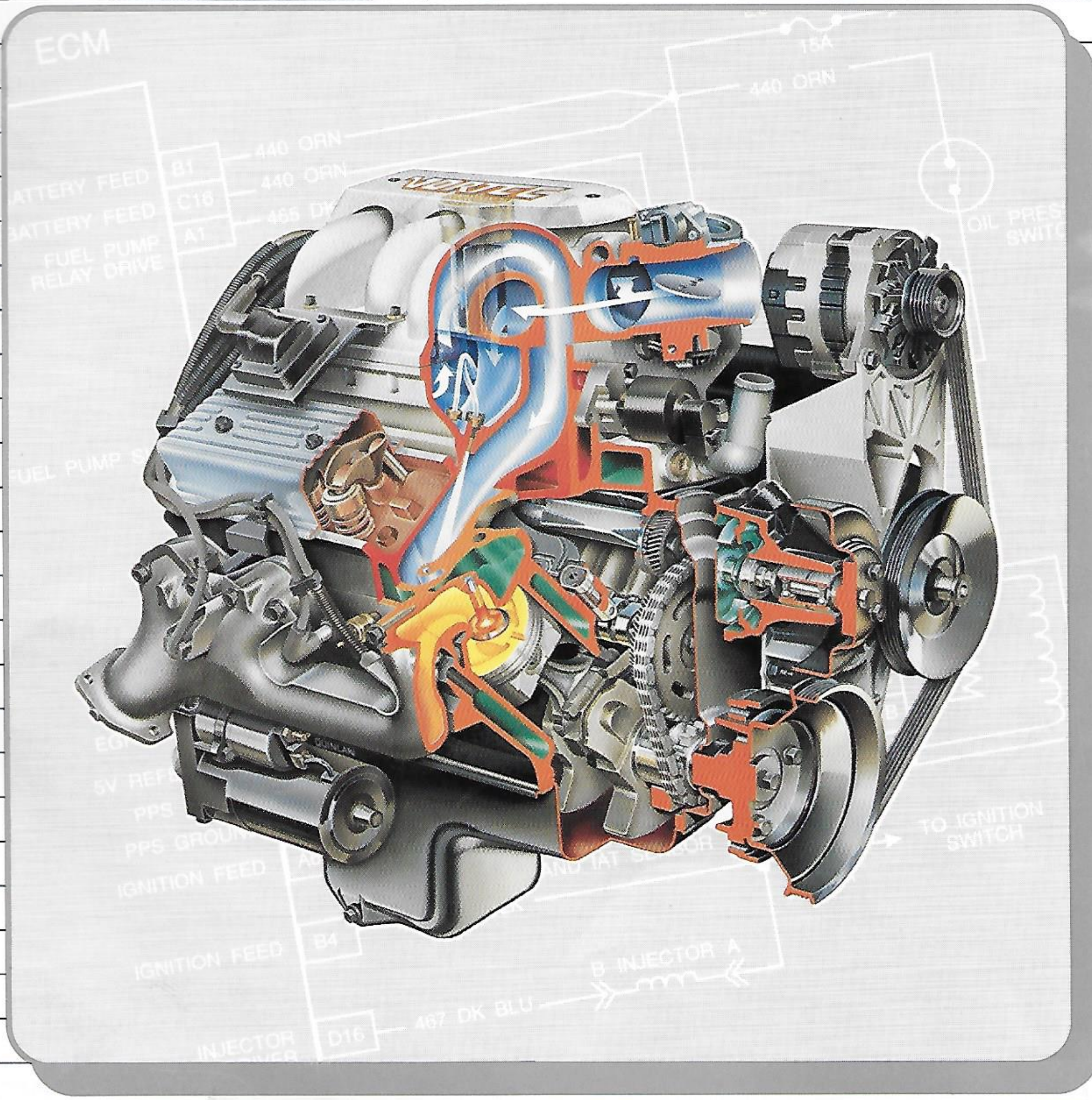
4.3L (L35) CPI Fuel System Operation and Diagnosis



STG

GM Service Technology Group

16009.19-1

Foreword

While this booklet will serve as an excellent review of the extensive program presented in the training center session, it is not intended to substitute for the various service manuals normally used on the job. The range of specifications and variations in procedures between divisions require that the division service publications be referred to, as necessary, when performing these operations.

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1. Introduction

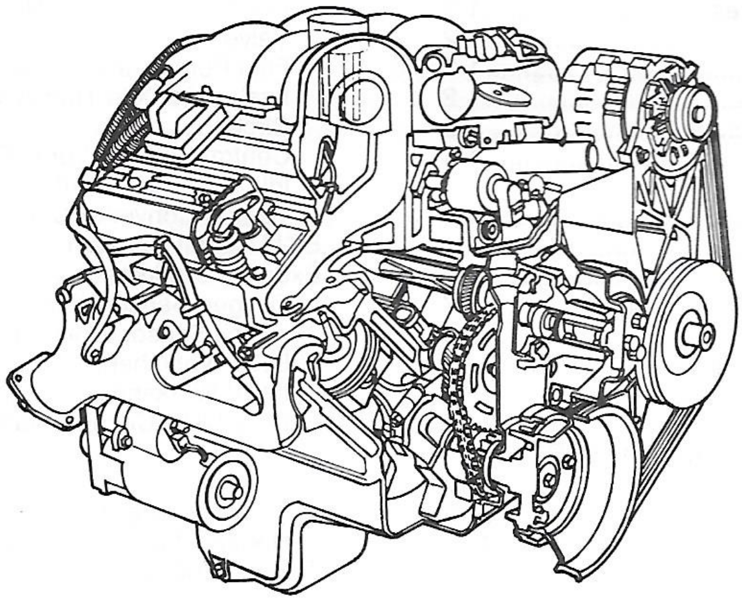


Figure 1-1, 4.3L Engine (L35 VIN W Version) with Central Port Injection

General Motors offers two 4.3-liter engines to truck buyers. Both are liquid-cooled, 90°, V6 engines with overhead valves and cast-iron blocks and heads.

The optional L35 VIN W version of this engine (figure 1-1) features a Central Port Injection (CPI) fuel metering system that provides enhanced performance characteristics. This engine uses a swirl inlet port design (figure 1-2), for airflow, thus giving the engine its Vortec name. This engine is available on 1992 L, M, S, and T model vehicles.

For technicians, the 4.3L L35 engine features an advanced engine management system that uses bi-directional communication between the ECM and Tech 1 "Scan" tool to allow more accurate symptom diagnosis and repair.

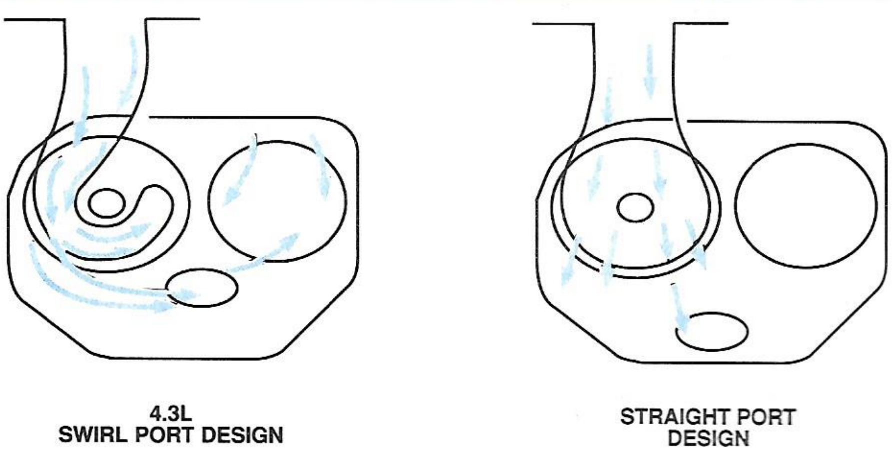


Figure 1-2, Swirl Inlet Port Design

ENGINE MECHANICAL FEATURES

Balance Shaft

The 4.3 L35 features a cast-iron balance shaft (figure 1-3). This shaft is mounted in the block above and in line with the camshaft. The front end of the balance shaft is supported by a ball bearing, while the opposite end uses a needle bearing.

The balance shaft receives lubrication from motor splash.

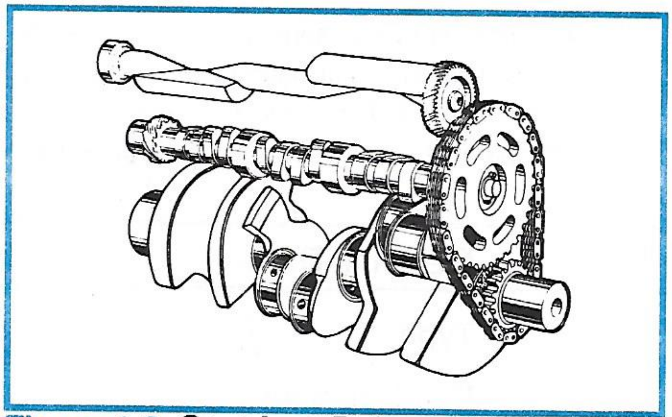


Figure 1-3, Cast-Iron Balance Shaft

Timing Marks

When setting timing on the 4.3L L35 engine, line up the timing marks on the camshaft sprocket and crankshaft sprocket dot to dot (figure 1-4). When these marks are lined up, the number 4 cylinder is at top dead center of its compression stroke.

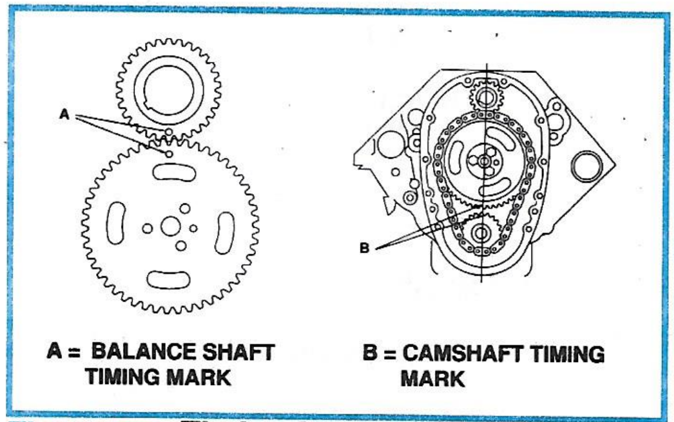


Figure 1-4, Timing Mark Alignment

Lifters

Like other GM 4.3L engines, the CPI version uses hydraulic valve lifters with roller followers (figure 1-5) to keep all parts of the valve train in constant contact.

Each lifter acts as an automatic adjuster that maintains zero lash in the valve train.

The splash shield over the balance shaft acts as a retainer to prevent rotation of the roller lifters.

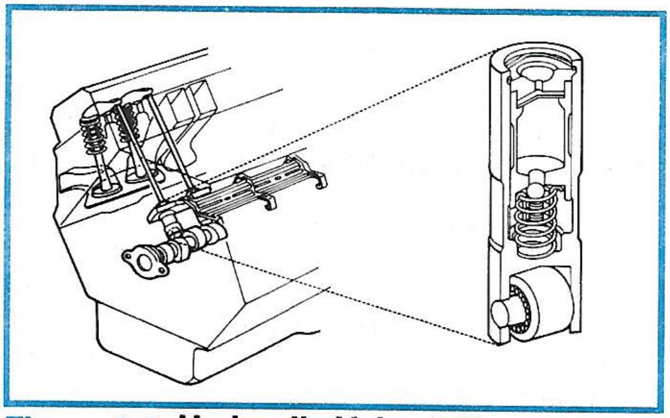


Figure 1-5, Hydraulic Valve Lifters

Specifications

Specifications for the 4.3L L35 engine are provided in figure 1-6. Other characteristics of the 4.3L L35 engine include:

- Horsepower ratings approaching 50 hp per liter
- Strong midrange and highrange torque output
- Smoothness and noise levels comparable to competitive V6 engines
- Comparable fuel economy to non high-performance 4.3L engines

General Data	Specification
Type	V6
Displacement	4.3L (262 Cu. in.)
RPO (VIN Code)	L35 (W)
Horsepower • M/L • S/T	 200 H.P. @ 4400 rpm 195 H.P. @ 4500 rpm
Torque • M/L • S/T	 260 lb/ft @ 3600 rpm 260 lb/ft @ 3600 rpm
Bore	4.00
Stroke	3.48
Compression Ratio	9.05:1
Firing Order	1-6-5-4-3-2
Oil Pressure	6 psi @ 1000 rpm 18 psi @ 2000 rpm 24 psi @ 4000 rpm
Oil Capacity	5 qts. (5W30) with filter
Spark Plugs	CR43TS
Spark Plug Gap	.045
Fuel Volume	31 gms/sec @ 350 kPa (13.5 volts ± 1 volt)
Fuel Pressure	370–440 kPa (54–64 psi)

Figure 1-6, 4.3L L35 Engine Specifications

Engine Lubrication

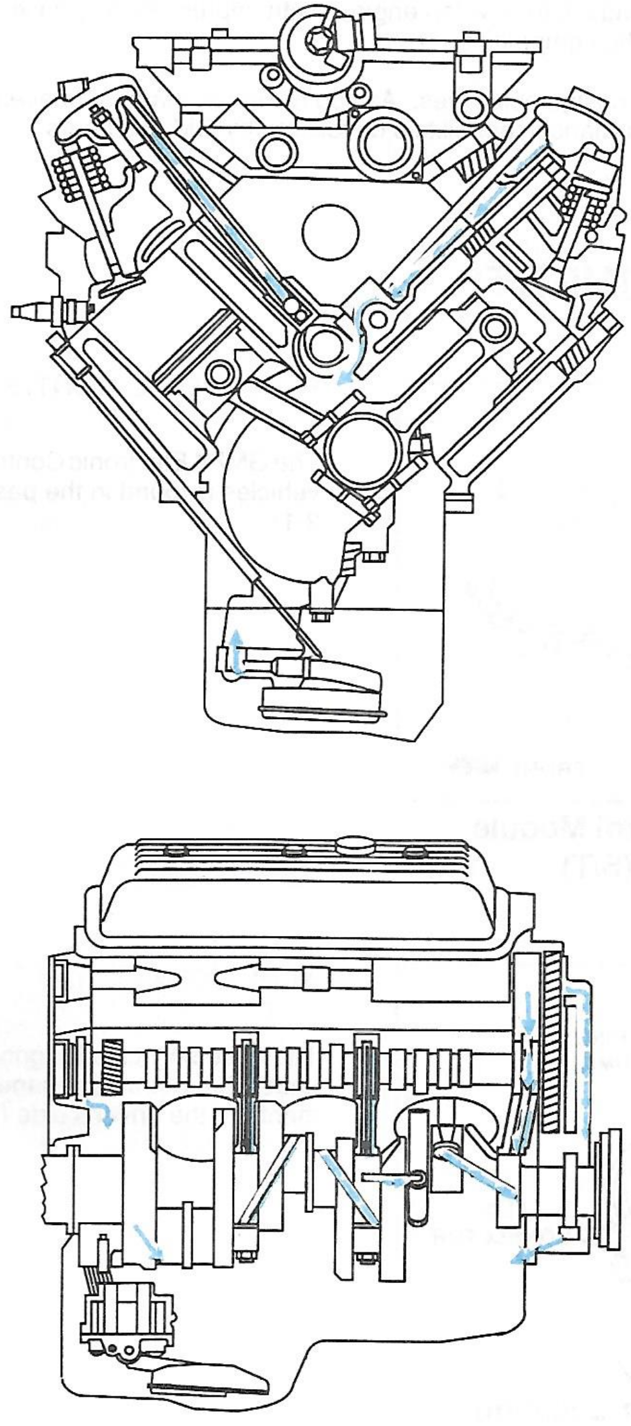


Figure 1-7, 4.3L L35 Engine Lubrication

2. System Components

Engine designers today face a two-sided challenge.

- On one hand, they must produce engines with emission and fuel economy levels that are better or at least competitive with anything in the market segment. In addition, more demanding government standards are being instituted on light-duty trucks.
- The designers' other challenge is to develop engines with impressive response and power levels to match or exceed the competition.

The 4.3L L35 engine achieves both design objectives. As you review its major air/fuel/emission components, you will begin to see the dual levels of performance capabilities developed by GM engineers.

GENERAL COMPONENTS

ELECTRONIC CONTROL MODULE (ECM)

The GMP4 Electronic Control Module (ECM) for 4.3L L35 vehicles is found in the passenger compartment (figure 2-1).

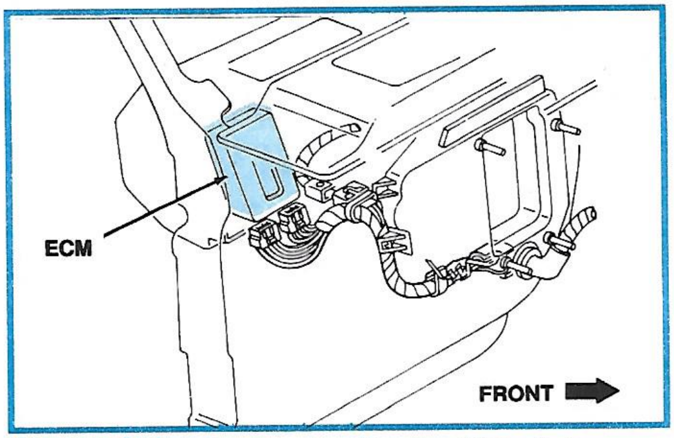


Figure 2-1, **Electronic Control Module (ECM) Location (S/T)**

ALDL CONNECTOR

The Assembly Line Diagnostic Link (ALDL) connector is under the instrument panel in the passenger compartment, on the driver's side (figure 2-2).

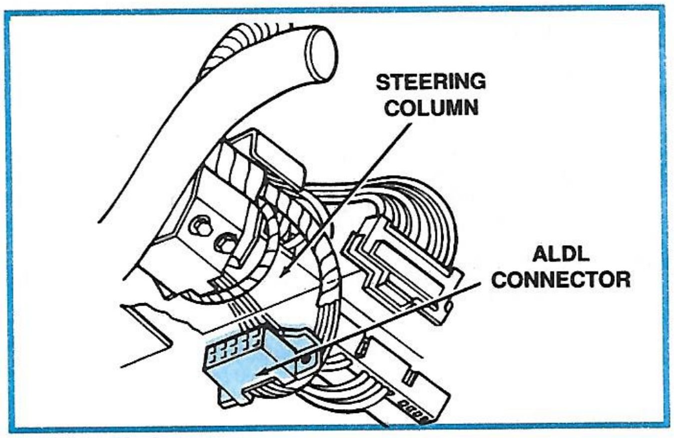


Figure 2-2, **ALDL Connector Location**

GROUNDS

The ECM grounds are located at the left rear cylinder head, as is the Oxygen sensor ground (figure 2-3).

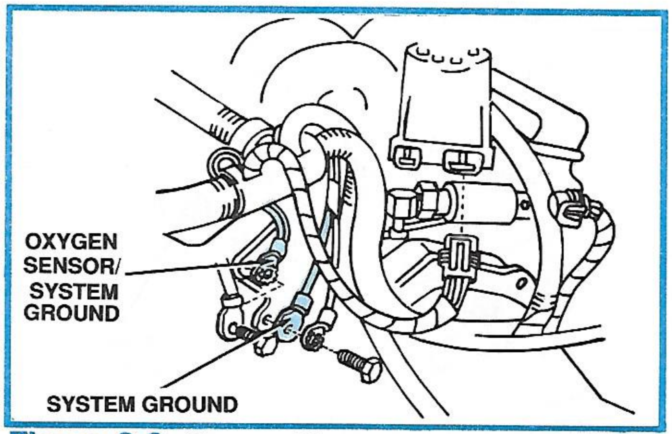


Figure 2-3, Ground Location

HEATED OXYGEN (O_2) SENSOR

The Oxygen (O_2) sensor for the 4.3L L35 is located at the crossover of the exhaust manifold from each head, just before the catalytic converter (figure 2-4).

The AFS11 sensor is a Bosch design that can be submerged in water. As opposed to other designs that require an air source at the sensor, this new design receives air through the lead wires (figure 2-5).

> **— NOTICE —**
> **The sensor and harness leads must not be damaged in such a way that the wires inside are exposed. If the sensor or harness leads are damaged in this way, this can provide a path for foreign materials to enter the sensor and cause poor performance conditions. Also, do not apply contact cleaner or other materials to the sensor or vehicle harness connectors.**

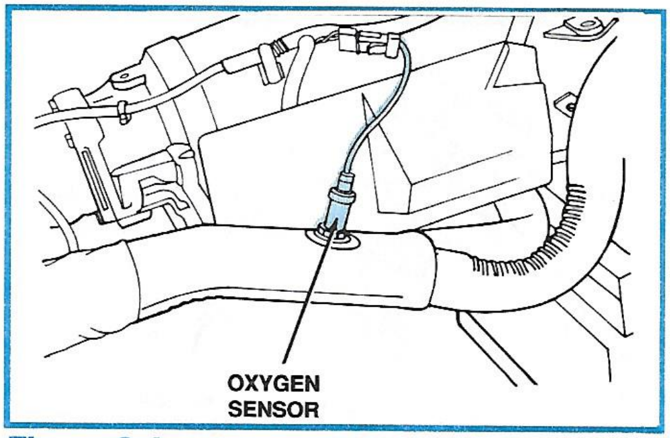


Figure 2-4, Oxygen (O_2) Sensor Location

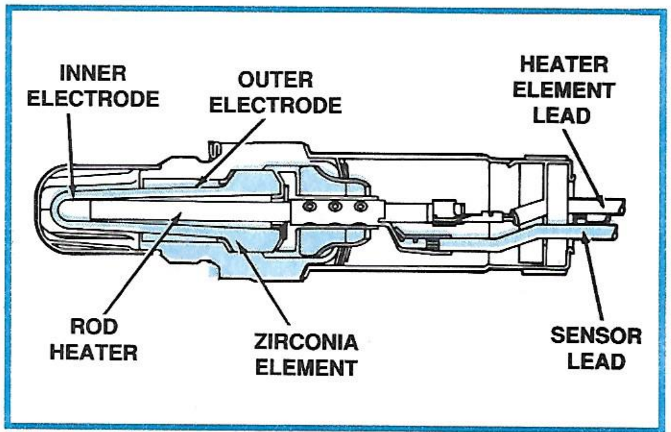


Figure 2-5, Oxygen (O_2) Sensor

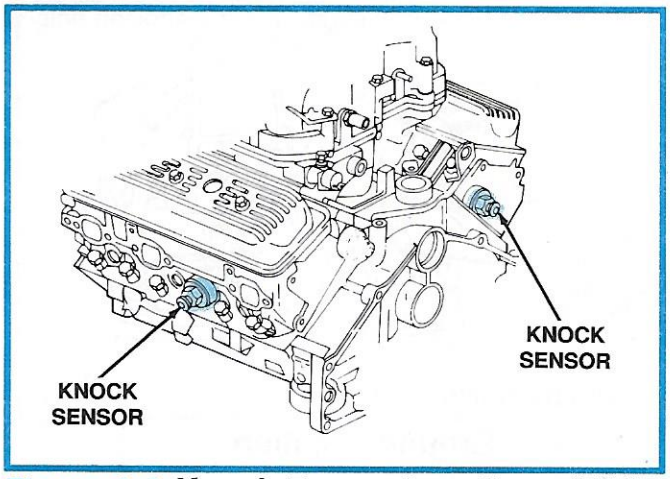


Figure 2-6, Knock Sensor Locations (S/T)

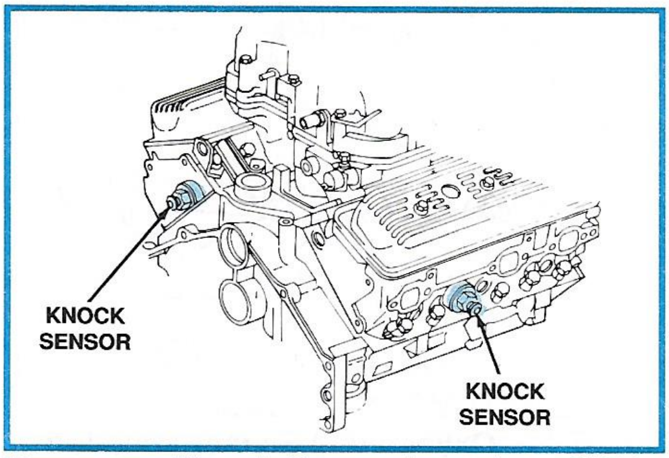


Figure 2-7, Knock Sensor Locations (M/L)

KNOCK SENSORS

The 4.3L L35 engine features a two knock sensor arrangement, connected in parallel. The use of two knock sensors allows for better detonation detection and control. The sensors are mounted to the cylinder heads.

- On S/T trucks, the knock sensors are found in the side of the left head and the rear of the right head (figure 2-6).
- On M/L vans, the knock sensors are located in the rear of the left head and the side of the right head (figure 2-7).

The knock sensor locations have changed from previous years' design because of alterations in the 4.3L L35 block to accommodate the balance shaft. The block has been reinforced to support the shaft, making the former sensor location acoustically "dead."

— CAUTION —
Knock sensors on the 4.3L L35 engine that are located on the side of the head are in a "wet" hole. Be sure that engine coolant has sufficiently cooled before removing these sensors to avoid injury.

COOLANT TEMPERATURE SENSOR (CTS)

The Coolant Temperature Sensor (CTS) is mounted in the coolant stream, in the right front corner of the intake manifold (figure 2-8).

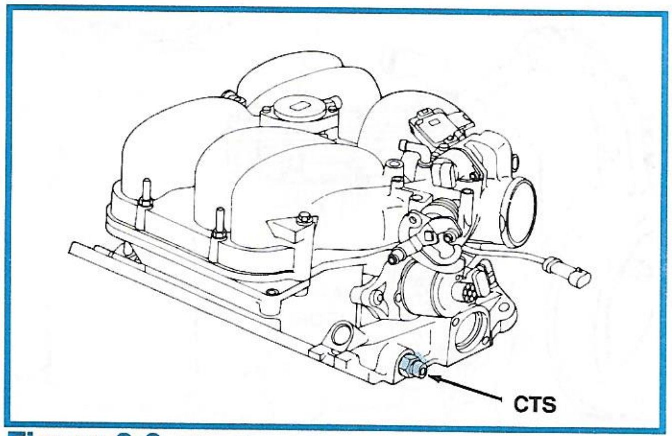


Figure 2-8, Coolant Temperature Sensor (CTS) Location

THROTTLE POSITION SENSOR (TPS)

The Throttle Position Sensor (TPS) is a non-adjustable type mounted on the side of the throttle body opposite the throttle lever assembly (figure 2-9).

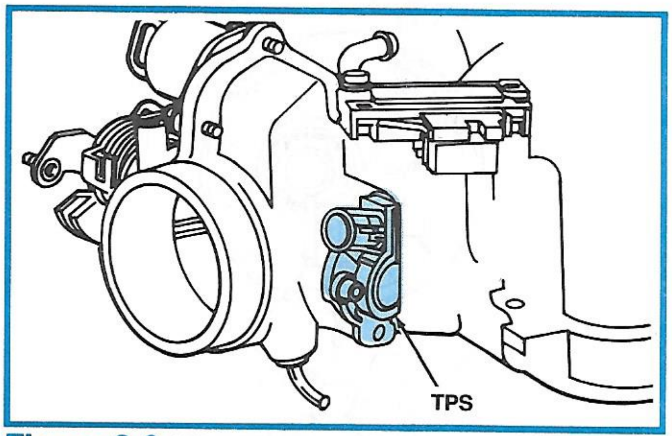


Figure 2-9, Throttle Position Sensor (TPS) Location

VEHICLE SPEED SENSOR (VSS)

The Vehicle Speed Sensor (VSS) is mounted to the transmission case extension (figure 2-10).

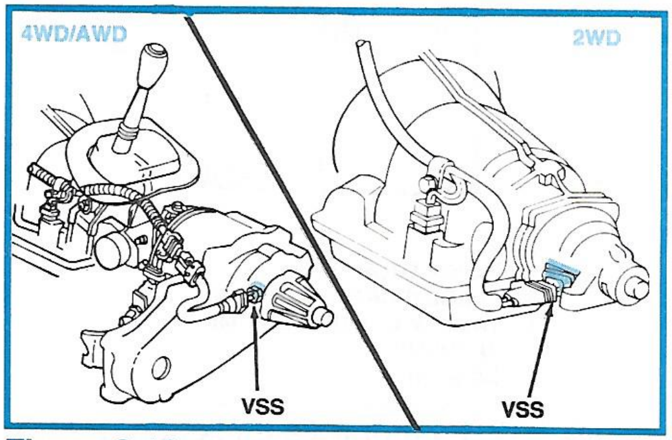


Figure 2-10, Vehicle Speed Sensor (VSS) Location

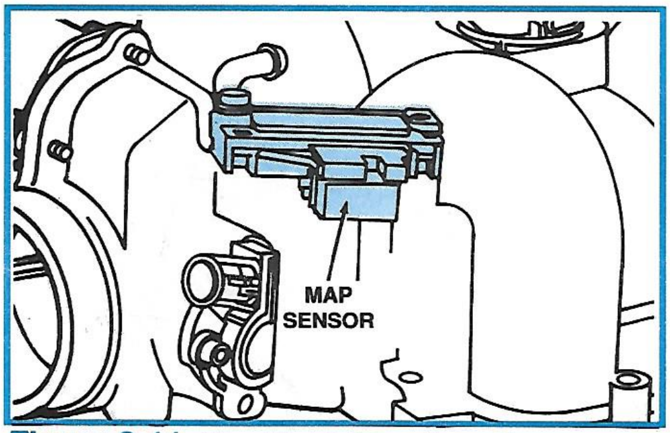
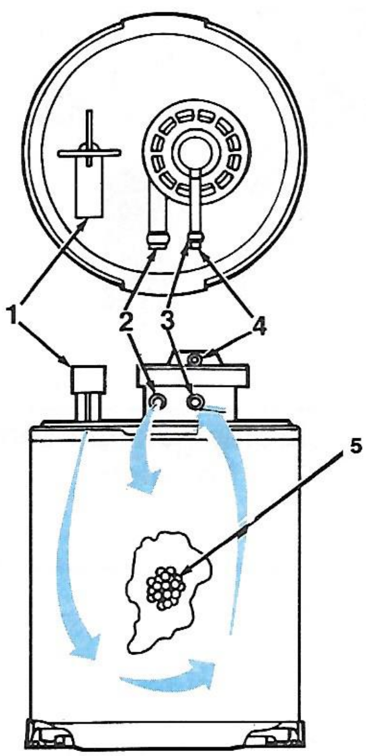


Figure 2-11, Manifold Absolute Pressure (MAP) Sensor Location



1 AIR
2 VAPOR FROM FUEL TANK
3 PURGE (PORTED VACUUM)
4 VACUUM CONTROLLER (MANIFOLD VACUUM)
5 CARBON

Figure 2-12, Evaporative Emission Control System (EECS) Canister

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The Manifold Absolute Pressure (MAP) sensor is located forward of the Intake Manifold Tuning Valve (IMTV), just above the TPS (figure 2-11). The MAP sensor is mounted directly to the manifold, eliminating the need for vacuum hoses.

EVAPORATIVE EMISSION CONTROL SYSTEM (EECS) VAPOR CANISTER

The evaporative canister on 4.3L L35 vehicles (figure 2-12) features an integral purge valve.

- When the engine is "OFF," the purge valve is closed, preventing vapors from traveling from the canister to the manifold.
- When the engine is operating at open throttle, ported vaccum draws vapor from the canister to the manifold.

This canister cannot be switched with canisters used in other applications.

POSITIVE CRANKCASE VENTILATION (PCV) VALVE

The Positive Crankcase Ventilation (PCV) system assists in recapturing crankcase vapors. The PCV valve is located on a hose leading to the intake manifold.

Fresh air from the air cleaner passes through a filter and is supplied to the crankcase, where it mixes with blow-by gases before passing through the PCV valve into the intake manifold. The flow rate through the PCV valve varies according to manifold vacuum.

The intake manifold on the 4.3L L35 engine has two drain-back holes machined into it that allow PCV-generated oil or fuel to drain into the number 3 and 4 intake runners.

When servicing the PCV system on 4.3L L35 vehicles, be sure to use the correct valve. An incorrect PCV valve could cause poor driveability conditions. Also be sure that the PCV retaining clip is securely fastened to prevent lines from becoming unsecured.

AIR INTAKE SYSTEM

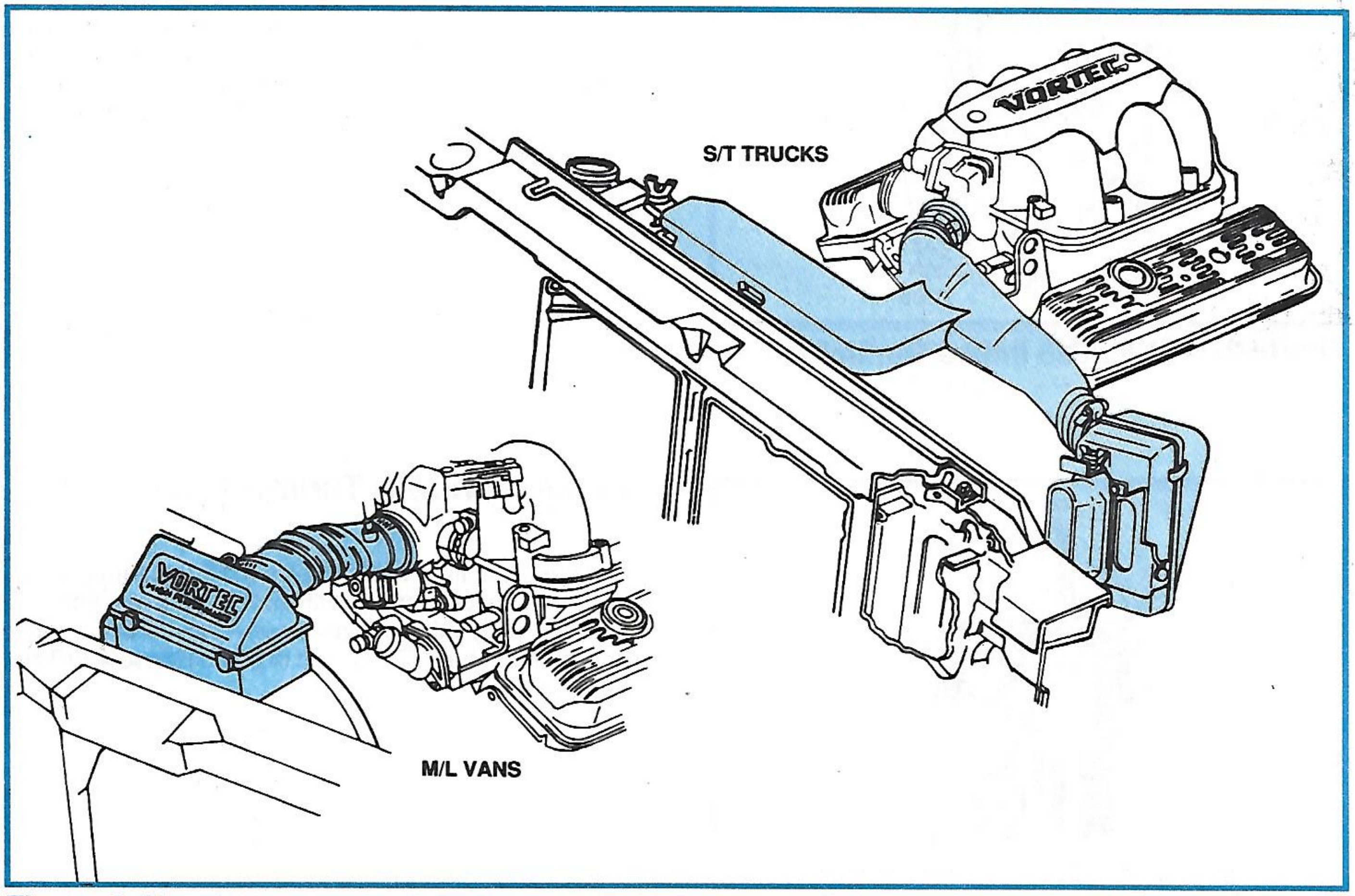


Figure 2-13, L35 Air Intake System

The 4.3L L35 air intake system consists of the following main components (figure 2-13):

- An air cleaner assembly.
- A two-piece cast-aluminum intake manifold with an integrated throttle body.
- An Intake Manifold Tuning Valve (IMTV), with an electric motor, to provide "active tuning." The IMTV is centrally mounted in the upper manifold.
- An Intake Air Temperature (IAT) sensor, formerly known as the Manifold Air Temperature (MAT) sensor, located on the underside of the flexible air tube leading into the throttle body.
- An Idle Air Control (IAC) valve, located in the throttle body, that controls engine idle speed.

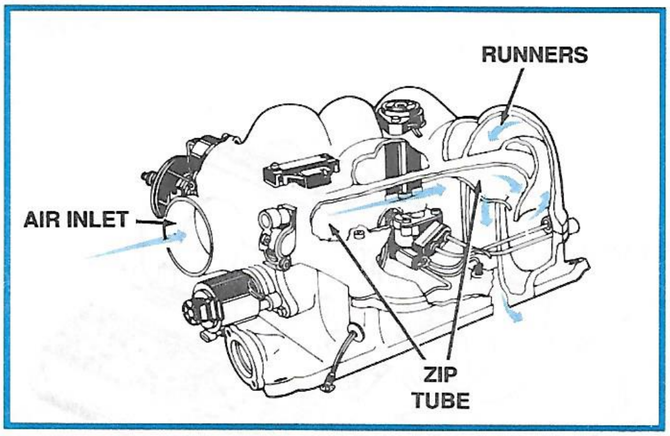


Figure 2-14, 4.3L L35 Intake Manifold

Unique 4.3L L35 intake manifold design features include (figure 2-14):

- Twin zip tubes
- Dual plenums
- Runners from the plenums to cylinder head ports

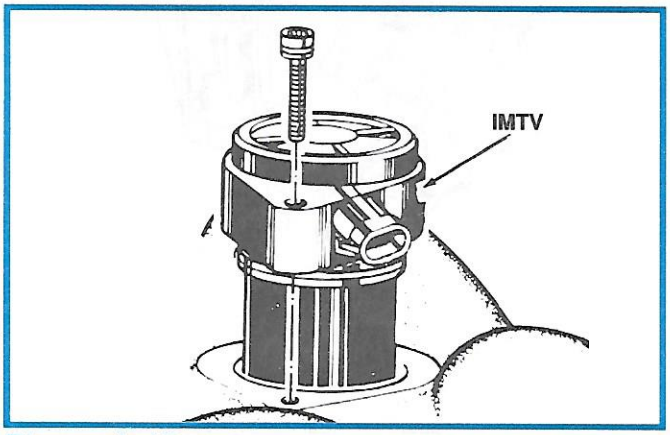


Figure 2-15, Intake Manifold Tuning Valve

Intake Manifold Tuning Valve (IMTV)

The Intake Manifold Tuning Valve (IMTV) (figure 2-15) is a rotary solenoid that streamlines intake air into the plenum during mid to high-range rpm, heavy-throttle applications. The IMTV is held in place by two #20 Torx bolts.

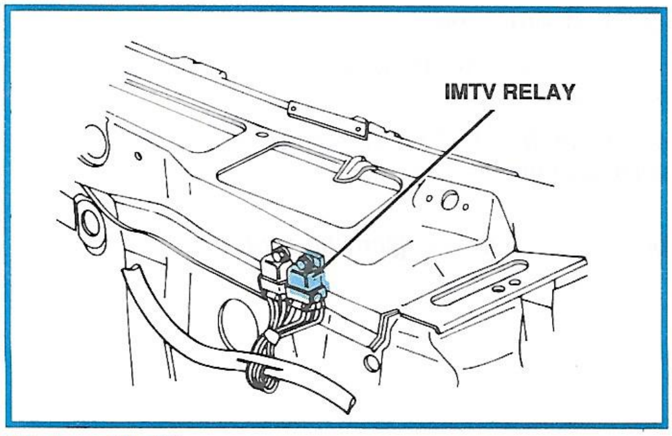


Figure 2-16, IMTV Relay Location

The IMTV relay is located in the engine compartment on the cowl, next to the fuel pump relay (figure 2-16).

The IMTV is either fully opened or fully closed, depending on requirements.

- During normal vehicle acceleration and at cruising speeds (low torque conditions), the IMTV is closed (figure 2-17) and the intake manifold supplies a more conservative airflow pattern to the cylinders.

  The manifold in these situations resembles a dual-plane design. Because the airflow dynamics are similar to those of a more conventional manifold, fuel economy is maximized.

- During high-torque conditions, the ECM commands the IMTV by energizing the IMTV relay. The relay sends voltage to open the IMTV to redirect air within the manifold (figure 2-18). This increased airflow takes full advantage of all the tubes inside the manifold to improve engine high-rpm torque. The manifold under these conditions is similar to a single-plane design.

The IMTV allows the manifold to operate with improved torque at both the low and high ends of the engine's power band (figure 2-19).

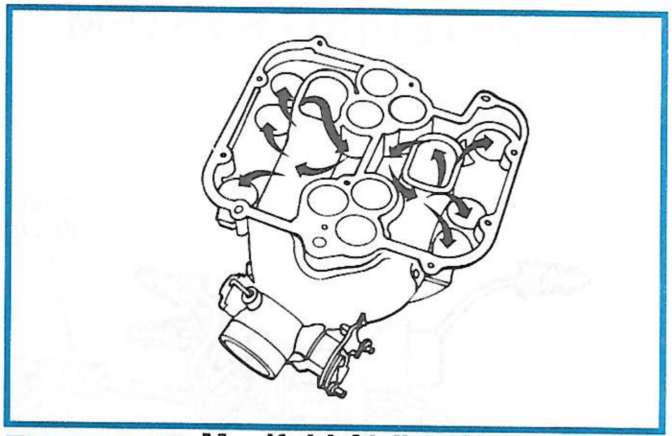


Figure 2-17, Manifold Airflow With IMTV Closed

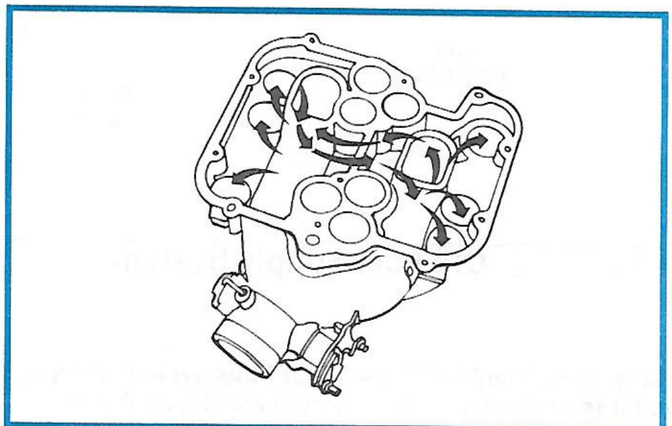


Figure 2-18, Manifold Airflow With IMTV Open

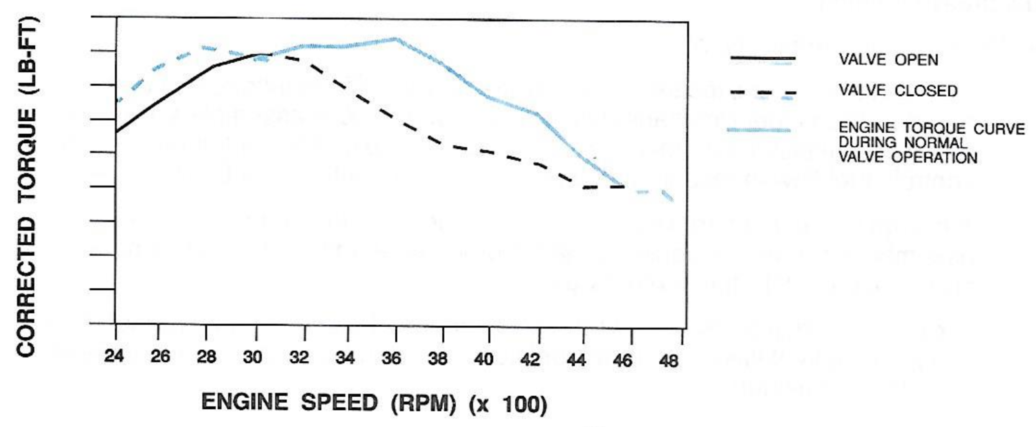


Figure 2-19, IMTV Effect on 4.3L L35 Engine Torque

FUEL METERING SYSTEM

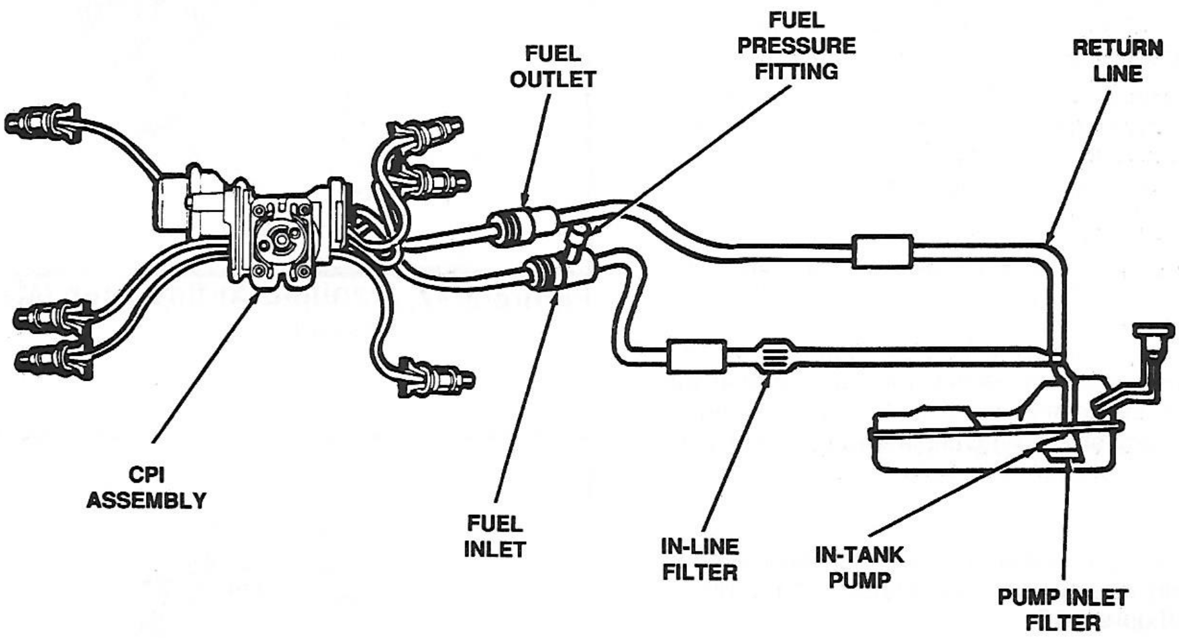


Figure 2-20, CPI Fuel Supply System

Many components of the 4.3L CPI fuel system are fully contained within the intake manifold. Major components and features of the overall fuel system are (figure 2-20):

- A positive-displacement, roller-vane, high-pressure electric fuel pump located in the fuel tank.
- Fuel lines from the tank to the CPI unit.
- An in-line fuel filter.
- A fuel pressure fitting.
- The CPI assembly, consisting of:
  - An injector solenoid, located in the center of the lower manifold, that meters and distributes fuel simultaneously to six poppet nozzle assemblies.The low-impedence injector solenoid is a single-disc, multiple-hole shutoff design that controls fuel flow in response to a pulse-width signal from the ECM.
  - A low-gain fuel pressure regulator that is integrally mounted to the CPI assembly for direct response to manifold pressure and control of fuel pressure within the CPI fuel meter body.
  - Six poppet nozzles, located at the port entrance of each manifold runner, that simultaneously deliver calibrated fuel flow via nylon tubes from the fuel meter body to the cylinders.

Fuel Pump, Lines, and Filter

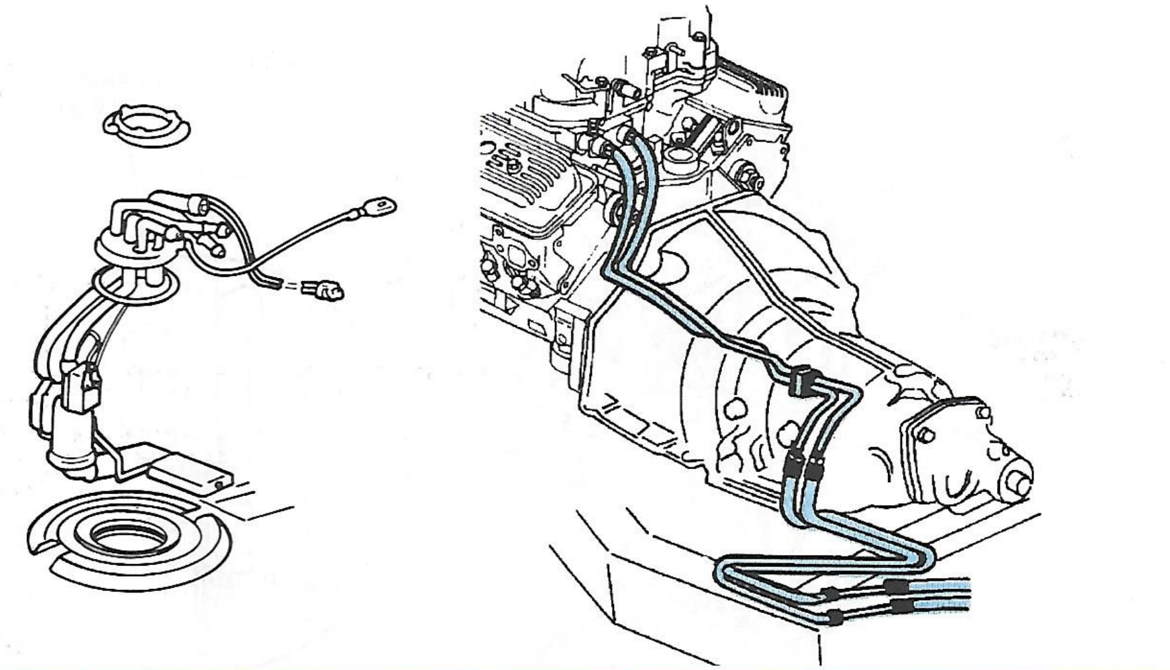


Figure 2-21, Fuel Pump and Lines

The 4.3L CPI fuel pump is a roller-vane, high pressure electric pump mounted in the fuel tank (figure 2-21). The unit pumps fuel at a rate of 31 gm/sec at approximately 350 kPa (51 psi). Pressure relief occurs at 490–685 kPa (72–100 psi).

- When the key is turned "ON" without the engine running, the ECM turns the fuel pump relay "ON" for 2 seconds. The pump quickly builds up fuel pressure in the lines to the CPI pressure regulator.
- If the engine is not started within 2 seconds, the ECM shuts the pump "OFF" and waits until the engine is started. As soon as the engine cranks, the ECM turns the relay "ON" and the fuel pump runs.
- The fuel pump is also turned "ON" by an oil pressure switch when engine oil pressure reaches 28 kPa (4 psi). This provides a back-up in the case of an inoperative fuel pump relay.

Fuel feed and return lines are routed along the frame side member from the fuel pump to the CPI unit. They are secured to the chassis with clamps.

The in-line fuel filter is located in the fuel feed line to prevent dirt from entering the CPI unit, while the in-tank filter prevents dirt and water from entering the feed line.

CPI Assembly

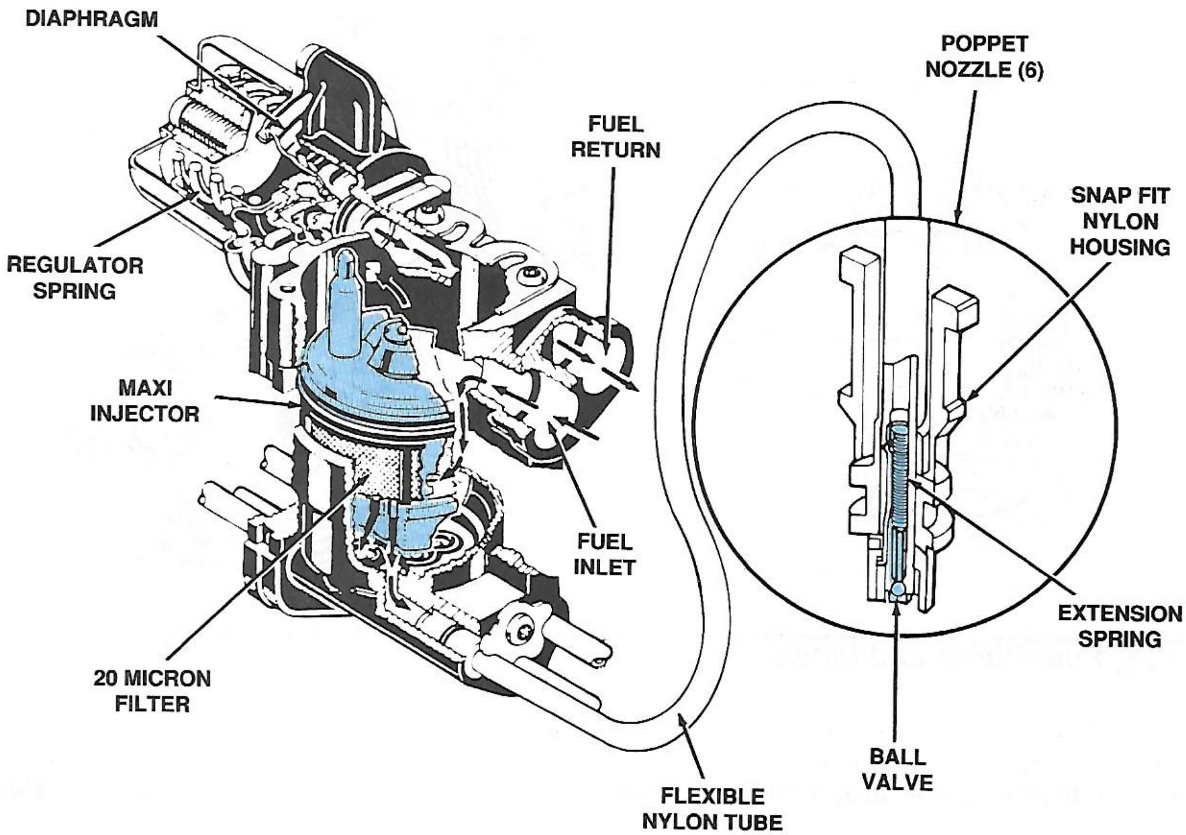


Figure 2-22, CPI Assembly

The CPI system is designed to provide port fuel delivery with performance features similar to multi-point fuel injection.

The centerpiece of the system is the central port injector (CPI) located in the middle of the lower manifold.

- The fuel meter body is connected by nylon tubes to six poppet valves that feed fuel into the runners just before the individual cylinders (figure 2-22).
- Fuel flow is controlled by pulse-width modulation of the injector solenoid. This solenoid is grounded through the ECM.

Flow control in the system is governed by three factors:

1. Fuel pressure at the injector solenoid (regulator).
2. Pulse-width activation of the solenoid controlled by the ECM.
3. Constant pressure drop through individual poppet nozzles.

INJECTOR SOLENOID

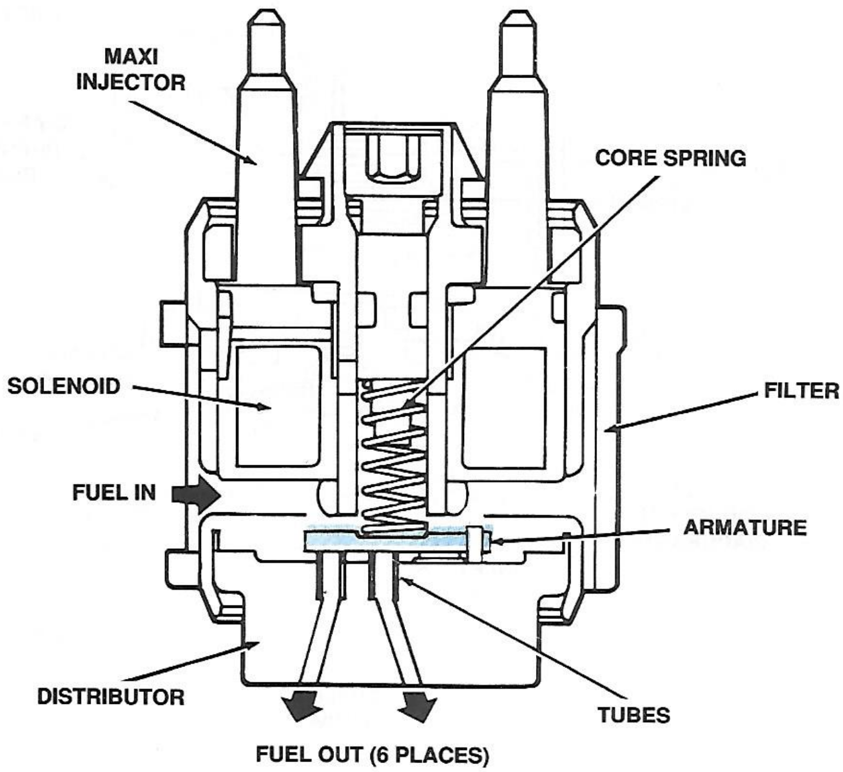


Figure 2-23, Injector Solenoid

The single-disc, centrally mounted injector solenoid (figure 2-23) is controlled by the ECM through injector pulse-width voltage. Fuel pressure at the injector solenoid is controlled by the pressure regulator.

The injector solenoid is a multiple-hole shutoff design that distributes metered fuel. A six-hole distributor gasket seals the pressurized fuel flow to each of the six fuel meter body passages that, in turn, transport the flow to the individual poppet nozzle tubes.

PRESSURE REGULATOR

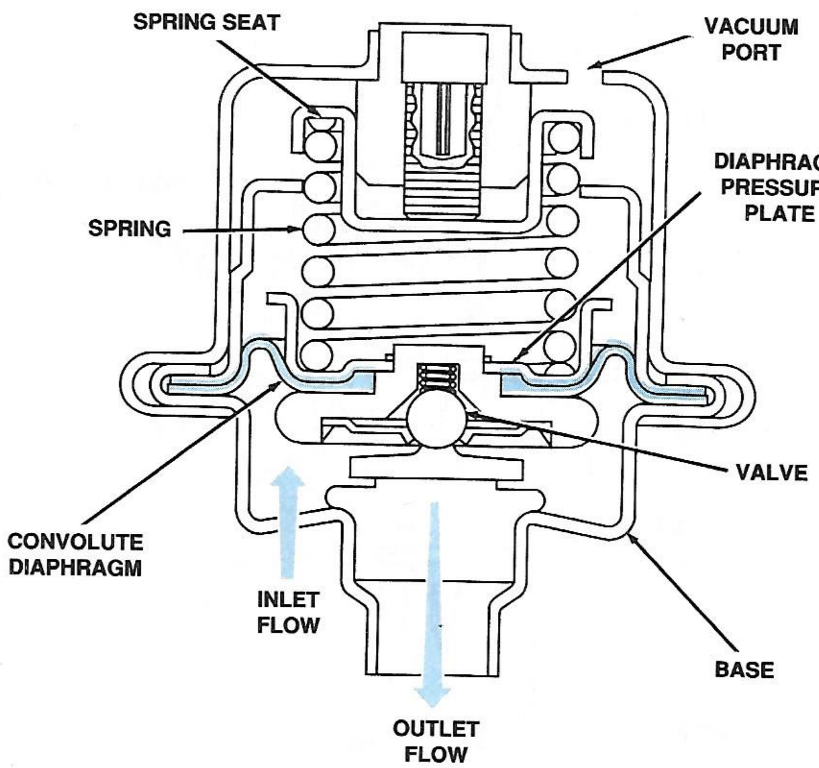


Figure 2-24, Pressure Regulator

The CPI system uses a specially designed low-gain pressure regulator (figure 2-24) that maintains a calibrated fuel pressure rate of 370 to 440 kPa (54 to 64 psi) at the injector solenoid.

Pressure Regulator Operation

The pressure regulator responds to changes in fuel flow by maintaining fuel pressure versus spring force balance. Because the regulator is within the manifold, fuel pressure is biased by manifold pressure, which also acts against the spring force.

- As fuel enters the CPI through an inlet fitting, it passes into the injector cavity. From there, it passes into the pressure regulator.
- When the injector solenoid is de-energized, all fuel passes through the regulator back into the fuel tank through the fuel return line.
- When the injector solenoid becomes energized, fuel is delivered equally to the six poppet nozzles. The rate of fuel delivered is controlled by pulse-width modulation of the solenoid by the ECM. Excess fuel flow is passed through the regulator back into the fuel tank through the fuel return line.

POPPET NOZZLES

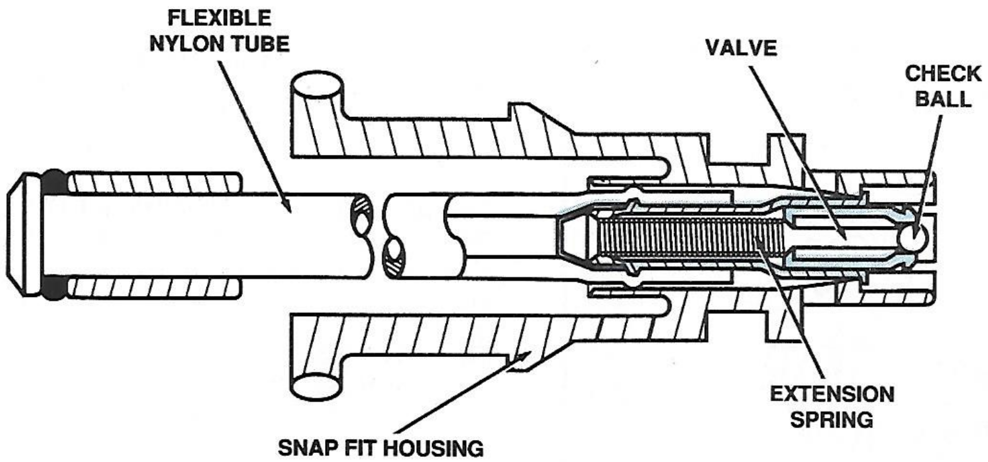


Figure 2-25, Poppet Nozzle

Each poppet nozzle contains a check ball and extension spring that together regulate fuel flow through the valve to its cylinder (figure 2-25). Fuel flows from the poppet nozzle when pressure exceeds 254–296 kPa (37–43 psi).

Injector Solenoid Energized

As fuel enters the poppet nozzle, the poppet recognizes an increase in pressure. When this pressure overcomes the force exerted by the extension spring, the ball at the cylinder end of the poppet nozzle unseats. Fuel can then spray to the cylinder.

Injector Solenoid Deenergized

When the injector solenoid deenergizes, pressure inside the poppet is reduced. Force applied by the extension spring causes the ball to seat again, thus cutting off fuel flow to the cylinder.

The checked pressure of the system inhibits fuel vaporization during hot soaks, providing better and quicker restarting of the engine.

EMISSIONS SYSTEM

Linear Exhaust Gas Recirculation (EGR) Valve

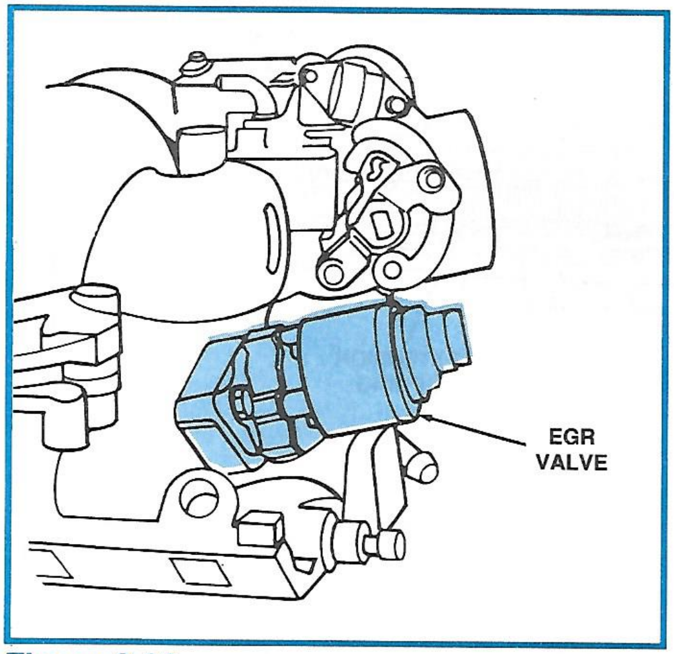


Figure 2-26, Linear Exhaust Gas Recirculation (EGR) Valve Location

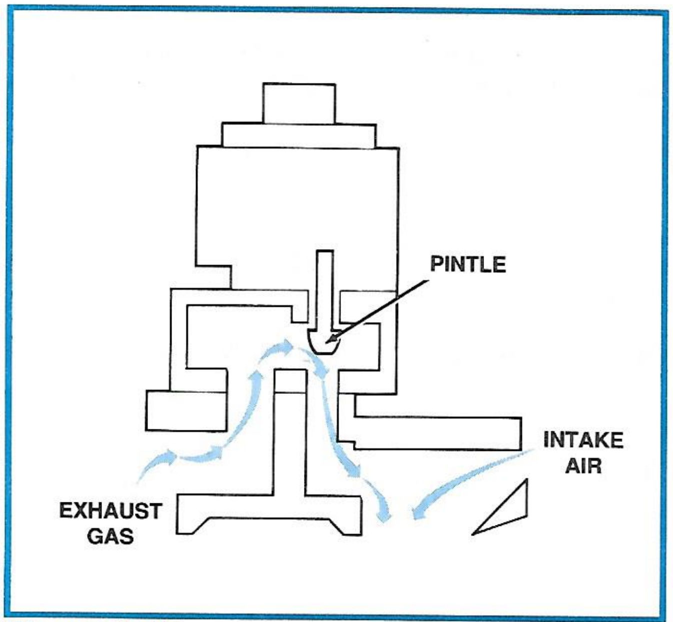


Figure 2-27, Exhaust Gas Flow in the EGR Valve

The 4.3L L35 engine features a linear Exhaust Gas Recirculation (EGR) valve (figure 2-26), located at the front of the lower manifold below the throttle body. The port for the EGR valve is cast into the manifold.

Like all EGR systems, the linear EGR reduces nitrous oxide emissions by supplying exhaust gas into the intake manifold (figure 2-27) to reduce combustion temperature.

The linear system provides improvements in flow accuracy and repeatability, and diagnostic capabilities. Response time is 10 times faster than vacuum-operated EGRs. Other benefits of the linear EGR system include:

- Continuously variable control of EGR flow by ECM.
- Maximum flow and quick response through direct pintle control.
- Protection from vehicle operating variables (such as vehicle voltage, ambient temperature, and vacuum variation) due to "Closed Loop" pintle position control.
- More accurate flow for better fuel and spark control.

EGR Components

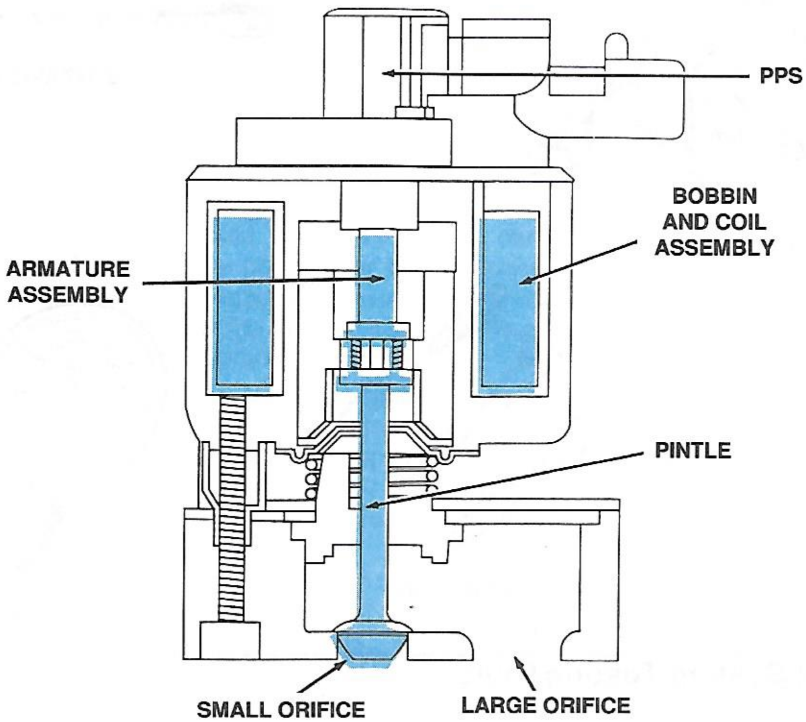


Figure 2-28, Linear EGR Components

The linear EGR valve is composed of the following subassemblies (figure 2-28):

- A solenoid (bobbin and coil) assembly, which consists of a solenoid that is encapsulated and joined to the Pintle Position Sensor (PPS) terminals to provide a common subassembly connector
- An armature assembly, which is located inside the bobbin and coil assembly and contains the pintle and valve assembly
- The base assembly, consisting of the base, a gasket, and a base plate. The base has two different-sized orifices:
    - the larger orifice allows exhaust gas into the valve
    - the smaller orifice allows exhaust gas to flow through the valve into the intake manifold

L35 FUEL SYSTEM SERVICE

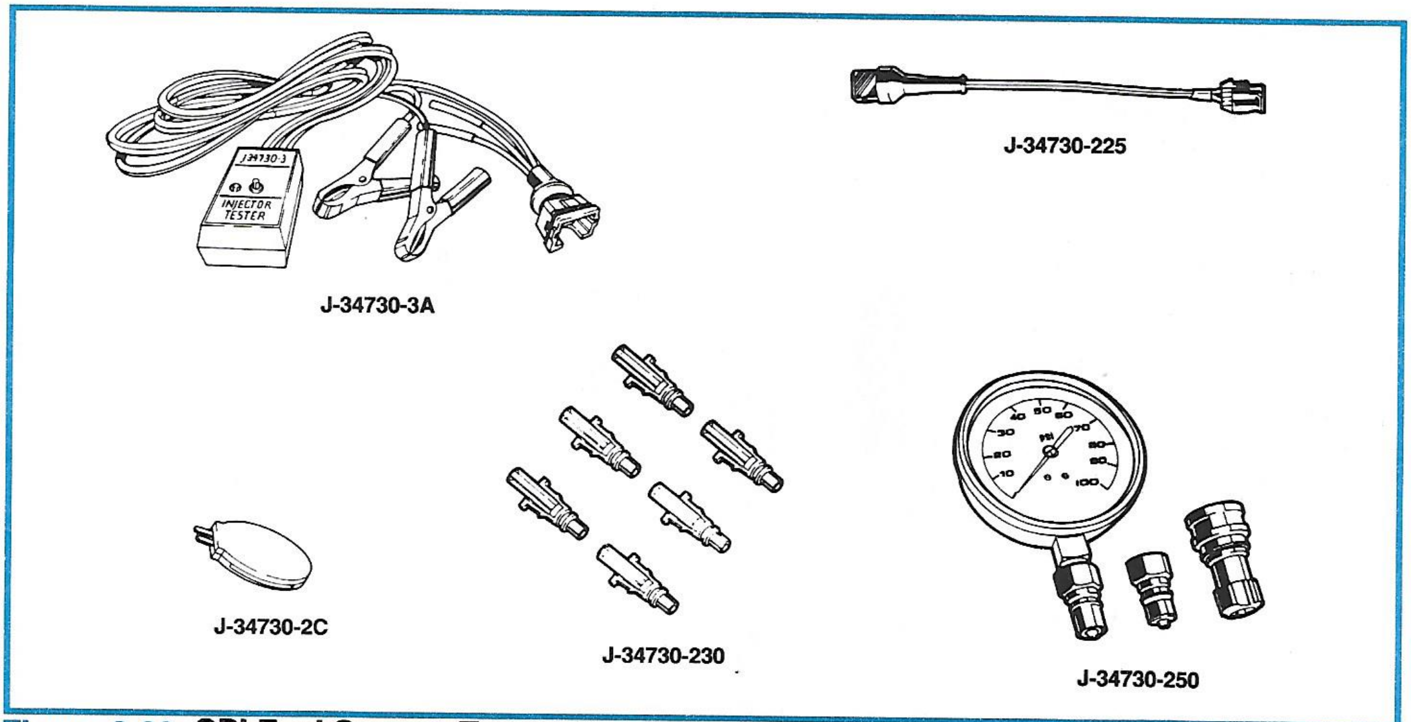


Figure 2-29, CPI Fuel System TestingTools

Fuel System Testing

SPECIAL TOOLS

Fuel system testing on the 4.3L CPI engine requires the special tools shown in figure 2-29. Dealers who already have fuel system test kit J-34730-B will receive the following adapter components to upgrade the kit for CPI testing:

- J-34730-250 Pressure Gauge (quick release) and fittings
- J-34730-225 Mini-Harness Adapter (1)
- J-34730-230 Poppet Nozzle Test Kit (consisting of 6 test devices)
- J-34730-2C Injector Test Light

For dealers who do not have the above kit, fuel system test kit J-34730-D includes the following items:

- Storage box (1)
- J-34730-1A Pressure Gauge (non quick release) (1)
- J-34730-225 Mini-Harness Adapter (1)
- J-34730-230 Poppet Nozzle Test Kit (consisting of 6 test devices)
- J-34730-3A Injector Tester (1)
- J-34730-2C Injector Test Light

FUEL SYSTEM PRESSURE TEST

1. Install the fuel pressure gauge J-34730-1A. (Use a shop towel to absorb the small amount of fuel that may leak.)

2. Turn ignition "ON" and wait 2 seconds. Pressure should be 370–440 kPa (54–64 psi) and should not bleed down even after the fuel pump stops operating.

3. If the fuel pressure does not hold, turn the ignition "OFF" for 10 seconds. Raise the vehicle to gain access to the flex fuel lines, then turn the ignition back "ON" and, after 2 seconds, pinch the fuel pressure line.
   - If pressure now holds, there may be poor connections at the pulse dampener coupling or a faulty fuel pump check valve.
   - If pressure continues to bleed down, remove the upper manifold (see page 2-19) and inspect for leaks at the fuel line connections at the CPI unit in the manifold. If there is no leak there, replace the CPI unit.

4. If pressure, as measured in step #2, does not bleed down, start the engine and observe the pressure gauge. Pressure should drop 5 to 10 psi at idle. Open the throttle rapidly and observe the pressure reading.
   - Pressure should increase as manifold pressure increases (i.e. as vacuum decreases).
   - If pressure does not respond to changes in manifold pressure, the pressure regulator may not be functioning properly. If this condition exists, replace the CPI unit.

POPPET NOZZLE DIAGNOSIS

1. Connect the fuel pressure gauge to the fuel fitting. Turn the ignition "ON." Check the fuel pressure reading after 2 seconds. Fuel pressure should be between 370 and 440 kPa (54–64 psi) and not bleed down.

2. Using injector tester J-34730-3A, activate the injector and record the pressure drop. It should drop to between 254 and 296 kPa (37–43 psi).

3. Trigger the injector a second time, without cycling the fuel pump. What is the pressure reading?__________. Why? ____.

4. If pressure dropped below the above specifications when the injector was triggered a second time, what could be the cause? ____________________________________.

5. To further test the injector poppet nozzle, remove the upper intake manifold (see page 2-19). Install injector poppet nozzle testers J-34730-230 and cycle the fuel pump again. Pressure should be between 370 and 440 kPa (54–64 psi). Trigger the injector again and observe the clear tube area. Was there fuel spray at each nozzle?_______.

L35 Manifold Service

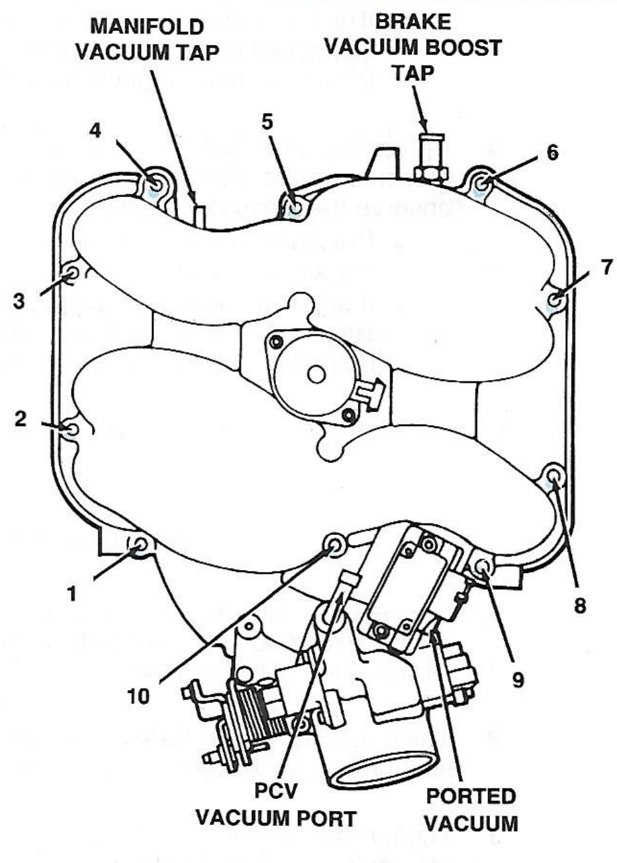
In order to gain access to the CPI assembly for service and diagnosis procedures, the upper manifold must be removed.

— NOTICE —
Do not attempt to start the vehicle with the upper manifold removed. To prevent the engine from starting, disconnect the primary side of the coil. Attempting to run the engine with the upper manifold removed can result in uncontrolled engine rpm. Also be sure to allow any aluminum components to cool before handling them.

UPPER MANIFOLD REMOVAL

To remove the upper intake manifold (figure 2-30):

1. Disconnect the negative battery cable.
2. Remove the engine cover.
3. Remove the air cleaner box, intake duct, and Intake Air Temperature (IAT) sensor.
4. Disconnect the following wiring harnesses:
   - Throttle Position Sensor (TPS)
   - Idle Air Control (IAC) motor
   - Manifold Absolute Pressure (MAP) sensor
   - Intake Manifold Tuning Valve (IMTV)
5. Disconnect and remove the throttle and cruise cables from the throttle cam and remove the linkage from the upper intake manifold.
6. Remove the nut holding the ignition coil in place, then remove the coil.
7. Disconnect the PCV hose at the upper manifold.
8. Disconnect the vacuum hoses at the front and rear of the upper intake manifold.
9. If the vehicle is equipped with A/C, disconnect the A/C compressor harness connector.
10. Loosen and remove the eight 10-mm upper intake manifold bolts and studs. Mark the location of all studs for proper reassembly.
11. Remove brake booster hose and vacuum tap hose.
12. Remove the upper intake manifold.



TORQUE SPECS: 10 N·M (88 IN/LBS)

Figure 2-30, Upper Manifold Removal and Bolt Tightening Sequence

— IMPORTANT —
Do not disassemble the CPI unit. It is only serviced as an assembly. For more detailed information on the upper and lower intake manifold components, refer to the 1992 Light Duty Truck Fuel and Emissions Service Manual.

CPI ASSEMBLY REMOVAL

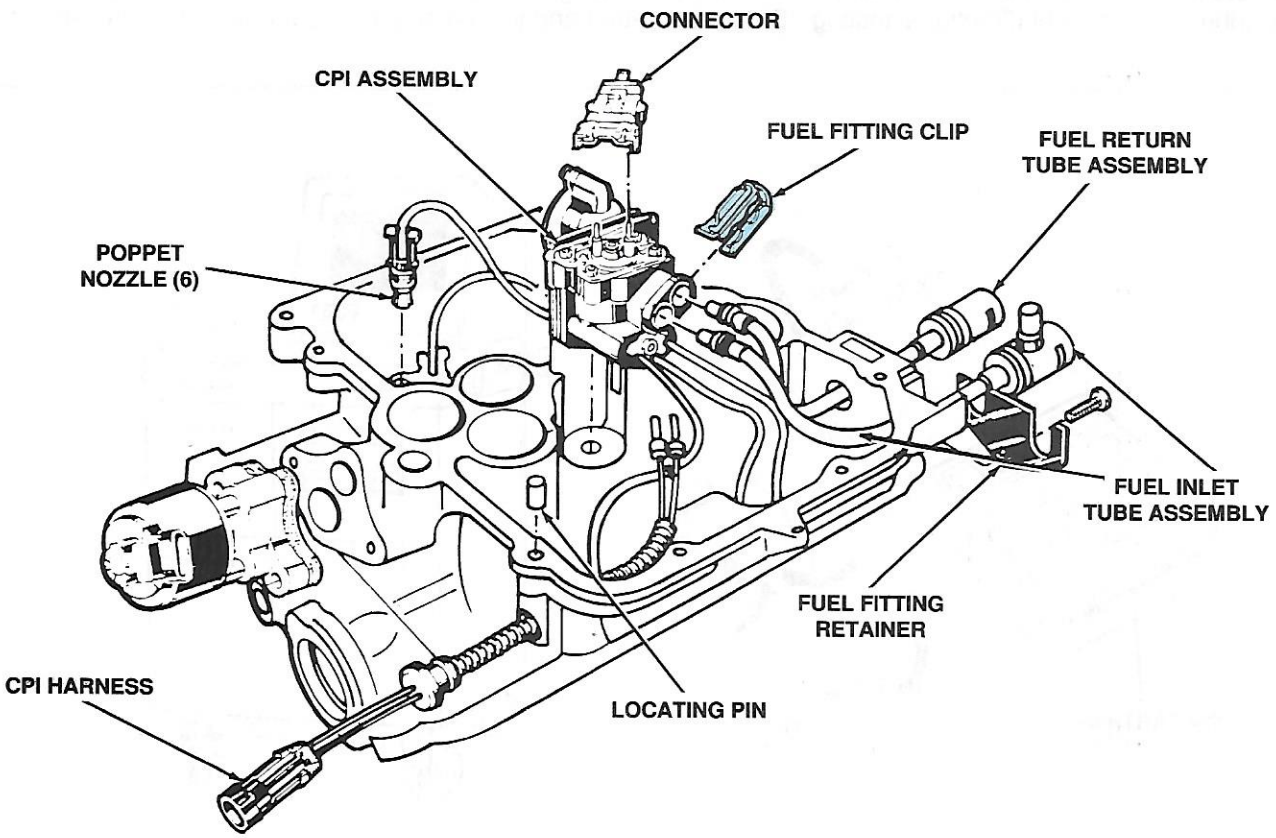


Figure 2-31, CPI Assembly Removal

The CPI assembly is positioned in the lower intake manifold. Remove the CPI assembly as follows (figure 2-31):

1. With the upper intake manifold separated from the lower manifold, remove the electrical connector to the injector solenoid.
2. Remove the clip retaining the nylon inlet and return fuel lines to the unit.
3. The poppet valves are freed by pinching the two snap-fit tangs on each poppet valve (6).
4. Lift up on the CPI unit.

— NOTICE —
If the fuel lines going to and from the CPI assembly are not properly connected, fuel will leak into the manifold. Be sure the retaining clip is properly and tightly secured.The retaining clip must be replaced each time the fuel lines to the CPI are serviced. Two part numbers are available: #17112702 (inlet/return line package, consisting of 2 o-rings and a clip) and #17112700 (replacement CPI kit, including clip).

3. Major System Operation

SCAN TOOL

Both the Tech 1 and T-100 diagnostic systems (figure 3-1) provide bi-directional testing capabilities. But because it offers hand-held flexibility and is also the basis for Service Manual diagnostic procedures, the Tech 1 is used in this booklet to describe "Scan" tool bi-directional testing. Data parameters and testing sequences on the T-100 are similar.

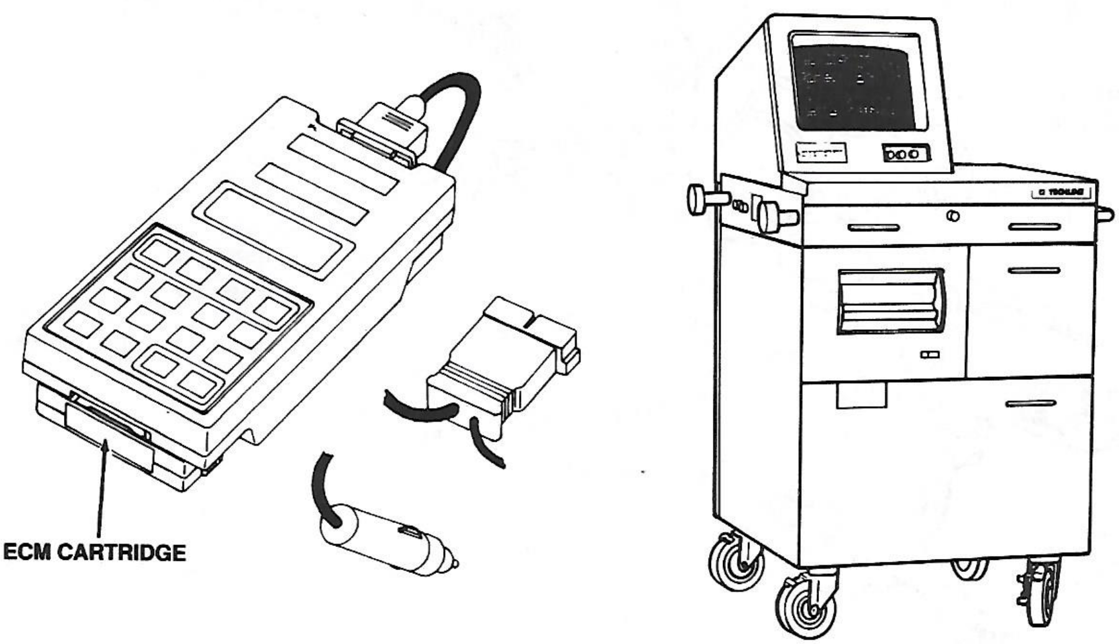


Figure 3-1, Tech 1 and T-100 Diagnostic Tools

"SCAN" TOOL DATA PARAMETERS

Parameter Name	Range in Units or 0 State/1 State Status
Engine Speed Desired Idle	0 — 9999 rpm 1 — 3187 rpm
Coolant Temperature Startup Coolant Temperature	-40°C (-40°F) — 151°C (304°F) -40°C (-40°F) — 151°C (304°F)
Coolant Temperature Intake Air Temperature	-40°C (-40°F) — 151°C (304°F) -38°C (-36°F) — 199°C (390°F)
MAP BARO	11 — 105 kPa / 0 — 5.1 Volts 11 — 105 kPa / 0 — 5.1 Volts
Throttle Position Throttle Angle	0 — 5.1 Volts 0 — 100%
Oxygen Sensor Injector Pulse Width	0 — 1132 mV 0 — 998.4 mSEC
Fuel Integrator Block Learn	0 — 255 0 — 255
Block Learn Cell Block Learn Enable	0 — 16 No/Yes
Air/Fuel Ratio Spark Advance	0 — 25.5 -90 — 90 Degrees
Knock Retard Knock Signal	0 — 45 Degrees No/Yes
"Open/Closed" Loop Converter High Temp.	"Open Loop"/"Closed Loop" No/Yes
Desired EGR Position Actual EGR Position	0 — 100% 0 — 100%
EGR Pintle Position EGR Duty Cycle	0 — 5.1 Volts 0 — 100%
EGR Auto-Zero EGR Pintle Position	Not Complete/Complete 0 — 5.1 Volts
Idle Air Control Park/Neutral	0 — 255 P-N—/R-DL
MPH KPH TCC/Shift Light	0 — 255 0 — 255 Off/On
Fourth Gear Switch A/C Request	Off/On No/Yes
Battery/Ignition Volts Fuel Pump Volts	0 — 25.5 Volts 0 — 25.5 Volts
IMTV Solenoid	Off/On
PROM ID Time From Start	0 — 9999 0:00:00 — 18:12:15

TROUBLE CODES

With this option, Tech 1 will display any stored trouble codes. The following 4.3L CPI fuel system-related trouble codes are possible.

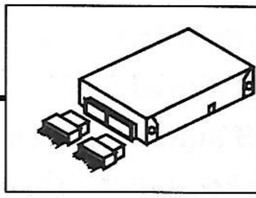
Code	Description
13	Oxygen sensor circuit
14	Coolant temperature high indicated
15	Coolant temperature low indicated
21	TPS signal voltage high
22	TPS signal voltage low
23	Intake air temperature low indicated
24	No VSS signal indicated
25	Intake air temperature high indicated
32	EGR condition
33	MAP sensor low vacuum
34	MAP sensor high vacuum
41	Fuel Moding Error
42	EST
43	ESC
44	Lean exhaust
45	Rich exhaust
51	PROM error
52	Cal-Pack missing
53	System over voltage
54	Fuel pump low voltage

— IMPORTANT —
Code 41 will set if the fuel moding program in the MEMCAL disagrees with the program in the ECM. Code 51 will set if there is a PROM error. Code 52 will set if the Cal-Pack is missing from the MEMCAL. If any of these codes set, replace the MEMCAL.

ELECTRONIC CONTROL MODULE (ECM)

OPERATING CONDITIONS SENSED

- A/C Signal
- Engine Coolant Temperature
- Oxygen (O_2) Sensor
- Distributor Reference (RPM)
- Manifold Absolute Pressure (MAP)
- Park/Neutral (P/N) Switch Position
- System Voltage
- Throttle Position Sensor (TPS)
- Vehicle Speed Sensor (VSS)
- Fuel Pump Voltage
- EGR Pintle Position (PPS)
- Engine Knock (ESC)
- Intake Air Temperature (IAT)
- 4th Gear Switch



ECM

SYSTEMS CONTROLLED

- CPI Injector Solenoid
- Diagnostics
  - "Service Engine Soon" Light
  - Serial Data (ALDL)
- Electronic Spark Timing (EST)
- Fuel Pump Relay
- Idle Air Control (IAC)
- Intake Manifold Tuning Valve (IMTV) relay
- Linear EGR Valve
- Torque Converter Clutch (TCC) Solenoid

Figure 3-3, 4.3L L35 Electronic Engine Management

The 4.3L L35 relies upon a complex system of electronic sensors to provide input information that permits the ECM to control output devices responsible for fuel metering, emissions, and performance (figure 3-3).

In addition to its duty as the control center of the CPI system, the ECM performs diagnostic functions. If it recognizes abnormal engine operating conditions, it can alert the driver through the "Service Engine Soon" (SES) light and/or store trouble codes. These codes can be accessed by technicians for quicker, more accurate diagnosis.

The ECM on 4.3L L35 vehicles is a bi-directional P4 ECM. Under this capability, the ECM not only uses information provided by inputs to control the operation and function of outputs, it also allows technicians to initiate output device operation for diagnosis and testing purposes.

INPUT CIRCUITS

Heated Oxygen (O_2) Sensor Circuit

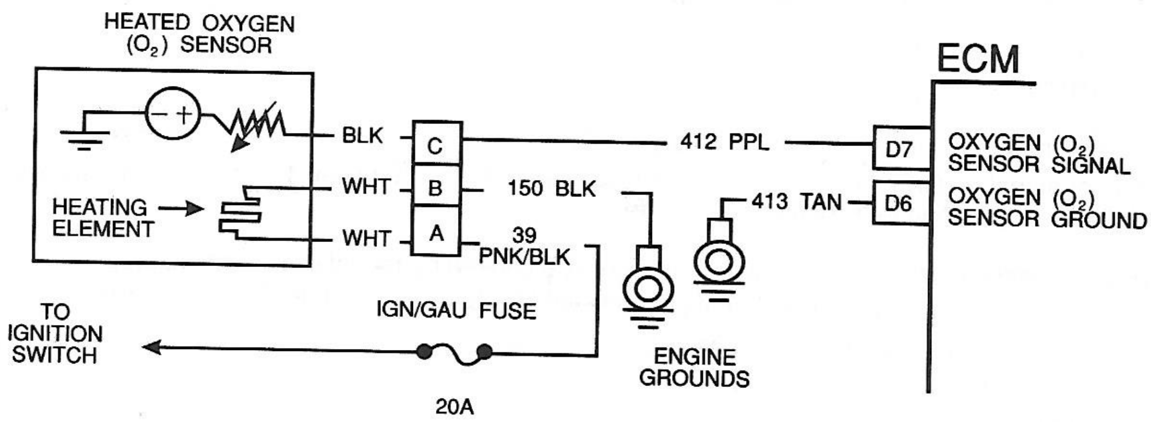


Figure 3-4, Heated Oxygen (O_2) Sensor Circuit

CIRCUIT OPERATION

The heated Oxygen (O_2) sensor is the primary feedback sensor of the 4.3L L35 engine management system. It monitors oxygen content of the exhaust gas. Oxygen in the exhaust gas reacts with the sensor to produce voltage that is read by the ECM (figure 3-4).

- The O_2 sensor receives a voltage of approximately .45 volt on CKT 412 from the ECM.
- When the engine is started, the fuel control system is in "Open Loop" operating mode and the O_2 signal is ignored by the ECM.
- When the O_2 sensor reaches 600°F, its signal is read by the ECM and used for "Closed Loop" system operation, providing that other operating requirements are met (i.e. coolant temperature and time).
- The heater element in the O_2 sensor receives voltage from the ignition/gauges fuse. This element helps the sensor achieve quicker operating temperature and continued "Closed Loop" operation at prolonged idle.

The sensor voltage varies within a range from 1 volt if the exhaust gas is rich to .01 volt if the exhaust is lean.

There are no trouble codes specific to the heater element. Indicators of heater element failure are sluggish performance and/or odor from the catalytic convertor. To check heater operation, refer to the Code 13 chart in the appropriate service manual.

CODE 13

Code 13 relates to O_2 sensor circuit operation. It will set if the following conditions are present for a 60-second duration 2 minutes after the engine was started:

- Engine temperature greater than 70°C (158°F)
- O_2 sensor signal voltage steady between .35 volt and .55 volt
- Throttle Position Sensor (TPS) signal above 5 percent

These conditions will prevent the system from going into "Closed Loop" operation. A possible cause for a Code 13 could be an open in CKT 412 or contamination of the sensor.

CODES 44 AND 45

A Code 44 (lean exhaust) will set under the following conditions:

- O_2 sensor signal on CKT 412 is below .2 volt for a period of time between 1 minute and 4 minutes while the system is operating in "Closed Loop" mode

A Code 44 also identifies a low voltage reading. This could be caused by the following conditions:

- O_2 sensor pigtail wire mispositioned or in contact with the exhaust manifold
- An intermittent ground between the sensor and connector
- Water near the in-tank fuel pump inlet
- Low fuel pressure
- Lean injector poppet nozzle(s)

Refer to Service Manual procedures for investigating the above conditions. If none of these proves to be the cause of a Code 44, the O_2 sensor may be faulty.

Code 45 sets when circuit voltage is high, possibly indicating a rich exhaust gas mixture. Code 45 will set if the following conditions are present 1 minute after engine start:

- CKT 412 voltage is above .7 volt for 60 seconds and the system is in "Closed Loop" operation
- Throttle angle is greater than 5 percent (about .2 volt above idle voltage)

Code 45 also could result from one of the following conditions:

- Too high fuel pressure
- A leaking fuel injector or poppet
- An open in ground CKT 453 (ignition system reference low) that results in higher than actual engine speed signals, causing the ECM to deliver too much fuel
- Saturated canister
- Higher than normal manifold pressure
- Leaking pressure regulator or poppet nozzle(s)
- Intermittent TPS
- Contaminated O_2 sensor
- Excessive fuel in oil (crankcase)

— IMPORTANT —

Code 45 is a "latching" code. If it sets, the "SES" light turns "ON" and remains "ON" until the ignition is turned "OFF." This service reminder is designed this way due to high fuel system pressure.

Coolant Temperature Sensor (CTS) Circuit

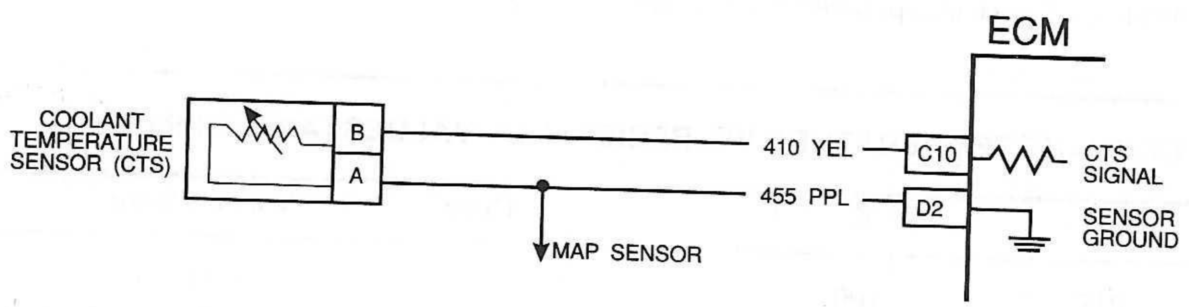


Figure 3-5, Coolant Temperature Sensor (CTS) Circuit

CIRCUIT OPERATION

The Coolant Temperature Sensor (CTS) is a thermistor that produces a signal inversely related to engine coolant temperature.

The ECM supplies 5 volts to the CTS on CKT 410 (figure 3-5). The CTS is grounded by way of CKT 455, which is shared with the MAP sensor. When coolant temperature is low, the CTS provides high resistance. This high resistance provides a high signal voltage to the ECM. The opposite is true for warm coolant.

Information from the CTS is used by the ECM for "Open Loop" and "Closed Loop" fuel control, ignition timing, TCC, and EGR.

CODE 14

Code 14 sets when the CTS detects a coolant temperature above 135°C (270°F) for 6 seconds. Other possible causes for a Code 14 include:

- A short in CKT 410 to ground
- A shifted CTS

CODE 15

Code 15 sets when the CTS detects that coolant temperature is less than -33°C (-27°F) for at least 30 seconds. Other possible causes for a Code 15 include an open in CKT 410 or 455.