

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

DESCRIPTION AND OPERATION

AIR INTAKE SYSTEM DESCRIPTION (W/LF1)

The mass air flow (MAF) sensor measures the amount of air coming into the engine. This direct airflow measurement is more accurate than the calculated airflow information obtained from the other sensor inputs. The MAF sensor also houses an integrated intake air temperature (IAT) sensor. The MAF sensor uses the following circuits:

- An ignition voltage circuit
- A signal circuit
- A ground circuit
- An IAT signal circuit
- An IAT low reference circuit

The MAF sensor that is used on this vehicle is a hot film type and is used in order to measure the air flow rate. The air flow through the sensor passes over a temperature sensor, is then heated, and then passes over another temperature sensor. The difference in air temperature before and after the heater is measured. The air temperature difference is proportional to the amount of air flow. This air temperature difference also allow for determination of whether the air is flowing in the forward or reverse directions. As the air flow increases the delta temperature between the two sensors increases. The MAF sensor converts the temperature difference into a frequency signal that the engine control module (ECM) monitors. The ECM calculates the air flow based on this signal.

The ECM monitors the MAF sensor signal frequency and can determine if the sensor signal is too low or too high. The ECM can also detect airflow that is inappropriate for a given operating condition based on the signal frequency.

The scan tool displays the MAF sensor value in grams per second (g/s) and hertz (Hz). Values should change rather quickly on acceleration, but should remain fairly stable at any given engine speed. If the ECM detects a condition with the MAF sensor circuits, the following DTCs set:

- P0101 Mass Air Flow (MAF) Sensor Performance
- P0102 Mass Air Flow (MAF) Sensor Circuit Low Voltage
- P0103 Mass Air Flow (MAF) Sensor Circuit High Voltage

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

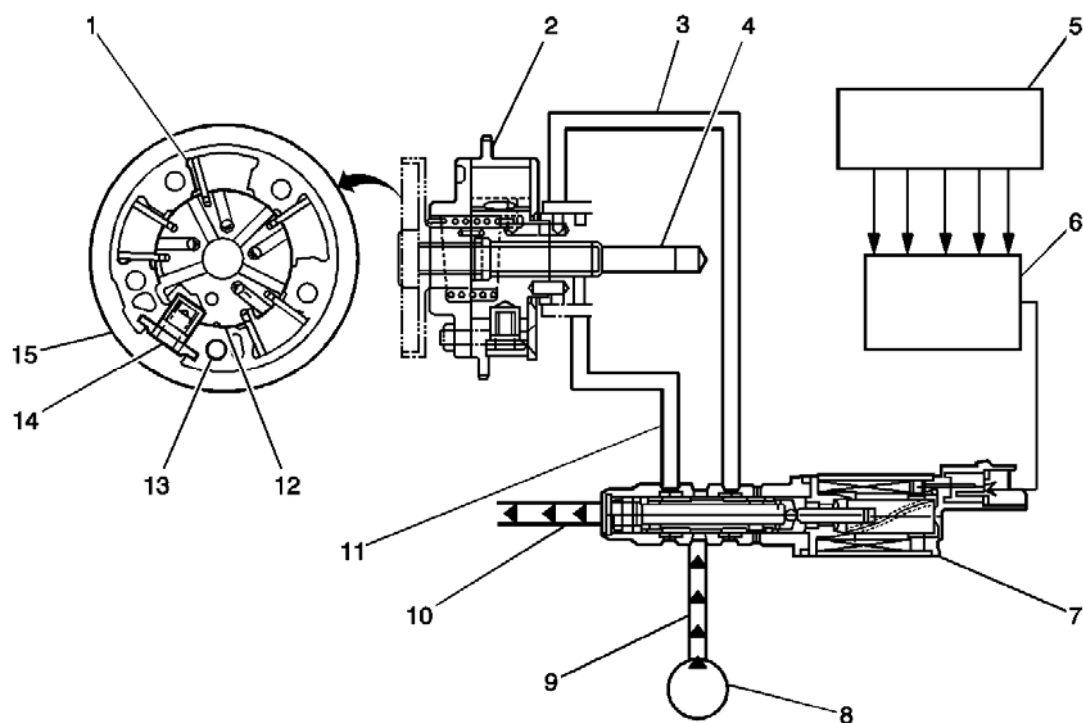


Fig. 1: Camshaft Actuator System Components
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Camshaft Actuator Vane
2	Timing Chain Sprocket
3	Engine Oil Pressure-For retarding the camshaft
4	Camshaft
5	Input Signals from Engine Sensors
6	Engine Control Module (ECM)
7	Camshaft Actuator Solenoid
8	Engine Oil Pump
9	Engine Oil Pressure Supply
10	Engine Oil Drain
11	Engine Oil Pressure-For advancing the camshaft
12	Camshaft Actuator Rotor
13	Camshaft Position Sensor Reluctor
14	Camshaft Actuator Lock Pin
15	Camshaft Actuator Housing

The camshaft actuator system enables the engine control module (ECM) to change camshaft timing of all 4 camshafts while the engine is operating. The CMP actuator assembly (15) varies the camshaft position in

response to directional changes in oil pressure. The CMP actuator solenoid valve controls the oil pressure that is applied to advance or retard a camshaft. Modifying camshaft timing under changing engine demand provides better balance between the following performance concerns:

- Engine power output
- Fuel economy
- Lower tailpipe emissions

The CMP actuator solenoid valve (7) is controlled by the ECM. The crankshaft position (CKP) sensor and the CMP sensors are used to monitor changes in camshaft positions. The ECM uses the following information in order to calculate the desired camshaft positions:

- The engine coolant temperature (ECT) sensor
- The calculated engine oil temperature (EOT)
- The mass air flow (MAF) sensor
- The throttle position (TP) sensor
- The vehicle speed sensor (VSS)
- The volumetric efficiency

Operation

The CMP actuator assembly has an outer housing that is driven by an engine timing chain. Inside the assembly is a rotor with fixed vanes that is attached to the camshaft. Oil pressure that is applied to the fixed vanes will rotate a specific camshaft in relationship to the crankshaft. The movement of the intake camshafts will advance the intake valve timing. The movement of the exhaust camshafts will retard the exhaust valve timing. When oil pressure is applied to the return side of the vanes, the camshafts will return to 0 crankshaft degrees, or top dead center (TDC). The CMP actuator solenoid valve directs the oil flow that controls the camshaft movement. The ECM commands the CMP solenoid to move the solenoid plunger and spool valve until oil flows from the advance passage (11). Oil flowing thru the CMP actuator assembly from the CMP solenoid advance passage applies pressure to the advance side of the vanes in the CMP actuator assembly. When the camshaft position is retarded, the CMP actuator solenoid valve directs oil to flow into the CMP actuator assembly from the retard passage (3). The ECM can also command the CMP actuator solenoid valve to stop oil flow from both passages in order to hold the current camshaft position.

The ECM operates the CMP actuator solenoid valve by pulse width modulation (PWM) of the solenoid coil. The higher the PWM duty cycle, the larger the change in camshaft timing. The CMP actuator assembly also contains a lock pin (14) that prevents movement between the outer housing and the rotor vane assembly. The lock pin is released by oil pressure before any movement in the CMP actuator assembly takes place. The ECM is continuously comparing CMP sensor inputs with CKP sensor input in order to monitor camshaft position and detect any system malfunctions. If a condition exists in either the intake or exhaust camshaft actuator system, the opposite bank, intake or exhaust, camshaft actuator will default to 0 crankshaft degrees.

CMP Actuator System Operation

Driving Condition	Change in Camshaft Position	Objective	Result
Idle	No Change	Minimize Valve Overlap	Stabilize Idle Speed

Light Engine Load	Retard Valve Timing	Decrease Valve Overlap	Stable Engine Output
Medium Engine Load	Advance Valve Timing	Increase Valve Overlap	Better Fuel Economy with Lower Emissions
Low to Medium RPM with Heavy Load	Advance Valve Timing	Advance Intake Valve Closing	Improve Low to Mid-range Torque
High RPM with Heavy Load	Retard Valve Timing	Retard Intake Valve Closing	Improve Engine Output

ELECTRONIC IGNITION SYSTEM DESCRIPTION

The electronic ignition (EI) system produces and controls a high-energy secondary spark. This spark is used to ignite the compressed air/fuel mixture at precisely the correct time. This provides optimal performance, fuel economy, and control of exhaust emissions. This ignition system uses an individual coil for each cylinder. The ignition coils are mounted in the center of each camshaft cover with short integrated boots connecting the coils to the spark plugs. The driver modules within each ignition coil are commanded ON/OFF by the engine control module (ECM). The ECM primarily uses engine speed, the MAF sensor signal, and position information from the crankshaft position and the camshaft position sensors. This controls the sequence, dwell, and timing of the spark. The EI system consists of the following components:

Crankshaft Position Sensor

The crankshaft position sensor works in conjunction with a 58 tooth reluctor wheel on the crankshaft. The engine control module (ECM) monitors the voltage frequency on the crankshaft position sensor signal circuit. As each reluctor wheel tooth rotates past the sensor, the sensor creates a digital ON/OFF pulse. This digital signal is processed by the ECM. The reluctor wheel teeth are 6 degrees apart. Having only 58 teeth leaves a 12 degree span that is uncut. This creates a signature pattern that enables the ECM to determine the crankshaft position. The ECM uses the signal to determine which pair of cylinders is approaching top dead center based on the crankshaft position signal alone. The camshaft position sensor signals are used in order to determine which of these 2 cylinders is on a firing stroke, and which is on the exhaust stroke. The ECM uses this to properly synchronize the ignition system, the fuel injectors, and the knock control. This sensor is also used in order to detect misfire.

Camshaft Position Sensor

This engine uses camshaft position sensor for each camshaft. The camshaft position sensor signals are a digital ON/OFF pulse, output 4 times per revolution of the camshaft. The camshaft position sensor does not directly affect the operation of the ignition system. The camshaft position sensor information is used by the engine control module (ECM) to determine the position of the camshaft relative to the crankshaft position. By monitoring the camshaft position and crankshaft position signals the ECM can accurately time the operation of the fuel injectors. The ECM supplies the camshaft position sensor with a 5 V reference circuit and a low reference circuit. The camshaft position sensor signals are an input to the ECM. These signals are also used to detect camshaft alignment with the crankshaft.

Knock Sensor

The knock sensor system enables the control module to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation, also known as spark

knock. The knock sensor system uses one or 2 flat response 2-wire sensors. The sensor uses piezo-electric crystal technology that produces an AC voltage signal of varying amplitude and frequency based on the engine vibration or noise level. The amplitude and frequency are dependant upon the level of knock that the knock sensor detects. The control module receives the knock sensor signal through the signal circuit. The knock sensor ground is supplied by the control module through the low reference circuit.

The control module learns a minimum noise level, or background noise, at idle from the knock sensor and uses calibrated values for the rest of the RPM range. The control module uses the minimum noise level to calculate a noise channel. A normal knock sensor signal will ride within the noise channel. As engine speed and load change, the noise channel upper and lower parameters will change to accommodate the normal knock sensor signal, keeping the signal within the channel. In order to determine which cylinders are knocking, the control module only uses knock sensor signal information when each cylinder is near top dead center (TDC) of the firing stroke. If knock is present, the signal will range outside of the noise channel.

If the control module has determined that knock is present, it will retard the ignition timing to attempt to eliminate the knock. The control module will always try to work back to a zero compensation level, or no spark retard. An abnormal knock sensor signal will stay outside of the noise channel or will not be present. knock sensor diagnostics are calibrated to detect faults with the knock sensor circuitry inside the control module, the knock sensor wiring, or the knock sensor voltage output. Some diagnostics are also calibrated to detect constant noise from an outside influence such as a loose/damaged component or excessive engine mechanical noise.

Ignition Coils

Each ignition coil contains a solid state driver module as its primary element. The engine control module (ECM) signals the coil driver to initiate a firing event by applying ignition control (IC) circuit voltage for the appropriate time, or dwell. When the voltage is removed the coil fires the spark plug.

Engine Control Module (ECM)

The engine control module (ECM) controls all ignition system functions, and constantly corrects the spark timing. The ECM monitors information from various sensor inputs that may include the following components, if applicable:

- The throttle position sensor
- The engine coolant temperature (ECT) sensor
- The mass air flow (MAF) sensor
- The intake air temperature (IAT) sensor
- The vehicle speed sensor (VSS)
- The transmission gear position or range information sensors
- The engine knock sensors
- Ambient pressure sensor (BARO)

Noteworthy Ignition Information

The cylinder 1 intake camshaft position sensor is used for injector and ignition system synchronization. A stalling condition will occur if the CMP sensor signal is intermittent and a DTC will not set. Inspect all cylinder

1 intake camshaft position sensor circuits for poor connections.

ENGINE CONTROL MODULE DESCRIPTION

The engine control module (ECM) interacts with many emission related components and systems, and monitors the emission related components and systems for deterioration. OBD II diagnostics monitor the system performance and a diagnostic trouble code (DTC) sets if the system performance degrades.

The malfunction indicator lamp (MIL) operation and the DTC storage are dictated by the DTC type. A DTC is ranked as a Type A or Type B if the DTC is emissions related. Type C is a non-emissions related DTC.

The ECM is in the engine compartment. The ECM is the control center of the engine controls system. The ECM controls the following components:

- The fuel injection system
- The ignition system
- The emission control systems
- The on-board diagnostics
- The A/C and fan systems
- The throttle actuation control (TAC) system

The ECM constantly monitors the information from various sensors and other inputs, and controls the systems that affect the vehicle performance and the emissions. The ECM also performs diagnostic tests on various parts of the system. The ECM can recognize operational problems and alert the driver via the MIL. When the ECM detects a malfunction, the ECM stores a DTC. The condition area is identified by the particular DTC that is set. This aids the technician in making repairs.

ECM Function

The engine control module (ECM) can supply 5 V or 12 V to the various sensors or switches. This is done through pull-up resistors to the regulated power supplies within the ECM. In some cases, even an ordinary shop voltmeter will not give an accurate reading because the resistance is too low. Therefore, a DMM with at least 10 Mohms input impedance is required in order to ensure accurate voltage readings.

The ECM controls the output circuits by controlling the ground or the power feed circuit through the transistors or a device called an output driver module.

EEPROM

The electronically erasable programmable read only memory (EEPROM) is a permanent memory that is physically part of the engine control module (ECM). The EEPROM contains program and calibration information that the ECM needs in order to control the powertrain operation.

Special equipment, as well as the correct program and calibration for the vehicle, are required in order to reprogram the ECM.

Data Link Connector (DLC)

The data link connector (DLC) is a 16-pin connector that provides the technician a means of accessing serial data for aid in the diagnosis. This connector allows the technician to use a scan tool in order to monitor the various serial data parameters, and display the DTC information. The DLC is located inside of the drivers compartment, underneath the dash.

Malfunction Indicator Lamp (MIL)

The malfunction indicator lamp (MIL) is inside of the instrument panel cluster (IPC). The MIL is controlled by the engine control module (ECM) and illuminates when the ECM detects a condition that affects the vehicle emissions.

ECM Service Precautions

The engine control module (ECM), by design, can withstand the normal current draws that are associated with the vehicle operations. However, care must be used in order to avoid overloading any of these circuits. When testing for opens or shorts, do not ground or apply voltage to any of the ECM circuits unless the diagnostic procedure instructs you to do so. These circuits should only be tested with a DMM.

Emissions Diagnosis For State I/M Programs

This OBD II equipped vehicle is designed to diagnose any conditions that could lead to excessive levels of the following emissions:

- Hydrocarbons (HC)
- Carbon monoxide (CO)
- Oxides of nitrogen (NOx)
- Evaporative emission (EVAP) system losses

Should this vehicles on-board diagnostic system (ECM) detect a condition that could result in excessive emissions, the ECM turns ON the malfunction indicator lamp (MIL) and stores a DTC that is associated with the condition.

Aftermarket (Add-On) Electrical And Vacuum Equipment

CAUTION: Do not attach add-on vacuum operated equipment to this vehicle. The use of add-on vacuum equipment may result in damage to vehicle components or systems.

CAUTION: Connect any add-on electrically operated equipment to the vehicle's electrical system at the battery (power and ground) in order to prevent damage to the vehicle.

Aftermarket, add-on, electrical and vacuum equipment is defined as any equipment installed on a vehicle after leaving the factory that connects to the vehicles electrical or vacuum systems. No allowances have been made in the vehicle design for this type of equipment.

Add-on electrical equipment, even when installed to these strict guidelines, may still cause the powertrain system to malfunction. This may also include equipment not connected to the vehicle electrical system, such as portable telephones and radios. Therefore, the first step in diagnosing any powertrain condition is to eliminate all of the aftermarket electrical equipment from the vehicle. After this is done, if the problem still exists, the problem may be diagnosed in the normal manner.

Electrostatic Discharge (ESD) Damage

NOTE: **In order to prevent possible electrostatic discharge damage to the engine control module (ECM), DO NOT touch the connector pins on the ECM.**

The electronic components that are used in the control systems are often designed to carry very low voltage. The electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 V of static electricity can cause damage to some electronic components.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a car seat.

Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off leaving the person highly charged with the opposite polarity. Static charges can cause damage, therefore, it is important to use care when handling and testing electronic components.

Emissions Control Information Label

The underhood Vehicle Emissions Control Information Label contains important emission specifications and setting procedures. In the upper right corner is the exhaust emission information. This identifies the year, the manufacturing division of the engine, the displacement of the engine in liters, the class of the vehicle, and type of fuel metering system. There is also an illustrated emission components and vacuum hose schematic.

This label is located in the engine compartment of every General Motors vehicle. If the label has been removed, it can be ordered from GM service parts operations (GMSPO).

Underhood Inspection

NOTE: **This inspection is very important and must be done carefully and thoroughly.**

Perform a careful underhood inspection when performing any diagnostic procedure or diagnosing the cause of an emission test failure. This can often lead to repairing a condition without further steps. Use the following guidelines when performing an inspection:

- Inspect all of the vacuum hoses for correct routing, pinches, cuts, or disconnects.
- Inspect any hoses that are difficult to see.
- Inspect all of the wires in the engine compartment for the following conditions:
 - Burned or chafed spots
 - Pinched wires

- Contact with sharp edges
- Contact with hot exhaust manifolds

EVAPORATIVE EMISSION CONTROL SYSTEM DESCRIPTION

Typical Evaporative Emission (EVAP) System Hose Routing Diagram

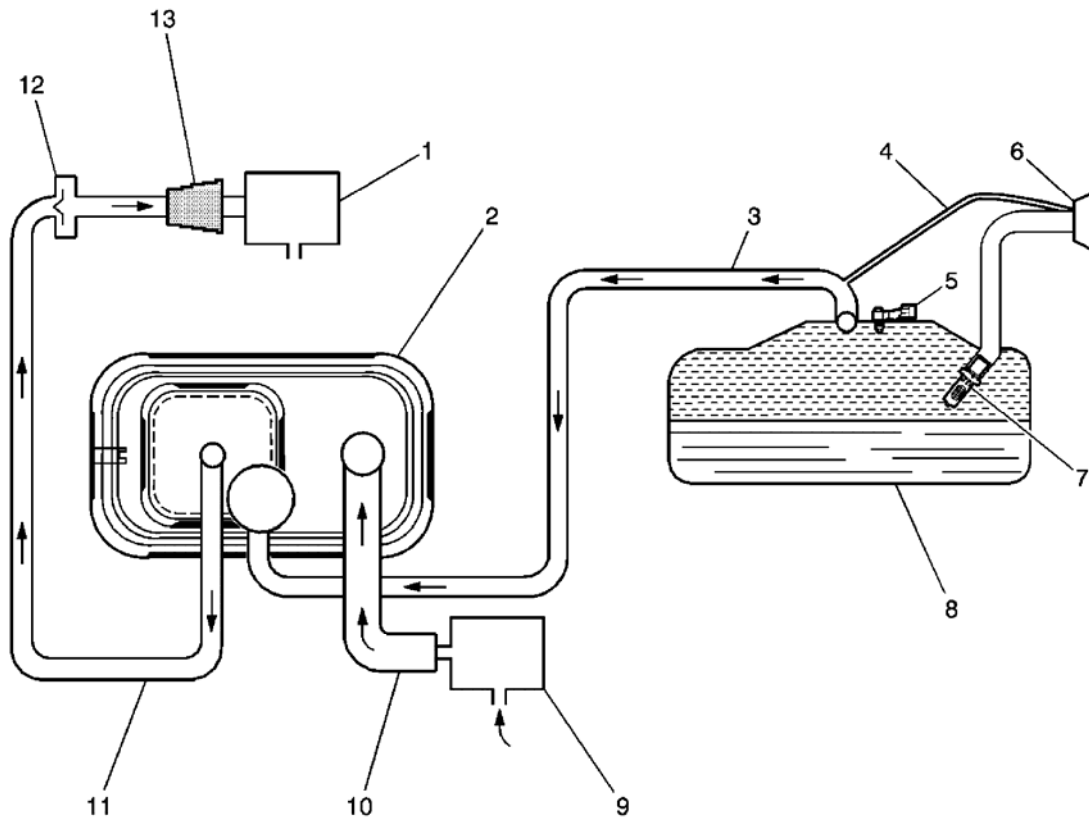


Fig. 2: Typical Evaporative Emission System Hose Routing Diagram
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Evaporative Emissions (EVAP) Purge Solenoid Valve
2	EVAP Canister
3	EVAP Vapor Tube
4	Vapor Recirculation Tube
5	Fuel Tank Pressure Sensor
6	Fuel Filler Cap
7	Fuel Fill Pipe Inlet Check Valve
8	Fuel Tank
9	EVAP Canister Vent Solenoid Valve

10	Vent hose
11	EVAP Purge Tube
12	Purge Tube Check Valve, Turbo-Charged Applications
13	EVAP Canister Purge Tube Connector

EVAP System Operation

The evaporative emission (EVAP) control system limits fuel vapors from escaping into the atmosphere. Fuel tank vapors are allowed to move from the fuel tank, due to pressure in the tank, through the EVAP vapor tube, into the EVAP canister. Carbon in the canister absorbs and stores the fuel vapors. Excess pressure is vented through the vent hose and EVAP canister vent solenoid valve to the atmosphere. The EVAP canister stores the fuel vapors until the engine is able to use them. At an appropriate time, the engine control module (ECM) will command the EVAP purge solenoid valve ON, allowing engine vacuum to be applied to the EVAP canister. With the normally open EVAP canister vent solenoid valve OFF, fresh air is drawn through the vent solenoid valve and the vent hose to the EVAP canister. Fresh air is drawn through the canister, pulling fuel vapors from the carbon. The air/fuel vapor mixture continues through the EVAP purge tube and EVAP purge solenoid valve into the intake manifold to be consumed during normal combustion. The control module uses several tests to determine if the EVAP system is leaking or restricted.

Purge Solenoid Valve Leak Test

If the evaporative emission (EVAP) purge solenoid valve does not seal properly fuel vapors could enter the engine at an undesired time, causing driveability concerns. The ECM tests for this by commanding the EVAP purge solenoid valve OFF and the canister vent solenoid valve ON which seals the system. With the engine running, the ECM then monitors the fuel tank pressure sensor for an increase in vacuum. The ECM will log a fault if a vacuum develops in the tank under these test conditions.

Large Leak Test

This diagnostic creates a vacuum condition in the EVAP system. When the enabling criteria has been met, the control module commands the normally open EVAP canister vent solenoid valve closed and the EVAP purge solenoid valve open, creating a vacuum in the EVAP system. The ECM then monitors the fuel tank pressure sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time. Failure to achieve the expected level of vacuum indicates the presence of a large leak in the EVAP system or a restriction in the purge path. The ECM will log a fault if it detects a weaker than expected vacuum level under these test conditions.

Canister Vent Restriction Test

If the evaporative emission (EVAP) vent system is restricted, fuel vapors will not be properly purged from the EVAP canister. The control module tests this by commanding the EVAP purge solenoid valve ON while commanding the EVAP canister vent solenoid valve OFF, and then monitoring the fuel tank pressure sensor for an increase in vacuum. If the vacuum increases more than the expected amount, in a set amount of time, a fault will be logged by the ECM.

Small Leak Test

The engine off natural vacuum diagnostic is the small-leak detection diagnostic for the evaporative emission

(EVAP) system. The engine off natural vacuum diagnostic monitors the EVAP system pressure with the ignition OFF. Because of this, it may be normal for the control module to remain active for up to 40 minutes after the ignition is turned OFF. This is important to remember when performing a parasitic draw test on vehicles equipped with engine off natural vacuum.

When the vehicle is driven, the temperature rises in the tank due to heat transfer from the exhaust system. After the vehicle is parked, the temperature in the tank continues to rise for a period of time, then starts to drop. The engine off natural vacuum diagnostic relies on this temperature change, and the corresponding pressure change in a sealed system, to determine if an EVAP system leak is present.

The engine off natural vacuum diagnostic is designed to detect leaks as small as 0.51 mm (0.020 in).

EVAP System Components

The evaporative emission (EVAP) system consists of the following components:

EVAP Canister Purge Solenoid Valve

The EVAP canister purge solenoid valve controls the flow of vapors from the EVAP system to the intake manifold. The purge solenoid valve opens when commanded ON by the control module. This normally closed valve is pulse width modulated (PWM) by the control module to precisely control the flow of fuel vapor to the engine. The valve will also be opened during some portions of the EVAP testing when the engine is running, allowing engine vacuum to enter the EVAP system.

Purge Tube Check Valve

Turbocharged vehicles have a check valve in the purge tube between the EVAP purge solenoid valve and the EVAP canister to prevent pressurization of the EVAP system under boost conditions. Note that the presence of this one-way check valve prevents pressure testing the EVAP system for leaks at the EVAP canister purge tube connector.

EVAP Canister

The canister is filled with carbon pellets used to absorb and store fuel vapors. Fuel vapor is stored in the canister until the control module determines that the vapor can be consumed in the normal combustion process.

Vapor Recirculation Tube

A vapor path between the fuel fill pipe and the vapor tube to the carbon canister is necessary for Vehicle Onboard Diagnostics to fully diagnose the EVAP system. It also accommodates service diagnostic procedures by allowing the entire EVAP system to be diagnosed from the either end of the system.

Fuel Tank Pressure Sensor

The fuel tank pressure sensor measures the difference between the pressure or vacuum in the fuel tank and outside air pressure. The control module provides a 5 V reference and a ground to the fuel tank pressure sensor. Depending on the vehicle, the sensor can be located in the vapor space on top of the fuel tank, in the vapor tube between the canister and the tank, or on the EVAP canister. The fuel tank pressure sensor provides a signal voltage back to the control module that can vary between 0.1-4.9 V. A high fuel tank pressure sensor voltage

indicates a low fuel tank pressure or vacuum. A low fuel tank pressure sensor voltage indicates a high fuel tank pressure.

Fuel Fill Pipe Check Valve

The check valve on the fuel fill pipe is there to prevent spit-back during refueling.

EVAP Canister Vent Solenoid Valve

The EVAP vent solenoid valve controls fresh airflow into the EVAP canister. The valve is normally open. The canister vent solenoid valve is closed only during EVAP system tests performed by the ECM.

Fuel Fill Cap

The fuel fill cap is equipped with a seal and a vacuum relief valve.

FUEL SYSTEM DESCRIPTION (LF1)

Fuel System Overview

The fuel system is an electronic returnless on-demand design. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

An electric turbine style fuel pump attaches to the fuel pump module inside the fuel tank. The fuel pump supplies fuel through the fuel feed pipe to the high pressure fuel pump. The high pressure fuel pump supplies fuel to a variable-pressure fuel rail. Fuel enters the combustion chamber through precision multi-hole fuel injectors. The high pressure fuel pump, fuel rail pressure, fuel injection timing, and injection duration are controlled by the engine control module (ECM).

Electronic Returnless Fuel System

The electronic returnless fuel system is a microprocessor controlled fuel delivery system which transports fuel from the tank to the fuel rail. It functions as an electronic replacement for a traditional, mechanical fuel pressure regulator. A pressure relief regulator valve within the fuel tank provides an added measure of over pressure protection. Desired fuel pressure is commanded by the engine control module (ECM), and transmitted to the fuel pump flow control module via a GMLAN serial data message. A liquid fuel pressure sensor provides the feedback the fuel pump flow control module requires for Closed Loop fuel pressure control.

Fuel Pump Flow Control Module

The fuel pump flow control module is a serviceable GMLAN module. The fuel pump flow control module receives the desired fuel pressure message from the engine control module (ECM) and controls the fuel pump located within the fuel tank to achieve the desired fuel pressure. The fuel pump flow control module sends a 25 KHz PWM signal to the fuel pump, and pump speed is changed by varying the duty cycle of this signal. Maximum current supplied to the fuel pump is 15 amps. A liquid fuel pressure sensor provides fuel pressure feedback to the fuel pump flow control module.

Fuel Pressure Sensor

The fuel pressure sensor is a serviceable 5V, 3-pin device. It is located on the fuel feed line forward of the fuel tank, and receives power and ground from the fuel pump flow control module through a vehicle wiring harness. The sensor provides a fuel pressure signal to the fuel pump flow control module, which is used to provide Closed Loop fuel pressure control.

Fuel Tank

The fuel tank stores the fuel supply. The fuel tank is located in the rear of the vehicle. The fuel tank is held in place by 2 metal straps that attach to the underbody of the vehicle. The fuel tank is molded from high-density polyethylene.

Fuel Fill Pipe

The fuel fill pipe has a built-in restrictor in order to prevent refueling with leaded fuel.

Fuel Filler Cap

The fuel fill pipe has a tethered fuel filler cap. A torque-limiting device prevents the cap from being over-tightened. To install the cap, turn the cap clockwise until you hear audible clicks. This indicates that the cap is correctly torqued and fully seated.

Fuel Pump Module

An electric turbine style fuel pump attaches to the fuel pump module inside the fuel tank. The fuel pump supplies fuel through the fuel feed pipe to the high pressure fuel pump. The fuel pump module contains a reverse flow check valve. The check valve maintains fuel pressure in the fuel feed pipe in order to prevent long cranking times.

Fuel Level Sensor

The fuel level sensor consists of a float, a wire float arm, and a ceramic resistor card. The position of the float arm indicates the fuel level. The fuel level sensor contains a variable resistor which changes resistance in correspondence with the position of the float arm. The engine control module (ECM) sends the fuel level information via the High Speed CAN-Bus to the body control module (BCM). The BCM then sends the fuel level percentage via the Low Speed CAN-Bus to the instrument cluster in order to control the fuel gauge.

Fuel Pump

The fuel pump is mounted in the fuel pump module reservoir. The fuel pump is an electric pump. Fuel is pumped to the high pressure fuel pump at a pressure that is based on feedback from the fuel pressure sensor. The fuel pump delivers a constant flow of fuel even during low fuel conditions and aggressive vehicle maneuvers. The fuel pump flex pipe acts to dampen the fuel pulses and noise generated by the fuel pump.

Pressure Relief Regulator Valve

The pressure relief regulator valve replaces the typical fuel pressure regulator used on a mechanical returnless fuel system. The pressure relief regulator valve is closed during normal vehicle operation. The pressure relief regulator valve is used to vent pressure during hot soaks and also functions as a fuel pressure regulator in the

event of the fuel pump flow control module defaulting to 100 percent pulse width modulation (PWM) of the fuel pump. Due to variation in the fuel system pressures, the opening pressure for the pressure relief regulator valve is set higher than the pressure that is used on a mechanical returnless fuel system pressure regulator.

Fuel Feed Pipes

The low pressure fuel feed pipe carries fuel from the fuel tank to the high pressure fuel pump.

The fuel feed pipe assembly located in the engine compartment connects the chassis fuel pipe to the high pressure fuel pump. This pipe contains the fuel pulse dampener and the fuel pressure service valve, and is constructed of stainless steel.

The fuel feed intermediate pipe is a high pressure pipe that carries fuel from the high pressure fuel pump to the fuel rail. The fuel feed intermediate pipe is constructed of stainless steel.

Nylon Fuel Pipes

WARNING: In order to reduce the risk of fire and personal injury observe the following items:

- **Replace all nylon fuel pipes that are nicked, scratched or damaged during installation, do not attempt to repair the sections of the nylon fuel pipes**
- **Do not hammer directly on the fuel harness body clips when installing new fuel pipes. Damage to the nylon pipes may result in a fuel leak.**
- **Always cover nylon vapor pipes with a wet towel before using a torch near them. Also, never expose the vehicle to temperatures higher than 115°C (239°F) for more than one hour, or more than 90°C (194°F) for any extended period.**
- **Apply a few drops of clean engine oil to the male pipe ends before connecting fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. (During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.)**

Nylon pipes are constructed to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature.

Heat resistant rubber hose or corrugated plastic conduit protect the sections of the pipes that are exposed to chafing, high temperature, or vibration.

Nylon fuel pipes are somewhat flexible and can be formed around gradual turns under the vehicle. However, if nylon fuel pipes are forced into sharp bends, the pipes kink and restrict the fuel flow. Also, once exposed to fuel, nylon pipes may become stiffer and are more likely to kink if bent too far. Take special care when working on a vehicle with nylon fuel pipes.

Quick-Connect Fittings

Quick-connect fittings provide a simplified means of installing and connecting fuel system components. The fittings consist of a unique female connector and a compatible male pipe end. O-rings, located inside the female connector, provide the fuel seal. Integral locking tabs inside the female connector hold the fittings together.

High Pressure Fuel Pump

The high pressure fuel pump is a mechanical one-cylinder design driven by an additional three lobe cam on the camshaft. High pressure fuel is regulated by the high pressure fuel pump actuator, which is a part of the high pressure fuel pump. The high pressure fuel pump actuator is a magnetic actuator which controls the inlet valve of the high pressure fuel pump. The ECM provides battery voltage on the actuator high control circuit and ground on the actuator low control circuit. Both circuits are controlled through output drivers within the ECM. When deactivated, both drivers are disabled and the inlet valve is held open with spring pressure. When activated, the actuator low control circuit driver connects the low control circuit to ground, and the actuator high control circuit driver pulse-width modulates the high control circuit. The ECM uses the camshaft and the crankshaft position sensor inputs to synchronize the actuator with the position of each of the three camshaft lobes. The ECM regulates fuel pressure by adjusting the portion of each pump stroke that provides fuel to the rail. The high pressure fuel pump also contains an integrated pressure relief valve.

Fuel Rail Assembly

The fuel rail assembly attaches to the cylinder head. The fuel rail distributes high pressure fuel to the fuel injectors. The fuel rail assembly consists of the following components:

- The direct fuel injectors
- The fuel rail pressure sensor

Fuel Injectors

The fuel injection system is a high pressure, direct injection, returnless on-demand design. The fuel injectors are mounted in the cylinder head beneath the intake ports and spray fuel directly into the combustion chamber. Direct injection requires high fuel pressure due to the fuel injector's location in the combustion chamber. Fuel pressure must be higher than compression pressure requiring a high pressure fuel pump. The fuel injectors also require more electrical power due to the high fuel pressure. The ECM supplies a separate high voltage supply circuit and a high voltage control circuit for each fuel injector. The injector high voltage supply circuit and the high voltage control circuit are both controlled by the ECM. The ECM energizes each fuel injector by grounding the control circuit. The ECM controls each fuel injector with 65V. This is controlled by a boost capacitor in the ECM. During the 65V boost phase, the capacitor is discharged through an injector, allowing for initial injector opening. The injector is then held open with 12V.

The fuel injector assembly is an inside opening electrical magnetic injector. The injector has six precision machined holes that generate a cone shaped oval spray pattern. The fuel injector has a slim extended tip in order to allow a sufficient cooling jacket in the cylinder head.

Fuel Injection Fuel Rail Fuel Pressure Sensor

The fuel rail pressure sensor detects fuel pressure within the fuel rail. The engine control module (ECM)

provides a 5V reference voltage on the 5V reference circuit and ground on the reference ground circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the fuel rail pressure sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

Fuel Pulse Dampener

The fuel pulse dampener is a part of the low pressure fuel feed pipe assembly. The fuel pulse dampener is diaphragm-operated, with fuel pump pressure on one side and with spring pressure on the other side. The function of the dampener is to dampen the fuel pump pressure pulsations.

Fuel Metering Modes of Operation

The control module monitors voltages from several sensors in order to determine how much fuel to give the engine. The control module controls the amount of fuel delivered to the engine by changing the fuel injector pulse width. The fuel is delivered under one of several modes.

Starting Mode

When the ignition is first turned ON, the control module energizes the fuel pump for 2 seconds. This allows the fuel pump to build pressure in the fuel system. The control module calculates the air/fuel ratio based on inputs from the engine coolant temperature (ECT), manifold absolute pressure (MAP), mass air flow (MAF), and throttle position sensors. The system stays in starting mode until the engine speed reaches a predetermined RPM.

Clear Flood Mode

If the engine floods, clear the engine by pressing the accelerator pedal down to the floor and then crank the engine. When the throttle position sensor is at wide open throttle (WOT), the control module reduces the fuel injector pulse width in order to increase the air to fuel ratio. The control module holds this injector rate as long as the throttle stays wide open and the engine speed is below a predetermined RPM. If the throttle is not held wide open, the control module returns to the starting mode.

Run Mode

The run mode has 2 conditions called Open Loop and Closed Loop. When the engine is first started and the engine speed is above a predetermined RPM, the system begins Open Loop operation. The control module ignores the signal from the heated oxygen sensor (HO2S). The control module calculates the air/fuel ratio based on inputs from the engine coolant temperature (ECT), manifold absolute pressure (MAP), mass air flow (MAF), and throttle position sensors. The system stays in Open Loop until meeting the following conditions:

- The HO2S has varying voltage output, showing that the HO2S is hot enough to operate properly.
- The ECT sensor is above a specified temperature.
- A specific amount of time has elapsed after starting the engine.

Specific values for the above conditions exist for each different engine, and are stored in the electrically erasable programmable read-only memory (EEPROM). The system begins Closed Loop operation after reaching these values. In Closed Loop, the control module calculates the air/fuel ratio, injector ON time, based

upon the signal from various sensors, but mainly from the HO2S. This allows the air/fuel ratio to stay very close to 14.7:1.

Acceleration Mode

When the driver pushes on the accelerator pedal, air flow into the cylinders increases rapidly. To prevent possible hesitation, the control module increases the pulse width to the injectors to provide extra fuel during acceleration. This is also known as power enrichment. The control module determines the amount of fuel required based upon the throttle position, the engine coolant temperature (ECT), the manifold absolute pressure (MAP), the mass air flow (MAF), and the engine speed.

Deceleration Mode

When the driver releases the accelerator pedal, air flow into the engine is reduced. The control module monitors the corresponding changes in the throttle position, the mass air flow (MAF), and the manifold absolute pressure (MAP). The control module shuts OFF fuel completely if the deceleration is very rapid, or for long periods, such as long, closed-throttle coast-down. The fuel shuts OFF in order to prevent damage to the catalytic converters.

Battery Voltage Correction Mode

When the battery voltage is low, the control module compensates for the weak spark delivered by the ignition system in the following ways:

- Increasing the amount of fuel delivered
- Increasing the idle RPM
- Increasing the ignition dwell time

Fuel Cutoff Mode

The control module cuts OFF fuel from the fuel injectors when the following conditions are met in order to protect the powertrain from damage and improve driveability:

- The ignition is OFF. This prevents engine run-on.
- The ignition is ON but there is no ignition reference signal. This prevents flooding or backfiring.
- The engine speed is too high, above red line.
- The vehicle speed is too high, above rated tire speed.
- During an extended, high speed, closed throttle coast down-This reduces emissions and increases engine braking.
- During extended deceleration, in order to prevent damage to the catalytic converters

Fuel Trim

The control module controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The control module monitors the heated oxygen sensor (HO2S) signal voltage while in Closed Loop and regulates the fuel delivery by adjusting the pulse width of the

injectors based on this signal. The ideal fuel trim values are around 0 percent for both short and long term fuel trim. A positive fuel trim value indicates the control module is adding fuel in order to compensate for a lean condition by increasing the pulse width. A negative fuel trim value indicates that the control module is reducing the amount of fuel in order to compensate for a rich condition by decreasing the pulse width. A change made to the fuel delivery changes the long and short term fuel trim values. The short term fuel trim values change rapidly in response to the HO2S signal voltage. These changes fine tune the engine fueling. The long term fuel trim makes coarse adjustments to fueling in order to re-center and restore control to short term fuel trim. A scan tool can be used to monitor the short and long term fuel trim values. The long term fuel trim diagnostic is based on an average of several of the long term speed load learn cells. The control module selects the cells based on the engine speed and engine load. If the control module detects an excessively lean or rich condition, the control module will set a fuel trim diagnostic trouble code (DTC).

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

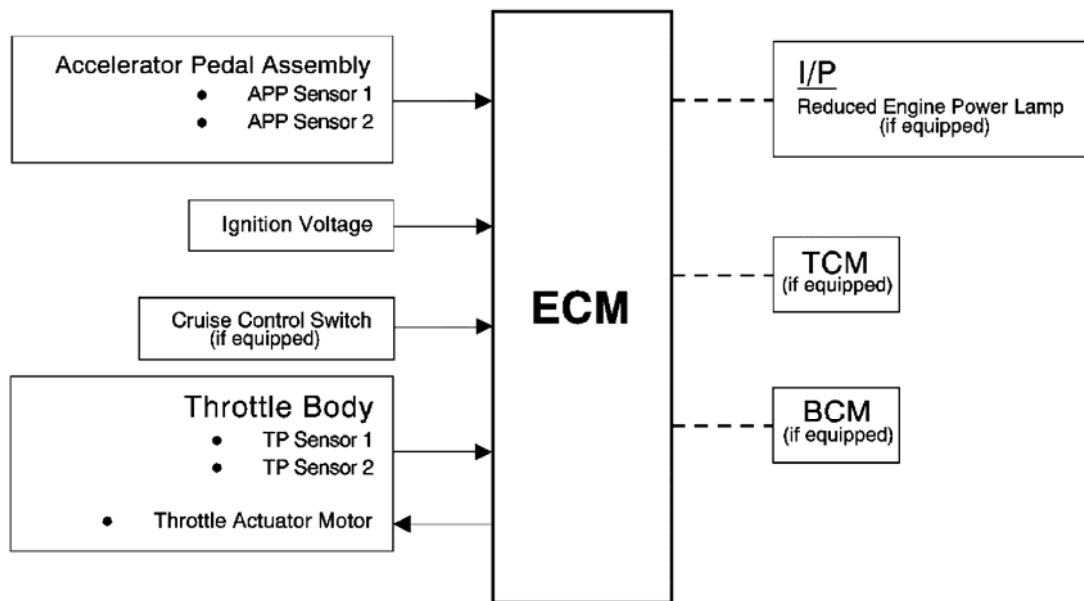


Fig. 3: Throttle Actuator Control (TAC) System
Courtesy of GENERAL MOTORS CORP.

The engine control module (ECM) is the control center for the throttle actuator control (TAC) system. The ECM determines the driver's intent based on input from the accelerator pedal position sensors, then calculates the appropriate throttle response based on the throttle position sensors. The ECM achieves throttle positioning by providing a pulse width modulated voltage to the throttle actuator motor. The throttle blade is spring loaded in both directions, and the default position is slightly open.

Modes Of Operation

Normal Mode

During the operation of the TAC system, several modes, or functions, are considered normal. The following modes may be entered during normal operations:

- Minimum pedal value-At key-up, the ECM updates the learned minimum pedal value.
- Minimum throttle position values-At key-up, the ECM updates the learned minimum throttle position value. In order to learn the minimum throttle position value, the throttle blade is moved to the Closed position.
- Ice break mode-If the throttle blade is not able to reach a predetermined minimum throttle position, the ice break mode is entered. During the ice break mode, the ECM commands the maximum pulse width several times to the throttle actuator motor in the closing direction.
- Minimum pedal value-At key-up, the ECM updates the learned minimum pedal value.
- Battery saver mode-After a predetermined time without engine RPM, the ECM commands the Battery Saver mode. During the Battery Saver mode, the TAC module removes the voltage from the motor control circuits, which removes the current draw used to maintain the idle position and allows the throttle to return to the spring loaded default position.

Reduced Engine Power Mode

When the ECM detects a condition with the TAC system, the ECM may enter a reduced engine power mode. Reduced engine power may cause one or more of the following conditions:

- Acceleration limiting-The ECM will continue to use the accelerator pedal for throttle control, however, the vehicle acceleration is limited.
- Limited throttle mode-The ECM will continue to use the accelerator pedal for throttle control, however, the maximum throttle opening is limited.
- Throttle default mode-The ECM will turn OFF the throttle actuator motor, and the throttle will return to the spring loaded default position.
- Forced idle mode-The ECM will perform the following actions:
 - Limit engine speed to idle positioning the throttle position, or by controlling the fuel and spark if the throttle is turned OFF.
 - Ignore the accelerator pedal input.
- Engine shutdown mode-The ECM will disable fuel and de-energize the throttle actuator.

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC P0010, P0013, P0020, or P0023 (LF1, LFW)</u>	P0010: Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1 P0013: Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1 P0020: Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2 P0023: Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2
<u>DTC P0011, P0014, P0021, or P0024 (LF1, LFW)</u>	P0011: Intake Camshaft Position System Performance Bank 1 P0014: Exhaust Camshaft Position System Performance Bank 1 P0021: Intake Camshaft Position System Performance Bank 2 P0024: Exhaust Camshaft Position System Performance Bank 2
<u>DTC P0016, P0017, P0018, or P0019 (LF1, LFW)</u>	P0016: Crankshaft Position - Intake Camshaft Position Not Plausible Bank 1 P0017: Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 1 P0018: Crankshaft Position - Intake Camshaft Position Not Plausible Bank 2 P0019: Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 2
<u>DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161 (LF1)</u>	P0030: HO2S Heater Control Circuit Bank 1 Sensor 1 P0036: HO2S Heater Control Circuit Bank 1 Sensor 2 P0050: HO2S Heater Control Circuit Bank 2 Sensor 1 P0053: HO2S Heater Resistance Bank 1 Sensor 1 P0054: HO2S Heater Resistance Bank 1 Sensor 2 P0056: HO2S Heater Control Circuit Bank 2 Sensor 2 P0059: HO2S Heater Resistance Bank 2 Sensor 1 P0060: HO2S Heater Resistance Bank 2 Sensor 2 P0135: HO2S Heater Performance Bank 1 Sensor 1 P0141: HO2S Heater Performance Bank 1 Sensor 2 P0155: HO2S Heater Performance Bank 2 Sensor 1 P0161: HO2S Heater Performance Bank 2 Sensor 2
<u>DTC P0068 or P1101</u>	P0068: Throttle Body Airflow Performance P1101: Intake Air Flow System Performance
<u>DTC P0089, P00C6, P228C, or P228D</u>	P0089: Fuel Pressure Regulator Performance P00C6: Fuel Rail Pressure Low During Engine Cranking P228C: Fuel Pressure Regulator 1 Control Performance - Low Pressure P228D: Fuel Pressure Regulator 1 Control Performance - High Pressure

<u>DTC P0090-P0092, P00C8, P00C9, or P00CA</u>	P0090: Fuel Pressure Regulator Control Circuit P0091: Fuel Pressure Regulator Control Circuit Low Voltage P0092: Fuel Pressure Regulator Control Circuit High Voltage P00C8: Fuel Pressure Regulator High Control Circuit P00C9: Fuel Pressure Regulator High Control Circuit Low Voltage P00CA: Fuel Pressure Regulator High Control Circuit High Voltage
<u>DTC P0101</u>	P0101: Mass Air Flow (MAF) Sensor Performance
<u>DTC P0102 or P0103</u>	P0102: Mass Air Flow (MAF) Sensor Circuit Low Frequency P0103: Mass Air Flow (MAF) Sensor Circuit High Frequency
<u>DTC P0106 (LF1)</u>	P0106: Manifold Absolute Pressure (MAP) Sensor Performance
<u>DTC P0107 or P0108 (w/LF1)</u>	P0107: Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage P0108: Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage
<u>DTC P0112, P0113, or P0114</u>	P0112: Intake Air Temperature (IAT) Sensor Circuit Low Voltage P0113: Intake Air Temperature (IAT) Sensor Circuit High Voltage P0114: Intake Air Temperature (IAT) Sensor Circuit Intermittent
<u>DTC P0116 (LF1)</u>	P0116: Engine Coolant Temperature (ECT) Sensor Performance
<u>DTC P0117 or P0118 (w/LF1)</u>	P0117: Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage P0118: Engine Coolant Temperature (ECT) Sensor Circuit High Voltage
<u>DTC P0121-P0123, P0222, P0223, or P2135 (LF1, LFW)</u>	P0121: Throttle Position Sensor Performance P0122: Throttle Position Sensor 1 Circuit Low Voltage P0123: Throttle Position Sensor 1 Circuit High Voltage P0222: Throttle Position Sensor 2 Circuit Low Voltage P0223: Throttle Position Sensor 2 Circuit High Voltage P2135: Throttle Position Sensors 1-2 Not Plausible
<u>DTC P0128 (w/LF1)</u>	P0128: Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature
<u>DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, P0158, P2A00, P2A01, P2A03, or P2A04 (LF1)</u>	P0131: HO2S Circuit Low Voltage Bank 1 Sensor 1 P0132: HO2S Circuit High Voltage Bank 1 Sensor 1 P0137: HO2S Circuit Low Voltage Bank 1 Sensor 2 P0138: HO2S Circuit High Voltage Bank 1 Sensor 2 P0151: HO2S Circuit Low Voltage Bank 2 Sensor 1 P0152: HO2S Circuit High Voltage Bank 2 Sensor 1 P0157: HO2S Circuit Low Voltage Bank 2 Sensor 2 P0158: HO2S Circuit High Voltage Bank 2 Sensor 2 P2A00: HO2S Circuit Closed Loop Performance Bank 1 Sensor 1 P2A03: HO2S Circuit Closed Loop Performance Bank 2 Sensor 1
<u>DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, or P1153 (LF1)</u>	P0133: HO2S Slow Response Bank 1 Sensor 1 P013A: HO2S Slow Response Rich to Lean Bank 1 Sensor 2 P013B: HO2S Slow Response Lean to Rich Bank 1 Sensor 2 P013C: HO2S Slow Response Rich to Lean Bank 2 Sensor 2 P013D: HO2S Slow Response Lean to Rich Bank 2 Sensor 2 P013E: HO2S Delayed Response Rich to Lean Bank 1 Sensor 2 P013F: HO2S Delayed Response Lean to Rich Bank 1 Sensor 2 P014A: HO2S Delayed Response Rich to Lean Bank 2 Sensor 2 P014B: HO2S Delayed Response Lean to Rich Bank 2 Sensor 2 P0153: HO2S Slow Response Bank 2 Sensor 1

	P1133: HO2S Insufficient Switching Bank 1 Sensor 1 P1153: HO2S Insufficient Switching Bank 2 Sensor 1
<u>DTC P0134, P0140, P0154, or P0160 (LF1)</u>	P0134: HO2S Circuit Insufficient Activity Bank 1 Sensor 1 P0140: HO2S Circuit Insufficient Activity Bank 1 Sensor 2 P0154: HO2S Circuit Insufficient Activity Bank 2 Sensor 1 P0160: HO2S Circuit Insufficient Activity Bank 2 Sensor 2
<u>DTC P0171, P0172, P0174, or P0175 (LF1, LFW)</u>	P0171: Fuel Trim System Lean Bank 1 P0172: Fuel Trim System Rich Bank 1 P0174: Fuel Trim System Lean Bank 2 P0175: Fuel Trim System Rich Bank 2
<u>DTC P018B-P018D</u>	P018B: Fuel Pressure Sensor Performance P018C: Fuel Pressure Sensor Circuit Low Voltage P018D: Fuel Pressure Sensor Circuit High Voltage
<u>DTC P0191</u>	P0191: Fuel Rail Pressure Sensor Performance
<u>DTC P0192 or P0193</u>	P0192: Fuel Rail Pressure Sensor Circuit Low Voltage P0193: Fuel Rail Pressure Sensor Circuit High Voltage
<u>DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277</u>	P0201: Cylinder 1 Injector Control Circuit P0202: Cylinder 2 Injector Control Circuit P0203: Cylinder 3 Injector Control Circuit P0204: Cylinder 4 Injector Control Circuit P0205: Cylinder 5 Injector Control Circuit P0206: Cylinder 6 Injector Control Circuit P0261: Cylinder 1 Injector Control Circuit Low Voltage P0262: Cylinder 1 Injector Control Circuit High Voltage P0264: Cylinder 2 Injector Control Circuit Low Voltage P0265: Cylinder 2 Injector Control Circuit High Voltage P0267: Cylinder 3 Injector Control Circuit Low Voltage P0268: Cylinder 3 Injector Control Circuit High Voltage P0270: Cylinder 4 Injector Control Circuit Low Voltage P0271: Cylinder 4 Injector Control Circuit High Voltage P0273: Cylinder 5 Injector Control Circuit Low Voltage P0274: Cylinder 5 Injector Control Circuit High Voltage P0276: Cylinder 6 Injector Control Circuit Low Voltage P0277: Cylinder 6 Injector Control Circuit High Voltage
<u>DTC P0231, P0232, or P023F</u>	P0231: Fuel Pump Control Circuit Low Voltage P0232: Fuel Pump Control Circuit High Voltage P023F: Fuel Pump Control Circuit
<u>DTC P025A</u>	P025A: Fuel Pump Control Module Enable Circuit
<u>DTC P0300-P0306</u>	P0300: Engine Misfire Detected P0301: Cylinder 1 Misfire Detected P0302: Cylinder 2 Misfire Detected P0303: Cylinder 3 Misfire Detected P0304: Cylinder 4 Misfire Detected P0305: Cylinder 5 Misfire Detected P0306: Cylinder 6 Misfire Detected
<u>DTC P0315</u>	The crankshaft position system variation learn feature is used to calculate

	reference period errors caused by slight tolerance variations in the crankshaft, and the crankshaft position sensor. The calculated error allows the engine control module (ECM) to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wider range of engine speed and load conditions.
<u>DTC P0324-P0328, P0330-P0333, P06B6, or P06B7</u>	P0324: Knock Sensor System Performance P0325: Knock Sensor Circuit Bank 1 P0326: Knock Sensor Performance Bank 1 P0327: Knock Sensor Circuit Low Voltage Bank 1 P0328: Knock Sensor Circuit High Voltage Bank 1 P0330: Knock Sensor Circuit Bank 2 P0331: Knock Sensor Performance Bank 2 P0332: Knock Sensor Circuit Low Voltage Bank 2 P0333: Knock Sensor Circuit High Voltage Bank 2 P06B6: Control Module Knock Sensor Processor 1 Performance P06B7: Control Module Knock Sensor Processor 2 Performance
<u>DTC P0335 (w/LF1)</u>	P0335: Crankshaft Position Sensor Circuit
<u>DTC P0336 (w/LF1)</u>	P0336: Crankshaft Position Sensor Performance
<u>DTC P0340, P0345, P0365, or P0390 (w/LF1)</u>	P0340: Intake Camshaft Position Sensor Circuit Bank 1 P0345: Intake Camshaft Position Sensor Circuit Bank 2 P0365: Exhaust Camshaft Position Sensor Circuit Bank 1 P0390: Exhaust Camshaft Position Sensor Circuit Bank 2
<u>DTC P0341, P0346, P0366, or P0391 (w/LF1)</u>	P0341: Intake Camshaft Position Sensor Performance Bank 1 P0346: Intake Camshaft Position Sensor Performance Bank 2 P0366: Exhaust Camshaft Position Sensor Performance Bank 1 P0391: Exhaust Camshaft Position Sensor Performance Bank 2
<u>DTC P0351-P0356 (LF1)</u>	P0351: Ignition Coil 1 Control Circuit P0352: Ignition Coil 2 Control Circuit P0353: Ignition Coil 3 Control Circuit P0354: Ignition Coil 4 Control Circuit P0355: Ignition Coil 5 Control Circuit P0356: Ignition Coil 6 Control Circuit
<u>DTC P0420 or P0430</u>	P0420: Catalyst System Low Efficiency Bank 1 P0430: Catalyst System Low Efficiency Bank 2
<u>DTC P0442</u>	P0442: Evaporative Emission (EVAP) System Small Leak Detected
<u>DTC P0443 or P0449 (w/LF1, LFW)</u>	P0443: Evaporative Emission (EVAP) Purge Solenoid Control Circuit P0449: Evaporative Emission (EVAP) Vent Solenoid Control Circuit
<u>DTC P0446</u>	P0446: Evaporative Emissions (EVAP) Vent System Performance
<u>DTC P0451-P0454 (w/LF1, LFW)</u>	P0451: Fuel Tank Pressure Sensor Performance P0452: Fuel Tank Pressure Sensor Circuit Low Voltage P0453: Fuel Tank Pressure Sensor Circuit High Voltage P0454: Fuel Tank Pressure Sensor Intermittent
<u>DTC P0455 (w/LF1, LFW)</u>	P0455: Evaporative Emission System Large Leak Detected
<u>DTC P0496</u>	P0496: Evaporative Emissions (EVAP) System Flow During Non-Purge
<u>DTC P0506 or P0507 (LF1,</u>	P0506: Idle Speed Low

<u>LFW)</u>	P0507: Idle Speed High
<u>DTC P050D</u>	P050D: Cold Start Rough Idle
<u>DTC P0601-P0604, P0606, P0607, P0610, P062B, P062F, P0630, P16F3, or P2610 (LF1, LFW, LWR)</u>	P0601: Control Module Read Only Memory Performance P0602: Control Module Not Programmed P0603: Control Module Long Term Memory Reset P0604: Control Module Random Access Memory Performance P0606: Control Module Processor Performance P062B: Control Module Fuel Injector Control Performance P062F: Control Module Long Term Memory Performance P0630: VIN Not Programmed or Mismatched - Engine Control Module (ECM) P16F3: Control Module Redundant Memory Performance P2610: Control Module Ignition Off Timer Performance
<u>DTC P0601-P0604, P0606, or P062F</u>	P0601: Control Module Read Only Memory (ROM) P0602: Control Module Not Programmed P0603: Control Module Long Term Memory Reset P0604: Control Module Random Access Memory (RAM) P0606: Control Module Internal Performance P062F: Control Module Long Term Memory Performance
<u>DTC P0627-P0629</u>	P0627: Fuel Pump Enable Circuit P0628: Fuel Pump Enable Circuit Low Voltage P0629: Fuel Pump Enable Circuit High Voltage
<u>DTC P0641 or P06A6</u>	P0641: 5 V Reference Circuit P06A6: 5 V Reference Performance
<u>DTC P0641, P0651, P0697, or P06A3 (ECM)</u>	P0641: 5 V Reference 1 Circuit P0651: 5 V Reference 2 Circuit P0697: 5 V Reference 3 Circuit P06A3: 5 V Reference 4 Circuit
<u>DTC P0650</u>	P0650: Malfunction Indicator Lamp (MIL) Control Circuit
<u>DTC P0685 or P0690</u>	P0685: Engine Controls Ignition Relay Control Circuit P0690: Engine Controls Ignition Relay Feedback Circuit High Voltage
<u>DTC P069E</u>	P069E: Fuel Pump Control Module Requested MIL Illumination
<u>DTC P0700</u>	P0700: Transmission Control Module (TCM) Requested MIL Illumination
<u>DTC P0856</u>	P0856: Traction Control Torque Request Circuit
<u>DTC P1248, P1249, P124A, P124B, P124C, or P124D</u>	P1248: Cylinder 1 Injector High Control Circuit Shorted to Control Circuit P1249: Cylinder 2 Injector High Control Circuit Shorted to Control Circuit P124A: Cylinder 3 Injector High Control Circuit Shorted to Control Circuit P124B: Cylinder 4 Injector High Control Circuit Shorted to Control Circuit P124C: Cylinder 5 Injector High Control Circuit Shorted to Control Circuit P124D: Cylinder 6 Injector High Control Circuit Shorted to Control Circuit

	Circuit
<u>DTC P1255 or P064A</u>	P064A: Fuel Pump Control Module Performance P1255: Fuel Pump Control Module Driver Over-temperature
<u>DTC P135A or P135B (LF1)</u>	P135A: Ignition Coil Supply Voltage Circuit Bank 1 P135B: Ignition Coil Supply Voltage Circuit Bank 2
<u>DTC P1400 (LF1)</u>	P1400: Cold Start Emission Reduction Control System
<u>DTC P150C (LF1)</u>	P150C: Transmission Control Module Engine Speed Request Signal Message Counter Incorrect
<u>DTC P1516, P2101, P2119, or P2176 (LF1, LFW)</u>	P1516: Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance P2101: Throttle Actuator Position Performance P2119: Throttle Closed Position Performance P2176: Minimum Throttle Position Not Learned
<u>DTC P159F or P15A0</u>	P159F: Fuel Economy Mode Switch Circuit Low Voltage P15A0: Fuel Economy Mode Switch Circuit High Voltage
<u>DTC P15A1</u>	P15A1: Fuel Economy Mode Switch Performance
<u>DTC P163A</u>	P163A: Control Module Fuel Pressure Regulator 1 Control System Circuitry Performance
<u>DTC P1682</u>	P1682: Ignition 1 Switch Circuit 2
<u>DTC P2122, P2123, P2127, P2128, or P2138 (LF1, LFW)</u>	P2122: Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage P2123: Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage P2127: Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage P2128: Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage P2138: Accelerator Pedal Position (APP) Sensor 1-2 Not Plausible
<u>DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F</u>	P2147: Cylinder 1 Injector High Control Circuit Low Voltage P2148: Cylinder 1 Injector High Control Circuit High Voltage P2150: Cylinder 2 Injector High Control Circuit Low Voltage P2151: Cylinder 2 Injector High Control Circuit High Voltage P2153: Cylinder 3 Injector High Control Circuit Low Voltage P2154: Cylinder 3 Injector High Control Circuit High Voltage P2156: Cylinder 4 Injector High Control Circuit Low Voltage P2157: Cylinder 4 Injector High Control Circuit High Voltage P216B: Cylinder 5 Injector High Control Circuit Low Voltage P216C: Cylinder 5 Injector High Control Circuit High Voltage P216E: Cylinder 6 Injector High Control Circuit Low Voltage P216F: Cylinder 6 Injector High Control Circuit High Voltage
<u>DTC P219A or P219B (LF1, LFW)</u>	P219A: Air Fuel Imbalance Bank 1 P219B: Air Fuel Imbalance Bank 2
<u>DTC P2227-P2229, or P2230 (LF1)</u>	P2227: Barometric Pressure (BARO) Sensor Performance P2228: Barometric Pressure (BARO) Sensor Circuit Low Voltage P2229: Barometric Pressure (BARO) Sensor Circuit High Voltage P2230: Barometric Pressure (BARO) Sensor Circuit Erratic
<u>DTC P2270 or P2272 (w/LF1)</u>	P2270: HO2S Signal Stuck Lean Bank 1 Sensor 2 P2272: HO2S Signal Stuck Lean Bank 2 Sensor 2
<u>DTC P2271 or P2273 (w/LF1)</u>	P2271: HO2S Signal Stuck Rich Bank 1 Sensor 2

	P2273: HO2S Signal Stuck Rich Bank 2 Sensor 2
<u>DTC P2534</u>	P2534: Ignition 1 Switch Circuit Low Voltage
<u>DTC P2544</u>	P2544: Transmission Torque Request Circuit P2544: Transmission Torque Request Signal Message Counter Incorrect
<u>DTC P2635</u>	P2635: Fuel Pump Flow Performance

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

DTC P0010, P0013, P0020, OR P0023 (LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0010

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0020

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

DTC P0023

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The camshaft position actuator system enables the Engine Control Module (ECM) to change the timing of the camshafts while the engine is operating. The Camshaft Position Actuator Solenoid Valve signal from the ECM is pulse width modulated (PWM). The ECM controls the Camshaft Position Actuator Solenoid Valve duty cycle by controlling the amount of solenoid valve ON time. The Camshaft Position Actuator Solenoid Valve controls the advance or the retard of each camshaft. The Camshaft Position Actuator Solenoid Valve controls the oil flow that applies the pressure to advance or retard the camshafts.

The ECM controls the Camshaft Position Actuator Solenoid Valve by supplying a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

CONDITIONS FOR RUNNING THE DTC

- The ignition voltage is greater than 11 V.
- The ignition switch is in the Crank or Run position.

- The ECM commanded the Camshaft Position Actuator Solenoid Valve ON.
- DTCs P0010, P0013, P0020, and P0023 run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0010, P0013, P0020, and P0023 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0010, P0013, P0020, and P0023 are type B DTCs.

DIAGNOSTIC AIDS

If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool circuit status parameters for the component. The circuit status parameters change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE: If a crankshaft or camshaft position sensor DTC is set, the Camshaft Position Actuator output control will not function.

1. Ignition ON, observe the DTC information with a scan tool. Verify DTC P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, and P0391 is not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Observe the appropriate control circuit status parameters listed below with a scan tool:
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2

Each parameter should display OK or Not Run

3. Engine idling, command the appropriate Camshaft Position Actuator from 0 degrees to 25 degrees and back to zero while observing the appropriate control circuit status parameters listed below with a scan tool:
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2
 - The Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2

Each parameter should display OK or Not Run

4. The engine at the normal operating temperature, raise the engine speed to 2,000 RPM for 10 s. DTCs P0010, P0013, P0020, or P0023 should not set.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power

down. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.

- If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

NOTE: **A test lamp must be used for this test. The control circuit is pulled-up to a low current voltage, 1.5-4.5 V on the control circuit is normal.**

3. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 1 and ground.
 - If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Connect the DMM black lead to the control circuit terminal 1. Connect the DMM red lead to B+. Set the DMM on the diode setting. Command the CMP actuator solenoid ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
 - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the K20 ECM.
5. If all circuits/connections test normal, test or replace the appropriate Q6 Camshaft Position Actuator Solenoid Valve.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 ohms between the control terminal 1 and the low reference circuit terminal 2 of the Q6 Camshaft Position Actuator Solenoid Valve.
 - If not within the specified range, replace the Q6 Camshaft Position Actuator Solenoid Valve.
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
 - If not the specified value, replace the Q6 Camshaft Position Actuator Solenoid Valve.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Control Module References** for Engine Control Module replacement, setup, and programming

DTC P0011, P0014, P0021, OR P0024 (LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0011

Intake Camshaft Position System Performance Bank 1

DTC P0014

Exhaust Camshaft Position System Performance Bank 1

DTC P0021

Intake Camshaft Position System Performance Bank 2

DTC P0024

Exhaust Camshaft Position System Performance Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The camshaft position actuator system enables the Engine Control Module (ECM) to change the timing of the camshafts while the engine is operating. The camshaft position actuator solenoid signal from the ECM is pulse width modulated (PWM). The ECM controls the camshaft position actuator solenoid duty cycle by controlling the amount of solenoid ON time. The camshaft position actuator solenoid controls the advance or the retard of each camshaft. The camshaft position actuator solenoid controls the oil flow that applies the pressure to advance or retard the camshafts.

CONDITIONS FOR RUNNING THE DTC

- DTC P0010, P0013, P0020, P0023, P0016, P0017, P0018, P0019, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, and P0391 is not set.
- The ignition voltage is greater than 11 V.
- The engine is operating.
- The desired camshaft position is not changing greater than 4.5 degrees for at least 1 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 20 degrees or less than 5 degrees.
- DTCs P0011, P0014, P0021, and P0024 run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0011 and P0021

The ECM detects the difference between the desired and actual camshaft position angle is greater than 5 degrees for greater 2.5 s.

P0014 and P0024

The ECM detects the difference between the desired and actual camshaft position angle is greater than 5 degrees for greater 10 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0011, P0014, P0021, and P0024 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0011, P0014, P0021, and P0024 are type B DTCs.

DIAGNOSTIC AIDS

Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft position actuator solenoid, mechanical camshaft actuator, or timing chain can cause this DTC to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE:

- The engine oil level and the oil pressure are critical to the correct operation of the camshaft position actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic. Refer to Oil Pressure Diagnosis and Testing .
- The engine oil condition has a major impact on the camshaft actuator system. Debris in the oil can interfere with the camshaft position actuator solenoid and the mechanical camshaft actuator operation. Inspect for dirty or degraded crankcase oil. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life parameter. Advise the customer an oil change may be required.
- If a crankshaft or camshaft position sensor DTC is set, the Camshaft Position Actuator output control will not function.

1. Ignition ON, observe the scan tool DTC information. Verify that DTC P0016, P0017, P0018, P0019, P0335, P0336, P0338, P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391 is not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Engine idling, command the appropriate Camshaft Position Actuator from 0 degrees to 20 degrees and back to zero while observing the appropriate scan tool Camshaft Position Variance parameters. The Camshaft Position Variance should be less than 2 degrees in each of the commanded states.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

NOTE:

A test lamp must be used for this test. The control circuit is pulled-up to a low current voltage, 1.5-4.5 V on the control circuit is normal.

3. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 1 and ground.

- If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
- 4. Connect the DMM black lead to the control circuit terminal 1. Connect the DMM red lead to B+. Set the DMM on the diode setting. Command the CMP actuator solenoid ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
 - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the K20 ECM.
- 5. Remove the Camshaft Position Actuator Solenoid Valve. Verify the following conditions do not exist with the Camshaft Position Actuator Solenoid Valve:
 - Torn, restricted, mis-positioned, or missing screens at the CMP actuator solenoid
 - Engine oil leak between the oil sealing lands of the CMP actuator solenoid. Inspect the lands of the CMP actuator solenoid for nicks.
 - Oil seepage at the CMP actuator solenoid connector
 - If a condition is found, replace Q6 Camshaft Position Actuator Solenoid Valve.
- 6. Ignition OFF, swap the appropriate Camshaft Position Actuator Solenoid Valve with a Camshaft Position Actuator Solenoid Valve that is operating correctly.
- 7. Engine idling. Command the appropriate Camshaft Position Actuator from 0 degrees to 20 degrees and back to zero while observing the appropriate scan tool Camshaft Position Variance parameters. The Camshaft Position Variance should be less than 2 degrees in each of the commanded states.
 - If greater than the specified value, replace the mechanical camshaft position actuator.
- 8. If all circuits/connections test normal, test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 ohms between the ignition circuit terminal 1 and the control circuit terminal 2 of the Q6 Camshaft Position Actuator Solenoid Valve.
 - If not within the specified range, replace the Q6 Camshaft Position Actuator Solenoid Valve.
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
 - If not the specified value, replace the Q6 Camshaft Position Actuator Solenoid Valve.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Actuator Replacement - Bank 1 (LF1)**
- **Camshaft Position Actuator Replacement - Bank 2 (LF1)**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**

- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Control Module References** for ECM replacement, programming, and setup

DTC P0016, P0017, P0018, OR P0019 (LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0016

Crankshaft Position - Intake Camshaft Position Not Plausible Bank 1

DTC P0017

Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 1

DTC P0018

Crankshaft Position - Intake Camshaft Position Not Plausible Bank 2

DTC P0019

Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) uses the crankshaft position (CKP) sensor and the camshaft position (CMP) sensor pulses to monitor the correlation between the crankshaft and the camshaft position. An improper relative position can be caused by either engine timing or improper indexing of the camshaft drive chain.

CONDITIONS FOR RUNNING THE DTC

- DTC P0335, P0336, P0338, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0641, and P0651 are not set.
- The engine is operating.
- The crankshaft and camshaft position signals are synchronized.
- The camshaft position actuator is in the parked position.
- DTC P0016, P0017, P0018, and P0019 run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

DTC P0016, P0017, P0018, or P0019

The ECM detects that one camshaft is mis-aligned with the crankshaft. The ECM detects one of the following conditions:

- Bank 1 intake camshaft is greater than 9 degrees retarded or 12 degrees advanced in relationship to the crankshaft.
- Bank 1 exhaust camshaft is greater than 10 degrees retarded or 13 degrees advanced in relationship to the crankshaft.
- Bank 2 intake camshaft is greater than 11 degrees retarded or 13 degrees advanced in relationship to the crankshaft.
- Bank 2 exhaust camshaft is greater than 9 degrees retarded or 13 degrees advanced in relationship to the crankshaft.

DTC P0016 and P0017

The ECM detects that both camshafts on bank 1 are mis-aligned with the crankshaft. The ECM detects the following conditions:

- Bank 1 intake camshaft is greater than 6 degrees retarded or 9 degrees advanced in relationship to the crankshaft.
- Bank 1 exhaust camshaft is greater than 6 degrees retarded or 9 degrees advanced in relationship to the crankshaft.

DTC P0018 and P0019

The ECM detects that both camshafts on bank 2 are mis-aligned with the crankshaft. The ECM detects the following conditions:

- Bank 2 intake camshaft is greater than 6 degrees retarded or 9 degrees advanced in relationship to the crankshaft.
- Bank 2 exhaust camshaft is greater than 7 degrees retarded or 9 degrees advanced in relationship to the crankshaft.

DTC P0016, P0017, P0018, and P0019

The ECM detects that all 4 camshafts are mis-aligned with the crankshaft. The ECM detects the following conditions:

- Bank 1 intake camshaft is greater than 6 degrees retarded or 9 degrees advanced in relationship to the crankshaft.
- Bank 1 exhaust camshaft is greater than 6 degrees retarded or 9 degrees advanced in relationship to the crankshaft.
- Bank 2 intake camshaft is greater than 6 degrees retarded or 8 degrees advanced in relationship to the crankshaft.
- Bank 2 exhaust camshaft is greater than 7 degrees retarded or 9 degrees advanced in relationship to the

crankshaft.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0016, P0017, P0018, and P0019 are type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0016, P0017, P0018, and P0019 are type B DTCs.

DIAGNOSTIC AIDS

- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed secondary timing chain can cause this DTC to set.
- This diagnostic algorithm is designed to detect an alignment condition between a primary intermediate sprocket and the secondary timing chain, or the alignment between a primary intermediate sprocket and the crankshaft. Either condition would cause the camshaft timing for both cams on one bank to be off an equal number of degrees.
- DTCs P0016, P0017, P0018, and P0019 set at the same time indicates a possible condition with the primary timing chain and the alignment between both intermediate sprockets and the crankshaft. Or, the crankshaft reluctor wheel has moved and is no longer referenced to top dead center (TDC).
- Observing the desired and actual camshaft angle parameters, with a scan tool before a DTC sets, may help to isolate whether a condition is specific to one camshaft, one bank, or caused by a condition with the primary crankshaft timing.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Ignition ON, observe the DTC information with a scan tool. Verify that none of the following DTCs are set. DTC P0010, P0013, P0020, P0023, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391.
 - If any of the DTCs listed are set refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.
2. Idle the engine at normal operating temperature. DTCs P0016, P0017, P0018, or P0019 should not set.
 - If a DTC sets, inspect for the following and repair as necessary:
 - The correct installation of the camshaft sensors
 - The correct installation of the crankshaft sensor
 - A timing chain tensioner condition
 - An incorrectly installed timing chain
 - Excessive play in the timing chain
 - A mechanical cam actuator that is stuck in the full advance or retard position.
 - A timing chain that jumped teeth
 - A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC) on the crankshaft
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Timing Chain Alignment Diagram
- Camshaft Timing Drive Components Cleaning and Inspection
- Crankshaft and Bearing Cleaning and Inspection

DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, OR P0161 (LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0030

HO2S Heater Control Circuit Bank 1 Sensor 1

DTC P0036

HO2S Heater Control Circuit Bank 1 Sensor 2

DTC P0050

HO2S Heater Control Circuit Bank 2 Sensor 1

DTC P0053

HO2S Heater Resistance Bank 1 Sensor 1

DTC P0054

HO2S Heater Resistance Bank 1 Sensor 2

DTC P0056

HO2S Heater Control Circuit Bank 2 Sensor 2

DTC P0059

HO2S Heater Resistance Bank 2 Sensor 1

DTC P0060

HO2S Heater Resistance Bank 2 Sensor 2

DTC P0135

HO2S Heater Performance Bank 1 Sensor 1

DTC P0141

HO2S Heater Performance Bank 1 Sensor 2

DTC P0155

HO2S Heater Performance Bank 2 Sensor 1

DTC P0161

HO2S Heater Performance Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Heater Voltage Supply	P0030, P0036, P0050, P0056, P0132, P0135, P0138,	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140,	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140,	P0690	P0135, P0141, P0155, P0161

	P0141, P0152, P0155, P0158, P0161, *	P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0141, P0152, P0154, P0155, P0158, P0160, P0161		
HO2S Heater Control	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161
* Opens Fuse					

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Current/HO2S Sensor 2 Current

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 0.2-1.5 A			
HO2S Heater Low Control	0 A	0 A	0 A
HO2S Heater Voltage Supply	0 A	0 A	0.2-1.5 A

CIRCUIT/SYSTEM DESCRIPTION

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. A heating element inside the HO2S minimizes the time required for the sensors to reach operating temperature. Voltage is provided to the heater by an ignition voltage circuit through a fuse. With the engine running, ground is provided to the heater by the HO2S heater low control circuit through a low side driver within the engine control module (ECM). The ECM uses pulse width modulation (PWM) to control the HO2S heater operation to maintain a specific HO2S operating temperature range.

CONDITIONS FOR RUNNING THE DTC

P0030, P0036, P0050, or P0056

- The ignition 1 voltage is between 11-18 V.
- The engine speed is greater than 400 RPM.
- The DTCs run continuously when the above conditions are met.

P0053, P0054, P0059, or P0060

- DTCs P0112, P0113, P0117, P0118, or P2610 are not set.
- The engine run time is greater than 20 s.
- The ignition voltage is less than 18 V.
- The ignition is OFF for greater than 8 h.
- The engine coolant temperature (ECT) is between -30 to +45°C (-22 to +113°F) at engine start-up.
- The ECT and the intake air temperature (IAT) are within 8°C (14°F) at engine start-up.
- The DTCs run once per drive cycle when the above conditions are met.

P0135, P0141, P0155, or P0161

- DTCs P0116, P0117, P0118, P0125, or P0128 are not set.
- The ignition 1 voltage is between 10-32 V.
- The HO2S is at operating temperature.
- The HO2S is commanded ON.
- The DTCs run once per drive cycle when the above conditions are met for 120 s.

CONDITIONS FOR SETTING THE DTC

P0030, P0036, P0050, or P0056

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 s.

P0053, P0054, P0059, or P0060

The ECM detects the HO2S heater is not within a specified resistance range at engine start-up.

P0135 or P0155

The ECM detects that the HO2S 1 heater current is greater than 3.1 amps, or less than 0.3 amps for greater than 8 s.

P0141 or P0161

The ECM detects that the HO2S 2 heater current is greater than 2.9 amps, or less than 0.3 amps for greater than 8 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, and P0161 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, and P0161 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Heated Oxygen Sensor Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, command the appropriate B52 HO2S heater ON and OFF with a scan tool while observing the B52 HO2S Heater Circuit Test Status parameter. The parameter should display OK or Not Run.
2. Engine idling at operating temperature, observe the scan tool B52 HO2S Heater parameter. The amperage should be within 0.2-1.5 A.
3. Engine idling at operating temperature, move the related wiring and connectors while observing the B52 HO2S Heater parameter with a scan tool. The parameter should not change with movement.
 - If movement affects the parameter, repair the appropriate harness or connector.

4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate B52 HO2S.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.
 - If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B52 HO2S heater circuit fuse is open, test all components connected to the fuse and replace as necessary.
3. Ignition ON, observe the appropriate scan tool HO2S Heater Control Open Circuit Test Status parameter. The parameter should display Malfunction.
 - If not the specified value, test the heater control circuit terminal E for a short to ground, or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Connect a 3 A fused jumper wire between the heater control circuit terminal E and ground. Observe the appropriate scan tool HO2S Heater Control Circuit Low Voltage Test Status parameter. The parameter should transition from OK to Malfunction.
 - If not the specified value, test the heater control circuit terminal E for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

NOTE:

- **Less than 10 ohms of additional resistance on the ignition voltage circuit, or control circuit may set a DTC. If there is resistance on a circuit, the driver will remain ON and the scan tool HO2S High Voltage Test Status parameter will display OK.**
- **Performing this test may set additional DTCs.**

5. Ignition OFF, connect a 10 A fused jumper wire between the control circuit terminal E and the ignition voltage circuit terminal D.
6. Engine idling, observe the appropriate HO2S Control Circuit High Voltage Test Status parameter. The parameter should transition from Not Run to Malfunction.
 - If not the specified value, test the control circuit and the ignition voltage circuit for high resistance. If the circuits test normal, replace the K20 ECM.
7. If all circuits test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0068 OR P1101

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0068

Throttle Body Airflow Performance

DTC P1101

Intake Air Flow System Performance

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) compares actual airflow based on throttle position (TP) to a calculated airflow based on manifold absolute pressure (MAP) sensor, and mass air flow (MAF).

CONDITIONS FOR RUNNING THE DTC

DTC P0068

- The engine speed is greater than 800 RPM.
- The ignition voltage is greater than 6.0 V.
- The throttle actuator control system is not in reduced power mode.
- The DTC runs continuously when the above conditions are met.

DTC P1101

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0335, P0336 are not set
- The engine speed is between 400-7,000 RPM
- The engine coolant temperature (ECT) is between 69-127°C (156-260°F).
- The intake air temperature (IAT) is between -20 to +125°C (-4 to +257°F).

- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the actual airflow rate is greater than the calculated airflow.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0068 is a type A DTC.
- DTC P1101 is a type B DTC.

CONDITIONS FOR CLEARING THE DTC

- DTC P0068 is a type A DTC.
- DTC P1101 is a type B DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Verify none of the following conditions exist:
 - The air intake duct system for loose clamps, cracks, or other damage

- The air intake duct system for being collapsed or restricted
 - The B75 mass airflow sensor is installed correctly.
 - Restricted air filter
 - Q38 throttle body for dirt, debris, and coking. Also, throttle body blade or shaft damage. Refer to **Throttle Body Inspection and Cleaning** for further diagnosis.
 - Splits, kinks, or improper connections at the vacuum hoses
 - Missing, restricted, or leaking exhaust components-Refer to **Symptoms - Engine Exhaust** .
 - Vacuum leaks at the intake manifold and Q38 throttle body.
 - If a condition exists, repair as necessary.
2. Ignition ON, observe the diagnostic trouble code (DTC) information with a scan tool. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
 - If any of the above DTCs are set, refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.
 3. Determine the current vehicle testing altitude. Compare the MAP Sensor pressure parameter to the reading in the **Altitude Versus Barometric Pressure** table. The MAP sensor pressure parameter should be within the specified range indicated in the table.
 - If the MAP sensor pressure is not within the range specified for your altitude, refer to **DTC P0106 (LF1)**.
 4. Engine idling, observe the MAP Sensor kPa parameter. The reading should be between 26-52 kPa (3.8-7.5 psi).
 - If not within the specified range, refer to **DTC P0106 (LF1)**.
 5. Use the scan tool snapshot function to take a snapshot of the engine data list while performing the actions listed below.
 1. Engine idling
 2. Increase the engine speed slowly to 3,000 RPM and then back to idle.
 3. Exit from the scan tool snapshot and review the data.
 4. Observe the MAF Sensor g/s parameter frame by frame with a scan tool. The MAF Sensor g/s parameter should change smoothly and gradually as the engine speed is increased and then returned to idle.
 - If the MAF Sensor g/s parameter does not change smoothly and gradually, refer to **DTC P0101** for further diagnosis.
 6. If all conditions test normal, test the engine for a mechanical condition. Refer to **Symptoms - Engine Mechanical** .

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Throttle Body Assembly Replacement (LF1)**
- **Air Cleaner Element Replacement (LE5)**

DTC P0089, P00C6, P228C, OR P228D

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0089

Fuel Pressure Regulator Performance

DTC P00C6

Fuel Rail Pressure Low During Engine Cranking

DTC P228C

Fuel Pressure Regulator 1 Control Performance - Low Pressure

DTC P228D

Fuel Pressure Regulator 1 Control Performance - High Pressure

CIRCUIT/SYSTEM DESCRIPTION

The fuel rail pressure sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 V reference voltage on the 5 V reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on the signal circuit.

High pressure fuel is regulated by the high pressure fuel pump actuator, which is a part of the high pressure fuel pump. The high pressure fuel pump actuator is a solenoid valve. The ECM provides a voltage on the actuator high control circuit and ground on the actuator low control circuit. Both circuits are controlled through output drivers within the ECM. When deactivated, both drivers are disabled. When activated, the high control circuit driver energizes the high pressure fuel pump actuator and the low control circuit driver pulse-width modulates (PWM) the low control circuit to ground.

The high pressure mechanical fuel pump is driven by three lobes on the camshaft. The ECM uses the camshaft and crankshaft position sensor inputs to synchronize the high pressure fuel pump actuator with the position of each of the camshaft lobes. The ECM regulates fuel pressure by adjusting the portion of each pump stroke that provides fuel to the rail.

The ECM monitors the fuel rail fuel pressure sensor and the high pressure fuel pump actuator to determine if the commanded and actual pressure are within a predetermined range, or if the amount of fuel pressure correction exceeds a calibrated pressure.

CONDITIONS FOR RUNNING THE DTC

P0089, P228C, or P228D

- DTC P0090, P0091, P0092, P0191, P0192, or P0193 is not set.
- The ignition voltage is less than 18 V.
- The deceleration fuel cut-off (DFCO) is inactive.
- The engine speed is greater than 25 RPM.
- The air bag is not deployed.
- The DTCs run continuously when the above conditions are met for 5 s.

P00C6

- DTC P0090, P0091, P0092, P00C8, P00C9, P00CA, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0627, P0628, P0629 are not set.
- The ignition voltage is more than 8 V.
- The engine coolant temperature is between -100 and +65°C (-148 and +149°F).
- The low side fuel pressure is more than 0 kPa (0 psi).
- The engine is not running.
- The DTC runs once for each engine start.

CONDITIONS FOR SETTING THE DTC

P0089

The high pressure fuel pump actuator command necessary to maintain the desired fuel rail pressure is +/-2,500 kPa (363 psi) of the command expected by the controller. The condition exists for greater than 5 s.

P00C6

The ECM detects that the fuel pressure is not rising or has fallen beyond acceptable limits during engine cranking.

P228C

The actual fuel rail pressure is 1,500 kPa (218 psi) less than the desired fuel pressure. The condition exists for greater than 5 s.

P228D

The actual fuel rail pressure is 3,600 kPa (522 psi) greater than the desired fuel rail pressure. The condition exists for greater than 5 s.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C and P228D are Type A DTCs.

- A message center or an indicator displays Reduced Engine Power.

CONDITIONS FOR CLEARING THE DTC

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C and P228D are Type A DTCs.

DIAGNOSTIC AIDS

- A restricted fuel feed pipe between the fuel feed pipe fuel pressure sensor and the high pressure fuel pump may set a DTC.
- A condition with the fuel tank fuel pump module or fuel pump flow control module may set these DTCs.
- A skewed fuel rail pressure sensor, or an intermittent condition in the fuel rail pressure sensor circuits may set these DTCs.
- A leaking or restricted fuel injector may set DTC P0089.
- A short to voltage in the crankshaft position signal circuit may set a DTC.
- A short to voltage in the camshaft position actuator solenoid valve control circuit may set a DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the DTC information with a scan tool. DTC P0627, P0628, P0629, P069E, or U0109 should not set.
 - o If a DTC is set refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Attempt to start and idle the engine.
3. Observe the DTC information with a scan tool. DTCs P0089, P00C6, P228C, and P228D should not set.
4. Engine idling, observe the Fuel Rail Pressure Sensor parameter with a scan tool. The pressure should be approximately 1.9-2.1 Mpa (279-305 psi).
5. Command an increase and decrease in fuel rail pressure with a scan tool. Observe the scan tool Fuel Rail Pressure Sensor parameter. The Fuel Rail Pressure Sensor should increase or decrease with each commanded state.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: **Circuit/System Verification must be performed first or misdiagnosis may result.**

1. Ignition ON, observe the scan tool fuel pump control module fuel line pressure sensor parameter. Command an increase in the fuel line pressure with a scan tool. Verify the fuel line pressure increases to greater than 414 kPa (60 psi) as commanded.
 - o If less than the specified range, refer to **Fuel System Diagnosis** .

NOTE: **As little as 2 ohms on either circuit of the high pressure fuel pump actuator will cause these DTCs to set. Test the circuits of the high pressure fuel pump actuator for a high resistance if you suspect a condition.**

2. Remove the G18 high pressure fuel pump and visually inspect the lobes on the camshaft for unusual wear.
 - o If the lobes appear normal, replace the G18 high pressure fuel pump.
 - o If the lobes are worn, replace the camshaft.

COMPONENT TESTING

Static Test

1. Ignition OFF, disconnect the harness connector at the G18 high pressure fuel pump.

NOTE: The DMM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis.

2. Test for 10 ohms plus/minus 1 ohms at 25°C (77°F) between the low control circuit terminal 1 and the high control circuit terminal 2.
 - If not within the specified range, replace the G18 high pressure fuel pump.
3. Test for infinite resistance between each terminal and the G18 high pressure fuel pump housing.
 - If not the specified value, replace the G18 high pressure fuel pump.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Camshaft Replacement - Right Side
- Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)
- Fuel Pump Replacement

DTC P0090-P0092, P00C8, P00C9, OR P00CA

DIAGNOSTIC INSTRUCTIONS

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0090

Fuel Pressure Regulator Control Circuit

DTC P0091

Fuel Pressure Regulator Control Circuit Low Voltage

DTC P0092

Fuel Pressure Regulator Control Circuit High Voltage

DTC P00C8

Fuel Pressure Regulator High Control Circuit

DTC P00C9

Fuel Pressure Regulator High Control Circuit Low Voltage

DTC P00CA

Fuel Pressure Regulator High Control Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Pressure Fuel Pump Actuator High Control	P0091, P00C9	P0090, P00C8	P0092, P00CA	-
High Pressure Fuel Pump Actuator Low Control	P0091, P00C9	P0090, P00C8	P0092, P00CA	-

CIRCUIT/SYSTEM DESCRIPTION

High pressure fuel is regulated by the high pressure fuel pump actuator, which is a part of the high pressure fuel pump. The high pressure fuel pump actuator is a solenoid valve. The ECM provides battery voltage on the actuator high control circuit and ground on the actuator low control circuit. Both circuits are controlled through output drivers within the ECM. When deactivated, both drivers are disabled. When activated, the high control circuit driver energizes the high pressure fuel pump actuator and the low control circuit driver pulse-width modulates (PWM) the low control circuit to ground. The ECM monitors the voltage on the circuits to detect a failure.

CONDITIONS FOR RUNNING THE DTC

- The ignition voltage is between 11-18 V.
- The DTCs run continuously within the enabling conditions.

CONDITIONS FOR SETTING THE DTC

P0090

- The ECM detects an open circuit in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P0091

- The ECM detects a short to ground in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P0092

- The ECM detects a short to voltage in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P00C8

- The ECM detects an open circuit in the high pressure fuel pump actuator high control circuit.
- The DTC sets when the above condition is present for 4 s.

P00C9

- The ECM detects a short to ground in the high pressure fuel pump actuator high control circuit.
- The DTC sets when the above condition is present for 4 s.

P00CA

- The ECM detects a short to voltage in the high pressure fuel pump actuator high control circuit.
- The DTC sets when the above condition is present for 4 s.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0090, P0091, P0092, P00C8, P00C9, and P00CA are Type A DTCs.
- A message center or an indicator displays Reduced Engine Power.

CONDITIONS FOR CLEARING THE DTC

DTCs P0090, P0091, P0092, P00C8, P00C9, and P00CA are Type A DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the DTC information with a scan tool. DTC P0090, P0091, P0092, P00C8, P00C9, P00CA, P0685, or P1682 should not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, command the Fuel Pressure Regulator ON and OFF with a scan tool while observing the following control circuit status parameters:
 - Fuel Pressure Regulator Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator Control Circuit Open Test Status
 - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
 - Fuel Pressure Regulator High Control Circuit Open Test Status
 - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
 - Each parameter should toggle between OK and Not Run or Not Run and OK.
3. Engine idling, observe the Fuel Rail Pressure Sensor parameter with a scan tool. The pressure should be approximately 1.9-2.1 MPa (279-305 psi).
4. Command an increase and decrease in fuel rail pressure with a scan tool. Observe the scan tool Fuel Rail Pressure Sensor parameter. The Fuel Rail Pressure Sensor should increase or decrease with each command.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the G18 high pressure fuel pump.
2. Ignition OFF, verify that a test lamp does not illuminate between B+ and the low control circuit terminal 1.
 - If the test lamp illuminates, test the low control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify that a test lamp does not illuminate between ground and the high control circuit terminal 2.
 - If the test lamp illuminates, test the high control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition ON, command the Fuel Pressure Regulator ON with a scan tool. Verify that the test lamp

illuminates.

- If the test lamp does not illuminate, test the high control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. Ignition OFF, connect a test lamp between the low control circuit terminal 1 and B+.
 6. Ignition ON, command the Fuel Pressure Regulator ON with a scan tool. Verify that the test lamp illuminates.
 - If the test lamp does not illuminate, test the low control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 7. If all circuits test normal, test or replace the G18 high pressure fuel pump.

COMPONENT TESTING

Static Test

1. Ignition OFF, disconnect the harness connector at the G18 high pressure fuel pump.

NOTE: **The DMM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis.**

2. Test for 9-11 ohms at 25°C (77°F) between the low control circuit terminal 1 and the high control circuit terminal 2.
 - If not within the specified range, replace the G18 high pressure fuel pump.
3. Measure the resistance between each terminal and the high pressure fuel pump housing. The DMM should display OL.
 - If less than the specified value, replace the G18 high pressure fuel pump.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Pump Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0101

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0101

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0102	P0101	P0102	-	P0101, P0103
MAF Sensor Signal	P0102	P0102	P0102	P0102	P0101, P0103, P1101
Ground	-	P0102	P0102	-	P0102

TYPICAL SCAN TOOL DATA

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions			
Parameter Normal Range: 2,000-10,000 Hz			
Ignition 1 Voltage	0 Hz	0 Hz	-
MAF Sensor Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

CIRCUIT DESCRIPTION

The intake flow rationality diagnostic provides the within-range rationality check for the mass air flow (MAF), manifold absolute pressure (MAP), and the throttle position sensors. This is an explicit model-based diagnostic containing 4 separate models for the intake system.

- The throttle model describes the flow through the throttle body and is used to estimate the MAF through the throttle body as a function of barometric pressure (BARO), throttle position sensors, intake air temperature (IAT), and estimated MAP. The information from this model is displayed on the scan tool as the MAF Performance Test parameter.
- The first intake manifold model describes the intake manifold and is used to estimate MAP as a function of the MAF into the manifold from the throttle body and the MAF out of the manifold caused by engine pumping. The flow into the manifold from the throttle uses the MAF estimate calculated from the above throttle model. The information from this model is displayed on the scan tool as the MAP Performance Test 1 parameter.
- The second intake manifold model is identical to the first intake manifold model except that the MAF sensor measurement is used instead of the throttle model estimate for the throttle air input. The information from this model is displayed on the scan tool as the MAP Performance Test 2 parameter.
- The fourth model is created from the combination and additional calculations of the throttle model and the first intake manifold model. The information from this model is displayed on the scan tool as the Throttle Position Sensors Performance Test parameter.

The estimates of MAF and MAP obtained from this system of models and calculations are then compared to the actual measured values from the MAF, MAP, and the throttle position sensors and to each other to determine

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the appropriate DTC to fail. The following table illustrates the possible failure combinations and the resulting DTC or DTCs.

Scan Tool Diagnostic Test Results

MAF Performance Test	MAP Performance Test 1	MAP Performance Test 2	Throttle Position Sensors Performance Test	DTCs Passed	DTCs Failed
-	-	OK	OK	P0101, P0106, P0121, P1101	None
OK	OK	Malfunction	OK	P0101, P0106, P0121, P1101	None
Malfunction	OK	Malfunction	OK	P0106, P0121, P1101	P0101
OK	Malfunction	Malfunction	OK	P0101, P0121, P1101	P0106
Malfunction	Malfunction	Malfunction	OK	P0121, P1101	P0101, P0106
-	-	OK	Malfunction	P0101, P0106, P1101	P0121
OK	OK	Malfunction	Malfunction	P0101, P0106, P0121, P1101	None
Malfunction	OK	Malfunction	Malfunction	P0101, P0106, P0121	P1101
-	Malfunction	Malfunction	Malfunction	P0101, P0106, P0121	P1101
OK	OK	Malfunction	OK	-	P0102

CONDITIONS FOR RUNNING THE DTCS

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335 or P0336 are not set.
- The engine is running.
- The engine coolant is between 69-127°C (156-261°F).
- The intake air temperature is between -20 and +125°C (-4 and +257°F).
- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The engine control module (ECM) detects that the actual measured airflow from the MAF, MAP, and throttle position sensors is not within range of the calculated airflow that is derived from the system of models for greater than 2 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P0101 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0101 is a Type B DTC.

DIAGNOSTIC AIDS

- A steady or intermittent high resistance of 15 ohms or greater on the ignition 1 voltage circuit will cause the MAF sensor signal to be increased by as much as 60 g/s.
- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will impair the response of the sensor to airflow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.
- Depending on the current ambient temperature, and the vehicle operating conditions, a MAF sensor signal circuit that is shorted to the IAT signal circuit will cause the MAF sensor signal to be skewed or erratic. Additionally, it may cause a rapid fluctuation in the IAT Sensor parameter.
- A skewed or stuck engine coolant temperature (ECT) or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** or **Temperature Versus Resistance - Intake Air Temperature Sensor**.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 38522:** Variable Signal Generator
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Verify that the following DTCs are not set:
 - 5 V reference circuits
 - Camshaft position system performance
 - Engine controls ignition relay circuits
 - Ignition circuits-Body control module (BCM)
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Verify that restrictions do not exist in the exhaust system. Refer to **Restricted Exhaust** .
3. Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 2,000-3,900 Hz depending on the engine coolant temperature (ECT).
4. A wide open throttle (WOT) acceleration from a stop should cause the MAF Sensor parameter on the scan tool to increase rapidly. This increase should be from 2-8 g/s at idle to greater than 180 g/s at the time of the 1-2 shift.
5. Use the scan tool and compare the MAF Sensor parameter to a known good vehicle, under various operating conditions.
6. Verify the proper operation of the ECT and IAT sensors. A skewed or stuck ECT or IAT sensor will cause the calculated models to be inaccurate and may cause this DTC to run when it should not. Refer to **Temperature Versus Resistance - Intake Air Temperature Sensor** .
7. Verify the proper operation of the MAP sensor. A skewed MAP sensor will cause the BARO value to be inaccurate. Refer to **DTC P0106 (LF1)**.
8. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify the integrity of the entire air induction system by inspecting for the following conditions:
 - Any damaged components
 - Loose or improper installation
 - An air flow restriction
 - Any vacuum leaks
 - Water intrusion
 - In cold climates, inspect for any snow or ice buildup
 - Inspect the B75B MAF/IAT sensor element for contamination.
2. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.
3. Ignition OFF, all vehicle systems OFF, this may take up to 2 min, test for less than 5 ohms between the ground circuit terminal B and ground.

- If greater than the specified range, test the ground circuit for an open/high resistance.
- 4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal C and ground.
 - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.
- 5. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal A and ground.
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
- 6. Ignition OFF, connect the red lead of the **J 38522: Variable Signal Generator** to the signal circuit terminal A at the B75B MAF/IAT sensor harness connector. Connect the battery voltage supply to the B+, and the black lead to ground.
- 7. Set the **J 38522: Variable Signal Generator** signal switch to 5 V, the Frequency switch to 5K, and the Duty Cycle switch to Normal.
- 8. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950-5,050 Hz.
 - If the MAF Sensor parameter is not within the specified range, replace the K20 ECM.
- 9. If all other circuits test normal, test or replace the B75B MAF/IAT sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Engine Coolant Temperature Sensor Replacement (LF1)**
- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0102 OR P0103

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0102

Mass Air Flow (MAF) Sensor Circuit Low Frequency

DTC P0103

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0102	P0101	P0102	P0690	P0101, P0103
MAF Sensor Signal	P0102	P0102	P0102	P0102	P0101, P0103, P1101
Ground	-	P0102	P0102	-	P0102

TYPICAL SCAN TOOL DATA

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions Parameter Normal Range: 2,000-10,000 Hz			
Ignition 1 Voltage	0 Hz	0 Hz	-
MAF Sensor Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

CIRCUIT/SYSTEM DESCRIPTION

The mass air flow (MAF) sensor is integrated with the intake air temperature (IAT) sensor. The MAF sensor is an air flow meter that measures the amount of air entering the engine. The engine control module (ECM) uses the MAF sensor signal to provide the correct fuel delivery for all engine speeds and loads. A small quantity of air entering the engine indicates a deceleration or idle condition. A large quantity of air entering the engine indicates an acceleration or high load condition. The MAF/IAT sensor has the following circuits:

The ECM applies 5 V to the MAF sensor on the MAF sensor signal circuit. The sensor uses the voltage to produce a frequency based on the inlet air flow through the sensor bore. The frequency varies in a range of near 2,000 Hertz at idle to near 10,000 Hertz at maximum engine load.

CONDITIONS FOR RUNNING THE DTC

- The engine is running for greater than 1 s.
- The ignition 1 signal is greater than 8 V.
- The above conditions are met for greater than 1 s.
- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0102

The ECM detects that the MAF Sensor Signal parameter is less than 500 Hz for greater than 10 s.

P0103

The ECM detects that the MAF Sensor Signal parameter is greater than 14,500 Hz for greater than 10 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0102 and P0103 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0102 and P0103 are Type B DTCs.

DIAGNOSTIC AIDS

- Verify the integrity of the air induction system by inspecting for the following conditions:
 - Loose or improper installation
 - Damaged components
 - Any water intrusion in the induction system
 - Any contamination or debris on the sensing elements of the MAF sensor
- A steady or intermittent high resistance of 15 ohms or greater on the ignition 1 voltage circuit will cause the MAF sensor signal to be increased by as much as 60 g/s.
- Depending on the current ambient temperature, and the vehicle operating conditions, a MAF sensor signal circuit that is shorted to the IAT signal circuit will cause the MAF sensor signal to be skewed or erratic. Additionally, it may cause a rapid fluctuation in the IAT Sensor parameter.
- Verify that any electrical aftermarket devices are properly connected and grounded. Refer to **Checking Aftermarket Accessories**

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 38522:** Variable Signal Generator
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

- Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 2,000-3,900 Hz depending on the engine coolant temperature (ECT).
- A wide open throttle (WOT) acceleration from a stop should cause the MAF Sensor parameter on the scan tool to increase rapidly. This increase should be from 2-8 g/s at idle to greater than 180 g/s at the time of the 1-2 shift.
- Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify that the following DTCs are not set: P0685, P0690 or B1380.
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.
3. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms between the ground circuit terminal B and ground.
 - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal C and ground.
 - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance.
 - If the circuit tests normal and the fuse is open, test all the components connected to the circuit and repair or replace as necessary.
5. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal A and ground.
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Ignition OFF, connect the red lead of the **J 38522:** Variable Signal Generator to the signal circuit terminal A at the B75B MAF/IAT sensor harness connector. Connect the battery voltage supply to B+, and the black lead to ground.
7. Set the **J 38522:** Variable Signal Generator signal to 5 V, the Frequency to 5K, and the Duty Cycle to

Normal.

- 8. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950-5,050 Hz.
 - o If the MAF Sensor parameter is not within the specified range, replace the K20 ECM.
- 9. If all other circuits test normal, replace the B75B MAF/IAT sensor.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Mass Airflow Sensor with Intake Air Temperature Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0106 (LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0107, P0641	P0106, P0697	P0107	P0106, P0697	P0106, P0107
MAP Sensor Signal	P0107	P0106, P0107	P0107	P0108	P0106, P0107, P1101
Low Reference	-	P0106, P0108	P0106, P0108	-	P0106, P0108

TYPICAL SCAN TOOL DATA

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, transmission in Park or Neutral Parameter Normal Range: 20-48 kPa (2.9-7 psi), varies with altitude			

5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
MAP Sensor Signal	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
Low Reference	-	127 kPa (18.4 psi)	-

CIRCUIT DESCRIPTION

The intake flow rationality diagnostic provides the within-range rationality check for the mass air flow (MAF), manifold absolute pressure (MAP), and the throttle position sensors. This is an explicit model-based diagnostic containing 4 separate models for the intake system.

- The throttle model describes the flow through the throttle body and is used to estimate the MAF through the throttle body as a function of barometric pressure (BARO), throttle position, intake air temperature (IAT), and estimated MAP. The information from this model is displayed on the scan tool as the MAF Performance Test parameter.
- The first intake manifold model describes the intake manifold and is used to estimate MAP as a function of the MAF into the manifold from the throttle body and the MAF out of the manifold caused by engine pumping. The flow into the manifold from the throttle uses the MAF estimate calculated from the above throttle model. The information from this model is displayed on the scan tool as the MAP Performance Test 1 parameter.
- The second intake manifold model is identical to the first intake manifold model except that the MAF sensor measurement is used instead of the throttle model estimate for the throttle air input. The information from this model is displayed on the scan tool as the MAP Performance Test 2 parameter.
- The fourth model is created from the combination and additional calculations of the throttle model and the first intake manifold model. The information from this model is displayed on the scan tool as the Throttle Position Performance Test parameter.

The estimates of MAF and MAP obtained from this system of models and calculations are then compared to the actual measured values from the MAF, MAP, and the throttle position sensors and to each other to determine the appropriate DTC to fail. The following table illustrates the possible failure combinations and the resulting DTC or DTCs.

Scan Tool Diagnostic Test Results

MAF Performance Test	MAP Performance Test 1	MAP Performance Test 2	Throttle Position Performance Test	DTCs Passed	DTCs Failed
-	-	OK	OK	P0101, P0106, P0121, P1101	None
OK	OK	Malfunction	OK	P0101, P0106, P0121, P1101	None
Malfunction	OK	Malfunction	OK	P0106, P0121, P1101	P0101
OK	Malfunction	Malfunction	OK	P0101, P0121, P1101	P0106
Malfunction	Malfunction	Malfunction	OK	P0121, P1101	P0101, P0106

-	-	OK	Malfunction	P0101, P0106, P1101	P0121
OK	OK	Malfunction	Malfunction	P0101, P0106, P0121, P1101	None
Malfunction	OK	Malfunction	Malfunction	P0101, P0106, P0121	P1101
-	Malfunction	Malfunction	Malfunction	P0101, P0106, P0121	P1101

CONDITIONS FOR RUNNING THE DTC

- DTC P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335 or P0336 is not set.
- The engine speed is between 400-7,000 RPM.
- The IAT Sensor parameter is between -20° to +125°C (-4° to +257°F).
- The ECT Sensor parameter is between 69-127°C (156-260°F).
- This DTC runs continuously within the enabling conditions.

CONDITIONS FOR SETTING THE DTCS

The engine control module (ECM) detects that the actual measured airflow from MAF, MAP, and throttle position is not within range of the calculated airflow that is derived from the system of models for more than 2 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P0106 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0106 is a Type B DTC.

DIAGNOSTIC AIDS

- A wide open throttle (WOT) acceleration from a stop should cause the MAP sensor parameter on the scan tool to increase rapidly to near the BARO parameter at the time of the 1-2 shift.
- The BARO that is used by the ECM to calculate the air flow models is initially based on the MAP sensor at ignition ON. When the engine is running, the ECM will continually update the BARO value near WOT using the MAP sensor and a calculation. A skewed MAP sensor will cause the BARO value to be inaccurate.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 23738-A:** Mityvac
- **J 35555:** Metal Mityvac
- For equivalent regional tools, refer to Special Tools .

CIRCUIT/SYSTEM VERIFICATION

1. Verify that DTC P0641, P0651, or P0697 is not set.
 - If any of the DTCs are set, refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .
2. Verify that restrictions do not exist in the exhaust system. Refer to **Restricted Exhaust** .
3. Ignition OFF for 90 s, determine the current vehicle testing altitude.
4. Ignition ON, engine OFF, observe the scan tool BARO parameter. Compare the parameter to the **Altitude Versus Barometric Pressure** table. The BARO parameter should be within the specified range indicated in the table.
5. Use the scan tool and compare the MAP Sensor parameter to a known good vehicle, under various operating conditions. The reading should be within 5 kPa of the known good vehicle.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify the integrity of the entire air induction system by inspecting for the following conditions:
 - Any damaged components
 - Loose or improper installation
 - An air flow restriction
 - Any vacuum leak
 - Improperly routed vacuum hoses
 - In cold climates, inspect for any snow or ice buildup
 - Verify that restrictions do not exist in the MAP sensor port or vacuum source.
2. Ignition OFF for 90 s, disconnect the harness connector at the B74 MAP sensor.
3. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Verify the scan tool MAP Sensor parameter is less than 1 kPa (0.2 psi).
 - If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1. Verify the scan tool MAP Sensor parameter is greater than 127 kPa (18.4 psi).
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
7. If the circuits test normal, test or replace the B74 MAP sensor.

COMPONENT TESTING

NOTE: You must perform the Circuit/System Testing in order to verify the integrity of the MAP sensor circuits before proceeding with the Component Testing.

Skewed Signal Test

1. Using the following steps and referencing the table below will determine if the MAP sensor is skewed.
2. Ignition ON, engine OFF, observe the MAP Sensor scan tool parameter.
3. Use the observed MAP Sensor scan tool parameter that is closest to a value that is indicated in the first column.

THEN

4. Using the **J 23738-A**: Mityvac or the **J 35555**: Metal Mityvac to apply 5 in Hg of vacuum to the B74 MAP sensor, the parameter in the first column should decrease by 17 kPa (2.5 psi). The acceptable range

is indicated in the second column.

- Using the **J 23738-A: Mityvac** or the **J 35555: Metal Mityvac** to apply 10 in Hg of vacuum to the B74 MAP sensor, the parameter in the first column should decrease by 34 kPa (4.9 psi). The acceptable range is indicated in the third column.

Ignition ON, Engine OFF, MAP Sensor Parameter	MAP Sensor Parameter With 5 Inches of Vacuum Applied	MAP Sensor Parameter With 10 Inches of Vacuum Applied
100 kPa (14.5 psi)	79-87 kPa (11.5-12.6 psi)	62-70 kPa (9-10.2 psi)
95 kPa (13.8 psi)	74-82 kPa (10.7-11.9 psi)	57-65 kPa (8.3-9.4 psi)
90 kPa (13.1 psi)	69-77 kPa (10-11.2 psi)	52-60 kPa (7.5-8.7 psi)
80 kPa (11.6 psi)	59-67 kPa (8.6-9.7 psi)	42-50 kPa (6.1-7.3 psi)
70 kPa (10.2 psi)	49-57 kPa (7.1-8.3 psi)	32-40 kPa (4.7-5.8 psi)
60 kPa (8.7 psi)	39-47 kPa (5.7-6.8 psi)	22-30 kPa (3.2-4.4 psi)

Erratic Signal Test

- Ignition OFF, remove the B74 MAP sensor.
- Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 and the corresponding terminal of the B74 MAP sensor.
- Install a jumper wire between the low reference circuit terminal 2 of the B74 MAP sensor and ground.
- Install a jumper wire at terminal 3 of the B74 MAP sensor.
- Connect a DMM between the jumper wire from terminal 3 of the B74 MAP sensor and ground.
- Ignition ON, with the **J 23738-A: Mityvac** or **J 35555: Metal Mityvac**, slowly apply vacuum to the sensor while observing the voltage on the DMM. The voltage should vary between 0-5.2 V, without any spikes or dropouts.
 - If the voltage reading is erratic, replace the B74 MAP sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM replacement, setup, and programming

DTC P0107 OR P0108 (W/LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P0108, P0697	P0106, P0107	P0107	P0106, P0108, P0697	P0106, P0107
MAP Sensor Signal	P0107	P0106, P0107	P0107	P0106, P0108	P0106, P0107, P1101
Low Reference	-	P0106, P0108	P0108	-	P0106, P0108

TYPICAL SCAN TOOL DATA

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, transmission in Park or Neutral			
Parameter Normal Range: 20-48 kPa (2.9-7.0 psi), varies with altitude			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
MAP Sensor Signal	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
Low Reference	-	127 kPa (18.4 psi)	-

CIRCUIT DESCRIPTION

The manifold absolute pressure (MAP) sensor has a 5 V reference circuit, a low reference circuit, and a signal circuit. The engine control module (ECM) supplies 5 V to the MAP sensor on the 5 V reference circuit, and provides a ground for the low reference circuit. The MAP sensor provides a voltage signal to the ECM on the signal circuit relative to the intake manifold pressure changes.

CONDITIONS FOR RUNNING THE DTC

- DTC P0697 is not set.
- The engine is running.
- This DTC runs continuously within the enabling conditions.

CONDITIONS FOR SETTING THE DTC

P0107

The ECM detects that the MAP sensor voltage is less than 0.20 V for more than 5 s.

P0108

The ECM detects that the MAP sensor voltage is more than 4.80 V for more than 5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0107 and P0108 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0107 and P0108 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 23738-A:** Mityvac
- **J 35555:** Metal Mityvac
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Verify that DTC P0641, P0651, or P0697 is not set.
 - If any of the DTCs are set refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .
2. Ignition ON, observe the scan tool MAP Sensor parameter. The reading should be between 0.20-4.80 V.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF for 90 s, disconnect the harness connector at the B74 MAP sensor.
2. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Verify the scan tool MAP Sensor parameter is less than 1 kPa (0.2 psi).
 - If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1. Verify the scan tool MAP Sensor parameter is greater than 127 kPa (18.4 psi).
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If the circuits test normal, test or replace the B74 MAP sensor.

COMPONENT TESTING

NOTE: **You must perform the Circuit/System Testing in order to verify the integrity of the MAP sensor circuits before proceeding with the Component Testing.**

Erratic Signal Test

1. Ignition OFF, remove the B74 MAP sensor.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 and the corresponding terminal of the B74 MAP sensor.
3. Install a jumper wire between the low reference circuit terminal 2 of the B74 MAP sensor and ground.
4. Install a jumper wire at terminal 3 of the B74 MAP sensor.
5. Connect a DMM between the jumper wire from terminal 3 of the B74 MAP sensor and ground.
6. Ignition ON, with the **J 23738-A: Mityvac** or the **J 35555: Metal Mityvac**, slowly apply vacuum to the sensor while observing the voltage on the DMM. The voltage should vary between 0-5 V without any

- spikes or dropouts.
- If the voltage reading is erratic, replace the B74 MAP sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM replacement, setup, and programming

DTC P0112, P0113, OR P0114

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0112

Intake Air Temperature (IAT) Sensor Circuit Low Voltage

DTC P0113

Intake Air Temperature (IAT) Sensor Circuit High Voltage

DTC P0114

Intake Air Temperature (IAT) Sensor Circuit Intermittent

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
IAT Sensor Signal	P0112, P0114	P0113, P0114, P0112	P0113, P0114	P0114
Low Reference	-	P0113, P0114	P0113, P0114	P0114

TYPICAL SCAN TOOL DATA

IAT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running			
Parameter Normal Range: Varies with ambient temperature			

IAT Sensor Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

CIRCUIT/SYSTEM DESCRIPTION

The intake air temperature (IAT) sensor is a variable resistor. It is integrated into the mass air flow (MAF) sensor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 V to the IAT signal circuit, and a ground for the IAT low reference circuit.

CONDITIONS FOR RUNNING THE DTC

P0112

- The engine run time is greater than 1 s.
- The DTC runs continuously when the above conditions are met.

P0113

- The engine run time is greater than 1 s.
- The DTC runs continuously when the above conditions are met.

P0114

- The ignition is ON or the engine is running.
- This DTC runs continuously within the enabling conditions.

CONDITIONS FOR SETTING THE DTC

P0112

The ECM detects that the IAT sensor signal is warmer than 149°C (300°F) for greater than 7 s.

P0113

The ECM detects that the IAT sensor signal is colder than -60°C (-76°F) for greater than 7 s.

P0114

The ECM detects that the IAT sensor signal is intermittent or has abruptly changed for greater than 4 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0112, P0113, and P0114 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

- DTCs P0112, P0113, and P0114 are Type B DTCs.
- The ECM commands the cooling fans ON.

DIAGNOSTIC AIDS

- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor will gradually increase the scan tool IAT Sensor parameter. This is due to the heat that is generated by the mass air flow (MAF) sensor heating elements
- Depending on the ambient temperature, an IAT sensor signal circuit or low reference circuit that is shorted to the MAF sensor signal circuit can cause a DTC P0113 and/or P0114 to set. This condition causes a rapid fluctuation in the IAT Sensor parameter.
- An IAT sensor signal circuit that is shorted to the MAF sensor ignition circuit can cause a DTC P0113 and/or P0114 to set.
- A MAF sensor ground circuit that is open will cause a DTC P0113 and/or a DTC P0114 to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine running, observe the scan tool IAT Sensor Signal parameter. The reading should be between -40

to +149°C (-40 to +300°F) depending on the current ambient temperature and the vehicle operating conditions.

2. Operate the vehicle within the Conditions for Running the DTC to verify that the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: All electrical components and accessories must be turned OFF and allowed to power down.

1. Ignition OFF, disconnect the harness connector at the B75B MAF/IAT sensor.
2. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes, test for less than 5 ohms between the low reference circuit terminal D and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify the scan tool IAT Sensor Signal parameter is colder than -39°C (-38°F).
 - If warmer than the specified range, test the signal circuit terminal E for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: If the fuse in the jumper wire opens, the signal circuit is shorted to voltage and the sensor may be damaged.

4. Install a 3 A fused jumper wire between the signal circuit terminal E and ground. Verify the scan tool IAT parameter is warmer than 149°C (300°F).
 - If colder than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B75B MAF/IAT sensor.

COMPONENT TESTING

Measure and record the resistance of the IAT sensor at various ambient temperatures, then compare those measurements to the **Temperature Versus Resistance - Intake Air Temperature Sensor** table.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0116 (LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0116

Engine Coolant Temperature (ECT) Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118	P0118*	P0116*
Low Reference	-	P0118	P0118*	P0116*
*Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+				

TYPICAL SCAN TOOL DATA

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop. Parameter Normal Range: -39 to +142°C (-38 to +288°F) Varies with coolant temperature.			
ECT Sensor Signal	143°C (289°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+			

CIRCUIT DESCRIPTION

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT signal circuit and supplies a ground to the low reference circuit. The ECM monitors the mutual performance of the ECT and the intake air temperature (IAT) signals. The ECM monitors the warm up and cool down behavior of the sensors, after a vehicle driven at operating temperature is shut down. If the ECM detects that the ECT is not with in a predetermined range of IAT after a long soak, or the ECT and IAT are not within a range of each other, as compared to a previous cold start, this DTC sets.

The following table illustrates the difference between temperature, resistance, and voltage:

ECT	ECT Resistance	ECT Signal Voltage
Cold	High	High
Warm	Low	Low

CONDITIONS FOR RUNNING THE DTC

Condition 1

- Before the ECM can report DTC P0116 failed, DTC P0101 must run and pass.
- DTC P0112, P0113, P0117, P0118 or P2610 is not set.
- The engine run time of the previous ignition cycle was greater than 10 min.
- The calculated engine cool down of the previous test was greater than 50°C (120°F).
- The ignition was OFF for greater than 330 min after the previous engine shut down.
- The accumulated air mass of the previous ignition cycle was greater than 6,000 grams.
- The DTC runs once an ignition cycle when the above conditions are met for greater than 35 s.

Condition 2

- Before the ECM can report DTC P0116 failed, DTC P0101 must run and pass.
- DTCs P0112, P0113, P0117, P0118 are not set.
- The ECT at the previous engine shut down is warmer than 82°C (180°F).
- The block heater is not detected.
- The ignition was OFF for greater than 330 min after the previous engine shut down.
- DTC runs once an ignition cycle when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM determines the difference between the ECT and IAT at ignition ON is not within 14°C (25°F) of the difference recorded during a previous ignition cycle, when the enable conditions were met.

OR

- The ECM determines the IAT at ignition ON is within a calibrated range of the ECT and IAT recorded during a previous ignition cycle, but the ECT is not within 14°C (25°F) of the calibrated range.

ACTION TAKEN WHEN THE DTC SETS

DTC P0116 is a Type A/B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0116 is a Type A/B DTC.

DIAGNOSTIC AIDS

- Test the ECT and the IAT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a DTC or a driveability condition. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** and **Temperature Versus Resistance -**

Intake Air Temperature Sensor .

- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5° F).
- After starting a cold engine, the ECT sensor temperature should rise steadily, then stabilize after the thermostat opens.
- High resistance in the circuits of either the ECT or IAT sensor could set a DTC.
- A short to ground or voltage through a conductive material or fluid could set this DTC. Inspect the ECT sensor for evidence of engine coolant leaking into the connector body.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Verify that DTC P0117, P0118, or P0119 is not set.
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Inspect the engine coolant level. Verify that the cooling system is operating correctly.
 - If you suspect a condition with engine cooling system, refer to **Loss of Coolant** .
3. Ignition ON, verify the P0116 Freeze Frame Start Up ECT and the Start Up IAT parameters are within 14°C (25°F).
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure

Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.

CAUTION: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

2. Test for less than 5 ohms between the low reference circuit terminal A and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify that the scan tool ECT sensor parameter is at -40°C (-40°F).
 - If warmer than the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

4. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal A and the low reference circuit terminal B. Verify the ECT sensor parameter is warmer than 142°C (288°F).
 - If colder than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B34 engine coolant temperature (ECT) sensor.

NOTE: A thermometer can be used to test the sensor off the vehicle.

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance - Engine Coolant Temperature Sensor table and verify that the resistance is within 5 % of the specification.
 - If not within the specified range, replace the B34 ECT sensor.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Coolant Temperature Sensor Replacement (LF1)

- **Control Module References** for ECM replacement, setup, and programming

DTC P0117 OR P0118 (W/LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0117

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118	P0118*	P0116
Low Reference	-	P0118	P0118*	P0116
* Sensor or ECM damage may occur if the circuit is shorted to B+				

TYPICAL SCAN TOOL DATA

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop.			
Parameter Normal Range: -39 to 142°C (-38 to 288°F) Varies with coolant temperature.			
ECT Sensor Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
* Internal ECM or ECT sensor damage may occur if the circuit is shorted to B+			

CIRCUIT DESCRIPTION

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT signal circuit and supplies a ground to the low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

ECT	ECT Resistance	ECT Signal Voltage
Cold	High	High
Warm	Low	Low

CONDITIONS FOR RUNNING THE DTC

P0117

- The engine is operating.
- The start up intake air temperature (IAT) is less than 72°C (161°F).

OR

- The start up intake air temperature (IAT) is greater than 72°C (161°F).
- The engine run time is greater than 59 s.
- The DTC runs continuously once the above conditions are met.

P0118

- The ignition is ON or the engine is operating.
- The DTC runs continuously once the above condition is met.

CONDITIONS FOR SETTING THE DTC

P0117

The ECM detects that the ECT is greater than 140°C (284°F) for greater than 1 s or a cumulative of 10 s.

P0118

The ECM detects that the ECT is less than -39°C (-38°F) for greater than 1 s or a cumulative of 10 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P0117 and P0118 are Type B DTCs.

The ECM may activate the Cooling Fans at high speed.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0117 and P0118 are Type B DTCs.

DIAGNOSTIC AIDS

- Test the ECT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a DTC or a driveability condition. Refer to **Temperature Versus**

Resistance - Engine Coolant Temperature Sensor

- If the vehicle has sat overnight, the IAT sensor and the ECT sensor values should display within 3°C (5°F).
- After starting a cold engine, the ECT sensor temperature should rise steadily, then stabilize after the thermostat opens.
- High resistance in the circuits of either the ECT or IAT sensor could set a DTC.
- DTC's must be cleared before Engine Cooling Fan's are Commanded Off.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling for 1 min. Observe the DTC information with a scan tool. DTCs P0117 and P0118 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.

CAUTION: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

2. Ignition Off all vehicle systems Off, this may take up to 2 minutes. Test for less than 5 ohms between the low reference circuit terminal A and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance, or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify that the scan tool ECT sensor parameter is at -40°C (-40°F).
 - If greater than the specified value, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

4. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal A and the low reference circuit terminal B. Verify the ECT sensor parameter is greater than 142°C (288°F).
 - If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B34 engine coolant temperature (ECT) sensor.

NOTE: A thermometer can be used to test the sensor off the vehicle.

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance - Engine Coolant Temperature Sensor table and verify that the resistance is within 5 % of the specification.
 - If not within the specified range, replace the B34 ECT sensor.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Engine Coolant Temperature Sensor Replacement (LF1)
- Control Module References for ECM replacement, setup, and programming

DTC P0121-P0123, P0222, P0223, OR P2135 (LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0121

Throttle Position Sensor Performance

DTC P0122

Throttle Position Sensor 1 Circuit Low Voltage

DTC P0123

Throttle Position Sensor 1 Circuit High Voltage

DTC P0222

Throttle Position Sensor 2 Circuit Low Voltage

DTC P0223

Throttle Position Sensor 2 Circuit High Voltage

DTC P2135

Throttle Position Sensors 1-2 Not Plausible

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5-Volt Reference	P06A3	-	P0122, P0222,	P06A3	P0121
TP Sensor 1 Signal	P0122	P2119, P2135, P2176	P0122	P0123, P2135	P0121, P2135
TP Sensor 2 Signal	P0222	P2135	P0223	P0223, P2135	P0121, P2135
Low Reference	-	-	P0122, P0223	-	-

TYPICAL SCAN TOOL DATA

TP Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is idling. Parameter Normal Range: TP Sensor 1 3.0-4.0 V			
5-Volt Reference	0.00 V	0.00 V	4-5 V
TP Sensor 1 Signal	0.00 V	0.00 V	5.00 V
Low Reference	-	4-5 V	-

TP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is idling. Parameter Normal Range: TP Sensor 2 1.4-2.4 V			
5-Volt Reference	0-0.5 V	0-0.5 V	3-5 V
TP Sensor 2 Signal	0.00 V	5.00 V	5.00 V
Low Reference	-	5.00 V	-

CIRCUIT/SYSTEM DESCRIPTION

The throttle body assembly contains 2 throttle position (TP) sensors. The TP sensors are mounted to the throttle body assembly and are not serviceable. The TP sensors provide a signal voltage that changes relative to throttle blade angle. The engine control module (ECM) supplies the TP sensors with a common 5-volt reference circuit, a common low reference circuit, and 2 independent signal circuits.

The TP sensors have opposite functionality. TP sensor 1 signal voltage decreases and TP sensor 2 signal voltage increases as the accelerator pedal increases to wide open throttle (WOT).

CONDITIONS FOR RUNNING THE DTC

P0121

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0335, or P0336 is not set.
- The engine speed is between 400-7,000 RPM.
- The engine coolant temperature (ECT) is between 69-127°C (156-260°F).
- The intake air temperature (IAT) is between -20 to +125°C (-4 to +257°F).
- The DTC runs continuously when the above conditions are met.

P0122, P0123, P0222, P0223

- DTC P06A3 is not set.
- The ignition is ON, or the engine is running.
- The engine is not operating in reduced power mode.
- The ignition voltage is greater than 6 V.
- The DTCs runs continuously when the above condition are met.

P2135

- DTCs P0121, P0122, P0123, P0222, P0223, or P06A3 are not set.
- The ignition is ON, or the engine is running.
- The engine is not operating in reduced power mode.
- The ignition voltage is greater than 6 V.
- The DTCs runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0121

The ECM detects that the TP sensor 1 voltage is stuck in range for less than 1 s.

P0122

The ECM detects that the TP sensor 1 voltage is less than 0.3 V for less than 1 s.

P0123

The ECM detects that the TP sensor 1 voltage is greater than 4.8 V for less than 1 s.

P0222

The ECM detects that the TP sensor 2 voltage is less than 0.3 V for less than 1 s.

P0223

The ECM detects that the TP sensor 2 voltage is greater than 4.6 V for less than 1 s.

P2135

The ECM detects that TP sensor 1 and TP sensor 2 disagree greater than 7-10 percent for less than 1 s.

ACTION TAKEN WHEN THE DTC SETS

P0121

- DTC P0121 is a type B DTC
- The ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power mode.

P0122, P0123, P0222, P0223, or P2135

- DTC P0122, P0123, P0222, P0223, and P2135 are type A DTCs
- The ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power

mode.

CONDITIONS FOR CLEARING THE DTC

- DTC P0121 is a type B DTC.
- DTCs P0122, P0123, P0222, P0223 and P2135 is a type A DTC.

DIAGNOSTIC AIDS

A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify DTC P06A3 is not set.
 - If the DTC is set, refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .
2. Ignition ON, observe both TP Sensor voltage parameters with a scan tool. Verify the scan tool TP sensor

parameters are between 1.0-4.0 V.

3. Observe the scan tool TP Sensor 1 and 2 Agree/Disagree parameter while performing the following tests:
 - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
 - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.

The TP Sensor 1 and 2 Agree/Disagree parameter should display Agree.

4. Observe the DTC Information with a scan tool. DTCs P0121, P0122, P0123, P0222, P0223, and P2135 should not set.
5. Observe both TP Sensor percentage parameters while quickly pressing the accelerator pedal from a closed throttle to WOT. Both TP Sensor percentage parameters should change.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the Q38 throttle body assembly.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 ohms between the low reference circuit terminal C and ground.
 - If greater than the specified range, test the low reference circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5-volt reference circuit terminal E and ground.
 - If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Test for less than 1 V between the TP sensor 1 signal circuit terminal D and ground.
 - If greater than specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Test for 4.8-5.2 V between the TP sensor 2 signal circuit terminal F and ground.
 - If less than specified range, test the signal circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Install a 3 A fused jumper wire between TP sensor 1 signal circuit terminal D and the 5-volt reference circuit terminal E. Verify the scan tool TP sensor 1 voltage parameter is greater than 4.8 V.
 - If less than the specified range, test the signal circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
7. If all circuits test normal, test or replace the Q38 throttle body assembly.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Throttle Body Assembly Replacement (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0128 (W/LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

CIRCUIT DESCRIPTION

The engine control module (ECM) monitors the temperature of the engine coolant for engine control and as an enabling criteria for some diagnostics. The amount of air flow into an engine is proportional to the amount of heat an engine generates. The ECM monitors the amount of air flow into the engine to calculate engine coolant temperature (ECT). The ECM uses the calculated temperature to determine if the engine has warmed up to the closed loop temperature or to the thermostat regulating temperature. If the coolant temperature does not increase normally or does not reach the closed loop temperature, diagnostics that use the ECT as enabling criteria, may not run when expected.

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P0128 failed, DTC P0117 and P0118 must run and pass.
- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0114, P0116, P0117, P0118, P0121, P0122, P0123, P0502, or P0503 is not set.
- The Engine has not run for greater than 30 minutes.
- The Engine run time from a cold start is greater than 2 minutes.
- The ECT is colder than 50°C (122°F) at start up.
- The vehicle speed is greater than 8 km/h (5 mph) for more than 2.4 km/h (1.5 miles).
- The Ethanol content of the fuel is less than 87 percent.
- DTC P0128 runs continuously once the above conditions have been met for approximately 15 min.

OR

- DTCs P0116, P0117, or P0118 is not set.
- The block heater is not detected.
- DTC P0128 runs continuously once the above conditions have been met for approximately 8 min.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the actual engine coolant temperature is 11°C (20°F) colder than the calculated thermostat regulating temperature of 89°C (192°F), for greater than 4 s or for a cumulative of 30 s.

OR

- The ECM detects that the actual engine coolant temperature is 10°C (18°F) colder than the calculated ECT for greater than 1 s or a cumulative of 10 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P0128 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0128 is a Type B DTC.

DIAGNOSTIC AIDS

An engine that soaks for about 8 h will help diagnosis the condition. After the cold soak, operate the vehicle at highway speeds for 20 min while monitoring the scan tool Calculated ECT - Thermostat parameter. If there is a condition, the calculated temperature will be 10°C (18°F) warmer than the actual engine coolant temperature.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Verify that the engine coolant level is correct.
 - If the engine coolant is not at the correct level, refer to **Loss of Coolant**.
2. Verify that the engine coolant temperature is at the normal operating temperature.
 - If the engine coolant temperature is colder than the normal operating temperature, refer to **Thermostat Diagnosis**.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.

CAUTION: Do NOT use a test lamp to test the continuity of the circuit. Damage to the control module may occur due to excessive current draw.

NOTE: The control module or the sensor may be damaged if the circuit is shorted to battery positive voltage.

2. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - If greater than specified value, test the circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, observe the scan tool the ECT sensor parameter. Verify that the ECT sensor parameter is at -40°C (-40°F).
 - If warmer than the specified value, test the signal circuit for a short to ground. If the circuit/connections test normal, replace the K20 ECM.

NOTE: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the ECT sensor may be damaged.

4. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the scan tool ECT sensor parameter is warmer than 142°C (288°F).
 - If colder than the specified value, test the signal circuit for an open/high resistance or for a short to voltage. If the circuit/connections test normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B34 ECT sensor.

COMPONENT TESTING

1. Ignition OFF, disconnect the harness connector at the B34 ECT sensor.

NOTE: **A thermometer can be used to test the sensor off the vehicle.**

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table and verify that the resistance is within 5 % of the specification.
 - If not within the specified range, replace the B34 ECT sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Temperature Sensor Replacement (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, P0158, P2A00, P2A01, P2A03, OR P2A04 (LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0131

HO2S Circuit Low Voltage Bank 1 Sensor 1

DTC P0132

HO2S Circuit High Voltage Bank 1 Sensor 1

DTC P0137

HO2S Circuit Low Voltage Bank 1 Sensor 2

DTC P0138

HO2S Circuit High Voltage Bank 1 Sensor 2

DTC P0151

HO2S Circuit Low Voltage Bank 2 Sensor 1

DTC P0152

HO2S Circuit High Voltage Bank 2 Sensor 1

DTC P0157

HO2S Circuit Low Voltage Bank 2 Sensor 2

DTC P0158

HO2S Circuit High Voltage Bank 2 Sensor 2

DTC P2A00

HO2S Circuit Closed Loop Performance Bank 1 Sensor 1

DTC P2A03

HO2S Circuit Closed Loop Performance Bank 2 Sensor 1

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
	P0030,	P0030, P0036, P0050,	P0030, P0036, P0050,		

HO2S Heater Voltage Supply	P0036, P0050, P0056, P0132, P0135, P0138, P0141, P0152, P0155, P0158, P0161, *	P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161
HO2S Heater Control	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161
* Opens Fuse					

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage, HO2S Sensor 2 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0.00 V	Approximately 1.27 V	Approximately 1.27 V
HO2S Low Signal	0.00 V	Approximately 1.27 V	Approximately 1.27 V

CIRCUIT/SYSTEM DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range

of 0-1,275 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

P0131, P0137, P0151, or P0157

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is operating in Closed Loop.
- The Ignition 1 voltage is between 10-32 V.
- The fuel level is greater than 10 %.
- The throttle position (TP) is between 3-70 %.
- The DTCs run continuously when the above conditions are met for 2 s.

P0132, P0138, P0152, or P0158

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is operating in Closed Loop.
- The Ignition 1 voltage is between 10-32 V.
- The fuel level is greater than 10 %.
- The throttle position (TP) is between 0-70 %.
- The DTCs run continuously when the above conditions are met for 3 s.

P2A00 or P2A03

- DTCs P0030, P0036, P0053, P0054, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P0140, P0141, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is running.

- The system voltage is between 10-32 V.
- The ECT Sensor parameter is more than 0°C (32°F).
- DTCs P2A00 and P2A03 run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0131, P0137, P0151, or P0157

- The ECM detects that the HO2S voltage is less than 50 mV.
- The DTCs set within 50 s when the above condition is met.

P0132, P0138, P0152, or P0158

- The ECM detects that the HO2S voltage is greater than 1,050 mV.
- The DTCs set within 50 s when the above condition is met.

P2A00 or P2A03

- The ECM detects that the Fuel Control Loop Status parameter is open.
- DTCs P2A00 and P2A03 set within 30 s when the above condition is met.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0131, P0132, P0137, P0138, P0151, P0152, P0158, P2A00 and P2A03 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0131, P0132, P0137, P0138, P0151, P0152, P0158, P2A00 and P2A03 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Heated Oxygen Sensor Wiring Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify no B52 HO2S heater DTCs are set.
 - If a B52 HO2S heater DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine running, observe the appropriate scan tool B52 HO2S voltage parameter. The reading should be within the range of 50-1,050 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the appropriate B52 HO2S harness connector.
2. Ignition ON, observe the appropriate scan tool HO2S voltage parameter. The parameter should display 1.27 V.
 - If less than the specified range, test the high and low signal circuits for a short to ground. If both signal circuit test normal, replace the K20 ECM.
3. Ignition ON, test for 2.5-3.0 V between the high signal circuit terminal B and ground.
 - If less than the specified range, test the high signal circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the high signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition OFF, connect a 3 A fused jumper wire between the high signal circuit terminal B and the low signal circuit terminal A.

NOTE: **The low signal circuit is tied to a pull-up circuit within the ECM. A voltage of 0.90-1.10 V on the low signal circuit is normal.**

5. Ignition ON, verify the scan tool HO2S parameter displays 0.0 V.
 - If greater than the specified range, test the low signal circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, OR P1153 (LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0133

HO2S Slow Response Bank 1 Sensor 1

DTC P013A

HO2S Slow Response Rich to Lean Bank 1 Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Bank 1 Sensor 2

DTC P013C

HO2S Slow Response Rich to Lean Bank 2 Sensor 2

DTC P013D

HO2S Slow Response Lean to Rich Bank 2 Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Bank 1 Sensor 2

DTC P013F

HO2S Delayed Response Lean to Rich Bank 1 Sensor 2

DTC P014A

HO2S Delayed Response Rich to Lean Bank 2 Sensor 2

DTC P014B

HO2S Delayed Response Lean to Rich Bank 2 Sensor 2

DTC P0153

HO2S Slow Response Bank 2 Sensor 1

DTC P1133

HO2S Insufficient Switching Bank 1 Sensor 1

DTC P1153

HO2S Insufficient Switching Bank 2 Sensor 1

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
	P0030,	P0030, P0036, P0050,	P0030, P0036, P0050,		

HO2S Heater Voltage Supply	P0036, P0050, P0056, P0132, P0135, P0138, P0141, P0152, P0155, P0158, P0161, *	P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161
HO2S Heater Control	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161
* Opens Fuse					

CIRCUIT/SYSTEM DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,275 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

P0133, P0153, P1133, or P1153

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine coolant temperature (ECT) is greater than 71°C (159°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F)
- The ignition 1 voltage is between 10-32 V.
- The fuel level is greater than 10 %.
- The engine run time is greater than 60 s.
- The engine speed is between 1,000-3,000 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 15-55 g/s.
- The fuel system is in Closed Loop.
- The throttle position (TP) is greater than 5 %.
- The DTCs run once per drive cycle when the above conditions are met.

P013A P013C, P013E, or P014A

- Before the ECM can report DTC P013A, or P013C failed, DTCs P013E, P014A, P2270, and P2272 must run and pass.
- Before the ECM can report DTC P013E, or P014A failed, DTCs P2270 and P2272 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The ignition 1 voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10 %.
- The engine run time is equal to or greater than 5 min.
- The accelerator pedal (APP) is steady.
- The torque converter clutch (TCC) is applied.
- The DTCs run once per ignition cycle, during decel fuel cut-off (DFCO), when the above conditions are met.

P013B P013D, P013F, or P014B

- Before the ECM can report DTC P013B, or P013D failed, DTCs P013A, P013C, P013E, P013F, P014A, P014B, P2270, P2271, P2272, and P2273 must run and pass.
- Before the ECM can report DTC P013F, or P014B failed, DTCs P013A, P013C, P013E, P014A, P2270,

P2271, P2272, and P2273 must run and pass.

- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The ignition 1 voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10 %.
- The engine run time is equal to or greater than 5 min.
- The DTCs run once per ignition cycle when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0133 or P0153

- The ECM detects that the HO2S 1 rich-to-lean or lean-to-rich average response time is greater than a calibrated value.
- The DTCs set within 60 s when the above condition is met.

P013A or P013C

The ECM detects that the accumulated mass air flow monitored during rich-to-lean transitions between 450-150 mV is greater than 75 grams.

P013B or P013D

The ECM detects that the accumulated mass air flow monitored during lean-to-rich transitions between 350-650 mV is greater than 75 grams.

P013E or P014A

The ECM detects that the O2 sensor voltage has not decreased below 450 mV within 42 grams of accumulated air flow.

P013F or P014B

The ECM detects that the O2 sensor voltage has not increased above 350 mV within 200 grams of accumulated air flow.

P1133 or P1153

- The ECM detects that the HO2S 1 rich-to-lean counts, or the lean-to-rich counts are less than a calibrated value.
- The DTCs set within 60 s when the above condition is met.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, and P1153 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, and P1153 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Heated Oxygen Sensor Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify no B52 HO2S heater DTCs are set.
 - If a B52 HO2S heater DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine running, observe the appropriate scan tool B52 HO2S voltage parameter. The reading should be within the range of 50-1,050 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify none of the following conditions exist:
 - Lean or rich fuel injectors-Refer to **Fuel Injector Solenoid Coil Test** .
 - Water intrusion in the B52 HO2S harness connector
 - Low or high fuel system pressure-Refer to **Fuel System Diagnosis** .
 - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
 - Fuel saturation of the evaporative emission (EVAP) canister
 - Exhaust leaks near the B52 HO2S
 - Engine vacuum leaks
 - Engine oil consumption-Refer to **Oil Consumption Diagnosis** .
 - Engine coolant consumption-Refer to **Loss of Coolant** .
 - If you find any of the above conditions, repair as necessary.
2. If all conditions test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to **Heated Oxygen Sensor Resistance Learn Reset Caution** .

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0134, P0140, P0154, OR P0160 (LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0134

HO2S Circuit Insufficient Activity Bank 1 Sensor 1

DTC P0140

HO2S Circuit Insufficient Activity Bank 1 Sensor 2

DTC P0154

HO2S Circuit Insufficient Activity Bank 2 Sensor 1

DTC P0160

HO2S Circuit Insufficient Activity Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Heater Voltage Supply	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0141, P0152, P0155, P0158, P0161, *	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160,	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160,	P0690	P0135, P0141, P0155, P0161

		P0161	P0161		
HO2S Heater Control	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161

* Opens Fuse

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage, HO2S Sensor 2 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0.00 mV	Approximately 1.27 V	Approximately 1.27 V
HO2S Low Signal	0.00 mV	Approximately 1.27 V	Approximately 1.27 V

CIRCUIT/SYSTEM DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,275 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The ignition 1 voltage is between 10-32 V.
- The engine run time is greater than 150 s.
- The fuel system is in Closed Loop.
- The DTCs run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0134 or P0154

- The ECM detects that the HO2S 1 voltage is between 350-550 mV.
- The HO2S heater warm-up cycle is complete.
- The DTCs set within 15 s when the above conditions are met.

P0140 or P0160

- The ECM detects that the HO2S 2 voltage is not varying.
- The HO2S heater warm-up cycle is complete.
- The DTCs set within 15 s when the above conditions are met.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0134, P0140, P0154, and P0160 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0134, P0140, P0154, and P0160 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Heated Oxygen Sensor Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify no B52 HO2S heater DTCs are set.
 - If a B52 HO2S heater DTC is set, refer to Diagnostic Trouble Code (DTC) List - Vehicle .
2. Engine running, observe the appropriate scan tool B52 HO2S voltage parameter. The reading should be within the range of 50-1,050 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: All modules must be powered down or misdiagnosis may result.

1. Ignition OFF, disconnect the appropriate B52 HO2S harness connector.
2. Ignition ON, observe the appropriate scan tool HO2S voltage parameter. The parameter should display 1.27 V.
 - If less than the specified range, test the high and low signal circuits for a short to ground. If both signal circuits test normal, replace the K20 ECM.
3. Ignition ON, test for 2.5-3.0 V between the high signal circuit terminal B and ground.
 - If less than the specified range, test the high signal circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the high signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition OFF, connect a 3 A fused jumper wire between the high signal circuit terminal B and the low signal circuit terminal A.

NOTE: The low signal circuit is tied to a pull-up circuit within the ECM. A voltage of 0.90-1.10 V on the low signal circuit is normal.

5. Ignition ON, verify the scan tool HO2S parameter displays 0.0 V.

- If greater than the specified value, test the low signal circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Verify none of the following conditions exist:
- Water intrusion in the HO2S harness connector
 - Low or high fuel system pressure-Refer to **Fuel System Diagnosis** .
 - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
 - Fuel saturation of the evaporative emission (EVAP) canister
 - Exhaust leaks near the HO2S
 - Engine vacuum leaks
- If any of the above conditions exist, repair as necessary. If all circuits test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to **Heated Oxygen Sensor Resistance Learn Reset Caution** .

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LF1)**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0171, P0172, P0174, OR P0175 (LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0171

Fuel Trim System Lean Bank 1

DTC P0172

Fuel Trim System Rich Bank 1

DTC P0174

Fuel Trim System Lean Bank 2

DTC P0175

Fuel Trim System Rich Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. Fuel delivery is controlled differently during Open Loop and Closed Loop (CL). During Open Loop, the ECM determines fuel delivery based on sensor signals without heated oxygen sensor (HO2S) input. During CL, the ECM adds HO2S inputs and level of purge to calculate the short and long term fuel trim (FT) adjustments. If the HO2S indicates a lean condition, the fuel trim values will be above 0 %. If the HO2S indicates a rich condition, the FT values will be below 0 %. The short term FT values change rapidly in response to the HO2S voltage signals. The long term FT makes coarse adjustments in order to maintain an optimum air/fuel ratio. A block of cells contain information arranged in combinations of engine RPM and engine load for a full range of vehicle operating conditions. The long term FT diagnostic is based on an average of cells currently being used. The ECM selects the cells based on the engine speed and load. The FT diagnostic will conduct a test to determine if a rich failure actually exists or if excessive vapor from the evaporative emission (EVAP) canister is causing a rich condition.

If the ECM detects an excessively lean condition, DTC P0171 or P0174 sets. If the ECM detects an excessively rich condition, DTC P0172 or P0175 sets.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0178, P0179, P0201-P0208, P0300, P0301-P0304, P0401, P0403-P0406, P0411, P042E, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0506, P0507, P2227-P2230, P2269, P2440, P2444 are not set.
- The engine is in Closed Loop status.
- The engine coolant temperature (ECT) is between -38 and +150°C (-36 and +302°F).
- The intake air temperature (IAT) is between -38 and +150°C (-36 and +302°F).
- The manifold absolute pressure (MAP) is between 5-255 kPa (1.45-37 psi).
- The vehicle speed is less than 134 km/h (83 mph).
- The engine speed is between 400-6,600 RPM.
- The mass air flow (MAF) is between 0.5-510 g/s.
- The barometric pressure (BARO) is more than 70 kPa (10.2 psi).
- The fuel level is more than 10 %.
- This diagnostic runs continuously when the above conditions have been met.

CONDITIONS FOR SETTING THE DTC

- The average long term FT weighted average value is more or less than a calibrated value.

- The above condition is present for approximately 3 min after the Conditions for Running the DTC have been met.

ACTION TAKEN WHEN THE DTC SETS

The ECM records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the ECM stores this information in the Failure Records. If the diagnostic reports a failure on the second ignition cycle the ECM records the operating conditions at the time of the failure. The ECM writes the operating conditions to the Freeze Frame and updates the Failure Records. The ECM illuminates the malfunction indicator lamp (MIL) when it detects the same fuel trim failure during 2 consecutive trips.

CONDITIONS FOR CLEARING THE MIL/DTC

- The ECM turns OFF the malfunction indicator lamp (MIL) at the beginning of the fourth ignition cycle, after 3 ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC and related Freeze Frame data clears after 40 warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

REFERENCE INFORMATION

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Disregard any transmission symptoms, antilock brake system (ABS) indicators, and traction control system (TCS) indicators until any fuel trim faults are repaired. A fuel trim fault may cause default actions such as harsh shifts and illumination of the ABS/TCS indicators.
2. E85 compatible engine only-Over estimation of the ethanol content will result in a rich shift of fuel trim values, and under-estimation will result in a lean shift of fuel trim values. A fuel trim DTC may set if the learned alcohol content, Fuel Alcohol Content parameter on the scan tool, is different than the measured alcohol content in the vehicle such that fuel trim values exceed failure threshold values.
3. Verify that other DTCs are not set.
 - If any DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
4. Allow the engine to reach operating temperature. With the engine running, observe the HO2S parameter

with a scan tool. The HO2S value should vary from approximately 40 mV to approximately 900 mV, and respond to fueling changes.

NOTE: EVAP purge enablement may cause the FT to be momentarily outside the normal range.

5. The normal Short Term FT parameter should be between +10 % and -10 % with near 0 % the optimum, with the engine running at operating temperature.
6. The Long Term FT parameter should be between +10 % and -10 %, with near 0 % the optimum, with the engine running at operating temperature.
7. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

P0171 or P0174

Allow the engine to reach operating temperature. With the engine running, observe the affected Long Term FT parameter with a scan tool. The value should be less than approximately 20 % with the engine running at operating temperature.

- If the value is not less than 20 %, inspect for the following:
 - With the ignition ON and the engine OFF, observe the manifold absolute pressure (MAP) sensor parameter. The MAP sensor pressure should be within the range specified for your altitude. Refer to **Altitude Versus Barometric Pressure** .
 - Refer to **DTC P0106 (LF1)** if the MAP sensor does not indicate the correct barometric pressure.
 - With the engine idling, observe the mass air flow (MAF) sensor parameter. The MAF sensor parameter should be within 2-6 g/s at idle.
 - Refer to **DTC P0101** or **DTC P0102 or P0103** if the MAF sensor parameter is not within 2-6 g/s at idle.
- Vacuum hoses for splits, kinks, and improper connections
- Insufficient fuel in the tank
- Low fuel pressure-Refer to **Fuel System Diagnosis** .
- Fuel contamination-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** for gasoline or **Fuel Composition Diagnosis** for E85.
- Malfunctioning fuel injectors-Refer to **Fuel Injector Solenoid Coil Test** .
- Missing, loose, or leaking exhaust components from the HO2S forward-Refer to **Symptoms - Engine Exhaust** .
- Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings
- The air induction system and the air intake ducts for leaks or for a missing air filter element
- A cracked EVAP canister

- Evaporative pipes obstructed or leaking
- The crankcase ventilation system for leaks
- The HO2S for improper installation and for electrical wires or connectors that may have contacted the exhaust system
- The HO2S signal circuit open, shorted to ground, or shorted to the low reference circuit
- Malfunctioning engine components-Refer to **Symptoms - Engine Mechanical** .

P0172 or P0175

Allow the engine to reach operating temperature. With the engine running, observe the affected Long Term FT parameter with a scan tool. The value should be more than approximately -20 % with the engine running at operating temperature.

- If the value is not more than -20 %, inspect for the following:
 - With the engine idling and the transmission in the Park or Neutral position, observe the manifold absolute pressure (MAP) sensor parameter. The MAP sensor parameter should be between 19-42 kPa.
 - Refer to **DTC P0106 (LF1)** if the MAP sensor parameter is not between 19-42 kPa.
 - With the engine idling, observe the mass air flow (MAF) sensor parameter. The MAF sensor parameter should be within 2-6 g/s at idle.
 - Refer to **DTC P0101** or **DTC P0102 or P0103** if the MAF sensor parameter is not within 2-6 g/s at idle.
 - Vacuum hoses for splits, kinks, and improper connections
 - The air intake duct for being collapsed or restricted
 - The air filter for being dirty or restricted
 - Objects blocking the throttle body
 - Excessive fuel in the crankcase due to leaking fuel injectors
 - The evaporative emissions control system for improper operation
 - Excessive fuel pressure-Refer to **Fuel System Diagnosis** .
 - Malfunctioning fuel injectors-Refer to **Fuel Injector Solenoid Coil Test** .
 - Fuel contamination-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** for gasoline or **Fuel Composition Diagnosis** for E85.
 - The HO2S for improper installation and for electrical wires or connectors that may have contacted the exhaust system
 - The HO2S signal circuit shorted to voltage

REPAIR PROCEDURES

- **Air Cleaner Element Replacement (LE5)**
- **Evaporative Emission Canister Replacement**
- **Evaporative Emission Canister Purge Solenoid Valve Replacement (LF1)**
- **Evaporative Emission Canister Vent Solenoid Valve Replacement**

- **Fuel System Cleaning**
- **Fuel Tank Draining**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 (LF1)** , **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)** , **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1 (LF1)** , and **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Throttle Body Assembly Replacement (LF1)**

REPAIR VERIFICATION

NOTE:

- After repairs, use the scan tool Fuel Trim Reset function in order to reset the Long Term Fuel Trim.
- To verify the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430. Refer to **DTC P0420 or P0430** .

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Turn ON the ignition, with the engine OFF.

NOTE: **DO NOT clear codes with the engine running. The codes may reset in the same ignition cycle.**

4. Clear the DTCs.
5. Turn OFF the ignition for 60 s.
6. Start the engine.
7. Duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets, or another DTC is present, refer to the **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.

DTC P018B-P018D

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P018B

Fuel Pressure Sensor Performance

DTC P018C

Fuel Pressure Sensor Circuit Low Voltage

DTC P018D

Fuel Pressure Sensor Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641	P0641, P06A6	P0641	P06A6
Signal	P018C	P018B, P018C	P018D	P018B
Low Reference	-	P0641, P06A6	-	P06A6

CIRCUIT/SYSTEM DESCRIPTION

The fuel pressure sensor is located on the fuel line. The fuel pressure sensor monitors the fuel pressure in the fuel line. The fuel pump control module monitors the voltage signal from the fuel pressure sensor.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- DTC P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The engine has been running for at least 5 seconds.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module does not detect a change in the fuel rail pressure of at least 30 kPa (4.4 psi) when the fuel pump is operating at its minimum or maximum voltage limits for over 5 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P018B, P018C and P018D are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTC P018B, P018C and P018D are Type A DTCs.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Connector Repairs
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

NOTE: Verify that the fuel tank is not empty. Only perform this diagnostic if there is at least 2 gallons of fuel in the fuel tank. Clear the DTC, and start and run the engine. Verify that the DTC P0118B resets before proceeding with the circuit system testing. If the DTC does not reset, refer to diagnostic aids.

1. Ignition OFF, disconnect the harness connector at the B47 fuel pressure sensor.
2. Ignition OFF, test for less than 1 ohms between the low reference circuit terminal 2 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
3. Ignition ON, test for 4.8-5.2 V between the B47 fuel pressure sensor 5 V reference circuit terminal 3 and

ground.

- If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump flow control module.
4. Verify the scan tool 5 V reference is less than 1 V.
- If greater than the specified range, test the signal circuit terminal 1 for a short to voltage. If the circuit tests normal, replace the K27 fuel pump flow control module.
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3. Verify the scan tool 5 V reference is greater than 4.8 V.
- If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump flow control module.
6. If all circuits test normal, replace the B47 fuel pressure sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for fuel pump control module replacement, setup, and programming

DTC P0191

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0191

Fuel Rail Pressure Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0192, P0193, P0340, P0345, P0365, P0390, P0506, P0641, P2227	P0192	P0193, P0641, P2227, P2229	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0192, P0193	P0193	P0191

Low Reference	-	P0193	P0193	P0191
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CIRCUIT/SYSTEM DESCRIPTION

The fuel rail fuel pressure sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 V reference voltage on the 5 V reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the fuel rail fuel pressure sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

CONDITIONS FOR RUNNING THE DTC

Condition 1

- The engine speed is greater than 25 RPM for greater than 31 s.
- DTC P0191 runs once an ignition cycle at engine start up when the condition has been met.

Condition 2 and 3

- The engine speed is greater than 25 RPM for greater than 30 s.
- The engine coolant temperature (ECT) at the previous engine shut down was warmer than 72°C (162°F).
- The ECT at engine start is colder than 55°C (131°F).
- At engine start, if the ECT is warmer than the intake air temperature (IAT), then the IAT must be within 35°C (95°F) of the ECT.
- At engine start, if the IAT is warmer than the ECT, then the ECT must be within 10°C (50°F) of the IAT.
- The block heater, if equipped, is not active.
- The engine off time since the previous engine shut down is greater than 4.2 h.
- DTC P0191 runs once an ignition cycle at engine start up when the above conditions have been met.

CONDITIONS FOR SETTING THE DTC

Condition 1

DTC P0087, P2187, or P2188 is set, and the fuel pressure at ignition ON is less than 120 kPa (17.4 psi) for greater than 4 s or for a cumulative of 30 s.

Condition 2

DTC P0088, P2177, or P2187 is set, and the fuel pressure at ignition ON is greater than 1500 kPa (218 psi) for greater than 4 s or for a cumulative of 30 s.

Condition 3

The fuel pressure at ignition ON is greater than 1500 kPa (218 psi) and a fuel pressure increase of greater than 385 kPa (56 psi) occurs during the fuel pump prime. The condition exists for greater than 4 s or for a cumulative

of 30 s.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0191 is a Type A DTC.
- A message center or an indicator may display Reduced Engine Power.

CONDITIONS FOR CLEARING THE DTC

DTC P0191 is a Type A DTC.

DIAGNOSTIC AIDS

A condition with the fuel tank fuel pump module or the fuel pump control module may set this DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the scan tool DTC information, verify DTC P0627, P0628, P0629, P069E or U0109 is not set.
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine idling, observe the scan tool Fuel Rail Pressure Sensor parameter. The pressure should be approximately 1.9-2.1 Mpa (279-305 psi).
3. Engine idling, the scan tool Fuel Rail Pressure Sensor should be close to the scan tool Desired Fuel Rail Pressure. As the engine speed increases, the Desired Fuel Rail Pressure and the Fuel Rail Pressure Sensor should closely match each other.
4. Move related harnesses/connectors of the B47 fuel rail fuel pressure sensor and verify the engine does not stumble, stall, or change engine speed.
 - If the engine stumbles, stalls, or changes engine speed, test or repair the suspected harness or connection.
5. Observe the DTC information with a scan tool, DTC P0191 should not set.
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the multi-way harness connector X109 at the rear of the intake manifold.
2. Remove the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.

NOTE: **Testing for steps 3 through 7 is performed on the ECM side of the multi-way harness connector.**

3. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 5 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
5. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 11 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Ignition ON, verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
 - If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
7. Connect a 3 A fused jumper wire between the signal circuit terminal 12 and the 5 V reference circuit terminal 11. Verify the scan tool Fuel Rail Pressure Sensor Voltage parameter is greater than 4.96 V.
 - If less than the specified value, test the signal circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the K20 ECM.
8. Ignition OFF, remove the intake manifold.
9. Connect the multi-way harness connector X109.

NOTE: **Testing for steps 12 through 16 are performed at the fuel rail fuel pressure sensor connector.**

10. Disconnect the B47 fuel rail fuel pressure sensor connector.
11. Remove the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
12. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal C and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance.
13. Install the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
14. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage.
15. Ignition ON, verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
 - If greater than the specified value, test the signal circuit for a short to voltage.
16. Connect a 3 A fused jumper wire between the signal circuit terminal B and the 5 V reference circuit terminal A. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.
 - If less than the specified value, test the signal circuit for an open/high resistance or a short to ground.
17. If all circuits test normal, replace the B47 fuel rail fuel pressure sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0192 OR P0193

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0192

Fuel Rail Pressure Sensor Circuit Low Voltage

DTC P0193

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0192, P0193, P0340, P0345, P0365, P0390, P0506, P0641, P2227, P2229	P0192	P0193, P0641, P2227, P2229	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0192, P0193	P0193	P0191
Low Reference	-	P0193	P0193	P0191

CIRCUIT/SYSTEM DESCRIPTION

The fuel rail fuel pressure sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 V reference voltage on the 5 V reference circuit and ground on the reference ground circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the fuel rail fuel pressure sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- The ignition voltage is between 11-18 V.
- The DTCs run continuously within the enabling conditions.

CONDITIONS FOR SETTING THE DTC

P0192

The ECM detects that the fuel rail fuel pressure sensor signal voltage is low.

P0193

The ECM detects that the fuel rail fuel pressure sensor signal voltage is high.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0192 and P0193 are Type A DTCs.
- A message center or an indicator may display Reduced Engine Power.

CONDITIONS FOR CLEARING THE DTC

DTCs P0192 and P0193 are Type A DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool, DTC P0641 should not be set.
 - If a DTC is set, refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .
2. Engine idling, observe the DTC information with a scan tool. DTC P0192 or P0193 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the multi-way harness connector X109 at the rear of the intake manifold.
2. Remove the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.

NOTE: **Testing for steps 3 through 7 is performed on the ECM side of the multi-way harness connector.**

3. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 5 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Install the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
5. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 11 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Ignition ON, verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
 - If greater than the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
7. Connect a 3 A fused jumper wire between the signal circuit terminal 12 and the 5 V reference circuit terminal 11. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.
 - If less than the specified value, test the signal circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the K20 ECM.
8. Ignition OFF, remove the intake manifold.
9. Connect the multi-way harness connector X109.

NOTE: **Testing for steps 12 through 16 are performed at the fuel rail fuel pressure sensor connector.**

10. Disconnect the B47 fuel rail fuel pressure sensor connector.
11. Remove the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
12. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal C and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance.
13. Install the fuse that supplies B+ to terminal 52-X1 of the K20 ECM.
14. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage.
15. Ignition ON, verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
 - If greater than the specified value, test the signal circuit for a short to voltage.
16. Connect a 3 A fused jumper wire between the signal circuit terminal B and the 5 V reference circuit terminal A. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.
 - If less than the specified value, test the signal circuit for an open/high resistance or a short to ground.
17. If all circuits test normal, replace the B47 fuel rail fuel pressure sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, OR P0277

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0201

Cylinder 1 Injector Control Circuit

DTC P0202

Cylinder 2 Injector Control Circuit

DTC P0203

Cylinder 3 Injector Control Circuit

DTC P0204

Cylinder 4 Injector Control Circuit

DTC P0205

Cylinder 5 Injector Control Circuit

DTC P0206

Cylinder 6 Injector Control Circuit

DTC P0261

Cylinder 1 Injector Control Circuit Low Voltage

DTC P0262

Cylinder 1 Injector Control Circuit High Voltage

DTC P0264

Cylinder 2 Injector Control Circuit Low Voltage

DTC P0265

Cylinder 2 Injector Control Circuit High Voltage

DTC P0267

Cylinder 3 Injector Control Circuit Low Voltage

DTC P0268

Cylinder 3 Injector Control Circuit High Voltage

DTC P0270

Cylinder 4 Injector Control Circuit Low Voltage

DTC P0271

Cylinder 4 Injector Control Circuit High Voltage

DTC P0273

Cylinder 5 Injector Control Circuit Low Voltage

DTC P0274

Cylinder 5 Injector Control Circuit High Voltage

DTC P0276

Cylinder 6 Injector Control Circuit Low Voltage

DTC P0277

Cylinder 6 Injector Control Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

				Short from Supply Circuit to Control
	Short to	Open/High	Short to	

Circuit	Ground	Resistance	Voltage	Circuit
Direct Fuel Injector High Voltage Supply Cylinder 1	P2147	P0201	P2148	P1248
Direct Fuel Injector High Voltage Control Cylinder 1	P0261	P0201	P0262	P1248
Direct Fuel Injector High Voltage Supply Cylinder 2	P2150	P0202	P2151	P1249
Direct Fuel Injector High Voltage Control Cylinder 2	P0264	P0202	P0265	P1249
Direct Fuel Injector High Voltage Supply Cylinder 3	P2153	P0203	P2154	P124A
Direct Fuel Injector High Voltage Control Cylinder 3	P0267	P0203	P0268	P124A
Direct Fuel Injector High Voltage Supply Cylinder 4	P2156	P0204	P2157	P124B
Direct Fuel Injector High Voltage Control Cylinder 4	P0270	P0204	P0271	P124B
Direct Fuel Injector High Voltage Supply Cylinder 5	P216B	P0205	P216C	P124C
Direct Fuel Injector High Voltage Control Cylinder 5	P0273	P0205	P0274	P124C
Direct Fuel Injector High Voltage Supply Cylinder 6	P216E	P0206	P216F	P124D
Direct Fuel Injector High Voltage Control Cylinder 6	P0276	P0206	P0277	P124D

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to each fuel injector on the injector high voltage supply circuits. The ECM energizes each fuel injector by grounding the high voltage control circuit of the fuel injector. The ECM monitors the status of the injector high voltage supply circuits and the fuel injector high voltage control circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- The ignition voltage is between 11-18 V.
- The DTCs run continuously once the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0201, P0202, P0203, P0204, P0205, or P0206

The ECM detects the injector high voltage supply circuit or the injector high voltage control circuit is open for

greater than 2 s.

P0261, P0264, P0267, P0270, P0273, or P0276

The ECM detects the injector high voltage control circuit is shorted to ground for greater than 2 s.

P0262, P0265, P0268, P0271, P0274, or P0277

The ECM detects the injector high voltage control circuit is shorted to voltage for greater than 2 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, and P0277 are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, and P0277 are Type A DTCs.

DIAGNOSTIC AIDS

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Solenoid Coil Test** .
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the DTC information with a scan tool. DTC P0685 or P1682 should not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine operating, observe the DTC information with a scan tool. DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 should not set.
3. Observe the scan tool Current Misfire Counter parameters. The Current Misfire Counters should not increment.
4. Ignition ON, observe the scan tool Cylinder 1-6 Injector Control Circuit Status parameters. Verify the Injector Control Circuit Status parameters display OK.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the appropriate multi-way harness connector X108 or X109, at the rear of the intake manifold.
2. Ignition ON, observe the appropriate scan tool Cylinder 1-6 Injector Control Circuit Status. The parameter should display Open.
 - If not the specified value, test the appropriate high voltage supply circuit, ECM side, for a short to ground or the appropriate high voltage control circuit, ECM side, for a short to voltage. If the circuits test normal, replace the K20 ECM.
3. Ignition ON, connect a test lamp between the appropriate high voltage supply circuit and the high voltage control circuit. The Injector Control Circuit Status should transition from Open to OK.
 - If not the specified value, test for the following conditions in the ECM side of the harness:
 - An open/high resistance in the high voltage supply circuit
 - An open/high resistance in the high voltage control circuit
 - A short to ground in the high voltage control circuit
 - A short to voltage in the high voltage supply circuit
 - If the circuits test normal, replace the K20 ECM.

NOTE: Testing for the following steps is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.

4. Ignition OFF, measure the resistance between the appropriate high voltage supply circuit and ground. The DMM should display OL ohms.
 - If less than the specified range, test the high voltage supply circuit and the high voltage control circuit for a short to ground. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector(s).
5. Test for 2-3 ohms between the appropriate high voltage supply circuit and high voltage control circuit.
 - If less than the specified range, test for a short between the high voltage supply circuit and high voltage control circuit. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector(s).
 - If greater than the specified range, test the high voltage supply circuit and high voltage control circuit for an open/high resistance. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector.

COMPONENT TESTING

NOTE: The DMM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis.

1. Remove the intake manifold and disconnect the appropriate Q17 fuel injector.
2. Test for 1.9-2.3 ohms at 20°C (68°F) between the high voltage supply circuit terminal 2 and the high voltage control circuit terminal 1 at the fuel injector.
 - If not within the specified range, replace the Q17 fuel injector.
3. Measure the resistance between each terminal at the Q17 fuel injector and the Q17 fuel injector housing/case. The DMM should display OL ohms.
 - If less than the specified value, replace the Q17 fuel injector.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF1)**
- **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0231, P0232, OR P023F

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0231

Fuel Pump Control Circuit Low Voltage

DTC P0232

Fuel Pump Control Circuit High Voltage

DTC P023F

Fuel Pump Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
Control	P0231	P023F	P0232	P023F, P2635
Low Reference	-	P023F	-	P023F, P2635

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

P0231, P023F

The ignition voltage is between 9-18 V.

P0232

The control enable voltage signal supplied for the ECM to fuel pump control module is inactive for 4 seconds after engine has been shut off.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module detects a fault on the fuel pump voltage circuit that is less than 4 V or greater than 4.5 V.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0231, P0232, and P023F are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0231, P0232, and P023F are Type A DTCs.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

Ignition ON, command the fuel pump ON and OFF using the scan tool ECM fuel pump output control. The fuel pump should turn ON and OFF.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the G12 fuel pump.
2. Connect a test lamp between the control circuit terminal 1 and ground.
3. Ignition ON, command the G12 fuel pump ON and OFF with a scan tool. The test lamp should turn ON and OFF, as commanded.
 - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
 - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
4. Ignition OFF, connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
5. Ignition ON, command the G12 fuel pump ON with a scan tool. The test lamp should illuminate.
 - If the test lamp does not illuminate, test the low reference circuit terminal 2 for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
6. If all circuits test normal, replace the G12 fuel pump.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Tank Fuel Pump Module Replacement**
- **Control Module References** for fuel pump control module replacement, setup, and programming

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

DTC P025A

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P025A

Fuel Pump Control Module Enable Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
FPCM Control	P025A	P025A	-	P025A

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

The ignition is ON.

CONDITIONS FOR SETTING THE DTC

The serial data message from the ECM to the fuel pump control module does not agree with the state of the control enable voltage signal supplied from the ECM to the fuel pump control module for more than 2 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P025A is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P025A is a Type A DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the K27 fuel pump control module.
2. Ignition OFF, connect a test lamp between the control circuit terminal 20 and ground.
3. Ignition ON, command the ECM fuel pump enable command ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
 - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
 - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. If all circuits test normal, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM or fuel pump control module replacement, setup, and programming

DTC P0300-P0306

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0300

Engine Misfire Detected

DTC P0301

Cylinder 1 Misfire Detected

DTC P0302

Cylinder 2 Misfire Detected

DTC P0303

Cylinder 3 Misfire Detected

DTC P0304

Cylinder 4 Misfire Detected

DTC P0305

Cylinder 5 Misfire Detected

DTC P0306

Cylinder 6 Misfire Detected

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) uses information from the crankshaft position sensor and the camshaft position sensors in order to determine when an engine misfire is occurring. By monitoring variations in the

crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. A misfire rate that is high enough can cause 3-way catalytic converter damage. The malfunction indicator lamp (MIL) will flash ON and OFF when the conditions for catalytic converter damage are present. DTCs P0301 through P0306 correspond to cylinders 1 through 6. If the ECM is able to determine that a specific cylinder is misfiring, the DTC for that cylinder will set, and the corresponding fuel injector is disabled. The ECM will re-enable the fuel injector after 4 crankshaft revolutions when the misfire is not current. The ECM will re-enable the fuel injector after 8 crankshaft revolutions when the misfire is not current, if the vehicle is equipped with a manual transmission.

CONDITIONS FOR RUNNING THE DTC

- DTC P0010, P0011, P0013, P0014, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0335, P0336, P0606, P0641, P0651, P1516, P2101, P2122, P2123, P2127, P2128 or P2176 is not set.
- The engine speed is between 450-6,600 RPM and steady.
- The evaporative emissions (EVAP) leak detection is not active.
- The delivered torque signal is greater than 5 % at idle.
- The delivered torque signal is between 6-29 % with the transmission in drive.
- The engine coolant temperature (ECT) is between -7 and +127°C (+19 and +261°F).
- The air conditioning compressor clutch is not changing states.
- The ECM is not receiving a rough road signal.
- The fuel level is greater than 11 %.
- The ECM is not in fuel cut-off or decel fuel cut-off mode.
- The increase in engine speed is less than 2,500-4,600 RPM/second.
- DTCs P0300 through P0306 run continuously when the above conditions exist for greater than 1,000 engine revolutions. 200 revolutions after the first failure.

CONDITIONS FOR SETTING THE DTC

P0300

The ECM detects a crankshaft rotation speed variation indicating a misfire rate sufficient to cause emissions levels to exceed a predetermined value.

P0301, P0302, P0303, P0304, P0305, P0306

The ECM detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0300-P0306 are Type B DTCs.
- The ECM disables the fuel injector of the misfiring cylinder when a misfire is present.

CONDITIONS FOR CLEARING THE DTC

DTCs P0300-P0306 are Type B DTCs.

DIAGNOSTIC AIDS

- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect for the following possible sources:
 - A tire or wheel that is out of round or out of balance
 - Variable thickness brake rotors
 - An unbalanced drive shaft
 - Certain rough road conditions
 - Transmission operation
 - A damaged accessory drive component or belt
- High resistance in the circuits of the injectors may set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- If the condition is intermittent, observing the scan tool IC Circuit Test and Fuel Injector Circuit Test Status parameters may help isolate the condition. The circuit test status parameters will change from OK or Not Run to Fault if a condition exists.
- A condition in the heated O2 sensor (HO2S) heater control circuits may set a DTC P0300.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 26792:** Spark Tester
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling at the normal operating temperature.
 - If there is an abnormal engine noise, refer to **Symptoms - Engine Mechanical** .
2. Verify that no other DTCs are set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. Observe the scan tool Misfire Current Cyl. 1-6 parameters. The Misfire Current Counters should not be incrementing.
4. Engine idling, perform the cylinder power balance test with a scan tool to isolate the misfiring cylinder. The engine speed should change when each injector is disabled.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Verify that the following conditions do not exist:
 - Vacuum hose splits, kinks, and incorrect connections
 - Engine vacuum leaks
 - Crankcase ventilation system for vacuum leaks
 - Fuel pressure that is too low or too high-Refer to **Fuel System Diagnosis** .
 - Contaminated Fuel-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
 - Exhaust system restrictions
 - If you find any of the above conditions, repair as necessary.
2. Ignition OFF, remove the T8 ignition coil of the misfiring cylinder, but leave the electrical connector connected.
3. Inspect the ignition coil boot for the following conditions:
 - Holes
 - Tears
 - Carbon tracking
 - Oil contamination
 - water intrusion
 - If you find any of the above conditions, repair as necessary.
4. Install the **J 26792:** Spark Tester to the boot of the appropriate T8 ignition coil and ground.

NOTE: **An erratic or weak spark is considered a no spark condition.**

5. Attempt to start the engine and observe the **J 26792: Spark Tester**. The spark tester should spark.
 - If there is no spark, refer to **Electronic Ignition System Diagnosis** for diagnosis of the ignition coil.
6. Ignition OFF, remove the spark plug from the misfiring cylinder. Verify that the spark plug does not exhibit the following conditions:
 - Gas, coolant, or oil fouled-Refer to **Spark Plug Inspection** .
 - Cracked, worn, incorrectly gapped-Refer to **Ignition System Specifications** .
 - If there is a condition with the spark plug, replace the spark plug.
7. Exchange the suspected spark plug with another cylinder that is operating correctly.
8. Engine idling, observe the scan tool Misfire Current Counter parameters. The misfire should not follow the spark plug exchange.
 - If the misfire follows the spark plug, replace the spark plug.
9. If all conditions test normal, test or inspect for the following:
 - A lean or rich Q17 fuel injector.
 - An engine mechanical condition-Refer to **Symptoms - Engine Mechanical** .

REPAIR PROCEDURES

- **Spark Plug Replacement**
- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**

REPAIR VERIFICATION

1. If the customer concern was a flashing malfunction indicator lamp (MIL), refer to **DTC P0420 or P0430**.
2. Clear the DTCs with a scan tool.
3. Turn OFF the ignition for 30 s.
4. Start the engine.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 - If the DTC fails this ignition, a misfire still exists.

DTC P0315

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0315: Crankshaft Position System Variation Not Learned

CIRCUIT/SYSTEM DESCRIPTION

The crankshaft position system variation learn feature is used to calculate reference period errors caused by slight tolerance variations in the crankshaft, and the crankshaft position sensor. The calculated error allows the engine control module (ECM) to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wider range of engine speed and load conditions.

The crankshaft position system variation compensating values are stored in ECM memory after a learn procedure has been performed and the ignition switch is turned to the OFF position for at least 30 s. If the actual variation is not within the crankshaft position system variation compensating values stored in the ECM, DTC P0300 may set.

If the crankshaft position system variation values are not stored in the ECM memory or a proper ECM power down does not occur after completing the Crankshaft Position Learn Procedure, DTC P0315 sets.

CONDITIONS FOR RUNNING THE DTC

DTC P0315 runs continuously.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the crankshaft position system variation values are not stored in memory.

ACTION TAKEN WHEN THE DTC SETS

DTC P0315 is a Type A DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0315 is a Type A DTC.

DIAGNOSTIC AIDS

This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to **Battery Inspection/Test** .

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End Views

Component Connector End Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

NOTE: **The Crankshaft Position System Variation Learn Procedure may have to be repeated up to 5 times before the procedure is successful.**

1. Perform the Crankshaft Position System Variation Learn procedure. The scan tool should display Learned Successful.
 - If the Crankshaft Position System Variation Learn Procedure cannot be performed successfully, inspect for the following conditions:
 - Worn crankshaft main bearings
 - A damaged or misaligned reluctor wheel
 - Excessive crankshaft runout
 - A damaged crankshaft-Refer to Crankshaft and Bearing Cleaning and Inspection .
 - Interference in the signal circuit of the crankshaft position sensor
 - The ignition switch is in the ON position until there is insufficient system voltage.
 - An ECM power disconnect with the ignition ON that may have erased the crankshaft position system variation values and set DTC P0315
 - Debris between the crankshaft position sensor and the reluctor wheel
2. Verify the Learn Procedure is successful.
 - If the ECM is unable to complete the learn procedure, replace the ECM.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after using this diagnostic procedure.

Control Module References for ECM replacement, setup, and programming

DTC P0324-P0328, P0330-P0333, P06B6, OR P06B7

DIAGNOSTIC INSTRUCTIONS

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0324

Knock Sensor System Performance

DTC P0325

Knock Sensor Circuit Bank 1

DTC P0326

Knock Sensor Performance Bank 1

DTC P0327

Knock Sensor Circuit Low Voltage Bank 1

DTC P0328

Knock Sensor Circuit High Voltage Bank 1

DTC P0330

Knock Sensor Circuit Bank 2

DTC P0331

Knock Sensor Performance Bank 2

DTC P0332

Knock Sensor Circuit Low Voltage Bank 2

DTC P0333

Knock Sensor Circuit High Voltage Bank 2

DTC P06B6

Control Module Knock Sensor Processor 1 Performance

DTC P06B7

Control Module Knock Sensor Processor 2 Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor 1 Signal	P0327	P0325, P06B6	P0328	P0326
Knock Sensor 2 Signal	P0332	P0330, P06B7	P0333	P0331

CIRCUIT/SYSTEM DESCRIPTION

The knock sensor system enables the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The knock sensor produces an AC voltage signal that varies depending on the vibration level during engine operation. The ECM adjusts the spark timing based on the amplitude and the frequency of the knock sensor signal. The ECM receives the knock sensor signal through 2 isolated signal circuits for each bank. The ECM learns a minimum knock sensor noise level at idle and uses calibrated values for the rest of the RPM range. The ECM monitors for a normal knock sensor signal. The ECM monitors the internal knock sensor processor by verifying a 20 KHz signal generated on the output circuit is detected on the return circuit.

CONDITIONS FOR RUNNING THE DTC

P0324, P0326 and P0331-Excessive Knock Detection Mode

- Engine speed is between 400-8,500 RPM.
- The engine coolant temperature (ECT) is greater than -40°C (-40°F).
- The intake air temperature (IAT) is greater than -40°C (-40°F).
- The DTCs run continuously when the above conditions are met.

P0324, P0326 and P0331-Abnormal Noise Detection Mode-Improperly Bolted Knock Sensor

- Engine speed is between 2,200-8,500 RPM.
- The ECT is greater than -40°C (-40°F).
- The IAT is greater than -40°C (-40°F).
- The DTCs run continuously when the above conditions are met.

P0325, P0327, P0328, P0330, P0332, and P0333

- Engine speed is between 400-8,500 RPM.
- The ECT is greater than -40°C (-40°F).
- The IAT is greater than -40°C (-40°F).
- The DTCs run continuously when the above conditions are met.

P06B6 and P06B7

- Engine speed is between 400-4,000 RPM.

- The ECT is greater than -40°C (-40°F).
- The IAT is greater than -40°C (-40°F).
- The DTCs run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0324

The knock sensor signal indicates an excessive engine knock is present for greater than 10 s for at least 1 single cylinder.

P0325 and P0330

The knock sensor signal circuits are open for greater than 10 s.

P0326 and P0331

- The signal indicates the sensor harness is connected, but the sensor is not properly bolted to the engine.

OR

- The knock sensor signal indicates an excessive engine knock is present in an entire bank.
- Either of the above conditions exist for greater than 10 s.

P0327 and P0332

The knock sensor signal circuits are shorted to ground for greater than 10 s.

P0328 and P0333

The knock sensor signal circuits are shorted to voltage for greater than 10 s.

P06B6 and P06B7

The ECM has detected an internal knock sensor processor fault.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0324, P0325, P0326, P0327, P0328, P0330, P0331, P0332 P0333, P06B6, and P06B7 are Type B DTCs.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

CONDITIONS FOR CLEARING THE DTC

DTCs P0324, P0325, P0326, P0327, P0328, P0330, P0331, P0332 P0333, P06B6, and P06B7 are Type B DTCs.

DIAGNOSTIC AIDS

- Inspect the knock sensor for physical damage. A knock sensor that is dropped or damaged may cause a DTC to set.
- Inspect the knock sensor for proper installation. A knock sensor that is loose or over torqued may cause a DTC to set. The knock sensor should be free of thread sealant.
- The knock sensor mounting surface should be free of burrs, casting flash, and foreign material.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine at operating temperature, all accessories OFF, and engine speed greater than 2,000 RPM, observe the Knock Retard and Total Knock Retard parameters. The parameters should be 0°.
2. Engine idling, move the related harnesses and connectors for the KS circuits while observing the scan tool Knock Retard and Total Knock Retard parameters. The parameters should remain steady with no abrupt changes.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You

may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE:

- Perform the Diagnostic System Check - Vehicle prior to using these diagnostic procedures.
- If an engine mechanical noise can be heard, repair the condition before proceeding with this diagnostic. Refer to Symptoms - Engine Mechanical .

P0324

NOTE:

If DTC P0325, P0326, P0327, P0328, P0330, P0332, or P0333 are also set, diagnose those DTCs first.

DTC P0324 indicates an internal control module circuitry failure. Replace the K20 ECM.

P0325, P0326, P0327, P0328, P0330, P0332, P0333

1. Ignition OFF, disconnect the affected B68 KS.
2. Ignition OFF. Connect a DMM to both B68 KS signal circuits, terminals A and B, at the affected B68 KS. Set the DMM to the 400 mV AC scale, select the Hz mode. Let the reading stabilize at 0 Hz.

NOTE:

DO NOT tap on plastic engine components.

3. Tap on the engine block with a non-metallic object near the affected B68 KS and observe the DMM for a fluctuating frequency.
 - If the DMM does not display a fluctuating frequency while tapping on the engine block then replace the affected B68 KS.
4. Verify the affected B68 KS is properly tightened, refer to Fastener Tightening Specifications .
5. Ignition OFF, with appropriate length jumper wires, connect the B68 KS1 harness to the B68 KS2 sensor and the B68 KS2 harness to the B68 KS1 sensor.
6. Monitor the DTCs using a scan tool. Operate the vehicle within the conditions for running the DTC. Verify the fault does not follow the sensor in question.
 - If the fault follows the sensor in question, replace the appropriate B68 KS.
7. Ignition OFF, remove the jumper wires from the previous step.
8. Measure for 1-4 volts between each of the following circuits and ground on the K20 ECM side of the harness connector:
 - The B68 KS signal circuit, terminal A or 1
 - The B68 KS signal circuit, terminal B or 2
 - If less than the specified range, test the circuits for a short to ground or an open/high resistance. If the circuits test normal, replace the K20 ECM.
 - If greater than the specified range, test the circuits for a short to voltage. If the circuits test normal,

replace the K20 ECM.

9. Test for intermittent or poor connections at the ECM, B68 KS, and in-line connectors where present.
10. If all circuits test normal, replace the K20 ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Knock Sensor Replacement - Bank 1**
- **Knock Sensor Replacement - Bank 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0335 (W/LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0335

Crankshaft Position Sensor Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Circuit	P0651	P0335	P0651, P2135	-
Crankshaft Position Sensor Signal Circuit	P0335	P0335	P0335	P0336
Low Reference Circuit	-	P0335	P0335	-

CIRCUIT/SYSTEM DESCRIPTION

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with 2 missing teeth for the reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on

the wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses crankshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control camshaft phasing, and to detect cylinder misfire.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0101, P0102, P0103, P0340, P0341, P0641, or P0651 P0697 are not set.
- The engine is cranking or running.
- The airflow into the engine is greater than 3 g/s.
- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the starter is commanded ON and the engine has been cranking for more than 4 seconds without a crankshaft position sensor pulse.
- The ECM detects that the engine has been running but has not received a crankshaft position sensor pulse for 2 of 10 engine revolutions.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0335 is a Type B DTC.
- The camshaft position actuator is commanded to the Home or Parked position.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0335 is a Type B DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- **Electronic Ignition System Description**
- **Engine Control Module Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information (LF1,LFW) or **Engine Control Module Scan Tool Information (LAF)** for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, observe the scan tool Crankshaft Position Active Counter parameter. The parameter should be incrementing.
2. Engine idling, observe the DTC information with a scan tool. DTC P0335 should not set.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the B26 crankshaft position sensor connector.
2. Ignition OFF, vehicle systems OFF, this may take up to 2 minutes, test for less than 3 ohms between low reference circuit terminal 1 and ground.
 - If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - If less than the specified range, test the 5 V reference circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
 - If less than the specified range, test the signal circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Ignition ON, engine OFF, using a 3 A jumper wire connected to ground, momentarily touch the crankshaft position sensor signal circuit terminal 2 repeatedly. The crankshaft position active counter parameter should increment.
 - If the crankshaft position active counter parameter does not increment, replace the K20 ECM.
 - If the crankshaft position active counter increments, test or replace the B26 crankshaft position

sensor.

COMPONENT TESTING

NOTE: You must perform the Circuit/System Testing before proceeding with Component Testing.

- 1. Inspect the B26 crankshaft position sensor for looseness and correct installation. Remove the crankshaft position sensor from the engine and inspect the sensor and the O-ring for damage.
 - o If the sensor is loose, incorrectly installed, or damaged, repair or replace the B26 crankshaft position sensor.
- 2. Connect the crankshaft position sensor connector to the crankshaft position sensor. Turn ON the ignition, with the engine OFF.
- 3. Observe the Crankshaft Position Active Counter parameter with a scan tool. Pass a flat steel object by the tip of the sensor repeatedly. The crankshaft position active counter parameter should increment.
 - o If the function does not perform as specified, replace the B26 crankshaft position sensor.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Crankshaft Position Sensor Replacement
- Control Module References for ECM replacement, setup, and programming

DTC P0336 (W/LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0336

Crankshaft Position Sensor Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Circuit	P0651	P0335	P0651, P2135	-
Crankshaft Position Sensor Signal	P0335	P0335	P0335	P0336

Circuit				
Low Reference Circuit	-	P0335	P0335	-

CIRCUIT/SYSTEM DESCRIPTION

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with 2 missing teeth for the reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on the wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses crankshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control camshaft phasing, and to detect cylinder misfire.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0101, P0102, P0103, P0340, P0341, P0641, or P0651 are not set.
- The engine is cranking or running.
- The airflow into the engine is greater than 3 g/s.
- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the engine is running, but receives less than 51 or more than 65 crankshaft position sensor pulses each engine revolution for 8 of 10 engine revolutions.
- The ECM detects that the engine is running, but more than 19 resyncs occur within 25 seconds.
- The ECM detects that the engine has been running, but the crankshaft does not sync for 0.4 second.

ACTION TAKEN WHEN THE DTC SETS

- DTC P0336 is a Type B DTC.
- The camshaft position actuator is commanded to the Home or Parked position.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0336 is a Type B DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- **Electronic Ignition System Description**
- **Engine Control Module Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information (LF1,LFW) or **Engine Control Module Scan Tool Information (LAF)** for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine idling, observe the scan tool Crankshaft Position Active Counter parameter. The parameter should be incrementing.
2. Engine idling, observe the DTC information with a scan tool. DTC P0335 should not set.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the B26 crankshaft position sensor connector.
2. Ignition OFF, vehicle systems OFF, this may take 2 minutes, test for less than 3 ohms between low reference circuit terminal 1 and ground.
 - If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - If less than the specified range, test the 5 V reference circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit

tests normal, replace the K20 ECM.

4. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
 - If less than the specified range, test the signal circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Ignition ON, engine OFF, using a 3 A jumper wire connected to ground, momentarily touch the crankshaft position sensor signal circuit terminal 2 repeatedly. The Crankshaft Position Active Counter parameter should increment.
 - If the Crankshaft Position Active Counter parameter does not increment, replace the K20 ECM.
 - If the Crankshaft Position Active Counter increments, test or replace the B26 crankshaft position sensor.

COMPONENT TESTING

NOTE: You must perform the Circuit/System Testing before proceeding with Component Testing.

1. Inspect the B26 crankshaft position sensor for looseness and correct installation. Remove the crankshaft position sensor from the engine and inspect the sensor and the O-ring for damage.
 - If the sensor is loose, incorrectly installed, or damaged, repair or replace the B26 crankshaft position sensor.
2. Connect the crankshaft position sensor connector to the crankshaft position sensor. Turn ON the ignition, with the engine OFF.
3. Observe the Crankshaft Position Active Counter parameter with a scan tool. Pass a steel object by the tip of the sensor repeatedly. The Crankshaft Position Active Counter parameter should increment.
 - If the function does not perform as specified, replace the B26 crankshaft position sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Crankshaft Position Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0340, P0345, P0365, OR P0390 (W/LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0340

Intake Camshaft Position Sensor Circuit Bank 1

DTC P0345

Intake Camshaft Position Sensor Circuit Bank 2

DTC P0365

Exhaust Camshaft Position Sensor Circuit Bank 1

DTC P0390

Exhaust Camshaft Position Sensor Circuit Bank 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Circuit	P0641, P0452, P0107, P0532, P0522	P0340, P0345, P0365, P0390	P0641	-
Camshaft Position Sensor Signal Circuit	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	P0341, P0346, P0366, P0391
Low Reference Circuit	-	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	-

CIRCUIT/SYSTEM DESCRIPTION

The 4X camshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency, with 4 varying width output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control camshaft phasing, and for limp-home operation.

CONDITIONS FOR RUNNING THE DTC

NOTE: The ECM detects engine movement by sensing the airflow through the MAF sensor when airflow is greater than 3 g/s, or by sensing crankshaft position sensor pulses.

- DTC P0102, P0103, P0335, P0336, P0641, P0651, or P0697 is not set.
- The engine is cranking or running.
- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the starter is commanded ON and the engine has been cranking for more than 4 seconds without a camshaft position sensor pulse.
- The ECM detects that the engine has started, but did not receive a camshaft position sensor pulse during the first engine revolution.
- The ECM detects that the engine is running, but does not receive a camshaft position sensor pulse for 800 of 1,000 engine cycles.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0340, P0345, P0365, and P0390 are Type B DTCs.
- The camshaft position actuator is commanded to the Home or Parked position.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0340, P0345, P0365, and P0390 are Type B DTCs.

DIAGNOSTIC AIDS

With a DTC set, the engine may crank for an extended period of time at start-up.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information (LF1,LFW) or **Engine Control Module Scan Tool Information (LAF)** for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. With the ignition OFF, inspect the engine wiring harnesses carrying the B23 camshaft position sensor circuits for the following conditions:
 - Close routing of aftermarket electrical equipment
 - Close to solenoids, motors, and relays
 - Correct any wire harness routing or component placement conditions if it is determined to be a possible source of electrical interference.
2. Observe the following scan tool parameters are all incrementing:
 - Exhaust Camshaft Position Active Counter Bank 1
 - Intake Camshaft Position Active Counter Bank 1
 - Exhaust Camshaft Position Active Counter Bank 2
 - Intake Camshaft Position Active Counter Bank 2
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, all vehicle systems OFF, this may take 2 minutes, disconnect the affected B23 camshaft position sensor connector.
2. Test for less than 3 ohms between the low reference circuit terminal 1 and ground.
 - If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

NOTE: **The control module or the sensor may be damaged if the circuit is shorted to B+ voltage.**

3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.

- If less than the specified range, test the 5 V reference circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
- If less than the specified range, test the affected signal circuit for an open/high resistance or short to ground. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the affected signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Ignition ON, using a 3 A fused jumper wire connected to ground; momentarily touch the camshaft position sensor signal circuit terminal 2 repeatedly. The appropriate camshaft position active counter parameter should increment.
- If the camshaft position active counter does not increment, replace the K20 ECM.
 - If the circuits test normal, replace the B23 camshaft position sensor.

COMPONENT TESTING

NOTE: **You must perform the Circuit/System Testing before proceeding with Component Testing.**

1. Inspect the B23 crankshaft position sensor for looseness and correct installation. Remove the crankshaft position sensor from the engine and inspect the sensor and the O-ring for damage.
 - If the sensor is loose, incorrectly installed, or damaged, repair or replace the B23 crankshaft position sensor.
2. Connect the crankshaft position sensor connector to the crankshaft position sensor.
3. Ignition ON, observe the applicable camshaft position active counter parameter with a scan tool. Pass a steel object by the tip of the sensor repeatedly. The camshaft position active counter parameter should increment.
 - If the function does not perform as specified, replace the B23 camshaft position sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust**
- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake**
- **Control Module References** for K20 ECM replacement, setup, and programming

DTC P0341, P0346, P0366, OR P0391 (W/LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0341

Intake Camshaft Position Sensor Performance Bank 1

DTC P0346

Intake Camshaft Position Sensor Performance Bank 2

DTC P0366

Exhaust Camshaft Position Sensor Performance Bank 1

DTC P0391

Exhaust Camshaft Position Sensor Performance Bank 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Circuit	P0641, P0452, P0107, P0532, P0522	P0340, P0345, P0365, P0390	P0641	-
Camshaft Position Sensor Signal Circuit	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	P0341, P0346, P0366, P0391
Low Reference Circuit	-	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	-

CIRCUIT/SYSTEM DESCRIPTION

The 4X camshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency, with 4 varying width output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses camshaft position sensor output

information to determine the camshaft relative position to the crankshaft, to control camshaft phasing, and for limp-home operation.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0335, P0336, P0641, P0651, or P0697 are not set.
- The engine is cranking or running.
- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the engine has started, but has received either of the following during the first engine revolution:
 - Less than or more than 4 camshaft position sensor pulses, if equipped with an automatic transmission
 - Less than 4 or more than 8 camshaft position sensor pulses, if equipped with a manual transmission
- The ECM detects that the engine is running, but receives less than 398 camshaft position or more than 402 camshaft position sensor pulses per 100 engine cycles in 800 of 1000 engine cycles.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0341, P0346, P0366, and P0391 are Type B DTCs.
- The camshaft position actuator is commanded to the Home or Parked position.
- The ignition system defaults to a failed camshaft position sensor based on the crankshaft position sensor.

CONDITIONS FOR CLEARING THE MIL/DTC

- DTCs P0341, P0346, P0366, and P0391 are Type B DTCs.
- With a DTC set, the engine may crank for an extended period of time at start-up.

DIAGNOSTIC AIDS

With a DTC set, the engine may crank for an extended period of time at start-up.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information (LF1,LFW) or **Engine Control Module Scan Tool Information (LAF)** for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. If DTC P0340, P0345, P0365, or P0390 are also set, diagnose those DTCs first
2. With the ignition OFF, inspect the engine wiring harnesses carrying the B23 camshaft position sensor circuits for the following conditions:
 - Close routing of aftermarket electrical equipment
 - Close to solenoids, motors, and relays
 - Correct any wire harness routing or component placement conditions if it is determined to be a possible source of electrical interference.
3. Observe the following scan tool parameters are all incrementing:
 - Exhaust Camshaft Position Active Counter Bank 1
 - Intake Camshaft Position Active Counter Bank 1
 - Exhaust Camshaft Position Active Counter Bank 2
 - Intake Camshaft Position Active Counter Bank 2
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Engine idling, move the related harnesses/connectors of the B23 camshaft position sensor while monitoring the scan tool Camshaft Position Variance parameter. The Camshaft Position Variance parameter should not change when moving the harness/connectors.
 - If the above condition exists, repair the harness/connectors as necessary.
2. Ignition OFF, inspect the B23 camshaft position sensor for correct installation.

- If the B23 camshaft position sensor is loose, inspect the sensor and the O-ring for damage and replace as necessary.
- 3. Disconnect the harness connector at the B23 camshaft position sensor.
- 4. Ignition OFF, all vehicle systems OFF, this may take 2 minutes, test for less than 5 ohms between the low reference circuit terminal B and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
- 5. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
- 6. Test for 4.8-5.2 V between the signal circuit terminal C and ground.
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
- 7. Ignition OFF, connect a 3 A fused jumper wire to the camshaft position signal circuit terminal C.
- 8. Ignition ON, momentarily touch the end of the fused jumper wire to ground while monitoring the scan tool camshaft position active counter. The camshaft position active counter should increment.
 - If the camshaft position active counter does not increment, replace the K20 ECM.
- 9. If all circuits test normal, replace the B23 camshaft position sensor.

COMPONENT TESTING

NOTE: **You must perform the Circuit/System Testing before proceeding with Component Testing.**

1. Inspect the B23 camshaft position sensor for looseness and correct installation. Remove the camshaft position sensor from the engine and inspect the sensor and the O-ring for damage.
 - If the sensor is loose, incorrectly installed, or damaged, repair or replace the B23 crankshaft position sensor.
2. Connect the camshaft position sensor connector to the camshaft position sensor. Turn ON the ignition, with the engine OFF.
3. Ignition ON, observe the applicable camshaft position active counter parameter with a scan tool. Pass a steel object by the tip of the sensor repeatedly. The camshaft position active counter parameter should increment.
 - If the function does not perform as specified, replace the B23 camshaft position sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust**
- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0351-P0356 (LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0351

Ignition Coil 1 Control Circuit

DTC P0352

Ignition Coil 2 Control Circuit

DTC P0353

Ignition Coil 3 Control Circuit

DTC P0354

Ignition Coil 4 Control Circuit

DTC P0355

Ignition Coil 5 Control Circuit

DTC P0356

Ignition Coil 6 Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	1	2	-	-

Ignition Coil 1 Control Circuit	P0300, P0351	P0300, P0351	P0300, P0351	-
Ignition Coil 2 Control Circuit	P0300, P0352	P0300, P0352	P0300, P0352	-
Ignition Coil 3 Control Circuit	P0300, P0353	P0300, P0353	P0300, P0353	-
Ignition Coil 4 Control Circuit	P0300, P0354	P0300, P0354	P0300, P0354	-
Ignition Coil 5 Control Circuit	P0300, P0355	P0300, P0355	P0300, P0355	-
Ignition Coil 6 Control Circuit	P0300, P0356	P0300, P0356	P0300, P0356	-
Low Reference	-	P0351, P0352, P0353, P0354, P0355, P0356	-	-
1. The Engine Cranks But Does Not Run and opens the fuse that supplies voltage to the ignition coils. 2. The Engine Cranks But Does Not Run				

CIRCUIT/SYSTEM DESCRIPTION

The ignition system on this engine uses an individual coil/module for each cylinder. The engine control module (ECM) controls the spark event for each cylinder through the eight individual ignition control circuits. When the ECM commands the ignition control circuit ON, electrical current will flow through the primary winding of the ignition coil, creating a magnetic field. When a spark event is requested, the ECM will command the ignition control circuit OFF, interrupting current flow through the primary winding. The magnetic field created by the primary winding will collapse across the secondary coil windings, producing a high voltage across the spark plug electrodes. The ECM uses information from the crankshaft position sensor, and the camshaft position sensor for sequencing and timing of the spark events.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- The ignition voltage is greater than 6 V.
- DTC P0351-P0356 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0351-P0356 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0351-P0356 are Type B DTCs.

DIAGNOSTIC AIDS

A high resistance condition on any ignition control circuit can cause an engine misfire without setting DTC P0351-P0356.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Engine running, observe the following scan tool control circuit status parameters for the appropriate cylinder T8 ignition coil:
 - Ignition Coil 1-6 Control Circuit Low Voltage Test Status
 - Ignition Coil 1-6 Control Circuit Open Test Status
 - Ignition Coil 1-6 Control Circuit High Voltage Test Status

Each parameter should display Not Run or OK.
2. Engine idling, observe the DTC information with a scan tool. DTC P0351, P0352, P0353, P0354, P0355, or P0356 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the appropriate T8 ignition coil.
2. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all the systems to power

down. Test for less than 5 ohms between the ground circuit terminal A and ground.

- If greater than the specified range, repair the ground circuit for an open/high resistance.

3. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal B and ground.

- If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

4. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.

- If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test all components connected to the ignition voltage circuit and replace as necessary.

5. Engine idling at operating temperature, test for 0.250-0.350 V between the appropriate ignition control circuit terminal C and ground.

- If less than the specified range, test the ignition control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
- If greater than the specified range, test the ignition control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.

6. If all circuits test normal, test or replace the T8 ignition coil.

REPAIR PROCEDURES

- T8 **Ignition Coil Replacement - Bank 1**
- T8 **Ignition Coil Replacement - Bank 2**
- **Control Module References** for ECM replacement, setup, and programming

REPAIR VERIFICATION

NOTE: An ignition control circuit fault condition will result in an engine misfire, and under certain driving conditions could possibly overheat the 3-way catalytic converter.

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming, or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn the ignition OFF for 60 s.
5. If the repair is related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.
6. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430.

DTC P0420 OR P0430

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0420

Catalyst System Low Efficiency Bank 1

DTC P0430

Catalyst System Low Efficiency Bank 2

CIRCUIT/SYSTEM DESCRIPTION

A 3-way catalytic converter (TWC) controls emissions of hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx). The catalyst within the converter promotes a chemical reaction, which oxidizes the HC and the CO that are present in the exhaust gas. This process converts the HC and the CO into water vapor and carbon dioxide (CO₂), and reduces the NOx, converting the NOx into nitrogen. The catalytic converter also stores oxygen. The engine control module (ECM) monitors this process by using a heated oxygen sensor (HO₂S) that is in the exhaust stream after the TWC. The HO₂S 2 produces an output signal that the ECM uses to calculate the oxygen storage capacity of the catalyst. This indicates the ability of the catalyst to convert the exhaust emissions efficiently. The ECM monitors the efficiency of the catalyst by allowing the catalyst to heat, then wait for a stabilization period while the engine is idling. The ECM then adds and removes fuel while monitoring the HO₂S 2. When the catalyst is functioning properly, the HO₂S 2 response to the extra fuel is slow compared to the response of the HO₂S 1, which is located before the TWC. When the HO₂S 2 response is near that of the HO₂S 1, the oxygen storage capability and efficiency of the catalyst may be degraded below an acceptable threshold.

CONDITIONS FOR RUNNING THE DTC

- DTCs P000A, P000B, P000C, P000D, P0010, P0011, P0013, P0014, P0020, P0021, P0023, P0024, P0030, P0031, P0032, P0050, P0051, P0052, P0100, P0101, P0102, P0103, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0130, P0131, P0132, P0133, P0135, P0137, P0138, P013A, P013C, P013E, P0140, P0141, P014A, P0150, P0151, P0152, P0153, P0155, P0157, P0158, P0160, P0161, P0221, P0222, P0223, P0300, P0301-P0306, P0443, P0455, P0458, P0459, P0496, P2088, P2089, P2090, P2091, P2092, P2093, P2094, P2095, P2096, P2097, P2098, P2099, P2100, P2101, P2107, P2119, P2122, P2123, P2127, P2128, P2138, P2176, P2177, P2178, P2179, P2180, P2187, P2188, P2189, P2190, P2232, P2235, P2270, P2271, P2272, or P2273 is not set.
- Before the ECM performs the idle test, the vehicle must be driven under the following conditions:
 - The engine speed is greater than 915 RPM
 - The engine run time is greater than a calibrated value
 - Both conditions exist for greater than 15 seconds

- The throttle is in the rest position.
- The intake air temperature (IAT) is between -20 to +250°C (-4 to +482°F).
- The ignition voltage is greater than 11 volts.
- The engine coolant temperature (ECT) is between 40-127°C (104-261°F).
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine has been idling less than 50 seconds.
- The vehicle speed is less than 2 km/h (1 mph).
- The short term fuel trim is learned.
- The air flow into the engine is between 3-13 g/s.
- The EVAP purge concentration is learned.
- The catalytic converter (TWC) calculated temperature is between 450-250°C (842-1,742°F).
- The engine is operating in Closed Loop.
- The transmission is not in P/N (automatic transmission only).

This diagnostic attempts one test during each valid idle period once the above conditions have been met. This diagnostic attempts up to 8 tests during each drive cycle.

CONDITIONS FOR SETTING THE DTC

The ECM determines that the efficiency of the catalyst has degraded below a calibrated threshold.

ACTION TAKEN WHEN THE DTC SETS

DTC P0420 and P0430 are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTC P0420 and P0430 are Type A DTCs.

DIAGNOSTIC AIDS

Inspect for the following conditions, which may cause a catalytic converter to degrade:

- An engine misfire
- High engine oil or high coolant consumption
- Retarded spark timing
- A weak or poor spark
- A lean fuel mixture
- A rich fuel mixture
- A damaged oxygen sensor or wiring harness

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Engine idling, observe the DTC information with a scan tool. Verify there are no HO2S or misfire DTCs set.
 - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** to diagnosis the applicable DTC, before proceeding with this diagnostic procedure.
2. Verify the following conditions do not exist with the catalytic converter:
 - Dents
 - A severe discoloration caused by excessive temperatures
 - Road damage
 - An internal rattle caused by damaged catalyst substrate
 - Restrictions
 - If a condition is found, replace the catalytic converter.
3. Verify the following conditions do not exist with the exhaust system:
 - Leaks
 - Physical damage
 - Loose or missing hardware
 - Properly torqued HO2S
 - If a condition is found, repair the exhaust system.
4. Verify the following conditions do not exist with the HO2S 2:
 - A grounded wiring harness
 - Damage
 - If a condition is found, replace the HO2S 2.
5. If no physical condition is detected and the HO2S 2 is as active as the HO2S 1 after operating the engine at 1,500 RPM for 1 minute and then returning to a stabilized idle, then replace the appropriate catalytic converter.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Exhaust Leakage**
- **Restricted Exhaust**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)**

- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Catalytic Converter Replacement - Left Side (LF1)**
- **Catalytic Converter Replacement - Right Side (LF1)**

DTC P0442

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0442

Evaporative Emission (EVAP) System Small Leak Detected

CIRCUIT/SYSTEM DESCRIPTION

The engine off natural vacuum (EONV) test is the small leak detection diagnostic for the evaporative emission system. This diagnostic tests the evaporative emission (EVAP) system for a small leak when the key is turned OFF and the correct conditions are met. Heat from the exhaust system is transferred into the fuel tank while the vehicle is operating. When the vehicle is turned OFF and the EVAP system is sealed a change in the fuel tank vapor temperature occurs which results in a corresponding pressure change in the fuel tank vapor space. This change is monitored by the ECM using the fuel tank pressure sensor input. With a leak in the system, the amount of pressure change will be less than that of a sealed system.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0222, P0223, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0461, P0462, P0463, P0464, P0496, P0502, P0503, P0608, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138 are not set.
- The ignition 1 voltage is between 10-16 V.
- The barometric pressure (BARO) is greater than 74 kPa.
- No fuel filling during the EONV test period.
- The fuel level is between 15-85 %.
- The start-up engine coolant temperature (ECT) and the start-up intake air temperature (IAT) are between 0-40°C (32-104°F).
- The barometric pressure (BARO) is more than 74 kPa.
- The engine run time before engine shut-off was greater than 10 min.
- The drive distance before engine shut-off was more than 5 kilometers (3.1 miles).
- The ignition is OFF.

- The ambient air temperature at the end of the drive cycle is between 0-32°C (32-93°F).
- DTC P0442 runs once per drive cycle during the hot soak period after the ignition is turned OFF and may require up to 45 min to complete. The controller will not make more than 2 test attempts per day. The time since the last completed EONV test must be at least 17 hours

CONDITIONS FOR SETTING THE DTC

- The ECM detects a leak in the EVAP system that is greater than a calibrated amount.
- The ECM must complete several EONV tests before the diagnostic can turn the MIL on or off.

ACTION TAKEN WHEN THE DTC SETS

DTC P0442 is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P0442 is a Type A DTC.

DIAGNOSTIC AIDS

- The evaporative emission system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. When injecting smoke at the service port tool temporarily leave the EVAP vent solenoid valve open until smoke is observed then close the system and continue testing.
- To help locate intermittent leaks using the **EN 41413-A: EEST**, move all evaporative emission components while observing smoke with the **EN 41413-SPT: White Light**.
- Individual components can be isolated and tested using adapters in the **EN 41413-300: Kit**.
- A condition may exist where a leak in the evaporative emission system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the evaporative emission system and then observe the fuel tank pressure parameter for vacuum decay.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Description and Operation

Evaporative Emission Control System Description

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48096:** EVAP Service Port Access Tool
- **EN 41413 A:** Evaporative Emissions System Tester (EEST)
- **EN 41413 300:** EVAP Cap and Plug Kit
- **EN 41413 SPT:** High Intensity White Light

For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM TESTING

NOTE:

- Refer to the **EN 41413-A: EEST** operation manual for detailed instructions in **Evaporative Emission System Diagnosis** .
- Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize.
- Ensure that the underbody temperature of the vehicle and the tester are similar.

1. Disconnect the purge tube at the quick connector on the evaporative emission canister side of the Q12 evaporative emission canister purge solenoid valve and install the **CH 48096:** Port Tool.
2. Connect the **EN 41413-A: EEST** to the **CH 48096:** Port Tool.
3. Using a scan tool close the evaporative emission canister vent solenoid valve to seal the evaporative emission system.
4. Use the flow meter on the **EN 41413-A: EEST**, calibrated to 0.51 mm (0.020 in) to determine that there is no leak in the evaporative emission system.
 - If a leak is detected, use the **EN 41413-A: EEST** to apply smoke to the evaporative emission system at the purge tube until the leak is located using the **EN 41413-SPT: White Light**.

REPAIR VERIFICATION

1. Seal the EVAP system and use the flow meter on the **EN 41413-A: EEST**, calibrated to 0.51 mm (0.020 in) to determine that there is no leak in the EVAP system.
2. Clear DTCs.

DTC P0443 OR P0449 (W/LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0443

Evaporative Emission (EVAP) Purge Solenoid Control Circuit

DTC P0449

Evaporative Emission (EVAP) Vent Solenoid Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 1 Voltage - Purge Supply	P0443	P0443	P0443	-	-
Battery Positive - Vent Supply	P0449	P0449	P0449	-	-
EVAP Purge Solenoid Control	P0443	P0443	P0443	P0443	-
EVAP Vent Solenoid Control	P0449	P0449	P0449	P0449	-

CIRCUIT/SYSTEM DESCRIPTION

An ignition voltage is supplied directly to the evaporative emission (EVAP) canister purge solenoid valve. The engine control module (ECM) grounds the EVAP canister purge solenoid valve control circuit through an internal switch called a driver. The ECM monitors the status of the driver. The EVAP canister purge solenoid valve is pulse width modulated (PWM). A scan tool will display the amount of ON time as a percentage.

Battery voltage is supplied to the EVAP canister solenoid valve. The ECM grounds the EVAP canister vent solenoid valve control circuit through an internal switch called a driver. The ECM monitors the status of the driver. A scan tool will display the commanded state of the EVAP canister vent solenoid valve as ON or OFF.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON.
- The system voltage is between 9-18 V.
- DTCs P0443 and P0449 run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0443 and P0449 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P0443 and P0449 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Description and Operation

Evaporative Emission Control System Description

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Troubleshooting with a Test Lamp
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

P0443

1. Ignition ON, engine OFF, you should hear a clicking sound when the EVAP canister purge solenoid valve is commanded to 50 % with a scan tool. The clicking sound should stop when the EVAP canister purge solenoid valve is commanded to 0 %. The rate at which the valve cycles should increase when the commanded state is increased, and decrease when the commanded state is decreased.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

P0449

1. Ignition ON, engine OFF, command the EVAP vent solenoid ON and OFF with a scan tool.
2. Listen for a click when the valve operates. Verify that both the ON, and the OFF states are commanded.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within

the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the Q12 EVAP canister purge or Q13 vent solenoid valve.
2. Ignition ON, verify that a test lamp illuminates between the voltage supply circuit terminal A and ground.
 - If the test lamp does not illuminate, test the voltage supply circuit for a short to ground or an open/high resistance. If the circuit tests normal and the voltage supply circuit fuse is open, test or replace the EVAP canister purge solenoid.
3. Connect a test lamp between the voltage supply circuit terminal A and the control circuit terminal B.
4. Command the EVAP canister purge solenoid valve to 50 % with a scan tool, or the EVAP canister vent solenoid valve ON and OFF. The test lamp should respond to the command.
 - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
 - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, replace the appropriate solenoid valve.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Evaporative Emission Canister Purge Solenoid Valve Replacement (LF1)**
- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0446

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0446

Evaporative Emissions (EVAP) Vent System Performance

CIRCUIT/SYSTEM DESCRIPTION

This DTC tests the evaporative emission (EVAP) system for a restricted or blocked EVAP vent path that would

cause excess amounts of vacuum to be developed in the EVAP system. With the purge valve open and the canister vent valve open, if the EVAP system vacuum goes above a calibrated threshold, the test will fail.

TYPICAL SCAN TOOL DATA

Fuel Tank Pressure Sensor Signal Voltage	Fuel Tank Pressure
1.5 V	Atmospheric Pressure/BARO
Less than 1.5 V	Positive Pressure
More than 1.5 V	Negative Pressure/Vacuum

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P0446 failed, DTCs P0450, P0451, P0452, and P0453 must run and pass.
- DTC P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0221, P0222, P0223, P0443, P0449, P0451, P0452, P0453, P0458, P0459, P0496, P0497, P0498, P0499, P0560, P0562, P0563, P0700, P2122, P2123, P2127, P2128 or P2138 is not set.
- The ignition voltage is 10-18 volts.
- The Closed Loop fuel control is enabled.
- The engine run time is greater than 10 minutes or the fuel trim is stable.
- The engine is idling.
- The Fuel Tank Pressure is between -18.7 and +9.8 mm Hg (-10.0 and +5.2 in. H2O).
- The ambient air temperature (AAT) is between 2-32°C (35-90°F).
- The ECT and the IAT are within 10°C (18°F) of each other at engine start-up.
- The barometric pressure (BARO) is greater than 68 kPa.
- The long term fuel trim remains steady, less than 3 percent change in 200 ms over a period of 8 seconds.
- The fuel level is between 11-88 percent.
- The vehicle speed sensor (VSS) is less than 3 km/h (2 mph).
- The above conditions exist for greater than 5 seconds.
- DTC P0446 will attempt to run up to 10 times or until the test completes successfully once per ignition cycle.

CONDITIONS FOR SETTING THE DTC

- The Fuel Tank Pressure Sensor is less than -7.5 mm Hg (-4.0 in. H2O).
- The condition is exists for greater than 4 seconds or a cumulative of 30 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P0446 is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P0446 is a Type B DTC.

DIAGNOSTIC AIDS

An intermittent condition could be caused by a damaged EVAP vent housing, a temporary blockage at the EVAP vent valve inlet or a pinched vent hose. A blockage in the vent system may also cause a poor fuel fill problem.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON and fuel cap removed, verify that the Fuel Tank Pressure Sensor parameter is between 1.3-1.7 volts.
 - If not within the specified range, go to the fuel tank pressure sensor section in Circuit/System Testing.
2. Install the fuel cap.
3. With the engine running, the EVAP canister vent solenoid valve open, use a scan tool to command the EVAP canister purge solenoid valve to 100 percent. The fuel tank vacuum should not increase to more than -15 mmHg (-8 inches H₂O).
 - If the fuel tank vacuum is greater than the specified range, go to the restriction section in Circuit/System Testing.
4. Using the scan tool, decrease the canister purge duty cycle from 100 percent to 0 percent. The vacuum should decrease to near zero.
 - If the fuel tank vacuum does not return to zero or appears to decrease too slowly go to the restriction section in Circuit/System Testing.

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

IMPORTANT: Perform the Circuit/System Verification before proceeding with the Circuit/System Testing.

Restriction

1. With the engine running, the EVAP canister vent solenoid valve open, and the EVAP canister purge solenoid valve commanded to 100 percent, the fuel tank vacuum should not increase to more than -15 mmHg (-8 inches H₂O).
 - If the fuel tank vacuum is greater than the specified value, isolate the restriction by disconnecting one component at a time while the EVAP canister purge solenoid valve is commanded to 100 percent and the vent valve is open.
2. Using the scan tool, decrease the canister purge duty cycle from 100 percent to 0 percent. The vacuum should decrease to near zero.
 - If the fuel tank vacuum does not return to zero, or appears to decrease too slowly, inspect the components in the EVAP vent system for a restriction.

Fuel Tank Pressure Sensor

1. Ignition OFF, disconnect the harness connector at the fuel tank pressure sensor.
2. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the fuel tank pressure sensor.

REPAIR PROCEDURES

Evaporative Emission Canister Vent Solenoid Valve Replacement

REPAIR VERIFICATION

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

With the engine running, the EVAP canister vent solenoid valve open and the EVAP canister purge solenoid valve commanded to 100 %, the fuel tank vacuum should not increase to more than -15 mmHg (-8 inches H₂O).

DTC P0451-P0454 (W/LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0451

Fuel Tank Pressure Sensor Performance

DTC P0452

Fuel Tank Pressure Sensor Circuit Low Voltage

DTC P0453

Fuel Tank Pressure Sensor Circuit High Voltage

DTC P0454

Fuel Tank Pressure Sensor Intermittent

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Tank Pressure Sensor 5V Reference	P0452, P0532, P0641	P0451	P0446, P0452	P0453, P0641	-
Fuel Tank Pressure Sensor Signal	P0452	P0451	P0452	P0453	P0451, P0454
Fuel Tank Pressure Sensor Low Reference	-	P0446, P0451	P0446	-	P0451

TYPICAL SCAN TOOL DATA

Fuel Tank Pressure Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF Parameter Normal Range: 1.3-1.7 V			
Fuel Tank Pressure Sensor 5V Reference	0 V	0 V	4.2-5 V
Fuel Tank Pressure Sensor Signal	0 V	0 V	5 V
Fuel Tank Pressure Sensor Low Reference	-	4.5 V	-

CIRCUIT/SYSTEM DESCRIPTION

The fuel tank pressure sensor measures air pressure or vacuum in the evaporative emission (EVAP) system. The engine control module (ECM) supplies a 5V reference and a low reference circuit to the fuel tank pressure

sensor. The fuel tank pressure sensor signal voltage varies depending on EVAP system pressure or vacuum. The controller also uses this fuel tank pressure signal to determine atmospheric pressure for use in the engine-off small leak test, DTC P0442. Before using this signal as an atmospheric reference it must first be re-zeroed.

CONDITIONS FOR RUNNING THE DTC

P0451

- DTC P0451 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- The number of times this test runs can range from 0-2 per engine-off period. The length of the test can be up to 10 minutes.

P0452 and P0453

DTC P0452 and P0453 run continuously when the ignition is ON.

P0454

- DTC P0454 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- This test can run once per engine-off period. The length of the test can be up to 10 minutes.
- A refueling event is not detected.

CONDITIONS FOR SETTING THE DTC

P0451

This DTC will set if the controller is unable to re-zero the fuel tank pressure sensor voltage within a calibrated range during the engine-off small leak test, P0442.

P0452

The fuel tank pressure sensor voltage is less than 0.1V for more than 5 seconds.

P0453

The fuel tank pressure sensor voltage is more than 4.9V for more than 5 seconds.

P0454

If, during the engine-off natural vacuum small leak test, P0442, the ECM detects an abrupt fuel tank pressure signal change, other than a refueling event, this DTC will set. An abrupt change is defined as a change of 0.45 inch H₂O in the span of 1 second.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

DIAGNOSTIC AIDS

P0451 and P0454

- A restriction in the EVAP canister or vent lines could prevent fuel vapor pressure from bleeding off fast enough. If the vent system cannot bleed off pressure fast enough, the re-zero procedure may not complete successfully, which could cause this code to set.
- Ensure that the reference port on the fuel tank pressure sensor is unobstructed.
- An fuel tank pressure sensor that is skewed or does not have a linear transition from low to high may cause this code to set. Scan tool output controls, snapshot, and plot functions can help detect erratic sensor response. To test the sensor signal under vacuum conditions, use the Quick Snapshot and the Purge/Seal functions to capture data while commanding purge to 20 percent, then plot the data to look for erratic sensor operation. A similar test can be done for the pressure side of the sensor operation by applying pressure with the **J 41413-200**: EEST while taking a snapshot.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 41413-200: Evaporative Emission System Tester (EEST)

CIRCUIT/SYSTEM VERIFICATION

1. Remove the fuel cap.
2. Ignition ON, engine OFF.
3. Observe the Fuel Tank Pressure Sensor parameter with a scan tool.
4. The fuel tank pressure Sensor parameter should be 1.3-1.7 V.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B150 fuel tank pressure sensor.
2. Ignition OFF, test for less than 5 ohms of resistance between the low reference circuit terminal and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2V between the 5V reference circuit terminal and ground.
 - If less than the specified range, test the 5V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - If greater than the specified range, test the 5V reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Verify the scan tool B150 fuel tank pressure sensor parameter is less than 0.2V.
 - If greater than the specified range, test the signal circuit terminal for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Install a 3A fused jumper wire between the signal circuit terminal and the 5V reference circuit terminal. Verify the scan tool fuel tank pressure sensor parameter is greater than 4.7V.
 - If less than the specified range, test the signal circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, test or replace the B150 fuel tank pressure sensor.

REPAIR PROCEDURES

- **Fuel Tank Pressure Sensor Replacement**
- For DTC P0452 or P0453, always perform the **Diagnostic Repair Verification** after completing the diagnostic procedure
- For DTC P0451 or P0454, clear DTCs with a scan tool
- **Control Module References** for ECM replacement, setup, and programming

DTC P0455 (W/LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0455

Evaporative Emission System Large Leak Detected

CIRCUIT/SYSTEM DESCRIPTION

The ECM tests the Evaporative Emission (EVAP) System for a large leak or restrictions to the purge path in the EVAP system. When the enabling criteria has been met the ECM commands the evaporative emission canister vent solenoid valve ON and the evaporative emission canister purge solenoid valve ON, allowing vacuum into the evaporative emission system. The ECM monitors the fuel tank pressure sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time.

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P0455 failed, DTC P0496 must run and pass.
- DTCs P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0442, P0443, P0449, P0451, P0452, P0453, P0454, P0464, P0496, P0608, P0609, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138 are not set.
- The ignition voltage is between 11-18 V.
- The barometric pressure (BARO) is more than 74 kPa.
- The fuel level is between 10-90 percent.
- The engine coolant temperature (ECT) at start-up is less than 35°C (95°F).
- The intake air temperature (IAT) is between 4-30°C (39-86°F).
- DTC P0455 runs once per cold start when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The evaporative emission system is not able to achieve or maintain a calibrated level of vacuum within a set amount of time.

ACTION TAKEN WHEN THE DTC SETS

DTC P0455 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0455 is a Type B DTC.

DIAGNOSTIC AIDS

- Inspect for a loose, missing, damaged, or incorrect fuel fill cap.
- Inspect for a damaged fuel filler neck seal surface.
- A blockage or restriction in the evaporative emission purge solenoid valve, purge pipe, evaporative emission canister, or vapor pipe, can cause this DTC to set.
- The evaporative emission system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. Close the system once smoke is observed.
- To help locate intermittent leaks using the **J 41413-200: EEST**, move all evaporative emission components while observing smoke with the **J 41413-SPT: White Light**.
- Individual components can be isolated and tested using adapters in the **J 41413-300: Kit**.
- A condition may exist where a leak in the evaporative emission system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the evaporative emission system and then observe the fuel tank pressure parameter for vacuum decay.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48096:** Evaporative Emissions Service Access Port Tool
- **J 41415-30:** Fuel Tank Adapter
- **J 41413-200:** Evaporative Emissions System Tester (EEST)
- **J 41413-300:** Evaporative Emissions Cap and Plug Kit
- **J 41413-311:** Evaporative Emissions Plug
- **J 41413-SPT:** High Intensity White Light
- **J 41413-VLV:** Evaporative Emissions Service Port Vent Tool
- For equivalent regional tools, refer to **Special Tools** .

CIRCUIT/SYSTEM TESTING

NOTE:

- **Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize.**
- **Refer to the J 41413-200: EEST operation manual for detailed instructions in Evaporative Emission System Diagnosis .**

1. Disconnect the purge tube at the quick connector on the evaporative emission canister side of the Q12 evaporative emission canister purge solenoid valve. Install the **CH 48096:** Port Tool between the disconnected purge tube and the purge solenoid valve. Connect the **J 41413-200:** EEST to the service access port tool.
2. Use a scan tool to seal the evaporative emission system.
3. Use the flow meter on the **J 41413-200:** EEST, calibrated to 0.51 millimeter (0.020 inch) to determine that there is no leak in the evaporative emission system.
 - If a leak is detected, use the **J 41413-200:** EEST to apply smoke to the evaporative emission system at the purge tube until the leak is located using the **J 41413-SPT:** White Light.
4. To test for a restriction, install the **J 41415-30:** Adapter to the fuel tank filler neck. Connect the **J 41413-200:** EEST to the adapter.
5. Allow the engine to idle.
6. Use the Purge/Seal function to seal the system with a scan tool.
7. Command the EVAP Purge Solenoid Valve to 30 percent.
8. The vacuum/pressure gauge on the **J 41413-200:** EEST and the fuel tank pressure parameter on the scan tool should both show vacuum.
 - If the vacuum/pressure gauge shows vacuum, but the fuel tank pressure parameter does not show vacuum, replace the fuel tank pressure sensor.
 - If neither the fuel tank pressure parameter nor the vacuum/pressure gauge shows vacuum, repair the restriction in the purge path.
9. Verify that the vacuum increases to the abort limit on the scan tool or more than 3.2 V, and the values are similar between the scan tool and the vacuum/pressure gauge on the **J 41413-200:** EEST.
 - If the values are not similar, or the voltage did not reach 3.2 V, replace the B150 fuel tank pressure sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Fuel Tank Pressure Sensor Replacement

DTC P0496

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0496

Evaporative Emissions (EVAP) System Flow During Non-Purge

CIRCUIT DESCRIPTION

This DTC tests for continuous intake manifold vacuum flow to the Evaporative Emission (EVAP) System. The control module seals the EVAP system by commanding the EVAP canister purge solenoid valve Closed and the EVAP canister vent solenoid valve Closed. The control module monitors the fuel tank pressure (FTP) sensor to determine if a vacuum is being drawn on the EVAP system. If vacuum in the EVAP system is greater than a predetermined value within a predetermined time, this DTC sets.

FTP Sensor Signal Voltage	Fuel Tank Pressure
High, Approximately 1.5 Volts or More	Negative Pressure/Vacuum
Low, Approximately 1.5 Volts or Less	Positive Pressure

Conditions for Running the DTC

- Before the engine control module (ECM) can report DTC P0496 failed, DTCs P0450, P0451, P0452, and P0453 must run and pass.
- DTC P0100, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0443, P0446, P0449, P0450, P0451, P0452, P0453, P0458, P0459, P0498, P0499, P0560, P0562, P0563, P0700, P2122, P2123, P2127, P2128, P2138, P2227, P2228, or P2229 is not set.
- The fuel system is in closed loop.
- The engine run time is greater than 10 minutes, or the long term fuel trim is stable.
- The vehicle speed sensor (VSS) is less than 3 km/h (2 mph).
- The engine is idling.
- The ignition voltage is between 10-18 volts.

- The Closed Loop fuel control is enabled.
- The fuel tank pressure (FTP) is between -10.0 and +5.0 in. H₂O (-18.7 and +9.8 mm Hg).
- The ambient air temperature is between 2-32°C (36-90°F).
- The start-up engine coolant temperature (ECT) is within 10°C (18°F) of ambient air temperature
- The fuel tank level is between 11-88 percent.
- The barometric pressure (BARO) is greater than 68 kPa.
- The above conditions are met for greater than 30 seconds.
- DTC P0496 will attempt to run up to 10 times or the test completes successfully once per ignition cycle.

CONDITIONS FOR SETTING THE DTC

- The control module detects vacuum during a non-purge condition.
- The condition exists for greater than 4 seconds or for a cumulative of 30 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTC P0496 is a Type A/B DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P0496 is a Type A/B DTC.

DIAGNOSTIC AIDS

- Observe the Freeze Frame/Failure Records vehicle mileage since the diagnostic test last failed may help determine how often the condition occurs that caused the DTC to set. This may assist in diagnosing the condition.
- The EVAP system tests run when engine is first started and meets The Conditions for Running the DTC. An intermittent condition could be caused by an improperly installed or damaged EVAP canister purge solenoid valve, or by a temporary blockage or restriction in the EVAP canister purge solenoid valve.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Evaporative Emission Control System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Disconnect the Q12 EVAP purge solenoid valve electrical harness connector.
2. Start the engine.
3. Command the Q13 EVAP vent solenoid valve Closed with a scan tool.
4. Increase the engine speed to 1,200-1,500 RPM.
5. Observe the scan tool fuel tank pressure (FTP) sensor parameter. Verify the scan tool FTP sensor parameter is -0.9 to +0.9 mm Hg (-0.5 to +0.5 in. H₂O).
 - If not within the specified range, replace the Q12 EVAP purge solenoid valve.
6. Ignition ON, engine OFF, disconnect the EVAP purge hose/pipe at the Q12 EVAP purge solenoid valve.
7. Observe the scan tool FTP sensor parameter. Verify the FTP sensor parameter is -0.9 to +0.9 mm Hg (-0.5 to +0.5 in. H₂O).
 - If not within the specified range, replace the B150 FTP sensor.

REPAIR PROCEDURES

- Evaporative Emission Canister Purge Solenoid Valve Replacement (LF1)
- Fuel Tank Pressure Sensor Replacement
- Control Module References for engine control module replacement, setup, and programming

REPAIR VERIFICATION

1. Start the engine.
2. Command the Q13 EVAP vent solenoid valve Closed with a scan tool.
3. Increase the engine idle to 1,200-1,500 RPM.
4. Observe the scan tool FTP sensor parameter. Verify the FTP sensor parameter is -0.9 to +0.9 mm Hg (-0.5 to +0.5 in. H₂O).
5. Clear the DTCs with a scan tool.

DTC P0506 OR P0507 (LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0506

Idle Speed Low

DTC P0507

Idle Speed High

CIRCUIT/SYSTEM DESCRIPTION

The throttle actuator control (TAC) motor is a DC motor that is part of the throttle body assembly. The TAC motor drives the throttle valve. The engine control module (ECM) controls the TAC motor based on throttle position sensor input. The idle speed is controlled by the ECM based on various inputs. The ECM commands the TAC motor to open or close the throttle valve in order to maintain the desired idle speed.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0068, P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0171, P0172, P0174, P0175, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300-P0306, P0351-P0356, P0461-P0464, P0496, P0627, P0628, P0629, P0722, P1516, P2066-P2068, are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant temperature (ECT) is greater than 60°C (140°F).
- The engine run time is greater than 60 seconds.
- The ignition voltage is between 11-18 volts.
- The transmission is not changing gears.
- The torque converter clutch (TCC) is not changing states.
- The intake air temperature (IAT) is warmer than -20°C (-4°F).
- The vehicle speed is less than 3 km/h (2 mph).
- The commanded RPM is steady within 25 RPM.
- The engine is idling for greater than 5 seconds.
- The DTCs run when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0506

The actual engine speed is 94 RPM less than the desired idle speed for 10 seconds.

P0507

The actual engine speed is 188 RPM greater than the desired idle speed for 10 seconds.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0506 and P0507 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0506 and P0507 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify there are no other DTCs set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.
2. Idle the engine at the normal operating temperature. Compare the Desired Idle Speed to the actual Engine Speed with a scan tool. The actual Engine Speed should not be less than 100 RPM of the Desired Idle Speed or 200 RPM greater than the Desired Idle Speed.
3. Allow the engine to idle within the Conditions for Running the DTC. DTCs P0506 or P0507 should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You

may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

Verify none of the following conditions exist:

P0506

- Excess deposits in the Q38 throttle body. Refer to **Throttle Body Inspection and Cleaning** .
- Restricted exhaust
- Mechanical conditions that limits engine speed
- Parasitic load on the engine-For example, a transmission condition, a belt driven accessory condition.
 - If a condition is found, repair as necessary.

P0507

- Vacuum leaks
- A throttle valve that does not close correctly
- Verify the correct operation of the crankcase ventilation system. Inspect for the following conditions:
 - The routing of the positive crankcase ventilation (PCV) system
 - Vacuum leaks in the PCV system-Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
- If a condition is found, repair as necessary.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Throttle Body Assembly Replacement (LF1)

DTC P050D

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P050D

Cold Start Rough Idle

CIRCUIT/SYSTEM DESCRIPTION

During a cold start, the engine control module (ECM) commands dual-pulse mode during Open Loop operation to improve cold start emissions. In dual-pulse mode, the injectors are energized twice during each injection event. As with misfire diagnosis, in dual-pulse mode the ECM monitors the crankshaft position sensor and the camshaft position sensors to calculate crankshaft rotation speed. In normal operation, optimum fuel delivery during dual-pulse mode produces a steady crankshaft rotation speed. If the variations exceed a calibrated value, the code will be set.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0010, P0011, P0013, P0014, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0089, P0090-P0092, P00C6, P00C8, P00C9, P00CA, P0101-P0103, P0106-P0108, P0112-P0114, P0116-P0118, P0121-P0123, P0128, P0192, P0193, P0201-P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0315, P0335, P0336, P0351-P0356, P0627-P0629, P069E, P0716, P0717, P0722, P0723, P0850-P0852, P1248, P1249, P124A, P124B, P124C, P124D, P1258, P135A, P135B, P150C, P163A, P1762, P1763, P1915, P2122, P2123, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P228C, P228D, U0109 are not set.
- The catalyst temperature is less than 100°C (212°F).
- The engine coolant temperature is warmer than 10°C (14°F).
- The barometric pressure is greater than 70 kPa.
- The engine speed is between 450-1800 RPM.
- The engine is running and a cold start has been detected.
- DTC P050D runs once per cold start.

CONDITIONS FOR SETTING THE DTC

This DTC will set if the ECM detects variations in crankshaft rotation speed caused by the lack of adequate fuel delivery during dual-pulse mode.

ACTION TAKEN WHEN THE DTC SETS

- DTC P050D is a Type B DTC.
- The ECM disables dual pulse mode and energizes the fuel injector as it would for a warm engine.

CONDITIONS FOR CLEARING THE DTC

DTC P050D is a Type B DTC.

DIAGNOSTIC AIDS

- This DTC may be set with a misfire DTC, however the existence of this DTC is a higher priority and indicates the condition to diagnose is related to fuel and/or injectors, not the ignition/spark system.
- A restricted fuel injector may cause this DTC to set.

- High resistance in the circuits of the injectors could set this DTC without setting an injector DTC. Test the injector circuits of the affected cylinders for a high resistance if you suspect a condition.
- A drop in system voltage during cold start may set this DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

NOTE: **Circuit/System Testing requires cold start. Do not start vehicle prior to connecting scan tool and preparing to evaluate the condition during engine crank.**

1. Start the engine and observe the Cylinder 1-4 Current Misfire Counters during the first 500 engine cycles. The Cylinder 1-4 Current Misfire Counters should not be incrementing.
 - If the misfire counters are incrementing on one or more cylinders, verify that the following conditions do not exist:
 - Fuel pressure that is too low or too high-Refer to **Fuel System Diagnosis** .
 - Contaminated fuel-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
2. If all conditions test normal, replace fuel injectors as indicated by high misfire counts.

REPAIR PROCEDURES

- **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF1)**
- **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1)**

REPAIR VERIFICATION

NOTE: **Repair Verification requires cold start.**

1. Ignition ON, engine OFF, clear the DTCs with a scan tool.
2. Start the engine.
3. Verify the DTC does not reset.

DTC P0601-P0604, P0606, P0607, P0610, P062B, P062F, P0630, P16F3, OR P2610 (LF1, LFW, LWR)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0606

Control Module Processor Performance

DTC P062B

Control Module Fuel Injector Control Performance

DTC P062F

Control Module Long Term Memory Performance

DTC P0630

VIN Not Programmed or Mismatched - Engine Control Module (ECM)

DTC P16F3

Control Module Redundant Memory Performance

DTC P2610

Control Module Ignition Off Timer Performance

CIRCUIT/SYSTEM DESCRIPTION

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed, or is programmed incorrectly.

CONDITIONS FOR RUNNING THE DTC

P0601, P062B, P0630, P16F3

These DTCs run continuously when the ignition is ON.

P0602, P0603, P062F

These DTCs run at power up.

P0604

DTC P0604 runs continuously when the ignition is ON. First memory scan may take up to 30 s.

P0606

- System voltage is greater than 6 V.
- Reduced engine power is not active.
- DTC P0606 runs continuously when the above conditions are met.

P2610

- The intake air temperature is between -40 to +80°C (-40 to +176°F).
- DTCs P0111, P0112, P0113 are not set.
- DTC P2610 runs on ECM power down.

CONDITIONS FOR SETTING THE DTC

The ECM detects an internal failure or incomplete or incorrect programming.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P062F, P0630 and P16F3 are Type A DTCs.
- DTC P2610 is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P062F, P0630 and P16F3 are Type A DTCs.
- DTC P2610 is a Type B DTC.

DIAGNOSTIC AIDS

Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set. Verify for the following:

- The battery cables are clean and tight, and the battery is fully charged-Refer to **Battery Inspection/Test** .
- The ECM ground circuits do not have an open or high resistance
- The ECM power circuits do not have an open, short to ground, or high resistance

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the DTC information with a scan tool. DTC P0601, P0602, P0603, P0604, P0606, P062B, P062F, P0630, P16F3, or P2610 should not set.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition ON, observe the DTC information with a scan tool.
 - If DTC P0602 or P0630 failed this ignition, program the K20 ECM. If the DTC resets, replace the K20 ECM.
2. Observe the DTC information with a scan tool. DTC P0601, P0603, P0604, P0606, P062B, P062F, P16F3, or P2610 should not set.
 - If a DTC failed this ignition, replace the K20 ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for engine control module replacement, setup, and programming

DTC P0601-P0604, P0606, OR P062F

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0601

Control Module Read Only Memory (ROM)

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory (RAM)

DTC P0606

Control Module Internal Performance

DTC P062F

Control Module Long Term Memory Performance

CIRCUIT/SYSTEM DESCRIPTION

The internal fault detection is handled inside the fuel pump control module. No external circuits are involved.

CONDITIONS FOR RUNNING THE DTC

The fuel pump control module runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module has detected an internal malfunction.

ACTION TAKEN WHEN THE DTC SETS

DTC P0601, P0602, P0603, P0604, P0606 and P062F are type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTC P0601, P0602, P0603, P0604, P0606 and P062F are type A DTCs.

REFERENCE INFORMATION

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

CIRCUIT/SYSTEM VERIFICATION

NOTE: This DTC may be stored as a history DTC without affecting the operation of the module. If stored only as a history DTC and not retrieved as a current DTC, do not replace the module.

Verify that DTC P0602 is not set.

- If the DTC is set, program the K27 fuel pump control module.

Verify that DTCs P0601, P0603, P0604, P0606, and P062F are not set.

- If the DTCs are set, program the K27 fuel pump control module. If the DTCs reset, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for fuel pump control module replacement, setup, and programming

DTC P0627-P0629

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0627

Fuel Pump Enable Circuit

DTC P0628

Fuel Pump Enable Circuit Low Voltage

DTC P0629

Fuel Pump Enable Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Pump Enable	P0628, P069E	P0627, P069E	P0629	-

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) provides ignition voltage to the fuel pump flow control module whenever the engine is cranking or running. The control module enables the fuel pump flow control module as long as the engine is cranking or running, and ignition system reference pulses are received. While this enable voltage is being received, the fuel pump flow control module supplies a varying voltage to the in-tank fuel pump module in order to maintain the desired fuel line pressure.

CONDITIONS FOR RUNNING THE DTC

- The engine speed is greater than 0 RPM.
- The ignition voltage is between 11-18 V.
- The DTCs run continuously when the conditions above are met.

CONDITIONS FOR SETTING THE DTC

- The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match.
- The above condition is met for a minimum of 2.5 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0627, P0628, and P0629 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0627, P0628, and P0629 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Attempt to start the engine. Observe the DTC information with a scan tool. DTC P0627, P0628, or P0629 should not set.
2. Ignition ON, command the ECM Fuel Pump Enable ON and OFF with a scan tool while observing the following control circuit status parameters:
 - Fuel Pump Enable Circuit Low Voltage Test Status
 - Fuel Pump Enable Circuit Open Test Status
 - Fuel Pump Enable Circuit High Voltage Test Status

Each parameter should toggle between OK and Not Run or Not Run and OK.

3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the K27 fuel pump control module harness connector.
2. Connect a test lamp between the enable circuit terminal 20 of the fuel pump control module and ground.
3. Ignition ON, command the ECM Fuel Pump Enable ON and OFF with a scan tool. The test lamp should turn ON and OFF as commanded.
 - If the test lamp remains OFF all the time, test for a short to ground or an open/high resistance on the enable circuit. If circuit/connections test normal, replace the K20 ECM.
 - If the test lamp remains ON all the time, test for a short to voltage on the enable circuit. If circuit/connections test normal, replace the K20 ECM.
4. Ignition ON, test for 2-3 V on the enable circuit terminal 20 of the fuel pump control module.
 - If not within the specified range, replace the K20 ECM.
5. If all circuits/connections test normal, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for ECM or fuel pump control module replacement, setup, and programming

DTC P0641 OR P06A6

DIAGNOSTIC INSTRUCTIONS

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0641

5 V Reference Circuit

DTC P06A6

5 V Reference Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641	P0641, P06A6	P0641	P06A6
Signal	P018C	P018B, P018C	P018D	P018B
Low Reference	-	P0641, P06A6	-	P06A6

CIRCUIT/SYSTEM DESCRIPTION

The fuel pressure sensor is located on the fuel line. The fuel pressure sensor monitors the fuel pressure in the fuel line. The fuel pump control module monitors the voltage signal from the fuel pressure sensor.

CONDITIONS FOR RUNNING THE DTC

The ignition is ON.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module detects that the fuel pressure 5 V reference is above or below a predetermined voltage threshold.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0641 and P06A6 are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0641 and P06A6 are Type A DTCs.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect harness connector of the B47 fuel pressure sensor.

2. Ignition OFF, test for less than 1.0 ohms between the low reference circuit terminal 2 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
4. If all circuits test normal, replace the B47 fuel pressure sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for fuel pump control module replacement, setup, and programming

DTC P0641, P0651, P0697, OR P06A3 (ECM)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0641

5 V Reference 1 Circuit

DTC P0651

5 V Reference 2 Circuit

DTC P0697

5 V Reference 3 Circuit

DTC P06A3

5 V Reference 4 Circuit

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) has 4 5 V reference buses called 5 V reference 1, 5 V reference 2, 5 V

reference 3, and 5 V reference 4. Each reference bus provides a 5 V reference for more than one sensor. A short to ground or voltage on one of the 5 V reference circuits can affect all the components connected to that 5 V reference bus. The ECM monitors the voltage on the 5 V reference buses.

CONDITIONS FOR RUNNING THE DTC

DTCs P0641, P0651, P0697, P06A3 run continuously when the ignition is ON.

CONDITIONS FOR SETTING THE DTC

The 5 V reference circuit voltage is greater or less than a predetermined threshold.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0641, P0651, P0697, and P06A3 are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0641, P0651, P0697, and P06A3 are Type A DTCs.

DIAGNOSTIC AIDS

P0641

The 5 V reference 1 bus provides 5 V to the following sensors:

- B150 fuel tank pressure (FTP) sensor
- B17 barometric pressure (BARO) sensor, throttle inlet absolute pressure sensor
- B47B fuel rail pressure (FRP) sensor
- B1 A/C refrigerant pressure sensor
- All four B23 camshaft position sensors

P0651

The 5 V reference 2 bus provides 5 V to the following components:

- B26 crankshaft position sensor
- S87 economy mode switch

P0697

The 5 V reference 3 bus provides 5 V to the following sensors:

- B74 manifold absolute pressure (MAP) sensor
- B107 accelerator pedal position sensor 2

P06A3

The 5 V reference 4 bus provides 5 V to the following sensors:

- B106 throttle position sensor
- B107 accelerator pedal position sensor 1
 - It may be possible to locate the fault by disconnecting one component at a time from the affected 5 V reference bus while viewing the 5 V Reference Circuit Status parameter on the scan tool. The scan tool parameter will change from Malfunction to OK when the source of the fault is disconnected. If all components have been disconnected from the affected 5 V reference bus and a fault is still indicated, the fault may exist in the wiring harness.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. DTC P0641, P0651, P0697, or P06A3 should not set.
2. Observe the appropriate scan tool 5 V Reference Circuit Test Status parameter. The parameter should display OK.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: Additional DTCs will set when disconnecting the components.

1. Ignition OFF, disconnect the harness connector of all appropriate sensors for the applicable DTC. Refer to Diagnostic Aids.
2. Ignition ON, test for 4.8-5.2 V between one of the affected 5 V reference circuits and ground.
 - If the voltage is less than the specified range, test for a short to ground on the 5 V reference circuit for each affected component. If all circuits test normal, replace the K20 ECM.
 - If the voltage is greater than the specified range, test for a short to voltage on the 5 V reference circuit for each affected component. If all circuits test normal, replace the K20 ECM.

NOTE: A short to voltage on the signal circuit of certain components may cause this DTC to set.

3. Connect each component associated with the affected 5 V reference circuit one at a time while monitoring the appropriate scan tool 5 V Reference Voltage parameter. Verify the voltage remains 4.8-5.2 V.
 - If not the specified range when a component is connected, test the signal circuit of that component for a short to voltage. If the circuit tests normal, replace the component.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Fuel Tank Pressure Sensor Replacement
- Throttle Inlet Absolute Pressure Sensor Replacement
- Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)
- Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake
- Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust
- Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake
- Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust
- Accelerator Pedal Position Sensor Replacement
- Throttle Body Assembly Replacement (LF1)
- Crankshaft Position Sensor Replacement
- Air Conditioning Refrigerant Pressure Sensor Valve Replacement (LAF) or Air Conditioning Refrigerant Pressure Sensor Valve Replacement (LF1)
- Manifold Absolute Pressure Sensor Replacement
- Control Module References for engine control module replacement, setup, and programming

DTC P0650

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P0650

Malfunction Indicator Lamp (MIL) Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
MIL Voltage Supply	P0650	P0650	-	-
MIL Control	P0650*	P0650	P0650	-
* The MIL remains ON				

CIRCUIT/SYSTEM DESCRIPTION

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC). The MIL informs the driver that an emission system fault has occurred and that the engine control system requires service. The engine control module (ECM) monitors the MIL control circuit for conditions that are incorrect for the commanded state of the MIL. For example, a failure condition exists if the ECM detects low voltage when the MIL is commanded OFF, or high voltage when the MIL is commanded ON.

CONDITIONS FOR RUNNING THE DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 10-18 V.
- The ECM has commanded the MIL ON and OFF at least once during the ignition cycle.
- DTC P0650 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

The ECM detects an open, a short to ground, or a short to voltage on the circuit that controls the MIL.

ACTION TAKEN WHEN THE DTC SETS

DTC P0650 is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P0650 is a Type B DTC.

DIAGNOSTIC AIDS

If the condition is intermittent, move the related harnesses and connectors with the engine operating. Monitor the scan tool Circuit Test Status parameters for the component. The Circuit Test Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, command the MIL ON and OFF with a scan tool. The MIL should turn ON and OFF as commanded.
2. Ignition ON, observe each of the MIL Control Circuit Test parameters listed below with a scan tool:
 - The MIL Control Circuit Low Voltage Test Status
 - The MIL Control Circuit Open Test Status
 - The MIL Control Circuit High Voltage Test Status

Each parameter should display OK or Not Run.

3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the P16 instrument cluster.
2. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal X1 31 and ground.
 - o If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, replace the P16 instrument cluster.
3. Connect a test lamp between the control circuit terminal X1 25 and the ignition circuit terminal X1 31.
4. Command the MIL ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
 - o If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
 - o If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, replace the P16 instrument cluster.

REPAIR PROCEDURES

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Instrument Cluster Replacement (Equinox) or Instrument Cluster Replacement (Terrain)
- Control Module References for engine control module replacement, setup, and programming

DTC P0685 OR P0690

DIAGNOSTIC INSTRUCTIONS

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0685

Engine Controls Ignition Relay Control Circuit

DTC P0690

Engine Controls Ignition Relay Feedback Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

	Short to	Open/High	Short to	Signal
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Circuit	Ground	Resistance	Voltage	Performance
Battery Supply Voltage - Coil	P0685	P0685	-	-
Relay Control Circuit	P0685	P0685, P1682	P0685, P0690, P1682, P2101	-
Relay Feedback Circuit	-	-	P0690	-

TYPICAL SCAN TOOL DATA

Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status-Component Commanded OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded OFF Parameter Normal Range: The following illustrates the normal parameter state with no circuit conditions: • Component OFF-OK for Open/Short Gnd test and Not Run for Short To Volts test • Component ON-Not Run for Open/Short Gnd test and OK for Short To Volts test			
Battery Voltage	Malfunction	Malfunction	-
Engine Controls Ignition Relay Control Circuit	Malfunction	Malfunction	Not Run

Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status-Component Commanded ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded ON Parameter Normal Range: The following illustrates the normal parameter state with no circuit conditions: • Component OFF-OK for Open/Short Gnd test and Not Run for Short To Volts test • Component ON-Not Run for Open/Short Gnd test and OK for Short To Volts test			
Battery Voltage	Not Run	Not Run	-
Engine Controls Ignition Relay Control Circuit	Not Run	Not Run	Malfunction

CIRCUIT/SYSTEM DESCRIPTION

The engine controls ignition relay or engine control module relay is a normally open relay. The relay switch is held in the open position by spring tension. Battery positive voltage is supplied directly to the relay coil and the switch contact at all times. The engine control module (ECM) supplies the ground path to the relay coil control circuit via an internal integrated circuit called an output driver. When the ECM commands the engine control module relay ON, ignition voltage is supplied to several fuses in the under-hood fuse block.

The ignition voltage that is supplied to the ECM provides power to the internal ECM circuits associated with the throttle actuator control (TAC) operation. The ECM also monitors the voltage level on the ignition voltage circuit to confirm that the engine control module relay contacts have closed.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON.
- The ignition voltage is between 11-18 V.
- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P0685

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 s.

P0690

- The ECM detects the engine controls ignition relay feedback circuit is greater than 2 V when the relay is commanded OFF.
- The ECM detects the engine controls ignition relay feedback circuit is greater than 18 V when the relay is commanded ON.
- The condition is present for greater than 2 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P0685 and P0690 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P0685 and P0690 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

- Engine Controls Schematics
- Power Distribution Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Electrical Center Identification Views

- **Probing Electrical Connectors**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE:

- **A short to voltage on other components may cause DTC P0690 to set. If other DTCs are set, diagnose those DTCs first.**
- **If you were sent here from Engine Cranks But Does Not Run proceed to Circuit/System Testing.**

1. Ignition ON, command the Engine Controls (EC) Ignition Relay ON and OFF with a scan tool while observing the following EC Ignition Relay control circuit status parameters:
 - Engine Controls Ignition Relay Control Circuit Low Voltage Test Status
 - Engine Controls Ignition Relay Control Circuit Open Test Status
 - Engine Controls Ignition Relay Control Circuit High Voltage Test Status

Each parameter should toggle between OK and Not Run or Not Run and OK.

2. Ignition ON, view the DTC information with a scan tool. DTC P0685 or P0690 should not set.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Ignition OFF, disconnect the KR71 engine control module relay.
2. Verify that a test lamp illuminates between both of the following relay battery voltage circuit terminals and ground.
 - Terminal 86
 - Terminal 87
 - If the test lamp does not illuminate, test the relay battery voltage circuit for an open/high resistance.

NOTE: **The ignition voltage circuit is between the KR71 engine control module relay and the ECM. The ignition voltage circuit is a feedback circuit.**

3. Ignition ON, verify that a test lamp does not illuminate between the ignition voltage circuit terminal 30 and ground.
 - If the test lamp illuminates, test the ignition voltage circuit for a short to voltage.
4. Connect a 20 A fused jumper wire between the relay switch B+ circuit terminal 87 and the relay switch ignition voltage circuit terminal 30.
5. Ignition ON, observe the scan tool EC Ignition Relay Feedback Signal parameter. The ECM should communicate, and the parameter should display 9-14 V.
 - If not the specified range, or the ECM does not communicate, test the ignition voltage circuit between the engine control module relay and the ECM for a short to ground or for an open/high resistance. If the circuit/connections test normal, replace the K20 ECM.
6. Ignition OFF, connect a DMM set to the diode setting between the control circuit terminal 85 and ground. Verify the DMM displays OL.
 - If not the specified value, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
7. Ignition ON, verify the DMM displays less than 1 V.
 - If not the specified range, test the control circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
8. If all circuits test normal, replace the KR71 engine control module relay.

COMPONENT TESTING

NOTE: **Depending on the application, the relay coil resistance will be within one of the following ranges.**

1. Test for one of the following resistance specifications between terminals 85 and 86 of the KR71 engine control module relay:
 - 70-110 ohms
 - 200-250 ohms
 - If not within the specified range, replace the KR71 engine control module relay.
2. Test for infinite resistance between the following terminals of the KR71 engine control module relay:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - If not the specified value, replace the KR71 engine control module relay.
3. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
 - If greater than the specified range, replace the KR71 engine control module relay.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for K20 ECM replacement, setup, and programming

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

DTC P069E

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P069E

Fuel Pump Control Module Requested MIL Illumination

CIRCUIT/SYSTEM DESCRIPTION

The fuel pump control module uses the serial data network to signal the engine control module (ECM) that the fuel pump control module is requesting malfunction indicator lamp (MIL) illumination. A DTC is set in the fuel pump control module, and the request for MIL illumination is sent when the fuel pump control module determines that a failure that affects emissions has occurred in the fuel pump control system. When the ECM receives the message from the fuel pump control module, DTC P069E will set in the ECM.

CONDITIONS FOR RUNNING THE DTC

The ignition is ON, or the engine is running.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module requests the ECM to illuminate the MIL.

ACTION TAKEN WHEN THE DTC SETS

- DTC P069E is a Type A DTC.
- DTC P069E will continue to be current or active as long as the fuel pump control module is requesting MIL illumination.

CONDITIONS FOR CLEARING THE DTC

DTC P069E is a Type A DTC.

DIAGNOSTIC AIDS

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the fuel pump control module will cause the fuel pump control module to request DTC P069E to be set in the ECM.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

CIRCUIT/SYSTEM VERIFICATION

NOTE: Correct any engine controls and communication DTCs before diagnosing fuel pump control module DTCs.

1. DTC P069E is an informational DTC. If there are no engine controls or communication DTCs, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for diagnosis of fuel pump control module DTCs.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

DTC P0700

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each of the diagnostic category.

DTC DESCRIPTOR

DTC P0700

Transmission Control Module (TCM) Requested MIL Illumination

CIRCUIT/SYSTEM DESCRIPTION

The diagnostic trouble code (DTC) indicates that an emission related transmission DTC set in the transmission control module (TCM). The engine control module (ECM) receives the TCM information over the serial data

circuit. The ECM turns ON the malfunction indicator lamp (MIL) when the TCM sends a message over the serial data circuit requesting MIL illumination. The DTC information for the ECM will only display DTC P0700, but the Freeze Frame/Failure Records data will display the transmission DTC that set.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON or the engine is operating.
- DTC P0700 runs continuously.

CONDITIONS FOR SETTING THE DTC

The ECM receives a serial data message from the TCM requesting the ECM to turn ON the MIL lamp.

ACTION TAKEN WHEN THE DTC SETS

DTC P0700 is a Type A DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P0700 is a Type A DTC.

DIAGNOSTIC AIDS

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the TCM can cause the TCM to request DTC P0700 to be set in the ECM.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

CIRCUIT/SYSTEM VERIFICATION

NOTE: **Correct any engine controls and communication DTCs before diagnosing TCM DTCs.**

1. DTC P0700 is an informational DTC. If there are no engine controls or communication DTCs, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for diagnosis of TCM DTCs.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

DTC P0856

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P0856

Traction Control Torque Request Circuit

CIRCUIT/SYSTEM DESCRIPTION

The electronic brake control module (EBCM) and the engine control module (ECM) simultaneously control the traction control. The ECM reduces the amount of torque supplied to the drive wheels and the EBCM actively applies the brakes to the front wheels in order to reduce torque. The EBCM sends a GMLAN serial data message to the engine control module (ECM) indicating the function that has been requested.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON.
- The DTCs run continuously once the above condition is met.

CONDITIONS FOR SETTING THE DTC

The ECM detects an invalid signal from the EBCM.

ACTION TAKEN WHEN THE DTC SETS

DTC P0856 is a Type C DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P0856 is a Type C DTC.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

CIRCUIT/SYSTEM VERIFICATION

1. Observe the Freeze Frame/Failure Records with a scan tool.
2. Clear the DTCs with a scan tool.
3. Ignition OFF for 30 seconds.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
 - If DTC P0856 failed this ignition, replace the EBCM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for EBCM replacement, setup, and programming.

DTC P1248, P1249, P124A, P124B, P124C, OR P124D

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P1248

Cylinder 1 Injector High Control Circuit Shorted to Control Circuit

DTC P1249

Cylinder 2 Injector High Control Circuit Shorted to Control Circuit

DTC P124A

Cylinder 3 Injector High Control Circuit Shorted to Control Circuit

DTC P124B

Cylinder 4 Injector High Control Circuit Shorted to Control Circuit

DTC P124C

Cylinder 5 Injector High Control Circuit Shorted to Control Circuit

DTC P124D

Cylinder 6 Injector High Control Circuit Shorted to Control Circuit

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Direct Fuel Injector High Voltage Supply Cylinder 1	P2147	P0201	P2148	P1248
Direct Fuel Injector High Voltage Control Cylinder 1	P0261	P0201	P0262	P1248
Direct Fuel Injector High Voltage Supply Cylinder 2	P2150	P0202	P2151	P1249
Direct Fuel Injector High Voltage Control Cylinder 2	P0264	P0202	P0265	P1249
Direct Fuel Injector High Voltage Supply Cylinder 3	P2153	P0203	P2154	P124A
Direct Fuel Injector High Voltage Control Cylinder 3	P0267	P0203	P0268	P124A
Direct Fuel Injector High Voltage Supply Cylinder 4	P2156	P0204	P2157	P124B
Direct Fuel Injector High Voltage Control Cylinder 4	P0270	P0204	P0271	P124B
Direct Fuel Injector High Voltage Supply Cylinder 5	P216B	P0205	P216C	P124C
Direct Fuel Injector High Voltage Control Cylinder 5	P0273	P0205	P0274	P124C
Direct Fuel Injector High Voltage Supply Cylinder 6	P216E	P0206	P216F	P124D
Direct Fuel Injector High Voltage Control Cylinder 6	P0276	P0206	P0277	P124D

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to each fuel injector on the injector high voltage supply circuits. The ECM energizes each fuel injector by grounding the high voltage control circuit of the fuel injector. The ECM monitors the status of the injector high voltage supply circuits and the fuel injector high voltage control circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.
- The ignition voltage is between 11-18 V.

- The DTCs run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P1248, P1249, P124A, P124B, P124C, or P124D

The ECM detects the injector high voltage supply circuit is shorted to the injector high voltage control circuit for greater than 2 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P1248, P1249, P124A, P124B, P124C, and P124D are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P1248, P1249, P124A, P124B, P124C, and P124D are Type A DTCs.

DIAGNOSTIC AIDS

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Solenoid Coil Test** .
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the DTC information with a scan tool. DTC P0685 or P1682 should not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine operating, observe the DTC information with a scan tool. DTC P1248, P1249, P124A, P124B, P124C, or P124D should not set.
3. Observe the scan tool Current Misfire Counter parameters. The Current Misfire Counters should not increment.
4. Ignition ON, observe the scan tool Cylinder 1-6 Injector Control Circuit Status parameters. Verify the Injector Control Circuit Status parameters display OK.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the appropriate multi-way harness connector X108 or X109, at the rear of the intake manifold.
2. Ignition ON, observe the appropriate scan tool Cylinder 1-6 Injector Control Circuit Status. The parameter should display Open.
 - If not the specified value, test the appropriate high voltage supply circuit, ECM side, for a short to ground or the appropriate high voltage control circuit, ECM side, for a short to voltage. If the circuits test normal, replace the K20 ECM.
3. Ignition ON, connect a test lamp between the appropriate high voltage supply circuit and the high voltage control circuit. The Injector Control Circuit Status should transition from Open to OK.
 - If not the specified value, test for the following conditions in the ECM side of the harness:
 - An open/high resistance in the high voltage supply circuit
 - An open/high resistance in the high voltage control circuit
 - A short to ground in the high voltage control circuit
 - A short to voltage in the high voltage supply circuit
 - If the circuits test normal, replace the K20 ECM.

NOTE: **Testing for the following steps is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.**

4. Ignition OFF, measure the resistance between the appropriate high voltage supply circuit and ground. The DMM should display OL ohms.
 - If less than the specified range, test the high voltage supply circuit and the high voltage control circuit for a short to ground. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector(s).
5. Test for 2-3 ohms between the appropriate high voltage supply circuit and high voltage control circuit.
 - If less than the specified range, test for a short between the high voltage supply circuit and high voltage control circuit. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector(s).
 - If greater than the specified range, test the high voltage supply circuit and high voltage control circuit for an open/high resistance. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector.

COMPONENT TESTING

NOTE: **The DMM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis.**

1. Remove the intake manifold and disconnect the appropriate Q17 fuel injector.
2. Test for 1.9-2.3 ohms at 20°C (68°F) between the high voltage supply circuit terminal 2 and the high voltage control circuit terminal 1 at the Q17 fuel injector.
 - If not within the specified range, replace the Q17 fuel injector.
3. Measure the resistance between each terminal at the Q17 fuel injector and the Q17 fuel injector housing/case. The DMM should display OL ohms.
 - If less than the specified value, replace the Q17 fuel injector.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF1)**
- **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P1255 OR P064A

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P064A

Fuel Pump Control Module Performance

DTC P1255

Fuel Pump Control Module Driver Over-temperature

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

The engine is running.

CONDITIONS FOR SETTING THE DTC

The fuel pump control module detects an over-temperature fault.

ACTION TAKEN WHEN THE DTC SETS

DTCs P064A and P1255 are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P064A and P1255 are Type A DTCs.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Verify that DTC P0231, P0232 or P023F are not set.
 - If any of those codes are set, refer to **DTC P0231, P0232, or P023F** .
2. Ensure that the entire undercarriage of the vehicle is clean, especially around the area where the K27 fuel pump control module is located. Clear all codes from the K27 fuel pump control module and test drive the vehicle. Verify that DTC P1255 or P064A do not set.
 - If DTC P1255 or P064A reset, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for fuel pump control module replacement, setup, and programming

DTC P135A OR P135B (LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P135A

Ignition Coil Supply Voltage Circuit Bank 1

DTC P135B

Ignition Coil Supply Voltage Circuit Bank 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Coil Supply Voltage Bank 1	P0201, P0203, P0205, P0300, P0351, P0353, P0355, P135A	P0201, P0203, P0205, P0300, P0351, P0353, P0355, P135A	-	-
Ignition Coil Supply Voltage Bank 2	P0202, P0204, P0206, P0300, P0352, P0354, P0356, P135B	P0202, P0204, P0206, P0300, P0352, P0354, P0356, P135B	-	-

CIRCUIT/SYSTEM DESCRIPTION

The ignition system on this engine uses an individual module/coil for each cylinder. The engine control module (ECM) monitors the ignition voltage from the fuse of each bank of coils to the ECM. The ECM uses this information to determine if the misfire is ignition coil voltage related.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON.
- The ignition module supply voltage is less than 2.5 V.
- The DTCs run continuously when the above condition is met.

CONDITIONS FOR SETTING THE DTC

The ECM detects a fault in an ignition coil control circuit for 50 out of 63 samples. Each sample runs on a 6.25 ms loop.

ACTION TAKEN WHEN THE DTC SETS

DTCs P135A and P135B are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P135A and P135B are Type A DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- Electronic Ignition System Description
- Engine Control Module Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information (LF1,LFW) or Engine Control Module Scan Tool Information (LAF) for scan tool information

CIRCUIT/SYSTEM VERIFICATION

With the ignition ON, observe the following scan tool parameters for each cylinder:

- Ignition Coil Supply Voltage Bank 1
- Ignition Coil Supply Voltage Bank 2
 - Each parameter should display ON.

CIRCUIT/SYSTEM TESTING

NOTE: **The ignition circuit supplies voltage to other components. Make sure you test all circuits for a short to ground or test all components for being shorted that share the ignition circuit.**

1. Ignition OFF, disconnect the harness connector at the appropriate T8 ignition coil.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground of each T8 ignition coil.

- If the test lamp does not illuminate, test the circuit for a short to ground or an open/high resistance.
 - If the circuit tests normal, with the ignition OFF, disconnect the harness connector at each T8 ignition coil and monitor the fuse while individually connecting each T8 ignition coil. If the fuse opens, replace the appropriate T8 ignition coil.
3. Ignition OFF, disconnect the K20 ECM harness connector X1.
 4. Ignition ON, connect a test lamp between the following ignition voltage circuits and ground:
 - X1 67
 - X1 62

The test lamp should illuminate on each circuit.

- If the test lamp does not illuminate, test the ignition circuit for an open/high resistance.
5. If all circuits/connections test normal, replace the K20 ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- T8 **Ignition Coil Replacement - Bank 1**
- T8 **Ignition Coil Replacement - Bank 2**
- **Control Module References** for K20 ECM replacement, setup, and programming

DTC P1400 (LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P1400

Cold Start Emission Reduction Control System

CIRCUIT/SYSTEM DESCRIPTION

The catalytic converter must be warmed to efficiently reduce the emissions. The cold start strategy is to reduce the amount of time it takes to warm the catalytic converter. During a cold start, the engine idle speed is elevated and spark timing is retarded to allow the catalyst to warm quickly. This diagnostic monitors the following to build an exhaust energy model:

- Engine speed

- Spark advance
- Throttle position
- Engine coolant temperature
- Engine runtime
- Park/neutral position
- Vehicle speed

The actual model is then compared to the expected exhaust energy model.

CONDITIONS FOR RUNNING THE DTC

- The engine is running, and a cold start has been detected.
- Vehicle speed is less than 3 km/h (2 mph).
- The engine is at idle with no input from the accelerator pedal.
- The calculated catalyst temperature is less than 100°C (212°F).
- Engine coolant is greater than 10°C (50°F) and less than 56°C (132°F).
- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0335, P0336, P0351, P0352, P0353, P0501, P0502, P0506, P0507, P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, P0641, P0651, P1101, P1516, P1682, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2176, P2610 are not set.

This DTC runs for 12 s within the first 17 s of start-up, or until the calculated catalyst temperature is greater than 900°C (1,652°F). This diagnostic runs once per trip when a cold start has been determined.

CONDITIONS FOR SETTING THE DTC

The actual exhaust energy model does not match the expected exhaust energy model.

ACTION TAKEN WHEN THE DTC SETS

DTC P1400 is a Type A DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P1400 is a Type A DTC.

REFERENCE INFORMATION

Description and Operation

Engine Control Module Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

DIAGNOSTIC AIDS

Any loading of the engine that lowers engine RPM, such as with partial application of the clutch, A/C cycling etc., during the first 17 s of engine run time may set this DTC.

CIRCUIT/SYSTEM VERIFICATION

1. Allow the engine to cool.
2. Start and idle the engine for at least 2 min.
3. DTC P1400 should run and pass.

CIRCUIT/SYSTEM TESTING

- Inspect the air intake system for the following:
 - Damage, restriction, or modification
 - Dirty or deteriorating air filter element
 - Crankcase ventilation system for correct operation-Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
 - Water intrusion
 - Vacuum leak and other un-metered air downstream of the mass air flow (MAF) sensor
 - Intake manifold leak
- Inspect the exhaust system for the following:
 - Water intrusion
 - Exhaust leak
 - Damaged, restricted, modified or enhanced exhaust system-Refer to **Symptoms - Engine Exhaust** .
- Inspect the engine mechanical for items that could alter the air flow into the combustion chamber. Refer to **Symptoms - Engine Mechanical** .

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

DTC P150C (LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P150C

Transmission Control Module Engine Speed Request Signal Message Counter Incorrect

CIRCUIT/SYSTEM DESCRIPTION

This diagnostic applies to communication integrity between the engine control module (ECM) and the transmission control module (TCM). The ECM determines that the engine speed signal counter is incorrect for the current vehicle operation.

CONDITIONS FOR RUNNING THE DTC

- The ignition switch is in Unlock, Accessory, Run or Crank.
- The system voltage is more than 5.23 V.
- DTCs P0601, P0602, P0603, P0604, P0606, P0607, P062F, P0641, P0651, P2610 and U0101 are not set.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the TCM engine speed request circuit does not match the expected engine speed request circuit. Each test runs in 5 milliseconds. This DTC runs continuously.

ACTION TAKEN WHEN THE DTC SETS

DTC P150C is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P150C is a Type B DTC.

REFERENCE INFORMATION

Description and Operation

Engine Control Module Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Engine Control Module Scan Tool Information (LF1,LFW) or **Engine Control Module Scan Tool Information (LAF)** for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. DTC U0101 should not be set.
 - If DTC U0101 is set, repair that DTC first.
2. Observe the DTC information with a scan tool. DTCs P0601, P0603, P0604, P0606, P0607, P0610, P062B, P0630, P167D or P2610 should not set. If a DTC failed this ignition, replace the K20 ECM. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

Replace the K71 TCM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for K71 ECM replacement, setup, and programming

DTC P1516, P2101, P2119, OR P2176 (LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P1516

Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance

DTC P2101

Throttle Actuator Position Performance

DTC P2119

Throttle Closed Position Performance

DTC P2176

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Motor Control 1	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P0690, P1516, P2101, P2176	P1516, P2101, P2176
Motor Control 2	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the throttle position (TP) sensors 1 and 2 to determine the actual throttle valve position.

CONDITIONS FOR RUNNING THE DTC

P1516

- The ignition voltage is greater than 6 V and reduced power is not active.
- The engine is running.
- DTCs P1516 runs continuously when the above conditions are met.

P2101

- DTC P1682 not set.
- The engine is running.
- The ECM has learned the minimum throttle position.
- The ignition voltage is greater than 6 V and reduced power is not active.
- DTCs P2101 run continuously when the above conditions are met.

P2119

- DTCs P0121, P0122, P0123, P0222, P0223, P0641, P0651, P0697, P06A3, or P2135 are not set.
- The ignition is ON.
- The ignition voltage is greater than 6 V.
- DTC P2119 runs continuously when the above conditions are met.

P2176

- DTCs P0068, P0122, P0123, P0222, P0223 are not set.
- The ignition is ON.
- The ignition voltage is greater than 6 V and reduced power is not active.
- DTC P2176 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P1516

The ECM detect an inability to maintain a steady state throttle position for 4 s.

P2101

The ECM detects the difference between the actual throttle position, and the desired position is greater than 7 percent.

P2119

- The ECM detects that the throttle blade did not return to the default position, during power down, within a calibrated amount of time.
- or
- The ECM detects the throttle control is driving the throttle in the incorrect direction or exceeds the reduced power limit.

P2176

The ECM detects that both throttle position sensors were greater than 0.95 V during the minimum learn procedure.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P1516, P2101, and P2176 are type A DTCs.
- DTC P2119 is a type C DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

- DTCs P1516, P2101, and P2176 are type A DTCs.
- DTC P2119 is a type C DTC.

DIAGNOSTIC AIDS

- Inspect for a condition in which the throttle valve may have been held open. For example, ice may have

formed in the throttle bore causing the throttle valve not to close.

- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- A low battery condition may cause a DTC to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE: A low battery voltage or charging system condition may cause a DTC to set.

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0121, P0122, P0123, P0222, P0223, P0562, P0621, P0622, P0625, P0626, or P2135 is not set.
 - If a DTC sets, refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.
2. Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times. DTCs P1516, P2101, P2119, or P2176 should not set.
3. Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat

the procedure several times. DTCs P1516, P2101, P2119, or P2176 should not set.

4. Engine idling, observe the TAC Command parameter with a scan tool. The reading should display greater than 0 %.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

WARNING: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

1. Ignition OFF, verify the following conditions do not exist with the Q38 throttle body assembly:
 - A throttle blade that is not in the rest position
 - A throttle blade that is binding open or closed
 - A throttle blade that is free to move open or closed without spring pressure
 - If a condition is found, replace the Q38 throttle body assembly.

NOTE: Disconnecting the throttle body harness connector may cause additional DTCs to set.

2. Ignition OFF, disconnect the harness connector at the Q38 throttle body assembly.
3. Ignition ON, verify that a test lamp does not illuminate between each motor control circuit listed below and ground.
 - Motor control circuit terminal A
 - Motor control circuit terminal B
 - If test lamp illuminates, test the motor control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition ON, verify that a test lamp does not illuminate between each motor control circuit listed below and B+.
 - Motor control circuit terminal A
 - Motor control circuit terminal B
 - If the test lamp illuminates, test the motor control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
5. Ignition OFF, set the DMM to the 40 V scale, select the Min/Max Recording Mode, and set the Peak Min/Max response time to 1 ms.

NOTE:

- **The DMM Min/Max Recording Mode and the response time of 1 ms must be reset after testing each circuit.**
- **The ignition must be OFF and the ECM completely powered down before testing each circuit.**

6. Ignition OFF, measure the voltage using the DMM Min/Max Recording Mode function on each circuit listed below as the ignition is turned ON. The Max voltage should be within 1 V of B+.
 - Motor control circuit terminal A
 - Motor control circuit terminal B
 - If not within the specified range, test the circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
7. If all circuits and connections test normal, replace the Q38 throttle body assembly.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Throttle Body Assembly Replacement (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P159F OR P15A0

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P159F

Fuel Economy Mode Switch Circuit Low Voltage

DTC P15A0

Fuel Economy Mode Switch Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Economy Mode Switch 5 V Reference	P159F	P159F, P15A1	P159F	P15A0	P15A1
Fuel Economy Mode Switch Signal	P159F	P159F	P159F	P15A0	P15A1
Fuel Economy Mode Switch Ground	-	P15A0, P15A1	P15A0	-	P15A1

CIRCUIT DESCRIPTION

The ECM supplies 5 V reference voltage, through the 5 V reference voltage circuit, to the fuel economy mode switch. The 5 V reference voltage causes current to flow through a series of resistors in the switch to the switch ground circuit. The ECM monitors the reference voltage through a discrete fuel economy mode switch signal circuit. When the switch button is momentarily pressed, the switch contacts allow the 5 V reference voltage to by-pass one of the resistors. The ECM detects the resulting voltage drop as a fuel economy mode request and sends a GMLAN message to the transmission control module (TCM) indicating the request. When the TCM receives the request, throttle progressions and transmission shift points are modified to optimize fuel efficiency. The instrument panel cluster (IPC) also receives the fuel economy mode request message from the ECM and illuminates the fuel economy mode indicator lamp. The fuel economy mode switch must be pressed for between 0.094-1.5 s to activate the fuel economy mode. Voltage on the signal wire is normally between 1.45-3.45 V with the switch depressed. When the switch is released, voltage on the signal wire is normally between 3.65-4.45 V.

CONDITIONS FOR RUNNING THE DTC

- Ignition key must be turned to ON.
- DTCs P159F and P15A0 run continuously when the above condition is met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the voltage on the fuel economy mode switch signal wire is either too low or too high out of range.

ACTION TAKEN WHEN THE DTC SETS

DTCs P159F and P15A0 are Type B DTCs

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P159F and P15A0 are Type B DTCs

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the scan tool Fuel Economy Mode parameter. The parameter should display Inactive.
2. Ignition ON, command the Fuel Economy ON and OFF with a scan tool. The Fuel Economy Mode parameter should display Active and Inactive as commanded.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Ignition OFF, disconnect the X1 harness connector at the Fuel Economy Mode switch.
2. Test for less than 5 ohms between the ground circuit terminal 1 of the harness connector and ground.
 - If greater than the specified range, test the ground circuit for a open/high resistance and repair as necessary.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 3 of the harness connector and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Observe the scan tool Fuel Economy Mode Switch parameter. The parameter should display Circuit Low Voltage.
 - If the parameter does not display the specified value, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Connect a 3 A fused jumper wire between 5 V reference circuit terminal 3 of the harness connector and signal circuit terminal 4 of the harness connector. Verify the scan tool Fuel Economy Mode Switch parameter displays Circuit High Voltage.
6. If all scan tool parameter displays are normal, test or replace the S87 fuel economy mode switch.

COMPONENT TESTING

1. Disconnect the fuel economy mode switch and measure between the 5 V reference voltage circuit terminal 3 of the switch and signal circuit terminal 4 of the switch for 266-294 ohms with a DMM.
 - If the DMM does not measure between 266-294 ohms, replace the S87 fuel economy mode switch.
2. Measure between the 5 V reference voltage circuit terminal 3 of the switch and the ground circuit terminal 1 of the switch for 1,414-1,562 ohms with a DMM.
 - If the DMM does not measure between 1,414-1,562 ohms, replace the S87 fuel economy mode switch.
3. With the fuel economy mode switch button depressed, measure between the 5 V reference voltage circuit terminal 3 of the switch and the ground circuit terminal 1 of the switch for 486ohms538 ohms with a DMM.
 - If the DMM does not measure between 486-538 ohms, replace the S87 fuel economy mode switch.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Economy Indicator Switch Replacement**
- **Control Module References** for ECM replacement, setup and programming

DTC P15A1

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P15A1

Fuel Economy Mode Switch Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Economy Mode Switch 5 V Reference	P159F	P159F, P15A1	P159F	P15A0	P15A1
Fuel Economy Mode Switch Signal	P159F	P159F	P159F	P15A0	P15A1
Fuel Economy Mode Switch Ground	-	P15A0, P15A1	P15A0	-	P15A1

CIRCUIT DESCRIPTION

The ECM supplies 5 V reference voltage, through the 5 V reference voltage circuit, to the fuel economy mode switch. This 5 V reference voltage causes current to flow through a series of resistors in the switch to the switch ground circuit. The ECM monitors the 5 V reference voltage through a discrete fuel economy mode switch signal circuit. When the switch button is momentarily pressed, the switch contacts allow the 5 V reference voltage signal to by-pass one of the resistors. The ECM detects the resulting voltage drop as a fuel economy mode request and sends a GMLAN message to the transmission control module (TCM) indicating the request. When the TCM receives the request, throttle progressions and transmission shift points are modified to optimize fuel efficiency. The instrument panel cluster (IPC) also receives the fuel economy mode request message from the ECM and illuminates the fuel economy mode indicator lamp. The fuel economy mode switch must be pressed for between 0.094-1.5 s to activate the fuel economy mode. Voltage on the signal wire is normally between 1.45-3.45 V with the switch depressed. When the switch is released, voltage on the signal wire is normally between 3.65-4.45 V.

CONDITIONS FOR RUNNING THE DTC

- The ignition key is turned to ON.
- DTC P15A1 runs continuously when the above condition is met.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the voltage on the fuel economy mode switch signal wire is in an indeterminate range.

ACTION TAKEN WHEN THE DTC SETS

DTC P15A1 is a Type B DTC.

CONDITIONS FOR CLEARING THE MIL/DTC

DTC P15A1 is a Type B DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. If you cannot duplicate the condition, refer to **Testing for Intermittent Conditions and Poor Connections**.
2. Verify that DTCs P159F and P015A0 are not set.
 - If either or both of the DTCs are set, refer to **Powertrain Diagnostic Trouble Code (DTC) Type Definitions**.
3. Engine running, observe the DTC information with a scan tool. DTC P15A1 should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Ignition OFF, disconnect the X1 harness connector at the Fuel Economy Mode switch.
2. Test for less than 5 ohms between the ground circuit terminal 1 of the harness connector and ground.
 - If greater than the specified range, test the ground circuit for a high resistance and repair as necessary.
3. Measure between the 5 V reference voltage circuit terminal 3 of the switch and signal circuit terminal 4 of the switch for 266-294 ohms with a DMM.
 - If the DMM does not measure between 266-294 ohms, replace the S87 fuel economy mode switch.
4. Measure between the 5 V reference voltage circuit terminal 3 of the switch and the ground circuit terminal 1 of the switch for 1,414-1,562 ohms with a DMM.
 - If the DMM does not measure between 1,414-1,562 ohms, replace the S87 fuel economy mode switch.
5. With the fuel economy mode switch button depressed, measure between the 5 V reference voltage circuit terminal 3 of the switch and the ground circuit terminal 1 of the switch for 486-538 ohms with a DMM.
 - If the DMM does not measure between 486-538 ohms, replace the S87 fuel economy mode switch.
6. Disconnect the X2 harness connector at the ECM.
7. Measure the 5 V reference voltage circuit, between terminal 14 of the ECM harness connector and

terminal 3 of the fuel economy mode switch harness connector, for less than 5 ohms.

- If greater than the specified range, repair or replace the 5 V reference voltage circuit as necessary.
8. Measure the signal circuit, between terminal 50 of the ECM harness connector and terminal 4 of the fuel economy mode switch harness connector, for less than 5 ohms.
 - If greater than the specified range, repair or replace the signal circuit as necessary.
 9. If all circuits test normal, replace the K20 ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Economy Indicator Switch Replacement**
- **Control Module References** for ECM replacement, setup and programming

DTC P163A

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P163A

Control Module Fuel Pressure Regulator 1 Control System Circuitry Performance

CIRCUIT/SYSTEM DESCRIPTION

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM).

CONDITIONS FOR RUNNING THE DTC

- The engine is running or cranking.
- The ignition voltage is between 8-18 V.
- DTC P163A runs continuously when the conditions are met for greater than 500 mS.

CONDITIONS FOR SETTING THE DTC

The ECM detects a condition with the integrated circuits of the high pressure fuel pump actuator driver module or the ECM detects that the current used to drive the high pressure fuel pump actuator is out of range for greater than 4 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P163A is a Type C DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P163A is a Type C DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Engine Control Module Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the G18 high pressure fuel pump.

NOTE: **The DMM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis.**

2. Test for 9-11 ohms at 25°C (77°F) between the low control circuit terminal 1 and the high control circuit terminal 2.
 - If not within the specified range, replace the G18 high pressure fuel pump.

3. Measure the resistance between each terminal and the high pressure fuel pump housing. The DMM should display OL.
 - If less than the specified value, replace the G18 high pressure fuel pump.
4. Ignition OFF, verify that a test lamp does not illuminate between B+ and the low control circuit terminal 1.
 - If the test lamp illuminates, test the low control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
5. Ignition ON, verify that a test lamp does not illuminate between ground and the high control circuit terminal 2.
 - If the test lamp illuminates, test the high control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. Ignition ON, command the Fuel Pressure Regulator ON with a scan tool. Verify that the test lamp illuminates.
 - If the test lamp does not illuminate, test the high control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
7. Ignition OFF, connect a test lamp between the low control circuit terminal 1 and B+.
8. Ignition ON, command the Fuel Pressure Regulator ON with a scan tool. Verify that the test lamp illuminates.
 - If the test lamp does not illuminate, test the low control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
9. If all circuits and the high pressure fuel pump test normal, replace the K20 ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Pump Replacement**
- **Control Module References** for engine control module replacement, setup, and programming

DTC P1682

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P1682

Ignition 1 Switch Circuit 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Engine Controls Ignition Relay Feedback Signal, Engine Control Module Relay	P1682	P1682	P0690
Ignition 1 Signal, Run/Crank Relay	1	1	2
1. A short to ground or open/high resistance will cause a No Crank condition. 2. A short to voltage will cause the engine to continue to run with ignition OFF.			

TYPICAL SCAN TOOL DATA

Ignition 1 Signal

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, engine OFF, and ignition Run/Crank and engine control module relays are commanded ON			
Ignition 1 Signal, Run/Crank Relay	0 V	0 V	B+
Engine Controls Ignition Relay Feedback Signal, Engine Control Module Relay	0 V	0 V	B+

CIRCUIT/SYSTEM DESCRIPTION

There are 2 ignition voltage circuits supplied to the engine control module (ECM). The first ignition circuit is provided by the engine control module relay through a fuse. This ignition voltage circuit supplies power to all the internal ECM circuits associated with the throttle actuator control (TAC) operation. The second ignition voltage circuit is supplied by the ignition Run/Crank relay through a fuse, and is used to power the remaining internal ECM circuits. If the ECM detects a voltage difference between the 2 ignition voltage circuits, DTC P1682 will set.

CONDITIONS FOR RUNNING THE DTC

- The ignition is ON.
- System voltage is more than 6 V.
- The engine control module relay is commanded ON.
- DTC P1682 runs continuously.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the voltage level difference is greater than 3 V between the 2 ignition voltage circuits for less than 1 s.

ACTION TAKEN WHEN THE DTC SETS

DTC P1682 is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P1682 is a Type A DTC.

REFERENCE INFORMATION

Schematic Reference

- Engine Controls Schematics
- Power Distribution Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Electrical Center Identification Views
- Probing Electrical Connectors
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

NOTE: On the scan tool, the engine control module relay is referred to as the engine controls ignition relay.

1. Ignition ON, observe the DTC information with a scan tool. If DTCs P0685 or P0690 are set, diagnose those DTCs first. DTC P1682 should not set.
2. Ignition ON, observe the scan tool Ignition 1 Voltage signal and the Engine Controls Ignition Relay Feedback signal parameters. There should be no more than 3 V difference between the two parameters.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

NOTE: You must perform the **Circuit/System Verification** before proceeding with **Circuit/System Testing**.

1. Ignition ON, observe the scan tool Ignition 1 Signal and the Engine Controls Ignition Relay Feedback parameters to determine which is more than 3 V lower than the other.

NOTE: The Ignition 1 Signal is supplied by the ignition run/crank relay. The Engine Controls Ignition Relay Feedback Signal is supplied by the engine control module relay.

2. Ignition OFF, remove the relay that corresponds to the scan tool parameter that is more than 3 V lower.

NOTE: A resistance of 6 ohms or greater in the circuit/underhood fuse block will cause the DTC to set.

3. Connect a 20 A fused jumper wire between B+ and the applicable ignition voltage circuit terminal 30 leading to the K20 ECM. Ignition ON, verify that the applicable scan tool parameter displays between 9-14 V.
 - If the applicable scan tool parameter is less than the specified value, test the ignition voltage circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
4. Ignition OFF, connect a DMM set to the diode setting between the control circuit terminal 85 and ground. Verify the DMM displays OL.
 - If not the specified value, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
5. Ignition ON, verify the DMM displays less than 1 V.
 - If not the specified range, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, replace the applicable relay.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P2122, P2123, P2127, P2128, OR P2138 (LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P2122

Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

DTC P2123

Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

DTC P2127

Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

DTC P2128

Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

DTC P2138

Accelerator Pedal Position (APP) Sensor 1-2 Not Plausible

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Accelerator Pedal Position (APP) Sensor 1 5-Volt Reference Circuit	P06A3, P2122, P2135	P2138	P2122	P06A3, P2135	P2138
Accelerator Pedal Position (APP) Sensor 1 Signal	P2122	P2138	P2122	P2123	P2138
Accelerator Pedal Position (APP) Sensor 1 Low Reference	-	P2138	P2123	-	P2138
Accelerator Pedal Position (APP) Sensor 2 5-Volt Reference Circuit	P0106, P0107, P0697	P2138	P2127	P0106, P0108, P0697	P2138
Accelerator Pedal Position (APP) Sensor 2 Signal	P2127	P2138	P2127	P06A3, P2123, P2128, P2138	P2138
Accelerator Pedal Position (APP) Sensor 2 Low Reference	-	P2138	P2128	-	P2138

TYPICAL SCAN TOOL DATA

APP Sensor 1 and 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle. Parameter Normal Range: APP Sensor 1 0.88-1.08 V Parameter Normal Range: APP Sensor 2 0.39-0.59 V			
APP Sensor 1 5-Volt Reference	0.00 V	0.00 V	2-3 V
APP Sensor 1 Signal	0.00 V	0.00 V	4.98 V
APP Sensor 1 Low Reference	-	4.94 V	-
APP Sensor 2 5-Volt Reference	0.00 V	0.00 V	1.35 V
APP Sensor 2 Signal	0.00 V	0.00 V	2-5 V
APP Sensor 2 Low Reference	-	4.92 V	-

CIRCUIT/SYSTEM DESCRIPTION

The accelerator pedal assembly contains 2 accelerator pedal position (APP) sensors. The APP sensors are mounted to the accelerator pedal assembly and are not serviceable. The APP sensors provide a signal voltage that changes relative to pedal position. The engine control module (ECM) supplies each APP sensor with a 5-volt reference circuit, a low reference circuit, and a signal circuit.

Both the APP sensors 1 and 2 signal percentages increase as the pedal is depressed, from approximately 0 percent at rest to above 95 percent when fully depressed.

CONDITIONS FOR RUNNING THE DTC

P2122, P2123, P2127, or P2128

- DTC P06A3 or P0697 are not set.
- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 6 V.
- The ECM is not commanding reduced power.
- The DTCs run continuously when the above conditions are met.

P2138

- DTCs P06A3, P0697, P2122, P2123, P2127, or P2128 are not set.
- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 6 V.
- The ECM is not commanding reduced power.
- The DTC runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P2122

The ECM detects that the APP sensor 1 voltage is less than 0.46 V for less than 1 s.

P2123

The ECM detects that the APP sensor 1 voltage is greater than 4.7 V for less than 1 s.

P2127

The ECM detects that the APP sensor 2 voltage is less than 0.32 V for less than 1 s.

P2128

The ECM detects that the APP sensor 2 voltage is greater than 2.6 V for less than 1 s.

P2138

The ECM detects that APP sensor 1 and APP sensor 2 disagree greater than 10 percent for less than 1 s.

OR

The ECM detects that both APP sensor 1 and APP sensor 2 are 5 percent greater than the learned minimum position for less than 1 s.

ACTION TAKEN WHEN THE DTC SETS

- DTCs P2122, P2123, P2127, P2128, and P2138 are type A DTCs.
- The ECM commands the TAC system to operate in a Reduced Engine Power mode.

CONDITIONS FOR CLEARING THE DTC

DTCs P2122, P2123, P2127, P2128, and P2138 are type A DTCs.

DIAGNOSTIC AIDS

- If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.
- The scan tool 5 volt reference parameter should display between 4.8-5.2 V.
- A high resistance condition on the accelerator pedal position circuits could cause a DTC to set.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify DTCs P0697 or P06A3 are not set.
 - If a DTC is set, refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.
2. Ignition ON, observe the scan tool Accelerator Pedal Position percentage parameter. The scan tool should display 0 percent.
3. Observe the scan tool APP Sensor 1 and 2 Agree/Disagree parameter while performing the following tests:
 - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
 - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.

The APP Sensor 1 and 2 Agree/Disagree parameter should display Agree.

4. Observe the DTC information with a scan tool. DTCs P2122, P2123, P2127, P2128, or P2138 should not set.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B107 accelerator pedal assembly.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 ohms between the low reference circuit terminals listed below and ground.
 - Low reference circuit terminal 4 or A
 - Low reference circuit terminal 5 or D
 - If greater than the specified range, test the appropriate low reference circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between both 5-volt reference circuit terminals listed below and ground.
 - 5 volt reference circuit terminal 1 or C
 - 5 volt reference circuit terminal 2 or F
 - If less than the specified range, test the appropriate 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Verify the appropriate APP sensor voltage parameter is at 0 V.
 - If greater than the specified range, test the appropriate signal circuit terminal listed below for a short to voltage. If the circuit tests normal, replace the K20 ECM.
 - APP sensor 1 signal circuit terminal 3 or E
 - APP sensor 2 signal circuit terminal 6 or B
5. Install a 3 A fused jumper wire between the appropriate signal circuit listed below and the 5-volt reference circuit terminal 1. Verify the appropriate APP sensor voltage parameter is greater than 4.8 V.
 - APP sensor 1 signal circuit terminal 3 or E
 - APP sensor 2 signal circuit terminal 6 or B
 - If less than the specified range, test the appropriate signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, replace the B107 accelerator pedal assembly.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accelerator Pedal Position Sensor Replacement**
- **Control Module References** for ECM replacement, setup, and programming

DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, OR P216F

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P2147

Cylinder 1 Injector High Control Circuit Low Voltage

DTC P2148

Cylinder 1 Injector High Control Circuit High Voltage

DTC P2150

Cylinder 2 Injector High Control Circuit Low Voltage

DTC P2151

Cylinder 2 Injector High Control Circuit High Voltage

DTC P2153

Cylinder 3 Injector High Control Circuit Low Voltage

DTC P2154

Cylinder 3 Injector High Control Circuit High Voltage

DTC P2156

Cylinder 4 Injector High Control Circuit Low Voltage

DTC P2157

Cylinder 4 Injector High Control Circuit High Voltage

DTC P216B

Cylinder 5 Injector High Control Circuit Low Voltage

DTC P216C

Cylinder 5 Injector High Control Circuit High Voltage

DTC P216E

Cylinder 6 Injector High Control Circuit Low Voltage

DTC P216F

Cylinder 6 Injector High Control Circuit High Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Direct Fuel Injector High Voltage Supply Cylinder 1	P2147	P0201	P2148	P1248
Direct Fuel Injector High Voltage Control Cylinder 1	P0261	P0201	P0262	P1248
Direct Fuel Injector High Voltage Supply Cylinder 2	P2150	P0202	P2151	P1249
Direct Fuel Injector High Voltage Control Cylinder 2	P0264	P0202	P0265	P1249
Direct Fuel Injector High Voltage Supply Cylinder 3	P2153	P0203	P2154	P124A
Direct Fuel Injector High Voltage Control Cylinder 3	P0267	P0203	P0268	P124A
Direct Fuel Injector High Voltage Supply Cylinder 4	P2156	P0204	P2157	P124B
Direct Fuel Injector High Voltage Control Cylinder 4	P0270	P0204	P0271	P124B
Direct Fuel Injector High Voltage Supply Cylinder 5	P216B	P0205	P216C	P124C
Direct Fuel Injector High Voltage Control Cylinder 5	P0273	P0205	P0274	P124C
Direct Fuel Injector High Voltage Supply Cylinder 6	P216E	P0206	P216F	P124D
Direct Fuel Injector High Voltage Control Cylinder 6	P0276	P0206	P0277	P124D

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to each fuel injector on the injector high voltage supply circuits. The ECM energizes each fuel injector by grounding the high voltage control circuit of the fuel injector. The ECM monitors the status of the injector high voltage supply circuits and the fuel injector high voltage control circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

CONDITIONS FOR RUNNING THE DTC

- The engine is running.

- The ignition voltage is between 11-18 V.
- The DTCs run continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P2147, P2150, P2153, P2156, P216B, or P216E

The ECM detects the injector high voltage supply circuit is shorted to ground for greater than 2 s.

P2148, P2151, P2154, P2157, P216C, or P216F

The ECM detects the injector high voltage supply circuit is shorted to voltage for greater than 2 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, and P216F are Type A DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, and P216F are Type A DTCs.

DIAGNOSTIC AIDS

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Solenoid Coil Test**.
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Fault if there is a condition with the circuit or a connection.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Observe the DTC information with a scan tool. DTC P0685 or P1682 should not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine operating, observe the DTC information with a scan tool. DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F should not set.
3. Observe the scan tool Current Misfire Counter parameters. The Current Misfire Counters should not increment.
4. Ignition ON, observe the scan tool Cylinder 1-6 Injector Control Circuit Status parameters. Verify the Injector Control Circuit Status parameters display OK.
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the appropriate multi-way harness connector X108 or X109, at the rear of the intake manifold.
2. Ignition ON, observe the appropriate scan tool Cylinder 1-6 Injector Control Circuit Status. The parameter should display Open.
 - If not the specified value, test the appropriate high voltage supply circuit, ECM side, for a short to ground or the appropriate high voltage control circuit, ECM side, for a short to voltage. If the circuits test normal, replace the K20 ECM.
3. Ignition ON, connect a test lamp between the appropriate high voltage supply circuit and the high voltage control circuit. The Injector Control Circuit Status should transition from Open to OK.
 - If not the specified value, test for the following conditions in the ECM side of the harness:
 - An open/high resistance in the high voltage supply circuit
 - An open/high resistance in the high voltage control circuit
 - A short to ground in the high voltage control circuit
 - A short to voltage in the high voltage supply circuit

- If the circuits test normal, replace the K20 ECM.

NOTE: **Testing for the following steps is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.**

4. Ignition OFF, measure the resistance between the appropriate high voltage supply circuit and ground. The DMM should display OL ohms.
 - If less than the specified range, test the high voltage supply circuit and the high voltage control circuit for a short to ground. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector(s).
5. Test for 2-3 ohms between the appropriate high voltage supply circuit and high voltage control circuit.
 - If less than the specified range, test for a short between the high voltage supply circuit and high voltage control circuit. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector(s).
 - If greater than the specified range, test the high voltage supply circuit and high voltage control circuit for an open/high resistance. If the circuits/connections test normal, test or replace the appropriate Q17 fuel injector.

COMPONENT TESTING

NOTE: **The DMM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis.**

1. Remove the intake manifold and disconnect the appropriate Q17 fuel injector.
2. Test for 1.9-2.3 ohms at 20°C (68°F) between the high voltage supply circuit terminal 2 and the high voltage control circuit terminal 1 at the Q17 fuel injector.
 - If not within the specified range, replace the Q17 fuel injector.
3. Measure the resistance between each terminal at the Q17 fuel injector and the Q17 fuel injector housing/case. The DMM should display OL ohms.
 - If less than the specified value, replace the Q17 fuel injector.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF1)**
- **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P219A OR P219B (LF1, LFW)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P219A

Air Fuel Imbalance Bank 1

DTC P219B

Air Fuel Imbalance Bank 2

CIRCUIT/SYSTEM DESCRIPTION

The Air Fuel Imbalance diagnostic detects a rich or lean cylinder to cylinder air/fuel ratio imbalance in each bank. The diagnostic monitors the pre-catalyst heated oxygen sensor (HO2S) signal's frequency and amplitude characteristics by calculating an accumulated voltage over a predetermined sample period. An imbalance is indicated when multiple samples of the accumulated voltage are consistently higher than the desired value.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0053, P0059, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0125, P0128, P0131, P0132, P0133, P0134, P0135, P0151, P0152, P0153, P0154, P0155, P0178, P0179, P0201-P0208, P0300, P0301-P0308, P0411, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0606, P1133, P1153, P1516, P2101, P2135, P2176, P2269, P2440, P2444, P2A00, P2A03 are not set.
- The device control is not active.
- The intrusive diagnostics are not active.
- The engine overspeed protection is not active.
- Reduced power mode, ETC DTC, is not active.
- The power take-off (PTO) is not active.
- The traction control is not active.
- The fuel control is in air-fuel Closed Loop.
- The system voltage is more than 10 V, or less than 18 V.
- The engine coolant temperature (ECT) is greater than -20°C (-4°F).
- The engine speed is greater than 350 RPM, but less than 6,000 RPM.
- The mass air flow is greater than 11 g/s, but less than 510 g/s.
- Percent ethanol is less than 87 %.

CONDITIONS FOR SETTING THE DTC

Multiple samples of the pre-catalyst HO2S accumulated voltage are consistently greater than the desired value.

ACTION TAKEN WHEN THE DTC SETS

DTCs P219A and P219B are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P219A and P219B are Type B DTCs.

DIAGNOSTIC AIDS

- The air fuel imbalance diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may set a false DTC.
- Monitoring the misfire current counters, or misfire graph, may help to isolate the cylinder that is causing the condition.
- E85 compatible engine only-Over-estimation of the ethanol content will result in a rich shift of fuel trim values, and under-estimation will result in a lean shift of fuel trim values. A fuel trim DTC may set if the learned alcohol content, Fuel Alcohol Content parameter on the scan tool, is different than the measured alcohol content in the vehicle such that fuel trim values exceed failure threshold values. Refer to **Fuel Composition Diagnosis** .

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Troubleshooting with a Test Lamp**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Read and record the Freeze Frame/Failure Records data taking note of the speed and load at which the DTC set.
2. Diagnose any other DTCs that are set. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. With the engine idling and the transmission in the Park or Neutral position, observe the manifold absolute pressure (MAP) sensor parameter. The MAP sensor parameter should be between 20-48 kPa.
 - If the MAP sensor parameter is not between 20-48 kPa, refer to **DTC P0106 (LF1)** or **DTC P0107 or P0108 (w/LF1)** .
4. Inspect the air induction system for modified, damaged, leaking, or restricted components.
5. Inspect the crankcase ventilation system for improper operation.
6. Inspect the vacuum hoses for splits, kinks, and improper connections.
7. Inspect for vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
8. Test for a restricted, damaged, leaking, or modified exhaust system from the catalytic converter forward. Refer to **Symptoms - Engine Exhaust** .
9. Test the fuel injectors for improper operation. Refer to **Fuel Injector Solenoid Coil Test** .
10. Test for fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** for gasoline or **Fuel Composition Diagnosis** for E85.
11. Test for excessive fuel in the crankcase due to leaking injectors.
12. Test the ignition system for improper operation. Refer to **Electronic Ignition System Diagnosis** .
13. Test the engine for any mechanical conditions such as sticking valves, lifters, etc., which could alter the flow into the combustion chamber. Refer to **Symptoms - Engine Mechanical** .

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure. Verify the repair under the same speed and load as noted in the Freeze Frame/Failure Records data recorded during testing.

DTC P2227-P2229, OR P2230 (LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P2227

Barometric Pressure (BARO) Sensor Performance

DTC P2228

Barometric Pressure (BARO) Sensor Circuit Low Voltage

DTC P2229

Barometric Pressure (BARO) Sensor Circuit High Voltage

DTC P2230

Barometric Pressure (BARO) Sensor Circuit Erratic

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641, P2227, P2228	P2228	P0641, P2229	P2227
Signal	P2227, P2228	P2227, P2228	P2227, P2229	P2227
Low Reference	-	P2227, P2229	-	P2227

TYPICAL SCAN TOOL DATA

BARO

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF Parameter Normal Range: 56-105 kPa (8.1-15.2 psi), varies with altitude			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
Signal	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
Low Reference	-	127 kPa (18.4 psi)	-

CIRCUIT/SYSTEM DESCRIPTION

The barometric pressure (BARO) sensor responds to changes in altitude and atmospheric conditions. This gives the engine control module (ECM) an indication of barometric pressure. The ECM uses this information to calculate fuel delivery. The BARO sensor provides a voltage signal to the ECM relative to the atmospheric pressure changes. The ECM monitors the BARO sensor signal for a voltage outside of the normal range.

CONDITIONS FOR RUNNING THE DTC

P2227

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0222, P0223, P1516, P2135, P2228 and P2229 are not set.
- Engine is running.

OR

- DTCs P0106, P0107, P0108, P2228, P2229 and P2230 are not set and are not pending.
- Ignition ON, engine OFF.
- DTC P2227 runs continuously when the above conditions are met.

P2228 or P2229

- The engine is running.
- The DTCs run continuously when the above condition is met.

P2230

- The engine is running.
- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0222, P0223, P1516, P2135, P2228 and P2229 are not set.
- DTC P2230 runs continuously when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P2227

- Engine running, the ECM detects that the difference between the BARO signal and the calculated BARO is greater than 15 kPa (2.2 psi) when the vehicle has traveled no more than 0.5 km (0.31 mi) since the last calculated BARO update, or if the difference is greater than 25 kPa (3.6 psi) when the vehicle has traveled greater than 0.5 km (0.31 mi) since the last calculated BARO update.
- Ignition ON, engine OFF, the ECM detects that the BARO pressure is less than 50 kPa (7.3 psi) or greater than 115 kPa (16.7 psi).

P2228

The ECM detects that the BARO sensor voltage is less than 1.95 V for greater than 4 s.

P2229

The ECM detects that the BARO sensor voltage is greater than 4.5 V for greater than 4 s.

P2230

The ECM detects that the difference between the current BARO sensor reading and the previous BARO sensor reading is greater than 10 kPa (1.5 psi) for less than 1 s.

ACTION TAKEN WHEN THE DTC SETS

DTCs P2227, P2228, P2229, and P2230 are Type B DTCs.

CONDITIONS FOR CLEARING THE MIL/DTC

DTCs P2227, P2228, P2229, and P2230 are Type B DTCs.

DIAGNOSTIC AIDS

Inspect the inlet port on the B17 BARO sensor for moisture or debris and attempt to dry or clean the inlet, if contaminated.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0641 is not set.
 - If the above DTC is set, refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .
2. Ignition ON, observe the scan tool BARO parameter. Compare the parameter to the **Altitude Versus Barometric Pressure** table. The BARO parameter should be within the specified range indicated in the table.
3. Engine running observe the DTC information with a scan tool. DTCs P2227, P2228, P2229, or P2230 should not set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure

Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the B17 BARO sensor.
2. Ignition OFF for 90 s, test for less than 5 ohms between the low reference circuit terminal 2 and ground.
 - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Verify the scan tool BARO Sensor parameter is less than 1 kPa (0.2 psi).
 - If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1. Verify the scan tool BARO Sensor parameter is greater than 127 kPa (18.4 psi).
 - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If the circuits test normal, replace the B17 BARO sensor.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Throttle Inlet Absolute Pressure Sensor Replacement** for BARO sensor replacement
- **Control Module References** for engine control module replacement, setup, and programming

DTC P2270 OR P2272 (W/LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P2270

HO2S Signal Stuck Lean Bank 1 Sensor 2

DTC P2272

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Heater Voltage Supply	P0030, P0036, P0050, P0056, P0132, P0135, P0138, P0140, P0141, P0152, P0155, P0158, P0161, *	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161
HO2S Heater Control	P0030, P0036, P0050, P0053, P0054, P0056, P0059,	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140,	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140,	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140,	P0135, P0141, P0155, P0161

	P0060, P0135, P0141, P0155, P0161	P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0141, P0152, P0154, P0155, P0158, P0160, P0161	
* Opens Fuse					

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage, HO2S Sensor 2 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0.00 V	Approximately 1.27 V	Approximately 1.27 V
HO2S Low Signal	0.00 V	Approximately 1.27 V	Approximately 1.27 V

CIRCUIT/SYSTEM DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,275 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The ignition voltage is between 10-32 V.
- The engine speed is between 1,225-2,100 RPM.
- The mass air flow (MAF) is between 4-13 g/s.
- The vehicle speed is between 64-125 km/h (40-78 mph).
- The fuel level is greater than 10 %.
- The fuel system is in Closed Loop.
- The predicted catalytic converter temperature is between 615-980°C (1,139-1,796°F).

- The HO2S is ON for more than 180 s.
- The DTCs run once per ignition cycle when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P2270

The ECM does not detect a HO2S voltage greater than 800 mV before accumulated mass air flow exceeds 62 grams.

P2272

The ECM does not detect a HO2S voltage greater than 800 mV before the accumulated mass air flow exceeds 62 grams.

ACTION TAKEN WHEN THE DTC SETS

DTCs P2270 and P2272 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P2270 and P2272 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Heated Oxygen Sensor Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify no B52 HO2S heater DTCs are set.
 - If a B52 HO2S heater DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine running, observe the appropriate scan tool B52 HO2S voltage parameter. The reading should be within the range of 50-1,050 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the appropriate B52 HO2S harness connector.
2. Ignition ON, observe the appropriate scan tool HO2S voltage parameter. The parameter should display 1.27 V.
 - If less than the specified range, test the high and low signal circuits for a short to ground. If both signal circuit test normal, replace the K20 ECM.
3. Ignition ON, test for 2.5-3.0 V between the high signal circuit terminal B and ground.
 - If less than the specified range, test the high signal circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
 - If greater than the specified range, test the high signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Ignition OFF, connect a 3 A fused jumper wire between the high signal circuit terminal B and the low signal circuit terminal A.

NOTE: **The low signal circuit is tied to a pull-up circuit within the ECM. A voltage of 0.90-1.10 V on the low signal circuit is normal.**

5. Ignition ON, verify the scan tool HO2S parameter displays 0.0 V.
 - If greater than the specified range, test the low signal circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
6. If all circuits test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to **Heated Oxygen Sensor Resistance Learn Reset Caution** .

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)**

- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- **Control Module References** for ECM replacement, setup, and programming

DTC P2271 OR P2273 (W/LF1)

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P2271

HO2S Signal Stuck Rich Bank 1 Sensor 2

DTC P2273

HO2S Signal Stuck Rich Bank 2 Sensor 2

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P1133, P1153, P2A00, P2A03
	P0030, P0036,	P0030, P0036, P0050, P0056,	P0030, P0036, P0050, P0056,		

HO2S Heater Voltage Supply	P0050, P0056, P0132, P0135, P0138, P0141, P0152, P0155, P0158, P0161, *	P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161
HO2S Heater Control	P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161
* Opens Fuse					

TYPICAL SCAN TOOL DATA

HO2S Sensor 1 Voltage, HO2S Sensor 2 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0.00 V	Approximately 1.27 V	Approximately 1.27 V
HO2S Low Signal	0.00 V	Approximately 1.27 V	Approximately 1.27 V

CIRCUIT/SYSTEM DESCRIPTION

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,275 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is

entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

CONDITIONS FOR RUNNING THE DTC

- Before the ECM can report DTC P2271, or P2273 failed, DTCs P013A, P013C, P013E, P014A, P2270, and P2272 must run and pass.
- DTCs P0036, P0037, P0038, P0137, P0138, P0140, P0141, P0443, P0458, P0459, P2232 are not set.
- The ignition voltage is between 10-32 V.
- The engine speed is between 1,225-2,100 RPM.
- The mass air flow (MAF) is between 4-13 g/s.
- The vehicle speed is between 64-125 km/h (40-78 mph).
- The fuel level is greater than 10 %.
- The fuel system is in Closed Loop.
- The predicted catalytic converter temperature is between 615-980°C (1,139-1,796°F).
- The HO2S heater is ON for more than 180 s.
- The DTCs run once per ignition cycle, during decel fuel cut-off, when the above conditions are met.

CONDITIONS FOR SETTING THE DTC

P2271

The ECM does not detect an HO2S voltage less than 100 mV before accumulated mass air flow exceeds 36 grams.

P2273

The ECM does not detect an HO2S voltage less than 100 mV before the accumulated mass air flow exceeds 36 grams.

ACTION TAKEN WHEN THE DTC SETS

DTCs P2271 or P2273 are Type B DTCs.

CONDITIONS FOR CLEARING THE DTC

DTCs P2271 or P2273 are Type B DTCs.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Heated Oxygen Sensor Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the DTC information with a scan tool. Verify no B52 HO2S heater DTCs are set.
 - If a B52 HO2S heater DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine running, observe the appropriate scan tool B52 HO2S voltage parameter. The reading should be within the range of 50-1,050 mV.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the appropriate B52 HO2S harness connector.
2. Ignition ON, observe the appropriate scan tool HO2S voltage parameter. The parameter should display 1.27 V.
 - If less than the specified range, test the high and low signal circuits for a short to ground. If both signal circuit test normal, replace the K20 ECM.
3. Ignition ON, test for 2.5-3.0 V between the high signal circuit terminal B and ground.
 - If less than the specified range, test the high signal circuit for an open/high resistance. If the circuit tests normal, replace the K20 ECM.

- If greater than the specified range, test the high signal circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
- 4. Ignition OFF, connect a 3 A fused jumper wire between the high signal circuit terminal B and the low signal circuit terminal A.

NOTE: **The low signal circuit is tied to a pull-up circuit within the ECM. A voltage of 0.90-1.10 V on the low signal circuit is normal.**

- 5. Ignition ON, verify the scan tool HO2S parameter displays 0.0 V.
 - If greater than the specified range, test the low signal circuit for an open/high resistance or for a short to voltage. If the circuit tests normal, replace the K20 ECM.
- 6. If all circuits test normal, test or replace the appropriate B52 HO2S.

REPAIR PROCEDURES

CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution .

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Heated Oxygen Sensor Replacement - Bank 1 Sensor 2 (LF1)
- Heated Oxygen Sensor Replacement - Bank 2 Sensor 2
- Control Module References for ECM replacement, setup, and programming

DTC P2534

DIAGNOSTIC INSTRUCTIONS

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P2534

Ignition 1 Switch Circuit Low Voltage

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
IGN Voltage	P2534	P2534	-	-

CIRCUIT/SYSTEM DESCRIPTION

The fuel pump control module monitors the ignition voltage circuit in order to determine if the voltage is within the normal operating range.

CONDITIONS FOR RUNNING THE DTC

The engine is running.

CONDITIONS FOR SETTING THE DTC

The FPCM detects that the IGN voltage is less than 6.0 V.

ACTION TAKEN WHEN THE DTC SETS

DTC P2534 is a Type A DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P2534 is a Type A DTC.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Verify that DTC P0562 is not set.
 - If DTC P0562 is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, disconnect the harness connector of the K27 fuel pump control module.
3. Ignition ON, test for greater than 11 V between the IGN voltage circuit terminal 21 and ground.
 - If less than the specified voltage, test the IGN voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the CCM/RUN/CRK fuse is open, test the voltage circuit for a short to ground. If the circuit tests normal, test or replace the Run/Crank relay.
4. If all circuits test normal, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for fuel pump control module replacement, setup, and programming

DTC P2544

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for a overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTORS

DTC P2544

Transmission Torque Request Circuit

DTC P2544

Transmission Torque Request Signal Message Counter Incorrect

CIRCUIT/SYSTEM DESCRIPTION

To improve shift feel, the transmission control module (TCM) is constantly sending the engine control module (ECM) serial data messages with information regarding it's request for modifying engine speed or torque. The

serial data messages are sent through two circuits which are part of a communication network called the controller area network (CAN). The ECM sets DTC P2544 when it detects a discrepancy in the structure of the message causing the integrity of the message to be questioned.

An intermittent fault in the CAN circuits will cause the ECM to set DTC P2544.

CONDITIONS FOR RUNNING THE DTC

- The engine run time is greater than 0.5 s.
- No other CAN errors are present.

CONDITIONS FOR SETTING THE DTC

The ECM detects that the engine speed and torque modification messages from the TCM are either corrupted or intermittently missing for greater than 4 s.

ACTION TAKEN WHEN THE DTC SETS

- DTC P2544 is a Type B DTC.
- The TCM commands maximum line pressure during shifts, which results in harsh shifts.
- The TCM freezes adaptive functions.

CONDITIONS FOR CLEARING THE DTC

DTC P2544 is a Type B DTC.

REFERENCE INFORMATION

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

CIRCUIT/SYSTEM VERIFICATION

1. DTC P2544 is an informational DTC. Diagnose all other engine control DTCs prior to DTC P2544. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.
2. If there are no other engine controls DTCs, diagnosis is accomplished by looking for an intermittent CAN circuit fault. Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device**.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for TCM replacement, setup, and programming.

DTC P2635

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC DESCRIPTOR

DTC P2635

Fuel Pump Flow Performance

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
Control	P0231	P023F	P0232	P023F, P2635
Low Reference	-	P023F	-	P023F, P2635

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

CONDITIONS FOR RUNNING THE DTC

- DTC P018B, P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The system voltage is greater than 11 V.
- The engine has been running for more than 30 seconds.

CONDITIONS FOR SETTING THE DTC

This DTC sets when the fuel pump control module detects a predetermined fuel pressure performance degradation between the desired fuel rail pressure and the current estimated fuel rail pressure.

ACTION TAKEN WHEN THE DTC SETS

DTC P2635 is a Type B DTC.

CONDITIONS FOR CLEARING THE DTC

DTC P2635 is a Type B DTC.

DIAGNOSTIC AIDS

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM TESTING

1. Verify that DTCs P018C, P018D, P0231, P0232, or P023F are not set.
 - If the DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, disconnect the harness connector at the G12 fuel pump.
3. Ignition ON, test for less than 5.0 ohms between the G12 fuel pump low reference circuit terminal 2 and ground.
 - If greater than the specified range, test the G12 fuel pump low reference circuit for a high

resistance. If the circuit tests normal, replace the K27 fuel pump control module.

4. Ignition OFF, install a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
5. Ignition ON, command the Fuel Pump Relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
 - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
 - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
6. Perform the **Fuel System Diagnosis** to verify proper fuel pressure.
 - If the fuel pressure is not normal, replace the G12 fuel pump
7. If all circuits test normal, replace the K27 fuel pump control module.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Tank Fuel Pump Module Replacement**
- **Control Module References** for fuel pump control module replacement, setup, and programming

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

REPAIR INSTRUCTIONS

CRANKSHAFT POSITION SYSTEM VARIATION LEARN

NOTE: The Crankshaft Position System Variation Learn procedure is also required when the following service procedures have been performed, regardless of whether DTC P0315 is set:

- An engine replacement
- An engine control module (ECM) replacement
- A crankshaft balancer replacement
- A crankshaft replacement
- A crankshaft position sensor replacement
- Any engine repairs which disturb the crankshaft to crankshaft position sensor relationship.

NOTE: The ECM monitors certain component signals to determine if all the conditions are met to continue with the crankshaft position System Variation Learn Procedure.

1. Install a scan tool.
2. Monitor the ECM for DTCs with a scan tool. If other DTCs are set, except DTC P0315, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
3. With a scan tool, select the Crankshaft Position System Variation Learn Procedure and perform the following:
 1. Block drive wheels.
 2. Set parking brake.
 3. DO NOT apply brake pedal.
 4. Cycle ignition from OFF to ON.
 5. Apply and hold brake pedal for the duration of the procedure.
 6. Start and idle engine.
 7. Turn the air conditioning (A/C) OFF.
 8. The vehicle must remain in Park or Neutral.

NOTE: While the learn procedure is in progress, release the throttle immediately when the engine starts to decelerate. The engine control is returned to the operator and the engine responds to throttle position after the learn procedure is complete.

9. Accelerate to wide open throttle (WOT) and release when the fuel cut-off occurs.
4. The scan tool displays Test In Progress.
5. The scan tool displays Learn Successful.
6. Verify DTC P0315 ran and passed This Ignition Cycle.
 - If DTC P0315 failed or did not run This Ignition Cycle, or another DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
7. Once the Learn Procedure has successfully completed, and in order to store the crankshaft position system variation values in the ECM, turn OFF the ignition and verify all vehicle systems are OFF. This may take up to 2 minutes.

ENGINE CONTROL MODULE REPLACEMENT

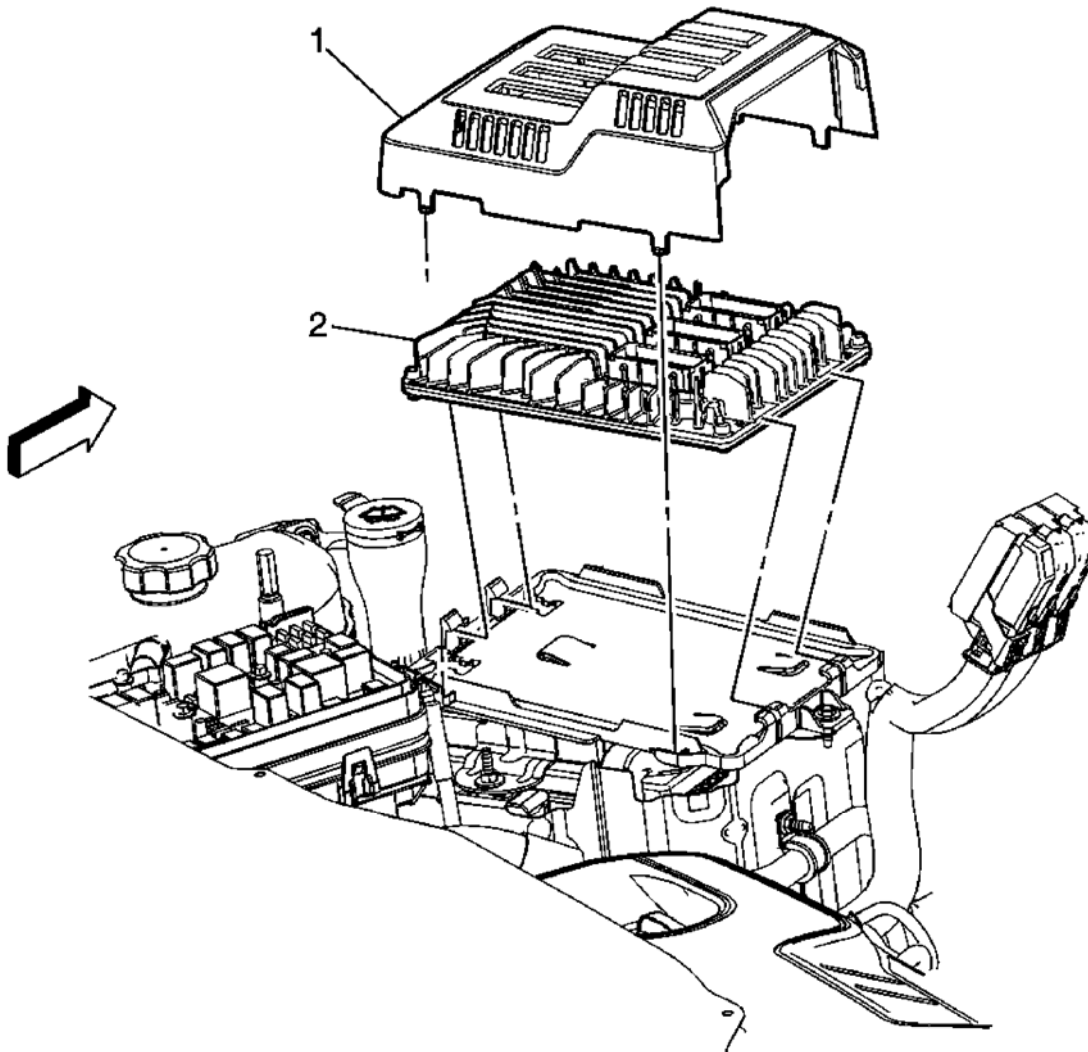


Fig. 1: Engine Control Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Control Module Cover
2	Engine Control Module CAUTION: • Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module (battery cable, powertrain control module (PCM)/engine control module (ECM)/transaxle control module (TCM) pigtail, control module fuse, jumper cables, etc.) in order to prevent internal control module damage. • Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control module, using battery booster cables, or when charging the vehicle battery. • In order to prevent any possible electrostatic discharge damage to the control module, do not touch the connector pins or the soldered components on the circuit board. • Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module. • The replacement control module must be programmed. CAUTION: In order to prevent any possible electrostatic discharge damage to the ECM, do not touch the connector pins. Procedure 1. Tip: It is necessary to record the remaining engine oil life. If the replacement module is not programmed with the remaining engine oil life, the engine oil life will default to 100 percent. If the replacement module is not programmed with the remaining engine oil life, the engine oil will need to be changed at 5000 km (3,000 mi) from the last engine oil change. Tip: It is necessary to record the remaining automatic transmission fluid life. If the replacement module is not programmed with the remaining automatic transmission fluid life, the automatic transmission fluid life will default to 100 percent. If the replacement module is not programmed with the remaining automatic transmission fluid life, the automatic transmission fluid will need to be changed at 83000 km (50,000 mi) from the last automatic transmission fluid change.

- | |
|---|
| <ol style="list-style-type: none">2. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u>.3. Disconnect the electrical connectors.4. If replacing ECM, reprogram the ECM. Refer to <u>Control Module References</u> |
|---|

THROTTLE/IDLE LEARN (LF1, LFW)

Description

The engine control module (ECM) learns the airflow through the throttle body to ensure the correct idle. The learned airflow values are stored within the ECM. These values are learned to adjust for production variation and will continuously learn during the life of the vehicle to compensate for reduced airflow due to throttle body coking. Anytime the throttle body airflow rate changes, for example due to cleaning or replacing, the values must be relearned.

An engine that had a heavily coked throttle body that has been cleaned or replaced may take several drive cycles to learn out the coking. To accelerate the process, the scan tool has the ability to reset all learned values back to zero. A new ECM will also have values set to zero.

The idle may be unstable or a DTC may set if the learned values do not match the actual airflow.

Conditions for Running the Throttle Learn Procedure

Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0220, P0222, P0223, P0300, P0351, P0352, P0353, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- Ignition ON, engine OFF.
- The vehicle speed sensor (VSS) is 0 km/h (0 mph).

Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0220, P0222, P0223, P0300, P0351, P0352, P0353, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- The engine speed is between 450-4,000 RPM.
- The manifold absolute pressure (MAP) is greater than 5 kPa.
- The mass air flow (MAF) is greater than 2 g/s.
- The ignition voltage is greater than 10 volts.

Throttle Learn

Reset Procedure (Performed after the throttle body is cleaned or replaced)

1. Ignition ON, engine OFF, perform the Idle Learn Reset in Module Setup with a scan tool.
2. Start the engine and monitor the TB Idle Airflow Compensation parameter. The TB Idle Airflow Compensation value should equal 0 percent and the engine should be idling at a normal idle speed.
3. Clear the DTCs and return to the diagnostic that referred you here.

Learn Procedure (Performed after the ECM is flashed or replaced)

NOTE: **Do NOT perform this procedure if DTCs are set. Refer to Diagnostic Trouble Code (DTC) List - Vehicle .**

1. Start and idle the engine for 3 minutes.
2. With a scan tool, monitor the Desired Idle Speed and the actual Engine Speed.
3. The ECM will start to learn the new idle cells and Desired Idle Speed should start to decrease.
4. Ignition OFF for 60 seconds.
5. Start and idle the engine for 3 minutes.
6. After the 3 minute run time the engine should be idling normal.

NOTE: **During the drive cycle the check engine light may come on with idle speed DTCs. If idle speed codes are set, clear codes so the ECM can continue to learn.**

- If the engine idle speed has not been learned the vehicle will need to be driven at speeds above 70 km/h (44 mph) with several decelerations and extended idles.
7. After the drive cycle, the engine should be idling normally.
 - If the engine idle speed has not been learned, turn OFF the ignition for 60 seconds and repeat step 6.
 8. Once the engine speed has returned to normal, clear DTCs and return to the diagnostic that referred you here.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT (LF1)

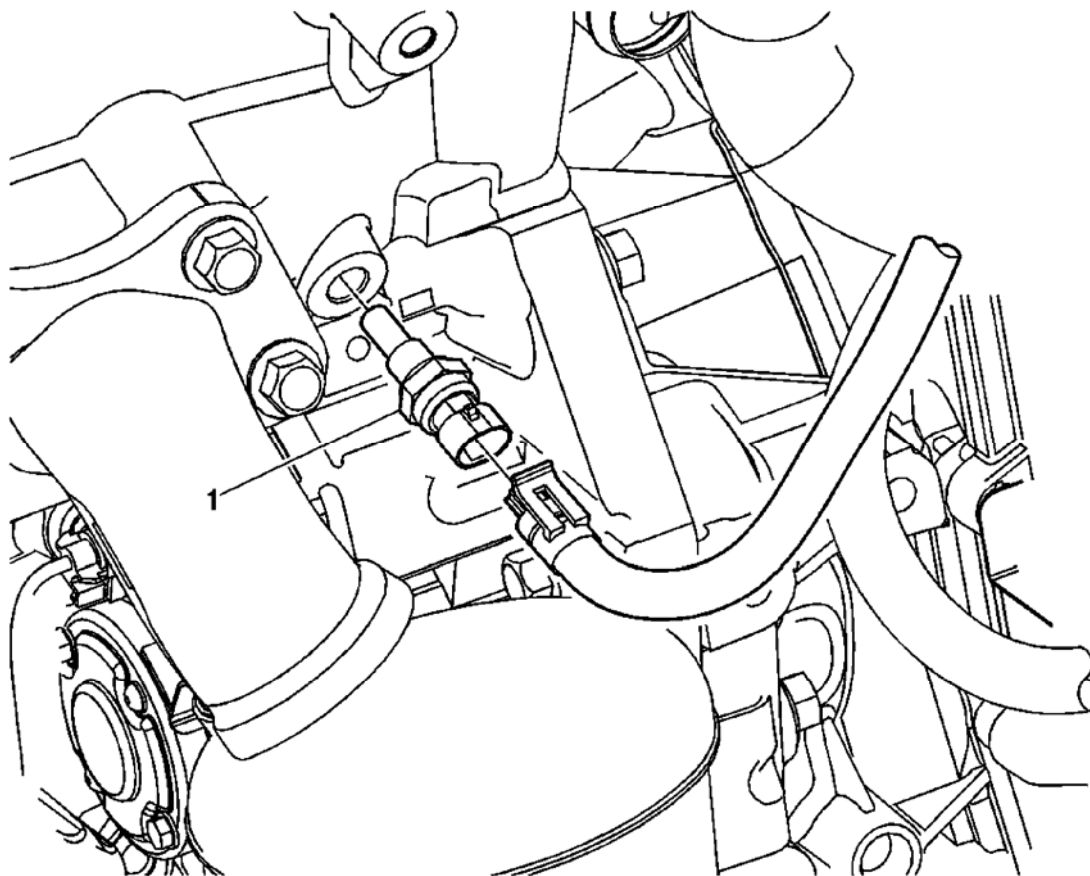


Fig. 2: Engine Coolant Temperature Sensor (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Partially drain the cooling system. Refer to <u>Cooling System Draining and Filling (Static)</u> or <u>Cooling System Draining and Filling (GE 47716)</u> .	
1	Engine Coolant Temperature Sensor CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Reposition the sensor heat shield. 2. Disconnect the ECT sensor harness connector. Tighten: 20 N.m (35 lb in)

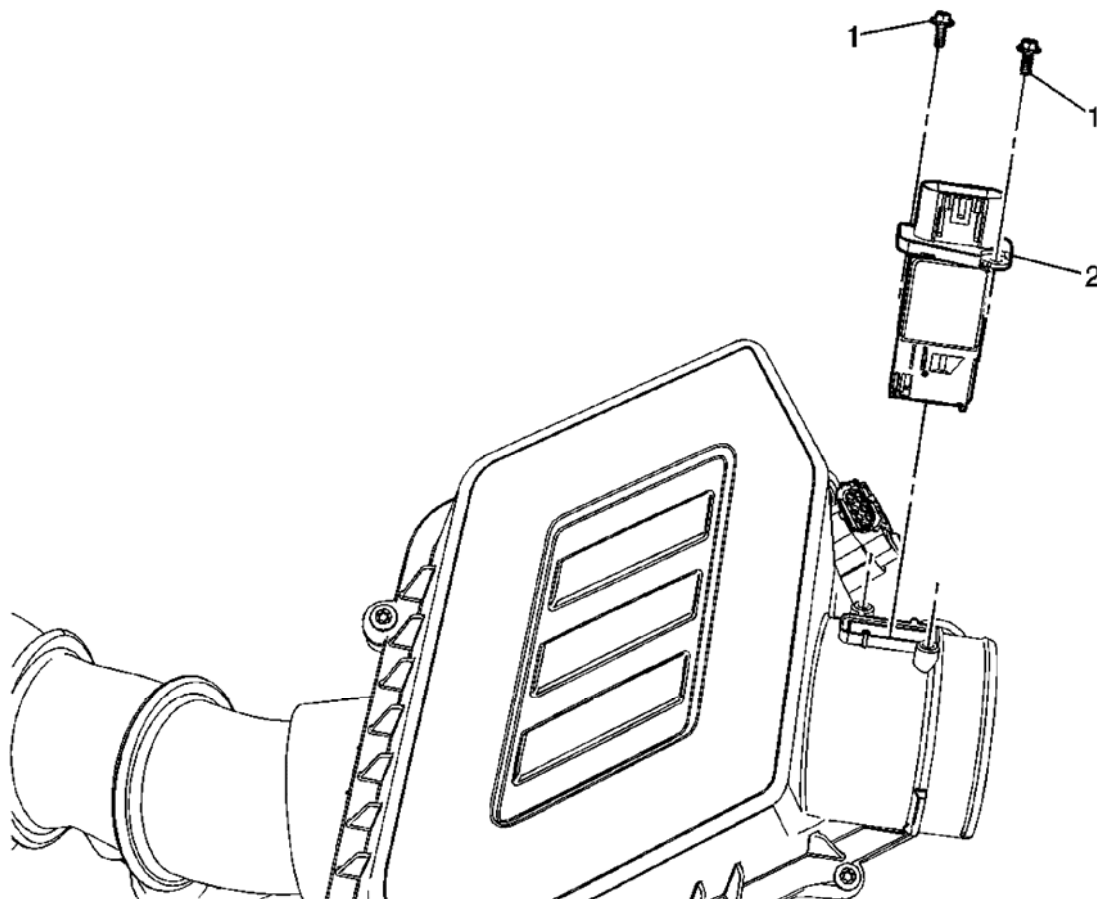


Fig. 3: Mass Airflow Sensor With Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Mass Airflow Sensor Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 4 N.m (35 lb in)
2	Mass Airflow Sensor with Intake Air Temperature Sensor Procedure: Disconnect the electrical connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

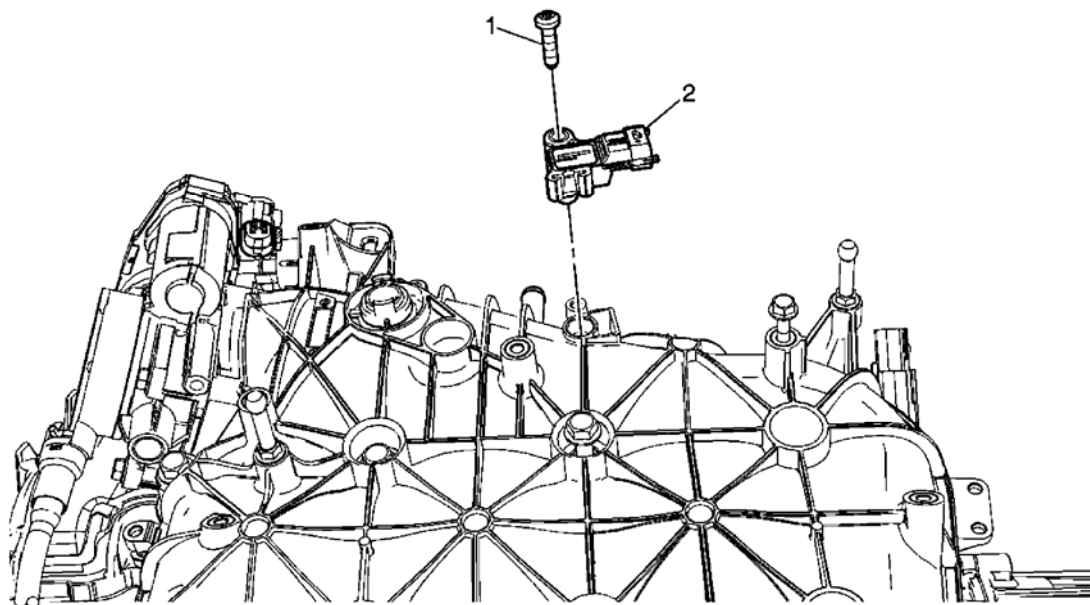


Fig. 4: Manifold Absolute Pressure Sensor
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Manifold Absolute Pressure Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 4 N.m(35 lb in)
2	Manifold Absolute Pressure Sensor Procedure: Disconnect the electrical connector.

THROTTLE INLET ABSOLUTE PRESSURE SENSOR REPLACEMENT

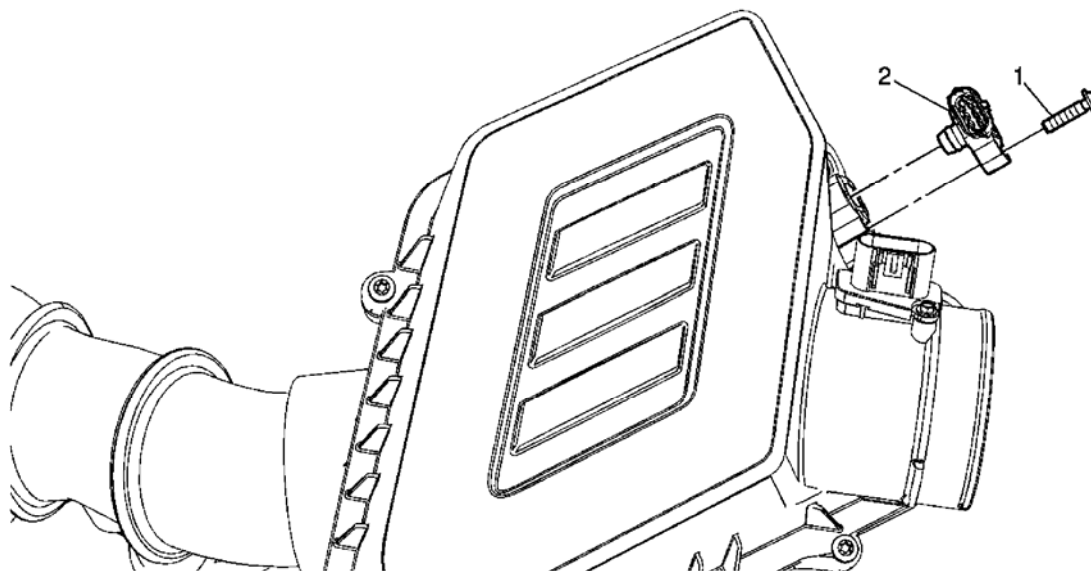


Fig. 5: Throttle Inlet Absolute Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Throttle Inlet Absolute Pressure Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 4 N.m (35 lb in)
2	Throttle Inlet Absolute Pressure Sensor Procedure: Disconnect the electrical connector.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1 (LF1)

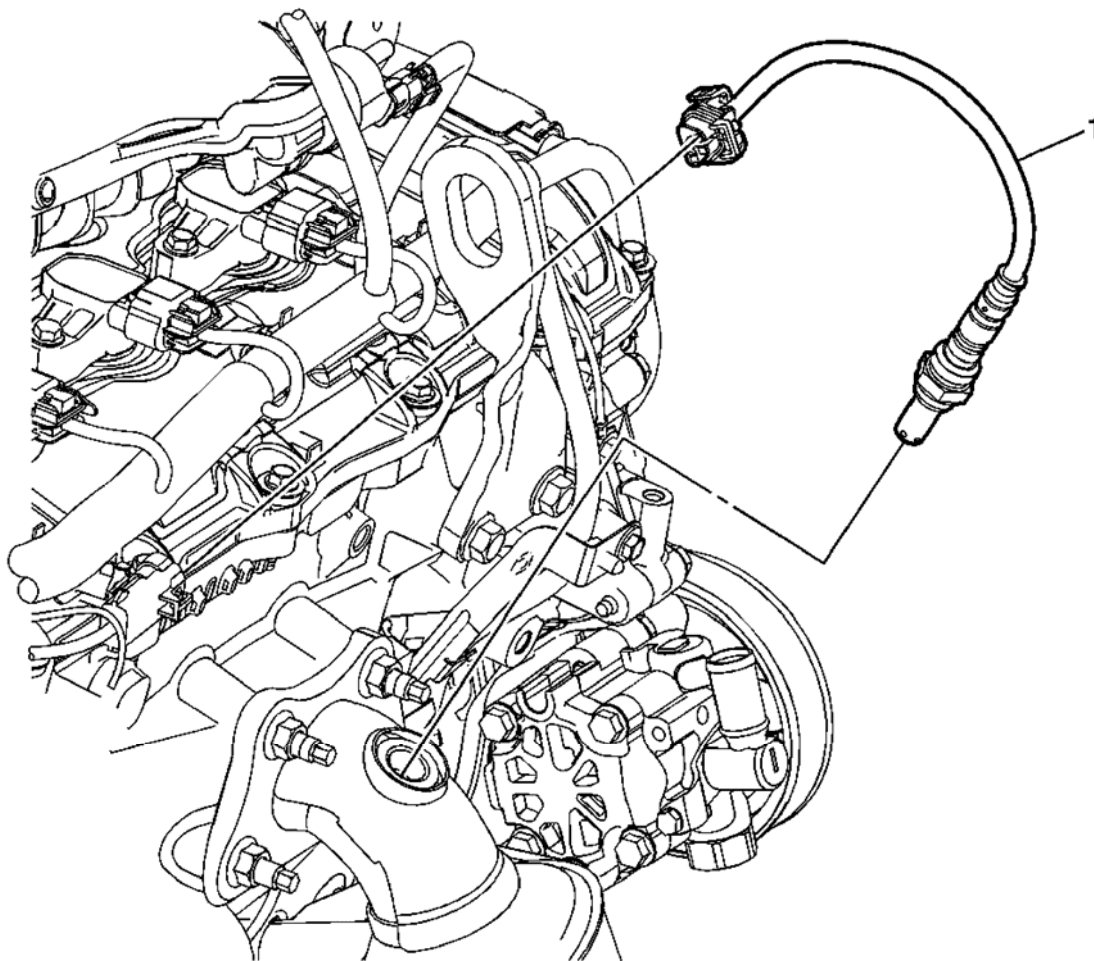


Fig. 6: Heated Oxygen Sensor - Bank 1 Sensor 1 (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1. If equipped with FWD, raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. If equipped with AWD, lower the front suspension frame. Refer to <u>Drivetrain and Front Suspension Frame Replacement</u>	
	Heated Oxygen Sensor CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> . CAUTION: Refer to <u>Fastener Caution</u> .

Procedure

- Disconnect the heated oxygen sensor harness connector.
- If reinstalling the old sensor, coat the threads with anti-sieze compound. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

1

Tip: A special anti-sieze compound is used in the HO2S threads. The compound consists of liquid graphic and glass beads. The graphic tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-sieze compound applied before reinstallation.

Tighten: 42 N.m (31 lb in)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2 (LF1)

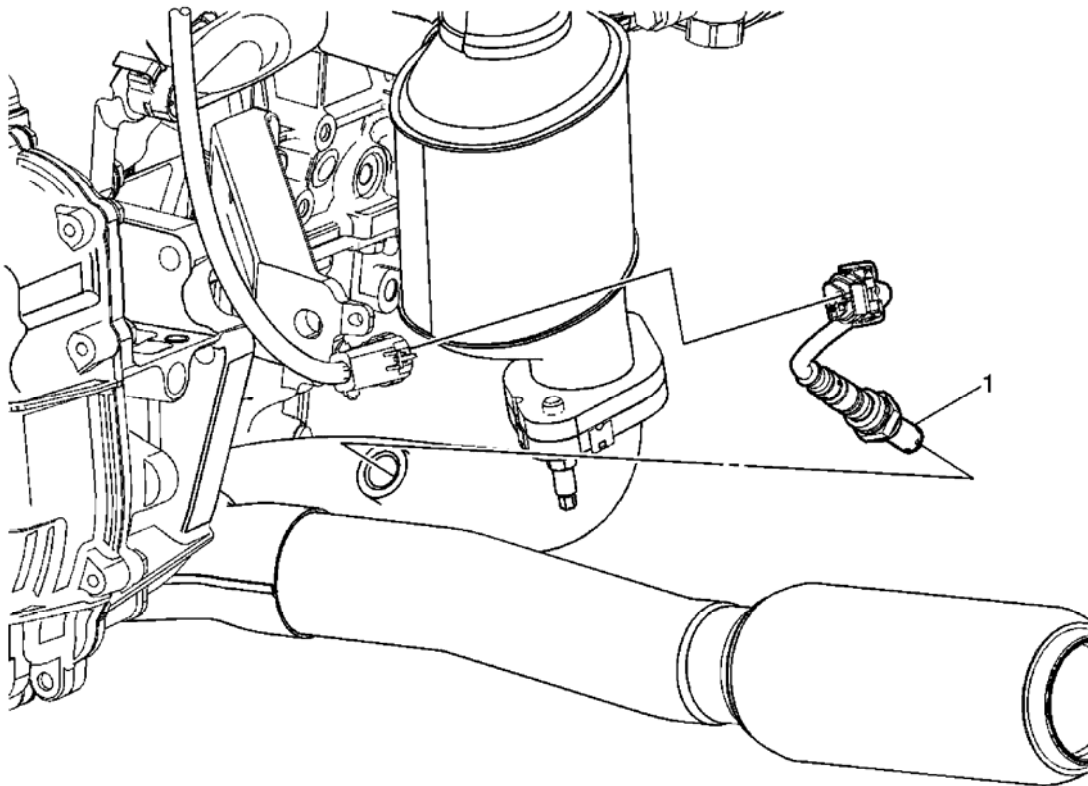


Fig. 7: Heated Oxygen Sensor - Bank 1 Sensor 2 (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

Preliminary Procedure:

Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

1	Heated Oxygen Sensor CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> . CAUTION: Refer to <u>Fastener Caution</u> . Procedure • Disconnect the heated oxygen sensor harness connector. • If reinstalling the old sensor, coat the threads with anti-sieze compound. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> . Tip: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphic and glass beads. The graphic tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-sieze compound applied before reinstallation. Tighten: 42 N.m (31 lb in)
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HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1 (LF1)

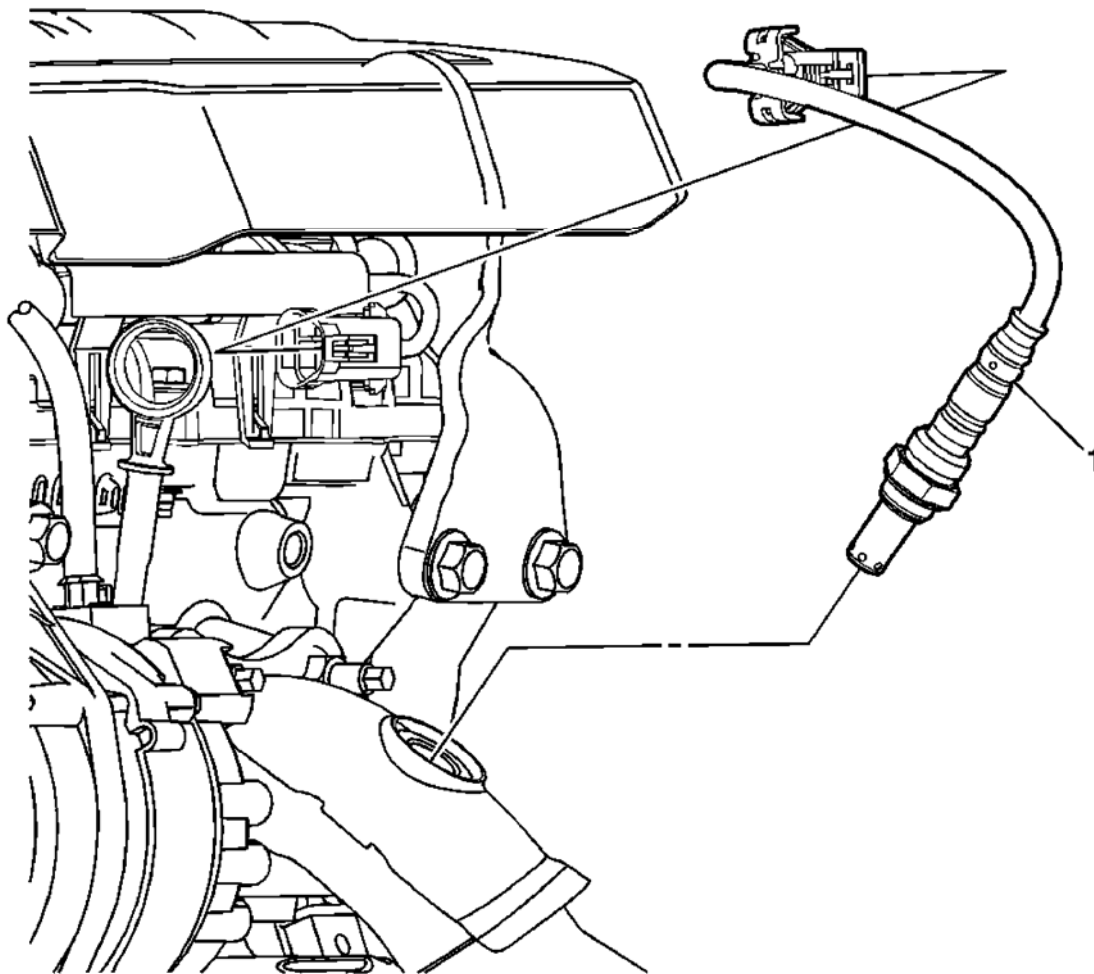


Fig. 8: Heated Oxygen Sensor - Bank 2 Sensor 1 (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Heated Oxygen Sensor CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> . CAUTION: Refer to <u>Fastener Caution</u> . Procedure • Disconnect the heated oxygen sensor harness connector. • If reinstalling the old sensor, coat the threads with anti-sieze compound. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> .

Tip: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphic and glass beads. The graphic tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-sieze compound applied before reinstallation.

Tighten: 42 N.m (31 lb in)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2

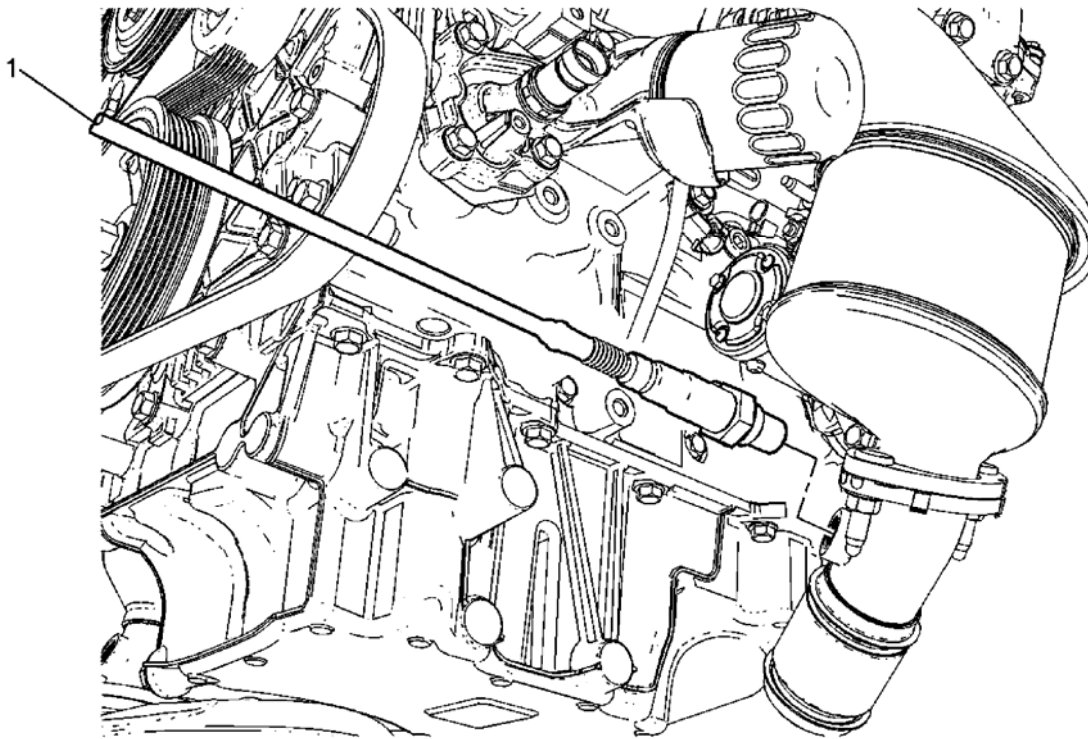


Fig. 9: Heated Oxygen Sensor - Bank 2 Sensor 2
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
	Heated Oxygen Sensor
	CAUTION: Refer to <u>Heated Oxygen and Oxygen Sensor Caution</u> .

CAUTION:

Refer to Fastener Caution .

Procedure

1. Disconnect the heated oxygen sensor harness connector.
2. If reinstalling the old sensor, coat the threads with anti-seize compound. Refer to Adhesives, Fluids, Lubricants, and Sealers .

1

Tip: A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphic and glass beads. The graphic tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-sieze compound applied before reinstallation.

Tighten: 42 N.m (31 lb in)

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

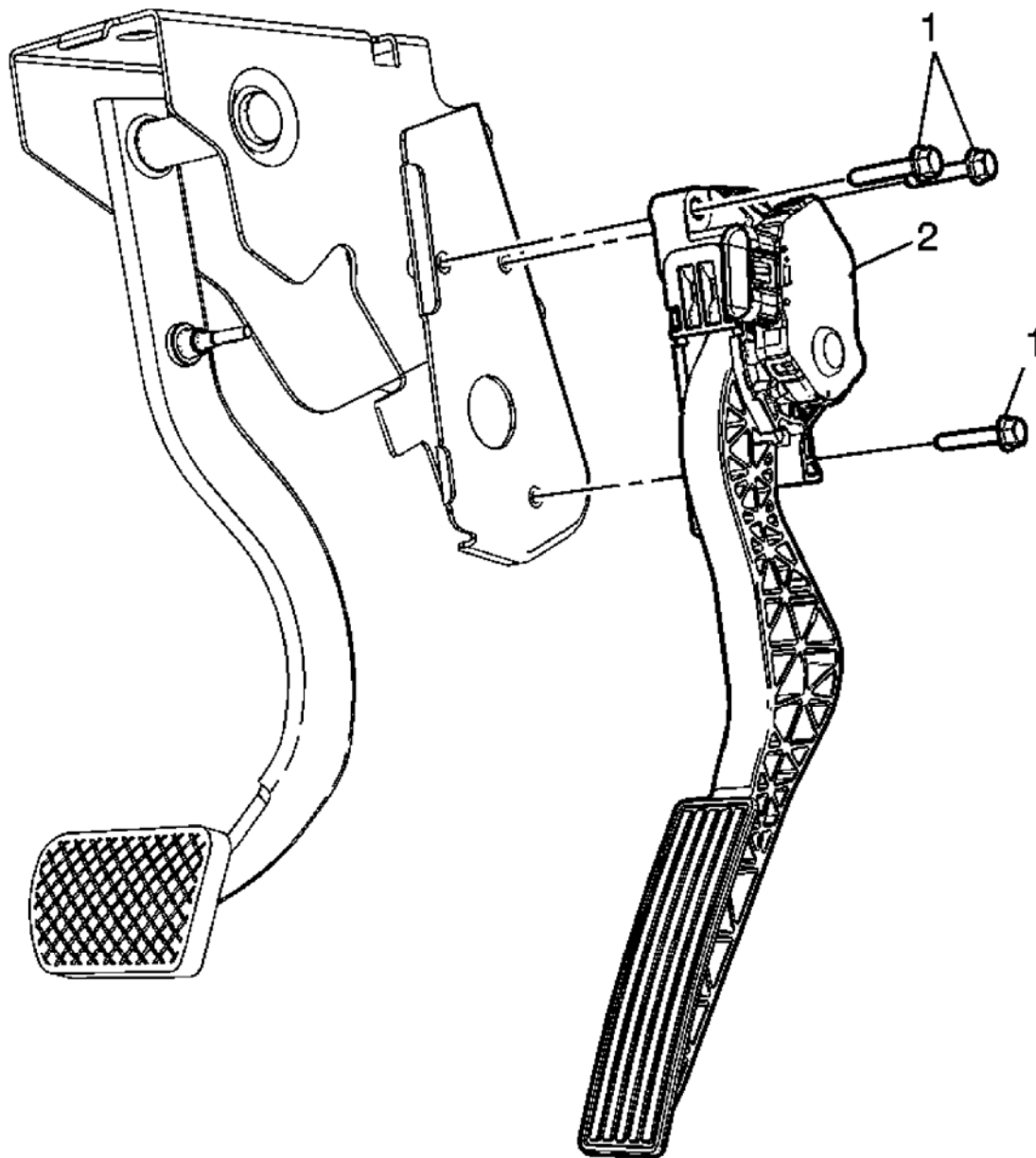


Fig. 10: Accelerator Pedal Position Sensor
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Accelerator Pedal Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 25 N.m (18 lb ft)

2

Accelerator Pedal Position Sensor
Procedure:
Disconnect the electrical connector.

THROTTLE BODY ASSEMBLY REPLACEMENT (LF1)

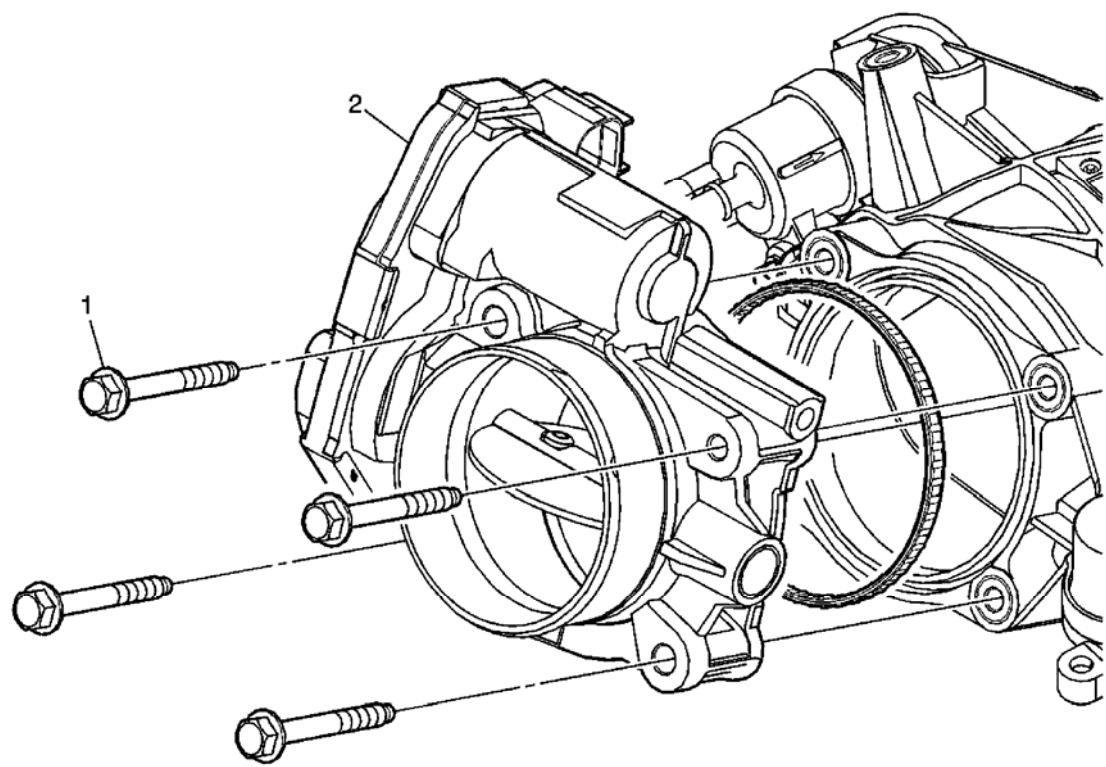


Fig. 11: Throttle Body Assembly (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Bolt (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Throttle Body Procedure 1. Disconnect the throttle body harness connector.

- | | |
|--|---|
| | <ol style="list-style-type: none">2. Install a NEW throttle body seal.3. Perform the throttle learn procedure. Refer to <u>Throttle/Idle Learn (LF1, LFW)</u>. |
|--|---|

THROTTLE BODY INSPECTION AND CLEANING

NOTE: Over extended time and mileage, deposits may accumulate on the back of the throttle valve plate. The source of the deposit is exhaust gas recirculation (EGR) gas. Typically these deposits pose no problem. Occasionally the deposit may accumulate to a point where perceived pedal effort or throttle valve movement is effected. This procedure should not be performed on vehicles with mileage under 80 450 km (50,000 mi).

1. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.

WARNING: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

CAUTION: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

2. Inspect the throttle body bore and the throttle valve plate for deposits. You will need to open the throttle valve in order to inspect all surfaces.

CAUTION: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with GM top engine cleaner, GM P/N 1052626 (Canadian P/N 993026) or AC-Delco Carburetor Tune-Up Conditioner, P/N X66-P, or an equivalent product.
4. Install the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.
5. Perform the idle learn procedure. Refer to Throttle/Idle Learn (LF1, LFW).

FUEL PRESSURE RELIEF

WARNING: Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.

NOTE: If a scan tool is not available, WAIT at LEAST 2 hours after the engine has been run, before removing the high pressure fuel line.

1. Install a scan tool to the vehicle and command the fuel pump relay OFF, allowing the low pressure fuel

pump to shut off.

2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 20-30 seconds.
3. Turn the ignition OFF.
4. Using the scan tool, verify that there is little to no fuel pressure, if there still is fuel pressure repeat step 2.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

CH-48027-100 Digital Pressure Gauge

Installation Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

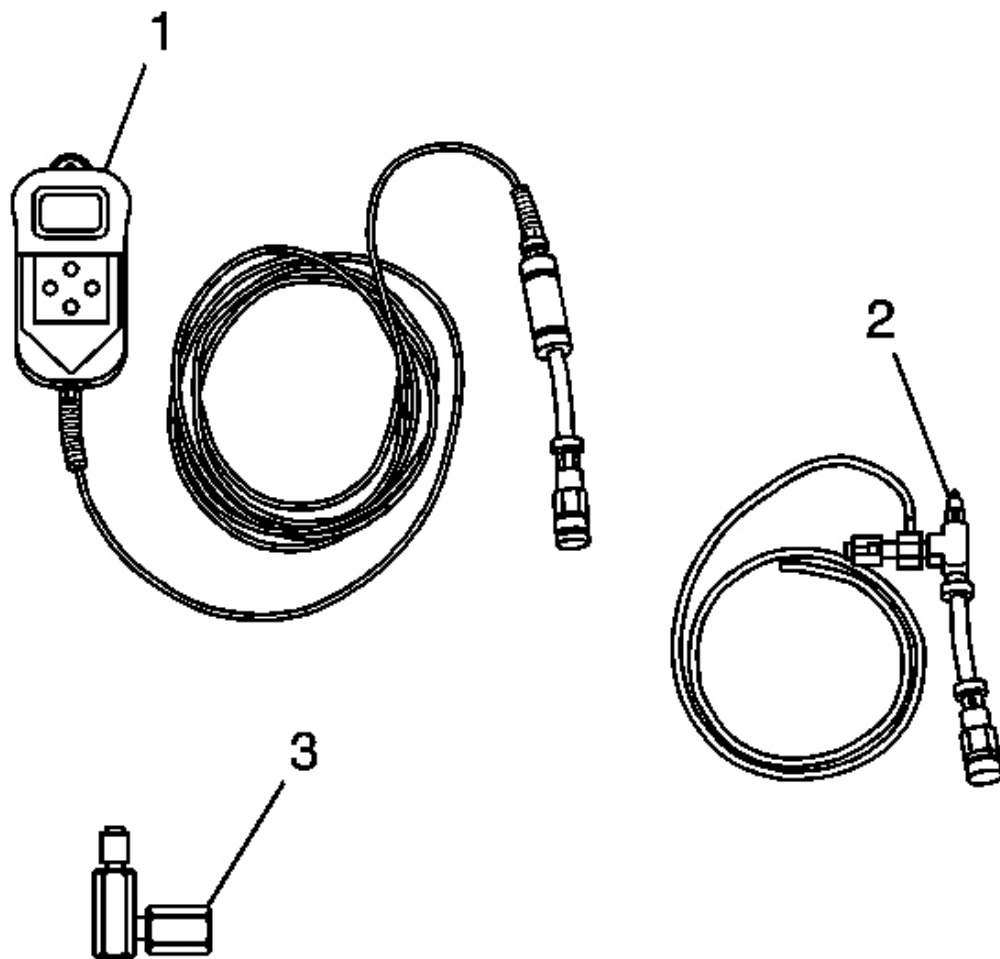


Fig. 12: Identifying CH-48027-100 Components
Courtesy of GENERAL MOTORS CORP.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Connect the CH-48027-1 (1) to the CH-48027-2 (2).
3. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
4. Perform any tests and/or diagnostics as needed. For the proper usage of the **CH-48027-100** , refer to the manufacture's directions.

Removal Procedure

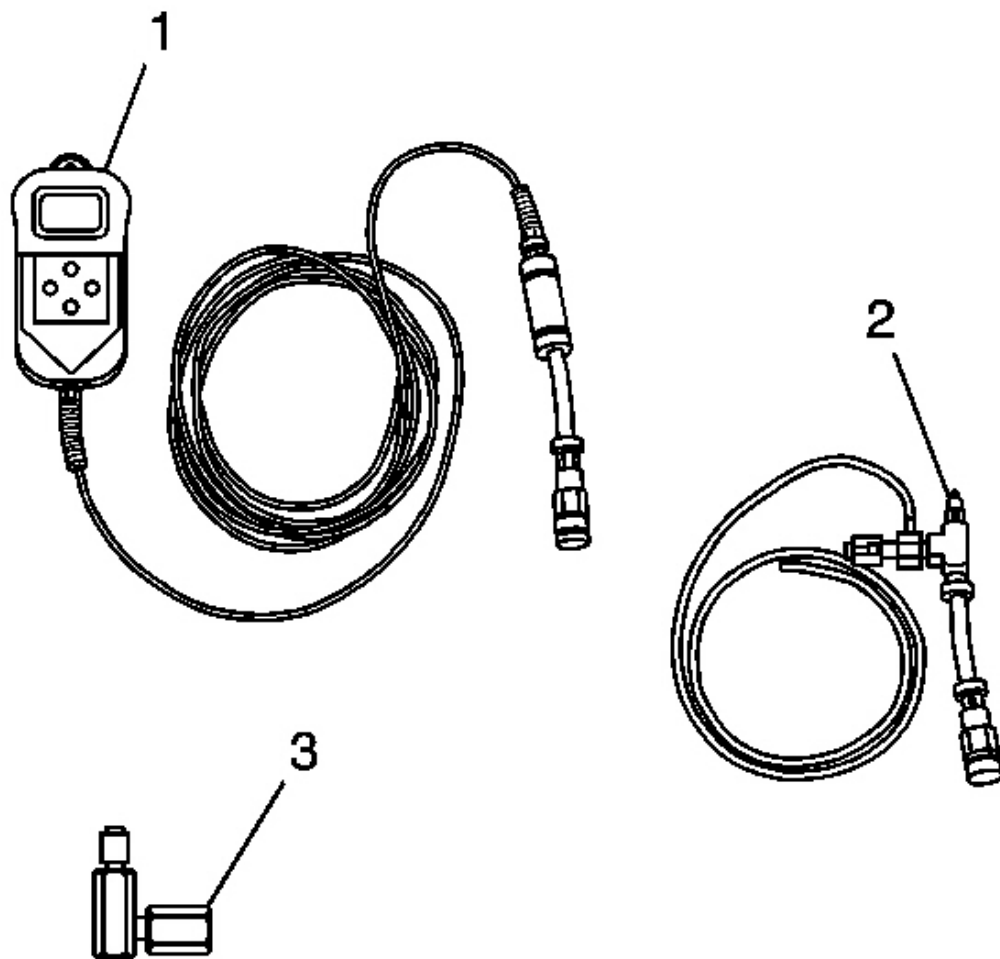


Fig. 13: Identifying CH-48027-100 Components
Courtesy of GENERAL MOTORS CORP.

WARNING: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

1. Relieve the fuel system pressure, if required. Perform the following steps:
 1. Wrap a shop towel around the fuel rail service port.
 2. Place the hose on the CH-48027-2 (2) into an approved gasoline container.

3. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
4. Close the valve on the CH-48027-2 (2).
5. Remove the hose on the CH-48027-2 (2) from the approved gasoline container.
6. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.

CAUTION: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- The fuel pipe connections
- The hose connections
- The areas surrounding the connections

2. Disconnect the CH-48027-1 (1) from the CH-48027-2 (2).
3. Disconnect the CH-48027-2 (2) from the CH-48027-3 (3).
4. Disconnect the CH-48027-3 (3) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Install the engine cover, if required.
7. Tighten the fuel fill cap.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

- **CH-41769:** Fuel Line Disconnect Tool Set
- **CH-44581:** Fuel Line Disconnect Tool

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

WARNING: Refer to **Gasoline/Gasoline Vapors Warning** .

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .

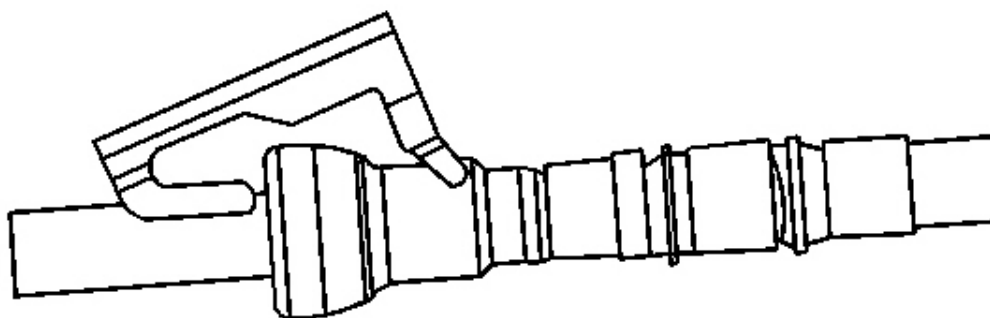


Fig. 14: View Of Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS CORP.

2. Remove the retainer from the quick-connect fitting.

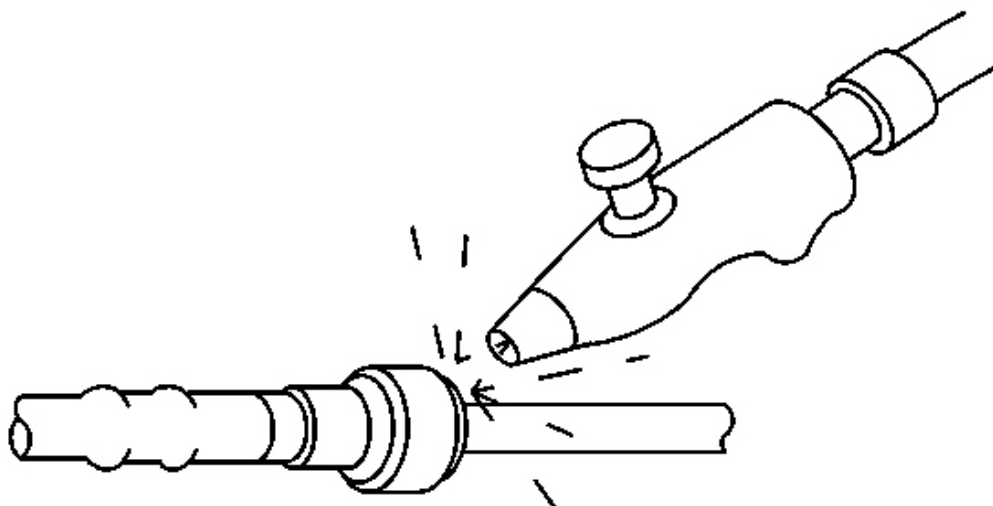


Fig. 15: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

WARNING: Wear safety glasses when using compressed air, as flying dirt

particles may cause eye injury.

3. Blow dirt out of the fitting using compressed air.

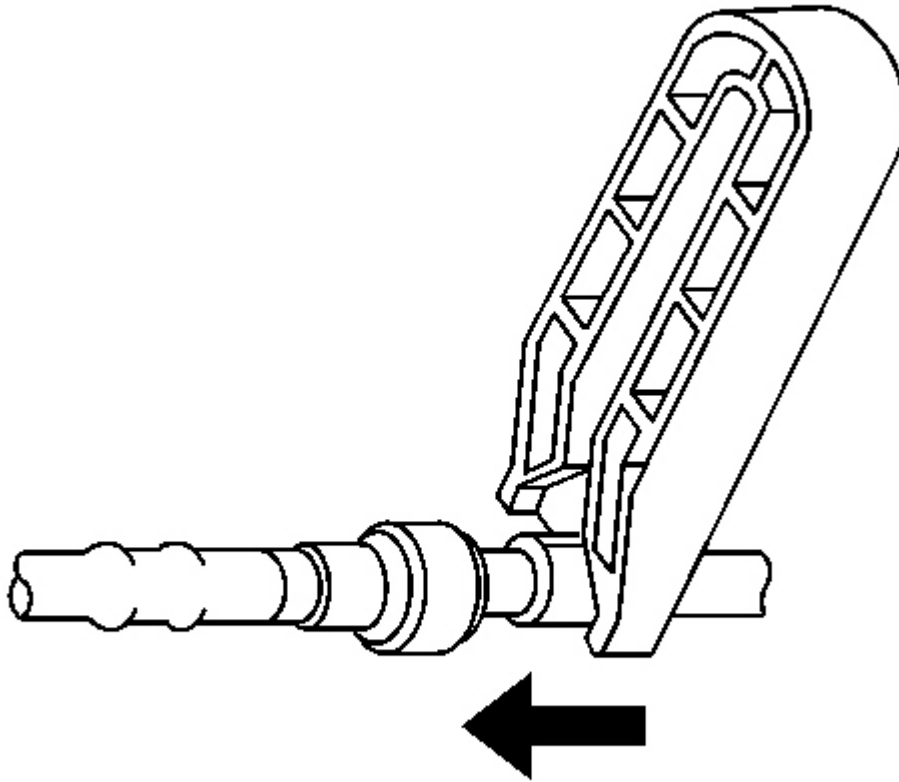


Fig. 16: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

4. Depending on the fuel line size and ability to access the fitting, choose the appropriate tool: **CH-41769:** fuel line disconnect tool set or **CH-44581:** fuel line disconnect tool. Insert the **CH-41769:** fuel line disconnect tool set or **CH-44581:** fuel line disconnect tool into the female connector, then push inward to release the locking tabs.

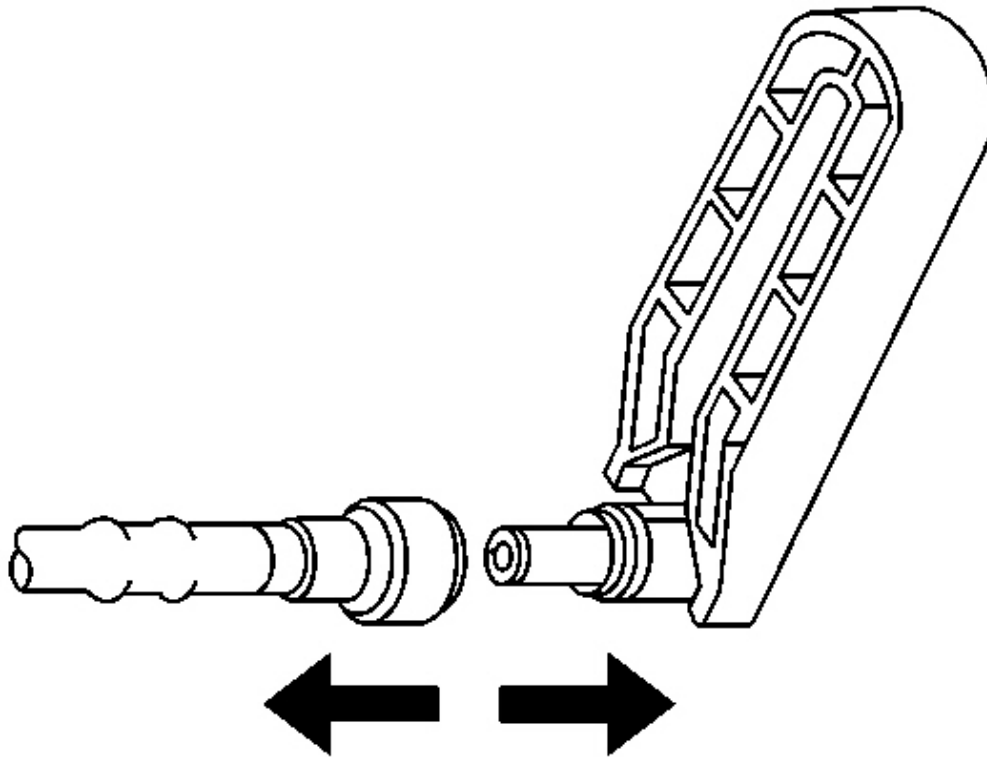


Fig. 17: Pulling Connection Apart
Courtesy of GENERAL MOTORS CORP.

5. Pull the connection apart.

CAUTION: If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.

6. Using a clean shop towel, wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs.
8. Clean or replace the components as required.

Installation Procedure

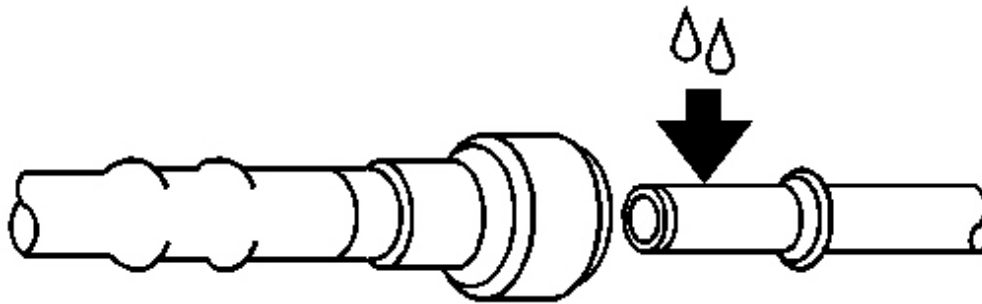


Fig. 18: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS CORP.

WARNING: In order to reduce the risk of fire and personal injury, before connecting fuel pipe fittings, always apply a few drops of clean engine oil to the male pipe ends. This will ensure proper reconnection and prevent a possible fuel leak. During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

1. Apply a few drops of clean engine oil to the male pipe end.

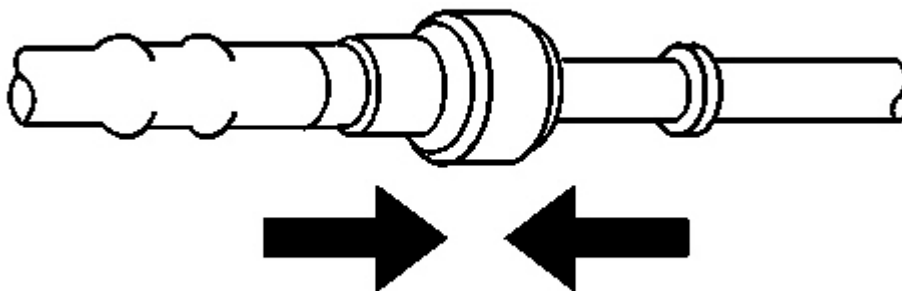


Fig. 19: Pushing Fittings Together
Courtesy of GENERAL MOTORS CORP.

2. Push both sides of the quick-connect fitting together to cause the retaining tabs to snap into place.

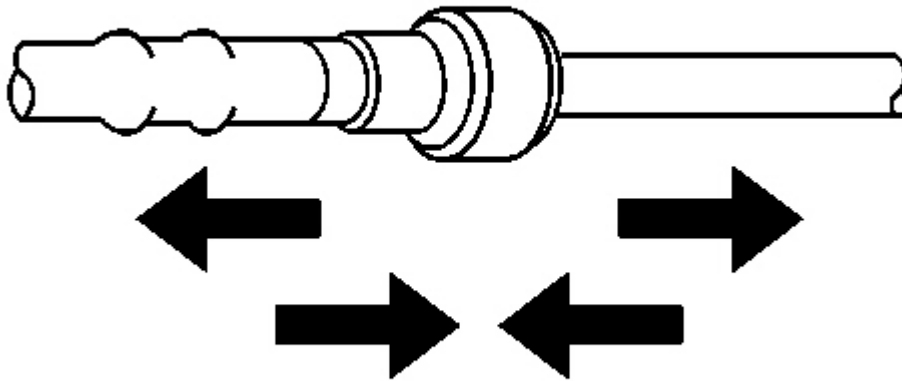


Fig. 20: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS CORP.

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

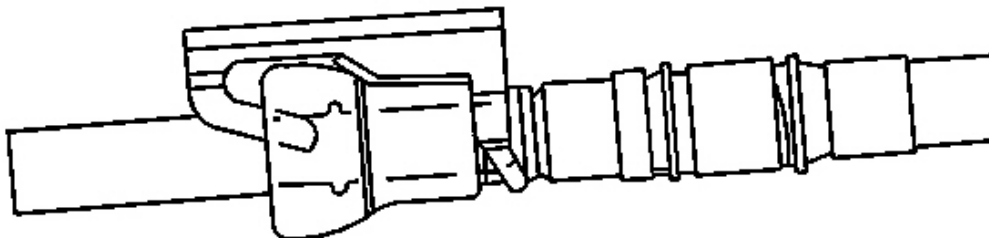


Fig. 21: View Of Fuel Pipe Retainer
Courtesy of GENERAL MOTORS CORP.

4. Install the retainer to the quick-connect fitting.

5. Inspect for leaks using the following procedure:
 1. Turn the ignition ON, with the engine OFF for 2 seconds.
 2. Turn the ignition OFF, for 10 seconds.
 3. Turn the ignition ON, with the engine OFF for 2 seconds.
 4. Turn the ignition OFF.
 5. Inspect for leaks.

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Removal Procedure

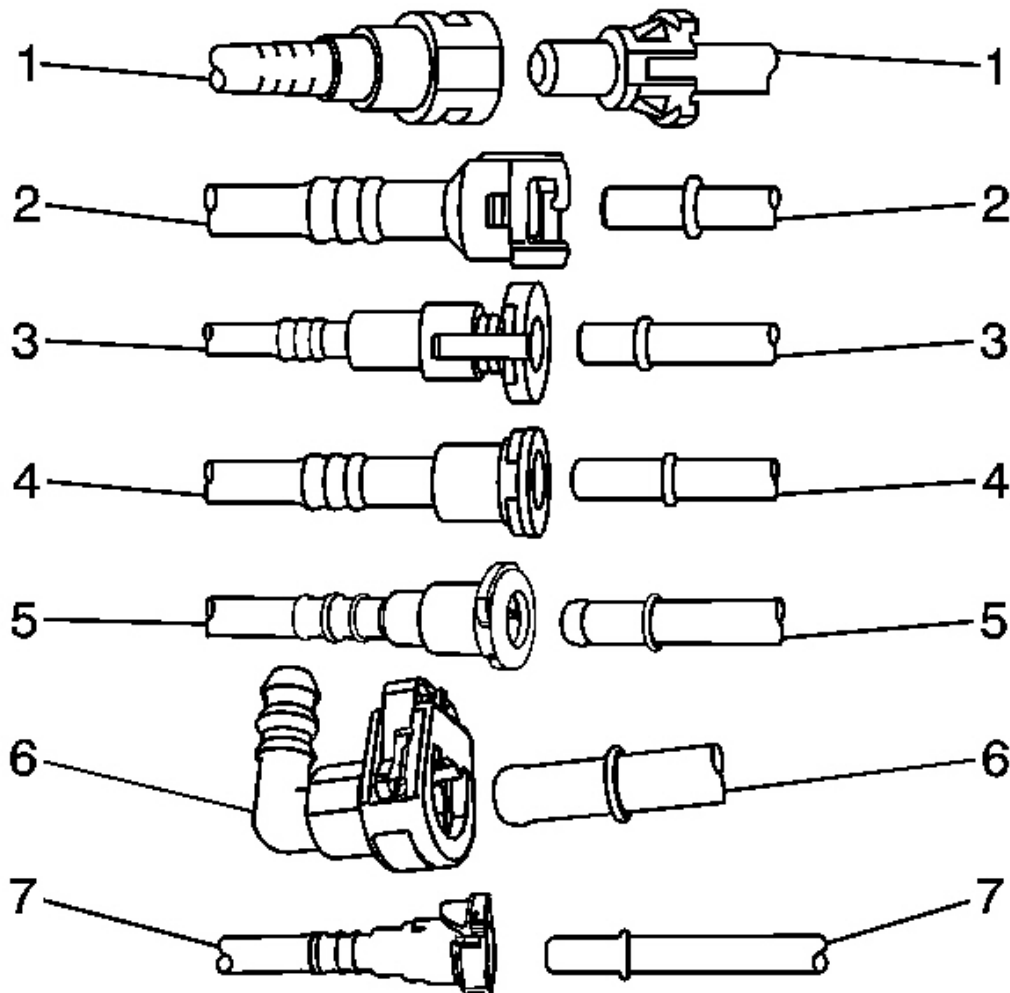


Fig. 22: Identifying Plastic Collar Quick Connect Fitting Types
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

NOTE: There are several types of Plastic Collar Fuel and Evaporative Emission Quick Connect Fittings used on this vehicle.

- Bartholomew (1)
- Q Release (2)
- Squeeze to Release (3)
- Sliding Retainer (4)
- Global Connect (5)
- TI Loc (6)
- Safe Lock (7)

The following instructions apply to all of these types of Plastic Collar Quick Connect Fittings except where indicated.

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to the Fuel Pressure Relief .

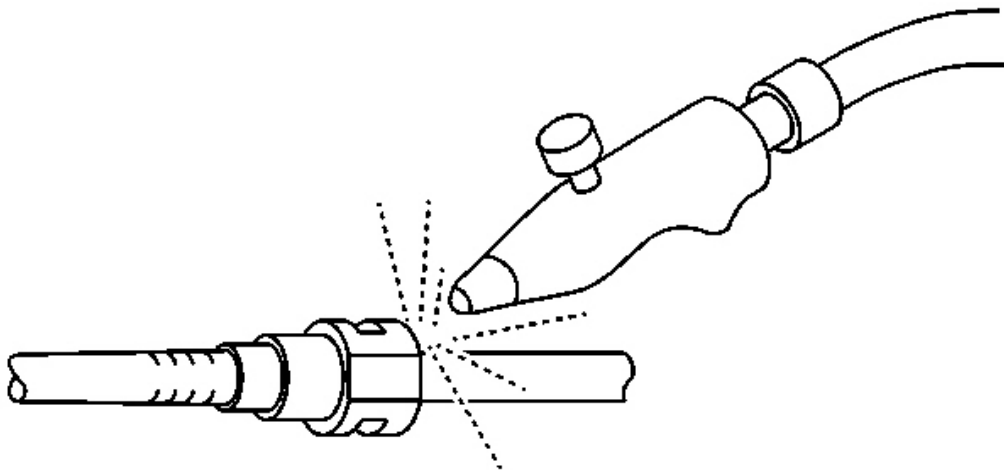


Fig. 23: Blowing Dirt Out Of Fitting (Plastic Collar)

Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Using compressed air, blow any dirt out of the quick-connect fitting.

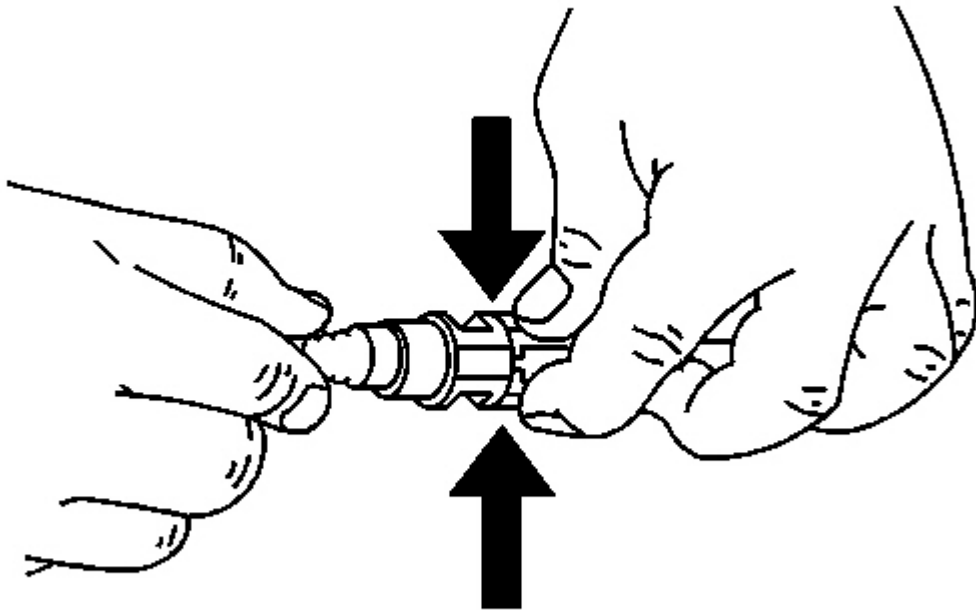


Fig. 24: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

3. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick-connect fitting release tabs.

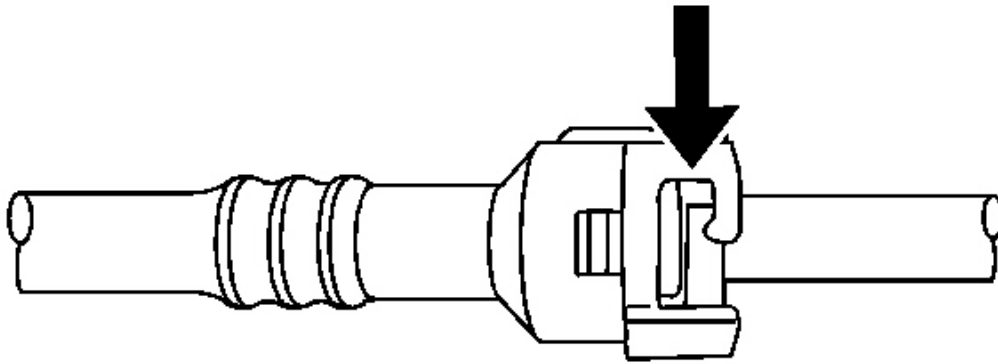


Fig. 25: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

4. This step applies to Q Release style connectors ONLY. Release the fitting by Pushing the tab toward the other side of the slot in the fitting.

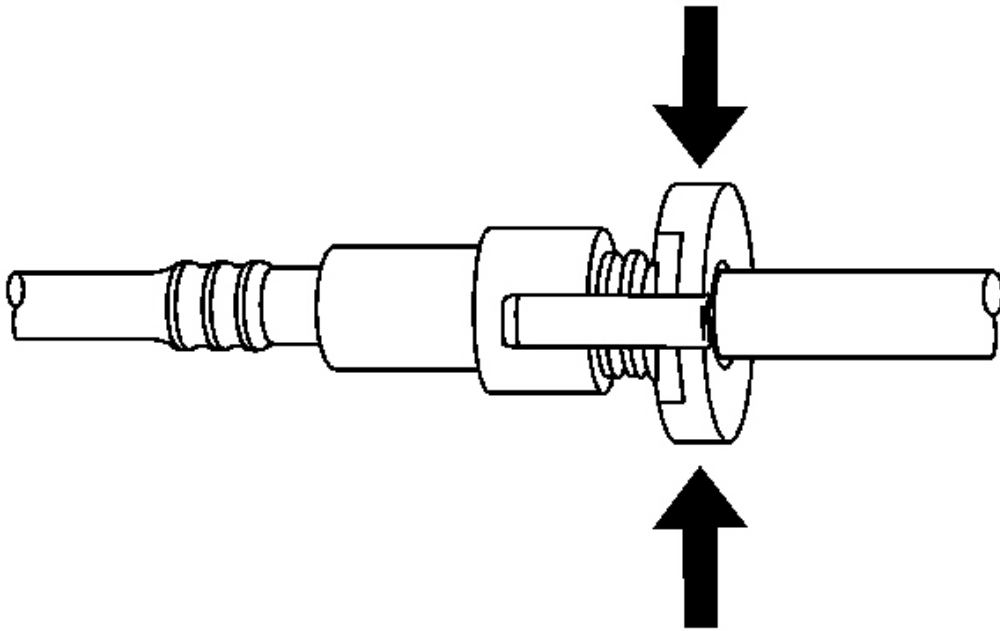


Fig. 26: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS CORP.

5. This step applies to Squeeze to Release style connectors ONLY. Squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick-connect fitting.

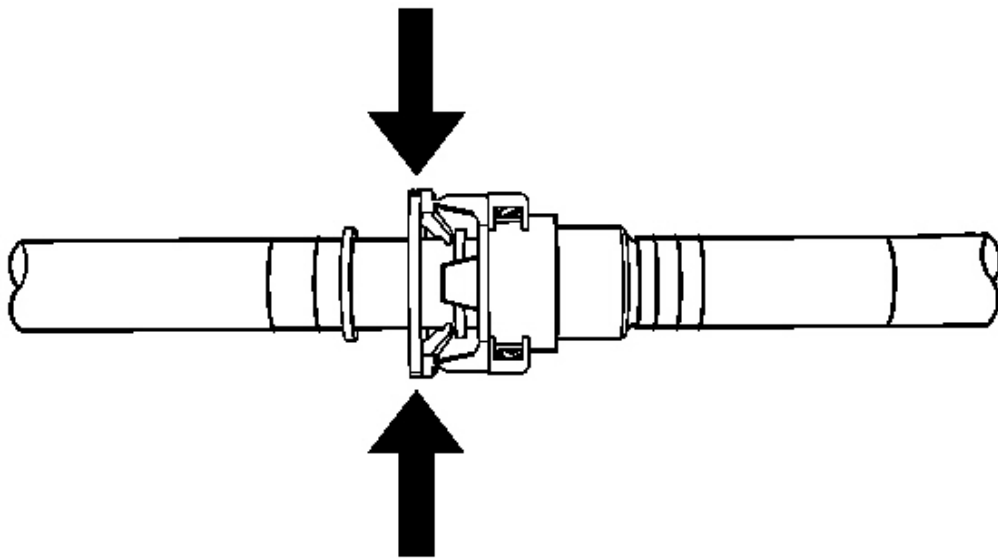


Fig. 27: Pushing In Male Side Of Connector
Courtesy of GENERAL MOTORS CORP.

6. This step applies to Squeeze to Release style connectors ONLY. Push in the male side slightly in order to slide the retainer away from the retainers, squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick-connect fitting.

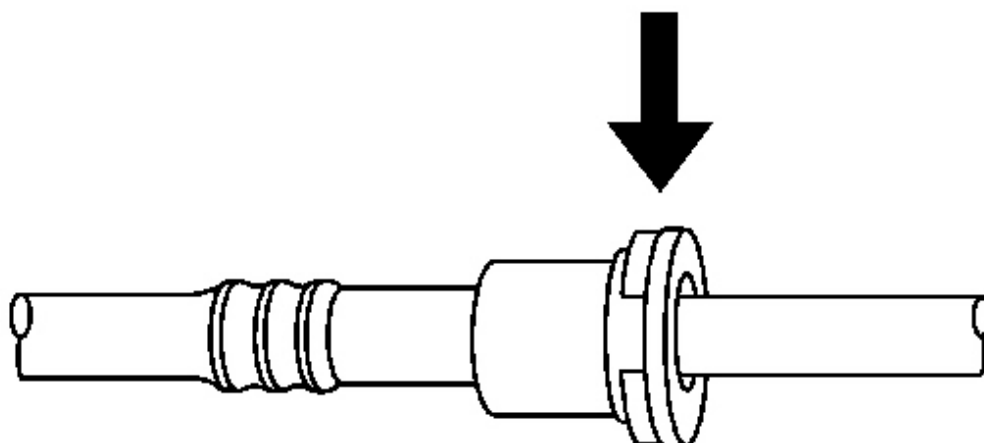


Fig. 28: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS CORP.

7. This step applies to Sliding Retainer style connectors ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab doesn't move try pressing the tab in from the opposite side. The tab will only move in one direction.

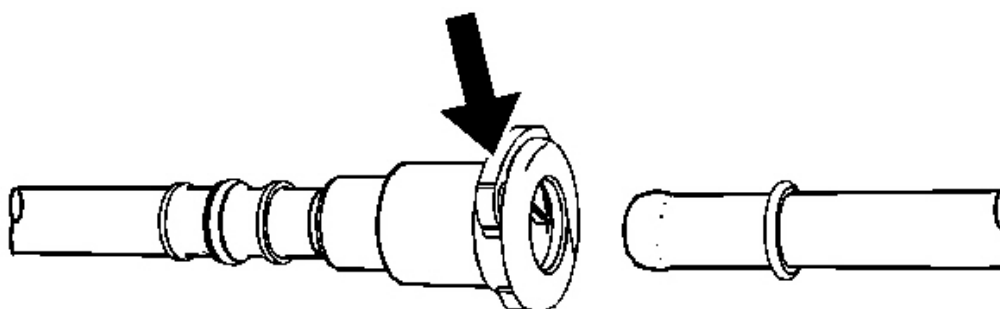


Fig. 29: Global Connector Style
Courtesy of GENERAL MOTORS CORP.

8. This step applies to the Global Connector style only. Push the connector toward the tube in order to

release the pressure. Press and hold down the release mechanism, and pull the connector straight out.

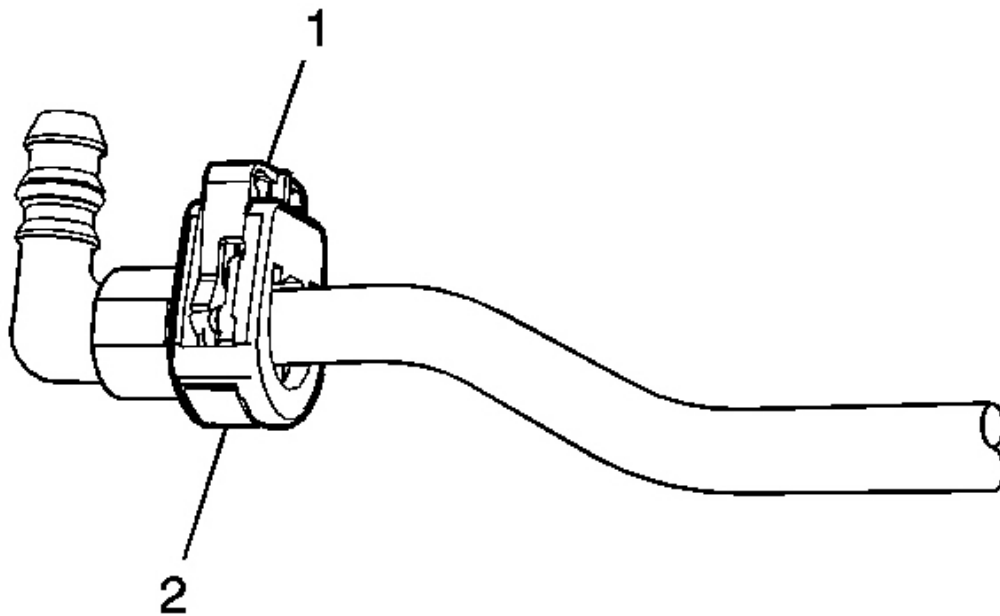


Fig. 30: TI Loc style

Courtesy of GENERAL MOTORS CORP.

9. This step applies to the TI Loc style only. Push the connector toward the tube in order to release the pressure. Release the redundant latch (1) with two fingers or a flat bladed tool. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

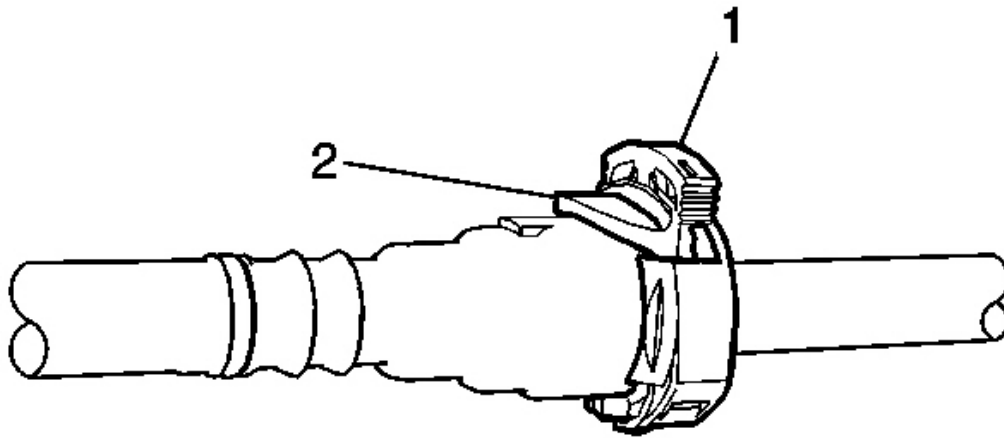


Fig. 31: Safe Lock Style
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Relieving Fuel Pressure Warning .

10. This step applies to the Safe Lock style only. Push the connector toward the tube in order to release the pressure. Release the second latch (1) with two fingers. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.
11. Using a clean shop towel, wipe off the male pipe end.
12. Inspect both ends of the fitting for dirt and burrs.
13. Clean or replace components as necessary.

Installation Procedure

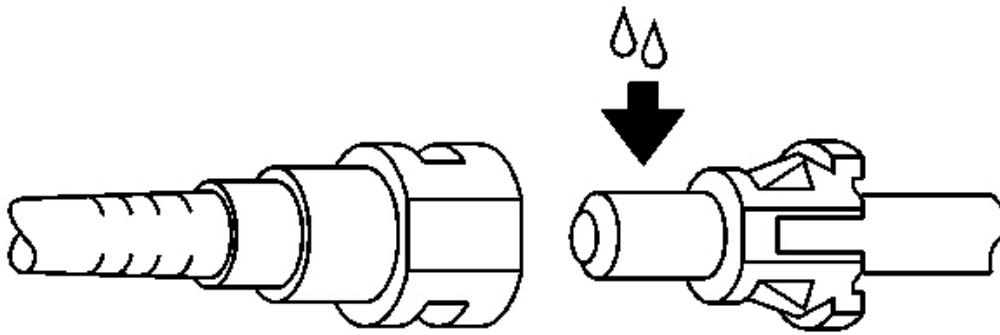


Fig. 32: Lubricating Male Pipe End
 Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Fuel Pipe Fitting Warning .

1. Apply a few drops of clean engine oil to the male pipe end.

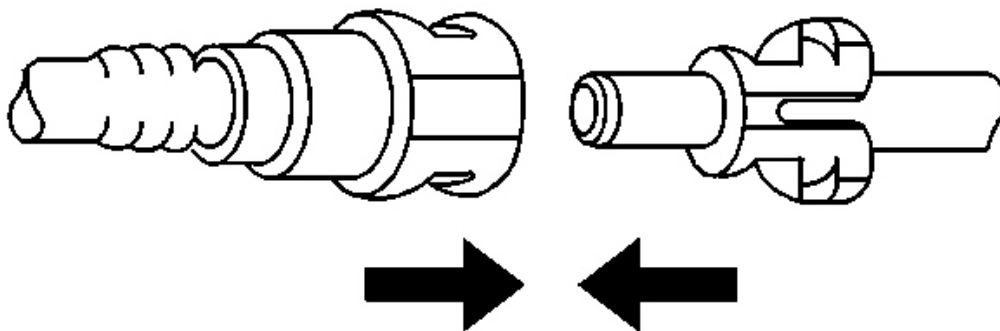


Fig. 33: Connecting Quick-Connect Fittings
 Courtesy of GENERAL MOTORS CORP.

2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

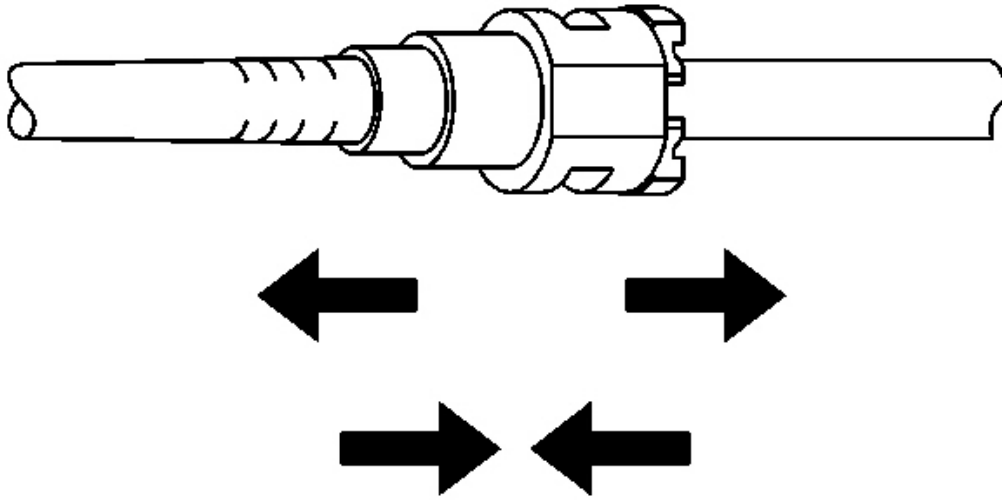


Fig. 34: Ensuring Quick-Connect Fitting Is Secure
Courtesy of GENERAL MOTORS CORP.

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

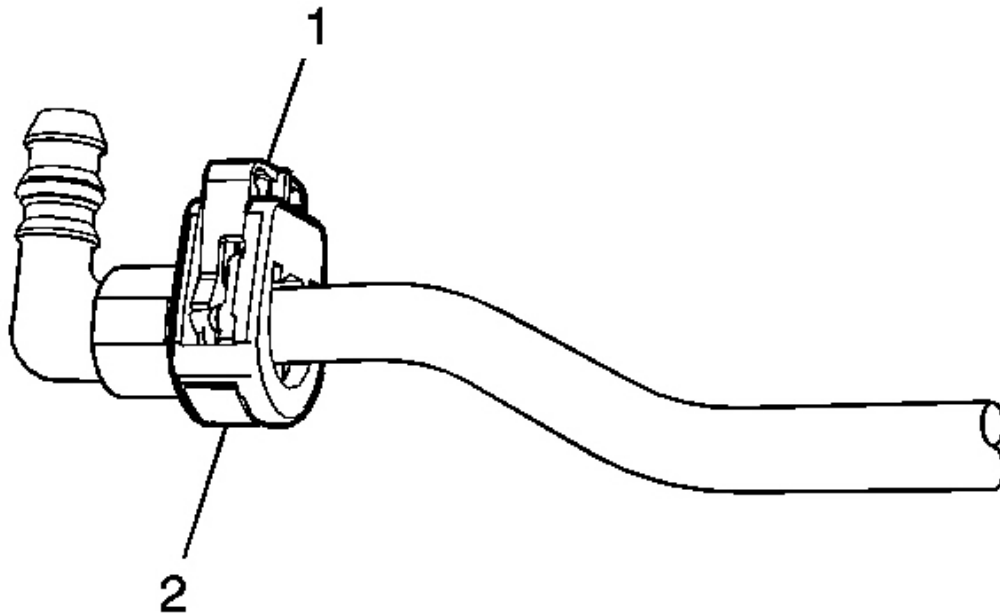


Fig. 35: TI Loc style

Courtesy of GENERAL MOTORS CORP.

4. Insert the tube in the connector until the retainer snaps in place.
5. Push down on the redundant latch (1) until it is fully engaged and snapped into position.

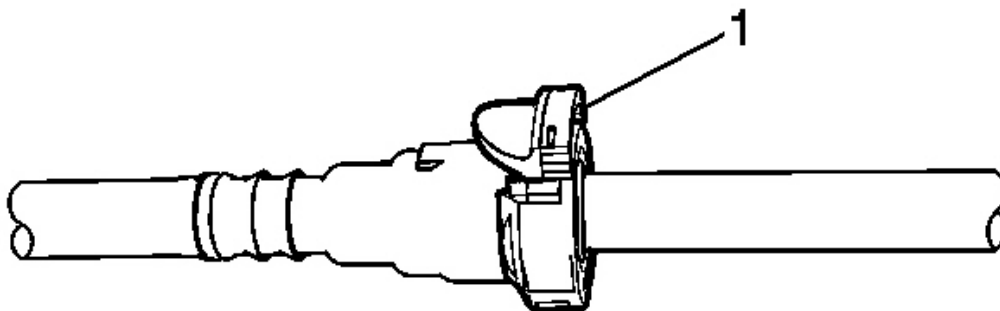


Fig. 36: Securing Connection

Courtesy of GENERAL MOTORS CORP.

6. Insert the tube in the connector until the retainer snaps in place.
7. Push down on the second latch (1) in order to secure the connection.
8. Inspect for leaks using the following procedure:
 1. Turn the ignition ON, with the engine OFF for 2 seconds.
 2. Turn the ignition OFF, for 10 seconds.
 3. Turn the ignition ON, with the engine OFF for 2 seconds.
 4. Turn the ignition OFF.
 5. Inspect for leaks.

FUEL TANK DRAINING

Special Tools

CH-45004: Fuel Tank Drain Hose

For equivalent regional tools, refer to **Special Tools** .

WARNING: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

WARNING: Place a dry chemical (Class B) fire extinguisher nearby before performing any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

Drain

1. Remove the fuel fill cap.
2. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Loosen the fuel fill pipe hose clamps and slide the fill pipe hose up the filler pipe.
4. Insert the **CH-45004:** fuel tank drain hose into the fuel tank until the hose reaches the bottom of the fuel tank.
5. Use an hand or air operated pump device in order to drain as much fuel as possible.

FUEL TANK REPLACEMENT (AWD)

Removal Procedure

WARNING: Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

1. Ensure that the fuel level in the tank is less than 1/4 full. If necessary, drain the fuel tank to at least this level. Refer to **Fuel Tank Draining**.

WARNING: Fuel supply lines will remain pressurized for long periods of time after the engine is shutdown. This pressure must be relieved before servicing the fuel system.

2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
3. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
5. Remove the exhaust system. Refer to **Exhaust Muffler Replacement**.
6. Remove the propeller shaft. Refer to **Propeller Shaft Replacement**.

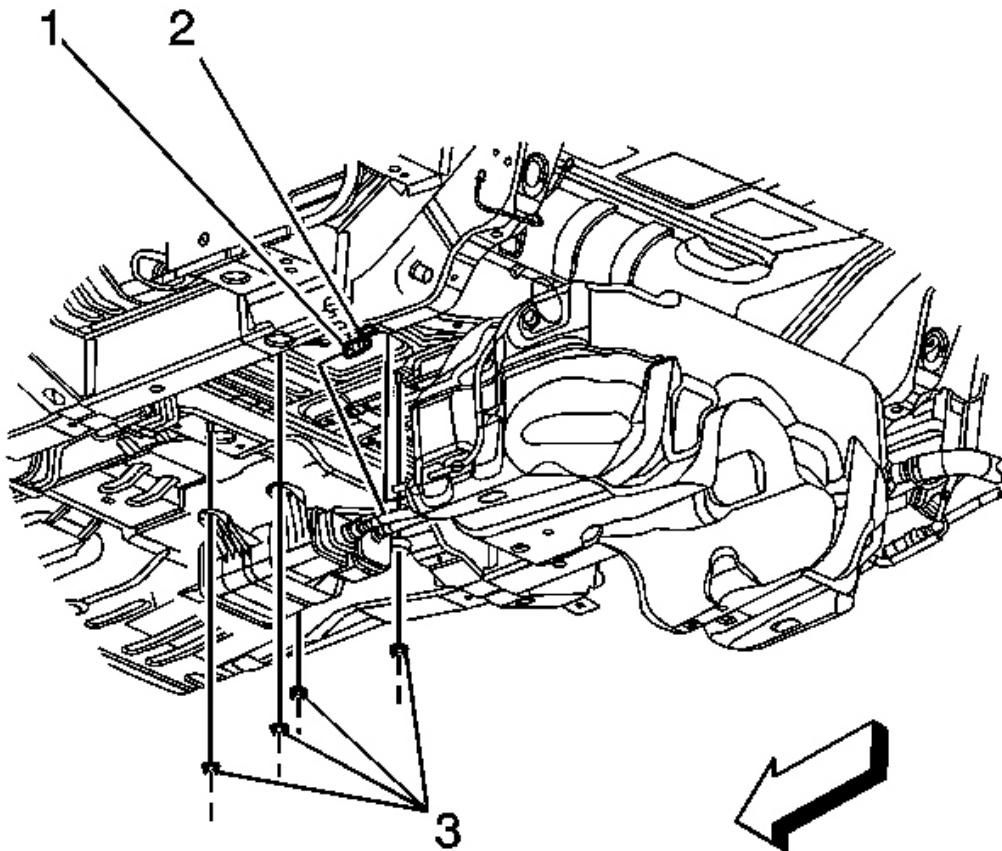


Fig. 37: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-

Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

WARNING: Whenever fuel lines are removed, catch fuel in an approved container. Container opening must be a minimum of 300 mm (12 in) diameter to adequately catch the fluid.

CAUTION: Clean all fuel pipe connections and surrounding areas before disconnecting the fuel pipes to avoid contamination of the fuel system.

7. Place a suitable container under the fuel line connection in order to catch any dripping fuel.
8. Remove the evaporative emission canister. Refer to **Evaporative Emission Canister Replacement**.
9. Disconnect the chassis fuel supply line (2) from the fuel tank.

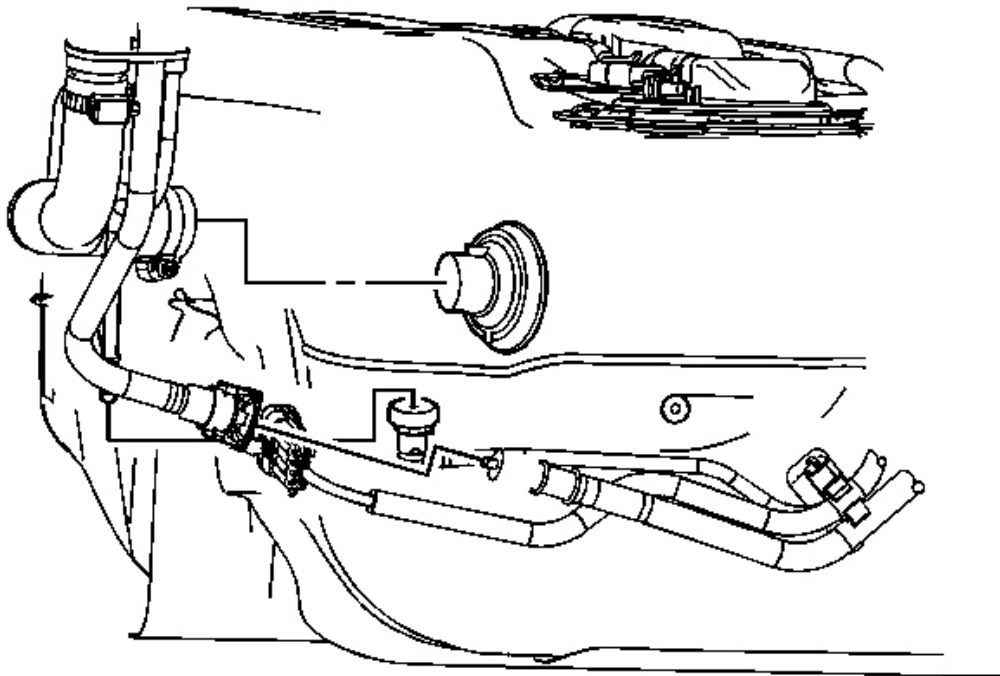


Fig. 38: View Of Fuel Filler Pipe, EVAP Vent & Fresh Air Hoses At Fuel Tank
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the fuel filler tube, EVAP vent hose, and fresh air hose from the fuel tank.
11. Disconnect the fuel tank electrical connector and remove the electrical connector retainer from the rear

frame.

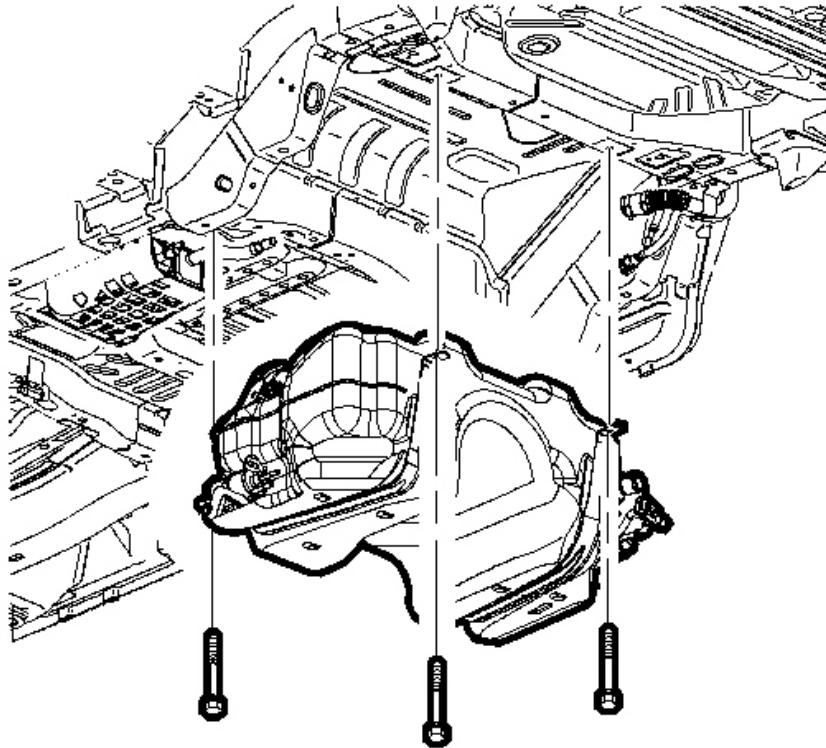


Fig. 39: View Of Fuel Tank Heat Shield & Fuel Tank Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not bend the fuel tank straps. Bending the fuel tank straps may cause damage to the straps.

12. Support the fuel tank.
13. Remove the fuel tank strap bolts and fuel tank straps.
14. Lower the front of the fuel tank (with shield), and pull the tank forward to clear the rear drive module.
15. If replacing the fuel tank, remove the fuel tank module assemblies. Refer to **Fuel Tank Fuel Pump**

Module Replacement and Fuel Tank Fuel Pump Module Replacement - Secondary .

16. If replacing the fuel tank, remove the heat shield from the tank.

Installation Procedure

1. If previously removed, install the fuel tank module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement** and **Fuel Tank Fuel Pump Module Replacement - Secondary** .
2. If previously removed, install the heat shield to the fuel tank.

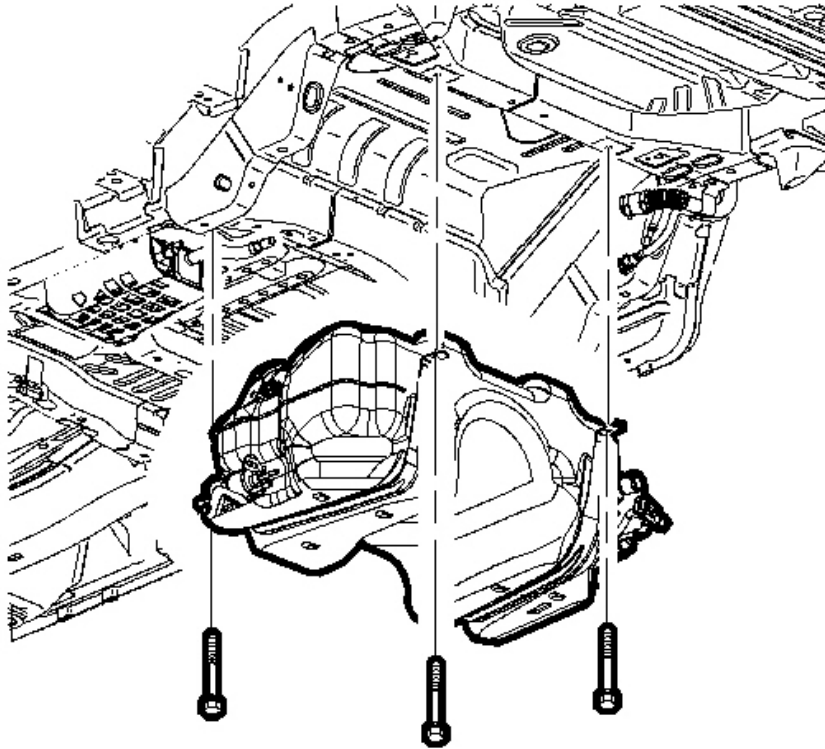


Fig. 40: View Of Fuel Tank Heat Shield & Fuel Tank Assembly
Courtesy of GENERAL MOTORS CORP.

3. Install the fuel tank heat shield and fuel tank assembly to the vehicle.

CAUTION: Refer to Fastener Caution .

4. Install the fuel tank straps and the fuel tank strap-to-body bolts.

Tighten: Tighten the bolts to 25 N.m (18 lb ft).

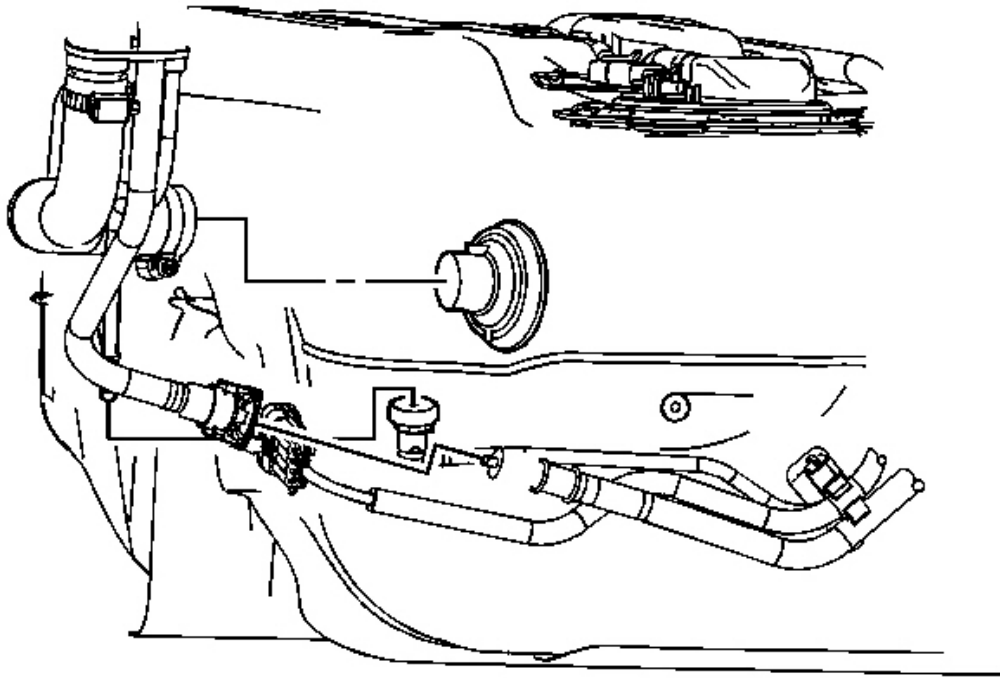


Fig. 41: View Of Fuel Filler Pipe, EVAP Vent & Fresh Air Hoses At Fuel Tank
Courtesy of GENERAL MOTORS CORP.

5. Connect the fuel tank electrical connector and install the electrical connector retainer to the rear frame.
6. Connect the EVAP vent, and fresh air hoses to the fuel tank.
7. Connect the fuel filler tube to the fuel tank.

Tighten: Tighten the fuel filler tube clamp to 5 N.m (44 lb in).

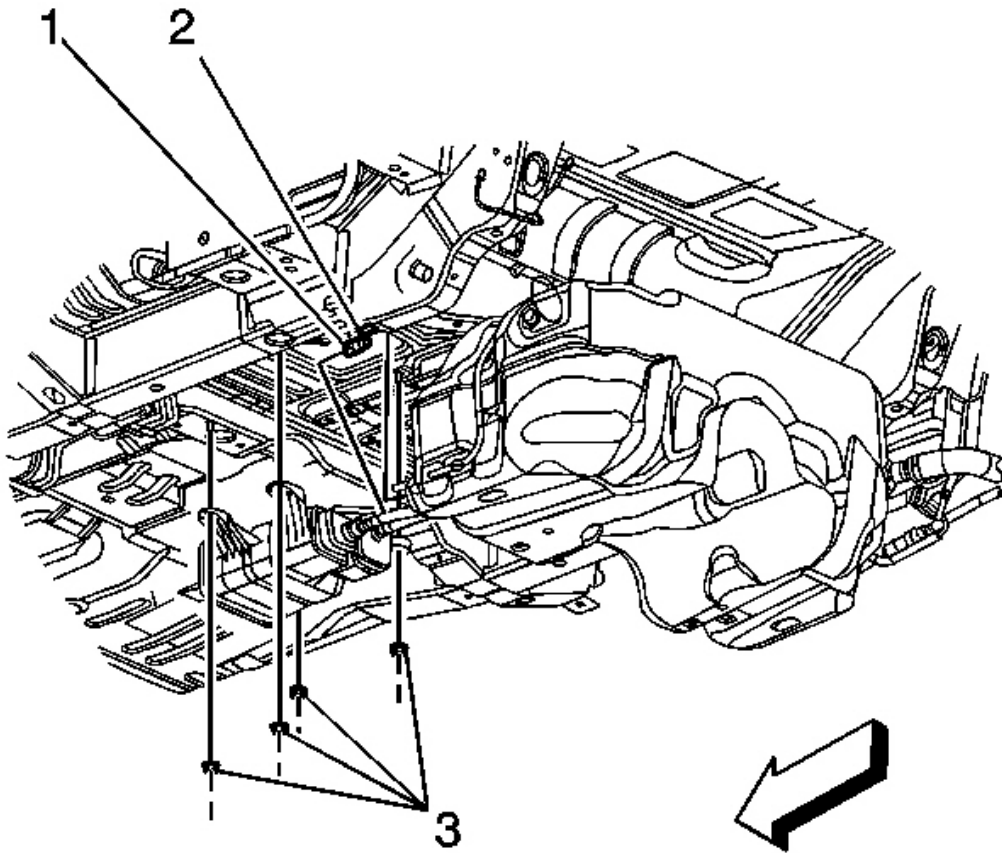


Fig. 42: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

8. Connect the chassis fuel supply line (2) to the fuel tank.
9. Install the evaporative emission canister. Refer to **Evaporative Emission Canister Replacement** .
10. Install the propeller shaft. Refer to **Propeller Shaft Replacement** .
11. Install the exhaust system. Refer to **Exhaust Muffler Replacement** .
12. Lower the vehicle.
13. Fill the fuel tank with gasoline.
14. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
15. Prime the fuel system:
 1. Cycle the ignition ON for 5 seconds and then OFF for 10 seconds.
 2. Repeat the previous step twice.

3. Crank the engine until it starts. The maximum starter motor cranking time is 20 seconds.
4. If the engine does not start, repeat steps 13.1-13.3.

FUEL TANK REPLACEMENT (FWD)

Removal Procedure

WARNING: Do not allow smoking or the use of open flames in the area where work on the fuel or EVAP system is taking place. Anytime work is being done on the fuel system, disconnect the negative battery cable, except for those tests where battery voltage is required.

1. Ensure that the fuel level in the tank is less than 1/4 full. If necessary, drain the fuel tank to at least this level. Refer to **Fuel Tank Draining**.

WARNING: Fuel supply lines will remain pressurized for long periods of time after the engine is shutdown. This pressure must be relieved before servicing the fuel system.

2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
3. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
5. Remove the exhaust system. Refer to **Exhaust Muffler Replacement**.

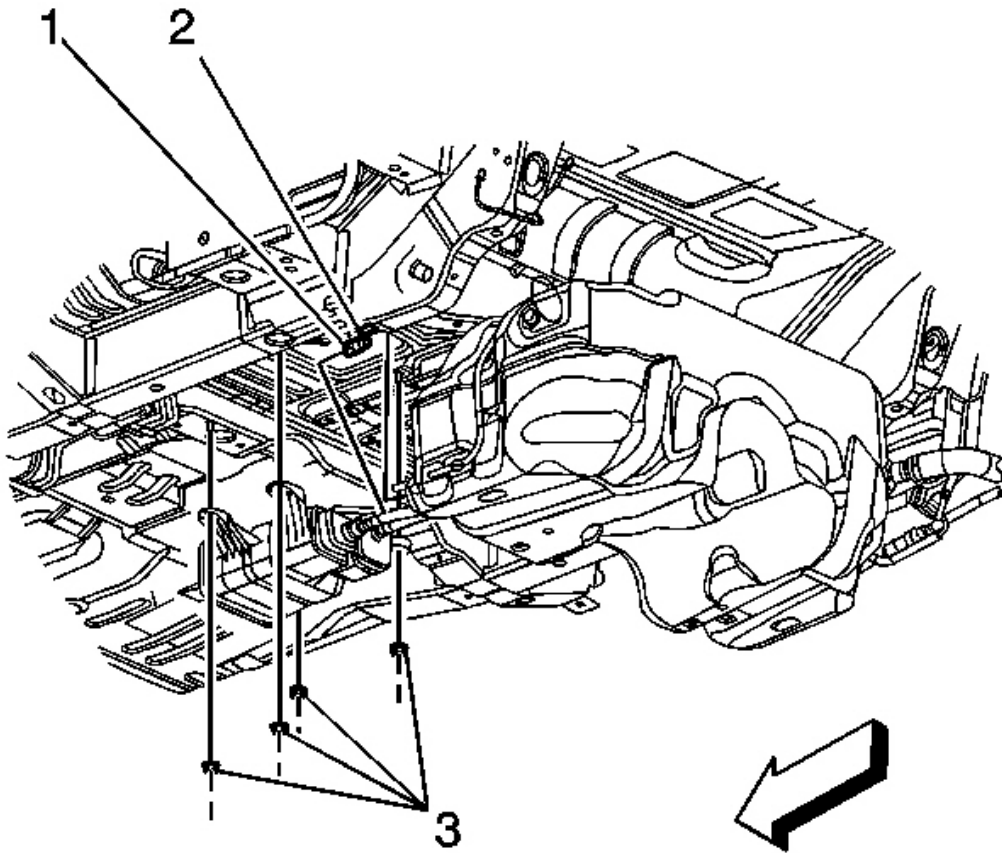


Fig. 43: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

6. Disconnect the canister vent valve electrical connectors.
7. Disconnect the vent hose from the canister filter.
8. Disconnect the fuel tank vent pipe from the evaporative emission canister.

WARNING: Whenever fuel lines are removed, catch fuel in an approved container. Container opening must be a minimum of 300 mm (12 in) diameter to adequately catch the fluid.

CAUTION: Clean all fuel pipe connections and surrounding areas before disconnecting the fuel pipes to avoid contamination of the fuel system.

9. Disconnect the chassis fuel supply line (2) from the fuel tank.

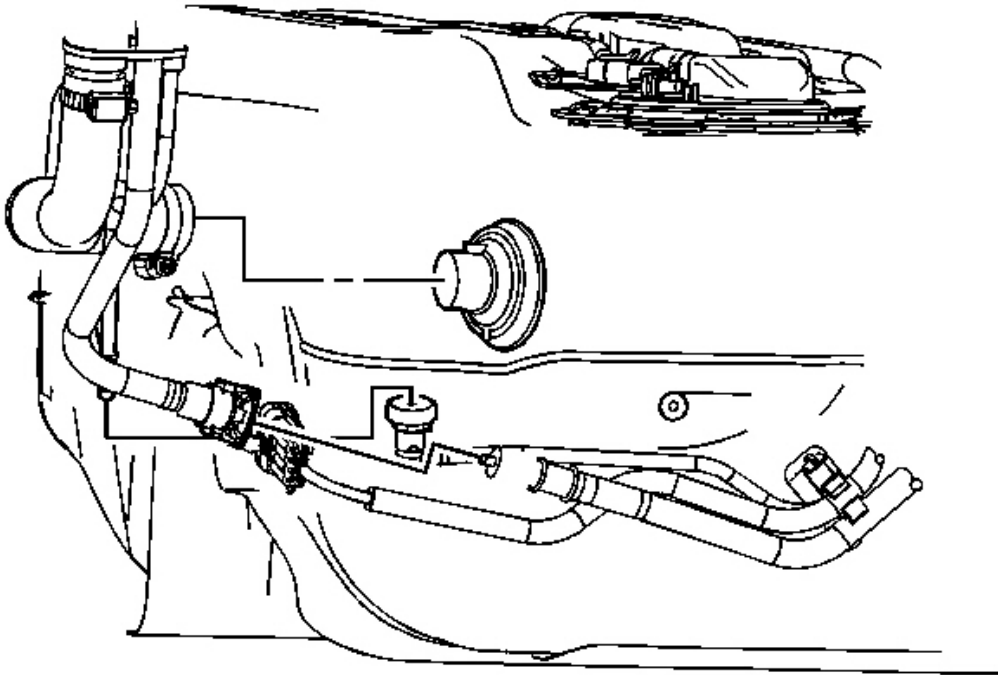


Fig. 44: View Of Fuel Filler Pipe, EVAP Vent & Fresh Air Hoses At Fuel Tank
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the fuel filler tube, EVAP vent hose, and fresh air hose from the fuel tank.
11. Disconnect the fuel tank electrical connector and remove the electrical connector retainer from the rear frame.

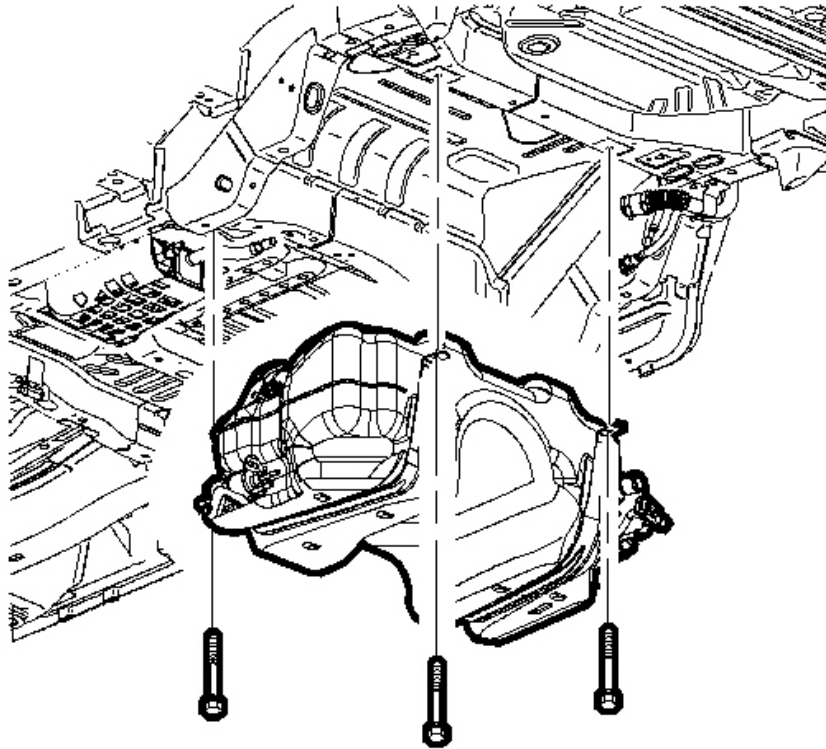


Fig. 45: View Of Fuel Tank Heat Shield & Fuel Tank Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not bend the fuel tank straps. Bending the fuel tank straps may cause damage to the straps.

NOTE: Do not lower the rear frame. It is not necessary to lower the rear frame for fuel tank removal.

12. Support the fuel tank.
13. Remove the fuel tank strap bolts and fuel tank straps.
14. Lower the fuel tank from the underbody of the vehicle.

15. If replacing the fuel tank, remove the fuel tank module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement** and **Fuel Tank Fuel Pump Module Replacement - Secondary** .

Installation Procedure

1. If previously removed, install the fuel tank module assemblies. Refer to **Fuel Tank Fuel Pump Module Replacement** and **Fuel Tank Fuel Pump Module Replacement - Secondary** .

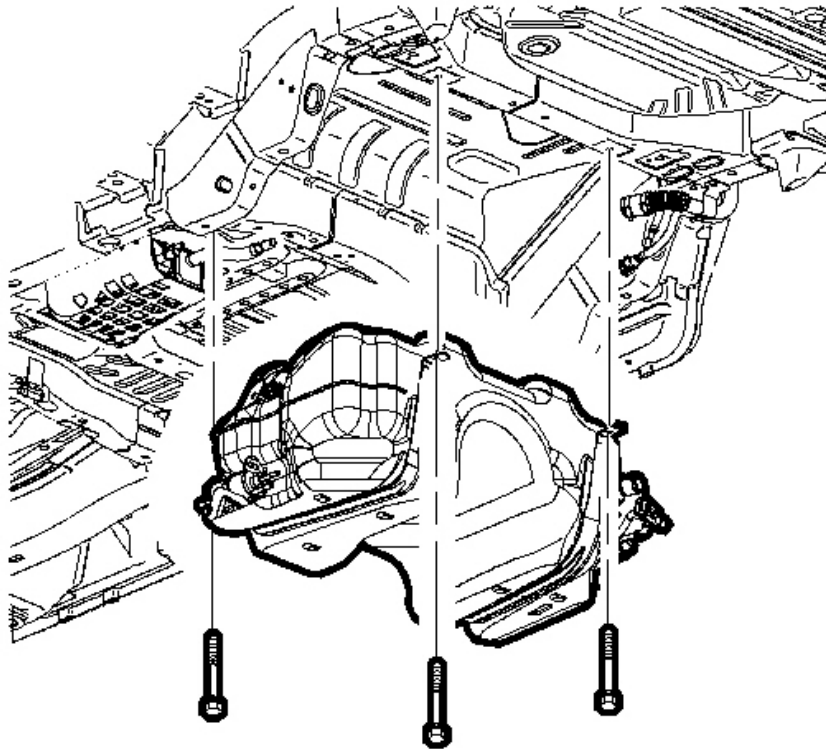


Fig. 46: View Of Fuel Tank Heat Shield & Fuel Tank Assembly
Courtesy of GENERAL MOTORS CORP.

2. Install the fuel tank heat shield and fuel tank assembly to the vehicle.

CAUTION: Refer to Fastener Caution .

3. Install the fuel tank straps and the fuel tank strap-to-body bolts and tighten to 25 N.m (18 lb ft).

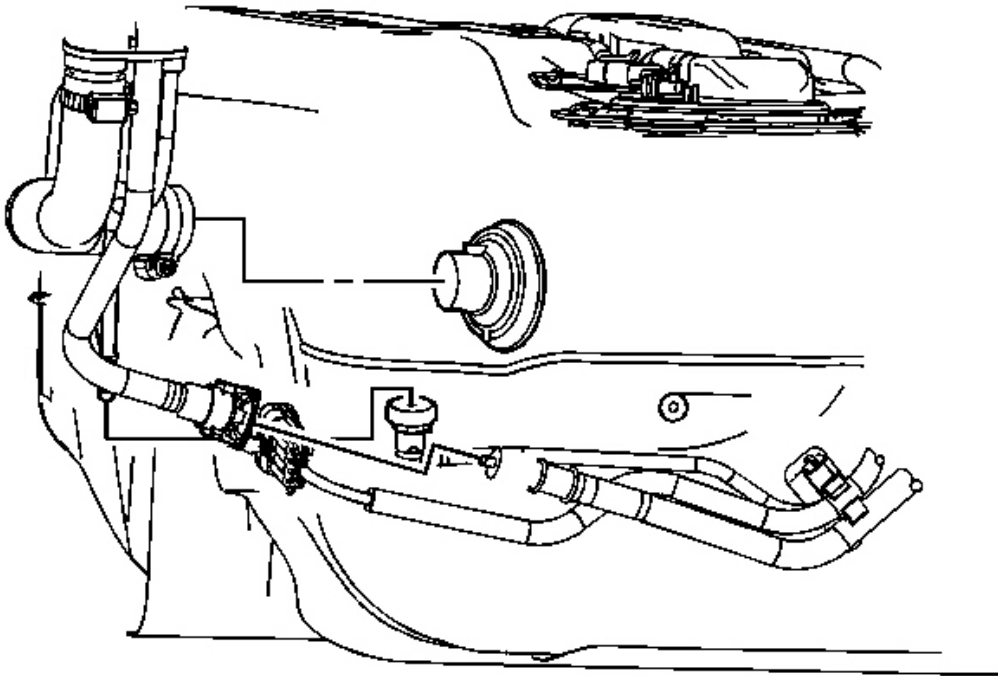


Fig. 47: View Of Fuel Filler Pipe, EVAP Vent & Fresh Air Hoses At Fuel Tank
Courtesy of GENERAL MOTORS CORP.

4. Connect the fuel tank electrical connector and install the electrical connector retainer to the rear frame.
5. Connect the EVAP vent, and fresh air hoses to the fuel tank.
6. Connect the fuel filler tube to the fuel tank. Tighten the fuel filler tube clamp to 5 N.m (44 lb in).

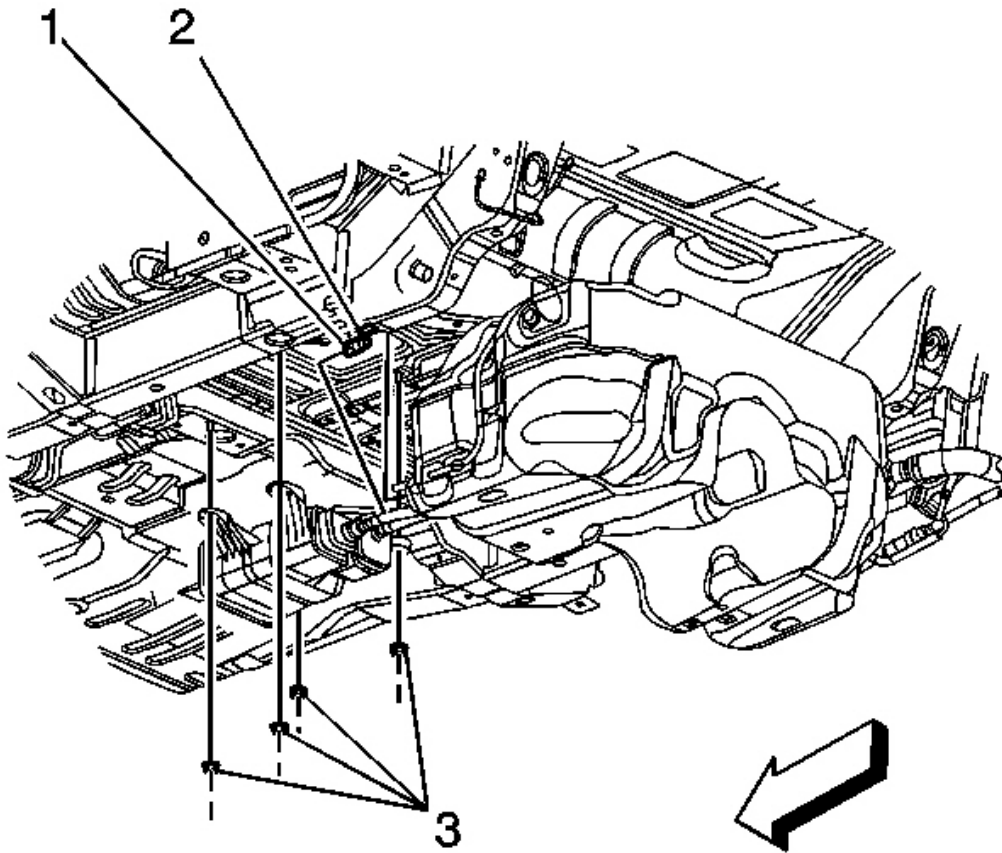


Fig. 48: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

7. Connect the chassis fuel supply line (2) to the fuel tank.
8. Connect the fuel tank vent pipe to the evaporative emission canister.
9. Connect the vent hose to the canister filter.
10. Connect the canister vent valve electrical connector.
11. Install the exhaust system. Refer to **Exhaust Muffler Replacement** .
12. Lower the vehicle.
13. Fill the fuel tank with gasoline.
14. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
15. Prime the fuel system:
 1. Cycle the ignition ON for 5 seconds and then OFF for 10 seconds.

2. Repeat the previous step twice.
3. Crank the engine until it starts. The maximum starter motor cranking time is 20 seconds.
4. If the engine does not start, repeat steps 15.1-15.3.

FUEL TANK FUEL PUMP MODULE REPLACEMENT

Special Tools

J-45722: Fuel Tank Sender Wrench

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Disconnect the crossover tube from the secondary fuel pump module. Refer to Fuel Tank Fuel Pump Module Replacement - Secondary .

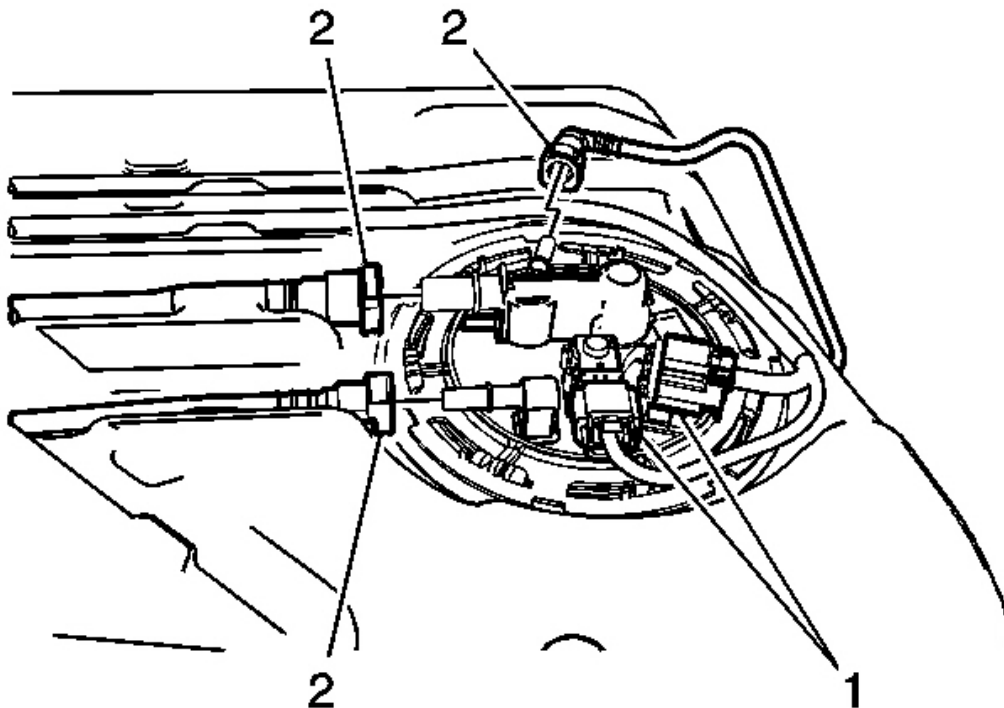


Fig. 49: Fuel & Evaporative Emission Lines, & Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the electrical connectors (1).
3. Disconnect the fuel and evaporative emission lines (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

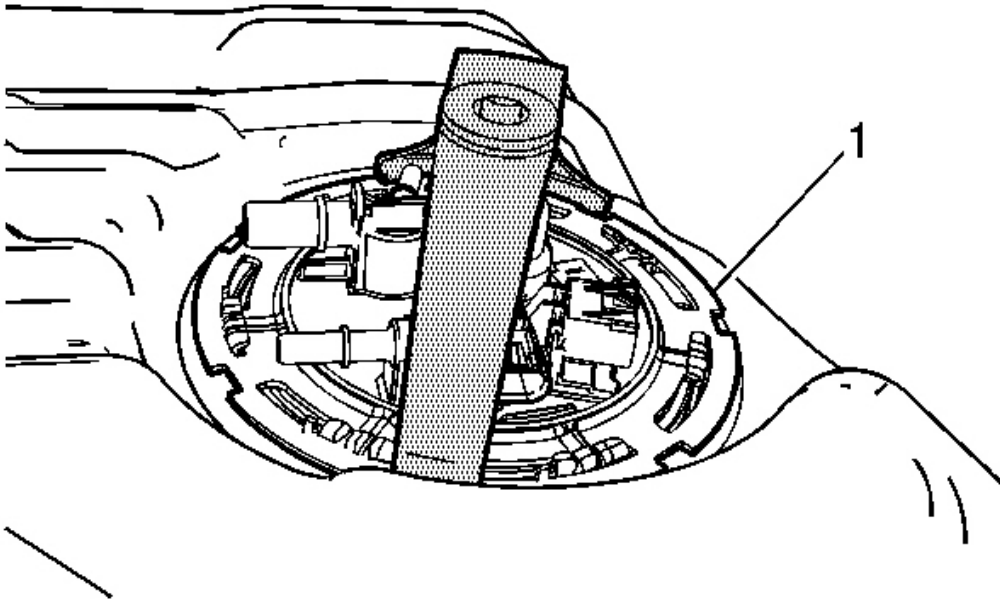


Fig. 50: Removing/Installing Cam Lock Ring
Courtesy of GENERAL MOTORS CORP.

4. Using the J-45722: wrench, remove the cam lock ring (1) by turning counterclockwise.

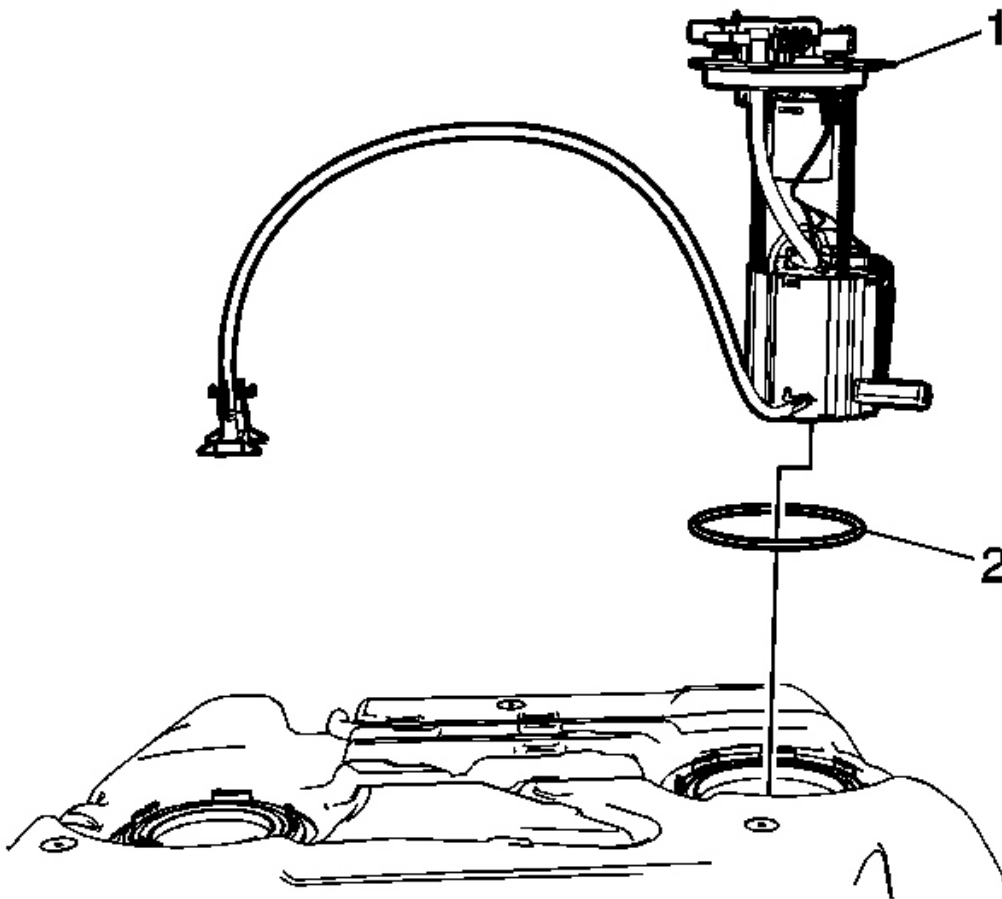


Fig. 51: Primary Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS CORP.

5. Remove the primary fuel tank module (1) and the O-ring (2).
6. If replacing the fuel pump module only, remove the primary fuel level sensor. Refer to **Primary Fuel Level Sensor Replacement** .

Installation Procedure

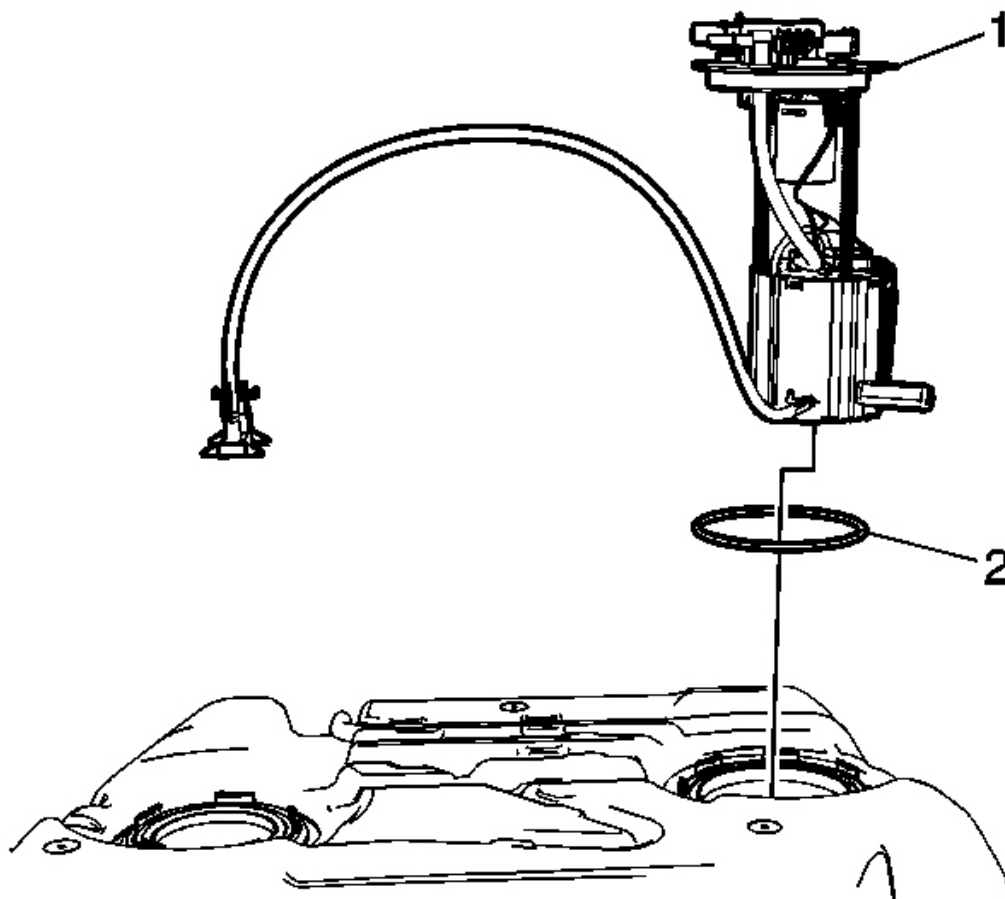


Fig. 52: Primary Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS CORP.

1. If replacing the fuel pump module only, install the primary fuel level sensor. Refer to **Primary Fuel Level Sensor Replacement** .
2. Install a NEW O-ring (2) and the primary fuel tank module (1).

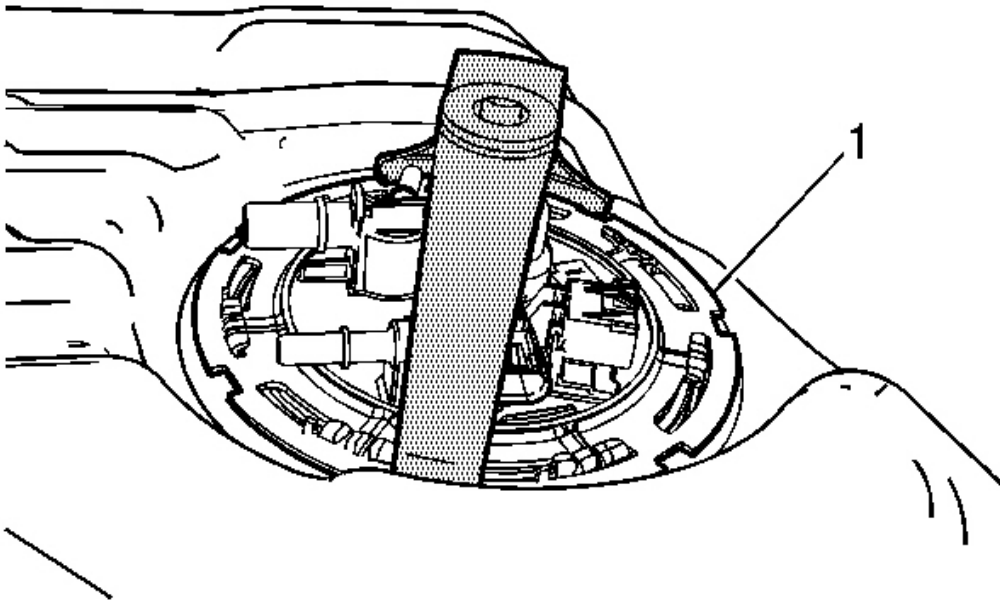


Fig. 53: Removing/Installing Cam Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Using the **J-45722**: wrench, install the cam lock ring (1) by turning clockwise.

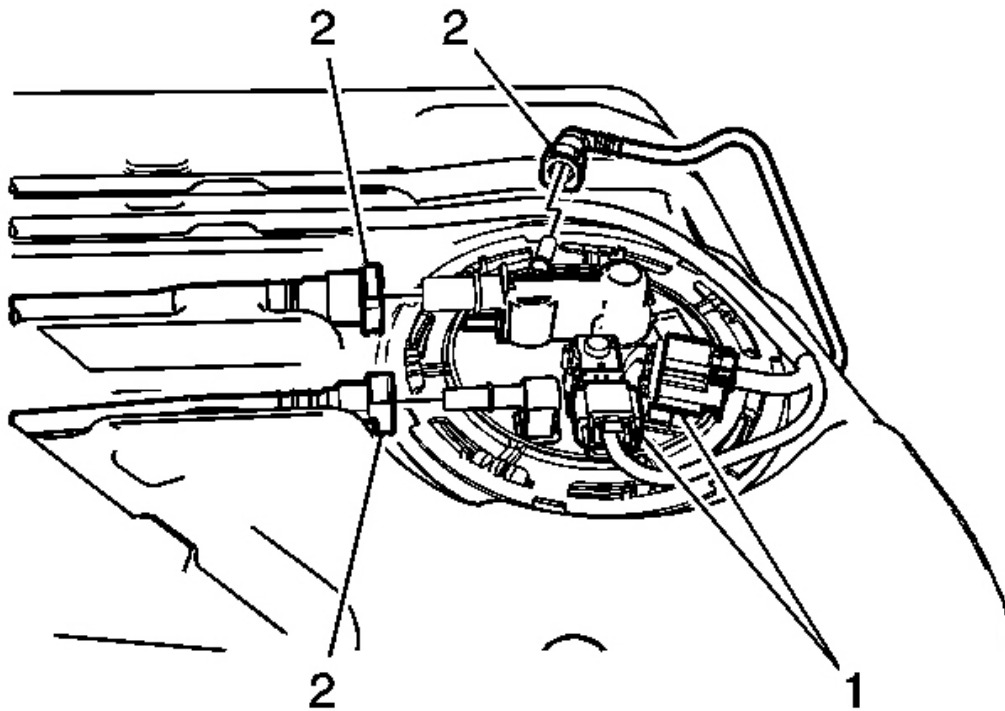


Fig. 54: Fuel & Evaporative Emission Lines, & Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

4. Connect the electrical connectors (1).
5. Connect the fuel and evaporative emission lines (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Connect the crossover tube to the secondary fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement - Secondary**.
7. Install the fuel tank. Refer to **Fuel Tank Replacement (AWD)** or **Fuel Tank Replacement (FWD)**.

FUEL TANK FUEL PUMP MODULE REPLACEMENT - SECONDARY

Special Tools

CH-48482: Fuel Tank Sender Wrench

Removal Procedure

WARNING: Refer to **Gasoline/Gasoline Vapors Warning**.

1. Remove the fuel tank. Refer to **Fuel Tank Replacement (AWD)** or **Fuel Tank Replacement (FWD)** .

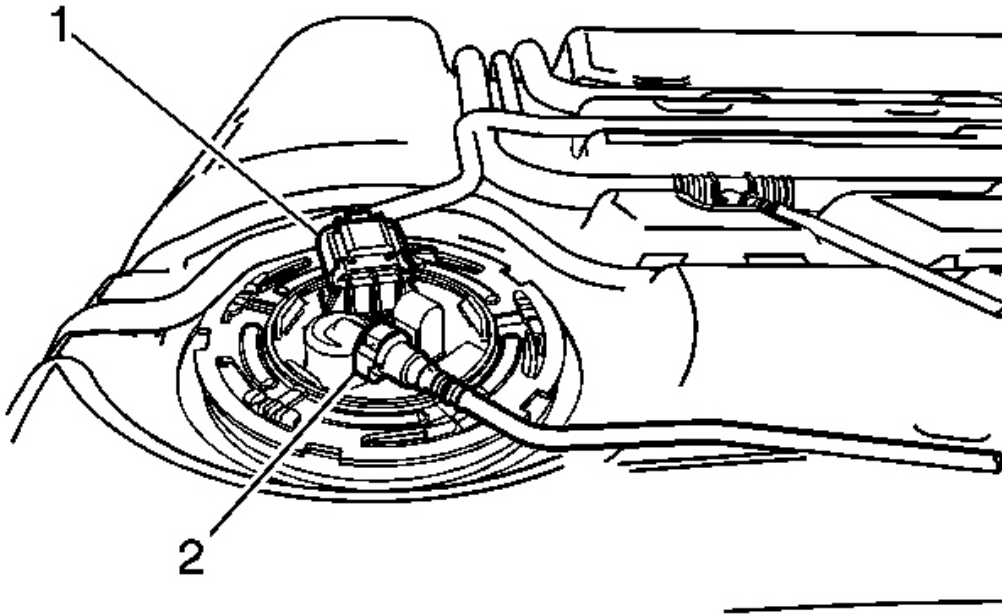


Fig. 55: Electrical Connector & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the electrical connector (1).
3. Disconnect the evaporative emission line (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

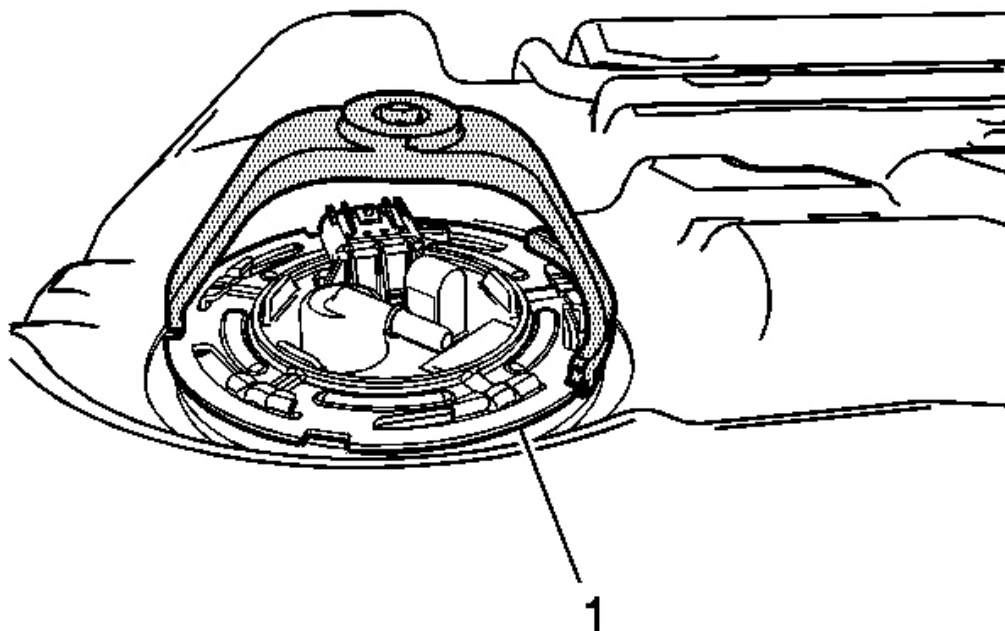


Fig. 56: Removing/Installing Cam Lock Ring
Courtesy of GENERAL MOTORS CORP.

4. Using the **CH-48482:** wrench, remove the cam lock ring (1) by turning counterclockwise.

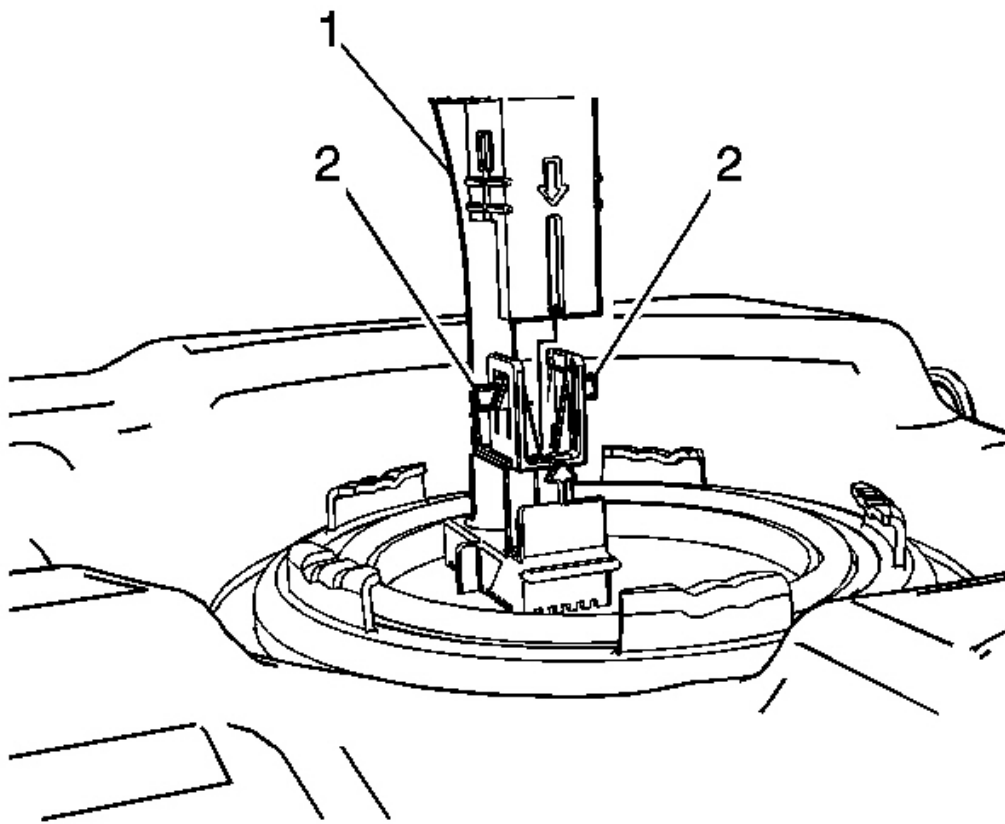


Fig. 57: Crossover Tube & Plastic Retaining Tabs
Courtesy of GENERAL MOTORS CORP.

5. Partially raise the secondary fuel pump module and disconnect the crossover tube (1) by squeezing the plastic retaining tabs (2).

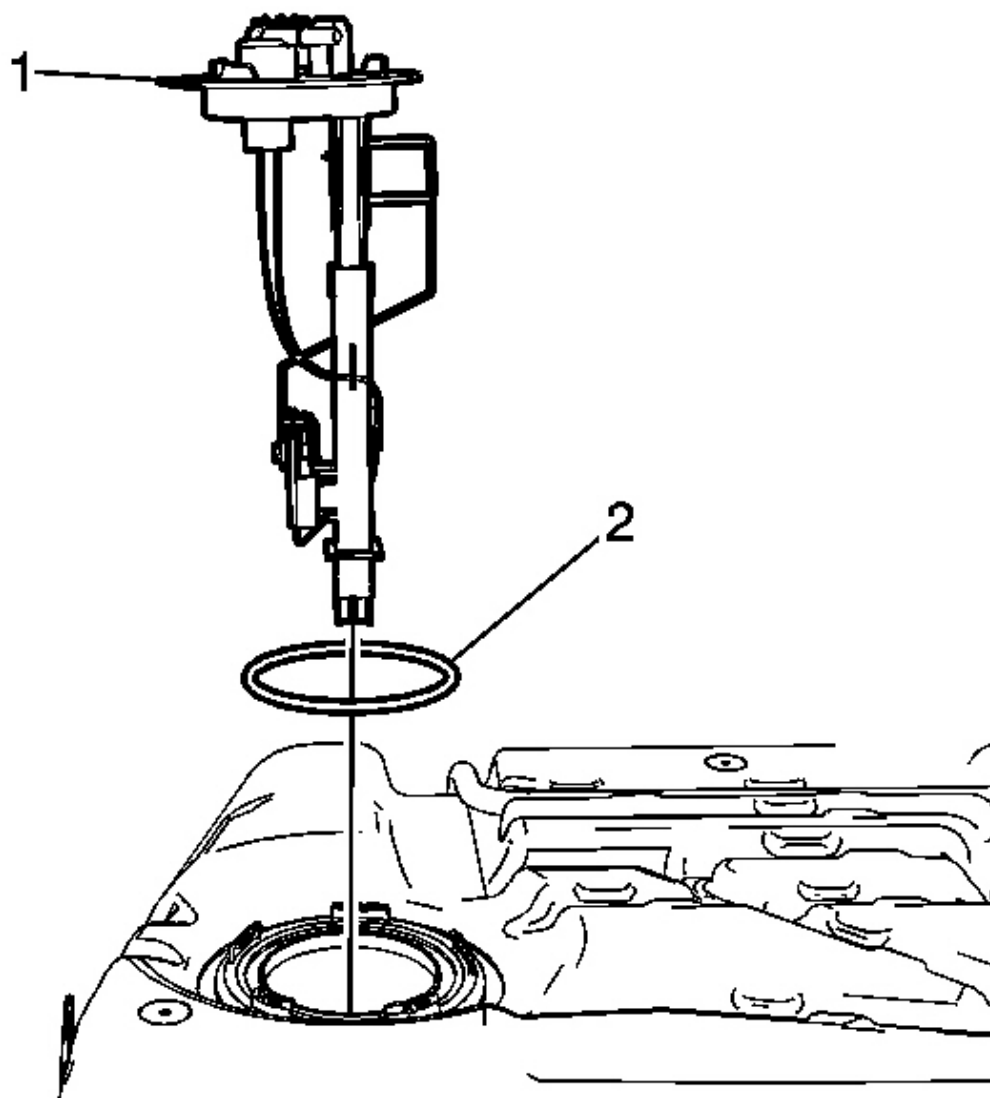


Fig. 58: Secondary Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS CORP.

6. Remove the secondary fuel tank module (1) and the O-ring (2).

Installation Procedure

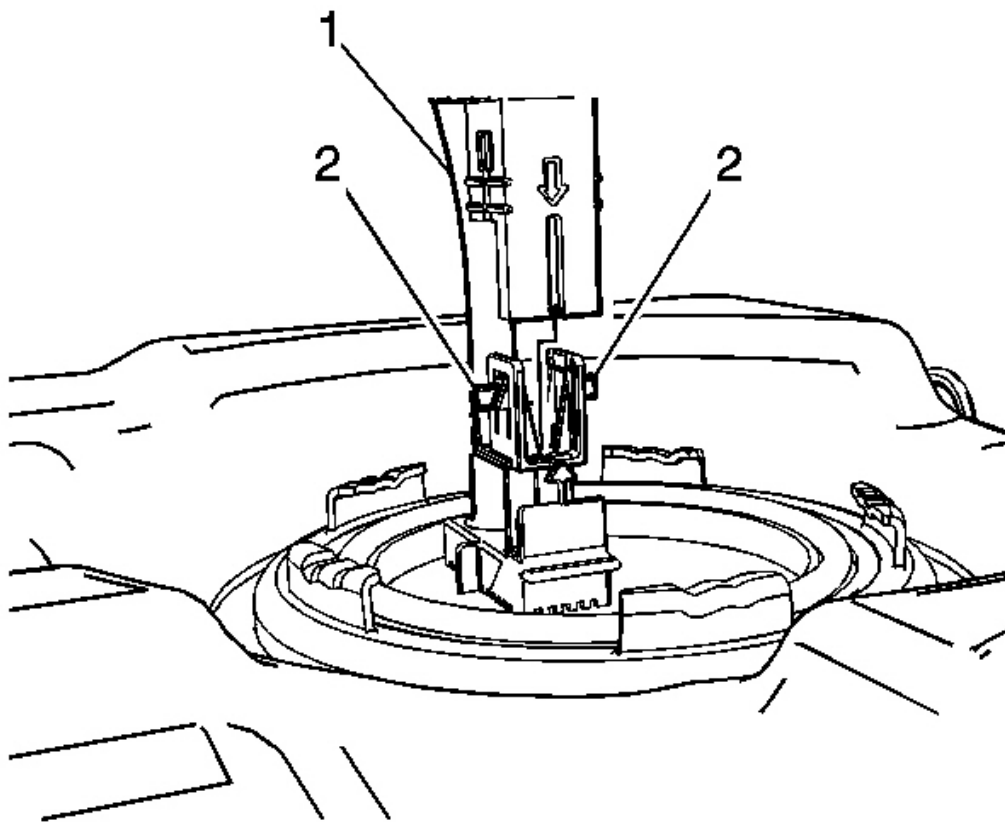


Fig. 59: Crossover Tube & Plastic Retaining Tabs
Courtesy of GENERAL MOTORS CORP.

1. Partially install the secondary fuel pump module and connect the crossover tube (1) by sliding into position.

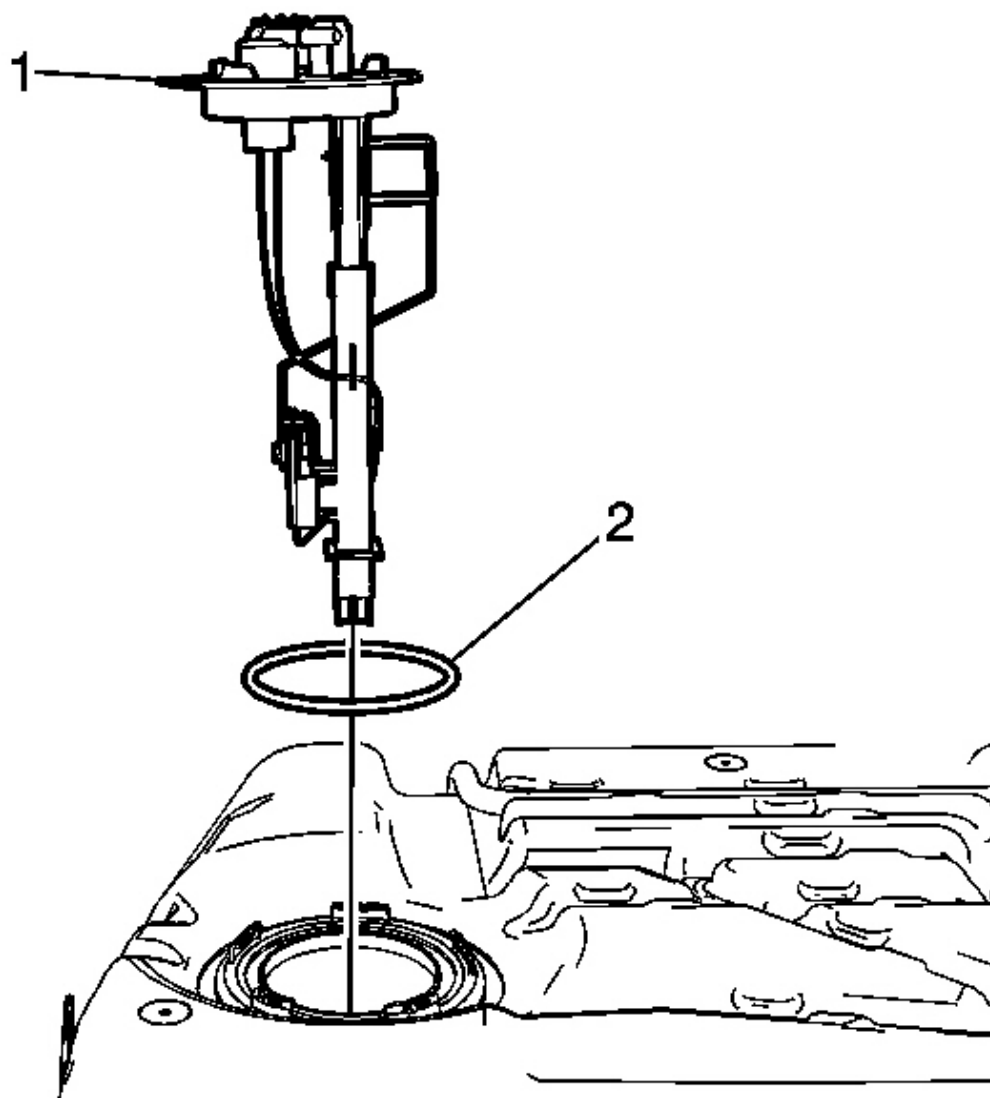


Fig. 60: Secondary Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS CORP.

2. Install a NEW O-ring (2) and the secondary fuel tank module (1).

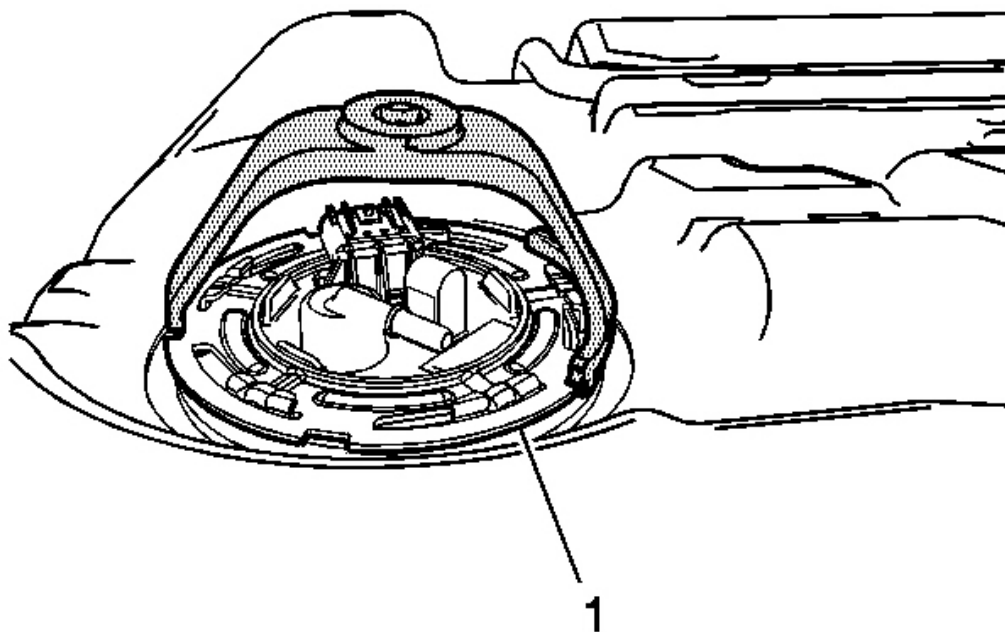


Fig. 61: Removing/Installing Cam Lock Ring
Courtesy of GENERAL MOTORS CORP.

3. Using the **CH-48482:** wrench, install the cam lock ring (1) by turning clockwise.

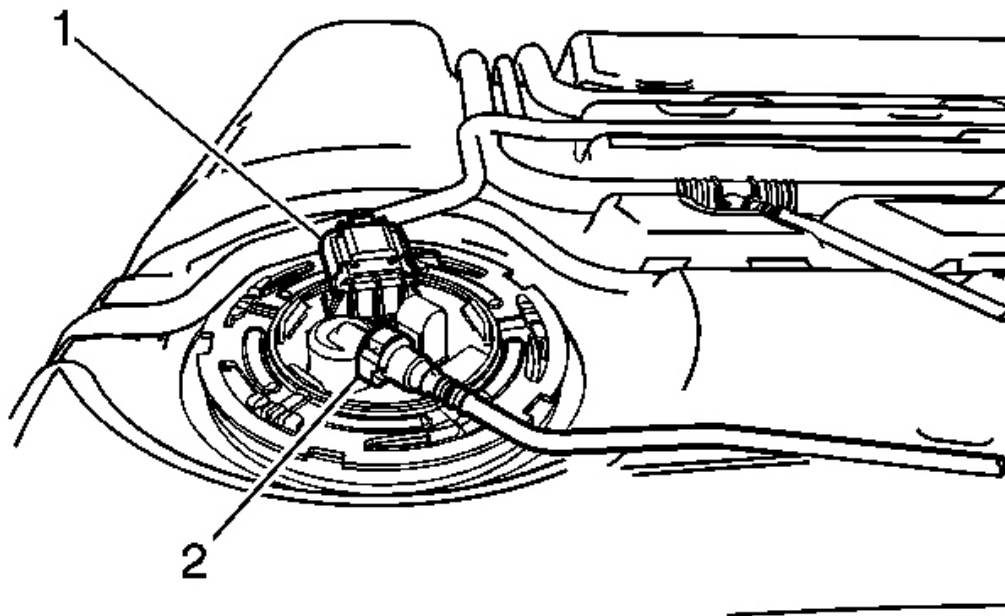


Fig. 62: Electrical Connector & Evaporative Emission Line
Courtesy of GENERAL MOTORS CORP.

4. Connect the electrical connector (1).
5. Connect the evaporative emission line (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Install the fuel tank. Refer to **Fuel Tank Replacement (AWD)** or **Fuel Tank Replacement (FWD)** .

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT

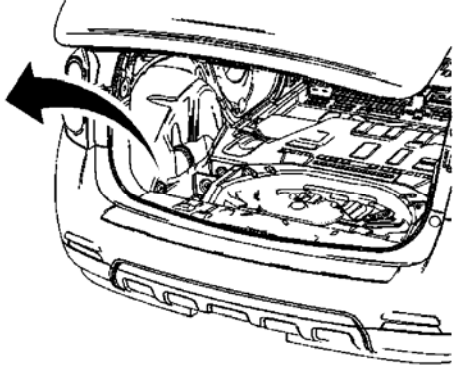
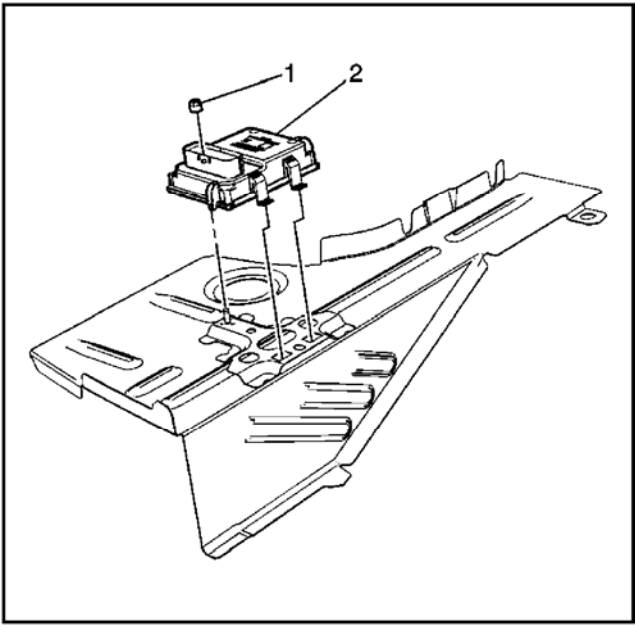


Fig. 63: Fuel Pump Flow Control Module
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Fuel Pump Flow Control Module Fastener CAUTION: Refer to <u>Fastener Caution</u> Tighten: 8 N.m(71 lb in)
2	Fuel Pump Flow Control Module Procedure 1. Open the spare tire compartment lid. 2. Disconnect the electrical connector. 3. If replacing, reprogram the module. Refer to <u>Control Module References</u>

FUEL TANK PRESSURE SENSOR REPLACEMENT

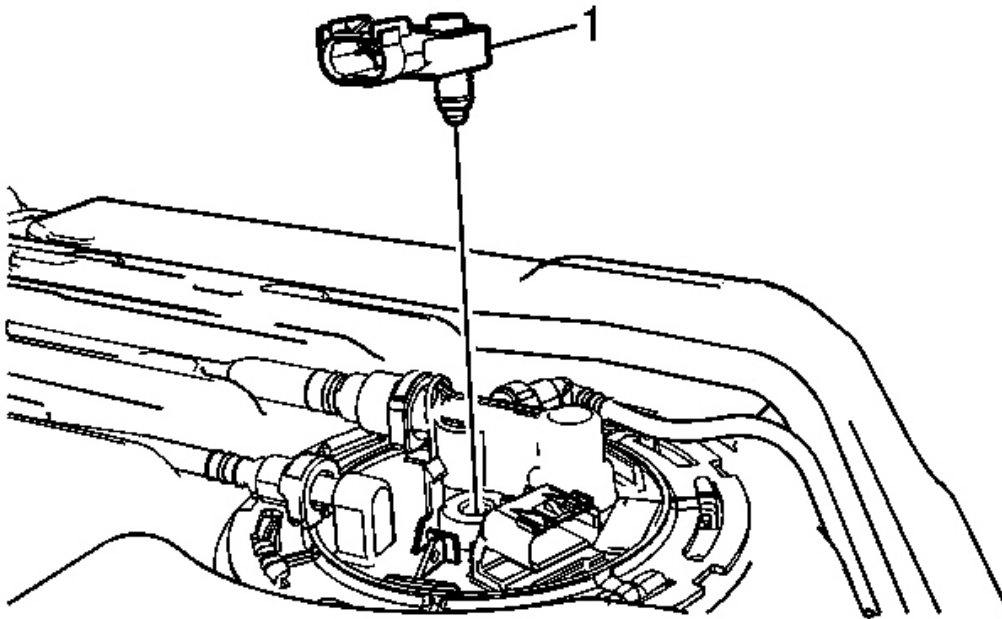


Fig. 64: Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Lower the fuel tank. Refer to <u>Fuel Tank Replacement (AWD)</u> or <u>Fuel Tank Replacement (FWD)</u> . 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Fuel Tank Pressure Sensor Procedure 1. Use a flat bladed tool to remove the sensor. 2. Disconnect the electrical connector.

FUEL TANK FILLER PIPE REPLACEMENT

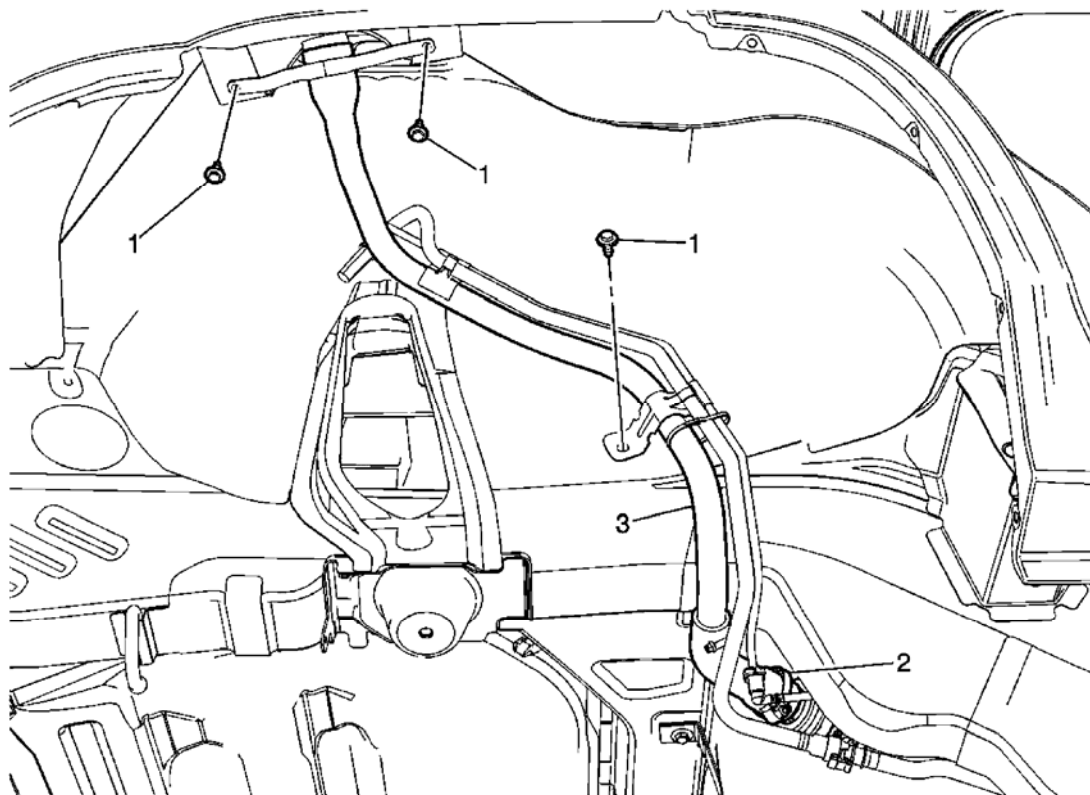


Fig. 65: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Remove the rear wheel house liner. Refer to <u>Rear Wheelhouse Panel Liner Replacement (Equinox)</u> or <u>Rear Wheelhouse Panel Liner Replacement (Terrain)</u> . 2. Disconnect the evaporative emission lines. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .	
1	Filler Pipe Fastener (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Fuel Tank Filler Pipe Clamp Tighten: 4 N.m (35 lb in)
3	Fuel Tank Filler Pipe

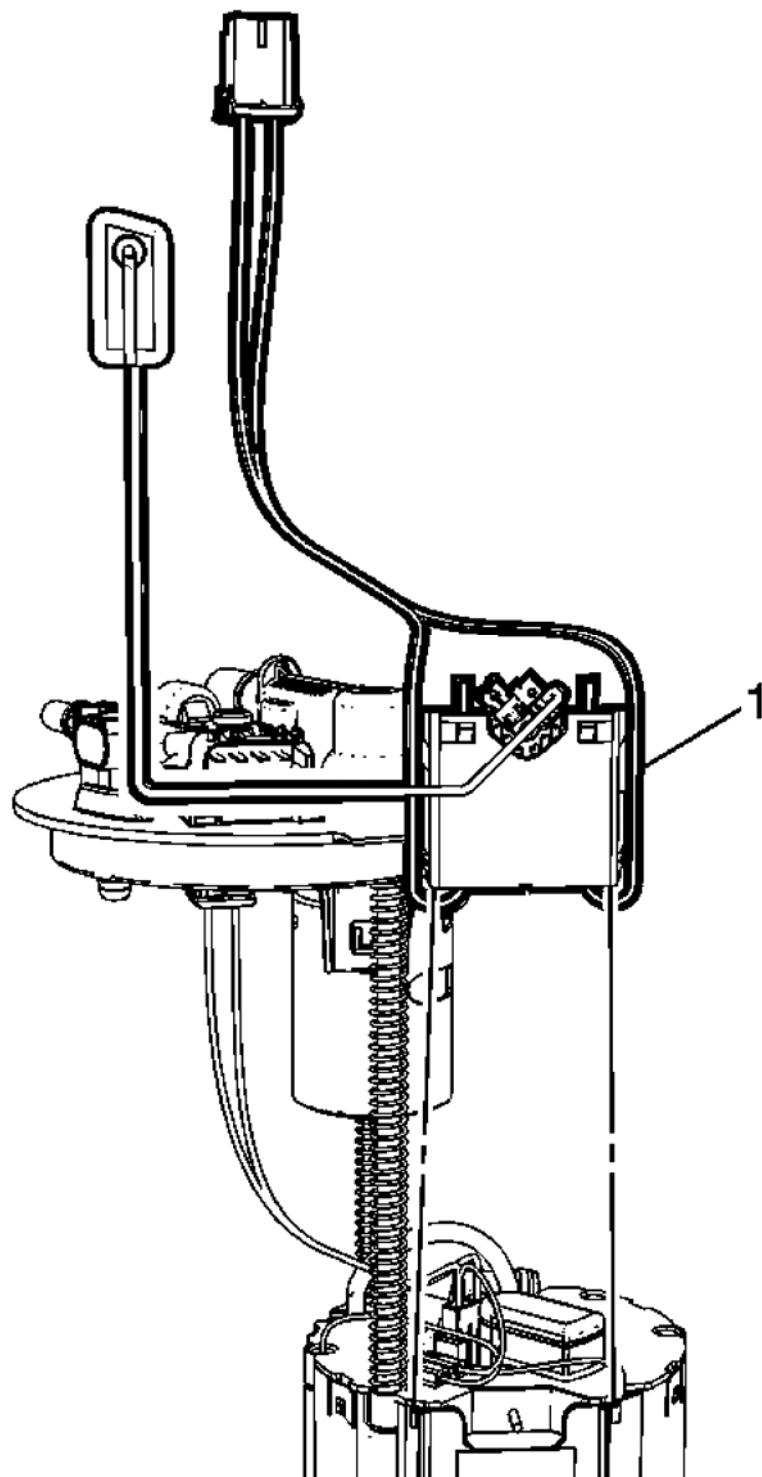


Fig. 66: Primary Fuel Level Sensor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

Preliminary Procedure:

Remove the fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement** .

1	Fuel Level Sensor
	Procedure
	1. Release the retaining tabs. 2. Disconnect the electrical connector.

FUEL LINE REPLACEMENT - CHASSIS

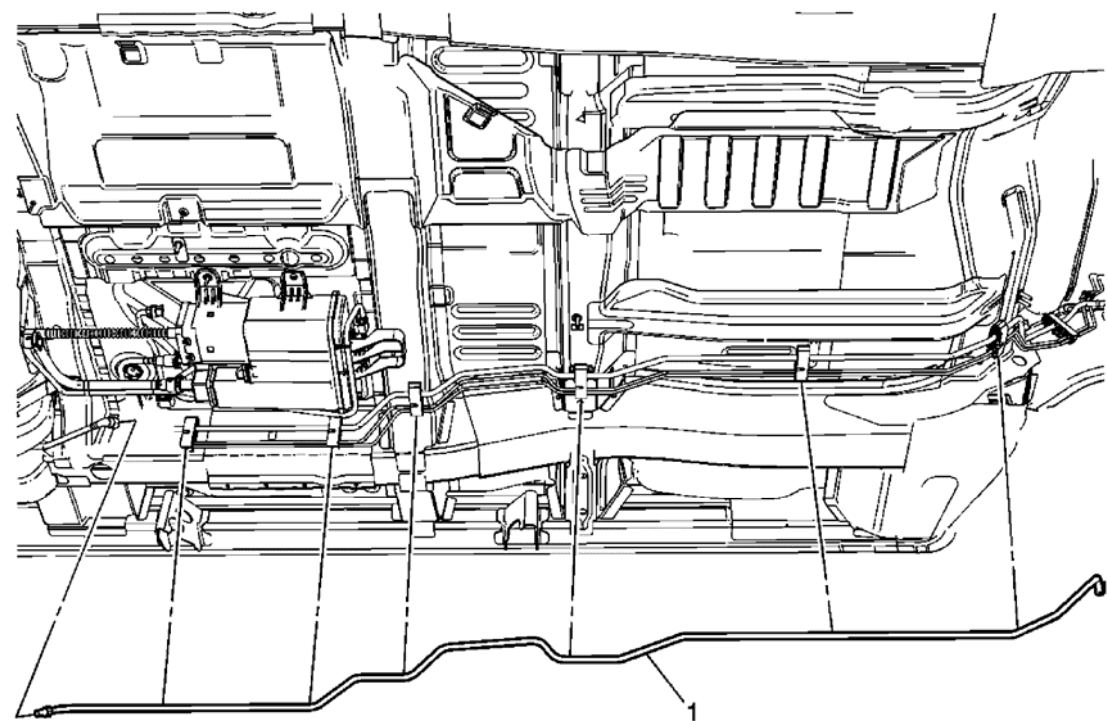


Fig. 67: Fuel Line - Chassis

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief . 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement . 3. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 4. Disconnect the quick connectors. Refer to Metal Collar Quick Connect Fitting Service and Plastic Collar Quick Connect Fitting Service.	
	Fuel Feed Line

1

Procedure:

Disengage the line from the plastic retainers.

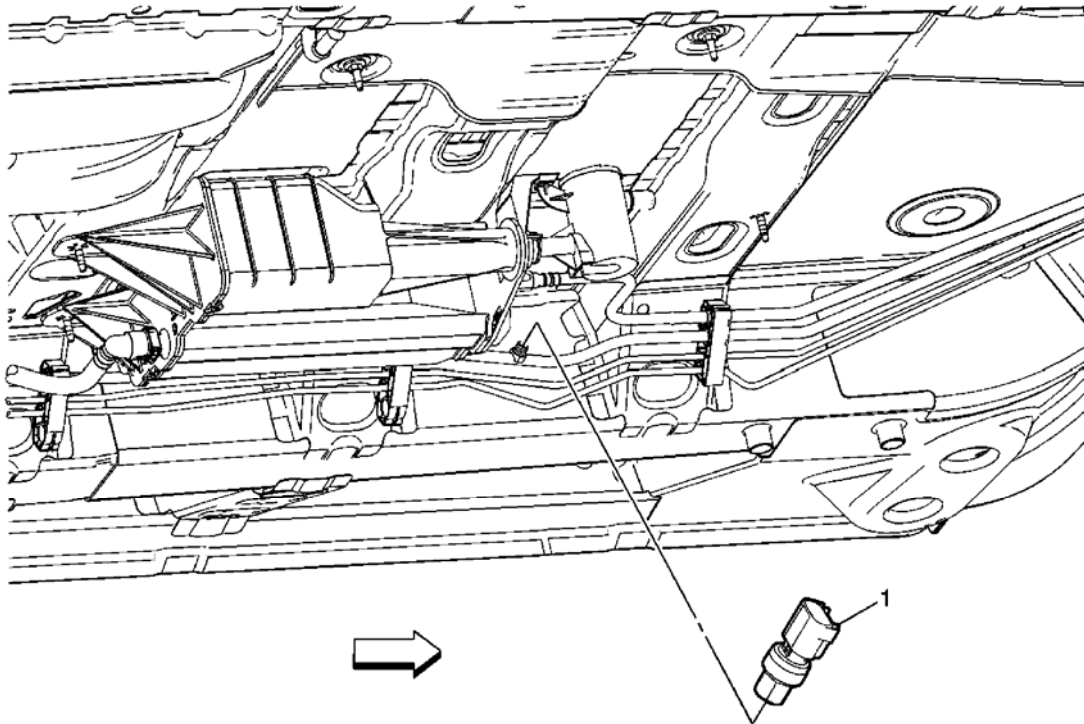
FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

Fig. 68: Fuel Pressure Sensor - Fuel Feed Pipe
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Relieve the fuel system pressure. Refer to <u>Fuel Pressure Relief</u> .	
2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Fuel Pressure Sensor CAUTION: Refer to <u>Fastener Caution</u> . Procedure: Disconnect the electrical connector. Tighten: 9 N.m (80 lb in)

FUEL FEED PIPE REPLACEMENT (LF1)

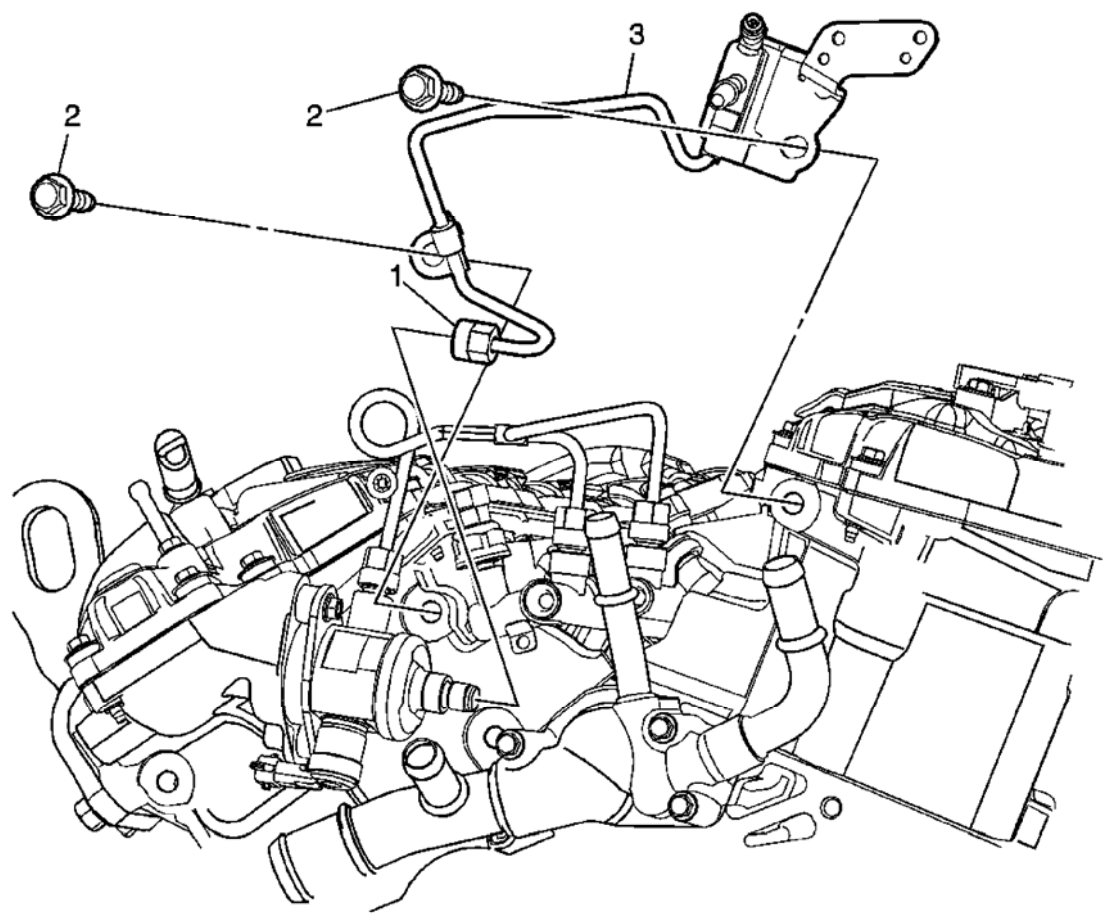


Fig. 69: Fuel Feed Pipe (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief .	
2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .	
3. Remove the fuel pipe shield. Refer to Fuel Pipe Shield Replacement (LF1) .	
1	Fitting (Qty: 1) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 28 N.m(20 lb ft)
	Bolt (Qty: 2)

2	Tighten: 50 N.m(28 lb ft)
3	Fuel Feed Pipe Procedure 1. DISCARD the pipe when removed, and install a NEW pipe. 2. Ensure that the high pressure fuel pipe, and fuel pump fittings are clean and dry prior to assembly. 3. Pressure up the fuel system and check for leaks.

FUEL SYSTEM CLEANING

NOTE: When flushing the fuel tank, treat the fuel and water mixture as a hazardous material. Handle the material in accordance with all local, state and federal laws and regulations.

NOTE: Whenever the fuel tank is cleaned, inspect the fuel pump fuel strainer. If the fuel pump fuel strainer is contaminated, replace the fuel pump fuel strainer and inspect the fuel pump.

NOTE: Always maintain cleanliness when servicing fuel system components.

1. Remove the fuel tank fuel pump modules. Refer to **Fuel Tank Fuel Pump Module Replacement** , and **Fuel Tank Fuel Pump Module Replacement - Secondary** .
2. Inspect the fuel pump inlet for dirt and debris. If dirt and debris are found, replace the fuel pump.
3. Flush fuel tank with hot water.
4. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to ensure that the removal of the water from the fuel tank is complete.
5. Allow tank to dry completely before reassembly.
6. Install the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement** .

FUEL PRESSURE SENSOR REPLACEMENT - FUEL INJECTION FUEL RAIL (LF1)

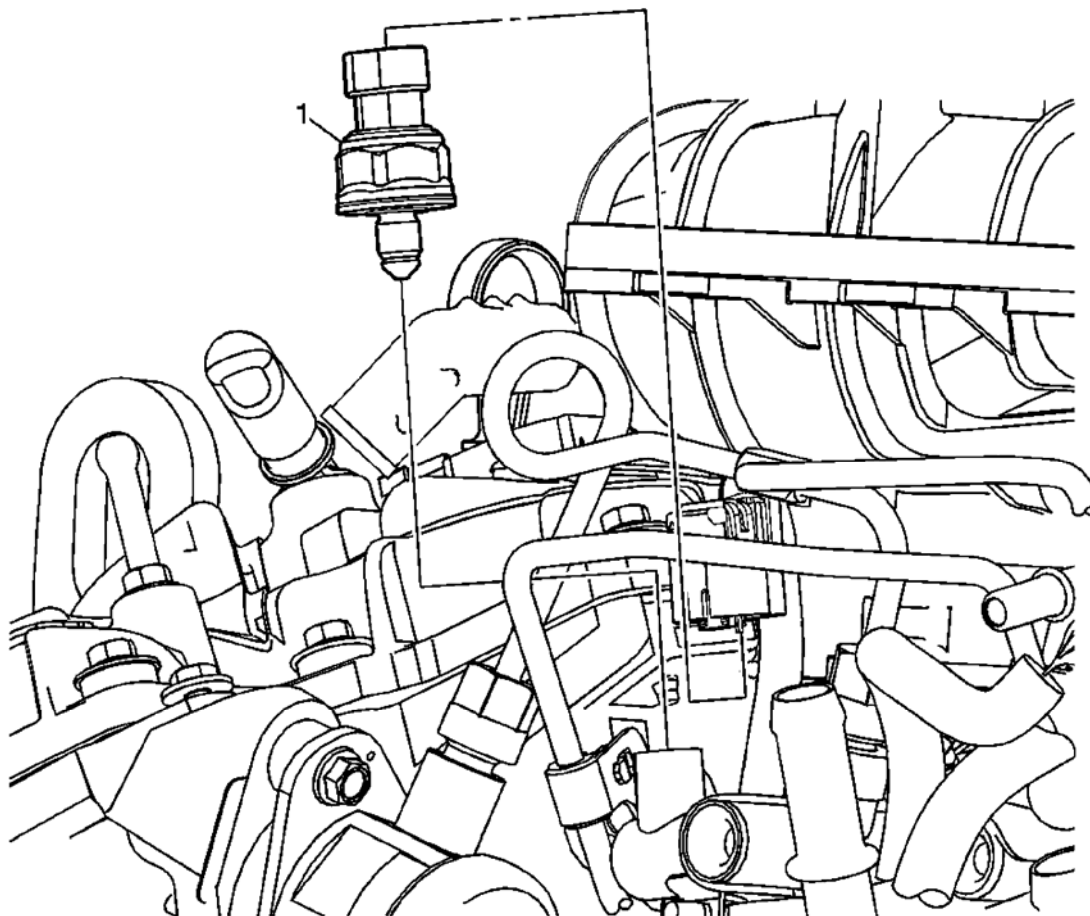


Fig. 70: Fuel Pressure Sensor - Fuel Injection Fuel Rail (LF1)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the fuel pipe shield. Refer to <u>Fuel Pipe Shield Replacement (LF1)</u> .	
1	Fuel Injection Fuel Rail Fuel Pressure Sensor CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 33 N.m (25 lb ft)

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 1 (LF1)

Special Tools

EN-49248: Injector Rail Assembly Remover

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
5. Remove the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** .
6. Remove the foam insulator from the fuel rails.

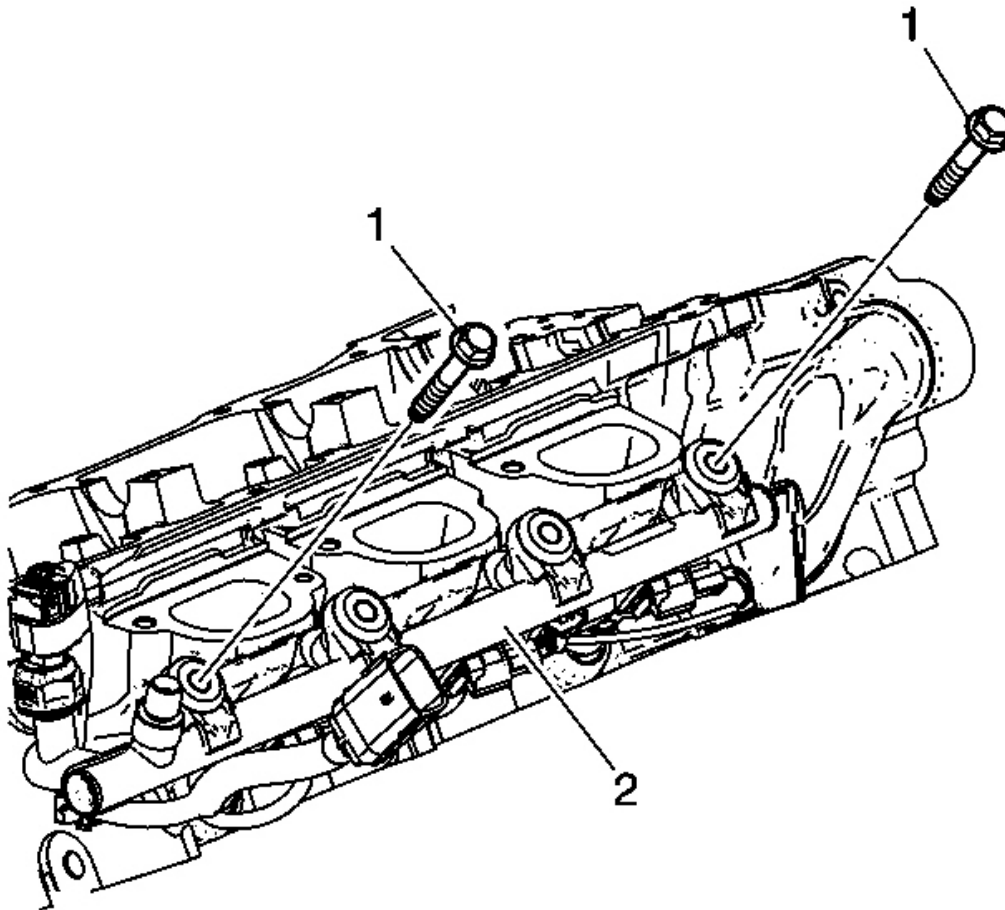


Fig. 71: Fuel Rail Bolts

Courtesy of GENERAL MOTORS CORP.

7. Disconnect the fuel pressure sensor electrical connector and cut the wire harness tie straps.
8. Remove the fuel rail bolts (1).

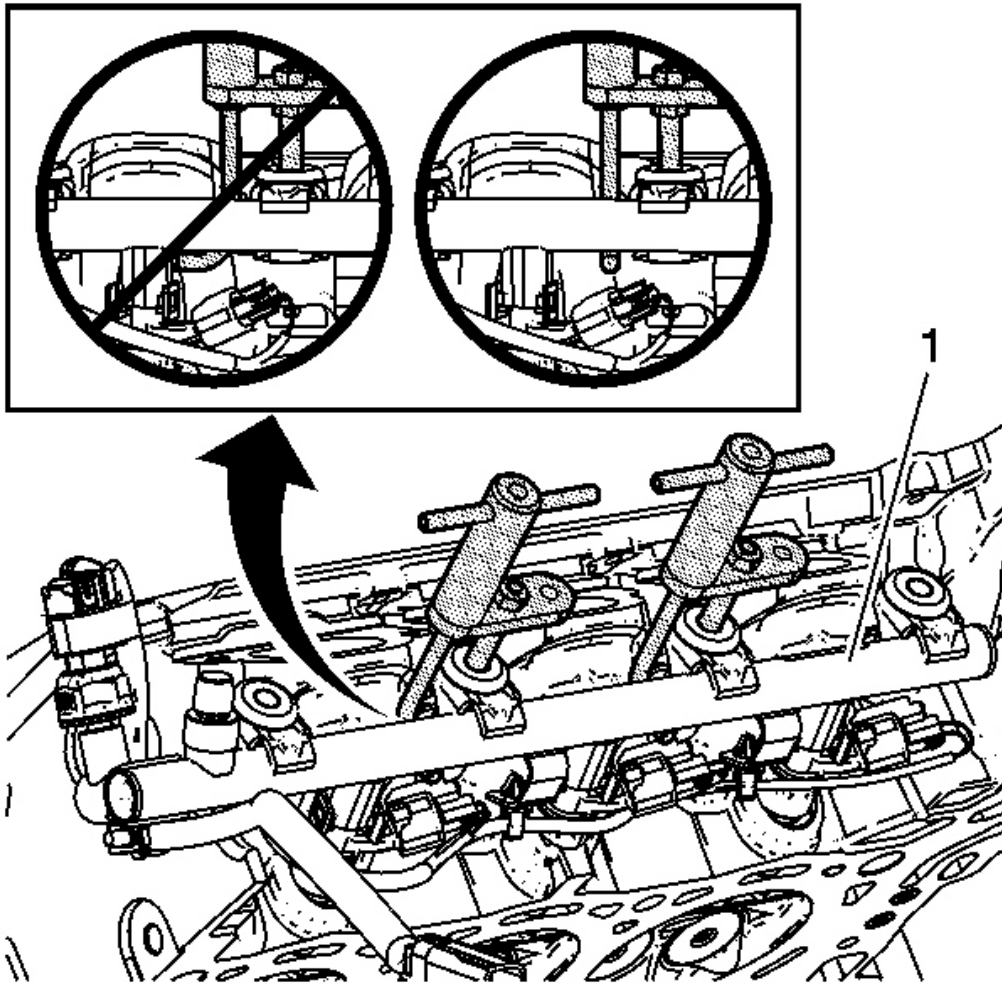


Fig. 72: Removing Fuel Rail & Injectors
Courtesy of GENERAL MOTORS CORP.

9. Remove the fuel rail and injectors (1) as an assembly using the **EN-49248**: remover.
10. Remove the fuel pressure sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)**.
11. Remove and discard the direct fuel injector hold down clamps.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been

released from the fuel rail or cylinder head.

12. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW)** .

Installation Procedure

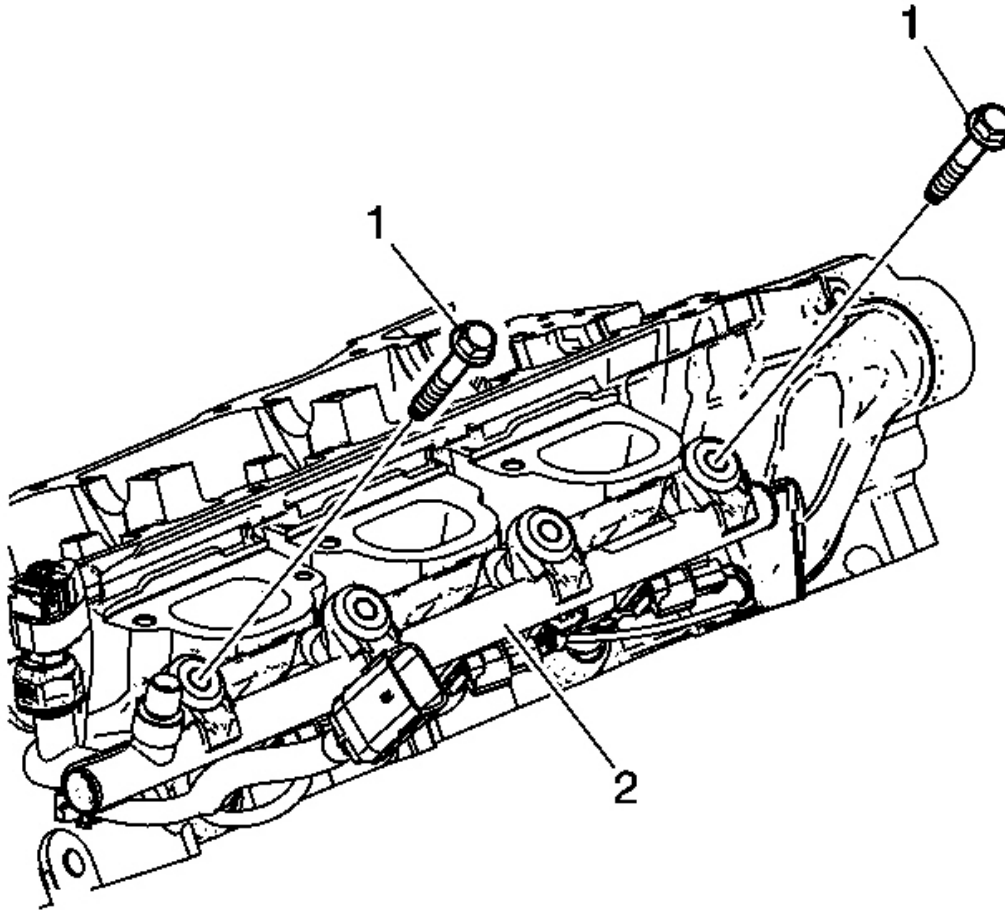


Fig. 73: Fuel Rail Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the fuel rail with injectors (2) into the cylinder head evenly.
2. Install NEW direct injector hold down clamps to the injector.
3. Hand tighten the two outer fuel rail bolts to seat the injector in the injector bores.
4. Start and hand tighten the remaining fuel rail bolts and tighten the fuel rail bolts (1).

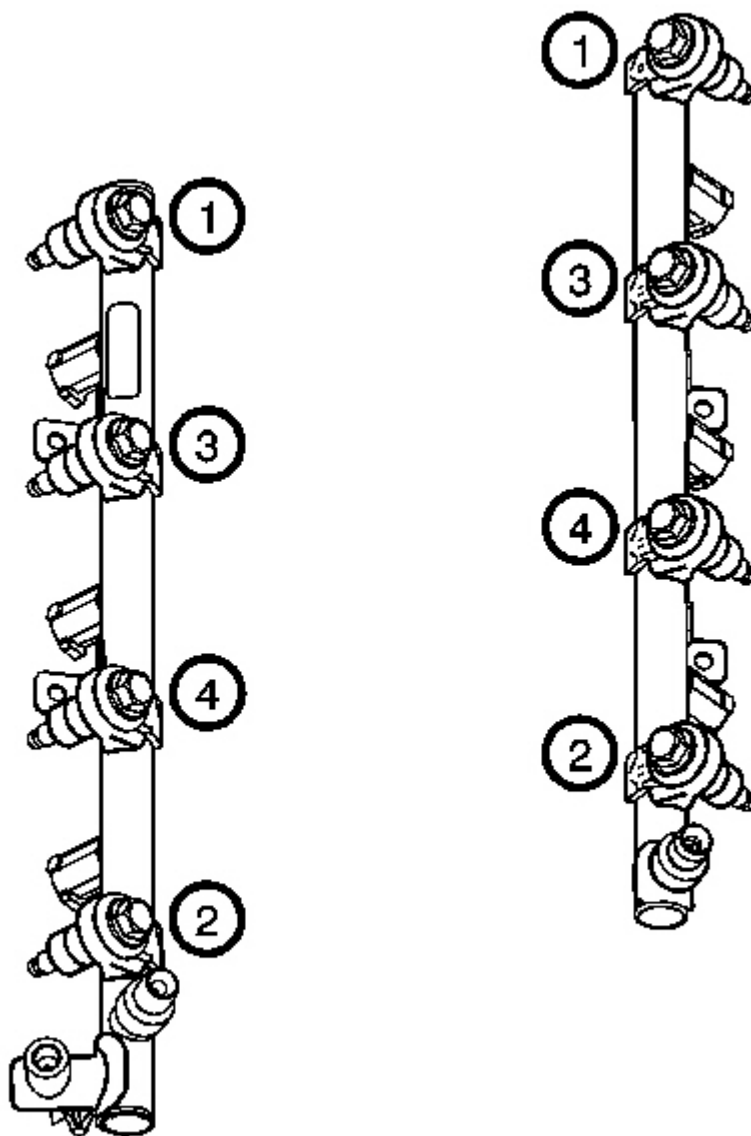


Fig. 74: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

5. Tighten the fuel rail bolts in the sequence shown:

1. Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
2. Tighten the Bank 1 fuel rail bolts final pass to 23 N.m (17 lb ft).
6. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
7. Install the high pressure fuel sensor. Refer to **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail (LF1)**.
8. Connect the fuel injector wiring harness electrical connector to the fuel injectors, fuel rail and fuel pressure sensor.
9. Inspect for fuel leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.
 4. Inspect for fuel leaks.

NOTE: Before installing the foam insulator, remove any remaining fuel from the injector well.

10. Install the foam insulator to the fuel rails.
11. Install the intake manifold. Refer to **Intake Manifold Replacement** .
12. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.
13. Install the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** .
14. Install the low side fuel pressure service port cap.
15. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2 (LF1)

Special Tools

EN-49248: Injector Rail Assembly Remover

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
5. Remove the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** .

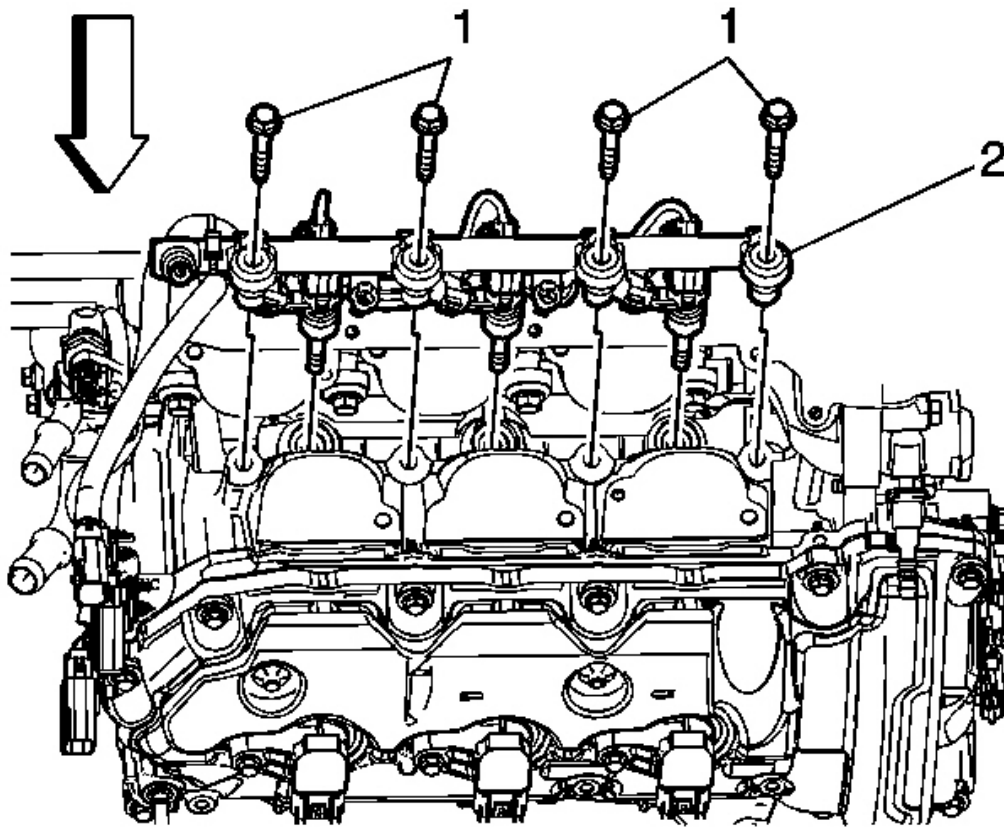


Fig. 75: Fuel Rail & Bolts

Courtesy of GENERAL MOTORS CORP.

6. Remove the fuel rail bolts (1).

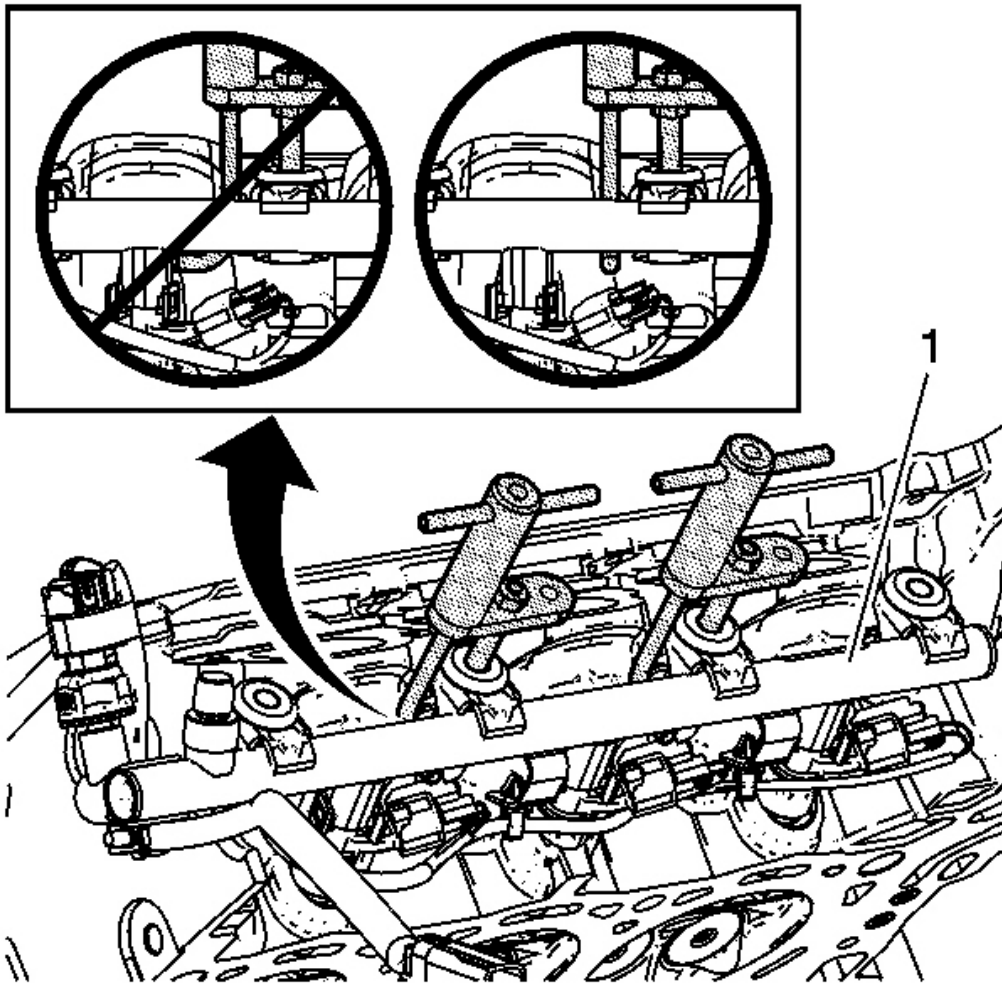


Fig. 76: Removing Fuel Rail & Injectors
Courtesy of GENERAL MOTORS CORP.

7. Remove the fuel rail and injectors (1) as an assembly using the **EN-49248**: remover.
8. Remove and discard the direct fuel injector hold down clamps.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

9. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW)** .

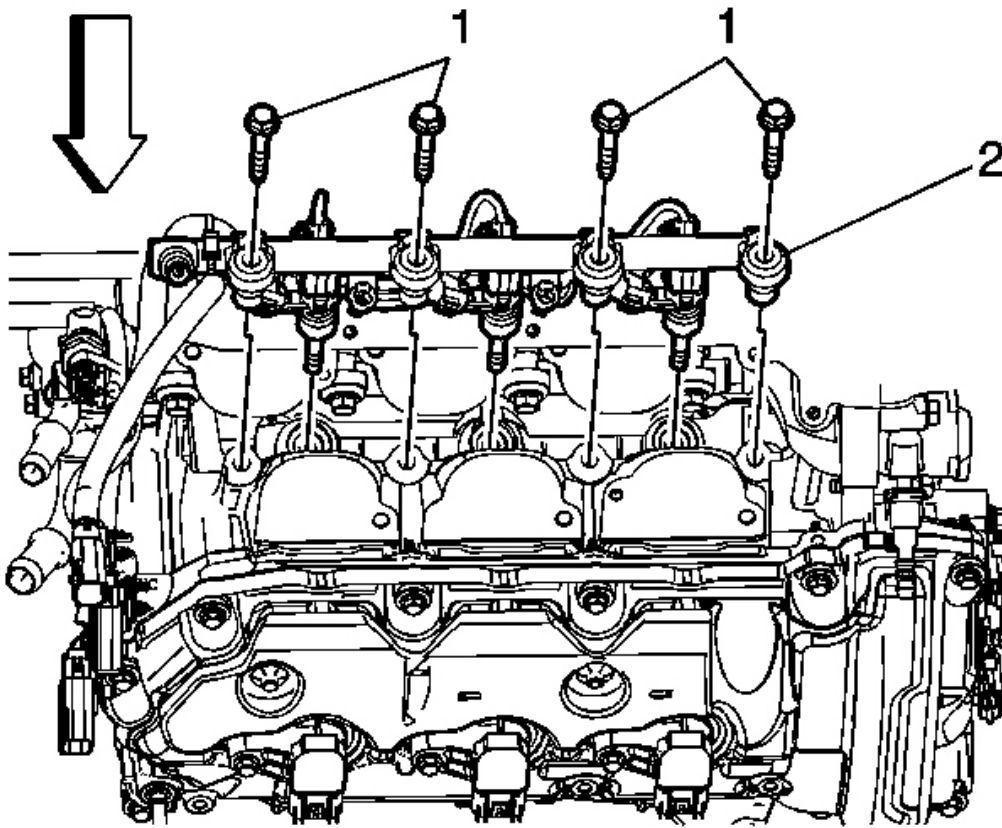


Fig. 77: Fuel Rail & Bolts

Courtesy of GENERAL MOTORS CORP.

1. Install the fuel rail with injectors (2) into the cylinder head evenly.
2. Hand tighten the two outer fuel rail bolts to seat the injector in the injector bores.
3. Start and hand tighten the remaining fuel rail bolts (1).

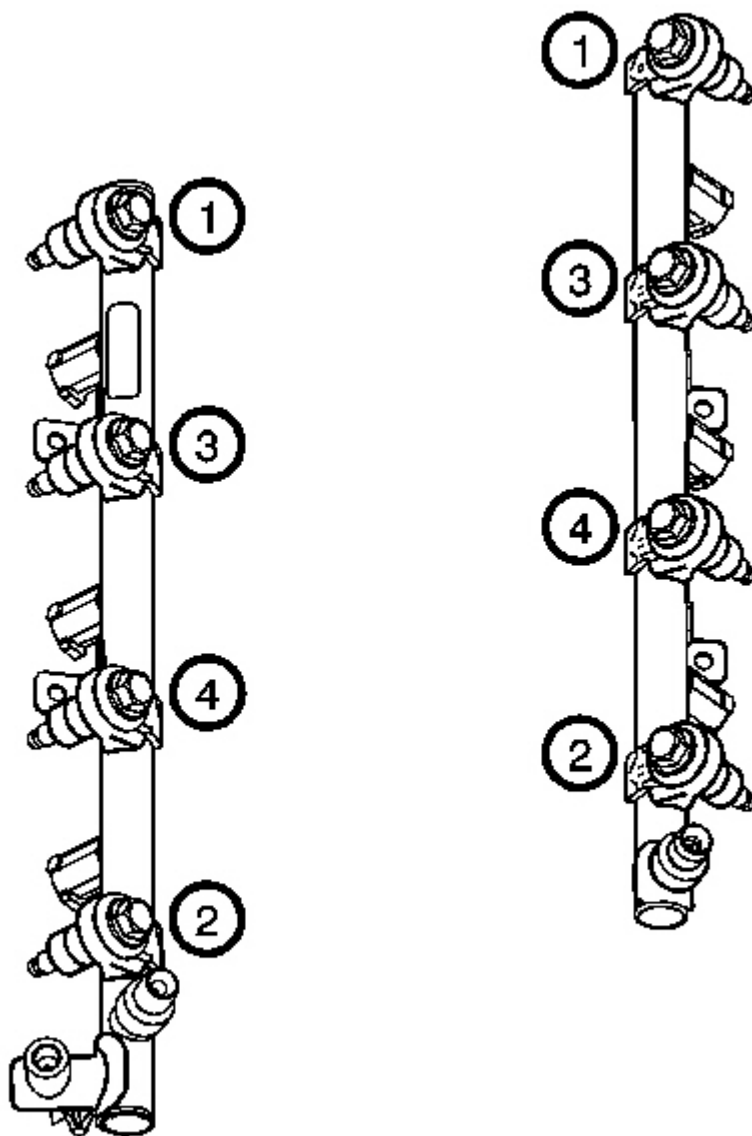


Fig. 78: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Tighten the fuel rail bolts in the sequence shown:

1. Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
2. Tighten the Bank 1 fuel rail bolts a final pass to 23 N.m (17 lb ft).
5. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
6. Connect the fuel injector wiring harness electrical connector from the fuel injectors, fuel rail and fuel pressure sensor.
7. Inspect for fuel leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.
 4. Inspect for fuel leaks.

NOTE: **Before installing the foam insulator, remove any remaining fuel from the injector well.**

8. Install the foam insulator to the fuel rails.
9. Install the intake manifold. Refer to **Intake Manifold Replacement** .
10. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.
11. Install the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** .
12. Install the low side fuel pressure service port cap.
13. Install the fuel tank cap.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT (LF1)

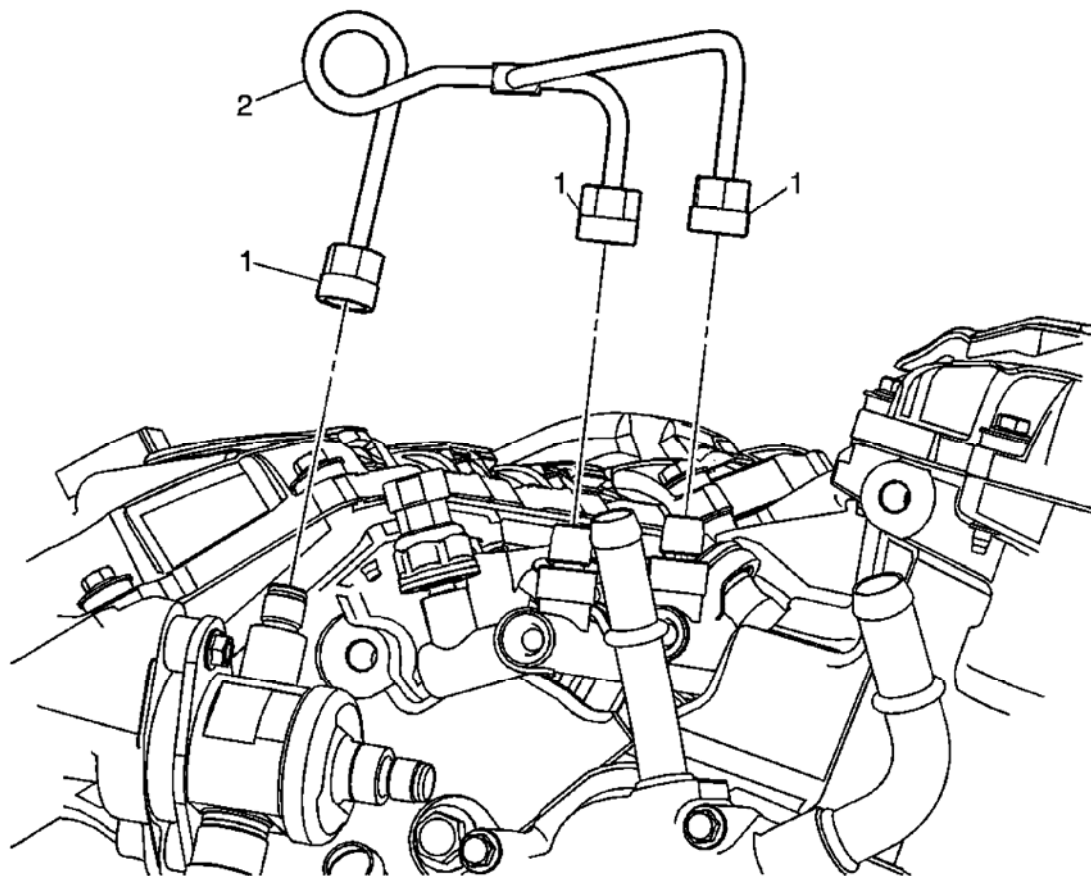


Fig. 79: Fuel Feed Intermediate Pipe (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to <u>Fuel Pressure Relief</u> . 2. Remove the Intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 3. Remove the fuel pipe shield. Refer to <u>Fuel Pipe Shield Replacement (LF1)</u>.	
1	Fitting (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 1. First Pass 15 N.m(11 lb ft) 2. Second Pass 30 N.m(22 lb ft)
	Fuel Feed Intermediate Pipe

Procedure

2

1. Discard the pipe when removed and install a new pipe.
2. Lubricate the pipes with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
3. Pressure up the fuel system and check for leaks.

FUEL PIPE SHIELD REPLACEMENT (LF1)

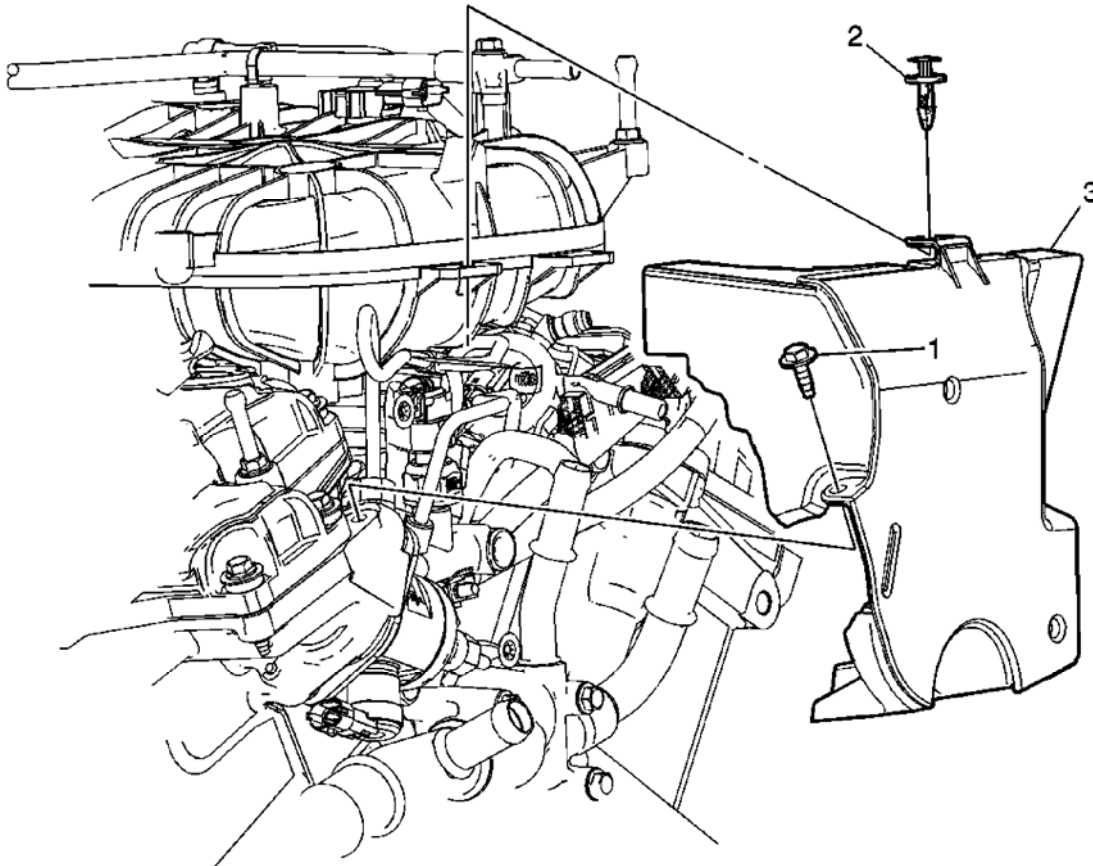


Fig. 80: Fuel Pipe Shield (LF1)

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Bolt CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten: 10 N.m (89 lb in)
2	Retainer
3	Fuel Pipe Shield

FUEL PUMP REPLACEMENT

Special Tools

EN-48896: High Pressure Fuel Pump Installation Alignment Gauge

Removal Procedure

1. Relieve the low and high side fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Remove the high pressure fuel pump shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.

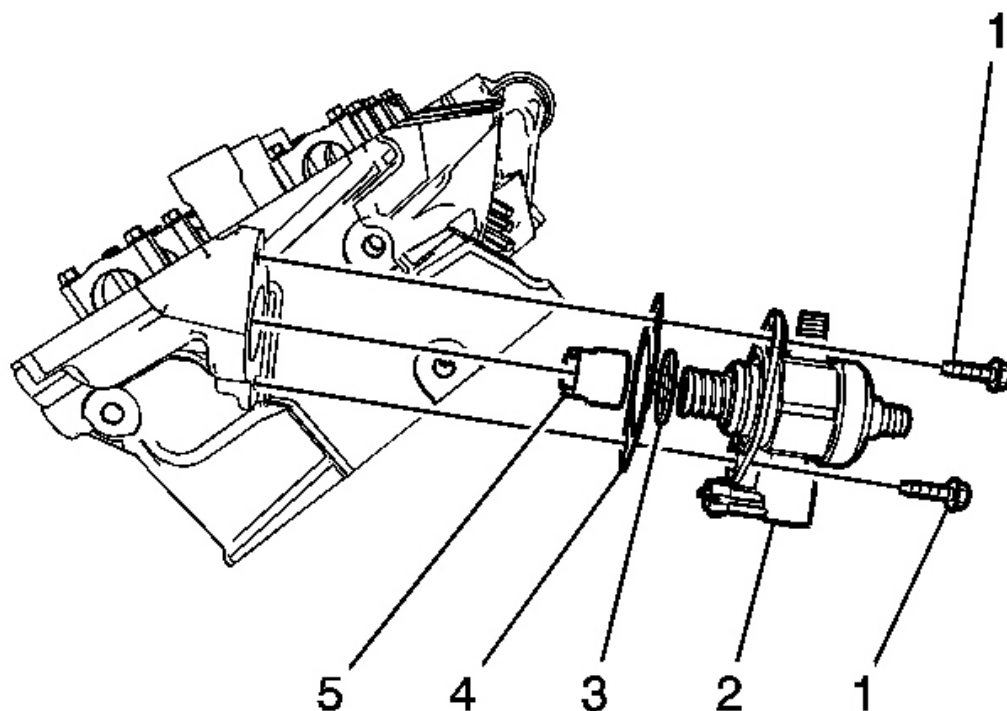


Fig. 81: High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS CORP.

3. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.

4. Remove the low pressure feed pipe. Refer to **Fuel Feed Pipe Replacement (LF1)**.
5. Remove the high pressure pipe. Discard the pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
6. Remove and discard the high pressure fuel pump bolts (1).
7. Remove the high pressure fuel pump (2).
8. Remove and discard the high pressure fuel pump O-ring (3).
9. Remove and discard the high pressure fuel pump gasket (4).
10. Remove the high pressure fuel pump roller lifter (5).

Installation Procedure

NOTE: **The camshaft must be in the base circle position before the high pressure fuel pump is installed.**

1. Use the **EN-48896**: alignment gauge to ensure that the camshaft lobe is in the base circle position. At base circle the tool will be flush with the head.
2. Lubricate the high pressure fuel pump cylinder head bore and roller lifter with camshaft prelube. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

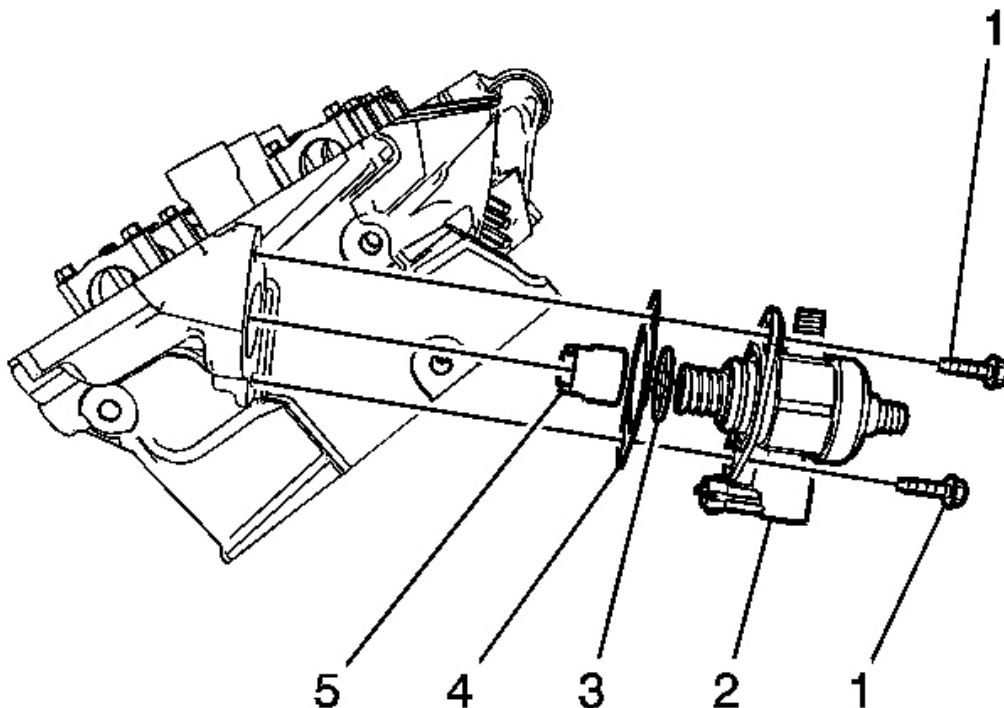


Fig. 82: High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS CORP.

NOTE: **The high pressure fuel pump gasket has a retaining feature to hold the pump retaining bolts in place.**

- 3.
4. Install the high pressure fuel pump roller lifter (5).
5. Install a NEW high pressure fuel pump O-ring (3).
6. Position the NEW high pressure fuel pump gasket (4) and bolts (1) to the fuel pump.
7. Install the high pressure fuel pump (2). Force will be required while hand tightening the bolts.

CAUTION: Refer to Fastener Caution .

8. Tighten the high pressure fuel pump retaining bolts to 15 N.m (11 lb ft).
9. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.
10. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
11. Install the fuel feed pipe to the high pressure fuel pump. Refer to **Fuel Feed Pipe Replacement (LF1)**.
12. Connect the high pressure fuel pump wiring harness.
13. Install the fuel tank cap.

NOTE: **If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.**

14. Inspect for leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.
 4. Inspect for fuel leaks.
15. Install the pressure relief cap to the fuel feed pipe.
16. Install the intake manifold. Refer to **Intake Manifold Replacement** .
17. Install the high pressure fuel pump shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.

FUEL INJECTOR AND FUEL RAIL REPLACEMENT

Special Tools

EN-47909: Fuel Injector Bore and Sleeve Cleaning Kit

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief** .
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
5. Remove the foam insulator from the fuel rails.
6. Remove the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** or **Cylinder Head Replacement - Right Side (LF1)**

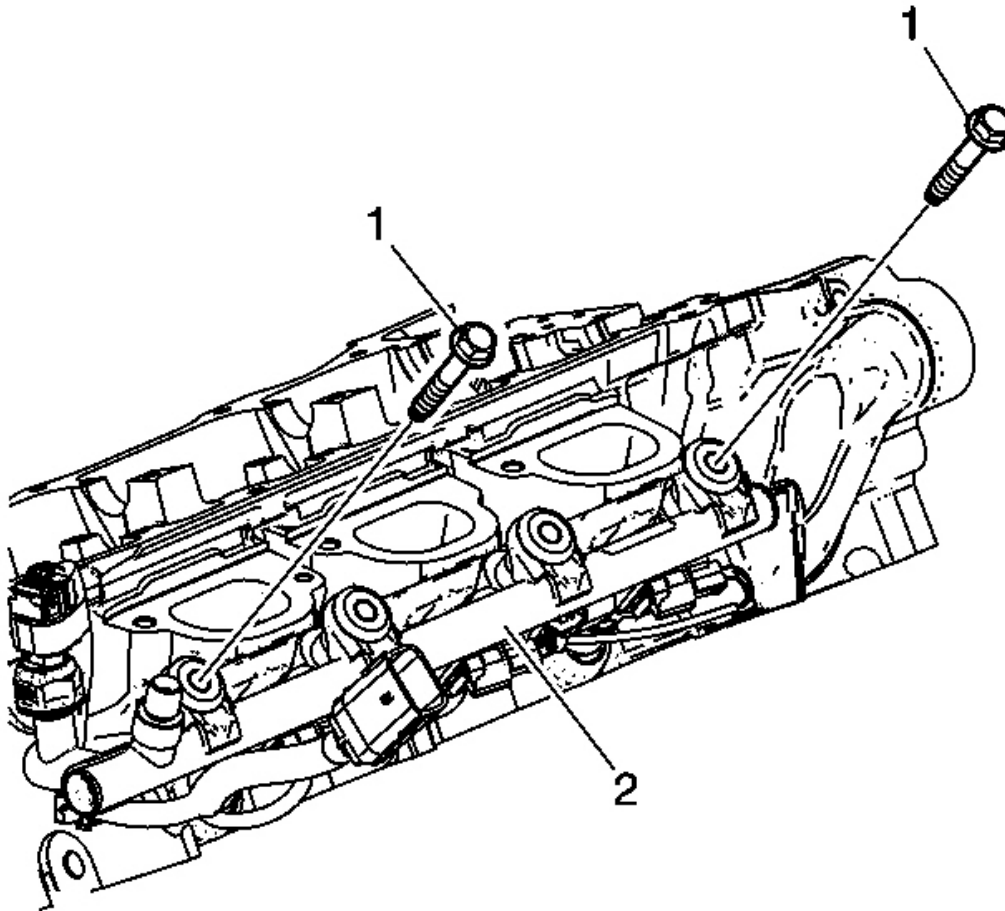


Fig. 83: Fuel Rail Bolts

Courtesy of GENERAL MOTORS CORP.

7. Remove the bolts (1) from the bank 2 fuel rail.
8. Remove the bank 1 fuel rail and injectors (1) as an assembly. Refer to **Cylinder Head Disassemble (LF1)**

or LFW).

9. Disconnect the bank 1 fuel injector electrical connections.

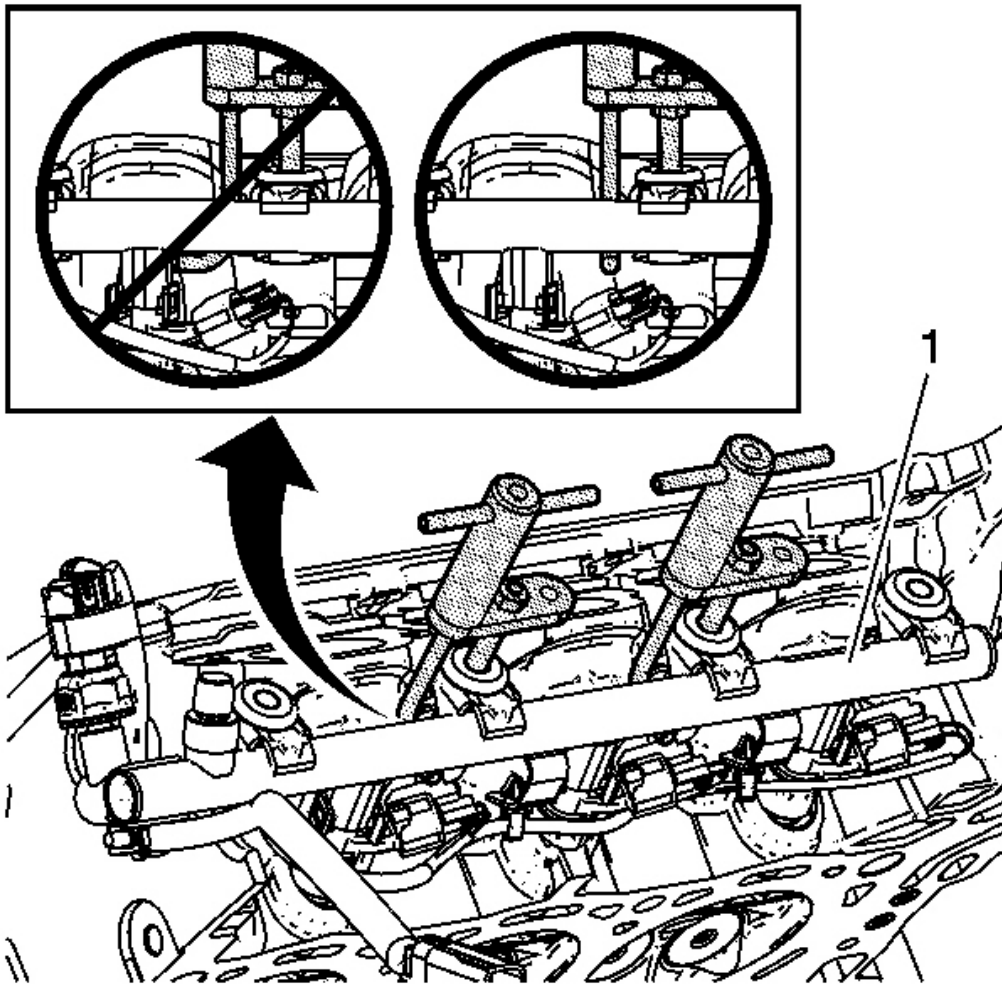


Fig. 84: Removing Fuel Rail & Injectors
Courtesy of GENERAL MOTORS CORP.

10. If the bank 2 fuel rail or injectors are being serviced, remove them. Refer to Cylinder Head Disassemble (LF1 or LFW).
11. Disconnect the bank 2 fuel injector and fuel pressure sensor electrical connections.

NOTE: The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.

12. It is necessary to rebuild the fuel injectors. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW)** .

Installation Procedure

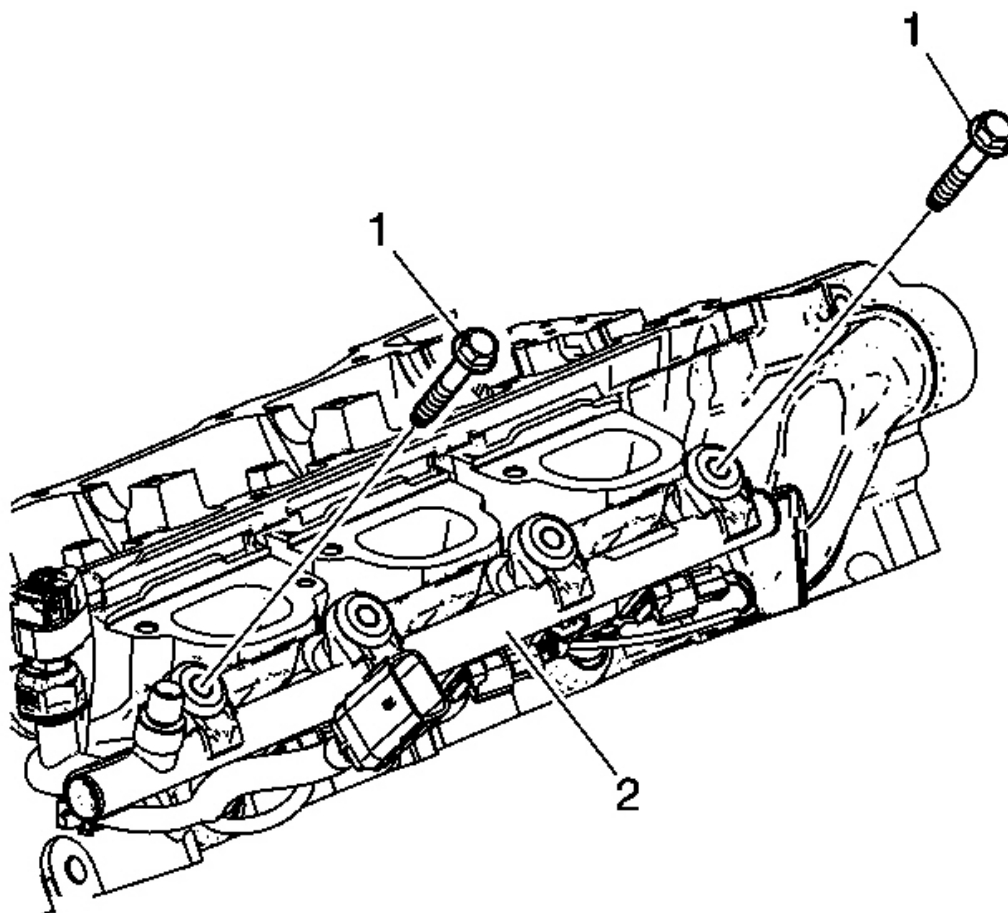


Fig. 85: Fuel Rail Bolts

Courtesy of GENERAL MOTORS CORP.

1. Clean the fuel injector bores using **EN-47909**: kit.
2. Ensure that the fuel injectors have been properly rebuilt and lubricated. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1 or LFW)** .
3. Connect the bank 2 fuel injector and fuel pressure sensor electrical connections.
4. Position the bank 2 fuel rail and evenly hand tighten the 2 outer fuel rail bolts to seat the injectors into the injector bores. Remove the bolts.

5. Connect the bank 1 fuel injector electrical connections.
6. Position the bank 1 fuel rail and evenly hand tighten the 2 outer fuel rail bolts to seat the injectors into the injector bores.
7. Start and hand tighten the remaining fuel rail bolts.

CAUTION: Refer to Fastener Caution .

8. Tighten the bank 1 and bank 2 fuel rail bolts.
 - Tighten the inner fuel rail bolts to 10 N.m (89 lb in).
 - Tighten the outer fuel rail bolts to 10 N.m (89 lb in).
9. Replace any wire harness tie straps cut from the fuel rails.
10. Install the cylinder head. Refer to **Cylinder Head Replacement - Left Side (LF1)** or **Cylinder Head Replacement - Right Side (LF1)**
11. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement (LF1)**.
12. Inspect for fuel leaks using the following procedure:
 1. Turn ON the ignition, with the engine OFF for 2 seconds.
 2. Turn OFF the ignition, for 10 seconds.
 3. Turn ON the ignition, with the engine OFF.
 4. Inspect for fuel leaks.

NOTE: Before installing the foam insulator, remove any remaining fuel from the injector well.

13. Install the foam insulator to the fuel rails.
14. Install the intake manifold. Refer to **Intake Manifold Replacement** .
15. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement (LF1)**.
16. Install the low side fuel pressure service port cap.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT (LF1)

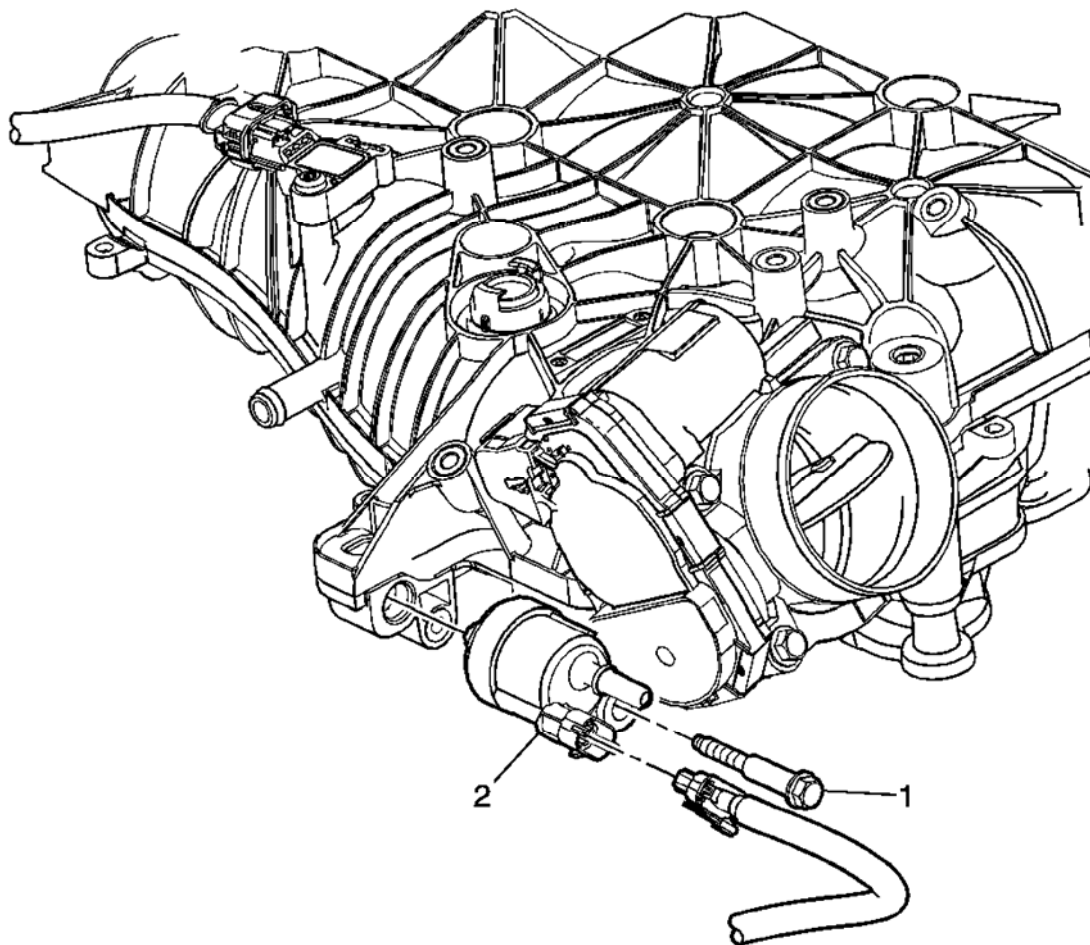


Fig. 86: Evaporative Emission Canister Purge Solenoid Valve (LF1)
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Evaporative Emission Canister Purge Solenoid Valve Procedure 1. Disconnect the EVAP canister purge solenoid harness connector. 2. Install a NEW O-ring.

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

Removal Procedure

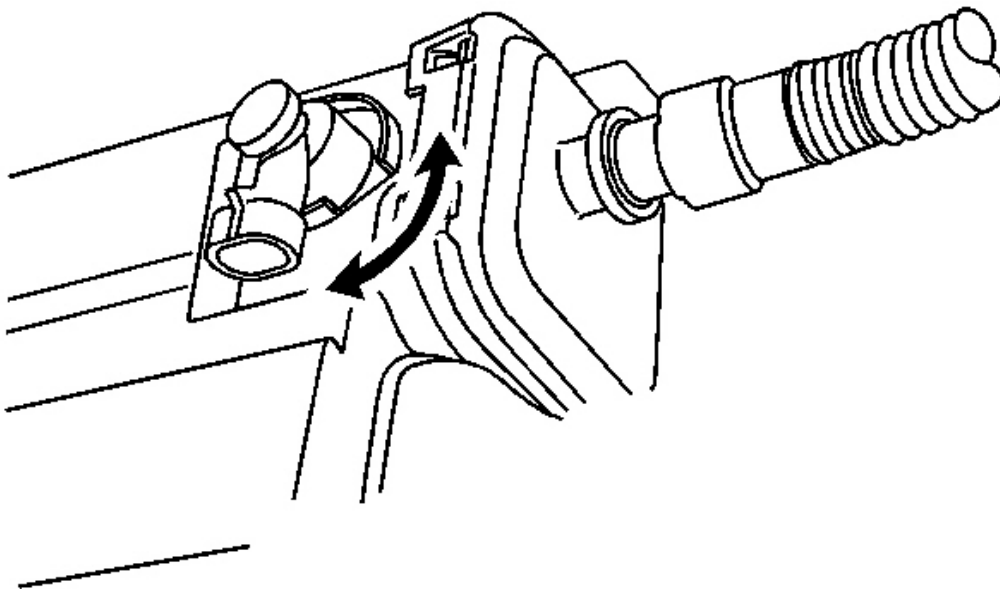


Fig. 87: Rotating EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

1. Remove the evaporative emission (EVAP) canister. Refer to **Evaporative Emission Canister Replacement** .
2. Rotate the EVAP canister vent valve counterclockwise to release from the locked position.

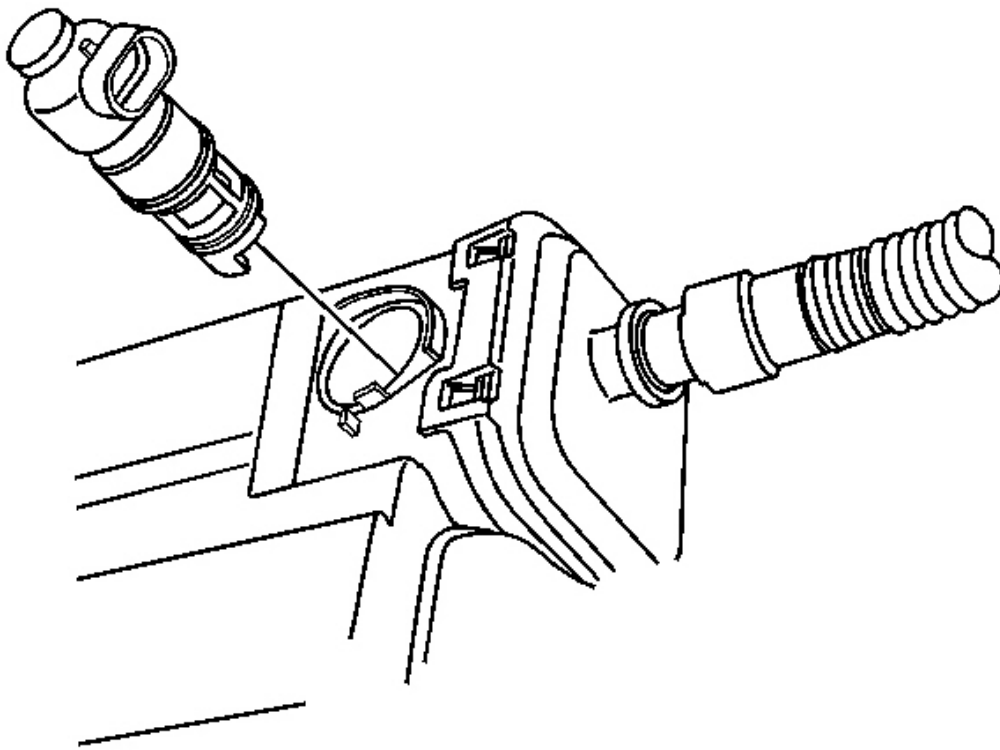


Fig. 88: View Of EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

3. Remove the vent valve from the EVAP canister.

Installation Procedure

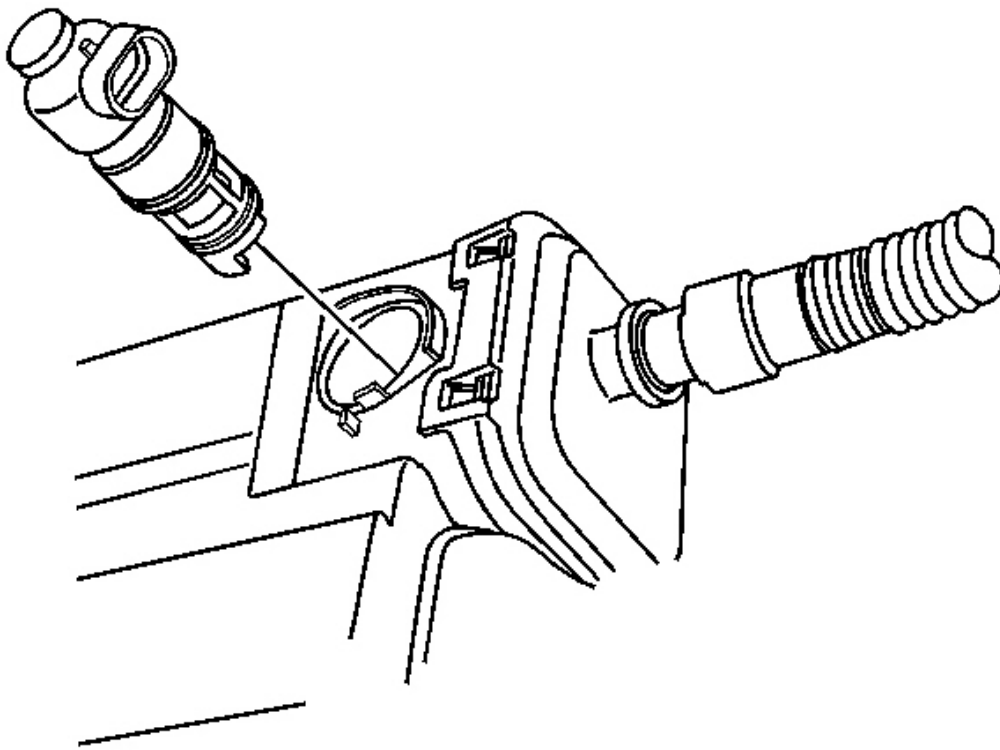


Fig. 89: View Of EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

1. Insert the EVAP canister vent solenoid valve into the EVAP canister, with the valve aligned to the released position.

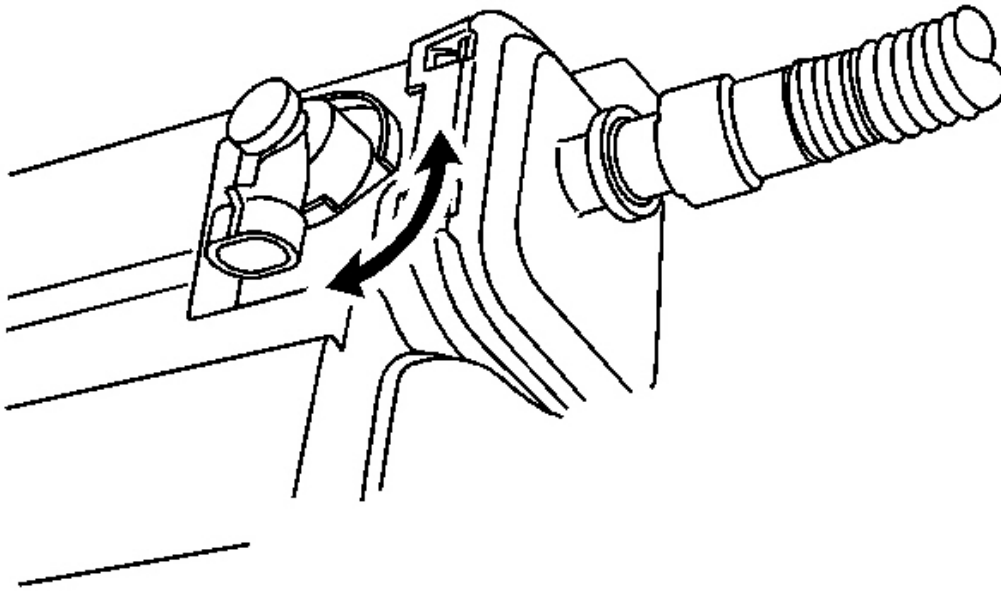


Fig. 90: Rotating EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS CORP.

2. Rotate vent valve clockwise to secure into the locked position.
3. Install the EVAP canister. Refer to **Evaporative Emission Canister Replacement** .

EVAPORATIVE EMISSION LINE REPLACEMENT - CHASSIS TO CANISTER

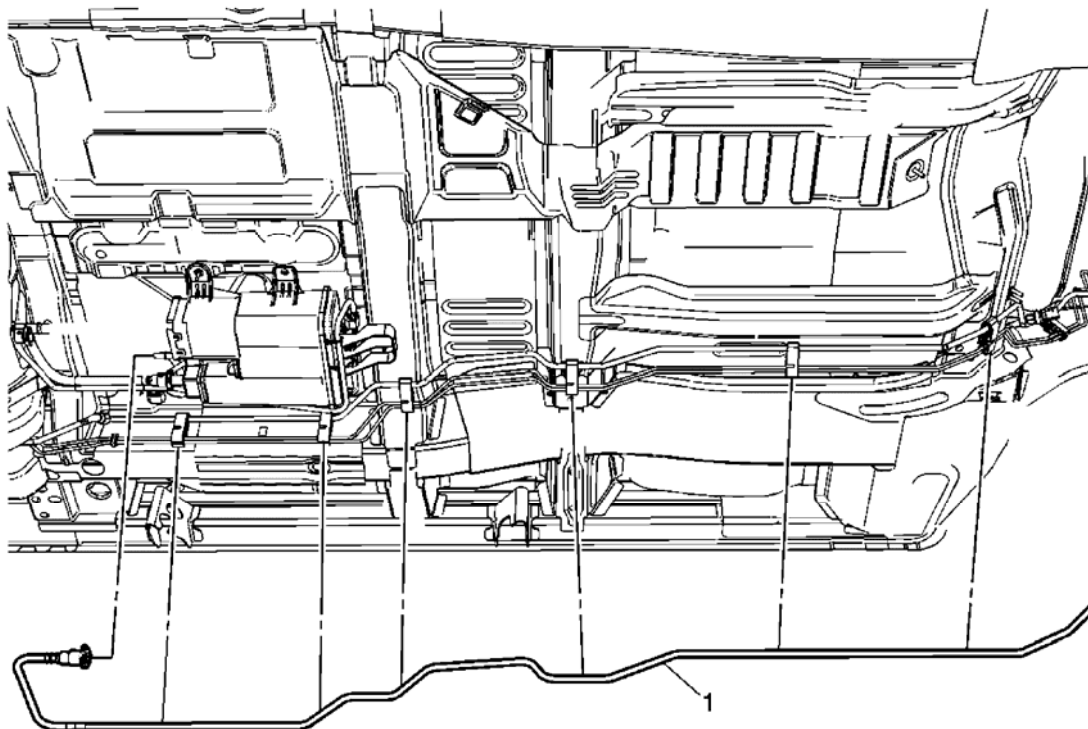


Fig. 91: Evaporative Emission Line - Chassis to Canister
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
2. Disconnect the quick connectors. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .	
1	Evaporative Emission Line Procedure: Disengage the line from the plastic retainers.

EVAPORATIVE EMISSION CANISTER REPLACEMENT

Removal Procedure

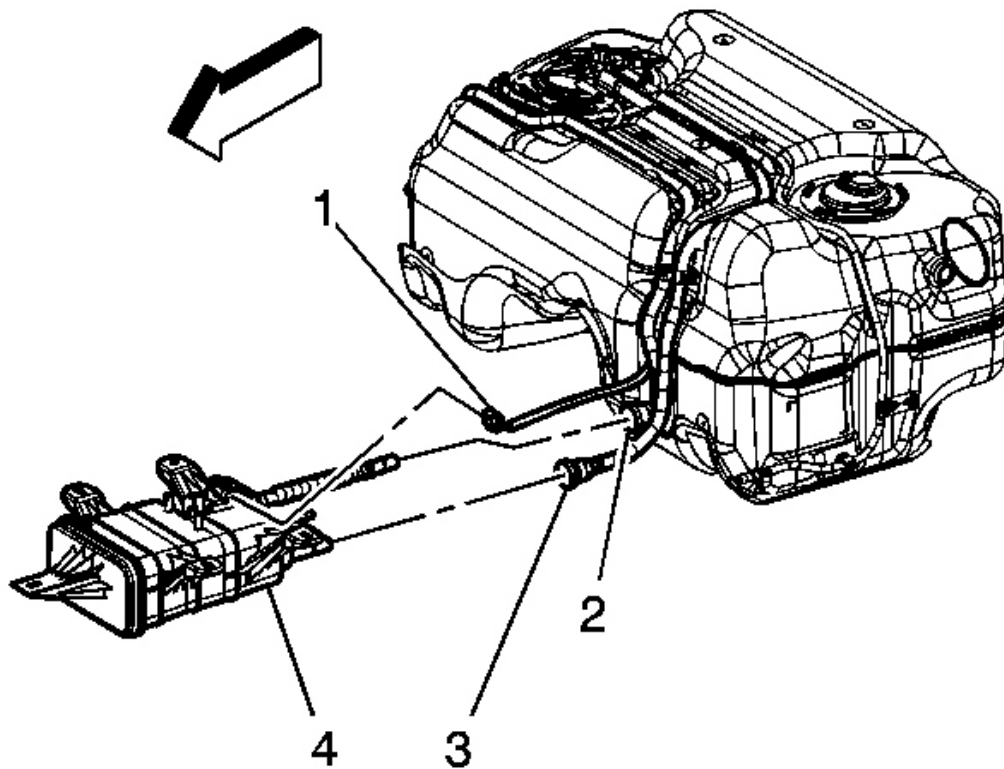


Fig. 92: View Of EVAP Canister, Hose/Pipes & EVAP Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

NOTE: The EVAP emissions canister is located under the center of the vehicle. It has 3 EVAP line connections:

- The EVAP fresh air
- The EVAP vent
- The EVAP purge

1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

CAUTION: Clean all fuel pipe connections and surrounding areas before disconnecting the fuel pipes to avoid contamination of the fuel system.

2. Disconnect the EVAP canister fresh air hose/pipe from the fuel tank fresh air hose/pipe (2). Refer to Plastic Collar Quick Connect Fitting Service.

3. Disconnect the EVAP canister vent hose/pipe from the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

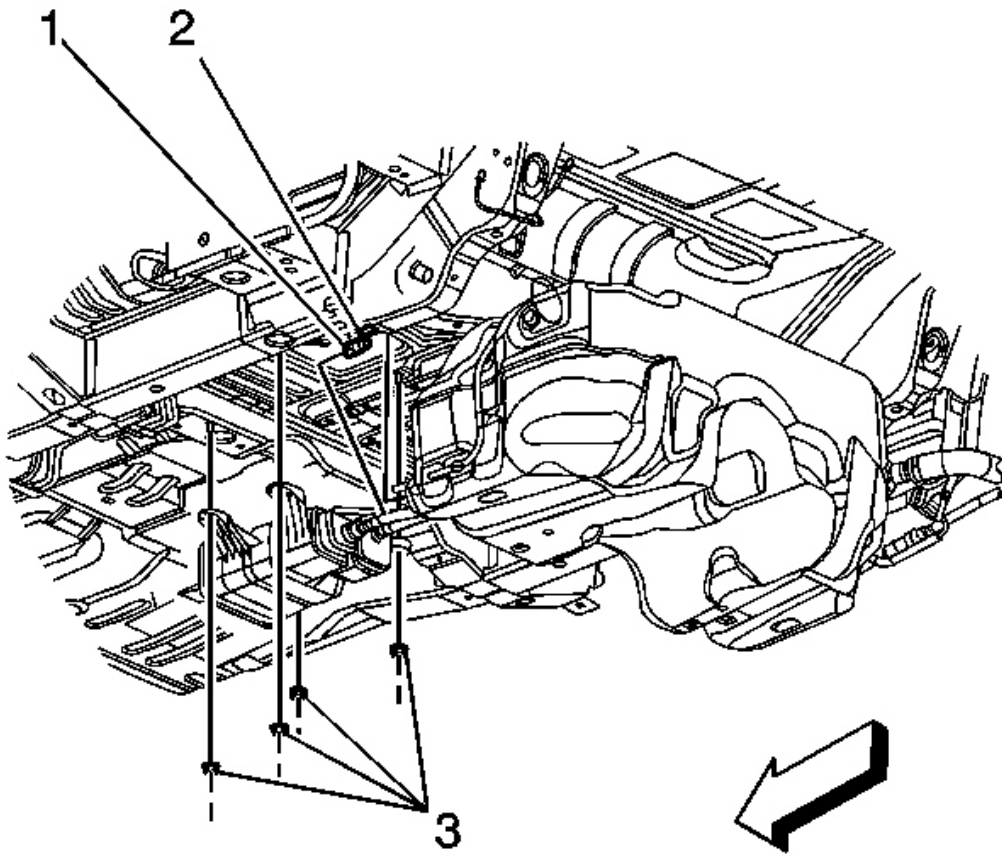


Fig. 93: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

4. Disconnect the EVAP canister purge hose/pipe (1) from the EVAP canister.
5. Remove the EVAP canister-to-underbody nuts (3).
6. Lower the EVAP canister.

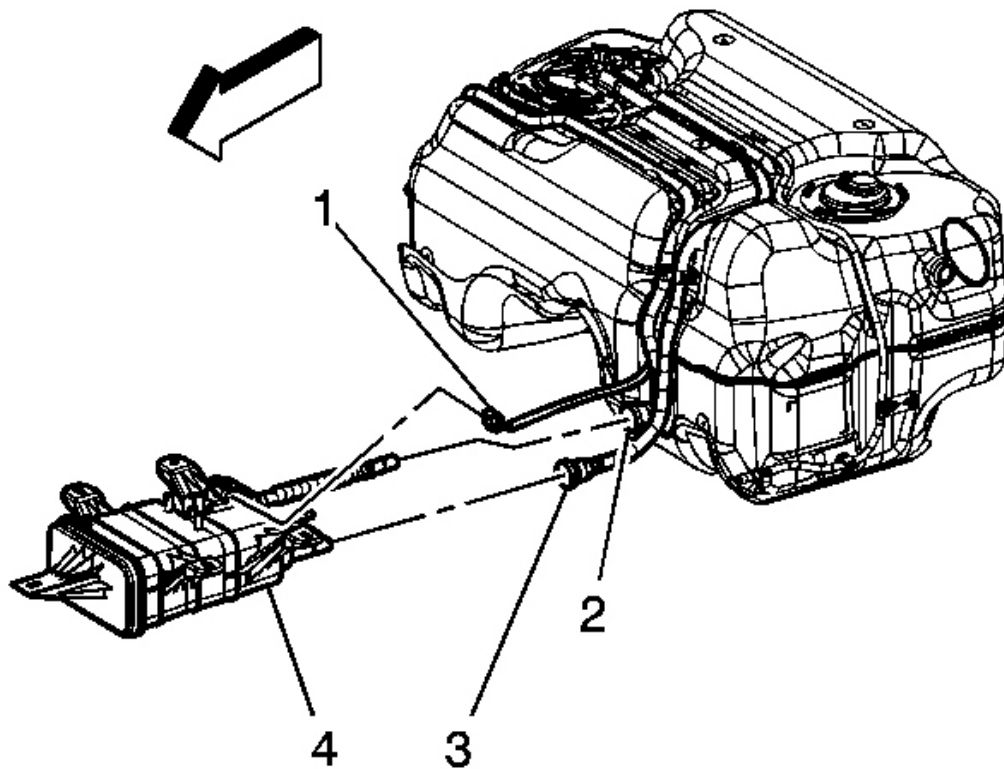


Fig. 94: View Of EVAP Canister, Hose/Pipes & EVAP Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the EVAP vent solenoid electrical connector (1).
8. Remove the EVAP canister (4) from the vehicle.

Installation Procedure

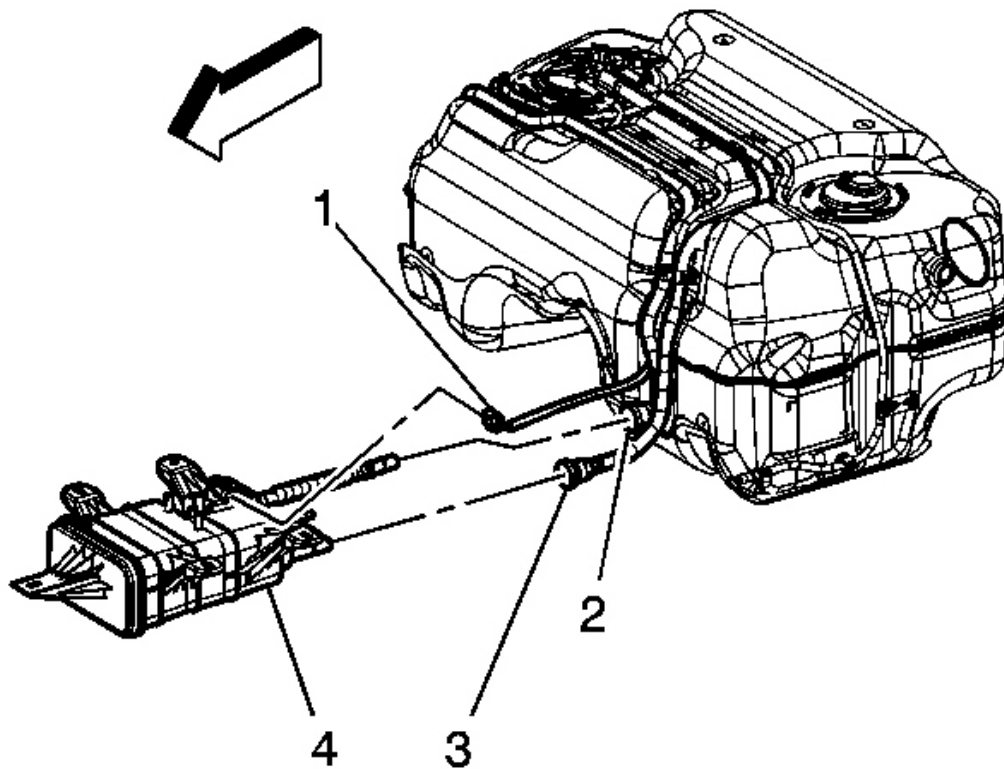


Fig. 95: View Of EVAP Canister, Hose/Pipes & EVAP Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Connect the EVAP vent solenoid electrical connector (1).
2. Install the EVAP canister (4) to the underbody of the vehicle.

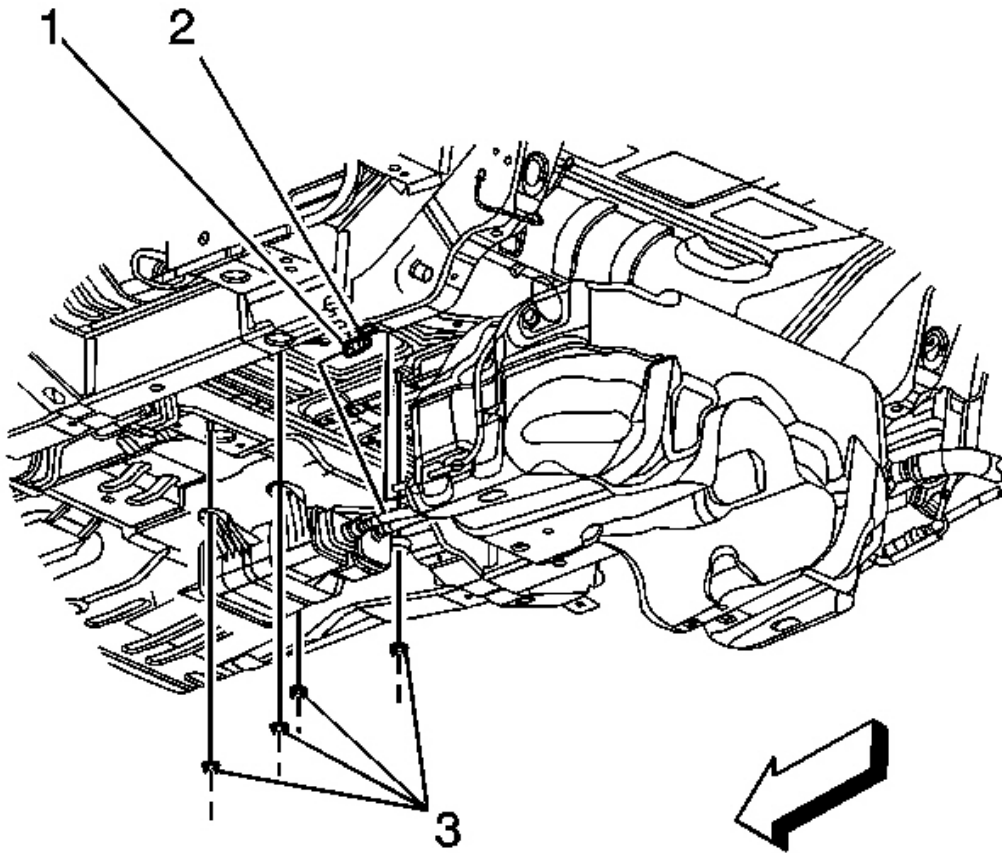


Fig. 96: View Of Chassis Fuel Supply Line, EVAP Canister Purge Hose/Pipe & EVAP Canister-To-Underbody Nuts

Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the EVAP canister-to-underbody nuts (3).

Tighten: Tighten the nuts to 9 N.m (80 lb in).

4. Connect the EVAP canister purge hose/pipe (1) to the EVAP canister.

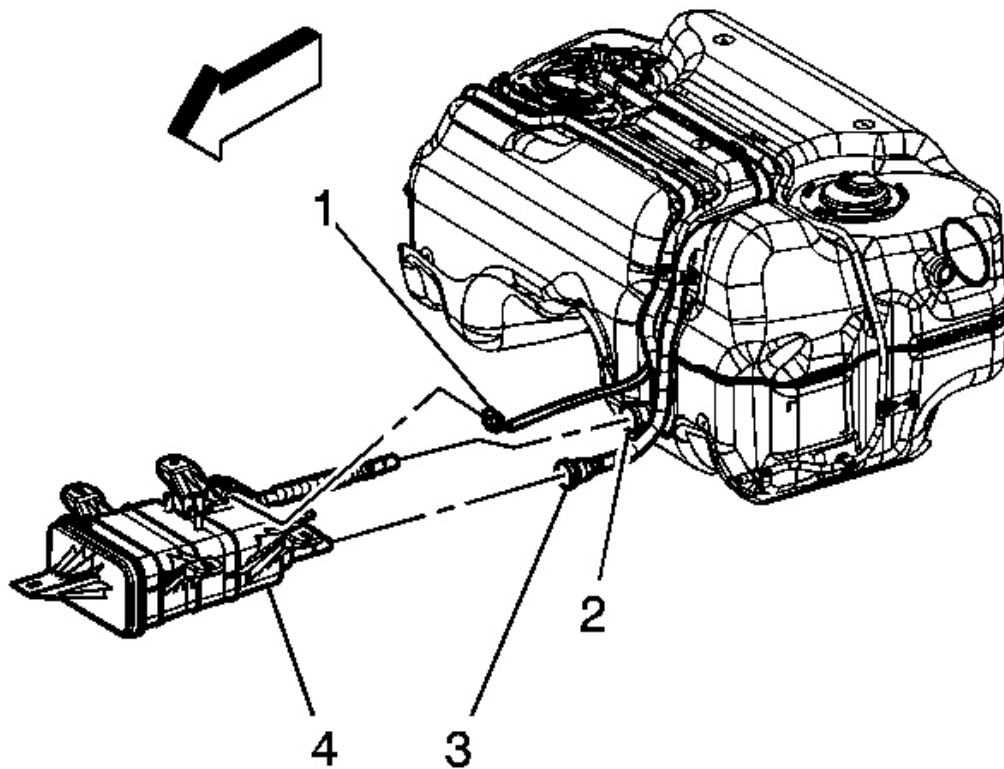


Fig. 97: View Of EVAP Canister, Hose/Pipes & EVAP Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS CORP.

5. Connect the EVAP canister vent hose/pipe (3) to the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Connect the EVAP canister fresh air hose/pipe to the fuel tank fresh air hose/pipe (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Lower the vehicle.

EVAPORATIVE EMISSION SYSTEM CLEANING

Special Tools

J 41413-200 Evaporative Emission System Tested

Inspection Procedure

CAUTION: Use the EVAP Pressure/Purge Diagnostic Station J 41413 in order to

provide a clean, dry, low pressure gas source. Do not substitute any other pressurized gas source. Damage may result to the EVAP system.

NOTE: Proceed with the following procedure only if referenced by an evaporative emission (EVAP) diagnostic or repair procedure.

1. Turn OFF the ignition.
2. Remove the EVAP canister purge valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement (LF1)**.
3. Lightly tap the EVAP canister purge valve on a hard surface.
4. Inspect for carbon particles exiting either of the vacuum ports.
 - If no carbon particles were detected, but a blockage was detected during a diagnostic procedure, install the original EVAP canister purge valve. Continue with the cleaning procedure.
 - If carbon particles are found during the inspection procedure, continue with the cleaning procedure.
 - If a diagnostic procedure directed you to replace the EVAP canister purge valve and no carbon particles were detected, replace the EVAP canister purge valve. Return to the published service procedure.

Cleaning Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the EVAP canister. Refer to **Evaporative Emission Canister Replacement** .
3. Turn OFF the main valve on the **J 41413-200** .
4. Disconnect the hose from the diagnostic station pressure regulator.
5. Using a section of vacuum hose, connect one end onto the EVAP pressure/purge diagnostic station pressure regulator.
6. Connect the other end of the vacuum hose to the canister side of the purge pipe.
7. Turn ON the main nitrogen cylinder valve and continue to discharge nitrogen for 15 seconds.
8. If the nitrogen does not clear the blockage, replace the purge pipe.
9. Return the EVAP pressure/purge diagnostic station to the stations original condition.
10. Install a new EVAP canister. Refer to **Evaporative Emission Canister Replacement** .
11. Lower the vehicle.
12. Install a new EVAP canister purge valve. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement (LF1)**.
13. Return to the diagnostic table that sent you here.

IGNITION COIL REPLACEMENT - BANK 1

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement** .

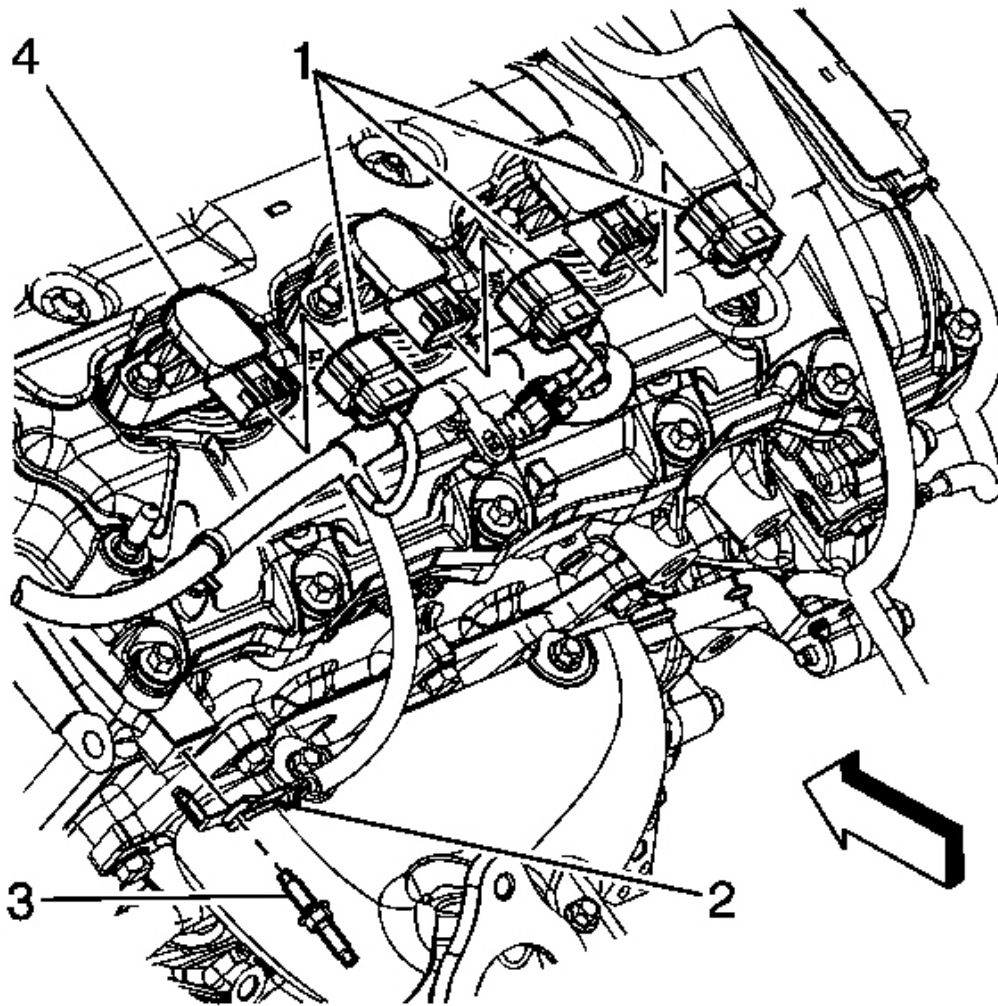


Fig. 98: View Of Ignition Coil Electrical Connector
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the engine wiring harness electrical connector(s) (1) from the ignition coil(s) (4).

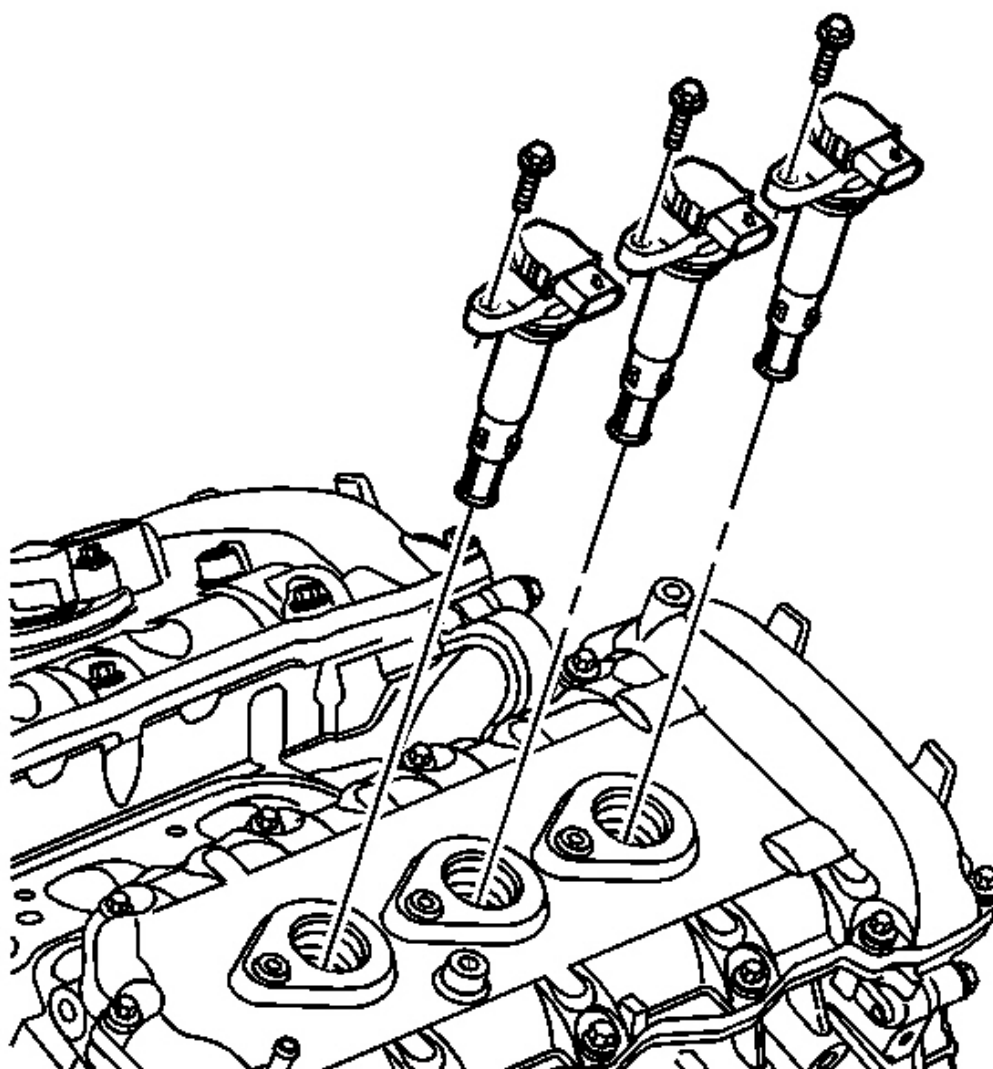


Fig. 99: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

3. Remove the ignition coil bolt(s).
4. Remove the ignition coil(s).

Installation Procedure

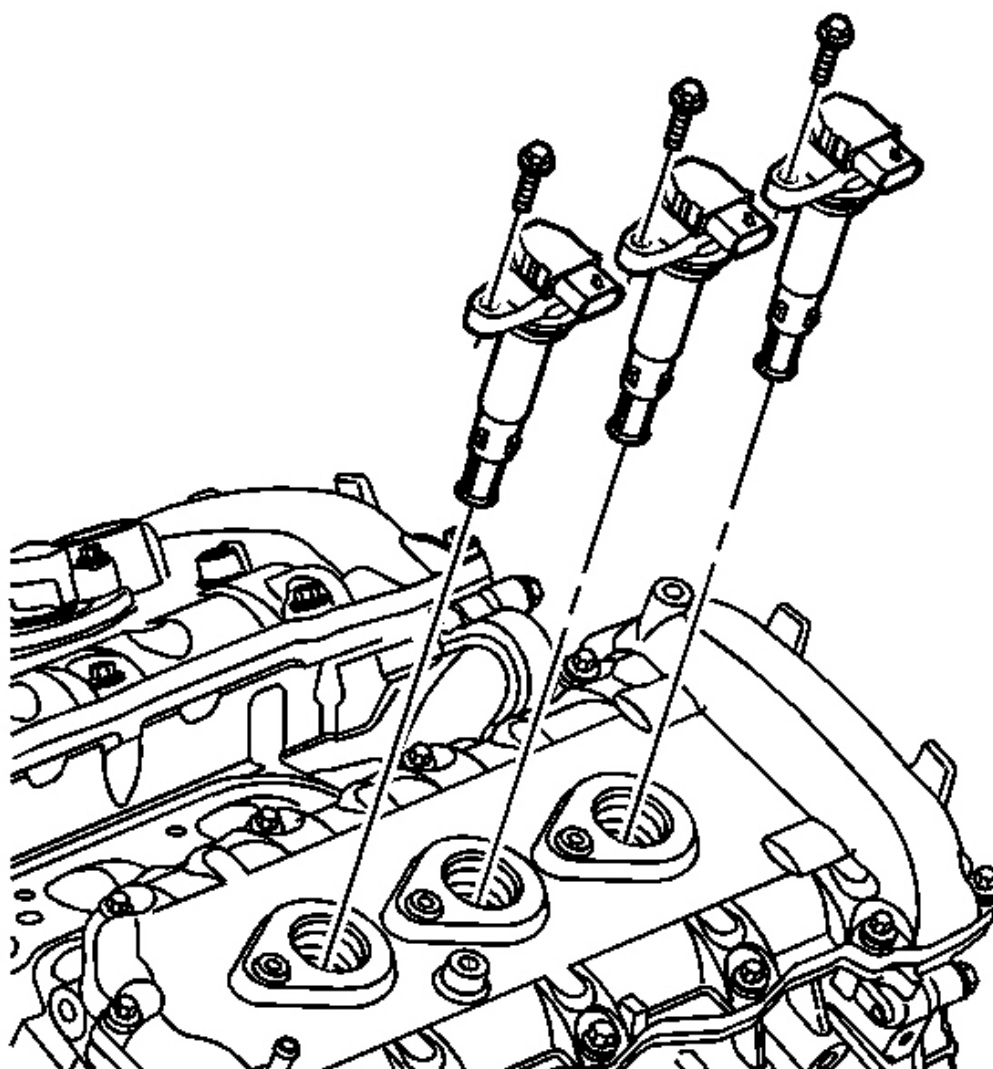


Fig. 100: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

1. Install the ignition coil(s).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s).

Tighten: Tighten the bolt(s) to 10 N.m (89 lb in).

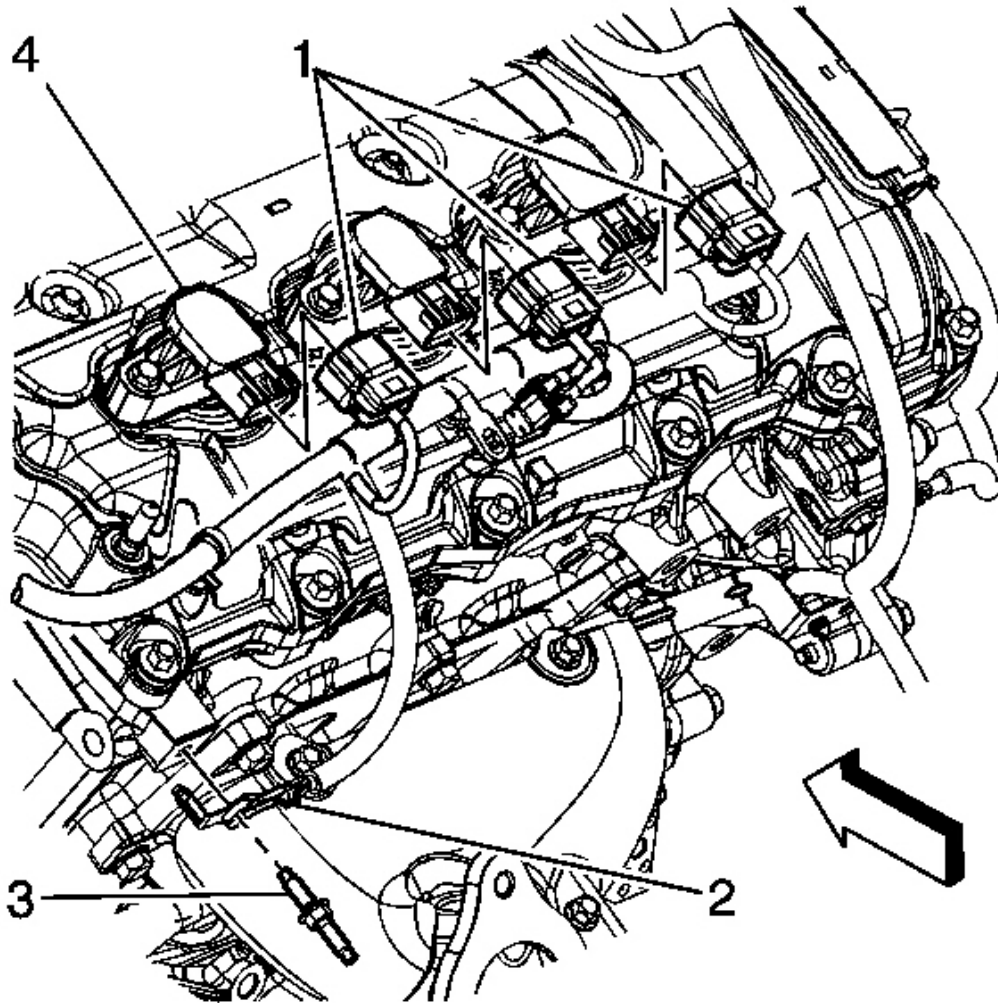


Fig. 101: View Of Ignition Coil Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the engine wiring harness electrical connector(s) (1) to the ignition coil(s) (4).
4. Install the intake manifold. Refer to **Intake Manifold Replacement** .

IGNITION COIL REPLACEMENT - BANK 2

Removal Procedure

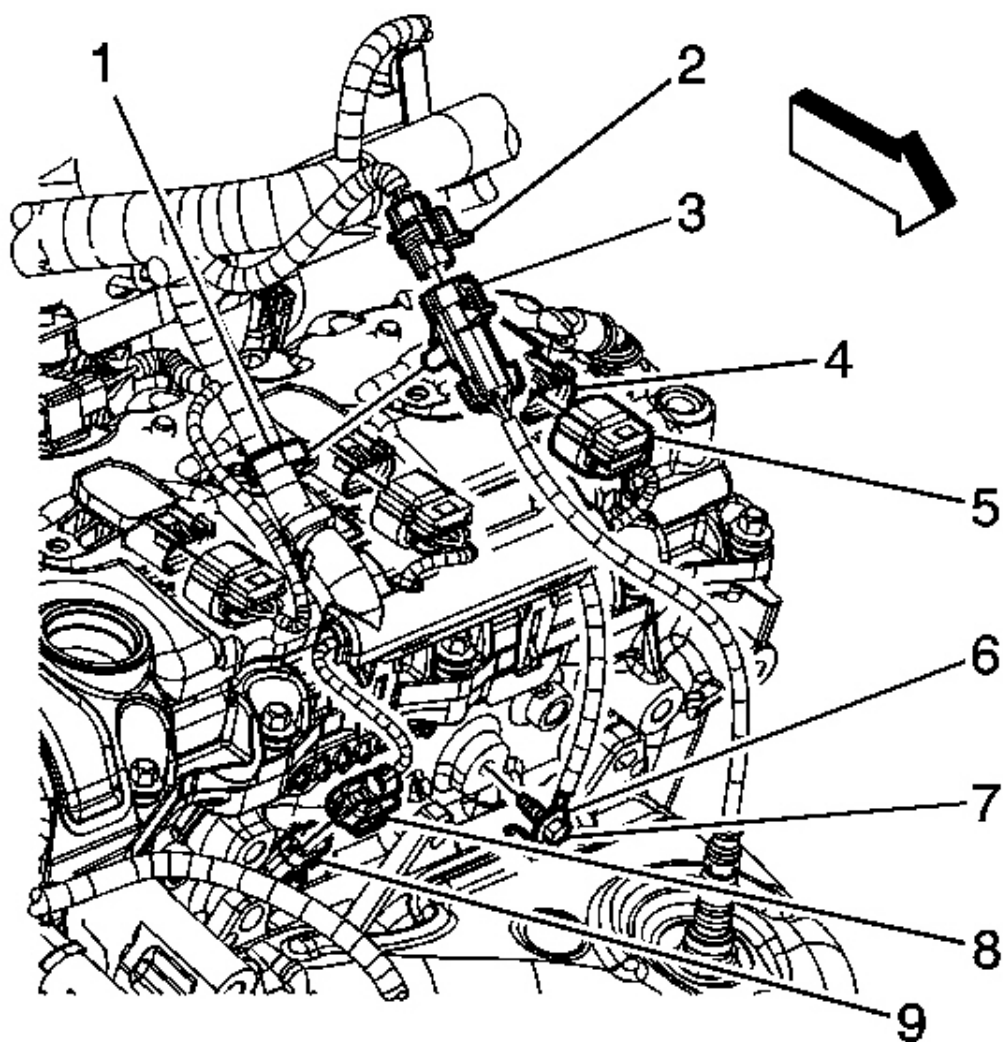


Fig. 102: Identifying Engine Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Disconnect the engine wiring harness electrical connector(s) (5) from the ignition coil(s) (4).

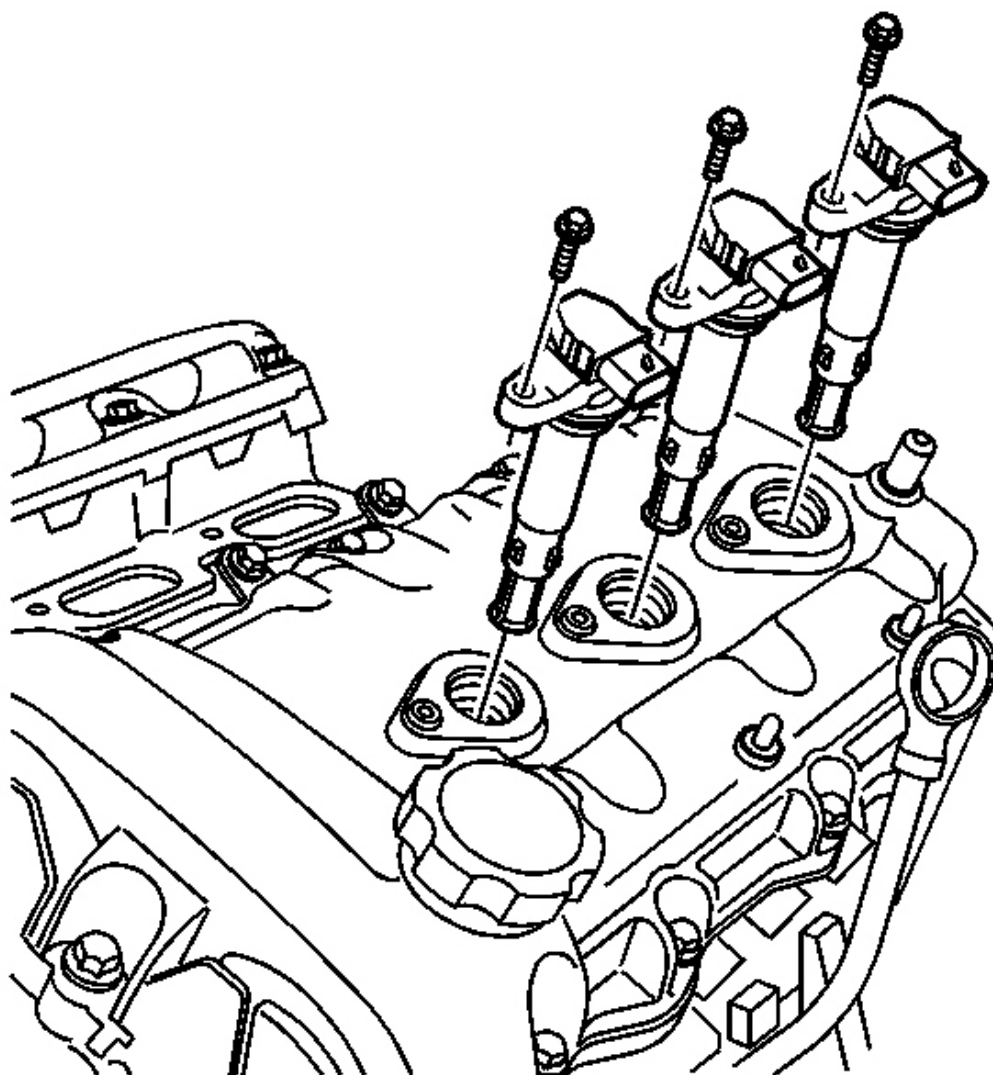


Fig. 103: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

3. Remove the ignition coil bolt(s).
4. Remove the ignition coil(s).

Installation Procedure

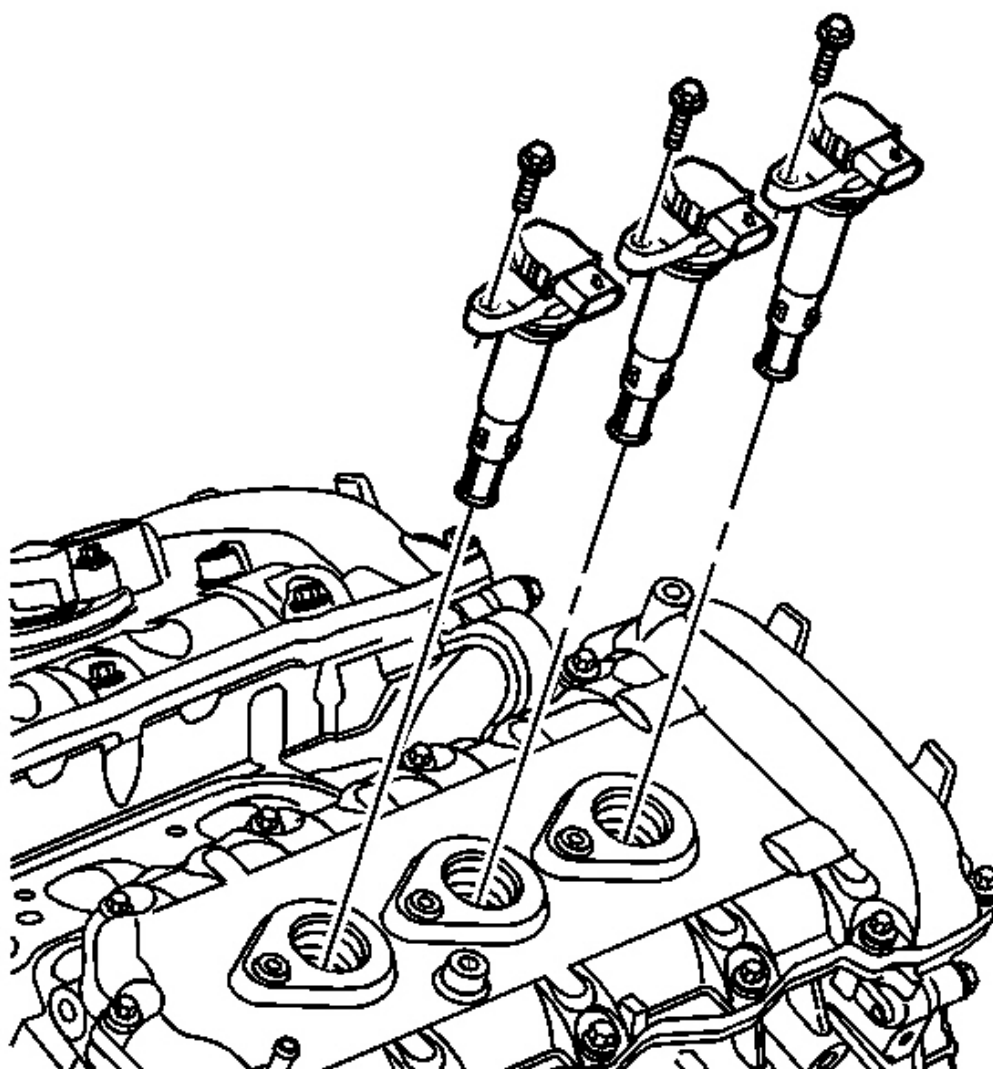


Fig. 104: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

1. Install the ignition coil(s).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s).

Tighten: Tighten the bolt(s) to 10 N.m (89 lb in).

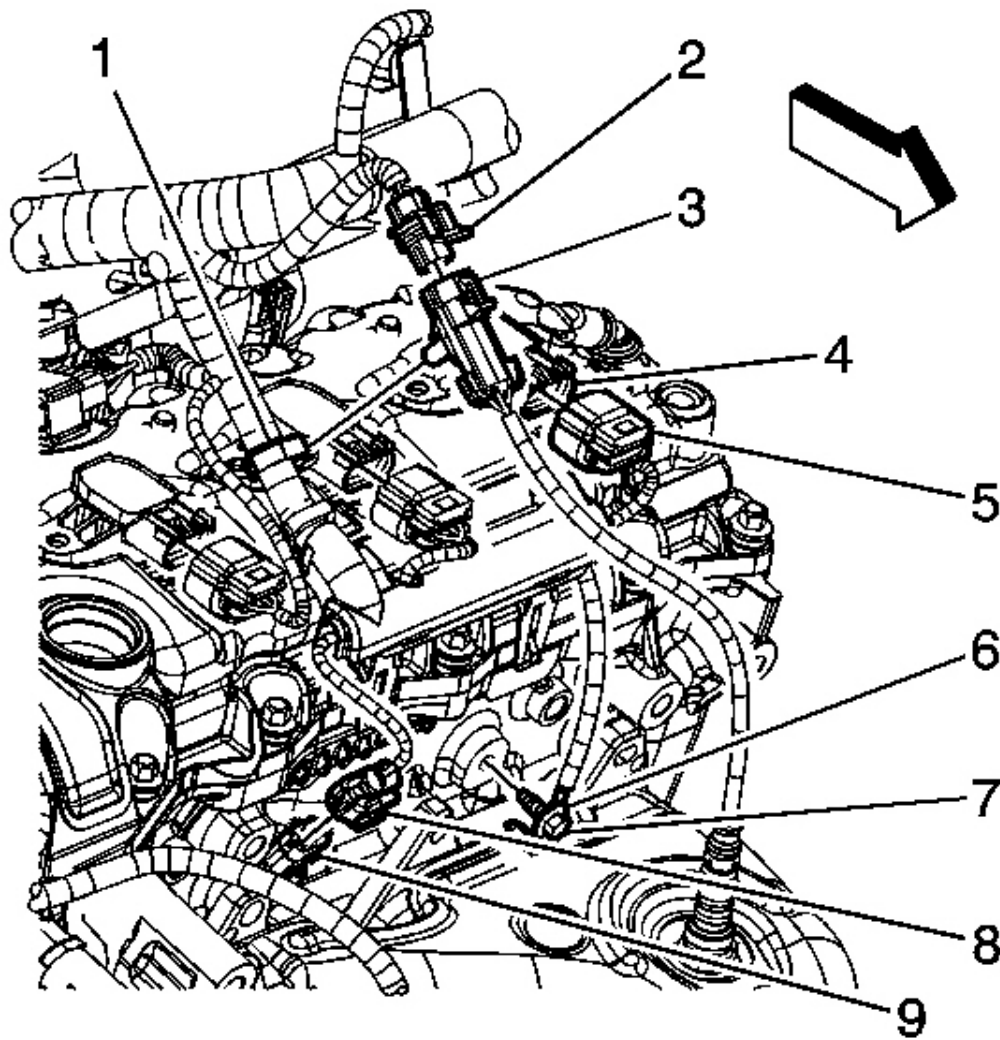


Fig. 105: Identifying Engine Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

3. Connect the engine wiring harness electrical connector(s) (5) to the ignition coil(s) (4).
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

SPARK PLUG INSPECTION

Spark Plug Usage

- Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to **Ignition System Specifications** for the correct spark plug.
- Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
 - Spark plug fouling-Colder plug
 - Pre-ignition causing spark plug and/or engine damage-Hotter plug

Spark Plug Inspection

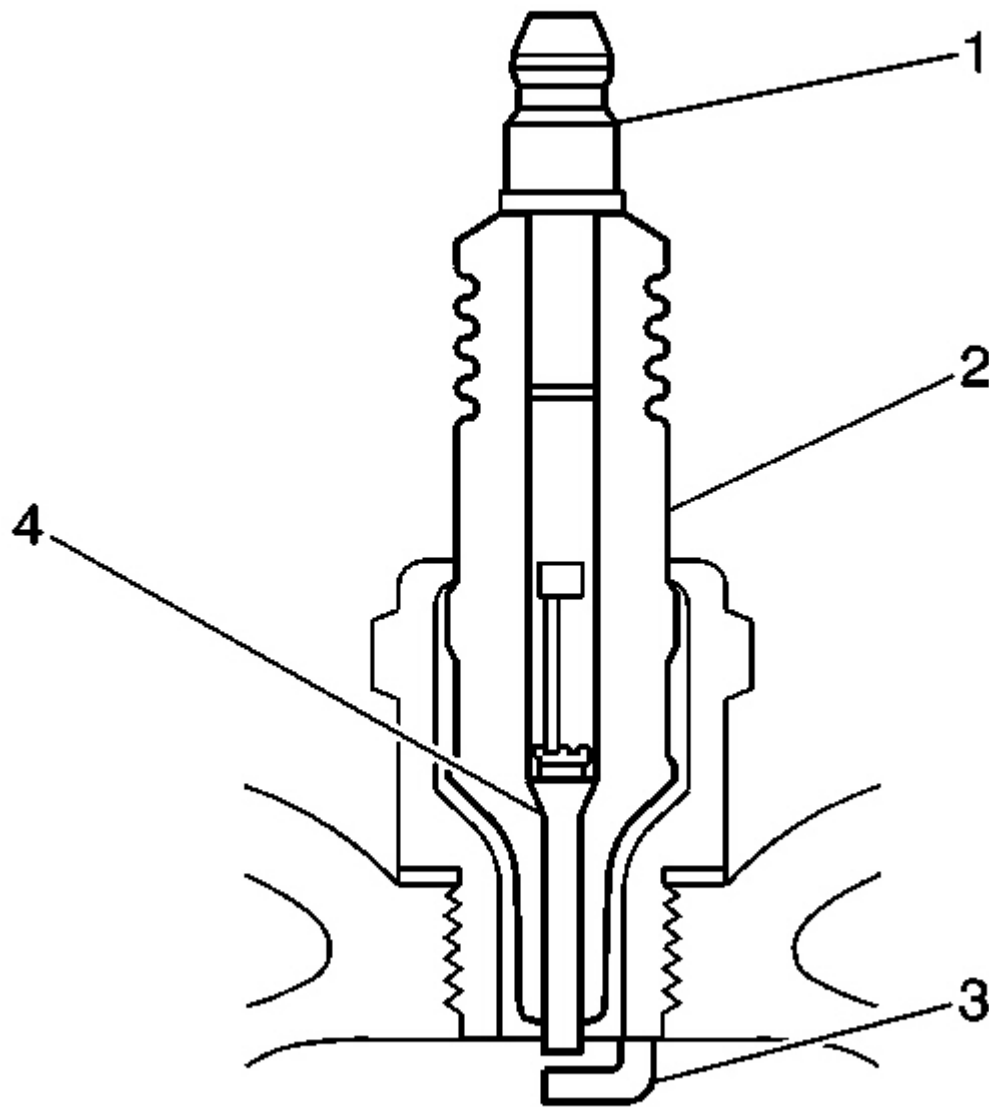


Fig. 106: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS CORP.

- Inspect the terminal post (1) for damage.
 - Inspect for a bent or broken terminal post (1).
 - Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.

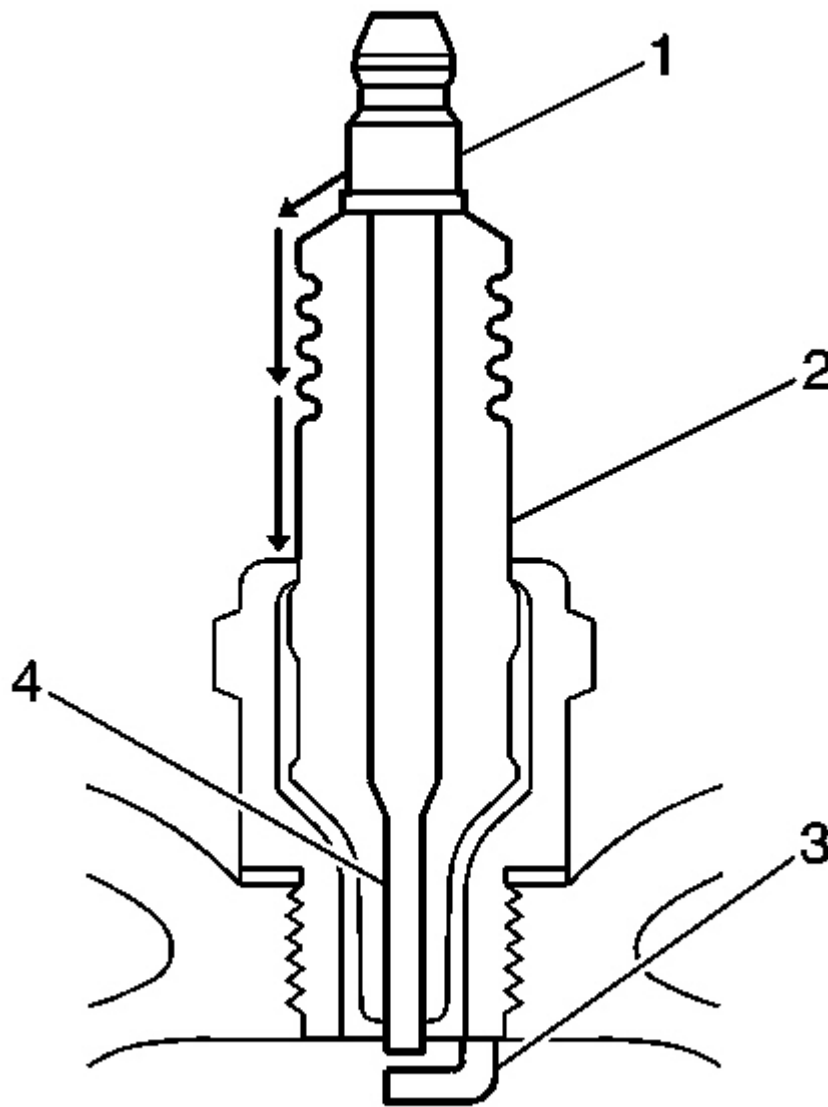


Fig. 107: Identifying Spark Plug Inspection Points
Courtesy of GENERAL MOTORS CORP.

- Inspect the insulator (2) for flashover or carbon tracking, soot. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
 - Inspect the spark plug boot for damage.
 - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant, or water. A

spark plug boot that is saturated causes arcing to ground.

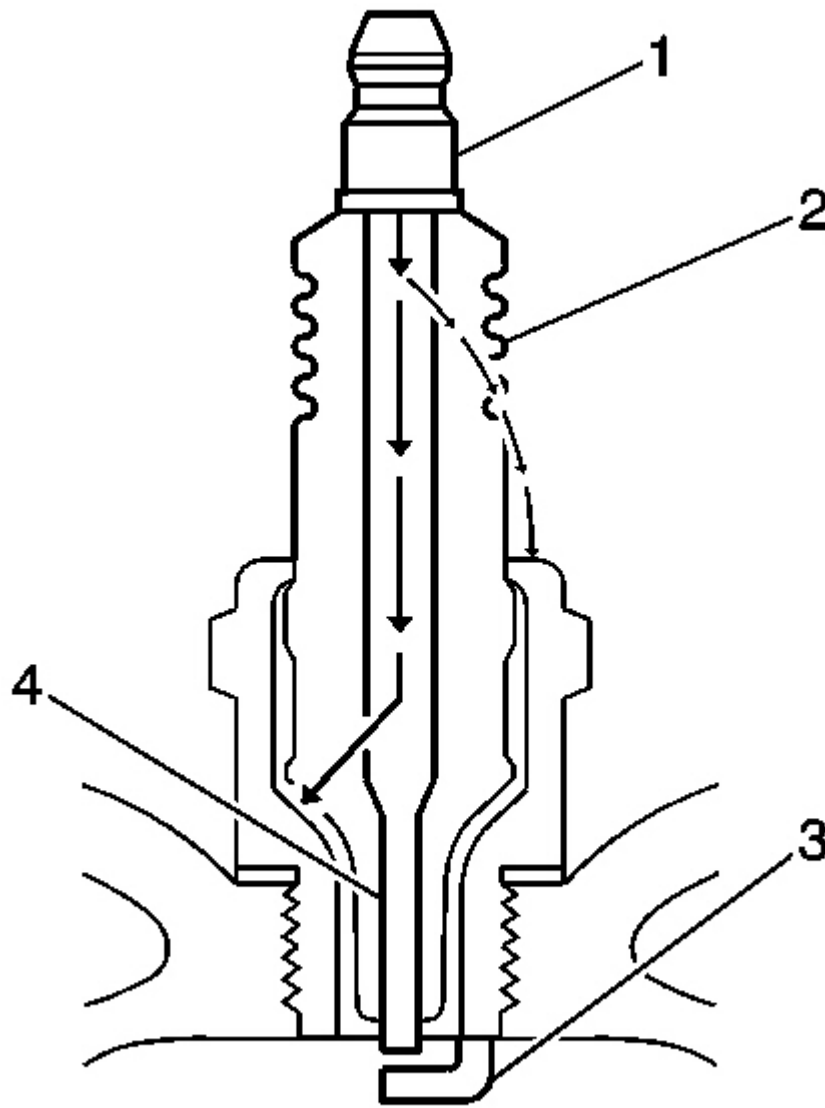


Fig. 108: Inspecting Spark Plug Insulator
Courtesy of GENERAL MOTORS CORP.

- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).

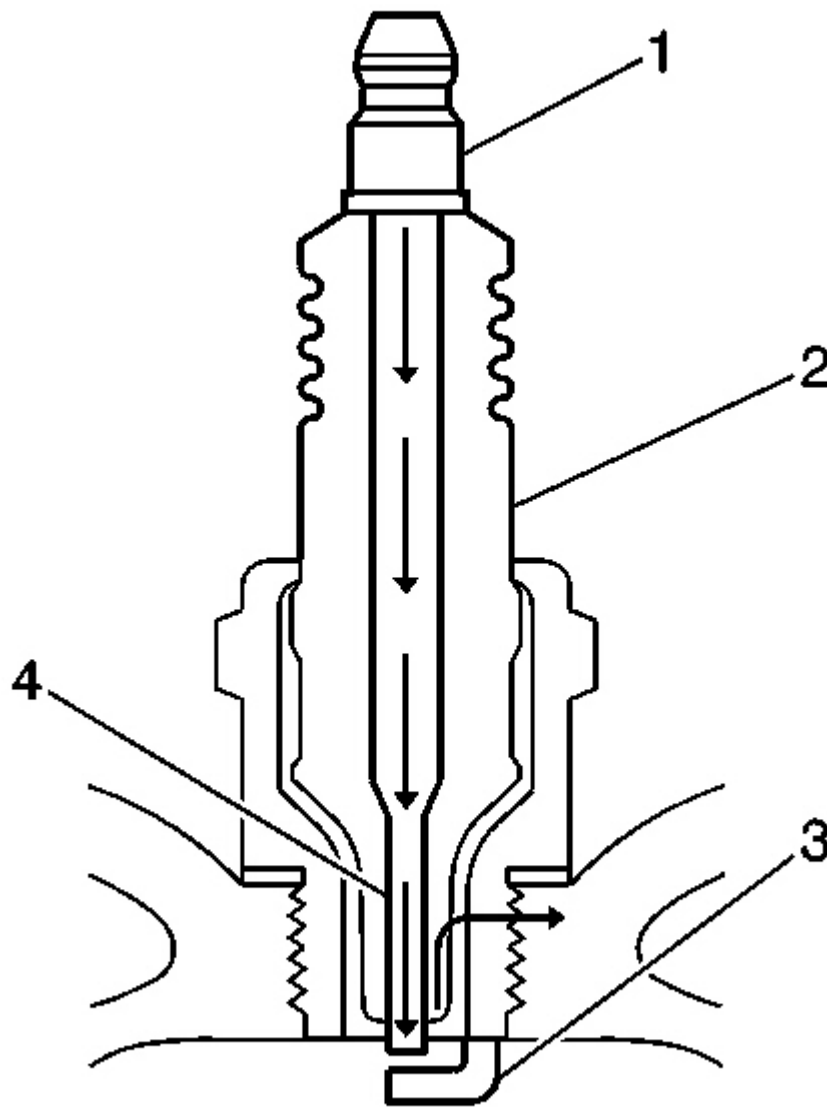


Fig. 109: Cutaway View Of Spark Plug
Courtesy of GENERAL MOTORS CORP.

- Inspect for evidence of improper arcing.
 - Measure the gap between the center electrode (4) and the side electrode (3) terminals. Refer to **Ignition System Specifications** . An excessively wide electrode gap can prevent correct spark plug operation.
 - Inspect for the correct spark plug torque. Refer to **Ignition System Specifications** . Insufficient

torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.

- Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
- Inspect for a broken or worn side electrode (3).
- Inspect for a broken, worn, or loose center electrode (4) by shaking the spark plug.
 - A rattling sound indicates internal damage.
 - A loose center electrode (4) reduces the spark intensity.
- Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
- Inspect for worn or missing platinum pads on the electrodes (3, 4), if equipped.
- Inspect for excessive fouling.
- Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

- Normal operation-Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
- Carbon fouled-Dry, fluffy, black carbon or soot caused by the following conditions:
 - Rich fuel mixtures
 - Leaking fuel injectors
 - Excessive fuel pressure
 - Restricted air filter element
 - Incorrect combustion
 - Reduced ignition system voltage output
 - Weak coils
 - Worn ignition wires
 - Incorrect spark plug gap
 - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit fouling-Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

SPARK PLUG REPLACEMENT

Removal Procedure

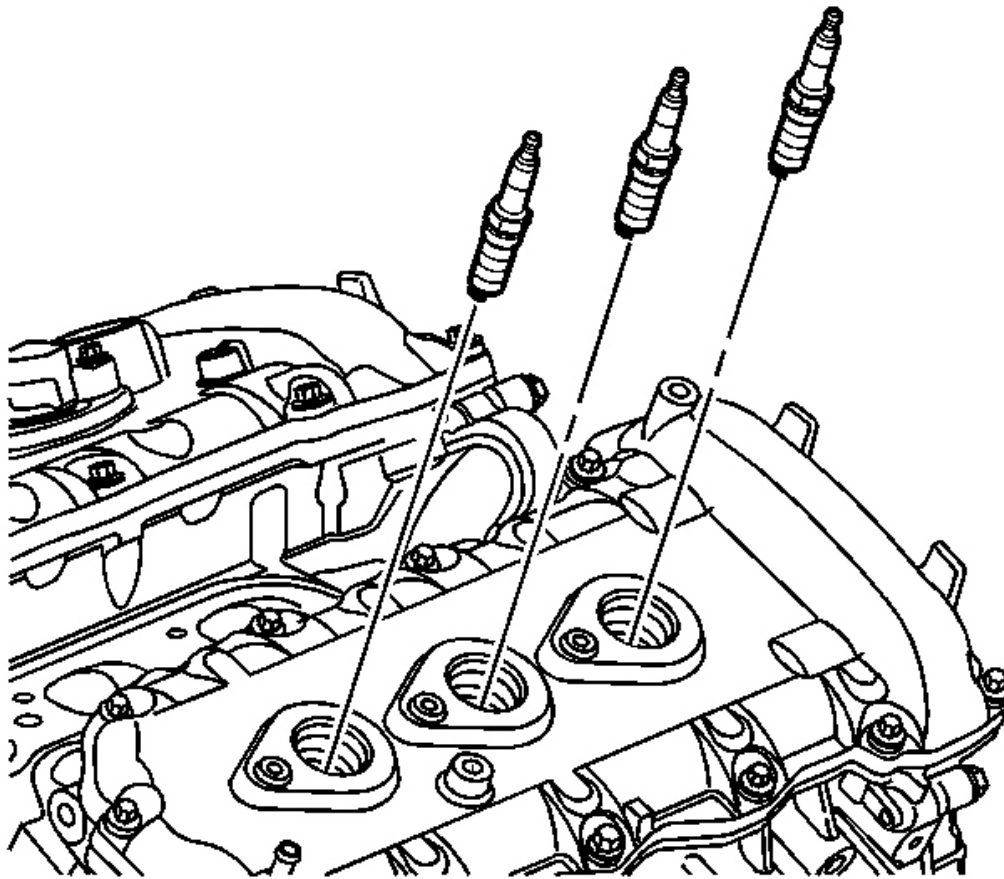


Fig. 110: View Of Spark Plugs

Courtesy of GENERAL MOTORS CORP.

1. Remove the ignition coil(s). Refer to **Ignition Coil Replacement - Bank 1** and/or **Ignition Coil Replacement - Bank 2**.

WARNING: Refer to **Safety Glasses and Compressed Air Warning** .

CAUTION: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

2. Use compressed air in order to remove debris from the spark plug cavity.

CAUTION: Allow the engine to cool before removing the spark plugs. Attempting to remove the spark plugs from a hot engine may cause the plug threads to seize, causing damage to cylinder head threads.

3. Remove the spark plug.

Installation Procedure

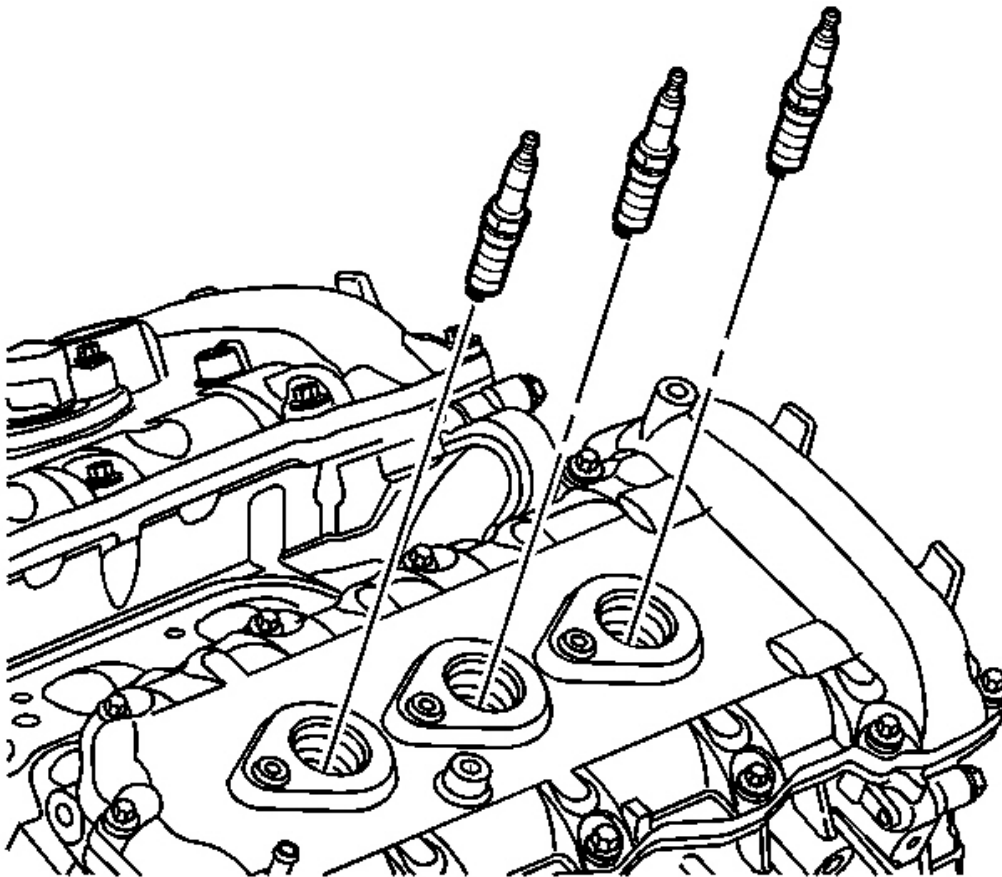


Fig. 111: View Of Spark Plugs

Courtesy of GENERAL MOTORS CORP.

CAUTION: Use only the spark plugs specified for use in the vehicle. Do not install spark plugs that are either hotter or colder than those

specified for the vehicle. Installing spark plugs of another type can severely damage the engine.

CAUTION: Check the gap of all new and reconditioned spark plugs before installation. The pre-set gaps may have changed during handling. Use a round feeler gauge to ensure an accurate check. Installing the spark plugs with the wrong gap can cause poor engine performance and may even damage the engine.

1. Ensure that the spark plug gap is equivalent to the spark plug gap specification. Refer to **Ignition System Specifications** .

CAUTION: Be sure that the spark plug threads smoothly into the cylinder head and the spark plug is fully seated. Use a thread chaser, if necessary, to clean threads in the cylinder head. Cross-threading or failing to fully seat the spark plug can cause overheating of the plug, exhaust blow-by, or thread damage.

CAUTION: Refer to **Fastener Caution** .

2. Install the spark plug.

Tighten: Tighten the spark plug to 20 N.m (15 lb ft).

3. Install the ignition coil(s). Refer to **Ignition Coil Replacement - Bank 1** and/or **Ignition Coil Replacement - Bank 2**.

CRANKSHAFT POSITION SENSOR REPLACEMENT

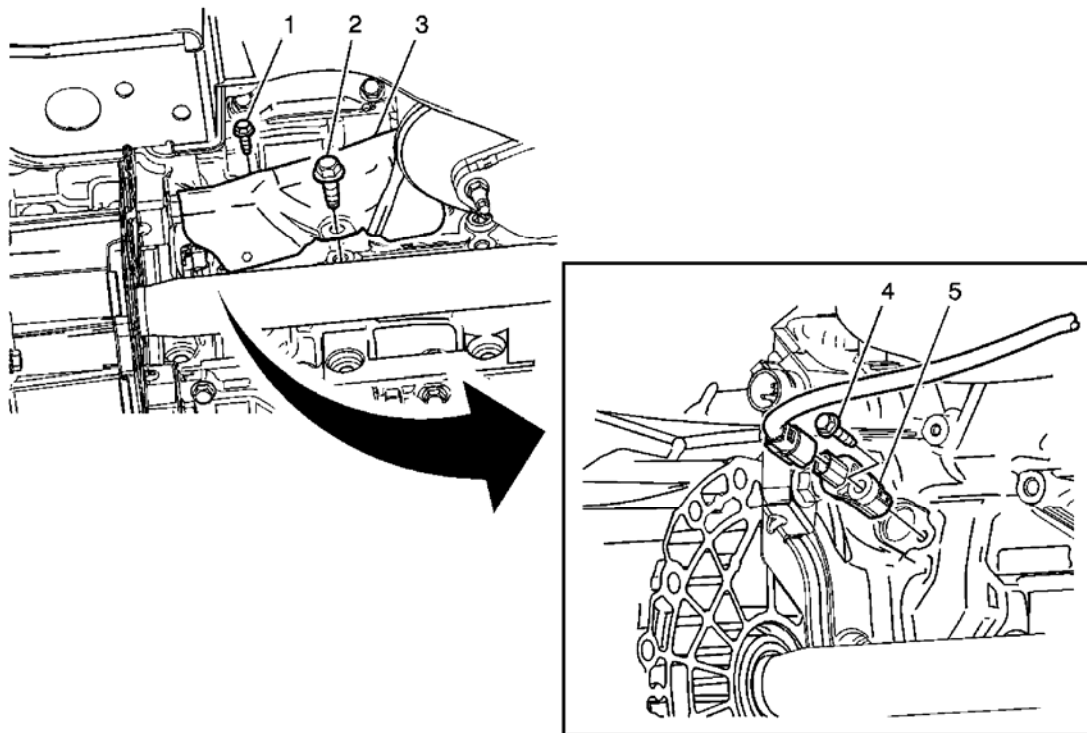


Fig. 112: Crankshaft Position Sensor
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. If equipped with AWD, remove the right side catalytic converter. Refer to <u>Catalytic Converter Replacement - Right Side (LF1)</u> . 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 9 N.m (80 lb in)
2	Bolt Tighten: 58 N.m (42 lb ft)
3	Exhaust Manifold Lower Heat Shield
4	Bolt Tighten: 10 N.m (89 lb in)
	Crankshaft Position Sensor

Procedure	
5	1. Disconnect the crankshaft position sensor harness connector. 2. If LF1, perform the crankshaft position system variation learn procedure. Refer to <u>Crankshaft Position System Variation Learn</u>

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

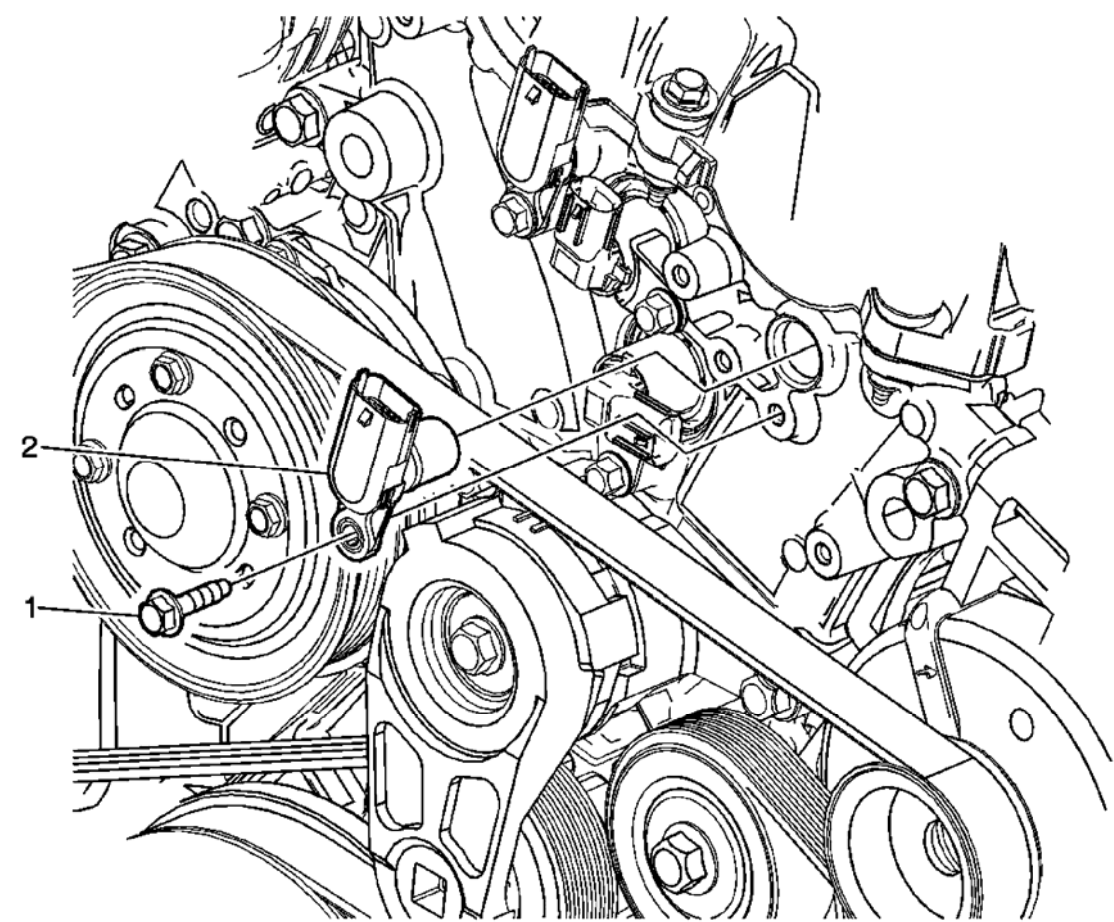


Fig. 113: Camshaft Position Sensor - Bank 2 (Left Side) Exhaust
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Right Side</u> .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> .

	Tighten: 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure: Disconnect the electrical connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

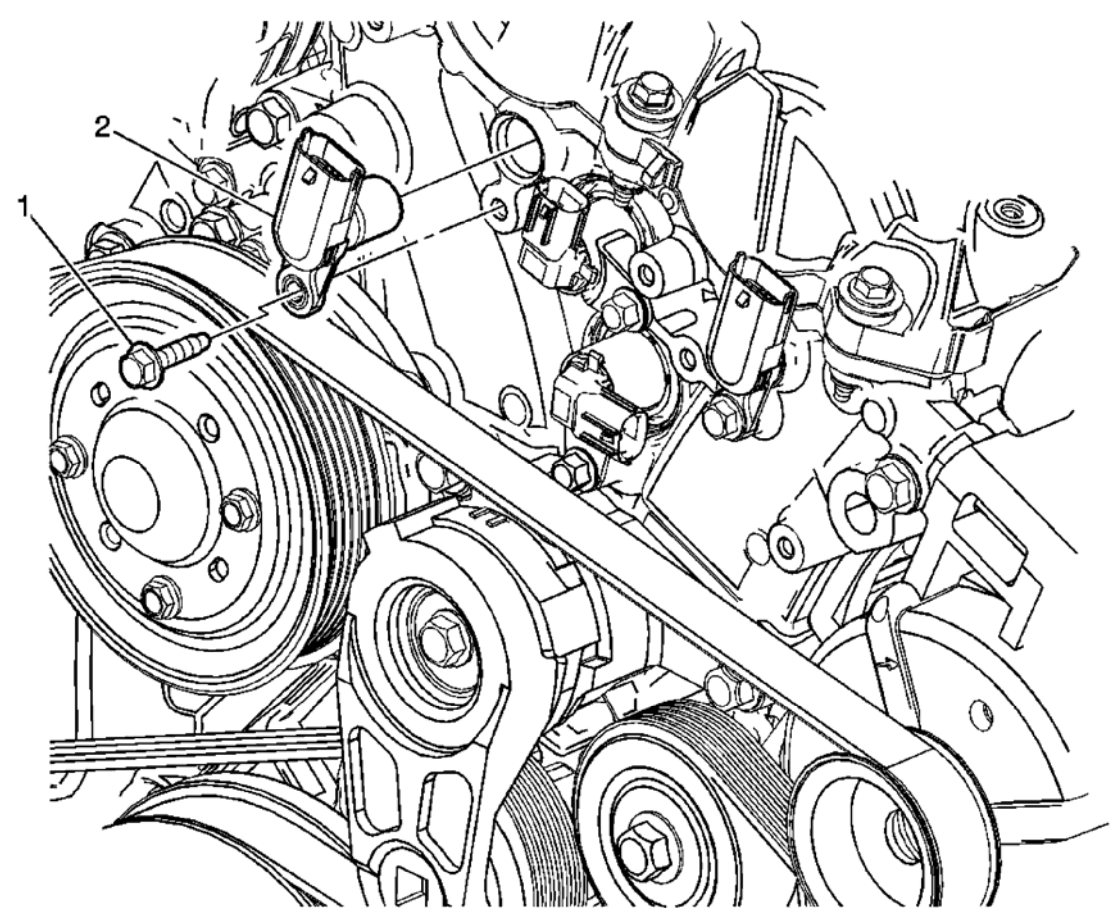


Fig. 114: Camshaft Position Sensor - Bank 2 (Left Side) Intake
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine mount bracket. Refer to Engine Mount Bracket Replacement - Right Side .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to Fastener Caution .

	Tighten: 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure: Disconnect the electrical connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

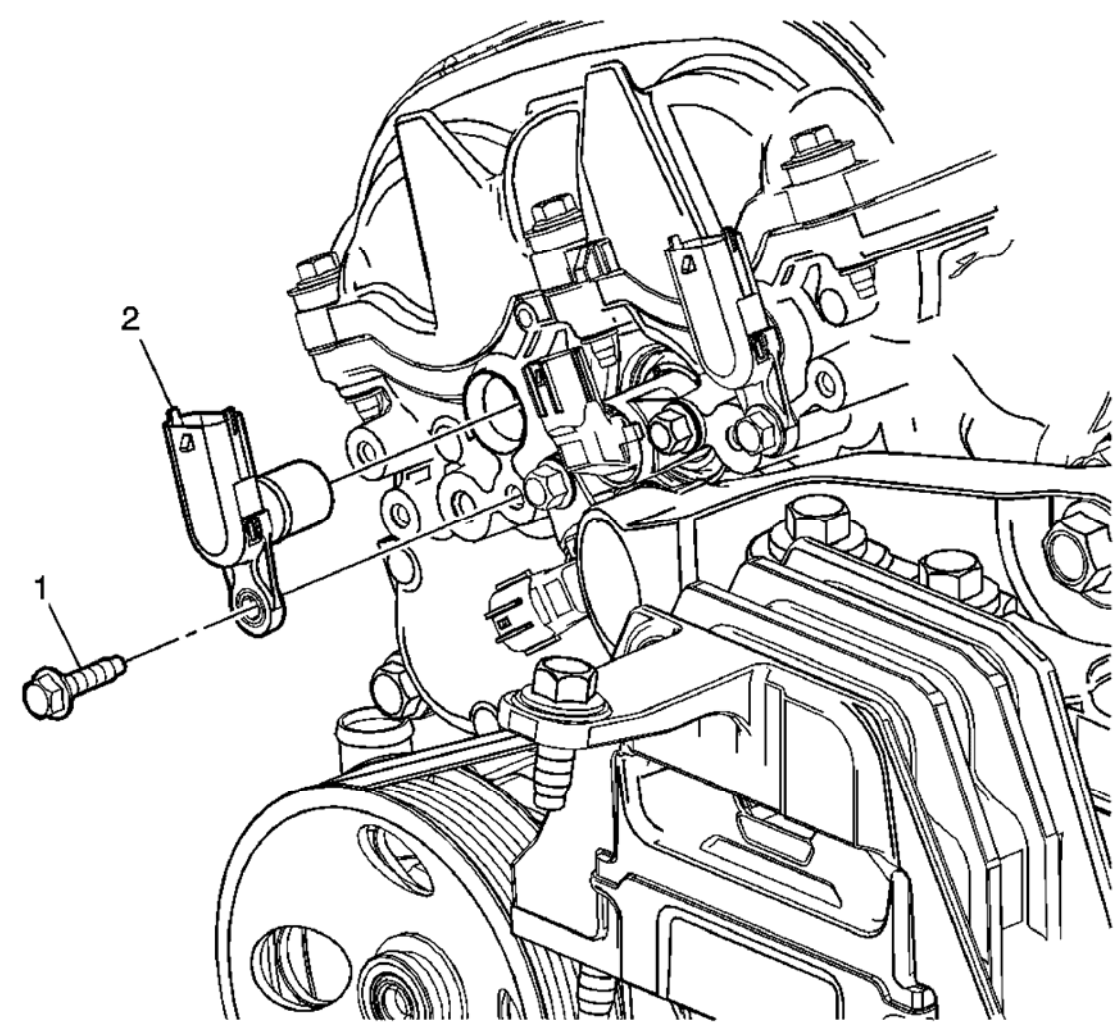


Fig. 115: Camshaft Position Sensor - Bank 1 (Right Side) Exhaust
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
	Camshaft Position Sensor Fastener
	CAUTION:

1	Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure: Disconnect the electrical connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

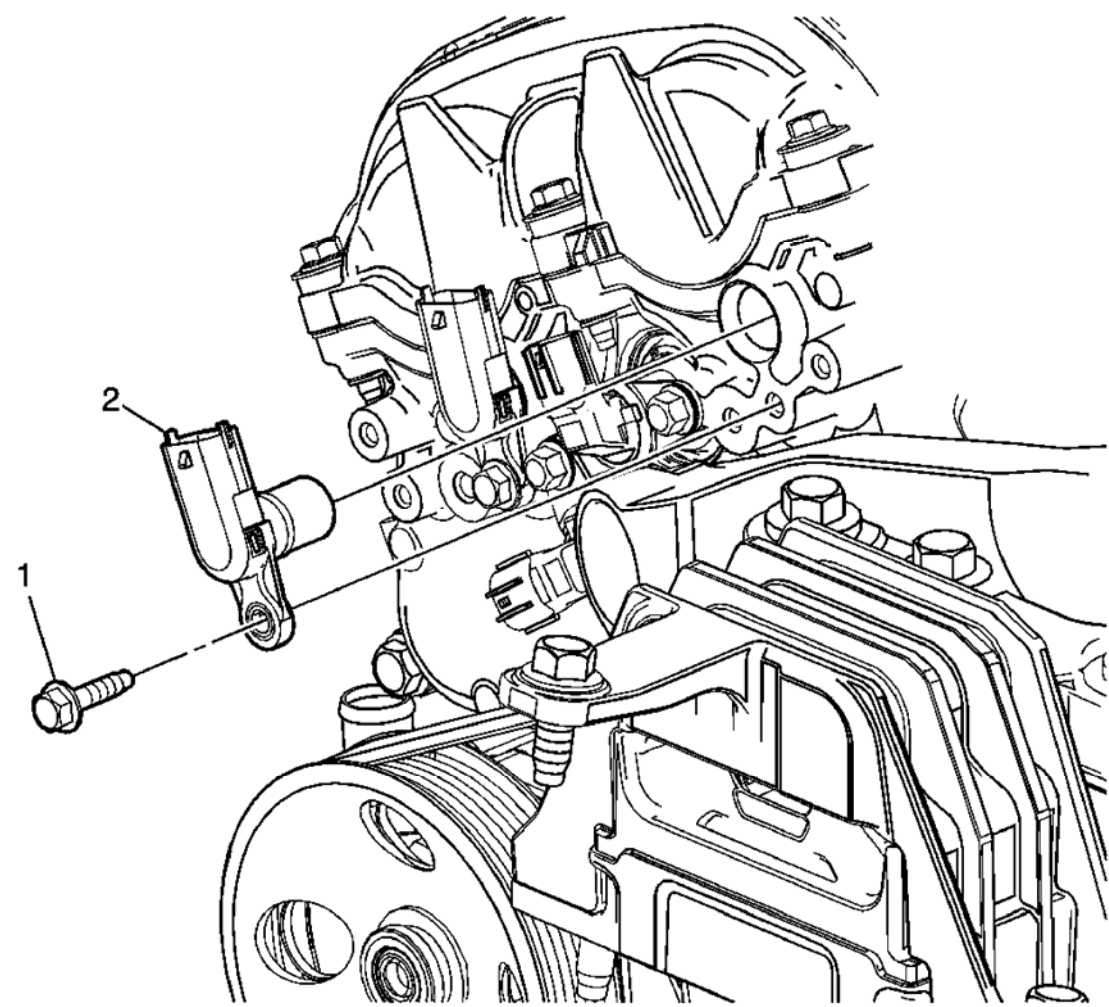


Fig. 116: Camshaft Position Sensor - Bank 1 (Right Side) Intake
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
	Camshaft Position Sensor Fastener

1	CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure: Disconnect the electrical connector.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

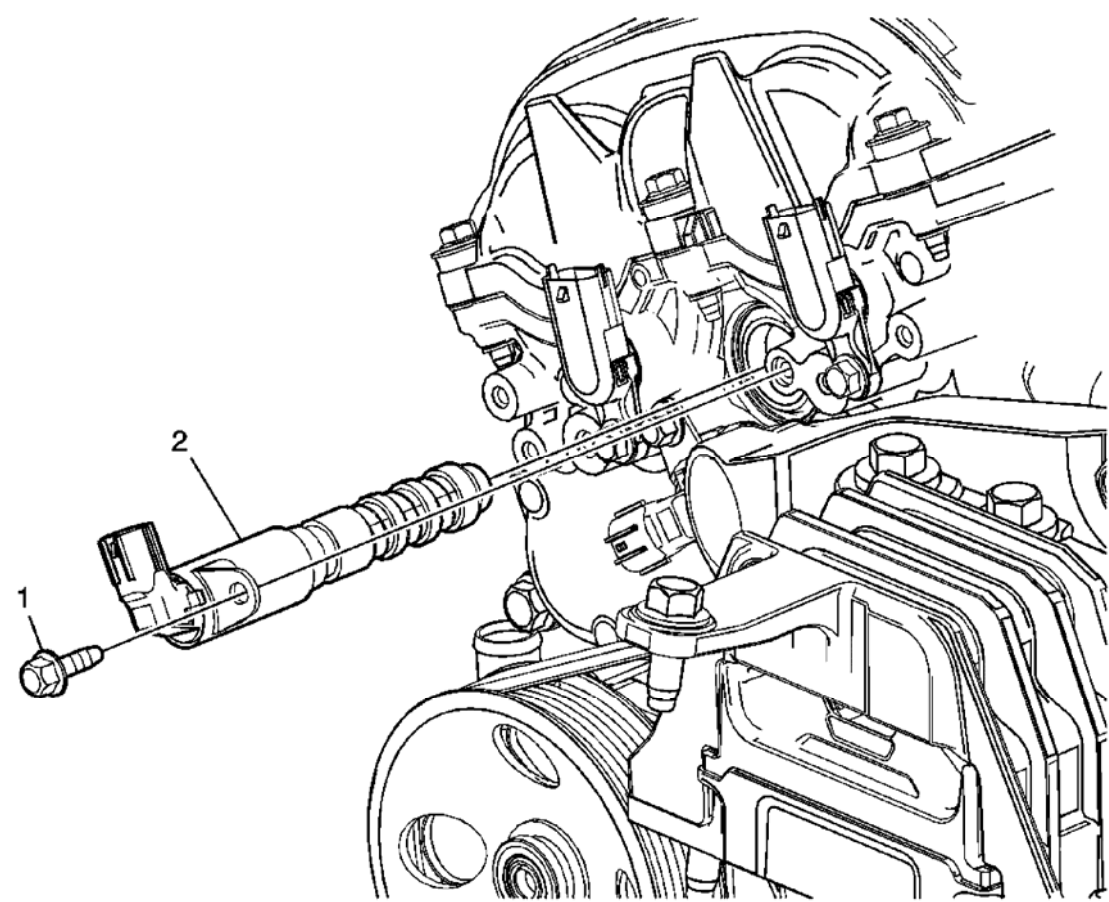


Fig. 117: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Intake
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
	Camshaft Position Actuator Solenoid Valve Fastener

1	CAUTION: Refer to <u>Fastener Caution</u> . Procedure: Disconnect the electrical connector. Tighten: 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

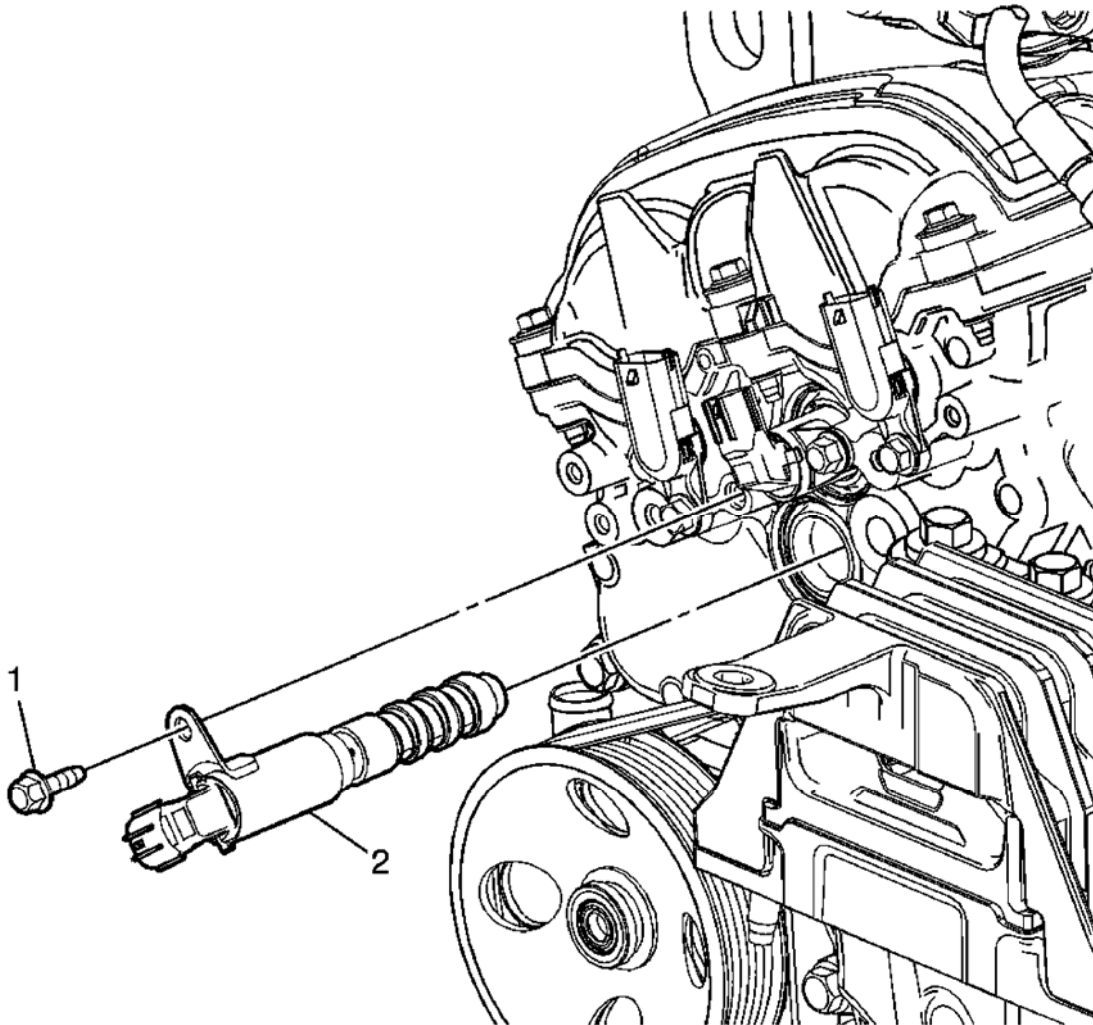


Fig. 118: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Exhaust
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner outlet duct. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure: Disconnect the electrical connector. Tighten: 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

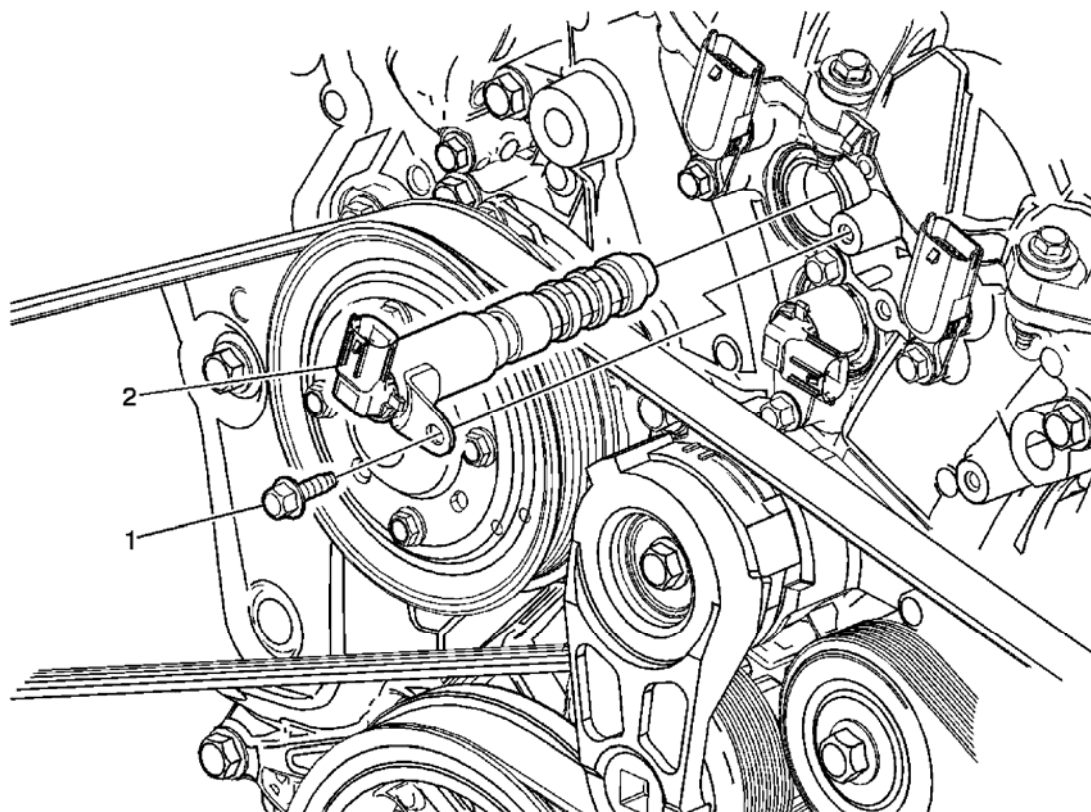


Fig. 119: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Intake
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Right Side</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Procedure: Disconnect the electrical connector. Tighten: 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

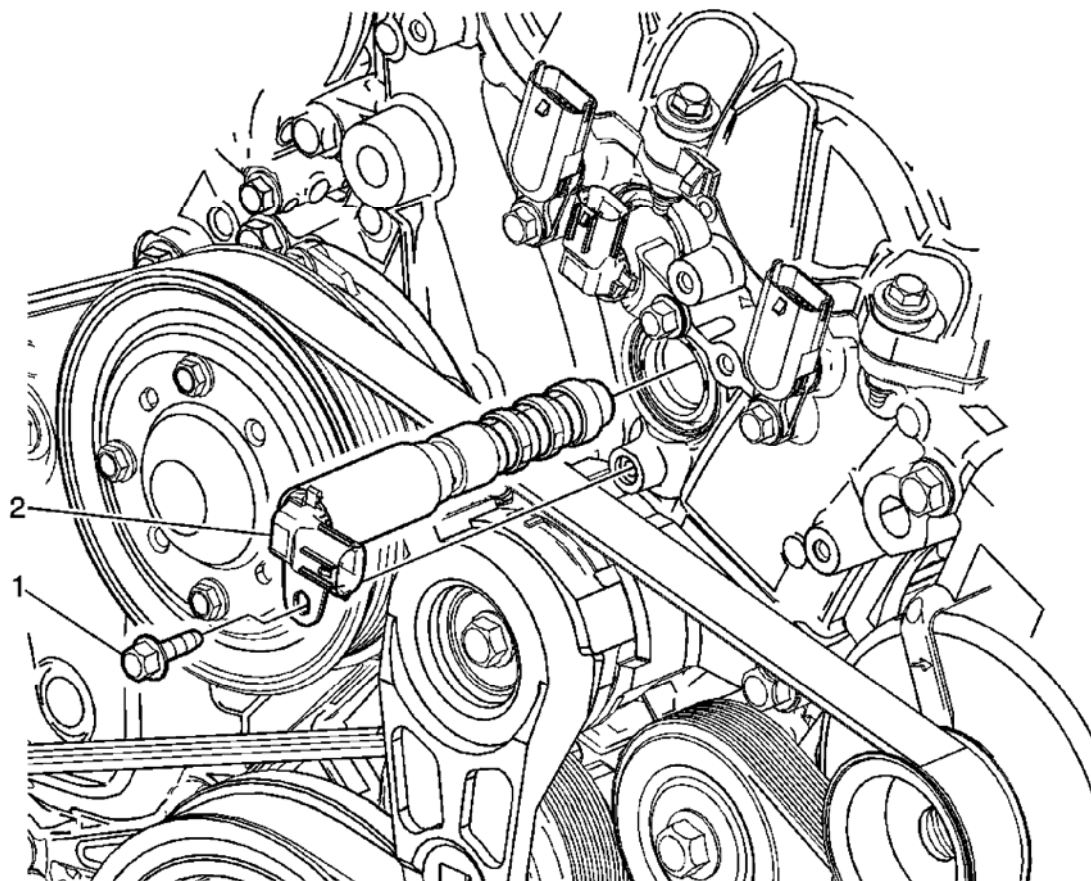


Fig. 120: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Exhaust
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine mount bracket. Refer to <u>Engine Mount Bracket Replacement - Right Side</u> .	
1	Camshaft Position Actuator Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve Procedure: Disconnect the electrical connector.

KNOCK SENSOR REPLACEMENT - BANK 1

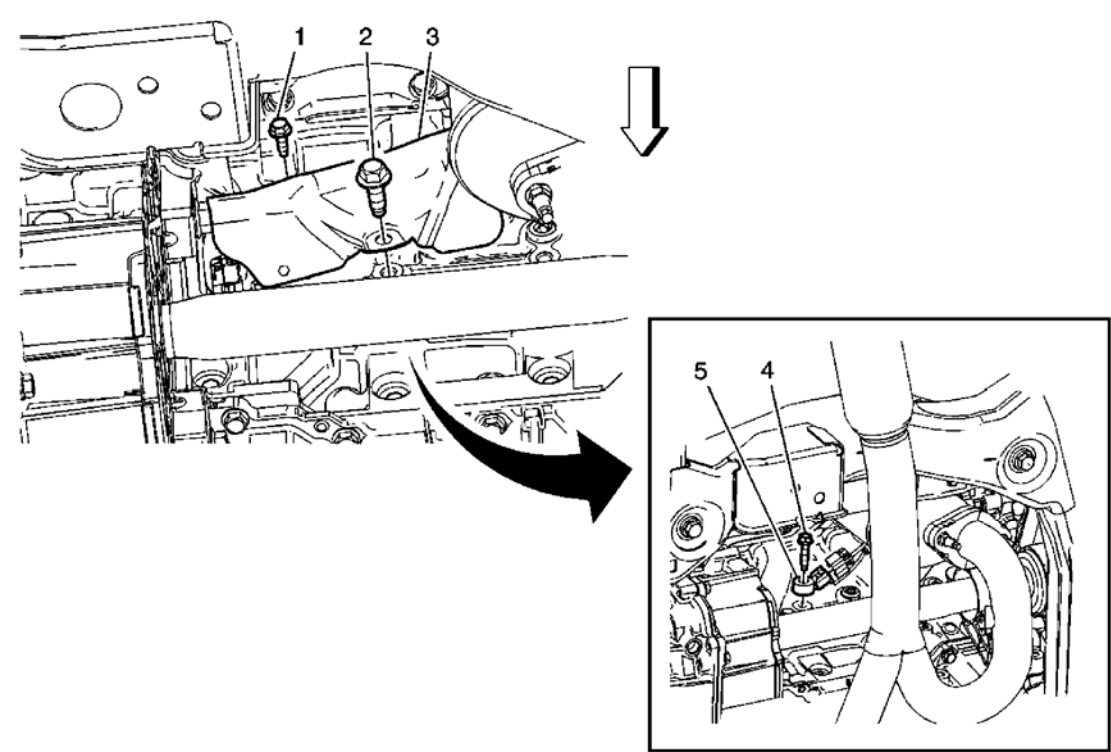


Fig. 121: Knock Sensor - Bank 1
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1.	If equipped with AWD, remove the right side catalytic converter. Refer to <u>Catalytic Converter Replacement - Right Side (LF1)</u> .

2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 25 N.m (18 lb ft)
2	Bolt Tighten: 58 N.m (42 lb ft)
3	Exhaust Manifold Lower Heat Shield
4	Bolt Tighten: 25 N.m (18 lb ft)
5	Knock Sensor Procedure: Disconnect the electrical connector.

KNOCK SENSOR REPLACEMENT - BANK 2

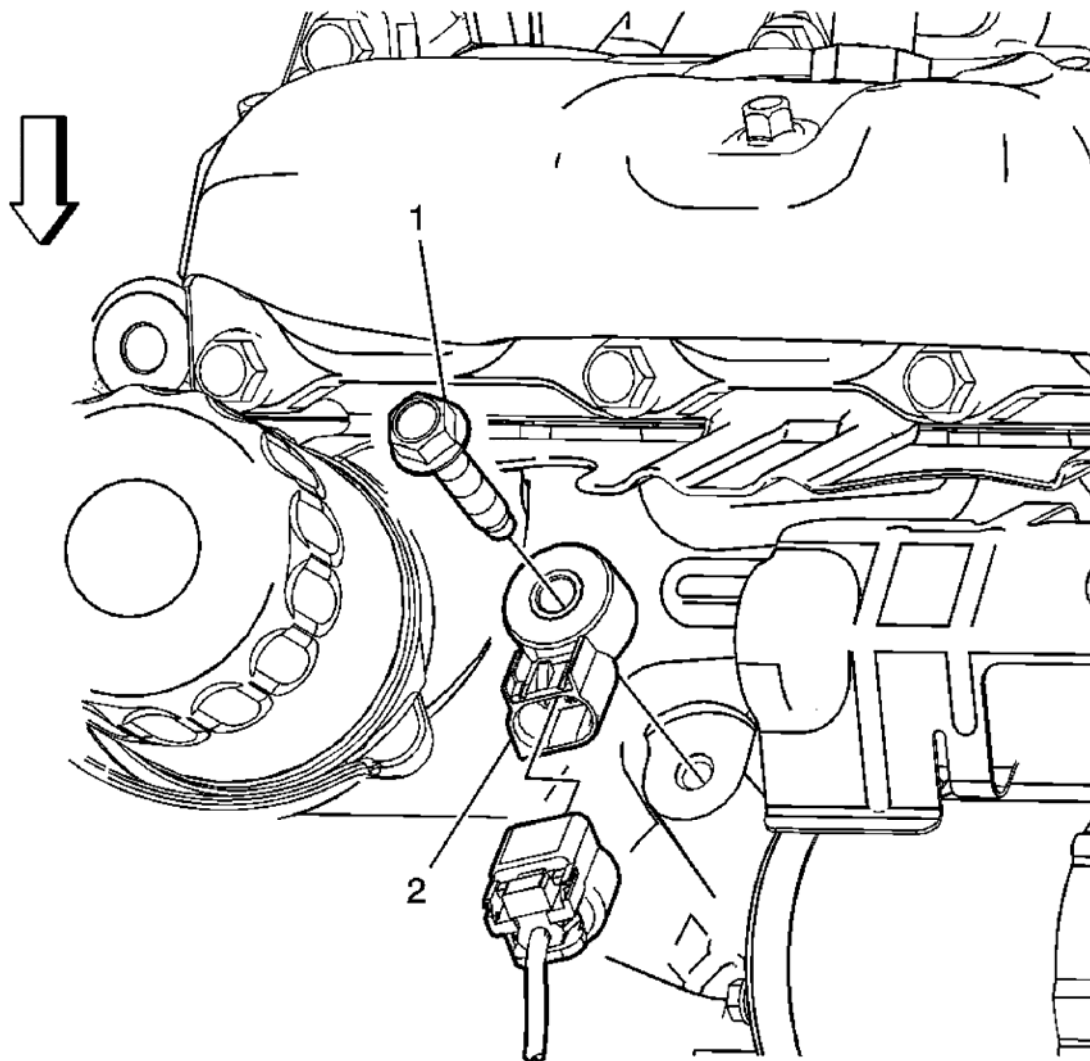


Fig. 122: Knock Sensor - Bank 2
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> .	
1	Knock Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 9 N.m (80 lb in)
2	Knock Sensor Procedure: Disconnect the electrical connector.

AIR CLEANER ELEMENT REPLACEMENT (LE5)

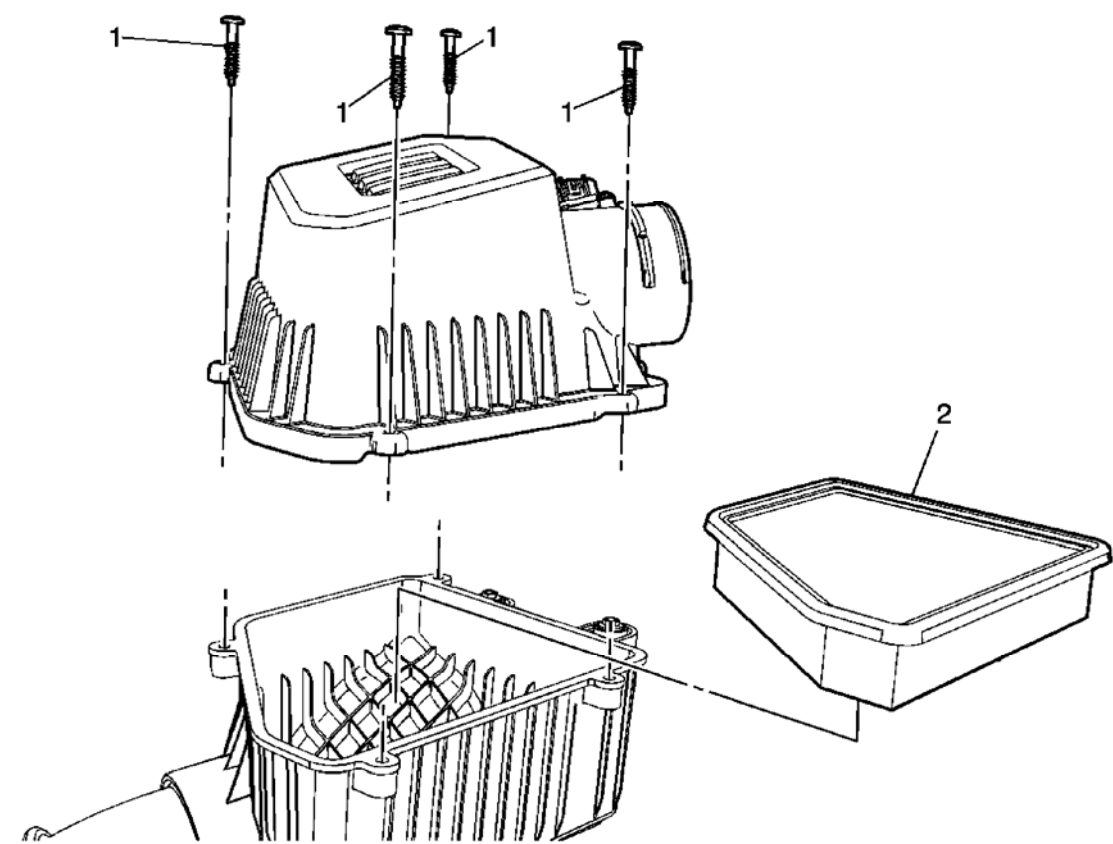


Fig. 123: Air Cleaner Element (LE5)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Disconnect the air cleaner outlet duct from the air cleaner. Refer to <u>Air Cleaner Outlet Duct Replacement</u> .	
1	Air Cleaner Fastener (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 5 N.m (44 lb in)
2	Air Cleaner Element Procedure 1. Disconnect the mass airflow with intake air temperature sensor. 2. Disconnect the throttle inlet absolute pressure sensor.

AIR CLEANER ASSEMBLY REPLACEMENT

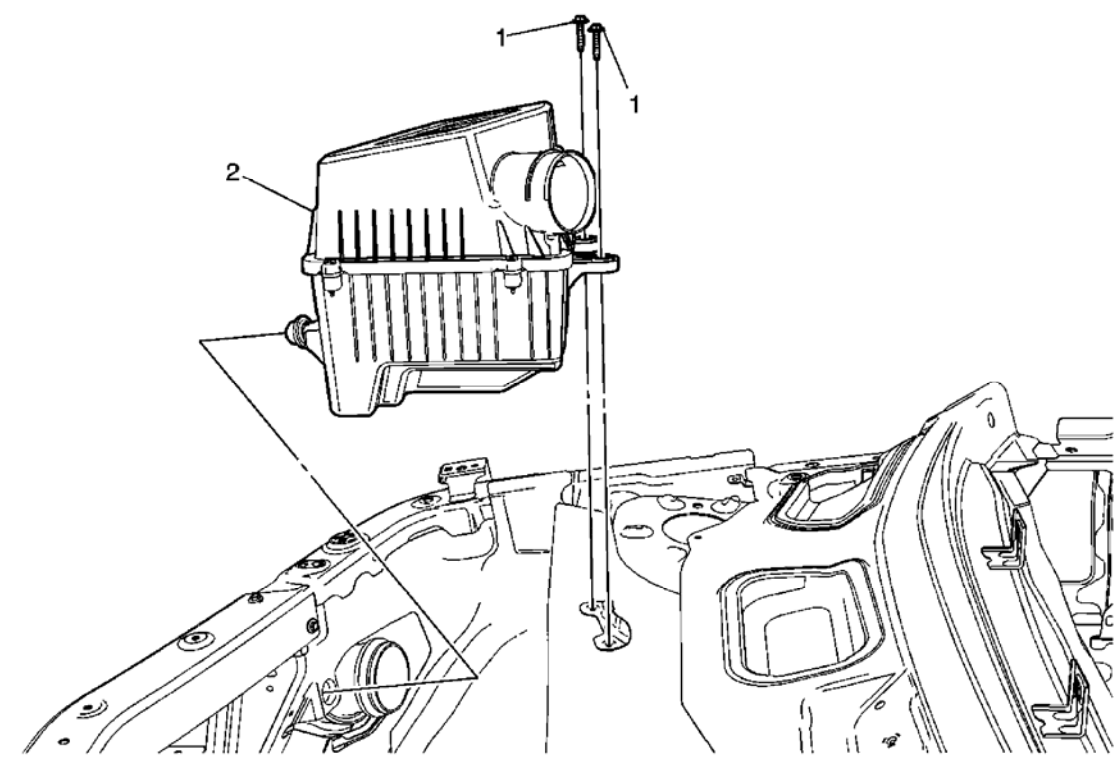


Fig. 124: Air Cleaner Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Disconnect the air cleaner outlet duct from the air cleaner assembly. Refer to <u>Air Cleaner Outlet Resonator Replacement</u> . 2. If required, remove the throttle inlet absolute pressure sensor. Refer to <u>Throttle Inlet Absolute Pressure Sensor Replacement</u>. 3. If required, remove the mass airflow sensor. Refer to <u>Mass Airflow Sensor with Intake Air Temperature Sensor Replacement</u>.	
1	Air Cleaner Assembly Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> Tighten: 10 N.m (89 lb in)
2	Air Cleaner Assembly

AIR CLEANER OUTLET DUCT REPLACEMENT

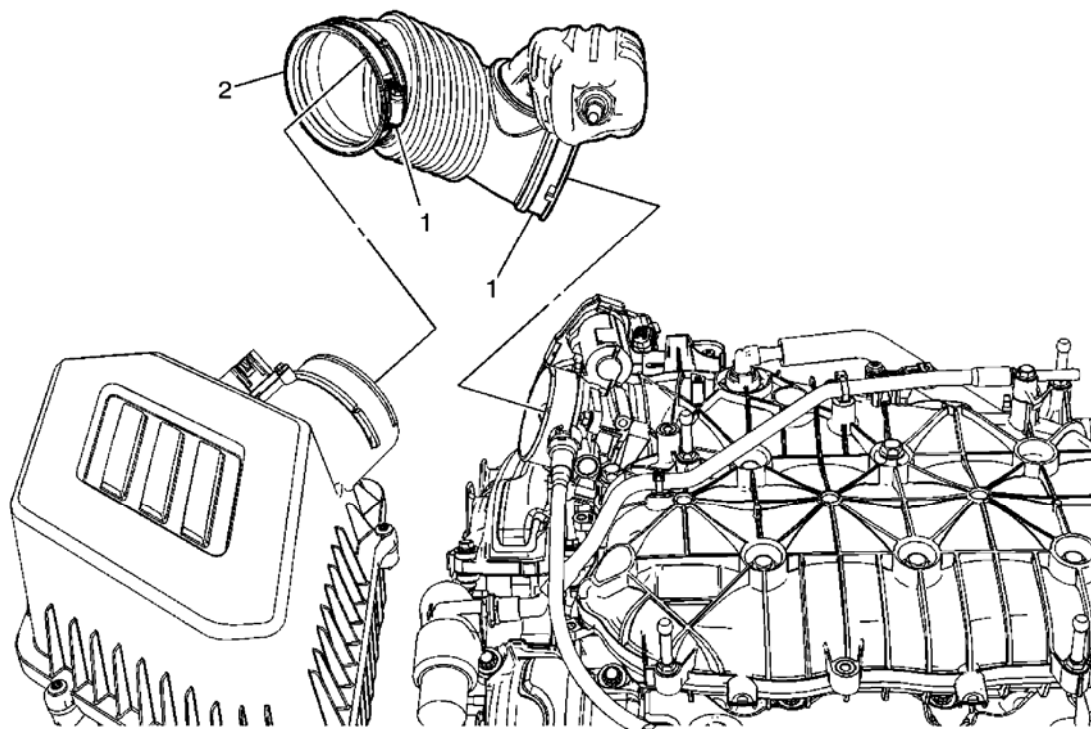


Fig. 125: Air Cleaner Outlet Duct

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Disconnect the front positive crankcase ventilation tube. Refer to <u>Positive Crankcase Ventilation Tube Replacement - Front</u> .	
1	Air Cleaner Clamp (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten: 4 N.m (35 lb in)
2	Air Cleaner Outlet Duct

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE CONTROLS SCHEMATICS

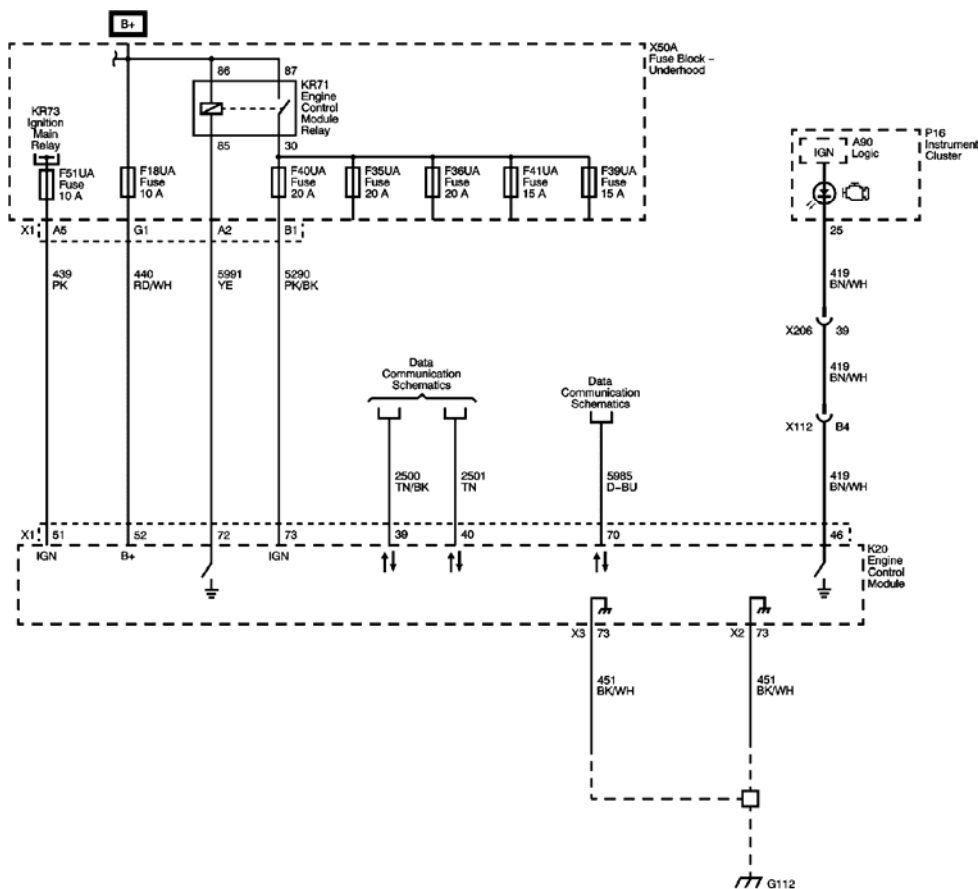


Fig. 1: Module Power, Ground Serial Data, and MIL (LF1)
Courtesy of GENERAL MOTORS CORP.

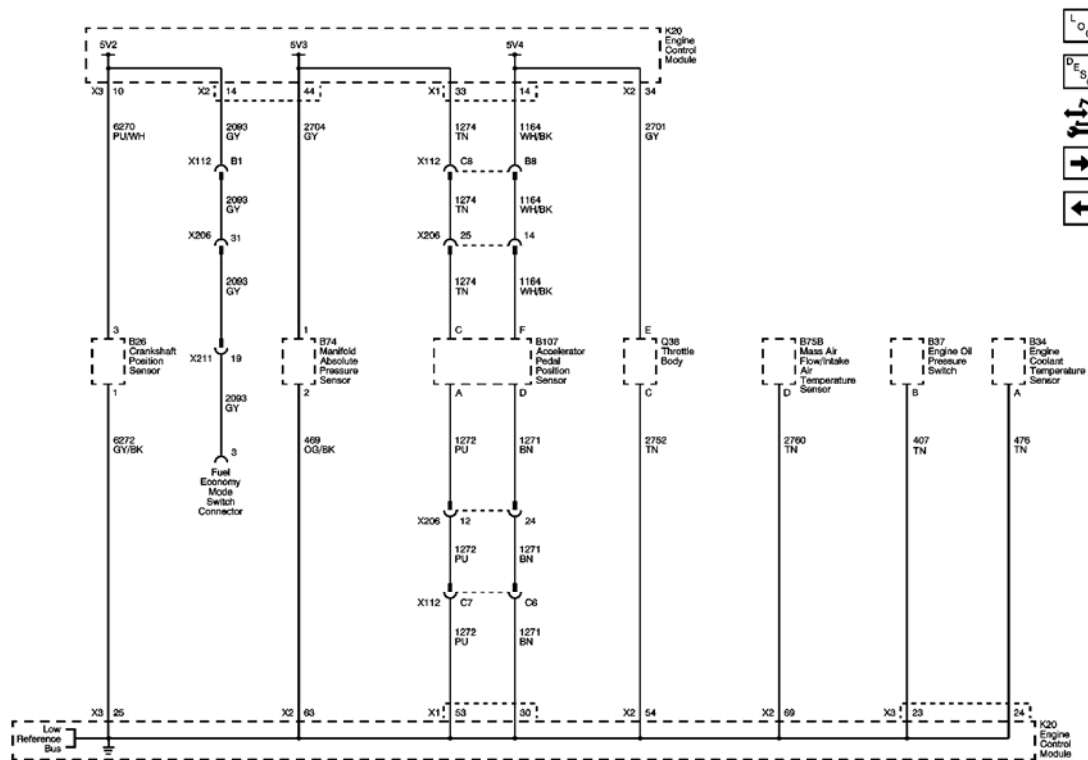


Fig. 3: 5V2, 5V3, 5V4, and Low Reference Bus (LF1)
Courtesy of GENERAL MOTORS CORP.

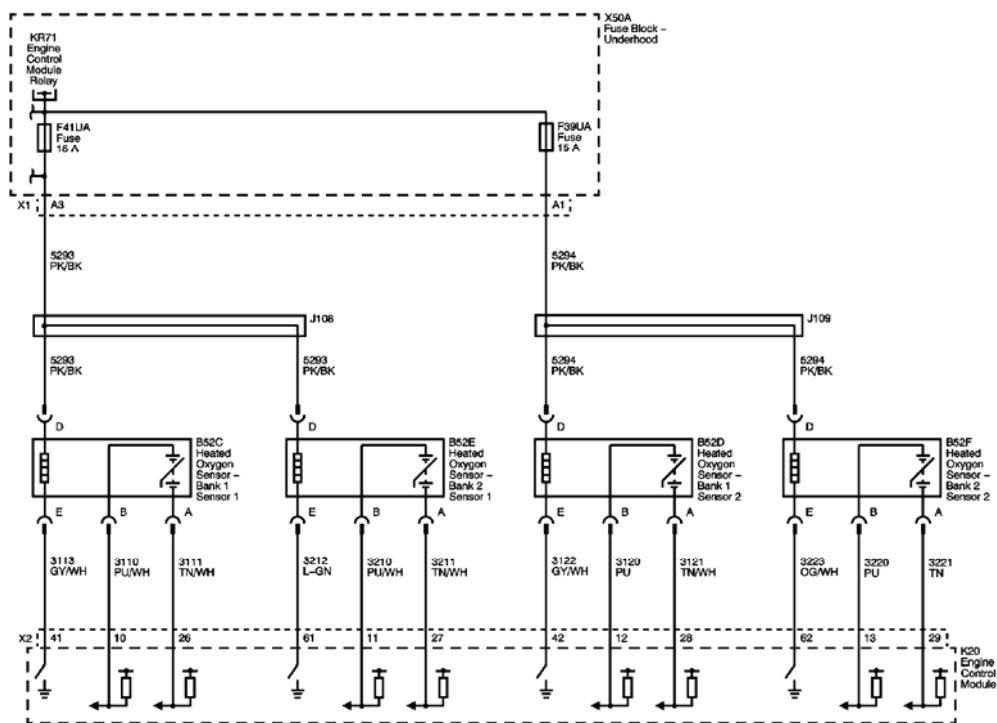


Fig. 5: Engine Data Sensors - Oxygen Sensors (LF1)
 Courtesy of GENERAL MOTORS CORP.

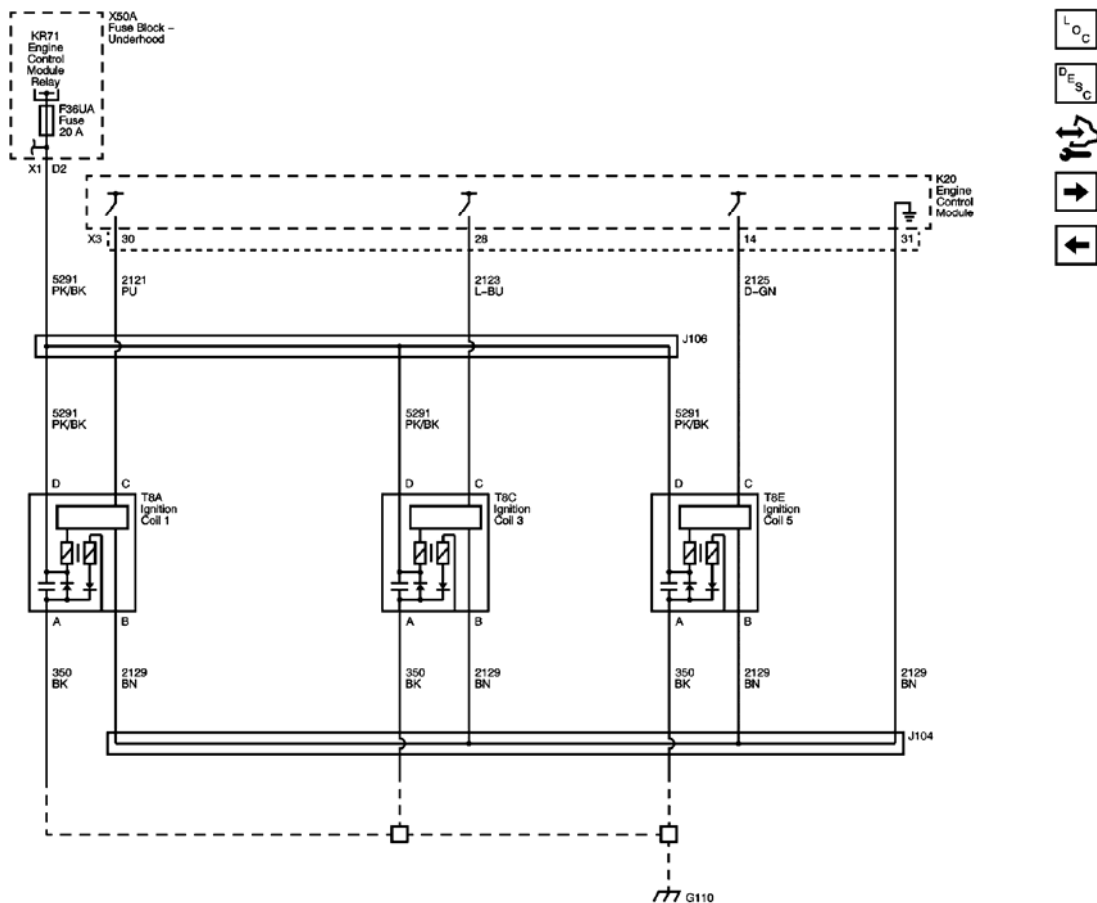


Fig. 6: Ignition Controls - Bank 1 Ignition System (LF1)
 Courtesy of GENERAL MOTORS CORP.

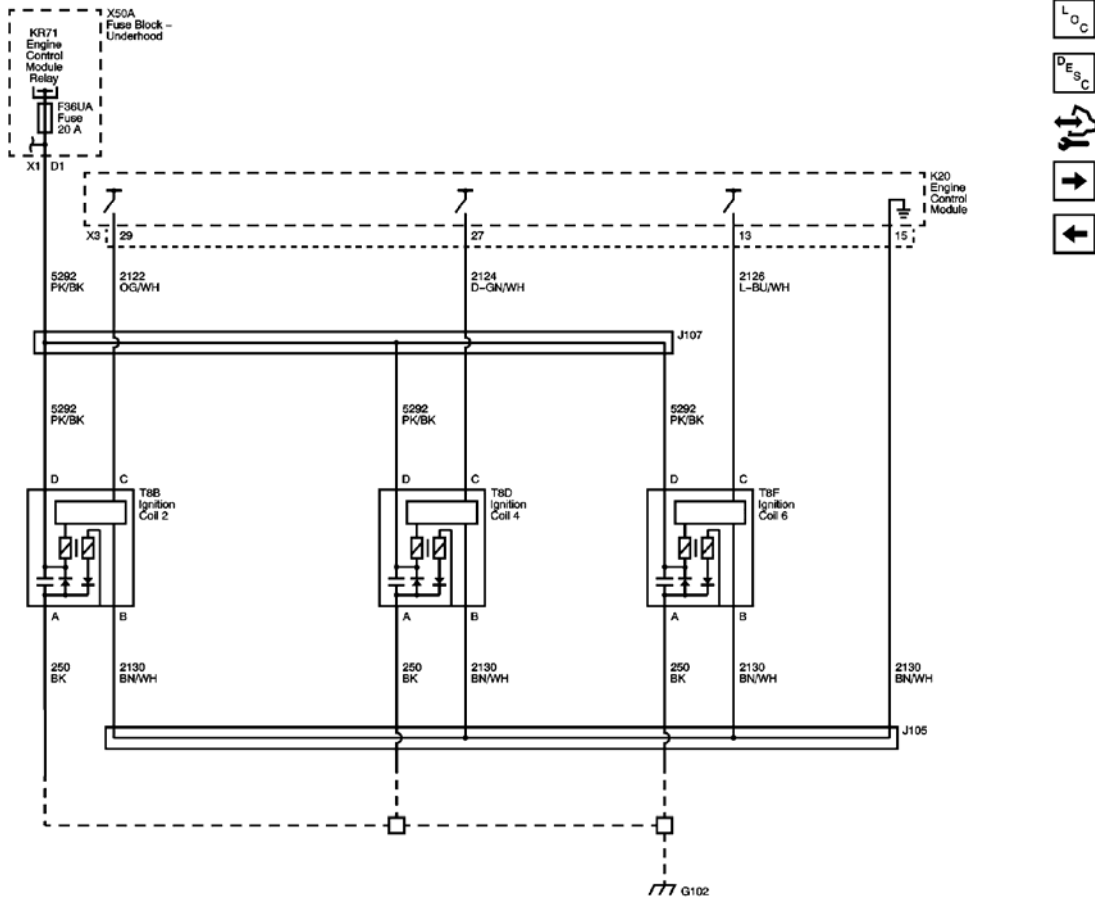


Fig. 7: Ignition Controls - Bank 2 Ignition System (LF1)
 Courtesy of GENERAL MOTORS CORP.

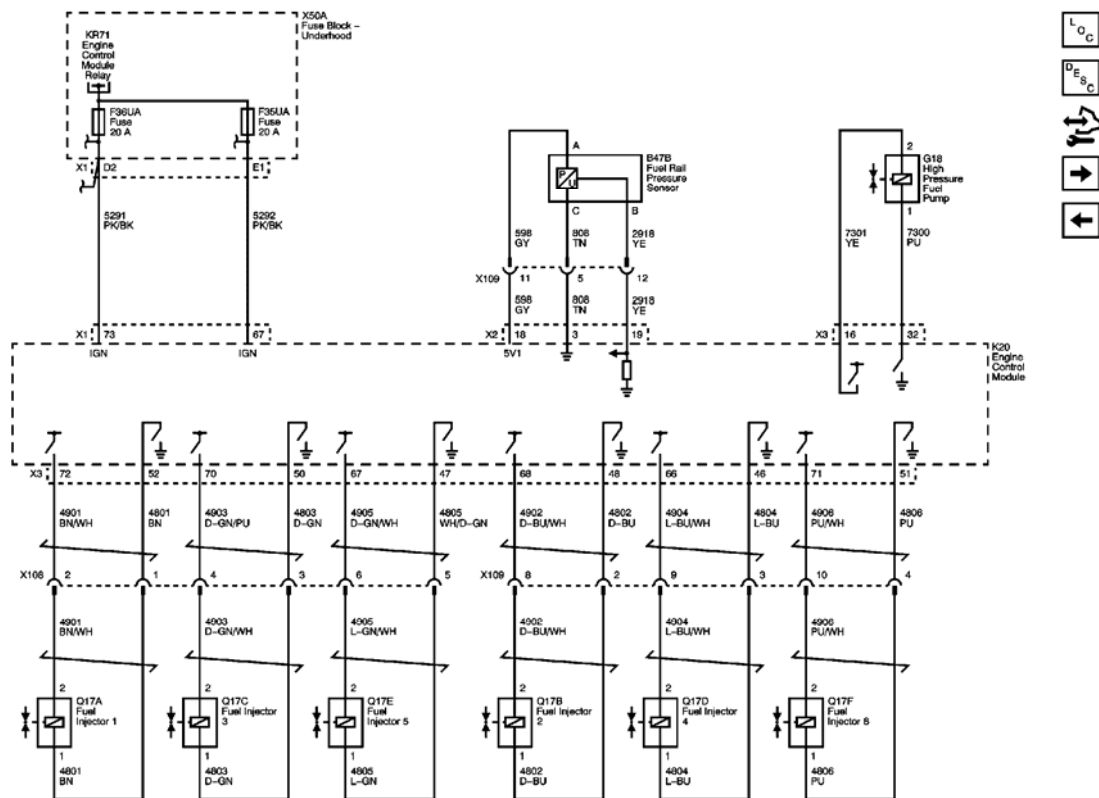


Fig. 9: Fuel Controls - Fuel Injectors, Fuel Rail Pressure Sensor, and High Pressure Fuel Pump (LF1)
 Courtesy of GENERAL MOTORS CORP.

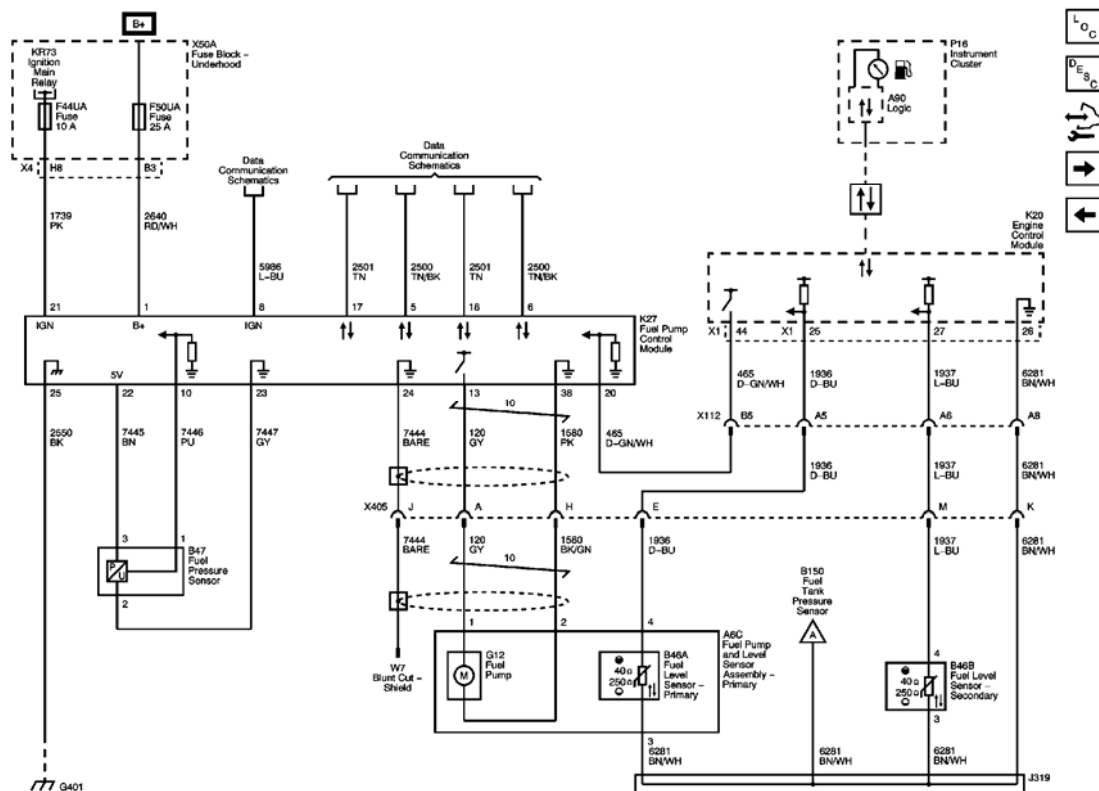


Fig. 10: Fuel Controls - Fuel Pump Control (LF1)
 Courtesy of GENERAL MOTORS CORP.

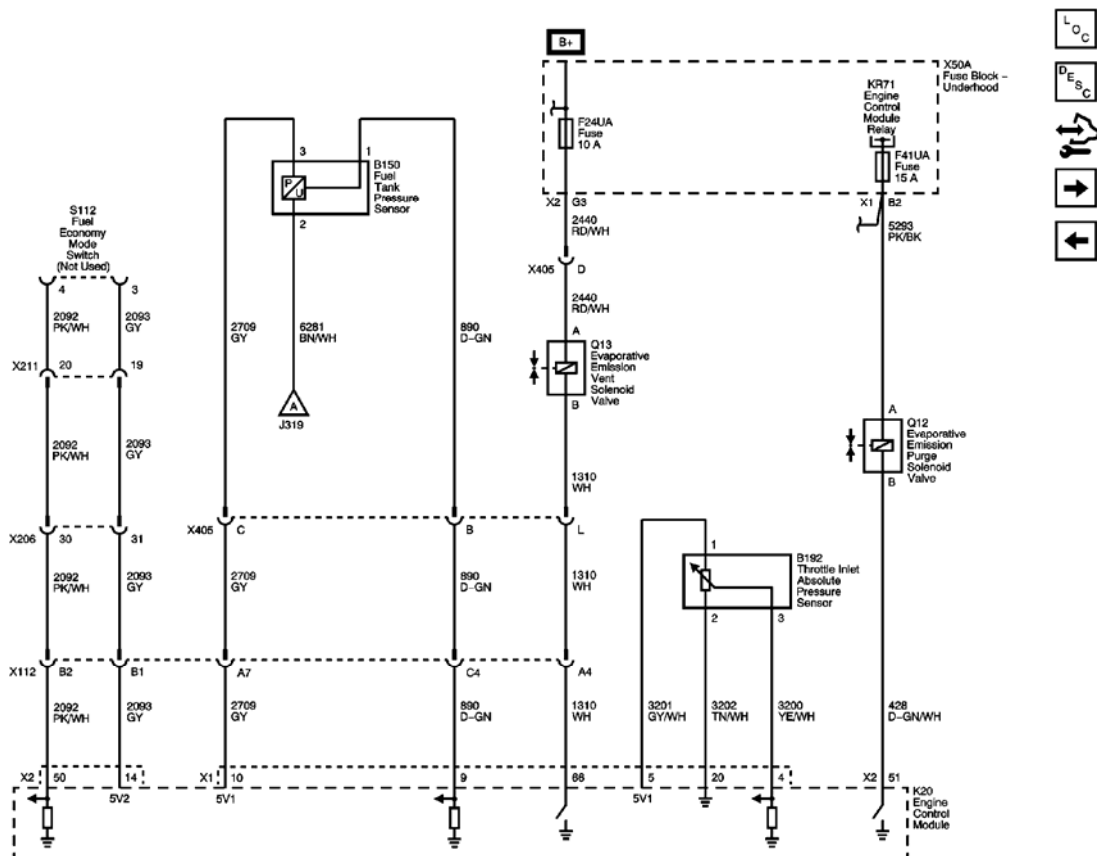


Fig. 11: Fuel Controls - EVAP Controls (LF1)
 Courtesy of GENERAL MOTORS CORP.

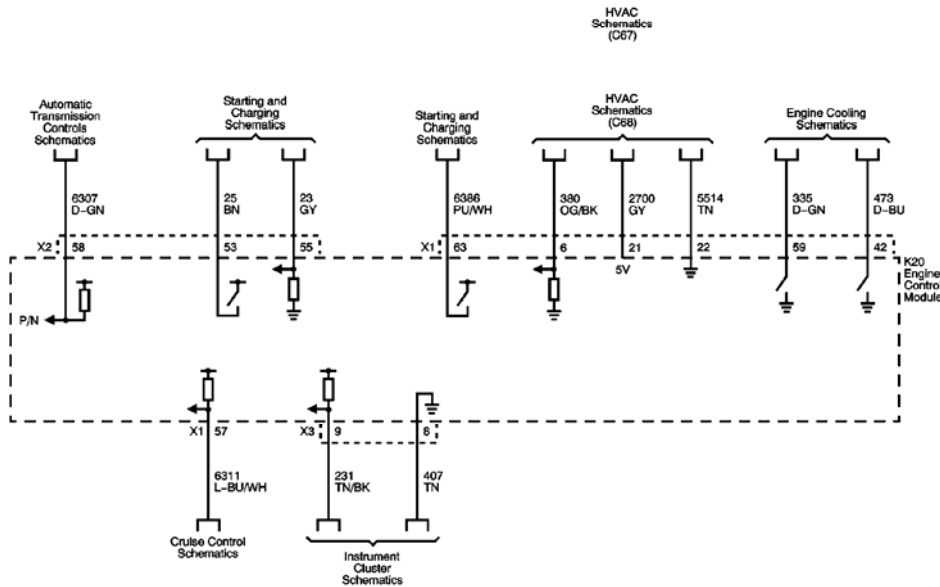


Fig. 12: Subsystem References (LF1)
 Courtesy of GENERAL MOTORS CORP.

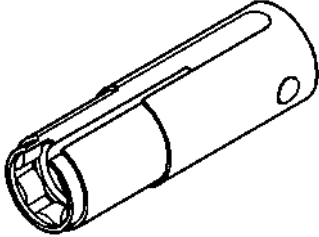
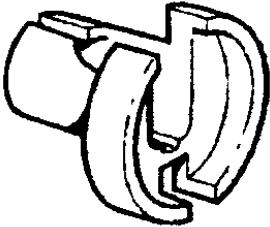
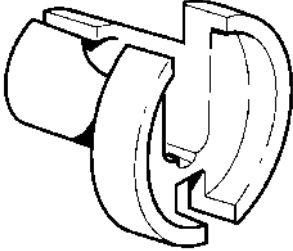
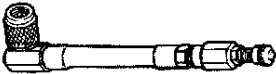


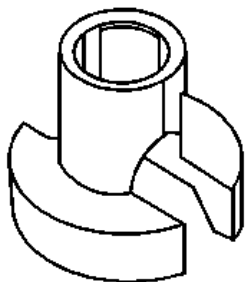
2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

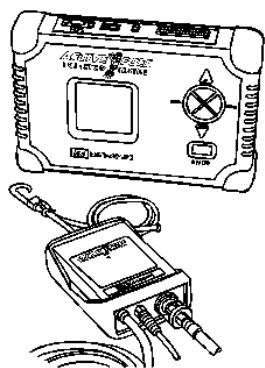
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

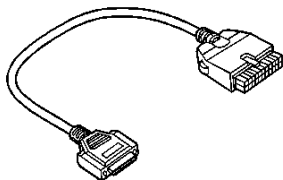
Illustration	Tool Number/Description
	CH 39194-C Oxygen Sensor Remover/Installer
	CH 41769-1 Fuel Line Quick Connect Separator 3/8
	CH 41769-2 Fuel Line Quick Connect Separator 5/16
	CH 42242 Fuel Pressure Test Hose Adapter



CH 47831
Fuel Line Disconnect Tool

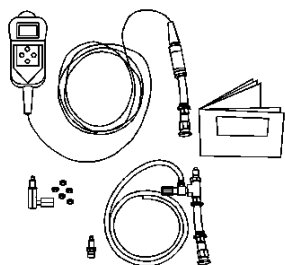
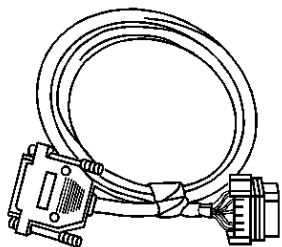


CH 47976
Active Fuel Injector Tester

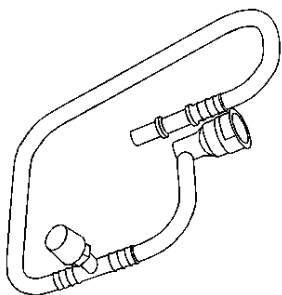


CH 47976-60
AFIT Harness Adapter

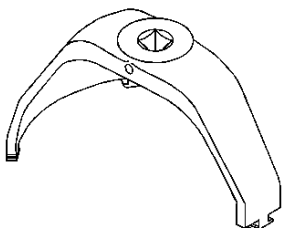
CH 47976-75
Fuel Injector Harness Adapter



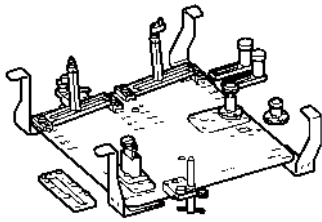
CH 48027
Digital Pressure Gauge



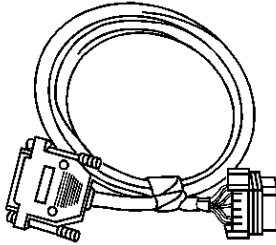
CH 48096
EVAP Service Access Port Tool



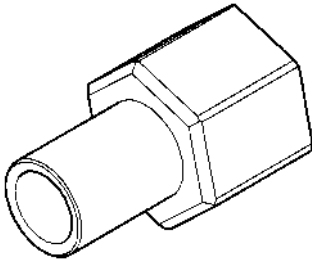
CH 48482
Fuel Sender Lock Ring Wrench



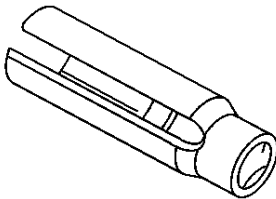
Centering Adapter Engine Subframe



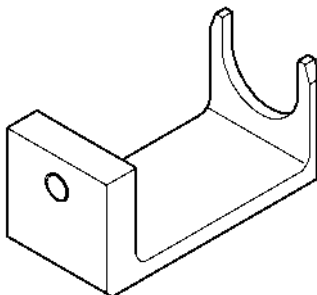
EL 39021-460
Fuel Injector Test Adapter



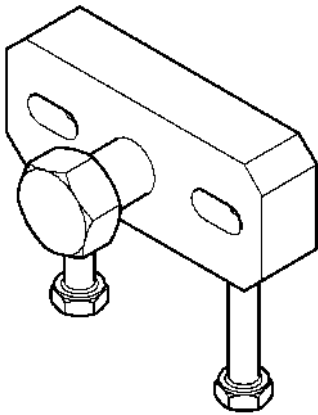
EN 32 025 012
Sliding Hammer Adapter



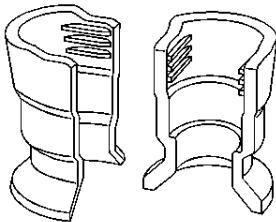
EN 46577
Oxygen Sensor Remover/Installer



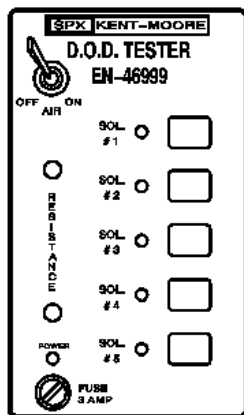
EN 46786 (32 025 013)
Injector Removal Tool



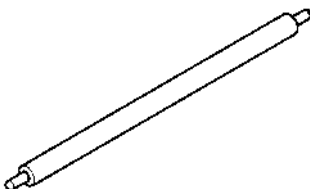
EN 46790 (32 025 005)
Puller



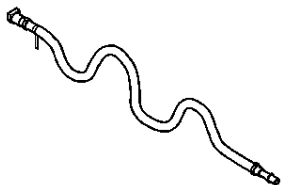
EN 46843
Quick Connect Release Tool



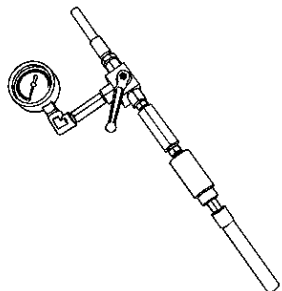
EN 46999
Displacement On Demand Electric Tool



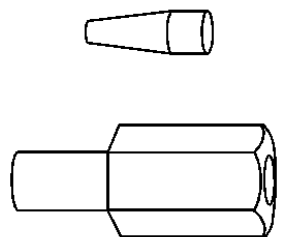
EN 47632 (32 025 010)
Cleaning Tool



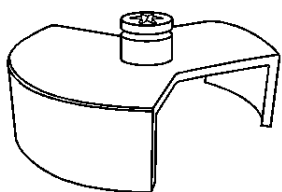
EN 47969
Fuel Supply Diagnostic Hose



EN 48248
Cylinder Compression Pressure Gauge

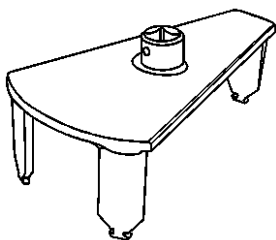


EN 48266
Injector Seal Installer/Sizer

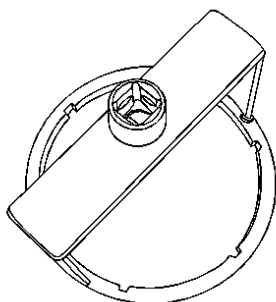


EN 48278
Sub Fuel Pump Locking Ring Remover/Installer

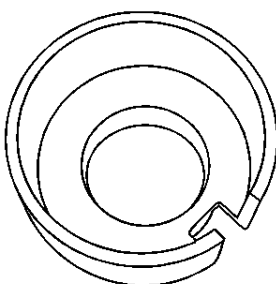
EN 48279
Main Fuel Pump Locking Ring Remover/Installer



EN 48303
Fuel Filter Housing Holder

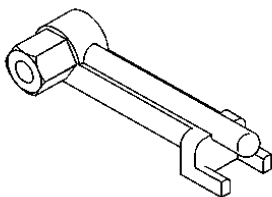
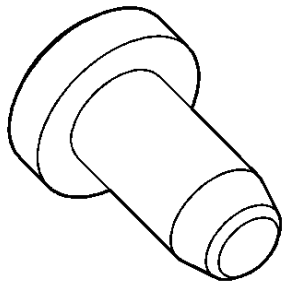
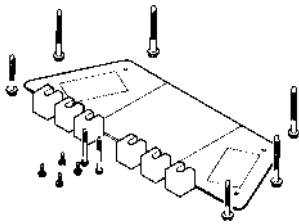


EN 48304
Fuel Filter Locker Installer/Remover



EN 48357
Injector Remover

EN 48536
Frame Support Tool (Engine Lower 65 mm Kit)

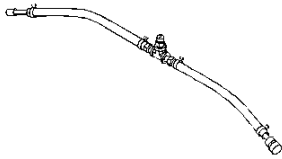


EN 48565
EGR Test Harness

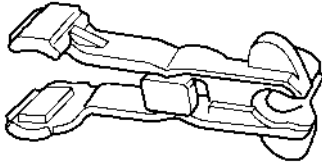
EN 48896
HP Fuel Pump Installation Alignment Gauge

EN 49232
Fuel Pump Lock Ring Remover

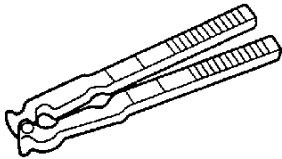
EN 49774
Fuel Injector Remover



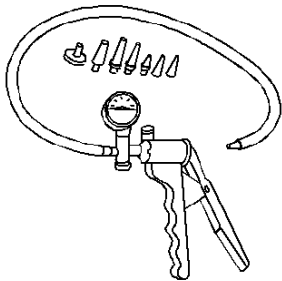
EN 49799
Fuel Pressure Gauge Adapter



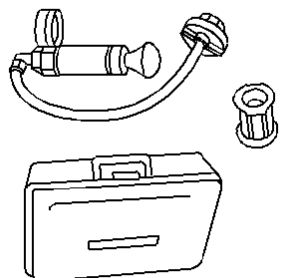
EN 83 95 261
Fuel Line Tool



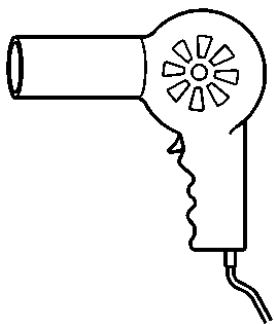
J 22610
Keystone Clamp Pliers



J 23738-A (GE 23738-A)
Vacuum Pump



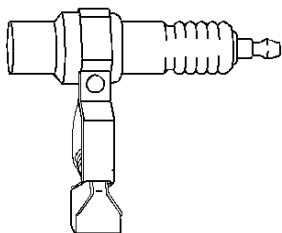
J 24460-A
Cooling System Pressure Tester



J 25070
Heat Gun 260-399°C (500-750°F)



J 2619-01 (DT 2619-01)
Slide Hammer

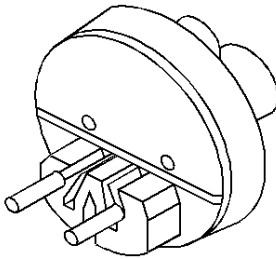
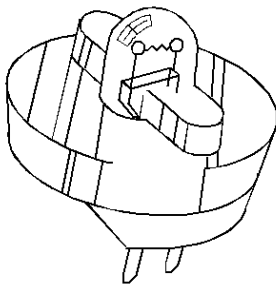


J 26792 (EL 26792)
HEI Spark Tester

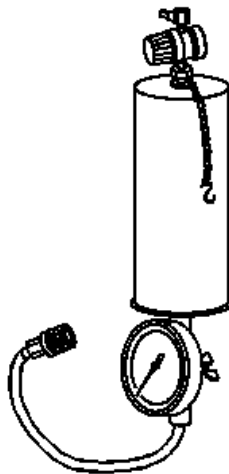


J 34730-262 (CH 34730-262)
Fuel Pressure Test Gauge Adapter

J 34730-375
Injector Test Lamp

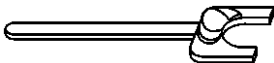
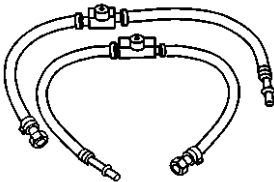
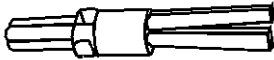
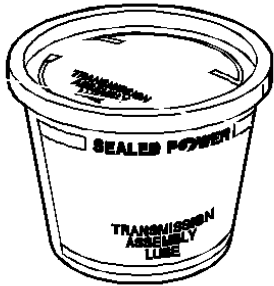
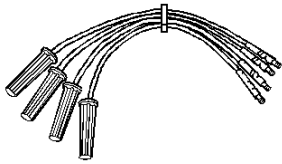


J 34730-405 (EL 34730-405)
Injector Test Lamp



J 35800-A (CH 35800-A)
Fuel Injector Cleaner

J 36012-A
Ignition System Diagnostic Harness

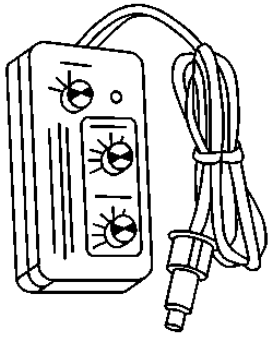


J 36850 (DT 36850)
Transjell Lubricant

J 37281-A (EN 37281-A)
Injector Remover

J 37287 (EN 37287)
Fuel Line Shut-Off Adaptors (Flex Fuel)

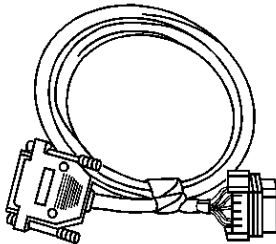
J 38491
Spark Plug Boot Removal Tool



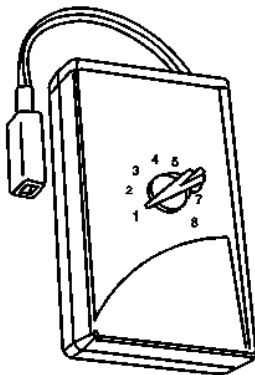
J 38522 (EN 38522)
Variable Signal Generator



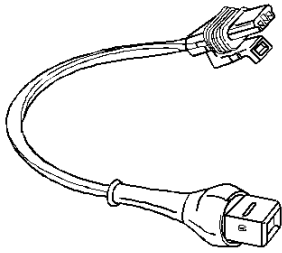
J 38641-B (CH 38641-C)
Diesel Fuel Quality Tester



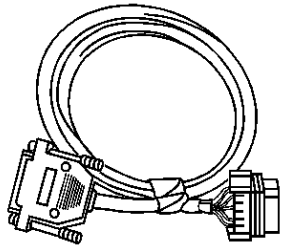
J 39021 (EL 39021)
Fuel Injector Coil and Balancer Tester



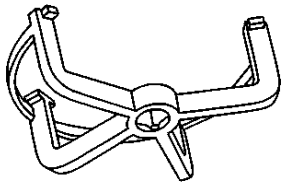
J 39021-210 (EL 39021-210)
Injector Tester Adapter Box



J 39021-380 (CH 39021-380)
Fuel Injector Harness Adapter

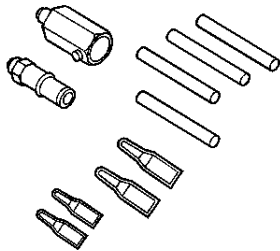
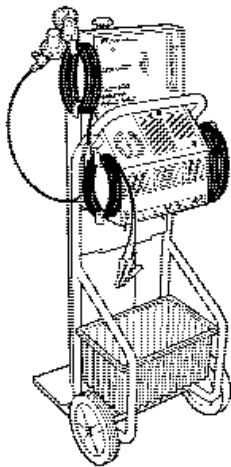


J 39021-450 (CH 39021-450)
Fuel Injector Harness Adapter

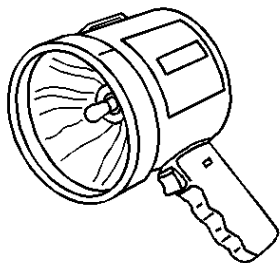


J 39765
Fuel Sender Locknut Wrench

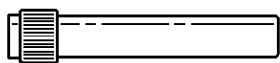
J 41413-200 (GE 41413-200)
Evaporative Emissions System Tester (EEST)



J 41413-300 (GE 41413-300)
EVAP Cap and Plug Kit



J 41413-SPT (GE 41413-SPT)
High Intensity White Light



J 41413-VLV (EN 41413-VLV)
EVAP Service Port Vent Fitting



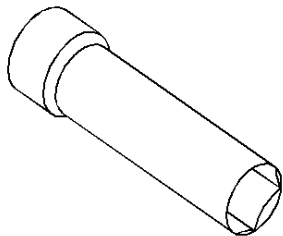
J 41415-30
Fuel Tank Cap Adapter



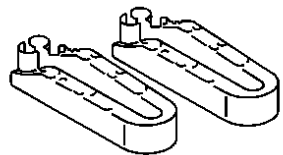
J 41415-40 (GE 41415-40)
Fuel Tank Cap Adapter



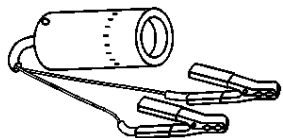
J 41415-50 (GE 41415-50)
Fuel Tank Cap Adapter



J 41515-A
Glow Plug Socket

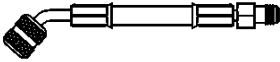
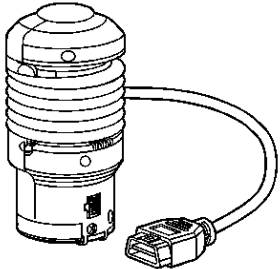
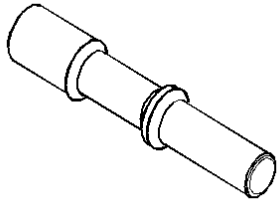
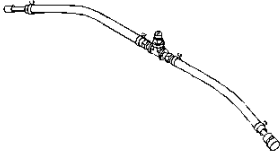
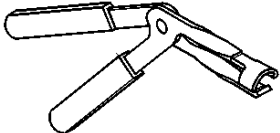


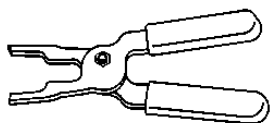
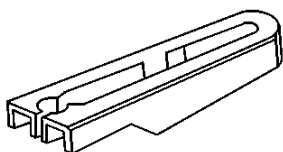
J 41769 (EN 41769) (KM J 41769)
Fuel Line Disconnect Tool Set



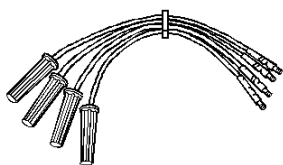
J 42220 (CH 42220)
Universal 12-Volt Leak Detection Lamp

J 42242 (CH 42242)

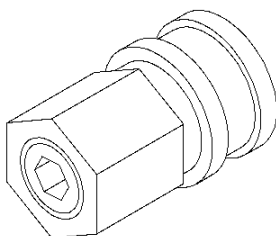
	Fuel Pressure Gauge Adapter
	J 42598-B Vehicle Data Recorder
	J 42960-2 (CH 42960-2) Fuel Flapper Door Holder
	J 42982 (CH 42982) Fuel Pressure Gauge Adapter
	J 43094 Spark Plug Boot Puller
	J 43178 (CH 43178) Fuel Line Disconnect Tool



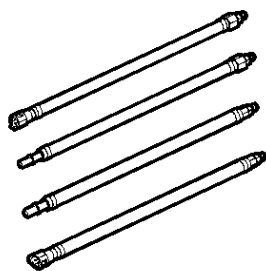
J 43244 (EL 43244)
Relay Puller Pliers



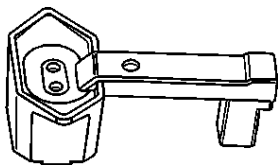
J 43883
Ignition System Diagnosis Harness



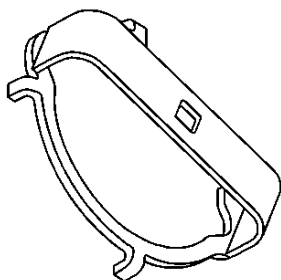
J 43936 (EN 43936)
Fuel Pressure Adapter Cap



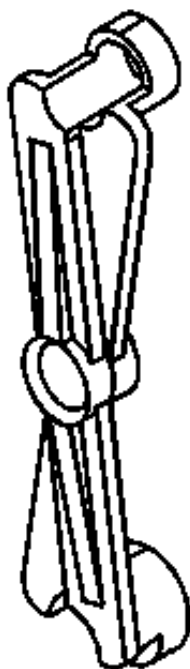
J 43937 (EN 43937)
Fuel Pressure Adapter Lines



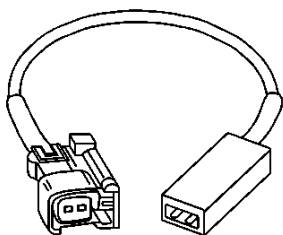
J 44175 (CH 44175)
Fuel Composition Tester



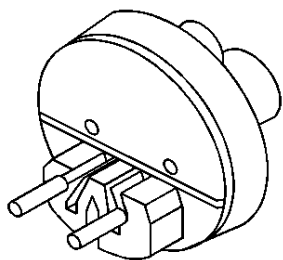
J 44402
Fuel Tank Sending Unit Wrench



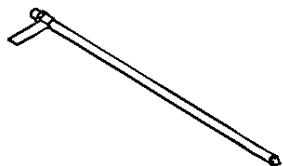
J 44581 (CH 44581)
Fuel Line Disconnect Tool



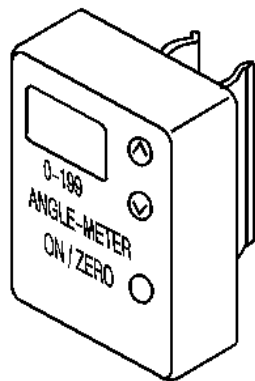
J 44602 (EN 44602)
Injector Test Adapter



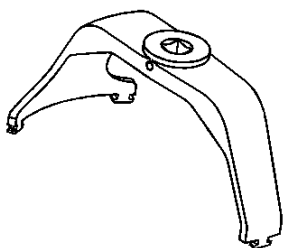
J 44603 (CH 44603)
Injector Test Lamp



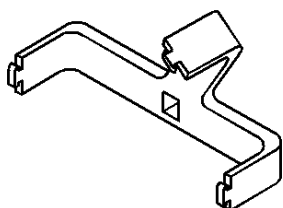
J 45004 (CH 45004)
Fuel Tank Drain Hose



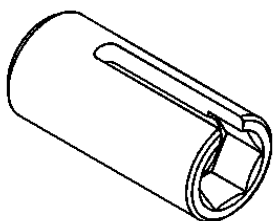
J 45059
Angle Meter



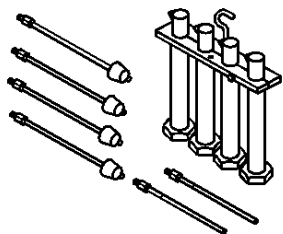
J 45722 (CH 45722)
Fuel Sender Lock Ring Wrench



J 45747 (CH 45747)
Wrench, Fuel Sending Unit

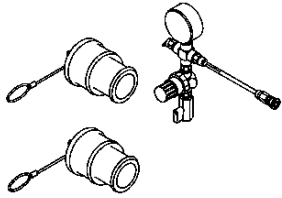
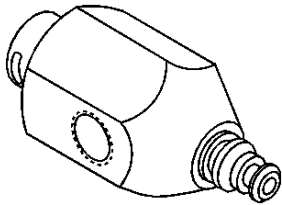


J 45861 (CH 45861)
ECT Sensor Socket

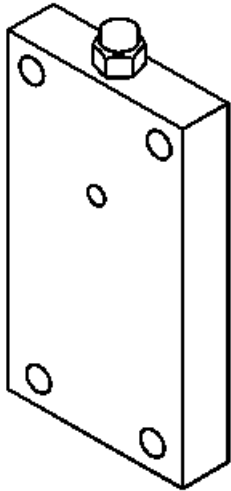


J 45873 (CH 45873)
Fuel Return Volume Test Kit

J 45873-30 (EN 45873-30)
Injector Flow Test Adapter

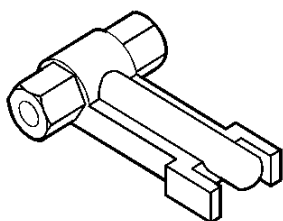
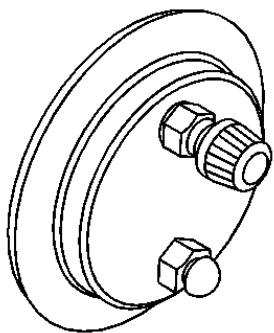


J 46091 (EN 46091)
Charge Air Cooler Tester

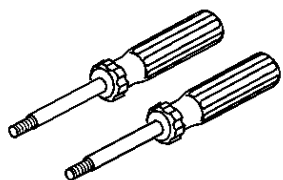


J 46091-5 (EN 46091-5)
Charge Air Cooler Tester Adapter

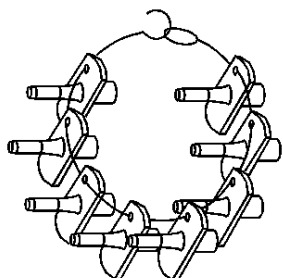
J 46091-15 (EN 46091-15)
Engine Pressure Test Adapter



J 46594 (EN 46594)
Fuel Injector Puller



KM 6009
Remover/Installer



KM 807
Closure Plugs

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE - ENGINE COOLANT TEMPERATURE SENSOR

Temperature C°/F°	Resistance Minimum Ohms	Resistance Maximum Ohms
Engine Coolant Temperature (ECT)		
-40/-40	40,490	50,136
-20/-4	14,096	16,827
-10/14	8,642	10,152
0/32	5,466	6,326
20/68	2,351	2,649
25/77	1,941	2,173
40/104	1,118	1,231
60/140	573	618
80/176	313	332
100/212	182	191
120/248	109	116
140/284	068	074

TEMPERATURE VERSUS RESISTANCE - INTAKE AIR TEMPERATURE SENSOR

Temperature C°/F°	Resistance Minimum Ohms	Resistance Maximum Ohms
Intake Air Temperature (IAT) Sensor		
-40/-40	35,140	43,760
-20/-4	12,660	15,120
-10/14	7,943	9,307
0/32	5,119	5,892
20/68	2,290	2,551
25/77	1,900	2,100
40/104	1,096	1,238
60/140	565	654
80/176	312	370
100/212	184	222
120/248	114	141
140/284	74	93

ALTITUDE VERSUS BAROMETRIC PRESSURE

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)	Barometric Pressure Measured in Pounds Per Square Inch (psi)
Determine your altitude by contacting a local weather station or by using another reference source.			
4 267	14,000	56-64	8.1-9.3
3 962	13,000	58-66	8.4-9.6
3 658	12,000	61-69	8.8-10.0
3 353	11,000	64-72	9.3-10.4
3 048	10,000	66-74	9.6-10.7
2 743	9,000	69-77	10.0-11.2
2 438	8,000	71-79	10.3-11.5
2 134	7,000	74-82	10.7-11.9
1 829	6,000	77-85	11.2-12.3
1 524	5,000	80-88	11.6-12.8
1 219	4,000	83-91	12.0-13.2
914	3,000	87-95	12.6-13.8
610	2,000	90-98	13.1-14.2
305	1,000	94-102	13.6-14.8
0	0 Sea Level	96-104	13.9-15.1
-305	-1,000	101-105	14.6-15.2

IGNITION SYSTEM SPECIFICATIONS

Application	Specification	
	Metric	English
Firing Order	1-2-3-4-5-6	
Spark Plug Gap	1.1 mm	0.043 in
Spark Plug Torque	20 N.m	15 lb ft

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Accelerator Cable Bracket Bolt	10 N.m	89 lb in
Accelerator Control Pedal Bolt and Stud	5 N.m	44 lb in
Air Cleaner Housing Cover Screws	4 N.m	35 lb in
Air Cleaner Outlet Duct Clamp	4 N.m	35 lb in
Boost Control Solenoid Nut	8 N.m	71 lb in
Bypass Valve Actuator Mounting Bolt	25 N.m	18 lb ft
Camshaft Position (CMP) Sensor Bolt	10 N.m	89 lb in
Crankshaft Position (CKP) Sensor Stud	30 N.m	22 lb ft
Engine Coolant Temperature (ECT) Sensor	20 N.m	15 lb ft

Engine Mount Strut Bolt/Nut	48 N.m	35 lb ft
EVAP Solenoid Vent Valve Bracket Bolt	10 N.m	89 lb in
Exhaust Gas Recirculation (EGR) Valve Adapter Bolt and Stud	50 N.m	37 lb ft
Exhaust Gas Recirculation (EGR) Valve Intake Pipe to Exhaust Manifold Bolt	30 N.m	22 lb ft
Exhaust Gas Recirculation (EGR) Valve Outlet Pipe to Adapter Nut	30 N.m	22 lb ft
Exhaust Gas Recirculation (EGR) Valve Outlet Pipe to Intake Manifold Bolt	30 N.m	22 lb ft
Exhaust Gas Recirculation (EGR) Valve Nut	30 N.m	22 lb ft
Fuel Feed Intermediate Pipe Fittings		
• First Pass	15 N.m	11 lb ft
• Second Pass	30 N.m	22 lb ft
Fuel Filler Pipe Screw to the Fuel Filler Pipe	2.5 N.m	22 lb in
Fuel Rail Hold-Down Bolt/Nut	10 N.m	89 lb in
Fuel Rail Hold-Down Stud	25 N.m	18 lb ft
Fuel Sender Access Panel Nut	10 N.m	89 lb in
Fuel Tank Filler Pipe Hose Clamp	2.5 N.m	22 lb in
Fuel Tank Filler Pipe Screw	13 N.m	115 lb in
Fuel Tank Retaining Strap Bolt	25 N.m	18 lb ft
Heated Oxygen Sensor (HO2S)	41 N.m	30 lb ft
Idle Air Control (IAC) Valve Screw	3 N.m	27 lb in
Ignition Coil to Ignition Control Module (ICM) Screw	4.5 N.m	40 lb in
Ignition Control Module (ICM) Nut	10 N.m	89 lb in
Ignition Control Module 14 Way Connector to Module Screw	2.1 N.m	19 lb in
In-Line Fuel Filter Mounting Bracket Bolt	20 N.m	15 lb ft
In-Line Fuel Filter Outlet Nut	30 N.m	22 lb ft
Knock Sensor (KS)	19 N.m	14 lb ft
Knock Sensor (KS) Heat Shield Bolt	60 N.m	44 lb ft
Manifold Absolute Pressure (MAP) Sensor Screw	5 N.m	44 lb in
Mass Air Flow (MAF) Sensor Screw	3 N.m	27 lb in
Powertrain Control Module (PCM) Electrical Connector Bolt	8 N.m	71 lb in
Spark Plug		
• To a New Cylinder Head	27 N.m	20 lb ft
• To an Existing Cylinder Head	15 N.m	11 lb ft
Throttle Body Nut	10 N.m	89 lb in
Throttle Body Support Bracket Bolt	16 N.m	12 lb ft
Throttle Position (TP) Sensor Screw	2 N.m	18 lb in

Throttle Inlet Absolute Pressure (TIAP) Sensor	4 N.m	35 lb in
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ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
All Purpose Parts Cleaner	Cleaner	12378553	88900920
Anti-Seize Compound	Lubricant	88862477	88862478
Coolant Temperature Sensor Threads	Sealant	12346004	10953480
Engine Oil	5W-30 Oil	12345610	993193
Fuel Injection Fuel Rail Bolts	Threadlock	12345382	10953489
Intake Air Temperature Sensor Threads	Sealant	12346004	10953480

2010 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.8L, 3.0L, 3.2L, or 3.6L - Equinox & Terrain

SYMPTOMS - ENGINE CONTROLS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

SYMPTOMS DESCRIPTION

Symptoms covers conditions that are not covered by DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause specific symptoms are listed separately under Additional Symptoms Testing. Perform the Symptoms Testing before using the Additional Symptoms Testing.

SYMPTOMS DEFINITION

Backfire

The fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Cuts Out, Misses

A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1,500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

Detonation/Spark Knock

A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Dieseling, Run-On

The engine continues to run after the key is turned OFF, but runs very rough.

Engine Control Module (ECM) Commanded Reduced Engine Power

The ECM illuminates the Reduced Engine Power lamp and will limit engine power under potential engine/vehicle damaging or emissions related conditions. A DTC may not be set.

Fuel Odor

A noticeable smell of unburned fuel.

Hard Start

The engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stall.

Hesitation, Sag, Stumble

A momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

Lack of Power, Sluggishness, or Sponginess

The engine delivers less than expected power. Little or no increase in vehicle speed when the accelerator pedal is pushed down part way.

Poor Fuel Economy

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

Rough, Unstable, or Incorrect Idle and Stalling

The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle speed may vary. Either condition may be severe enough to stall the engine.

Surges/Chuggles

An engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

SYMPTOMS VERIFICATION

Before using the Symptom tables, perform the following inspections:

- Ensure that the malfunction indicator lamp (MIL) is operating correctly. Use the scan tool to command the lamp ON and OFF.
- Ensure that there are no DTCs that are stored.
- Ensure that the scan tool data is within a normal operating range. Refer to **Control Module References** for scan tool information.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

- Moisture and water intrusion in connectors, terminals, and components
- Incomplete connector mating
- Poor terminal contact
- High circuit or component resistance-High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness that is too short or tight
- Wire insulation that is chaffed or cut
- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surfaces
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of aftermarket, add on accessories

Visual/Physical Check

- Ensure that the control module grounds are clean, tight, and correctly located.
- Ensure that the vacuum hoses are not split or kinked, and are properly connected.
- Ensure that the air filter is clean and free from restrictions.
- Ensure that there is no water intrusion in connectors terminals and components.
- Inspect the air intake ducts for the following conditions:
 - Collapsed
 - Damaged areas
 - Looseness
 - Incorrect installation
 - Leaking
- Inspect for air leaks at the throttle body mounting area, the mass air flow (MAF) sensor and intake manifold sealing surfaces.
- Inspect the wiring harness for the following conditions:
 - Poor connections
 - Pinches

- Cuts
- Inspect for loose, damaged, unseated, or missing sensors/components.
- Inspect the terminals for corrosion and correct contact.

SYMPTOMS TESTING

Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles

- Test the fuel system for the following:
 - The fuel system for correct operation and pressure-Refer to **Fuel System Diagnosis**.
 - The fuel injectors for proper operation-Refer to **Fuel Injector Solenoid Coil Test**.
 - A fuel quality condition-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Test ignition system for the following:
 - Spark plugs for incorrect heat range or an abnormal condition-Refer to **Spark Plug Inspection** and **Ignition System Specifications**.
 - For diagnosis of coolant or oil fouled spark plugs-Refer to **Coolant in Combustion Chamber** or **Oil Consumption Diagnosis**.
 - Wet down the secondary ignition system with water from a spray bottle-Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied.
 - Weak spark using the J 26792 Spark Tester-Refer to **Electronic Ignition System Diagnosis**.
- Inspect for the following conditions:
 - The proper operation of the transmission torque converter clutch (TCC) - The scan tool should indicate an engine speed drop when the TCC is commanded ON. Refer to **Torque Converter Diagnosis**.
 - The proper operation of the A/C compressor
 - An engine that runs lean or rich-Observe the Fuel Trim parameters with a scan tool.
 - Slow responding heated oxygen sensors (HO2S)-The HO2S should respond quickly to different throttle positions.

CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution.

- Water intrusion in the HO2S connector

NOTE: **The embossed arrows on the mass air flow (MAF) sensor indicate the direction of the intake air flow. The arrows must point toward the engine.**

- Inspect the MAF sensor installation. A MAF sensor that is incorrectly installed may cause a hard

start. Install the MAF in the proper direction. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .

- Inspect the mass air flow (MAF) sensor connections.
- Engine oil contaminated by fuel
- Vacuum hoses for splits or kinks-Verify that the routing and connections are correct.
- Knock sensor (KS) system for excessive spark retard activity-Observe the scan tool Knock Retard parameter for activity greater than 0°.
- The exhaust system components for the following:
 - Physical damage or possible internal failure
 - The three-way catalytic converters for a restriction

For more information, refer to **Symptoms - Engine Exhaust** .

- Electromagnetic interference (EMI) on a reference circuit can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuit if a condition exists.
- The crankcase ventilation valve for proper operation-Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
- Evaporative emission (EVAP) canister purge solenoid that is stuck open
- The engine cooling system for the following conditions:
 - A thermostat with an incorrect heat range-Refer to **Thermostat Diagnosis** .
 - Improper engine coolant level-If the level is low, refer to **Loss of Coolant** .
- The crankshaft position (CKP) sensor for an intermittent condition-Observe the scan tool CKP Resync parameter. The Resync parameter should remain at 0 during all operating conditions, and when moving the related harnesses and connectors between the CKP sensor and the ECM.
- Inspect the engine for the following mechanical failures:

Refer to **Symptoms - Engine Mechanical** .

- Excessive oil in the combustion chamber or leaking valve seals
- Oil consumption
- Incorrect cylinder compression
- Sticking or leaking valves
- Worn camshaft lobes
- Incorrect valve timing
- Worn rocker arms
- Broken valve springs
- Excessive carbon buildup in the combustion chambers-Clean the chambers with top engine cleaner. Follow the instructions on the can.
- Incorrect engine parts

- If the above conditions do not address the symptom, refer to the additional symptoms tests.

ADDITIONAL SYMPTOMS TESTS

Hard Start

- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 80% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and clean, if necessary. Refer to **Throttle Body Inspection and Cleaning**.
- Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within $\pm 3^{\circ}\text{C}$ (5°F). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement (LF1)**. If the sensor is within the specification, test the ECT sensor circuits for high resistance.
- Verify that the fuel system has adequate pressure for engine start-up. With a scan tool, compare the Fuel Pressure Sensor parameter value to the Desired Fuel Pressure parameter value when the ignition key is first turned to ON. Refer to **Fuel System Diagnosis**.
- Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP sensor. Refer to **Crankshaft and Bearing Cleaning and Inspection** and **Engine Mechanical Specifications (LF1)**.

Hesitation, Sag, Stumble

- Test the fuel pressure. Refer to **Fuel System Diagnosis**.
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**.
- Test the generator. Refer to **Symptoms - Engine Electrical**. Repair the charging system if the generator output voltage is less than 9 volts or more than 16 volts.
- Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP sensor. Refer to **Crankshaft and Bearing Cleaning and Inspection** and **Engine Mechanical Specifications (LF1)**.
- Test the manifold absolute pressure (MAP) sensor. Refer to **DTC P0106 (LF1)**.

NOTE: The following actions may need to be repeated in order to verify an intermittent intake or exhaust camshaft actuator condition.

- Engine warm and idling, verify the correct operation of the camshaft actuator system. Command the intake and exhaust camshaft actuator for each cylinder bank from 0 degrees to 25 degrees and back to zero while observing the appropriate scan tool Intake Camshaft Position Variance and exhaust Camshaft Position Variance parameters. Each parameter should be less than 2 degrees in each of the commanded states.
 - If any of the parameters is greater than 2 degrees, inspect the suspect camshaft actuator and camshaft actuator solenoid valve and valve bore for contamination, obstruction, and damage. Refer

to **Camshaft Timing Drive Components Cleaning and Inspection** and **Camshaft Actuator System Description** for additional information.

Poor Fuel Economy

- Heavy loads being carried or towed
- Acceleration rate too much or too often
- Inspect the brake system for brake drag.
- Inspect for incorrect operation of the speedometer.
- Verify that the engine coolant temperature (ECT) has not shifted in value. Allow the engine to run and reach operating temperature. Observe the ECT Sensor parameter with a scan tool and compare the reading to the parameter listed in the **Engine Control Module Scan Tool Information (LF1,LFW)** list. If the reading is not in the range specified in the list, test the resistance of the ECT sensor. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement (LF1)** . If the sensor is within the specification, test the ECT sensor circuits for high resistance.
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .
- Observe scan tool the Throttle Body Idle Airflow Compensation parameter. A value greater than 80% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and clean, if necessary. Refer to **Throttle Body Inspection and Cleaning** .

Detonation/Spark Knock

- Inspect for excessive carbon buildup in the combustion chambers. Clean the chambers with Top Engine Cleaner. Follow the instructions on the can.
- Test for an engine overheating condition. Refer to **Engine Overheating** .
- Verify that the engine coolant temperature (ECT) has not shifted in value. Allow the engine to run and reach operating temperature. Observe the ECT Sensor parameter with a scan tool and compare the reading to that parameter listed on the **Engine Control Module Scan Tool Information (LF1,LFW)** list. If the reading is not in the range specified in the list, test the resistance of the ECT sensor. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement (LF1)** . If the sensor is within the specification, test the ECT sensor circuits for high resistance.
- If there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicle minimum octane requirements.

Lack of Power, Hesitation, or Cut Out

- Inspect the engine electrical system for correct operation. Refer to **Symptoms - Engine Electrical** .
- Verify that each injector harness is connected to the correct injector.
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .

NOTE: **The following actions may need to be repeated in order to verify an intermittent intake or exhaust camshaft actuator condition.**

- Engine warm and idling, verify the correct operation of the camshaft actuator system. Command the intake and exhaust camshaft actuator for each cylinder bank from 0 degrees to 25 degrees and back to zero while observing the appropriate scan tool Intake Camshaft Position Variance and exhaust Camshaft Position Variance parameters. Each parameter should be less than 2 degrees in each of the commanded states.
 - If any of the parameters is greater than 2 degrees, inspect the suspect camshaft actuator and camshaft actuator solenoid valve and valve bore for contamination, obstruction, and damage. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** and **Camshaft Actuator System Description** for additional information.

Rough, Unstable, or Incorrect Idle and Stalling

- Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 80% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and clean, if necessary. Refer to **Throttle Body Inspection and Cleaning** .
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .
- Inspect the engine mounts.
- Inspect the intake and exhaust manifolds for casting flash.

NOTE: **The ECM uses the cylinder 1 intake camshaft position sensor to determine injector and ignition system synchronization as well as to determine camshaft to crankshaft relationship. If the cylinder 1 intake camshaft position sensor signal to the ECM is intermittent, a stalling condition will occur and a DTC will not set.**

- Inspect all cylinder 1 intake camshaft position sensor wiring for poor connections. Start the engine and observe for engine stalling while wiggling the cylinder 1 intake camshaft position sensor wiring harness. Refer to **Inducing Intermittent Fault Conditions** for further diagnosis.

Surges/Chuggles

- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .
- Test the heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The PCM reduces the amount of fuel delivered to the engine, causing a driveability condition.
- Verify that each injector harness is connected to the correct injector.

Fuel Odor

- Saturated EVAP canister-Refer to **Evaporative Emission Control System Description** .
- A condition with the internal components of the fuel tank assembly-Refer to **Fuel System Description (LF1)** .
- Inspect for damaged or deteriorated fuel lines.

ECM Commanded Reduced Engine Power

Review the scan tool Reduced Engine Power History parameter to determine the reason for the last reduced engine power event and refer to **Engine Control Module Scan Tool Information (LF1, LFW)** for various conditions that can cause reduced engine power.

MALFUNCTION INDICATOR LAMP (MIL) DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

Ignition voltage is supplied to the malfunction indicator lamp (MIL). The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit.

DIAGNOSTIC AIDS

If the condition is intermittent, move the related harnesses and connectors with the engine operating. Monitor the scan tool Circuit Test Status parameters for the component. The Circuit Test Status parameter will change from OK or Not run to Fault if there is a condition with the circuit or a connection.

REFERENCE INFORMATION

Schematic Reference

- **Instrument Cluster Schematics**
- **Engine Controls Schematics**

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

1. Ignition ON, observe the scan tool MIL Circuit Test Status parameters. Each of the MIL circuit test status parameters should display OK or Not Run.
2. Ignition ON, command the MIL ON and OFF with a scan tool. The MIL should turn ON and OFF as commanded.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

CIRCUIT/SYSTEM TESTING

1. If any other IPC indicators or gauges are inoperative, refer to **Instrument Cluster Gauges Inoperative**.
2. Ignition OFF, disconnect the ECM harness connectors. Ignition ON, the MIL should not illuminate.
 - If the MIL is illuminated, test the MIL control circuit terminal 46-X1 for a short to ground. If the circuit tests normal, replace the IPC.
3. Ignition ON, connect a 3 A fused jumper wire between the MIL control circuit terminal 46-X1 and ground. The MIL should illuminate.
 - If the MIL does not illuminate, test the MIL control circuit for a short to voltage, or an open/high resistance. If the circuit test normal, replace the IPC/bulb.
4. If all circuits/connections test normal, replace the ECM.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References**
- **Instrument Cluster Replacement (Equinox)** or **Instrument Cluster Replacement (Terrain)**

ENGINE CRANKS BUT DOES NOT RUN

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but not start. This diagnostic directs the technician to the appropriate system diagnosis.

DIAGNOSTIC AIDS

Inspect for any of the following conditions:

- The Immobilizer system is not designed to have the key FOB folded 90 degrees when attempting to start the engine. This may cause an intermittent no start condition. If you receive a customer complaint of an intermittent no start condition, verify that the customer is not folding the key while attempting to start the engine. The fob must be parallel to the key to function properly.
- The engine control module (ECM) uses the camshaft position sensors to determine engine speed and position when there is a crankshaft position sensor condition.
- The engine will operate with a crankshaft position sensor condition only if the ECM has stored the learned reference position of the camshafts in memory. With a crankshaft position sensor condition in the signal circuit, the engine will go into a limp home mode after a hard restart. The ECM then calculates engine speed from one of the camshaft position sensors.
- The fuel pump flow control module controls and monitors the operation of the in-tank fuel pump. If the fuel pump flow control module detects a fault, a DTC sets in the fuel pump flow control module. The fuel pump flow control module will then send a serial data message to the engine control module (ECM) requesting the illumination of the malfunction indicator lamp (MIL).
- Insufficient fuel can cause a no start condition. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition. Refer to **Fuel Injector Solenoid Coil Test**.
- There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK, and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Check all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.
- Inspect the engine for good secure electrical grounds.
- Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 min in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.
- A vehicle that starts and runs after being brought to the repair shop for a no start condition, may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to check for an engine starting or will not stay running concern.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48027:** Digital Pressure Gauge
- **J 26792:** Spark Tester
- For equivalent regional tools, refer to Special Tools .

CIRCUIT/SYSTEM VERIFICATION

NOTE: This diagnostic assumes the following:

- The battery is completely charged. Refer to Battery Inspection/Test .
- The engine cranking speed is acceptable. Refer to Engine Cranks Slowly .
- There is adequate fuel in the fuel tank.

1. Attempt to start the engine. Observe the DTC information with a scan tool. Verify that DTC P0116, P0118, P0335, P0336, P0513, P0601, P0602, P0603-P0606, P062B, P0627, P0628, P0629, P0633, P069E, P1631, P1649, or U0109 does not set.
 - If any of the listed DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle .
2. Ignition ON, observe the Theft Deterrent parameter with a scan tool. The parameter should display Disabled.
 - If Enabled is displayed, refer to Diagnostic Trouble Code (DTC) List - Vehicle .

NOTE: A MAF sensor circuit condition may cause an Engine Cranks But Does Not

Run condition without setting a DTC.

3. Engine cranking, observe the scan tool Mass Airflow Sensor parameter. The parameter should display greater than 0 Hz.
 - If the parameter is not the specified value, refer to **DTC P0102 or P0103** for further diagnosis.
4. Test the ignition system for spark. Refer to **Electronic Ignition System Diagnosis**.
5. Ignition ON, command the fuel pump ON with a scan tool. You should hear the fuel pump turn ON.
 - If the fuel pump does not turn ON, refer to **Fuel System Diagnosis**.
6. Ignition OFF, install the **CH 48027**: Digital Pressure Gauge.

NOTE:

- **The fuel pump may need to be commanded ON a few times, in order to obtain the highest possible fuel pressure.**
- **Do NOT start the engine for this test.**

7. Ignition ON, command an increase in the fuel line pressure with a scan tool. The fuel line pressure should increase to greater than 410 kPa (60 psi) as commanded.
 - If the fuel pressure is not within range, refer to **Fuel System Diagnosis**.
8. Verify that the following conditions do not exist:
 - Collapsed air intake duct to the throttle body
 - Restricted air filter element
 - Spark plugs for being gas or coolant fouled
 - A skewed engine coolant temperature (ECT) sensor-Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** .
 - Exhaust system restricted-Refer to **Restricted Exhaust** .
 - Fuel contamination-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
 - Engine mechanical condition, for example, worn timing chain and gears, low compression-Refer to **Symptoms - Engine Mechanical** .
 - If you find any of the above conditions, repair as necessary.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

FUEL PUMP ELECTRICAL CIRCUIT DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DIAGNOSTIC FAULT INFORMATION

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
Fuel Pump High Signal	P0231	P023F	P0232	P023F, P2635
Fuel Pump Low Signal	-	P023F	-	P023F, P2635

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump control module remains active for two seconds, unless the engine is in crank or run. While this voltage is being received, the fuel pump control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

CIRCUIT/SYSTEM VERIFICATION

Ignition ON, command the fuel pump ON and OFF using the scan tool ECM output control. The fuel pump should turn on and off.

CIRCUIT/SYSTEM TESTING

1. Ignition OFF, disconnect the harness connector at the G12 fuel pump.
2. Connect a test lamp between the control circuit terminal 1 and ground.
3. Ignition ON, command the G12 fuel pump ON and OFF using a scan tool ECM fuel pump output control. The test lamp should turn ON and OFF, as commanded.
 - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K27 fuel pump control module.
 - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
4. Ignition OFF, connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
5. Ignition ON, command the G12 fuel pump ON using a scan tool. The test lamp should illuminate.
 - If the test lamp does not illuminate, test the low reference circuit terminal 1 for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K27 fuel pump control module.
6. If all circuits test normal, replace the G12 fuel pump.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for fuel pump control module replacement, setup, and programming

FUEL SYSTEM DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is ON. The voltage from the ECM to the fuel pump control module remains active for 2 s, unless the engine is in Crank or Run. While this voltage is being received, the fuel pump control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank module in order to maintain the desired fuel rail pressure.

The fuel system is an electronic returnless on-demand design. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

An electric turbine style fuel pump attaches to the primary fuel pump module inside the fuel tank. The fuel pump supplies fuel through the fuel feed pipe to the high pressure fuel pump. The high pressure fuel pump supplies fuel to a variable-pressure fuel rail. Fuel enters the combustion chamber through precision multi-hole fuel injectors. The high pressure fuel pump, fuel rail pressure, fuel injection timing, and injection duration are controlled by the engine control module (ECM).

The primary fuel tank module also contains a primary jet pump and a secondary jet pump. Fuel pump flow loss, caused by vapor expulsion in the pump inlet chamber, is diverted to the primary jet pump and the secondary jet pump through a restrictive orifice located on the pump cover. The primary jet pump fills the reservoir of the primary fuel tank module. The secondary jet pump creates a venturi action which causes the fuel to be drawn from the secondary side of the fuel tank, through the fuel transfer pipe, to the primary side of the fuel tank.

REFERENCE INFORMATION

Description and Operation

Fuel System Description (LF1)

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48027:** Digital Pressure Gauge
- **J 37287:** Fuel Line Shut-off Adapter

CIRCUIT/SYSTEM VERIFICATION

NOTE:

- **Repair all fuel system related DTCs before performing this diagnostic.**
- **Inspect the fuel system for damage or external leaks before proceeding.**
- **Verify that adequate fuel is in the fuel tank before proceeding.**
- **The Fuel Pump Enable may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.**
- **Before proceeding with this test review the User Manual CH 48027-5 for Safety Information and Instructions.**

1. Ignition OFF, all accessories OFF, install a **CH 48027:** Gauge. Refer to **Fuel Pressure Gauge**

Installation and Removal

NOTE: High fuel pressure readings may result due to hot soak fuel boiling. With the engine OFF, the fuel pressure may increase to the setting of the pressure relief regulator valve, approximately 580 kPa (84 psi).

2. Ignition ON, engine OFF, command the Fuel Pump Enable ON with a scan tool. Verify the fuel pressure is between 276-448 kPa (40-65 psi) and does not decrease more than 34 kPa (5 psi) in 1 min.
3. Engine idling at normal operating temperature, verify the scan tool Fuel Pump Control Module Fuel Pressure Sensor parameter is between 276-324 kPa (40-47 psi).

CIRCUIT/SYSTEM TESTING

NOTE:

- The Fuel Pump Enable may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
- DO NOT start the engine.
- High fuel pressure readings may result due to hot soak fuel boiling. With the engine OFF, the fuel pressure may increase to the setting of the pressure relief regulator valve, approximately 580 kPa (84 psi).

1. Ignition ON, engine OFF, command the Fuel Pump Enable ON with a scan tool and observe the fuel pressure gauge while the fuel pump is operating. Verify the fuel pressure is between 276-448 kPa (40-65 psi).
 - If the fuel pressure is less than the specified range, test, inspect, and repair the items listed below. If all items test normal, replace the primary fuel tank module.
 - Restricted fuel feed pipe
 - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
2. Verify that the fuel pressure does not decrease more than 34 kPa (5 psi) in 1 min.
 - If the fuel pressure decreases more than the specified value, perform the following procedure:
 1. Ignition OFF, relieve the fuel pressure. Refer to **Fuel Pressure Relief**.
 2. Install the **J 37287**: Adapter between the chassis fuel feed hose and the engine compartment fuel feed pipe.
 3. Open the valve on the **J 37287**: Adapter.
 4. Ignition ON, command the Fuel Pump Enable ON with a scan tool and bleed the air from the **CH 48027**: Gauge.
 5. Command the Fuel Pump Enable ON and then OFF with a scan tool.
 6. Close the valve on the **J 37287**: Adapter.
 7. Monitor the fuel pressure for 1 min.
 - If the fuel pressure does not decrease more than 34 kPa (5 psi) within the specified time, replace the primary fuel tank module.
3. Relieve the fuel pressure to 69 kPa (10 psi). Verify that the fuel pressure does not decrease more than 14 kPa (2 psi) in 5 min.

- If the fuel pressure decreases more than the specified value, replace the primary fuel tank module.
- 4. Operate the vehicle within the conditions of the customer's concern while monitoring the fuel pressure with the **CH 48027: Gauge**. The fuel pressure should not drop off during acceleration, cruise or hard cornering.
 - If the fuel pressure drops off, test, inspect, and repair the items listed below. If all items test normal, replace the primary fuel tank module.
 - Restricted fuel feed pipe
 - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections
- 5. If the fuel system tests normal, refer to **Symptoms - Engine Controls**.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Feed Pipe Replacement (LF1)**
- **Fuel Tank Fuel Pump Module Replacement**

FUEL COMPOSITION DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

When an E85 compatible vehicle is built, an engine control module (ECM) or powertrain control module (PCM) replaced, or when the learned alcohol content has been reset with a scan tool, the fuel system will need to contain ASTM gasoline with 15 % or less ethanol content. If the fuel in the fuel system needs to be drained and replaced with ASTM gasoline, the engine will need to run at operating temperature and consume at least 1 liter (0.3 gallon) of fuel before the system will recognize the correct alcohol content. Either ASTM gasoline or ASTM E85 fuel can then be used. In order that the ECM/PCM recognizes a proper next fuel fill, the amount must be 11 liters (3 gallons) or more, and the ethanol content must be between 0-85 %.

REFERENCE INFORMATION

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 44175: Fuel Composition Tester**

- **J 44175-A: Fuel Composition Tester**

CIRCUIT/SYSTEM VERIFICATION

1. Observe the Fuel Composition Learn parameter using the scan tool. The Fuel Composition Learn parameter should display Inactive.

IMPORTANT:

- **The key needs to be turned OFF for at least 30 s after the parameter displays Inactive to properly store the ethanol learned value in the ECM/PCM memory.**
- **The vehicle may need to be driven more than 11 km (7 mi) with the engine at operating temperature.**

- If the Fuel Composition Learn parameter displays Active, drive the vehicle until the Fuel Composition Learn parameter displays Inactive.
2. Record the ECM/PCM estimated value of the ethanol content using a scan tool.
3. Record the actual measured percentage of ethanol content using the **J 44175: Tester** or **J 44175-A: Tester**. The ECM/PCM estimated value should be within 15 % of the ethanol content measured with the **J 44175: Tester**.
 - If the ECM/PCM estimated value is not within 15 % of the ethanol content measured with the J44175 Tester continue with Circuit/System Testing.

CIRCUIT/SYSTEM TESTING - J44175 ETHANOL CONTENT LESS THAN 15 %

1. Use the scan tool to reset the Fuel Alcohol Content parameter to 3 %.
2. Use the scan tool to reset the fuel trim values.

CIRCUIT/SYSTEM TESTING - J44175 ETHANOL CONTENT MORE THAN 15 %

1. Perform a complete key cycle, key ON, engine OFF, in order to ensure that the ECM/PCM recognizes a refueling event.

IMPORTANT: It may be necessary to partially drain the fuel tank.

2. Key OFF, add at least 11 liters (3 gallons) of non-blended gasoline to the fuel tank.
3. Use the scan tool to reset the Fuel Alcohol Content parameter to 3 %.

NOTE: In order to ensure the non-blended gasoline has reached the fuel injectors, the vehicle may need to be driven more than 11 km (7 mi) with the engine at operating temperature.

4. Drive the vehicle until the Fuel Composition Learn parameter displays Inactive.
5. Use the scan tool to reset the fuel trim values.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel System Cleaning**
- **Fuel Tank Draining**

FUEL INJECTOR SOLENOID COIL TEST

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

The engine control module (ECM) supplies a separate high voltage supply circuit and a high voltage control circuit for each fuel injector. The injector high voltage supply circuit and the high voltage control circuit are both controlled by the ECM. The ECM energizes each fuel injector by grounding the control circuit. The ECM controls each fuel injector with 65 V. This is controlled by a boost capacitor in the ECM. During the 65 V boost phase, the capacitor is discharged through an injector, allowing for initial injector opening. The injector is then held open with 12 V. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

COMPONENT TESTING

NOTE:

- The resistance test must be performed at the fuel injector or mis-diagnosis will occur.
- The DMM and test leads must be calibrated to 0 ohms in order to prevent mis-diagnosis.

1. Test for 1.9-2.3 ohms at 20°C (68°F) between the high voltage supply circuit terminal 2 and the high voltage control circuit terminal 1 at the Q17 fuel injector.
 - If not within the specified range, replace the Q17 fuel injector.
2. Measure the resistance between each terminal at the Q17 fuel injector and the Q17 fuel injector housing/case. The DMM should display OL ohms.
 - If less than the specified value, replace the Q17 fuel injector.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Injection Fuel Rail Assembly Replacement - Bank 1 (LF1)**
- **Fuel Injection Fuel Rail Assembly Replacement - Bank 2 (LF1)**

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

TEST DESCRIPTION

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10 percent can cause driveability conditions and fuel system deterioration. Fuel with more than 10 percent ethanol could result in driveability conditions such as hesitation, lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

REFERENCE INFORMATION

Special Tools

J 44175 Fuel Composition Tester

SYSTEM VERIFICATION

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear.

- If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample, perform the Particulate Contaminants in Fuel Testing Procedure.
- If alcohol contamination is suspected, perform the Alcohol in Fuel Testing procedure.

ALCOHOL IN FUEL TESTING WITH SPECIAL TOOL

1. Test the fuel composition using **J 44175** and Instruction Manual.
2. If water appears in the fuel sample, clean the fuel system.
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
4. If the fuel sample contains more than 15 percent ethanol, add fresh, regular gasoline to the vehicle's fuel tank.
5. Test the fuel composition.
6. If testing shows the ethanol percentage is still more than 15 percent, replace the fuel in the vehicle.

ALCOHOL IN FUEL TESTING WITHOUT SPECIAL TOOL

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.034 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.38 oz) and install a stopper.
3. Shake the cylinder vigorously for 10-15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10-15 seconds.
6. Put the cylinder on a level surface for approximately 5 minutes in order to allow adequate liquid separation. If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10 ml (0.34 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5 percent alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.

PARTICULATE CONTAMINANTS IN FUEL TESTING PROCEDURE

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel.
2. Place the container on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination. Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles.
3. Observe the fuel sample. If any physical contaminants or water are present, clean the fuel system.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel System Cleaning**
- **Fuel Tank Draining**

EVAPORATIVE EMISSION SYSTEM DIAGNOSIS

OPERATING INSTRUCTIONS FOR THE EVAPORATIVE EMISSION SYSTEM TESTER (EEST)

Vehicle Setup

NOTE: A large difference between the vehicle temperature and shop temperature will seriously affect the accuracy of the tests. Always allow enough time, at least 15 minutes, for the vehicle temperature to adjust to the shop temperature. Refer to Temperature Variation Instructions for more information about vehicle versus shop temperatures.

1. Engine OFF, open the hood. Position a large fan to blow air under the vehicle onto the fuel tank area.
2. Connect the red battery clip from the tester to the positive battery terminal.

NOTE: The vehicle battery must be fully charged for optimum tester performance.

3. Connect the black battery clip from the tester to chassis ground.

FLOWMETER TEST - LEAK DETECTION

1. Open the Nitrogen tank valve and turn the NITROGEN/SMOKE valve on the front control panel to NITROGEN.
2. Connect the hose to the correct test orifice on the bottom front of the tester. For orifice size, refer to the GM Service manual for the vehicle being tested. The vehicle specific information can be found in service procedures for DTCs that relate to evaporative emission (EVAP) system leaks.
3. Press and release the remote switch to activate the tester.
4. Position the sliding red flag on the flowmeter to align with the floating indicator. When the red flag is set, press and release the remote switch to deactivate the tester.
5. Remove the hose from the test orifice and install the hose onto the vehicle. For proper connection location, and the special tool numbers for any adapters that may be required, refer to the service procedures for DTCs that relate to EVAP system leaks.
6. Ignition ON, seal the EVAP system per instructions in the service procedures for DTCs that relate to EVAP system leaks. Most systems can be sealed using a scan tool output control for the EVAP canister vent solenoid valve, other systems require that the vent system be plugged.

NOTE:

- Larger volume fuel tanks, and/or those with lower fuel levels, may require several minutes to fill with nitrogen.
- Static buildup may cause the float indicator to stick. It may be necessary to tap on the flowmeter to free up the float.

7. Press and release the remote switch to activate the nitrogen flow and fill the system.
8. Compare the stable floating indicator position to the red flag.
 - ABOVE the red flag, the result is UNACCEPTABLE, FAIL-Go to Smoke Procedure

- BELOW the red flag, the result is ACCEPTABLE, PASS-Test complete
9. Press and release the remote switch to deactivate the tester.

SMOKE PROCEDURE - LOCATE THE LEAK

NOTE: It is not recommended to use the tester in an outside repair bay area because wind and sunlight may affect temperature and your ability to see the smoke.

1. Turn OFF any fans that may cause air movement around or near the vehicle.

NOTE: Completely unwind the nitrogen/smoke hose from the bracket to optimize the tester's performance.

2. Connect the nitrogen/smoke hose to the vehicle as directed in the service procedures. Some vehicles require that the nitrogen/smoke hose be connected at the front of the EVAP system at the EVAP service port. An adapter may be necessary. Other vehicles require the connection be made at the rear of the system using an adapter at the fuel fill cap. Consult the service procedures for DTCs that relate to evaporative emission (EVAP) system leaks for vehicle specific instructions regarding connection location and adapters.
3. Open the nitrogen tank valve and turn the NITROGEN/SMOKE valve on the control panel to SMOKE.

NOTE: The remote switch operates in a push ON, push OFF fashion.

4. Press and release the remote switch to activate the tester and inject smoke into the EVAP system.
5. Verify smoke has filled the EVAP system by opening the system opposite the end where smoke is injected. When injecting smoke at the service port, remove the fuel fill cap, or temporarily leave the EVAP canister vent valve open, until smoke is observed. Then close the system and continue testing. If using a special tool fuel fill cap adapter at the filler neck, vent the system at the service port until smoke is observed then close the system to continue with the test.

NOTE: Inject smoke in less than 2-minute cycles for optimum tester performance.

6. Press and release the remote switch to deactivate the tester.

NOTE: For optimum visual smoke performance, deactivate the smoke flow and allow the system pressure to drop. Allowing the smoke to exit small holes at a low flow rate greatly enhances visibility.

7. Introduce smoke into the system for an additional 60 seconds. Continue introducing smoke at 15-second intervals, as necessary.
8. Using the a high-intensity white light, inspect the entire EVAP system path, and look for the source of the leak indicated by the exiting smoke. Introduce smoke at 15-second intervals, as needed, until leak source is identified.

TEMPERATURE VARIATION INSTRUCTIONS

The Concern

Ideal circumstances for conducting the EVAP Flowmeter Test require equal temperatures between the nitrogen gas and the vehicle EVAP system. Significant differences in temperature between them can result in a flow or pressure change during testing, causing misleading results. Typically, the Evaporative Emissions System Tester is stored indoors, approximately 21°C (70°F). Vehicles brought in for diagnosis may have an EVAP system at significantly different temperatures -40 to +43°C (-40 to +110°F).

For Example

NOTE: **With no temperature difference between the nitrogen gas and EVAP system, the resulting vehicle EVAP system pressure will remain stable at 13 inches H2O once pressurized, providing no leaks are present.**

When the EVAP Flowmeter Tests are performed with significant differences in temperature between the nitrogen gas and the vehicle EVAP system, the following results can occur:

- An increase in flow during the flowmeter test can be caused by a vehicle's warm EVAP system cooling down.
- A decrease in flow during the flowmeter test can be caused by a vehicle's cool EVAP system warming up.

The Solution

When working on a vehicle with significant temperature differences between the vehicle EVAP system and the nitrogen gas, allow the vehicle EVAP system temperature to stabilize as close as possible to the temperature of the nitrogen gas before conducting the Flowmeter Test.

ELECTRONIC IGNITION SYSTEM DIAGNOSIS

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

CIRCUIT/SYSTEM DESCRIPTION

The ignition system on this engine uses individual ignition coils and ignition control circuits for each cylinder. Ignition voltage is supplied to each bank of ignition coils. The engine control module (ECM) controls the ignition system operation. The ECM controls each coil using the ignition control circuits. The ECM commands the ignition control circuit low when a spark event is requested. The sequencing and timing are controlled by the ECM.

DIAGNOSTIC AIDS

- The ignition coils for each bank are fused separately. If a fuse opens or the ignition voltage circuit opens between the fuse and the splice, all the ignition coils for one bank of the engine would be inoperative. If the ground circuit opens at the engine block, the ignition coils would be inoperative for one bank of the engine.
- Inspect the ignition coils for aftermarket devices. An aftermarket device connected to the ignition coil circuits, may cause a condition with the ignition coils.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL 26792:** Spark Tester
- For equivalent regional tools, refer to Special Tools .

CIRCUIT/SYSTEM TESTING

NOTE: Do not perform this diagnostic procedure if you were not sent here from a misfire DTC or the Engine Cranks but Does Not Run diagnostic.

1. Ignition OFF, disconnect the harness connector of the affected T8 ignition coil.
2. Ignition ON, test for battery voltage between the ignition voltage circuit terminal D or 2 and ground.
 - If less than B+, test the ignition voltage circuit for a short to ground or an open/high resistance. If

the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition voltage circuit and replace as necessary.

3. Crank or start the engine. Test for 200-400 mV between the appropriate ignition control circuit terminal C or 1 and ground.
 - If less than the specified value, test the ignition control circuit for a short to ground or an open/high resistance. If the circuit/connection tests normal, replace the K20 ECM.
 - If greater than the specified value, test the ignition control circuit for a short to voltage. If the circuit/connection tests normal, replace the K20 ECM.
4. Ignition OFF, all vehicle systems OFF, this may take up to 2 min, test for less than 5 ohms between the low reference circuit terminal B or 3 and the K20 ECM housing.
 - If greater than the specified value, test for an open/high resistance in the low reference circuit. If the circuit/connection tests normal, replace the K20 ECM.
5. Test for less than 5 ohms between the ground circuit terminal A or 4 and ground.
 - If greater than the specified value, test for an open, or high resistance in the ground circuit.
6. Remove the T8 ignition coil from the engine. Connect the harness.
7. Remove the fuse for the fuel pump or the fuel pump control module, if equipped.
8. Crank the engine and test for strong spark using the **EL 26792**: Tester.
 - If no spark or weak spark is observed, replace the T8 ignition coil.

REPAIR PROCEDURES

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**
- **Control Module References** for ECM replacement, setup, and programming

INSPECTION/MAINTENANCE SYSTEM CHECK

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DESCRIPTION

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and the inspection/maintenance (I/M) emission inspection in order to renew license plates. This is accomplished by viewing the I/M System Status display on a scan tool. Using a scan tool, the technician can observe the I/M System Status in order to verify that the vehicle meets the criteria that complies with the local area requirements. While testing in the I/M System Status mode, some DTCs may occur that are called I/M Test DTCs. An I/M Test DTC is defined as a fault code that is currently commanding the MIL ON, and is stored in

non-volatile memory. The intended use of this data is to prevent vehicles from passing I/M inspection without proper repair to the vehicle. These fault codes are not erasable from any scan tool command or erasable by disconnecting power to the controller. The I/M Test DTCs will be supported by all emissions related ECUs such as ECMs, TCMs, FPCMs, etc. An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing which occurs 5 s after ignition OFF.

CONDITIONS FOR UPDATING THE I/M SYSTEM STATUS

Each system requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a diagnostic trouble code (DTC). A system monitor is complete when either all of the DTCs comprising the monitor have Run and Passed, or any one of the DTCs comprising the monitor have illuminated the malfunction indicator lamp (MIL). Once all of the tests are completed, the I/M System Status display will indicate YES in the Completed column.

For example, when the HO2S Heater Status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has four heated oxygen sensors, either all four heater circuit tests have passed or one of the heater circuit tests has illuminated the MIL. The I/M System Status will indicate NO under the Completed column when any of the required tests for that system have not run. The following is a list of conditions that would set the I/M System Status indicator to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the tests.
- The battery has been disconnected or discharged below operating voltage.
- The control module power or ground has been interrupted.
- The control module has been reprogrammed.
- The control module DTCs have been cleared as part of a service procedure.

CONDITIONS FOR CLEARING I/M TEST DTCs

1. Only the OBD II System can erase the I/M Test DTC. The OBD II system must determine that the malfunction that caused the I/M Test DTC to be stored is no longer present and is not commanding the MIL. Each of the following represents ways to clear an I/M Test DTC:
 - If the MIL goes out due to 3 passing drive cycles, scan tool code clear is not used, the I/M Test DTC is erased at power down of the last drive cycle.
 - If a scan tool code clear is used to turn OFF the MIL, the I/M Test DTC is not erased, the DTC must PASS and not FAIL. The I/M Test DTC is erased at power down of the drive cycle.
 - If the controller is reflashed/reprogrammed, all I/M Test DTCs are erased.
2. For the OBD II System to run a single drive cycle for clearing an I/M Test DTC, all of the following conditions must occur:
 - Cumulative time of engine run time is greater than 600 s.
 - Cumulative vehicle operation above 41 kPa (25 mph) for over 300 s.
 - Continuous vehicle idle for greater than 30 s.
 - Turn ignition OFF for 5 s and allow the code to clear.

MONITORED EMISSION CONTROL SYSTEMS

The OBD II system monitors all emission control systems that are on-board. Not all vehicles need every possible emission control system. For example, a vehicle may not be equipped with secondary air injection (AIR) or exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following; if equipped:

- The air conditioning system
- The catalytic converter efficiency
- Comprehensive component monitoring-Emission related inputs and outputs
- The evaporative emission (EVAP) system
- The fuel delivery system
- Heated catalyst monitoring
- Misfire monitoring
- The oxygen sensor system (O2S or HO2S)
- The oxygen sensor heater system (HO2S heater)

For the specific DTCs required for each system, refer to **Inspection/Maintenance System DTC Table**. Systems such as misfire and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an I/M System Status indicator.

DIAGNOSTIC AIDS

The I/M System Status display provides an indication of when the control module has completed the required tests. This does not necessarily mean that the test has passed, only that a decision was made. If the diagnostic fails, a DTC will indicate the failure. If a failure indication is present for a DTC associated with one of the I/M regulated systems, it may prevent other required tests from running. For example, a DTC for the control circuit of the EVAP purge solenoid may not be listed in the Inspection/Maintenance System DTC Table because it is a continuous test. If this DTC is set, the Active Tests for the EVAP system may not run.

The I/M System Status information may be useful for a technician to determine if diagnostics have run when verifying repairs.

CIRCUIT/SYSTEM VERIFICATION

Review the I/M System Status indicators. All I/M System Status indicators should report YES, and no I/M Test DTCs should be present.

CIRCUIT/SYSTEM TESTING

NOTE: Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the I/M System Status indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.

1. Observe the Engine DTC information with a scan tool. Verify no DTCs are present.
 - If a DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC

before continuing. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.
 - If a control module re-program or other repair is required, perform the **Inspection/Maintenance Complete System Set Procedure**.
3. Observe the I/M System Status indicators.
 - If any I/M System Status indicators report NO, perform the **Inspection/Maintenance Complete System Set Procedure**.
4. Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.
 - If an I/M Test DTC is set and all of the I/M System Status indicators are Yes, there is no need to perform the Complete System Set Procedure. Diagnose the DTC using the **Diagnostic Trouble Code (DTC) List - Vehicle** and refer to Conditions for Clearing the I/M Test DTCs.
 - If an I/M Test DTC is set and the I/M System Status indicators are NO, diagnosis the DTC and perform the **Inspection/Maintenance Complete System Set Procedure**.

INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DESCRIPTION

The purpose of the Inspection/Maintenance (I/M) complete system set procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics and complete the trips for those particular diagnostics. When all I/M monitored diagnostic tests are completed, the I/M System Status indicators are set to YES. Perform the Inspection/Maintenance (I/M) Complete System Set Procedure if any I/M System Status indicators are set to NO.

CONDITIONS FOR MEETING A COLD START

- The ignition voltage between 10 and 15 V.
- The barometric pressure (BARO) is more than 75 kPa (10.9 psi).
- The engine coolant temperature (ECT) at start-up is less than 42°C (108°F).
- The intake air temperature (IAT) is between 2-32°C (36-90°F).
- The engine is OFF for greater than 6 hours or the following conditions must be met:
 - The start-up IAT minus start-up ECT are within 12°C (22°F).
 - The start-up ECT minus start-up IAT are within 50°C (90°F).
- Fuel level is between 25 and 75 %.

CIRCUIT/SYSTEM VERIFICATION

Review the Inspection/Maintenance (I/M) System Status indicators. All I/M System Status indicators should report YES, and no I/M Test DTCs should be present.

INSPECTION/MAINTENANCE (I/M) SYSTEM SET PROCEDURE

1. Ensure that the vehicle meets the conditions for a cold start listed above.
 - If the EVAP I/M System Status indicator displays NO, perform the EVAP Service bay test if applicable.
2. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc., and open the hood.
3. Set the vehicle parking brake and ensure the vehicle is in park for automatic transmission or neutral for manual transmission.
4. Start and idle the engine for 2 min.

WARNING: Refer to Road Test Warning .

5. Close the hood, release the parking brake and Accelerate at part throttle to 72-80 km/h (45-50 mph) with this speed maintained until the engine reaches operating temperature, 8-10 min.
6. Continue operation under these conditions for an additional 6 min.
7. Accelerate at part throttle to 90 km/h (55 mph) with this speed maintained for 2 min.
8. Release the accelerator pedal for at least 10 s. This will allow the vehicle to enter the decel fuel cut off.

NOTE: Do NOT touch the accelerator pedal until told to do so. A change in TP Sensor angle or an increase in engine speed may invalidate this portion of the test.

9. Safely stop the vehicle, with the engine in drive for automatic or neutral with the clutch pedal depressed and parking brake applied for manual. Allow the vehicle to idle for 2 min.
10. Shift the vehicle to park for automatic and neutral for manual. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 45 min.
11. Observe the Inspection/Maintenance (I/M) System Status with a scan tool. All of the I/M System Status indicators should display YES.
 - If the EVAP I/M System Status indicator displays NO, turn OFF the ignition, ensure that the vehicle meets the conditions for a cold start, and repeat steps 6-11 three more times, or until the EVAP I/M System Status indicator transitions to YES. If the indicator continues to display NO, refer to the **Inspection/Maintenance System DTC Table** to identify the DTCs that did not run.
 - If any of the I/M System Status indicators display NO, refer to the **Inspection/Maintenance System DTC Table** for the indicator which did not display YES. The I/M System DTC Table identifies the DTCs associated with each I/M System Status Indicator.

NOTE: An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing, which occurs 5 s after ignition OFF.

12. Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.
 - If an I/M Test DTC is set, diagnose the DTC using the **Diagnostic Trouble Code (DTC) List - Vehicle** and refer to **Inspection/Maintenance System Check**.
13. Observe the engine DTC information with a scan tool. Verify no DTCs are present.
 - If a DTC is set, diagnose using the **Diagnostic Trouble Code (DTC) List - Vehicle** . After repairs, perform the **Inspection/Maintenance Complete System Set Procedure** to verify no further DTCs are set.

INSPECTION/MAINTENANCE SYSTEM DTC TABLE

System	DTCs Required to Set System Status to YES
If an I/M System Status indicator did NOT update to YES during the <u>Inspection/Maintenance Complete System Set Procedure</u> , review each indicator and reference this table to determine each DTC associated with the I/M System Status Indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included within the conditions are additional DTCs, which if set, may inhibit the DTCs listed below from running. Reviewing and operating the vehicle within the Conditions for Running for each DTC listed below will allow the I/M System Status Indicators to transition to YES.	
Catalyst	<u>DTC P0420 or P0430</u>
EVAP	• <u>DTC P0442</u> • <u>DTC P0446</u> • <u>DTC P0451-P0454 (w/LF1, LFW)</u> • <u>DTC P0455 (w/LF1, LFW)</u> • <u>DTC P0496</u>
Oxygen Sensor	• <u>DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, P0158, P2A00, P2A01, P2A03, or P2A04 (LF1)</u> • <u>DTC P0133, P013A-P013F, P014A, P014B, P0153, P1133, or P1153 (LF1)</u> • <u>DTC P0134, P0140, P0154, or P0160 (LF1)</u> • <u>DTC P2270 or P2272 (w/LF1)</u> • <u>DTC P2271 or P2273 (w/LF1)</u>
Oxygen Sensor Heater	<u>DTC P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0135, P0141, P0155, or P0161 (LF1)</u>
Camshaft System	<u>DTC P0011, P0014, P0021, or P0024 (LF1, LFW)</u>

SERVICE BAY TEST

DIAGNOSTIC INSTRUCTIONS

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DESCRIPTION

The purpose of the evaporative emission (EVAP) Service Bay Test is to aid in resetting the EVAP inspection/maintenance system status. For this vehicle that is equipped with the engine off natural vacuum diagnostic, the Service Bay Test uses the scan tool to initiate the engine control module (ECM) regular sequence of EVAP system DTC tests, but with different enable criteria. By using the Service Bay Test the inspection/maintenance indicator can be set without the need for multiple cold soaks.

The scan tool displays for the Service Bay Test are based on the events that occur within the following three categories:

- The engine running portion of the tests-The vehicle must remain at rest, in Park, or in Neutral, during this portion of the test. This test inspects for large leaks, a leaking purge valve and/or vent system restrictions. The scan tool will display test progress or the reason for an abort or failure.
- Drive cycle-The scan tool will display time and distance needed to warm the fuel.
- Ignition OFF-During this portion of the test, the engine controller will remain active for up to 45 minutes when the ignition is turned OFF to allow control of the EVAP canister vent valve and run the engine off natural vacuum test. The engine controller inspects for small leaks during this period by monitoring fuel tank pressure or vacuum. If the system is sealed, there will be a pressure or vacuum change. Pressure or vacuum changes that are less than the calibrated values indicate a leak.

When the EVAP diagnostics are initiated by the Service Bay Test, the scan tool will indicate if the enable conditions listed below are not met, or will display a specific reason if the test aborts. When complete, the display will indicate that the tests passed or failed.

CONDITIONS FOR RUNNING THE TEST

The following conditions must be met in order to enable the Service Bay Test:

- The battery voltage is between 11-18V.
- The engine coolant temperature (ECT) is less than 35°C (95°F) at start-up.
- The EVAP inspection/maintenance system status indicator is set to NO.
- The fuel level is 15-85 percent capacity and cannot be refueled during the tests.
- There are no DTCs displayed.
- The vehicle must be driven for the time and distance specified on the scan tool.
- The ambient air temperature is between 0-40°C (32-104°F).
- The ignition must remain OFF during the engine OFF portion of the test, and the vehicle must remain at rest.

TEST PROCEDURE

NOTE: If the Service Bay Test aborts or fails, a DTC will NOT be set.

1. Install a scan tool.
2. Select the Service Bay Test with the scan tool.

WARNING: Refer to Road Test Warning .

3. Follow the instructions on the scan tool.
 - If the test aborts, correct the condition for running the test, then retest.
 - If the test fails, repair the vehicle for the condition indicated by the failure message on the scan tool.
4. Verify that the EVAP inspection/maintenance system status is set to YES.