

Fuel System

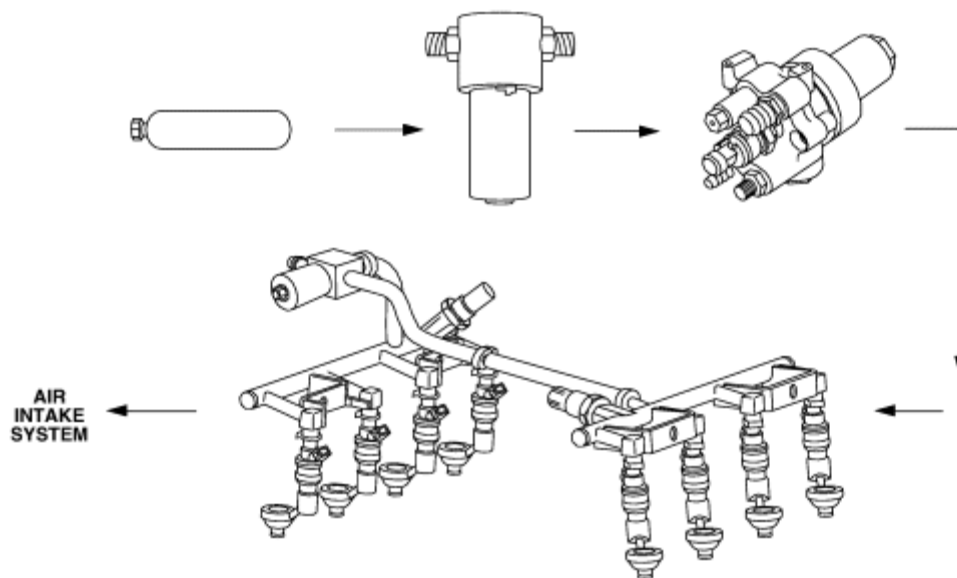
The alternative fuel system consists of an ALT/GAS switch and indicator assembly, an ALT fuel relay, a compressed natural gas (CNG) fuel tank, a solenoid tank valve, a CNG fuel filter, a CNG high pressure gas regulator, a fuel rail solenoid, fuel rails, fuel injector sleeves, ALT fuel injectors and an alternative fuel control module (AFCM).

Compressed Natural Gas (CNG) System

Fuel from the compressed natural gas (CNG) fuel tank flows through the solenoid tank valve and coalescent fuel filter to the gas regulator. The gas regulator provides a consistent system operating fuel pressure of approximately 724 kPa (105 psia). The fuel is passed to the fuel rail solenoid and is then introduced into the fuel rails. The fuel in the fuel rails is introduced into the intake air system through the fuel injectors and fuel injector sleeve assemblies.

The alternative fuel control module (AFCM) meters fuel according to demand from the powertrain control module (PCM). The AFCM will enable the ALT fuel injectors and disable the gasoline injectors when in ALT fuel mode. The AFCM monitors the fuel tank pressure and communicates the fuel level to the instrument cluster on the SCP network. The fuel gauge, integral to the instrument cluster, will display the appropriate fuel level when in ALT fuel mode.

The PCM calculates the spark advance for maximum power. A combination of sensors and inputs from the PCM are used to monitor the engine and environment to provide closed loop fuel control. Through speed density calculations, the PCM determines fuel flow and air flow while adjusting the air/fuel mixture. The air/fuel adjustment is required for each spark event.



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Bi-Fuel Switch-Over Pressures

The bi-fuel system will auto-switch to gasoline mode while operating on CNG if the fuel rail pressure is below

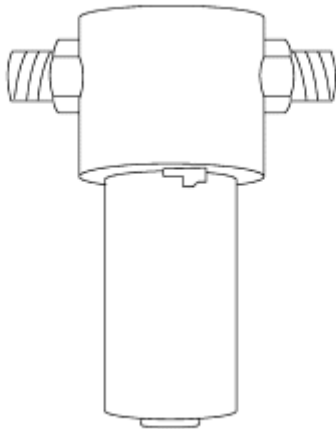
517 kPa (75 psi).

Alternative Fuel Tank

The compressed natural gas (CNG) fuel tank is a refillable storage tank requiring replacement only when damaged, failing an inspection or when the expiration date stamped on the tank is past. The CNG fuel tank has an operating pressure rating of 24,822 kPa (3,600 psi). The CNG tank is equipped with a non-repairable pressure relief device (PRD) designed to relieve all fuel pressure within the alternative fuel tank if exposed to fire (tank replacement is required once the PRD safety valve has been released). The CNG tank construction consists of a metal liner reinforced with a resin impregnated continuous filament shell. The tank is refueled through the use of a fuel fill valve (located behind the ALT fuel filler door) containing a safety valve that only allows one-way fuel flow to the tank. The CNG fuel tank is connected to the fill valve by a high-pressure hose.

Coalescent Fuel Filter

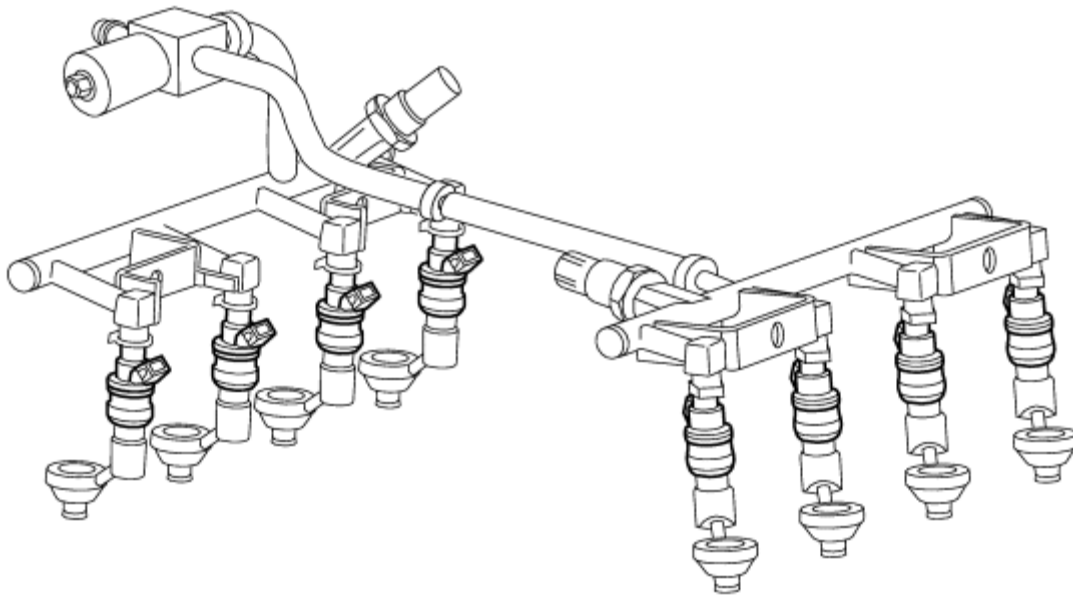
The coalescent fuel filter removes water and particulate contamination from the CNG fuel system. The fuel filter housing has a drain plug allowing excess moisture to be removed during scheduled maintenance.



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ALT Fuel Injectors

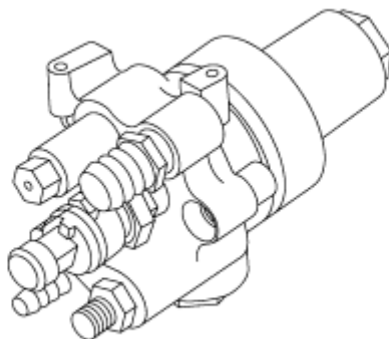
The alternative fuel control module (AFCM) contains the drivers for both the ALT fuel and gasoline injectors. In CNG mode, the AFCM disables the gasoline fuel injectors and enables the ALT fuel injectors. The AFCM controls the ALT fuel injectors based on the corresponding input signals from the powertrain control module (PCM) fuel injector drivers. The ALT fuel injectors require an increased driver due to the higher operating current requiring greater heat dissipation.



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Gas Regulator

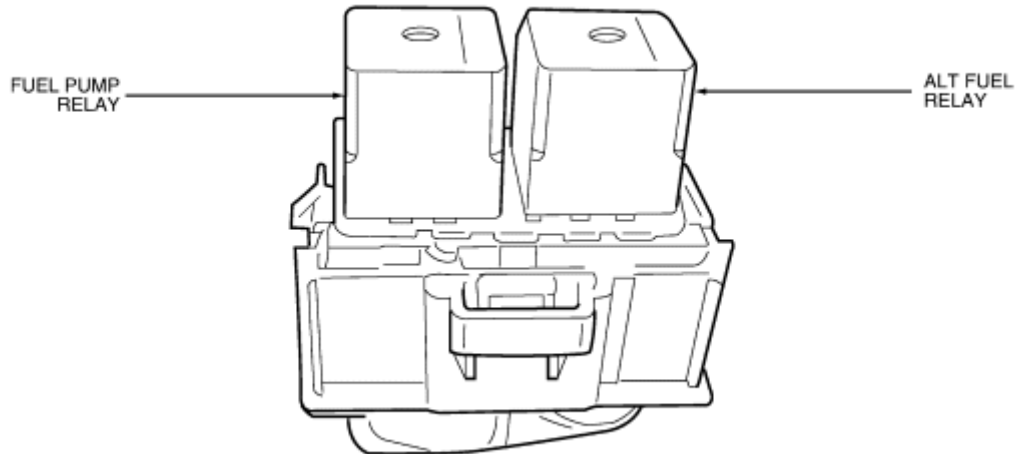
High pressure CNG enters the high pressure regulator from the CNG fuel tank. The gas regulator delivers fuel at approximately 724 kPa (105 psia) to the fuel rail solenoid.



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ALT Fuel Relay

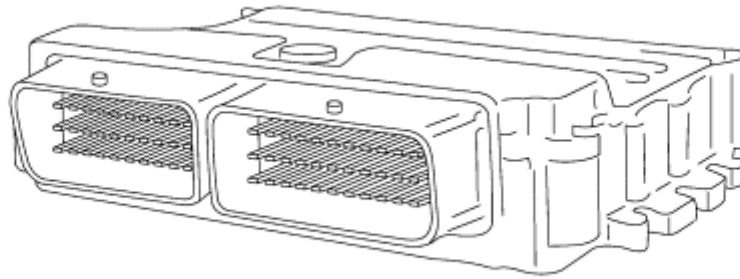
The ALT fuel relay is a standard mini-ISO type. The fuel pump relay and ALT fuel relay are controlled by the alternative fuel control module (AFCM). The ALT fuel relay is normally open, while the fuel pump relay is normally closed. When ALT fuel operation is enabled the AFCM will energize both relays. VPWR from the inertia switch is then directed from the fuel pump to the CNG fuel tank and alternative fuel solenoids.



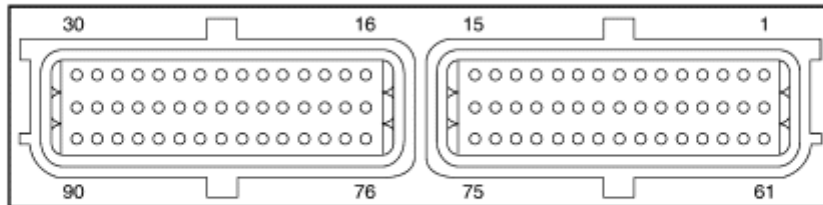
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Alternative Fuel Control Module (AFCM)

The alternative fuel control module (AFCM) receives input from sensors and other electronic components (switches, relays). Based on the information received and programmed into its memory, the AFCM generates output signals to control various relays, solenoids and actuators. The AFCM contains a set of drivers for both the gasoline and the alternative fuel injectors. Fuel injector driver signals from the powertrain control module (PCM) are used to control both sets of output drivers in the AFCM. Based on fuel selector switch input the AFCM decides which set of injectors is in use, both on key-up and in fuel switchover situations.



90 PIN ALTERNATIVE FUEL CONTROL MODULE (AFCM)

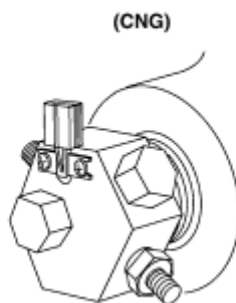


90 PIN HARNESS CONNECTOR

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Solenoid Tank Valve

The tank valve solenoid is normally closed. When the ALT fuel switch is placed in the ALT position, the solenoid receives VPWR from the inertia fuel shutoff (IFS) switch through the ALT fuel relay. This opens the solenoid allowing CNG fuel flow to the fuel rail solenoid. The AFCM will close the tank valve if the gaseous fuel system pressure drops below 517 kPa (75 psia).



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Alternative Fuel Selector Indicator/Switch

ALT/GAS Switch

The ALT/GAS switch is located on the instrument panel and allows the driver to pre-select the operating fuel before starting the vehicle. The switch only operates with the ignition switch in the OFF position. If the switch is pressed while the vehicle is running, the input is ignored. The gaseous fuel system will NOT automatically change fuel modes with the vehicle running.

The ALT/GAS switch has two operating positions:

- GAS
- ALT

When the GAS position is selected, the engine will operate in the gasoline mode. Selecting the ALT position sends a signal to the alternative fuel control module (AFCM) requesting ALT fuel mode. If the temperature and pressure conditions are correct, the vehicle will switch to the gaseous fuel mode. A green indicator will also illuminate on the switch to verify the vehicle is operating in the CNG mode. If no signal is received by the AFCM, the system defaults to gasoline mode.

ALT/GAS Indicator

The ALT/GAS switch indicator is integral to the ALT/GAS switch. The indicator is controlled by the AFCM and is illuminated when operating in CNG mode. If an emission-critical diagnostic trouble code (DTC) is recorded, the indicator will flash with a steady ON, then OFF pulse.



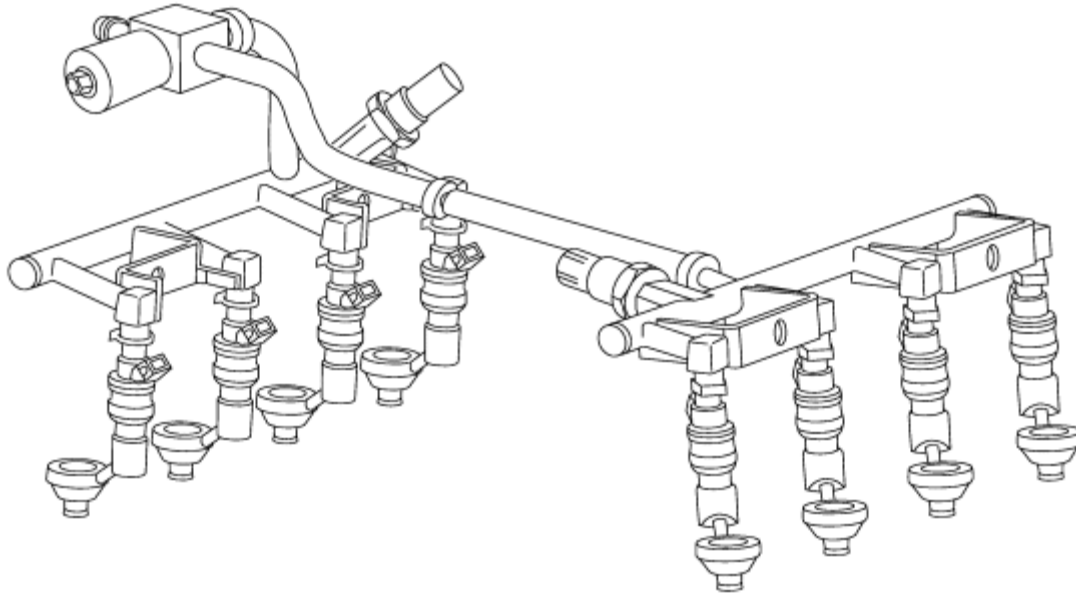
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Fuel Gauge

Fuel gauge operation in a CNG Bi-Fuel vehicle behaves similarly to a standard gasoline fuel gauge. The fuel gauge provides a linear reading from full down to empty. Fuel gauge operation for a CNG Bi-Fuel vehicle is based on the pressure of the natural gas in the fuel tank. A full fuel gauge reading will occur at a pressure of approximately 24,800 kPa (3,600 psi) at a temperature of approximately 21°C (70°F). If a fault with the fuel tank pressure sensor occurs, the alternative fuel control module (AFCM) will drive the fuel gauge to empty. For more information on fuel gauge performance during the fast-fill method of CNG fueling, refer to the Owner Literature.

Fuel Rail

The fuel rails route alternative fuel from the fuel rail solenoid to the base vehicle intake runners.



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Injector Sleeves

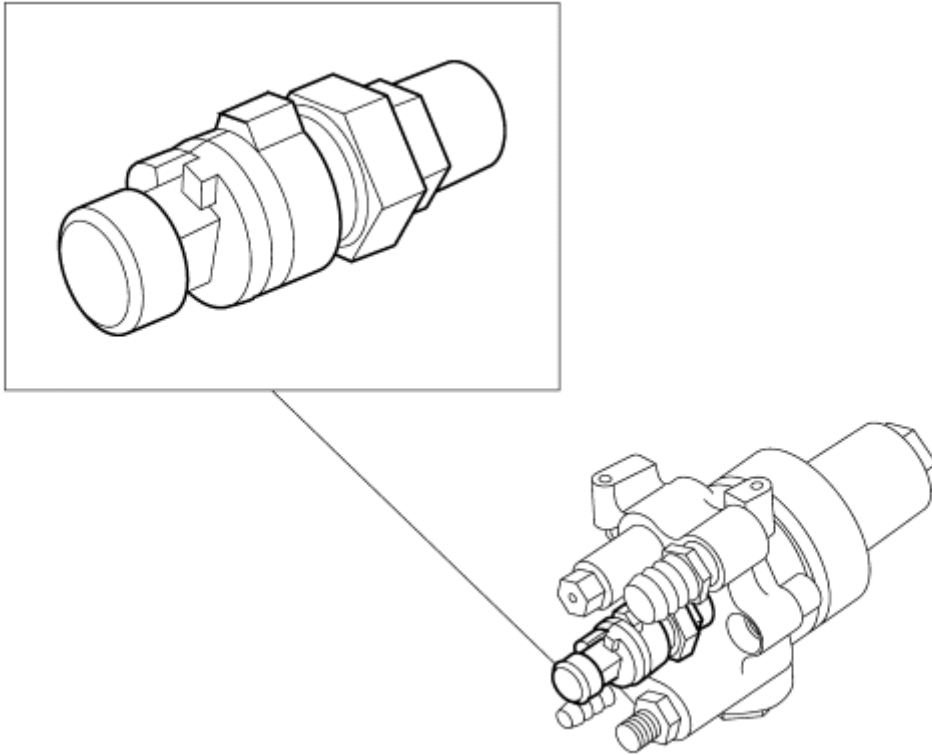
The injector sleeves are placed in the injector seats. The gasoline fuel injectors are placed in the injector sleeve seats. When the gasoline fuel injectors are de-energized and the CNG injectors are energized, the sleeves bypass the gasoline fuel injectors, delivering alternative fuel into the intake system and providing a path of fuel flow from the gasoline injectors.



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Fuel Tank Pressure Sensor

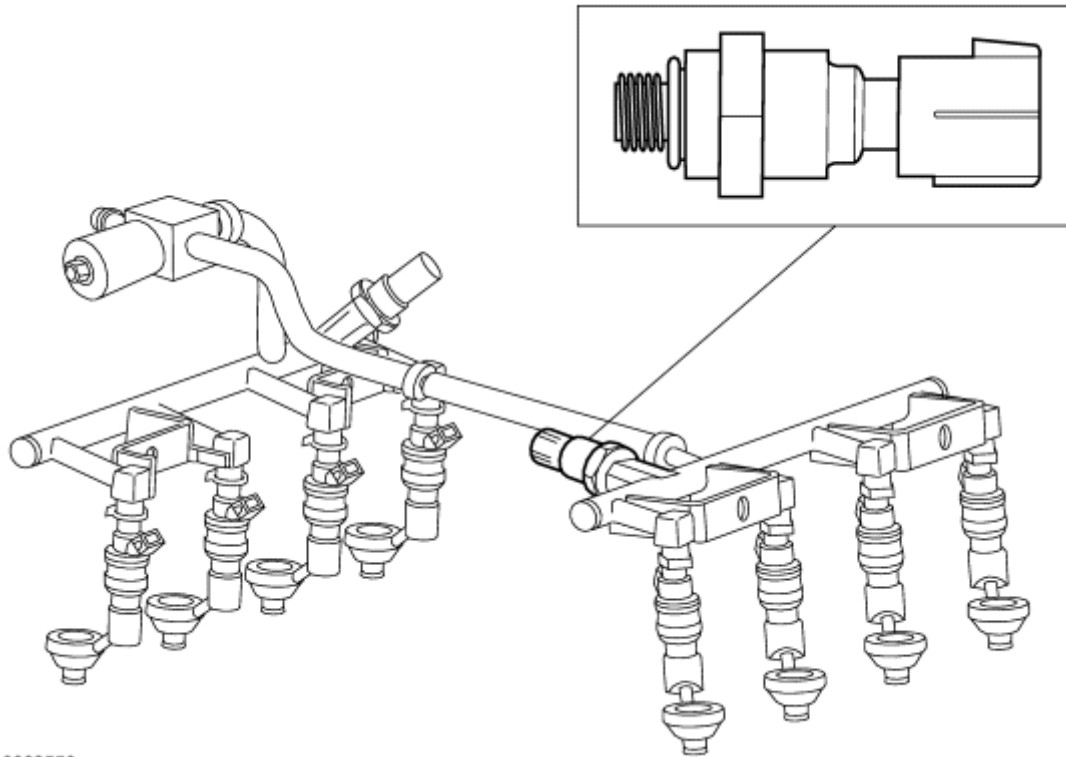
The fuel tank pressure (FTP) sensor is integral to the gas regulator. It provides information on CNG fuel tank pressure to the AFCM and is also used to determine the alternative fuel gauge reading.



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Fuel Rail Pressure Sensor

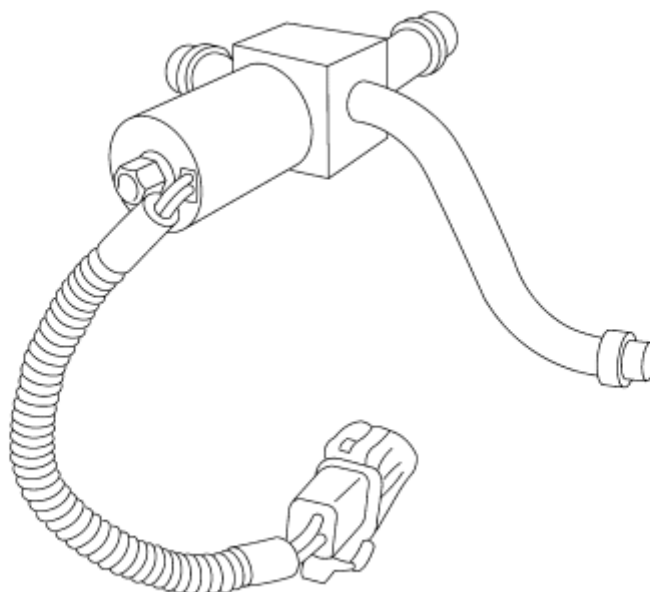
The fuel rail pressure (FRP) sensor is a pressure transducer that converts pressure to voltage through a piezo-resistive element. The FRP sensor is used to adjust the injector combination according to supply pressure and allows the vehicle to start in ALT fuel mode at a minimum of 517 kPa (75 psia). The resistance of the sensor increases as the pressure increases and decreases as the pressure decreases.



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Fuel Rail Solenoid

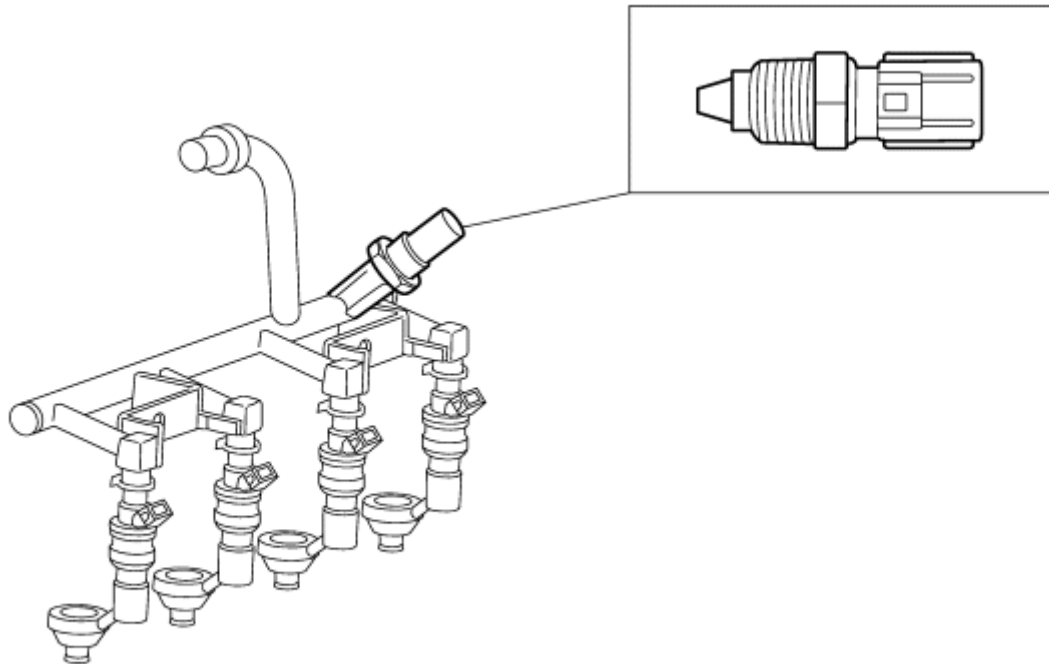
The fuel rail solenoid is used to control the alternative fuel flow into the left and right fuel rails. The solenoid is normally closed. When the ALT fuel switch is placed in the ALT position, the solenoid receives VPWR from the inertia fuel shutoff (IFS) switch through the ALT fuel relay. This opens the solenoid allowing CNG fuel flow to the ALT fuel injectors.



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Fuel Rail Temperature Sensor

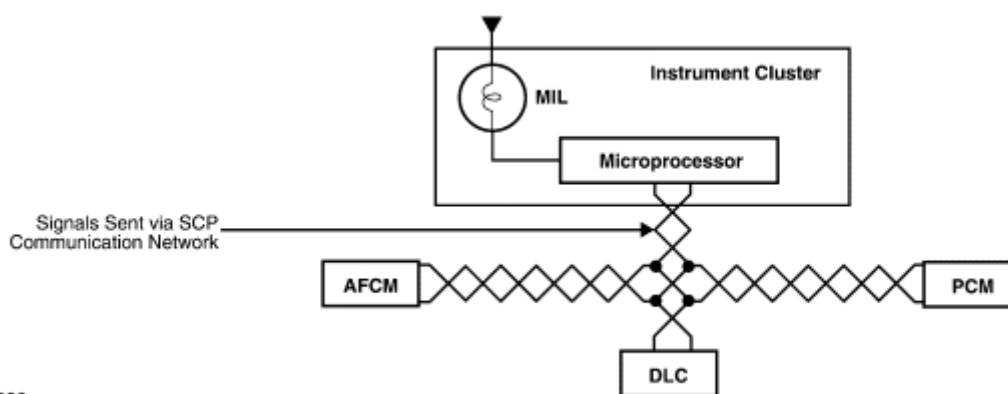
The fuel rail temperature (FRT) sensor is used to calculate fuel density (the amount of vapor within the fuel rail). The FRT sensor is a thermistor style element that converts temperature into voltage. The resistance of a thermistor decreases as the temperature increases and increases as the temperature decreases.



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Malfunction Indicator Lamp (MIL)

Alternative fuel diagnostics are automatic, active and continuous monitors of the bi-fuel system while the vehicle is operating in compressed natural gas (CNG) mode. The system monitors the activity of various sensor inputs and compares the values to calibrated reference criteria. If a signal does not satisfy the reference criteria, a fault code is generated and stored. If the fault is of an emissions-critical nature, the system will illuminate the malfunction indicator lamp (MIL) and the ALT fuel selector switch indicator will change from a steady on to an irregular flashing condition. If the fault condition stops, the MIL will return to normal status after three trips and the fault code is stored in continuous memory for access during diagnostic procedures. If the fault condition does not occur for forty trips, the fault code is erased.



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