid
- Speed control vent solenoid
- Tachometer (on instrument panel, if equipped)

The powertrain control module (PCM) contains a voltage convertor. This converts battery voltage to a regulated 8.0 volts. It is used to power the crankshaft position sensor and camshaft position sensor. The PCM also provides a five (5) volt supply for the Manifold Absolute Pressure (MAP) sensor and Throttle Position Sensor (TPS).

AIR CONDITIONING (A/C) CONTROLS—PCM INPUT

The A/C control system information applies to factory installed air conditioning units.

A/C SELECT SIGNAL: When the A/C switch is in the ON position and the A/C low pressure switch is closed, an input signal is sent to the powertrain control module (PCM). The signal informs the PCM that the A/C has been selected. The PCM adjusts idle speed to a pre-programmed rpm through the idle air control (IAC) motor to compensate for increased engine load.

A/C REQUEST SIGNAL: Once A/C has been selected, the powertrain control module (PCM) receives the A/C request signal from the evaporator switch. The input indicates that the evaporator temperature is in the proper range for A/C application. The PCM uses this input to cycle the A/C compressor clutch (through the A/C relay). It will also determine the correct engine idle speed through the idle air control (IAC) motor position.

If the A/C low pressure switch opens (indicating a low refrigerant level), the PCM will not receive an A/C select signal. The PCM will then remove the ground from the A/C relay. This will deactivate the A/C compressor clutch.

If the evaporator switch opens, (indicating that evaporator is not in proper temperature range), the PCM will not receive the A/C request signal. The PCM will then remove the ground from the A/C relay, deactivating the A/C compressor clutch.

AUTOMATIC SHUT DOWN (ASD) SENSE—PCM INPUT

A 12 volt signal at this input indicates to the PCM that the ASD has been activated. The ASD relay is located in the Power Distribution Center (PDC) in the engine compartment. It is used to connect oxygen winding and fuel injectors to 12 volt + power supply.

This input is used only to sense that the ASD relay is energized. If the powertrain control module (PCM) does not see 12 volts at this input when the ASD should be activated, it will set a Diagnostic Trouble Code (DTC).

BATTERY VOLTAGE—PCM INPUT

The battery voltage input provides power to the powertrain control module (PCM). It also informs the PCM what voltage level is supplied to the ignition coil and fuel injectors.

If battery voltage is low, the PCM will increase injector pulse width (period of time that the injector is energized). This is done to compensate for the reduced flow through injector caused by the lowered voltage.

BRAKE SWITCH—PCM INPUT

When the brake light switch is activated, the powertrain control module (PCM) receives an input indicating that the brakes are being applied. After receiving this input, the PCM maintains idle speed to a scheduled rpm through control of the idle air control (IAC) motor. The brake switch input is also used to operate the speed control system.

CAMSHAFT POSITION SENSOR—PCM INPUT

A sync signal is provided by the camshaft position sensor located in the ignition distributor (Fig. 3). The sync signal from this sensor works in conjunction with the crankshaft position sensor to provide the powertrain control module (PCM) with inputs. This is done to establish and maintain correct injector firing order.

Refer to Camshaft Position Sensor in Group 8D, Ignition System for more information.

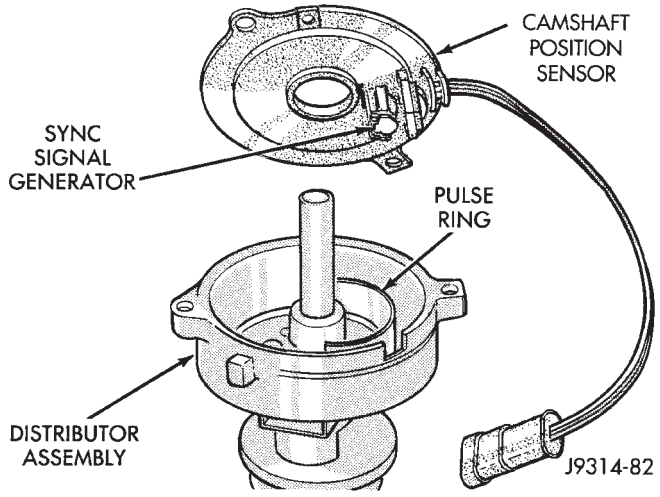


Fig. 3 Camshaft Position Sensor

CHARGE AIR TEMPERATURE SENSOR—PCM INPUT

The intake manifold charge air temperature sensor is installed in the intake manifold with the sensor element extending into the air stream (Fig. 4). The sensor provides an input voltage to the powertrain control module (PCM) indicating intake manifold air temperature. The input is used along with inputs from other sensors to determine injector pulse width. As the temperature of the air-fuel stream in the manifold varies, the sensor resistance changes. This results in a different input voltage to the PCM.

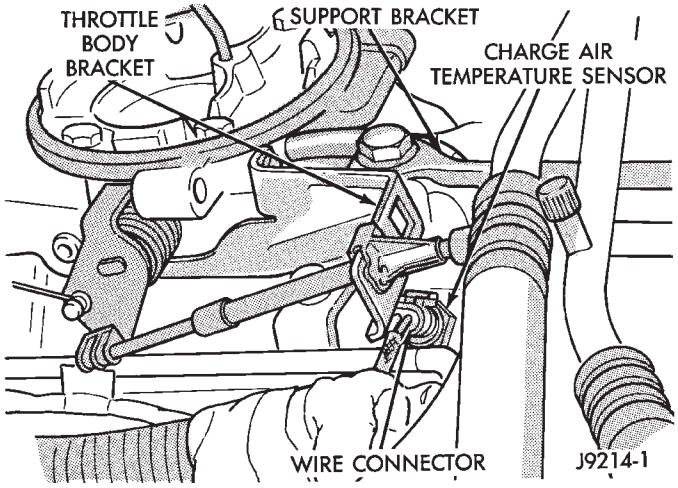


Fig. 4 Charge Air Temperature Sensor—Typical

CRANKSHAFT POSITION SENSOR—PCM INPUT

This sensor is a Hall Effect device that detects notches in the flywheel (manual transmission), or flexplate (automatic transmission).

This sensor is used to indicate to the powertrain control module (PCM) that a spark and or fuel injection event is to be required. The output from this sensor, in conjunction with the camshaft position sensor signal, is used to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

The sensor is bolted to the cylinder block near the rear of the right cylinder head (Fig. 5).

Refer to Group 8D, Ignition System for more crankshaft position sensor information.

The engine will not operate if the PCM does not receive a crankshaft position sensor input.

ENGINE COOLANT TEMPERATURE SENSOR—PCM INPUT

The coolant temperature sensor is installed next to the thermostat housing (Fig. 6) and protrudes into the water jacket. The sensor provides an input voltage to the powertrain control module (PCM) relating coolant temperature. The PCM uses this input along with inputs from other sensors to determine injector pulse width and ignition timing. As coolant temperature varies, the coolant temperature sensor's resistance changes. The change in resistance results in a different input voltage to the PCM.

When the engine is cold, the PCM will operate in Open Loop cycle. It will demand slightly richer air-

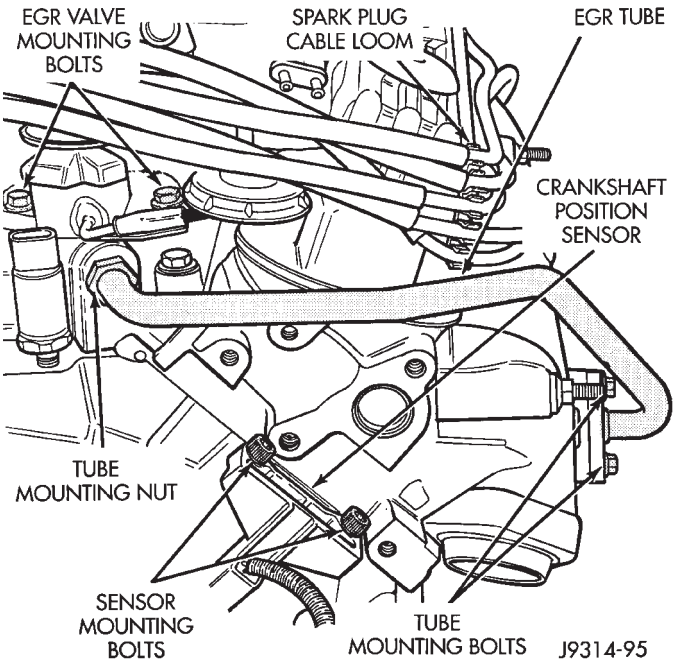


Fig. 5 Crankshaft Position Sensor

fuel mixtures and higher idle speeds. This is done until normal operating temperatures are reached.

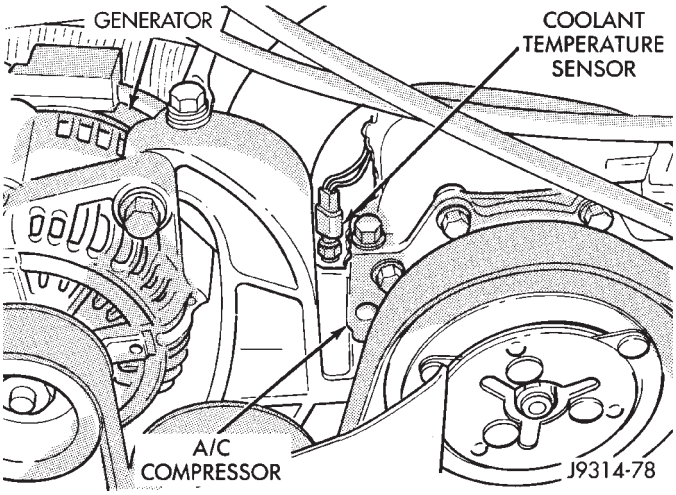


Fig. 6 Coolant Temperature Sensor—Typical

IGNITION CIRCUIT SENSE—PCM INPUT

The ignition circuit sense input tells the powertrain control module (PCM) the ignition switch has energized the ignition circuit. Refer to the wiring diagrams for circuit information.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—PCM INPUT

The MAP sensor reacts to absolute pressure in the intake manifold. It provides an input voltage to the powertrain control module (PCM). As engine load changes, manifold pressure varies. The change in manifold pressure causes MAP sensor voltage to change. The change in MAP sensor voltage results in a different input voltage to the PCM. The input voltage level supplies the PCM with information about ambient barometric pressure during engine start-up (cranking) and engine load while the engine is running. The PCM uses this input along with inputs from other sensors to adjust air-fuel mixture.

The MAP sensor is mounted on the side of the engine throttle body (Fig. 7). The sensor is connected to the throttle body with a rubber L-shaped fitting.

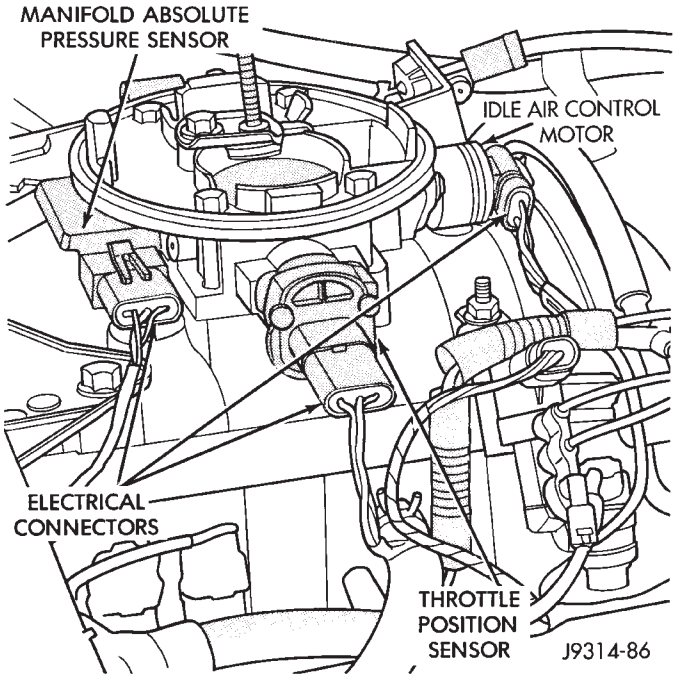


Fig. 7 Manifold Absolute Pressure (MAP) Sensor

OXYGEN (O_2) SENSOR—PCM INPUT

The O_2 sensor is located in the right exhaust down pipe (Fig. 8). It provides an input voltage to the powertrain control module (PCM) relating the oxygen content of the exhaust gas. The PCM uses this information to fine tune the air-fuel ratio by adjusting injector pulse width.

The O_2 sensor produces voltages from 0 to 1 volt. This voltage will depend upon the oxygen content of the exhaust gas in the exhaust manifold. When a large amount of oxygen is present (caused by a lean air-fuel mixture), the sensor produces a low voltage. When there is a lesser amount present (rich air-fuel mixture) it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensor acts as a rich-lean switch.

The oxygen sensor is equipped with a heating element that keeps the sensor at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner.

In Closed Loop operation, the powertrain control module (PCM) monitors the O_2 sensor input (along with other inputs). It then adjusts the injector pulse width accordingly. During Open Loop operation, the

PCM ignores the O_2 sensor input and adjusts injector pulse width to a preprogrammed value (based on other sensor inputs).

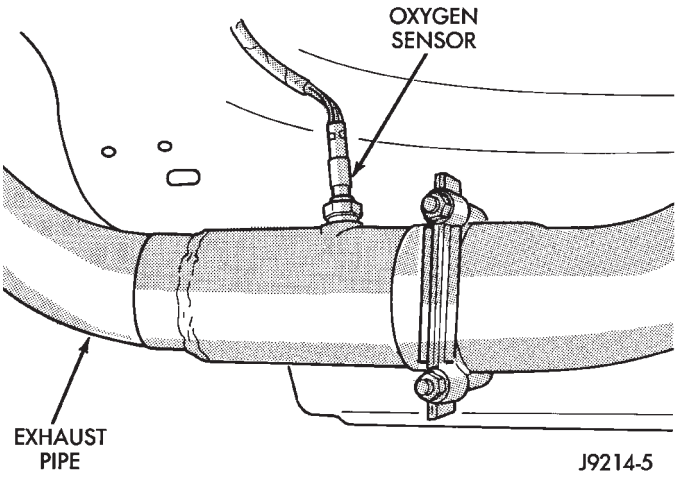


Fig. 8 Heated Oxygen Sensor—Typical

OVERDRIVE/OVERRIDE SWITCH

On vehicles equipped with overdrive, the powertrain control module (PCM) regulates the 3-4 overdrive up-shift and down-shift through the overdrive solenoid. An override switch is located on the instrument panel.

The overdrive/override switch is normally closed. It opens when the operator presses the switch. The transmission will not enter overdrive when the operator presses the override switch. The transmission downshifts if the operator presses the override switch while in overdrive.

The overdrive switch circuit contains two other switches: A transmission thermo-switch and a coolant temperature switch. When either switch opens, the transmission will not shift into overdrive, or downshift (if already in overdrive).

Refer to Group 21 for more information.

PARK/NEUTRAL SWITCH—PCM INPUT

The park/neutral switch is located on the transmission housing and provides an input to the powertrain control module (PCM). This will indicate that the automatic transmission is in Park, Neutral or a drive gear selection. This input is used to determine idle speed (varying with gear selection), fuel injector pulse width and ignition timing advance. Refer to Group 21, Transmissions, for testing, replacement and adjustment information.

POWER GROUND

The power ground is used to control ground circuits for the following powertrain control module (PCM) loads:

- Generator Field Winding
- 8 volt (PCM) power supply
- Fuel Injectors
- Ignition Coil

SCI RECEIVE—PCM INPUT

SCI Receive is the serial data communication receive circuit for the DRB II scan tool. The powertrain control module (PCM) receives data from the DRB II through the SCI Receive circuit.

SPEED CONTROL—PCM INPUT

The speed control system provides three separate inputs to the powertrain control module (PCM); On/Off, Set and Resume. The On/Off input informs the PCM that the speed control system has been activated. The Set input informs the PCM that a fixed vehicle speed has been selected. The Resume input indicates to the PCM that the previous fixed speed is requested.

The speed control operating range is from 50 km/h to 142 km/h (35 to 85 mph). Inputs that effect speed control operation are:

- Park/neutral switch
- Vehicle speed sensor
- Throttle position sensor

Refer to Group 8H for further speed control information.

SENSOR RETURN—PCM INPUT

Sensor Return provides a low noise ground reference for all system sensors.

THROTTLE POSITION SENSOR (TPS)—PCM INPUT

The Throttle Position Sensor (TPS) is mounted on the throttle body (Fig. 9). The TPS is a variable resistor that provides the powertrain control module (PCM) with an input signal (voltage) that represents throttle blade position. The sensor is connected to the throttle blade shaft. As the position of the throttle blade changes, the resistance of the TPS changes.

The PCM supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the PCM) represents the throttle blade position. The PCM receives an input signal voltage from the TPS. This will vary in an approximate range of from 1 volt at minimum throttle opening (idle), to 4 volts at wide open throttle. Along with inputs from other sensors, the PCM uses the TPS input to determine current engine operating conditions. In response to engine operating conditions, the PCM will adjust fuel injector pulse width and ignition timing.

VEHICLE SPEED SENSOR—PCM INPUT

The speed sensor (Fig. 10) is located in the extension housing of the transmission (2WD) or on the transfer case extension housing (4WD). The sensor input is used by the powertrain control module (PCM) to determine vehicle speed and distance traveled.

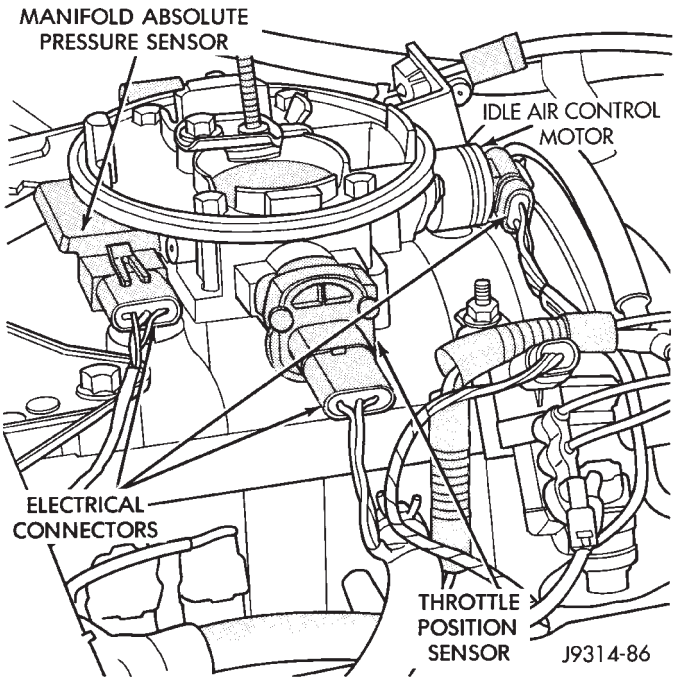


Fig. 9 Throttle Position Sensor

The speed sensor generates 8 pulses per sensor revolution. These signals, in conjunction with a closed throttle signal from the throttle position sensor, indicate a closed throttle deceleration to the PCM. When the vehicle is stopped at idle, a closed throttle signal is received by the PCM (but a speed sensor signal is not received).

Under deceleration conditions, the PCM adjusts the idle air control (IAC) motor to maintain a desired MAP value. Under idle conditions, the PCM adjusts the IAC motor to maintain a desired engine speed.

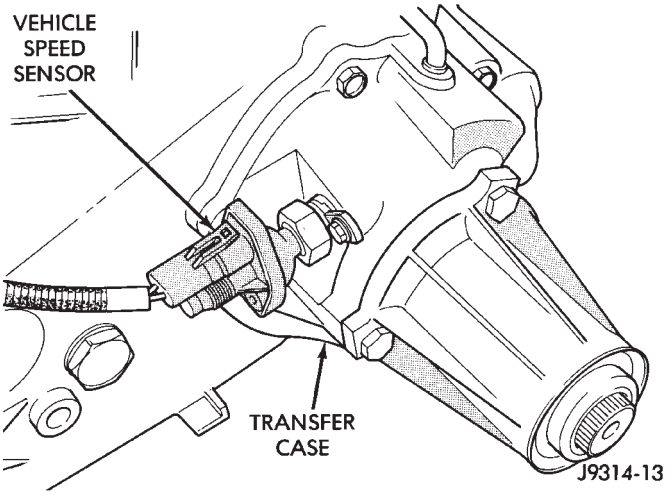


Fig. 10 Vehicle Speed Sensor—Typical

AIR CONDITIONING (A/C) CLUTCH RELAY—PCM OUTPUT

The powertrain control module (PCM) activates the A/C compressor through the A/C clutch relay. The PCM regulates A/C compressor operation by switching the ground circuit for the A/C clutch relay on and off. The relay is located in the Power Distribution Center (PDC) (Fig. 11). For the location of the relay within the PDC, refer to label under PDC cover.

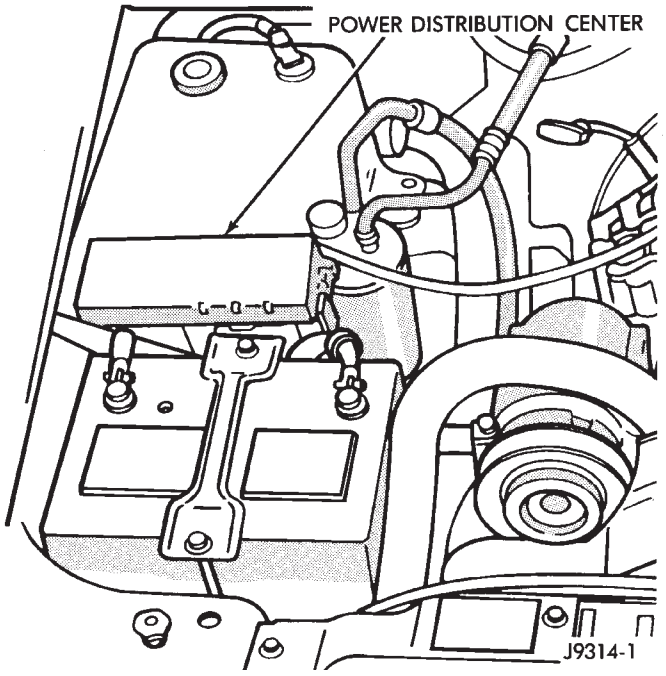


Fig. 11 Power Distribution Center (PDC)

When the PCM receives a request for A/C from A/C evaporator switch, it will adjust idle air control (IAC) motor position. This is done to increase idle speed. The PCM will then activate the A/C clutch through the A/C clutch relay. The PCM adjusts idle air control (IAC) stepper motor position to compensate for increased engine load from the A/C compressor.

By switching the ground path for the relay on and off, the PCM is able to cycle the A/C compressor clutch. This is based on changes in engine operating conditions. If, during A/C operation, the PCM senses low idle speeds or a wide open throttle condition, it will de-energize the relay. This prevents A/C clutch engagement. The relay will remain de-energized until the idle speed increases or the wide open throttle condition exceeds 15 seconds or no longer exists. The PCM will also de-energize the relay if coolant temperature exceeds 125°C (257°F).

IDLE AIR CONTROL (IAC) MOTOR—PCM OUTPUT

The IAC motor is mounted to the back of the throttle body (Fig. 12) and is controlled by the powertrain control module (PCM).

The throttle body has an air control passage that provides air for the engine at idle (the throttle plate is closed). The IAC motor pintle protrudes into the air control passage (Fig. 13) and regulates air flow through it. Based on various sensor inputs, the powertrain control module (PCM) adjusts engine idle

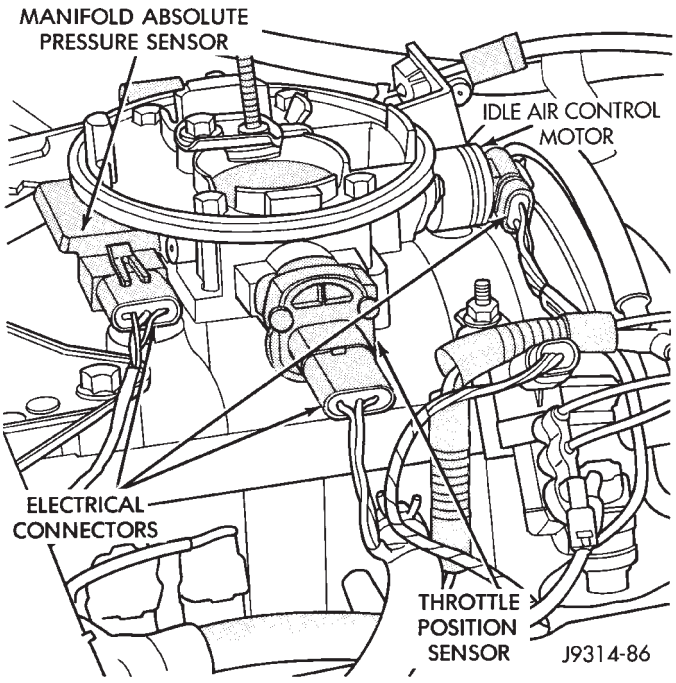


Fig. 12 IAC Motor

speed by moving the IAC motor pintle in and out of the air control passage. The IAC motor is positioned when the ignition key is turned to the On position.

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

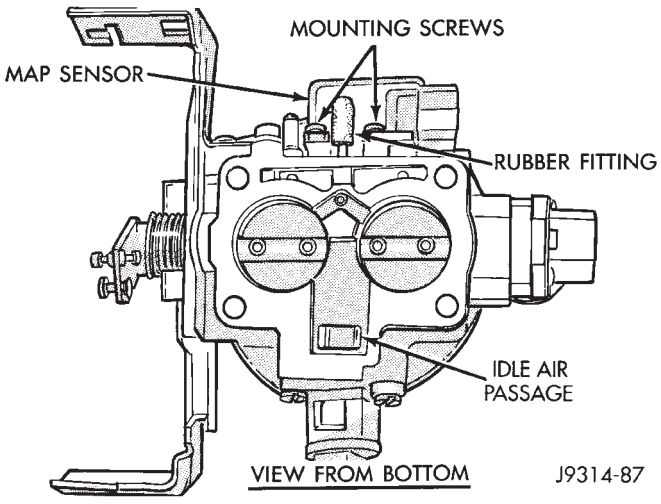


Fig. 13 Throttle Body Air Control Passage

AUTO SHUT DOWN (ASD) RELAY—PCM OUTPUT

The ASD relay is located in the Power Distribution Center (PDC) (Fig. 11). For the location of this relay within the PDC, refer to label under PDC cover.

The ASD supplies battery voltage to the fuel pump, fuel injector, ignition coil, generator field winding and oxygen (O_2) sensor heating element. The ground circuit for the coil in the ASD relay is controlled by the powertrain control module (PCM). The PCM operates the relay by switching the ground circuit on and off.

The fuel pump relay is controlled by the PCM through same circuit that the ASD relay is controlled.

GENERATOR FIELD—PCM OUTPUT

The powertrain control module (PCM) regulates the charging system voltage within a range of 12.9 to 15.0 volts. Refer to Group 8A for charging system information.

GENERATOR LAMP—PCM OUTPUT

If the powertrain control module (PCM) senses a low charging condition in the charging system, it will illuminate the generator lamp on the instrument panel. For example, during low idle with all accessories turned on, the light may momentarily go on. Once the PCM corrects idle speed to a higher rpm, the light will go out. Refer to Group 8A for charging system information.

ELECTRIC EXHAUST GAS RECIRCULATION TRANSDUCER (EET) SOLENOID—PCM OUTPUT

Refer to Group 25, Emission Control System for information. See Electric Exhaust Gas Recirculation Transducer (EET) Solenoid.

EMR LAMP—PCM OUTPUT

The EMR lamp is not used for the 1993 model year.

EVAP CANISTER PURGE SOLENOID—PCM OUTPUT

Refer to Group 25, Emission Control System. See EVAP Canister Purge Solenoid.

FUEL INJECTORS—PCM OUTPUT

The fuel injectors are attached to the fuel rail (Fig. 14). 5.2L engines use eight individual injectors for each cylinder.

The nozzle ends of the injectors are positioned into openings in the intake manifold just above the intake valve ports of the cylinder head. The engine wiring harness connector for each fuel injector is equipped with an attached numerical tag (INJ 1, INJ 2 etc.). This is used to identify each fuel injector.

The injectors are energized individually in a sequential order by the powertrain control module (PCM). The PCM will adjust injector pulse width by switching the ground path to each individual injector on and off. Injector pulse width is the period of time that the injector is energized. The PCM will adjust injector pulse width based on various inputs it receives.

During start up, battery voltage is supplied to the injectors through the ASD relay. When the engine is

operating, voltage is supplied by the charging system. The PCM determines injector pulse width based on various inputs.

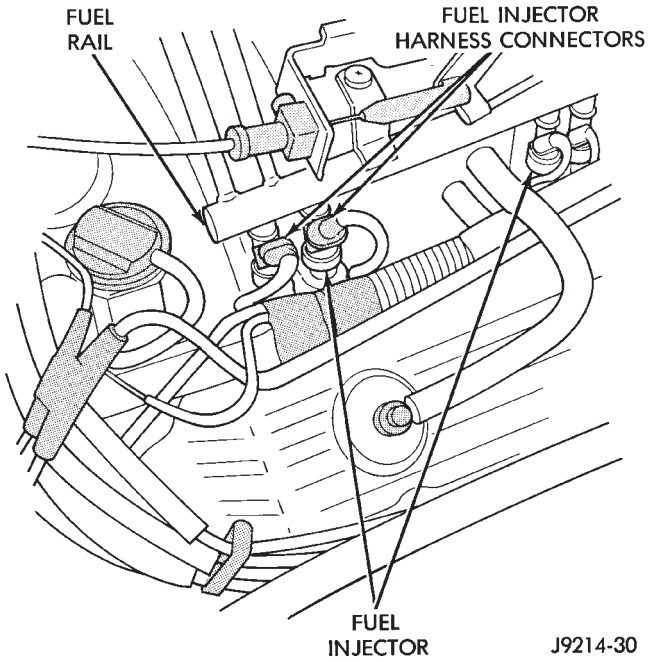


Fig. 14 Fuel Injectors—Typical

MALFUNCTION INDICATOR LAMP—PCM OUTPUT

The Malfunction Indicator Lamp (formerly referred to as the Check Engine Lamp) illuminates on the instrument panel each time the ignition key is turned on. It will stay on for three seconds as a bulb test.

If the powertrain control module (PCM) receives an incorrect signal, or no signal from certain sensors or emission related systems, the lamp is turned on. This is a warning that the PCM has recorded a system or sensor malfunction. In some cases, when a problem is declared, the PCM will go into a limp-in mode. This is an attempt to keep the system operating. It signals an immediate need for service.

The lamp can also be used to display a Diagnostic Trouble Code (DTC). Cycle the ignition switch On-Off-On-Off-On within three seconds and any codes stored in the PCM memory will be displayed. This is done in a series of flashes representing digits. Refer to On-Board Diagnostics in the General Diagnosis section of this group for more information.

IGNITION COIL—PCM OUTPUT

System voltage is supplied to the ignition coil positive terminal. The powertrain control module (PCM) operates the ignition coil. **Base (initial) ignition timing is not adjustable.** The PCM adjusts ignition timing to meet changing engine operating conditions.

The ignition coil is located near the front of the right cylinder head (Fig. 15).

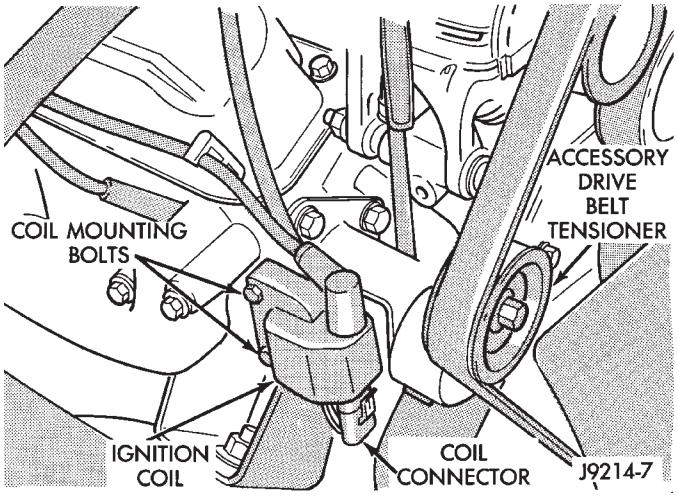


Fig. 15 Ignition Coil

SCI TRANSMIT—PCM OUTPUT

SCI Transmit is the serial data communication transmit circuit for the DRB II scan tool. The powertrain control module (PCM) transmits data to the DRB II through the SCI Transmit circuit.

SHIFT INDICATOR—PCM OUTPUT

Vehicles equipped with manual transmissions have an Up-Shift indicator lamp. The lamp is controlled by the powertrain control module (PCM). The lamp illuminates on the instrument panel to indicate when the driver should shift to the next highest gear for best fuel economy. The PCM will turn the lamp OFF after 3 to 5 seconds if the shift of gears is not performed. The up-shift light will remain off until vehicle stops accelerating and is brought back to range of up-shift light operation. This will also happen if vehicle is shifted into fifth gear.

The indicator lamp is normally illuminated when the ignition switch is turned on and it is turned off when the engine is started up. With the engine running, the lamp is turned on/off depending upon engine speed and load.

SPEED CONTROL—PCM OUTPUT

Speed control operation is regulated by the powertrain control module (PCM). The PCM controls the vacuum to the throttle actuator through the speed control vacuum and vent solenoids. Refer to Group 8H for Speed Control Information.

TACHOMETER—PCM OUTPUT

The powertrain control module (PCM) supplies engine rpm values to the instrument cluster tachometer. Refer to Group 8E for tachometer information.

OPEN LOOP/CLOSED LOOP MODES OF OPERATION

As input signals to the powertrain control module (PCM) change, the PCM adjusts its response to the output devices. For example, the PCM must calculate

different injector pulse width and ignition timing for idle than it does for wide open throttle (WOT). There are several different modes of operation that determine how the PCM responds to the various input signals.

MODES

- Open Loop
- Closed Loop

During Open Loop modes, the powertrain control module (PCM) receives input signals and responds only according to preset PCM programming. Input from the oxygen (O_2) sensor is not monitored during Open Loop modes.

During Closed Loop modes, the PCM will monitor the oxygen (O_2) sensor input. This input indicates to the PCM whether or not the calculated injector pulse width results in the ideal air-fuel ratio. This ratio is 14.7 parts air-to-1 part fuel. By monitoring the exhaust oxygen content through the O_2 sensor, the PCM can fine tune the injector pulse width. This is done to achieve optimum fuel economy combined with low emission engine performance.

The fuel injection system has the following modes of operation:

- Ignition switch ON
- Engine start-up (crank)
- Engine warm-up
- Idle
- Cruise
- Acceleration
- Deceleration
- Wide open throttle (WOT)
- Ignition switch OFF

The ignition switch On, engine start-up (crank), engine warm-up, acceleration, deceleration and wide open throttle modes are Open Loop modes. The idle and cruise modes, (with the engine at operating temperature) are Closed Loop modes.

IGNITION SWITCH (KEY-ON) MODE

This is an Open Loop mode. When the fuel system is activated by the ignition switch, the following actions occur:

- The powertrain control module (PCM) pre-positions the idle air control (IAC) motor.
- The PCM determines atmospheric air pressure from the MAP sensor input to determine basic fuel strategy.
- The PCM monitors the engine coolant temperature sensor input. The PCM modifies fuel strategy based on this input.
- Intake manifold charge air temperature sensor input is monitored
- Throttle position sensor (TPS) is monitored
- The auto shut down (ASD) relay is energized by the PCM for approximately three seconds.
- The fuel pump is energized through the fuel pump relay by the PCM. The fuel pump will operate for approximately one second unless the engine is operating or the starter motor is engaged.
- The O_2 sensor heater element is energized through the fuel pump relay. The O_2 sensor input is not used by the PCM to calibrate air-fuel ratio during this mode of operation.
- The up-shift indicator light is illuminated (manual transmission only).

ENGINE START-UP MODE

This is an Open Loop mode. The following actions occur when the starter motor is engaged.

The powertrain control module (PCM) receives inputs from:

- Battery voltage
- Engine coolant temperature sensor
- Crankshaft position sensor
- Intake manifold charge air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Starter motor relay
- Camshaft position sensor signal

The PCM monitors the crankshaft position sensor. If the PCM does not receive a crankshaft position sensor signal within 3 seconds of cranking the engine, it will shut down the fuel injection system.

The fuel pump is activated by the PCM through the fuel pump relay.

Voltage is applied to the fuel injectors with the PCM. The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.

The PCM determines the proper ignition timing according to input received from the crankshaft position sensor.

ENGINE WARM-UP MODE

This is an Open Loop mode. During engine warm-up, the powertrain control module (PCM) receives inputs from:

- Battery voltage
- Crankshaft position sensor
- Engine coolant temperature sensor
- Intake manifold charge air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)
- Park/Neutral Switch (Gear indicator signal—auto. trans. only)
- Air conditioning select signal (if equipped)
- Air conditioning request signal (if equipped)

Based on these inputs the following occurs:

- Voltage is applied to the fuel injectors with the powertrain control module (PCM). The PCM will

then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.
• The PCM adjusts engine idle speed through the idle air control (IAC) motor and adjusts ignition timing.
• The PCM operates the A/C compressor clutch through the clutch relay. This is done if A/C has been selected by the vehicle operator and requested by the A/C thermostat.
• If the vehicle has a manual transmission, the upshift light is operated by the PCM.
• When engine has reached operating temperature, the PCM will begin monitoring O_2 sensor input. The system will then leave the warm-up mode and go into closed loop operation.

IDLE MODE

When the engine is at operating temperature, this is a Closed Loop mode. At idle speed, the powertrain control module (PCM) receives inputs from:
• Air conditioning select signal (if equipped)
• Air conditioning request signal (if equipped)
• Battery voltage
• Crankshaft position sensor
• Engine coolant temperature sensor
• Intake manifold charge air temperature sensor
• Manifold absolute pressure (MAP) sensor
• Throttle position sensor (TPS)
• Camshaft position sensor signal (in the distributor)
• Battery voltage
• Park/Neutral Switch (Gear indicator signal—Auto. trans. only)
• Oxygen sensor

Based on these inputs, the following occurs:
• Voltage is applied to the fuel injectors with the powertrain control module (PCM). The PCM will then control injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off.
• The PCM monitors the O_2 sensor input and adjusts air-fuel ratio by varying injector pulse width. It also adjusts engine idle speed through the idle air control (IAC) motor.
• The PCM adjusts ignition timing by increasing and decreasing spark advance.
• The PCM operates the A/C compressor clutch through the clutch relay. This happens if A/C has been selected by the vehicle operator and requested by the A/C thermostat.

CRUISE MODE

When the engine is at operating temperature, this is a Closed Loop mode. At cruising speed, the powertrain control module (PCM) receives inputs from:
• Air conditioning select signal (if equipped)
• Air conditioning request signal (if equipped)
• Battery voltage
• Engine coolant temperature sensor
• Crankshaft position sensor
• Intake manifold charge air temperature sensor
• Manifold absolute pressure (MAP) sensor
• Throttle position sensor (TPS)
• Camshaft position sensor signal (in the distributor)
• Park/Neutral switch (gear indicator signal—auto. trans. only)
• Oxygen (O_2) sensor

Based on these inputs, the following occurs:
• Voltage is applied to the fuel injectors with the PCM. The PCM will then adjust the injector pulse width by turning the ground circuit to each individual injector on and off.
• The PCM monitors the O_2 sensor input and adjusts air-fuel ratio. It also adjusts engine idle speed through the idle air control (IAC) motor.
• The PCM adjusts ignition timing by turning the ground path to the coil on and off.
• The PCM operates the A/C compressor clutch through the clutch relay. This happens if A/C has been selected by the vehicle operator and requested by the A/C thermostat.

ACCELERATION MODE

This is an Open Loop mode. The powertrain control module (PCM) recognizes an abrupt increase in throttle position or MAP pressure as a demand for increased engine output and vehicle acceleration. The PCM increases injector pulse width in response to increased throttle opening.

DECELERATION MODE

When the engine is at operating temperature, this is an Open Loop mode. During hard deceleration, the powertrain control module (PCM) receives the following inputs.
• Air conditioning select signal (if equipped)
• Air conditioning request signal (if equipped)
• Battery voltage
• Engine coolant temperature sensor
• Crankshaft position sensor
• Intake manifold charge air temperature sensor
• Manifold absolute pressure (MAP) sensor
• Throttle position sensor (TPS)
• Camshaft position sensor signal (in the distributor)
• Park/Neutral switch (gear indicator signal—auto. trans. only)

If the vehicle is under hard deceleration with the proper rpm and closed throttle conditions, the PCM will ignore the oxygen sensor input signal. The PCM will enter a fuel cut-off strategy in which it will not supply battery voltage to the injectors. If a hard deceleration does not exist, the PCM will determine the proper injector pulse width and continue injection.

Based on the above inputs, the PCM will adjust engine idle speed through the idle air control (IAC) motor.

The PCM adjusts ignition timing by turning the ground path to the coil on and off.

The PCM opens the ground circuit to the A/C clutch relay to disengage the A/C compressor clutch. This is done until the vehicle is no longer under deceleration (if the A/C system is operating).

WIDE OPEN THROTTLE MODE

This is an Open Loop mode. During wide open throttle operation, the powertrain control module (PCM) receives the following inputs.

- Battery voltage
- Crankshaft position sensor
- Engine coolant temperature sensor
- Intake manifold charge air temperature sensor
- Manifold absolute pressure (MAP) sensor
- Throttle position sensor (TPS)
- Camshaft position sensor signal (in the distributor)

During wide open throttle conditions, the following occurs:

- Voltage is applied to the fuel injectors with the powertrain control module (PCM). The PCM will then control the injection sequence and injector pulse width by turning the ground circuit to each individual injector on and off. The PCM ignores the oxygen sensor input signal and provides a predetermined amount of additional fuel. This is done by adjusting injector pulse width.
- The PCM adjusts ignition timing by turning the ground path to the coil on and off.
- The PCM opens the ground circuit to the A/C clutch relay to disengage the A/C compressor clutch. This will be done for approximately 15 seconds (if the air conditioning system is operating).

If the vehicle has a manual transmission, the upshift light is operated by the PCM.

When the PCM senses wide open throttle condition through the throttle position sensor (TPS), it will provide a ground for the EGR solenoid. This will prevent any EGR functions.

IGNITION SWITCH OFF MODE

When ignition switch is turned to OFF position, the PCM stops operating the injectors, ignition coil, ASD relay and fuel pump relay.

THROTTLE BODY

Filtered air from the air cleaner enters the intake manifold through the throttle body (Fig. 16). Fuel does not enter the intake manifold through the throttle body. Fuel is sprayed into the manifold by the fuel injectors. The throttle body is mounted on the intake manifold. It contains an air control passage (Fig. 17) controlled by an Idle Air Control (IAC) motor. The air control passage is used to supply air for idle conditions. A throttle valve (plate) is used to supply air for above idle conditions.

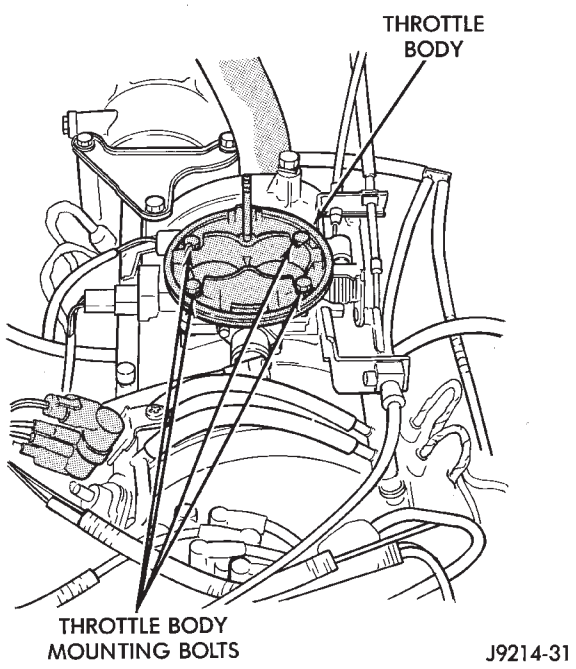


Fig. 16 Throttle Body

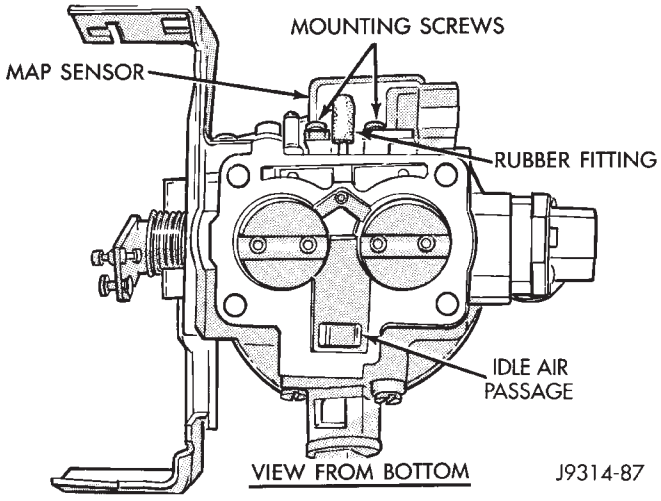


Fig. 17 Air Control Passage

The throttle position sensor (TPS), idle air control (IAC) motor and manifold absolute pressure sensor (MAP) are attached to the throttle body. The accelerator pedal cable, speed control cable and transmission control cable (when equipped) are connected to the throttle arm.

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the PCM.

FUEL RAIL

The fuel rail supplies fuel to the injectors and is mounted to the intake manifold (Fig. 18). The fuel

pressure regulator is attached to the rail and the fuel pressure test port is integral with the rail. The fuel rail is not repairable.

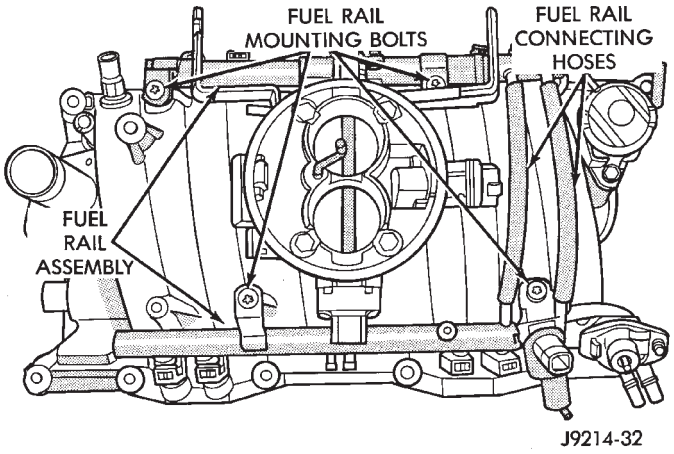


Fig. 18 Fuel Rail—Typical

FUEL PRESSURE REGULATOR

The fuel pressure regulator is a mechanical device that is not controlled by the powertrain control module (PCM).

The fuel pressure regulator used is a vacuum balanced, nonadjustable type. The regulator is mounted on the output end of the fuel rail and is connected to intake manifold vacuum (Fig. 19). The fuel return tube (to the fuel tank) is connected to the fuel pressure regulator.

The regulator is calibrated to maintain fuel system pressure at approximately 214 kPa (31 psi). This is with vacuum applied while the engine is at idle. Fuel pressure will be 55-69 kPa (8-10 psi) higher if vacuum is not applied to the regulator.

The pressure regulator contains a diaphragm, calibrated spring and a fuel return valve. Fuel pressure operates on one side of the regulator, while spring pressure and intake manifold vacuum operate on the other side. Spring pressure on one side of the diaphragm tries to force the return valve closed. Fuel pressure on other side of diaphragm, with assistance from manifold vacuum on spring side of diaphragm,

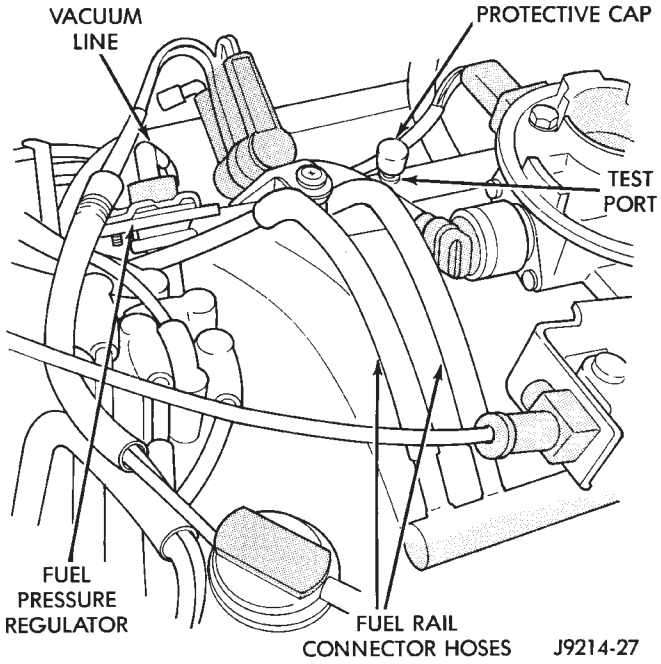


Fig. 19 Fuel Pressure Regulator

act against spring pressure to open the return valve. System fuel pressure is the amount of fuel pressure required to force against spring pressure and unseat the return valve.

Without vacuum applied to the spring side of the regulator, the spring is calibrated to open the fuel return outlet. This happens when the pressure differential between the fuel injectors and the intake manifold reaches approximately 269 kPa (39 psi). Since manifold vacuum varies with engine operating conditions, the amount of vacuum applied to the spring side of the diaphragm varies. For this reason, fuel pressure varies, depending upon intake manifold vacuum. With low vacuum, such as during wide open throttle conditions, minimal vacuum assistance is available. Full spring pressure is exerted to seal the fuel outlet. This causes the system pressure to increase. With high vacuum, such as at engine idle or during vehicle deceleration, fuel pressure on one side of the diaphragm is balanced by intake manifold pressure. This is done on the spring side of the diaphragm and results in lower system fuel pressure.

MPI SYSTEM—5.2L ENGINE—GENERAL DIAGNOSIS

INDEX

VISUAL INSPECTION

A visual inspection for loose, disconnected, or incorrectly routed wires and hoses should be made. This should be done before attempting to diagnose or service the fuel injection system. A visual check will help spot these faults and save unnecessary test and diagnostic time. A thorough visual inspection will include the following checks:

(1) Verify that the 60-way connector is fully inserted into the connector of the powertrain control module (PCM) (Fig. 1). Verify that the connector mounting screw is tightened to 4 N•m (35 in. lbs.) torque.

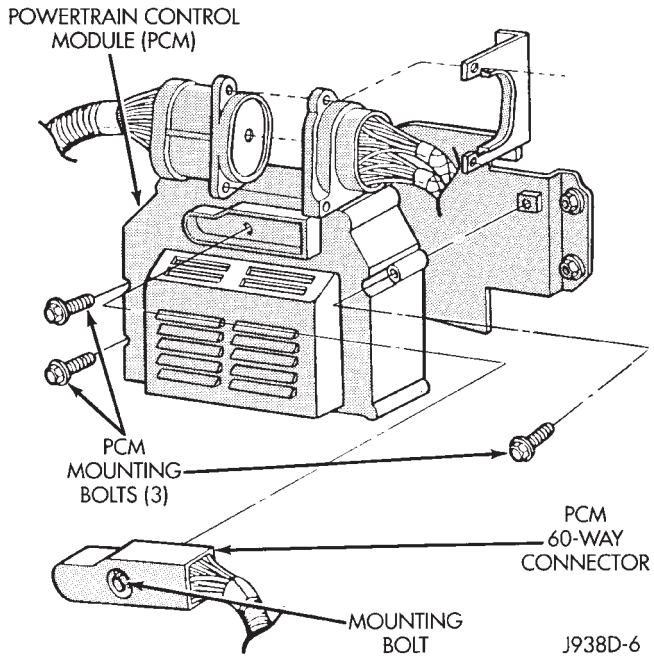


Fig. 1 Powertrain Control Module (PCM)

(2) Inspect the battery cable connections. Be sure that they are clean and tight.

(3) Inspect fuel pump relay and air conditioning compressor clutch relay (if equipped). Inspect the ASD relay connections. Inspect starter motor relay connections. Inspect relays for signs of physical damage and corrosion. The relays are located in the Power Distribution Center (PDC) (Fig. 2). For the location of the relays within the PDC, refer to label under PDC cover.

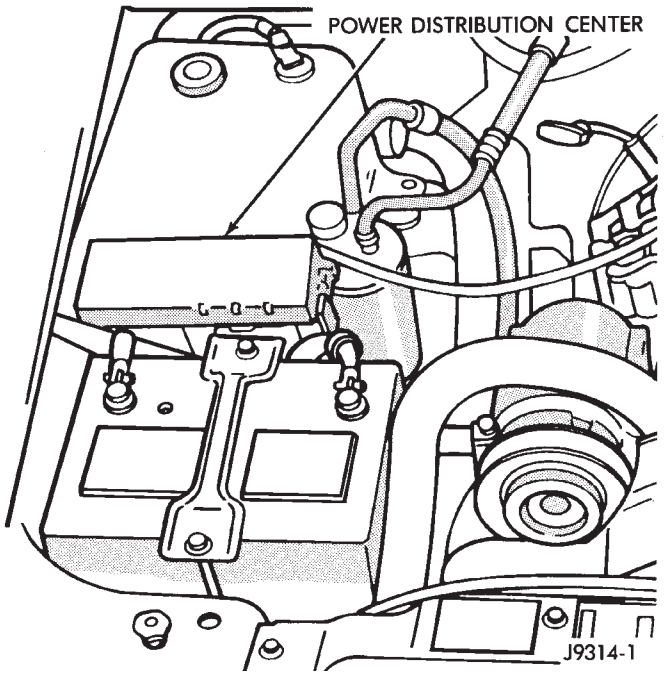


Fig. 2 Power Distribution Center (PDC)

(4) Inspect ignition coil connections. Verify that coil secondary cable is firmly connected to coil (Fig. 3).

(5) Verify that distributor cap is correctly attached to distributor. Be sure that spark plug cables are firmly connected to the distributor cap and the spark plugs are in their correct firing order. Be sure that coil cable is firmly connected to distributor cap and coil. Be sure that camshaft position sensor wire connector (at the distributor) is firmly connected to harness connector. Inspect spark plug condition. Refer to

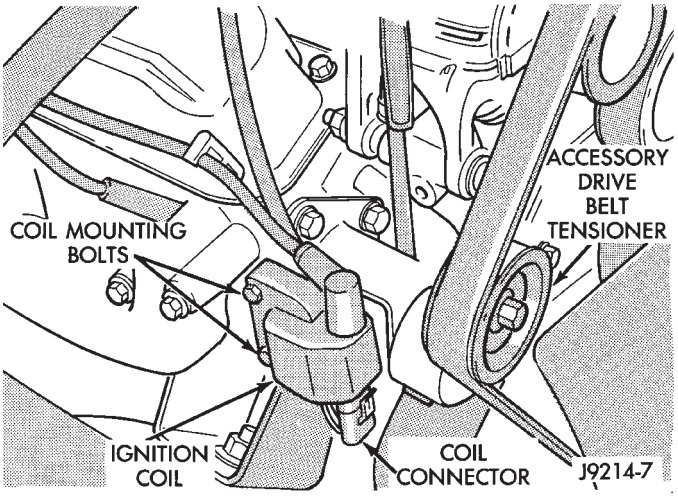


Fig. 3 Ignition Coil

Group 8D, Ignition. Connect vehicle to an oscilloscope and inspect spark events for fouled or damaged spark plugs or cables.

(6) Verify that generator output wire, generator connector and ground wire are firmly connected to the generator.

(7) Inspect the system body grounds for loose or dirty connections. Refer to Group 8W, Wiring for location of body ground connections.

(8) Verify Positive Crankcase Ventilation (PCV) valve operation. Refer to Group 25, Emission Control System for additional information. Verify PCV valve hose is firmly connected to PCV valve and manifold (Fig. 4).

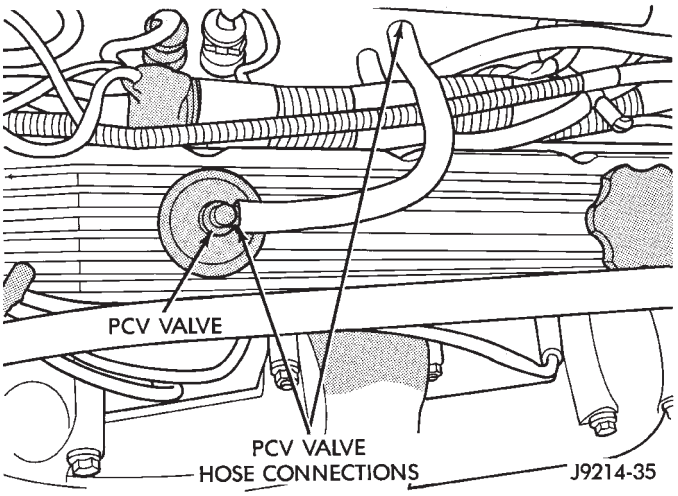


Fig. 4 PCV Valve Hose Connections

(9) Verify that vacuum line is firmly connected to fuel pressure regulator and manifold fitting (Fig. 5).

(10) Inspect fuel tube quick-connect fitting-to-fuel rail connections.

(11) Verify that hose connections to all ports of vacuum fittings on intake manifold are tight and not leaking.

(12) Inspect accelerator cable, transmission throttle cable (if equipped) and cruise control cable connections (if equipped). Check their connections to the throttle arm of throttle body for any binding or restrictions.

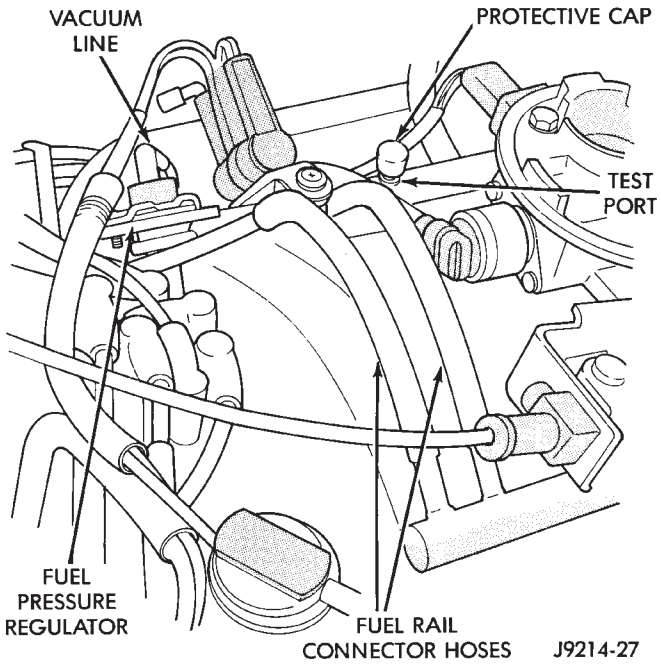


Fig. 5 Pressure Regulator Vacuum Hose

(13) If equipped with vacuum brake booster, verify that vacuum booster hose is firmly connected to fitting on intake manifold. Also check connection to brake vacuum booster.

(14) Inspect the air cleaner inlet and air filter element for dirt or restrictions.

(15) Inspect radiator grille area, radiator fins and air conditioning condenser for restrictions.

(16) Verify that the intake manifold charge air temperature sensor wire connector is firmly connected to harness connector (Fig. 6).

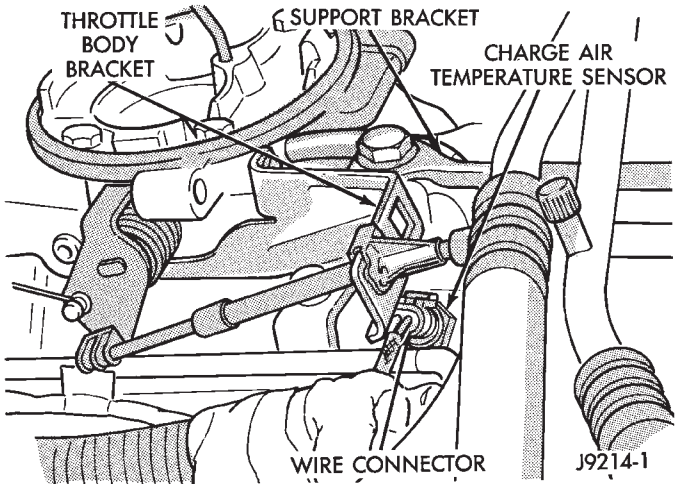


Fig. 6 Charge Air Temperature Sensor—Typical

(17) Verify that MAP sensor electrical connector is firmly connected to MAP sensor (Fig. 7). Also verify that rubber L-shaped fitting from MAP sensor to the throttle body is firmly connected (Fig. 8).

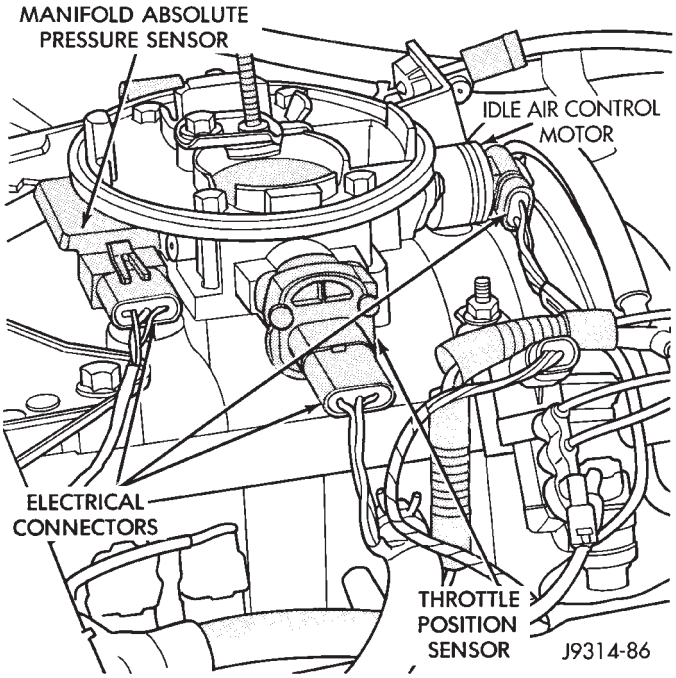


Fig. 7 Manifold Absolute Pressure (MAP) Sensor

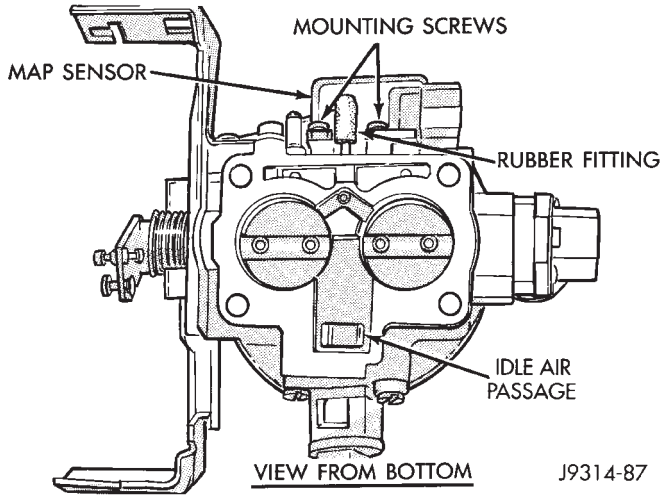


Fig. 8 Rubber L-Shaped Fitting—MAP Sensor-to-Throttle Body

(18) Verify that fuel injector wire harness connectors are firmly connected to injectors in the correct firing order. Each harness connector is numerically tagged with the injector number (INJ 1, INJ 2 etc.) of its corresponding fuel injector and cylinder number.

(19) Verify harness connectors are firmly connected to idle air control (IAC) motor, throttle position sensor (TPS) and manifold absolute pressure (MAP) sensor.

(20) Verify that wire harness connector is firmly connected to the engine coolant temperature sensor (Fig. 9).

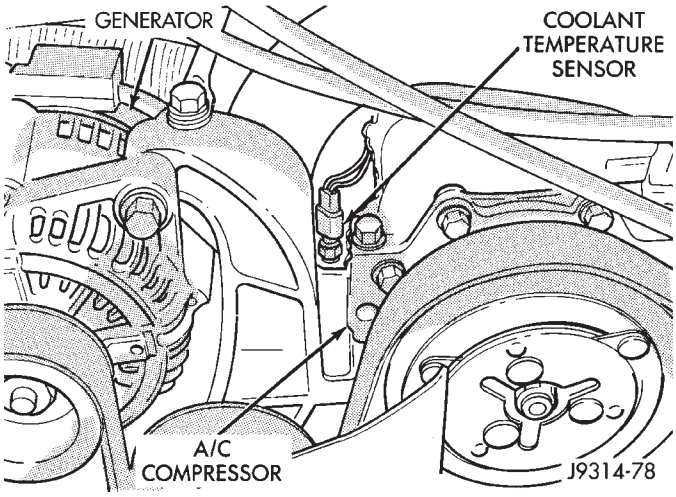


Fig. 9 Engine Coolant Temperature Sensor—Typical

(21) Raise and support the vehicle.

(22) Verify that oxygen sensor wire connector is firmly connected to the sensor. Inspect sensor and connector for damage (Fig. 10).

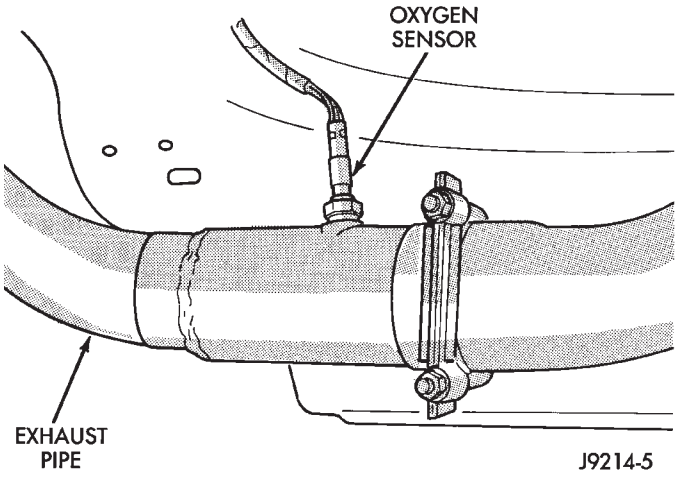


Fig. 10 Oxygen Sensor—Typical

(23) Inspect for pinched or leaking fuel tubes. Inspect for pinched, cracked or leaking fuel hoses.

(24) Inspect for exhaust system restrictions such as pinched exhaust pipes, collapsed muffler or plugged catalytic convertor.

(25) If equipped with automatic transmission, verify that electrical harness is firmly connected to park/neutral switch. Refer to Automatic Transmission section of Group 21.

(26) Verify that the harness connector is firmly connected to the vehicle speed sensor (Fig. 11).

(27) Verify that fuel pump/gauge sender unit wire connector is firmly connected to harness connector.

(28) Inspect fuel hoses at fuel pump/gauge sender unit for cracks or leaks.

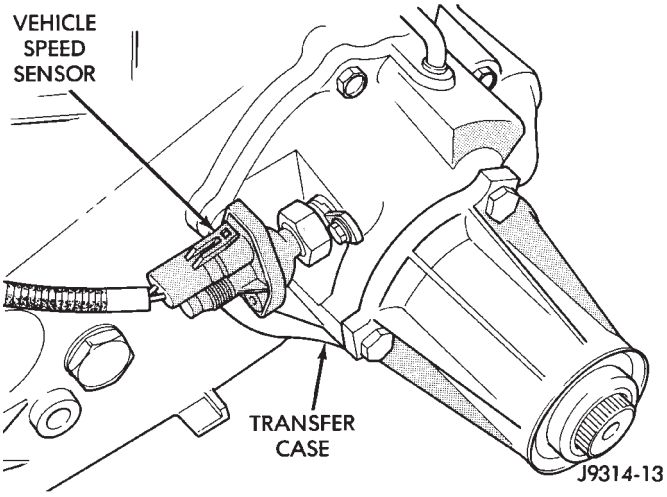


Fig. 11 Vehicle Speed Sensor—Typical

(29) Inspect transmission torque convertor housing (automatic transmission) or clutch housing (manual transmission) for damage to timing ring on drive plate/flywheel.

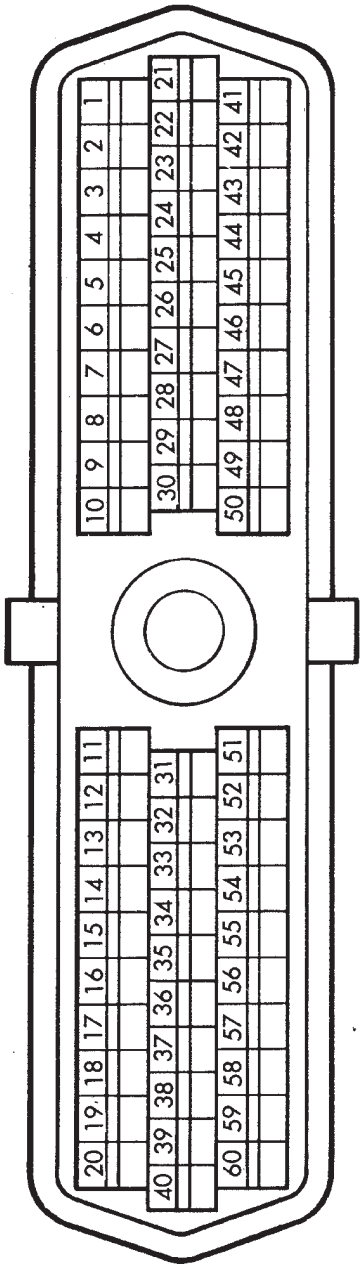
(30) Verify that battery cable and solenoid feed wire connections to the starter solenoid are tight and clean. Inspect for chaffed wires or wires rubbing up against other components.

POWERTRAIN CONTROL MODULE (PCM) 60-WAY CONNECTOR

Terminal identification and specific circuit applications for the 5.2L (V-8) engine are shown in the PCM connector charts (Fig. 12). Also refer to Group 8W, Wiring Diagrams.

SYSTEM SCHEMATICS

Fuel system schematics for the 5.2L (V-8) engine are shown in figure 13.



VIEWED FROM WIRE END

CAV	CIRCUIT	FUNCTION
1	K70 18RD/WT*	MAP SIGNAL
2	K2 20TN/BK*	ENGINE COOLANT TEMPERATURE SENSOR
3	A5 16PK/BK*	BATTERY
4	K4 18BK/LB*	SENSOR GROUND
5	Z12 18BK/TN*	POWER GROUND
6	K6 18VT/WT*	5 VOLTS
7	K25 20WT/BK*	8 VOLT SUPPLY
8	T40 14LG/BK*	ENGINE STARTER RELAY
9	F86 16LB	IGNITION ACCESSORY FEED
10	T9 200R/BK*	TRANSMISSION OVERDRIVE PRESSURE SIGNAL
11	Z12 18BK/TN*	POWER GROUND
12	Z12 18BK/TN*	POWER GROUND
13	K14 18LB/BR*	INJECTOR 4
14	K13 18YL/WT*	INJECTOR 3
15	K12 18TN	INJECTOR 2
16	K11 18WT/DB*	INJECTOR 1
17	K17 18DB/WT*	INJECTOR 7
18	K18 18DB/YL*	INJECTOR 8
19	K19 18GY/WT*	DISTRIBUTOR IGNITION COIL (-)
20	K20 18DG	GENERATOR FIELD
21	K21 20BK/RD*	INTAKE AIR TEMPERATURE SENSOR
22	K22 18OR/DB*	THROTTLE POSITION (SENSOR)
23	—	—
24	K27 200RD/LG*	CRANKSHAFT POSITION SENSOR
25	D84 20BK	DIAGNOSTIC (DATA 2)
26	D1 20VT/BR*	CCD (+)
27	C21 18DB/OR*	A/C LOW PRESSURE SWITCH
28	C90 20LG	A/C SELECT SIGNAL
29	L53 20BR	TCU BRAKE (—)
30	T41 20BK/WT*	PARK/NEUTRAL SWITCH
31	—	—
32	G3 20BK/PK*	MALFUNCTION INDICATOR LAMP
33	V36 20TN/RD*	VEHICLE SPEED CONTROL (VACUUM)
34	C13 20DB/RD*	A/C COMPRESSOR CLUTCH RELAY
35	K35 20GY/YL*	EXHAUST GAS RECIRCULATION SOLENOID
36	—	—
37	G68 20PK/OR*	TRANSMISSION OVERDRIVE LAMP
38	K38 18GY	INJECTOR 5
39	K60 18YL/BK*	STEPPER IDLE AIR CONTROL (4)
40	K40 18BR/WT*	STEPPER IDLE AIR CONTROL (2)
41	K41 18BK/OR*	OXYGEN SENSOR
42	—	—
43	G21 20GY/LB*	BUFFERED TACHOMETER SIGNAL
44	K24 18GY/BK*	CAMSHAFT POSITION SENSOR SIGNAL
45	D83 20BK/YL*	DIAGNOSTIC (DATA 1)
46	D2 20WT/GY*	CCD (—)
47	G7 18WT/OR*	VEHICLE SPEED SIGNAL
48	V31 20BR/RD*	VEHICLE SPEED CONTROL SWITCH (SET)
49	V32 20YL/RD*	VEHICLE SPEED CONTROL SWITCH (IGNITION)
50	V33 20WT/LG*	VEHICLE SPEED CONTROL SWITCH (RESUME)
51	K81 20PK	FUEL PUMP RELAY COIL
52	K52 20PK/BK*	EVAP/PURGE SOLENOID
53	V35 20LG/RD*	VEHICLE SPEED CONTROL (VENT)
54	T6 20VT/YL*	TRANSMISSION TCC LU SOLENOID
55	T60 18BR/LG*	TRANSMISSION OVERDRIVE SOLENOID
56	G24 20GY/PK*	MAINTENANCE INDICATOR
57	A61 18DG/BK*	IGNITION COIL: FUEL INJ: FUEL PUMP
58	K58 18BR/YL*	INJECTOR 6
59	K39 18GY/RD*	STEPPER IDLE AIR CONTROL (1)
60	K59 18VT/BK*	STEPPER IDLE AIR CONTROL (3)

* - INDICATES TWISTED PAIR

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Fig. 12 PCM Connector—5.2L Engine

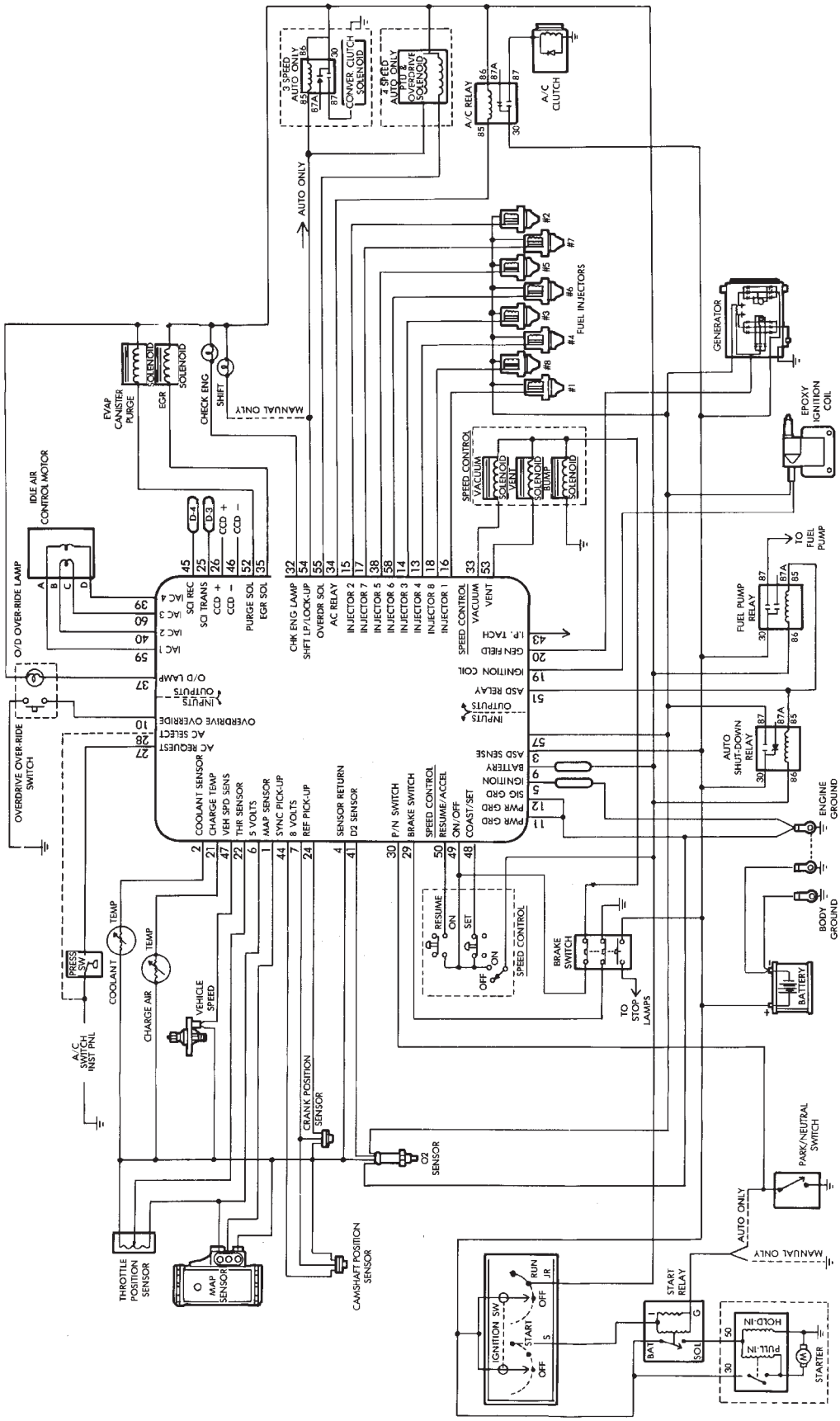

Fig. 13 System Schematic—5.2L Engine

CAMSHAFT POSITION SENSOR TESTING

Refer to Group 8D, Ignition Systems for testing.

COOLANT TEMPERATURE SENSOR TEST

To perform a complete test of the Engine Coolant Temperature Sensor and its circuitry, refer to DRB II tester and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Disconnect wire harness connector from coolant temperature sensor (Fig. 14).

Engines with air conditioning: When removing the connector from sensor, do not pull directly on wiring harness. Fabricate an L-shaped hook tool from a coat hanger (approximately eight inches long). Place the hook part of tool under the connector for removal. The connector is snapped onto the sensor. It is not equipped with a lock type tab.

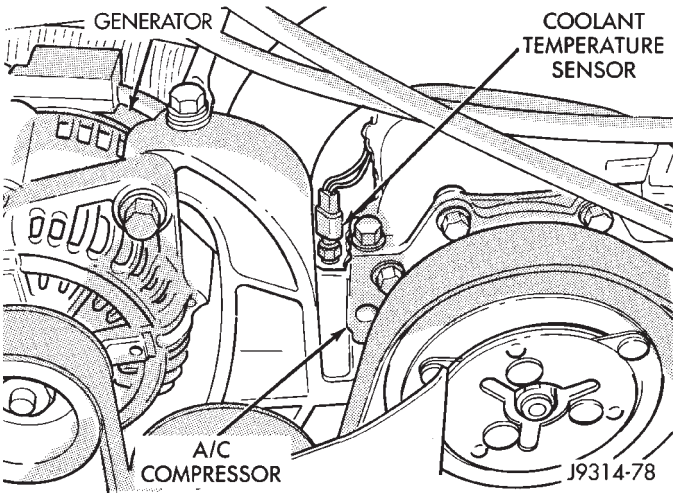

Fig. 14 Coolant Temperature Sensor—Typical

(2) Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter. The resistance (as measured across the sensor terminals) should be less than 1340 ohms with the engine warm. Refer to the Coolant Temperature sensor/Charge Air Temperature sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

(3) Test continuity of the wire harness. Do this between the powertrain control module (PCM) wire harness connector terminal 2 and the sensor connector terminal. Also test continuity of wire harness terminal 4 to the sensor connector terminal. Repair the wire harness if an open circuit is indicated.

(4) After tests are completed, connect electrical connector to sensor. The sensor connector is symmetrical (not indexed). It can be installed to the sensor in either direction.

CHARGE AIR TEMPERATURE SENSOR TEST

To perform a complete test of the Intake Manifold Charge Air Temperature sensor and its circuitry, refer to DRB II tester and appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

SENSOR RESISTANCE (OHMS)—COOLANT TEMPERATURE SENSOR/CHARGE AIR TEMPERATURE SENSOR

TEMPERATURE		RESISTANCE (OHMS)	
C	F	MIN	MAX
−40	−40	291,490	381,710
−20	−4	85,850	108,390
−10	14	49,250	61,430
0	32	29,330	35,990
10	50	17,990	21,810
20	68	11,370	13,610
25	77	9,120	10,880
30	86	7,370	8,750
40	104	4,900	5,750
50	122	3,330	3,880
60	140	2,310	2,670
70	158	1,630	1,870
80	176	1,170	1,340
90	194	860	970
100	212	640	720
110	230	480	540
120	248	370	410

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(1) Disconnect the wire harness connector from the Charge Air Temperature sensor (Fig. 15).

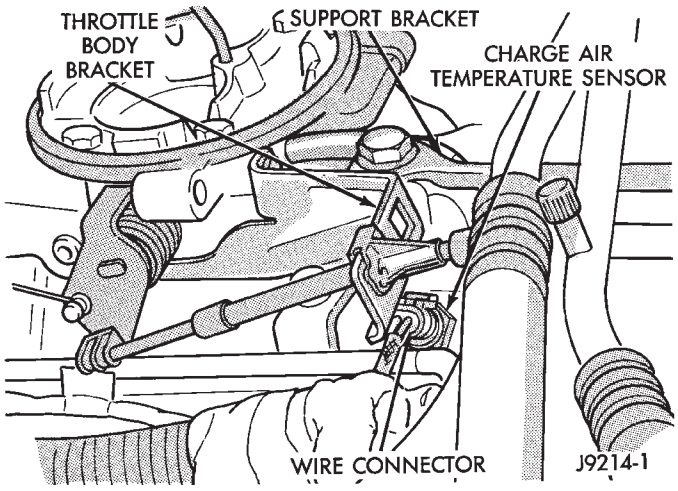


Fig. 15 Charge Air Temperature Sensor—Typical

(2) Test the resistance of the sensor with an input impedance (digital) volt-ohmmeter. The resistance (as measured across the sensor terminals) should be less than 1340 ohms with the engine warm. Refer to the Coolant Temperature sensor/Charge Air Temperature sensor resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

(3) Test the resistance of the wire harness. Do this between the powertrain control module (PCM) wire harness connector terminal 21 and the sensor connector terminal. Also check between terminal 4 to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST

To perform a complete test of MAP sensor (Fig. 16) and its circuitry, refer to DRB II tester and appropriate Powertrain Diagnostics Procedures manual. To test the MAP sensor only, refer to the following:

(1) Inspect the rubber L-shaped fitting from the MAP sensor to the throttle body (Fig. 17). Repair as necessary.

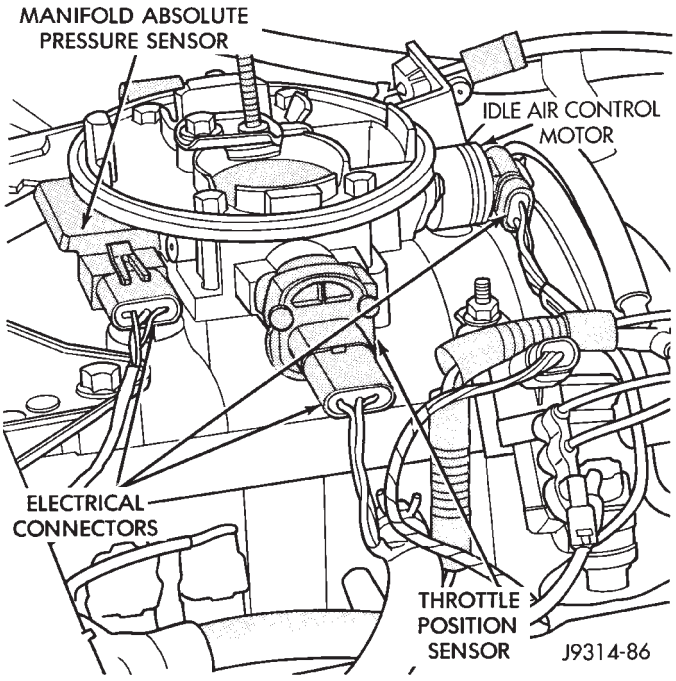


Fig. 16 Manifold Absolute Pressure (MAP) Sensor

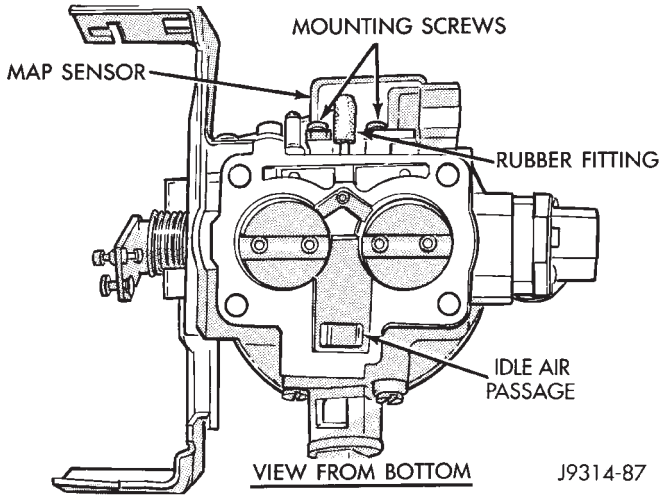


Fig. 17 Rubber L-Shaped Fitting—MAP Sensor-to-Throttle Body

CAUTION: When testing the MAP sensor, be sure that the harness wires are not damaged by the test meter probes.

(2) Test the MAP sensor output voltage at the MAP sensor connector between terminals A and B (Fig. 18). With the ignition switch ON and the engine OFF, output voltage should be 4-to-5 volts. The voltage should drop to 1.5-to-2.1 volts with a hot, neutral idle speed condition.

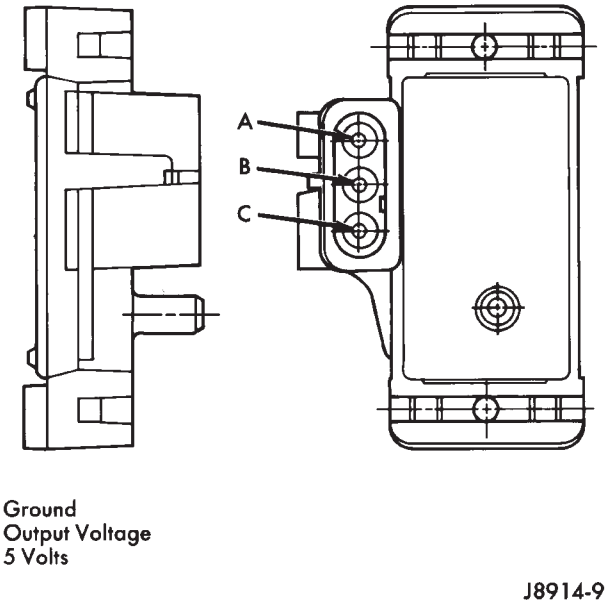


Fig. 18 MAP Sensor Connector Terminals—Typical

(3) Test powertrain control module (PCM) pin-1 for the same voltage described above to verify the wire harness condition. Repair as necessary.

(4) Test MAP sensor supply voltage at sensor connector between terminals A and C (Fig. 18) with the ignition ON. The voltage should be approximately 5 volts (±0.5V). Five volts (±0.5V) should also be at terminal 6 of the powertrain control module (PCM) wire harness connector. Repair or replace the wire harness as necessary.

(5) Test the MAP sensor ground circuit at sensor connector terminal A (Fig. 18) and PCM connector terminal/pin-4. Repair the wire harness if necessary.

(6) Test the MAP sensor ground circuit at the PCM connector between terminal/pin-4 and terminal/pin-11 with an ohmmeter. If the ohmmeter indicates an open circuit, inspect for a defective sensor ground connection. Refer to Group 8W, Wiring Diagrams for location of this connection. If the ground connection is good, replace the PCM. If terminal/pin-4 has a short circuit to 12 volts +, correct this condition before replacing the PCM.

CRANKSHAFT POSITION SENSOR TEST

To perform a complete test of this sensor (Fig. 19) and its circuitry, refer to the DRB II tester and ap-

propriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

(1) Near the rear of the right cylinder head, disconnect the sensor pigtail harness connector from the main wiring harness.

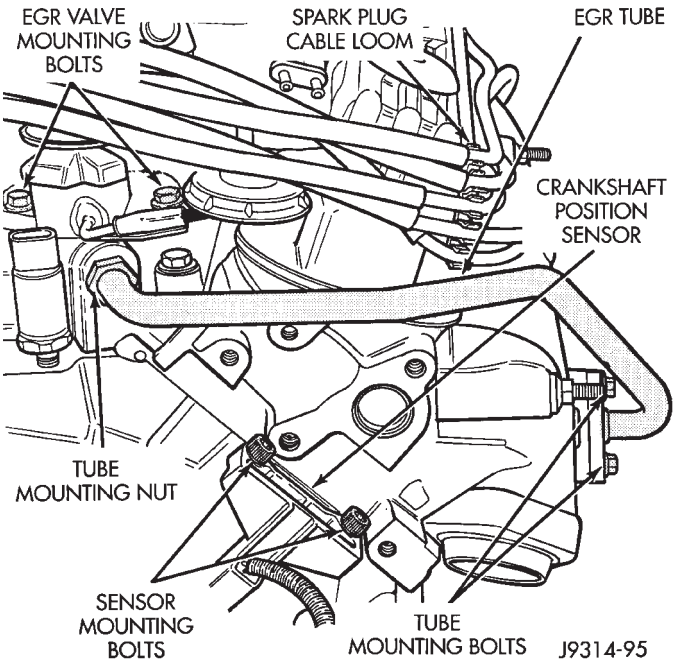


Fig. 19 Crankshaft Position Sensor

(2) Place an ohmmeter across terminals B and C (Fig. 20). Ohmmeter should be set to 1K-to-10K scale for this test. The meter reading should be open (no resistance). Replace sensor if a low resistance is indicated.

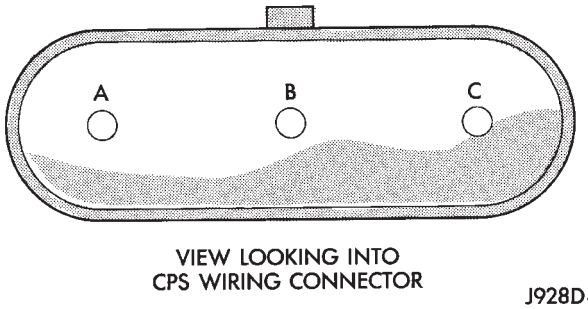


Fig. 20 Sensor Wiring Connector

THROTTLE POSITION SENSOR (TPS) TEST

To perform a complete test of the TPS and its circuitry, refer to the DRB II tester and appropriate Powertrain Diagnostics Procedures manual. To test the TPS only, refer to the following:

The TPS can be tested with a digital voltmeter. The center terminal of the TPS is the output terminal (Fig. 21).

With the ignition key in the ON position, check the TPS output voltage at the center terminal wire of the connector. Check this at idle (throttle plate closed) and at wide open throttle (WOT). At idle, TPS output voltage should must be greater than 200 millivolts. At wide open throttle, TPS output voltage must be less than 4.8 volts. The output voltage should increase gradually as the throttle plate is slowly opened from idle to WOT.

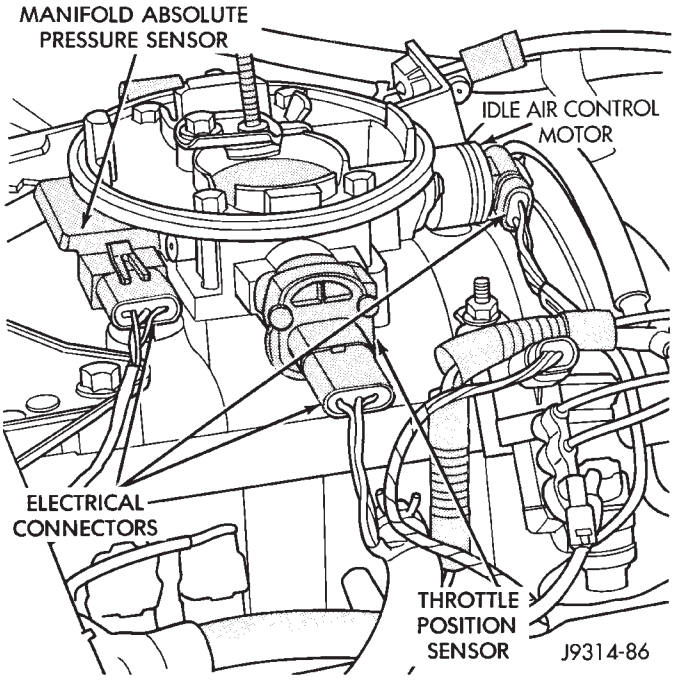


Fig. 21 Throttle Position Sensor (TPS) Connector

OXYGEN (O_2) SENSOR HEATING ELEMENT TEST

To perform a complete test of O_2 sensor and its circuitry, refer to DRB II tester and appropriate Powertrain Diagnostics Procedures manual. To test the O_2 only, refer to the following:

The O_2 sensor is located on the right exhaust down pipe (Fig. 22). The O_2 heating element can be tested with an ohmmeter as follows:

Disconnect the O_2 sensor connector. Connect the ohmmeter test leads across the white wire terminals of the sensor connector. Resistance should be between 5 and 7 ohms. Replace the sensor if the ohmmeter displays an infinity (open) reading.

IDLE AIR CONTROL (IAC) MOTOR TEST

To perform a complete test of IAC motor (Fig. 23) and its circuitry, refer to DRB II scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the IAC motor only, special IAC motor exerciser tool number 7558 (Fig. 24) may be used.

CAUTION: Proper safety precautions must be taken when testing the IAC motor.

- Set the parking brake and block the drive wheels
- Route all tester cables away from the cooling fans, drive belt, pulleys and exhaust components

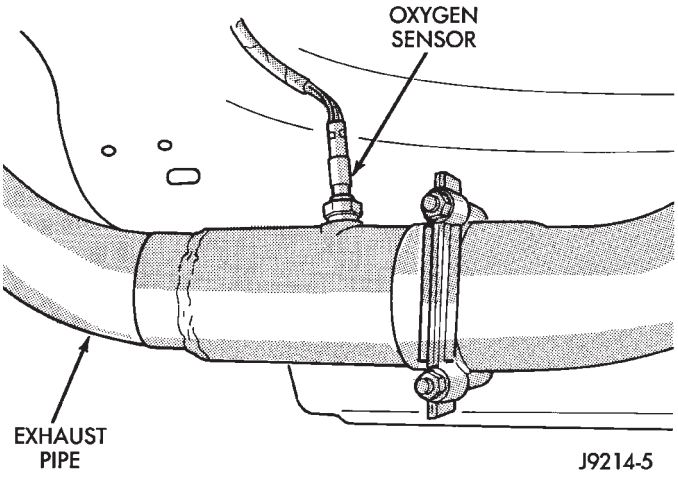


Fig. 22 Oxygen Sensor—Typical

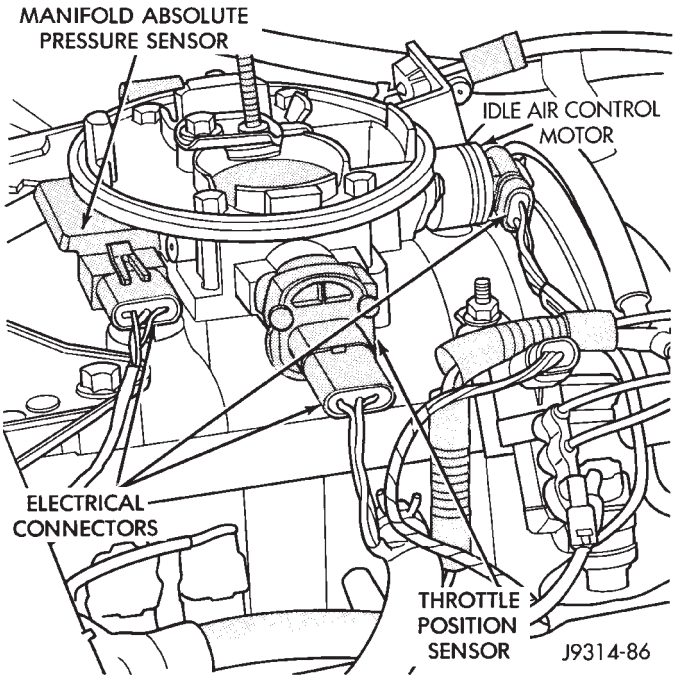


Fig. 23 IAC Motor

• Provide proper ventilation while operating the engine

• Always return the engine idle speed to normal before disconnecting the exerciser tool

(1) With the ignition OFF, disconnect the IAC motor wire connector at throttle body (Fig. 24).

(2) Plug the exerciser tool (7558) harness connector into the IAC motor (Fig. 24).

(3) Connect the red clip of exerciser tool (7558) to battery positive terminal. Connect the black clip to negative battery terminal. The red light on the exerciser tool will be illuminated when the exerciser is properly connected to battery.

(4) Start engine.

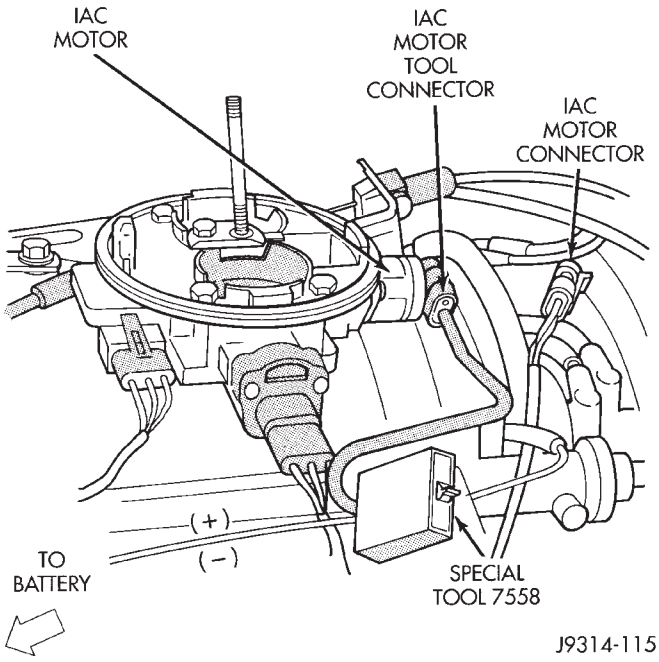


Fig. 24 IAC Motor Testing

When the switch is in the HIGH or LOW position, the light on the exerciser tool will flash. This indicates that voltage pulses are being sent to the IAC stepper motor.

(5) Move the switch to the HIGH position. The engine speed should increase. Move the switch to the LOW position. The engine speed should decrease.

(a) If the engine speed changes while using the exerciser tool, the IAC motor is functioning properly. Disconnect the exerciser tool and connect the IAC stepper motor wire connector to the stepper motor.

(b) If the engine speed does not change, turn the ignition OFF and proceed to step (6). Do not disconnect exerciser from the IAC stepper motor.

(6) Remove the IAC stepper motor from the throttle body.

CAUTION: When checking IAC motor operation with the motor removed from the throttle body, do not extend the pintle (Fig. 25) more than 6.35 mm (.250 in). If the pintle is extended more than this amount, it may separate from the IAC stepper motor. The IAC motor must be replaced if the pintle separates from the motor.

(7) With the ignition OFF, cycle the exerciser tool switch between the HIGH and LOW positions. Observe the pintle. The pintle should move in-and-out of the motor.

(a) If the pintle does not move, replace the IAC motor. Start the engine and test the replacement motor operation as described in step (5).

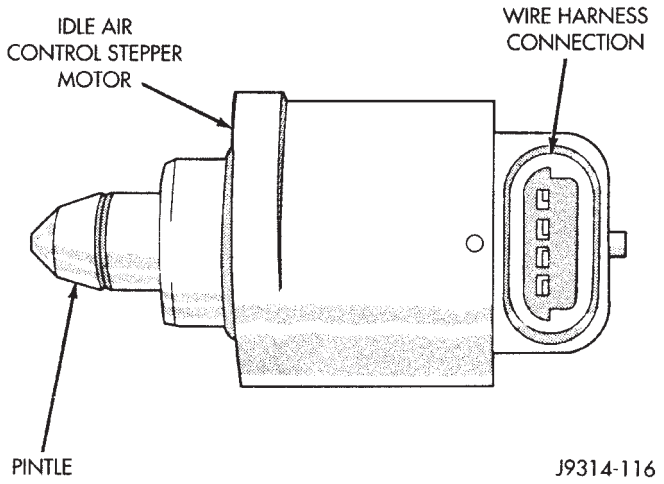


Fig. 25 IAC Stepper Motor Pintle—Typical

(b) If the pintle operates properly, check the IAC motor bore in the throttle body bore for blockage and clean as necessary. Install the IAC motor and retest. If blockage is not found, refer to the DRB II scan tool and the appropriate Powertrain Diagnostics Procedures service manual.

RELAYS—OPERATION/TESTING

OPERATION

The following operations/tests apply to these relays only: Automatic Shut Down (ASD) and Fuel Pump. For operations/tests on all other relays, refer to the appropriate section of this service manual.

These relays are located in the Power Distribution Center (PDC) (Fig. 26). For the location of the relay within the PDC, refer to label under PDC cover.

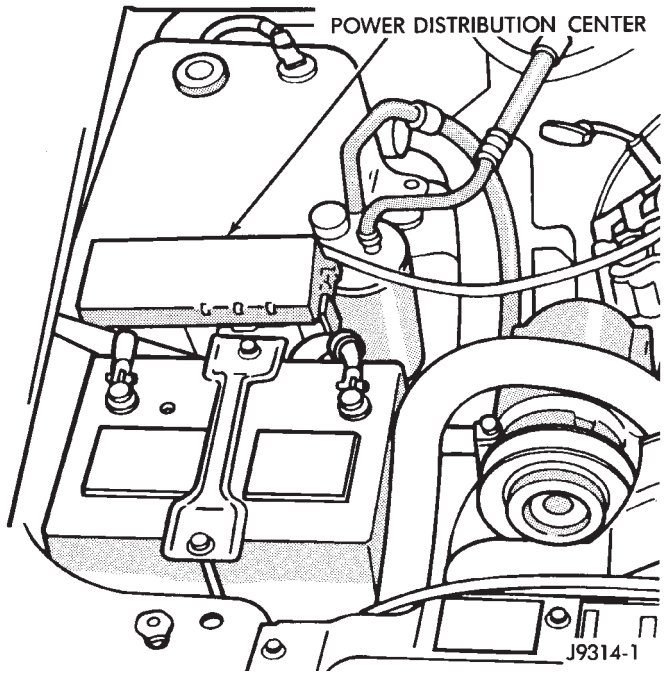


Fig. 26 Power Distribution Center (PDC)

The relay terminal numbers from (Fig. 27) can be found on the bottom of the relay.

- Terminal number 30 is connected to battery voltage and can be switched or B+ (hot) at all times.
- The center terminal number 87A is connected (a circuit is formed) to terminal 30 in the de-energized (normally OFF) position.
- Terminal number 87 is connected (a circuit is formed) to terminal 30 in the energized (ON) position. Terminal number 87 then supplies battery voltage to the component being operated.
- Terminal number 86 is connected to a switched (+) power source.
- Terminal number 85 is grounded by the powertrain control module (PCM).

TESTING

(1) Remove relay before testing.

(2) Using an ohmmeter, perform a resistance test between terminals 85 and 86. Resistance value (ohms) should be 75 ±5 ohms for resistor equipped relays.

(3) Connect the ohmmeter between terminals number 87A and 30. Continuity should be present at this time.

(4) Connect the ohmmeter between terminals number 87 and 30. Continuity should not be present at this time.

(5) Use a set of jumper wires (16 gauge or smaller). Connect one jumper wire between terminal number 85 (on the relay) to the ground side (-) of a 12 Volt power source.

(6) Attach the other jumper wire to the positive side (+) of a 12V power source. Do not connect this jumper wire to relay at this time.

CAUTION: DO NOT ALLOW THE OHMMETER TO CONTACT TERMINALS 85 OR 86 DURING THESE TESTS. DAMAGE TO OHMMETER MAY RESULT.

(7) Attach the other jumper wire (12V +) to terminal number 86. This will activate the relay. Continuity should now be present between terminals number 87 and 30. Continuity should not be present between terminals number 87A and 30.

(8) Disconnect jumper wires from relay and 12 Volt power source.

If continuity or resistance tests did not pass, replace relay. If tests passed, refer to Group 8W, Wiring Diagrams for (fuel system) relay wiring schematics and for additional circuit information.

STARTER MOTOR RELAY TEST

Refer to Group 8A, Battery/Starting/Charging System Diagnostics, for starter motor relay testing.

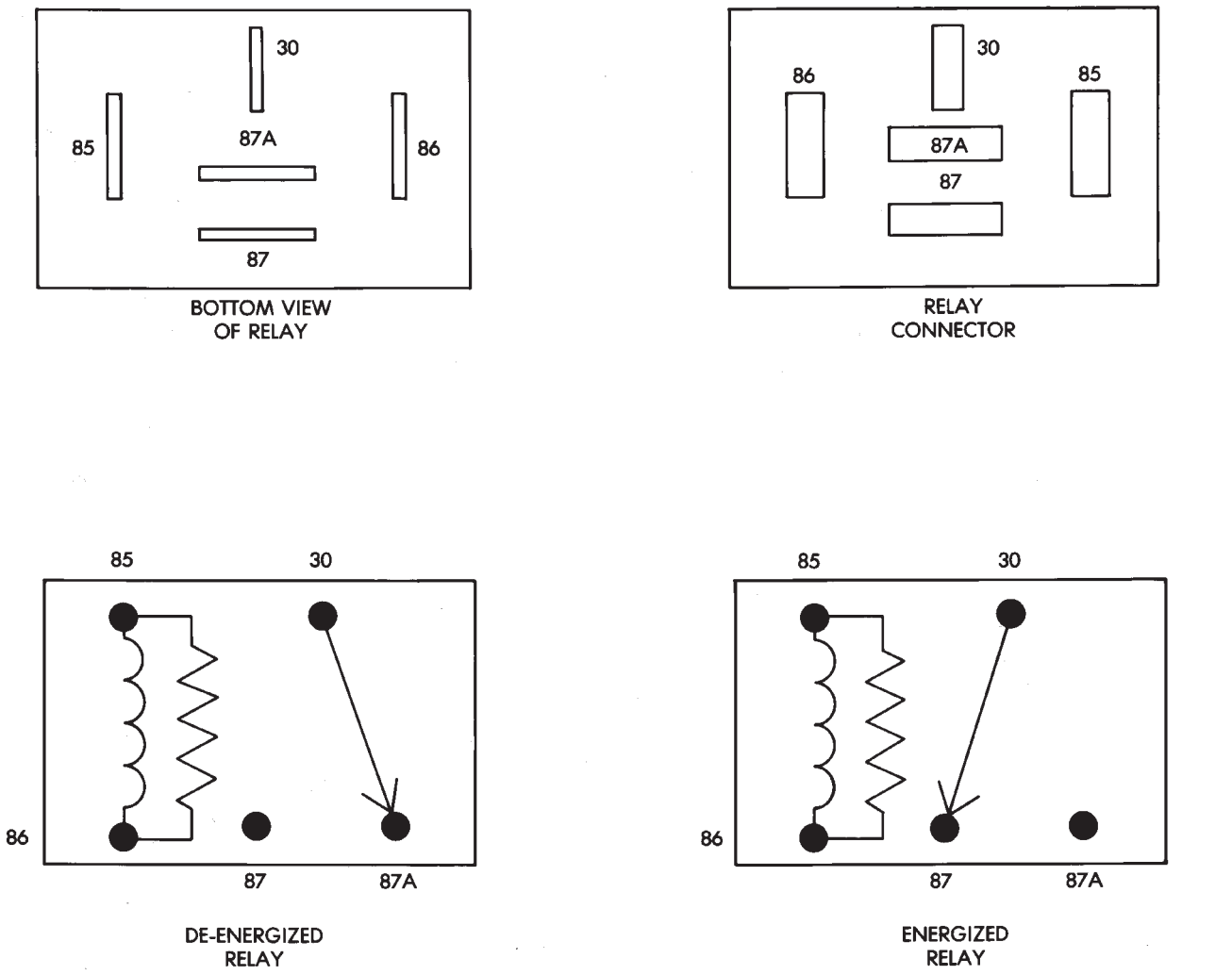


Fig. 27 Relay Terminals

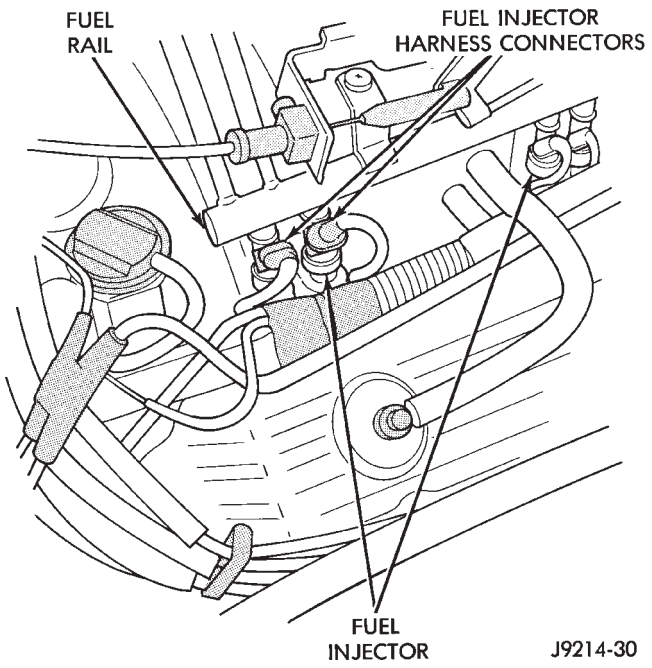


Fig. 28 Fuel Injector Wiring Connector

FUEL INJECTOR TEST

Disconnect the fuel injector wire harness connector from the injector (Fig. 28). Place an ohmmeter across the injector terminals. Resistance reading should be approximately 14.5 ohms ±1.2 ohms at 20°C (68°F). Proceed to following Fuel Injector diagnosis chart.

FUEL PUMP PRESSURE TEST

Refer to Fuel Pump Pressure Test in the Fuel Delivery System section of this group.

ON-BOARD DIAGNOSTICS (OBD)

The Powertrain Control Module (PCM) has been programmed to monitor many different circuits of the fuel injection system. If a problem is sensed in a monitored circuit often enough to indicate an actual problem, a Diagnostic Trouble Code (DTC) is stored. The DTC will be stored in the PCM memory for eventual display to the service technician. If the problem is repaired or ceases to exist, the PCM cancels the DTC after 51 engine starts.

Certain criteria must be met for a diagnostic trouble code (DTC) to be entered into PCM memory. The criteria may be a specific range of engine rpm, engine temperature and/or input voltage to the PCM.

It is possible that a DTC for a monitored circuit may not be entered into memory even though a malfunction has occurred. This may happen because one of the DTC criteria for the circuit has not been met. Example: assume that one of the criteria for the MAP sensor circuit is that the engine must be operating between 750 and 2000 rpm to be monitored for a DTC. If the MAP sensor output circuit shorts to ground when the engine rpm is above 2400 rpm, a 0 volt input will be seen by the PCM. A DTC will not be entered into memory because the condition does not occur within the specified rpm range.

A DTC indicates that the powertrain control module (PCM) has recognized an abnormal signal in a circuit or the system. A DTC may indicate the result of a failure, but never identify the failed component directly.

There are several operating conditions that the PCM does not monitor and set a DTC for. Refer to the following Monitored Circuits and Non-Monitored Circuits in this section.

MONITORED CIRCUITS

The powertrain control module (PCM) can detect certain problems in the fuel injection system.

Open or Shorted Circuit - The PCM can determine if sensor output (which is the input to PCM) is within proper range. It also determines if the circuit is open or shorted.

Output Device Current Flow - The PCM senses whether the output devices are hooked up.

If there is a problem with the circuit, the PCM senses whether the circuit is open, shorted to ground (-), or shorted to (+) voltage.

Oxygen Sensor - The PCM can determine if the oxygen sensor is switching between rich and lean. This is, once the system has entered Closed Loop. Refer to Open Loop/Closed Loop Modes Of Operation in the Component Description/System Operation section for an explanation of Closed (or Open) Loop operation.

NON-MONITORED CIRCUITS

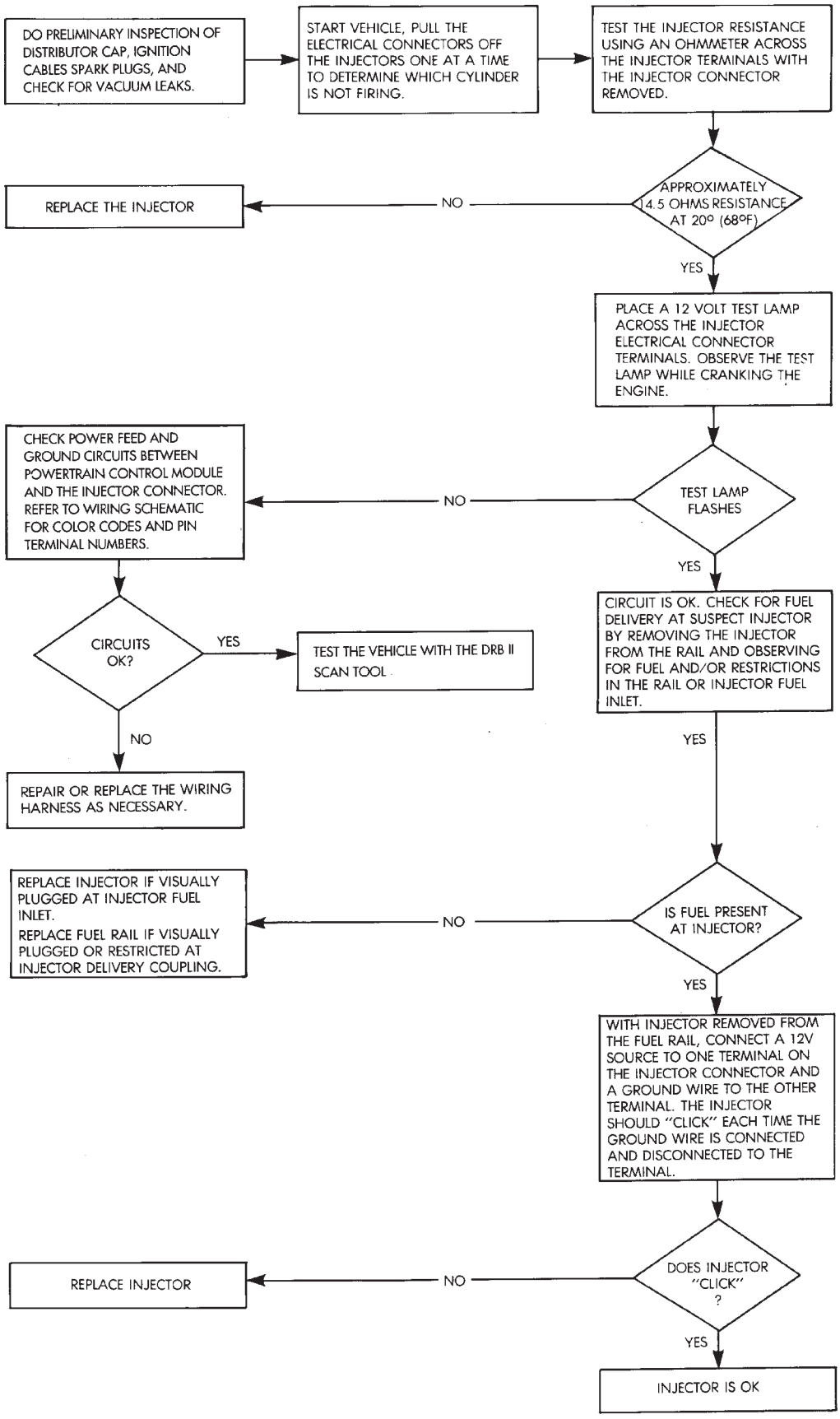
The PCM does not monitor the following circuits, systems or conditions that could have malfunctions that result in driveability problems. A Diagnostic Trouble Code (DTC) may not be displayed for these conditions.

Fuel Pressure: Fuel pressure is controlled by the vacuum assisted fuel pressure regulator. The PCM cannot detect a clogged fuel pump inlet filter, clogged in-line fuel filter, or a pinched fuel supply or return line. However, these could result in a rich or lean condition causing an oxygen sensor DTC to be stored in the PCM.

Secondary Ignition Circuit: The PCM cannot detect an inoperative ignition coil, fouled or worn spark plugs, ignition cross firing, or open circuited spark plug cables.

Engine Timing: The PCM cannot detect an incorrectly indexed timing chain, camshaft sprocket or crankshaft sprocket. The PCM also cannot detect an incorrectly indexed distributor. However, these could result in a rich or lean condition causing an oxygen sensor DTC to be stored in the PCM.

INJECTOR DIAGNOSIS—VEHICLE RUNS ROUGH AND/OR HAS A MISS



Cylinder Compression: The PCM cannot detect uneven, low, or high engine cylinder compression.

Exhaust System: The PCM cannot detect a plugged, restricted or leaking exhaust system.

Fuel Injector Malfunctions: The PCM cannot determine if the fuel injector is clogged, or the wrong injector is installed. However, these could result in a rich or lean condition causing an oxygen sensor DTC to be stored in the PCM.

Excessive Oil Consumption: Although the PCM monitors exhaust stream oxygen content through oxygen sensor (closed loop), it cannot determine excessive oil consumption.

Throttle Body Air Flow: The PCM cannot detect a clogged or restricted air cleaner inlet or air filter element.

Evaporative System: The PCM will not detect a restricted, plugged or loaded EVAP canister.

Vacuum Assist: Leaks or restrictions in the vacuum circuits of vacuum assisted engine control system devices are not monitored by the PCM. However, a vacuum leak at the MAP sensor will be monitored and a diagnostic trouble code (DTC) will be generated by the PCM.

Powertrain Control Module (PCM) System Ground: The PCM cannot determine a poor system ground. However, a DTC may be generated as a result of this condition.

Powertrain Control Module (PCM) Connector Engagement: The PCM cannot determine spread or damaged connector pins. However, a DTC may be generated as a result of this condition.

HIGH AND LOW LIMITS

The powertrain control module (PCM) compares input signal voltages from each input device. It will establish high and low limits that are programmed into it for that device. If the input voltage is not within specifications and other Diagnostic Trouble Code (DTC) criteria are met, a DTC will be stored in memory. Other DTC criteria might include engine rpm limits or input voltages from other sensors or switches. The other inputs might have to be sensed by the PCM when it senses a high or low input voltage from the control system device in question.

ACCESSING DIAGNOSTIC TROUBLE CODES

A stored Diagnostic Trouble Code (DTC) can be displayed by cycling the ignition key On-Off-On-Off-On within three seconds and observing the Malfunction Indicator Lamp. This lamp was formerly referred to as the Check Engine Lamp. The lamp is located on the instrument panel.

They can also be displayed through the use of the Diagnostic Readout Box II (DRB II scan tool). The DRB II connects to the data link connector in the vehicle (Fig. 29). For operation of the DRB II, refer to the appropriate Powertrain Diagnostic Procedures service manual.

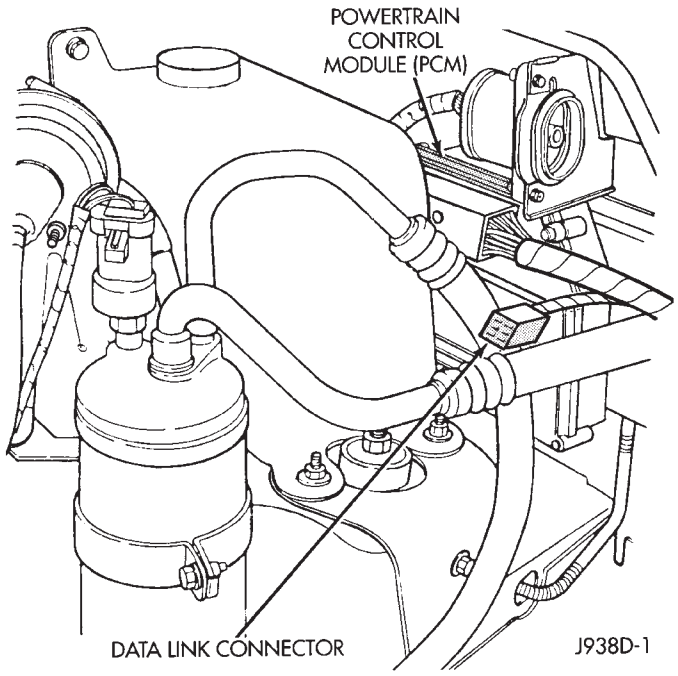


Fig. 29 Data Link Connector—Typical

EXAMPLES

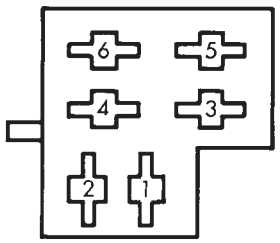
- If the lamp flashes 4 times, pauses and flashes 1 more time, a Diagnostic Trouble Code (DTC) number 41 is indicated.
- If the lamp flashes 4 times, pauses and flashes 6 more times, a Diagnostic Trouble Code (DTC) number 46 is indicated.

Refer to the Diagnostic Trouble Code (DTC) charts for DTC identification.

If the problem is repaired or ceases to exist, the Powertrain Control Module (PCM) cancels the DTC after 51 engine starts.

Diagnostic Trouble Codes indicate the results of a failure, but never identify the failed component directly.

The circuits of the data link connector are shown in (Fig. 30).



D-1	GROUND
D-2	N/C
D-3	SCI TRANS
D-4	SCI RECEIVE
D-5	IGNITION
D-6	NOT USED

Fig. 30 Data Link Connector Schematic

ERASING TROUBLE CODES

The DRB II scan tool must be used to erase a Diagnostic Trouble Code (DTC). Refer to the appropriate Powertrain Diagnostic Procedures service manual for operation of the DRB II scan tool.

DRB II SCAN TOOL

For operation of the DRB II scan tool, refer to the appropriate Powertrain Diagnostic Procedures service manual.

DIAGNOSTIC TROUBLE CODE (DTC)

On the following pages, a list of diagnostic trouble codes is provided for the 5.2L (V-8) engine. A DTC indicates that the powertrain control module (PCM) has recognized an abnormal signal in a circuit or the system. A DTC may indicate the result of a failure, but never identify the failed component directly.

DIAGNOSTIC TROUBLE CODE (DTC) DESCRIPTION

Diagnostic Trouble Code	DRB II Display	Description of Trouble Code Condition
11	No Crank Reference Signal at PCM	No distributor reference signal detected during engine cranking.
13+**	No Change in MAP From Start to Run	No variation in MAP sensor signal is detected. No difference is recognized between the engine MAP reading and the barometric pressure reading at start up.
14+**	MAP Voltage Too Low or MAP Voltage Too High	MAP sensor input below minimum acceptable voltage. MAP sensor input above maximum acceptable voltage.
15**	No Vehicle Speed Sensor Signal	No speed sensor signal detected during road load conditions.
17	Engine is Cold Too Long	Engine coolant temperature remains below normal operating temperatures during vehicle travel (thermostat).
21**	O_2 Signal Stays at Center or O_2 Signal Shorted to Voltage	Neither rich or lean condition is detected from the oxygen sensor input. Oxygen sensor input voltage maintained above normal operating range.
22+**	ECT Sensor Voltage Too Low or ECT Sensor Voltage Too High	Coolant temperature sensor input below the minimum acceptable voltage. Coolant temperature sensor input above the maximum acceptable voltage.
23	Charge Air Temperature Sensor Voltage High or Charge Air Temperature Sensor Voltage Low	Charge Air Temperature Sensor input above/below acceptable minimum.
24+**	Throttle Position Sensor Voltage High or Throttle Position Sensor Voltage Low	Throttle position sensor (TPS) input above the maximum acceptable voltage. Throttle position sensor (TPS) input below the minimum acceptable voltage.

** Check Engine Lamp ON (California only)
+ Check Engine Lamp ON

J9314-126

DIAGNOSTIC TROUBLE CODE (DTC) DESCRIPTION—CONTINUED

Diagnostic Trouble Code	DRB II Display	Description of Trouble Code Condition
25**	Idle Air Control Motor Circuits (ISC Actuator)	A shorted condition detected in one or more of the idle air control actuator circuits.
27+**	Control Circuit	Injector output driver does not respond properly to the control signal.
31**	EVAP Purge Solenoid Circuit	An open or shorted condition detected in the purge solenoid circuit.
32**	EGR System Failure	An open or shorted condition detected in the EGR solenoid circuit. Required change in air-fuel ratio not detected during diagnostic test (California emissions packages only).
33	A/C Clutch Relay Circuit	An open or shorted condition detected in the A/C clutch relay circuit.
34	Speed Control Solenoid Circuits	An open or shorted condition detected in the speed control vacuum or vent solenoid circuits.
37	Torque Converter Clutch Solenoid Circuit (CKT)	An open or shorted condition detected in the torque converter clutch solenoid circuit (vehicles with automatic transmissions only).
41+**	Generator Field Not Switching Properly	Generator field not switching properly.
42	Auto Shutdown Relay Control Circuit or No ASD Relay Voltage Sense at Controller	An open or short condition detected in the auto shutdown relay circuit. No ASD voltage sensed at PCM.

** Check Engine Lamp ON (California only)
+ Check Engine Lamp ON

J9314-127

DIAGNOSTIC TROUBLE CODE (DTC) DESCRIPTION—CONTINUED

Diagnostic Trouble Code	DRB II Display	Description of Trouble Code Condition
45	Overdrive Solenoid	An open or shorted condition detected in overdrive solenoid circuit.
46+**	Charging system voltage too high.	Charging system voltage too high.
47+**	Charging system voltage too low.	Charging system voltage too low.
51**	O_2 Signal Stays Below Center (Lean) or Additive Adaptive Memory at Rich Limit	O_2 sensor signal stays lean. Additive adaptive memory at rich limit.
52**	O_2 Signal Stays Above Center (Rich) or Additive Adaptive Memory at Lean Limit	O_2 sensor signal stays rich. Additive adaptive memory at lean limit.
53	Internal PCM Failure	Internal failure in the PCM (Powertrain Control Module).
62	PCM Failure SRI Miles not Stored	PCM (Powertrain Control Module) failure - SRI miles not stored.
63	PCM Failure EEprom Write Denied	PCM (Powertrain Control Module) failure - EEprom write denied.
54	Sync Pick-up Signal	No fuel sync signal detected during crankshaft rotation.
55	NA	Completion of trouble code display on the Malfunction Indicator (MIL) lamp.

+ Check Engine Lamp ON ** Check Engine Lamp ON (California only) J9314-128

MPI SYSTEM—5.2L ENGINE—COMPONENT REMOVAL/INSTALLATION

INDEX

ACCELERATOR PEDAL AND THROTTLE CABLE

Refer to the Accelerator Pedal and Throttle Cable section of this group for removal/installation procedures.

AIR CONDITIONING (A/C) CLUTCH RELAY

The A/C clutch relay is located in the Power Distribution Center (PDC) (Fig. 1). For location of this relay within the PDC, refer to label attached to bottom of PDC cover.

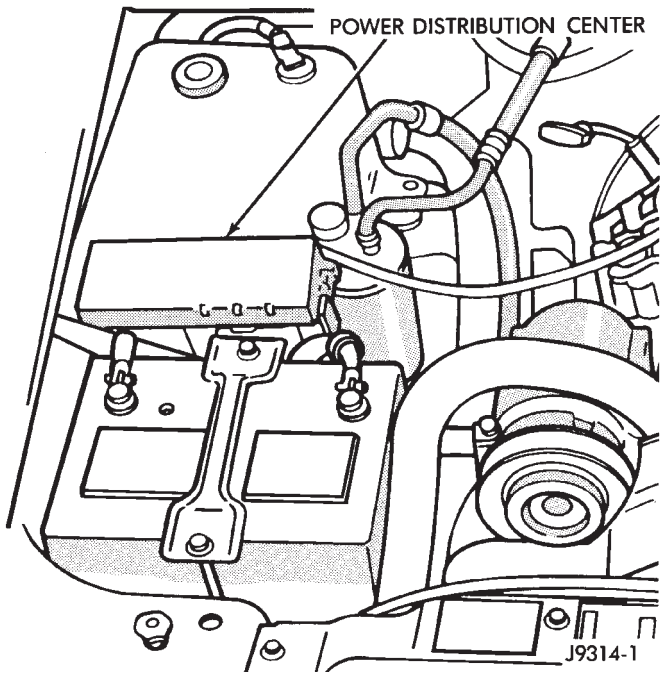


Fig. 1 Power Distribution Center (PDC)

AIR CLEANER HOUSING

Refer to Group 25, Emission Control System.

AIR FILTER

Refer to Group 25, Emission Control System.

AUTOMATIC SHUT DOWN (ASD) RELAY

The ASD relay is located in the Power Distribution Center (Fig. 1) (PDC). For location of this relay within the PDC, refer to label attached to bottom of PDC cover.

BRAKE SWITCH

Refer to Group 5, Brakes for removal/installation procedures.

CAMSHAFT POSITION SENSOR

For removal/installation procedures, refer to Group 8D, Ignition System. See Camshaft Position Sensor.

CHARGE AIR TEMPERATURE SENSOR

The intake manifold charge air temperature sensor is located in the front/side of the intake manifold (Fig. 2).

REMOVAL

(1) Remove air cleaner assembly.
(2) Disconnect electrical connector at sensor (Fig. 2).
(3) Remove sensor from intake manifold.

INSTALLATION

(1) Install sensor to intake manifold. Tighten to 28 N●m (20 ft. lbs.) torque.
(2) Install electrical connector.
(3) Install air cleaner.

CRANKSHAFT POSITION SENSOR

For removal and installation procedures, refer to Group 8D, Ignition System.

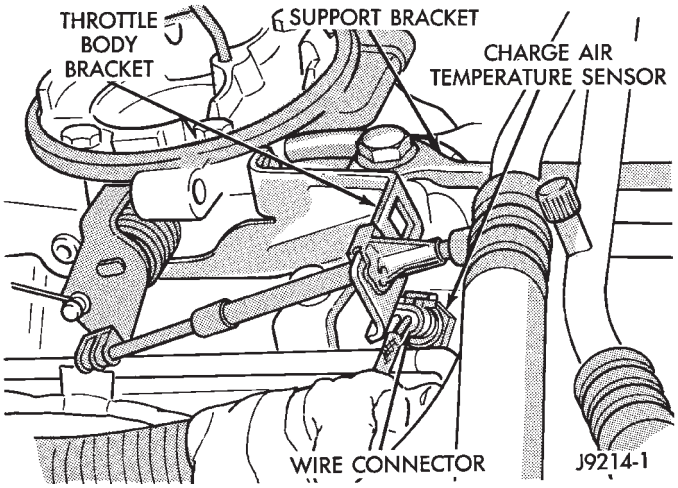


Fig. 2 Charge Air Temperature Sensor—Typical

ENGINE COOLANT TEMPERATURE SENSOR

REMOVAL

WARNING: HOT, PRESSURIZED COOLANT CAN CAUSE INJURY BY SCALDING. COOLING SYSTEM MUST BE PARTIALLY DRAINED BEFORE REMOVING THE COOLANT TEMPERATURE SENSOR. REFER TO GROUP 7, COOLING.

(1) Partially drain cooling system. Refer to Group 7, Cooling.

(2) Disconnect electrical connector from sensor (Fig. 3).

Engines with air conditioning: When removing the connector from sensor, do not pull directly on wiring harness. Fabricate an L-shaped hook tool from a coat hanger (approximately eight inches long). Place the hook part of tool under the connector for removal. The connector is snapped onto the sensor. It is not equipped with a lock type tab.

(3) Remove sensor from intake manifold.

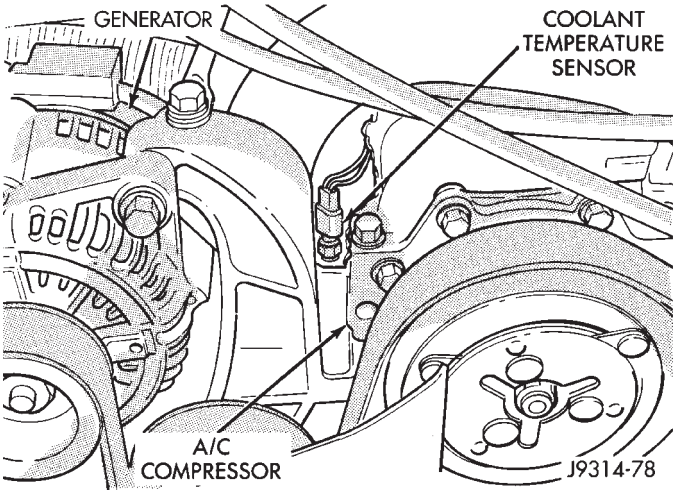


Fig. 3 Coolant Temperature Sensor—Typical

INSTALLATION

(1) Install sensor.

(2) Tighten to 11 N•m (8 ft. lbs.) torque.

(3) Connect electrical connector to sensor.

The sensor connector is symmetrical (not indexed). It can be installed to the sensor in either direction.

(4) Replace any lost engine coolant. Refer to Group 7, Cooling System.

EVAP CANISTER PURGE SOLENOID

Refer to Group 25, Emission Control System for removal/installation procedures.

FUEL FILTER

Refer to the Fuel Delivery System section of this group for removal/installation procedures.

FUEL INJECTOR(S)

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE TURNED OFF). BEFORE SERVICING THE FUEL INJECTOR(S), THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

To release fuel pressure, refer to the Fuel Delivery System section of this group. See Fuel System Pressure Release.

To remove one or more fuel injectors, the fuel rail assembly must be removed from engine.

REMOVAL

(1) Remove air duct at throttle body.

(2) Remove fuel rail assembly. Refer to Fuel Rail removal in this section.

(3) Remove the clip(s) retaining the injector(s) to fuel rail (Fig. 4).

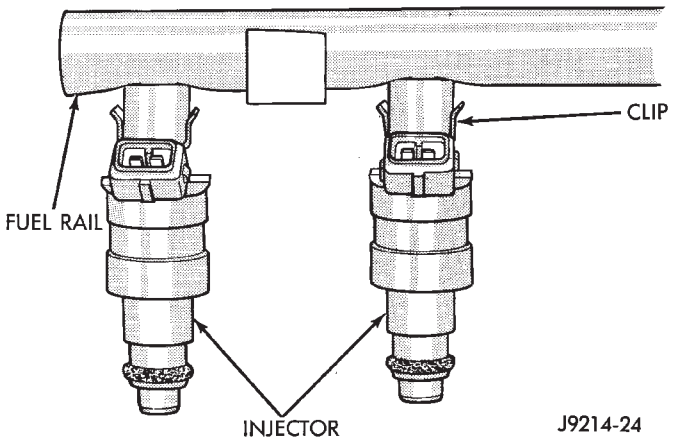


Fig. 4 Fuel Injector and Retaining Clip

(4) Remove injector(s) from fuel rail.

INSTALLATION

(1) Apply a small amount of engine oil to each fuel injector O-ring. This will help in fuel rail installation.
(2) Install injector(s) and injector clip(s) to fuel rail.
(3) Install fuel rail assembly. Refer to Fuel Rail installation.
(4) Install air duct to throttle body.
(5) Start engine and check for leaks.

FUEL PRESSURE REGULATOR

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE TURNED OFF). BEFORE SERVICING THE FUEL PRESSURE REGULATOR, THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

To release fuel pressure, refer to the Fuel Delivery System section of this group. See Fuel System Pressure Release.

REMOVAL

The pressure regulator is located (mounted vertically) in the fuel rail assembly near the dash panel (Fig. 5). It is held to the fuel rail with a clamp and bolt (Fig. 6).

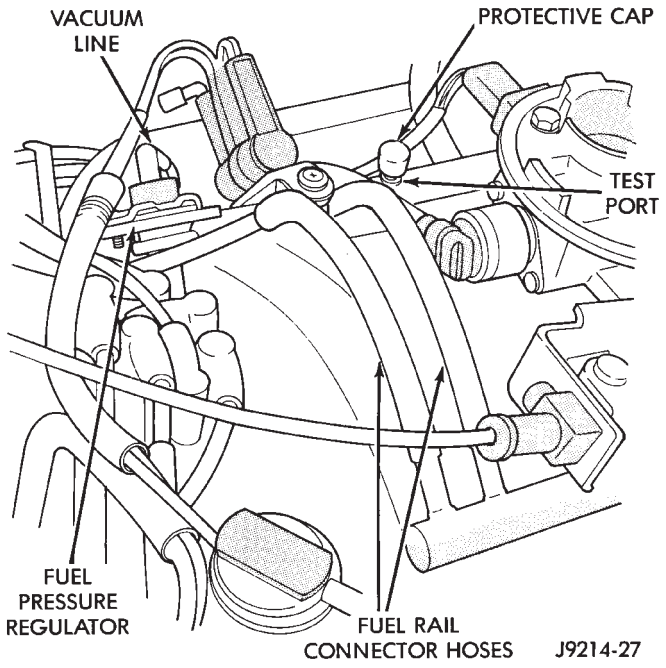


Fig. 5 Fuel Pressure Regulator

(1) Perform the fuel pressure release procedure.
(2) Remove the vacuum line from the pressure regulator.
(3) Remove the clamp bolt and regulator retaining clamp from fuel rail.
(4) Remove pressure regulator from fuel rail.

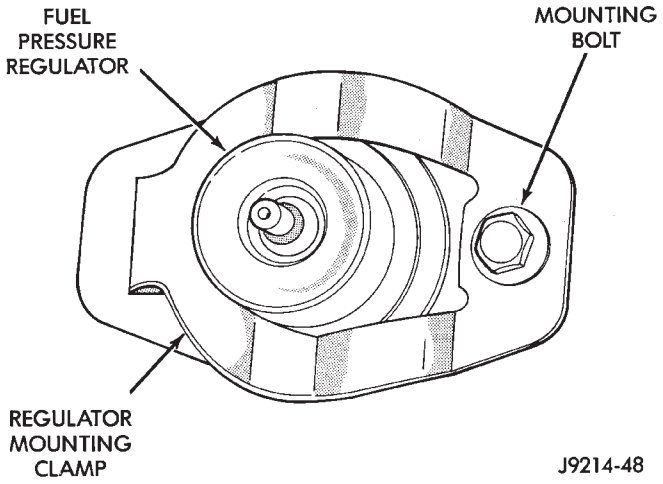


Fig. 6 Pressure Regulator Mounting

INSTALLATION

(1) Install new O-ring seals to pressure regulator.
(2) Install pressure regulator to fuel rail.
(3) Install retaining clamp and clamp bolt.
(4) Install vacuum line to pressure regulator.
(5) Start engine and check for leaks.

FUEL PUMP MODULE

Refer to the Fuel Delivery System section of this group for removal/installation procedures.

FUEL PUMP RELAY

The Fuel Pump relay is located in the Power Distribution Center (PDC) (Fig. 1). For location of this relay within the PDC, refer to label attached to bottom of PDC cover.

FUEL RAIL

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE TURNED OFF). BEFORE SERVICING THE FUEL RAIL ASSEMBLY, THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

To release fuel pressure, refer to the Fuel Delivery System section of this group. See Fuel System Pressure Release.

CAUTION: The left and right fuel rails are replaced as an assembly. Do not attempt to separate the rail halves at the connecting hoses (Fig. 7). Due to the design of these connecting hoses, they do not use any clamps. Never attempt to install a clamping device of any kind to the hoses. When removing the fuel rail assembly for any reason, be careful not to bend or kink the connecting hoses.

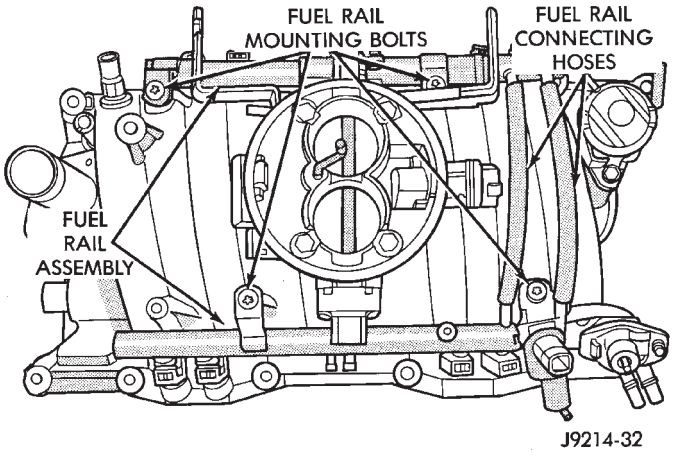


Fig. 7 Fuel Rail Assembly—Typical

REMOVAL

(1) Remove negative battery cable at battery.

(2) Remove air duct at throttle body.

(3) Perform the fuel pressure release procedure. Refer to the Fuel Delivery System section of this group.

(4) Remove throttle body from intake manifold. Refer to Throttle Body removal in this group.

(5) If equipped with air conditioning, remove the A/C compressor-to-intake manifold support bracket (three bolts) (Fig. 8).

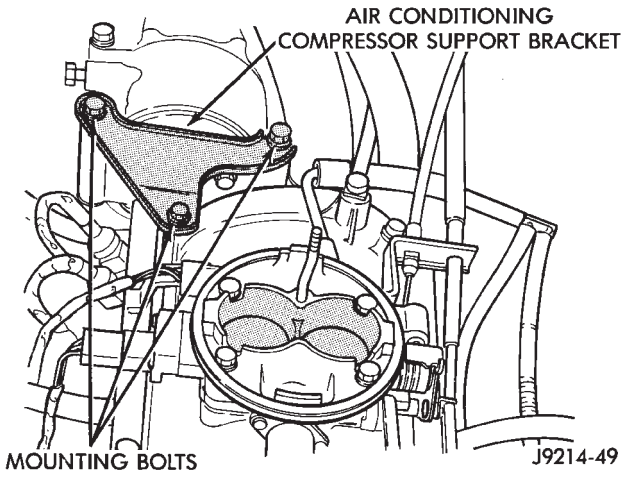


Fig. 8 A/C Compressor Support Bracket—Typical

(6) Disconnect electrical connectors at all fuel injectors (Fig. 9). The factory fuel injection wiring harness is numerically tagged (INJ 1, INJ 2, etc.) for injector position identification.

(7) Remove vacuum line at fuel pressure regulator (Fig. 10).

(8) Remove EVAP canister purge solenoid/bracket assembly (Fig. 11) from intake manifold.

(9) Disconnect two fuel lines at rear of fuel rail. Refer to Fuel Tubes/Lines/Hoses and Clamps in the Fuel Delivery System section of this group.

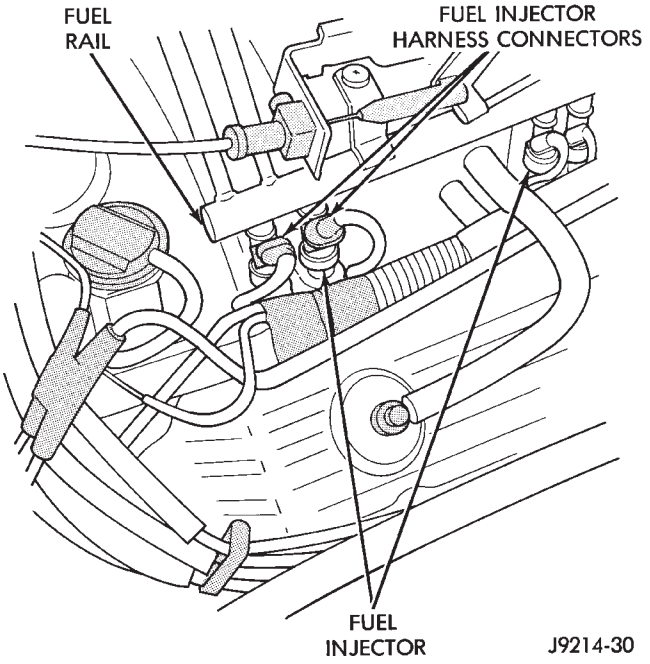


Fig. 9 Fuel Injector Connectors

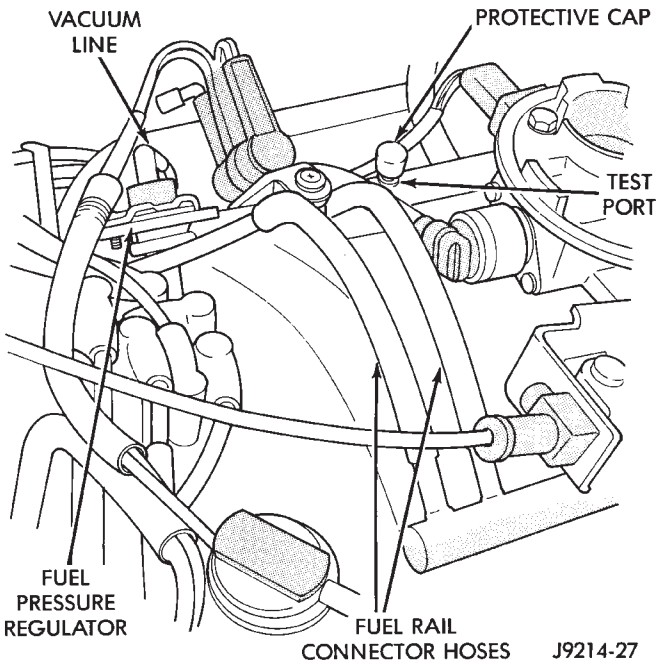


Fig. 10 Pressure Regulator Vacuum Line—Typical

(10) Remove the remaining fuel rail mounting bolts (Fig. 12).

(11) Gently rock and pull the **left** fuel rail until the fuel injectors just start to clear the intake manifold. Gently rock and pull the **right** fuel rail until the fuel injectors just start to clear the intake manifold. Repeat this procedure (left/right) until all fuel injectors have cleared the intake manifold.

(12) Remove fuel rail (with injectors attached) from engine.

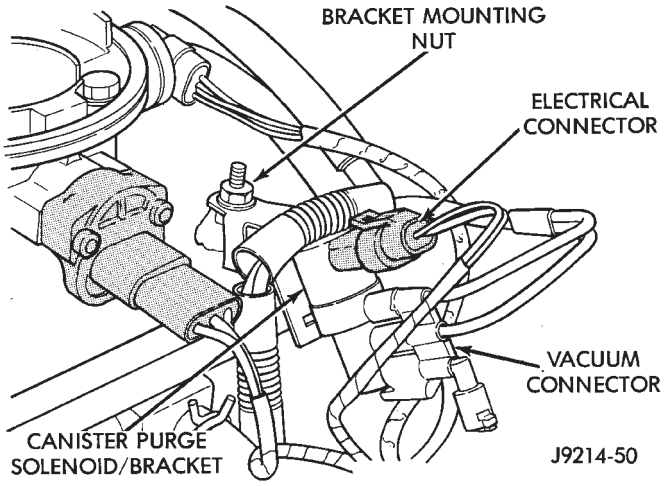


Fig. 11 EVAP Canister Purge Solenoid

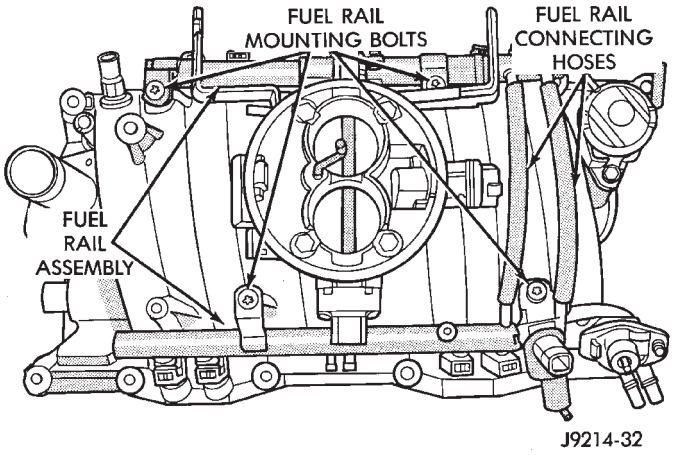


Fig. 12 Fuel Rail Mounting Bolts—Typical

(13) Remove the clip(s) retaining the injector(s) to fuel rail (Fig. 13).

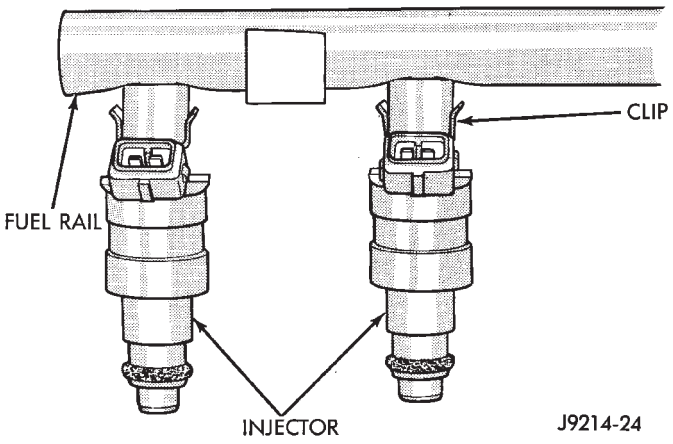


Fig. 13 Fuel Injector Clip

INSTALLATION

(1) Apply a small amount of engine oil to each fuel injector O-ring. This will help in fuel rail installation.

(2) Install injector(s) and injector clip(s) to fuel rail.

(3) Position the fuel rail/fuel injector assembly to the injector openings on the intake manifold.

(4) Guide each injector into the intake manifold. Be careful not to tear the injector O-ring.

(5) Push the **right** fuel rail down until fuel injectors have bottomed on injector shoulder. Push the **left** fuel rail down until fuel injectors have bottomed on injector shoulder.

(6) Install fuel rail mounting bolts.

(7) Install EVAP canister purge solenoid to intake manifold.

(8) Connect electrical connector to intake manifold charge air temperature sensor.

(9) Connect wiring to all fuel injectors. The injector wiring harness is numerically tagged.

(10) Install the A/C support bracket (if equipped).

(11) Install throttle body to intake manifold. Refer to Throttle Body installation in this section of the group.

(12) Install vacuum line to fuel pressure regulator.

(13) Install two fuel lines at rear of fuel rail. Refer to Fuel Tubes/Lines/Hoses and Clamps in the Fuel Delivery System section of this group.

(14) Install air duct at throttle body.

(15) Connect battery cable to battery.

(16) Start engine and check for leaks.

FUEL SYSTEM PRESSURE RELEASE PROCEDURE

WARNING: THE FUEL SYSTEM IS UNDER A CONSTANT PRESSURE (EVEN WITH THE ENGINE TURNED OFF). BEFORE SERVICING THE FUEL PUMP, FUEL LINES, FUEL FILTER, OR FUEL INJECTOR(S), THE FUEL SYSTEM PRESSURE MUST BE RELEASED.

To release fuel pressure, refer to the Fuel Delivery System section of this group. See Fuel System Pressure Release Procedure.

FUEL TANKS

Refer to the Fuel Tank section of this group for removal/installation procedures.

FUEL TANK PRESSURE RELIEF/ROLLOVER VALVE

Refer to the Fuel Tank section of this group for removal/installation procedures.

FUEL TUBES/LINES/HOSES AND CLAMPS

Refer to Fuel Tubes/Lines/Hoses and Clamps in the Fuel Delivery System section of this group for removal/installation procedures.

Also refer to Quick-Connect Fittings in the Fuel Delivery System section of this group for removal/installation procedures.

IDLE AIR CONTROL (IAC) MOTOR

The IAC motor is located on the back of the throttle body (Fig. 14).

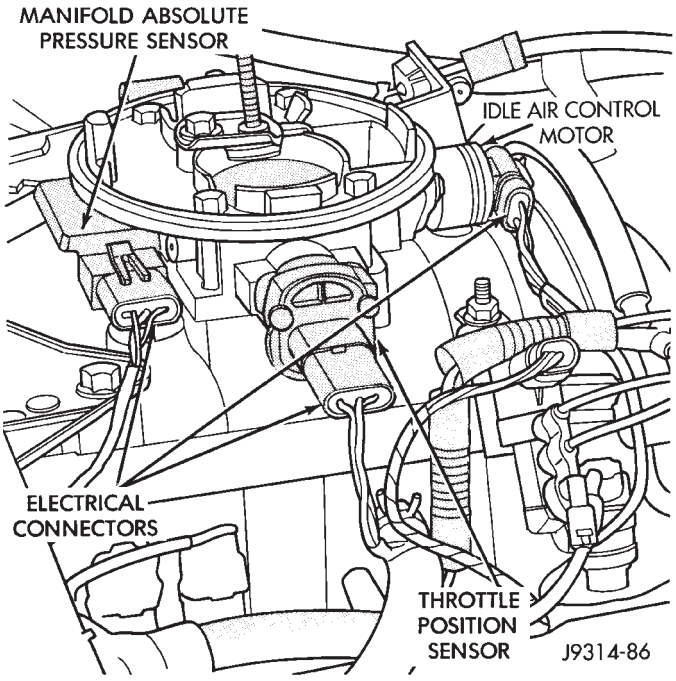


Fig. 14 Idle Air Control Motor

REMOVAL

(1) Remove air duct at throttle body.
(2) Disconnect electrical connector from IAC motor.
(3) Remove two mounting screws (Fig. 15).
(4) Remove IAC motor from throttle body.

INSTALLATION

(1) Install IAC motor to throttle body.
(2) Install and tighten two mounting screws to 7 N•m (60 in. lbs.) torque.
(3) Install electrical connector.
(4) Install air duct to throttle body.

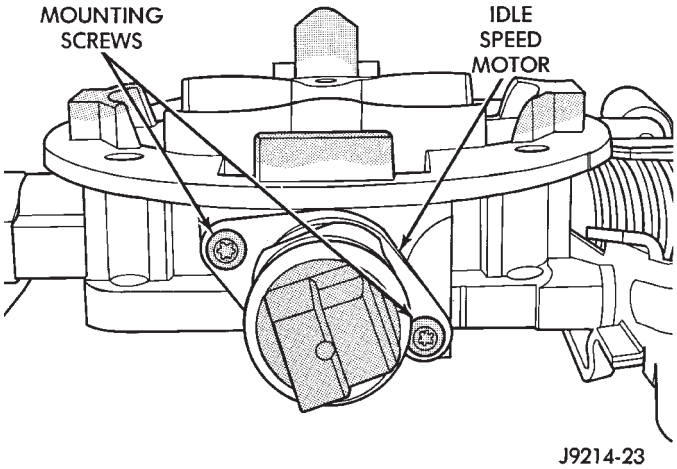


Fig. 15 Mounting Screws—IAC Motor

IGNITION COIL

Refer to Group 8D, Ignition Systems for removal/installation procedures.

INTAKE MANIFOLD

Refer to Group 11, Exhaust System and Intake Manifold for removal/installation procedures.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The MAP sensor is located on the front of the throttle body (Fig. 16). An L-shaped rubber fitting is used to connect the MAP sensor to throttle body (Fig. 17).

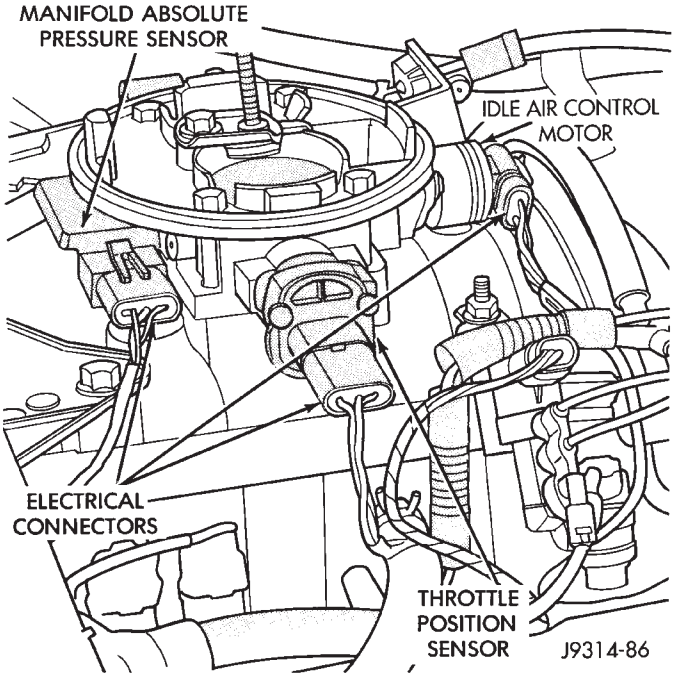


Fig. 16 MAP Sensor

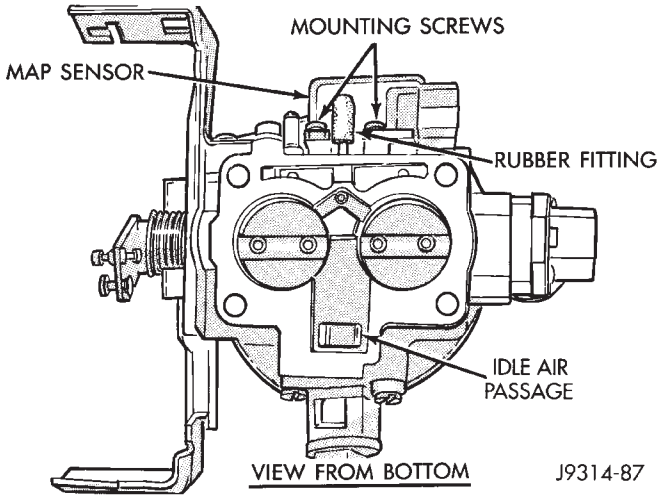


Fig. 17 MAP Sensor L-Shaped Rubber Fitting

REMOVAL

The throttle body must be removed from the intake manifold for MAP sensor removal.
(1) Remove air duct at throttle body.

(2) Remove throttle body. Refer to Throttle Body removal in this section.

(3) Remove two MAP sensor mounting screws (Fig. 17).

(4) While removing MAP sensor, slide the vacuum rubber L-shaped fitting (Fig. 17) from the throttle body.

(5) Remove rubber L-shaped fitting from MAP sensor.

INSTALLATION

(1) Install rubber L-shaped fitting to MAP sensor.

(2) Position sensor to throttle body while guiding rubber fitting over throttle body vacuum nipple.

(3) Install MAP sensor mounting screws. Tighten screws to 3 N●m (25 in. lbs.) torque.

(4) Install throttle body. Refer to Throttle Body installation in this section.

(5) Install air duct to throttle body.

OXYGEN (O_2) SENSOR

The O_2 sensor is located in the right exhaust downpipe below the exhaust manifold flange (Fig. 18).

REMOVAL

WARNING: THE EXHAUST MANIFOLD BECOMES VERY HOT DURING ENGINE OPERATION. ALLOW ENGINE TO COOL BEFORE REMOVING OXYGEN SENSOR.

(1) Raise and support the vehicle.

(2) Disconnect the wire connector from the O_2 sensor.

CAUTION: When disconnecting the sensor electrical connector, do not pull directly on wire going into sensor.

(3) Remove the O_2 sensor from the exhaust manifold.

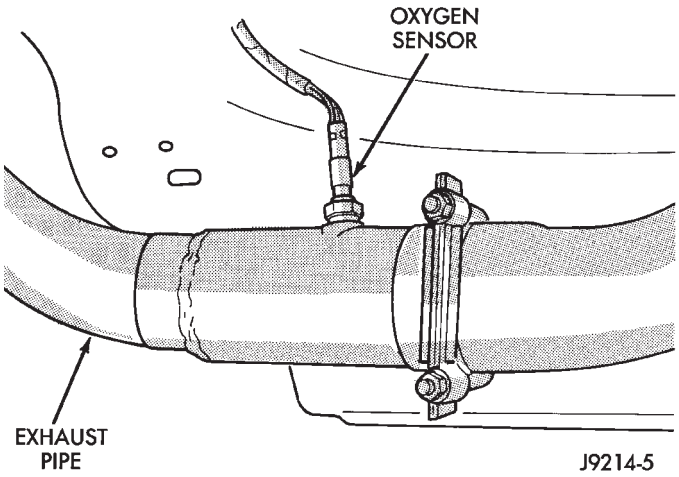


Fig. 18 Oxygen Sensor

INSTALLATION

Threads of new oxygen sensors are factory coated with anti-seize compound to aid in removal. **DO NOT add any additional anti-seize compound to the threads of a new oxygen sensor.**

(1) Install the O_2 sensor into the exhaust manifold. Tighten to 30 N●m (22 ft. lbs.) torque.

(2) Connect the O_2 sensor wire connector.

(3) Lower the vehicle.

PARK/NEUTRAL SWITCH

Refer to Group 21, Transmission and Transfer Case for removal/installation procedures.

POWERTRAIN CONTROL MODULE (PCM)

The PCM is located on the cowl panel in the right/rear side of the engine compartment (Fig. 19).

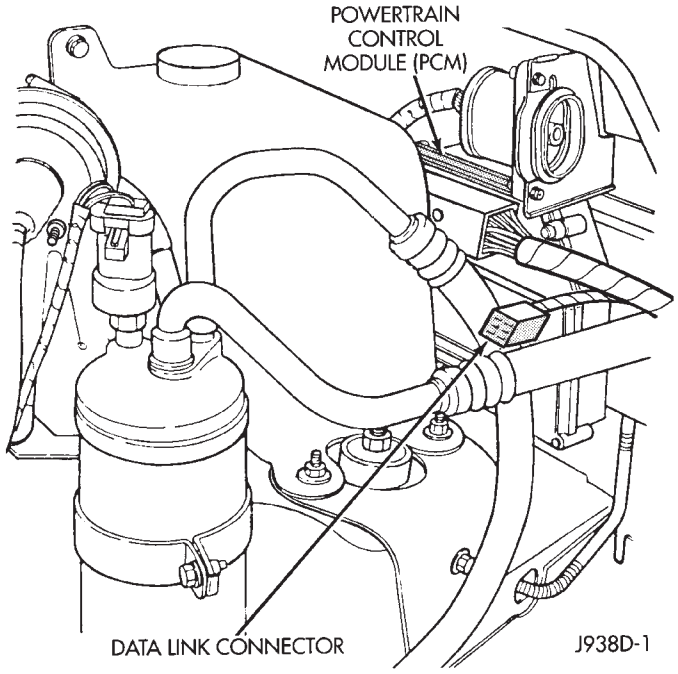


Fig. 19 Powertrain Control Module (PCM) Location

REMOVAL

(1) Disconnect the negative battery cable at the battery.

(2) Remove the coolant reserve/overflow bottle (one bolt and two nuts) (Fig. 20)

(3) Loosen the 60-Way connector mounting bolt (Fig. 21).

(4) Remove the electrical connector by pulling straight back.

(5) Remove the three PCM mounting bolts (Fig. 21).

(6) Remove PCM.

INSTALLATION

(1) Check the pins in 60-way electrical connector for damage. Repair as necessary.

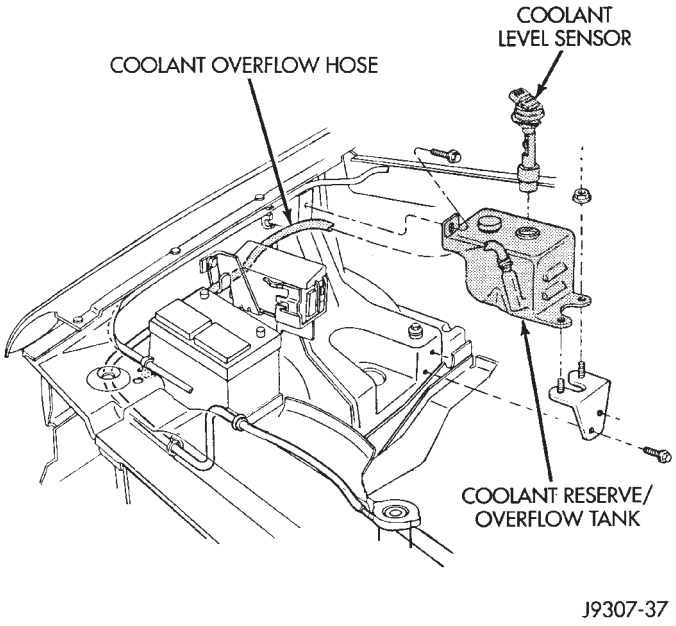


Fig. 20 Coolant Reserve/Overflow Bottle Mounting

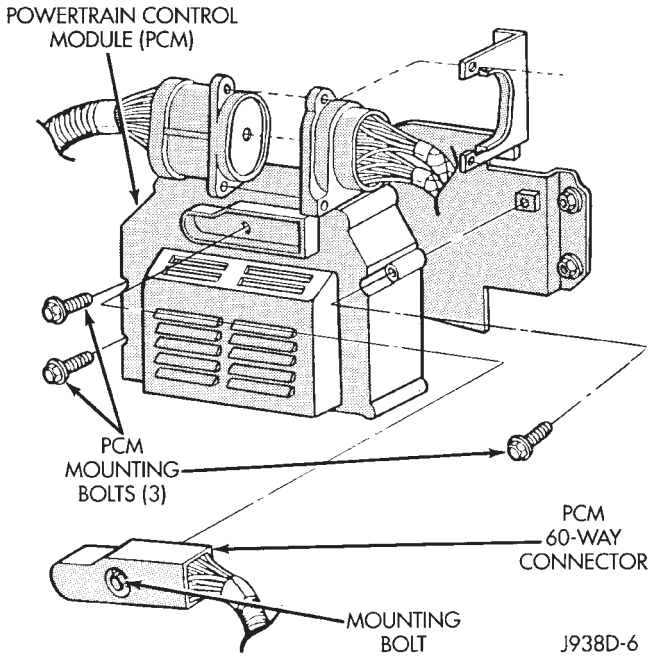


Fig. 21 Powertrain Control Module (PCM) Mounting

(2) Install PCM. Tighten three mounting bolts to 1 N●m (9 in. lbs.) torque.

(3) Engage 60-way connector into PCM. Tighten connector mounting bolt to 4 N●m (35 in. lbs.) torque.

(4) Install coolant reserve/overflow bottle.

(5) Connect negative cable to battery.

QUICK-CONNECT FITTINGS

Refer to the Fuel Delivery System section of this group for removal/installation procedures.

THROTTLE BODY

A (factory adjusted) set screw is used to mechanically limit the position of the throttle body throttle plate. **Never attempt to adjust the engine idle speed using this screw.** All idle speed functions are controlled by the powertrain control module (PCM).

REMOVAL

(1) Remove the air duct at throttle body.

(2) Disconnect throttle body electrical connectors at MAP sensor, IAC motor and TPS (Fig. 22).

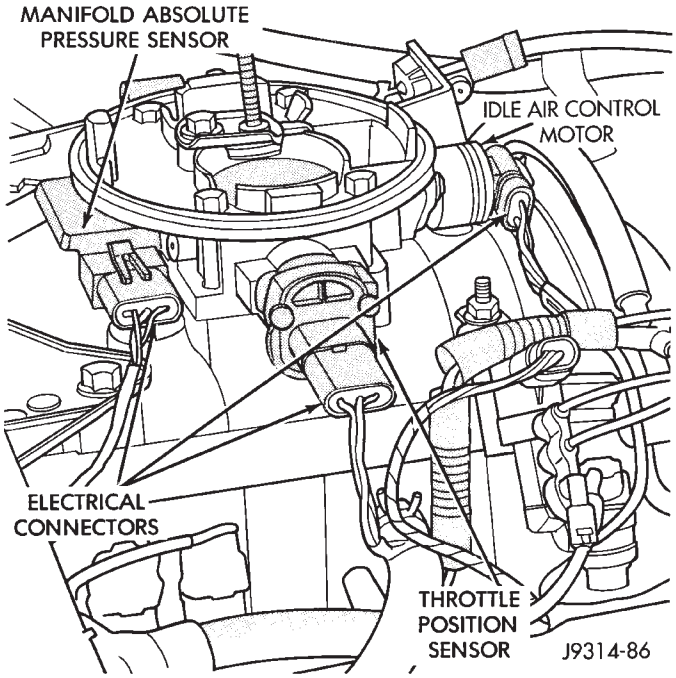


Fig. 22 Sensor Electrical Connectors

(3) Remove vacuum line at throttle body.

(4) Remove (unsnap) all control cables from throttle body (lever) arm. Refer to the Accelerator Pedal and Throttle Cable section of this group for additional information.

(5) Remove four throttle body mounting bolts (Fig. 23).

(6) Remove throttle body from intake manifold.

(7) Discard old throttle body-to-intake manifold gasket.

INSTALLATION

(1) Clean the mating surfaces of the throttle body and the intake manifold.

(2) Install new throttle body-to-intake manifold gasket.

(3) Install throttle body to intake manifold.

(4) Install four mounting bolts. Tighten bolts to 23 N●m (200 in. lbs.) torque.

(5) Install control cables.

CAUTION: When the automatic transmission throttle cable is connected, it MUST be adjusted.

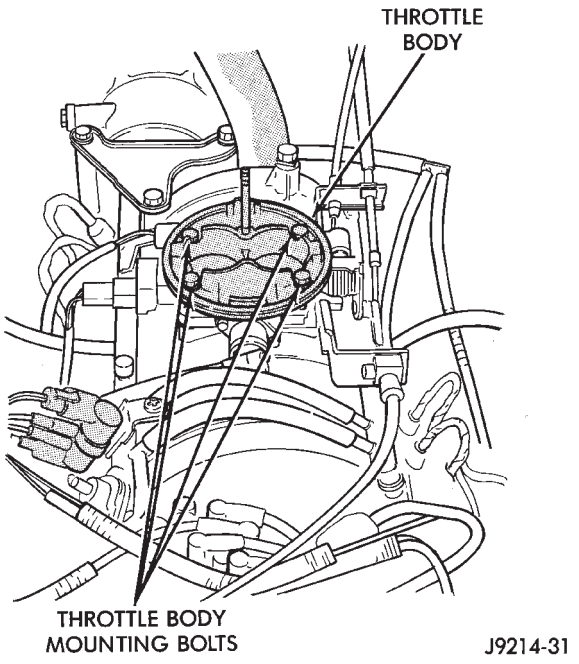


Fig. 23 Throttle Body Mounting Bolts—Typical

(6) If equipped with an automatic transmission, connect and adjust the transmission line pressure cable. Refer to Group 21, Transmissions for adjustment procedure.

(7) Install vacuum line to throttle body.

(8) Install electrical connectors.

(9) Install air duct to throttle body.

THROTTLE POSITION SENSOR (TPS)

REMOVAL

The TPS is located on the side of the throttle body (Fig. 24).

(1) Remove air intake tube at throttle body.

(2) Disconnect TPS electrical connector.

(3) Remove two TPS mounting screws (Fig. 25).

(4) Remove TPS from throttle body.

INSTALLATION

The throttle shaft end of the throttle body slides into a socket in the TPS (Fig. 26). The TPS must be installed so that it can be rotated a few degrees. If the sensor will not rotate, install the sensor with the throttle shaft on the other side of the socket tangs. The TPS will be under slight tension when rotated.

(1) Install the TPS and two retaining screws.

(2) Tighten screws to 7 N•m (60 in. lbs.) torque.

(3) Manually operate the throttle control lever by hand to check for any binding of the TPS.

(4) Connect TPS electrical connector to TPS.

(5) Install air intake tube.

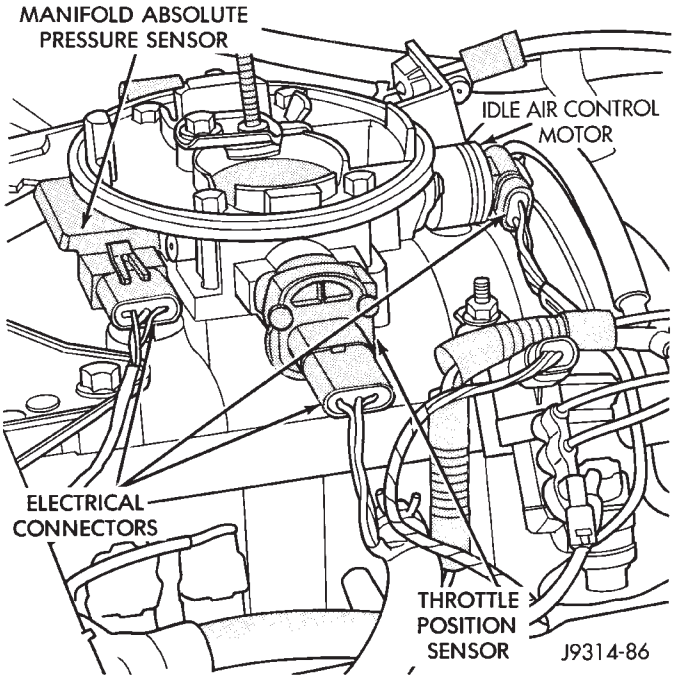


Fig. 24 TPS—Typical

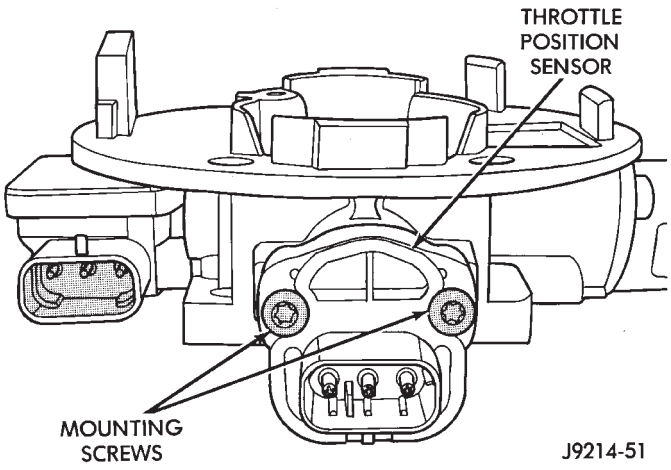


Fig. 25 TPS Mounting Screws

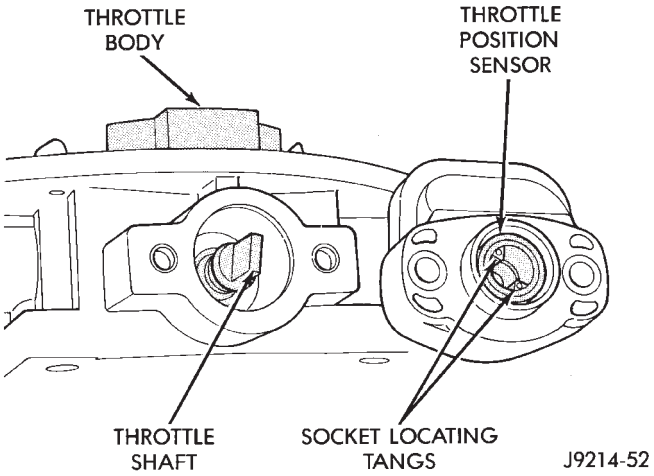


Fig. 26 TPS Installation

(3) Connect electrical connector to sensor.

(4) Connect the speedometer cable.

VEHICLE SPEED SENSOR

The vehicle speed sensor (Fig. 27) is located on the extension housing of the transmission on 2WD models. It is located on the transfer case on 4WD models.

REMOVAL

(1) Raise and support vehicle.
(2) Disconnect the electrical connector from the sensor.
(3) Remove (unscrew) the speedometer cable from the sensor (Fig. 28).
(4) Loosen the sensor mounting nut (Fig. 28).
(5) Remove the sensor.

INSTALLATION

(1) Install new sensor into speedometer adapter.
(2) Tighten sensor mounting nut.

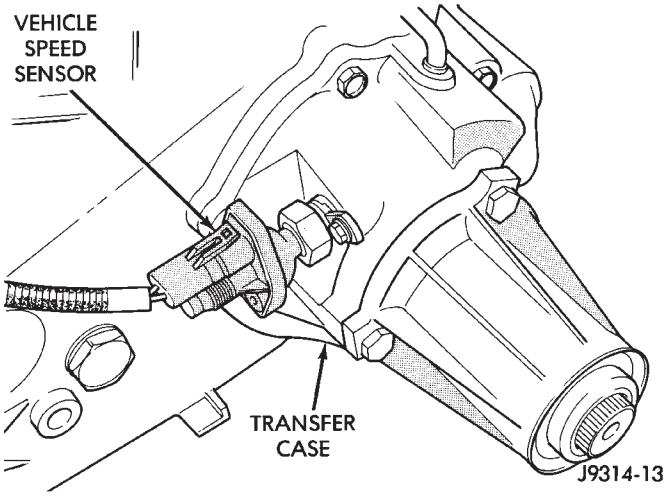


Fig. 27 Vehicle Speed Sensor—Typical

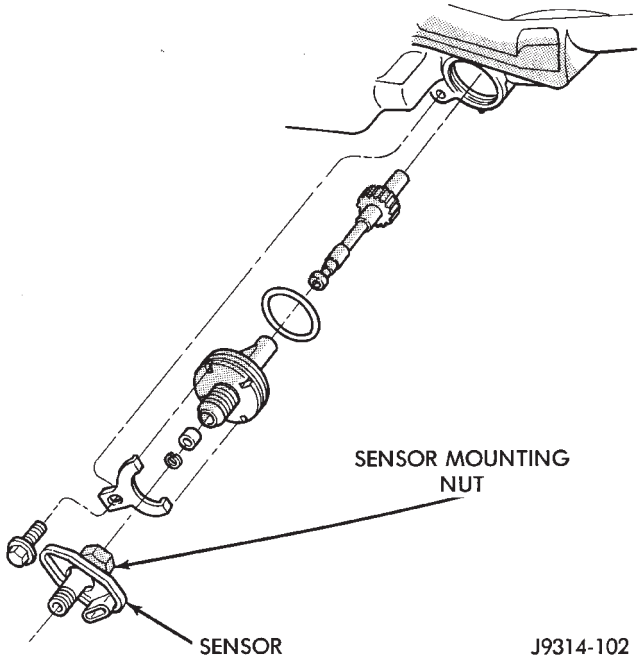


Fig. 28 Sensor and Components

SPECIFICATIONS

GENERAL INFORMATION

The following specifications are published from the latest information available at the time of publication. **If anything differs between the specifications found on the Vehicle Emission Control Information (VECI) label and the following specifications, use specifications on VECI label.** The VECI label is located in the engine compartment.

FUEL TANK CAPACITIES

FUEL TANK	LITERS*	GALLONS*
ALL MODELS	87	23.0

*Nominal refill capacities are shown. A variation may be observed from vehicle to vehicle due to manufacturing tolerances, ambient temperature and refill procedures.

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FUEL SYSTEM

COMPONENT	RATING
MFI Fuel System Pressure (with vacuum applied to regulator)	214 kPa (31 psi)
MFI Fuel System Pressure (without vacuum applied to pressure regulator)	269-276 kPa (39-41 psi)
MFI Fuel System Pressure Drop (fuel pump not engaged).....	Up to 138 kPa (20 psi)
Pressure-Vacuum Filler Cap Relief..	10 kPa (1.5 psi) pressure 6 kPa (1.8 in. Hg) vacuum

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TORQUE

DESCRIPTION	TORQUE
Accelerator Pedal Mounting Nuts	10 N·m (92 in. lbs.)
Coolant Temperature Sensor 4.0L	28 N·m (21 ft. lbs.)
Coolant Temperature Sensor 5.2L	11 N·m (8 ft. lbs.)
Crankshaft Position Sensor 4.0L	18 N·m (15 ft. lbs.)
Fuel Filter Retaining Strap Bolt	7 N·m (66 in. lbs.)
Fuel Rail Mounting Bolts	27 N·m (20 ft. lbs.)
Idle Air Control Motor Mounting Screws	7 N·m (60 in. lbs.)
Intake Manifold Charge Air Temperature Sensor	28 N·m (20 ft. lbs.)
MAP Sensor Mounting Screws 5.2L	3 N·m (25 in. lbs.)
Oxygen Sensor	30 N·m (22 ft. lbs.)
PCM 60-Way Connector Mounting Screw	4 N·m (35 in. lbs.)
PCM Mounting Bolts	1 N·m (9 in. lbs.)
Throttle Body Mounting Bolts (4.0L)	12 N·m (9 ft. lbs.)
Throttle Body Mounting Bolts (5.2L)	23 N·m (200 in. lbs.)
TPS Screws	7 N·m (60 in. lbs.)

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