FUEL SYSTEM

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GENERAL INFORMATION

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GENERAL INFORMATION

INTRODUCTION

Throughout this group, references may be made to a particular vehicle by letter or number designation. A chart showing the breakdown of these designations is included in the Introduction Section at the front of this service manual.

The Evaporation Control System, is also considered part of the fuel system. The system reduces the emission of fuel vapor into the atmosphere.

The description and function of the Evaporation Control System is found in Group 25 of this manual.

PCM REPLACEMENT

USE THE DRB SCAN TOOL TO REPROGRAM THE NEW PCM WITH THE VEHICLES ORIGINAL IDENTIFICATION NUMBER (VIN) AND THE VEHICLES ORIGINAL MILEAGE. IF THIS STEP IS NOT DONE A DIAGNOSTIC TROUBLE CODE (DTC) MAY BE SET.

FUEL REQUIREMENTS

Your vehicle was designed to meet all emission regulations and provide excellent fuel economy when using high quality unleaded gasoline.

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.

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

GENERAL INFORMATION (Continued)

GASOLINE/OXYGENATE BLENDS

Some fuel suppliers blend unleaded gasoline with materials that contain oxygen such as alcohol, MTBE (Methyl Tertiary Butyl Ether) and ETBE (Ethyl Tertiary Butyl Ether). Oxygenates are required in some areas of the country during winter months to reduce carbon monoxide emissions. The type and amount of oxygenate used in the blend is important.

The following are generally used in gasoline blends:

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

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.

Methanol - 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.

DO NOT USE GASOLINES CONTAINING METHANOL.

Use of methanol/gasoline blends may result in starting and driveability problems and damage critical fuel system components.

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

Reformulated Gasoline

Many areas of the country are requiring the use of cleaner-burning fuel referred to as **Reformulated Gasoline**. Reformulated gasolines are specially blended to reduce vehicle emissions and improve air quality.

Chrysler Corporation strongly supports the use of reformulated gasolines whenever available. Although your vehicle was designed to provide optimum performance and lowest emissions operating on high quality unleaded gasoline, it will perform equally well and produce even lower emissions when operating on reformulated gasoline.

Materials Added to Fuel

Indiscriminate use of fuel system cleaning agents should be avoided. Many of these materials intended for gum and varnish removal may contain active solvents of similar ingredients that can be harmful to fuel system gasket and diaphragm materials.

E-85 GENERAL INFORMATION

The information in this section is for Flexible Fuel Vehicles (FFV) only. These vehicles can be identified by the unique Fuel Filler Door Label that states Ethanol (E-85) or Unleaded Gasoline Only. This section only covers those subjects that are unique to these vehicles. Please refer to the other sections of this manual for information on features that are common between Flexible Fuel and gasoline only powered vehicles.

ETHANOL FUEL (E-85)

E-85 is a mixture of approximately 85% fuel ethanol and 15% unleaded gasoline.

WARNING: Ethanol vapors are extremely flammable and could cause serious personal injury. Never have any smoking materials lit in or near the vehicle when removing the fuel filler tube cap (gas cap) or filling the tank. Do not use E-85 as a cleaning agent and never use it near an open flame.

FUEL REQUIREMENTS

Your vehicle will operate on both unleaded gasoline with an octane rating of 87, or E-85 fuel, or any mixture of these two.

For best results, a refueling pattern that alternates between E-85 and unleaded gasoline should be avoided. When you do switch fuels, it is recommended that

- you do not switch when the fuel gauge indicates less than 1/4 full
- you do not add less than 5 gallons when refueling
- you operate the vehicle immediately after refueling for a period of at least 5 minutes

Observing these precautions will avoid possible hard starting and/or significant deterioration in drivability during warm up.

NOTE: When the ambient temperature is above 90°F, you may experience hard starting and rough idle following start up even if the above recommendations are followed.

STARTING

The characteristics of E-85 fuel make it unsuitable for use when ambient temperatures fall below 0°F. In the range of 0°F to 32°F, you may experience an increase in the time it takes for your engine to start, and a deterioration in drivability (sags and/or hesitations) until the engine is fully warmed up.

GENERAL INFORMATION (Continued)

CRUISING RANGE

Because E-85 fuel contains less energy per gallon than gasoline, you will experience an increase in fuel consumption. You can expect your MPG and your driving range to decrease by about 30% compared to gasoline operation.

REPLACEMENT PARTS

Many components in your Flexible Fuel Vehicle (FFV) are designed to be compatible with ethanol. Always be sure that your vehicle is serviced with correct ethanol compatible parts.

CAUTION: Replacing fuel system components with non-ethanol compatible components can damage your vehicle and may void the warranty.

FUEL DELIVERY SYSTEM

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DESCRIPTION AND OPERATION

FUEL DELIVERY SYSTEM

The front wheel drive van uses a plastic fuel tank located on the left side of the vehicle.

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

The in-tank fuel pump module contains the fuel pump and pressure regulator. The pump is serviced as part of the fuel pump module. Refer to Fuel Pump Module.

The fuel filter is a replaceable in-line filter. The filter attaches to a bracket mounted on top of the fuel tank. Refer to the Maintenance Schedules in the Introduction section of this manual for recommended fuel filter replacement intervals.

A returnless fuel system is used on all vehicles. Fuel is returned through the fuel pump module and back to the fuel tank. A separate fuel return line from the tank to the engine is no longer used.

FUEL PUMP MODULE

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

- Electric fuel pump
- Fuel pump reservoir
- Inlet strainer
- Fuel pressure regulator
- Fuel gauge sending unit
- Fuel supply line connection

The inlet strainer, fuel pressure regulator and fuel level sensor are the only serviceable items. If the fuel pump or electrical wiring harness requires service, replace the fuel pump module.

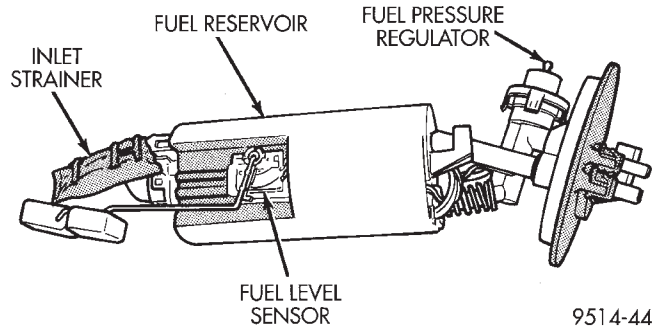


Fig. 1 Fuel Pump Module

ELECTRIC FUEL PUMP

The electric fuel pump is located in and is part of the fuel pump module. It is a positive displacement, gerotor type, immersible pump with a permanent magnet electric motor. The pump draws fuel through a strainer and pushes it through the motor to the outlet. The pump contains one check valve. The

DESCRIPTION AND OPERATION (Continued)

check valve, in the pump outlet, maintains pump pressure during engine off conditions. The fuel pump relay provides voltage to the fuel pump.

The fuel pump has a maximum deadheaded pressure output of approximately 635 kPa (95 psi). The regulator adjusts fuel system pressure to approximately 338 kPa (49 psi).

FUEL PUMP ELECTRICAL CONTROL

Voltage to operate the electric pump is supplied through the fuel pump relay. For an electrical operational description of the fuel pump refer to fuel Pump Relay—PCM Output.

ELECTRICAL PUMP REPLACEMENT

The electric fuel pump is not serviceable. If the fuel pump or electrical wiring harness needs replacement, the complete fuel pump module must be replaced. Perform the Fuel System Pressure Release procedure before servicing the fuel pump.

FUEL LEVEL SENSOR

The level sensor is attached to the side of the fuel pump module. The level sensor consists of a float, an arm, and a variable resistor. As the fuel level increases, the float and arm move up. This decreases the sending unit resistance, causing the fuel gauge on the instrument panel to read full.

FUEL PRESSURE REGULATOR

The fuel system uses a nonadjustable pressure regulator that maintains fuel system pressure at approximately 338 kPa (49 psi), 3.3l uses approximately 379 kPa (55 psi). The fuel pressure regulator contains a diaphragm, calibrated spring and a fuel return valve. The spring pushes down on the diaphragm and closes off the fuel return port. System fuel pressure reflects the amount of fuel pressure required to open the return port.

The pressure regulator is a mechanical device that is NOT controlled by the PCM or engine vacuum.

FUEL INJECTORS

The fuel injectors are 12 ohm electrical solenoids (Fig. 2). The injector contains a pintle that closes off an orifice at the nozzle end. When electric current is supplied to the injector, the armature and needle move a short distance against a spring, allowing fuel to flow out the orifice. Because the fuel is under high pressure, a fine spray is developed in the shape of a hollow cone. The spraying action atomizes the fuel, adding it to the air entering the combustion chamber. The injectors are positioned in the intake manifold. Fuel injectors are not interchangeable between engines.

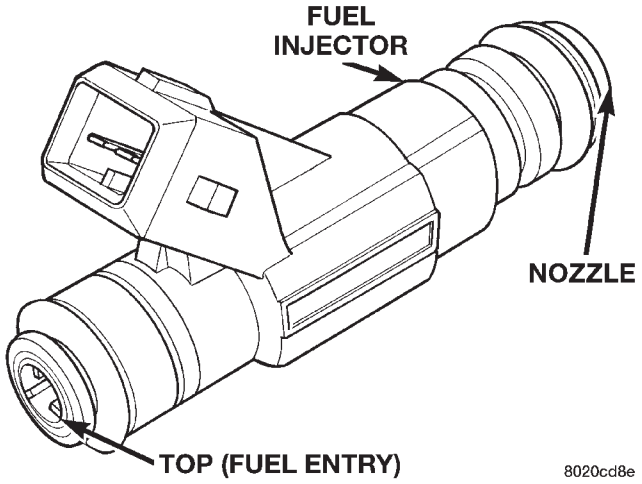


Fig. 2 Fuel Injector

The injectors are positioned in the intake manifold with the nozzle ends directly above the intake valve port (Fig. 3).

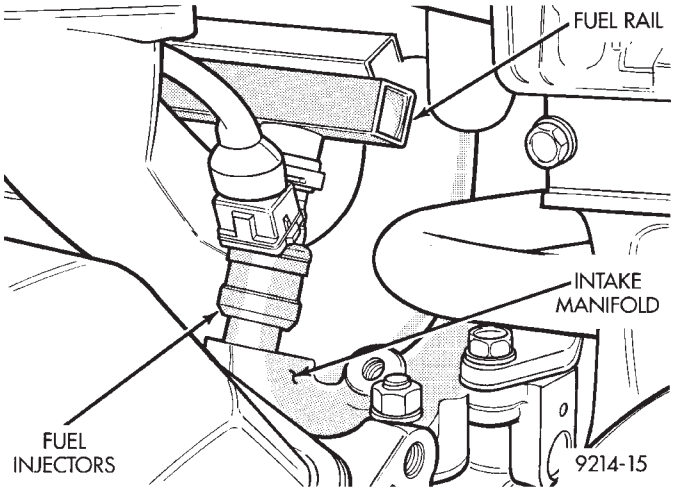


Fig. 3 Fuel Injector Location—Typical

FUEL TANK

The fuel tanks of all Chrysler Motors built vehicles are equipped with fuel and vapor controls that allow the vehicle to pass a full 360° rollover without fuel leakage.

Front Wheel Drive fuel delivery systems contain a fuel tank rollover valve. The valve is mounted on top of the fuel tank. The valve functions as a tank pressure control valve while the vehicle is upright, but contains a check valve that prevents fuel from escaping from the fuel tank when the vehicle is turned over.

The fuel filler cap acts as a pressure/vacuum relief valve. When air pressure inside the fuel tank gets too high or too low, the fuel filler cap opens to relieve the difference in pressure.

An evaporation control system restricts fuel evaporation into the atmosphere and reduces unburned

DESCRIPTION AND OPERATION (Continued)

hydrocarbons. Vapors from the fuel tank are collected in a charcoal filled canister. The vapors are held in the canister until the engine is operating. When the engine is running, the vapors are drawn through the intake manifold into the combustion chambers.

PRESSURE-VACUUM FILLER CAP

The loss of any fuel or vapor out of the filler neck is prevented by the use of a safety filler cap. The cap will release pressure only under significant pressure of 10.9 to 13.45 kPa (1.58 to 1.95 psi). The vacuum release for all gas caps is between 0.97 and 2.0 kPa (0.14 and 0.29 psi). The cap must be replaced by a similar unit if replacement is necessary.

WARNING: REMOVE FILLER CAP TO RELIEVE TANK PRESSURE BEFORE REMOVING OR REPAIRING FUEL SYSTEM COMPONENTS.

QUICK-CONNECT FITTINGS

Different types of quick-connect fittings are used to attach various fuel system components. These are: a single-tab type, a two-tab type or a plastic retainer ring type. Some are equipped with safety latch clips. Refer to the Removal/Installation section for more information.

CAUTION: The interior components (o-rings, spacers) of quick-connect fitting are not serviced separately. Do not attempt to repair damaged fittings or fuel lines/tubes. If repair is necessary, replace the complete fuel tube assembly.

Fuel tubes connect fuel system components with plastic quick-connect fuel fittings. The fitting contains non-serviceable O-ring seals (Fig. 4).

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

The quick-connect fitting consists of the O-rings, retainer and casing (Fig. 4). When the fuel tube enters the fitting, the retainer locks the shoulder of the nipple in place and the O-rings seal the tube.

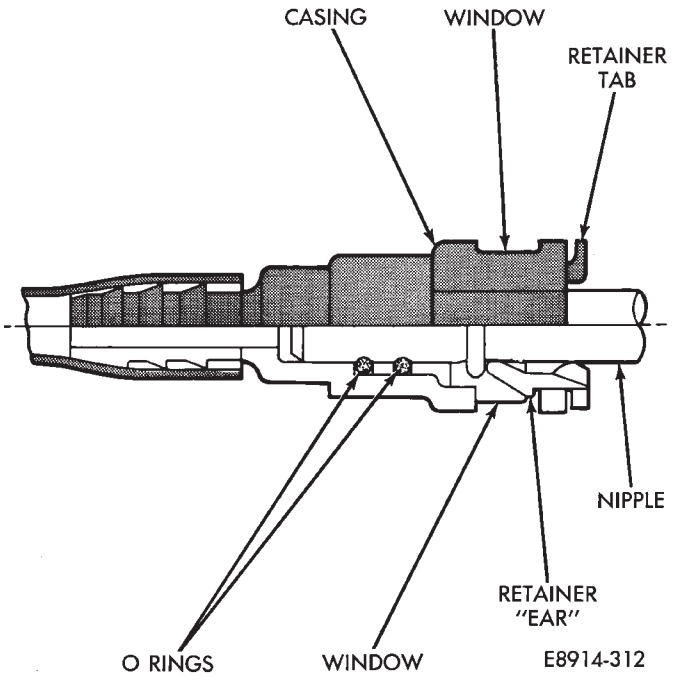


Fig. 4 Plastic Quick-Connect Fittings

The fuel system operates at approximately 338 kPa (49 psi), 3.3L uses approximately 379 kPa (55 psi). Check fuel system pressure at the test port on the fuel rail (Fig. 5) or (Fig. 6).

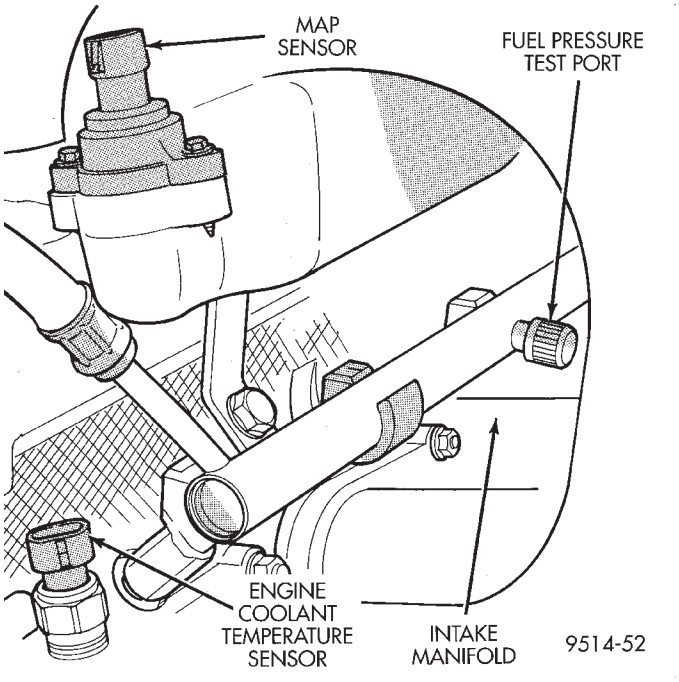


Fig. 5 Fuel Pressure Test Port—2.4L

DIAGNOSIS AND TESTING

FUEL PUMP PRESSURE TEST 2.4/3.3/3.8L

WARNING: FUEL SYSTEM PRESSURE MUST BE RELEASED BEFORE A FUEL SYSTEM HOSE OR COMPONENT IS DISCONNECTED.

DIAGNOSIS AND TESTING (Continued)

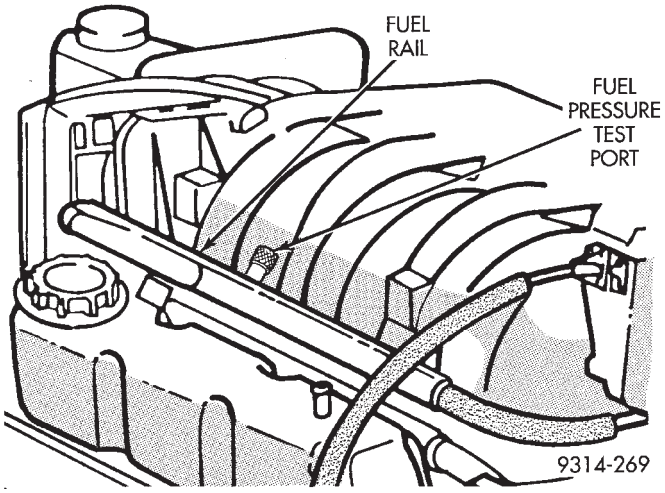


Fig. 6 Fuel Pressure Test Port—3.3/3.8L

(1) Remove cap from fuel pressure test port on fuel rail.

(2) Connect Fuel Pressure Gauge C-4799B to test port (Fig. 7).

CAUTION: When using the ASD Fuel System Test, the ASD relay and fuel pump relay remain energized for 7 minutes or until the test is stopped, or until the ignition switch is turned to the Off position.

(3) Place the ignition key in the ON position. Using the DRB scan tool, access ASD Fuel System Test. The ASD Fuel System Test will activate the fuel pump and pressurize the system.

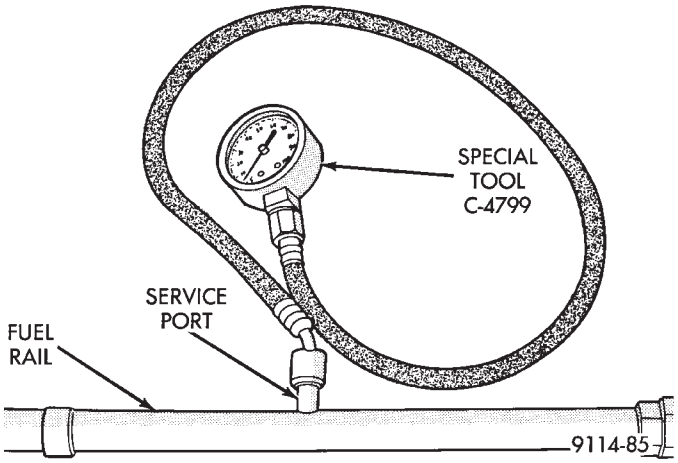


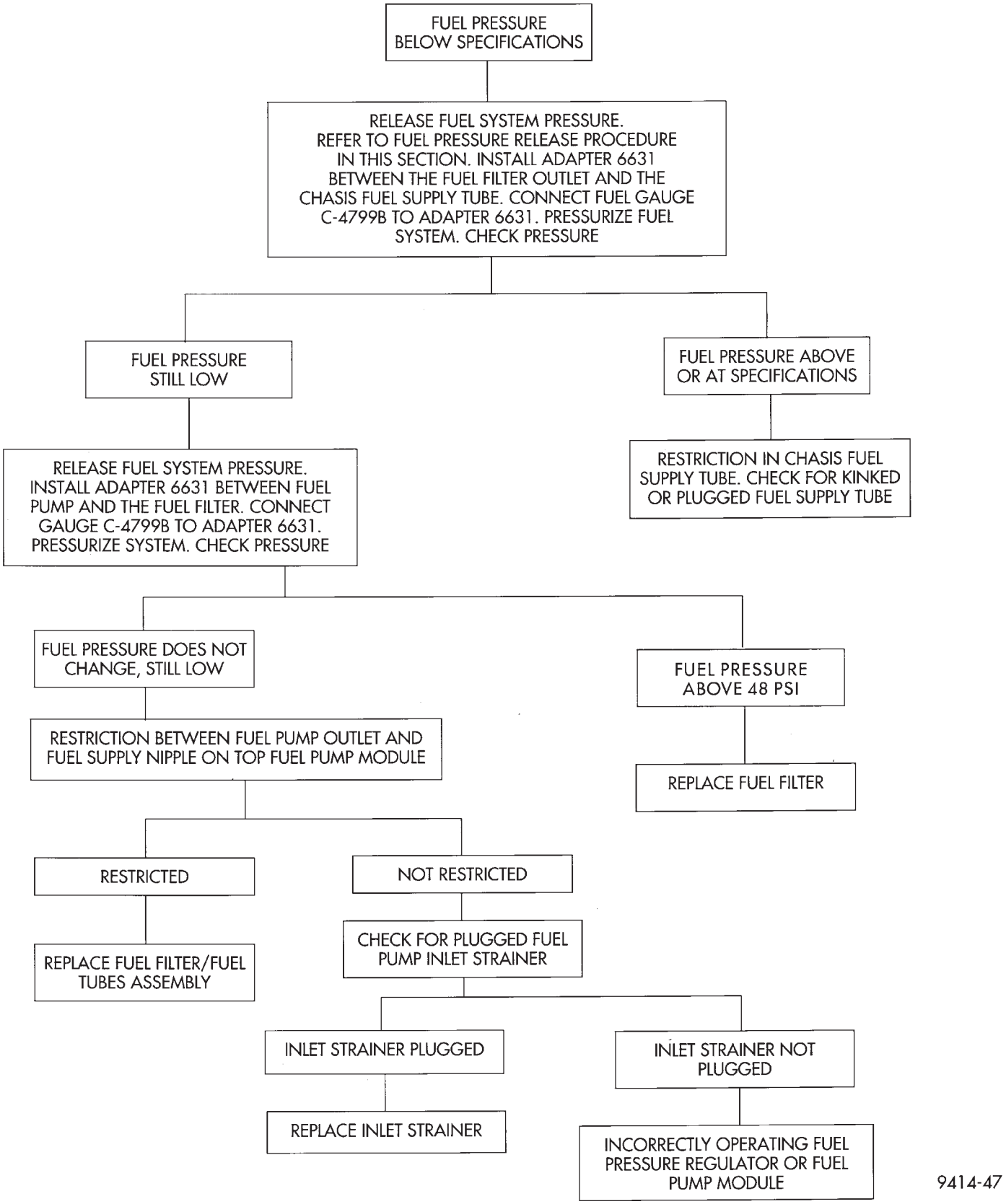
Fig. 7 Checking Fuel Pressure at Fuel Rail

- If the gauge reading equals 338 kPa (49 psi) 3.3L uses approximately 379 kPa (55 psi) further testing is not required. If pressure is not correct, record the pressure.
- If pressure is above specifications, check for a kinked or restricted fuel return tube (from filter to pump module). If the fuel return tube is not pinched or restricted, replace the fuel pressure regulator.
- If fuel pressure is below specifications, refer to the diagnosis chart for Fuel Pressure Below Specifications.

(4) **Replace Pressure test port cap when finished doing pressure test.**

DIAGNOSIS AND TESTING (Continued)

FUEL PRESSURE BELOW SPECIFICATIONS



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DIAGNOSIS AND TESTING (Continued)

FUEL LEVEL SENSOR

This procedure tests the resistance of the level sensor itself. It does not test the level sensor circuit. Refer to Group 8W - Wiring Diagrams for circuit identification.

The level sensor is a variable resistor. Its resistance changes with the amount of fuel in the tank. The float arm attached to the sensor moves as the fuel level changes. To test the level sensor, connect an ohmmeter across the sensor signal and sensor ground terminals of the fuel pump module connector (Fig. 8). Move the float lever to the positions shown in the resistance chart (Fig. 8). Record the resistance at each point. Replace the level sensor if the resistance is not within specifications.

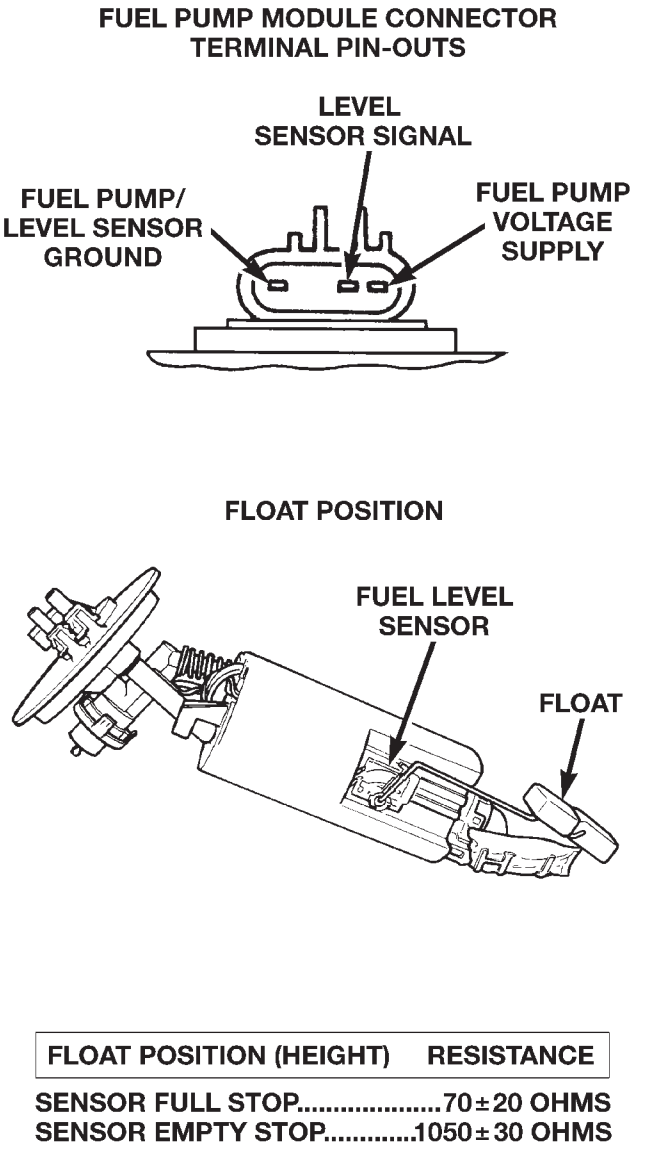


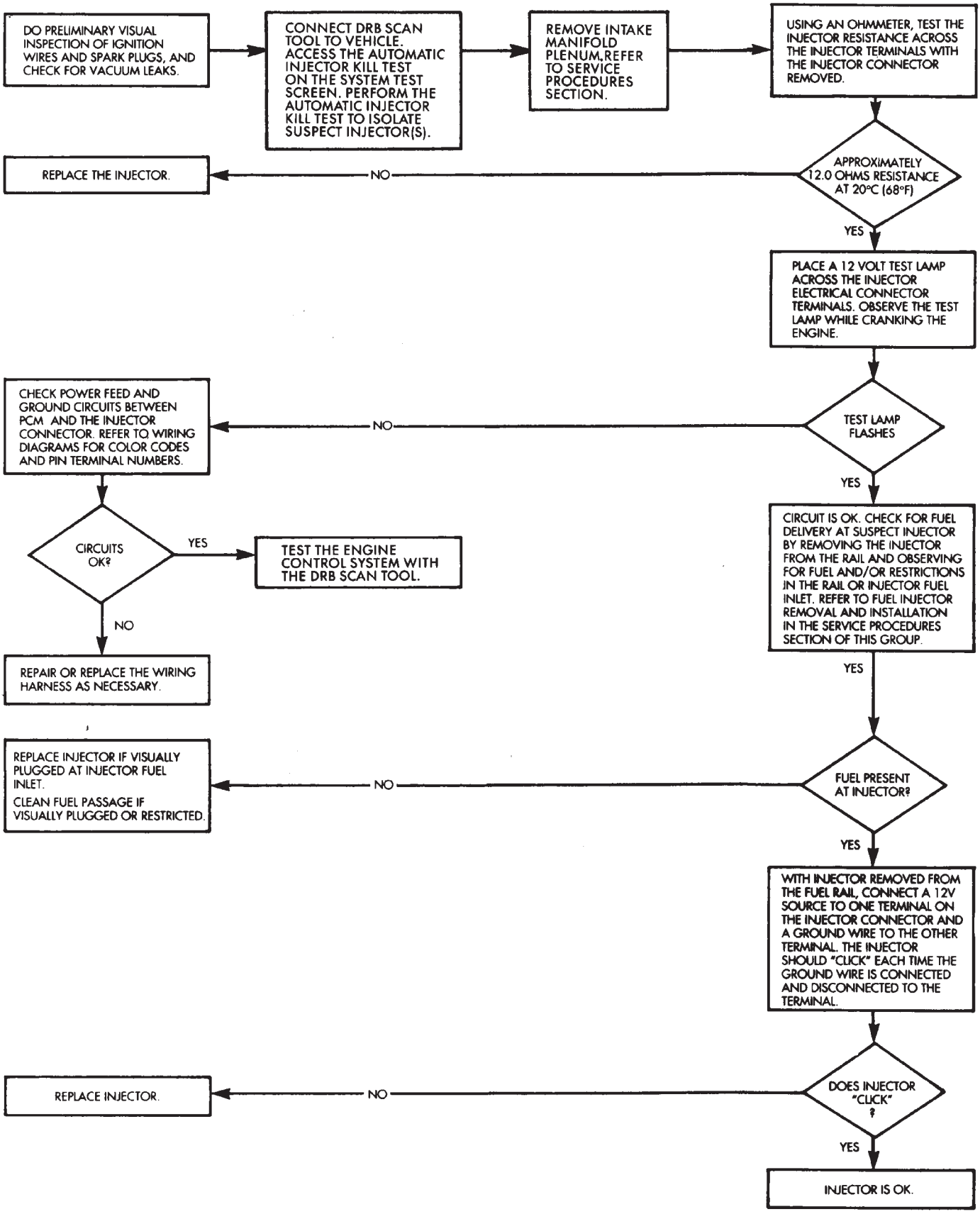
Fig. 8 Level Sensor Diagnosis

FUEL INJECTORS

For fuel injector diagnosis, refer to the Fuel Injector Diagnosis charts. For poor fuel economy diagnosis or engine miss, also refer to Transmission Driveplate in this section.

DIAGNOSIS AND TESTING (Continued)

FUEL INJECTOR DIAGNOSIS



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SERVICE PROCEDURES

FUEL SYSTEM PRESSURE RELEASE PROCEDURE—2.4/3.3/3.8L

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE SERVICING FUEL SYSTEM COMPONENTS. SERVICE VEHICLES IN WELL VENTILATED AREAS AND AVOID IGNITION SOURCES. NEVER SMOKE WHILE SERVICING THE VEHICLE.

(1) Disconnect negative cable from battery.
(2) Remove fuel filler cap.
(3) Remove protective cap from fuel pressure test port on fuel rail (Fig. 9) or (Fig. 10).

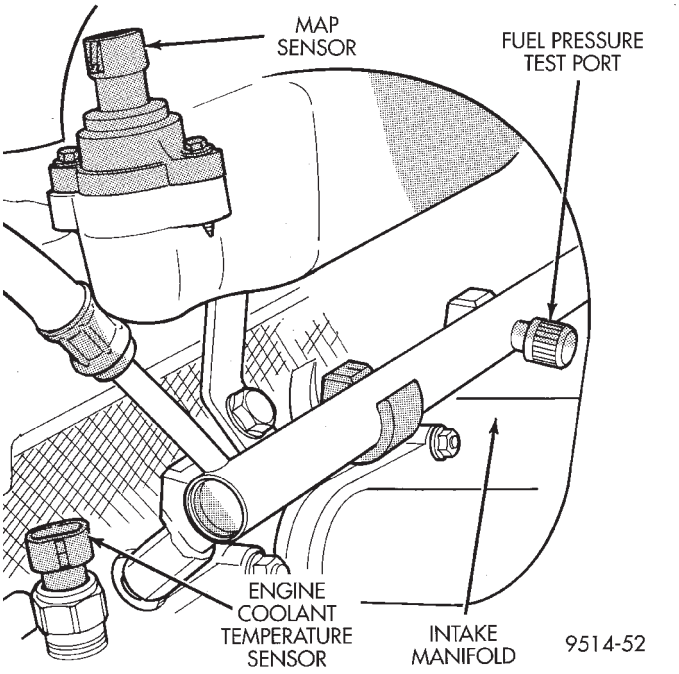


Fig. 9 Fuel Pressure Test Port—2.4L

(4) Place open end of fuel pressure release hose, tool number C-4799-1, into an approved gasoline container. Connect other end of hose C-4799-1 to fuel pressure test port (Fig. 11). Fuel pressure will bleed off through the hose into the gasoline container. Fuel gauge C-4799-B contains hose C-4799-1.
(5) **Replace Pressure test port cap when finished doing pressure test.**

FUEL SYSTEM PRESSURE RELEASE PROCEDURE—3.0L ENGINE

(1) Remove the Fuel Pump relay from the Power Distribution Center (PDC). For location of the relay, refer to the label on the underside of the PDC cover.
(2) Start and run engine it stalls.
(3) Attemp restarting engine until it will no longer run.

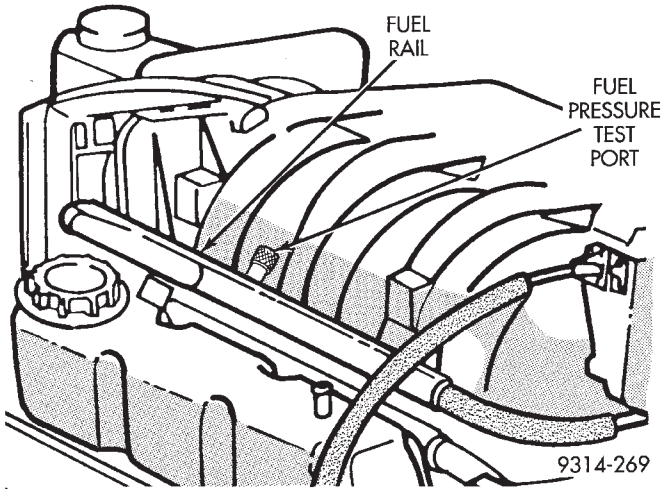


Fig. 10 Fuel Pressure Test Port—3.3/3.8L

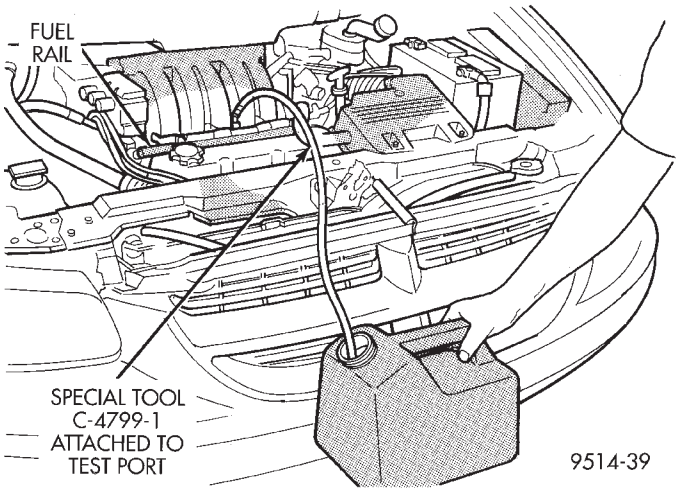


Fig. 11 Releasing Fuel Pressure

(4) Turn ignition key to OFF position.

CAUTION: Steps 1, 2, 3 and 4 must be performed to relieve high pressure fuel from within the fuel rail. Do not attempt to use the following steps to relieve this pressure as excessive fuel will be forced into a cylinder chamber.

(5) Unplug connector from any injector.
(6) Attach one end of a jumper wire with alligator clips (18 gauge or smaller) to either injector terminal.
(7) Connect the other end of the jumper wire to the positive side of the battery.
(8) Connect one end of a second jumper wire to the remaining injector terminal.

CAUTION: Supplying power to an injector for more than 4 seconds will permantely damage the injector. Do not leave the injector connected to power for more than 4 seconds.

SERVICE PROCEDURES (Continued)

(9) Momentarily touch the other end of this jumper wire to the negative terminal of the battery for no more than 4 seconds.

(10) Place a rag or towel below the fuel line at the quick connect to the rail.

(11) Disconnect the quick connect fitting to the rail. Refer to Quick-Connect Fittings in this section.

(12) Return the fuel pump relay to the PDC.

(13) One or more Diagnostic Trouble Codes (DTC's) may have been stored in the PCM memory due to the fuel pump relay removal. The DRB scan tool must be used to erase a DTC. Refer to group 25, On-Board Diagnostics.

HOSES AND CLAMPS

Inspect all hose connections (clamps and quick connect fittings) for completeness and leaks. Replace cracked, scuffed, or swelled hoses. Replace hoses that rub against other vehicle components or show sign of wear.

Fuel injected vehicles use specially constructed hoses. When replacing hoses, only use hoses marked EFM/EFI.

When installing hoses, ensure that they are routed away from contact with other vehicle components that could rub against them and cause failure. Avoid contact with clamps or other components that cause abrasions or scuffing. Ensure that rubber hoses are properly routed and avoid heat sources.

The hose clamps have rolled edges to prevent the clamp from cutting into the hose. Only use clamps that are original equipment or equivalent. Other types of clamps may cut into the hoses and cause high pressure fuel leaks. Tighten hose clamps to 1 N·m (10 in. lbs.) torque.

QUICK-CONNECT FITTINGS

REMOVAL

When disconnecting a quick-connect fitting, the retainer will remain on the fuel tube nipple.

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

(1) Disconnect negative cable from battery.

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

(3) Squeeze retainer tabs together and pull fuel tube/quick-connect fitting assembly off of fuel tube nipple. The retainer will remain on fuel tube.

INSTALLATION

CAUTION: Never install a quick-connect fitting without the retainer being either on the fuel tube or already in the quick-connect fitting. In either case, ensure the retainer locks securely into the quick-connect fitting by firmly pulling on fuel tube and fitting to ensure it is secured.

(1) Using a clean lint free cloth, clean the fuel tube nipple and retainer.

(2) Prior to connecting the fitting to the fuel tube, coat the fuel tube nipple with clean 30 weight engine oil.

(3) Push the quick-connect fitting over the fuel tube until the **retainer seats and a click is heard.**

(4) The plastic quick-connect fitting has windows in the sides of the casing. When the fitting completely attaches to the fuel tube, the retainer locking ears and the fuel tube shoulder are visible in the windows. If they are not visible, the retainer was not properly installed (Fig. 12). **Do not rely upon the audible click to confirm a secure connection.**

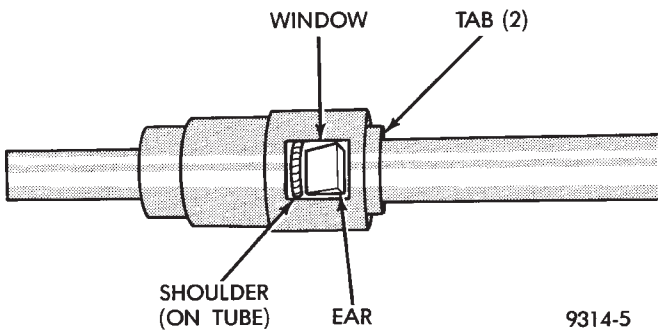


Fig. 12 Plastic Quick-Connect Fitting/Fuel Tube Connection

CAUTION: When using the ASD Fuel System Test, the Auto Shutdown (ASD) Relay remains energized for either 7 minutes, until the test is stopped, or until the ignition switch is turned to the Off position.

(5) Use the DRB scan tool ASD Fuel System Test to pressurize the fuel system. Check for leaks.

REMOVAL AND INSTALLATION

FUEL FILTER

The fuel filter mounts to the top of the fuel tank. The inlet and outlet tubes are permanently attached to the filter (Fig. 13).

REMOVAL AND INSTALLATION (Continued)

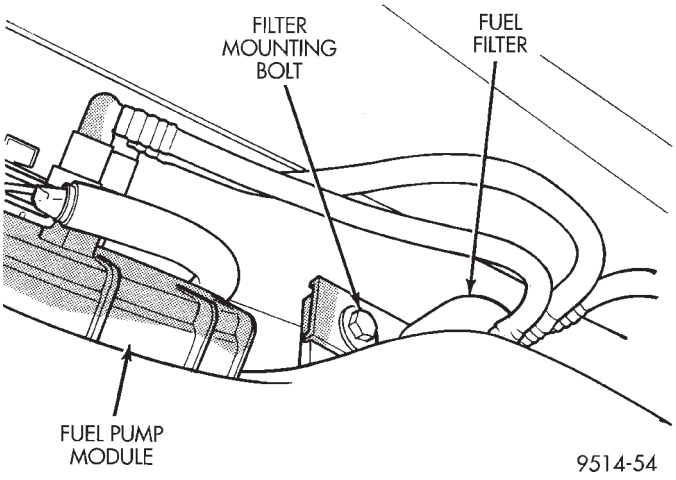


Fig. 13 Fuel Filter

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE DISCONNECTING QUICK-CONNECT FITTINGS AT FUEL FILTER. REFER TO THE FUEL PRESSURE RELEASE PROCEDURE.

REMOVAL

(1) Perform fuel system pressure release.

(2) Disconnect quick-connect fittings from fuel pump module and chassis fuel supply tube. Refer to Quick-Connect Fittings in this section.

(3) Remove filter retaining screw (Fig. 13) and remove filter from tank.

INSTALLATION

(1) Install fuel filter to tank.

(2) The fuel supply (to filter) tube, return tube (to pump module) and fuel supply (to chassis fuel line) are permanently attached the fuel filter. The ends of the fuel supply and return tubes have different size quick-connect fittings.

(3) Apply a light coating of clean 30 weight engine oil to the fuel filter nipples. Install fuel tubes. Refer to Fuel Tubes and Quick-Connect Fittings in this section.

FUEL PUMP MODULE

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE SERVICING FUEL SYSTEM COMPONENTS. SERVICE VEHICLES IN WELL VENTILATED AREAS AND AVOID IGNITION SOURCES. NEVER SMOKE WHILE SERVICING THE VEHICLE.

WARNING: THE FUEL RESERVOIR OF THE FUEL PUMP MODULE DOES NOT EMPTY OUT WHEN THE TANK IS DRAINED. THE FUEL IN THE RESERVOIR WILL SPILL OUT WHEN THE MODULE IS REMOVED.

REMOVAL

(1) Remove fuel filler cap and perform Fuel System Pressure Release procedure.

(2) Disconnect negative cable from battery.

(3) Insert fuel siphon hose into fuel filler neck and push it into the tank.

(4) Drain fuel tank dry into holding tank or a properly labeled **GASOLINE** safety container.

(5) Raise vehicle on hoist.

(6) Use a transmission jack to support the fuel tank. Remove bolts from fuel tank straps. Lower tank slightly.

(7) Clean area around fuel tank module and tank to keep dirt and foreign material out of tank.

(8) Disconnect fuel lines from fuel pump module by depressing quick connect retainers with thumb and fore finger (Fig. 14).

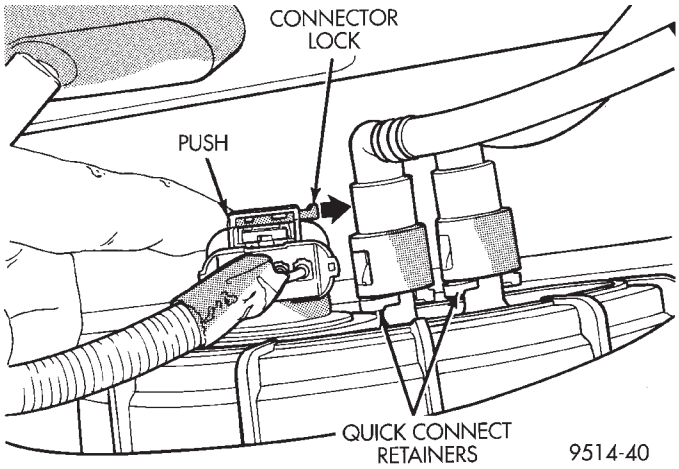


Fig. 14 Fuel Line Retainers and Pump Connector Lock

(9) Slide fuel pump module electrical connector lock to unlock.

(10) Push down on connector retainer (Fig. 15) and pull connector off module.

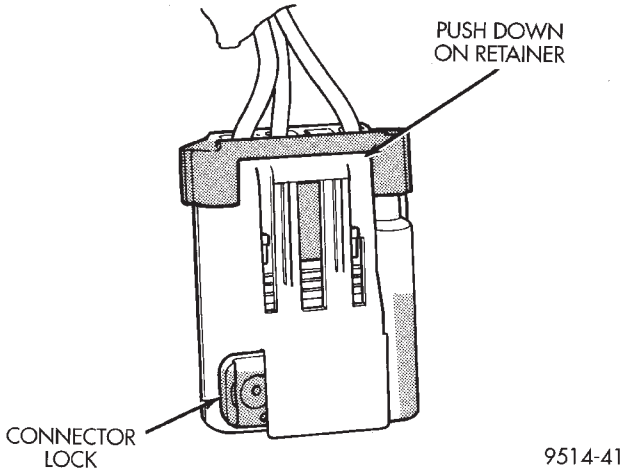


Fig. 15 Pump Module Connector Retainer and Lock

REMOVAL AND INSTALLATION (Continued)

(11) Using Special Tool 6856, remove plastic locknut counterclockwise to release pump module (Fig. 16).

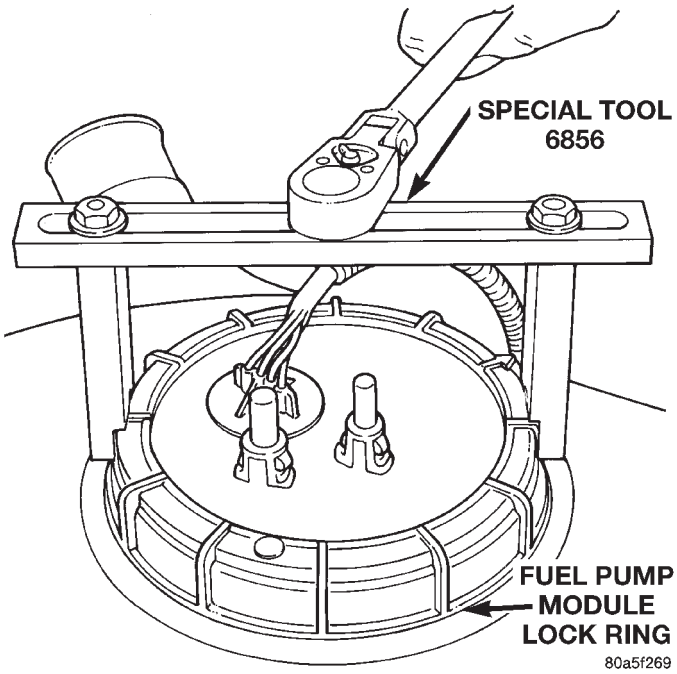


Fig. 16 Fuel Pump Module Lock Nut Removal

(12) Carefully remove pump module and O-ring from tank (Fig. 17).

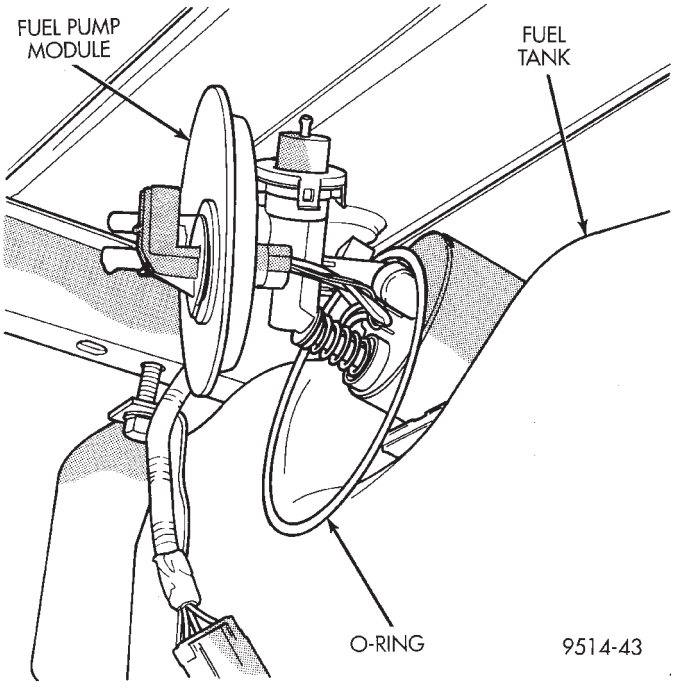


Fig. 17 Fuel Pump Module Removal

(13) Discard old O-ring.

INSTALLATION

(1) Wipe seal area of tank clean and place a new O-ring seal in position on pump.

(2) Position fuel pump in tank with locknut.

(3) Tighten locknut to 53 N·m (43 ft. lbs.).

(4) Connect fuel lines.

(5) Plug in electrical connector. Slide connector lock into position.

(6) Raise fuel tank, install bolts into fuel tank straps and tighten.

(7) Lower vehicle on hoist.

(8) Connect negative cable from battery.

(9) Fill fuel tank. Check for leaks.

(10) Install fuel filler cap.

FUEL PRESSURE REGULATOR

The fuel pressure regulator is part of the fuel pump module (Fig. 18). Remove the fuel pump module from the fuel tank to access the fuel pressure regulator.

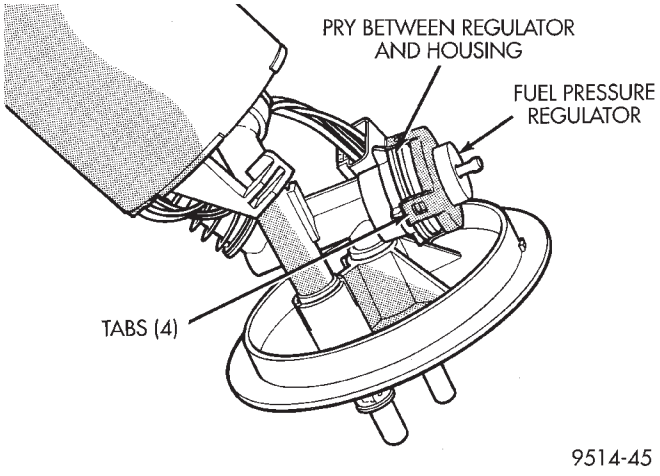


Fig. 18 Fuel Pressure Regulator

WARNING: FUEL SYSTEM PRESSURE MUST BE RELEASED BEFORE SERVICING ANY FUEL SYSTEM COMPONENT. PERFORM THE FUEL SYSTEM PRESSURE RELEASE PROCEDURE.

REMOVAL

(1) Spread tangs on pressure regulator retainer (Fig. 18).

(2) Pry fuel pressure regulator out of housing.

(3) Ensure both upper and lower O-rings were removed with regulator.

INSTALLATION

(1) Lightly lubricate the O-rings with clean engine oil and place them into opening in pump module (Fig. 19).

(2) Push regulator into opening in pump module.

REMOVAL AND INSTALLATION (Continued)

(3) Fold tangs on regulator retainer over tabs on housing.

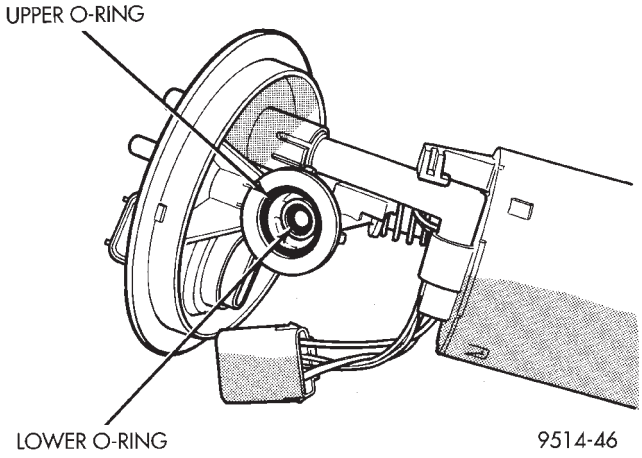


Fig. 19 Fuel Pressure Regulator O-rings

FUEL PUMP INLET STRAINER

REMOVAL

(1) Remove fuel pump module. Refer to Fuel Pump Module Removal in this section.

(2) Using a thin straight blade screwdriver, pry back the locking tabs on fuel pump reservoir and remove the strainer (Fig. 20).

(3) Remove strainer O-ring from the fuel pump reservoir body.

(4) Remove any contaminants in the fuel tank by washing the inside of the fuel tank.

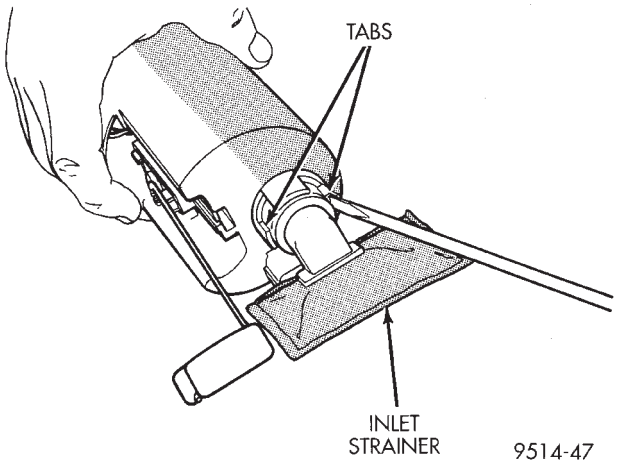


Fig. 20 Inlet Strainer Removal

INSTALLATION

(1) Lubricate the strainer O-ring with clean engine oil.

(2) Insert strainer O-ring into outlet of strainer so that it sits evenly on the step inside the outlet.

(3) Push strainer onto the inlet of the fuel pump reservoir body. Make sure the locking tabs on the reservoir body lock over the locking tangs on the strainer.

(4) Install fuel pump module. Refer to Fuel Pump Module Installation in this section.

FUEL LEVEL SENSOR

REMOVAL

Remove fuel pump module. Refer to Fuel Pump Module in this section.

(1) Depress retaining tab and remove the fuel pump/level sensor connector from the **BOTTOM** of the fuel pump module electrical connector (Fig. 21).

NOTE: The pump module harness on TOP of flange is not serviceable or removable.

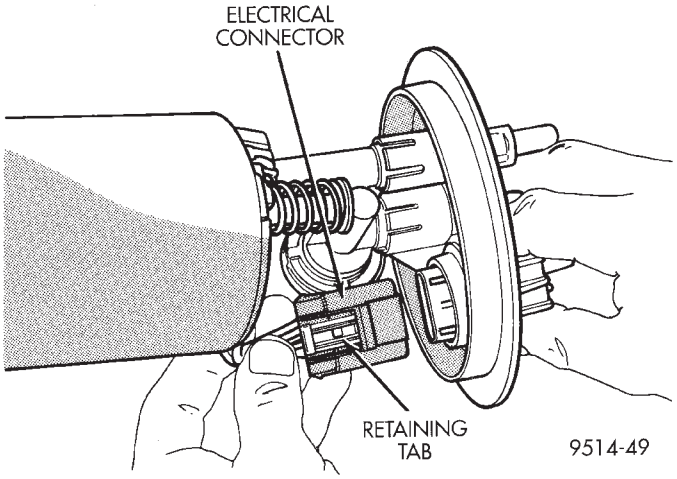


Fig. 21 Fuel Pump/Level Sensor Electrical Connector

(2) Pull off blue locking wedge (Fig. 22).

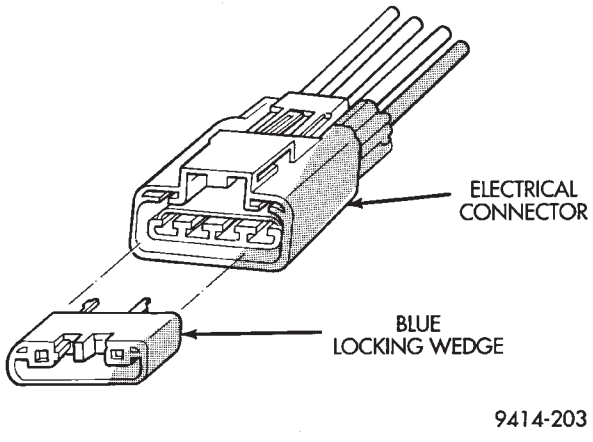


Fig. 22 Wire Terminal Locking Wedge

(3) Using a small screwdriver lift locking finger away from terminal and push terminal out of connector (Fig. 23).

REMOVAL AND INSTALLATION (Continued)

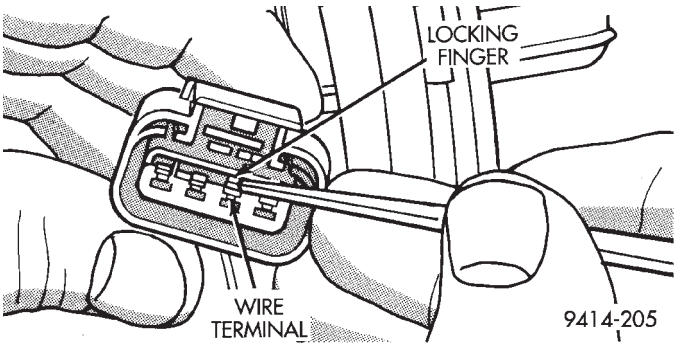


Fig. 23 Wire Terminal Locking Finger

(4) Push level sensor signal and ground terminals out of the connector (Fig. 24).

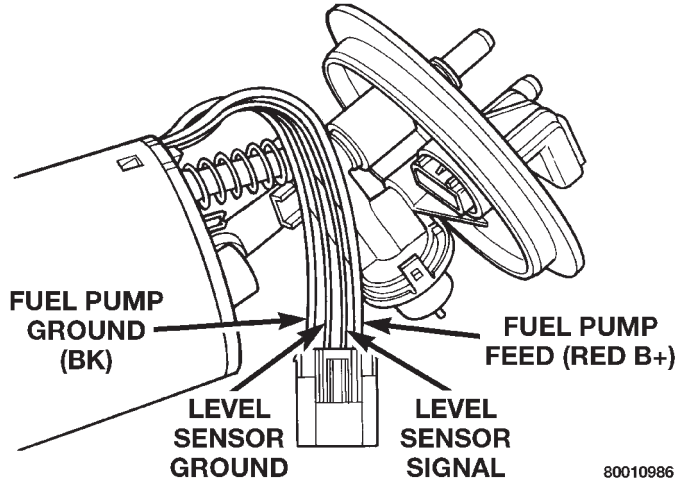


Fig. 24 Removing Wires From Connector

(5) Insert a screwdriver between the fuel pump module and the top of the level sensor housing (Fig. 25). Push level sensor down slightly.

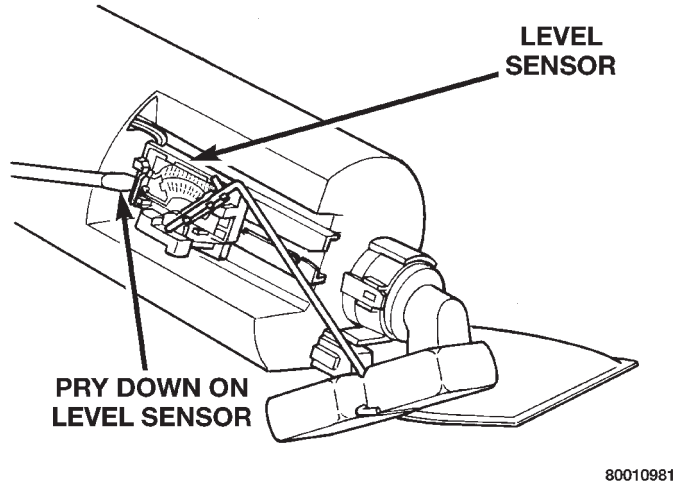


Fig. 25 Loosening Level Sensor

(6) Slide level sensor wires through opening fuel pump module (Fig. 26).

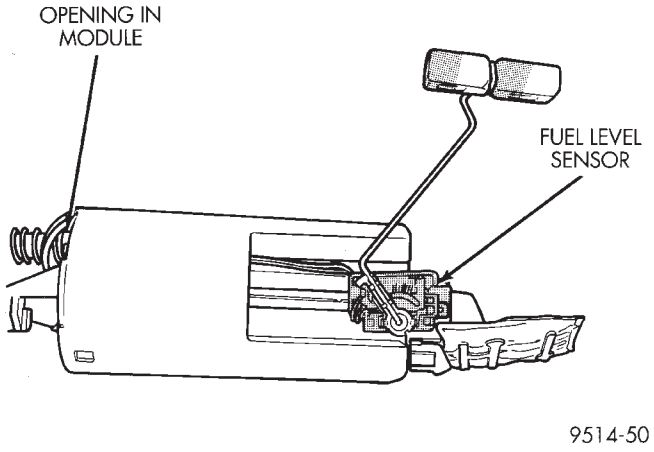


Fig. 26 Level Sensor Removal/Installation

(7) Slide level sensor out of installation channel in module.

INSTALLATION

(1) Insert level sensor wires into bottom of opening in module.

(2) Wrap wires into groove in back of level sensor (Fig. 27).

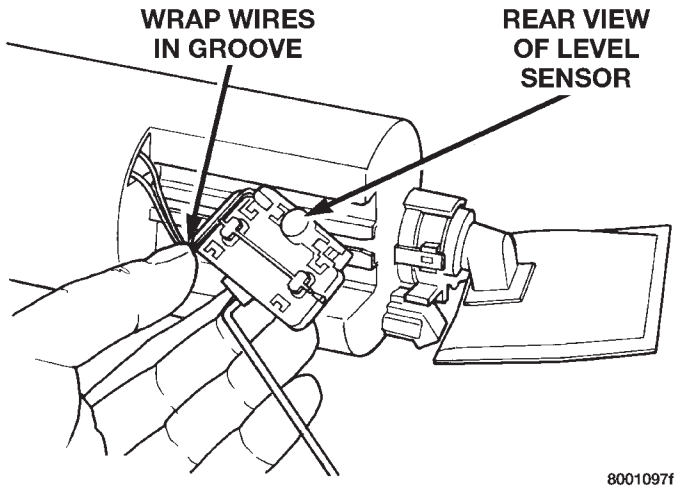


Fig. 27 Groove in Back Side of Level Sensor

(3) While feeding wires into guide grooves, slide level sensor up into channel until it snaps into place (Fig. 28). Ensure tab at bottom of sensor locks in place.

(4) Install level sensor wires in connector. Push the wires up through the connector and then pull them down until they lock in place. Ensure signal and ground wires are installed in the correct position.

(5) Install locking wedge on connector.

(6) Push connector up into bottom of fuel pump module electrical connector.

REMOVAL AND INSTALLATION (Continued)

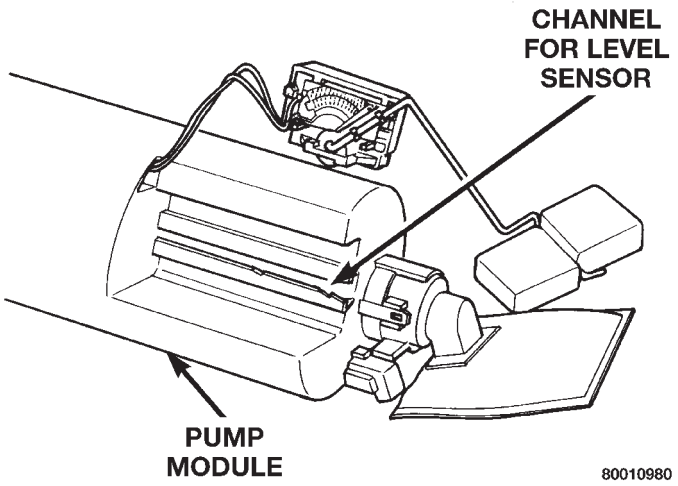
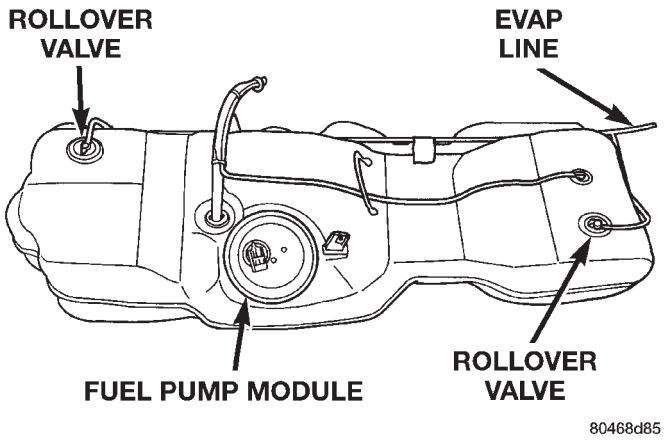


Fig. 28 Installation Channel

(7) Install fuel pump module. Refer to Fuel Pump Module in this section.

FUEL TANK



Fuel Tank

WARNING: RELEASE FUEL SYSTEM PRESSURE BEFORE SERVICING FUEL SYSTEM COMPONENTS. SERVICE VEHICLES IN WELL VENTILATED AREAS AND AVOID IGNITION SOURCES. NEVER SMOKE WHILE SERVICING THE VEHICLE.

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove fuel filler cap and perform Fuel System Pressure Release procedure.

(3) Insert fuel siphon hose into fuel filler neck and push it into the tank.

(4) Drain fuel tank dry into holding tank or a properly labeled **GASOLINE** safety container.

(5) Raise vehicle on hoist.

(6) Disconnect both the fuel fill and fuel vent rubber hoses at the fuel tank.

(7) Disconnect fuel supply lines from the steel supply line.

The fuel pump module electrical connector has a retainer that locks it in place.

(8) Slide fuel pump module electrical connector lock to unlock (Fig. 29).

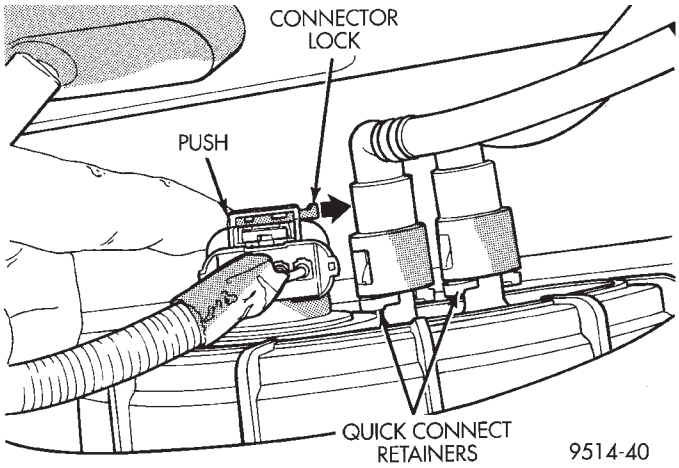


Fig. 29 Fuel Line Retainers and Pump Connector Lock

(9) Push down on connector retainer (Fig. 30) and pull connector off module.

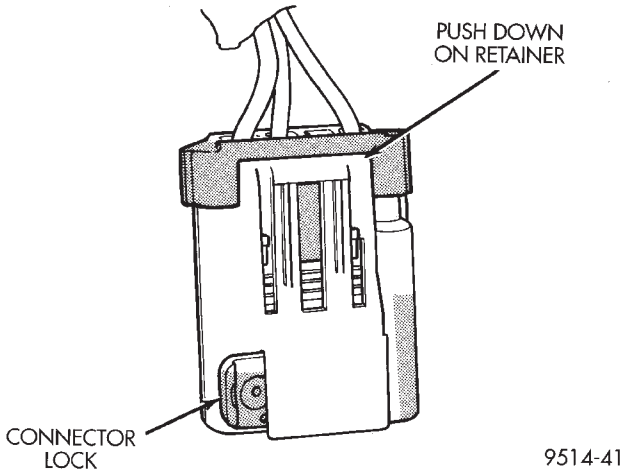


Fig. 30 Pump Module Connector Retainer and Lock

(10) Use a transmission jack to support fuel tank. Remove bolts from fuel tank straps.

(11) Lower tank slightly. Carefully remove filler hose from tank.

(12) Lower the fuel tank. Disconnect pressure relief/rollover valve hose at the front of tank. Remove clamp and remove fuel filler tube vent hose. Remove fuel tank from vehicle.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Position fuel tank on transmission jack. Connect pressure relief/rollover valve hose. Connect fuel filler tube vent hose and replace clamp.

(2) Raise tank into position and carefully work filler tube into tank. A light coating of clean engine oil on the tube end may be used to aid assembly.

(3) Feed filler vent line thru frame rail. Careful not to cross lines.

(4) Tighten strap bolts to 54 N·m (40 ft. lbs.) torque. Remove transmission jack.

(5) Tighten filler hose clamp to 3.3 N·m (30 in. lbs.).

CAUTION: Ensure straps are not twisted or bent before or after tightening strap nuts.

(6) Connect fuel pump/module electrical connector. Place retainer in locked position.

(7) Lubricate the fuel supply line with clean 30 weight engine oil, install the quick connect fuel fitting. Refer to Tube/Fitting Assembly in the Fuel Delivery section of this Group.

(8) Attach filler line to filler tube. Pull on connector to make sure of connection.

(9) Fill fuel tank, replace cap, and connect battery negative cable.

CAUTION: When using the ASD Fuel System Test, the ASD relay and fuel pump relay remain energized for 7 minutes or until the test is stopped, or until the ignition switch is turned to the Off position.

(10) Use the DRB scan tool ASD Fuel System Test to pressurize the fuel system. Check for leaks.

FUEL INJECTOR RAIL—2.4L

REMOVAL

(1) Perform fuel system pressure release procedure **before servicing or starting repairs.** Refer to Fuel System Pressure Release Procedure in this section.

(2) Disconnect negative cable from battery.

(3) Remove air cleaner inlet hose from throttle body.

(4) Remove throttle cable and speed control cable (if equipped) from throttle lever.

(5) Remove throttle cables from bracket by compressing retaining tabs.

(6) Remove connector from throttle position sensor.

(7) Remove connector from idle air control motor.

(8) Remove vacuum lines from intake plenum fittings (Fig. 31) and (Fig. 32).

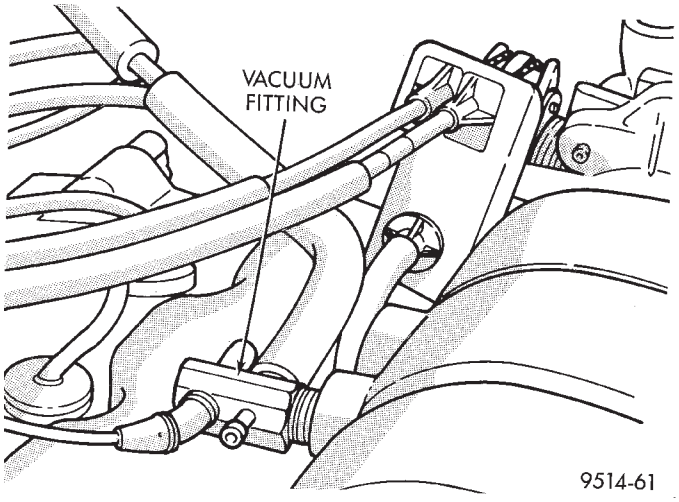


Fig. 31 Vacuum Fitting on Rear of Intake Manifold

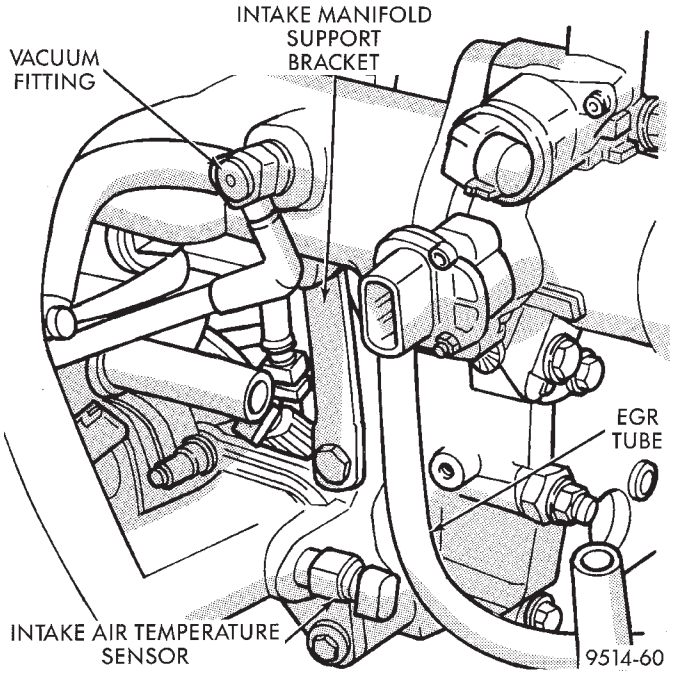


Fig. 32 Electrical and Vacuum Connections

(9) Remove connector from intake air temperature sensor (Fig. 32).

(10) Remove connector from MAP sensor (Fig. 33).

(11) Remove fuel hose quick connect fitting from the chassis tube (Fig. 34). **Refer to Fuel Hoses, Clamps and Quick Connect Fittings in this Section.** Place a shop towel under the connections to absorb any fuel spilled from the fitting.

REMOVAL AND INSTALLATION (Continued)

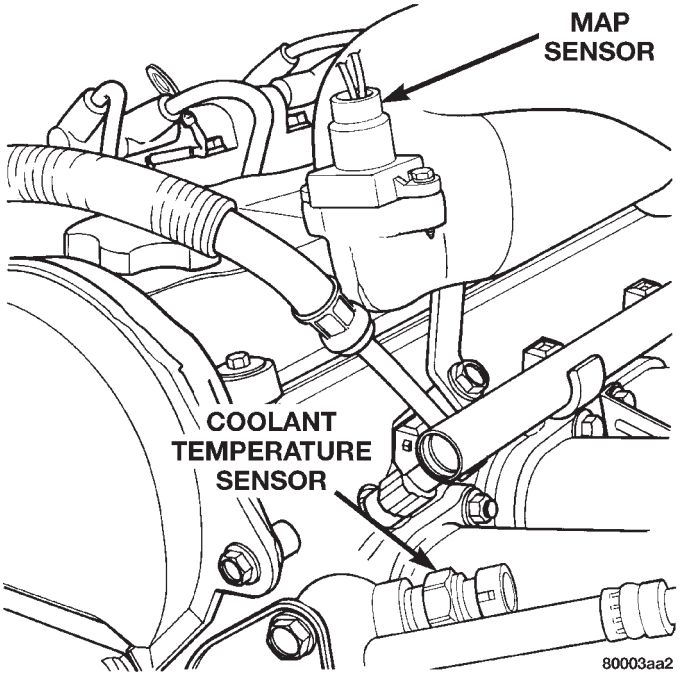


Fig. 33 Map Sensor—2.4L

WARNING: WRAP A SHOP TOWEL AROUND HOSES TO CATCH ANY GASOLINE SPILLAGE.

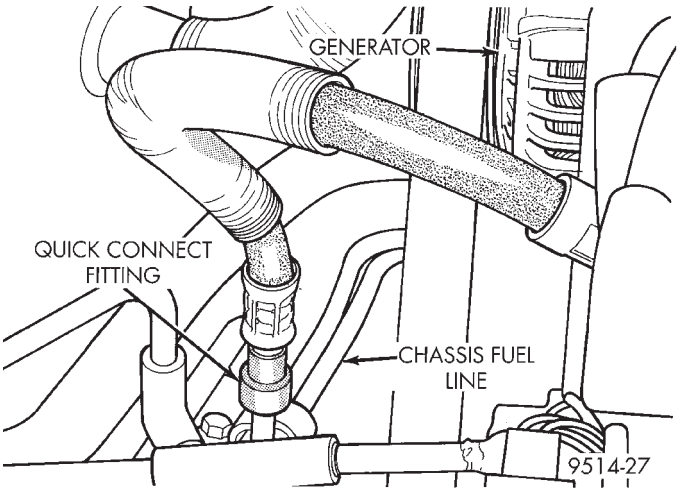


Fig. 34 Fuel Line Quick Disconnect

(12) Remove bolt holding bottom of intake support bracket.

(13) Remove intake manifold screws (Fig. 35).

(14) Remove fuel rail attaching bolts.

(15) Remove fuel rail. Be careful not to damage the injector O-rings upon removal from their ports.

INSTALLATION

(1) Ensure injector holes are clean. Replace O-rings if damaged.

(2) Lubricate injector O-rings with a drop of clean engine oil to ease installation.

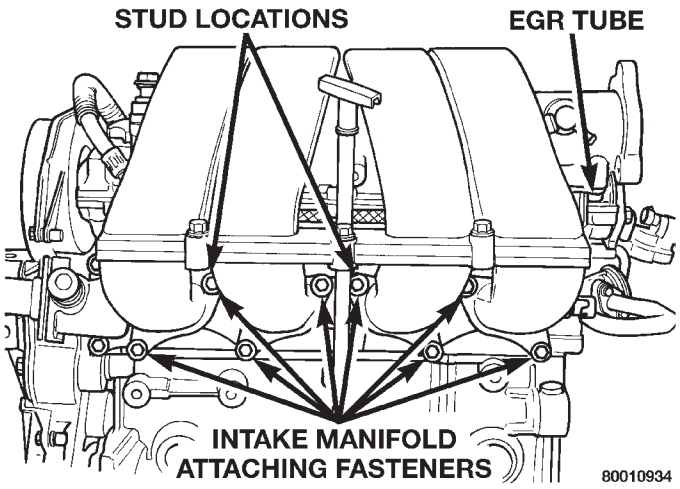


Fig. 35 Intake Manifold Attaching Points

(3) Put the tip of each injector into their ports. Push the assembly into place until the injectors are seated in the ports.

(4) Install the fuel rail mounting bolts. Tighten bolts to 22 N·m (200 in. lbs.) torque (Fig. 35).

(5) Install a new intake manifold gasket.

(6) Position intake manifold.

(7) Tighten retaining bolts starting at center and progressing outward in both directions to 23 N·m (200 in. lbs.) (Fig. 35). Repeat this procedure until all bolts are at specified torque.

(8) Install fuel hose quick connector fitting to chassis tubes. **Refer to Fuel Hoses, Clamps and Quick Connect Fittings in this Section.** Push the fitting onto the chassis tube until it clicks into place. Pull on the fitting to ensure complete insertion.

(9) Reverse removal procedures Step 2 thru Step 12 for installation.

CAUTION: When using the ASD Fuel System Test, the ASD relay and fuel pump relay remain energized for 7 minutes or until the test is stopped, or until the ignition switch is turned to the Off position.

(10) With the ignition key in ON position, access the DRB scan tool ASD Fuel System Test to pressurize the fuel system. Check for leaks.

FUEL INJECTOR RAIL—3.0L

WARNING: THE 3.0L MPI FUEL SYSTEM IS UNDER A CONSTANT PRESSURE OF APPROXIMATELY 330 KPA (48 PSI). PERFORM FUEL PRESSURE RELEASE PROCEDURE BEFORE SERVICING THE FUEL RAIL OR FUEL INJECTORS.

REMOVAL

(1) Perform the Fuel Pressure Release Procedure.

(2) Disconnect negative cable from battery.

REMOVAL AND INSTALLATION (Continued)

(3) Remove air inlet resonator (Fig. 36).

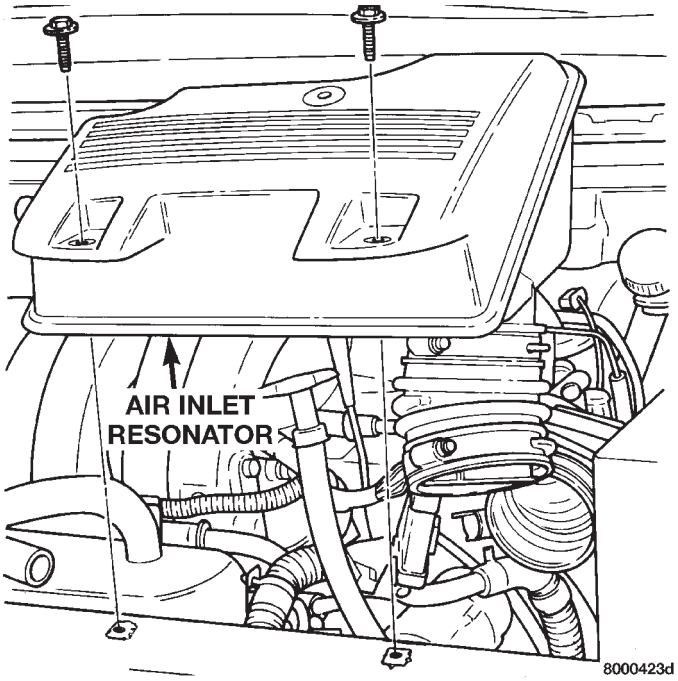


Fig. 36 Air Inlet Resonator

(4) Remove throttle cable (Fig. 37).

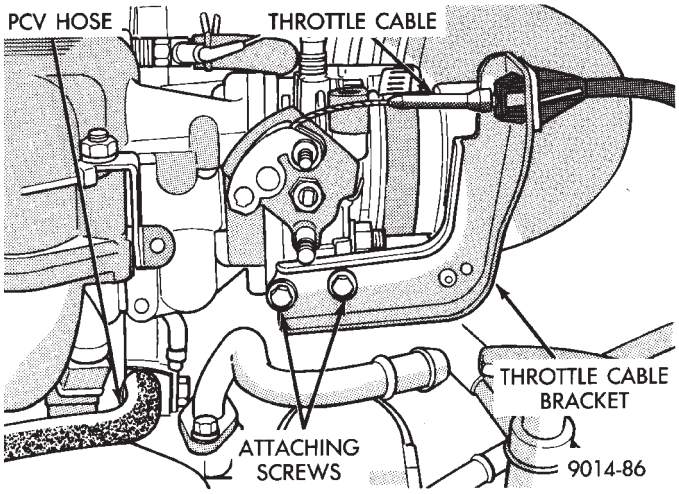


Fig. 37 Throttle Cable Attachment

(5) Disconnect electrical connectors from the idle air control motor and Throttle Position Sensor (TPS).

(6) Remove vacuum hose harness from throttle body (Fig. 38).

(7) Remove electrical connector from the coolant temperature sensor (Fig. 39).

(8) Remove vacuum connections from air intake plenum vacuum connector (Fig. 39).

(9) Remove the fuel hose quick connect fitting from the chassis tube (Fig. 40). **Refer to Fuel Hoses, Clamps and Quick Connect Fittings in this Section.** Place a shop towel under the connections to absorb any fuel spilled from the fitting.

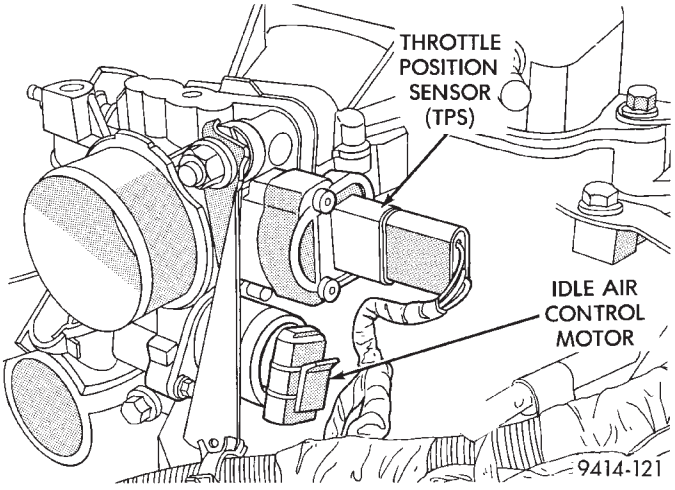


Fig. 38 Electrical and Vacuum Connection to Throttle Body

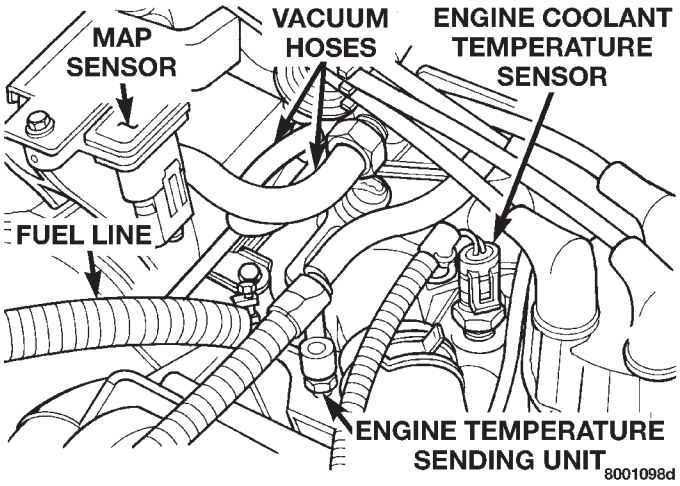


Fig. 39 Coolant Temperature Sensor Electrical Connections

WARNING: WRAP A SHOP TOWEL AROUND HOSES TO CATCH ANY GASOLINE SPILLAGE.

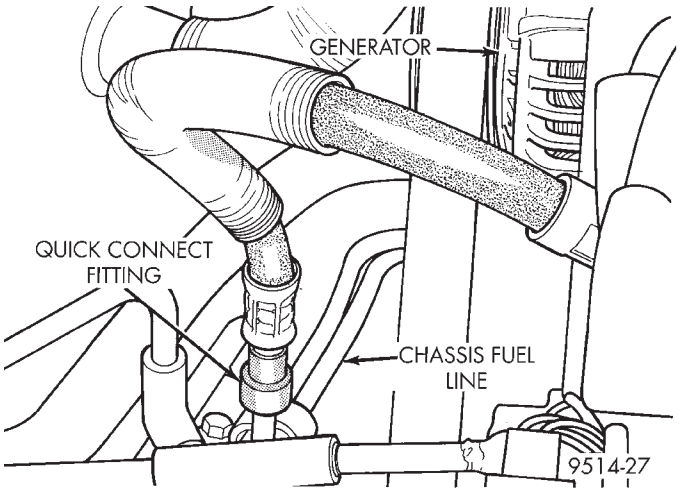


Fig. 40 Fuel Line Quick Disconnect

REMOVAL AND INSTALLATION (Continued)

(10) Remove air intake plenum to intake manifold mounting fasteners (Fig. 41).

(11) Remove ignition coil.

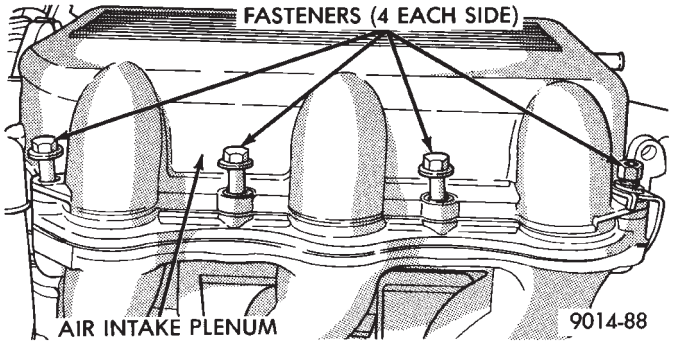


Fig. 41 Air Intake Plenum to Intake Manifold Attaching Fasteners

(12) Remove air intake plenum (Fig. 42).

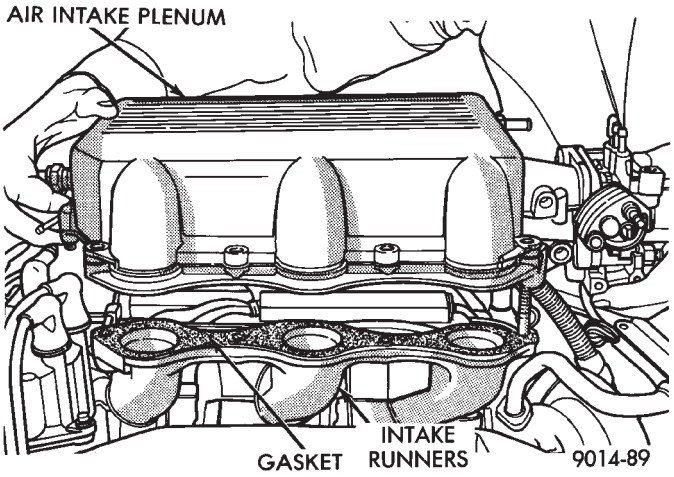


Fig. 42 Removing Air Intake Plenum

(13) Cover intake manifold while servicing injector fuel rail.

(14) Disconnect fuel injector wiring harness from engine wiring harness.

CAUTION: Do not damage the injector O-Rings when removing the injectors and fuel rail assembly.

(15) Remove fuel rail mounting bolts. Lift fuel rail assembly off of intake manifold.

INSTALLATION

(1) Ensure injectors are seated into the receiver cup of fuel rail with lock ring in place.

(2) Make sure the injector holes in the manifold are clean.

(3) To ease installation, lubricate injector O-ring with a drop of clean engine oil.

(4) Put the tip of each injector into their ports. Push the assembly into place until the injectors are seated in the ports.

(5) Install fuel rail attaching bolts. Tighten bolts to 13 N·m (115 in. lbs.) torque.

(6) Install fuel supply and return tube holddown bolt and the vacuum crossover tube holddown bolt. Tighten bolts to 10 N·m (95 in. lbs.) torque.

(7) Connect fuel injector wiring harness to engine wiring harness.

(8) Remove covering from lower intake manifold and clean surface.

(9) Place intake manifold gaskets **with beaded sealer** upon lower manifold. Put air intake in place. Install ignition coil. Install attaching fasteners and tighten to 13 N·m (115 in. lbs.) torque.

(10) Connect fuel line to fuel rail.

(11) Connect vacuum harness to air intake plenum.

(12) Connect coolant temperature sensor electrical connector to sensor.

(13) Connect PCV and brake booster supply hose to intake plenum.

(14) Connect idle air control motor and Throttle Position Sensor (TPS) electrical connectors.

(15) Connect vacuum vapor harness to throttle body.

(16) Install throttle cable.

(17) Install air inlet resonator.

(18) Connect negative cable to battery.

CAUTION: When using the ASD Fuel System Test, the ASD relay and fuel pump relay remain energized for 7 minutes or until the test is stopped, or until the ignition switch is turned to the Off position.

(19) With the ignition key in ON position, access the DRB scan tool ASD Fuel System Test to pressurize the fuel system. Check for leaks.

FUEL INJECTOR RAIL—3.3/3.8L

WARNING: THE 3.3/3.8L MPI FUEL SYSTEM IS UNDER A CONSTANT PRESSURE OF APPROXIMATELY 330 KPA (49 PSI), 3.3L USES APPROXIMATELY 379 KPA (55 PSI). PERFORM FUEL PRESSURE RELEASE PROCEDURE BEFORE SERVICING THE FUEL RAIL OR FUEL INJECTORS.

REMOVAL

(1) Perform fuel system pressure release procedure.

(2) Disconnect negative cable from battery.

(3) Remove intake manifold cover.

(4) Remove air inlet resonator (Fig. 36).

(5) Remove throttle cable and speed control cable (if equipped) (Fig. 43) from throttle lever and bracket.

REMOVAL AND INSTALLATION (Continued)

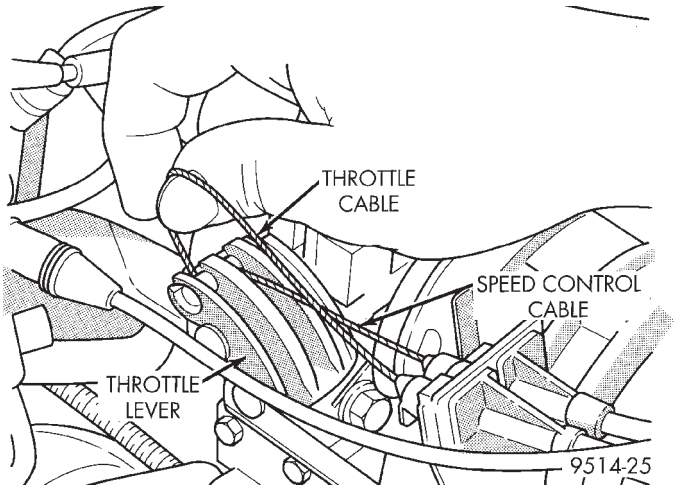


Fig. 43 Throttle Cable Attachment

(6) Disconnect idle air control motor and Throttle Position Sensor (TPS) electrical connectors (Fig. 44).

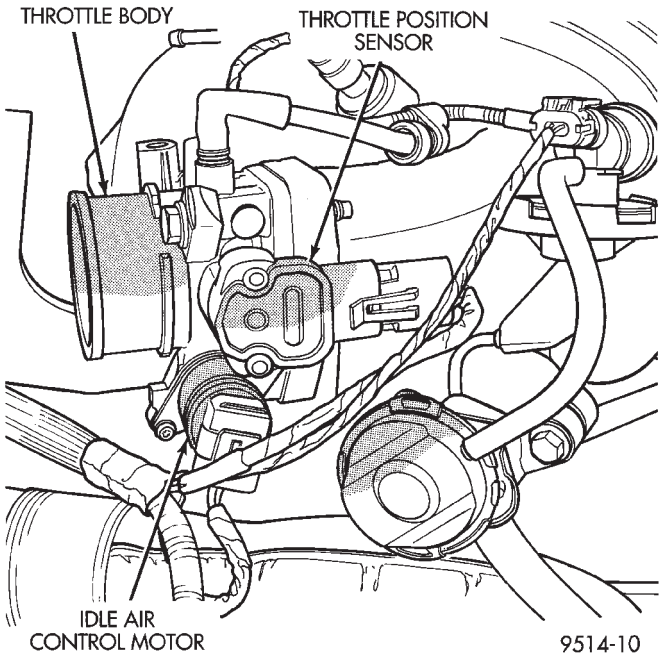


Fig. 44 Electrical and Vacuum Connection to Throttle Body

(7) Remove vacuum hose harness from throttle body and intake manifold (Fig. 45).

(8) Remove EGR tube to intake manifold flange bolts (Fig. 46).

(9) Remove cylinder head to intake plenum strut.

(10) Disconnect electrical connector from the MAP sensor (Fig. 47)

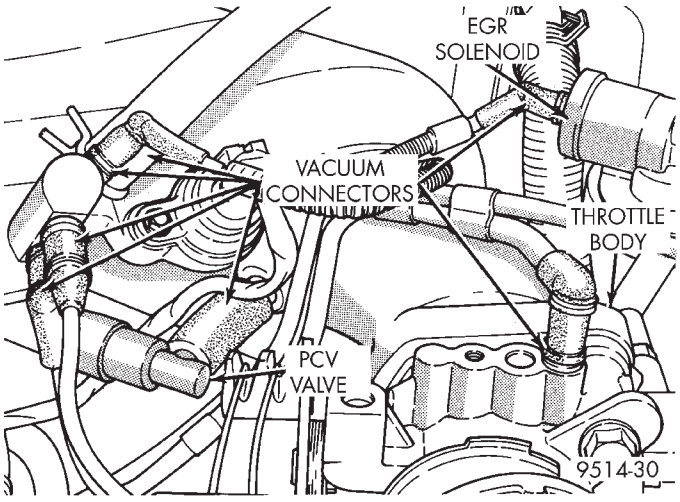


Fig. 45 Vacuum Connections

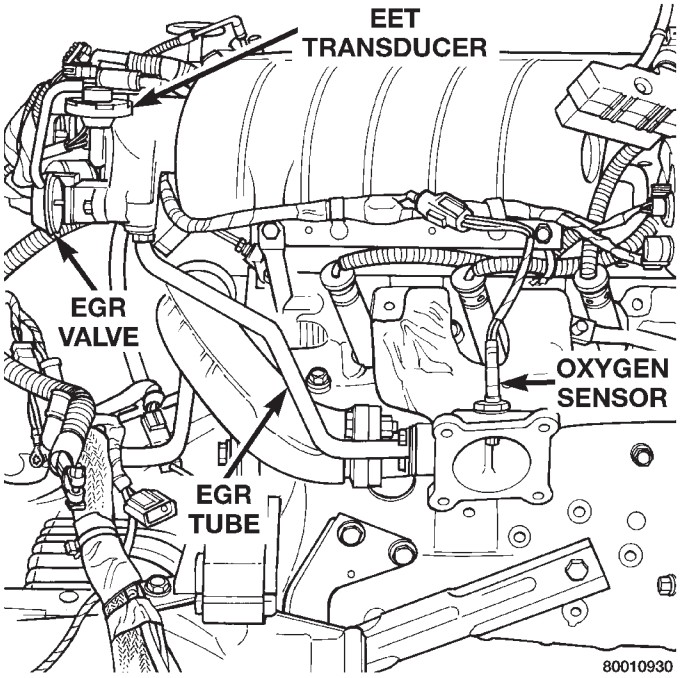


Fig. 46 EGR Tube—3.3L/3.8

(11) Remove engine mounted ground strap.

(12) Remove the fuel hose quick connect fitting from the chassis tube (Fig. 48). **Refer to Fuel Hoses, Clamps and Quick Connect Fittings in this Section.**

WARNING: WRAP A SHOP TOWEL AROUND HOSES TO CATCH ANY GASOLINE SPILLAGE.

REMOVAL AND INSTALLATION (Continued)

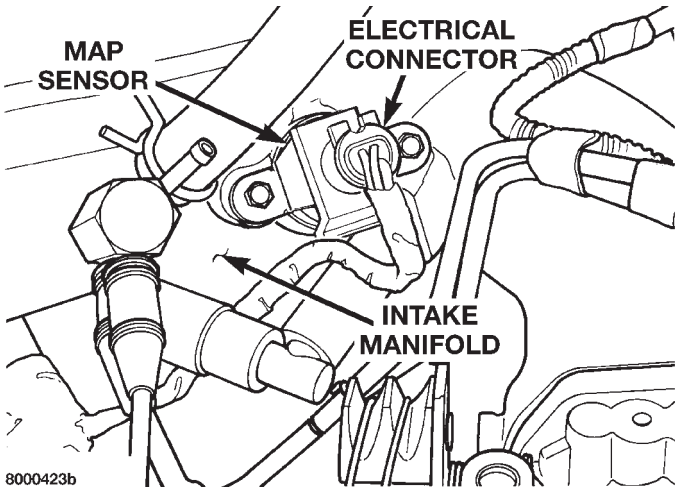


Fig. 47 Map Sensor

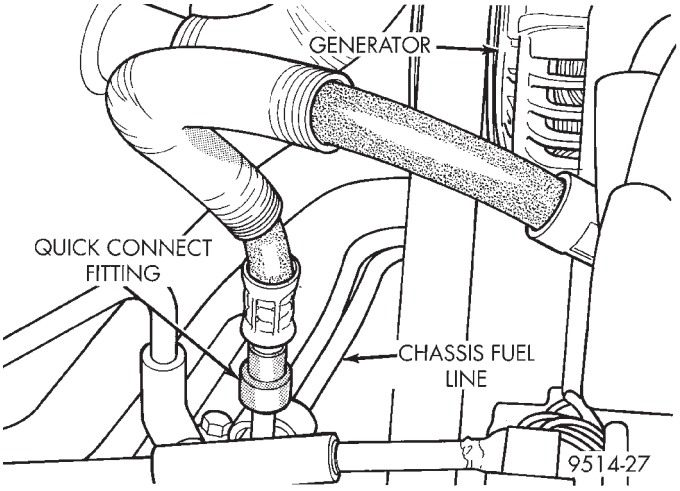


Fig. 48 Fuel Line Quick Disconnect

(13) Remove Direct Ignition System (DIS) coils (Fig. 49).

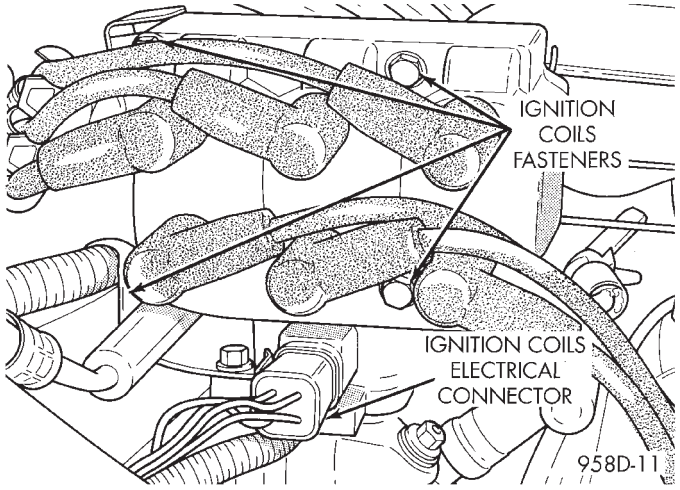


Fig. 49 Ignition Coils

(14) Remove generator bracket to intake manifold bolt.

(15) Remove intake mounting manifold bolts and rotate manifold back over rear valve cover (Fig. 50).

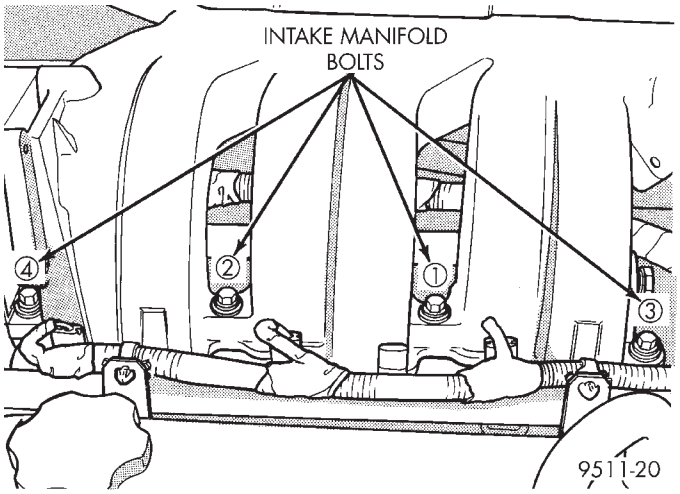


Fig. 50 Intake Manifold Bolts

(16) Cover intake manifold with suitable cover when servicing (Fig. 51).

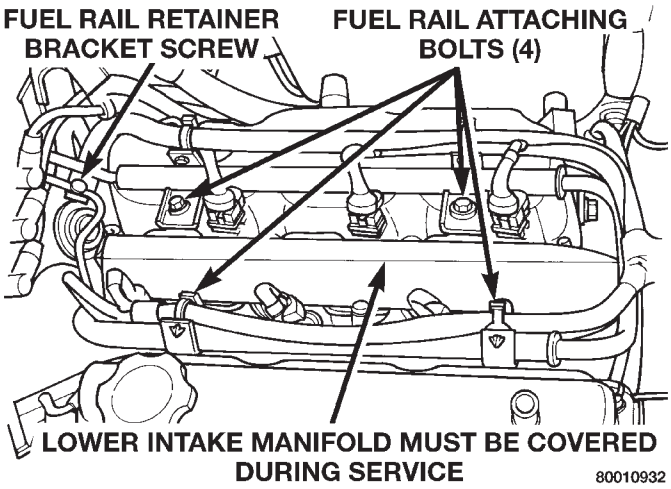


Fig. 51 Fuel Rail Attaching Bolts

(17) Remove fuel tube retainer bracket screw and fuel rail attaching bolts (Fig. 51). Spread the retainer bracket to allow fuel tube removal clearance.

(18) Disconnect camshaft position sensor (Fig. 52) and engine coolant temperature sensor.

(19) Remove fuel rail. Be careful not to damage the injector O-rings upon removal from their ports (Fig. 53).

INSTALLATION

(1) Ensure injector holes are clean. Replace O-rings if damaged.

(2) Lubricate injector O-rings with a drop of clean engine oil to ease installation.

(3) Put the tip of each injector into their ports. Push the assembly into place until the injectors are seated in the ports.

REMOVAL AND INSTALLATION (Continued)

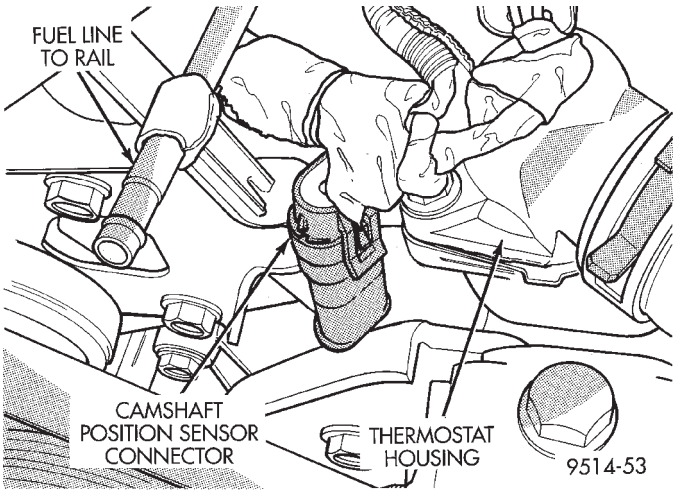


Fig. 52 Camshaft Position Sensor Connector

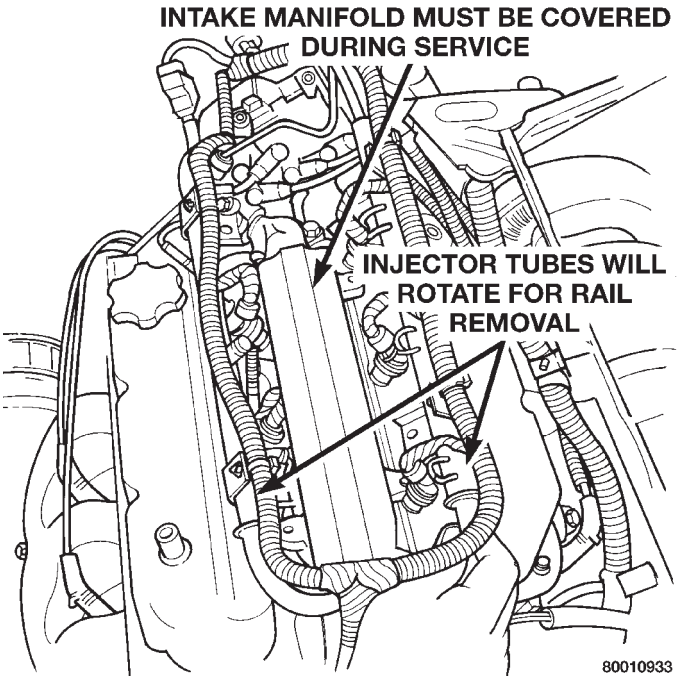


Fig. 53 Fuel Rail Removal

(4) Install the fuel rail mounting bolts. Tighten bolts to 22 N·m (200 in. lbs.) torque (Fig. 51).

(5) Install fuel tube retaining bracket screw. Tighten screw to 4 N·m (35 in. lbs.) torque.

(6) Connect electrical connectors to camshaft position sensor and engine coolant temperature sensor.

(7) Remove covering on lower intake manifold and clean surface.

(8) Place intake manifold gasket on lower manifold. Put upper manifold into place and install bolts finger tight.

(9) Install the generator bracket to intake manifold bolt and the cylinder head to intake manifold strut bolts (do not tighten.)

(10) Following the tightening sequence in (Fig. 50), tighten intake manifold bolts to 28 N·m (250 in. lbs.) torque.

(11) Tighten generator bracket to intake manifold bolt to 54 N·m (40 ft. lbs.) torque.

(12) Tighten the cylinder head to intake manifold strut bolts to 54 N·m (40 ft. lbs.) torque.

(13) Connect ground strap and MAP sensor electrical connector.

(14) Connect vacuum harness to intake plenum. Connect PCV system hoses.

(15) Using a new gasket, connect the EGR tube to the intake manifold plenum. Tighten screws to 22 N·m (200 in. lbs.) torque.

(16) Connect electrical connectors to the TPS and idle air control motor.

(17) Connect vacuum harness to throttle body.

(18) Install the direct ignition system (DIS) coils. Tighten fasteners to 12 N·m (105 in. lbs.) torque.

(19) Install fuel hose quick connector fitting to chassis tubes. **Refer to Fuel Hoses, Clamps and Quick Connect Fittings in this Section.** Push the fitting onto the chassis tube until it clicks into place. Pull on the fitting to ensure complete insertion.

(20) Install throttle cable and speed control cable (if equipped).

(21) Install air inlet resonator.

(22) Connect negative cable to battery.

CAUTION: When using the ASD Fuel System Test, the ASD relay and fuel pump relay remain energized for 7 minutes or until the test is stopped, or until the ignition switch is turned to the Off position.

(23) With the ignition key in ON position, access the DRB scan tool ASD Fuel System Test to pressurize the fuel system. Check for leaks.

FUEL INJECTOR—2.4L

The fuel rail must be removed first. Refer to Fuel Injector Rail Removal in this section.

REMOVAL

(1) Disconnect injector wiring connector from injector.

(2) Position fuel rail assembly so that the fuel injectors are easily accessible (Fig. 54).

(3) Rotate injector and pull injector out of fuel rail. The clip will stay on the injector.

(4) Check injector O-ring for damage. If O-ring is damaged, it must be replaced. If injector is reused, a protective cap must be installed on the injector tip to prevent damage. Replace the injector clip if it is damaged.

(5) Repeat for remaining injectors.

REMOVAL AND INSTALLATION (Continued)

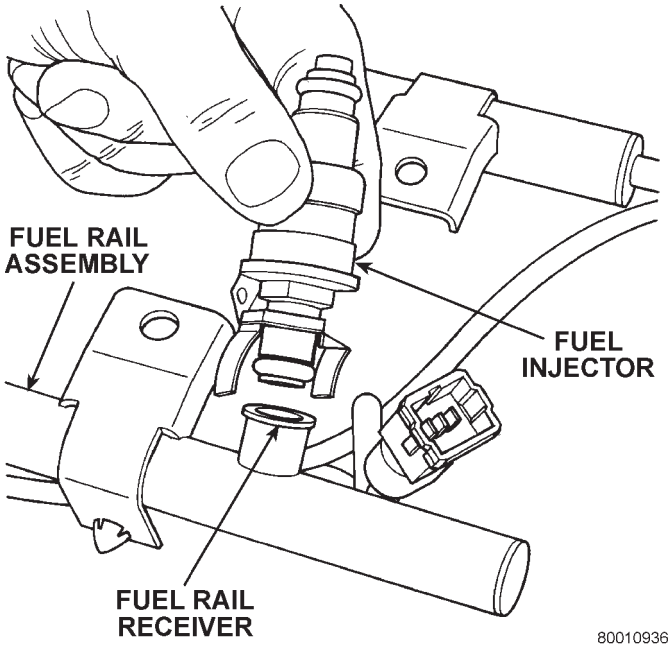


Fig. 54 Fuel Injector and Rail—Typical

INSTALLATION

(1) Before installing an injector the rubber O-ring must be lubricated with a drop of clean engine oil to aid in installation.

(2) Install injector clip by sliding open end into the top slot of the injector. The edge of the receiver cup will slide into the side slots of clip.

(3) Install injector top end into fuel rail receiver cap. Be careful not to damage O-ring during installation (Fig. 55).

(4) Repeat steps for remaining injectors.

(5) Connect fuel injector wiring.

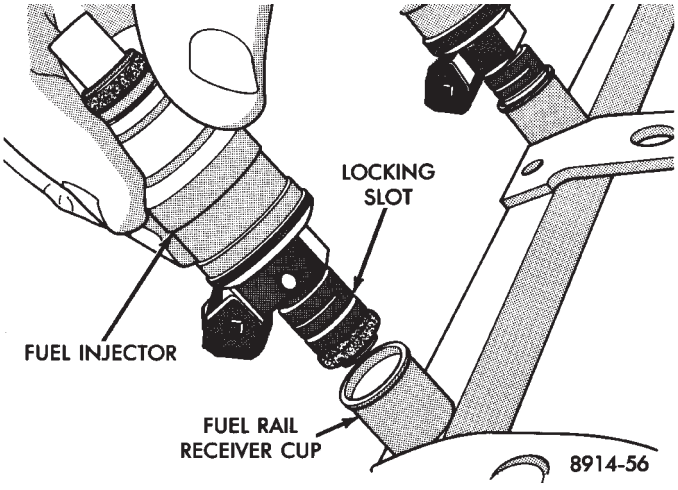


Fig. 55 Servicing Fuel Injector—Typical

FUEL INJECTORS—3.0L

WARNING: THE 3.0L MPI FUEL SYSTEM IS UNDER A CONSTANT PRESSURE OF APPROXIMATELY 330 KPA (48 PSI). PERFORM FUEL PRESSURE RELEASE PROCEDURE BEFORE SERVICING THE FUEL INJECTORS.

REMOVAL

(1) Perform the Fuel Pressure Release Procedure.

(2) Disconnect negative cable from battery.

(3) The fuel rail must be removed first to service the injectors. Refer to Fuel Injector Rail Assembly Removal in this section.

(4) Label each injector connector with its cylinder number. Disconnect electrical connector from injector.

(5) Position fuel rail assembly so that the fuel injectors are easily accessible.

(6) Remove injector clip from fuel rail and injector (Fig. 54).

(7) Pull injector straight out of fuel rail receiver cup (Fig. 55).

(8) Check injector O-ring for damage. If O-ring is damaged, it must be replaced. If injector is to be reused, a protective cap must be installed on the injector tip to prevent damage.

(9) Repeat procedure for remaining injectors.

INSTALLATION

(1) Before installing an injector, the rubber O-ring must be lubricated with a drop of clean engine oil to aid in installation.

(2) Being careful not to damage O-ring, install injector nozzle end into fuel rail receiver cap.

(3) Install injector clip by sliding open end into **top slot** of the injector. The edge of the receiver cup will slide into the side slots of clip (Fig. 55)

(4) Repeat steps for remaining injectors.

(5) Install fuel rail assembly. Refer to Fuel Rail Assembly Installation in this section.

(6) Connect electrical connectors to injectors in correct order.

(7) Connect negative battery cable.

CAUTION: When using the ASD Fuel System Test, the ASD relay and fuel pump relay remain energized for 7 minutes or until the test is stopped, or until the ignition switch is turned to the Off position.

(8) With the ignition key in ON position, access the DRB scan tool ASD Fuel System Test to pressurize the fuel system. Check for leaks.

REMOVAL AND INSTALLATION (Continued)

FUEL INJECTOR—3.3/3.8L

The fuel rail must be removed first. Refer to Fuel Injector Rail Assembly Removal in this section.

REMOVAL

(1) Disconnect injector wiring connector from injector.

(2) Position fuel rail assembly so that the fuel injectors are easily accessible (Fig. 54).

(3) Rotate injector and pull injector out of fuel rail. The clip will stay on the injector.

(4) Check injector O-ring for damage. If O-ring is damaged, it must be replaced. If injector is reused, a protective cap must be installed on the injector tip to prevent damage. Replace the injector clip if it is damaged.

(5) Repeat for remaining injectors.

INSTALLATION

(1) Before installing an injector the rubber O-ring must be lubricated with a drop of clean engine oil to aid in installation.

(2) Install injector clip by sliding open end into the top slot of the injector. The edge of the receiver cup will slide into the side slots of clip (Fig. 56).

(3) Install injector top end into fuel rail receiver cap. Be careful not to damage O-ring during installation (Fig. 56).

(4) Repeat steps for remaining injectors.

(5) Connect fuel injector wiring.

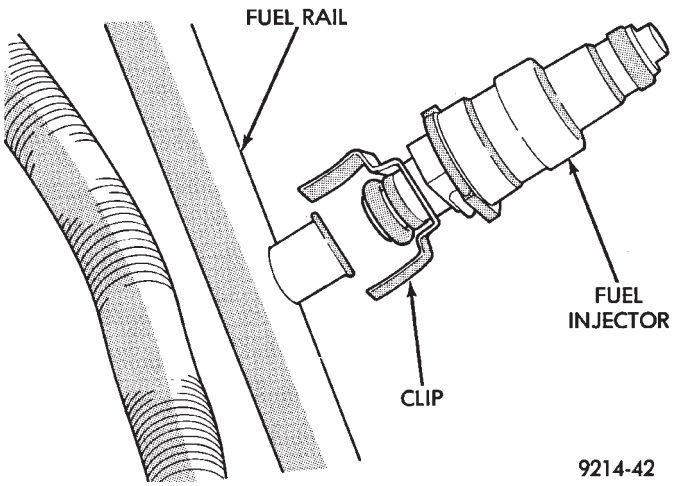


Fig. 56 Servicing Fuel Injector—Typical

ACCELERATOR PEDAL

CAUTION: When servicing the accelerator pedal, throttle cable or speed control cable, do not damage or kink the core wire inside the cable sheathing.

REMOVAL

(1) Working from the engine compartment, remove the throttle control shield.

(2) Hold the throttle body throttle lever in the wide open position. Remove the throttle cable from the throttle body cam.

(3) From inside the vehicle, hold up the pedal and remove the cable retainer and throttle cable from the upper end of the pedal shaft (Fig. 57) and (Fig. 58).

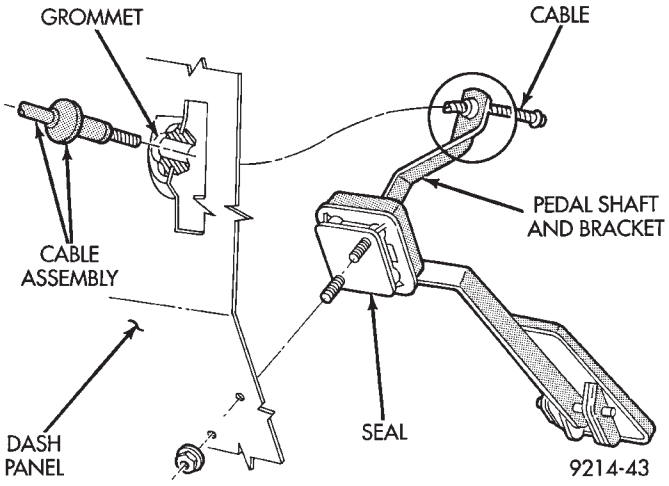


Fig. 57 Accelerator Pedal and Throttle Cable—Front View

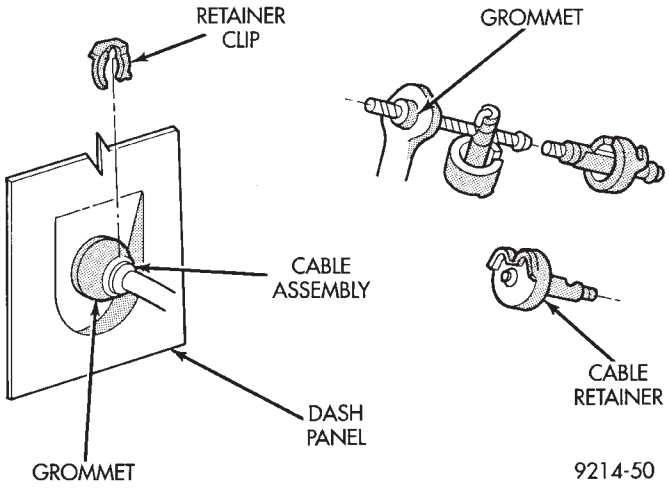


Fig. 58 Accelerator Pedal and Throttle Cable—Rear View

(4) Working from the engine compartment, remove nuts from accelerator pedal attaching studs (Fig. 57). Remove assembly from vehicle.

INSTALLATION

(1) Position accelerator pedal assembly on dash panel. Install retaining nuts. Tighten retaining nuts to 12 N·m (105 in. lbs.) torque.

REMOVAL AND INSTALLATION (Continued)

(2) From inside the vehicle, hold up the pedal and install the throttle cable and cable retainer in the upper end of the pedal shaft.

(3) From the engine compartment, hold the throttle body lever in the wide open position and install the throttle cable. Install the throttle control shield.

THROTTLE CABLE

CAUTION: When servicing the accelerator pedal, throttle cable or speed control cable, do not damage or kink the core wire inside the cable sheathing.

REMOVAL

(1) Working from the engine compartment, hold the throttle body throttle lever in the wide open position.

(2) Remove the throttle cable from the throttle body cam (Fig. 59), (Fig. 60) and (Fig. 61).

(3) From inside the vehicle, hold up the pedal and remove the cable retainer and throttle cable from the upper end of the pedal shaft (Fig. 57).

(4) Remove retainer clip from throttle cable and grommet at dash panel (Fig. 58).

(5) From the engine compartment, pull the throttle cable out of the dash panel grommet. The grommet should remain in the dash panel.

(6) Remove the throttle cable from throttle bracket by carefully compressing both retaining ears simultaneously. Then gently pull the throttle cable from throttle bracket.

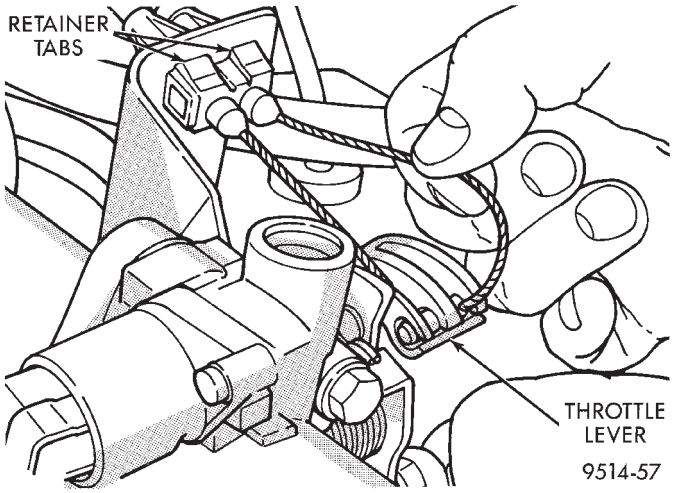


Fig. 59 Throttle Cable Attachment to Throttle Body Attachment—2.4L Engine

INSTALLATION

(1) From the engine compartment, push the housing end fitting into the dash panel grommet.

(2) Install the cable housing (throttle body end) into the cable mounting bracket on the engine.

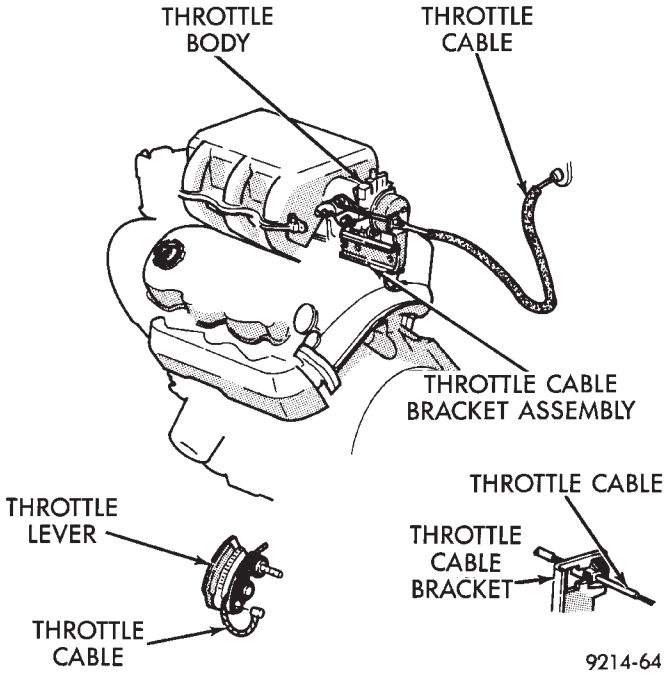


Fig. 60 Throttle Cable Attachment to Throttle Body Attachment—3.0L Engine

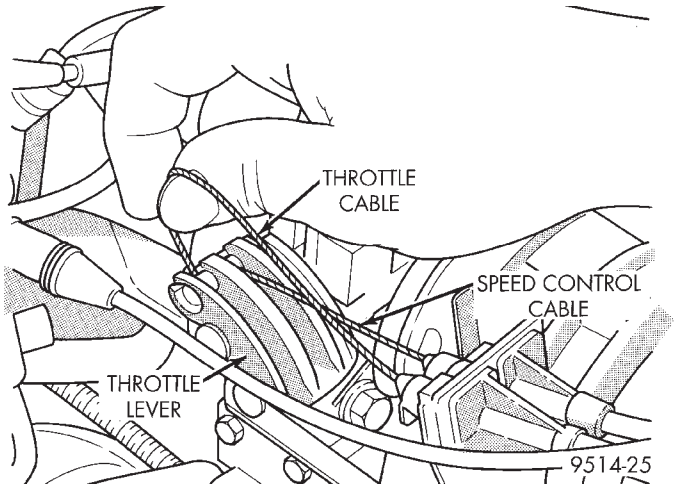


Fig. 61 Throttle Cable Attachment to Throttle Body Attachment—3.3/3.8L Engines

(3) From inside the vehicle, hold up the pedal and install throttle cable and cable retainer in the upper end of the pedal shaft.

(4) At the dash panel, install the cable retainer clip between the end of the throttle cable fitting and grommet (Fig. 58)

(5) From the engine compartment, rotate the throttle lever wide open and install the throttle cable.

SPECIFICATIONS

TORQUE

DESCRIPTION	TORQUE
Fuel Pump Module Locknut	.58 N·m (43 ft. lbs.)
Fuel Tank Strap Bolts	.54 N·m (40 ft. lbs.)
Fuel Rail Bolts—2.4L	.22 N·m (200 in. lbs.)
Fuel Rail Bolts—3.0L	.13 N·m (115 in. lbs.)
Fuel Rail Bolts—3.3/3.8L	.10 N·m (95 in. lbs.)
Fuel Tube Holddown Bolts—3.0L	.22 N·m (200 in. lbs.)
Fuel Tube Holddown Screw	.4 N·m (35 in. lbs.)
Intake Manifold Bolts—2.4L	.22 N·m (200 in. lbs.)
Intake Manifold Bolts—3.0L	.13 N·m (115 in. lbs.)
Intake Manifold Bolts—3.3/3.8L	.28 N·m (250 in. lbs.)
Accelerator Pedal to Dash Nuts	.12 N·m (105 in. lbs.)

FUEL TANK CAPACITY

Vehicle	Liters	U.S. Gallons
NS	75.O	20
Nominal refill capacities are shown. A variation may be observed from vehicle to vehicle due to manufacturing tolerance and refill procedure.		

FUEL INJECTION SYSTEM

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GENERAL INFORMATION

INTRODUCTION

All engines used in this section have a sequential Multi-Port Electronic Fuel Injection system. The MPI system is computer regulated and provides precise air/fuel ratios for all driving conditions. The Powertrain Control Module (PCM) operates the fuel injection system.

The PCM regulates:

- Ignition timing
- Air/fuel ratio
- Emission control devices
- Cooling fan
- Charging system
- Idle speed
- Vehicle speed control

Various sensors provide the inputs necessary for the PCM to correctly operate these systems. In addition to the sensors, various switches also provide inputs to the PCM.

All inputs to the PCM are converted into signals. The PCM can adapt its programming to meet changing operating conditions.

Fuel is injected into the intake port above the intake valve in precise metered amounts through electrically operated injectors. The PCM fires the injectors in a specific sequence. Under most operating conditions, the PCM maintains an air fuel ratio of 14.7 parts air to 1 part fuel by constantly adjusting injector pulse width. Injector pulse width is the length of time the injector is open.

The PCM adjusts injector pulse width by opening and closing the ground path to the injector. Engine RPM (speed) and manifold absolute pressure (air density) are the primary inputs that determine injector pulse width.

MODES OF OPERATION

As input signals to the PCM change, the PCM adjusts its response to output devices. For example, the PCM must calculate a 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.

There are two different areas of operation, OPEN LOOP and CLOSED LOOP.

During OPEN LOOP modes the PCM receives input signals and responds according to preset PCM programming. Input from the oxygen (O2S) sensor is not monitored during OPEN LOOP modes.

During CLOSED LOOP modes the PCM does monitor the O2S sensor input. This input indicates to the PCM whether or not the calculated injector pulse width results in the ideal air/fuel ratio of 14.7 parts air to 1 part fuel. By monitoring the exhaust oxygen content through the O2S sensor, the PCM can fine tune the injector pulse width. Fine tuning injector pulse width allows the PCM to achieve optimum fuel economy combined with low emissions.

The multi-port fuel injection system has the following modes of operation:

- Ignition switch ON (zero RPM)
- Engine start-up
- Engine warm-up
- Cruise (Idle)
- Acceleration
- Deceleration
- Wide Open Throttle
- Ignition switch OFF

The engine start-up (crank), engine warm-up, and wide open throttle modes are OPEN LOOP modes. Under most operating conditions, the acceleration, deceleration, and cruise modes, **with the engine at operating temperature** are CLOSED LOOP modes.

IGNITION SWITCH ON (ZERO RPM) MODE

When the multi-port fuel injection system is activated by the ignition switch, the following actions occur:

- The PCM determines atmospheric air pressure from the MAP sensor input to determine basic fuel strategy.
- The PCM monitors the coolant temperature sensor and throttle position sensor input. The PCM modifies fuel strategy based on this input.

When the key is in the ON position and the engine is not running (zero rpm), the Automatic Shutdown (ASD) relay and fuel pump relay are not energized. Therefore battery voltage is not supplied to the fuel pump, ignition coil, fuel injectors or oxygen sensor heating element.

ENGINE START-UP MODE

This is an OPEN LOOP mode. The following actions occur when the starter motor is engaged.

If the PCM receives the camshaft position sensor and crankshaft position sensor signals, it energizes the ASD relay and fuel pump relay. These relays supply battery voltage to the fuel pump, fuel injectors,

GENERAL INFORMATION (Continued)

ignition coil, and oxygen sensor heating element. If the PCM does not receive the camshaft position sensor and crankshaft position sensor signals within approximately one second, it de-energizes the ASD relay and fuel pump relay.

The PCM energizes all injectors until it determines crankshaft position from the camshaft position sensor and crankshaft position sensor signals. The PCM determines crankshaft position within 1 engine revolution.

After determining crankshaft position, the PCM begins energizing the injectors in sequence. The PCM adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

When the engine idles within ±64 RPM of its target RPM, the PCM compares current MAP sensor value with the atmospheric pressure value received during the Ignition Switch On (zero RPM) mode. If the PCM does not detect a minimum difference between the two values, it sets a MAP diagnostic trouble code into memory.

Once the ASD and fuel pump relays have been energized, the PCM:

- Determines injector pulse width based on engine coolant temperature, MAP and the number of engine revolutions since cranking was initiated.
- Monitors the engine coolant temperature sensor, camshaft position sensor, crankshaft position sensor, MAP sensor, and throttle position sensor to determine correct ignition timing.

ENGINE WARM-UP MODE

This is a OPEN LOOP mode. The following inputs are received by the PCM:

- Engine coolant temperature
- Manifold absolute pressure
- Engine speed (crankshaft position sensor)
- Throttle position
- A/C switch
- Battery voltage

The PCM adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

The PCM adjusts ignition timing and engine idle speed. Engine idle speed is adjusted through the idle air control motor.

CRUISE OR IDLE MODE

This is a CLOSED LOOP mode. The 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 fuel demand.

When the engine is at operating temperature this is a CLOSED LOOP mode. During cruising speed the following inputs are received by the PCM:

- Engine coolant temperature
- Manifold absolute pressure
- Engine speed (crankshaft position sensor)
- Throttle position
- Exhaust gas oxygen content
- A/C control positions
- Battery voltage

The PCM adjusts injector pulse width and controls injector synchronization by turning the individual ground paths to the injectors On and Off.

The PCM adjusts engine idle speed and ignition timing. The PCM adjusts the air/fuel ratio according to the oxygen content in the exhaust gas.

ACCELERATION MODE

This is a CLOSED LOOP mode. The 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 fuel demand.

DECELERATION MODE

This is a CLOSED LOOP mode. During deceleration the following inputs are received by the PCM:

- Engine coolant temperature
- Manifold absolute pressure
- Engine speed
- Throttle position
- Exhaust gas oxygen content
- A/C control positions
- Battery voltage

The PCM may receive a closed throttle input from the Throttle Position Sensor (TPS) when it senses an abrupt decrease in manifold pressure. This indicates a hard deceleration. The PCM may reduce injector pulse width or the number of injectors firing per engine revolution. This helps maintain better control of the air/fuel mixture (as sensed through the O2S sensor).

WIDE OPEN THROTTLE (WOT) MODE

This is an OPEN LOOP mode. During WOT operation, the following inputs are received by the PCM:

- Engine coolant temperature
- Manifold absolute pressure
- Engine speed
- Throttle position

When the PCM senses WOT condition through the Throttle Position Sensor (TPS) it will:

- De-energize the air conditioning relay. This disables the air conditioning system.

The exhaust gas oxygen content input is not accepted by the PCM during WOT operation. The PCM will adjust injector pulse width to supply a predetermined amount of additional fuel.

GENERAL INFORMATION (Continued)

IGNITION SWITCH OFF MODE

When the ignition switch is turned to the OFF position, the following occurs:

- All outputs are turned off.
- No inputs are monitored.
- The PCM shuts down.

DESCRIPTION AND OPERATION

SYSTEM DIAGNOSIS

The PCM can test many of its own input and output circuits. If the PCM senses a fault in a major system, the PCM stores a Diagnostic Trouble Code (DTC) in memory.

For DTC information, refer to Group 25, Emission Control Systems. See On-Board Diagnostics.

CCD BUS

Various controllers and modules exchange information through a communications port called the CCD Bus. The PCM transmits the malfunction indicator (check engine) lamp On/Off signal, engine RPM and vehicle load information on the CCD Bus.

POWERTRAIN CONTROL MODULE (PCM)

The PCM is a digital computer containing a microprocessor (Fig. 1). The PCM receives input signals from various switches and sensors that are referred to as PCM Inputs. Based on these inputs, the PCM adjusts various engine and vehicle operations through devices that are referred to as PCM Outputs.

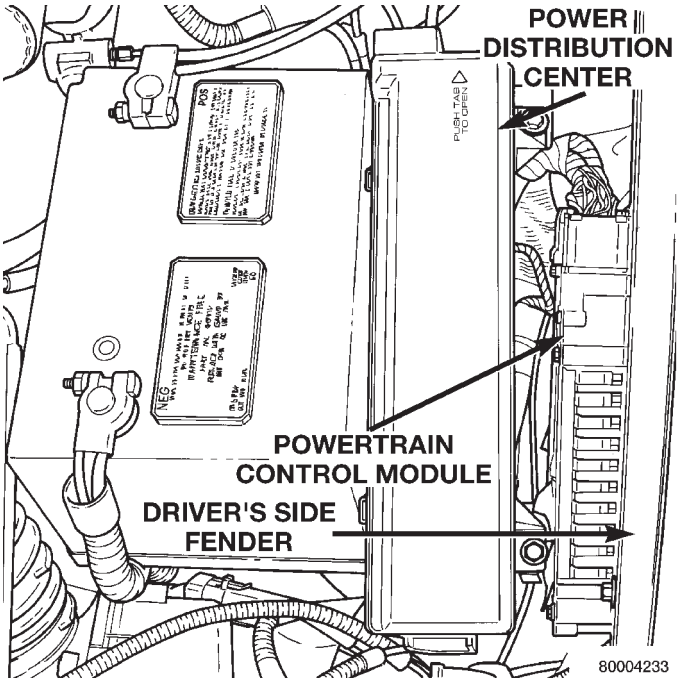


Fig. 1 Powertrain Control Module (PCM)

PCM Inputs:

- Air Conditioning Head Pressure
- Battery Voltage
- Brake Switch
- Camshaft Position Sensor
- Crankshaft Position Sensor
- Engine Coolant Temperature Sensor
- Heated Oxygen Sensors (Upstream and Downstream)
- Intake Air Temperature Sensor (2.4L only)
- Knock Sensor (execpt 3.0L)
- Manifold Absolute Pressure (MAP) Sensor
- SCI Receive
- Speed Control System Controls
- Throttle Position Sensor
- Transaxle Park/Neutral Position Switch (automatic transaxle)
- Transmission Control Module
- Vehicle Speed Sensor

PCM Outputs:

- Air Conditioning Clutch Relay
- Automatic Shutdown (ASD) Relay
- Data Link Connector
- Proportional Purge Solenoid
- Electric EGR Transducer
- Fuel Injectors
- Fuel Pump Relay
- Generator Field
- Idle Air Control Motor
- Ignition Coil
- Leak Detection Pump
- Malfunction Indicator (Check Engine) Lamp
- Radiator Fan Control Module
- Speed Control Solenoids
- Tachometer Output
- Torque Converter Clutch Solenoid (3 speed transmission)
- Transmission Control Module

Based on inputs it receives, the PCM adjusts fuel injector pulse width, idle speed, ignition spark advance, ignition coil dwell and canister purge operation. The PCM regulates the cooling fan, air conditioning and speed control systems. The PCM changes generator charge rate by adjusting the generator field.

The PCM adjusts injector pulse width (air/fuel ratio) based on the following inputs:

- Battery voltage
- Engine coolant temperature
- Exhaust gas content (oxygen sensors)
- Engine speed (crankshaft position sensor)
- Manifold absolute pressure
- Throttle position

The PCM adjusts ignition timing based on the following inputs.

- Barometric pressure

DESCRIPTION AND OPERATION (Continued)

- Engine coolant temperature
- Engine speed (crankshaft position sensor)
- Intake air temperature (2.4L only)
- Manifold absolute pressure
- Throttle position
- Transaxle gear selection (park/neutral switch)

The PCM also adjusts engine idle speed through the idle air control motor based on the following inputs.

- Air conditioning select switch head pressure
- Brake switch
- Engine coolant temperature
- Engine speed (crankshaft position sensor)
- Manifold absolute pressure
- Throttle position
- Transaxle gear selection (park/neutral switch)
- Vehicle distance (speed)

The Automatic Shutdown (ASD) and fuel pump relays are located in the Power Distribution Center (PDC).

The camshaft position sensor (distributor pick-up signal 3.0L) and crankshaft position sensor signals are sent to the PCM. If the PCM does not receive both signals within approximately one second of engine cranking, it deactivates the ASD relay and fuel pump relay. When these relays are deactivated, power is shut off to the fuel injectors, ignition coil, oxygen sensor heating element and fuel pump.

The PCM contains a voltage converter that changes battery voltage to a regulated 8.0 volts to power the camshaft position sensor, crankshaft position sensor and vehicle speed sensor. The PCM also provides a 5.0 volt supply for the manifold absolute pressure sensor, throttle position sensor and engine coolant temperature sensor.

AIR CONDITIONING PRESSURE TRANSDUCER—PCM INPUT

The Powertrain Control Module (PCM) monitors the A/C compressor discharge (high side) pressure through the air conditioning pressure transducer. The transducer supplies an input to the PCM. The PCM engages the A/C compressor clutch if pressure is sufficient for A/C system operation.

AIR CONDITIONING SWITCH SENSE—PCM INPUT

When the air conditioning or defrost switch is put in the ON position and the low pressure switch, combination valve, and high pressure switch close, the PCM receives an A/C input. After receiving this input, the PCM activates the A/C compressor clutch by grounding the A/C clutch relay. The PCM also adjusts idle speed to a scheduled RPM to compensate for increased engine load.

AUTOMATIC SHUTDOWN (ASD) SENSE—PCM INPUT

The ASD sense circuit informs the PCM when the ASD relay energizes. A 12 volt signal at this input indicates to the PCM that the ASD has been activated. This input is used only to sense that the ASD relay is energized.

When energized, the ASD relay supplies battery voltage to the fuel injectors, ignition coils and the heating element in each oxygen sensor. If the PCM does not receive 12 volts from this input after grounding the ASD relay, it sets a Diagnostic Trouble Code (DTC).

BATTERY VOLTAGE—PCM INPUT

The PCM monitors the battery voltage input to determine fuel injector pulse width and generator field control.

If battery voltage is low the PCM will increase injector pulse width (period of time that the injector is energized).

BRAKE SWITCH—PCM INPUT

When the brake switch is activated, the 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 motor. The brake switch is mounted on the brake pedal support bracket.

CAMSHAFT POSITION SENSOR—PCM INPUT

The PCM determines fuel injection synchronization and cylinder identification from inputs provided by the camshaft position sensor and crankshaft position sensor. From the two inputs, the PCM determines crankshaft position.

3.3/3.8L

The sensor generates pulses as groups of notches on the camshaft sprocket pass underneath it (Fig. 2). The PCM keeps track of crankshaft rotation and identifies each cylinder by the pulses generated by the notches on the camshaft sprocket. Four crankshaft pulses follow each group of camshaft pulses.

When the PCM receives two camshaft pulses followed by the long flat spot on the camshaft sprocket, it knows that the crankshaft timing marks for cylinder one are next (on driveplate). When the PCM receives one camshaft pulse after the long flat spot on the sprocket, cylinder number two crankshaft timing marks are next. After 3 camshaft pulses, the PCM knows cylinder four crankshaft timing marks follow. One camshaft pulse after the three pulses indicates cylinder five. The two camshaft pulses after cylinder 5 signals cylinder six (Fig. 3). The PCM can synchronize on cylinders 1 or 4.

DESCRIPTION AND OPERATION (Continued)

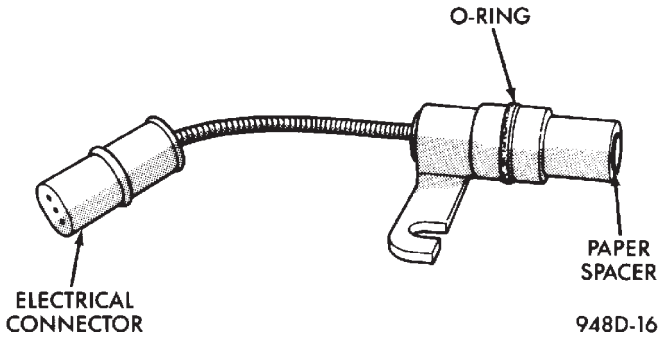


Fig. 2 Camshaft Position Sensor

When metal aligns with the sensor, voltage goes low (less than 0.5 volts). When a notch aligns with the sensor, voltage spikes high (5.0 volts). As a group of notches pass under the sensor, the voltage switches from low (metal) to high (notch) then back to low. The number of notches determine the amount of pulses. If available, an oscilloscope can display the square wave patterns of each timing events.

Top dead center (TDC) does not occur when notches on the camshaft sprocket pass below the cylinder. TDC occurs after the camshaft pulse (or pulses) and after the 4 crankshaft pulses associated with the particular cylinder. The arrows and cylinder call outs on Figure 4 represent which cylinder the flat spot and notches identify, they do not indicate TDC position.

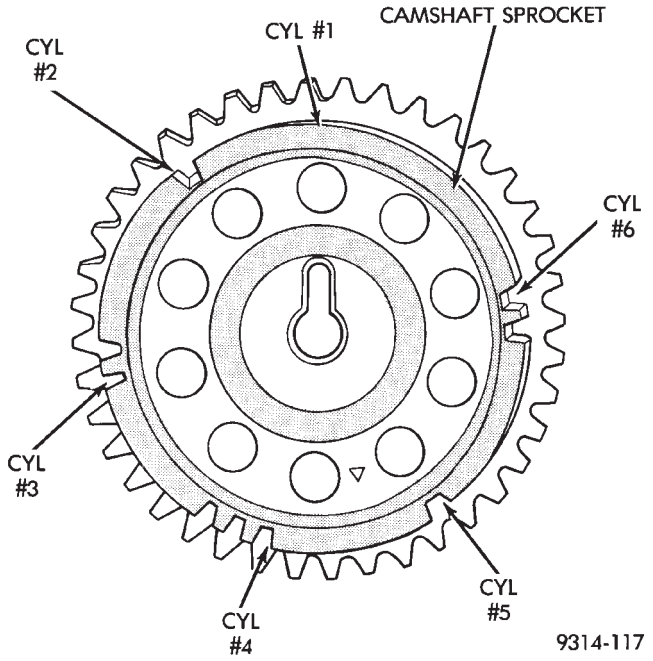


Fig. 3 Camshaft Sprocket

The camshaft position sensor is mounted to the top of the timing case cover (Fig. 4). The bottom of the sensor is positioned above the camshaft sprocket. **The distance between the bottom of sensor and the camshaft sprocket is critical to the operation of the system. When servicing the camshaft position sensor, refer to the 3.3L and 3.8L Multi-Port Fuel Injection—Service Procedures section in this Group.**

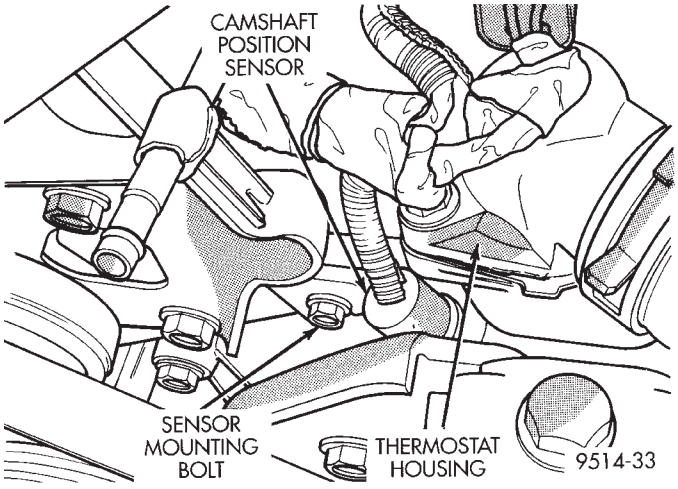


Fig. 4 Camshaft Position Sensor Location

2.4L

The camshaft position sensor attaches to the rear of the cylinder head (Fig. 5). A target magnet attaches to the rear of the camshaft and indexes to the correct position (Fig. 6). The target magnet has four different poles arranged in an asymmetrical pattern. As the target magnet rotates, the camshaft position sensor senses the change in polarity (Fig. 7). The sensor output switch switches from high (5.0 volts) to low (0.30 volts) as the target magnet rotates. When the north pole of the target magnet passes under the sensor, the output switches high. The sensor output switches low when the south pole of the target magnet passes underneath.

DESCRIPTION AND OPERATION (Continued)

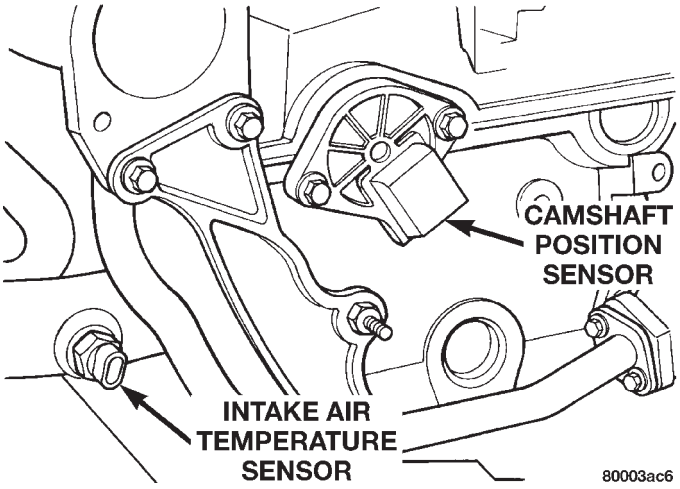


Fig. 5 Camshaft Position Sensor

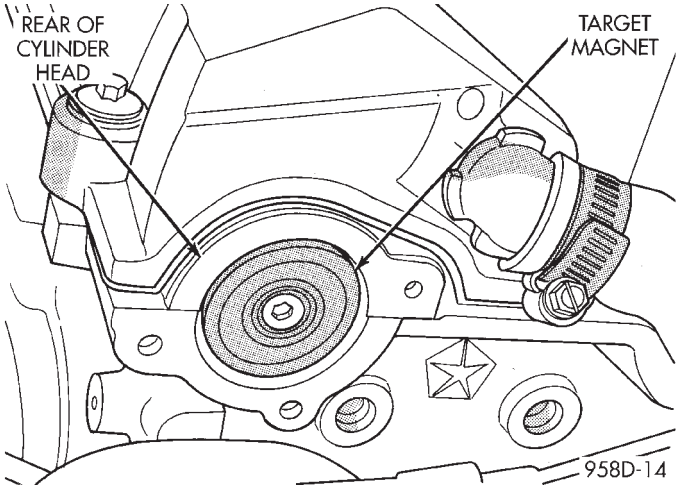


Fig. 6 Target Magnet

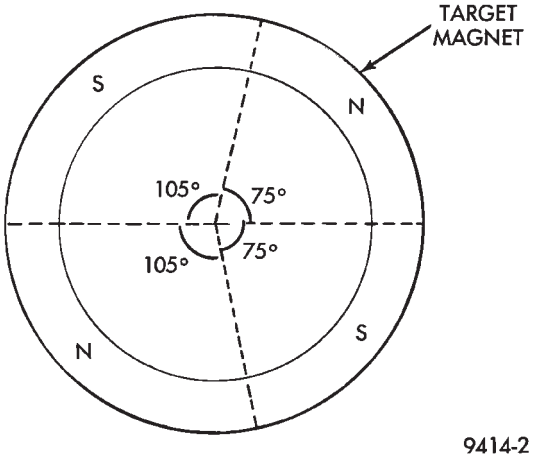


Fig. 7 Target Magnet Polarity

CRANKSHAFT POSITION SENSOR—PCM INPUT

3.0/3.3/3.8L

The crankshaft position sensor (Fig. 8) senses slots cut into the transaxle driveplate extension. There are 3 sets of slots. Each set contains 4 slots, for a total of 12 slots (Fig. 9). Basic timing is set by the position of the last slot in each group. Once the PCM senses the last slot, it determines crankshaft position (which piston will next be at TDC) from the camshaft position sensor input. It may take the PCM one engine revolution to determine crankshaft position.

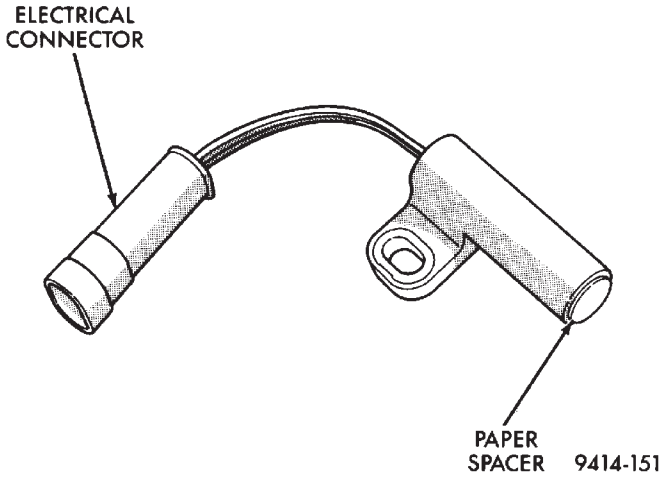


Fig. 8 Crankshaft Position Sensor

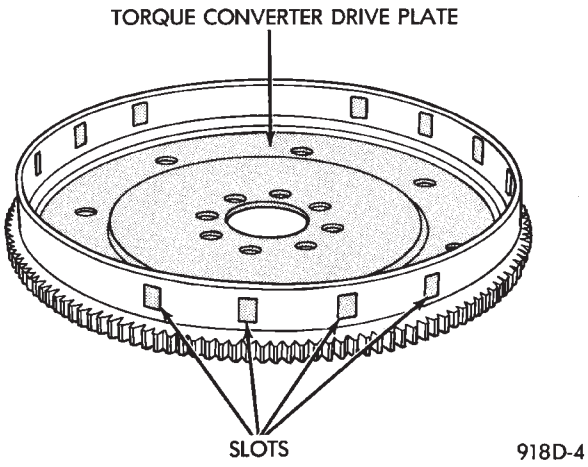


Fig. 9 Timing Slots

The PCM uses the crankshaft position sensor signal to determine injector sequence, ignition timing and presence of misfire. Once crankshaft position has been determined, the PCM begins energizing the injectors in sequence.

DESCRIPTION AND OPERATION (Continued)

The crankshaft position sensor is located in the transaxle housing, above the vehicle speed sensor (Fig. 10). The bottom of the sensor is positioned next to the drive plate. **The distance between the bottom of sensor and the drive plate is critical to the operation of the system. When servicing the crankshaft position sensor, refer to the appropriate Multi-Port Fuel Injection Service Procedures section in this Group.**

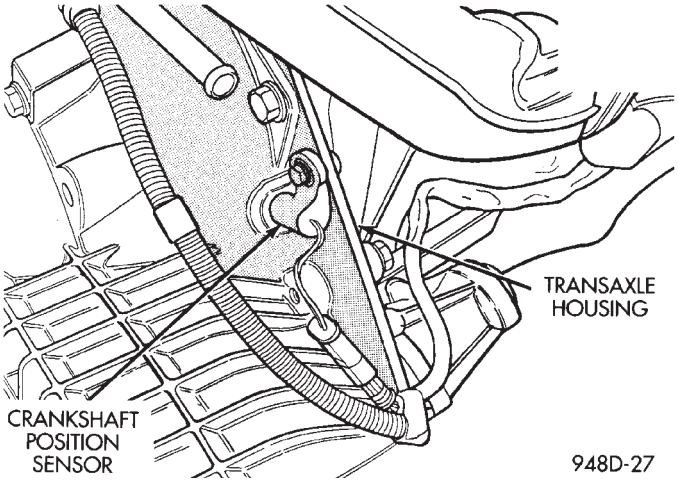


Fig. 10 Crankshaft Position Sensor Location—3.0/3.3/3.8L

2.4L

The second crankshaft counterweight has machined into it two sets of four timing reference notches and a 60 degree signature notch (Fig. 11). From the crankshaft position sensor input the PCM determines engine speed and crankshaft angle (position).

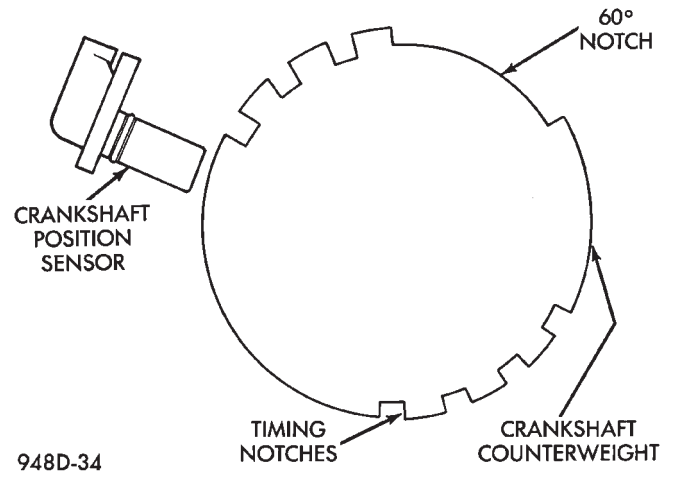


Fig. 11 Timing Reference Notches

The notches generate pulses from high to low in the crankshaft position sensor output voltage. When a metal portion of the counterweight aligns with the crankshaft position sensor, the sensor output voltage goes low (less than 0.3 volts). When a notch aligns with the sensor, voltage spikes high (5.0 volts). As a group of notches pass under the sensor, the output voltage switches from low (metal) to high (notch) then back to low.

If available, an oscilloscope can display the square wave patterns of each voltage pulse. From the width of the output voltage pulses, the PCM calculates engine speed. The width of the pulses represent the amount of time the output voltage stays high before switching back to low. The period of time the sensor output voltage stays high before switching back to low is referred to as pulse width. The faster the engine is operating, the smaller the pulse width on the oscilloscope.

By counting the pulses and referencing the pulse from the 60 degree signature notch, the PCM calculates crankshaft angle (position). In each group of timing reference notches, the first notch represents 69 degrees before top dead center (BTDC). The second notch represents 49 degrees BTDC. The third notch represents 29 degrees. The last notch in each set represents 9 degrees before top dead center (TDC).

The timing reference notches are machined to a uniform width representing 13.6 degrees of crankshaft rotation. From the voltage pulse width the PCM tells the difference between the timing reference notches and the 60 degree signature notch. The 60 degree signature notch produces a longer pulse width than the smaller timing reference notches. If the camshaft position sensor input switches from high to low when the 60 degree signature notch passes under the crankshaft position sensor, the PCM knows cylinder number one is the next cylinder at TDC.

The crankshaft position sensor mounts to the engine block behind the generator, just above the oil filter (Fig. 12).

ENGINE COOLANT TEMPERATURE SENSOR—PCM INPUT

The engine coolant temperature sensor is a variable resistor with a range of -40°C to 129°C (-40°F to 265°F).

The engine coolant temperature sensor provides an input voltage to the PCM. As coolant temperature varies, the sensor resistance changes resulting in a different input voltage to the PCM.

When the engine is cold, the PCM will demand slightly richer air/fuel mixtures and higher idle speeds until normal operating temperatures are reached.

The engine coolant sensor is also used for cooling fan control.

DESCRIPTION AND OPERATION (Continued)

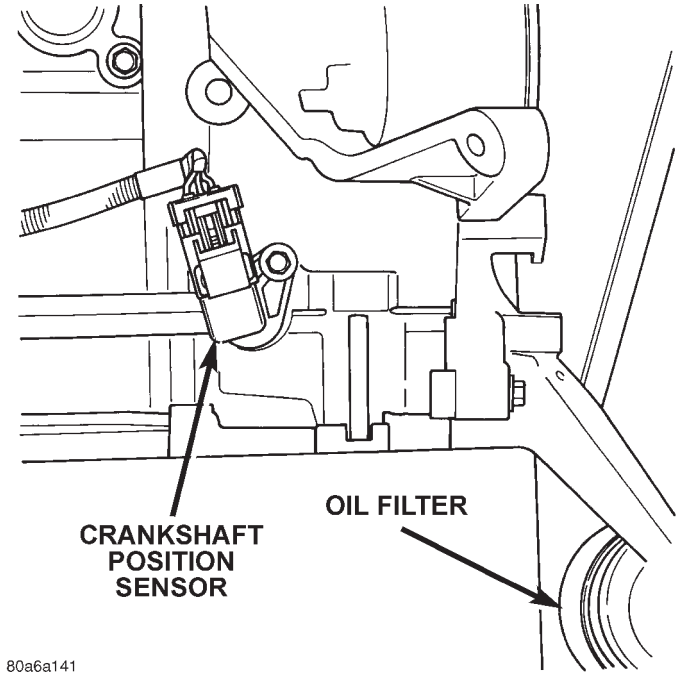


Fig. 12 Crankshaft Position Sensor—2.4L

3.0/3.3/3.8L

The sensor is installed next to the thermostat housing (Fig. 13) and (Fig. 14).

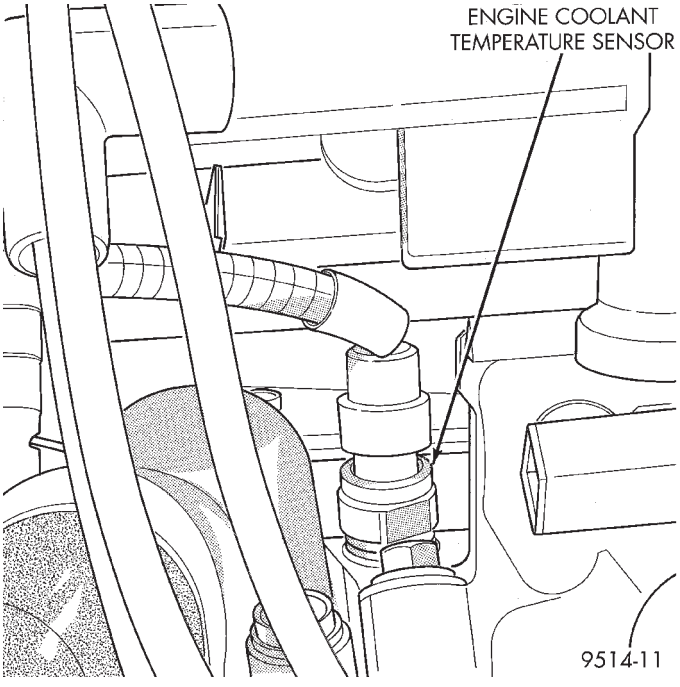


Fig. 13 Engine Coolant Temperature Sensor—3.3/3.8L

2.4L

The coolant sensor threads into the top of the thermostat housing (Fig. 15). New sensors have sealant applied to the threads.

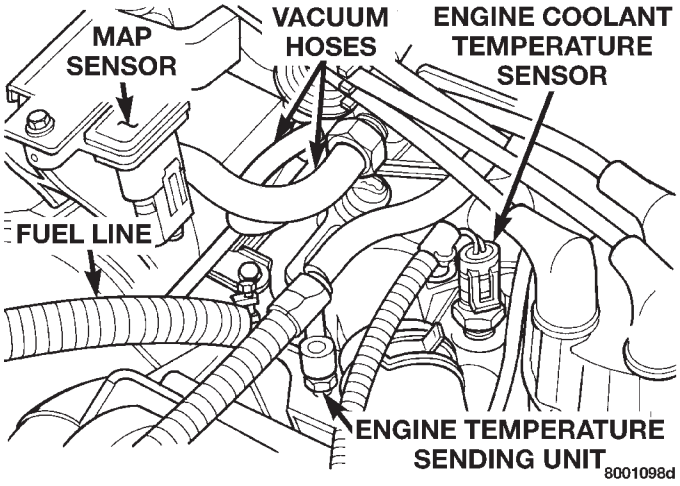


Fig. 14 Engine Coolant Temperature Sensor—3.0L

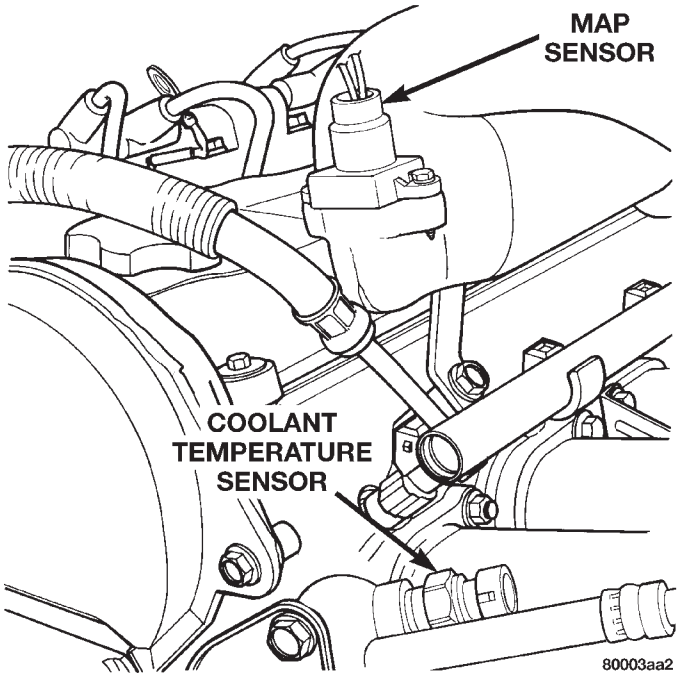


Fig. 15 Engine Coolant Temperature Sensor—2.4L

HEATED OXYGEN SENSOR (O2S SENSOR)—PCM INPUT

The O2S produce voltages from 0 to 1 volt, depending 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 sensors 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 sensors act as a rich- lean switch.

The oxygen sensors are equipped with a heating element that keeps the sensors at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the

DESCRIPTION AND OPERATION (Continued)

system to enter into closed loop operation sooner. Also, it allows the system to remain in closed loop operation during periods of extended idle.

In Closed Loop operation the PCM monitors the O2S input (along with other inputs) and adjusts the injector pulse width accordingly. During Open Loop operation the PCM ignores the O2 sensor input. The PCM adjusts injector pulse width based on preprogrammed (fixed) values and inputs from other sensors.

The Automatic Shutdown (ASD) relay supplies battery voltage to both the upstream and downstream heated oxygen sensors. The oxygen sensors are equipped with a heating element. The heating elements reduce the time required for the sensors to reach operating temperature.

UPSTREAM HEATED OXYGEN SENSOR

The upstream O2S is located in the exhaust manifold and provides an input voltage to the PCM. The input tells the PCM the oxygen content of the exhaust gas (Fig. 16) or (Fig. 17) or (Fig. 18). The PCM uses this information to fine tune the air/fuel ratio by adjusting injector pulse width.

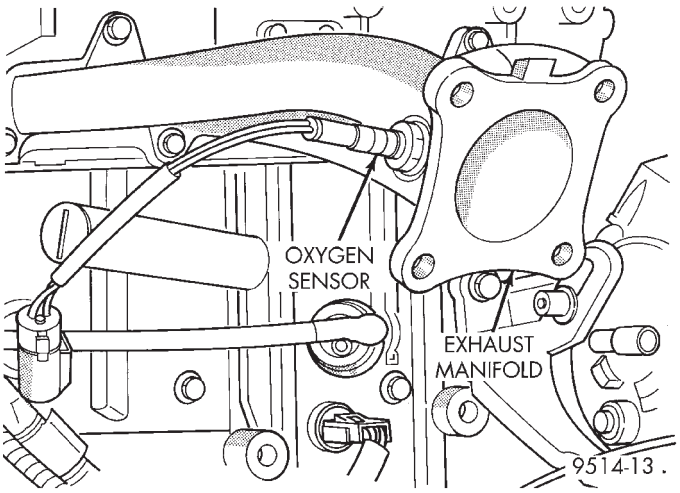


Fig. 16 Heated Oxygen Sensor—2.4L Engine

DOWNSTREAM HEATED OXYGEN SENSOR

The downstream heated oxygen sensor threads into the outlet pipe at the rear of the catalytic convertor (Fig. 19). The downstream heated oxygen sensor input is used to detect catalytic convertor deterioration. As the convertor deteriorates, the input from the downstream sensor begins to match the upstream sensor input except for a slight time delay. By comparing the downstream heated oxygen sensor input to the input from the upstream sensor, the PCM calculates catalytic convertor efficiency.

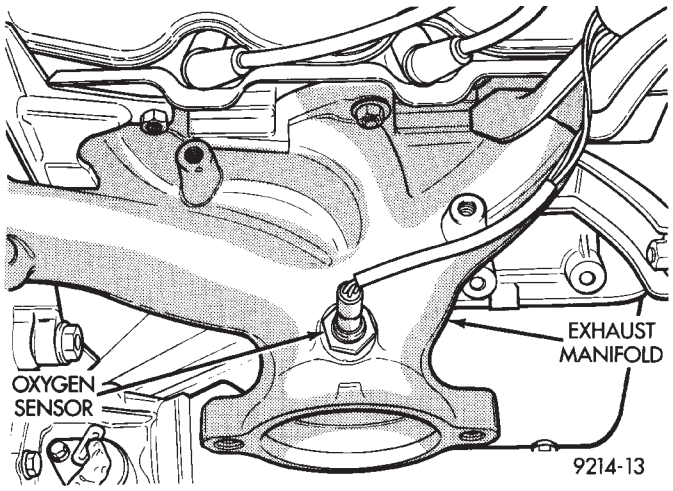


Fig. 17 Heated Oxygen Sensor—3.0L Engine

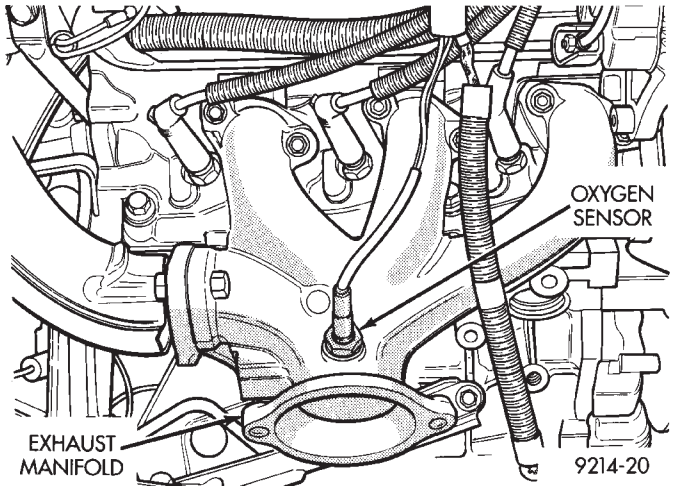


Fig. 18 Heated Oxygen Sensor—3.3/3.8L Engine

When the catalytic converter efficiency drops below emission standards, the PCM stores a diagnostic trouble code and illuminates the Malfunction Indicator Lamp (MIL). For more information, refer to Group 25 - Emission Control Systems.

KNOCK SENSOR—PCM INPUT

The knock sensor is only on the 2.4/3.3/3.8L engines, not used on the 3.0L engine.

The knock sensor threads into the side of the cylinder block in front of the starter (Fig. 20) or (Fig. 21). When the knock sensor detects a knock in one of the cylinders, it sends an input signal to the PCM. In response, the PCM retards ignition timing for all cylinders by a scheduled amount.

Knock sensors contain a piezoelectric material which sends an input voltage (signal) to the PCM. As the intensity of the engine knock vibration increases, the knock sensor output voltage also increases.

DESCRIPTION AND OPERATION (Continued)

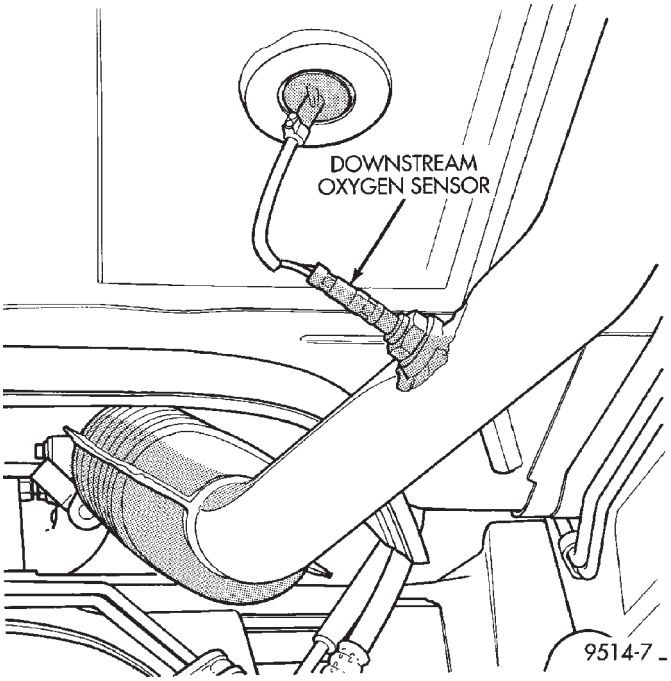


Fig. 19 Downstream Heated Oxygen Sensor

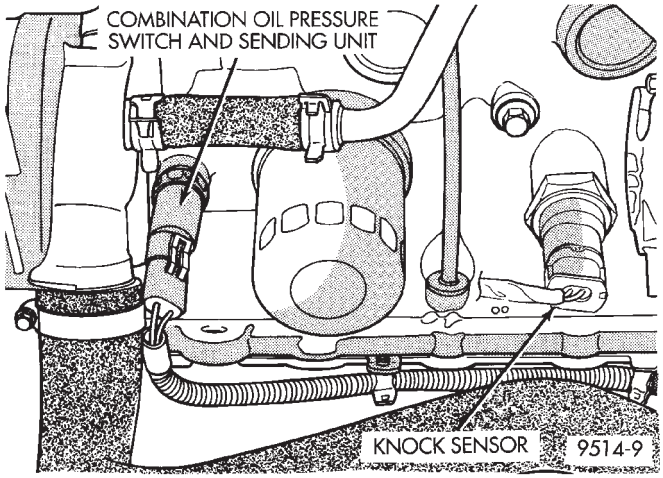


Fig. 20 Knock Sensor—3.3/3.8L Engines

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—PCM INPUT

The PCM supplies 5 volts to the MAP sensor. The MAP sensor converts intake manifold pressure into voltage. The PCM monitors the MAP sensor output voltage. As vacuum increases, MAP sensor voltage decreases proportionately. Also, as vacuum decreases, MAP sensor voltage increases proportionately.

During cranking, before the engine starts running, the PCM determines atmospheric air pressure from the MAP sensor voltage. While the engine operates, the PCM determines intake manifold pressure from the MAP sensor voltage.

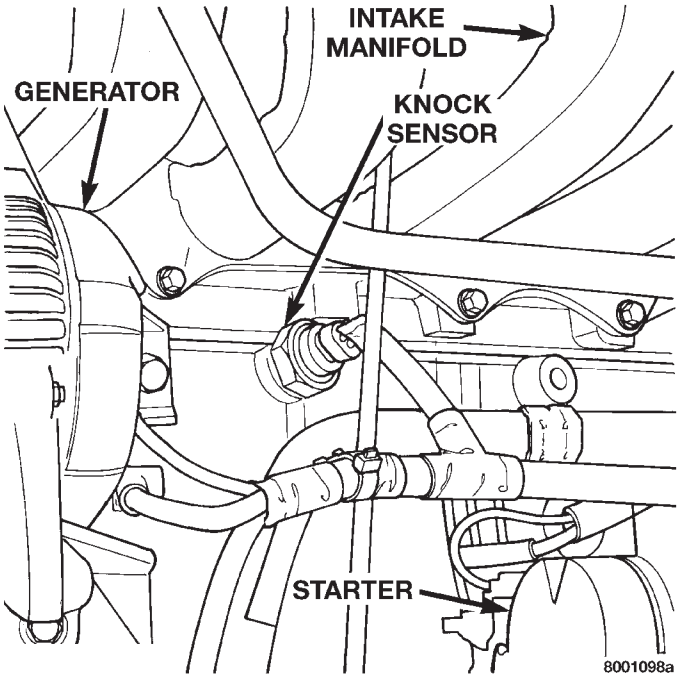


Fig. 21 Knock Sensor—2.4L Engine

Based on MAP sensor voltage and inputs from other sensors, the PCM adjusts spark advance and the air/fuel mixture.

The MAP sensor (Fig. 22) or (Fig. 23) or (Fig. 24) mounts to the intake manifold near the throttle body inlet to the manifold. The sensor connects electrically to the PCM.

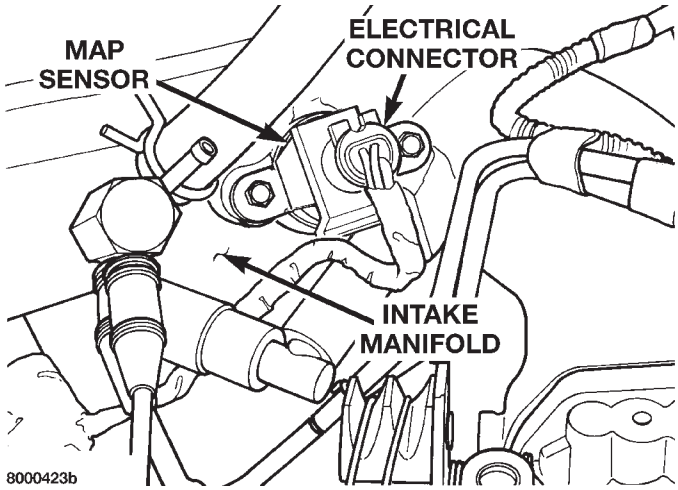


Fig. 22 MAP Sensor—3.3/3.8L

SPEED CONTROL—PCM INPUT

The speed control system provides five separate voltages (inputs) to the Powertrain Control Module (PCM). The voltages correspond to the ON/OFF, SET, RESUME and CANCEL.

The speed control ON voltage informs the PCM that the speed control system has been activated. The speed control SET voltage informs the PCM that

DESCRIPTION AND OPERATION (Continued)

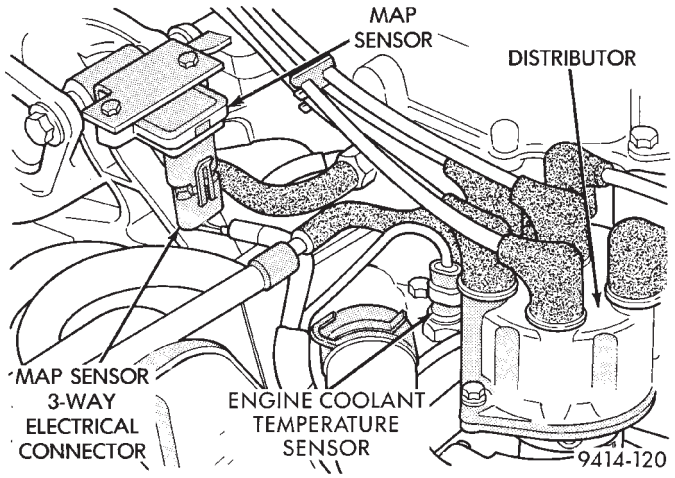


Fig. 23 MAP Sensor—3.0L

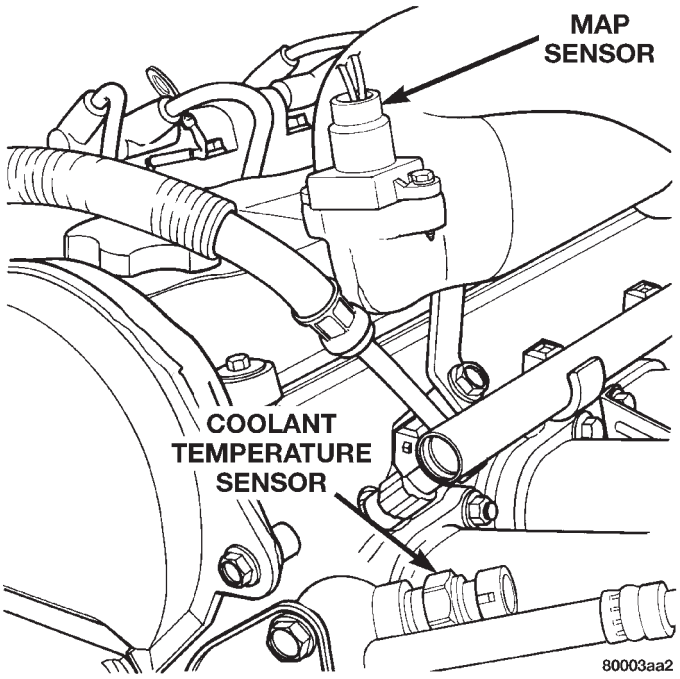


Fig. 24 MAP Sensor—2.4L

a fixed vehicle speed has been selected. The speed control RESUME voltage indicates the previous fixed speed is requested. The speed control CANCEL voltage tells the PCM to deactivate but retain set speed in memory (same as depressing the brake pedal). The speed control OFF voltage tells the PCM that the speed control system has deactivated. Refer to Group 8H for more speed control information.

TRANSAXLE PARK/NEUTRAL SWITCH—PCM INPUT

The park/neutral switch is located on the transaxle housing (Fig. 25). It provides an input to the PCM indicating whether the automatic transaxle is in Park or Neutral. This input is used to determine idle speed (varying with gear selection) and ignition timing advance. The park neutral switch is sometimes referred to as the neutral safety switch.

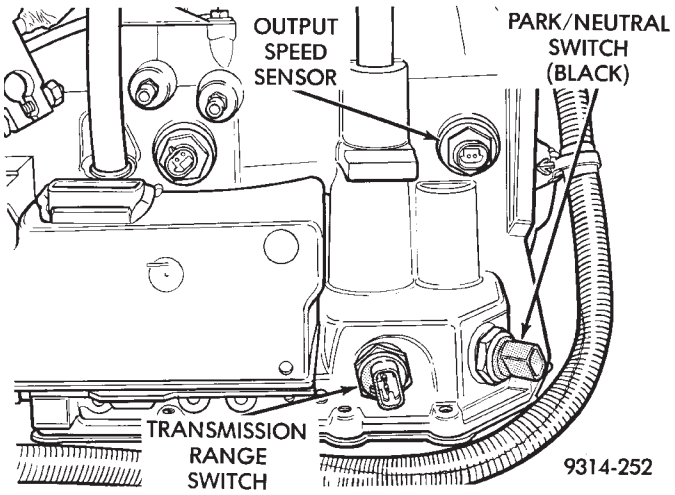


Fig. 25 Park Neutral Switch—4-Speed Electronic Automatic Transaxle—Typical

THROTTLE POSITION SENSOR (TPS)—PCM INPUT

The TPS is mounted on the throttle body and connected to the throttle blade shaft (Fig. 26) or (Fig. 27) or (Fig. 28). The TPS is a variable resistor that provides the (PCM) with an input signal (voltage) representing throttle blade position. As the position of the throttle blade changes, the resistance of the TPS changes.

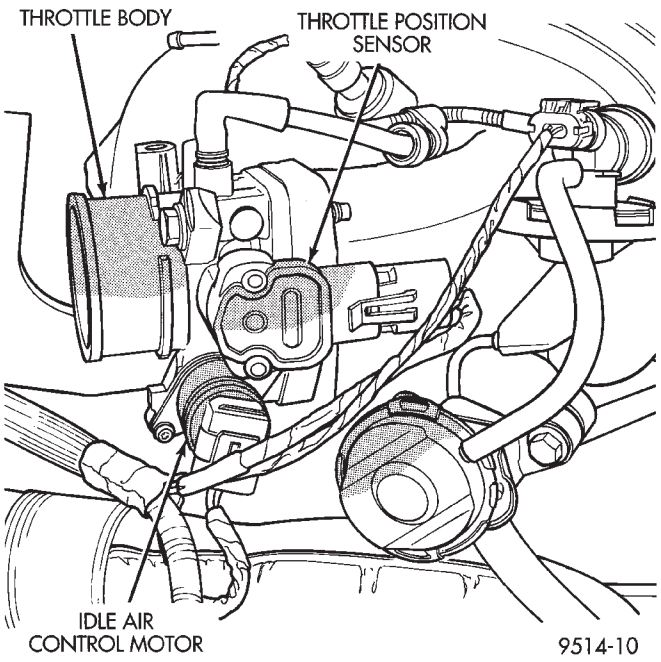


Fig. 26 Throttle Position Sensor—3.3/3.8L

DESCRIPTION AND OPERATION (Continued)

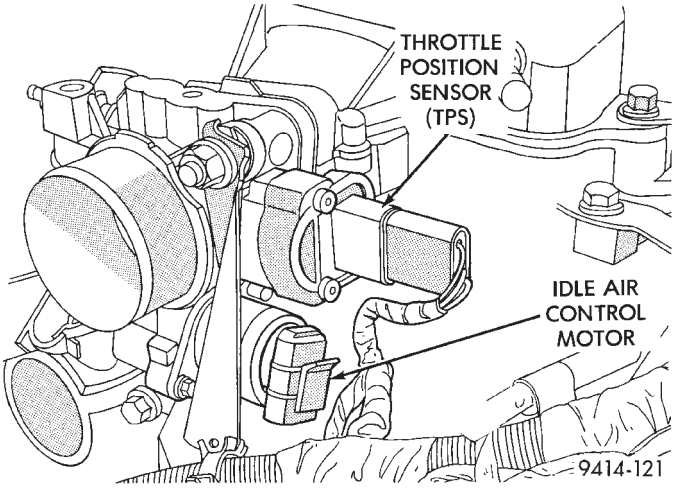


Fig. 27 Throttle Position Sensor—3.0L

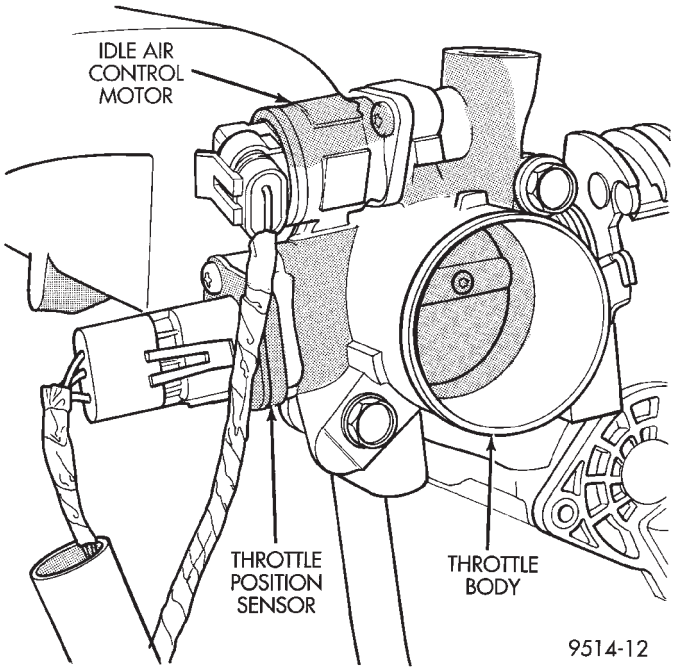


Fig. 28 Throttle Position Sensor—2.4L

The PCM supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the PCM) represents the throttle blade position. The TPS output voltage to the PCM varies from approximately 0.5 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 and adjust fuel injector pulse width and ignition timing.

VEHICLE SPEED AND DISTANCE—PCM INPUT

The transaxle output speed sensor supplies the vehicle speed and distance inputs to the PCM. The output speed sensor is located on the side of the transaxle (Fig. 25).

The speed and distance signals, along with a closed throttle signal from the TPS, determine if a closed throttle deceleration or normal idle condition (vehicle stopped) exists. Under deceleration conditions, the PCM adjusts the idle air control motor to maintain a desired MAP value. Under idle conditions, the PCM adjusts the idle air control motor to maintain a desired engine speed.

INTAKE AIR TEMPERATURE SENSOR—PCM INPUT (2.4L ONLY)

The Intake Air Temperature (IAT) sensor measures the temperature of the intake air as it enters the engine. The sensor supplies one of the inputs the PCM uses to determine injector pulse width and spark advance.

The IAT sensor threads into the intake manifold (Fig. 29).

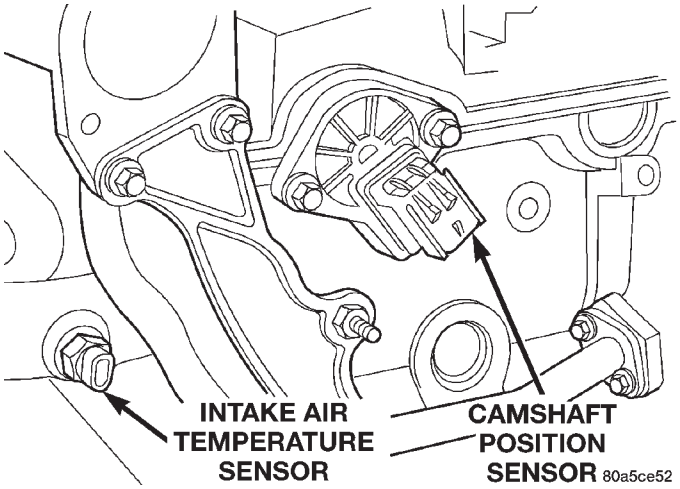


Fig. 29 Intake Air Temperature Sensor

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

The PCM operates the air conditioning clutch relay ground circuit. The radiator fan control module supplies battery power to the solenoid side of the relay. The air conditioning clutch relay will not energize unless the radiator fan control module energizes. The radiator control module energizes when the air conditioning or defrost switch is put in the ON position and the low pressure switch, combination valve, and high pressure switch close.

With the engine operating, the PCM cycles the air conditioning clutch on and off when the A/C switch closes with the blower motor switch in the On position. When the PCM senses low idle speeds or wide-open-throttle through the throttle position sensor, it de-energizes the A/C clutch relay. The relay contacts open, preventing air conditioning clutch engagement.

The air conditioning clutch relay is located in the Power Distribution Center (PDC). The PDC is located

DESCRIPTION AND OPERATION (Continued)

in the engine compartment next to the battery (Fig. 30). A label affixed to the underside of the PDC cover identifies the relays and fuses in the PDC.

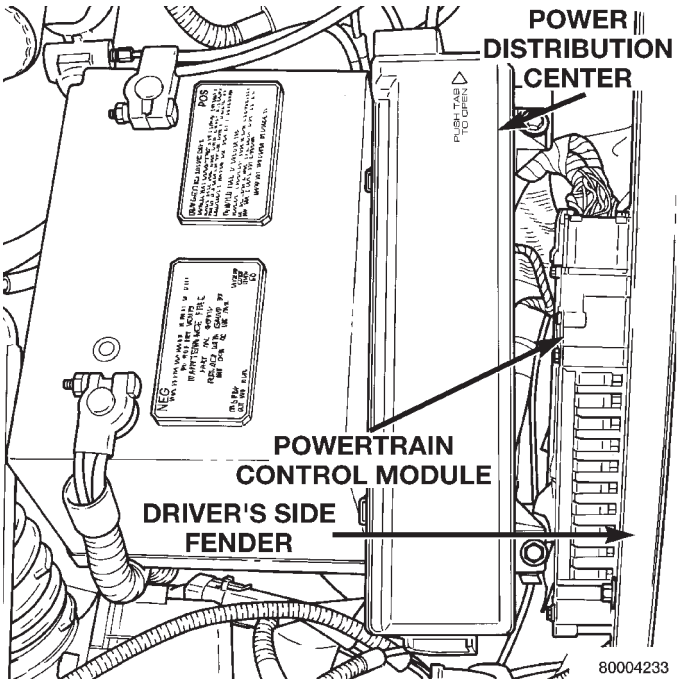


Fig. 30 Power Distribution Center (PDC)

GENERATOR FIELD—PCM OUTPUT

The PCM regulates the charging system voltage within a range of 12.9 to 15.0 volts. Refer to Group 8A for Battery system information and 8C for charging system information.

AUTOMATIC SHUTDOWN RELAY—PCM OUTPUT

The Automatic Shutdown (ASD) relay supplies battery voltage to the fuel injectors, electronic ignition coil and the heating elements in the oxygen sensors.

A buss bar in the Power Distribution Center (PDC) supplies voltage to the solenoid side and contact side of the relay. The ASD relay power circuit contains a 25 amp fuse between the buss bar in the PDC and the relay. The fuse is located in the PDC. Refer to Group 8W, Wiring Diagrams for circuit information.

The PCM controls the relay by switching the ground path for the solenoid side of the relay on and off. The PCM turns the ground path off when the ignition switch is in the Off position unless the 02 Heater Monitor test is being run. Refer to Group 25, On-Board Diagnostics. When the ignition switch is in the On or Crank position, the PCM monitors the crankshaft position sensor and camshaft position sensor signals to determine engine speed and ignition timing (coil dwell). If the PCM does not receive the crankshaft position sensor and camshaft position sensor signals when the ignition switch is in the Run position, it will de-energize the ASD relay.

The ASD relay is located in the PDC (Fig. 30). A label affixed to the underside of the PDC cover identifies the relays and fuses in the PDC.

FUEL PUMP RELAY—PCM OUTPUT

The fuel pump relay supplies battery voltage to the fuel pump. The fuel pump relay power circuit contains a 9 amp fuse. The fuse is located in the PDC. Refer to Group 8W, Wiring Diagrams for circuit information.

The PCM controls the fuel pump relay by switching the ground path for the solenoid side of the relay on and off. The PCM turns the ground path off when the ignition switch is in the Off position. When the ignition switch is in the On position, the PCM energizes the fuel pump. If the crankshaft position sensor does not detect engine rotation, the PCM de-energizes the relay after approximately one second.

The fuel pump relay is located in the PDC (Fig. 30). A label affixed to the underside of the PDC cover identifies the relays and fuses in the PDC.

STARTER RELAY—PCM OUTPUT

Double Start Override ia a feature that prevents the starter from operating if the engine is already running. This feature is accomplished with software only. There was no hardware added because of this feature. To incorporate the unique feature of Double Start Override, it was necessary to use the PCM (software) to control the starter circuit. To use the PCM it was necessary to separate the starter relay coil ground from the park neutral switch. The starter relay ground is now controlled through Pin 60 of the PCM. This allows the PCM to interrupt the ground circuit if other inputs tell it that the engine is turning. If the starter system is operating properly, it can be assumed that the override protection is also working.

IDLE AIR CONTROL MOTOR—PCM OUTPUT

The idle air control motor is mounted on the throttle body. The PCM operates the idle air control motor (Fig. 26) or (Fig. 27) or (Fig. 28). The PCM adjusts engine idle speed through the idle air control motor to compensate for engine load or ambient conditions.

The throttle body has an air bypass passage that provides air for the engine at idle (the throttle blade is closed). The idle air control motor pintle protrudes into the air bypass passage and regulates air flow through it.

The PCM adjusts engine idle speed by moving the idle air control motor pintle in and out of the bypass passage. The adjustments are based on inputs the PCM receives. The inputs are from the throttle position sensor, crankshaft position sensor, coolant temperature sensor, and various switch operations

DESCRIPTION AND OPERATION (Continued)

(brake, park/neutral, air conditioning). Deceleration die out is also prevented by increasing airflow when the throttle is closed quickly after a driving (speed) condition.

DUTY CYCLE EVAP CANISTER PURGE SOLENOID—PCM OUTPUT

The duty cycle EVAP purge solenoid regulates the rate of vapor flow from the EVAP canister to the throttle body. The PCM operates the solenoid.

During the cold start warm-up period and the hot start time delay, the PCM does not energize the solenoid. When de-energized, no vapors are purged. The PCM de-energizes the solenoid during open loop operation.

The engine enters closed loop operation after it reaches a specified temperature and the time delay ends. During closed loop operation, the PCM energizes and de-energizes the solenoid 5 or 10 times per second, depending upon operating conditions. The PCM varies the vapor flow rate by changing solenoid pulse width. Pulse width is the amount of time the solenoid energizes.

A rubber boot covers the duty cycle EVAP purge solenoid. The solenoid attaches to a bracket mounted to the right engine mount (Fig. 31). The top of the solenoid has the word TOP on it. The solenoid will not operate properly unless it is installed correctly.

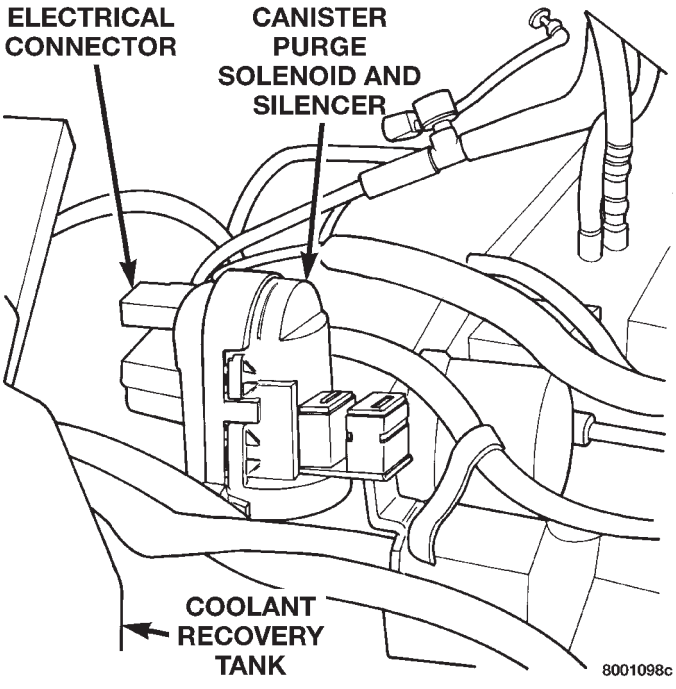


Fig. 31 Duty Cycle EVAP Purge Solenoid

PROPORTIONAL PURGE SOLENOID

All vehicles use a proportional purge solenoid. The solenoid regulates the rate of vapor flow from the EVAP canister to the throttle body. The PCM operates the solenoid.

During the cold start warm-up period and the hot start time delay, the PCM does not energize the solenoid. When de-energized, no vapors are purged.

The proportional purge solenoid operates at a frequency of 200 hz and is controlled by an engine controller circuit that senses the current being applied to the proportional purge solenoid and then adjusts that current to achieve the desired purge flow. The proportional purge solenoid controls the purge rate of fuel vapors from the vapor canister and fuel tank to the engine intake manifold.

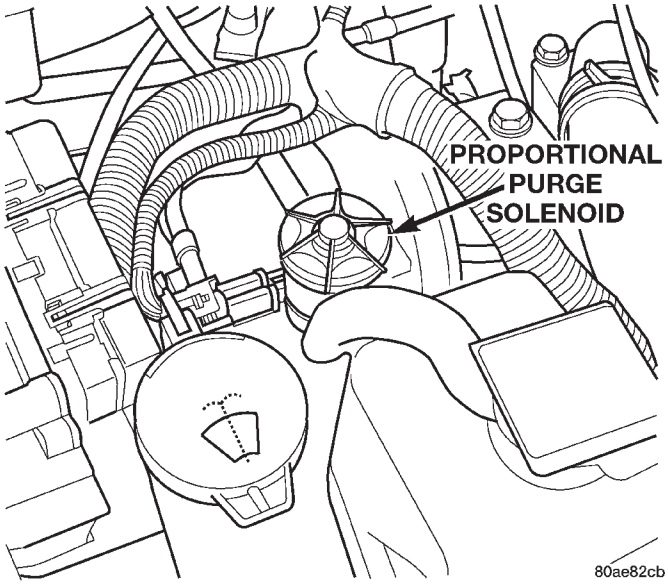


Fig. 32 Proportional Purge Solenoid

ELECTRONIC EGR TRANSDUCER SOLENOID—PCM OUTPUT

The electronic EGR transducer contains an electrically operated solenoid and a back-pressure transducer (Fig. 33) or (Fig. 34) or (Fig. 35). The PCM operates the solenoid. The PCM determines when to energize the solenoid. Exhaust system back-pressure controls the transducer.

When the PCM energizes the solenoid, vacuum does not reach the transducer. Vacuum flows to the transducer when the PCM de-energizes the solenoid.

When exhaust system back-pressure becomes high enough, it fully closes a bleed valve in the transducer. When the PCM de-energizes the solenoid and back-pressure closes the transducer bleed valve, vacuum flows through the transducer to operate the EGR valve.

De-energizing the solenoid, but not fully closing the transducer bleed hole (because of low back-pressure), varies the strength of vacuum applied to the EGR valve. Varying the strength of the vacuum changes the amount of EGR supplied to the engine. This pro-

DESCRIPTION AND OPERATION (Continued)

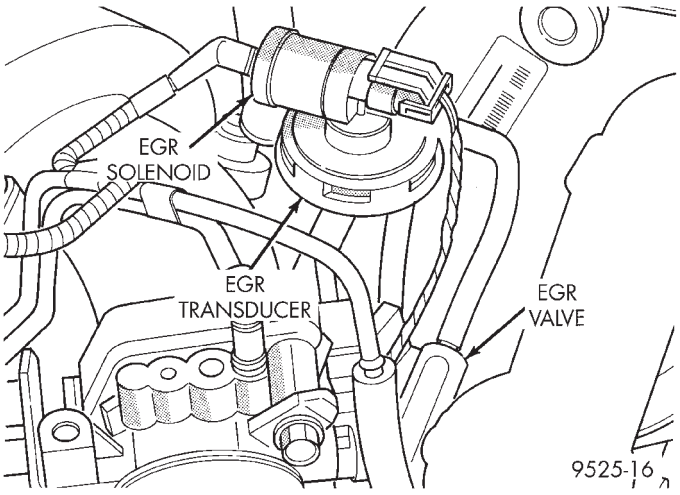


Fig. 33 EGR Solenoid—3.3/3.8L

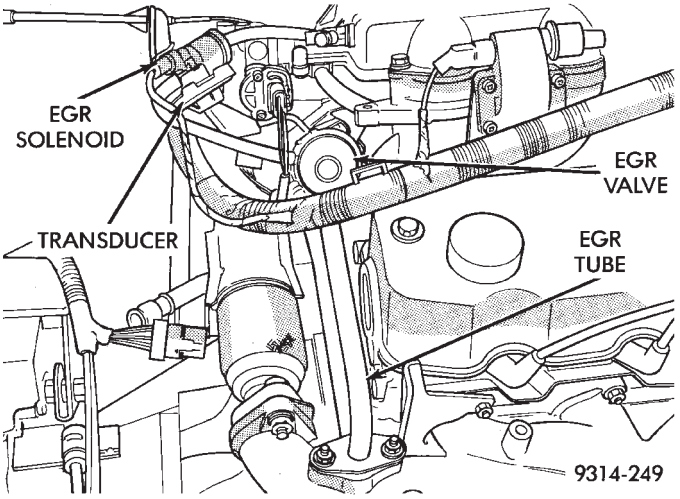


Fig. 34 EGR Solenoid—3.0L

vides the correct amount of exhaust gas recirculation for different operating conditions.

DATA LINK CONNECTOR—PCM OUTPUT

The data link connector provides the technician with the means to connect the DRB scan tool to diagnosis the vehicle. The connector is located under the dash (Fig. 36).

AUTOMATIC TRANSAXLE CONTROL MODULE—PCM OUTPUT

The electronic automatic transaxle control module and the PCM supply information to each other through the CCD Bus. The information includes engine speed and vehicle load. The PCM uses the information when adjusting the fuel and ignition strategy.

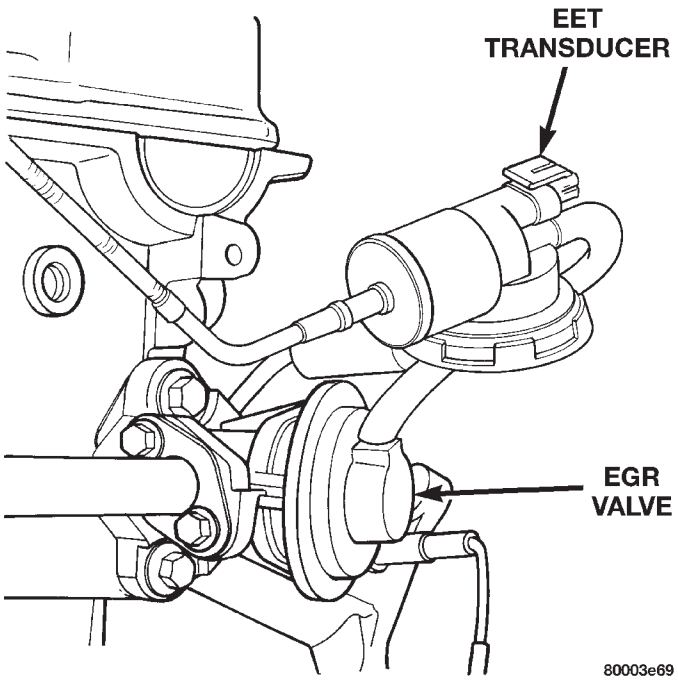


Fig. 35 EGR Solenoid—2.4L

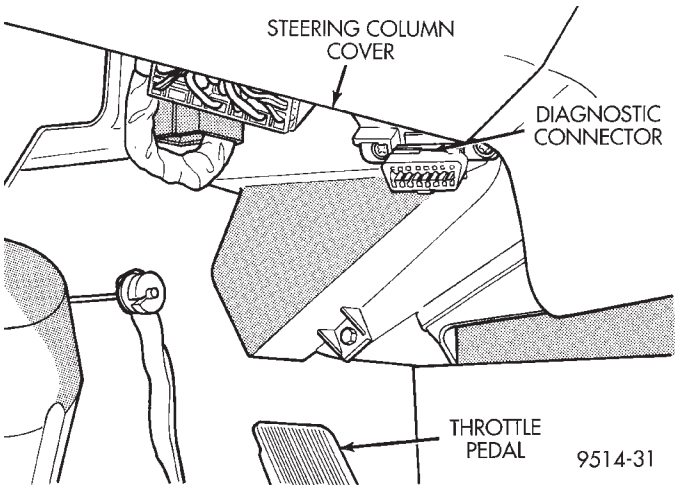


Fig. 36 Data Link Connector

FUEL INJECTORS—PCM OUTPUT

The fuel injectors are 12 ohm electrical solenoids (Fig. 37). The injector contains a pintle that closes off an orifice at the nozzle end. When electric current is supplied to the injector, the armature and needle move a short distance against a spring, allowing fuel to flow out the orifice. Because the fuel is under high pressure, a fine spray is developed in the shape of a hollow cone. The spraying action atomizes the fuel, adding it to the air entering the combustion chamber. The injectors are positioned in the intake manifold.

DESCRIPTION AND OPERATION (Continued)

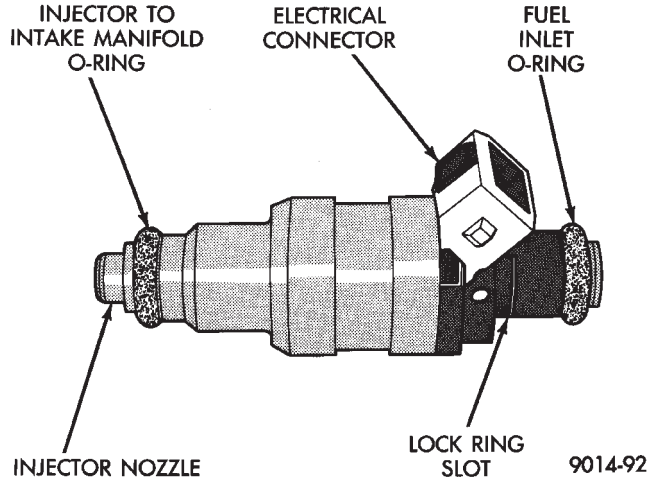


Fig. 37 Fuel Injector

The injectors are positioned in the intake manifold with the nozzle ends directly above the intake valve port (Fig. 38).

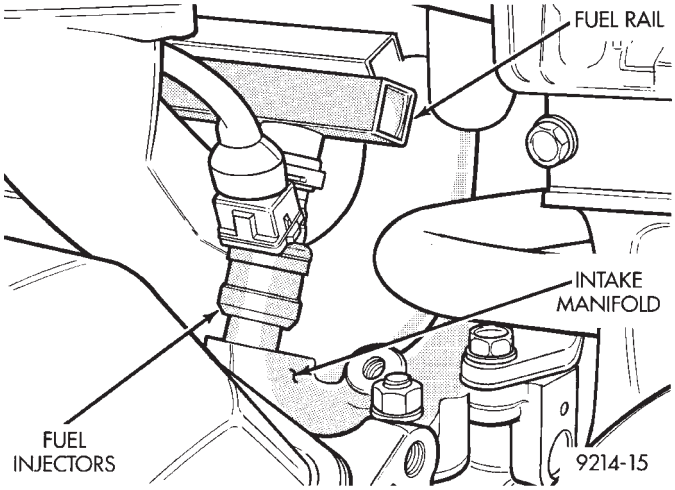


Fig. 38 Fuel Injector Location—Typical

The fuel injectors are operated by the PCM. They are energized in a sequential order during all engine operating conditions except start up. The PCM initially energizes all injectors at the same time. Once PCM determines crankshaft position, it begins energizing the injectors in sequence.

The Automatic Shutdown (ASD) relay supplies battery voltage to the injectors. The PCM provides the ground path for the injectors. By switching the ground path on and off, the PCM adjusts injector pulse width. Pulse width is the amount of time the injector is energized. The PCM adjusts injector pulse width based on inputs it receives.

IGNITION COIL—PCM OUTPUT

The coil assembly consists of independent coils molded together (Fig. 39) or (Fig. 40) or (Fig. 41). The coil assembly is mounted on the intake manifold. High tension leads route to each cylinder from the coil. The coil fires two spark plugs every power stroke. One plug is the cylinder under compression, the other cylinder fires on the exhaust stroke. The PCM determines which of the coils to charge and fire at the correct time.

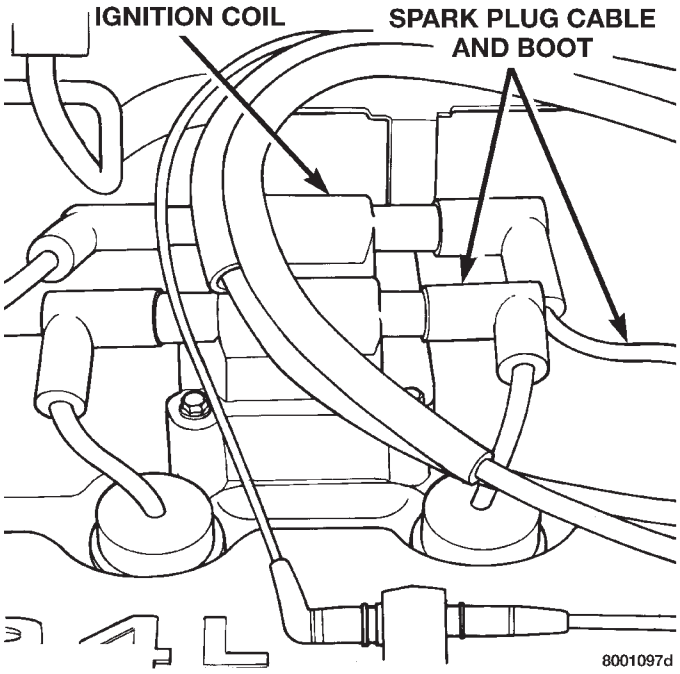


Fig. 39 Ignition Coil—2.4L

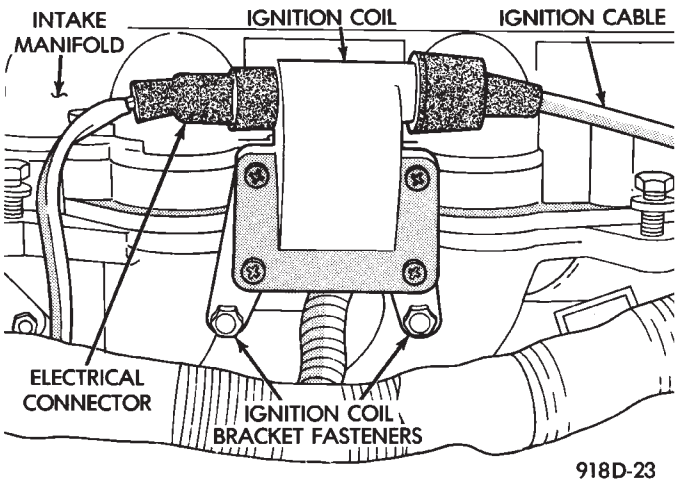


Fig. 40 Ignition Coil—3.0L

The Automatic Shutdown (ASD) relay provides battery voltage to the ignition coil. The PCM provides a ground contact (circuit) for energizing the coil. When the PCM breaks the contact, the energy in the coil primary transfers to the secondary causing the spark. The PCM will de-energize the ASD relay if it does not receive the crankshaft position sensor and camshaft position sensor inputs. Refer to Automatic

DESCRIPTION AND OPERATION (Continued)

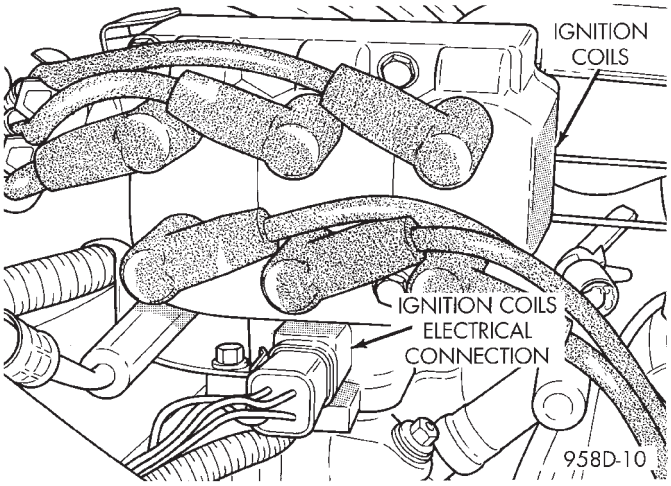


Fig. 41 Ignition Coil —3.3/3.8L

Shutdown (ASD) Relay—PCM Output in this section for relay operation.

TORQUE CONVERTER CLUTCH SOLENOID—PCM OUTPUT

Three-speed automatic transaxles use a torque converter clutch solenoid. The PCM controls the engagement of the torque converter clutch through the solenoid. The torque converter clutch is engaged only in direct drive mode. Refer to Group 21 for transaxle information.

MALFUNCTION INDICATOR (CHECK ENGINE) LAMP—PCM OUTPUT

The PCM supplies the malfunction indicator (check engine) lamp on/off signal to the instrument panel through the CCD Bus. The CCD Bus is a communications port. Various modules use the CCD Bus to exchange information.

The Check Engine lamp comes on each time the ignition key is turned ON and stays on for 3 seconds as a bulb test.

The Malfunction Indicator Lamp (MIL) stays on continuously, when the PCM has entered a Limp-In mode or identified a failed emission component. During Limp-in Mode, the PCM attempts to keep the system operational. The MIL signals the need for immediate service. In limp-in mode, the PCM compensates for the failure of certain components that send incorrect signals. The PCM substitutes for the incorrect signals with inputs from other sensors.

If the PCM detects active engine misfire severe enough to cause catalyst damage, it flashes the MIL. At the same time the PCM also sets a Diagnostic Trouble Code (DTC).

For signals that can trigger the MIL (Check Engine Lamp) refer to Group 25, On-Board Dianostics.

SOLID STATE FAN RELAY—PCM OUTPUT

The radiator fan runs at a variable speed depending on coolant temperature and A/C system pressure. The radiator fan circuit contains a Solid State Fan Relay (SSFR). Refer to the Group 8W for a circuit schematic.

A 5 volt signal is supplied to the SSFR. The PCM provides a pulsed ground for the SSFR. Depending upon the amount of pulse on time, the SSFR puts out a proportional voltage to the fan motor at the lower speed. For instance, if the on time is 30 percent, then the voltage to the fan motor will be 3.6 volts.

When engine coolant reaches approximately 102°C (215°F) the PCM grounds the SSFR relay. If engine coolant reaches 207°C (225°F) the PCM grounds the high speed ground relay and high speed fan relay. If the fan operates at high speed, the PCM de-energizes the high speed relay and high speed ground relay when coolant temperature drops to approximately 101°C (214°F). When coolant temperature drops to 101°C (214°F) the fan operates at low speed. The PCM de-energizes the low speed relay when coolant temperature drops to approximately 93°C (199°F).

Also, when the air conditioning pressure switch closes, the fan operates at high speed. The air conditioning switch closes at 285 psi ±10 psi. When air conditioning pressure drops approximately 40 psi, the pressure switch opens and the fan operates at low speed.

The SSFR relay is located on the left front inner frame just behind the radiator (Fig. 42).

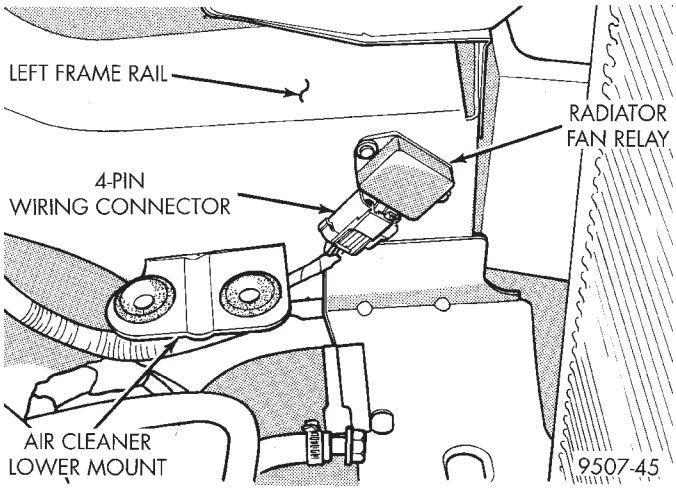


Fig. 42 Fan Control Module

SPEED CONTROL SOLENOIDS—PCM OUTPUT

The speed control vacuum and vent solenoids are operated by the PCM. When the PCM supplies a ground to the vacuum and vent solenoids, the speed control system opens the throttle plate. When the PCM removes the ground from the vacuum and vent solenoids, the throttle blade closes. The PCM bal-

DESCRIPTION AND OPERATION (Continued)

ances the two solenoids to maintain the set speed. Refer to Group 8H for speed control information.

TACHOMETER—PCM OUTPUT

The PCM supplies engine RPM to the instrument panel tachometer through the CCD Bus. The CCD Bus is a communications port. Various modules use the CCD Bus to exchange information. Refer to Group 8E for more information.

THROTTLE BODY

On all engine assemblies (2.4, 3.0, and 3.3/3.8L) the throttle body's are located on the left side of the intake manifold plenum. The throttle body houses the throttle position sensor and the idle air control motor. Air flow through the throttle body is controlled by a cable operated throttle blade located in the base of the throttle body (Fig. 43) or (Fig. 44) or (Fig. 45).

DIAGNOSIS AND TESTING

VISUAL INSPECTION—2.4L ENGINE

A visual inspection for loose, disconnected, or misrouted wires and hoses should be made before attempting to diagnose or service the fuel injection system. A visual check helps save unnecessary test and diagnostic time. A thorough visual inspection will include the following checks:

(1) Check ignition cable routing from the coil pack to the spark plugs. Verify the cable are routed in the correct order and are fully seated to the coil and spark plug.

(2) Check direct ignition system (DIS) coil electrical connection for damage and a complete connection to the coil pack (Fig. 46).

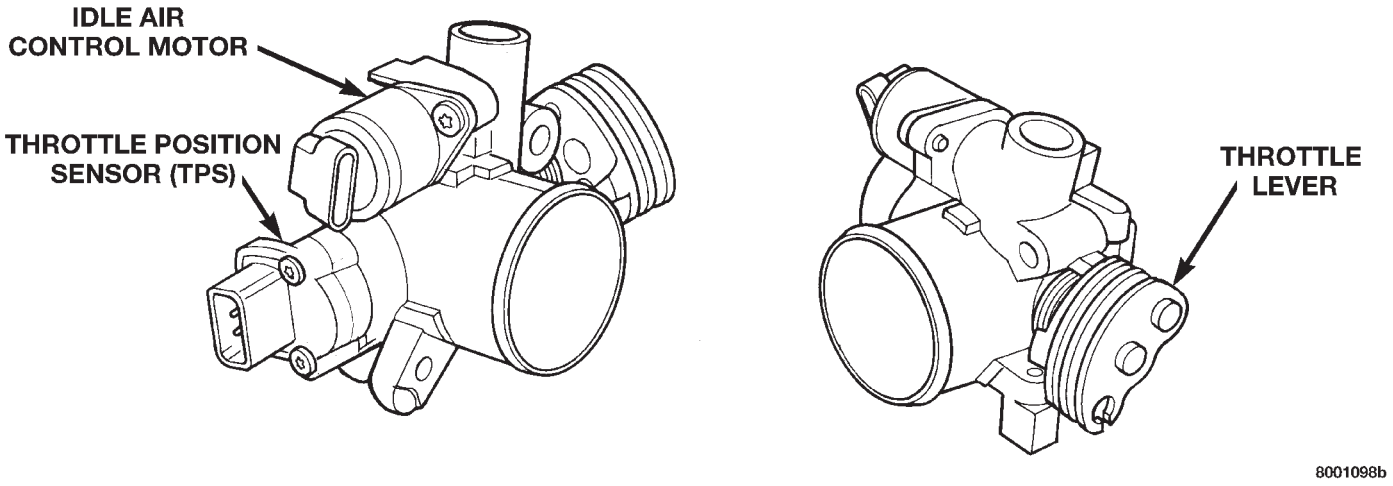


Fig. 43 Throttle Body—2.4L

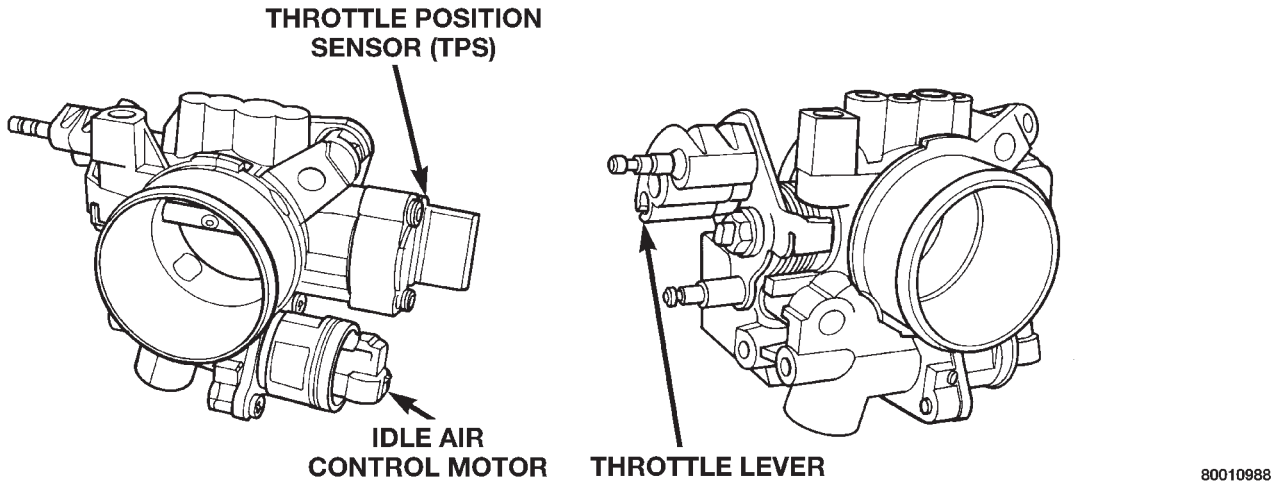


Fig. 44 Throttle Body—3.0L

DIAGNOSIS AND TESTING (Continued)

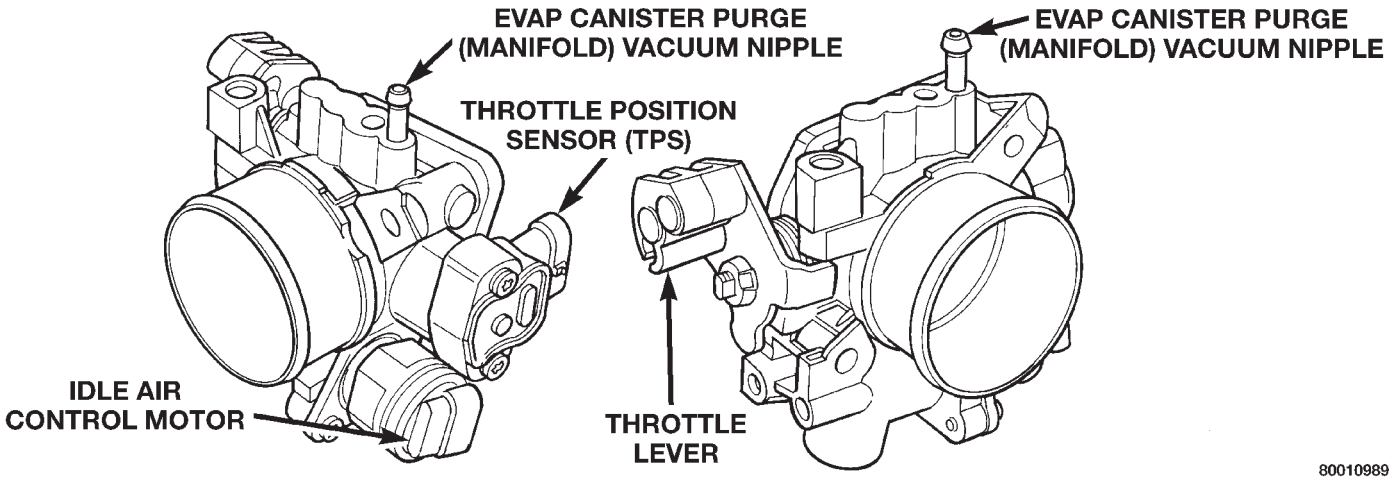


Fig. 45 Throttle Body—3.3/3.8L

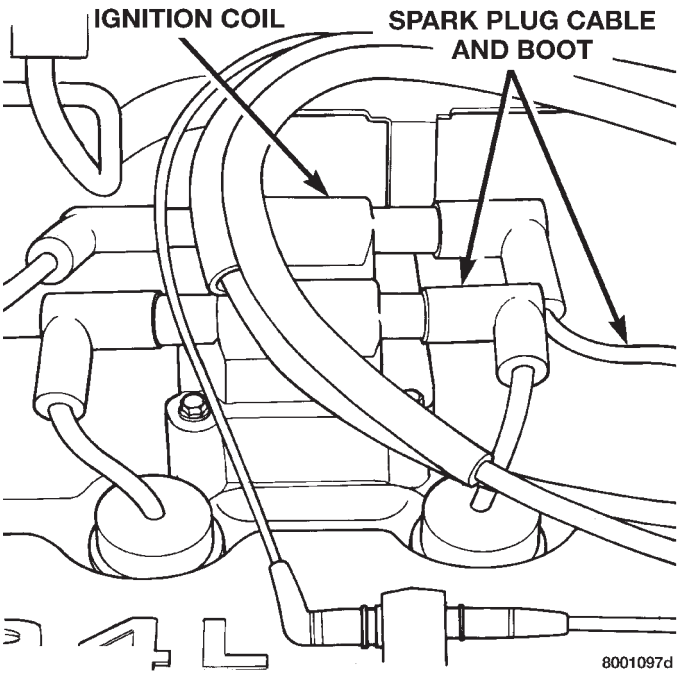


Fig. 46 Ignition Coil Pack Electrical Connection

(3) Verify the camshaft position sensor electrical connector is connected to the harness and not damaged (Fig. 47).

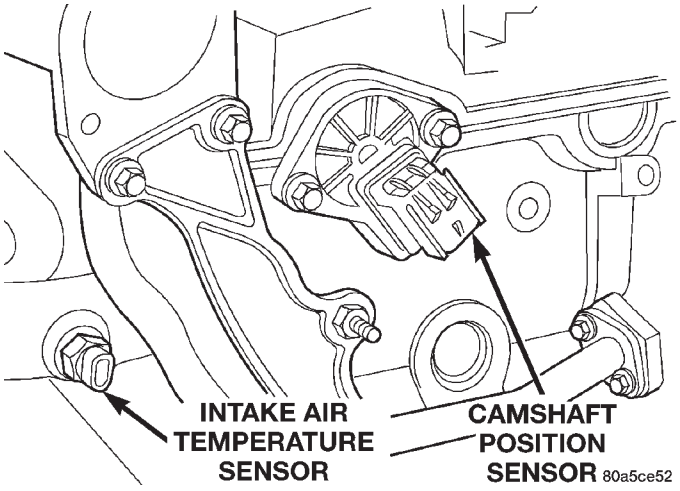


Fig. 47 Camshaft Position Sensor

(4) Ensure the engine temperature sensor electrical connector is connected to the sensor and not damaged (Fig. 48).

(5) Verify the quick connect fuel fitting is fully inserted on the fuel supply tube.

(6) Check the oil pressure sending unit electrical connection.

(7) Verify the electrical connector at the knock sensor is fully seated and not damaged (Fig. 49).

DIAGNOSIS AND TESTING (Continued)

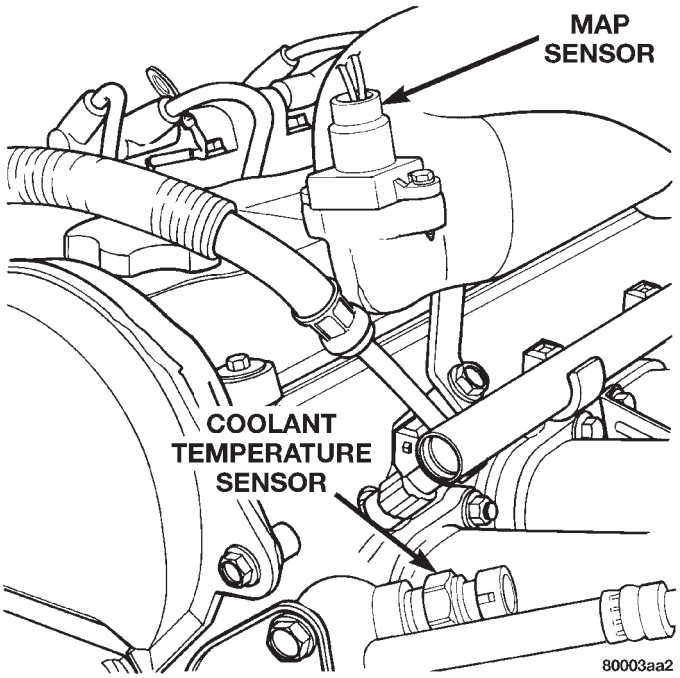


Fig. 48 Engine Coolant Temperature Sensor

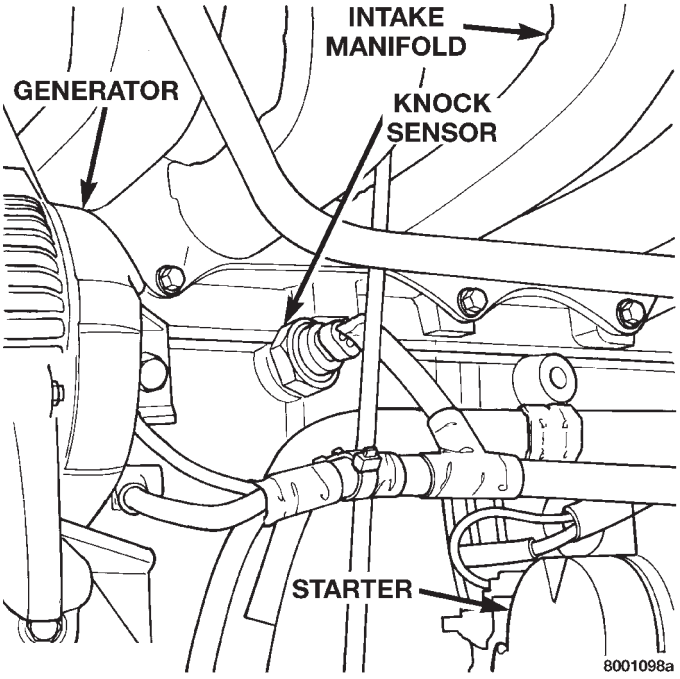


Fig. 49 Knock Sensor

(8) Verify the electrical connector is attached to the Proportional purge solenoid (Fig. 50) and not damaged.

(9) Verify the vacuum connection at the Proportional purge solenoid is secure and not leaking.

(10) Verify the hoses are securely attached to the EVAP canister (Fig. 51).

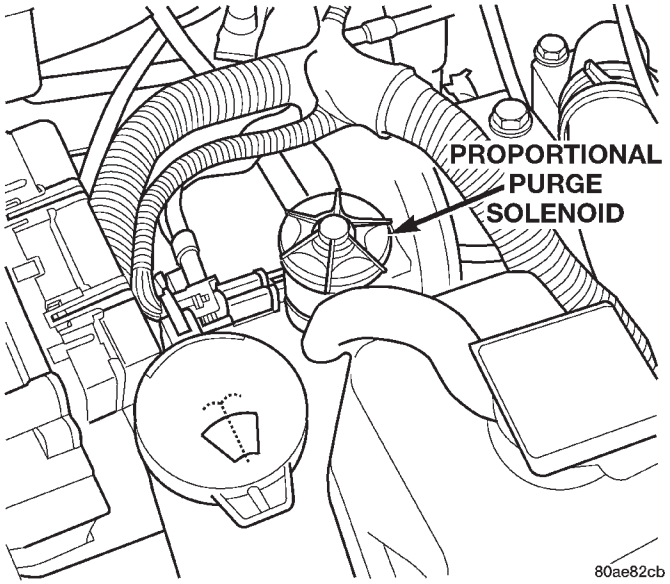


Fig. 50 Proportional Purge Solenoid

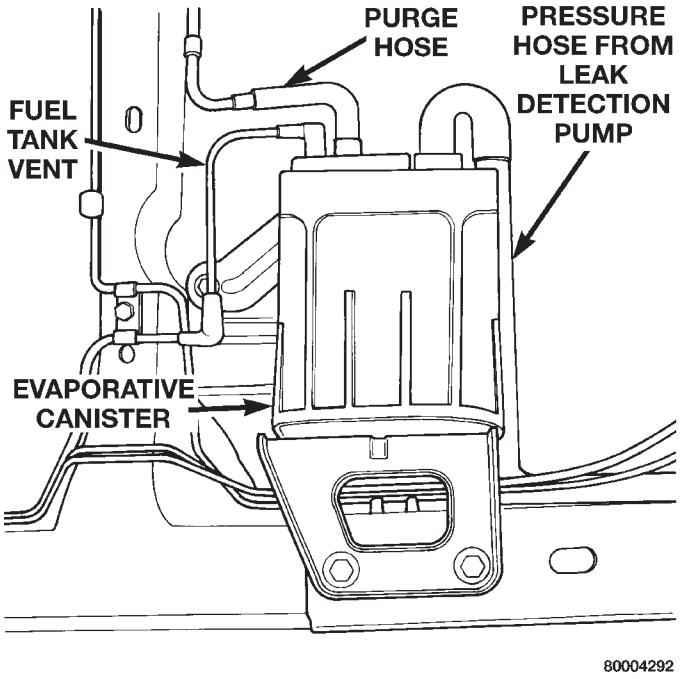


Fig. 51 Evaporative Canister

(11) Ensure the harness connectors for the fuel injectors are attached to the correct injector and not damaged.

(12) Verify the fuel injector harness and engine wiring harness connectors are fully inserted into the main wiring harness.

(13) Check the vacuum connections at the throttle body and intake plenum.

DIAGNOSIS AND TESTING (Continued)

(14) Ensure the idle air control motor and TPS electrical connectors are fully seated and not damaged (Fig. 52).

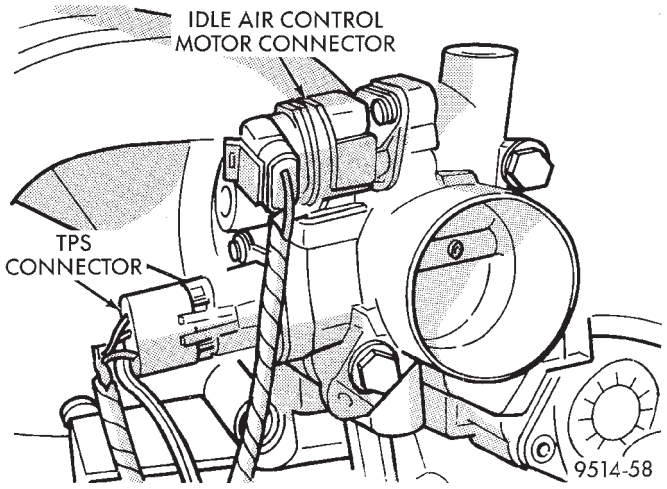


Fig. 52 Throttle Body Electrical Connections

(15) Inspect the park/neutral switch wiring connection for damage. Ensure the automatic transaxle electrical connections are not damaged (Fig. 53).

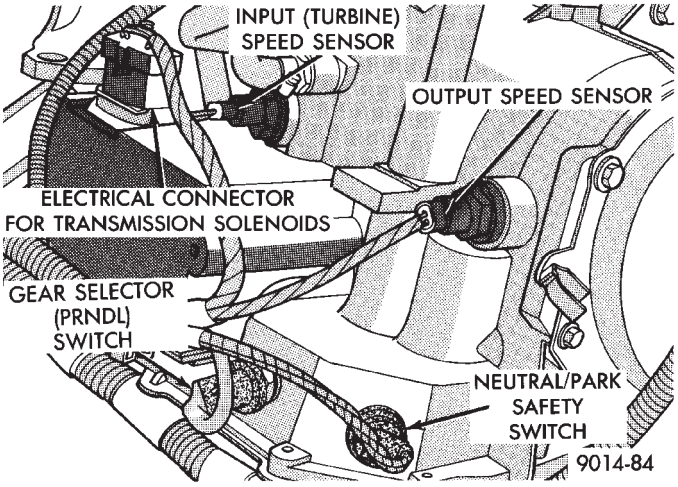


Fig. 53 Automatic Transaxle Electrical Connections

(16) Inspect the PCV system connections for damage (Fig. 54).

(17) Inspect the crankshaft position sensor electrical connector for damage (Fig. 55).

(18) Verify the Manifold Absolute Pressure (MAP) sensor electrical connector is attached to the sensor and not damaged (Fig. 56).

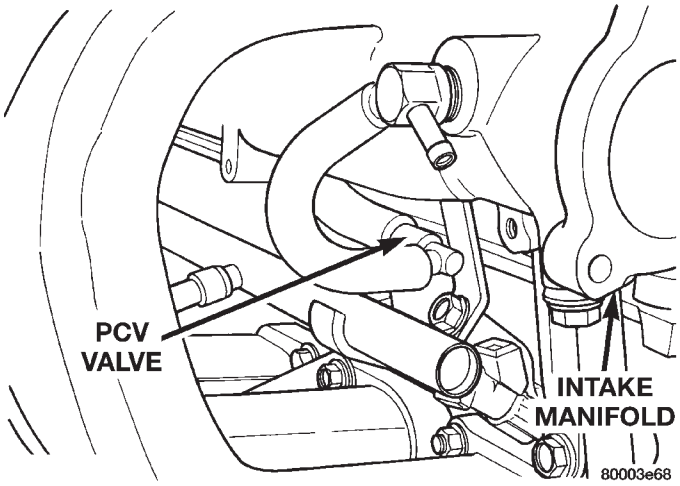


Fig. 54 PCV Valve

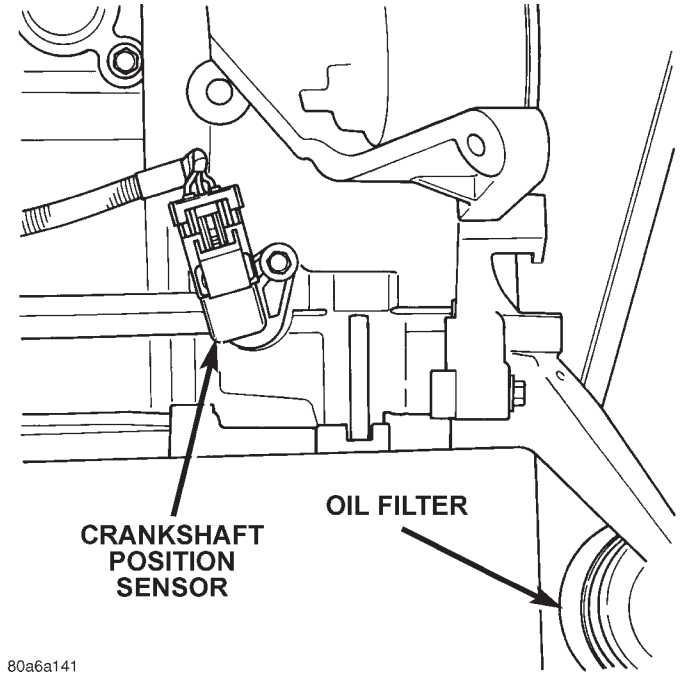


Fig. 55 Crankshaft Position Sensor

(19) Check the heated oxygen sensor electrical connectors for damage (Fig. 57) and (Fig. 58).

(20) Verify the engine ground strap is attached at the engine and dash panel. Inspect the strap for corrosion or damage.

(21) Inspect the generator wiring connections for damage.

DIAGNOSIS AND TESTING (Continued)

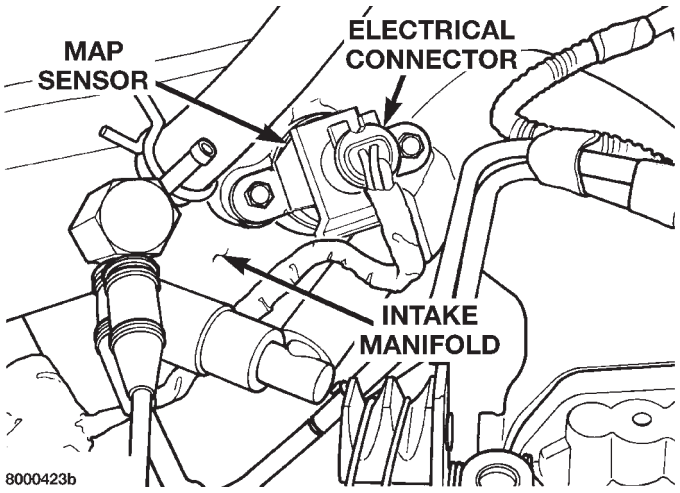


Fig. 56 Map Sensor

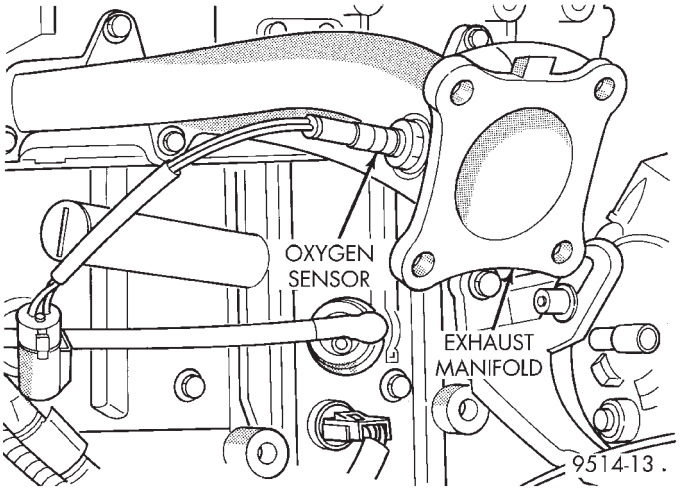


Fig. 57 Upstream Heated Oxygen Sensor

(22) Check the accessory drive belt tension.

(23) Check the 40-way electrical connectors at the Powertrain Control Module (PCM) (Fig. 59) for damage or spread terminals. Verify that the connectors are fully inserted into the PCM sockets. Ensure the wires are not stretched or pulled out of the connector.

(24) Inspect fuses in the Power Distribution Center (PDC). Verify all fuses and relays are fully inserted into the PDC (Fig. 60). A label affixed to the underside of the PDC cover identifies the relays and fuses in the PDC.

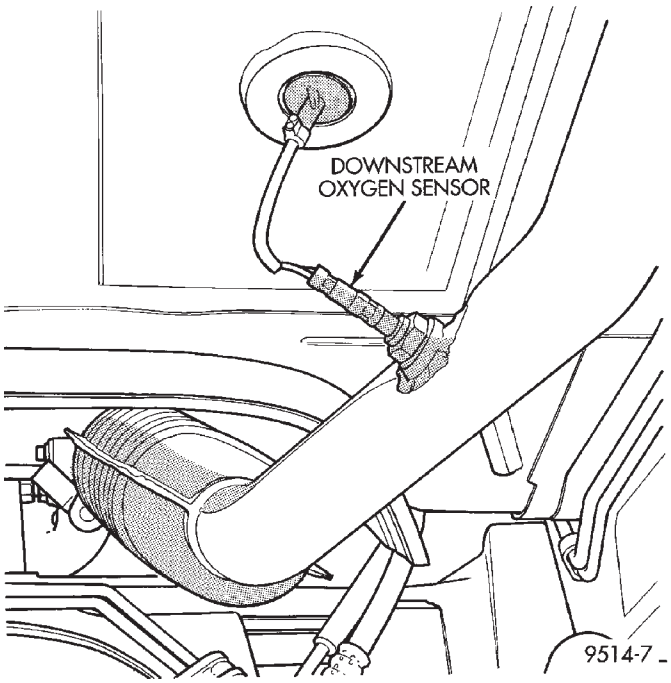


Fig. 58 Downstream Heated Oxygen Sensor

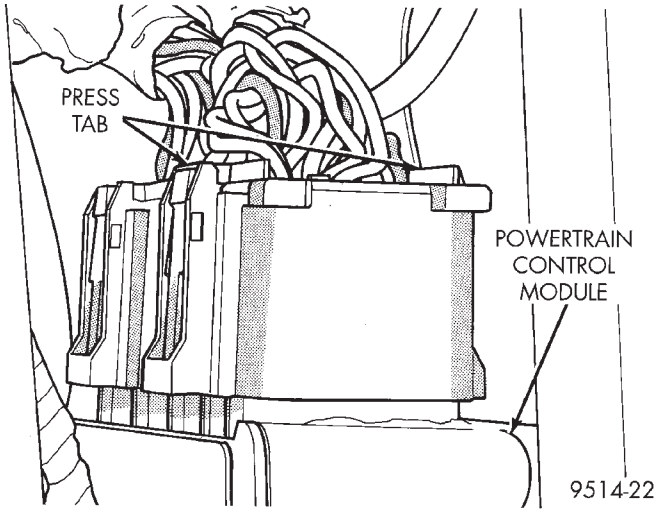


Fig. 59 Powertrain Control Module (PCM) Connectors

(25) Inspect battery cable connections for corrosion.

(26) Check the power brake booster hose connection (without anti-lock brake systems) (Fig. 61).

(27) Inspect the speed control vacuum connection.

(28) Inspect hose and wiring connections at fuel pump module. Check that wiring connector is making contact with terminals on pump.

DIAGNOSIS AND TESTING (Continued)

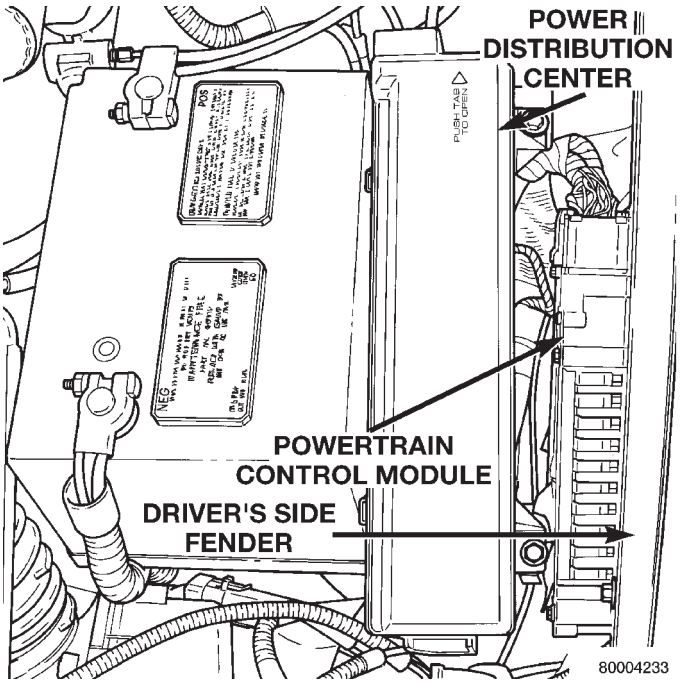


Fig. 60 Power Distribution Center (PDC)

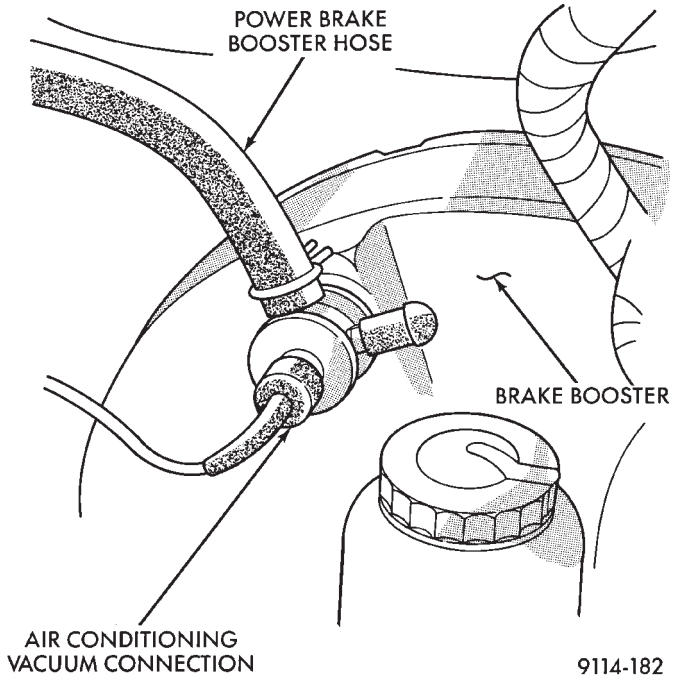


Fig. 61 Power Brake Booster Hose

VISUAL INSPECTION—3.0L ENGINE

A visual inspection for loose, disconnected, or misrouted wires and hoses should be made before attempting to diagnose or service the fuel injection system. A visual check helps save unnecessary test and diagnostic time. A thorough visual inspection will include the following checks:

(1) Check for correct spark plug cable routing. Ensure that the cables are completely connected to the spark plugs and distributor.

(2) Check ignition coil electrical connections (Fig. 62).

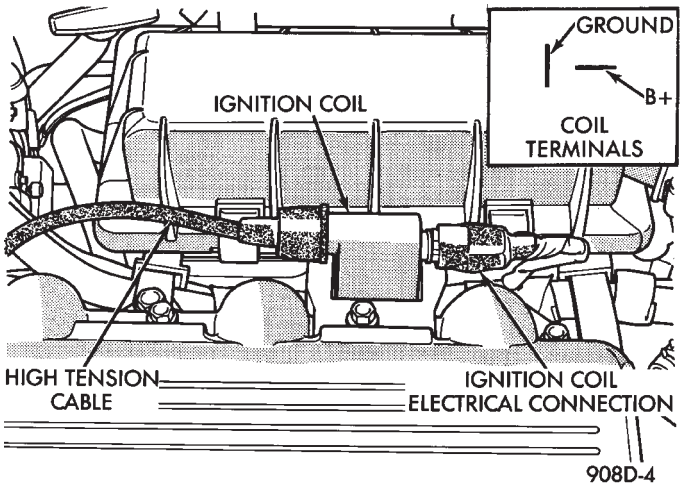


Fig. 62 Ignition Coil Electrical Connection

(3) Verify that the electrical connector is attached to the Proportional Purge Solenoid (Fig. 63).

(4) Verify that vacuum connection at the duty cycle Proportional Purge Solenoid valve is secure and not leaking.

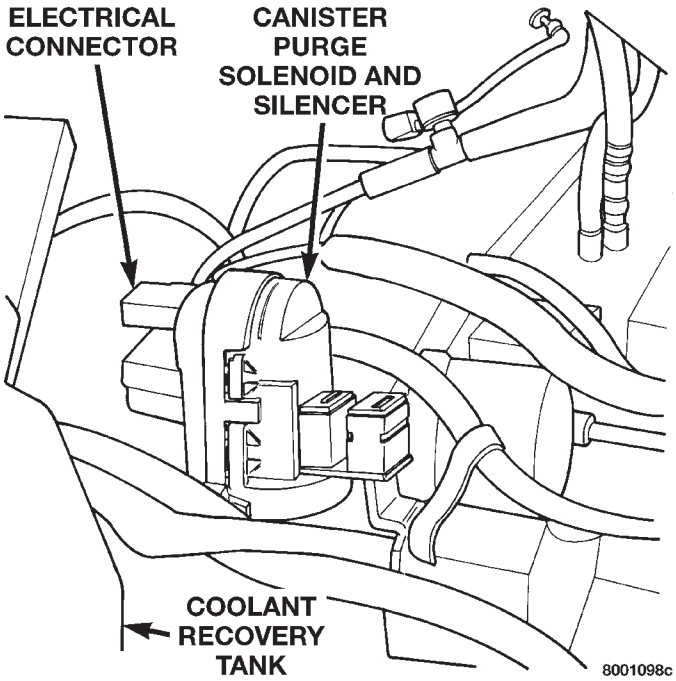


Fig. 63 Proportional Purge Solenoid Valve

DIAGNOSIS AND TESTING (Continued)

(5) Verify that the electrical connector is attached to the MAP sensor (Fig. 64).

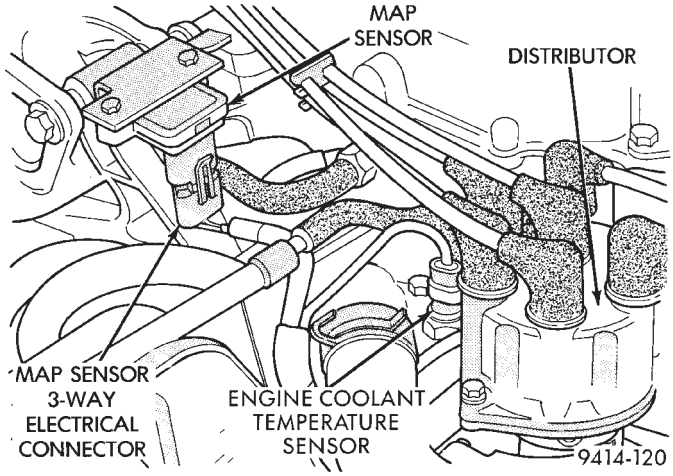


Fig. 64 Map Sensor Electrical and Vacuum Connections

(6) Check generator wiring connections. Ensure the accessory drive belt has proper tension.

(7) Verify that hoses are securely attached to the evaporative canister (Fig. 65).

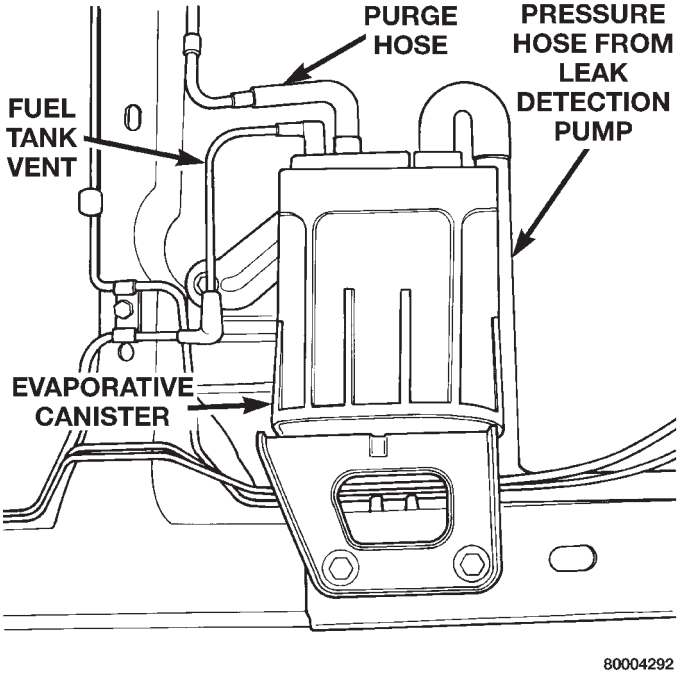


Fig. 65 Evaporative Canister

(8) Verify the engine ground strap is attached at the engine and dash panel (Fig. 66).

(9) Ensure the heated oxygen sensor connector is connected to the harness connector.

(10) Verify the distributor connector is connected to the harness connector (Fig. 67).

(11) Verify the coolant temperature sensor connector is connected to the harness connector (Fig. 68).

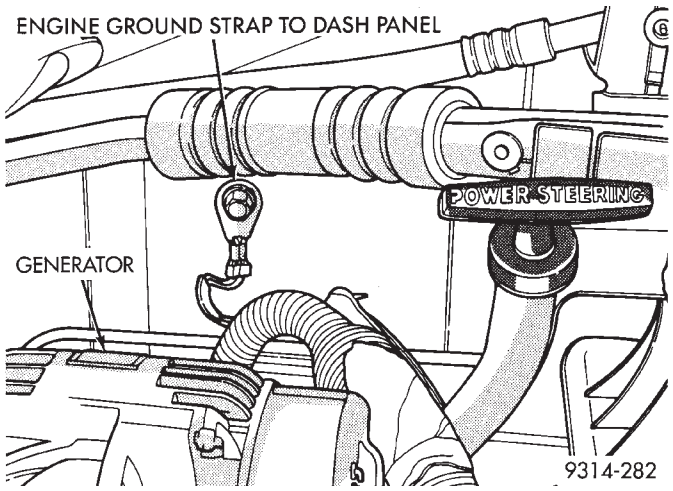


Fig. 66 Engine Ground Strap

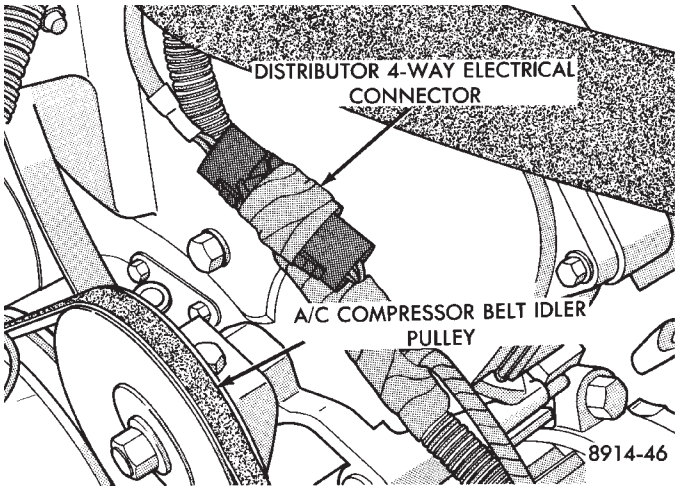


Fig. 67 Distributor Connector

(12) Check vacuum hose connection at fuel pressure regulator and intake plenum connector (Fig. 68).

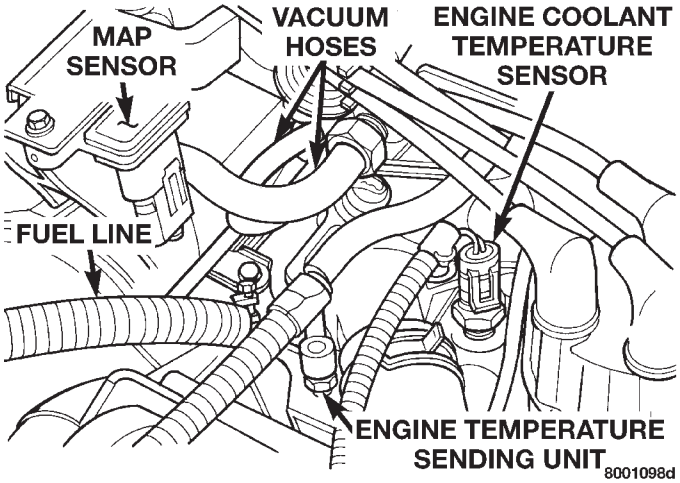


Fig. 68 Coolant Temperature Sensor Electrical Connections and Vacuum Hose Connections at the Air Intake Plenum

DIAGNOSIS AND TESTING (Continued)

(13) Ensure the harness connector is securely attached to each fuel injector.

(14) Check the oil pressure sending unit electrical connection (Fig. 69).

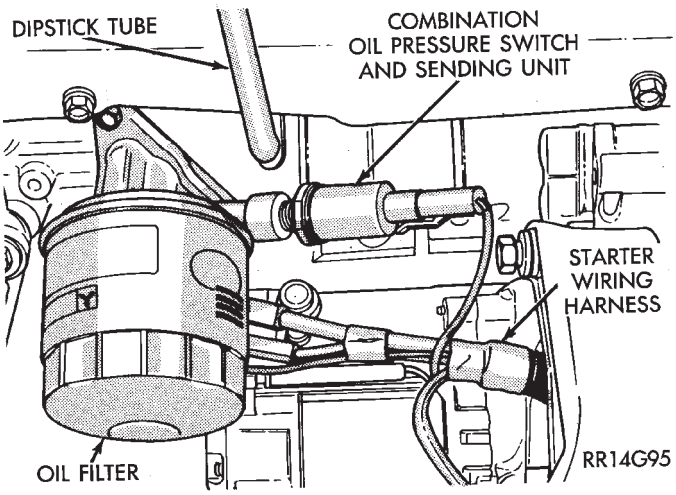


Fig. 69 Oil Pressure Sending Unit Electrical Connection

(15) Check hose connections at throttle body.

(16) Check throttle body electrical connections (Fig. 70).

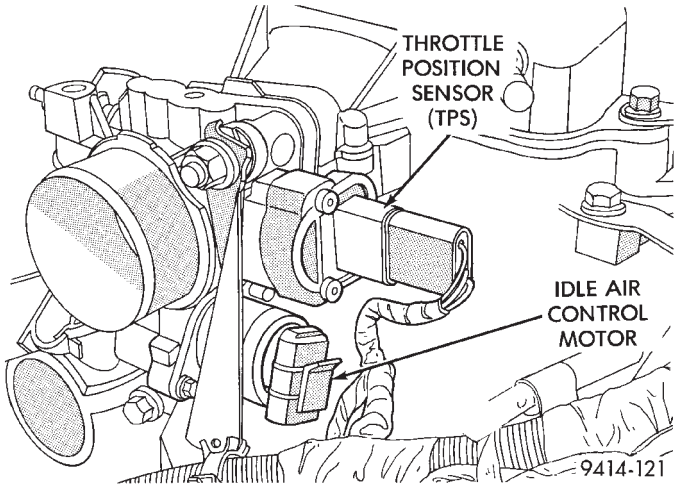


Fig. 70 Throttle Body Electrical and Vacuum Hose Connections

(17) Check PCV hose connections (Fig. 71).

(18) Check EGR system vacuum hose connections (Fig. 72).

(19) Check EGR tube to intake plenum connections.

(20) Check power brake booster vacuum connections.

(21) Check engine harness to main harness electrical connections.

(22) Check all electronic automatic transaxle electrical connections (Fig. 73).

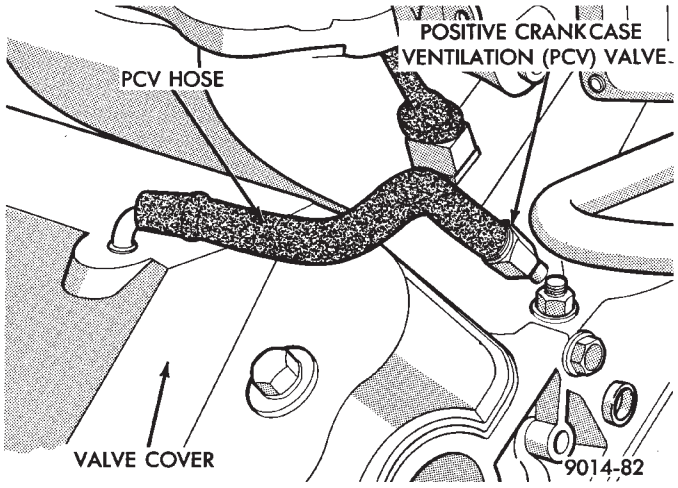


Fig. 71 Positive Crankcase Ventilation (PCV) System

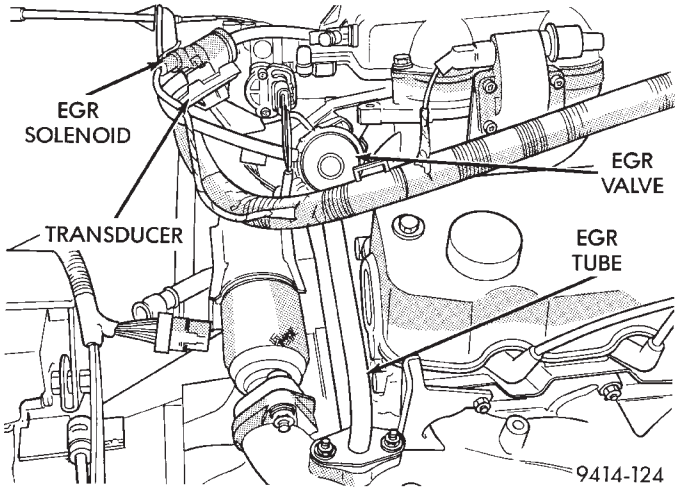


Fig. 72 EGR System

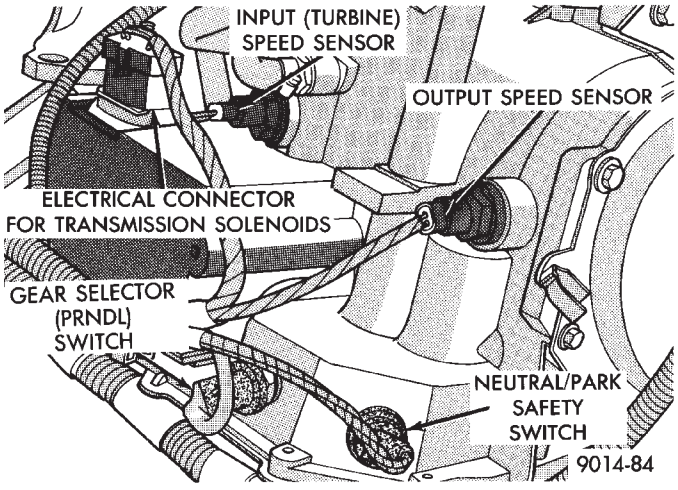


Fig. 73 Electronic Automatic Transaxle Electrical Connections

(23) Inspect the Powertrain Control Module (PCM) 40-way electrical connectors for damage or spread

DIAGNOSIS AND TESTING (Continued)

terminals. Verify the connectors are fully inserted into the socket of the PCM (Fig. 74). Ensure that wires are not stretched or pulled out of the connector.

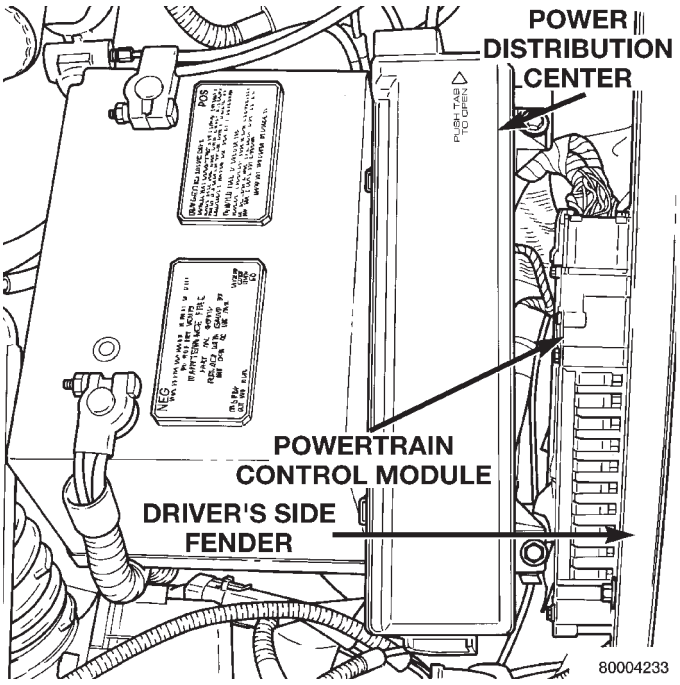


Fig. 74 Powertrain Control Module (PCM)

(24) Inspect fuses in the Power Distribution Center (PDC). Verify all fuses and relays are fully inserted into the PDC (Fig. 74). A label affixed to the underside of the PDC cover identifies the relays and fuses in the PDC.

(25) Check Battery Cable Connections.

(26) Check hose and wiring connections at fuel pump module. Check that wiring connector is making contact with terminals on pump.

VISUAL INSPECTION—3.3/3.8L ENGINES

A visual inspection for loose, disconnected, or misrouted wires and hoses should be made before attempting to diagnose or service the fuel injection system. A visual check helps save unnecessary test and diagnostic time. A thorough visual inspection will include the following checks:

(1) Check ignition cable routing from the coil pack to the spark plugs. Verify the cable are routed in the correct order and are fully seated to the coil and spark plug.

(2) Check direct ignition system (DIS) coil electrical connection for damage and a complete connection to the coil pack (Fig. 75).

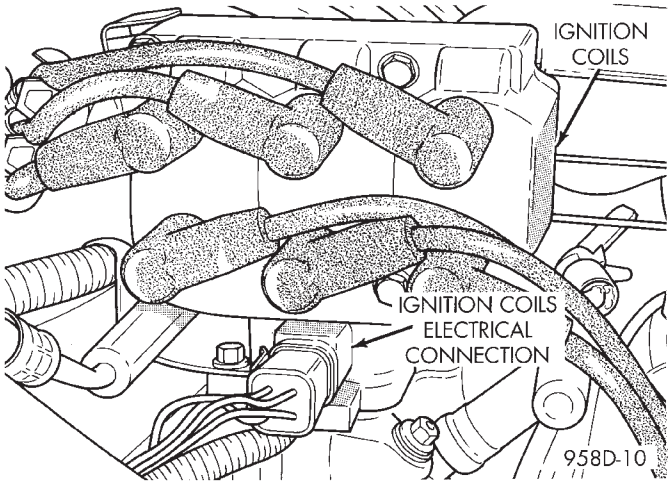


Fig. 75 Ignition Coil Pack Electrical Connection

(3) Verify the camshaft position sensor electrical connector is connected to the harness and not damaged (Fig. 76).

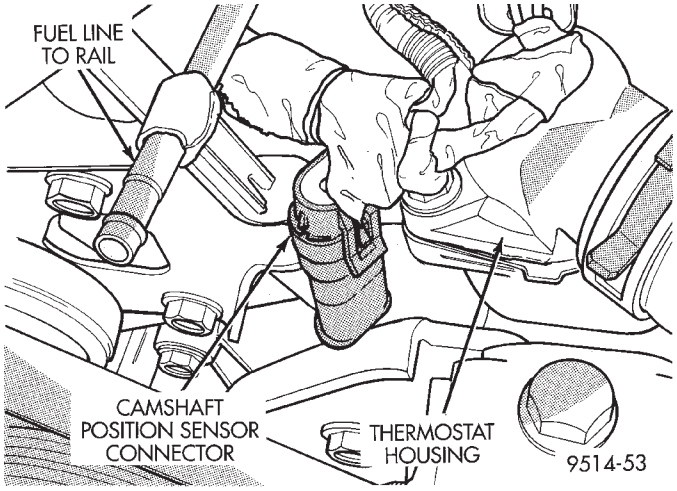


Fig. 76 Camshaft Position Sensor

(4) Ensure the engine temperature sensor electrical connector is connected to the sensor and not damaged (Fig. 77).

(5) Verify the quick connect fuel fitting is fully inserted on the fuel supply tube.

(6) Check the oil pressure sending unit electrical connection (Fig. 78).

DIAGNOSIS AND TESTING (Continued)

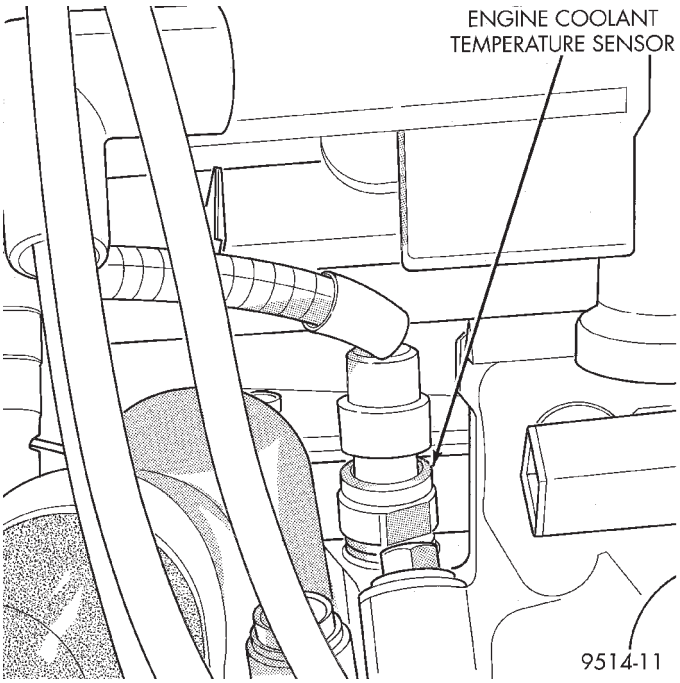


Fig. 77 Engine Coolant Temperature Sensor

(7) Verify the electrical connector at the knock sensor is fully seated and not damaged (Fig. 78).

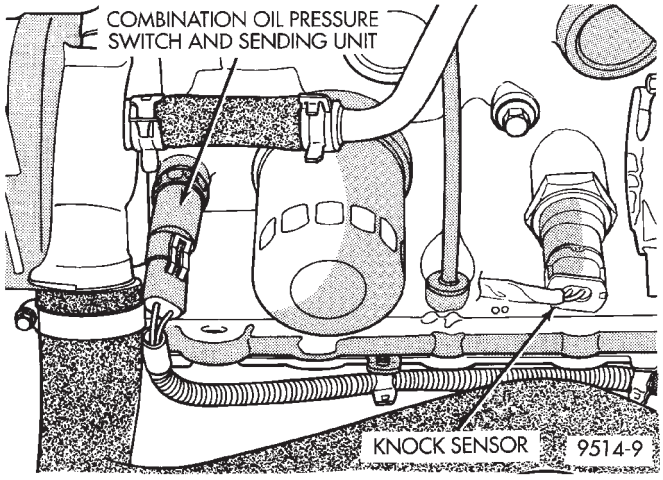


Fig. 78 Knock Sensor and Oil Pressure Sending Unit Electrical Connection

(8) Verify the electrical connector is attached to the Proportional purge solenoid (Fig. 79) and not damaged.

(9) Verify the vacuum connection at the Proportional purge solenoid is secure and not leaking (Fig. 79).

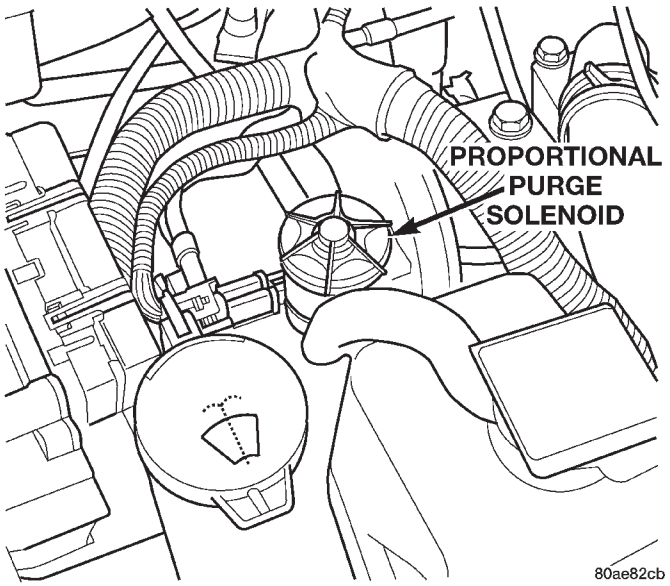


Fig. 79 Proportional Purge Solenoid

(10) Verify the hoses are securely attached to the EVAP canister (Fig. 80).

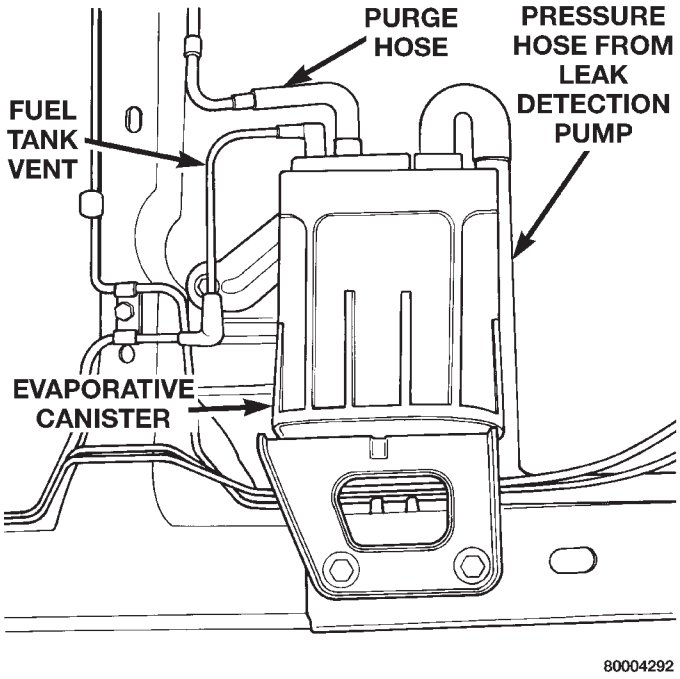


Fig. 80 Evaporative Canister

(11) Ensure the harness connectors for the fuel injectors are attached to the correct injector and not damaged.

(12) Verify the fuel injector harness and engine wiring harness connectors are fully inserted into the main wiring harness.

DIAGNOSIS AND TESTING (Continued)

(13) Check the vacuum connections at the throttle body and intake plenum (Fig. 81).

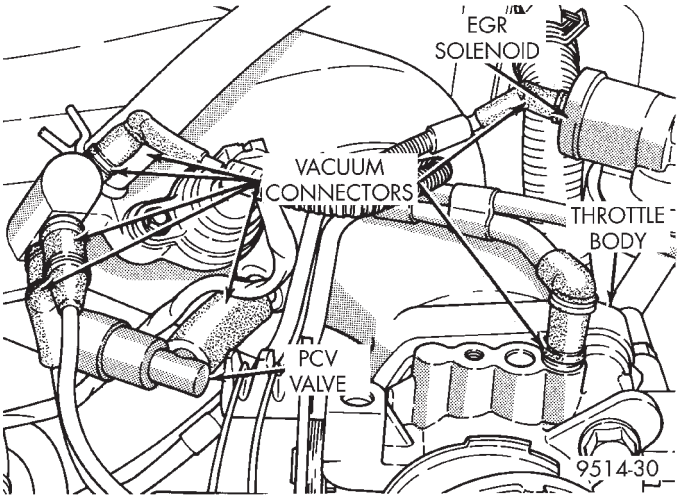


Fig. 81 Throttle Body Vacuum Connections

(14) Ensure the idle air control motor and TPS electrical connectors are fully seated and not damaged (Fig. 82).

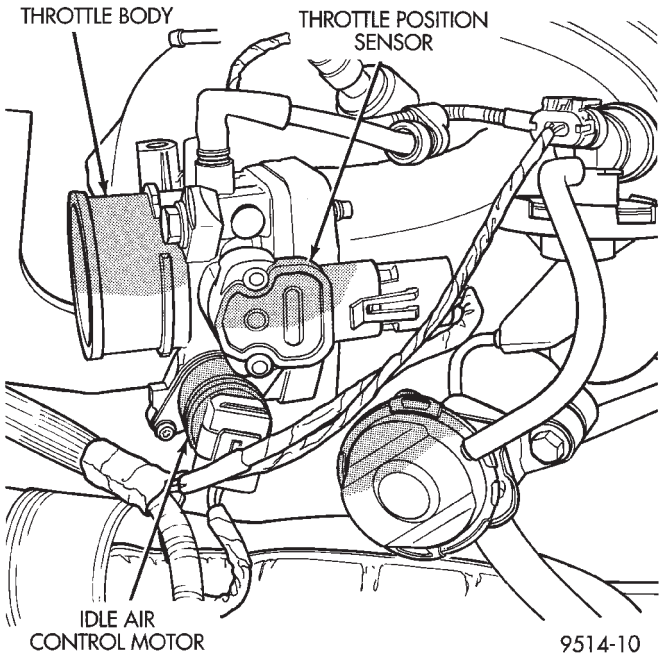


Fig. 82 Throttle Body Electrical Connections

(15) Inspect the park/neutral switch wiring connection for damage. Ensure the automatic transaxle electrical connections are not damaged (Fig. 83).

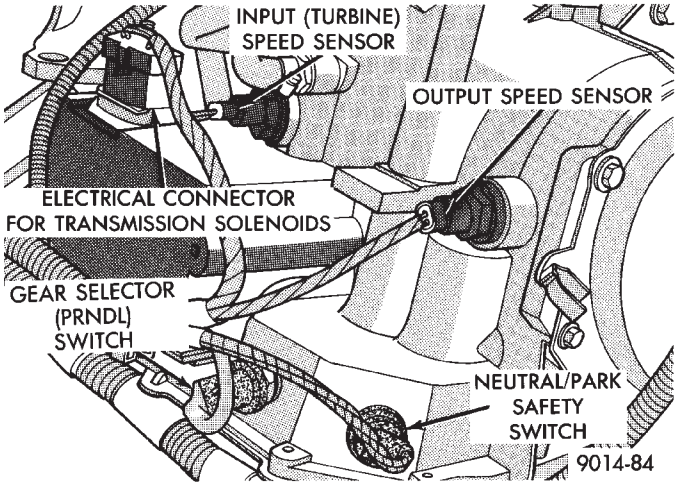


Fig. 83 Automatic Transaxle Electrical Connections

(16) Inspect the PCV system connections for damage (Fig. 84).

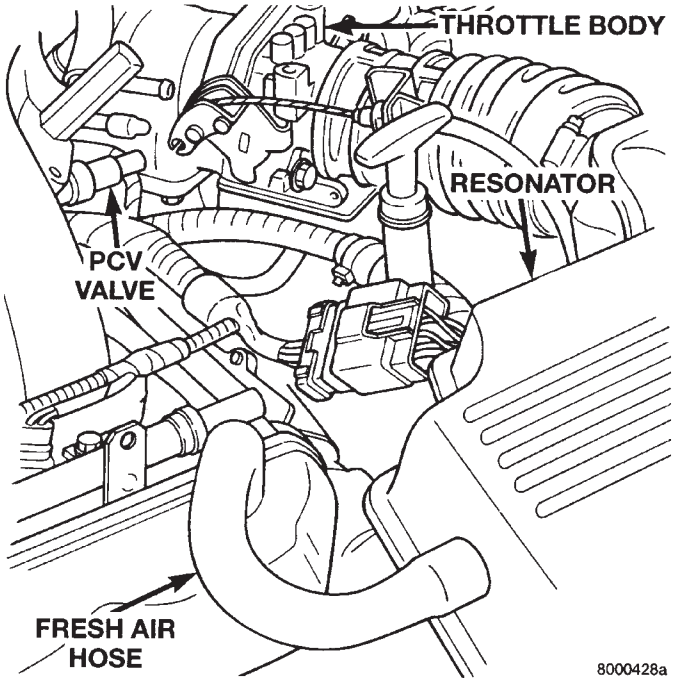


Fig. 84 PCV Valve and Fresh Air Hose

(17) Inspect the crankshaft position sensor electrical connector for damage (Fig. 85).

(18) Verify the Manifold Absolute Pressure (MAP) sensor electrical connector is attached to the sensor and not damaged (Fig. 86).

DIAGNOSIS AND TESTING (Continued)

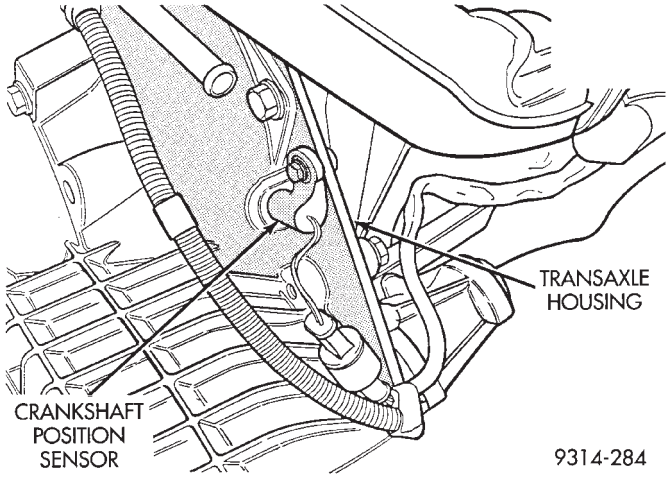


Fig. 85 Crankshaft Position Sensor

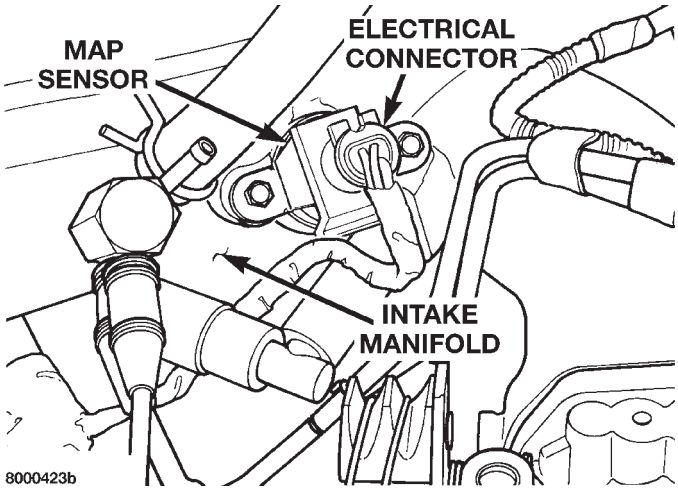


Fig. 86 MAP Sensor

(19) Check the heated oxygen sensor electrical connectors for damage (Fig. 87) and (Fig. 88).

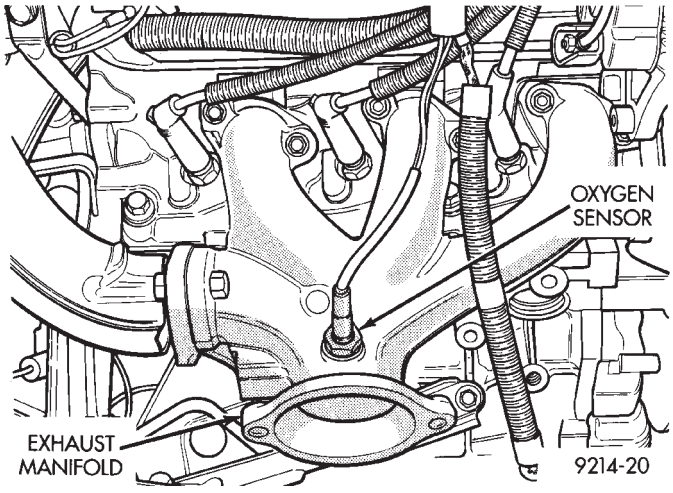


Fig. 87 Upstream Heated Oxygen Sensor

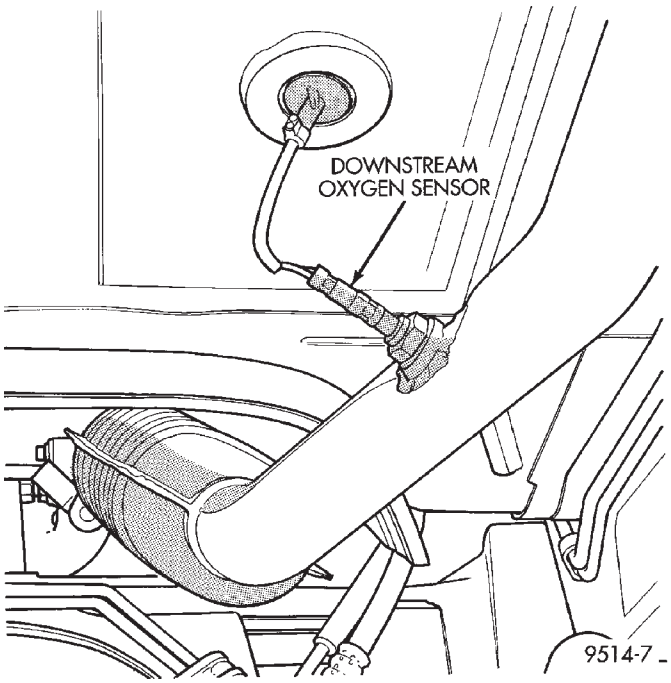


Fig. 88 Downstream Heated Oxygen Sensor

(20) Verify the engine ground strap is attached at the engine and dash panel. Inspect the strap for corrosion or damage.

(21) Inspect the generator wiring connections for damage.

(22) Check the accessory drive belt tension.

(23) Check the 40-way electrical connectors at the Powertrain Control Module (PCM) (Fig. 89) for damage or spread terminals. Verify that the connectors are fully inserted into the PCM sockets. Ensure the wires are not stretched or pulled out of the connector.

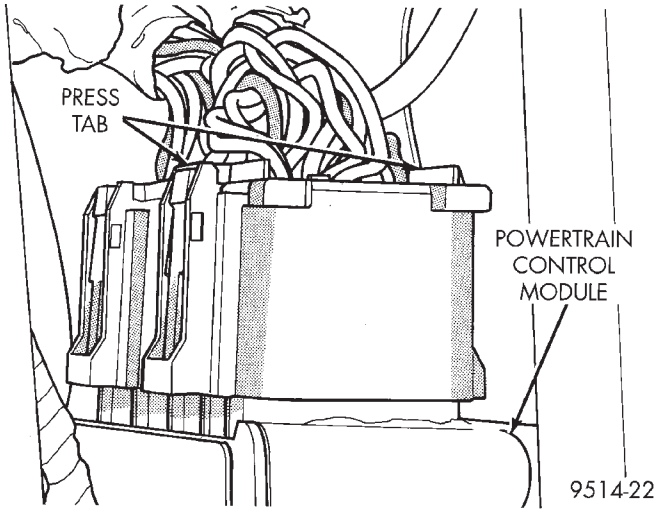


Fig. 89 Powertrain Control Module (PCM) Connectors

(24) Inspect fuses in the Power Distribution Center (PDC). Verify all fuses and relays are fully

DIAGNOSIS AND TESTING (Continued)

inserted into the PDC (Fig. 90). A label affixed to the underside of the PDC cover identifies the relays and fuses in the PDC.

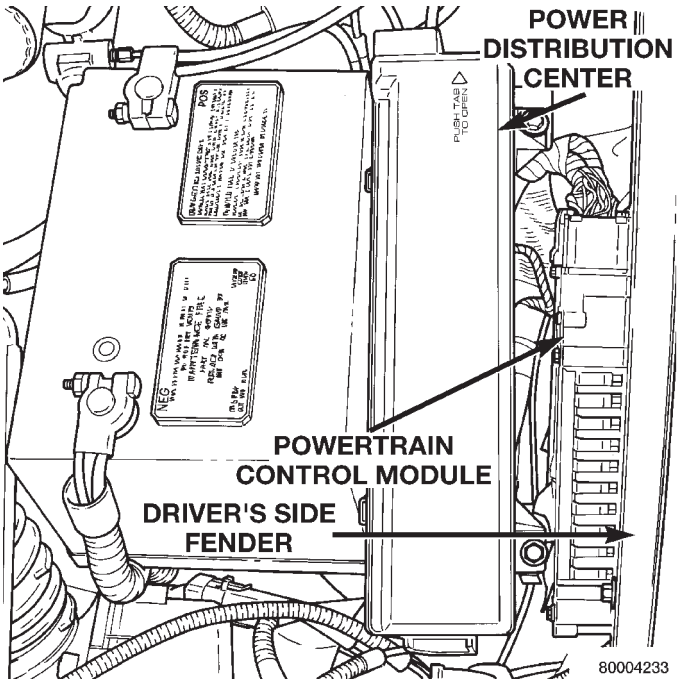


Fig. 90 Power Distribution Center (PDC)

(25) Inspect battery cable connections for corrosion.

(26) Check the power brake booster hose connection (without anti-lock brake systems) (Fig. 91).

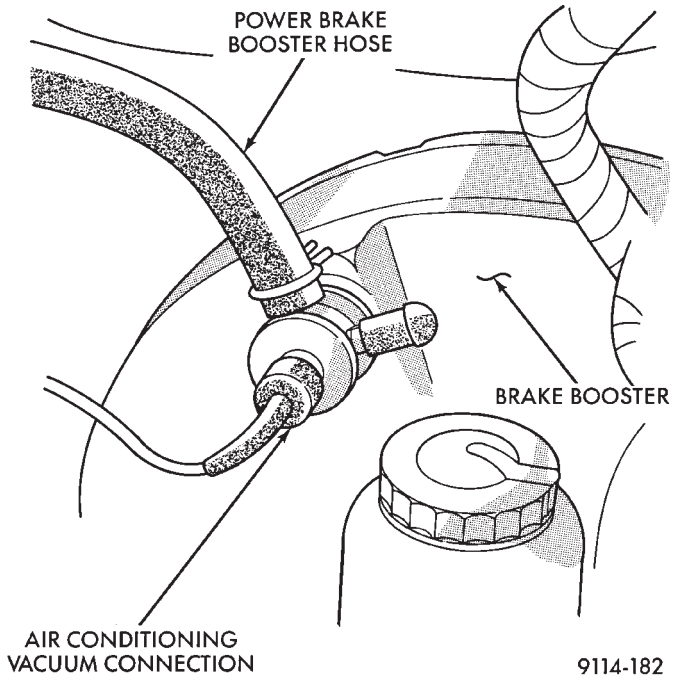


Fig. 91 Power Brake Booster Hose

(27) Inspect the speed control vacuum connection (Fig. 92).

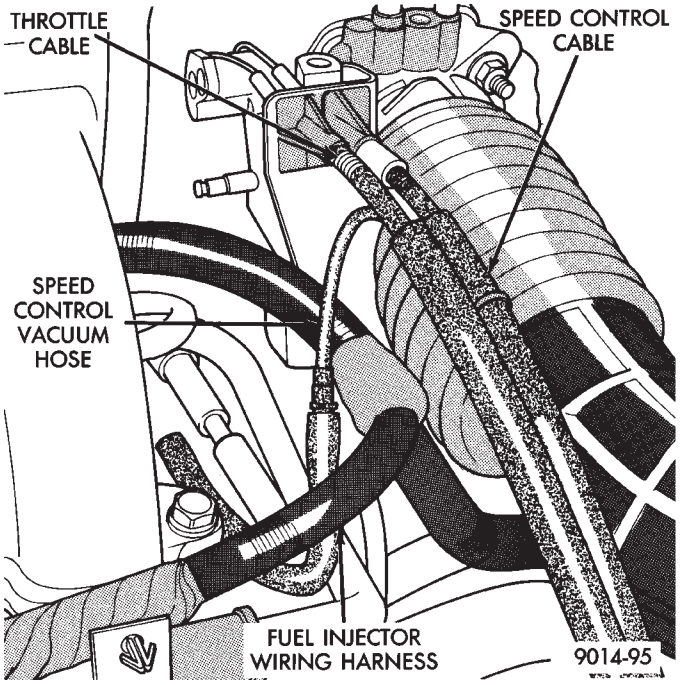
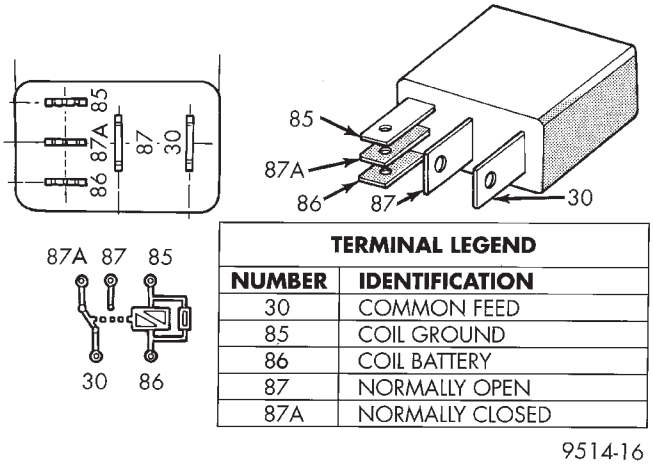


Fig. 92 Speed Control Vacuum

(28) Inspect hose and wiring connections at fuel pump module. Check that wiring connector is making contact with terminals on pump.

ASD AND FUEL PUMP RELAYS

The following description of operation and tests apply only to the Automatic Shutdown (ASD) and fuel pump relays. The terminals on the bottom of each relay are numbered (Fig. 93) or (Fig. 94).



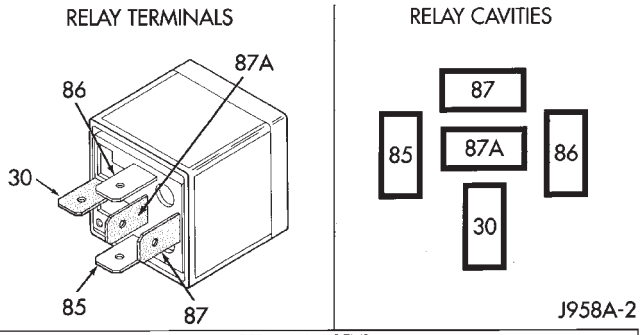
TERMINAL LEGEND	
NUMBER	IDENTIFICATION
30	COMMON FEED
85	COIL GROUND
86	COIL BATTERY
87	NORMALLY OPEN
87A	NORMALLY CLOSED

Fig. 93 ASD and Fuel Pump Relay Terminals

OPERATION

- Terminal number 30 is connected to battery voltage. For both the ASD and fuel pump relays, terminal 30 is connected to battery voltage at all times.

DIAGNOSIS AND TESTING (Continued)



TERMINAL LEGEND	
NUMBER	IDENTIFICATION
30	COMMON FEED
85	COIL GROUND
86	COIL BATTERY
87	NORMALLY OPEN
87A	NORMALLY CLOSED

Fig. 94 ASD and Fuel Pump Relay Terminals

- The PCM grounds the coil side of the relay through terminal number 85.
- Terminal number 86 supplies voltage to the coil side of the relay.
- When the PCM de-energizes the ASD and fuel pump relays, terminal number 87A connects to terminal 30. This is the Off position. In the off position, voltage is not supplied to the rest of the circuit. Terminal 87A is the center terminal on the relay.
- When the PCM energizes the ASD and fuel pump relays, terminal 87 connects to terminal 30. This is the On position. Terminal 87 supplies voltage to the rest of the circuit.

TESTING

The following procedure applies to the ASD and fuel pump relays.

(1) Remove relay from connector before testing.

(2) With the relay removed from the vehicle, use an ohmmeter to check the resistance between terminals 85 and 86. The resistance should be between 75 ±5 ohms.

(3) Connect the ohmmeter between terminals 30 and 87A. The ohmmeter should show continuity between terminals 30 and 87A.

(4) Connect the ohmmeter between terminals 87 and 30. The ohmmeter should not show continuity at this time.

(5) Connect one end of a jumper wire (16 gauge or smaller) to relay terminal 85. Connect the other end of the jumper wire to the ground side of a 12 volt power source.

(6) Connect one end of another jumper wire (16 gauge or smaller) to the power side of the 12 volt power source. **Do not attach the other end of the jumper wire to the relay at this time.**

WARNING: DO NOT ALLOW OHMMETER TO CONTACT TERMINALS 85 OR 86 DURING THIS TEST.

(7) Attach the other end of the jumper wire to relay terminal 86. This activates the relay. The ohmmeter should now show continuity between relay terminals 87 and 30. The ohmmeter should not show continuity between relay terminals 87A and 30.

(8) Disconnect jumper wires.

(9) Replace the relay if it did not pass the continuity and resistance tests. If the relay passed the tests, it operates properly. Check the remainder of the ASD and fuel pump relay circuits. Refer to group 8W, Wiring Diagrams.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

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

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

(1) Test the MAP sensor output voltage at the MAP sensor connector between terminals 2 and 3 (Fig. 95). With the ignition switch ON and the engine not running, 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. If OK, go to next step. If not OK, go to step 3.

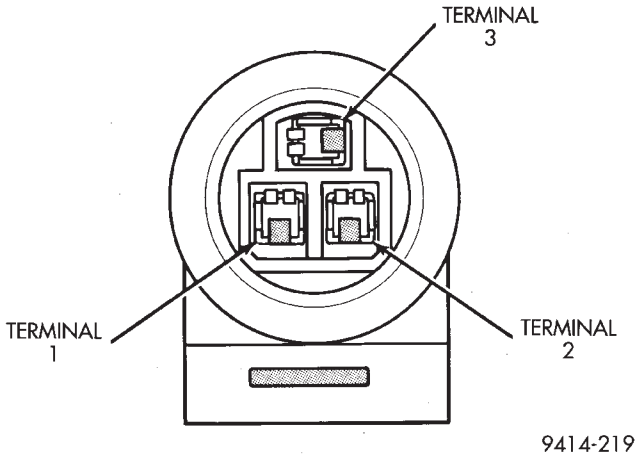


Fig. 95 MAP Sensor Connector

(2) Test PCM terminal 36 for the same voltage described in the previous step to verify wire harness condition. Repair as required.

(3) Test the MAP sensor ground circuit at sensor connector terminal 1 and PCM terminal 43. If OK, go to next step. If not OK, repair as required.

(4) Test MAP sensor supply voltage between sensor connector terminals 2 and 1 with the key ON. The voltage should be approximately 5 volts (±.5V). Five volts (±.5V) should also be at terminal 61 of the

DIAGNOSIS AND TESTING (Continued)

PCM. If OK, replace MAP sensor. If not OK, repair or replace the wire harness as required.

HEATED OXYGEN SENSOR

Use an ohmmeter to test the heating element of the oxygen sensors. Disconnect the electrical connector from each oxygen sensor. The white wires in the sensor connector are the power and ground circuits for the heater. Connect the ohmmeter test leads to terminals of the white wires in the heated oxygen sensor connector. Replace the heated oxygen sensor if the resistance is not between 4 and 7 ohms.

KNOCK SENSOR

The engine knock sensor is affected by a number of factors. A few of these are: ignition timing, cylinder pressure, fuel octane, etc. The knock sensor generates an AC voltage whose amplitude increases with the increase of engine knock. The knock sensor can be tested with a digital voltmeter. The RMS voltage starts at about 20mVac (at about 700 rpm) and increases to approximately 600 mVac (5000 rpm). If the output falls outside of this range a DTC will be set.

CAMSHAFT AND CRANKSHAFT POSITION SENSOR

Refer to Group 8D, Ignition for Diagnosis and Testing of Camshaft and Crankshaft Sensors.

ENGINE COOLANT TEMPERATURE SENSOR

(1) With the key off, disconnect wire harness connector from coolant temperature sensor (Fig. 96) or (Fig. 97) or (Fig. 98).

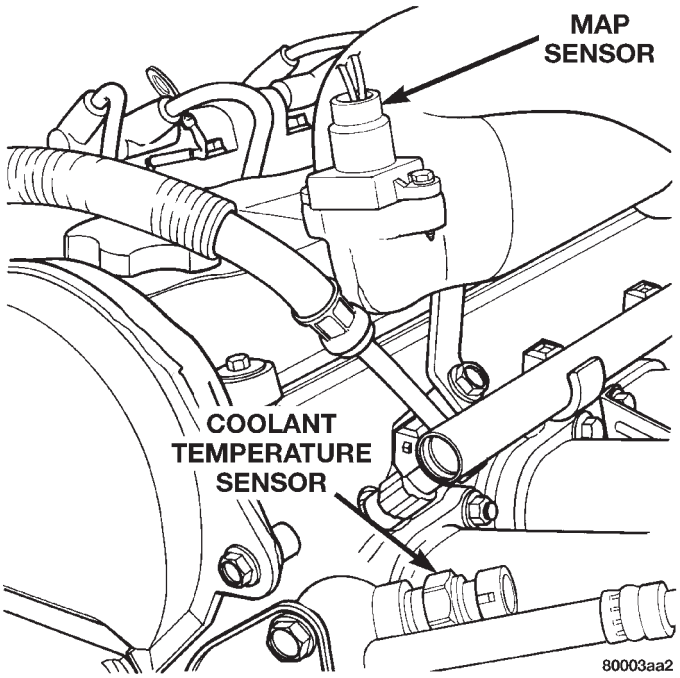


Fig. 96 Engine Coolant Temperature Sensor—2.4L

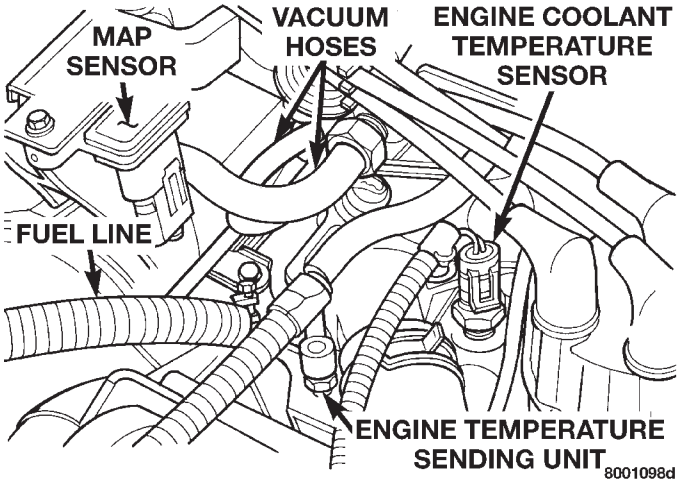


Fig. 97 Engine Coolant Temperature Sensor—3.0L

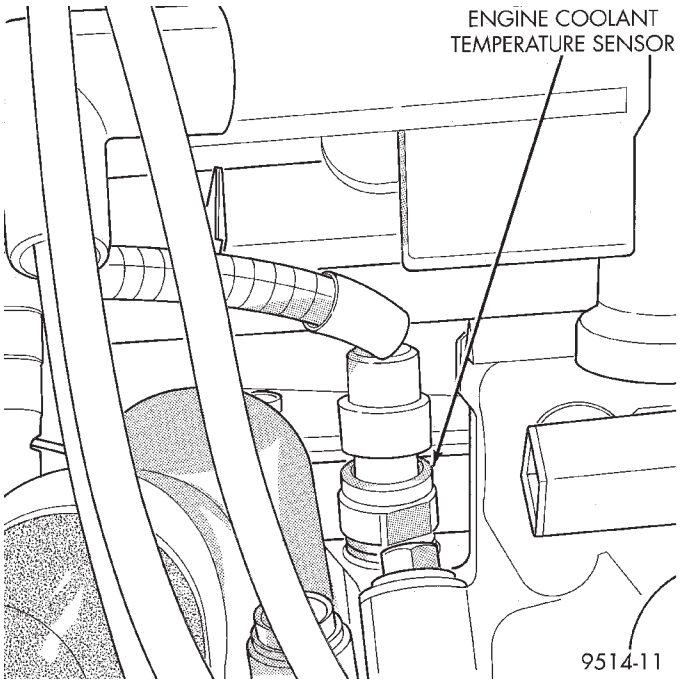


Fig. 98 Engine Coolant Temperature Sensor—3.3/ 3.8L

(2) Connect a high input impedance (digital) volt-ohmmeter to terminals A and B (Fig. 99). The ohmmeter should read as follows:

(a) ECT STET at normal operating temperature around 200°F should read approximately 700 to 1,000 ohms.

(b) ECT STET at room temperature around 70°F ohmmeter should read approximately 7,000 to 13,000 ohms.

(3) Test the resistance of the wire harness between the PCM connector terminal 26 and the sensor harness connector. Also check for continuity between PCM connector terminal 43 and the sensor harness connector. Refer to Group 8W, Wiring diagrams for

DIAGNOSIS AND TESTING (Continued)

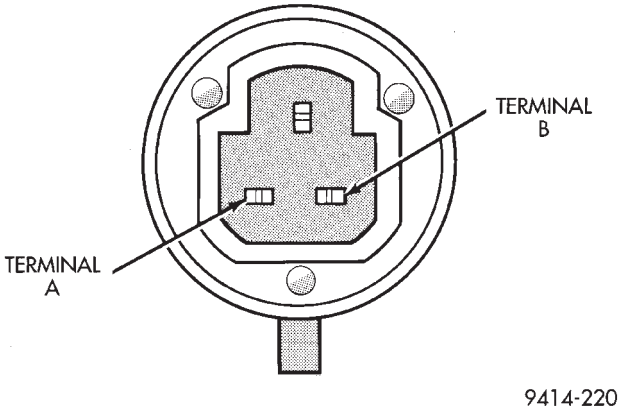


Fig. 99 Engine Coolant Temperature Sensor

circuit information. If the resistance is greater than 1 ohm, repair the wire harness as necessary.

THROTTLE POSITION SENSOR

To perform a complete test of the this sensor and its circuitry, refer to the DRB scan tool and appropriate Powertrain Diagnostics Procedures manual. To test the throttle position sensor only, refer to the following:

The Throttle Position Sensor (TPS) can be tested with a digital voltmeter (DVM). The center terminal of the sensor is the output terminal. One of the other terminals is a 5 volt supply and the remaining terminal is ground.

Connect the DVM between the center and sensor ground terminal. Refer to Group 8W - Wiring Diagrams for correct pinout.

With the ignition switch in the ON position, check the output voltage at the center terminal wire of the connector. Check the output voltage at idle and at Wide-Open-Throttle (WOT). At idle, TPS output voltage should be approximately 0.38 volts to 1.2 volts. At wide open throttle, TPS output voltage should be approximately 3.1 volts to 4.4 volts. The output voltage should gradually increase as the throttle plate moves slowly from idle to WOT.

Check for spread terminals at the sensor and PCM connections before replacing the TPS.

THROTTLE BODY MINIMUM AIR FLOW CHECK PROCEDURE

(1) Warm engine in Park or Neutral until the cooling fan has cycled on and off at least once.

(2) Ensure that all accessories are off.

(3) Shut off engine.

(4) **3.0L Engine**

(a) Hook-up the timing check device and tachometer.

(b) Disconnect the engine coolant temperature sensor and set basic timing to 12° BTDC ± 2°.

(c) Shut off engine. Reconnect coolant temperature sensor wire.

(5) Disconnect the PCV valve hose from the intake manifold nipple (Fig. 101), (Fig. 102) or (Fig. 103).

(6) Cap the PCV valve nipple.

(7) **3.3/3.8L Engines**

(a) Install Air Metering Fitting 6457 (0.125 in. orifice) to the intake manifold PCV nipple (Fig. 100).

(b) Disconnect the idle purge line from the throttle body nipple.

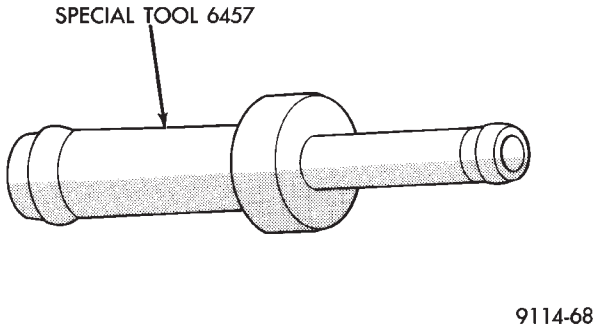


Fig. 100 Air Metering Fitting 6457

(8) **3.0/2.4L Engines**

(a) Install Air Metering Fitting 6457 (0.125 in. orifice) to the purge nipple on the throttle body.

(9) **3.3/3.8L Engines**

(a) Cap the 3/16 inch nipple.

(b) Connect the DRB scan tool to the data link connector.

(10) Restart the engine. Allow engine to idle until the cooling fan has cycled on and off at least one 180°F cycle.

(11) Using the DRB scan tool, access the Minimum Airflow Idle Speed screen.

(12) The following will then occur:

- Idle air control motor will fully close.
- Idle spark advance will become fixed.
- DRB scan tool displays engine rpm.

(13) If idle rpm is within the range shown in the Idle Specification chart, throttle body minimum airflow is set correctly.

IDLE SPECIFICATIONS—2.4L ENGINE

Odometer Reading	Idle RPM
Below 1000 Miles	500-875 RPM
Above 1000 Miles	550–875 RPM

DIAGNOSIS AND TESTING (Continued)

IDLE SPECIFICATIONS—3.0L ENGINE

Odometer Reading	Idle RPM
Below 1000 Miles	560-910 RPM
Above 1000 Miles	610-910 RPM

IDLE SPECIFICATIONS—3.3/3.3L ENGINE

Odometer Reading	Idle RPM
Below 1000 Miles	525–875 RPM
Above 1000 Miles	575–875 RPM

(14) If idle rpm is not within specifications, shut off the engine and clean the throttle body as follows:

(a) Remove the throttle body from engine.

WARNING: CLEAN THROTTLE BODY IN A WELL VENTILATED AREA. WEAR RUBBER OR BUTYL GLOVES, DO NOT LET MOPAR PARTS CLEANER COME IN CONTACT WITH EYES OR SKIN. AVOID INGESTING THE CLEANER. WASH THOROUGHLY AFTER USING CLEANER.

(b) While holding the throttle open, spray the entire throttle body bore and the manifold side of the throttle plate with Mopar Parts Cleaner. **Only use Mopar Parts Cleaner to clean the throttle body.**

(c) Using a soft scuff pad, clean the top and bottom of throttle body bore and the edges and manifold side of the throttle blade. **The edges of the throttle blade and portions of the throttle bore that are closest to the throttle blade when closed, must be free of deposits.**

(d) Use compressed air to dry the throttle body.

(e) Inspect throttle body for foreign material.

(f) Install throttle body on manifold.

(g) Repeat steps 1 through 12. If the minimum air flow is still not within specifications, the problem is not caused by the throttle body.

(15) Shut off engine.

(16) Remove Air Metering Fitting 6457 from the intake manifold PCV nipple. Reinstall the PCV valve hose.

(17) Uncap the throttle body idle purge nipple and connect the idle purge line.

(18) Remove DRB scan tool.

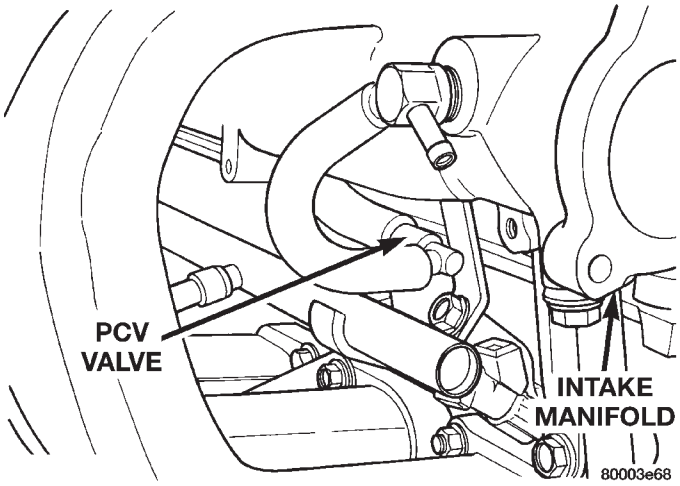


Fig. 101 PCV Valve—2.4L Engine

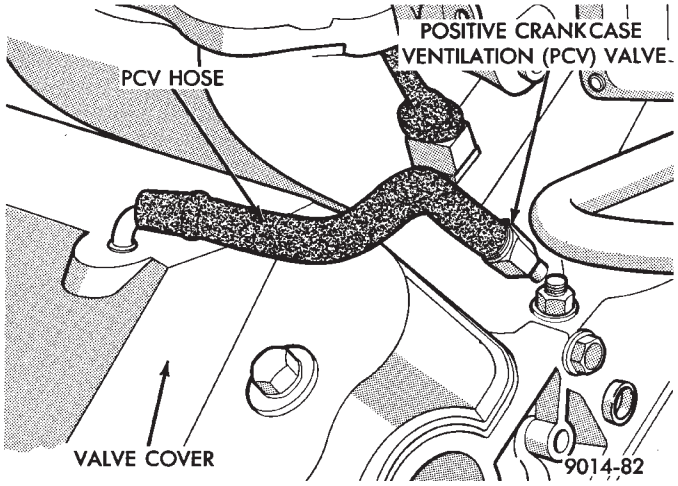


Fig. 102 PCV Valve—3.0L Engine

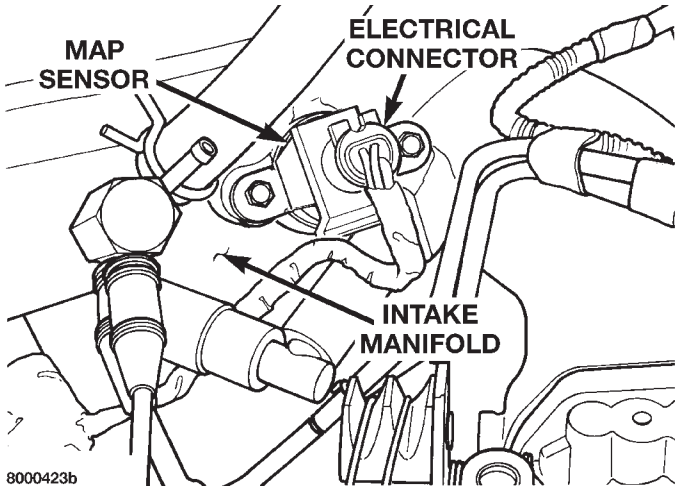


Fig. 103 PCV Valve—3.3/3.8L Engines

REMOVAL AND INSTALLATION

THROTTLE BODY

REMOVAL

(1) Disconnect negative cable from battery cable.
(2) Remove air inlet to throttle body hose clamp.
(3) Remove 2 screws and air inlet resonator (Fig. 104).

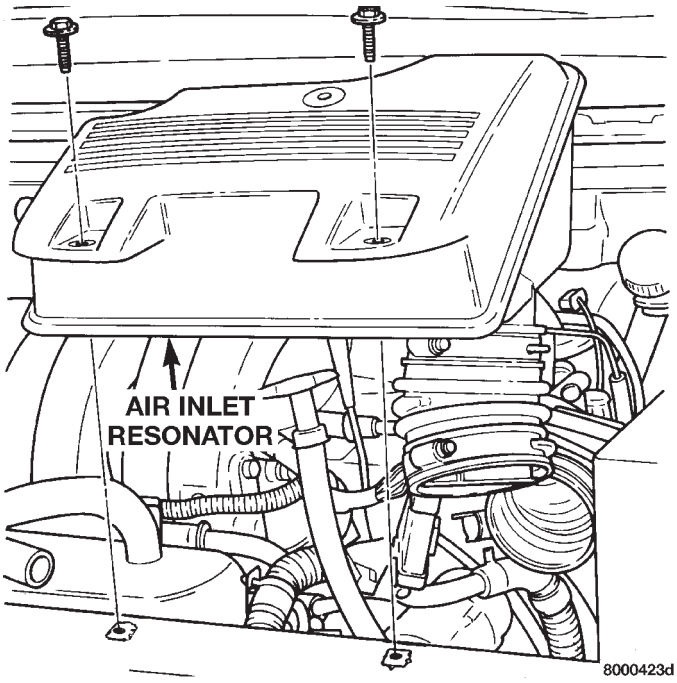


Fig. 104 Air Inlet Resonator

(4) Remove throttle and the speed control (if equipped) cables from lever and bracket (Fig. 105).

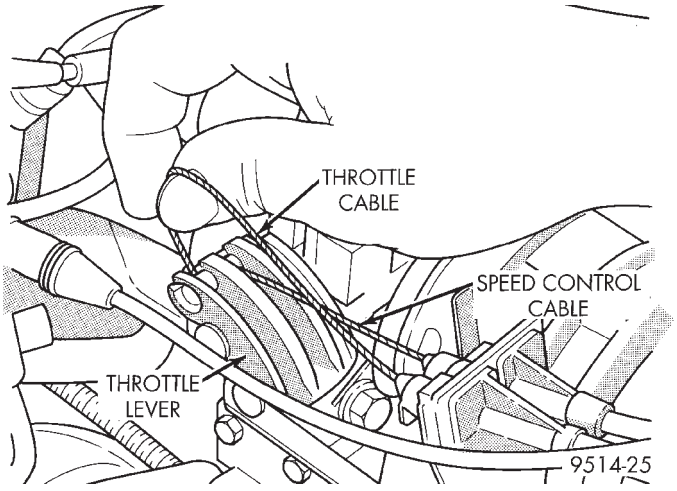


Fig. 105 Throttle Cable Attachment to Throttle Body Attachment

(5) Disconnect electrical connectors from the idle air control motor and throttle position sensor (TPS) (Fig. 106) or (Fig. 107) or (Fig. 108).

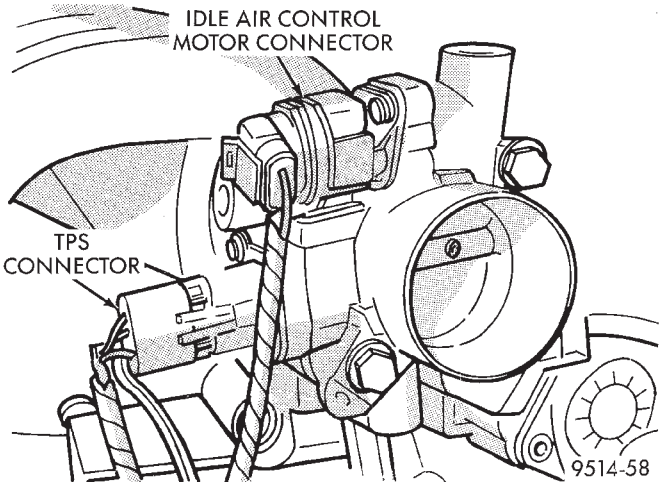


Fig. 106 Throttle Body Electrical and Vacuum Connections—2.4L

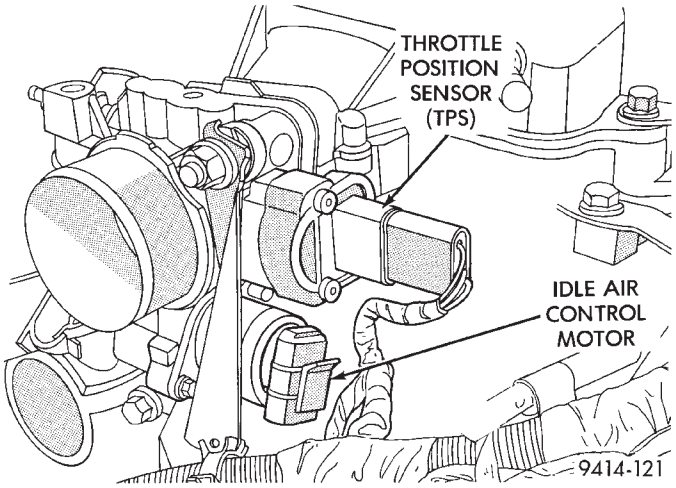


Fig. 107 Throttle Body Electrical and Vacuum Connections—3.0L

(6) Disconnect vacuum hoses from throttle body.
(7) Remove throttle body to intake manifold attaching nuts.
(8) Remove throttle body and gasket.

INSTALLATION

(1) Reverse procedure for installation. Tighten throttle body mounting nuts to 25 N·m (225 in. lbs.) torque.

FUEL PUMP RELAY

The fuel pump relay is located in the PDC. The inside top of the PDC cover has a label showing relay and fuse location.

AUTOMATIC SHUTDOWN (ASD) RELAY

The Automatic Shutdown relay (ASD) relay is located in the PCD. The inside top of the PDC cover has a label showing relay and fuse location.

REMOVAL AND INSTALLATION (Continued)

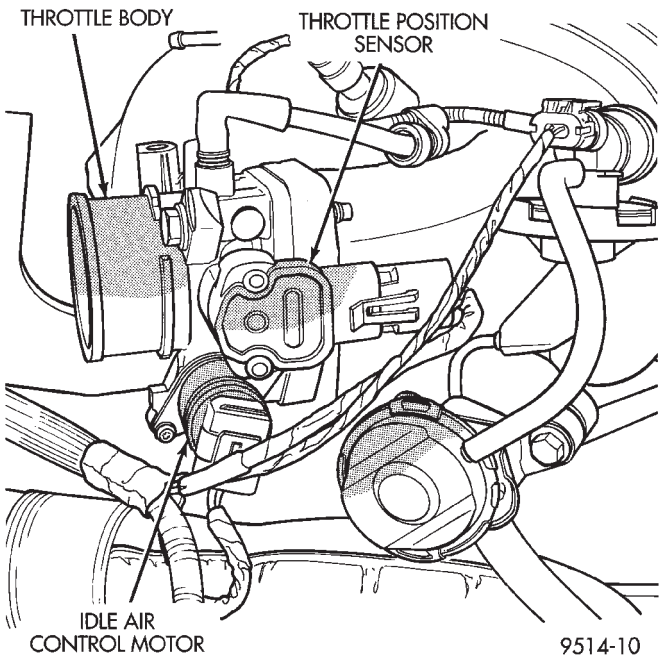


Fig. 108 Throttle Body Electrical and Vacuum Connections—3.3/3.8L

THROTTLE POSITION SENSOR

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove electrical connector from throttle position sensor.

(3) Remove throttle position sensor mounting screws.

(4) Lift throttle position sensor off throttle shaft (Fig. 109), (Fig. 110) or (Fig. 111).

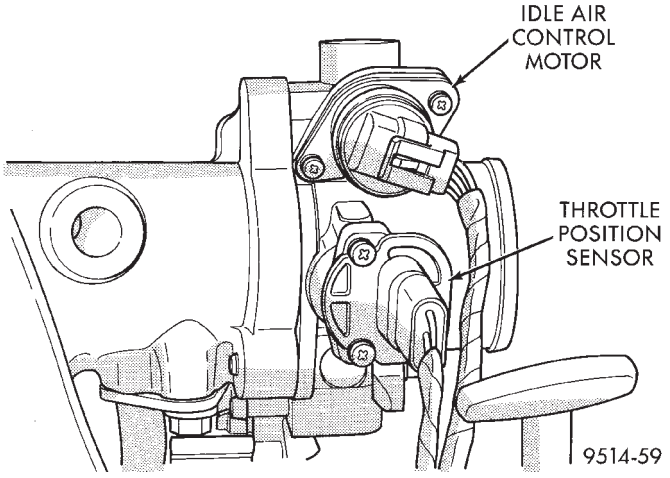


Fig. 109 Servicing Throttle Position Sensor—2.4L

INSTALLATION

(1) Install throttle position sensor on throttle shaft. Install mounting screws. Tighten screw to 2 N·m (17 in. lbs.) torque.

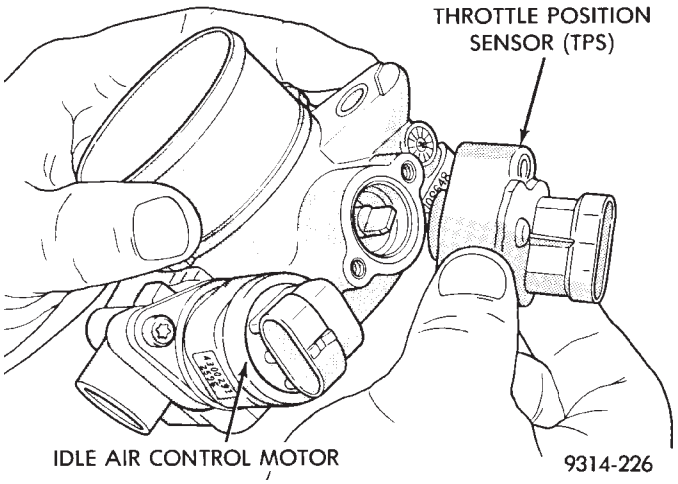


Fig. 110 Servicing Throttle Position Sensor—3.0L

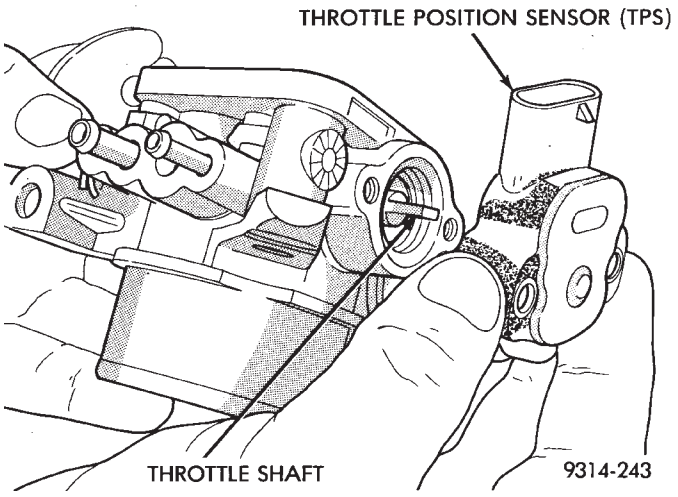


Fig. 111 Servicing Throttle Position Sensor—3.3/3.8L

(2) Connect electrical connector to throttle position sensor.

(3) Connect negative cable to battery.

IDLE AIR CONTROL MOTOR

When servicing throttle body components, always reassemble components with new O-rings and seals where applicable. Never use lubricants on O-rings or seals, damage may result. If assembly of component is difficult, use water to aid assembly. Use care when removing hoses to prevent damage to hose or hose nipple.

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove electrical connector from idle air control motor.

(3) Remove idle air control motor mounting screws (Fig. 112).

(4) Remove motor from throttle body. Ensure the O-ring is removed with the motor.

REMOVAL AND INSTALLATION (Continued)

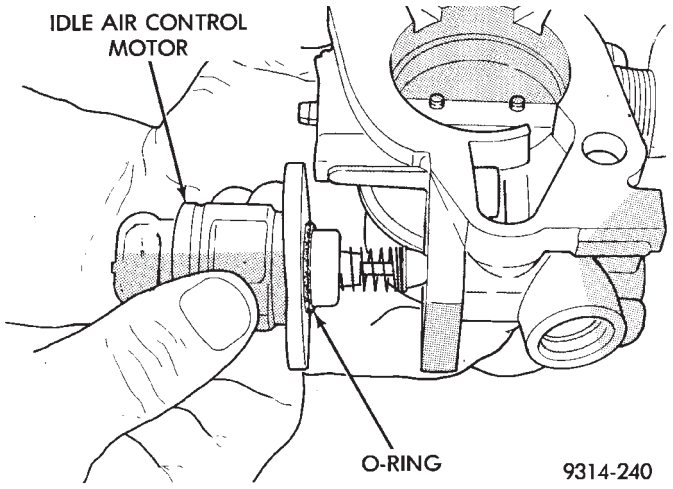


Fig. 112 Servicing Idle Air Control Motor

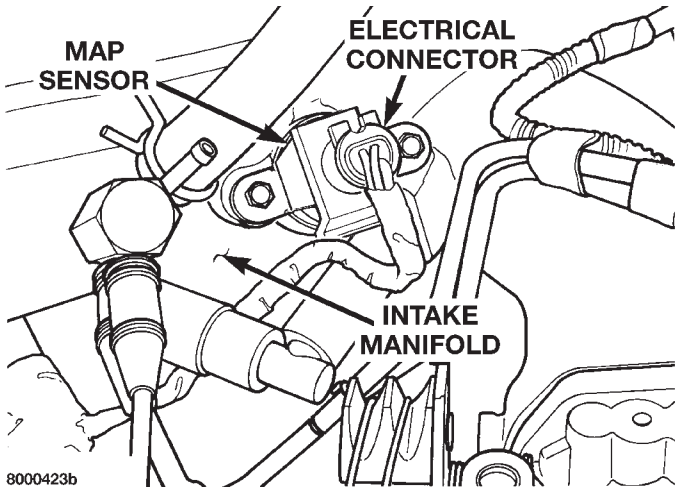


Fig. 113 Map Absolute Pressure Sensor

INSTALLATION

(1) The new idle air control motor has a new O-ring installed on it. If pintle measures more than 1 inch (25 mm) it must be retracted. Use the DRB Idle Air Control Motor Open/Close Test to retract the pintle (battery must be connected.)

(2) Carefully place idle air control motor into throttle body.

(3) Install mounting screws. Tighten screws to 2 N·m (17 in. lbs.) torque.

(4) Connect electrical connector to idle air control motor.

(5) Connect negative cable to battery.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—2.4/3.3/3.8L

REMOVAL

(1) Disconnect electrical connector from MAP sensor (Fig. 113).

(2) Remove two screws holding sensor to the intake manifold.

INSTALLATION

(1) Reverse the above procedure for installation.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—3.0L

REMOVAL

(1) Remove vacuum hose and mounting screws from manifold absolute pressure (MAP) sensor (Fig. 114).

(2) Disconnect electrical connector from sensor. Remove sensor.

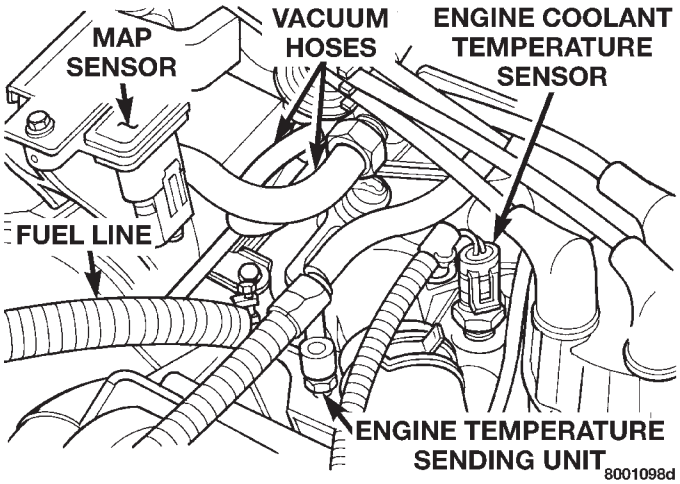


Fig. 114 Manifold Absolute Pressure Sensor

INSTALLATION

(1) Reverse the above procedure for installation.

PROPORTIONAL PURGE SOLENOID VALVE

REMOVAL

(1) Remove vacuum hose and electrical connector from solenoid (Fig. 115).

(2) Pull solenoid up to remove it from mounting bracket.

INSTALLATION

Reverse above procedure for installation.

REMOVAL AND INSTALLATION (Continued)

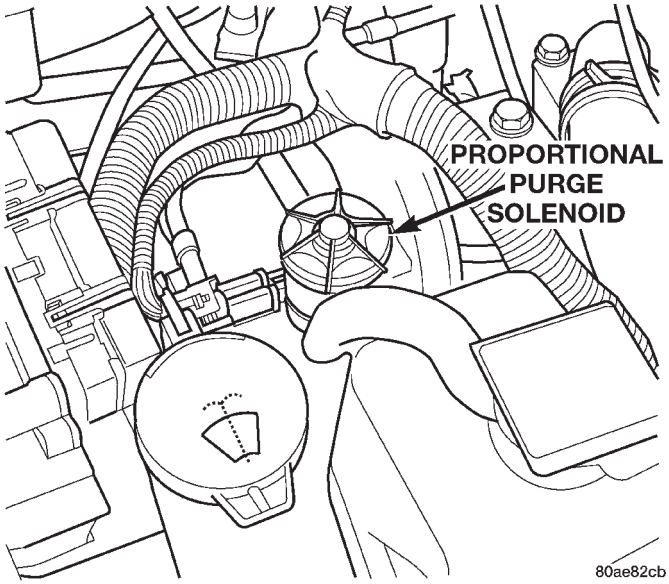


Fig. 115 Proportional Purge Solenoid Valve

POWERTRAIN CONTROL MODULE

REMOVAL

(1) Disconnect both cables from battery, negative cable first.

(2) Remove 2 screws holding Power Distribution Center (PDC) to bracket (Fig. 116).

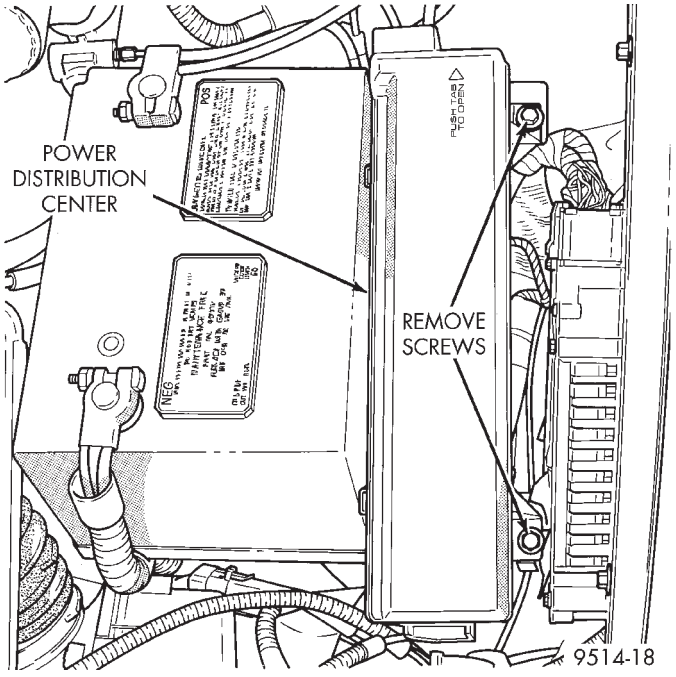


Fig. 116 Power Distribution Center Retaining Screws

(3) Remove heat shield from battery (Fig. 117).

(4) Remove nut and clamp holding battery to battery tray (Fig. 118).

(5) Remove battery from vehicle.

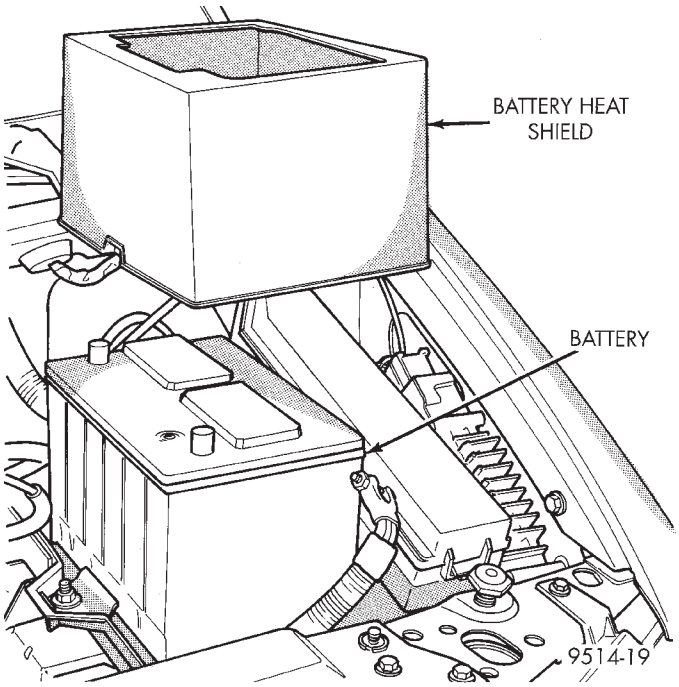


Fig. 117 Battery Heat Shield

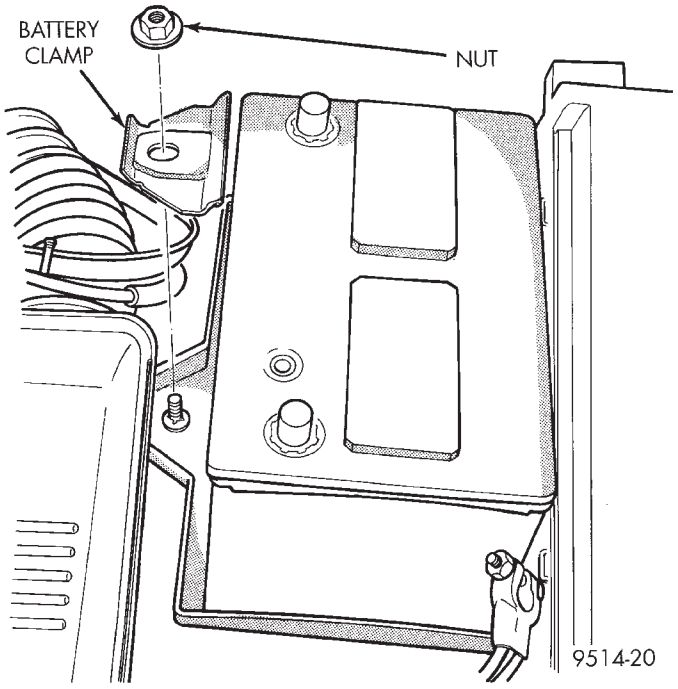


Fig. 118 Battery Clamp

(6) Rotate PDC toward center of vehicle to remove from rear bracket (Fig. 119).

(7) Pull PDC rearward to remove from front bracket. Lay PDC aside to allow access to Powertrain Control Module (PCM).

(8) Squeeze tabs on 40-way connector. Pull connector rearward to remove from PCM (Fig. 120). Remove both way connectors.

REMOVAL AND INSTALLATION (Continued)

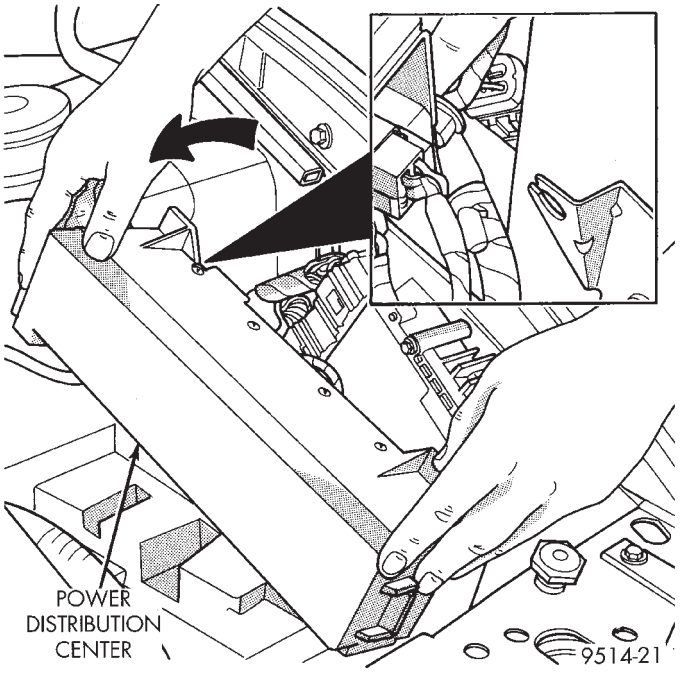


Fig. 119 PDC Rear Bracket

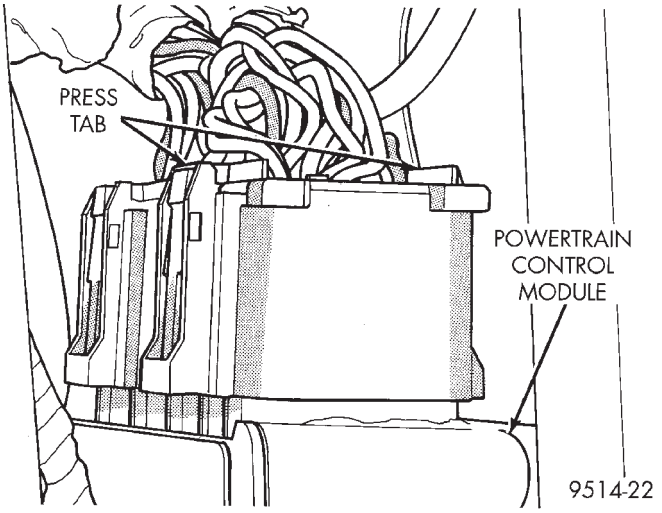


Fig. 120 PCM 40-Way Connectors

(9) Remove 3 screws holding PCM to fender (Fig. 121).

(10) Remove PCM from vehicle.

INSTALLATION

(1) Connect 2 40-Way electrical connectors to PCM (Fig. 120).

(2) Install PCM. Tighten mounting screws.

(3) Install PDC bracket.

(4) Install battery.

CRANKSHAFT POSITION SENSOR

For removal/installation procedures refer to group 8D - Ignition System, Service Procedures.

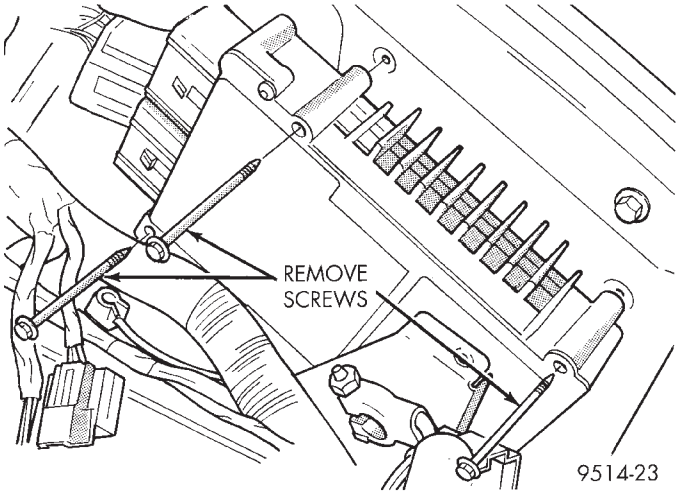


Fig. 121 PCM Removal/Installation

CAMSHAFT POSITION SENSOR

For removal/installation procedures refer to group 8D - Ignition System, Service Procedures.

UPSTREAM OXYGEN SENSOR

The oxygen sensor is installed in the exhaust manifold (Fig. 122) or (Fig. 123) or (Fig. 124).

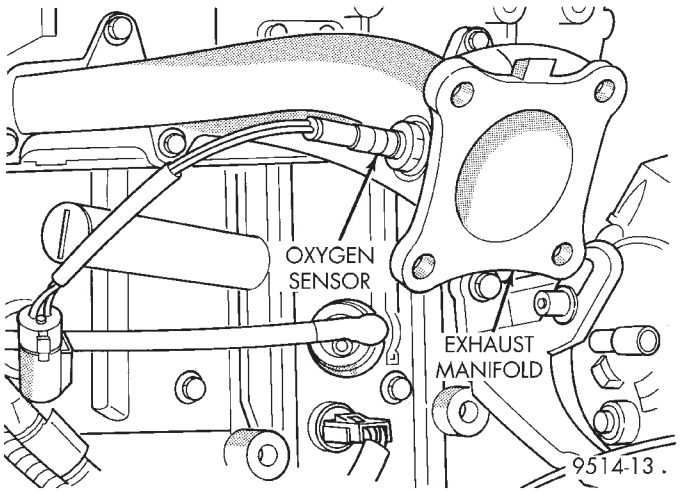


Fig. 122 Upstream Heated Oxygen Sensor—2.4L

CAUTION: Do not pull on the oxygen sensor wire when unplugging the electrical connector.

WARNING: THE EXHAUST MANIFOLD AND CATALYTIC CONVERTER MAY BE EXTREMELY HOT. USE CARE WHEN SERVICING THE OXYGEN SENSOR.

REMOVAL

(1) Raise and support vehicle.

(2) Unplug oxygen sensor electrical connector.

(3) Use a socket such as Snap-On YA8875 or equivalent to remove sensor.

REMOVAL AND INSTALLATION (Continued)

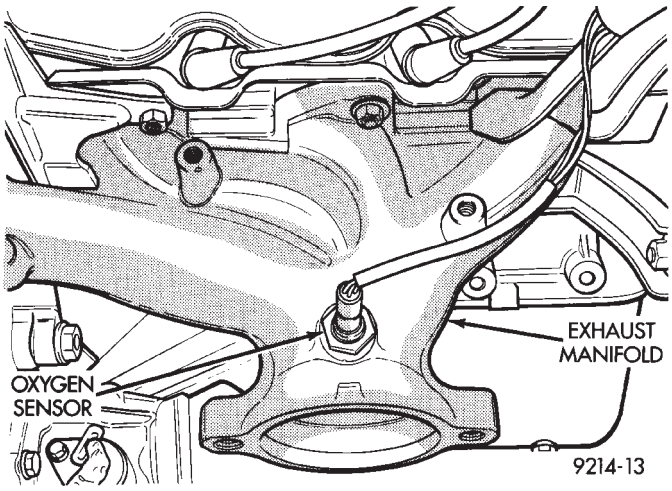


Fig. 123 Upstream Heated Oxygen Sensor—3.0L

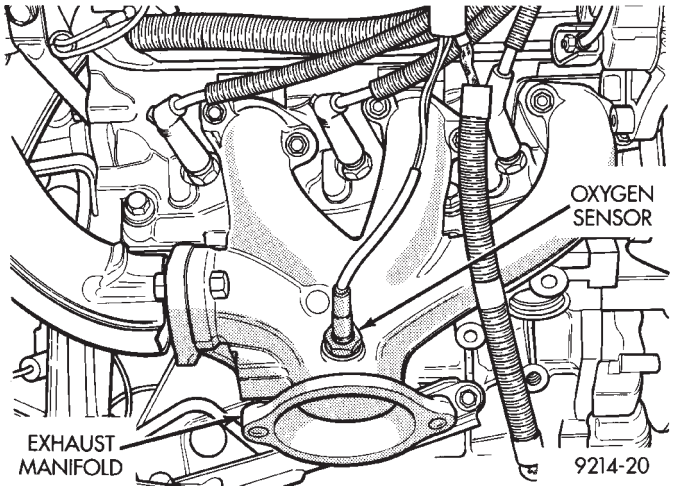


Fig. 124 Upstream Heated Oxygen Sensor—3.3/3.8L

(4) When the sensor is removed, the exhaust manifold threads must be cleaned with an 18 mm X 1.5 + 6E tap. If using original sensor, coat the threads with Loctite 771-64 anti-seize compound or equivalent.

INSTALLATION

(1) Reverse removal procedure to install a new sensor.

New sensors are packaged with compound on the threads and no additional compound is required. The sensor must be tightened to 27 N·m (20 ft. lbs.) torque.

DOWNSTREAM OXYGEN SENSOR

REMOVAL

(1) Raise and support vehicle.

WARNING: THE EXHAUST MANIFOLD MAY BE EXTREMELY HOT. USE CARE WHEN SERVICING THE OXYGEN SENSOR.

(2) Remove grommet cover to expose connector (Fig. 125).

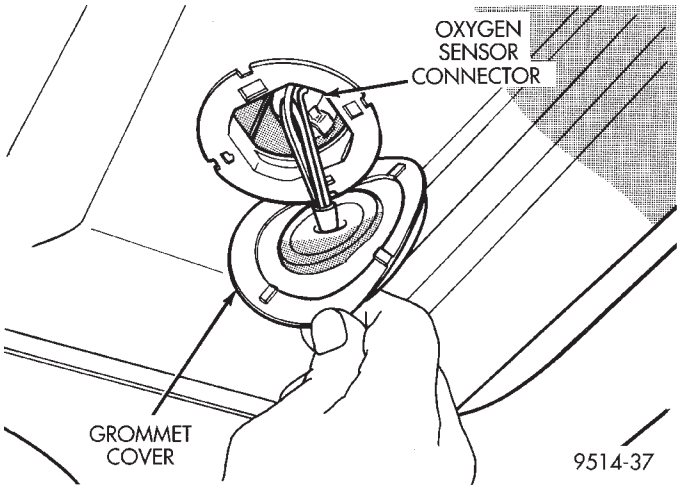


Fig. 125 Oxygen Sensor Grommet Cover

(3) Push locking tab back and unplug oxygen sensor electrical connector (Fig. 126).

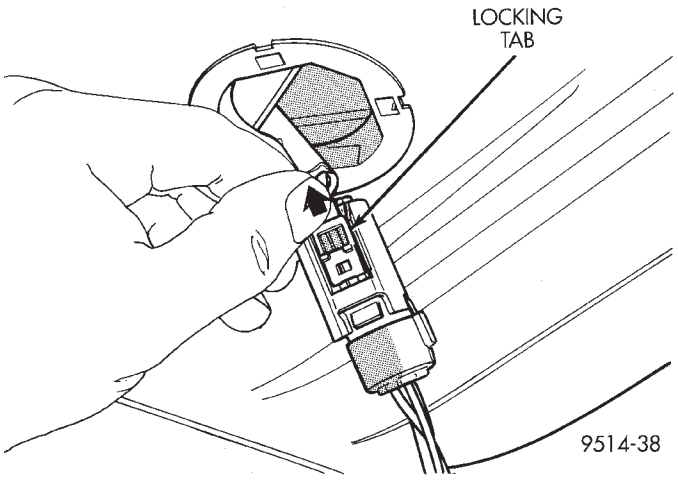


Fig. 126 Oxygen Sensor Connector Locking Tab

(4) Use a socket such as Snap-On YA8875 or equivalent to remove sensor (Fig. 127).

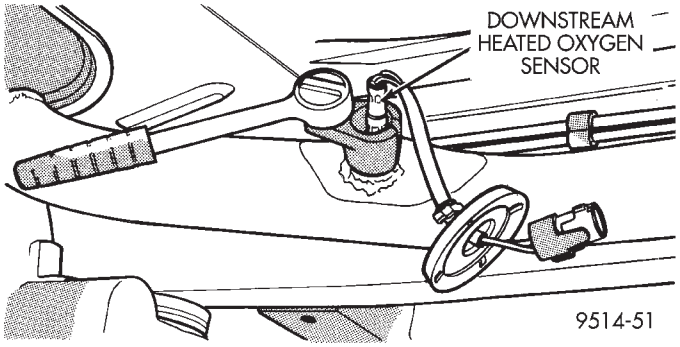


Fig. 127 Oxygen Sensor Removal/Installation

REMOVAL AND INSTALLATION (Continued)

(5) When the sensor is removed, the exhaust manifold threads must be cleaned with an 18 mm X 1.5 + 6E tap. If using original sensor, coat the threads with Loctite 771-64 anti-seize compound or equivalent.

INSTALLATION

(1) Reverse removal procedure to install a new sensor.

New sensors are packaged with compound on the threads and no additional compound is required. The sensor must be tightened to 27 N·m (20 ft. lbs.) torque.

KNOCK SENSOR

For removal/installation procedures refer to Group 8D- Ignition System, Service Procedures.

AIR CLEANER ELEMENT

REMOVAL

(1) Remove 2 screws and air inlet resonator (Fig. 128).

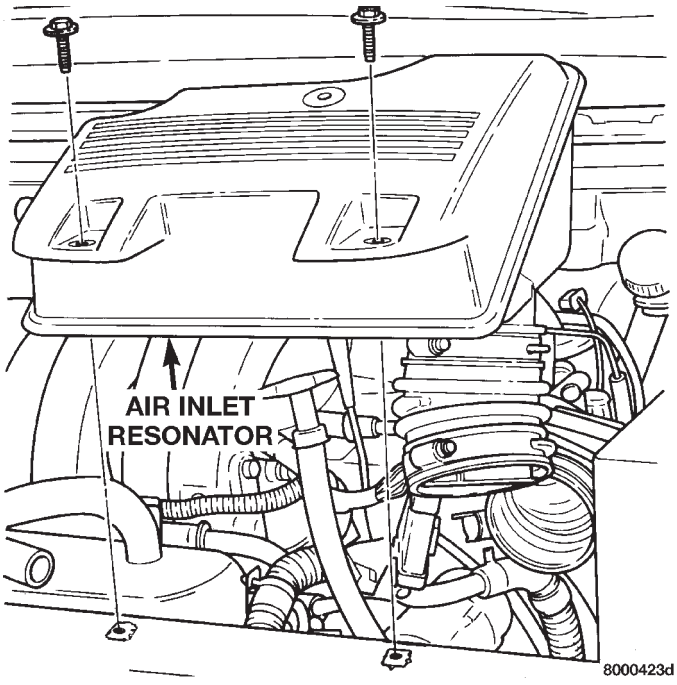


Fig. 128 Air Inlet Resonator

(2) Loosen 3 clamps holding air cleaner housing halves together.

(3) Remove left side of air cleaner housing (Fig. 129).

(4) Remove element from air cleaner housing (Fig. 130).

INSTALLATION

(1) Install a new element in housing.

(2) Position left side of housing.

(3) Snap clamps into place.

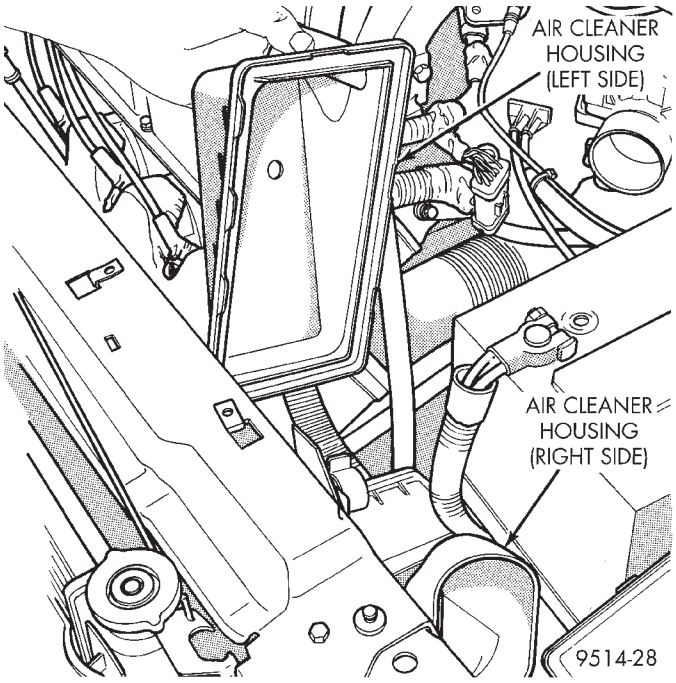


Fig. 129 Air Cleaner Housing (Left Side)

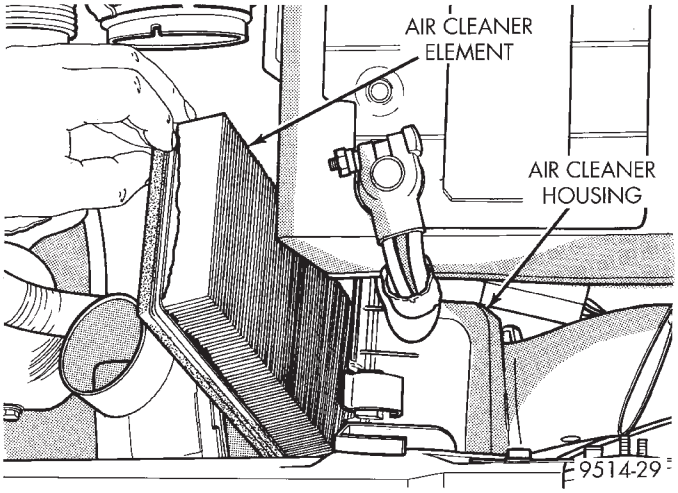


Fig. 130 Air Cleaner Element

(4) Install hoses and air inlet resonator.

ENGINE COOLANT TEMPERATURE SENSOR—2.4L

The coolant sensor threads into the top of the thermostat housing (Fig. 131). New sensors have sealant applied to the threads.

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.

REMOVAL AND INSTALLATION (Continued)

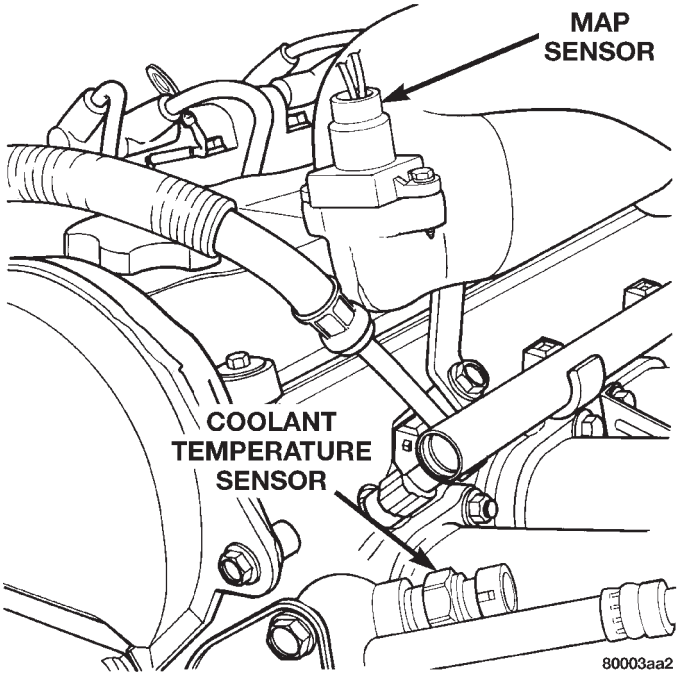


Fig. 131 Engine Coolant Temperature Sensor—2.4L

REMOVAL

(1) With the engine cold, drain coolant until level drops below cylinder head. Refer to Group 7, Cooling System.

(2) Disconnect coolant sensor electrical connector.

(3) Remove coolant sensor.

INSTALLATION

(1) Install coolant sensor. Tighten sensor to 7 N·m (60 in. lbs.) torque.

(2) Attach electrical connector to sensor.

(3) Fill cooling system. Refer to Group 7, Cooling System.

ENGINE COOLANT TEMPERATURE SENSOR—3.0L

The sensor is installed next to the thermostat housing (Fig. 114).

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.

REMOVAL

(1) With the engine cold, drain coolant until level drops below cylinder head. Refer to Group 7, Cooling System.

(2) Disconnect coolant sensor electrical connector.

(3) Remove coolant sensor.

INSTALLATION

(1) Install coolant sensor. Tighten sensor to 7 N·m (60 in. lbs.) torque.

(2) Attach electrical connector to sensor.

(3) Fill cooling system. Refer to Group 7, Cooling System.

ENGINE COOLANT TEMPERATURE SENSOR—3.3/3.8L

The sensor is installed next to the thermostat housing (Fig. 132).

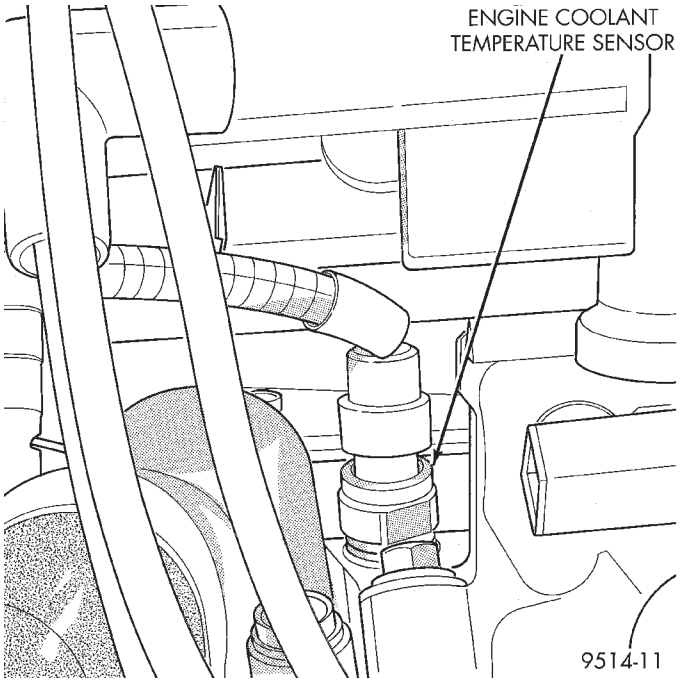


Fig. 132 Engine Coolant Temperature Sensor

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.

REMOVAL

(1) With the engine cold, drain coolant until level drops below cylinder head. Refer to Group 7, Cooling System.

(2) Disconnect coolant sensor electrical connector.

(3) Remove coolant sensor.

INSTALLATION

(1) Install coolant sensor. Tighten sensor to 7 N·m (60 in. lbs.) torque.

(2) Attach electrical connector to sensor.

(3) Fill cooling system. Refer to Group 7, Cooling System.

REMOVAL AND INSTALLATION (Continued)

INTAKE AIR TEMPERATURE SENSOR—2.4L

The intake air temperature sensor threads into the intake manifold plenum (Fig. 133).

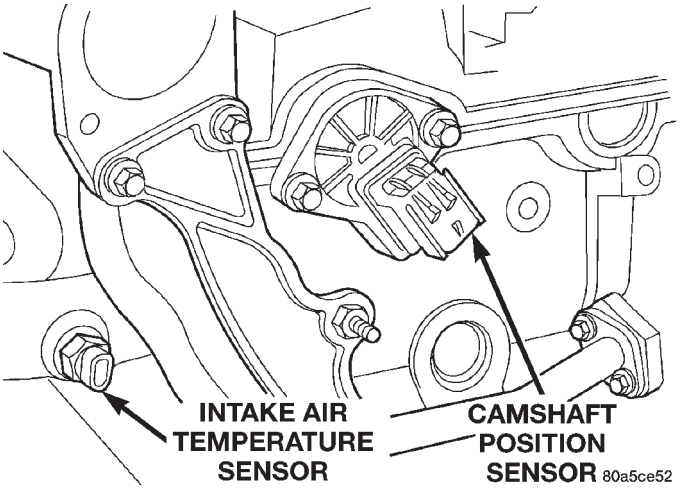


Fig. 133 Intake Air Temperature Sensor

REMOVAL

(1) Remove electrical connector from sensor.
(2) Remove sensor.

INSTALLATION

(1) Install sensor. Tighten sensor to 28 N·m (20 ft. lbs.) torque.
(2) Attach electrical connector to sensor.

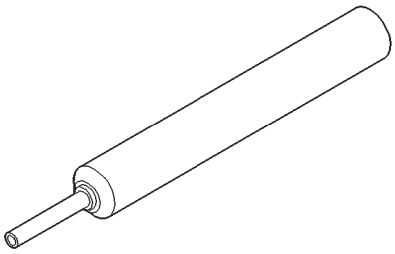
SPECIFICATIONS

TORQUE

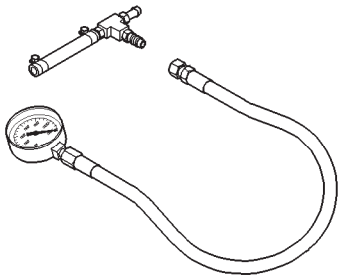
DESCRIPTION	TORQUE
Generator Brkt. to Intake Manifold Bolts—3.3/3.8L	54 N·m (40 ft. lbs.)
Coolant Sensor—2.4L	7 N·m (62 in. lbs.)
Coolant Sensor—3.0L	7 N·m (62 in. lbs.)
Coolant Sensor—3.3/3.8L	7 N·m (62 in. lbs.)
Cly. Head to Intake Manifold Strut Bolts—3.3/3.8L	54 N·m (40 ft. lbs.)
EGR Tube to Intake Manifold Screws	22 N·m (200 in. lbs.)
Idle Air Control Motor	2 N·m (18 in. lbs.)
Ignition Coil Fasteners	12 N·m (105 in. lbs.)
Intake Air Temperature Sensor	28 N·m (20 ft. lbs.)
MAP Sensor—2.4L	4 N·m (35 in. lbs.)
MAP Sensor—3.0L	4 N·m (35 in. lbs.)
MAP Sensor—3.3/3.8L	4 N·m (35 in. lbs.)
Upstream O2S	27 N·m (20 ft. lbs.)
Downstream O2S	27 N·m (20 ft. lbs.)
Throttle Body Bolts	26 N·m (225 in. lbs.)

SPECIAL TOOLS

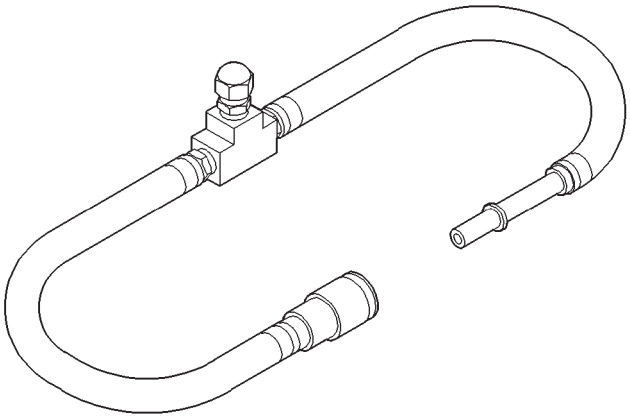
FUEL



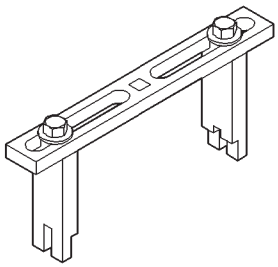
Extractor C–4334



Pressure Gauge Assembly C–4799–B

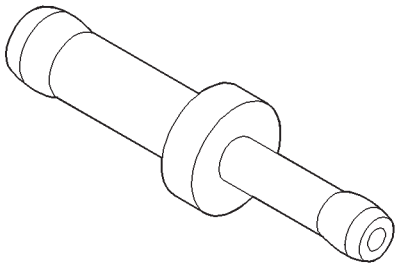


Fuel Pressure Test Adapter 6539

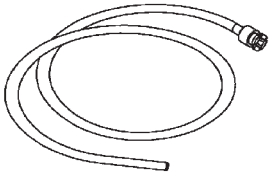


Spanner Wrench 6856

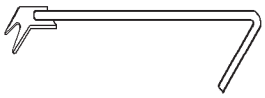
SPECIAL TOOLS (Continued)



Metering Orifice

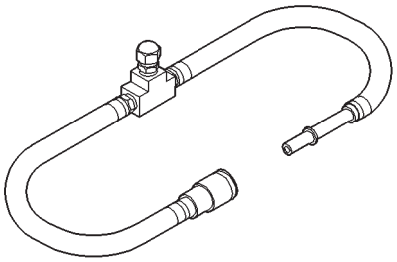


Fuel Line Adapter 1/4



Fuel Line Tool

O2S (Oxygen Sensor) Remover/Installer—C-4907



Fuel Line Adapter