

GENERAL MOTORS ELECTRONIC FUEL INJECTION – SINGLE UNIT

General Motors
1.8L (112") OHC
2.5L (151")

THROTTLE BODY APPLICATION

Application	Rochester Throttle Body No.	
	Man. Trans.	Auto. Trans.
1.8L (112") OHC		
Nationwide	17082066	17082066
2.5L (151")		
Nationwide	17082060	17082060

THROTTLE BODY IDENTIFICATION

The throttle body identification number is "roll-stamped" on the front mounting flange on the throttle lever side of the throttle body. Alphabetical code letters are stamped on the throttle body at external tube locations to identify vacuum hose connections.

DESCRIPTION

The General Motors single unit Electronic Fuel Injection (EFI) system consists of 7 major sub-assemblies: Fuel supply system, Throttle Body Injector (TBI) assembly, Idle Air Control (IAC) system, Electronic Control Module (ECM), Electronic Spark Timing (EST), data sensors and emission controls.

Fuel is supplied to engine through an electronically pulsed (timed) injector valve located in throttle body on top of intake manifold. The ECM controls amount of fuel metered through injector valve based upon engine demand and efficiency information. The ECM is a digital electronic computer which receives and computes signals from various data sensors.

NOTE – Primary sub-systems which affect fuel system operation will be covered in this article: Fuel supply system, TBI assembly, IAC system, ECM and data sensors. Because of the interrelated functions of the Computer Command Control (CCC) system (the ECM is the "brain"), refer to "GENERAL MOTORS COMPUTER COMMAND SYSTEM" in Computerized Engine Controls section for more information.

OPERATION

FUEL SUPPLY SYSTEM

An electric fuel pump (located inside fuel tank as an integral part of fuel gauge sending unit) supplies fuel under pressure to throttle body. A fuel pump relay located on the right side of the engine compartment controls fuel pump operation. When the ignition switch is turned on, the fuel pump relay activates the fuel pump for 1½-2 seconds to prime the injector. If the ECM does not receive reference pulses from the distributor after this period, the ECM deactivates the fuel pump circuit. The fuel pump circuit will be activated again through the relay when the ECM receives distributor reference pulses.

THROTTLE BODY INJECTOR (TBI) ASSEMBLY

The TBI assembly is composed of 2 castings: a throttle body with a valve to control air flow and a fuel body with an integral pressure regulator and fuel injector. The throttle body casting may contain ports to generate vacuum signals for EGR valve, MAP sensor and canister purge system.

The pressure regulator is a diaphragm-operated relief valve with injector pressure on one side and air cleaner pressure on the other side. The pressure regulator maintains a constant pressure drop (about 10 psi) across the injector throughout all engine operating conditions. See Fig. 1.

The fuel injector is a solenoid-operated device controlled by the ECM. Fuel is supplied at the lower end of the injector by the

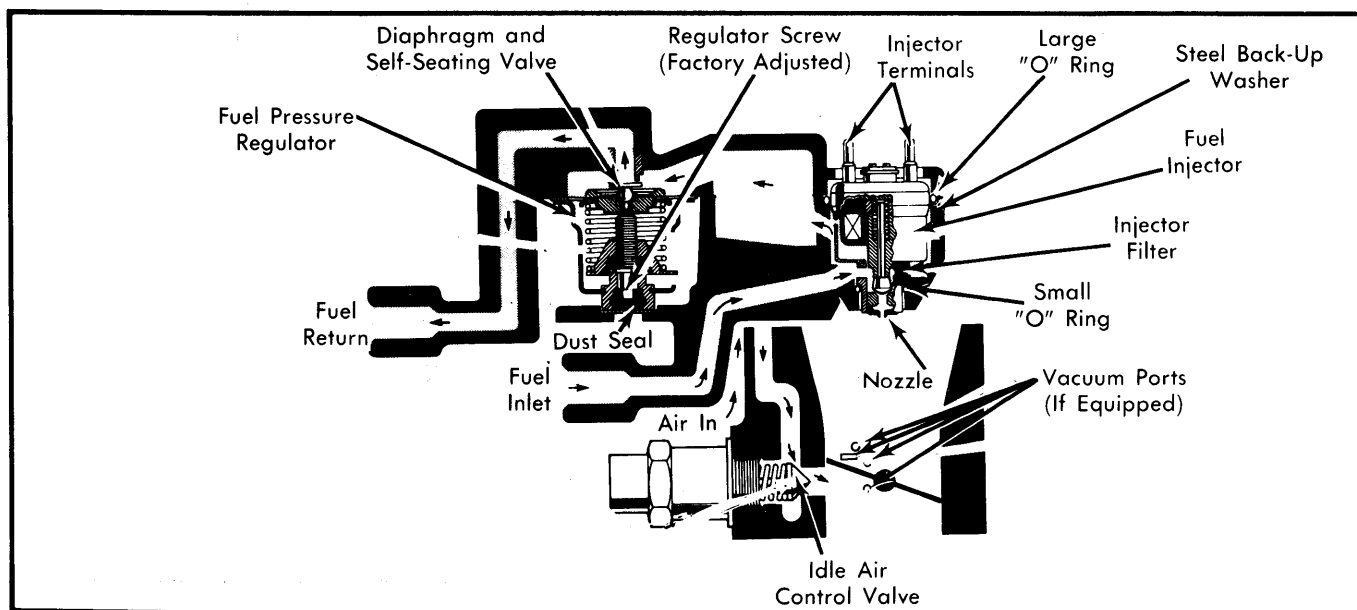


Fig. 1 Sectional View of Throttle Body Assembly

GENERAL MOTORS ELECTRONIC FUEL INJECTION – SINGLE UNIT (Cont.)

fuel supply system. The ECM activates the solenoid which lifts a normally closed ball valve off its seat. Fuel under pressure is injected in a conical spray pattern at the walls of the throttle bore above the throttle valve. Excess fuel passes through the pressure regulator and is returned to fuel tank.

IDLE AIR CONTROL (IAC) SYSTEM

The IAC system consists of an electrically controlled motor which positions the IAC valve in the air by-pass channel around the throttle plate. The ECM calculates the desired position of the IAC valve based upon battery voltage, coolant temperature, engine load and engine speed to control idle speed while preventing stalls due to engine load changes.

If engine speed is lower than desired, the ECM activates the motor to retract the IAC valve. When the IAC valve is retracted, more air is diverted around the throttle plate to increase engine speed. If engine speed is higher than desired, the ECM activates the motor to extend the IAC valve. When the IAC valve is extended, less air is diverted around the throttle plate to decrease engine speed. If engine speed falls below a preset speed and the throttle plate is closed, the ECM senses a near stall condition. To prevent stalling, the ECM will calculate an IAC valve position based upon barometric pressure.

ELECTRONIC CONTROL MODULE (ECM)

The ECM is located in the passenger compartment and is the "brain" of the EFI system and Computer Command Control system. Information from all data sensors is received and processed by the ECM to produce proper pulse duration for the injector, correct idle speed and proper spark timing. The ECM performs calculations to control the following EFI operating conditions: Engine start, engine flooding, engine running, fuel enrichment during acceleration, lean fuel mixture during deceleration, fuel cutoff and battery voltage correction.

During engine starts, the ECM delivers an injector pulse for each distributor reference pulse received. The injector pulse width (injector "on" time) is based upon coolant temperature and throttle position. The air/fuel ratio is determined by the ECM when throttle position is less than 80 percent open. Engine starting air/fuel ratio ranges from 1.5:1 at -33°F (-36°C) to 14.7:1 at 220°F (104°C). The lower the coolant temperature, the longer the injector pulse width (richer air/fuel ratio). The higher the coolant temperature, the shorter the injector pulse width (leaner air/fuel ratio).

During engine flooding, the driver must depress the accelerator pedal enough to set the wide open throttle position. At this position, the ECM calculates injector pulse width equal to an air/fuel ratio of 20:1. This air/fuel ratio will be maintained as long as the throttle remains wide open and engine speed is below 600 RPM. If the throttle position becomes less than 80 percent, the ECM changes injector pulse width to that used during engine starting.

When the engine is running above 600 RPM, the ECM operates in the open loop mode. In open loop, the ECM calculates injector pulse width based upon coolant temperature and manifold absolute pressure (MAP). The engine will remain in open loop operation until the oxygen sensor reaches operating tem-

perature, coolant temperature reaches a preset temperature and a specific period of time elapses after engine start. When all these conditions are met, the ECM operates in the closed loop mode. In closed loop, the ECM controls the injector pulse width according to oxygen sensor signals to maintain the air/fuel ratio at 14.7:1. In either mode, the injector is pulsed once for each distributor reference.

Fuel enrichment during acceleration is provided by the ECM. Sudden opening of the throttle plate causes a rapid increase in MAP. The pulse width is directly equal to MAP, throttle position and coolant temperature. The higher the MAP and wider the throttle angle, the wider the pulse width (richer mixture). During enrichment, the injector pulses are not in proportion to distributor reference signals. Any reduction in throttle angle cancels fuel enrichment.

During deceleration, the air/fuel mixture must be leaner. The ECM calculates the injector pulse width similar to that during fuel enrichment. Fuel output is reduced due to fuel remaining in the intake manifold. During sudden deceleration, when MAP, throttle position and engine speed are at preset specifications, fuel is cutoff to remove fuel from the engine. This deceleration fuel cutoff overrides the normal deceleration mode. During either deceleration mode, the injector pulses are not in proportion to distributor reference signals.

Battery voltage corrections by the ECM are performed during all operating modes of the EFI system. As battery voltage decreases, the ECM increases the injector pulse width with a correction factor stored in the ECM's memory.

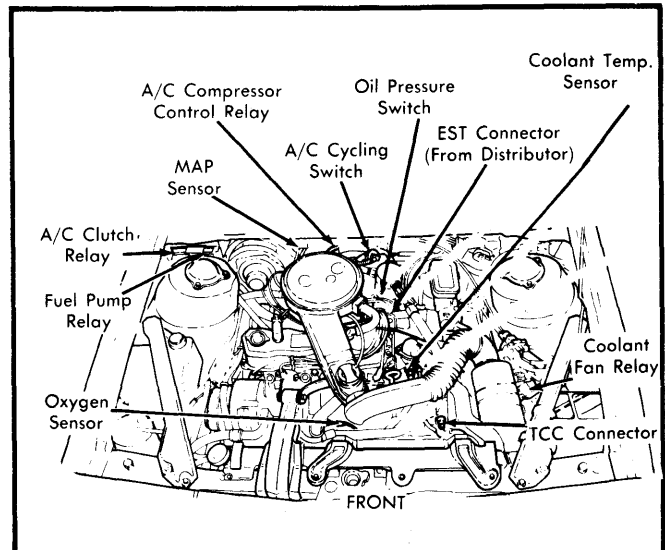


Fig. 2 Component Location for 2.5L Engine

DATA SENSORS

Each sensor furnishes an electrical signal to ECM, modifying injector pulse to conform to engine operating conditions. These sensors are as follows:

Coolant Temperature Sensor (CTS) – The CTS is located in the thermostat housing. This sensor is a variable resistant type which transmits an electrical signal (proportionate to engine temperature) to the ECM.

GENERAL MOTORS ELECTRONIC FUEL INJECTION – SINGLE UNIT (Cont.)

Oxygen Sensor – The oxygen sensor is mounted in the exhaust manifold. This sensor is similar to a small battery. The voltage output of the sensor indicates to the ECM the amount of oxygen in the exhaust gases. The ECM corrects the air/fuel ratio according to signals received by the oxygen sensor only when the system is operating in closed loop.

CAUTION – No attempt should be made to measure oxygen sensor voltage output. Current drain of conventional voltmeter could permanently damage sensor, shift sensor calibration range and/or render sensor unserviceable. Do not connect jumper wire, test leads or other electrical connectors to sensor.

Manifold Absolute Pressure (MAP) Sensor – The MAP sensor is mounted on the right side of the engine compartment. This sensor is a variable resistant type which has a vacuum hose connected to the throttle body. The sensor monitors changes in intake manifold pressure which result from engine load and speed changes. As MAP changes, the electrical resistance of the sensor changes. The ECM uses the resistance value of the sensor to control injector pulse width.

Vehicle Speed Sensor (VSS) – The VSS is mounted behind the speedometer in the instrument cluster. This sensor provides the ECM with pulses to determine vehicle speed. This information is used by the ECM to control the IAC motor.

NOTE – Vehicle should not be driven without the VSS installed.

Throttle Position Sensor (TPS) – The TPS is mounted on side of throttle body and is connected to throttle shaft. This sensor converts throttle angle to an electrical signal for use by the ECM to determine engine fuel requirements.

Hall Effect Unit – This unit is mounted above the distributor pick-up coil on 2.5L engines only. This unit is used in place of the "R" terminal of the conventional HEI module to send engine RPM signals to ECM. The 1.8L does use the "R" terminal for engine RPM reference.

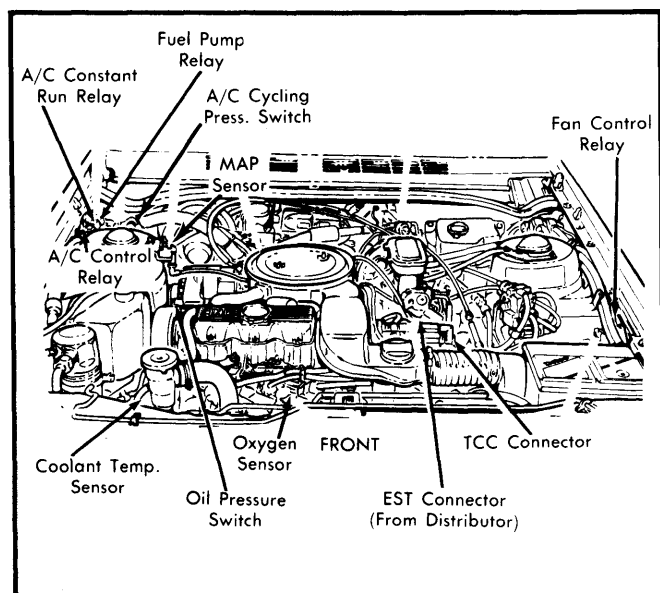


Fig. 3 Component Location for 1.8L Engine

NOTE – More sensors are used by the ECM to control engine performance and other systems. Refer to "GENERAL MOTORS COMPUTER COMMAND CONTROL SYSTEM" in Computerized Engine Controls section for more information.

TROUBLE SHOOTING & DIAGNOSIS

NOTE – Diagnosis of fuel system should begin with determining fuel system pressure. Before performing any test on the fuel system, pressure must be released from the system.

FUEL SYSTEM PRESSURE TEST

- 1) Remove "FUEL PUMP" fuse from fuse block in passenger compartment. Crank engine. Engine will start and run until fuel supply remaining in fuel lines is used. Engage starter again for about 3 seconds to assure all fuel is out of lines. Turn ignition off and replace fuse.
- 2) Remove air cleaner and plug thermal vacuum port on throttle body. Remove steel fuel line between throttle body and fuel filter. When removing fuel line, always use 2 wrenches. Install a fuel pressure gauge (J-29658 or equivalent) between throttle body and fuel filter.
- 3) Start car and observe fuel pressure reading. Use Fuel System Diagnosis chart if pressure is not between 9-13 psi. Use Injector System Diagnosis chart if pressure is between 9-13 psi.
- 4) Depressurize fuel system as described in step 1). Remove fuel pressure gauge and reinstall steel line between filter and throttle body. Start car and watch for leaks. Remove plug from throttle body thermal vacuum port and reinstall air cleaner.

HESITATES, SLUGGISH, SAGS OR POOR MILEAGE

- 1) Visually check MAP hose for leaks or restrictions and TPS for sticking or binding. Ensure fuel pressure is steady 9-13 psi at all operating ranges. Ensure base timing is correct.
- 2) With injector connector disconnected, check for fuel leakage from injector while cranking. Check for open HEI ground (circuit 453). Check fuel injector fuel filter for blockage.
- 3) Check fan control circuit (2.5L engine only). Check A/C compressor control and torque converter clutch (TCC) system. Refer to "GENERAL MOTORS COMPUTER COMMAND CONTROL SYSTEM" in Computerized Engine Controls section for testing procedures.

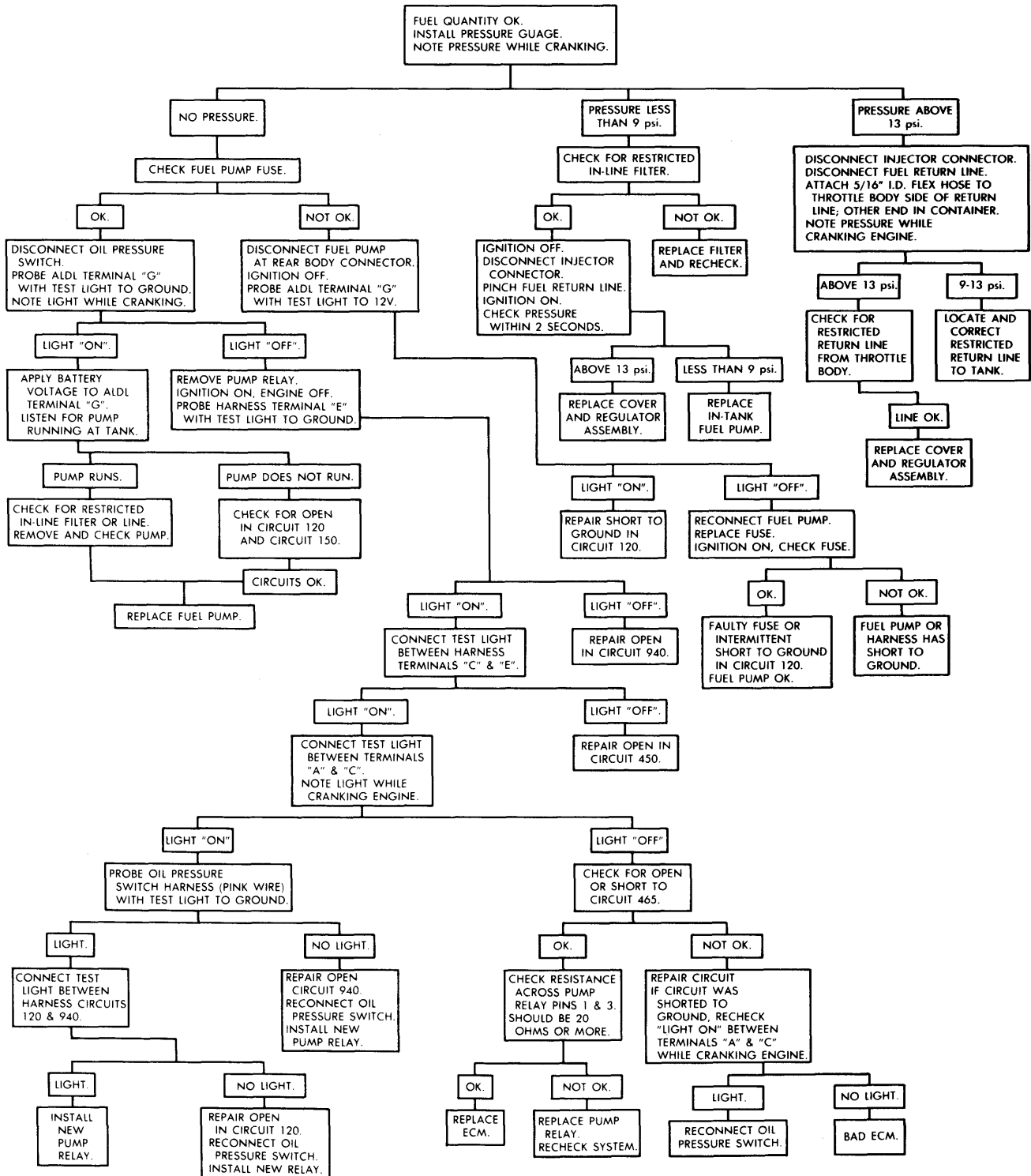
CUTS OUT OR STALLS

- 1) Check for intermittent open or short to ground in the following circuits: 5 volt reference (416), HEI reference (430), fuel pump circuit (120), injector drive circuits (467 and 468), IAC drive circuits (441, 442, 443 or 444).
- 2) Check for restricted fuel filter. Ensure fuel pressure is 9-13 psi at all operating ranges. Inspect fuel injector "O" rings for damage. Ensure steel back-up washer is located beneath large "O" ring.

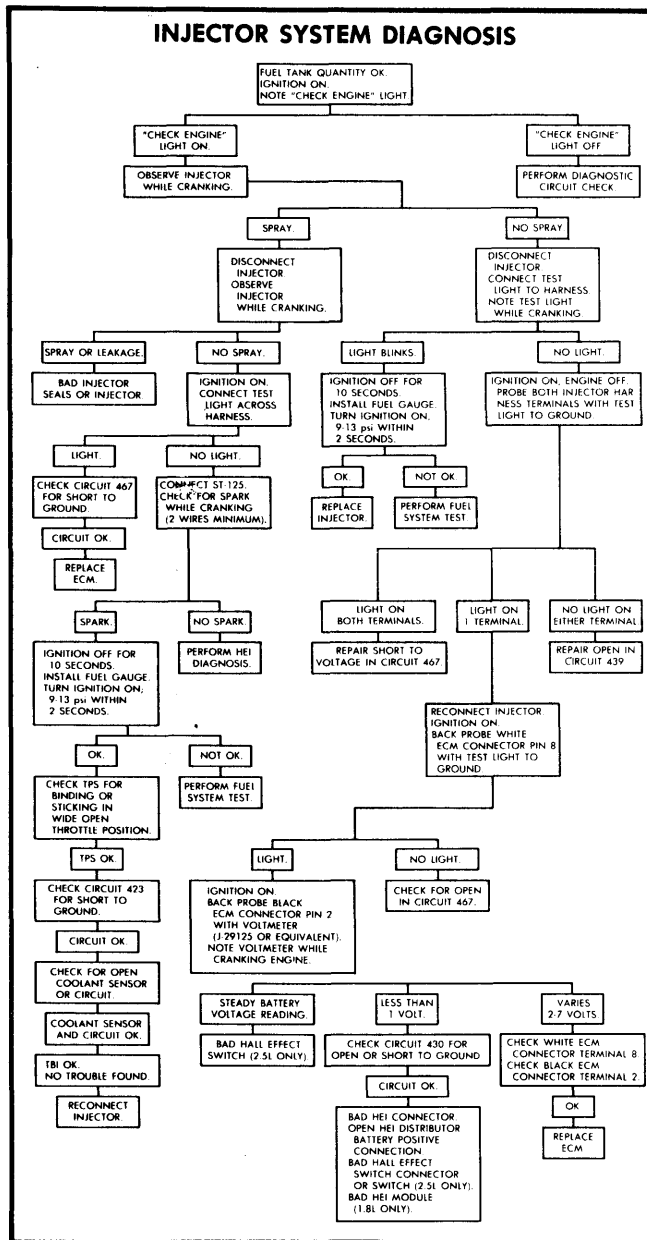
1982 Fuel Injection

GENERAL MOTORS ELECTRONIC FUEL INJECTION - SINGLE UNIT (Cont.)

FUEL SYSTEM DIAGNOSIS



GENERAL MOTORS ELECTRONIC FUEL INJECTION – SINGLE UNIT (Cont.)



SURGE

Check for intermittent open or short to ground in the following circuits: transmission converter clutch (420 and 422), HEI bypass (424), EST (423). Refer to "GENERAL MOTORS COMPUTER COMMAND CONTROL SYSTEM" in Computerized Engine Controls section for testing procedures.

HARD STARTING (HOT OR COLD)

1) Check for high resistance in coolant sensor circuit. Visually check TPS for sticking or binding. Ensure fuel pressure is 9-13 psi at all operating ranges. On 2.5L engine, fuel pressure leakdown after ignition is turned off should be gradual. An instant drop in pressure indicates a leaking in-tank fuel pump coupling, hose or check valve.

2) Check fuel pump relay. Disconnect oil pressure switch. If engine cranks but will not start, perform fuel system diagnosis (at point where fuel pump fuse proves okay).

3) Check injector. With injector harness connector disconnected, check for fuel leakage while cranking.

4) Check cranking circuit. Refer to "GENERAL MOTORS COMPUTER COMMAND CONTROL SYSTEM" in Computerized Engine Controls section for testing procedure.

REMOVAL & INSTALLATION

ELECTRONIC CONTROL MODULE (ECM)

NOTE – Location of ECM varies between model application. ECM is located within passenger compartment either behind right kick panel or under instrument panel.

Removal & Installation – Disconnect negative battery cable. Disconnect 2 electrical connectors from ECM. Remove ECM mounting hardware and ECM. To install, reverse removal procedure.

FUEL PUMP RELAY

Removal & Installation – Fuel pump relay is located on right side of engine compartment. On 2.5L engine vehicles, relay is mounted on firewall and is the one closest to fender. On 1.8L engines, relay is mounted on right fender near firewall. Remove electrical connector, mounting screws and relay. To install, reverse removal procedure.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Removal & Installation – MAP sensor is located in engine compartment. On 2.5L engine vehicles, sensor is mounted on firewall behind throttle body assembly. On 1.8L engine vehicles, sensor is mounted on right spring tower. Remove vacuum hose, mounting screws and MAP sensor. To install, reverse removal procedure.

VEHICLE SPEED SENSOR (VSS)

Removal & Installation – Remove instrument cluster and speedometer assembly. Disconnect VSS from speedometer. Disconnect VSS electrical connector and remove VSS. To install, reverse removal procedure.

COOLANT TEMPERATURE SENSOR (CTS)

Removal & Installation – Disconnect electrical connector and remove CTS. To install, reverse removal procedure.

NOTE – Handle CTS with care to prevent damage to sensor calibration.

OXYGEN SENSOR

NOTE – Oxygen sensor may be difficult to remove when engine temperature is below 120°F (48°C). Excessive force may damage threads.

Removal & Installation – Disconnect electrical connector. Do not attempt to remove single wire from oxygen sensor. Carefully back sensor out of exhaust manifold. Handle sensor with care and do not allow dirt or other foreign matter to contact louvered end of sensor. To install, reverse removal procedure.

GENERAL MOTORS ELECTRONIC FUEL INJECTION – SINGLE UNIT (Cont.)

NOTE – Prior to reinstalling a serviceable sensor, coat threads with liquid graphite compound containing glass beads (special anti-seize compound).

FUEL PUMP

Removal & Installation – Disconnect negative battery cable. Remove pressure from fuel lines as described under Fuel Pump Pressure Test. Remove fuel lines. Lower fuel tank. Remove attaching screws and fuel pump. To install, reverse removal procedure.

THROTTLE BODY ASSEMBLY

Removal – 1) Relieve pressure from fuel lines as explained under Fuel Pump Pressure Test. Remove air cleaner. Disconnect throttle linkage, return spring and cruise control linkage (if equipped). Disconnect and identify all electrical connectors from throttle body.

2) Disconnect and identify all vacuum hoses from throttle body for installation reference. Disconnect fuel lines from throttle body using 2 wrenches. Remove 3 throttle body-to-manifold bolts. Remove throttle body.

Installation – To install, reverse removal procedure and note the following: Ensure throttle body and intake manifold sealing surfaces are clean. Always use new throttle body-to-manifold gasket.

ADJUSTMENTS**THROTTLE POSITION SENSOR (TPS)**

See appropriate article in TUNE-UP SERVICE PROCEDURES.

MINIMUM AIR RATE (IDLE SPEED)

See appropriate article in TUNE-UP SERVICE PROCEDURES.

OVERHAUL**DISASSEMBLY**

NOTE – Before performing any service on throttle body assembly, it is essential that throttle body be placed on a holding fixture (J-9789-118, BT 30-15 or equivalent) to prevent damage to throttle valve.

Fuel Meter Cover – 1) Remove 5 cover-to-meter body screws and lock washers. Lift off fuel meter cover with fuel pressure regulator assembly attached. Remove cover gaskets. See Fig. 4.

NOTE – Do not remove screws attaching pressure regulator to fuel meter cover. The pressure regulator includes a spring under heavy tension which may cause personal injury if released. Fuel meter cover and pressure regulator are serviced as an assembly only. Do not immerse cover and regulator assembly in any type of cleaning solvent.

2) Remove fuel pressure regulator dust seal from fuel meter body.

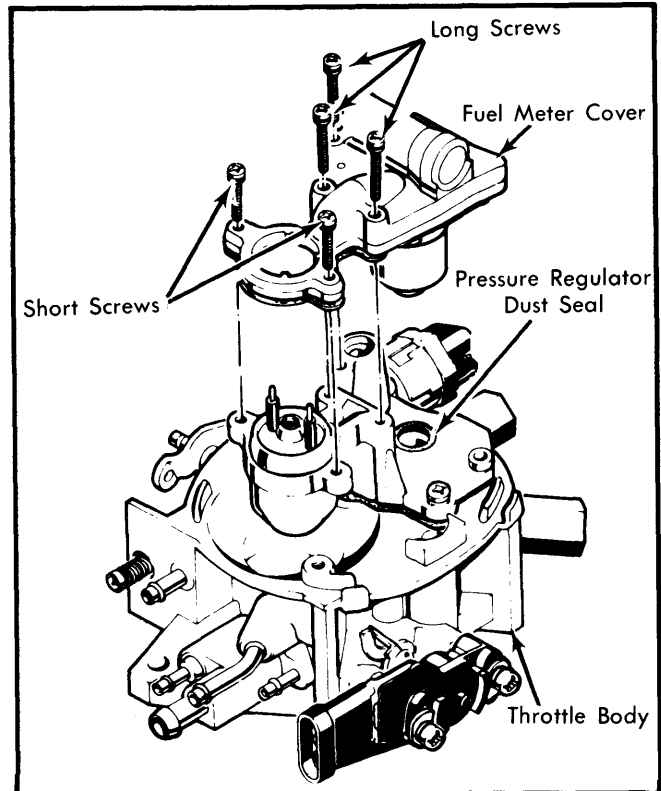


Fig. 4 Removing Fuel Meter Cover Assembly

Fuel Injector – 1) Using a pair of pliers, gently grasp center collar of injector between electrical connectors. Carefully pull injector out with a twisting motion. See Fig. 5.

NOTE – Use care in removing injector to prevent damage to electrical connectors, fuel filter and nozzle. Injector is serviced as complete assembly only.

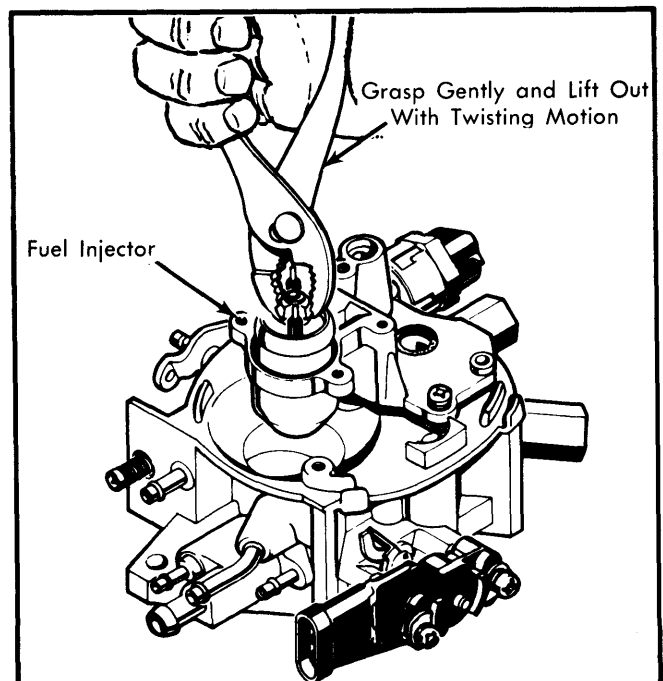


Fig. 5 Removing Fuel Injector Assembly

GENERAL MOTORS ELECTRONIC FUEL INJECTION – SINGLE UNIT (Cont.)

2) Carefully rotate injector filter back and forth to remove from base of injector. Remove large "O" ring and steel back-up washer at top of injector cavity in fuel meter body. Remove small "O" ring at bottom of injector cavity.

Fuel Meter Body – Remove fuel inlet and outlet nuts and gaskets from fuel meter body. Remove air cleaner stud. Remove 3 fuel meter body-to-throttle body screws and lock washers. Remove fuel meter body and gasket.

Throttle Body – 1) Disassembly of throttle body unit for immersion in cleaning solvent requires removal of TPS and IAC assembly. Throttle valve screws are staked in position and should not be removed. If necessary to remove TPS, continue as follows:

NOTE – TPS assembly is preset at the factory and retaining screws are spot-welded in position.

2) Invert throttle body assembly and place on clean, flat surface. Using a $\frac{5}{16}$ " drill, drill through each TPS screw access hole in base of throttle body to remove spot welds. See Fig. 6.

3) Remove and discard TPS attaching screws. Remove lock washers, retainers and TPS from throttle body. If necessary, remove TPS actuator lever-to-throttle shaft screw. Remove IAC assembly and gasket from throttle body.

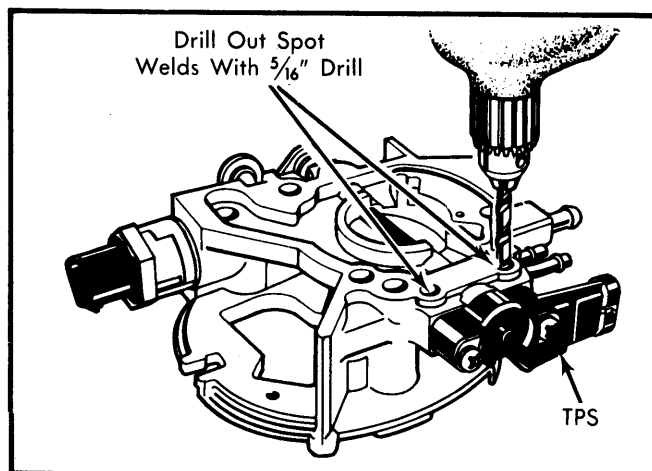


Fig. 6 Removing TPS Assembly (Throttle Body Inverted)

CLEANING & INSPECTION

1) Clean all metal parts in a cold immersion-type cleaner and blow dry with compressed air.

2) Do not immerse TPS, IAC, fuel meter cover and pressure regulator assembly, fuel injector, fuel filter, rubber parts and diaphragms in cleaner.

3) Inspect mating surfaces for damage that may prevent gasket sealing. Repair or replace components which may be cause of problems listed under Trouble Shooting and Diagnosis.

REASSEMBLY

Throttle Body – Place throttle body on holding fixture. Install IAC assembly with new gasket. Tighten securely. Install TPS actuator lever by aligning flats on lever with flats on end of shaft.

Do not install TPS until complete assembly of throttle body assembly.

NOTE – Before installing IAC assembly, measure distance that valve extends from motor housing. Measuring from end of housing to end of cone, distance should not exceed $1\frac{1}{8}$ " (28 mm). If not to specification, push pintle inward (ISC valve with collar on electrical connector) or compress pintle retaining spring toward IAC body while turning pintle inward with a clockwise motion (IAC valve without collar on connector). On IAC valves without collar, return spring to original position with straight portion of spring end aligned with flat surface under pintle head.

Fuel Meter Body – 1) Install fuel meter body gasket on throttle body. Cutout portions of gasket must match cutouts on throttle body. Install fuel meter body on gasket.

2) Apply thread locking compound (supplied in service kit) on 3 attaching screws. Install lock washers and screws. Tighten screws. Install fuel inlet and outlet nuts with new gaskets.

Fuel Injector – 1) Using a slight twisting motion, install fuel injector filter on nozzle end of injector until seated against injector base.

NOTE – Filter is cone-shaped. Large end of filter points up toward injector electrical connectors. Filter should cover raised rib at base of injector.

2) Lubricate "O" rings with lithium grease (or equivalent). Push small "O" ring on nozzle end of injector until seated against injector fuel filter. Install steel back-up washer in recess in injector cavity of fuel meter body. Install large "O" ring directly above back-up washer. Press "O" ring down in cavity recess until flush with top of fuel meter body casting surface. See Fig. 7.

NOTE – "O" rings and back-up washer must be installed in this manner. Do not attempt to seat "O" rings and washer after injector is placed in cavity.

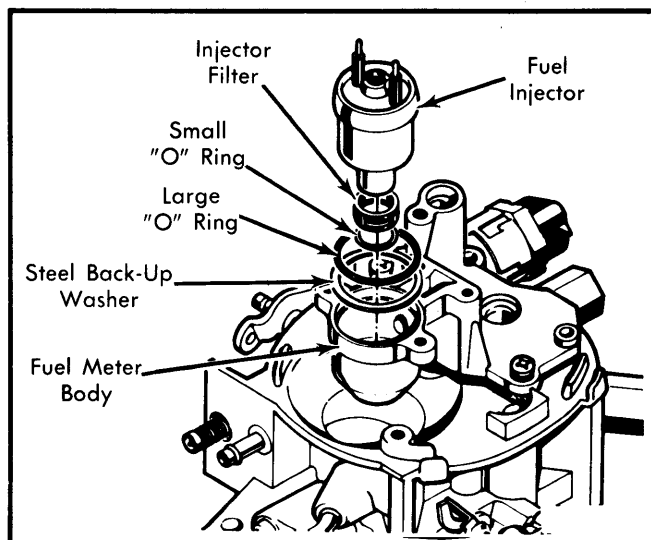


Fig. 7 Installing Fuel Injector

