1.5 FUEL CONTROL SYSTEM

PURPOSE

The purpose of closed loop fuel control is to control tailpipe emissions consisting of hydrocarbons (HC), Carbon Monoxide (CO), and Oxides of Nitrogen (NOx). At the same time, the system must achieve good engine performance and good fuel economy.

The closed loop system regulates exhaust emissions by controlling the air/fuel ratio at an optimum level during various driving conditions. The most efficient air/fuel ratio to minimise exhaust emissions is 14.7 to 1, which allows the 3-way catalytic converter to operate at maximum conversion efficiency of exhaust pollutants. Because of the constant measuring of the exhaust gases by the oxygen sensor, and adjusting of the fuel injector pulse width by the ECM/PCM, the fuel injection system is called a "closed-loop" control system.

FUNCTION

The fuel supply system delivers fuel at a regulated pressure to the fuel rail. The fuel injectors, located directly ahead of each inlet port of the cylinder head, act as fuel flow control valves, "spraying" atomised fuel into the inlet ports when they are electrically "pulsed" by the ECM/PCM. On all of the manual transmission vehicles, and the automatic transmission equipped V-8 engine, all injectors are wired in parallel, so they are pulsed simultaneously, i.e. all together at the same time.

The ECM/PCM controls the amount of fuel injected into the engine by controlling the length of time the injectors are held open. This "length-of-time" is called PULSE WIDTH. To increase the amount of fuel injected, the pulse width is lengthened, and vice versa. The pulse width is calibratable and varies between 0 - 11 milliseconds with the engine running at idle, and injection pulses normally occur once every crankshaft revolution.

SPEED DENSITY SYSTEM

The Holden/Delco Fuel Injection system is a speed and air density system. The system is based on "speed density" fuel management, let's define their basis of operation.

Three specific data sensors provide the ECM/PCM with the basic information for the fuel management portion of its operation. That is, three specific signals; crankshaft reference signal from the ignition system, Intake Air Temperature (IAT) sensor signal and the Manifold Absolute Pressure (MAP)sensor signal, to the ECM/PCM establish the engine speed and air density factors.

Speed

The engine speed signal comes from the ignition module to the ECM/PCM on the crankshaft reference signal, CKT 430. The ECM/PCM uses rpm information to calculate the best fuel injector pulse width and spark timing for a given operating rpm band.

Density

Density can be described as how much

Density can be described as how much oxygen is contained in the air coming into the engine. The density of the intake air will be affected by both temperature and pressure. Intake air that is cold will contain more oxygen because the air molecules are very close to each other, therefore, a litre of cold air will contain more oxygen than a litre of hot air. The reason for this is that the oxygen in hot air is spaced further apart for the given volume. Pressure also affects the density of the intake air. By pressuring the intake air molecules the air is squeezed together tighter, thus the oxygen content becomes greater for the given volume. The density of the intake air is a major factor in controlling both the fuel and ignition system. Two sensors contribute to the density factor, the Intake Air Temperature (IAT) sensor and the Manifold Absolute Pressure (MAP) sensor.

The IAT sensor is a 2-wire sensor that measures the temperature of the air in the intake manifold. The IAT sensor is a thermistor that changes its resistance as an inverse function of temperature. When the temperature is low, the resistance is high, and when the temperature is high, the resistance is low.

When the engine is started cold, the ECM/PCM will immediately look at the Engine Coolant Temperature (ECT) and IAT values to determine how much fuel is required to start the engine. After the engine is started, the ECM/PCM will constantly monitor the ECT and IAT values to determine both the spark advance and engine fueling requirements. An engine started in cold weather will require more fuel and spark advance than an engine started hot, which requires less fuel and less spark advance.

The Manifold Absolute Pressure (MAP) sensor is a 3-wire sensor that monitors the changes in intake manifold pressure that results from changes in engine loading and throttle opening. These pressure changes are supplied to the ECM/PCM in the form of an analog electrical signal.

As intake manifold pressure increases, such as when under Wide Open Throttle (WOT) load the air density in the intake manifold also increases, and additional fuel is required. The MAP sensor sends this pressure information to the ECM/PCM, and the ECM/PCM increases the amount of fuel injected, by increasing the injector pulse width. Conversely, as manifold pressure decreases, throttle closing, the amount of fuel is decreased.

Three inputs: MAP, IAT and RPM are the major determinants of the air/fuel mixture delivered by the fuel injection system. The rpm factor determines the rate at which the airflow is coming into the engine. The MAP and IAT values determine the density of the airflow.

The remaining sensors and switches provide electrical inputs to the ECM/PCM which are used for modification of the air/fuel mixture as well as for other ECM/PCM control functions, such as Idle Air Control (IAC).

MODES OF OPERATION

The ECM/PCM looks at voltage signals from several sensors to determine how much fuel to give the engine, and when to operate in the open-loop or closed-loop modes. The fuel is controlled in one of several possible modes.

controlled in one of several possible modes. All the modes are controlled by the ECM/PCM, and are described in the following paragraphs.

Starting Mode

When the ignition key is first turned "ON," the ECM/PCM will energise the fuel pump relay, and the fuel pump will build up pressure to the fuel rail. The ECM/PCM then checks the engine coolant temperature sensor and determines the proper injector pulse width for starting the engine.

When cranking begins, the ECM/PCM will operate in the Starting Mode until engine RPM is more than about 400 -or- the "Clear Flood" mode is enabled. Pulse width during the Starting Mode is between approximately 4 - 26 milliseconds, depending upon engine coolant temperature.

Clear Flood Mode

If the engine floods, it can be started by pushing the accelerator pedal down all the way to the floor while cranking the engine. The ECM/PCM then pulses the injectors with only a four millisecond pulse width, which should "clear" a flooded engine. The ECM/PCM holds this pulse width as long as the throttle position sensor input indicates the throttle is nearly wide open, and RPM is below 400.

If the throttle is held wide-open while attempting to make a normal start with a non-flooded engine, the engine may not start. A 4 millisecond pulse width may not be enough fuel to start a non-flooded engine, especially if it is cold.

Run Open Loop Mode

After the engine is running (RPM more than 400), the ECM/PCM will operate the fuel control system in the Open Loop mode. In open loop, the ECM/PCM ignores the signal from the Oxygen Sensor, and calculates the air/fuel ratio injector pulse width based on inputs from the crankshaft reference signal (RPM input) and these sensors: MAP, IAT, ECT, and TP sensor. The system will stay in the Open Loop mode until all the following conditions have been met:

1. The oxygen sensor has a varying voltage output, indicating that it is hot enough to operate properly. This is described fully in the previous section on ECM/PCM and sensor operation.
2. The engine coolant temperature is more than 44 degrees C.
3. Not at idle. Refer Idle Mode.

In open loop, the calculated pulse width may give an air/fuel ratio other than 14.7 to 1. An example of this would be when the engine is cold, because a richer mixture is needed to ensure good driveability.

Run Closed Loop Mode

In Closed Loop mode, the ECM/PCM initially calculates injector pulse width based on the same sensors used in open loop. The difference is that in closed loop, the ECM/PCM uses the Exhaust Gas Oxygen Sensor signal to modify and precisely fine tune the fuel pulse width calculations in order to precisely maintain the 14.7 to 1 air/fuel ratio that allows the catalytic converter to operate at it's maximum conversion efficiency.

Idle Mode

The reason for the Idle Mode is to allow a slightly richer mixture at idle for better idle quality. Idle Mode air/fuel ratio is about 14.0 to 1. This is an open loop mode, meaning the O2 sensor signal is ignored.

The Idle Mode is in effect when the throttle is closed (TP Sensor), and vehicle speed is below 5 km/h (VSS).

In the case where the vehicle rolls to a stop while operating in the Closed Loop mode, Idle Mode will be delayed for about 20-30 seconds. During this time, the ECM/PCM will "learn" a fuel correction factor for a 14.7 to 1 air/fuel ratio before switching to the Idle Mode.

Acceleration Mode

The ECM/PCM looks at rapid changes in throttle position (TP sensor) and manifold pressure (MAP), and provides extra fuel by increasing the injector pulse width. If the increased fuel requirements are great enough, the ECM/PCM may add extra fuel injection pulses between the injector pulses that normally occur once per crankshaft revolution.

Deceleration Mode

When deceleration occurs, the fuel remaining in the intake manifold can cause excessive emissions and possibly backfiring. Again, the ECM/PCM looks at changes in throttle position (TP sensor) and manifold pressure (MAP), and reduces the amount of fuel by decreasing the pulse width.

Decel Fuel Cutoff Mode

When deceleration from road speed occurs, the ECM/PCM can cut off fuel pulses completely for short periods. The decel fuel cutoff mode occurs when all these conditions are met:

1. Coolant temperature above 56 degrees C.
2. Engine RPM above 1500.
3. Vehicle speed above 30 km/h.
4. Throttle is closed.
5. MAP input indicates no engine load (less than 20 kPa on a manual transmission or 30 kPa on an automatic transmission).

When decel fuel cutoff is in effect, any one of these can cause injection pulses to restart.

1. Engine RPM below 1400.
2. Vehicle speed is less than 30 km/h.
3. Throttle is open at least 1%.
4. MAP input indicates some engine load (more than 28 kPa on manual transmission or 38 kPa on an automatic transmission).

Battery Voltage Correction Mode

At low battery voltages, the ignition system may deliver a weak spark, and the injector mechanical movement takes longer to "open." The ECM/PCM will compensate by:

Increasing ignition coil dwell time if voltage is less than 12 volts.

Increasing idle RPM if voltage drops

Increasing idle RPM if voltage drops below 10 volts.

Increasing injector pulse width if voltage drops below 10 volts.

Fuel Cutoff Mode

No fuel is delivered by the injectors when the ignition is (OFF). This prevents dieseling. Also, fuel pulses are not delivered if the ECM/PCM receives no distributor reference pulses from the ignition module, which means the engine is not running.

The Fuel Cutoff Mode is also enabled at:

High engine RPM, as an overspeed protection for the engine. When cutoff is in effect due to high RPM, injection pulses will resume after engine RPM drops slightly.

High vehicle speed. When the vehicle speed exceeds a calibratable value (about 220 km/h) the fuel base pulse width is set equal to zero. Normal fuel operation will return when the vehicle speed falls below a calibratable value (about 210 km/h).

Adaptive Learning

Adaptive learning is the ability of the on-board computer to determine and remember its most recent operating experience. The ECM/PCM uses this remembered information to "learn from experience" and to make adjustments with respect to what it learned. If the engine where to develop a restricted fuel filter, the ECM/PCM will change the fuel injector pulse width richer to compensate for this condition and will remember to keep this fuel injector pulse width in memory until the restriction is corrected. After the leak has been fixed, the ECM/PCM will eventually go back to the original preprogrammed fuel injector pulse width. Another example of adaptive learning is used when a vehicle is driven from a low elevation to a higher elevation. The weight of air is less at higher elevations and the ECM/PCM will detect this from its barometric pressure reading, from the MAP sensor, when the ignition is first turned "ON," and will be updated any time the engine is operated at wide open throttle. When less air pressure is sensed the ECM/PCM will decrease the injector pulse width proportionally to compensate for this condition and maintain the correct air fuel ratio.

Adaptive learning is an on-going process that continues throughout the life of the engine. A new engine with good compression will have good vacuum (low pressure) in the intake manifold. The MAP sensor will detect this low pressure and have a voltage of about 1.2 volts at idle, at sea level. As the engine wears and compression decreases, a slight decrease in engine vacuum will be noticed, which translates into a slightly higher MAP voltage at idle, which will increase fuel injector pulse width to compensate for this condition.

SHORT TERM FUEL TRIM

Short Term Fuel Trim (STFT) represents short term corrections to the fuel injector pulse width calculations, based on the oxygen sensor input signal to the ECM/PCM.

When the engine is started cold, in "Open Loop," the ECM/PCM will control the fuel injection pulse width based upon various sensor inputs such as RPM, ECT, MAP and TP sensor until the oxygen sensor becomes

TP sensor until the oxygen sensor becomes hot enough (approximately 315 C) to operate properly. During this "Open Loop" period, both Short Term Fuel Trim (STFT) and Long Term Fuel Trim (LTFT) are disabled and will read 0% on a Tech 1 scan tool.

When the oxygen sensor has come up to its normal operating temperature (approximately 600 degrees C or above), it will produce a varying voltage to the ECM/PCM and provide a good indication of what has happened in the combustion chambers.

At this time the ECM/PCM will switch from "Open Loop" to "Closed Loop" and the STFT will start to constantly monitor the oxygen sensor signal, so that the ECM/PCM can modify fuel injector pulse width with greater accuracy than in "Open Loop."

STFT monitors the oxygen sensor signal so that it can adjust the fuel injector pulse width to maintain an air/fuel ratio of 14.7 to 1 for maximum catalytic converter efficiency. An STFT value of 0% is equivalent to an air/fuel ratio of 14.7 to 1 and an average oxygen sensor signal voltage of 450 mV.

The normal position for Short Term Fuel Trim is 0%, any change from this value indicates the Short Term Fuel Trim is changing the fuel injector pulse width. The amount of pulse width change depends upon how far the STFT value is from 0%. If the STFT value is above 0%, the fuel injector pulse width is being increased, thus adding more fuel. If the STFT value is below 0%, the fuel injector pulse width is being decreased, thus removing fuel. The normal operating range of STFT is considered to be between -18% +13%; any value out of this range is usually caused by a malfunction.

If an engine has a restricted fuel filter, the low fuel pressure will result in less fuel being injected and allows more air into the air charge than is needed to ignite the amount of fuel the fuel injector has injected, therefore, a lean air/fuel ratio exists in the combustion chamber. After combustion has taken place, the exhaust gases still contain more oxygen content than normal and the oxygen sensor reads this as low voltage, say 200 mV. The STFT detects that the oxygen sensor signal is low and will increase the value to richen up the air/fuel mixture. On a Tech 1 scan tool it will display STFT as a value above 0%. This STFT change will increase the injector pulse width allowing the fuel injectors to stay open longer and inject more fuel.

If the additional fuel was injected and the oxygen sensor signal voltage is still low, the STFT will continue to increase its value until the oxygen sensor signal voltage goes above 450 mV. If the STFT continues to detect a low oxygen sensor signal voltage it will continue to try and compensate for the lean exhaust condition until it runs out of its authority in the particular Long Term Fuel Trim (LTFT) cell it's operating in. At this point, the ECM/PCM will reset STFT to 0% and go through this procedure again until it can control the system.

If after a specified amount of resets have been tried and failed, the ECM/PCM knows that it cannot control for the failure and the STFT will remain at its maximum value.

STFT values are based off the oxygen sensor signal voltage reading, therefore, STFT is used by the ECM/PCM to make quick changes to the fuel injector pulse width over a short period of time.

LONG TERM FUEL TRIM

Long Term Fuel Trim is used to adjust for engine to engine variation and to adjust for engine aging. LTFT is a portion of the ECM/PCM memory used to adjust fuel delivery across all operating conditions of the engine. The ECM/PCM monitors the STFT and will adjust the long term trend of the fuel injector pulse width if the STFT has been at a value for a certain period of time. LTFT is used to change the long term fuel injector pulse width and is only operational when the fuel control system is in "Closed Loop." A normal LTFT value is 0% and should follow the STFT value.

If an engine has a restricted fuel filter, the low fuel pressure will result in less fuel being injected and will cause the STFT value to go higher than 0%, say 2%. If this STFT value change does not compensate for the restricted fuel filter, the ECM/PCM will continue to increase the STFT value. The STFT may climb as high as its maximum calibrated value if there is a severe restriction. The ECM/PCM will continue to monitor STFT as it climbs, but it will not make any changes to the fuel injector pulse width for a specific period of time. After a specific period of time has elapsed and the STFT value has remained above say +8, the LTFT will move up to say 4% and wait again to detect if the STFT has dropped back down to 0%. If not, the STFT will gradually move toward its maximum calibrated value limit until it gains control of the fuel injection system. If STFT and LTFT are both set at there maximum value limit, the fuel control system is "out of the limits of control" and will set either a Diagnostic Trouble Code (DTC) 44 (lean exhaust) or DTC 45 (rich exhaust) and go into "open loop" operation.

Under the conditions of power enrichment, (Wide Open Throttle, WOT), the ECM/PCM sets the STFT to 0% and freezes it there until power enrichment is no longer in effect. This is done so that LTFT will not try to correct for the commanded richness of power enrichment.

The ECM/PCM will keep the latest LTFT values stored in its LTFT memory cells. MAP sensor pressure readings and engine RPM are used by the LTFT to determine what cell to read. LTFT values are stored in the ECM/PCM's long term memory, for use each time the engine's RPM and load matches one of the LTFT cells. All LTFT values are reset to 0% when the ECM/PCM's "long term memory power supply" is disconnected, as when diagnostic trouble codes are cleared. The Tech 1 scan tool also has the ability to reset LTFT to 0% with a special command.

Long Term Fuel Trim Cell

Engine Speed (RPM)

Manifold Pressure	1200 RPM	1600 RPM	2400 RPM	3600 RPM
30 kPa	0%	0%	+3%	+4%
40 kPa	+1%	+2%	+2%	+3%
50 kPa	0%	0%	0%	0%
60 kPa	+1%	+2%	+2%	+2%
70 kPa	0%	+1%	+1%	+2%

0% IN "D" - A/C "OFF"
+1% IN "D" - A/C "ON"
0% IN "N" - A/C "OFF"
0% IN "N" - A/C "ON"

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Figure 6C2-1-82 Long Term Fuel Trim Values

The Long Term Fuel Trim function of the ECM/PCM is divided up into cells arranged by a Manifold Absolute Pressure (MAP) and Engine Speed (RPM). Each cell corresponds to a region on a MAP vs rpm table. Each region is calibrated to a LTFT value of 0%. A value of 0% in a given block indicates no fuel adjustment is needed for that engine load condition. A higher number, say 4%, indicates that the ECM/PCM has detected a lean exhaust indication under those conditions, and is adding fuel (increasing fuel injector pulse width) to compensate. Conversely, a lower number, say -6%, indicates that the ECM/PCM has detected a rich exhaust indication under those load conditions, and is subtracting fuel (decreasing fuel injector pulse width) to compensate.

As the vehicle is driven from a standing start and accelerated or decelerated from various engine speeds, the engines LTFT calibration will change from one cell to another cell. As the LTFT changes cell so does STFT, however, STFT will only make short term corrections in whatever LTFT cell the engine is operating in. When the engine is idling, it can be in one of four cells 20, 21, 22 or 23. If the engine was running at 2400 RPM and the manifold pressure was at 60 kPa, we would be in cell - 13. Whatever cell the engine is operating in, the ECM/PCM will read that cells particular LTFT value and electronically adjust the fuel injector base pulse width to compensate for a rich or lean condition in the engine. If an engine has a restricted fuel filter and the customer has driven the vehicle like this for quite some time, the STFT value would be high, and the ECM/PCM would be compensating for this condition by adding more fuel. Because the STFT value is above 0%, LTFT will also be greater than 0% in most of the cells to compensate for the lean exhaust.

If you suspect a driveability problem associated with an over rich or over lean condition, then use the STFT value to detect what the fuel control system is doing at the present time. Use the LTFT to identify what the system has "learned" over a greater period of time to compensate for the condition.

Use the LTFT cells to determine if the fuel control system is commanding rich or lean throughout the operating range. If it is only rich or lean at idle or part throttle look for components that would cause problems in these areas.

All LTFT cell values are reset to 0% when long term memory power to the ECM/PCM is removed, such as when clearing codes.

The Tech 1 scan tool has the ability to reset all LTFT cells to 0% with a special command.

Engine Speed (RPM)

Manifold Pressure	1200 RPM	1600 RPM	2400 RPM	3600 RPM
30 kPa	cell 0	cell 5	cell 10	cell 15
40 kPa	cell 1	cell 6	cell 11	cell 16
50 kPa	cell 2	cell 7	cell 12	cell 17
60 kPa	cell 3	cell 8	cell 13	cell 18
70 kPa	cell 4	cell 9	cell 14	cell 19

cell 20 idle in "D" - A/C "OFF"
cell 21 idle in "D" - A/C "ON"
cell 22 idle in "N" - A/C "OFF"
cell 23 idle in "N" - A/C "ON"

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Figure 6C2-1-83 Long Term Fuel Trim Cell Matrix

BASIC FUEL SYSTEM OPERATION

The fuel control system starts with the fuel in the fuel tank. A single in-tank high pressure fuel pump is used. From the high pressure pump, fuel flows through a fuel filter, then on to the engine fuel rail through the fuel pressure supply line.

The high pressure in-tank single pump is capable of providing fuel at more than 575 kPa. A pressure regulator connects between the fuel rail and the return fuel line, and keeps fuel available to the injectors at a regulated pressure between 235 and 320 kPa.

The regulated pressure will vary, depending on intake manifold pressure. The pressure regulator senses manifold pressure through a small hose connecting it to the throttle body adaptor. When throttle body adaptor pressure is low (closed-throttle), the regulated pressure is at its lowest. When the throttle is wide open, intake manifold pressure is high and the fuel pressure also is at its highest.

Fuel in excess of injector needs is returned to the fuel tank by the separate return line connected to the outlet of the pressure regulator.

The injectors, located in each runner of the intake manifold just ahead of the inlet ports to the cylinder head, are controlled by the ECM/PCM. They deliver fuel in one of several modes, as described previously.

The fuel pump is normally energised by the ECM/PCM via the fuel pump relay. As a back-up, the fuel pump can be energised directly by the oil pressure switch after the engine oil lubrication system comes up to operating pressure. Refer to Diagnosis CHART A 4.1 in Section 6C2-2A for PCM or 6C2-2B CHART A 4.1 for ECM.

SYSTEM COMPONENTS

The Fuel Control System is made up of the following components:

- ECM/PCM
- Fuel pressure supply line
- Fuel pump relay
- Fuel rail
- Fuel strainer
- Injectors
- Fuel pump
- Fuel pressure regulator
- Fuel filter
- Fuel return line
- Oil pressure switch
- Swirl pot

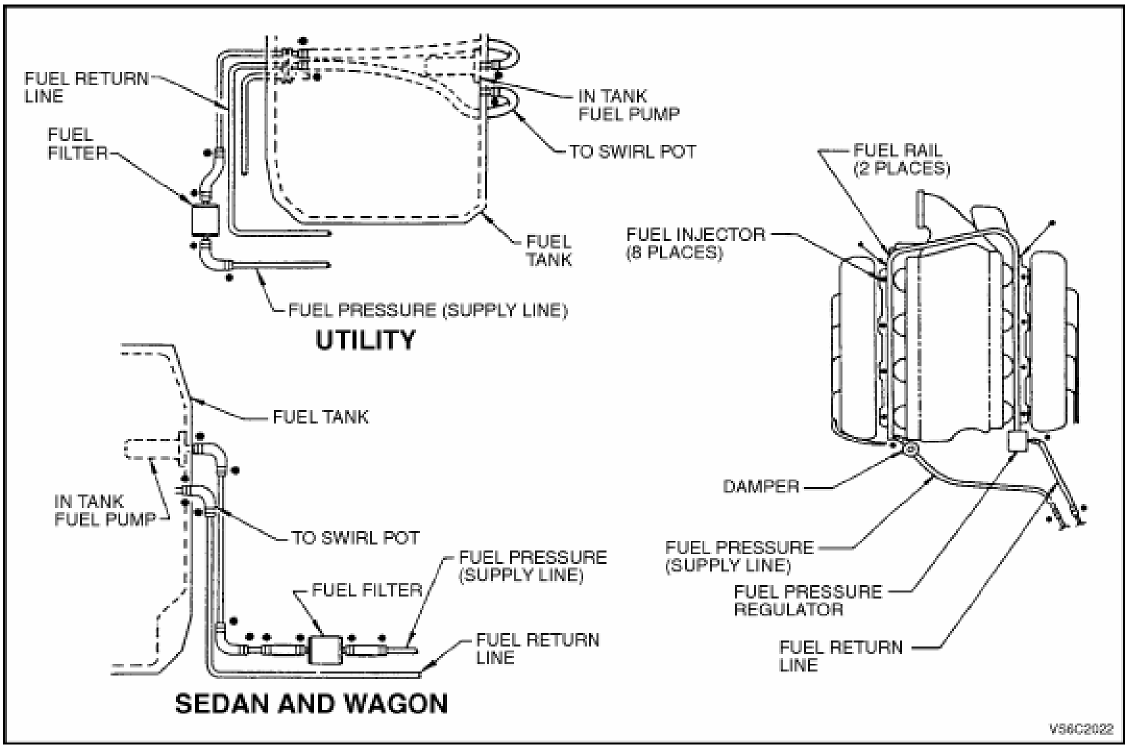


Figure 6C2-1-84 Fuel Delivery System

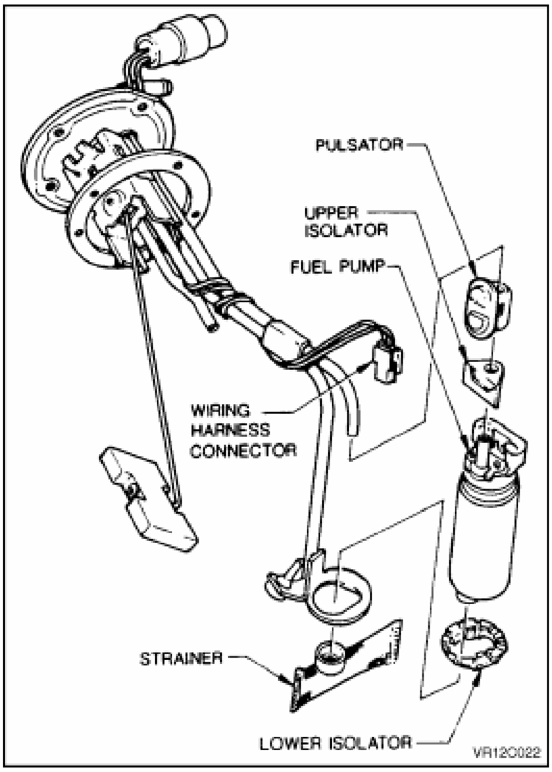


Figure 6C2-1-85 In Tank Fuel Pump Assembly

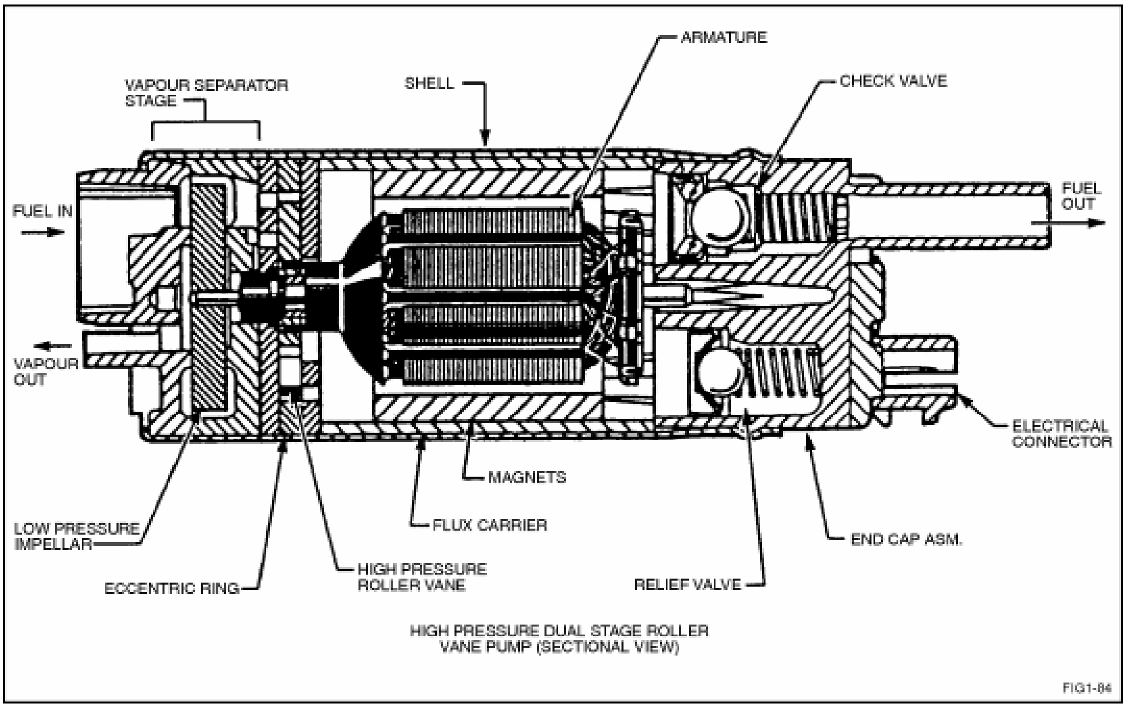


Figure 6C2-1-86 Fuel Pump

Throttle body unit

The throttle body unit is made up of one casting assembly, with two electrical components connected to it. They are:

1. An Idle Air Control (IAC) valve to control air flow bypassing around the throttle blade. This "bypass" airflow provides the air requirements for the engine when the throttle is closed. More "bypass" air gives the engine the ability of a higher idle speed, while lower flow rates of this "bypass" air give lower idle speeds. The IAC acts as an ECM/PCM-controlled bypass air valve, allowing the ECM/PCM to control idle speed.
2. A Throttle Position Sensor, which gives the ECM/PCM information about current throttle position, and if the throttle is moving (opening or closing). The ECM/PCM can also determine how quickly the throttle is opening or closing with this signal.

   The throttle body contains 2 small vacuum ports. These ports provide vacuum signals to the evaporative emission's canister. In a V8 engine there are also 2 larger ports that provide for the crankcase ventilation system.

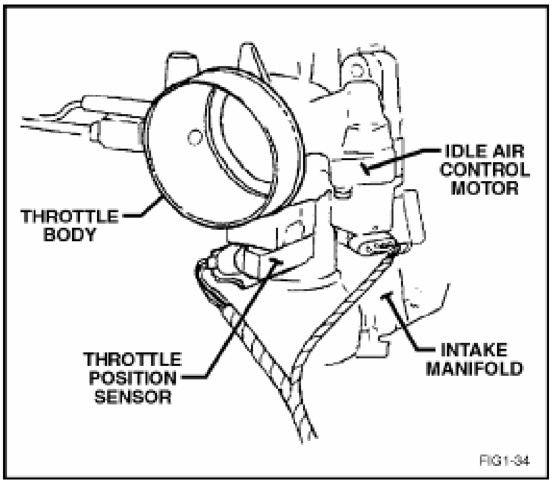


Figure 6C2-1-87 Throttle Body

Fuel Injectors

The fuel injectors are electrically-operated fuel flow control valves. They are supplied with +12 volts through Fuse No. F25 and the EFI relay, both located in the engine compartment fuse and relay housing. The injectors are controlled by the ECM/PCM providing the earth circuit. The ECM/PCM energises the injectors to "open" the flow of fuel. The injectors are never fully energised "ON," as that would flood the engine with too much fuel. The ECM/PCM supplies the earth circuit in short pulses. The longer the duration of the pulse (pulse width), the more fuel is injected into the engine. Inside, the injectors have a coil of electrical wire that becomes an electromagnet when energised. The resistance of these windings is important for the ECM/PCM to operate correctly.

The injector electrical resistance is approximately 14.5 ohms at 20 C. If measurement with an accurate ohmmeter shows less than 14 ohms or more than 16 ohms, replace the injector.

(Acceptable: 14-16 ohms).

A fuel injector which does not open causes a misfire condition. An injector which is stuck partly open could cause dieseling because some fuel would be delivered to the engine after the ignition key is turned "OFF."

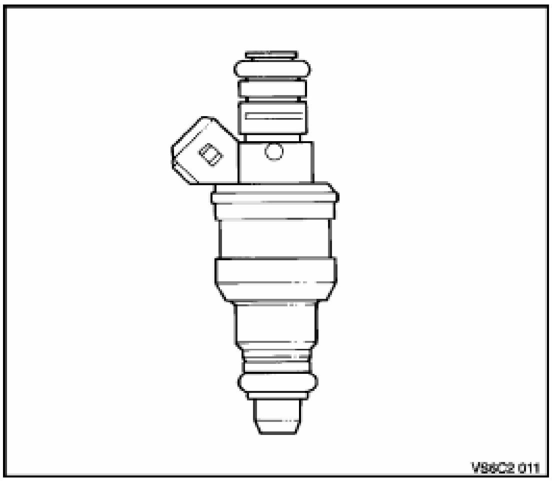


Figure 6C2-1-88 Typical Fuel Injector

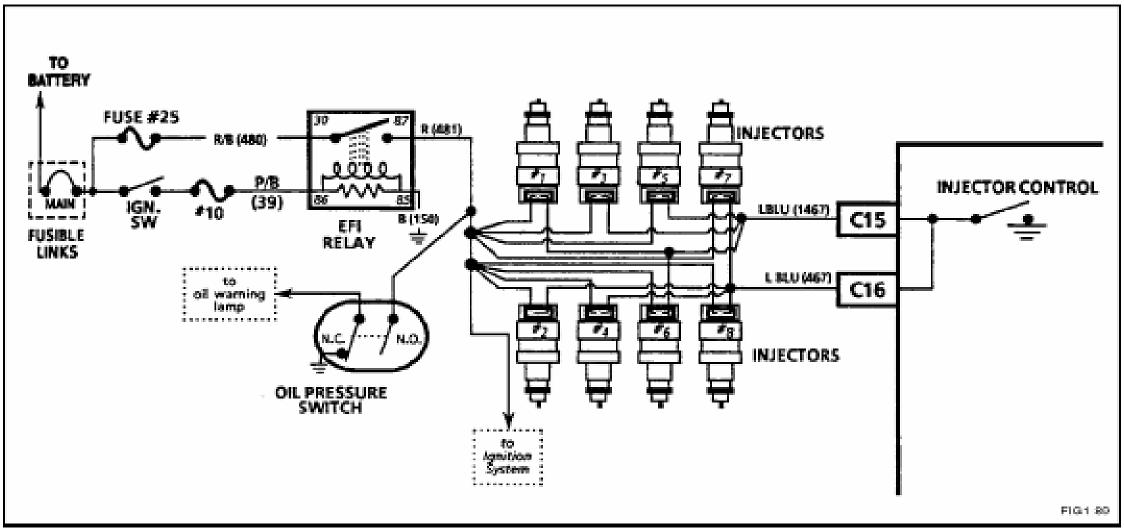


Figure 6C2-1-89 Injector Circuit

Pressure Regulator

The pressure regulator is a diaphragm-operated relief valve with fuel pump pressure on one side, and intake manifold pressure (engine vacuum) combined with mechanical spring pressure on the other. The function of the regulator is to maintain a regulated pressure at the injectors at all times, by controlling the flow into the return line.

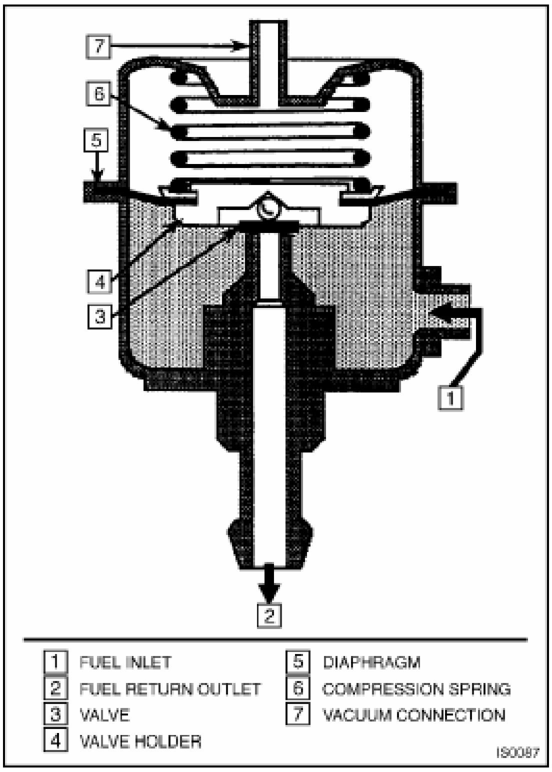


Figure 6C2-1-90 Typical Fuel Pressure Regulator

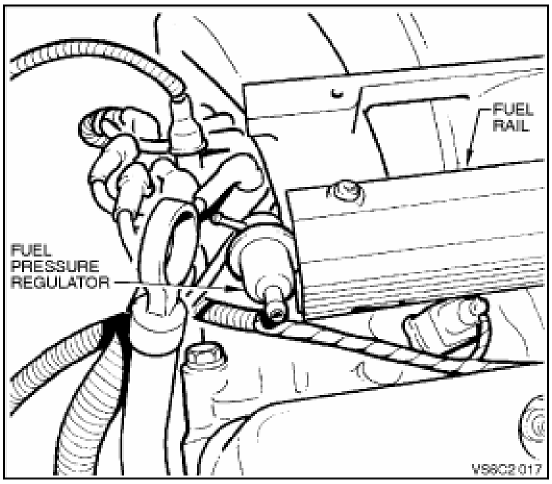


Figure 6C2-1-91 Fuel Pressure Regulator Location

Fuel Filter

On vehicles with IRS, the fuel filter is located next to the right hand rear side frame, forward of the fuel tank.

On vehicles with five link rear suspension, the fuel filter is located next to the underbody forward of the fuel tank on sedan and station wagon models.

On utility models, the fuel filter is located beneath the vehicle, adjacent to the RH lower control arm outboard mounting point.

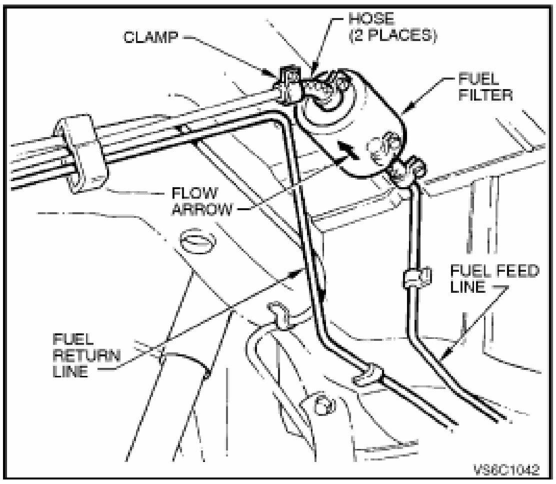


Figure 6C2-1-92 Fuel Filter Location

Fuel Pump Electrical Circuits

When the ignition switch is turned to "ON" or "crank" after having been "OFF" for at least 10 seconds, the ECM/PCM will immediately energise the fuel pump relay to operate the fuel pump. This builds up the fuel pressure quickly. If the engine is not cranked within two seconds, the ECM/PCM will shut the fuel pump relay "OFF" and wait until the engine is cranked. As soon as the engine begins cranking, the ECM/PCM will sense the engine turning from the crankshaft reference input, and turn the relay "ON" again to run the fuel pump.

As a backup system for the fuel pump relay, the fuel pump can also be operated by the oil pressure switch. The oil pressure switch is a normally open switch which closes when oil pressure reaches about 28 kPa. This oil pressure switch also operates the oil pressure warning light. When sufficient oil pressure is present to turn off the light, the switch closes to operate the fuel pump circuit. If the fuel pump relay circuitry fails, the oil pressure switch can operate the pump. A failed fuel pump relay circuit can result in long cranking times.

The fuel pump relay is located in the engine compartment relay housing.

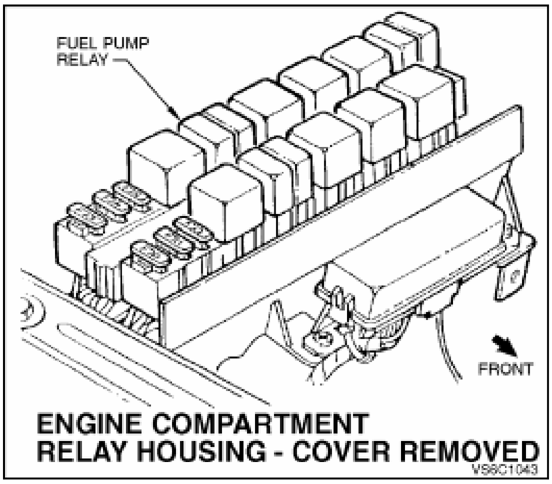
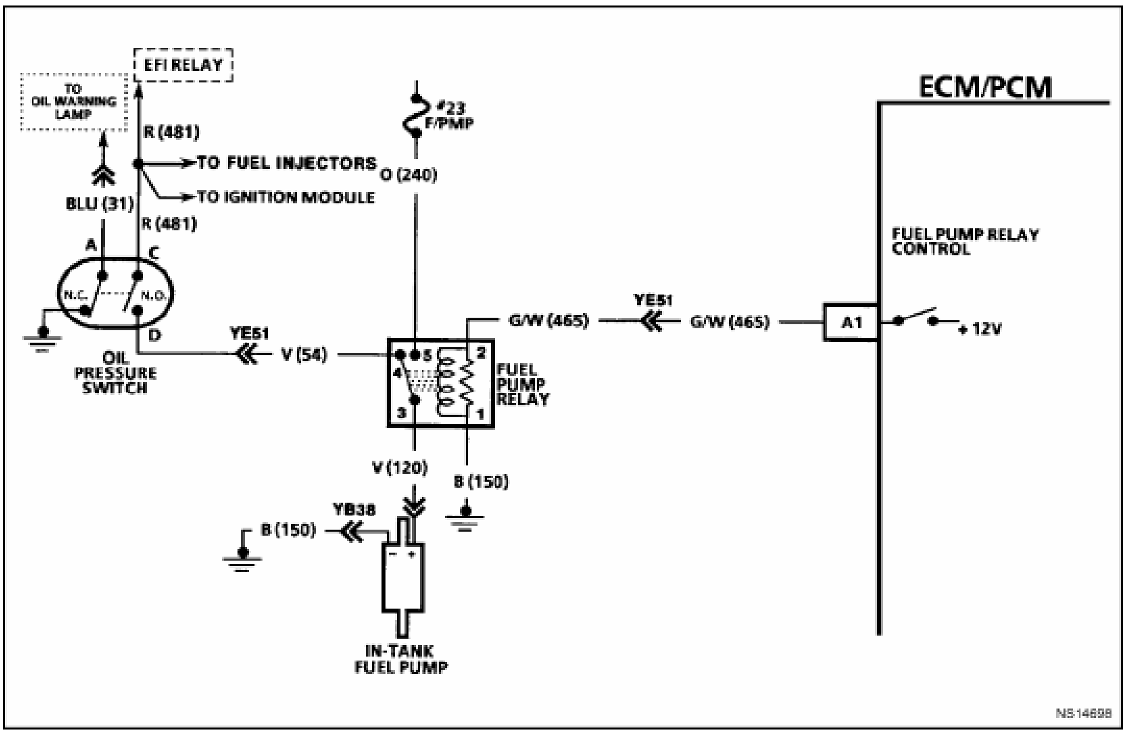


Figure 6C2-1-93 Fuel Pump Relay Location



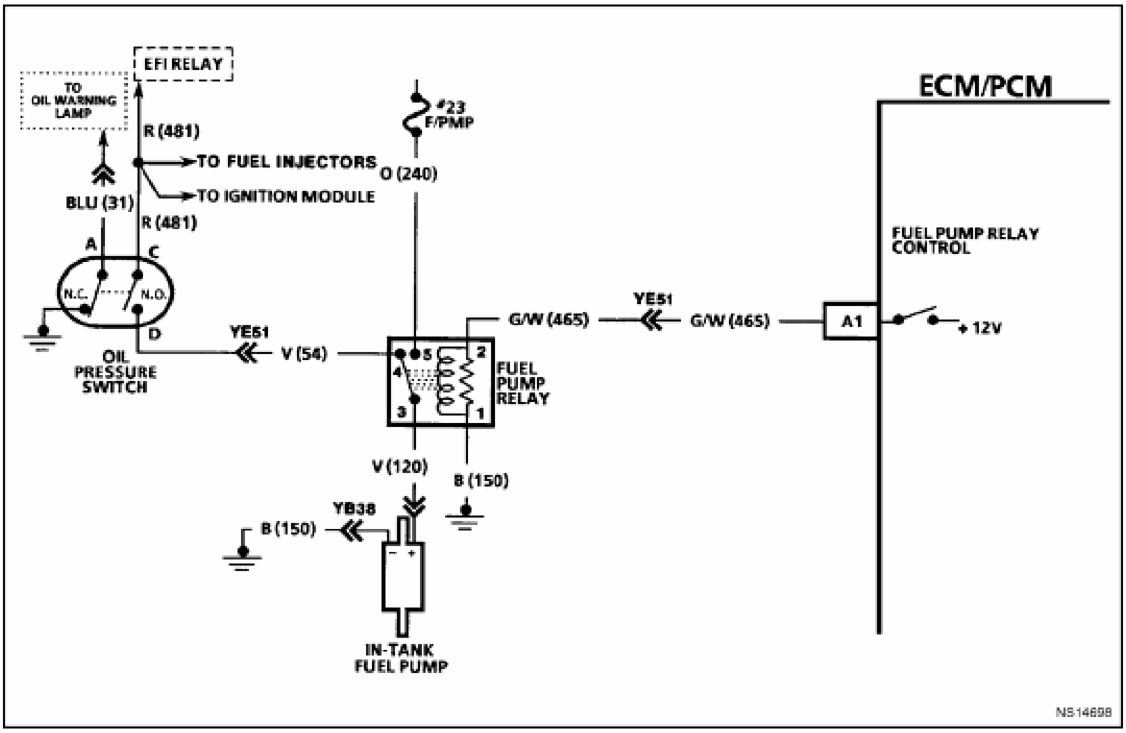


Figure 6C2-1-94 Fuel Pump Electrical Circuits

Idle Air Control (IAC) Valve

The purpose of the Idle Air Control (IAC) valve, is to control engine idle speed, and prevent stalls due to changes in engine load at idle.

The IAC valve, mounted in the throttle body, controls bypass air around the throttle valve. By extending the pintle (to decrease air flow) or retracting the pintle (to increase air flow), a controlled amount of air can move around the throttle valve. If RPM is too low, more air is bypassed around the throttle valve to increase RPM. If RPM is too high, less air is bypassed around the throttle valve to decrease RPM.

The IAC Valve moves in small steps numbered from 0 (extended pintle, bypass air passage fully shut) to 196 (retracted pintle, maximum bypass airflow) as commanded by the ECM/PCM.

At idle, the desired position of the IAC valve is calculated by the ECM/PCM based on coolant temperature, actual engine RPM, engine load, and battery voltage.

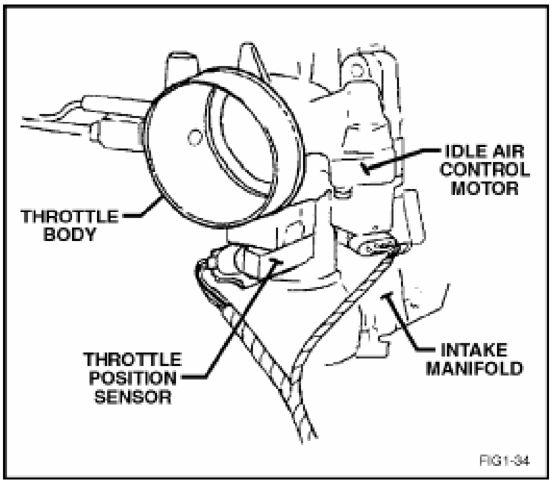


Figure 6C2-1-95 IAC Valve

If the IAC Valve is disconnected or reconnected with the engine running, the ECM/PCM can "lose track" of the actual position of the IAC. This also happens when ECM/PCM keep alive memory voltage, ie. ECM/PCM connectors, ENGINE fuse F25, or battery cables, are disconnected. If this happens, the ECM/PCM will "reset" the IAC. When the ECM/PCM decides to reset the IAC, the actual reset procedure takes place when the engine RPM first goes above 2000, after the ignition has been "off" for at least 10 seconds.

The "reset" procedure goes like this:

The ECM/PCM commands the IAC to shut the idle air passageway in the throttle body. It does so by issuing enough "extend" pulses to move the IAC pintle fully shut in the bore, regardless of where the actual position was. Then, the ECM/PCM calculates the IAC is at

Then, the ECM/PCM calculates the IAC is at a fully shut position, and calls that position "0 steps." Next, the ECM/PCM issues "retract" steps to properly position the pintle.

The IAC valve affects only the idle RPM of the engine. If it is open fully, too much air will be allowed into the manifold and idle speed will be too high. If it is stuck closed, too little air will be allowed into the intake manifold, and idle speed will be too low.

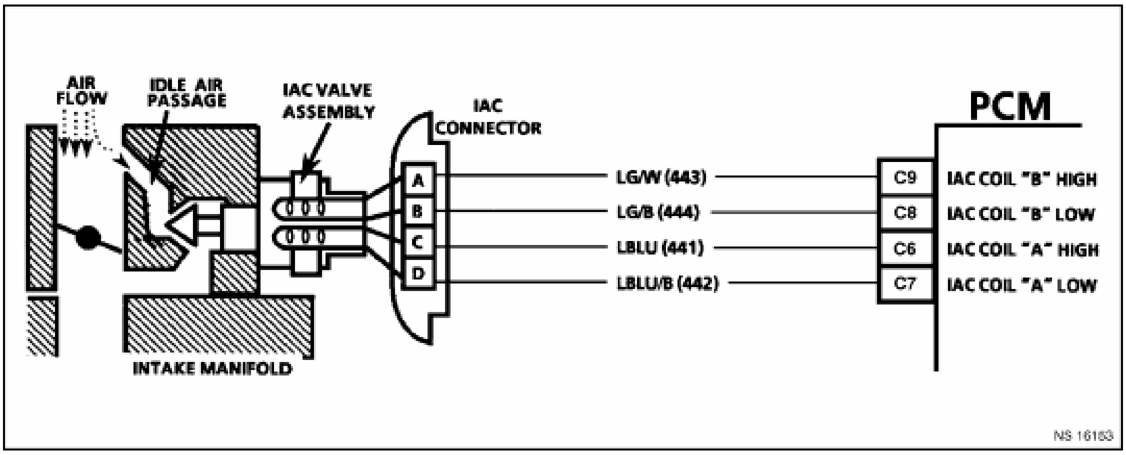


Figure 6C2-1-96 PCM IAC Valve Circuit

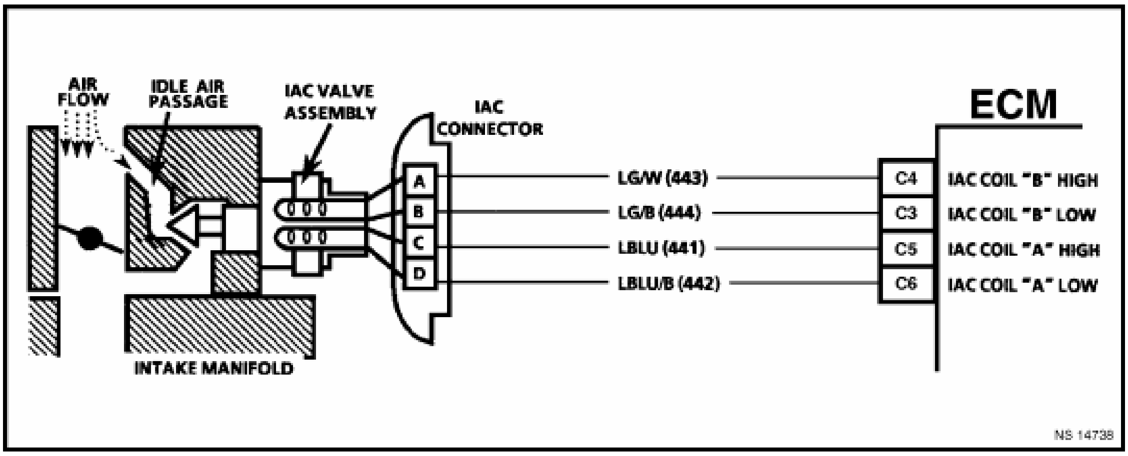


Figure 6C2-1-97 ECM IAC Valve Circuit