

2013 ENGINE PERFORMANCE

Engine Controls/Fuel - 2.4L (LUK) - Description and Operation - Malibu

DESCRIPTION AND OPERATION

ENGINE CONTROL MODULE DESCRIPTION

The Engine Control Module (ECM) interacts with many emission related components and systems, and monitors 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 ECM is part of a network and communicates with various other vehicle control modules.

Malfunction indicator lamp (MIL) operation and 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 the control center of the engine controls system. Review the components and wiring diagrams in order to determine which systems are controlled by the ECM.

The ECM constantly monitors the information from various sensors and other inputs, and controls the systems that affect engine performance and emissions. The ECM also performs diagnostic tests on various parts of the system and can turn on the MIL when it recognizes an operational problem that affects emissions. 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 ECM can supply 5 V or 12 V to various sensors or switches. This is done through pull-up resistors to regulated power supplies within the ECM. In some cases, even an ordinary shop voltmeter will not give an accurate reading due to low input resistance. Therefore, a digital multimeter (DMM) with at least 10 megaohms 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 transistors or a device called an output driver module.

EEPROM

The electronically erasable programmable read only memory (EEPROM) is an integral part of the ECM. The EEPROM contains program and calibration information that the ECM needs in order to control engine 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) provides serial data communication for ECM diagnosis. This connector allows the technician to use a scan tool in order to monitor various serial data parameters, and display DTC

information. The DLC is located inside the driver's compartment, underneath the instrument panel.

Malfunction Indicator Lamp (MIL)

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

ECM Service Precautions

The ECM, by design, can withstand normal current draws that are associated with 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 unless the diagnostic procedure instructs otherwise.

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 vehicle's on-board diagnostic system (ECM) detect a condition that could result in excessive emissions, the ECM turns ON the 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 12 V 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 vehicle's 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 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. These electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 V of static electricity can cause damage to some electronic components. By comparison, it takes as much as 4,000 V for a person to even feel a static discharge.

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. This identifies the year, the displacement of the engine in liters, and the class of the vehicle.

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).

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

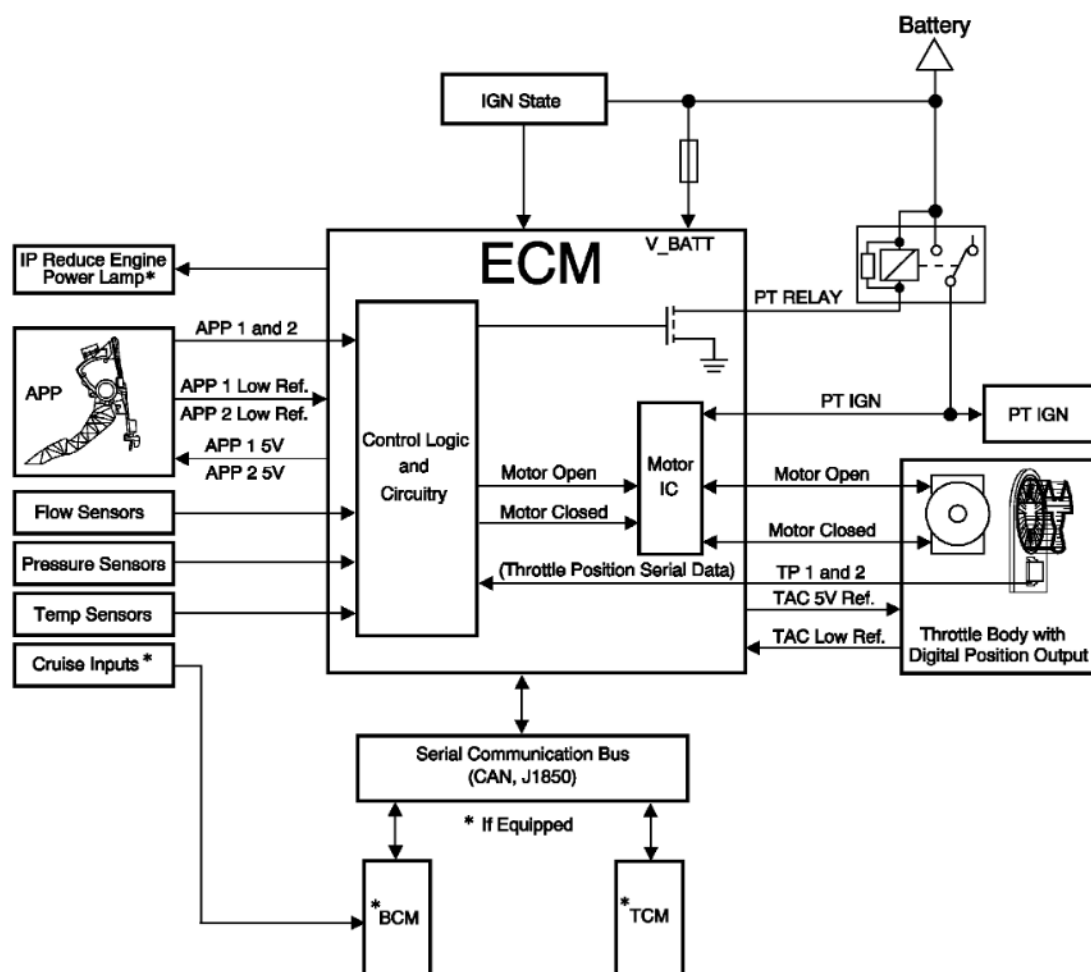


Fig. 1: Throttle Actuator Control (TAC) System Diagram
 Courtesy of GENERAL MOTORS COMPANY

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.
- Battery saver mode-After a predetermined time without engine speed, 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 the idle position
 - Ignore the accelerator pedal input.
- Engine shutdown mode-The ECM will disable fuel and de-energize the throttle actuator.

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

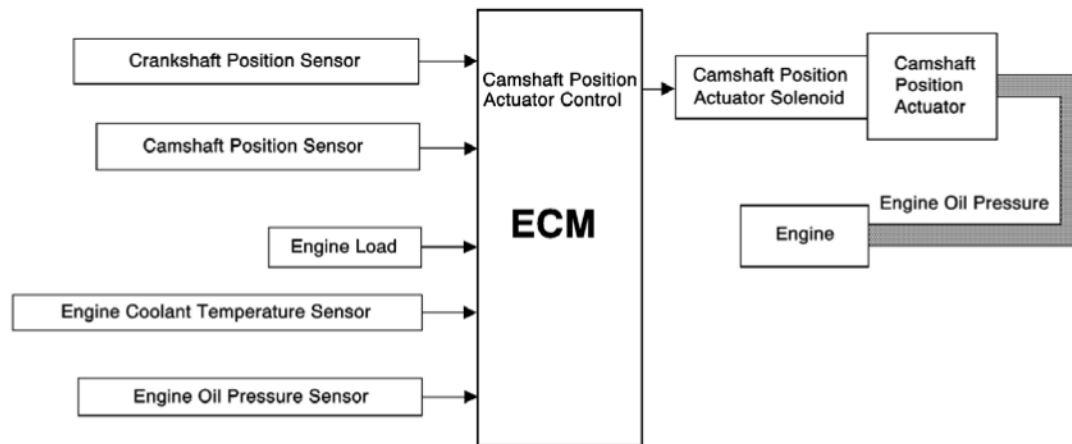


Fig. 2: Camshaft Actuator System Description
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Position (CMP) Actuator System

The camshaft position (CMP) actuator system is an electro-hydraulic operated device used for a variety of engine performance and operational enhancements. These enhancements include lower emission output through exhaust gas dilution of the intake charge in the combustion chamber, a broader engine torque range, and improved fuel economy. The CMP actuator system accomplishes this by changing the angle or timing of the camshaft relative to the crankshaft position. The CMP actuator simply allows earlier or later intake and exhaust valve opening during the four stroke engine cycle. The CMP actuator cannot vary the duration of valve opening, or the valve lift.

During engine OFF, engine idling conditions, and engine shutdown, the camshaft actuator is held in the Park position. Internal to the CMP actuator assembly is a return spring and a locking pin. During non-phasing modes of the camshaft, the return spring rotates the camshaft back to the Park position, and the locking pin retains the CMP actuator sprocket to the camshaft.

CMP Actuator System Operation

The CMP actuator system is controlled by the engine control module (ECM). The ECM sends a signal to a CMP actuator solenoid in order to control the amount of engine oil flow to a Cam Actuator passage. The pressurized engine oil is sent to unseat the locking pin, and to the vane and rotor assembly of the CMP actuator. There are 2 different passages for oil to flow through, a passage for cam advance and a passage for cam retard. The Cam Actuator is attached to a camshaft and is hydraulically operated in order to change the angle of the camshaft relative to crankshaft position (CKP). Engine oil pressure (EOP), viscosity, temperature and engine oil

level can have an adverse affect on Cam Actuator performance.

FUEL SYSTEM DESCRIPTION

Fuel System Overview

The fuel system is an electronic returnless on-demand design. The 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 tank 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. The 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 fuel pressure sensor located on the fuel feed pipe 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 fuel pressure sensor located on the fuel feed pipe provides fuel pressure feedback to the fuel pump flow control module.

Fuel Pressure Sensor

The fuel pressure sensor is a serviceable 5 V, 3-pin device. It is located on the fuel feed pipe 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 Tank Fuel Pump Module

The electric turbine style fuel pump attaches to the fuel tank fuel pump module inside the fuel tank and supplies fuel through the fuel feed pipe to the high pressure fuel pump. The fuel tank 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.

The fuel tank fuel pump module consists of the following major components:

- The fuel level sensor
- The fuel pump and reservoir assembly
- The fuel filter
- The pressure relief regulator valve

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.

Fuel Pump

The fuel pump is mounted in the fuel tank fuel pump module reservoir. The fuel pump is an electric turbine style pump which pumps fuel 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.

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 may 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

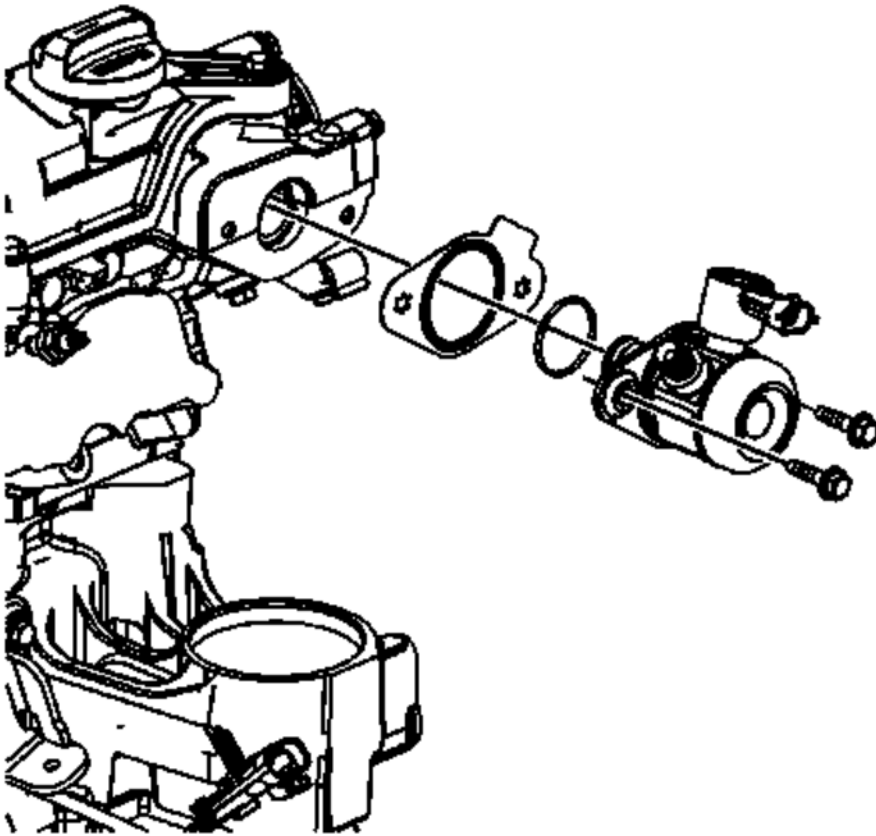


Fig. 3: High Pressure Fuel Pump & Bolts
Courtesy of GENERAL MOTORS COMPANY

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The pump is mounted on the rear of the engine and is driven by a three-lobe cam on the camshaft. This pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 to 15 MPa (290 to 2176 psi), depending on engine speed and load. Output drivers in the ECM provide the pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail. When the control solenoid is NOT powered, the pump operates at maximum flow rate. In the event of pump control failure, the high pressure system is protected by a relief valve in the pump.

Fuel Rail Assembly

The fuel rail assembly attaches to the cylinder head and distributes the 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 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.

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 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 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 ECM monitors voltages from several sensors in order to determine how much fuel to give the engine. The ECM 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

The 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 tank fuel pump module and also supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line pressure. The ECM 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, the engine can be cleared by pressing the accelerator pedal down to the floor and then cranking the engine. When the throttle position sensor is at wide open throttle (WOT), the ECM reduces the fuel injector pulse width in order to increase the air to fuel ratio. The ECM 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 ECM 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 ECM ignores the signal from the heated oxygen sensor (HO2S). The ECM 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 ECM 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 ECM increases the pulse width to the injectors to provide extra fuel during acceleration. This is also known as power enrichment. The ECM determines the amount of fuel required based upon throttle position, engine coolant temperature (ECT), manifold absolute pressure (MAP), mass air flow (MAF), and engine speed.

Deceleration Mode

When the driver releases the accelerator pedal, air flow into the engine is reduced. The ECM monitors the corresponding changes in throttle position, mass air flow (MAF), and manifold absolute pressure (MAP). The ECM 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 ECM 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 ECM 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 ECM controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The ECM 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 ECM is adding fuel in order to compensate for a lean condition by increasing the pulse width. A negative fuel trim value indicates that the ECM 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 ECM selects the cells based on the engine speed and engine load. If the ECM detects an excessively lean or rich condition, the ECM will set a fuel trim diagnostic trouble code (DTC).

EVAPORATIVE EMISSION CONTROL SYSTEM DESCRIPTION

Typical Evaporative Emission (EVAP) System Hose Routing Diagram

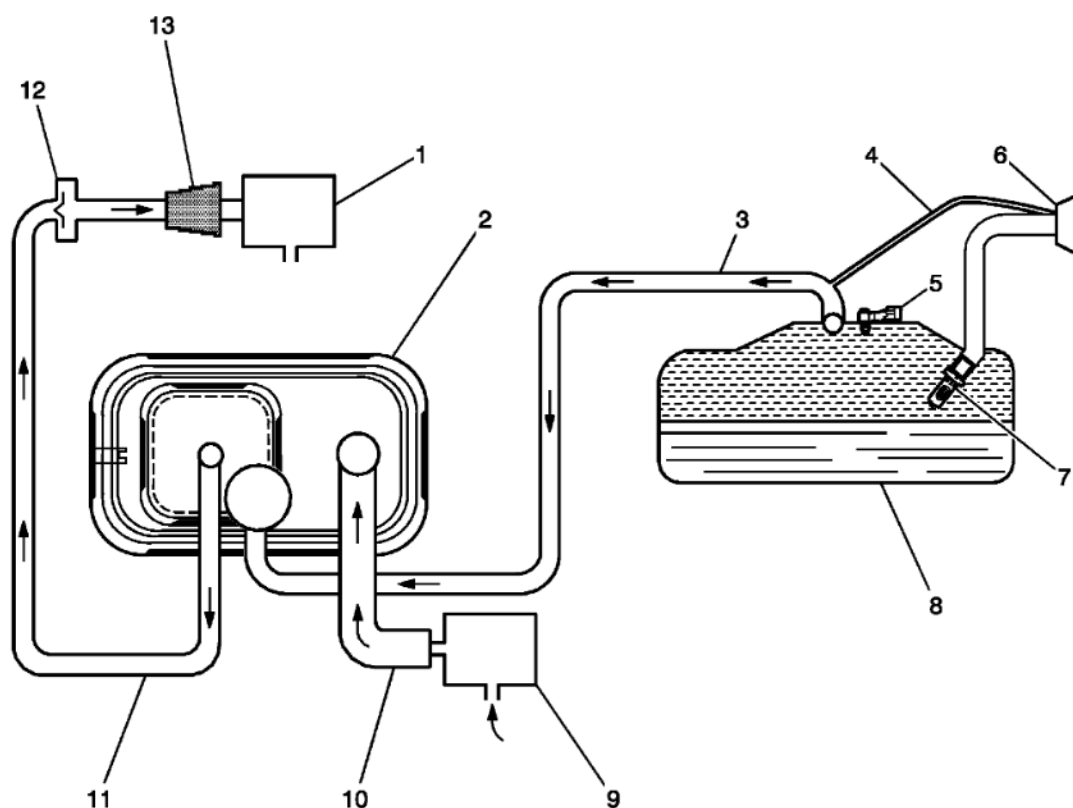


Fig. 4: View Of Evaporative Emission (EVAP) System Hose Routing Diagram
Courtesy of GENERAL MOTORS COMPANY

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 (Some Vehicles May Have A Capless Design)
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 Only
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 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 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 ECM uses several tests to determine if the EVAP system is leaking or restricted.

Purge Solenoid Valve Leak Test

If the 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 vent solenoid valve ON which seals the system. With the engine running, the ECM then monitors the fuel tank pressure (FTP) 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 ECM commands the normally open EVAP vent solenoid valve closed and the EVAP purge solenoid valve open, creating a vacuum in the EVAP system. The ECM then monitors the FTP 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 EVAP vent system is restricted, fuel vapors will not be properly purged from the EVAP canister. The ECM tests this by commanding the EVAP purge solenoid valve ON while commanding the EVAP vent solenoid valve OFF, and then monitoring the FTP 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 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 ECM to remain active for up to 40 min 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 EVAP system consists of the following components:

EVAP Purge Solenoid Valve

The EVAP 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 ECM. This normally closed valve is pulse width modulated (PWM) by the ECM 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 ECM 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 either end of the system.

Fuel Tank Pressure Sensor

The FTP sensor measures the difference between the pressure or vacuum in the fuel tank and outside air pressure. The ECM provides a 5 V reference and a ground to the FTP 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 FTP sensor provides a signal voltage back to the ECM that can vary between 0.1-4.9 V. A high FTP sensor voltage indicates a low fuel tank pressure or vacuum. A low FTP 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 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.

Capless Fuel Fill

Some vehicles may have a capless fuel fill design behind a locking fuel door. There is no fuel fill cap to remove. One just fully inserts the fuel nozzle into the fill neck, making sure it latches before refueling. Flapper valves close to seal this interface once the fill nozzle is removed.

ELECTRONIC IGNITION SYSTEM DESCRIPTION

The electronic ignition 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 mass air flow (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 electronic ignition 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.

The ECM also has a dedicated replicated crankshaft position sensor signal output circuit that may be used as an input signal to other modules for monitoring engine RPM.

Camshaft Position Sensor

This engine uses a camshaft position sensor for each camshaft. The camshaft position sensor signals are a digital ON/OFF pulse and 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 1 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 depend 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 amount of time otherwise known as 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:

- Throttle position sensor
- Engine coolant temperature (ECT) sensor
- Mass air flow (MAF) sensor
- Intake air temperature (IAT) sensor

- Vehicle speed sensor (VSS)
- Transmission gear position or range information sensors
- Engine knock sensors
- Ambient pressure sensor (BARO)

SECONDARY AIR INJECTION SYSTEM DESCRIPTION

The Secondary Air Injection System aids in the reduction of hydrocarbon exhaust emissions during a cold start. This occurs when the start-up engine coolant temperature (ECT) is between -10 to +56°C (14-133°F), the intake air temperature (IAT) is greater than -10°C (14°F) and it has been more than 60 minutes since the last engine start. The secondary air injection pump operates 5-60 s after start-up.

The engine control module (ECM) activates the secondary air injection system by simultaneously completing the ground paths for the secondary air injection pump relay and the secondary air injection solenoid (shutoff and check) valve relay. This action closes the relays' internal contacts. The pump and both valves are in turn energized. The pump turns ON and both valves open.

The secondary air injection pump sends pressurized filtered fresh air into the pipes/hoses, through the open valves and into the exhaust manifold(s). The extra air accelerates the catalyst operation, helping it to reach operating temperature faster. The secondary air injection pump remains ON for a short period of time after the valves are commanded OFF. When the pump is commanded OFF it will not run or be activated until the next vehicle cold start. When the secondary air injection system is inactive, the valves are closed to prevent air/exhaust flow in either direction.

The ECM monitors the secondary air injection system pressure by tracking voltage signals from the pressure sensors, which are integral to the solenoid (shutoff and check) valve assemblies.

The ECM utilizes a 3 phase diagnostic routine to test the secondary air injection system:

During phase 1, DTCs P0411, P2430 and P2435 run and both the secondary air injection pump and the solenoid (shutoff and check) valves are activated. Normal secondary air function occurs. Expected system pressure is 5-13 kPa (0.7-1.9 psi) above BARO.

During phase 2, DTCs P2430, P2435 and P2440 run and only the secondary air injection pump is activated. The valves are closed. Pressure sensor performance and valve deactivation are tested. Expected system pressure is 14-22 kPa (2.0-3.2 psi) above BARO.

During phase 3, DTC P2444 runs and neither the secondary air injection pump nor the valves are activated. Secondary air injection pump deactivation is tested. Expected system pressure equals BARO.

The secondary air injection system includes the following components:

- The secondary air injection pump-The electric secondary air injection pump supplies pressurized, filtered air to the secondary air injection solenoid (shutoff and check) valves. The secondary air injection pump is a turbine type pump that is permanently lubricated and requires no periodic maintenance.

NOTE: **The secondary air injection solenoid valve and the pressure sensor are serviced as an assembly.**

- The secondary air injection solenoid (shutoff and check) valve assemblies-The valve assemblies have direct current (DC) motor operated valves. When the valve motors are energized by the secondary air injection solenoid valve relay, the valves open, pressurized air from the secondary air injection pump flows through the valves and is directed into the exhaust manifold(s).
- The secondary air injection pressure sensors-The pressure sensors are integral to the secondary air injection solenoid valve assemblies. The sensors are 3-wire sensors that measure the secondary air injection system pressure at the inlets of the valve assemblies.
- The secondary air injection pump relay-The relay supplies high current and battery voltage to the secondary air injection pump. The ECM commands the relay ON by supplying a ground to the relay control circuit.
- The secondary air injection solenoid valve relay-The relay supplies high current and battery voltage to the secondary air injection solenoid valves. The ECM commands the relay ON by supplying a ground to the relay control circuit.
- The pipes and hoses-The secondary air injection pump inlet hose carries filtered air from the engine intake air cleaner to the secondary air injection pump inlet. The secondary air injection pump pipe carries the air from the pump outlet to the solenoid valves which in turn feed the exhaust manifold(s).

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2013 ENGINE PERFORMANCE

Engine Controls/Fuel - 2.4L (LUK) - Diagnostic Information and Procedures - Malibu

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0411

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 P0411

Secondary Air Injection System Incorrect Air Flow Detected

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. A pressure sensor in each shutoff/check valve is used to monitor the air flow from the secondary air injection pump. The engine control module (ECM) supplies voltage to the 5-volt reference circuits and supplies a ground to the low reference circuits. The sensors provide a signal voltage to the ECM relative to the pressure changes within the secondary air injection system.

Ignition voltage is supplied to the secondary air injection pump and air injection shutoff/check valve relays. The ECM controls the relays by grounding the control circuits, which activates the relays. When the relay contacts close, voltage is supplied to the pump and the valves, which turns the pump on and opens the valves.

The diagnostic uses 3 phases to test the secondary air injection system:

- DTCs P0411, P2430 and P2435 run during Phase 1
- DTCs P2430, P2435 and P2440 run during Phase 2
- DTC P2444 runs during Phase 3

During phase 1, the secondary air injection pump and both secondary air injection shutoff and check valves are activated. Normal secondary air function occurs. Expected system pressure is 5-11 kPa (0.7-1.6 psi) above BARO. Relatively high magnitude of pressure pulses are expected due to exhaust pulses. Low magnitude pressure pulses indicate a blockage or disconnect downstream of the valve.

During phase 2, only the secondary air injection pump is activated. The shutoff and check valves are closed. Pressure sensor performance and shutoff and check valve deactivation are tested. Expected system pressure is

14-22 kPa (2.0-3.2 psi) above BARO.

During phase 3, neither the secondary air injection pump nor the secondary air injection shutoff and check valves are activated. Secondary air injection pump deactivation is tested. Expected system pressure equals BARO.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0351, P0352, P0353, P0354, P0412, P0418, P0420, P0606, P0641, P0651, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2430, P2431, P2432, P2433, P2435, P2436, P2437, or P2438 is not set.
- Greater than 60 min has elapsed since the last cold start.
- Ignition voltage is between 10-32 V.
- Engine speed is less than 5,000 RPM.
- Intake air temperature (IAT) is greater than -10°C (+14°F).
- Engine coolant temperature (ECT) is between -10 and +56°C (14-133°F).
- Barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- Manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- Mass air flow (MAF) is less than 50 g/s.
- Secondary air injection pump is commanded ON.
- DTC P0411 runs once per ignition cycle when the above conditions are met for greater than 7 s.

Conditions for Setting the DTC

- The actual system pressure at either shutoff/check valve is at least 7 kPa (1.0 psi) greater or 7 kPa (1.0 psi) less than the predicted system pressure for greater than 7 s.

OR

- The difference between the predicted magnitude of pressure pulsations and the actual magnitude of pressure pulsations, at either shutoff/check valve over a specific length of time, exceeds a calibrated threshold.

Action Taken When the DTC Sets

DTC P0411 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0411 is a Type B DTC.

Diagnostic Aids

Ice buildup due to condensation/water in the air passages or pump may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection 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

J-36169-HD Fused Jumper

Circuit/System Verification

NOTE: Verify the battery is fully charged before proceeding with this diagnostic procedure. The secondary air injection pump output will vary with system voltage.

1. Ignition ON
2. Verify that DTC P0412, P0418, P2430, P2431, P2432, P2433, P2235, P2236, P2237, P2238, P2440, or P2444 is not set.
 - If any of the DTCs are set

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- If none of the DTCs are set.

3. Verify the scan tool BARO pressure parameter is within the range specified in the Altitude Versus Barometric Pressure table.

- If not within the specified range

Refer to DTC P0106 .

- If within the specified range

NOTE: Engine coolant temperature must be greater than 5°C (41°F) to enable scan tool device control. Repeat multiple times to verify secondary air injection shutoff and check valve operation.

4. Verify the secondary air injection shutoff and check valves turn ON and OFF when commanding the Secondary Air Injection Solenoid Valve between ON and OFF with a scan tool.

- If the valves do not operate as specified

Refer to Circuit/System Testing below -Secondary Air Injection Shutoff and Check Valve Malfunction.

- If the valves operate as specified

NOTE: To prevent the secondary air injection pump from overheating, do not operate the pump consecutively for greater than 2 minutes. The pump is provided with a thermal protector that will automatically reset when allowed to cool.

5. Verify the G21 Secondary Air Injection Pump turns ON and OFF when commanding the Secondary Air Injection Pump Relay between ON and OFF with a scan tool.

- If the pump does not operate as specified

Refer to Circuit/System Testing below -Secondary Air Injection Pump Malfunction.

- If the pump operates as specified

6. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 (left hand), Bank 2 (right hand) and the BARO pressure parameters are within 3 kPa (0.4 psi).

- If not within the specified range

Refer to Circuit/System Testing below -Secondary Air Injection System Pressure Not In Range.

- If within the specified range

7. Engine running

8. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 (left hand) and Bank 2 (right hand) parameters increase between 14-22 kPa (2.0-3.2 psi), greater than BARO, when the Secondary Air

Injection Pump Relay is commanded ON with a scan tool.

- **If not within the specified range**

Refer to Circuit/System Testing below -Secondary Air Injection System Pressure Not In Range.

- **If within the specified range**

9. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 (left hand) and Bank 2 (right hand) parameters increase between 5-11 kPa (0.7-1.6 psi), greater than BARO, when the Secondary Air Injection System is commanded ON with a scan tool.

- **If not within the specified range**

Refer to Circuit/System Testing below -Secondary Air Injection System Pressure Not In Range.

- **If within the specified range**

10. 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.
11. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing below.

- **If the DTC does not set**

12. All OK

Circuit/System Testing

Secondary Air Injection Shutoff and Check Valve Malfunction

1. Ignition OFF, disconnect the KR26 Secondary Air Injection Solenoid Valve Relay.
2. Verify a test lamp illuminates between the B+ circuit terminal 87 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Disconnect the harness connector at the appropriate Q29 Secondary Air Injection Solenoid Valve.
 4. Test for infinite resistance between the control circuit terminal 5 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance
- 5. Test or replace the Q29 Secondary Air Injection Solenoid Valve.
 - **If the test lamp illuminates**
- 3. Disconnect the harness connector at the appropriate Q29 Secondary Air Injection Solenoid Valve.
- 4. 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 10 ohms between the Q29 Secondary Air Injection Solenoid Valve ground circuit terminal 4 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
- 5. Connect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
- 6. Connect a 10 A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30.
- 7. Verify the Q29 Secondary Air Injection Solenoid Valves are activated.
 - **If a Q29 Secondary Air Injection Solenoid Valve does not activate**
 1. Ignition OFF, disconnect the harness connector at the appropriate Q29 Secondary Air Injection Solenoid Valve.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, test or replace the Q29 Secondary Air Injection Solenoid Valve.
 - **If the Q29 Secondary Air Injection Solenoid Valves activate**
- 8. Test or replace the KR26 Secondary Air Injection Solenoid Valve Relay.

Secondary Air Injection Pump Malfunction

1. Ignition OFF, disconnect the KR25 Secondary Air Injection Pump Relay.
2. Verify a test lamp illuminates between the B+ circuit terminal 87 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance

3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
4. Test for infinite resistance between the control circuit terminal A and ground.
 - o If less than infinite resistance, repair the short to ground on the circuit.
 - o If infinite resistance
5. Test or replace the G21 Secondary Air Injection Pump.
 - o **If the test lamp illuminates**
3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
4. 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 10 ohms between the G21 Secondary Air Injection Pump ground circuit terminal B and ground.
 - o **If 10 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - o If 2 ohms or greater, repair the open/high resistance in the circuit.
 - o If less than 2 ohms, repair the open/high resistance in the ground connection.
 - o **If less than 10 ohms**
5. Connect the harness connector at the G21 Secondary Air Injection Pump.
6. Connect a 50 A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30.

NOTE: To prevent the secondary air injection pump from overheating, do not operate the pump consecutively for greater than 2 minutes. The pump is provided with a thermal protector that will automatically reset when allowed to cool.

7. Verify the G21 Secondary Air Injection Pump is activated.
 - o **If the G21 Secondary Air Injection Pump does not activate**
 1. Ignition OFF, disconnect the harness connector at the G21 Secondary Air Injection Pump.
 2. Test for less than 2 ohms in the control circuit end to end.
 - o If 2 ohms or greater, repair the open/high resistance in the circuit.
 - o If less than 2 ohms,
 3. Test or replace the G21 Secondary Air Injection Pump.
 - o **If the G21 Secondary Air Injection Pump activates**
8. Test or replace the KR25 Secondary Air Injection Pump Relay.

Secondary Air Injection System Pressure Not In Range

NOTE: The exhaust manifold and exhaust manifold gasket are provided with openings, at the secondary air injection check valve adapter interfaces, which are used to regulate the system pressure and flow. Any damage or restriction to these openings may cause a DTC to set.

1. Verify the following conditions do not exist with the appropriate secondary air injection shutoff and check valve:
 - Hoses/pipes/adapters restricted or blocked
 - Hoses/pipes/adapters leaking or disconnected
 - Plugged secondary air injection pressure sensor port (integral to shutoff and check valve)
 - Damaged secondary air injection shutoff and check valve
 - Restricted or blocked cylinder head secondary air injection inlet ports and passages
 - Damaged or restricted secondary air injection check valve adapter air flow openings in exhaust manifold or gasket. Refer to **Secondary Air Injection Check Valve Pipe Adapter Replacement - Left Side**
 - **If a condition is located**

Repair or replace the affected component as necessary.

- **If all components test normal**
2. Disconnect the secondary air injection hoses/pipes from the Q29 Secondary Air Injection Solenoid Valves.
 3. Ignition ON, command the Secondary Air Injection Pump Relay ON with a scan tool.
 4. Verify airflow to the Q29 Secondary Air Injection Solenoid Valves.
 - **If no airflow**

Replace the G21 Secondary Air Injection Pump.

- **If airflow**
5. Replace the appropriate Q29 Secondary Air Injection Solenoid Valve or valves.

Component Testing

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for the following resistance between terminals 85-86.
 - 50-75 ohms-KR25 Secondary Air Injection Pump Relay
 - 70-110 ohms-KR26 Secondary Air Injection Solenoid Valve Relay
 - **If not within the specified range**

Replace the relay.

- **If within the specified range**
3. Test for infinite resistance between the terminals listed below:
 - 30 and 86
 - 30 and 87

- 30 and 85
- 85 and 87
- **If less than infinite resistance**

Replace the relay.

- **If infinite resistance**

4. Install a 15 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 ohms between terminals 30 and 87.
 - **If 2 ohms or greater**

Replace the relay.

- **If less than 2 ohms**

6. All OK

Repair Instructions

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

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Secondary Air Injection Check Valve Replacement - Left Side** for secondary air injection shutoff and check valve and pressure sensor - Left Side replacement
- **Secondary Air Injection Check Valve Replacement - Right Side** for secondary air injection shutoff and check valve and pressure sensor - Right Side replacement
- **Secondary Air Injection Pump Replacement**

DTC P0412 OR P0418

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 P0412

Secondary Air Injection Valve Control Circuit

DTC P0418

Secondary Air Injection Pump Relay Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Secondary Air Injection Pump Relay Coil Voltage Supply	P0418	P0418	P0690	-
Secondary Air Injection Pump Relay Coil Control	P0418	P0418	P0690, P2431	-
Solenoid Relay Coil Voltage Supply	P0412	P0412	P0690	-
Solenoid Relay Coil Control	P0412	P0412	P0412, P0690	-

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. Ignition voltage is supplied directly to the secondary air injection pump relay and secondary air solenoid valve relay. The engine control module (ECM) controls the relays by grounding the control circuit with a solid state device called a driver. The ECM monitors the control circuits for open, short to ground, or short to voltage conditions.

Conditions for Running the DTC

- The ignition voltage is between 10-32 V.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

DTC P0412 or P0418

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

DTC P0412, and P0418 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0412, and P0418 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 Secondary Air Injection Solenoid Valve Control Circuit and Secondary Air Injection Pump Relay Control Circuit Test Status parameters. The circuit status parameter changes 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 - INDEX

Description and Operation

Secondary Air Injection 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, command the appropriate relay ON and OFF with a scan tool. You should hear or feel a click and the corresponding secondary air injection component should turn ON and OFF.
2. Command the relay ON and OFF with a scan tool while observing the following corresponding circuit status parameters:
 - Secondary Air Injection Pump Relay Control Circuit Low Voltage Test Status
 - Secondary Air Injection Pump Relay Control Circuit Open Test Status
 - Secondary Air Injection Pump Relay Control Circuit High Voltage Test Status

OR

- Secondary Air Injection Solenoid Valve Control Circuit Low Voltage Test Status

- Secondary Air Injection Solenoid Valve Control Circuit Open Test Status
- Secondary Air Injection Solenoid Valve Control Circuit High Voltage Test Status

Each parameter should toggle between OK and 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, remove the appropriate relay.
2. Ignition ON, verify that a test lamp illuminates between the relay coil voltage supply circuit terminal 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 ignition circuit fuse is open, test all components connected to the voltage supply circuit and replace as necessary.
3. Verify a test lamp does not illuminate between the relay control circuit terminal and 12 V.
 - If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 engine control module.
4. Test for less than 1 V between the relay coil control circuit terminal and ground.
 - If greater than the specified range, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 engine control module.
5. Connect a DMM set to the diode setting between the control circuit terminal and ground.
6. Command the relay ON and OFF with a scan tool. The DMM should transition from 2.5-3.5 V 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. If the circuit tests normal, replace the K20 engine control module.
7. If all circuits test normal, test or replace the relay.

Component Testing

1. Ignition OFF, disconnect the appropriate relay.
2. Test for the following resistance between terminals 85 and 86.
 - 50-75 ohms-KR25 secondary air injection pump relay
 - 70-11 ohms-KR26 secondary air injection solenoid relay
 - If the resistance is not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
 - 86 and 87
 - 86 and 30
 - 85 and 87
 - 87 and 30

- If not the specified value, replace the relay.
- 4. Install a 15 A fused jumper wire between relay terminal 86 and B+. Install a jumper wire between relay terminal 85 and ground. Test for less than 2 ohms between terminals 87 and 30.
 - If greater than the specified range, replace the relay.

Repair Instructions

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

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for Engine Control Module replacement, programming, and setup

DTC P0420

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

Circuit/System Description

A 3-way catalyst controls emissions of hydrocarbons, carbon monoxide (CO) and nitrogen oxide (NOx). The catalyst within the converter promotes a chemical reaction, which oxidizes the hydrocarbons and the CO that are present in the exhaust gas. This process converts the hydrocarbons and the CO into water vapor and carbon dioxide (CO₂), and reduces the NOx, converting the NOx into nitrogen. The catalyst also stores oxygen. The engine control module (ECM) monitors this process by using heated oxygen sensors (HO₂S) that are in the exhaust stream before and after the 3- way catalyst. The HO₂S 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 monitoring the HO₂S during an off-idle, decel fuel cut off (DFCO) event. When the catalyst is functioning properly, the post catalyst HO₂S response to the fuel conditions during the DFCO event is slow compared to the response of the pre catalyst HO₂S. When the post HO₂S response is near that of the pre HO₂S, the oxygen storage capability and efficiency of the catalyst may be degraded below an acceptable threshold.

Conditions for Running the DTC

- DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0053, P0054, P0056, P0057, P0058, P0059, P0060, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0135, P0137, P0138, P013A, P013B, P013C, P013D, P013E, P013F, P0141, P014A, P014B, P0151, P0152, P0153, P0155, P0157,

P0158, P015A, P015B, P015C, P015D, P0161, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P1248, P1249, P124A, P124B, P124C, P124D, P16F3, P2101, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216C, P216E, P216F, P2270, P2271, P2272, or P2273 is not set.

- The engine speed is between 1, 250-2, 500 RPM to enable the catalyst diagnostic. Once the engine speed is in range, the engine speed must be between 1, 100-2, 450 RPM to keep the test enabled.
- The accelerator pedal position is at most 100 %.
- Ethanol estimation is not active.
- The evaporative emission (EVAP) purge is not active.
- The post HO2S heater is ON for greater than 180 s.
- The mass air flow (MAF) is between 2-12 g/s.
- The system voltage is between 10-32 V.
- The vehicle speed is between 67-120 km/h (42-75 MPH) to enable the catalyst diagnostic. To keep the test enabled the vehicle speed is between 60-120 km/h (37-75 MPH).
- The catalyst calculated temperature is between 600-900°C (1, 112-1, 652°F).
- The engine is operating in closed loop.
- The engine is operating in Decel Fuel Cut Off (DFCO).

This diagnostic attempts one test during each valid OFF-idle period once the above conditions have been met. This diagnostic attempts up to 3 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 is a Type A DTC.

Conditions for Clearing the DTC

DTC P0420 is a Type A DTC.

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 Verification

1. Ignition ON.
2. Verify there are no other DTCs set.
 - **If a DTC is set**

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

- **If a DTC is not set**
3. Operate the vehicle within the Conditions for Running the DTC.
4. Verify the scan tool Catalyst Monitor Not At Idle Test Conditions Met parameter changes to Yes.
 - **If Yes is not displayed**

Refer to step 3.

- **If Yes is displayed**
5. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.

NOTE: When the test has completed, the Catalyst Monitor Test Counter parameter will increment by one and the Catalyst Monitor Test Result parameter will indicate Passed, Failed or No Result.

6. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.
 - **If the Catalyst Monitor Test Result parameter indicates No Result**

Repeat steps 3-6 until the Test Result parameter indicates Passed or Failed

- **If the Catalyst Monitor Test Result parameter indicates Failed**

Refer to Circuit /System Testing below

- **If the Catalyst Monitor Test Result parameter indicates Pass**

7. All OK.

Circuit/System Testing

1. Verify the conditions listed below do not exist with the catalytic converter:

- Dents
- Severe discoloration caused by excessive temperatures
- Road damage
- Internal rattles caused by damaged catalyst substrate
- Restrictions

- **If a condition is found**

Replace the catalytic converter.

- **If no condition is found**

2. Verify the conditions listed below do not exist with the exhaust system:

- Leaks
- Physical damage
- Loose or missing hardware

- **If a condition is found**

Repair or replace the component as necessary.

- **If no condition is found**

3. Verify the conditions listed below do not exist with the B52B heated oxygen sensor 2:

- Incorrect torque
- Damage

- **If a condition is found**

Replace the B52B heated oxygen sensor 2 or repair the condition as necessary.

- **If no condition is found**

4. Test or replace the catalytic converter.

Repair Instructions

- **Exhaust Leakage**
- **Restricted Exhaust**
- **Heated Oxygen Sensor Replacement - Sensor 2**
- **Catalytic Converter Replacement (LUK) ,**

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Turn OFF the ignition for 60 s
5. Operate the vehicle within the Conditions for Running the DTC.
6. Verify the scan tool Catalyst Monitor Not At Idle Test Conditions Met parameter changes to Yes.

- **If Yes is not displayed**

Refer to step 5.

- **If Yes is displayed**

7. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.

NOTE: When the test has completed, the Catalyst Monitor Test Counter parameter will increment by one and the Catalyst Monitor Test Result parameter will indicate Passed, Failed or No Result.

8. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.

- **If the Catalyst Monitor Test Result parameter indicates No Result**

Repeat steps 5-8 until the Test Result parameter indicates Passed or Failed

- **If the Catalyst Monitor Test Result parameter indicates Failed**

Refer to Circuit /System Testing below

- **If the Catalyst Monitor Test Result parameter indicates Pass**

9. All OK.

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 (EVAP) system. This diagnostic tests the 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 (FTP) 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, P0452, P0453, 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 barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant sensor (ECT) is greater than 68°C (154°F)
- No fuel filling during the EONV test period.
- The fuel level is between 10-90%.
- The start-up engine coolant temperature (ECT) and the start-up intake air temperature (IAT) are within 8°C (46°F).
- The engine run time before engine shut-off was greater than 10 min.
- The drive distance before engine shut-off was more than 8 km (5 mi).
- The ambient air temperature at the end of the drive cycle is between 0-34°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 40 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 h if passed or 10 h if failed.

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 EVAP 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 **GE 41413-A** , move all EVAP components while observing smoke with the **GE 41413-SPT** .
- Individual components can be isolated and tested using adapters in the **GE 41413-300** .
- When servicing the EVAP system, test pressure must not exceed 13 in H2O (0.5 PSI) as pressure in excess of this could cause system components to perform inaccurately.
- A condition may exist where a leak in the EVAP 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 EVAP system and then observe the FTP Sensor parameter for vacuum decay.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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** EVAP Service Port Access Tool

- **GE 41413 A** Evaporative Emissions System Tester (EEST)
- **GE 41413 300** EVAP Cap and Plug Kit
- **GE 41413 SPT** High Intensity White Light

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Testing

NOTE:

- Refer to the **GE 41413-A** 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 or produce smoke from a leak.
- Ensure that the underbody temperature of the vehicle and the tester are similar.

1. Disconnect the purge tube at the quick connector on the EVAP canister side of the Q12 Evaporative Emission Canister Purge Solenoid Valve and install the **CH 48096** .
2. Connect the **GE 41413-A** to the **CH 48096** .
3. Command the EVAP Purge/Seal function to System Seal with a scan tool to seal the EVAP system.
4. Use the flow meter on the **GE 41413-A** , calibrated to 0.51 mm (0.020 in) to determine that there is no leak in the EVAP system.
 - If a leak is detected, use the **GE 41413-A** to apply smoke to the EVAP system at the purge tube service port until the leak is located using the **GE 41413-SPT** .
5. Repair or replace the affected component as necessary.

Repair Instructions

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

DTC P0443 OR P0449

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 Valve Control Circuit

DTC P0449

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open / High Resistance	Short to Voltage
Ignition Voltage - Purge Supply	P0030, P0031, P0033, P0036, P0050, P0051, P0102, P0132, P0135, P0152, P0155, P0443	P0030, P0031, P0050, P0051, P0443	-
Battery Positive - Vent Supply	P0449	P0449	-
EVAP Purge Solenoid Control	P0443	P0443	-
EVAP Vent Solenoid Control	P0449	P0449	P0449

Circuit/System Description

An ignition voltage is supplied directly to the evaporative emission (EVAP) purge solenoid valve. The engine control module (ECM) grounds the EVAP purge solenoid valve control circuit through an internal switch called a driver. The ECM monitors the status of the driver. The EVAP 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 vent solenoid valve. The ECM grounds the EVAP 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 vent solenoid valve as ON (Not Venting) or OFF (Venting).

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is greater than 11 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 0.25 s.

Action Taken When the DTC Sets

DTC P0443 and P0449 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTC P0443 and P0449 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: For P0443, the audible clicking intensity will vary depending on mounting locations and interference with the fuel injectors clicking. You may also feel a change in the frequency of clicking.

P0443

1. Ignition ON, engine OFF, you should hear or feel a clicking sound when the EVAP purge solenoid valve is commanded to 50 % with a scan tool.
2. Verify the control circuit parameter status while commanding the EVAP purge solenoid valve from 0 to 50 % and back to 0 % with a scan tool.
 - EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status
 - EVAP Purge Solenoid Valve Control Circuit Low Voltage Test Status
 - EVAP Purge Solenoid Valve Control Circuit Open 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.

P0449

1. Ignition ON, engine OFF, command the EVAP vent solenoid ON (Not Venting) and OFF (Venting) with a scan tool. Listen or feel for a click when the valve operates.
2. Verify that both the ON (Not Venting) and the OFF (Venting) states are commanded with a scan tool while observing their parameter status.
 - EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status
 - EVAP Vent Solenoid Valve Control Circuit Low Voltage Test Status
 - EVAP Vent Solenoid Valve Control Circuit Open 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,
 - Q12 Evaporative Emission Purge Solenoid Valve for P0443
 - Q13 Evaporative Emission Vent Solenoid Valve for P0449
2. Ignition ON, verify that a test lamp illuminates between the voltage supply circuit,
 - Terminal 1 or A and ground for the purge solenoid valve
 - Terminal 2 or B or A and ground for the vent solenoid valve
 - 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 all components connected to the voltage supply circuit and replace as necessary.
3. Connect a test lamp between the voltage supply circuit and the control circuit.
4. With a scan tool command the,
 - EVAP purge solenoid valve to 50 %
 - EVAP vent solenoid valve ON (Not Venting) and OFF (Venting)

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 Engine Control Module.
- 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 Engine Control Module.

5. If all circuits test normal, replace the appropriate solenoid valve.

Repair Instructions

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

- **Evaporative Emission Canister Purge Solenoid Valve Replacement**
- EVAP Vent Solenoid Valve link **Evaporative Emission Canister Solenoid 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 Emission (EVAP) Vent System Performance

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

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. The engine control module (ECM) uses the fuel tank pressure (FTP) sensor to monitor EVAP system vacuum. With the purge and vent solenoid valves open, if the EVAP system vacuum goes above a calibrated threshold, P0446 will set.

The following table illustrates the relationship between the ON and OFF states, and the OPEN or CLOSED states of the EVAP purge and vent solenoid valves.

ECM Command	EVAP Purge Solenoid Valve	EVAP Vent Solenoid Valve
ON	Open	Closed
OFF	Closed	Open

Conditions for Running the DTC

- DTCs P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0121, P0122, P0123, P0128, P0191, P0192, P0193, P0222, P0223, P0443, P0601, P0604, P0606, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2176, are not set.
- The ignition voltage is between 11-32 V.
- The barometric pressure (BARO) is more than 70 kPa.
- The fuel level is between 10-90 %.
- The startup engine coolant temperature (ECT) is less than 35°C (95°F).
- The startup intake air temperature (IAT) is between 4-30°C (39-86°F)
- This test runs once per cold start, for up to 17 min, when the above conditions are met.

Conditions for Setting the DTC

NOTE: There are two stages to setting this DTC. Stage one, prep test, then stage two test.

- If fuel tank pressure sensor reading is greater than 2.5 in H₂O of pressure or less than -5 in H₂O of vacuum for 60 s.

OR

- If fuel tank pressure sensor reading is less than -12 in H₂O of vacuum for 5 s before 10 L (2.6 gal) of purge volume.
- After setting the DTC for the first time, 2 L (0.5 gal) of fuel must be consumed before setting the DTC for the second time.

Action Taken When the DTC Sets

DTC P0446 is a Type B DTC.

Conditions for Clearing the MIL/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 solenoid valve inlet, or a pinched vent hose. A blockage in the vent system may also cause a poor fuel fill condition.
- An EVAP canister filter that is restricted can cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Description and Operation

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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 41415-30 Fuel Tank Cap Adapter
- GE 41413-A Evaporative Emissions System Tester (EEST)

For equivalent regional tools, refer to **Special Tools**

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0443 is not set.
 - **If the DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If the DTC is not set**
3. Ignition OFF, remove the fuel tank filler cap. Ignition ON.
4. Verify the scan tool Fuel Tank Pressure Sensor voltage parameter is within 1.3-1.7 V.
 - **If not between the 1.3-1.7 V**

Refer to P0452, P0453 within **DTC P0451-P0454**

○ **If between the 1.3-1.7 V**

5. Install the fuel tank filler cap. Engine idling at operating temperature for 5 min,
6. Verify the scan tool Fuel Tank Pressure Sensor parameter does not increase to greater than 2.5 V when commanding the EVAP Purge Solenoid Valve to 50 %.

○ **If greater than 2.5 V**

Refer to Circuit System Testing below.

○ **If 2.5 V or less**

7. 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.

○ **If the DTC sets**

Refer to Circuit System Testing below.

○ **If the DTC does not set**

8. All OK.

Circuit/System Testing

NOTE: **Perform the Circuit/System Verification before proceeding with the Circuit/System Testing.**

1. Test for a blockage or restrictions in the EVAP system components listed below and repair as necessary.
 - Evaporative Emission Vent System Hoses
 - Evaporative Emission Canister
 - Q13 Evaporative Emission Vent Solenoid Valve
 - Evaporative Emission Vent Filter
2. Reconnect all previously disconnected EVAP hardware.

NOTE: **Refer to the GE-41413-A operation manual for detailed instructions in Evaporative Emission System Diagnosis**

3. Remove the fuel fill cap and connect the CH 41415-30 to the fuel tank filler neck. Connect the GE 41413-A to the CH 41415-30.
4. Command the EVAP Purge/Seal function to System Seal with a scan tool to seal the EVAP system.
5. Turn the nitrogen/smoke valve on the GE 41413-A to nitrogen.

NOTE: **DO NOT exceed the specified value in this step. Exceeding the specified value may produce incorrect test results.**

6. Use the remote switch to activate the GE 41413-A and pressurize the fuel tank to 5.0 in H2O.
7. Verify the scan tool Fuel Tank Pressure Sensor parameter is 0 in H2O when commanding the EVAP Vent Solenoid Valve to OFF.

- **If not 0 in H2O**

Test for a blockage or a restriction in the EVAP vent hose or inlet. If the inlet or hose test normal, replace the Q13 Evaporative Emission Vent Solenoid Valve.

- **If 0 in H2O**

8. 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.

- **If the DTC sets**

Refer to step 1 above.

- **If the DTC does not set**

9. All OK.

Repair Instructions

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

- **Evaporative Emission Canister Solenoid Replacement** for EVAP Vent Solenoid Valve replacement.
- **Evaporative Emission Canister Replacement**
- **Fuel Tank Pressure Sensor Replacement (NT7)** , **Fuel Tank Pressure Sensor Replacement (NU6)**

DTC P0451-P0454

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 Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
FTP Sensor 5 V Reference	P0452, P0532, P0641	P0451	P0446, P0452	P0453, P0641	-
FTP Sensor Signal	P0452	P0451	P0452	P0453	P0451, P0454
FTP 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			
FTP Sensor 5 V Reference	0 V	0 V	4.2-5 V
FTP Sensor Signal	0 V	0 V	5 V
FTP Sensor Low Reference	-	4.5 V	-

Circuit/System Description

The fuel tank pressure (FTP) sensor measures air pressure or vacuum in the evaporative emission (EVAP) system. The engine control module (ECM) supplies a 5 V reference and a low reference circuit to the FTP sensor. The FTP sensor signal voltage varies depending on EVAP system pressure or vacuum. The ECM also uses this FTP 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 min.

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 min.
- 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 FTP sensor voltage within a calibrated range during the engine-off small leak test, P0442.

P0452

The FTP sensor voltage is less than 0.1 V for more than 5 s.

P0453

The FTP sensor voltage is more than 4.9 V for more than 5 s.

P0454

If, during the engine-off natural vacuum small leak test, P0442, the ECM detects an abrupt FTP signal change, other than a refueling event, this DTC will set. An abrupt change is defined as a change of 0.45 in H₂O in the span of 1 s.

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 FTP sensor is unobstructed.
- An FTP 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 %, 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 **GE 41413-A** Evaporative Emission System Tester while taking a snapshot.

Reference Information

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- **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

GE 41413-A Evaporative Emission System Tester (EEST)

Circuit/System Verification

1. Remove the fuel cap.
2. Ignition ON, engine OFF.
3. Observe the FTP Sensor parameter with a scan tool.
4. The FTP 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. It may take up to for 2 min for all vehicle systems to power down. 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 K20 Engine Control Module.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 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 Engine 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 K20 Engine Control Module.
4. Verify the scan tool B150 Fuel Tank Pressure Sensor parameter is less than 0.2 V.
 - If greater than the specified range, test the signal circuit terminal for a short to voltage. If the circuit tests normal, replace the K20 Engine Control Module.
5. Install a 3 A fused jumper wire between the signal circuit terminal and the 5 V reference circuit terminal. Verify the scan tool FTP sensor parameter is greater than 4.7 V.
 - 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 Engine Control Module.
6. If all circuits test normal, test or replace the B150 Fuel Tank Pressure Sensor.

Repair Instructions

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

- **Fuel Tank Pressure Sensor Replacement (NT7)** , **Fuel Tank Pressure Sensor Replacement (NU6)**
- **Control Module References** for ECM replacement, setup, and programming.

DTC P0455

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 (EVAP) 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 EVAP vent solenoid valve and purge solenoid valve ON, allowing vacuum into the EVAP system. The ECM monitors the fuel tank pressure (FTP) 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

- DTCs P00C8, P00C9, P0068, P16A0, P16A1, P16A2, P16F3, P0068, P0101, P0102, P0103, P010C, P010D, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P160E, P160D, P0191, P0192, P0193, P0220, P0222, P0223, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0606, P0722, P0723, P1104, P1516, P2100, P2101, P2102, P2103, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2227, P2228, P2229, P2230 is not set
- The ignition voltage is between 11-32 V.
- The barometric pressure (BARO) is more than 70 kPa.
- The fuel level is between 10-90 %.
- The cold startup engine coolant temperature (ECT) and the startup intake air temperature (IAT) are equal to or less than 8°C (46°F).
- The startup engine coolant temperature (ECT) is less than 35°C (95°F).
- The startup intake air temperature (IAT) is between 4-30°C (39-86°F).
- DTC P0455 runs once per cold start, for up to 17 min, when the above conditions are met.

Conditions for Setting the DTC

- The EVAP system is not able to achieve or maintain a calibrated level of vacuum within a set amount of time.
- After setting the DTC for the first time, 2 L (0.5 gal) of fuel must be consumed before setting the DTC for the second time.
- With a DTC P0455 detected a weak vacuum follow-up test (fuel cap replacement test) will run and passes if tank vacuum is greater than 2.74 kPa (11 in H20). This test will run for a maximum of 21 min. This test runs until it passes.

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 EVAP purge solenoid valve, purge pipe, EVAP canister, or vapor pipe,

can cause this DTC to set.

- The EVAP 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 **GE 41413-A** Evaporative Emissions System Tester (EEST), move all EVAP components while observing smoke with the **J-41413-SPT** High Intensity White Light.
- Individual components can be isolated and tested using adapters in the **J-41413-300** EVAP Cap And Plug Kit.
- A condition may exist where a leak in the EVAP 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 EVAP system and then observe the FTP parameter for vacuum decay.

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Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48096** EVAP Service Access Port Tool
- **GE 41413-300** EVAP Cap And Plug Kit
- **GE 41413-SPT** High Intensity White Light

- **J 41415-30** Fuel Tank Cap Adapter
- **GE 41413-A** Evaporative Emissions System Tester (EEST)
- **J 41413-311** EVAP Plug
- **J 41413-VLV** EVAP Service Port Vent Fitting

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 or produce smoke from a leak.**
- **Refer to the GE 41413-A Evaporative Emissions System Tester (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** EVAP Service Access Port Tool between the disconnected purge tube and the purge solenoid valve. Connect the **GE 41413-A** Evaporative Emissions System Tester (EEST) to the service access port tool.
2. Use a scan tool to seal the EVAP system and use the flow meter on the **GE 41413-A** Evaporative Emissions System Tester (EEST), calibrated to 0.51 mm (0.020 in) to determine that there is no leak in the EVAP system.
 - If a leak is detected, use the **GE 41413-A** Evaporative Emissions System Tester (EEST) to apply smoke to the EVAP system at the purge tube until the leak is located using the **J 41413-SPT** High Intensity White Light.
3. To test for a restriction, connect the **GE 41413-A** Evaporative Emissions System Tester (EEST) nitrogen/smoke hose to the **J 41413-311** EVAP plug brass cone adapter. Disconnect the hose at the fuel cap end of the **J 41415-30** Fuel Tank Cap Adapter. Connect the **J 41413-311** EVAP Plug brass cone adapter to the disconnected hose on the **J 41415-30** Fuel Tank Cap Adapter. Install the **J 41415-30** Fuel Tank Cap Adapter, filler neck end only, to the vehicle.
4. Engine to idling, command the Purge/Seal function to seal the system with a scan tool.
5. Command the EVAP Purge Solenoid Valve to 30 %.
6. The vacuum/pressure gauge on the **GE 41413-A** Evaporative Emissions System Tester (EEST) and the FTP parameter on the scan tool should both show vacuum.
 - If the vacuum/pressure gauge shows vacuum, but the FTP parameter does not show vacuum, replace the B150 fuel tank pressure sensor.
 - If neither the FTP parameter nor the vacuum/pressure gauge shows vacuum, repair the restriction in the purge path.
7. 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 **GE 41413-A** Evaporative Emissions System Tester (EEST).
 - If the values are not similar, or the voltage did not reach 3.2 V, replace the B150 fuel tank pressure

sensor.

Repair Instructions

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

Fuel Tank Pressure Sensor Replacement (NT7) , **Fuel Tank Pressure Sensor Replacement (NU6)**

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 Emission (EVAP) System Flow During Non-Purge

Circuit/System Description

This DTC tests for undesired intake manifold vacuum flow to the evaporative emission (EVAP) system. The engine control module (ECM) seals the EVAP system by commanding the EVAP purge solenoid valve OFF and the vent solenoid valve ON. The ECM 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 more than a predetermined value within a predetermined time, this DTC sets.

The following table illustrates the relationship between the ON and OFF states, and the Open or Closed states of the EVAP purge and vent solenoid valves.

ECM Command	EVAP Purge Solenoid Valve	EVAP Vent Solenoid Valve
ON	Open	Closed
OFF	Closed	Open

Conditions for Running the DTC

- DTCs P00C8, P00C9, P0068, P16A0, P16A1, P16A2, P16F3, P0068, P0101, P0102, P0103, P010C, P010D, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P160E, P160D, P0191, P0192, P0193, P0220, P0222, P0223, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0606, P0722, P0723, P1104, P1516, P2100, P2101, P2102, P2103, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2227, P2228, P2229, P2230 are not set.
- The ignition voltage is between 11-32 V.

- The engine OFF time is greater than 8 h,
- The barometric pressure (BARO) is greater than 70 kPa.
- The fuel level is between 10-90 %.
- The startup engine coolant temperature (ECT) is less than 35°C (95°F).
- The startup intake air temperature (IAT) is between 4-30°C (39-86°F).
- DTC P0496 runs once per cold start, for up to 17 min, when the above conditions are met.

Conditions for Setting the DTC

The ECM detects more than 10 in H₂O vacuum for 5 s during a non-purge condition.

Action Taken When the DTC Sets

DTC P0496 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0496 is a Type B DTC.

Diagnostic Aids

An intermittent condition could be caused by an improperly installed or damaged EVAP purge solenoid valve or by a temporary blockage or restriction in the EVAP purge solenoid valve.

Reference Information

Schematic Reference

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- **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, engine OFF, seal the EVAP system using the Purge/Seal function with a scan tool.
2. Start the engine.
3. Observe the FTP sensor with a scan tool. The FTP sensor parameter should be less than 1.7 V after 90 s.
 - o If the FTP sensor parameter is greater than the specified range, go to Circuit/System Testing.
4. 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 ON, engine OFF.
2. Seal the EVAP system using the Purge/Seal function with a scan tool.
3. Start the engine.
4. Observe the FTP sensor with a scan tool. The FTP sensor parameter should be less than 1.7 V after 90 s.
 - o If the FTP sensor parameter is greater than the specified range, replace the Q12 Evaporative Emission Purge Solenoid Valve.

Repair Instructions

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

Evaporative Emission Canister Purge Solenoid Valve Replacement

DTC P0506 OR P0507

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, P0201-P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300-P0304, P0351-P0354, P0461-P0464, P0496, P0627, P0628, P0629, P0722, P1248, P1249, P124A, P124B, P1516, P2066-P2068, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157 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 s.
- The ignition voltage is greater than 11 V but less than 18 V.
- 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 engine speed is steady within 25 RPM.
- The engine is idling for greater than 10 s.
- The DTCs run when the above conditions are met.

Conditions for Setting the DTC

P0506

The actual engine speed is 100 RPM less than the desired idle speed for 10 s.

P0507

The actual engine speed is 200 RPM greater than the desired idle speed for 10 s.

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

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Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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- **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.
2. Verify no other DTCs set.
 - **If any other DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
 - **If no other DTC is set**
3. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
 - **90 % or greater**

Refer to **Throttle Body Cleaning** .

- **If less than 90 %**

4. Engine Idling at the normal operating temperature.
5. Verify the actual Engine Speed is not 100 RPM less than the Desired Idle Speed.
 - **If 100 RPM less than the Desired Idle Speed**

Refer to Circuit/System Testing below.

- **If 100 RPM greater than the Desired Idle Speed**
6. Verify the actual Engine Speed is not 200 RPM greater than the Desired Idle Speed.
 - **If 200 RPM greater than the Desired Idle Speed**

Refer to Circuit/System Testing below.

- **If 200 RPM less than the Desired Idle Speed**
7. 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.
 8. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing below.

- **If the DTC does not set**
9. All OK

Circuit/System Testing

P0506

1. Verify the conditions listed below do not exist.
 - 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.

- **If a condition is not found**
2. All OK.

P0507

1. Verify the conditions listed below do not exist.
 - Vacuum leaks

- A throttle valve that does not close correctly
- Verify the correct operation of the crankcase ventilation system. Inspect for the conditions listed below:
 - Improper routing of the positive crankcase ventilation (PCV) system
 - Vacuum leaks in the PCV system-Refer to **Crankcase Ventilation System Inspection/Diagnosis (Without Turbocharger)** .
 - **If a condition is found**

Repair as necessary.

- **If a condition is not found**

2. All OK.

Repair Instructions

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

Throttle Body Assembly Replacement

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, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101-P0103, P0106-P0108, P0112, P0113, P0116-P0118, P0122, P0123, P0128, P0171, P0172, P0192, P0193, P0201-

P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301-P0304, P0335, P0336, P0351-P0354, P0506, P0507, P0627-P0629, P0722, P0723, P1248, P1249, P124A, P124B, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157 are not set.

- The catalyst temperature is less than 500°C (932°F).
- The engine coolant temperature is warmer than -10°C (14°F).
- The barometric pressure is greater than 60 kPa.
- The engine speed is between 250-1900 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.

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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 first 500 engine cycles. The Cylinder 1-4 Current Misfire Counters should not be incrementing.
 - o 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 Instructions

Direct Fuel Injector Replacement

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, P062B, P062F, P0630, P16F3, OR P2610 (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 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, P0602, P0630, P16F3

These DTCs run continuously when the ignition is ON.

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, P062B

- The ignition is ON.
- System voltage is greater than 11 V.
- These DTCs run continuously when the above conditions are met.

P2610

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

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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, P0651, P0697, or P06A3 does not set.
 - If a DTC is set, refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.
2. Observe the DTC information with a scan tool. DTC P0601, P0602, P0603, P0604, P0606, P062B, P062F, P0630, P16F3, or P2610 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 ON, clear the DTC information with a scan tool.
2. Observe the scan tool DTC information. Verify that DTC P0602 or P0630 does not set.
 - If DTC P0602 or P0630 failed this ignition, reprogram the K20 ECM. Refer to **Control Module References** . If the DTC resets, replace the K20 ECM.

3. Observe the DTC information with a scan tool. Verify that DTC P0601, P0603, P0604, P0606, P062B, P062F, P16F3, or P2610 does not set.
 - If a DTC failed this ignition, replace the K20 ECM.

Repair Instructions

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 (FUEL PUMP CONTROL MODULE)

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 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

Engine Controls Schematics

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.

1. Ignition ON.
2. Verify DTC P0602 is not set.
 - **If DTC P0602 is set**
 1. Program the K27 fuel pump control module.
 2. Verify the DTC does not set.

- If the DTC sets, replace the K27 fuel pump control module.
- If the DTC does not set.
- 3. All OK.
 - **If DTC P0602 is not set**
- 3. Verify DTCs P0601, P0603, P0604, P0606, and P062F are not set.
 - **If any of the DTCs are set**
 1. Program the K27 fuel pump control module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the K27 fuel pump control module.
 - If the DTC does not set.
 3. All OK.
 - **If none of the DTCs are set**
- 4. All OK

Repair Instructions

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

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

DTC P0627 OR P0628

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Pump Enable	P025A, P0628,	P025A, P0627,	P025A,	-

	P069E	P069E	P0627, P069E
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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 greater than 11 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 and P0628 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0627 and P0628 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 or P0628 should not set.
2. Ignition ON, command the 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. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Test for 0 V on the enable circuit terminal 20 of the fuel pump control module.
 - If greater than the specified value, test for a short to voltage on the enable circuit. If the circuit/connections test normal, replace the K20 ECM.
3. Ignition ON, command the Fuel Pump Enable ON with a scan tool. Test for B+ on the enable circuit terminal 20 of the fuel pump control module.
 - If less than the specified range, test for a short to ground or an open/high resistance on the enable circuit. If the circuit/connections test normal, replace the K20 ECM.
4. If all circuits/connections test normal, replace the K27 fuel pump control module.

Repair Instructions

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, 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 internal 5 V reference circuits. Each internal reference circuit provides a 5 V reference for more than one sensor. A short to ground or short to voltage on one external 5 V reference circuit will affect the other components connected to the same internal reference circuit.

Conditions for Running the DTC

These DTCs run continuously when the ignition voltage is greater than 6.4 V.

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

DTC P0641

The 5 V reference 1 circuit provides 5 V to the following sensors:

- Fuel rail pressure sensor
- A/C refrigerant pressure sensor
- Fuel tank pressure sensor
- Exhaust camshaft position sensor
- Intake camshaft position sensor

DTC P0651

The 5 V reference 2 circuit provides 5 V to the following sensors:

- Secondary air injection pressure sensors, if equipped
- Crankshaft position sensor

DTC P0697

The 5 V reference 3 circuit provides 5 V to the following sensors:

- Manifold absolute pressure (MAP) sensor
- Accelerator pedal position sensor 2

DTC P06A3

The 5 V reference 4 circuit provides 5 V to the following sensors:

- Throttle position sensor
- 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 circuit while viewing the 5 V Reference Circuit 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 5 V reference components have been disconnected 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 - INDEX

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 circuit status parameters listed below:
 - 5 V Reference 1 Circuit Status
 - 5 V Reference 2 Circuit Status
 - 5 V Reference 3 Circuit Status
 - 5 V Reference 4 Circuit Status

Each 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 less than the specified range, test for a short to ground on the 5 V reference circuit for each of the affected components. If all circuits test normal, replace the K20 engine control module.
 - If greater than the specified range, test for a short to voltage on the 5 V reference circuit for each of the affected components. If all circuits test normal, replace the K20 engine control module.

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 1, 2, 3, or 4 Circuit Status parameter. Verify the parameter displays OK.
 - If the parameter displays Malfunction 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 Instructions

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

- **Accelerator Pedal with Position Sensor Assembly Replacement**
- **Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement (LUK)**
- **Camshaft Position Sensor Replacement - Intake**
- **Camshaft Position Sensor Replacement - Exhaust**
- **Crankshaft Position Sensor Replacement**
- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**
- **Manifold Absolute Pressure Sensor Replacement**
- **Secondary Air Injection Check Valve Pipe Adapter Replacement - Left Side**
- **Throttle Body Assembly Replacement**
- **Control Module References** for engine control module replacement, setup, and programming

DTC P0641 OR P06A6 (FUEL PUMP CONTROL MODULE)

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 1 Performance

Diagnostic Fault Information

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

Description and Operation

Fuel 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 OFF and all vehicle systems OFF, disconnect the harness connector at the B47 Fuel Pressure Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K27 Fuel Pump Control Module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K27 Fuel Pump Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K27 Fuel Pump Control Module.
- **If between 4.8-5.2 V**
- 5. Verify the scan tool Fuel Pressure Sensor Voltage parameter is less than 1 V.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K27 Fuel Pump Control Module.
 - **If less than 1 V**
- 6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.
- 7. Verify the scan tool Fuel Pressure Sensor Voltage parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K27 Fuel Pump Control Module.
 - **If greater than 4.8 V**
- 8. Test or replace the B47 Fuel Pressure Sensor.

Repair Instructions

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

- **Fuel Pressure Sensor Replacement - Fuel Feed Pipe**
- **Control Module References** for fuel pump control module replacement, programming and setup

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
Ignition Voltage	P0650	P0650	-	-
MIL Control	P0650*	P0650	P0650	-

* The MIL remains ON

Circuit/System Description

The malfunction indicator lamp (MIL) illuminates to inform the driver that an emission system fault has occurred and the engine control system requires service. Ignition voltage is supplied directly to the MIL. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit when the emission system fault occurs. Under normal operating conditions, the MIL should be ON only when the ignition is ON and the engine is OFF.

Conditions for Running the DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 11-32 V.
- 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 while monitoring the scan tool MIL control circuit status parameters. Perform this test with the ignition ON and the engine OFF, and with the engine running. The MIL control circuit status parameters 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**
- **Instrument Cluster Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Command the MIL ON and OFF with a scan tool while observing the following control circuit status parameters:
 - 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. Engine running, command the MIL ON and OFF with a scan tool while observing the following control circuit status parameters:
 - 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.

4. 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 X1 harness connector at the K20 Engine Control Module.
2. Ignition ON, the MIL should not illuminate.
 - o If the MIL is illuminated, test the MIL control circuit terminal X1-46 for a short to ground. If the circuit tests normal, replace the P16 instrument panel cluster.

NOTE: The MIL is powered by a dedicated ignition voltage circuit.

3. Connect a 3 A fused jumper wire between the MIL control circuit terminal X1-46 and ground. The MIL should illuminate.
 - o If the MIL illuminates, replace the 20 Engine Control Module.
 - o If the MIL does not illuminate, test the MIL control circuit for a short to voltage or an open/high resistance. If the MIL control circuit tests OK, test the instrument cluster ignition voltage circuit for a short to ground or open/high resistance. If the circuits test normal, replace the instrument panel cluster/bulb.

Repair Instructions

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

- **Instrument Cluster Replacement**
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P0685, P0689, P0690, OR 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 Descriptors

DTC P0685

Engine Controls Ignition Relay Control Circuit

DTC P0689

Engine Controls Ignition Relay Feedback Circuit Low Voltage

DTC P0690

Engine Controls Ignition Relay Feedback Circuit High Voltage

DTC P1682

Ignition 1 Switch Circuit 2

Diagnostic Fault Information

Engine Controls Ignition Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Relay Coil Supply Voltage	-	P0685, P0689, P1682	-
Relay Control Circuit	P0690	P1682	P0685, P0689, P1682
Relay Feedback Circuit	P0689, P1682	P0689, P1682	P0690

Ignition Run Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Ignition 1 Signal, Ignition Run Relay	1	1	2
1. No Crank condition. 2. Engine continues to operate with ignition OFF.			

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/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
Battery Voltage	Fault	Fault	-
Engine Controls Ignition Relay Control Circuit	Fault	Fault	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/Low Voltage test and Not Run for High Voltage test
- Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test

Battery Voltage	Not Run	Not Run	-
Engine Controls Ignition Relay Control Circuit	Not Run	Not Run	Fault

Circuit/System Description

There are 2 ignition voltage circuits supplied to the engine control module (ECM). One is supplied by the engine controls ignition relay and the other is supplied by the ignition run relay. The ECM monitors and compares the ignition voltage supplied by the two relays.

Conditions for Running the DTC

P0685

The DTC runs continuously when the ignition voltage is greater than 11 V.

P0689

- The engine controls ignition relay is commanded ON.
- The ignition voltage is greater than 11 V.
- DTC P0685 is not set.
- The DTC runs continuously when the above conditions are met.

P0690

- The engine controls ignition relay is commanded ON.
- DTC P0685 is not set.
- The DTC runs continuously when the above conditions are met.

P1682

- The engine controls ignition relay is commanded ON.
- The ignition voltage is greater than 5.5 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.

P0689

The engine controls ignition relay voltage is less than 5 volts for greater than 5 s.

P0690

- The ECM detects the engine controls ignition relay feedback circuit is greater than 4 V when the relay is commanded OFF.
- The condition is present for greater than 5 s.

P1682

The ECM detects that there is greater than 3 V difference between the ignition run relay signal and the engine controls ignition relay signal circuits for less than 1 s.

Action Taken When the DTC Sets

- DTC P1682 is a Type A DTC.
- DTCs P0685 and P0690 are Type B DTCs.
- DTC P0689 is a Type C DTC.

Conditions for Clearing the DTC

- DTC P1682 is a Type A DTC.
- DTCs P0685 and P0690 are Type B DTCs.
- DTC P0689 is a Type C DTC.

Diagnostic Aids

The engine controls ignition relay may also be labeled the powertrain relay, the engine control module relay, or the main relay. The ignition run relay may also be labeled the run/crank relay, the ignition 1 relay, the ignition main relay, or the ignition relay.

Reference Information

Schematic Reference

- Engine Controls Schematics
- Power Distribution Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Electrical Center Identification Views
- 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, observe the DTC information with a scan tool. DTC P0685, P0689, P0690, or 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 less 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 unless sent here from Engine Cranks But Does Not Run.

1. Ignition OFF, disconnect the KR75 engine controls ignition relay.
2. Verify that a test lamp illuminates between ground and the relay circuit terminals listed below:
 - Terminal 85
 - Terminal 30
 - If the test lamp does not illuminate, test the relay battery voltage circuit for an open/high resistance.

NOTE: High resistance in the circuit/underhood fuse block for either the engine controls ignition relay or the ignition run relay can cause DTC P1682 to set.

3. Ignition ON, verify that a test lamp does not illuminate between the ignition voltage circuit terminal 87 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 30 and the relay switch ignition voltage circuit terminal 87.
5. Ignition ON, observe the scan tool Engine Controls Ignition Relay Feedback Signal parameter. The ECM should communicate, and the parameter should display B+.
 - If not the specified value, or the ECM does not communicate, test the ignition voltage circuit between the engine controls ignition 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 control circuit terminal 86 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 KR75 engine controls ignition relay.

Component Testing

1. Remove the KR75 engine controls ignition relay.

NOTE: **Depending on the application, the relay coil resistance will be within one of the following ranges.**

2. Test for one of the following resistance specifications between terminals 85 and 86 of the KR75 engine controls ignition relay:
 - 70-110 ohms
 - 200-250 ohms
 - If not within the specified range, replace the KR75 engine controls ignition relay.
3. Test for infinite resistance between the following terminals of the KR75 engine controls ignition relay:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - If not the specified value, replace the KR75 engine controls ignition relay.
4. 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 KR75 engine controls ignition relay.

Repair Instructions

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

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Control Module References** for ECM replacement, setup, and programming

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 monitors the fuel pump control system for any conditions which may adversely affect vehicle emissions. If an adverse condition is detected, the fuel pump control module sets a fuel pump control system DTC. The fuel pump control module then sends a serial data message to the engine control module (ECM) requesting malfunction indicator lamp (MIL) illumination. 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 for greater than 3 s.

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 for scan tool information

Circuit/System Verification

NOTE:

- Do not replace the engine control module for this DTC. DTC P069E is an informational DTC.
- Correct any engine control and communication DTCs before diagnosing fuel pump control module DTCs.

1. Verify there are no engine control or communication DTCs set.

○ If a DTC is set

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

○ If a DTC is not set

2. Verify there are no fuel pump control module DTCs set.

○ If a DTC is set

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

○ If a DTC is 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.

4. Verify the DTC does not set.

○ If the DTC sets

Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

○ If the DTC does not set

5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

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 Requested MIL Illumination

Circuit/System Description

Diagnostic trouble code (DTC) P0700 is an informational DTC that indicates that an emission related transmission DTC has set in the transmission control module (TCM). The engine control module (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, and the ECM Freeze Frame/Failure Records data will display the engine operating conditions that were present when the transmission DTC was set. The TCM Freeze Frame/Failure records data is available from the DTC that was set in the TCM.

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.

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 for scan tool information

Circuit/System Verification

NOTE:

- Do not replace the engine control module for this DTC. DTC P0700 is an informational DTC.
- Correct any engine control and communication DTCs before diagnosing transmission control module DTCs.

1. Verify there are no engine control or communication DTCs set.

○ If a DTC is set

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

○ If a DTC is not set

2. Verify there are no transmission control module DTCs set.

○ If a DTC is set

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

○ If a DTC is 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.

4. Verify the DTC does not set.

○ If the DTC sets

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

○ If the DTC does not set

5. All OK.

Repair Instructions

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

DTC P0AC4

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 P0AC4

Hybrid/EV Powertrain Control Module Requested MIL Illumination

Circuit/System Description

This DTC indicates the hybrid powertrain control module has set an emission related hybrid powertrain DTC. The hybrid powertrain control module sends a message via the serial data circuit to the engine control module (ECM) requesting illumination of the malfunction indicator lamp (MIL). When the ECM receives the message, DTC P0AC4 will set. The DTC information for the ECM will only display DTC P0AC4, but the freeze frame/failure records data may display the hybrid powertrain DTC that set.

Conditions for Running the DTC

- The ignition is ON for greater than 3 s.
- This DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

The hybrid powertrain control module has set an emission related DTC.

Action Taken When the DTC Sets

DTC P0AC4 is a Type A DTC.

Conditions for Clearing the DTC

DTC P0AC4 is a Type A DTC.

Reference Information

Description and Operation

Hybrid Modes of Operation Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Correct any engine control DTCs before diagnosing hybrid powertrain control module DTCs.**

1. DTC P0AC4 is an informational DTC. If there are no other engine control DTCs set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for diagnosis of hybrid powertrain control module DTCs.
2. 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.

Repair Instructions

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

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 High 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 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 - INDEX

Description and Operation

Fuel 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.
2. Verify DTC P0231, P0232 or P023F is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
3. Verify that the area where the K27 fuel pump control module is located is free of debris, clutter, or any insulating material that would cause the K27 fuel pump control module to overheat.
 - **If any debris, clutter, or other material is found**
 1. Clear the area where the K27 fuel pump control module is located.
 2. Clear the DTC and test drive the vehicle.
 3. Verify DTC P1255 or P064A is not set.
 - If DTC P1255 or P064A is set, replace the K27 fuel pump control module.
 - If DTC P1255 or P064A is not set
 4. All OK.
 - **If no debris, clutter, or other material is found**
 4. Clear the DTC and test drive the vehicle.
 5. Verify DTC P1255 or P064A is not set.
 - **If DTC P1255 or P064A is set**

Replace the K27 fuel pump control module.
 - **If DTC P1255 or P064A is not set.**
 6. All OK.

Repair Instructions

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

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

DTC P135A

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 P135A

Ignition Coil Supply Voltage Circuit Bank 1

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0201, P0202, P0203, P0204, P0300, P0351, P0352, P0353, P0354, P135A	P0201, P0202, P0203, P0204, P0300, P0351, P0352, P0353, P0354, P135A	-	-

Circuit/System Description

The ignition system uses an individual ignition coil for each cylinder. The engine control module (ECM) monitors the ignition voltage from the fuse to the individual coils.

Conditions for Running the DTC

- The ignition is ON.
- Ignition Run/Crank and PT relay voltages are greater than 11 V

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects less than 2.5 V on the ignition coil supply voltage circuit for greater than 313 ms.

Action Taken When the DTC Sets

DTC P135A is a Type A DTC.

Conditions for Clearing the DTC

DTC P135A is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Ignition Coil Supply Voltage parameter displays ON.
 - **If ON is not displayed**

Refer to Circuit/System Testing below.
 - **If ON is displayed**
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.
4. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing below.
 - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
2. Verify a test lamp illuminates between the ignition circuit terminal 62 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**

NOTE: The ignition circuit may supply voltage to other components. Make sure to test all circuits and components for a short to ground that share the ignition circuit.

1. Ignition OFF, remove the test lamp, and disconnect all components on the circuit.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Replace the fuse, ignition ON.
 4. Verify the fuse is good after connecting each of the components one at a time.
 - If the fuse opens, replace the component that opens the fuse when connected.
 - If the fuse is good, all OK.
- **If the test lamp illuminates**
3. Replace the K20 Engine Control Module.

Repair Instructions

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

- **Ignition Coil Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P1400

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 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 airflow
- Engine coolant temperature
- Engine run time
- 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.
- The vehicle speed is less than 2 km/h (1 mph).
- The catalyst temperature is greater than 1,000°C (1,832°F).
- The coolant temperature is greater than 56°C (133°F).
- The engine run time is greater than 18 s.
- The engine is at idle with no input from the accelerator pedal for greater than 5 s.
- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0201, P0202, P0203, P0204, P0300, P0335, P0336, P0351, P0352, P0353, P0506, P0507, P0601, P0602, P0603, P0604, P0606, P0607, P062F, P0641, P0651, P1516, P1682, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2176, P2610 are not set.
- This DTC runs within 15 seconds within the first 2 minutes of start-up. 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.

Diagnostic Aids

Any loading of the engine that lowers engine RPM, such as partial application of the clutch, A/C cycling, etc. during the first 120 seconds of the engine run time may set this DTC.

Circuit/System Verification

1. Allow the engine to cool until the catalyst temperature is less than 500°C (932°F) and the engine coolant is greater than -10°C (+14°F).
2. Idle the engine for greater than 2 minutes.
3. Observe the scan tool DTC information. DTC P1400 should not set.
4. 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. Inspect the air intake system for the following:
 - Modified, damaged, or restricted
 - Dirty or deteriorating air filter element
 - Crankcase ventilation system for correct operation.
 - Water intrusion
 - Vacuum leak and other unmetered air downstream of the MAF sensor
 - Intake manifold leak
2. Inspect the exhaust system for the following:
 - Water intrusion
 - Exhaust leak
 - Damaged, restricted, modified or enhanced exhaust system.
3. Inspect the engine mechanical for items that could alter the air flow into the combustion chamber.

DTC P1516, P2101, P2119, OR P2176

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

Minimum Throttle Position Not Learned

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
TAC Motor Control Closed	P1516, P2101, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P0690, P1516, P2101, P2176	P1516, P2101, P2176
TAC Motor Control Open	P1516, P2101, P2119, P2176	P1516, P2101, P2176	P1516, P2101, P2176	P0690, P1516, P2101, P2176	P1516, P2101, P2176

Circuit/System Description

The throttle body assembly contains a contact-less inductive throttle position sensing element that is managed by a customized integrated circuit. The throttle position sensor is mounted within the throttle body assembly and is not serviceable. The engine control module (ECM) supplies the throttle body with a 5 V reference circuit, a low reference circuit, an H-bridge motor directional control circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the throttle body to the ECM. The throttle body cannot receive data from the ECM over the signal/serial data circuit. The throttle position sensor provides a signal voltage that changes relative to throttle blade angle. The customized integrated circuit translates the voltage based position information into serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The throttle position sensor information is transmitted between the throttle body and the ECM on the signal/serial data circuit. The ECM decodes the serial data signal into separate voltages which are displayed on a scan tool as the voltage inputs from TP sensors 1 and 2.

The 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 sensor signal/serial data circuit to determine the actual throttle valve position.

Conditions for Running the DTC

P1516

- The run/crank or powertrain relay voltage is greater than 6.4 V and reduced power is not active.
- DTC P1516 runs continuously when the above conditions are met.

P2101

- DTC P1682 is not set.
- The run/crank or powertrain relay voltage is greater than 6.4 V and reduced power is not active.

- The engine is running or the following conditions are met:
 - The engine is not running.
 - The ignition voltage is greater than 11 V.
 - The TAC system is not in the Battery Saver mode.
 - The ECM is commanding the throttle.
 - The ECM has learned the minimum throttle position.
- DTC P2101 runs continuously when the above conditions are met.

P2119

- DTCs P0122, P0123, P0222, P0223, or P06A3 is not set.
- The run/crank or powertrain relay voltage is greater than 6.4 V and reduced power is not active.
- The system is not in the Battery Save mode.
- The ECM is not commanding the throttle.
- DTC P2119 runs continuously when the above conditions are met.

P2176

- The run/crank or powertrain relay voltage is greater than 6.4 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 detects an unstable throttle position for greater than 1 s.

P2101

- The ECM detects the actual throttle position does not match the predicted throttle position for greater than 1 s.

OR

- The ECM detects the throttle control is driving the throttle in the incorrect direction or exceed the reduced power limit.

P2119

The ECM determines that the throttle blade did not return to the rest position within 1 s.

P2176

The ECM detects that both throttle position sensors were greater than a predetermined voltage during the

minimum throttle learn procedure for greater than 2 s.

Action Taken When the DTC Sets

- DTCs P2101 and P2176 are Type A DTCs.
- DTC P1516 is a Type B DTC.
- DTC P2119 is a Type C DTC.
- The ECM commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions, the control module commands the engine OFF.

Conditions for Clearing the MIL/DTC

- DTCs P2101 and P2176 are Type A DTCs.
- DTC P1516 is a Type B DTC.
- DTC P2119 is a Type C DTC.

Diagnostic Aids

- Depending on the Start Up ECT, the Desired Throttle Position percentage maybe greater or less than the Throttle Position with the TAC motor at rest. When the ignition is initially turned ON, or when the engine is cranking or running the Desired and Actual Throttle positions should closely match.
- 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 - INDEX

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.

NOTE: A low battery voltage or charging system condition may cause a DTC to set.

2. Verify DTC P0121, P0122, P0123, P0222, P0223, P0562, P0621, P0622, or P2135 is not set.
 - o If any of the DTCs are set

Refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.

- o If none of the DTCs are set

3. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
 - o If 90 % or greater

Refer to Throttle Body Cleaning .

- o If less than 90 %

4. Clear the DTCs with a scan tool.
5. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
6. Ignition ON.
7. Verify the scan tool TAC Motor parameter displays Enabled while slowly depressing the accelerator pedal.
 - o If Enabled is Not displayed

Refer to Circuit/System Testing below.

- o If Enabled is displayed

8. Verify DTC P1516, P2101, P2119, or P2176 is not set.
 - o If any of the DTCs are set

Refer to Circuit/System Testing below

- If none of the DTCs are set

NOTE: If there is a condition with the throttle body, the TAC Motor Command parameter will go to 99 % for a predetermined amount of time and then a DTC sets. Once a DTC is set, the TAC Motor Command parameter will go to 0 % and the TAC Motor parameter will display Disabled.

9. Verify the scan tool TAC Motor parameter displays Enabled while performing the Throttle Sweep Test with a scan tool.

- If Disabled

Test or replace the Q38 Throttle Body assembly.

- If Enabled

10. 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.
11. Verify the DTC does not set.

- If the DTC sets

Refer to Circuit/System Testing below

- If the DTC does not set

12. All OK

Circuit/System Testing

1. Ignition OFF.

WARNING: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

2. Verify the conditions listed below do not exist with the Q38 Throttle Body assembly:

NOTE:

- The rest position is defined as the actual Throttle Position percentage when the ignition is OFF or with the ignition ON for greater than 30 seconds.
- When the ignition is OFF, spring tension should hold the throttle plate in the rest position. You should be able to open the throttle plate to wide open throttle (WOT) or push the throttle plate to the fully closed position. In each case, the throttle plate should return to the rest position without assistance.

- 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**

Test or replace the Q38 Throttle Body assembly.

- **If a condition is not found**

3. Ignition OFF.

NOTE:

- **Disconnecting the throttle body harness connector may cause additional DTCs to set.**
- **The ignition must be OFF and the ECM completely powered down before testing each circuit.**
- **The Test Lamp must be connected to circuit before turning ignition on or incorrect diagnosis may occur.**

4. Disconnect the harness connector at the Q38 Throttle Body assembly, ignition ON.
5. Verify that a test lamp does not illuminate continuously between each motor control circuit listed below and ground.
 - TAC Motor Control Open circuit terminal 1
 - TAC Motor Control Closed circuit terminal 2
 - **If the test lamp illuminates continuously**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If the test lamp is always OFF**
6. Verify that a test lamp does not illuminate between each motor control circuit listed below and B+.
 - TAC Motor Control Open circuit terminal 1
 - TAC Motor Control Closed circuit terminal 2
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If the test lamp is always OFF**
7. Ignition OFF, set the DMM to the 40 V scale or higher, select the Min/Max Recording Mode, and set the Peak Min/Max response time to 1 ms or faster.

NOTE:

- The DMM Min/Max Recording Mode and the response time of 1 ms or faster must be reset after testing each circuit or a lower voltage will be recorded.
- The ignition must be OFF and the ECM completely powered down before testing each circuit or a lower voltage will be recorded.

8. Verify the Max voltage is within 3 V of B+ while using DMM Min/Max Recording Mode function on each control circuit listed below as the ignition is turned ON.
 - TAC Motor Control Open circuit terminal 1
 - TAC Motor Control Closed circuit terminal 2
 - If not within 3 V of B+
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - If within 3 V of B+
9. Test or replace the Q38 Throttle Body assembly.

Repair Instructions

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

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
5. Ignition ON.
6. Verify the scan tool TAC Motor parameter displays Enabled while performing the Throttle Sweep Test with a scan tool.
 - **If Disabled**

Test or replace the Q38 Throttle Body assembly.
 - **If Enabled**
7. If the repair was 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 set.
 - **If DTC sets**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

- If DTC does not set

8. All OK

DTC P15F9

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 Descriptor

DTC P15F9

Hybrid/EV System Engine Speed Control Intervention Request Type Signal Message Counter Incorrect

Circuit/System Description

The hybrid powertrain control module is constantly sending serial data messages to the ECM regarding the operating state of the powertrain propulsion system. These messages are sent in a continuously repeating series of rolling counts with associated password protect samples. Each count/sample is assigned a value. The ECM uses the values, during a propulsion system mode shift, to determine when and at what RPM to idle the internal combustion engine. When the ECM determines that too many of the counts/samples contain an error value, the ECM sets DTC P15F9.

Conditions for Running the DTC

- DTC U1817 is not set.
- The engine run time is greater than 0.5 s.
- No other CAN errors are present.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that 10 of 16 counts/samples contain an error value.

Action Taken When the DTC Sets

DTC P15F9 is a Type B DTC

Conditions for Clearing the DTC

DTC P15F9 is a Type B DTC.

Diagnostic Aids

An intermittent fault in the CAN circuits will cause the ECM to set DTC P15F9.

Reference Information

Description and Operation

Hybrid Modes of Operation Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Correct any engine control DTCs before diagnosing hybrid powertrain control module DTCs.

1. DTC P15F9 is an informational DTC. If there are no other engine control DTCs set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for diagnosis of hybrid powertrain control module DTCs.
2. 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.

Repair Instructions

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

DTC P15FB

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 Descriptor

DTC P15FB

Brake Pedal Position Sensor Signal Message Counter Incorrect

Circuit/System Description

The electronic brake control module (EBCM) monitors the brake pedal position sensor in order to provide emission related brake pedal position information to the engine control module (ECM). The EBCM sends the information, via the serial data circuit, to the ECM in a continuously repeating series of 16 rolling counts, with each count assigned a value. When the ECM determines that too many of the counts have an incorrect value, the ECM sets DTC P15FB.

Conditions for Running the DTC

- The vehicle is ON.
- DTC P15FB runs continuously when the above condition is met.

Conditions for Setting the DTC

The ECM detects that too many of the rolling counts have an incorrect value.

Action Taken When the DTC Sets

- DTC P15FB is a Type B DTC.
- Brake pedal position is defaulted to 0 for as long as the fault is active.

Conditions for Clearing the DTC

DTC P15FB is a Type B DTC.

Reference Information

Description and Operation

Hybrid Modes of Operation Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

NOTE:

- **DTC P15FB is an informational DTC.**
- **Diagnose all other engine control module DTCs prior to DTC P15FB.**

1. Verify that no other DTCs are set except for DTC P15FB.
 - **If any other DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

○ **If only DTC P15FB is set**

2. Replace the K17 Electronic Brake Control Module.
3. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.

○ **If DTC sets**

Replace the K20 Engine Control Module.

○ **If DTC does not set**

4. All OK.

Repair Instructions

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

Control Module References for Electronic Brake Control Module and Engine Control Module replacement, programming and setup

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) or an out of range high pressure fuel pump actuator current.

Conditions for Running the DTC

- DTCs P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0112, P0113, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0627-P0629, P1682 are not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The low side fuel pressure is greater than 275 kPa (40 psi).

- 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 B DTC.

Conditions for Clearing the DTC

DTC P163A is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 ON, verify that a test lamp does not illuminate between the high control circuit terminal 2 and ground and the low control circuit terminal 1 and ground.
 - If the test lamp illuminates, test the appropriate control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. Verify that a test lamp does not illuminate between the high control circuit terminal 2 and B+ and the low control circuit terminal 1 and B+.
 - If the test lamp illuminates, test the appropriate control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
6. Connect a 3 A fused jumper wire between the high control circuit terminal 2 and ground. The Fuel Pressure Regulator High Control Circuit Open Test Status should transition from Malfunction to OK and the Fuel Pressure Regulator High Control Circuit Low Voltage Test Status should transition from OK to Malfunction.
 - If not the specified value, test the high control circuit for an open/high resistance.
7. Connect a 3 A fused jumper wire between the low control circuit terminal 1 and B+. The Fuel Pressure Regulator Control Circuit Open Test Status should transition from Malfunction to OK and the Fuel Pressure Regulator Control Circuit High Voltage Test Status should transition from OK to Malfunction.
 - If not the specified value, test the low control circuit for an open/high resistance.
8. If all circuits and the high pressure fuel pump test normal, replace the K20 ECM.

Repair Instructions

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 P2096

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 P2096

Post Catalyst Fuel Trim System Low Limit

Circuit Description

Fuel trim bias is used to keep the post catalyst air/fuel ratio within a predetermined range. This allows optimal catalyst efficiency under various operating conditions. The engine control module (ECM) constantly monitors how lean or rich the fuel trim bias is commanded, to determine if the fuel trim bias is greater than a calibrated amount.

Conditions for Running the DTC

- DTC P0016, P0017, P0018, P0019, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0178, P0179, P0201, P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0301, P0302, P0303, P0304, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P1221, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P219A, P2227, P2228, P2229, P2230, P2269, P2270, P2271, P2440, P2444, or P2A00 is not set.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 PSI).
- The manifold absolute pressure (MAP) is between 0-200 kPa (0-29 PSI).
- The intake air temperature (IAT) is between -20 and +200°C (-4 and +392°F).
- The engine coolant temperature is greater than -20°C (-4°F).
- The engine is in Closed Loop status.
- The fuel control intrusive diagnostics are not active.
- The engine is operating under light acceleration, heavy acceleration, deceleration, or cruise.
- DTC P2096 runs continuously when the conditions above have been met for greater than 40 seconds.

Conditions for Setting the DTC

The lean correction limit for a condition causing a rich air/fuel ratio has been exceeded.

Action Taken when the DTC Sets

- DTCs P2096 is a Type B DTC.
- 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 one of the following occurs:

- The ECM detects the same fuel trim failure during 2 consecutive trips.
- The ECM detects any fuel trim failure during any subsequent trip if the conditions at the time of failure meet the following criteria:
 - The engine load is within 20 percent of the previous test that failed.
 - The engine speed is within 375 RPM of the previous test that failed.
 - The engine coolant temperature is in the same range of the previous test that failed.

Conditions for Clearing the MIL/DTC

- DTCs P2096 is a Type B 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.

Diagnostic Aids

- It is very unlikely that an HO2S will cause this DTC to set without the occurrence of circuit related HO2S DTCs. Do not replace an HO2S to address this DTC without first performing all the steps in Circuit/System Verification.
- The post catalyst fuel trim diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 DTC information. Verify there is no other HO2S or fuel trim DTC set.
 - If any other HO2S or fuel trim DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.
2. Verify that none of the following conditions exist:
 - 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. Change engine oil as necessary.
 - Rich fuel injectors-Refer to **Fuel Injector Solenoid Coil Test**.
 - Excessive fuel system pressure-Refer to **Fuel System Diagnosis**.
 - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
 - Fuel saturation of the evaporative emissions (EVAP) canister
 - Stuck open or leaking EVAP purge valve
 - Restricted exhaust-Refer to **Symptoms - Engine Exhaust**.
 - Incorrect PCV system operation-Refer to **Crankcase Ventilation System Inspection/Diagnosis (Without Turbocharger)**.
 - If you find any of the above conditions, repair as necessary.

WARNING: Refer to **Road Test Warning**.

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 Instructions

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

DTC P2097

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 P2097

Post Catalyst Fuel Trim System High Limit

Circuit Description

Fuel trim bias is used to keep the post catalyst air/fuel ratio within a predetermined range. This allows optimal catalyst efficiency under various operating conditions. The engine control module (ECM) constantly monitors how lean or rich the fuel trim bias is commanded, to determine if the fuel trim bias is greater than a calibrated amount.

Conditions for Running the DTC

- DTC P0016, P0017, P0018, P0019, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0178, P0179, P0201, P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0301, P0302, P0303, P0304, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P1221, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P219A, P2227, P2228, P2229, P2230, P2269, P2270, P2271, P2440, P2444, or P2A00 is not set.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 PSI).
- The manifold absolute pressure (MAP) is between 0-200 kPa (0-29 PSI).
- The intake air temperature (IAT) is between -20 and +200°C (-4 and +392°F).
- The engine coolant temperature is greater than -20°C (-4°F).
- The engine is in Closed Loop status.
- The fuel control intrusive diagnostics are not active.
- The engine is operating under light acceleration, heavy acceleration, deceleration, or cruise.
- DTC P2097 runs continuously when the conditions above have been met for greater than 40 seconds.

Conditions for Setting the DTC

The rich correction limit for a condition causing a lean air/fuel ratio has been exceeded.

Action Taken when the DTC Sets

- DTCs P2097 is a Type B DTC.
- 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 one of the following occurs:

- The ECM detects the same fuel trim failure during 2 consecutive trips.
- The ECM detects any fuel trim failure during any subsequent trip if the conditions at the time of failure meet the following criteria:
 - The engine load is within 20 percent of the previous test that failed.
 - The engine speed is within 375 RPM of the previous test that failed.
 - The engine coolant temperature is in the same range of the previous test that failed.

Conditions for Clearing the MIL/DTC

- DTCs P2097 is a Type B 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.

Diagnostic Aids

- It is very unlikely that an HO2S will cause this DTC to set without the occurrence of circuit related HO2S DTCs. Do not replace an HO2S to address this DTC without first performing all the steps in Circuit/System Verification.
- The post catalyst fuel trim diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.
- An exhaust system leak that may not be audible can set this DTC.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 DTC information. Verify there is no other HO2S or fuel trim DTC set.
 - If any other HO2S or fuel trim DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Verify that none of the following conditions exist:
 - Exhaust system leaks-Refer to **Symptoms - Engine Exhaust** .
 - Vacuum hoses for splits, kinks, and proper connections
 - Insufficient fuel in the tank
 - The air induction system and the air intake ducts for leaks or for a missing air filter element
 - A cracked evaporative canister
 - Evaporative pipes plugged, obstructed, or leaking
 - The crankcase ventilation system for leaks. Refer to **Crankcase Ventilation System Inspection/Diagnosis (Without Turbocharger)** .
 - Engine vacuum leaks
 - Low fuel system pressure-Refer to **Fuel System Diagnosis**.
 - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
 - Lean fuel injectors-Refer to **Fuel Injector Solenoid Coil Test**.
 - If you find any of the above conditions, repair as necessary.

WARNING: Refer to **Road Test Warning** .

NOTE: **A road load condition is necessary to duplicate the conditions for running the DTC.**

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 Instructions

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

DTC P2122, P2123, P2127, P2128, OR P2138

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) Sensors 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 V Reference Circuit	P06A3	P2138	P2122	P06A3	P2138
Accelerator Pedal Position (APP) Sensor 2 5 V Reference Circuit	P0108, P0107, P0697	P2138	P2127	P0106, P0108, P0697	P2138
Accelerator Pedal Position (APP) Sensor 1 Signal	P2122	P2138	P2122	P2123, P2138	P2138
Accelerator Pedal				P2128,	

Position (APP) Sensor 2 Signal	P2127	P2138	P2127	P2138	P2138
Accelerator Pedal Position (APP) Sensor 1 Low Reference	-	P2138	P2123	-	P2138
Accelerator Pedal Position (APP) Sensor 2 Low Reference	-	P2138	P2128	-	P2138

Typical Scan Tool Data

APP Sensor 1

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			
APP Sensor 1 5 V Reference	0.00 V	0.00 V	2-5 V
APP Sensor 1 Signal	0.00 V	0.00 V	4-5 V
APP Sensor 1 Low Reference	-	4-5 V	-

APP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle. Parameter Normal Range: APP Sensor 2 0.39-0.59 V			
APP Sensor 2 5 V Reference	0.00 V	0.00 V	1-2 V
APP Sensor 2 Signal	0.00 V	0.00 V	2-5 V
APP Sensor 2 Low Reference	-	4-5 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 V 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 greater than 1 s.

P2123

The ECM detects that the APP sensor 1 voltage is greater than 4.7 V for greater than 1 s.

P2127

The ECM detects that the APP sensor 2 voltage is less than 0.32 V for greater than 1 s.

P2128

The ECM detects that the APP sensor 2 voltage is greater than 2.6 V for greater than 1 s.

P2138

The ECM detects that APP sensor 1 and APP sensor 2 disagree greater than 10 percent for greater 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 greater 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

- A high resistance condition on the accelerator pedal position circuits could cause a DTC to set.
- Ensure that the in-line harness connector seals are installed correctly. Improper installation could result in water intrusion into the connector and cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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.
2. Verify DTC P0697 or P06A3 is not set.
 - **If any of the DTCs are set**

Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.

- **If none of the DTCs are set**
3. Verify the APP Sensor 1 Circuit Status and APP Sensor 2 Circuit Status displays OK.

- **If Malfunction is displayed**

Refer to Circuit/System Testing below

- **If OK is displayed**

4. Verify the scan tool APP Sensor 1 and 2 Agree/Disagree parameter displays Agree while performing the tests listed below:

- 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.

- **If Disagree**

Refer to Circuit/System Testing below

- **If Agree**

5. Verify that DTC P2122, P2123, P2127, P2128, or P2138 is not set.

- **If any of the DTCs are set**

Refer to Circuit/System Testing below

- **If none of the DTCs set**

6. 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.
7. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing below

- **If the DTC does not set**

8. All OK

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B107 accelerator pedal assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between each low reference circuit terminal listed below and ground.
 - Low reference circuit terminal 4 or A
 - Low reference circuit terminal 5 or D
- **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K20 engine control module.
 - **If less than 5 ohms**
- 3. Ignition ON.
- 4. Test for 4.8-5.2 V between each 5 V reference circuit terminal listed below and ground.
 - 5 V reference circuit terminal 1 or C
 - 5 V reference circuit terminal 2 or F
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 engine control module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 engine control module.
 - **If between 4.8-5.2 V**
- 5. Verify each APP sensor voltage parameter is less than 0.2 V.
 - **If 0.2 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal listed below and ground.
 - APP sensor 1 signal circuit terminal 3 or E
 - APP sensor 2 signal circuit terminal 6 or B
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 engine control module.
 - **If less than 0.2 V**
- 6. Install a 3 A fused jumper wire between each signal circuit terminal listed below and the 5 V reference circuit terminal 1 or C.
 - APP sensor 1 signal circuit terminal 3 or E
 - APP sensor 2 signal circuit terminal 6 or B
- 7. Verify the scan tool APP sensor voltage parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for infinite resistance between the signal circuit terminal and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance
- 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 engine control module.
- **If greater than 4.8 V**
- 8. Test or replace the B107 accelerator pedal assembly.

Repair Instructions

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

- **Accelerator Pedal with Position Sensor Assembly Replacement**
- **Control Module References** for ECM replacement, programming, and setup

DTC P219A

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 P219A

Fuel Trim Cylinder Balance

Circuit/System Description

The Air Fuel Imbalance diagnostic detects a rich or lean cylinder to cylinder air/fuel ratio imbalance. 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 P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0122, P0123, P0128, P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301-P0304, P0411, P0442, P0443, P0455, P0496, P1248, P1249, P124A, P124B, P2101, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2440, P2444 are not set.
- The device control is not active.
- The intrusive diagnostics are not active.
- The engine overspeed protection is not active.
- The engine is in closed loop status.

- The system voltage is greater than 11 V for greater than 2 s.
- The engine coolant temperature (ECT) is warmer than -20°C (-4°F).
- The engine speed is between 900-4, 200 RPM.
- The mass air flow is between 7-200 g/s.
- The AIR pump is not ON.
- Engine run time is greater than 30 s.
- Fuel level is greater than 10% and no fuel level sensor fault is present.
- The DTC runs continuously when the above conditions have been met.

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

DTC P219A is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P219A is a Type A DTC.

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 cause a DTC to set.
- Monitoring the misfire current counters, or misfire graph, may help to isolate the cylinder that is causing the condition.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**

- Troubleshooting with a Test Lamp
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Connector 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.
 - o If the MAP sensor parameter is not between 20-48 kPa, refer to **DTC P0106** .
4. Inspect the air induction system for modified, damaged, leaking, or restricted components.
5. Inspect the crankcase ventilation system for improper operation. Refer to **Crankcase Ventilation System Inspection/Diagnosis (Without Turbocharger)** .
6. Inspect the vacuum hoses for splits, kinks, and improper connections.
7. Test for a restricted, damaged, leaking, or modified exhaust system from the catalytic converter forward. Refer to **Symptoms - Engine Exhaust** .
8. Test the fuel injectors for improper operation. Refer to **Fuel Injector Solenoid Coil Test**.
9. Test for fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
10. Test for excessive fuel in the crankcase due to leaking injectors. Change engine oil as necessary.
11. Test the ignition system for improper operation. Refer to **Electronic Ignition System Diagnosis**.
12. 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 Instructions

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 P2430, P2431, P2435, OR P2436

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 P2430

Secondary Air Injection System Pressure Sensor Circuit - Bank 1 (Left Hand)

DTC P2431

Secondary Air Injection System Pressure Sensor Performance - Bank 1 (Left Hand)

DTC P2435

Secondary Air Injection System Pressure Sensor Circuit Bank 2 - (Right Hand)

DTC P2436

Secondary Air Injection System Pressure Sensor Performance Bank 2 - (Right Hand)

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. A pressure sensor in each shutoff/check valve is used to monitor the air flow from the secondary air injection pump. The engine control module (ECM) supplies voltage to the 5-volt reference circuits and supplies a ground to the low reference circuits. The sensors provide a signal voltage to the ECM relative to the pressure changes within the secondary air injection system.

Ignition voltage is supplied to the secondary air injection pump and air injection shutoff/check valve relays. The ECM controls the relays by grounding the control circuits, which activates the relays. When the relay contacts close, voltage is supplied to the pump and the valves, which turns the pump on and opens the valves.

The diagnostic uses 3 phases to test the secondary air injection system:

- DTCs P0411, P2430 and P2435 run during Phase 1
- DTCs P2430, P2435 and P2440 run during Phase 2
- DTC P2444 runs during Phase 3

During phase 1, the secondary air injection pump and both secondary air injection shutoff and check valves are activated. Normal secondary air function occurs. Expected system pressure is 5-11 kPa (0.7-1.6 psi) above BARO. Relatively high magnitude of pressure pulses are expected due to exhaust pulses. Low magnitude pressure pulses indicate a blockage or disconnect downstream of the valve.

During phase 2, only the secondary air injection pump is activated. The shutoff and check valves are closed. Pressure sensor performance and shutoff and check valve deactivation are tested. Expected system pressure is

14-22 kPa (2.0-3.2 psi) above BARO.

During phase 3, neither the secondary air injection pump nor the secondary air injection shutoff and check valves are activated. Secondary air injection pump deactivation is tested. Expected system pressure equals BARO.

Conditions for Running the DTC

P2430 and P2435

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0351, P0352, P0353, P0354, P0411, P0412, P0418, P0420, P0606, P0641, P0651, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2431, P2432, P2433, P2436, P2437, or P2438 is not set.
- Greater than 60 min has elapsed since the last cold start.
- The ignition voltage is between 10-32 V.
- The engine speed is less than 5, 000 RPM.
- The intake air temperature (IAT) is greater than -10°C (+14°F).
- The engine coolant temperature (ECT) is between -10 and +56°C (14-133°F).
- The barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- The manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- The mass air flow (MAF) is less than 50 g/s.
- The secondary air injection pump is commanded ON.
- DTC P2430 and P2435 run once per ignition cycle when the above conditions are met.

P2431 and P2436

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0351, P0352, P0353, P0354, P0411, P0412, P0418, P0420, P0606, P0641, P0651, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2430, P2432, P2433, P2435, P2437, or P2438 is not set.
- Greater than 60 min has elapsed since the last cold start.
- The ignition voltage is between 10-32 V.
- The engine speed is less than 5, 000 RPM.
- The intake air temperature (IAT) is greater than -10°C (+14°F).
- The engine coolant temperature (ECT) is between -10 and +56°C (14-133°F).
- The barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- The manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- The mass air flow (MAF) is less than 50 g/s.
- DTC P2431 and P2436 run continuously when the above conditions are met.

Conditions for Setting the DTC

P2430 or P2435

The ECM determines that the pressure sensor value change at either shutoff/check valve is less than 0.5 kPa and the signal variation is less than 0.15 kPa for greater than 5 s when the secondary air injection pump is commanded ON.

P2431 or P2436

- The difference between the actual system pressure at either shutoff/check valve and BARO is greater than 18 kPa (2.6 psi) or less than -10 kPa (-1.5 psi) for greater than 5 s when the secondary air injection pump is commanded OFF.

OR

- The difference between the actual system pressure at either shutoff/check valve and BARO is greater than 50 kPa (7.3 psi) for greater than 5 s when the secondary air injection pump is commanded ON.

Action Taken When the DTC Sets

DTCs P2430, P2431, P2435, and P2436 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2430, P2431, P2435, and P2436 are Type B DTCs.

Diagnostic Aids

Ice buildup due to condensation/water in the air passages or pump may cause these DTCs to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection 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

J-36169-HD Fused Jumper

Circuit/System Verification

NOTE: Verify the battery is fully charged before proceeding with this diagnostic procedure. The secondary air injection pump output will vary with system voltage.

1. Ignition ON
2. Verify that DTC P0411, P0412, P0418, P2432, P2433, P2237, P2238, P2440, or P2444 is not set.
 - If any of the DTCs are set

Refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.

- If none of the DTCs are set.
3. Verify the scan tool BARO pressure parameter is within the range specified in the Altitude Versus Barometric Pressure table.
 - If not within the specified range

Refer to DTC P0106 for further diagnosis.

- If within the specified range

NOTE: To prevent the secondary air injection pump from overheating, do not operate the pump consecutively for greater than 2 minutes. The pump is provided with a thermal protector that will automatically reset when allowed to cool. Engine coolant temperature must be greater than 5°C (41° F) to enable scan tool device control.

4. Verify the secondary air injection pump turns ON and OFF when commanding the Secondary Air Injection Pump Relay between ON and OFF with a scan tool.
 - If the secondary air injection pump does not operate as specified

Refer to Circuit/System Testing below -Secondary Air Injection Pump Malfunction

- **If the secondary air injection pump operates as specified**

5. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 (left hand), Bank 2 (right hand) and the BARO pressure parameters are within 3 kPa (0.4 psi).

- **If not within the specified range**

Refer to Circuit/System Testing below -Secondary Air Injection System Pressure Not In Range.

- **If within the specified range**

6. Engine running
7. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 (left hand) and Bank 2 (right hand) parameters increase between 14-22 kPa (2.0-3.2 psi), greater than BARO, when the Secondary Air Injection Pump Relay is commanded ON with a scan tool.

- **If not within the specified range**

Refer to Circuit/System Testing below -Secondary Air Injection System Pressure Not In Range.

- **If within the specified range**

8. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 (left hand) and Bank 2 (right hand) parameters increase between 5-11 kPa (0.7-1.6 psi), greater than BARO, when the Secondary Air Injection System is commanded ON with a scan tool.

- **If not within the specified range**

Refer to Circuit/System Testing below -Secondary Air Injection System Pressure Not In Range.

- **If within the specified range**

9. 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.
10. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing below

- **If the DTC does not set**

11. All OK

Circuit/System Testing

Secondary Air Injection Pump Malfunction

1. Ignition OFF, disconnect the KR25 Secondary Air Injection Pump Relay.
2. Verify a test lamp illuminates between the B+ circuit terminal 87 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF
2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
1. Ignition OFF
2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
4. Test for infinite resistance between the control circuit terminal A and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
5. Test or replace the G21 Secondary Air Injection Pump.
 - **If the test lamp illuminates**
3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
4. 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 10 ohms between the G21 Secondary Air Injection Pump ground circuit terminal B and ground.
 - **If 10 ohms or greater**
 - 1. Ignition OFF.
 - 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.
 - **If less than 10 ohms**
5. Connect the harness connector at the G21 Secondary Air Injection Pump.
6. Connect a 50 A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30.

NOTE: To prevent the secondary air injection pump from overheating, do not operate the pump consecutively for greater than 2 minutes. The pump is provided with a thermal protector that will automatically reset when allowed to cool.

7. Verify the G21 Secondary Air Injection Pump is activated.
 - **If the G21 Secondary Air Injection Pump does not activate**
 - 1. Ignition OFF, disconnect the harness connector at the G21 Secondary Air Injection Pump.
 - 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms,

3. Test or replace the G21 Secondary Air Injection Pump.
 - **If the G21 Secondary Air Injection Pump activates**
8. Test or replace the KR25 Secondary Air Injection Pump Relay.

Secondary Air Injection System Pressure Not In Range

NOTE: The exhaust manifold and exhaust manifold gasket are provided with openings, at the secondary air injection check valve adapter interfaces, which are used to regulate the system pressure and flow. Any damage or restriction to these openings may cause a DTC to set.

1. Verify the following conditions do not exist with the appropriate secondary air injection shutoff and check valve:
 - Hoses/pipes/adapters restricted or blocked
 - Hoses/pipes/adapters leaking or disconnected
 - Plugged secondary air injection pressure sensor port (integral to shutoff and check valve)
 - Damaged secondary air injection shutoff and check valve
 - Restricted or blocked cylinder head secondary air injection inlet ports and passages
 - Damaged or restricted secondary air injection check valve pipe adapter air flow openings in exhaust manifold or gasket. Refer to Secondary Air Injection Check Valve Pipe Adapter Replacement - Left Side , and Secondary Air Injection Check Valve Pipe Adapter Replacement - Right Side .
- **If a condition is located**

Repair or replace the affected component as necessary.

- **If all components test normal**
2. Disconnect the secondary air injection hoses/pipes from the Q29 Secondary Air Injection Solenoid Valves.
 3. Ignition ON, command the Secondary Air Injection Pump Relay ON with a scan tool.
 4. Verify airflow to the Q29 Secondary Air Injection Solenoid Valves.
 - **If no airflow**

Replace the G21 Secondary Air Injection Pump.

- **If airflow**
5. Replace the appropriate Q29 Secondary Air Injection Solenoid Valve or Valves.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR25 Secondary Air Injection Pump Relay.
2. Test for 50-75 ohms between terminals 85-86.

- **If not within the specified range**

Replace the KR25 Secondary Air Injection Pump Relay.

- **If within the specified range**

3. Test for infinite resistance between the terminals listed below:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87

- **If less than infinite resistance**

Replace the KR25 Secondary Air Injection Pump Relay.

- **If infinite resistance**

4. Install a 15 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.

5. Test for less than 2 ohms between terminals 30 and 87.

- **If 2 ohms or greater**

Replace the KR25 Secondary Air Injection Pump Relay.

- **If less than 2 ohms**

6. All OK

Repair Instructions

- **Relay Replacement (Within an Electrical Center) , Relay Replacement (Attached to Wire Harness)**
- **Secondary Air Injection Check Valve Replacement - Left Side** for secondary air injection shutoff and check valve and pressure sensor - Left Side replacement
- **Secondary Air Injection Check Valve Replacement - Right Side** for secondary air injection shutoff and check valve and pressure sensor - Right Side replacement
- **Secondary Air Injection Check Valve Pipe Adapter Replacement - Left Side**
- **Secondary Air Injection Check Valve Pipe Adapter Replacement - Right Side**
- **Secondary Air Injection Pump Replacement**
- **Secondary Air Injection Pump Inlet Hose Replacement**

Repair Verification

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 with a scan tool.

4. Ignition OFF, all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
5. Ignition ON.
6. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1, Bank 2 and BARO pressure parameters are within 3 kPa (0.4 psi).

- **If not within the specified range**

Refer to Circuit/System Verification below -step 1

- **If within the specified range**

7. Engine running.
8. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 and Bank 2 parameters increase between 5-11 kPa (0.7-1.6 psi) greater than BARO, when the Secondary Air Injection System is commanded ON with a scan tool.

- **If not within the specified range**

Refer to Circuit/System Verification below-step 1

- **If within the specified range**

9. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1 and Bank 2 parameters increase between 14-22 kPa (2.0-3.2 psi), greater than BARO, when the Secondary Air Injection Pump Relay is commanded ON with a scan tool.

- **If not within the specified range**

Refer to Circuit/System Verification below -step 1

- **If within the specified range**

10. If the repair was 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 any DTC sets**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

- **If no DTC sets.**

11. All OK

DTC P2432, P2433, P2437, OR P2438

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 P2432

Secondary Air Injection System Pressure Sensor Circuit Low Voltage - Bank 1 (Left Hand)

DTC P2433

Secondary Air Injection System Pressure Sensor Circuit High Voltage - Bank 1 (Left Hand)

DTC P2437

Secondary Air Injection System Pressure Sensor Circuit Low Voltage Bank 2 - (Right Hand)

DTC P2438

Secondary Air Injection System Pressure Sensor Circuit High Voltage Bank 2 - (Right Hand)

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Secondary Air Injection Pressure Sensor 5 V Reference Bank 1	P0335, P2432	P2432	P2433*	P2431
Secondary Air Injection Pressure Sensor Signal Bank 1	P2432	P2432	P2433*	P2431
Secondary Air Injection Pressure Sensor Low Reference Bank 1	-	P2433	-	P2431
Secondary Air Injection Pressure Sensor 5 V Reference Bank 2	P0335, P2437	P2437	P2438*	P2436
Secondary Air Injection Pressure Sensor Signal Bank 2	-	P2438	P2438*	P2436
Secondary Air Injection Pressure Sensor Low Reference Bank 2	-	P2438	-	P2436
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Secondary Air Injection Pressure Sensor Bank 1 and Bank 2

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: BARO			
Operating Conditions: Ignition ON, Engine OFF			
5-Volt Reference	41 kPa (6 psi)	41 kPa (6 psi)	149 kPa (21.6 psi)
Secondary Air Pressure Sensor Signal	40 kPa (5.8 psi)	40 kPa (5.8 psi)	149 kPa (21.6 psi)
Low Reference	-	149 kPa (21.6 psi)	-

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. Secondary air injection pressure sensors, which are integral to the shutoff and check valves, are used to monitor the air flow from the secondary air injection pump. The engine control module (ECM) supplies voltage to the 5 V reference circuits and provides a ground for the low reference circuits. The sensors provide a signal voltage to the ECM relative to the pressure changes within the secondary air injection system.

Conditions for Running the DTC

- DTC P0606, P0641, or P0651 is not set.
- The ignition is ON, or the engine is running.
- The DTC runs continuously when the above conditions exist.

Conditions for Setting the DTC

P2432 or P2437

The ECM detects that the corresponding bank 1 or bank 2 secondary air injection pressure sensor signal is less than 0.3 V for greater than 6 s.

P2433 or P2438

The ECM detects that the corresponding bank 1 or bank 2 secondary air injection pressure sensor signal is greater than 4.7 V for greater than 6 s.

Action Taken When the DTC Sets

DTCs P2432, P2433, P2437 and P2438 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P2432, P2433, P2437 and P2438 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Secondary Air Injection System Description

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- **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 P0651 is not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Verify the scan tool BARO pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.
3. Verify the scan tool Secondary Air Injection Pressure Sensor Bank 1, Bank 2 and the BARO pressure parameters are within 3 kPa (0.4 psi).
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, Bank 1 (left hand) or Bank 2 (right hand), Q29 Secondary Air Injection 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 3 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 Engine Control Module.
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 Engine 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 K20 Engine Control Module.
4. Verify the corresponding scan tool Secondary Air Injection Pressure Sensor Bank 1 or Bank 2 voltage parameter is less than 0.5 V.

- If greater than the specified range, test the signal circuit terminal 2 for a short to voltage. If the circuit tests normal, replace the K20 Engine Control Module.
- 5. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the 5 V reference circuit terminal 1. Verify the corresponding scan tool Secondary Air Injection Pressure Sensor Bank 1 or Bank 2 voltage parameter is greater than 4.8 V.
 - 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 Engine Control Module.
- 6. If all circuits test normal, test or replace the Q29 Secondary Air Injection Solenoid Valve.

Repair Instructions

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

- **Secondary Air Injection Check Valve Replacement - Left Side** for secondary air injection shutoff and check valve and pressure sensor - Left Side replacement
- **Secondary Air Injection Check Valve Replacement - Right Side** for secondary air injection shutoff and check valve and pressure sensor - Right Side replacement
- **Control Module References** for ECM replacement, programming, and setup

DTC P2440

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 P2440

Secondary Air Injection System Cut-Off Valve Stuck Open

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. A pressure sensor in each bank is used to monitor the air flow from the secondary air injection pump. The engine control module (ECM) supplies voltage to the 5-volt reference circuits and supplies a ground to the low reference circuits. The sensors provide a signal voltage to the ECM relative to the pressure changes within the secondary air injection system.

Ignition voltage is supplied to the secondary air injection pump and air injection shutoff/check valve relays. The ECM controls the relays by grounding the control circuits, which activates the relays. When the relay contacts close, voltage is supplied to the pump and the valves, which turns the pump on and opens the valves.

The diagnostic uses 3 phases to test the secondary air injection system:

- DTCs P0411, P2430 and P2435 run during Phase 1
- DTCs P2430, P2435 and P2440 run during Phase 2
- DTC P2444 runs during Phase 3

During phase 1, both the secondary air injection pump and the secondary air injection shutoff and check valves are activated. Normal secondary air function occurs. Expected system pressure is 5-11 kPa (0.7-1.6 psi) above BARO. Relatively high magnitude of pressure pulses are expected due to exhaust pulses. Low magnitude pressure pulses indicate a blockage or disconnect downstream of the valve.

During phase 2, only the secondary air injection pump is activated. The shutoff and check valves are closed. Pressure sensor performance and shutoff and check valve deactivation are tested. Expected system pressure is 14-22 kPa (2.0-3.2 psi) above BARO.

During phase 3, neither the secondary air injection pump nor the secondary air injection shutoff and check valves are activated. Secondary air injection pump deactivation is tested. Expected system pressure equals BARO.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0351, P0352, P0353, P0354, P0412, P0418, P0420, P0606, P0641, P0651, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2430, P2431, P2432, P2433, P2435, P2436, P2437, or P2438 is not set.
- Greater than 60 min has elapsed since the last cold start.
- Ignition voltage is between 10-32 V.
- Engine speed is less than 5,000 RPM.
- Intake air temperature (IAT) is greater than -10°C (+14°F).
- Engine coolant temperature (ECT) is between -10 and +56°C (14-133°F).
- Barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- Manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- Mass air flow (MAF) is less than 50 g/s.
- Secondary air injection pump is commanded ON.
- Secondary air injection diagnostic test Phase 1 has run and passed.
- DTC P2440 runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that average difference between the predicted system pressure and the actual system pressure is less than a calibrated threshold for greater than 8 s.

Action Taken When the DTC Sets

DTC P2440 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2440 is a Type B DTC.

Diagnostic Aids

Ice buildup due to condensation/water in the air passages or pump may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection 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, verify that DTC P0412, P0418, P2430, P2431, P2432, P2433, P2235, P2236, P2237, or P2238 is not set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, verify the scan tool BARO pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.

- If not within the specified range, refer to **DTC P0106**.
- 3. Compare the scan tool Secondary Air Pressure Sensor Bank 1 and Bank 2 pressure parameters to the BARO parameter. The readings should be within 3 kPa (0.4 psi).
 - If not within the specified range, refer to **DTC P2430, P2431, P2435, or P2436**.
- 4. Command the Secondary Air Injection Solenoid Valve ON and OFF with a scan tool. You should hear and feel the relay click as the command is changed between ON and OFF.
 - If the relay does not respond to the scan tool commands, refer to **DTC P0412 or P0418**.
- 5. Command the Secondary Air Injection Solenoid Valve ON and OFF with a scan tool. Listen or and feel for secondary air injection shutoff and check valve operation. Both valves should respond to the scan tool commands. Repeat as necessary in order to verify valve operation.
- 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 appropriate, Bank 1 (left hand) or Bank 2 (right hand), Q29 Secondary Air Injection Solenoid Valve
2. Connect a test lamp between the Q29 Secondary Air Injection Solenoid Valve control circuit terminal 5 and ground.
3. Ignition ON, command the Secondary Air Injection Solenoid Valve ON and OFF with a scan tool. The test lamp should respond to the scan tool commands.
 - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the KR26 secondary air injection solenoid valve relay.
4. Verify the following conditions do not exist:
 - Hoses/pipes restricted or blocked upstream of valve
 - Hoses/pipes leaking or disconnected
 - Plugged secondary air injection pressure sensor port
 - Damaged or restricted secondary air injection pump
 - Damaged secondary air injection check valve
 - If a condition is located, repair as necessary.
5. If all components test normal, test or replace the Q29 Secondary Air Injection Solenoid Valve.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate Q29 Secondary Air Injection Solenoid Valve.
2. Test for 8-15 ohms between terminals 4-5 of the Q29 Secondary Air Injection Solenoid Valve.
 - If not within the specified range, replace the Q29 Secondary Air Injection Solenoid Valve.

Repair Instructions

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

- **Secondary Air Injection Check Valve Replacement - Left Side** for secondary air injection shutoff and check valve and pressure sensor - Left Side replacement
- **Secondary Air Injection Check Valve Replacement - Right Side** for secondary air injection shutoff and check valve and pressure sensor - Right Side replacement

DTC P2444

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 P2444

Secondary Air Injection System Pump Stuck On

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. A pressure sensor in each bank is used to monitor the air flow from the secondary air injection pump. The engine control module (ECM) supplies voltage to the 5-volt reference circuits and supplies a ground to the low reference circuits. The sensors provide a signal voltage to the ECM relative to the pressure changes within the secondary air injection system.

Ignition voltage is supplied to the secondary air injection pump and air injection shutoff/check valve relays. The ECM controls the relays by grounding the control circuits, which activates the relays. When the relay contacts close, voltage is supplied to the pump and the valves, which turns the pump on and opens the valves.

The diagnostic uses 3 phases to test the secondary air injection system:

- DTCs P0411, P2430 and P2435 run during Phase 1
- DTCs P2430, P2435 and P2440 run during Phase 2
- DTC P2444 runs during Phase 3

During phase 1, both the secondary air injection pump and the secondary air injection shutoff and check valves are activated. Normal secondary air function occurs. Expected system pressure is 5-11 kPa (0.7-1.6 psi) above BARO. Relatively high magnitude of pressure pulses are expected due to exhaust pulses. Low magnitude pressure pulses indicate a blockage or disconnect downstream of the valve.

During phase 2, only the secondary air injection pump is activated. The shutoff and check valves are closed. Pressure sensor performance and shutoff and check valve deactivation are tested. Expected system pressure is 14-22 kPa (2.0-3.2 psi) above BARO.

During phase 3, neither the secondary air injection pump nor the secondary air injection shutoff and check valves are activated. Secondary air injection pump deactivation is tested. Expected system pressure equals BARO.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0351, P0352, P0353, P0354, P0412, P0418, P0420, P0606, P0641, P0651, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2430, P2431, P2432, P2433, P2435, P2436, P2437, or P2438 is not set.
- Greater than 60 min has elapsed since the last cold start.
- Ignition voltage is between 10-32 V.
- Engine speed is less than 5,000 RPM.
- Intake air temperature (IAT) is greater than -10°C (+14°F).
- Engine coolant temperature (ECT) is between -10 and +56°C (14-133°F).
- Barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- Manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- Mass air flow (MAF) is less than 50 g/s.
- Secondary air injection pump is commanded ON.
- Secondary air injection diagnostic test Phase 1 and Phase 2 have run and passed.
- DTC P2444 runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that average difference between the predicted system pressure and the actual system pressure is greater than or less than calibrated thresholds for greater than 8 s.

Action Taken When the DTC Sets

DTC P2444 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P2444 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection 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: To prevent the secondary air injection pump from overheating, do not operate the pump consecutively for greater than 2 minutes. The pump is provided with a thermal protector that will automatically reset when allowed to cool.

1. Command the Secondary Air Injection Pump Relay ON and OFF with a scan tool. The secondary air injection pump should turn ON and OFF.
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 G21 Secondary Air Injection Pump.
2. Ignition ON, verify that a test lamp does not illuminate between the G21 Secondary Air Injection Pump ignition voltage circuit terminal A and ground.
 - o If the test lamp illuminates, test the ignition circuit for a short to voltage.
3. If the circuit tests normal replace the KR25 Secondary Air Injection Pump Relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Relay Replacement (Within an Electrical Center) , Relay Replacement (Attached to Wire Harness)

DTC P2534 (FUEL PUMP CONTROL MODULE)

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 On/Start Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	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 fuel pump control module detects that the ignition 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 - INDEX

Description and Operation

Fuel 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.
2. Verify DTC P0562 is not set.
 - **If the DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If the DTC is not set**
3. Ignition OFF, disconnect the harness connector at the K27 fuel pump control module, ignition ON.
 4. Verify a test lamp illuminates between the ignition circuit terminal 21 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K27 fuel pump control module.
 - **If the test lamp illuminates**
5. Replace the K27 fuel pump control module.

Repair Instructions

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

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

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 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

NOTE:

- **DTC P2544 is an informational DTC.**
- **Diagnose all other engine control module DTCs prior to DTC P2544.**

1. Verify there are no other engine control module or communication DTCs set.

○ **If a DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

○ **If a DTC is not set**

2. Complete the diagnosis by looking for an intermittent CAN circuit fault. Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** .

○ **If an intermittent CAN circuit fault is found**

Repair as necessary.

○ **If an intermittent CAN circuit fault is not found**

3. All OK.

Repair Instructions

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

Control Module References for TCM replacement, setup, and programming.

DTC P2635 (FUEL PUMP CONTROL MODULE)

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/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 line 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.
- Low fuel level warning not present.

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 pressure and the current fuel 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.

On vehicles equipped with a high pressure mechanical pump on Direct Fuel Injection engines, the vehicle may continue to run even though the pump in the fuel tank is not operating.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel 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

NOTE: Do not replace the fuel pump control module based on a history DTC P2635. The DTC P2635 may be stored but that does not indicate a failure of the fuel pump control module. Refer to Strategy Based Diagnosis for further history DTC diagnostics.

1. Ignition ON.

2. Verify DTCs P018B, P018C, P018D, P0231, P0232 or P023F are not set.

- **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

3. Verify the proper fuel system pressure. Perform the fuel system pressure test, refer to **Fuel System Diagnosis**.

- **If the fuel system pressure test is not normal**

Replace the G12 Fuel Pump.

- **If the fuel system pressure test is normal**

4. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G12 Fuel Pump. It may take up to 2 minutes for all vehicle systems to power down.
5. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K27 Fuel Pump Control Module.
 - **If less than 10 ohms**
6. Connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
7. Ignition ON.
8. Verify the test lamp turns ON and OFF when commanding the fuel pump ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K27 Fuel Pump Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K27 Fuel Pump Control Module.
 - **If the test lamp turns ON and OFF**

9. All OK.

Repair Instructions

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

- **Fuel Tank Fuel Pump Module Replacement (NU6)** , **Fuel Tank Fuel Pump Module Replacement (NT7)**
- **Control Module References** for fuel pump control module replacement, programming and setup

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

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:

- Verify that the malfunction indicator lamp (MIL) is operating correctly. Use the scan tool to command the lamp ON and OFF.
- Verify that there are no DTCs that are stored.
- Verify 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

- Verify that the control module grounds are clean, tight, and correctly located.
- Verify that the vacuum hoses are not split or kinked, and are properly connected, as shown on the Vehicle Emission Control Information label.
- Verify that the air filter is clean and free from restrictions.
- Verify 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, Engine Control Module (ECM) Commanded Reduced Engine Power, 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:
 - Correct operation and pressure-Refer to **Fuel System Diagnosis**.
 - Improperly operating fuel injectors-Refer to **Fuel Injector Solenoid Coil Test**.
 - Improper fuel quality condition-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Test the ignition system for the following:
 - Spark plugs with incorrect heat range or an abnormal condition-Refer to **Spark Plug Inspection** , and **Ignition System Specifications** .
 - Coolant or oil fouled spark plugs-For diagnosis, refer to **Coolant in Combustion Chamber** , or **Oil Consumption Diagnosis** .
 - Secondary ignition system susceptible to moisture. Engine running, wet down the secondary ignition system with water from a spray bottle to 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:
 - Improper operation of the transmission torque converter clutch (TCC) - The scan tool should indicate an engine speed drop when the TCC is commanded ON. For Non-Hybrid equipped vehicles, refer to **Torque Converter Diagnosis** .
 - Improper operation of the A/C compressor
 - An engine that runs lean or rich-Observe the Fuel Trim parameters with a scan tool. Refer to **DTC P0171 or P0172** .
 - Slow responding heated oxygen sensors (HO2S). The heated oxygen sensors should respond quickly to different throttle positions.

CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution .

- Water intrusion in the heated oxygen sensors 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.**

- Improper MAF sensor installation. A mass air flow sensor that is improperly installed may cause a hard start. Install the mass air flow in the proper direction. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .
- Improper mass air flow (MAF) sensor connections.
- Engine oil contaminated by fuel
- Split or kinked vacuum hoses-Verify that the routing and connections are as shown on the Vehicle Emission Control Information label.
- Excessive knock sensor system spark retard activity-Observe the Knock Retard parameter on the scan tool for activity more than 0°.
- Electromagnetic interference (EMI) on the reference circuit, which can cause a misfire condition. You can usually detect electromagnetic interference 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 electromagnetic interference is present. Inspect the high voltage components near the ignition control circuit if a condition exists.
- A crankshaft position sensor with an intermittent condition-Observe the scan tool Crankshaft Position Resync Counter parameter. The Resync Counter parameter should remain at 0 during all operating conditions, and when moving the related harnesses and connectors between the crankshaft position sensor and the ECM.
- A stuck open evaporative emission (EVAP) canister purge solenoid.
- Improper operation of the crankcase ventilation valve-Refer to **Crankcase Ventilation System Inspection/Diagnosis (Without Turbocharger)** .
- The exhaust system components for the following:
 - Physical damage or possible internal failure
 - Restricted three-way catalytic converters

For more information, refer to **Symptoms - Engine Exhaust** .

- The engine cooling system for the following conditions:
 - A thermostat with incorrect heat range. Refer to **Thermostat Diagnosis** .
 - Improper engine coolant level-If the level is low, refer to **Loss of Coolant** .
- 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

Detonation/Spark Knock

- 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 **K20 Engine Control Module: Scan Tool Information (LCV or LUK)** list. If the reading is not in the range specified in the list, test the resistance of the engine coolant temperature sensor. Refer to **Temperature Versus Resistance** , for resistance specifications. Replace the engine coolant temperature sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement** . If the sensor is within the specification, test the engine coolant temperature sensor circuits for high resistance.
- Test for an engine overheating condition. Refer to **Engine Overheating** .
- Inspect for excessive carbon buildup in the combustion chambers. Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.
- If there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicle minimum octane requirements.

Engine Control Module (ECM) Commanded Reduced Engine Power

Under certain conditions the engine control module may limit engine power by reducing engine torque and, for some vehicles, fuel pressure as well. For most, but not all of the conditions, the engine control module will illuminate the reduced engine power lamp on the instrument panel cluster, however a DTC may not be set. Observe the scan tool Reduced Engine Power History parameter, if applicable, or refer to **K20 Engine Control Module: Scan Tool Information (LCV or LUK)** to determine the reason for the reduced engine power event.

Verify or inspect for the following:

- Vehicle being operated at sustained high engine speeds, or, towing heavy loads up an incline for an extended period of time, which may cause the engine oil or coolant to overheat. A repair may not be necessary. Inspect the airflow passageways in front of the engine for obstructions and clear away any debris or foreign material that is found. If no obstructions are found, review approved driving habits with

the customer. The customer may need to operate the vehicle at a higher engine speed to improve cooling system performance, or, at a slower engine speed to reduce engine load.

- A cooling fan condition which may cause the engine control module to reduce engine power. Refer to **Cooling Fan Description and Operation** , and **Cooling System Description and Operation** to verify correct operation of the cooling fan.
- Temporarily reduced engine power. Under extremely cold ambient temperatures some SIDI equipped vehicles may experience engine control module commanded reduced engine power for a few minutes during engine warm-up. This would be a normal condition, noticeable only at wide open throttle, and the reduced engine power lamp would not be illuminated.
- If the vehicle is equipped with the OnStar® feature, reduced engine power may be due to OnStar® remote command. Verify the vehicle is not in the OnStar® initiated Stolen Vehicle Slowdown mode. Refer to **OnStar Stolen Vehicle Slowdown Active** , and **Remote Vehicle Speed Limiting Description and Operation** for additional information.
- Excessively high fuel pressure condition. Refer to **Fuel System Diagnosis**, and **Fuel System Description** to verify fuel system operation.
- Maximum recommended engine oil life exceeded. Refer to the Owners Manual for scheduled maintenance recommendations.
- Intake air temperature out of range too high. Engine running, observe the scan tool IAT Sensor parameter. The readings should be between -40°C and +149°C (-40°F and +300°F). Refer to **DTC P0112, P0113, or P0114** for additional information.
- Fuel temperature out of range too high.

Fuel Odor

- Inspect for leaking, damaged, or deteriorated fuel lines.
- Inspect for a saturated EVAP canister-Refer to **Evaporative Emission Control System Description** .
- Inspect for a condition with the internal components of the fuel tank assembly-Refer to **Fuel System Description** .

Hard Start

- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary. Refer to **Throttle Body Cleaning** .
- Test the engine coolant temperature (ECT) sensor. Compare the scan tool ECT Sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT Sensor values should be within 3° C (5°F). If the engine coolant temperature sensor is out of range with the intake air temperature sensor, test the resistance of the engine coolant temperature sensor. Refer to **Temperature Versus Resistance** , for resistance specifications. Replace the engine coolant temperature sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement** . If the sensor is within the specifications, test the engine coolant temperature sensor circuits for high resistance.
- Verify that the fuel system has adequate pressure for engine start-up. The fuel pump control module should command the fuel pump ON for 2 S when the ignition is turned to ON. Refer to **Fuel System Description** , and **Fuel System Diagnosis** for correct fuel pressure specifications.
- Inspect for excessive crankshaft endplay that will cause the crankshaft position sensor reluctor wheel to

move out of alignment with the crankshaft position sensor. Refer to **Crankshaft and Bearing Cleaning and Inspection** .

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 V or more than 16 V.
- Test the manifold absolute pressure (MAP) sensor. Refer to **DTC P0106** .
- Inspect for excessive crankshaft endplay that will cause the crankshaft position sensor reluctor wheel to move out of alignment with the crankshaft position sensor. Refer to **Crankshaft and Bearing Cleaning and Inspection** .

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 actuators from 0 degrees to 25 degrees and back to zero while observing the 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 Actuator System Description** ,, **Camshaft Position Exhaust Actuator Replacement** ,, and **Camshaft Position Intake Actuator Replacement** .

Lack of Power, Sluggishness, or Sponginess

- 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 actuators from 0 degrees to 25 degrees and back to zero while observing the 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 Actuator System Description** ,, **Camshaft Position Exhaust Actuator Replacement** ,, and **Camshaft Position Intake Actuator Replacement** .

Poor Fuel Economy

- Inspect for heavy loads being carried or towed
- Inspect for acceleration rate too much or too often
- Inspect for incorrect operation of the speedometer.
- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary. Refer to **Throttle Body Cleaning**.
- 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 **K20 Engine Control Module: Scan Tool Information (LCV or LUK)**, list. If the reading is not in the range specified in the list, test the resistance of the engine coolant temperature sensor. Refer to **Temperature Versus Resistance**, for resistance specifications. Replace the engine coolant temperature sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement**. If the sensor is within the specification, test the engine coolant temperature 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**.
- Inspect the brake system for brake drag.

Rough, Unstable, or Incorrect Idle and Stalling

- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary. Refer to **Throttle Body 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. Refer to **Engine Mount Inspection**.
- Inspect the intake and exhaust manifolds for casting flash.
- An excessively high idle may be due to the floor mat interfering with the accelerator pedal. With this condition present, it may not be possible to shift the transmission into gear. Inspect the accelerator pedal for binding and verify that the floor mat is not interfering with the accelerator pedal movement.

Surges/Chuggles

- 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**.
- Inspect for slow responding heated oxygen sensors (HO2S). The heated oxygen sensors should respond quickly to a change in throttle position. If the heated oxygen sensors 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 engine control module reduces the amount of fuel delivered to the engine, causing a drivability condition.

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

The malfunction indicator lamp (MIL) illuminates to inform the driver that an emission system fault has occurred and the engine control system requires service. Ignition voltage is supplied directly to the MIL. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit when the emission system fault occurs. Under normal operating conditions, the MIL should be ON only when the ignition is ON and the engine is OFF.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors while monitoring the scan tool MIL control circuit status parameters. Perform this test with the ignition ON and the engine OFF, and with the engine running. The MIL control circuit status parameters 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**
- **Instrument Cluster Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

NOTE: Any MIL requesting DTCs that may be set should be diagnosed first.

1. Ignition ON, command the MIL ON and OFF with a scan tool. The MIL should turn ON and OFF as commanded.
2. Command the MIL ON and OFF with a scan tool while observing the following control circuit status parameters:
 - 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. Engine running, command the MIL ON and OFF with a scan tool while observing the following control circuit status parameters:
 - 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.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
2. Ignition ON, the MIL should not illuminate.
 - If the MIL is illuminated, test the MIL control circuit terminal X1-46 for a short to ground. If the circuit tests normal, replace the IPC.

NOTE: The MIL is powered by a dedicated ignition voltage circuit.

3. Connect a 3 A fused jumper wire between the MIL control circuit terminal X1-46 and ground. The MIL should illuminate.
 - If the MIL illuminates, replace the K20 Engine Control Module.
 - If the MIL does not illuminate, test the MIL control circuit for a short to voltage or an open/high resistance. If the MIL control circuit tests OK, test the instrument cluster ignition voltage circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the IPC\bulb.

Repair Instructions

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

- **Instrument Cluster Replacement**
- **Control Module References** for replacement, programming, and setup.

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.
 - o If the test aborts, correct the condition for running the test, then retest.
 - o 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.

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:

- When attempting to start the engine, the mechanical portion of the vehicle key must be locked in the fully extended position with the fob parallel to the key. Leaving the key partially retracted or folded over when starting may interrupt transponder authentication and result in an intermittent no-start condition. In such instances, DTC B3055 may also be set. If an intermittent no-start complaint is received, it may be necessary to discuss with the customer their starting habits and verify they are locking the key in the fully extended position, fob parallel to the key, before starting.
- 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.
- The fuel injectors are calibrated to begin operating when fuel pressure reaches 0.7 MPa (101.5 psi) at 20-32°C (68-90°F). This specification will vary when the temperature is outside of this range.
- 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.
- Check the crankshaft position sensor engine reference signal with a scan tool. Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200-300 RPM while cranking. If erratic values, such as sudden spikes in the engine speed are displayed, the engine reference signal is not stable enough for the engine to start and run properly.
- Inspect the engine for good secure electrical grounds.
- If the engine almost starts and then stalls, check for an open in the ground circuits of the crankshaft position sensor and the camshaft position sensor.
- 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 - INDEX

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** HEI Spark Tester

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

NOTE: **This diagnostic assumes the following:**

- **The battery is completely charged.**
- **The engine cranking speed is acceptable.**
- **There is adequate fuel in the fuel tank.**

1. Engine cranking, observe the DTC information with a scan tool. Verify the following DTCs are not set:

DTC P0016, P0017, P0201-P0204, P0230, P0335, P0336, P0351-P0354, P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, P0685, P0689, P0690, P1516, P1682, P2610.

○ If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

2. Ignition ON, engine OFF, observe the Theft Deterrent LED located on the instrument panel cluster. The LED should illuminate momentarily and then go out.

○ If the LED stays ON or is flashing, review the scan tool DTC information for Immobilizer system DTCs-Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** . For more information, refer to **Immobilizer Description and Operation** .

3. Engine cranking, observe the scan tool Engine Speed parameter. The scan tool should indicate an engine speed greater than 0 RPM.

○ If the engine speed is 0 RPM refer to **DTC P0335 or P0336** for further diagnosis.

NOTE: **Use the J 26792 HEI spark tester to verify the output of each T8 ignition coil.**

4. Ignition OFF, disconnect the T8 ignition coil from the cylinder and spark plug.
5. Connect the **J 26792** HEI spark tester to the boot of the T8 ignition coil and ground.

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

6. Engine cranking, verify that the spark tester sparks.

○ If there is no spark on any cylinder tested, refer to **Electronic Ignition System Diagnosis**.

7. Ignition OFF, install the **CH-48027** digital pressure gauge -Refer to **Fuel Pressure Gauge Installation and Removal** .

NOTE: The fuel pump may need to be commanded ON a few times, in order to obtain the highest possible fuel pressure.

8. Ignition ON, engine OFF, command the Fuel Pump Enable ON with a scan tool. Verify the fuel pressure is between 345-690 kPa (50-100 psi) with the fuel pump running.
 - If the fuel pump does not run, or if the fuel pump runs but the fuel pressure is not within the specified range, refer to **Fuel System Diagnosis**.
9. Verify that the fuel pressure, after the fuel pump has turned off, decreases to 500-599 kPa (72-87 psi), and does not decrease more than 34 kPa (5 psi) in 1 minute from that point.
 - If the fuel pressure is not within the specified range, refer to **Fuel System Diagnosis**.
10. Verify that the following conditions do not exist:
 - Collapsed air intake duct to the throttle body
 - Restricted air filter element
 - Spark plugs gas or coolant fouled
 - A skewed B74 manifold absolute pressure (MAP) sensor-Refer to **DTC P0106** .
 - A skewed B74 engine coolant temperature (ECT) sensor-Refer to **Temperature Versus Resistance** .
 - 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 or low compression-Refer to **Symptoms - Engine Mechanical** , or **Engine Compression Test** .
 - If you find any of the above conditions, repair as necessary.

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 tank fuel pump module and also supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line 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.

Diagnostic Aids

Observe the Misfire Counters or perform the Fuel Injector Balance Test to help identify a leaking fuel injector.

Reference Information

Description and Operation

Fuel 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

- **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.

NOTE: **DO NOT perform the Fuel System Diagnosis if the engine coolant temperature is above 60°C (150°F). High fuel pressure readings may result due to hot soak fuel boiling. With the engine OFF, the fuel pressure may increase beyond the pressure relief regulator valve's setting point of 690 kPa (100 psi) $\pm$ 5 percent.**

2. Ignition ON, engine OFF, command the Fuel Pump Enable ON with a scan tool. Verify the fuel pressure is between 345-690 kPa (50-100 psi) with the fuel pump running.
3. Engine idling at normal operating temperature, the Fuel Pump Flow Control Module Fuel Pressure Sensor parameter should read between 300-400 kPa (43-58 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.**

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 345-690 kPa (50-100 psi).
 - If the fuel pressure is greater than the specified range, replace the fuel tank fuel pump module.
 - 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 fuel tank fuel pump module.
 - Restricted fuel feed pipe
 - Inspect the harness connectors and the ground circuits of the fuel tank fuel pump module for poor connections.
2. Verify that the fuel pressure, after the fuel pump is turned off, decreases to 500-599 kPa (72-87 psi), and does not decrease more than 34 kPa (5 psi) in 1 minute from that point.
 - If the fuel pressure stays above 600 kPa (87 psi), replace the fuel tank fuel pump module.
 - 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. Disconnect the chassis fuel feed hose from the engine compartment fuel pipe.
 3. Install the **J 37287** Adapter between the chassis fuel hose and the engine compartment fuel pipe.
 4. Open the valve on the **J 37287** Adapter.
 5. Ignition ON, command the Fuel Pump Enable ON with a scan tool and bleed the air from the **CH-48027** Gauge.
 6. Command the Fuel Pump Enable ON and then OFF with a scan tool.
 7. Close the valve on the **J 37287** Adapter.

8. Monitor the fuel pressure for 1 min.
 - If the fuel pressure decreases more than 34 kPa (5 psi) within the specified time, locate and replace the leaking fuel injector(s).
 - If the fuel pressure does not decrease more than 34 kPa (5 psi) within the specified time, replace the fuel tank fuel pump module.
3. Relieve the fuel pressure to 69 kPa (10 psi). Verify that the fuel pressure does not decrease greater than 14 kPa (2 psi) in 5 min.
 - If the fuel pressure decreases greater than the specified value, replace the fuel tank fuel pump 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 fuel tank fuel pump module.
 - Restricted fuel feed pipe
 - Inspect the harness connectors and the ground circuits of the fuel tank fuel pump module for poor connections.
5. If the fuel system tests normal, refer to **Symptoms - Engine Controls**, **Fuel Injector Solenoid Coil Test**, and **Fuel Injector Balance Test**.

Repair Instructions

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

- **Direct Fuel Injector Replacement**
- **Fuel Feed Pipe Replacement (Engine)** , **Fuel Feed Pipe Replacement (Fuel Tank)** , **Fuel Feed Pipe Replacement (Chassis to Engine)**
- **Fuel Pump Fuel Feed Hose Replacement**
- **Fuel Tank Fuel Pump Module Replacement (NU6)** , **Fuel Tank Fuel Pump Module Replacement (NT7)**

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 the injector high voltage supply circuit, 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. 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.
4. If the injectors measure OK, perform the Fuel Injector Balance Test. Refer to **Fuel Injector Balance Test**.

Repair Instructions

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

Direct Fuel Injector Replacement

FUEL INJECTOR BALANCE 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 fuel injector balance test is performed while the engine is running at idle. The scan tool pressurizes the fuel rail to a predetermined pressure before each injector is pulsed for a precise amount of time allowing a measured amount of the fuel to be injected. This causes a drop in the system fuel pressure that is recorded and used to compare each injector.

Diagnostic Aids

- Monitoring the Current Misfire Counters may help to isolate the fuel injector that is causing the condition.
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.

Component Testing

NOTE:

- **DO NOT perform this test if the engine coolant temperature (ECT) is above 60°C (140°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.**
- **Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.**

Fuel Injector Balance Test

1. Verify the correct low side fuel pressure. Refer to **Fuel System Diagnosis**.
2. Engine idling, observe the Fuel Rail Pressure Sensor parameter with a scan tool. The pressure should be approximately 3 MPa (435 psi).

NOTE: **The engine speed must be between 600-1000 RPM to perform this test.**

3. With a scan tool, select the Fuel Injector Balance function within the Output Controls menu.
4. Select and test an injector. Repeat for each injector in order to obtain a pressure drop value for each injector.
5. After all injectors are tested, record the fuel pressure drops.
6. Add all of the individual pressure drop values except for the injector suspected of being faulty. This is the total pressure drop.
7. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop.
8. Multiply the average pressure drop by 0.20. This is the acceptable variance from the average pressure drop, 20 percent.

- If the difference between any individual pressure drop and the average pressure drop is more than the acceptable variance, replace the fuel injector.

Repair Instructions

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

Direct Fuel Injector Replacement

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 Tool

CH 44175-A Fuel Composition Tester

For equivalent regional tools, refer to **Special Tools**.

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 the **CH 44175-A** Fuel Composition Tester and the 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 Instructions

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

Fuel System Cleaning

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

This ignition system uses individual ignition coil assemblies for each cylinder. The engine control module (ECM) controls the spark events by transmitting the timing pulses on the ignition control (IC) circuits to the individual ignition module/coil assemblies in firing order sequence.

Diagnostic Aids

- An open/high resistance on the low reference circuit to the ignition coil may cause a misfire.
- An erratic or weak spark is considered a no spark condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

Special Tools

EL 26792 HEI Spark Tester

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Testing

NOTE: Do not perform this diagnostic procedure unless you were sent here from a misfire DTC or the Engine Cranks But Does Not Run diagnostic.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate T8 Ignition Coil. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 ohms between the ground circuit terminal A and ground.
 - o **If 5 ohms or greater**
 1. Ignition OFF.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - o If 2 ohms or greater, repair the open/high resistance in the circuit.
 - o If less than 2 ohms, repair the open/high resistance in the ground connection.
 - o **If less than 5 ohms**
3. Test for less than 5 ohms between the low reference circuit terminal B and ground.
 - o **If 5 ohms or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - o If 2 ohms or greater, repair the open/high resistance in the circuit.
 - o If less than 2 ohms, replace the K20 Engine Control Module.
 - o **If less than 5 ohms**
4. Ignition OFF, exchange the suspect T8 Ignition Coil with the T8 Ignition Coil of a known functioning cylinder.
5. Engine Running.
6. Verify the scan tool Ignition Coil Control Circuit Status parameter displays OK for the same cylinder that the suspect T8 Ignition Coil was removed from.
 - o **If OK is not displayed**

Replace the K20 Engine Control Module.
 - o **If OK is displayed**

Test or replace the T8 Ignition Coil.

Component Test

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

1. Ignition OFF, connect the **EL 26792** HEI Spark Tester to the appropriate T8 Ignition Coil.
2. Engine Running.
3. Verify the spark output of the T8 Ignition Coil.
 - o **If no output or the output is weak**

Replace the T8 Ignition Coil.

○ **If the output is normal**

4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Ignition Coil Replacement
- Control Module References for engine control module replacement, programming, and setup.

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 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.

Flow Meter 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 vehicle specific information 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 flow meter 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 flow meter to free up the float.**
- **If fuel level is 90% or greater it will take longer to fill the system with smoke because the fuel fill tube check valve will be closed and force any smoke to pass through the ORVR pipe and orifice.**

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. The floating indicator should be below the red flag. If above the red flag, go to the Smoke Procedure.
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 on 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 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, with special tool EN 41413-VLV EVAP Service Port Vent Fitting, until smoke is observed then remove the vent fitting tool and 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 s. Continue introducing smoke at 15 s intervals, as necessary.
8. Using 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 s intervals, as needed, until leak source is identified.

Temperature Variation Instructions

The Concern

Ideal circumstances for conducting the EVAP flow meter 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.

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 flow meter 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 flow meter test can be caused by a vehicle's warm EVAP system cooling down.
- A decrease in flow during the flow meter 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 Flow Meter Test.

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 Monitor 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 40 km/h (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 (I/M) 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 Complete System Set Procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics and complete the drive cycles 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 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 11-18 V.
- The barometric pressure is more than 75 kPa (10.9 psi).
- The start-up engine coolant temperature (ECT) is between 4-30°C (39-86°F).
- The start-up intake air temperature (IAT) is between 4-30°C (39-86°F).
- The difference between the IAT and the ECT is less than or equal to 6°C (43°F).
- The ambient air temperature is between 4-30°C (39-86°F).
- The fuel level is between 15-85 %.

Circuit/System Verification

Review the inspection/maintenance system status indicators with a scan tool. All I/M system status indicators should report YES, and no I/M Test DTCs should be present.

Inspection/Maintenance System Set Procedure

NOTE: Whenever the ignition is turned ON, ignition positive voltage is supplied to the heated oxygen sensor (HO2S) heaters. After verifying the enable criteria, turn OFF the ignition for approximately 5 min to allow the sensors to cool before continuing with the test. When the engine is started, DO NOT turn the engine OFF for the remaining portion of the set procedure.

1. Ensure that the vehicle meets the conditions for a cold start listed above.
2. The evaporative emission inspection/maintenance system status indicator should display YES.
 - If the inspection/maintenance system status indicator displays NO, perform the Service Bay Test, if applicable. If the Service Bay Test is NOT available, it may take up to 6 drive cycles, with up to 17 h between drive cycles, for the inspection/maintenance system status indicator to transition to YES.
3. The O2S Heater inspection/maintenance system status indicator should display YES.
 - If the O2S Heater inspection/maintenance system status indicator displays NO, ensure that the ignition has been turned OFF for at least 10 h.
4. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc.
5. Set the vehicle parking brake and ensure the vehicle is in Park for automatic transmission or Neutral for manual transmission.
6. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc.
7. Start and idle the engine for at least 2 min and until 65°C (149°F) is achieved.
8. Run the engine for 6.5 min within the following conditions:
 - MAF parameter between 4-30 g/s
 - Engine speed steady between 1,000-3,000 RPM
9. Return the engine to idle for 1 minute.
10. Apply and hold the brake pedal, and shift to Drive for automatic transmission, or apply the clutch pedal

for manual transmission and operate the vehicle within the following conditions for 2 min:

- Depress the accelerator pedal until throttle position sensor angle is more than 2 %.
- Mass air flow signal between 15-30 g/s
- RPM steady between 1, 200-2, 000 RPM

NOTE: **DO NOT touch the accelerator pedal during the idle period. A change in throttle position sensor angle or an increase in engine speed may invalidate this portion of the test.**

11. Release the accelerator pedal and shift the vehicle to Park for automatic transmission, or Neutral and release the clutch pedal for manual transmission, and allow the engine to idle for 2 min.
12. Quickly depress the accelerator pedal until throttle position sensor angle is more than 8 % and return to idle, repeat 3 times.
13. Allow engine to idle for at least 2 min.

WARNING: Refer to Road Test Warning .

14. Release the parking brake and drive vehicle at 24 km/h (15 mph) or slower for 2 min.
15. Continue to drive the vehicle for at least 5.5 mi between 45-112 km/h (28-70 mph) with the vehicle reaching at least 80 km/h (50 mph).
16. Release the accelerator pedal for at least 2 s. This will allow the vehicle to enter decel fuel cut-off.
17. Depress the accelerator pedal until the throttle position sensor angle is increased 3-20 % and maintain a safe speed for 1 min.
18. Safely stop the vehicle, with the engine in Drive for automatic transmission or in Neutral with the clutch pedal depressed and parking brake applied for manual transmission, idle for 2 min.
19. Shift to Park for automatic and apply the parking brake, or neutral and release clutch pedal for manual.

NOTE: **DO NOT disturb the vehicle or turn ON the ignition until told to do so. Disturbing the vehicle may invalidate this portion of the test.**

20. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 60 min.
21. Observe the Inspection/Maintenance System Status with a scan tool. All of the Inspection/Maintenance System Status indicators should display YES.
 - If the evaporative emission Inspection/Maintenance System Status indicator displays NO, turn OFF the ignition for 17 h, ensure that the vehicle meets the conditions for a cold start, and repeat steps 12-18 six more times, or until the evaporative emission Inspection/Maintenance System Status indicator transitions to YES. If the indicator continues to display NO, refer to the **Inspection/Maintenance (I/M) System DTC Table** to identify the DTCs that did not run. Follow the Conditions for Running the DTC in order to set the evaporative emission Inspection/Maintenance System Status indicator
 - If any of the Inspection/Maintenance System Status display NO, refer to the **Inspection/Maintenance (I/M) System DTC Table** for the indicator which did not display YES.

The Inspection/Maintenance System DTC Table identifies the DTCs associated with each Inspection/Maintenance System Status Indicator. Follow the Conditions for Running the DTC in order to set the associated 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.

22. 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** for clearing 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**.
23. 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 (I/M) SYSTEM DTC TABLE

Inspection/Maintenance (I/M) 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</u>
EVAP	• <u>DTC P0442</u> • <u>DTC P0446</u> • <u>DTC P0451-P0454</u> • <u>DTC P0455</u> • <u>DTC P0496</u>
Oxygen Sensor	• <u>DTC P0131, P0132, P0134, P0137, P0138, P0140, or P2A00</u> • <u>DTC P0133, P013A, P013B, P013E, P013F, P1133, P2270, or P2271</u>
Oxygen Sensor Heater	<u>DTC P0030, P0036, P0053, P0054, P0135, or P0141</u>
Camshaft System	<u>DTC P0011 or P0014</u>

POOR FUEL FILL QUALITY

Poor Fuel Fill Quality

Problem	Causes
DEFINITION: During the fueling process a continual, occasional, or no-fuel nozzle shut-off condition has occurred.	
Difficult to fill	• Fuel fill limiter vent valve stuck closed • Evaporative emission (EVAP) canister restricted • EVAP vent valve stuck closed • Hose between canister and canister vent solenoid twisted or kinked if applicable • High fuel temperature • Fuel filler hose is kinked • Faulty dispensing nozzle • Ignition switch ON, vent valve closed
Over fill	• Fill limiter vent valve stuck open or leaking • Fuel inlet check valve stuck open
Pre-mature shut-off of the fuel dispensing nozzle occurs immediately after engaging dispensing nozzle, tank empty	• Restricted vapor lines or fuel fill pipe • High fuel temperature • Inlet check valve at tank stuck closed, fill pipe full of fuel • Fuel tank full, gauge not accurate
Pre-mature shut-off of the fuel dispensing nozzle, more than 1/8 of tank capacity dispensed	• Kinked, pinched or plugged lines in fuel tank vent system • EVAP vent valve stuck closed or restricted • EVAP canister restricted • Fuel limiting vent valve stuck closed or obstruction at top of fuel tank
Fuel Spitback	• Restricted EVAP canister • High fuel temperature • Ignition switch ON, EVAP vent valve closed

2013 ENGINE PERFORMANCE

Engine Controls/Fuel - 2.4L (LUK) - Diagnostic Information and Procedures - Malibu

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0010, P0013, OR P2088-P2091

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

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit

DTC P2088

Intake Camshaft Position Actuator Solenoid Control Circuit Low Voltage

DTC P2089

Intake Camshaft Position Actuator Solenoid Control Circuit High Voltage

DTC P2090

Exhaust Camshaft Position Actuator Solenoid Control Circuit Low Voltage

DTC P2091

Exhaust Camshaft Position Actuator Solenoid Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Camshaft Position Actuator Solenoid Valve	P0010, P0013,	P0010, P0013	P0010,	P0010, P0013,	P0011, P0014

High Control	P2088, P2090		P0013	P2089, P2091	
Camshaft Position Actuator Solenoid Valve Low Reference	-	P0010, P0013	P0010, P0013	-	-

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 ECM has commanded the camshaft position actuator solenoid valve ON.
- The DTCs 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 and P2088 - P2091 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0010, P0013 and P2088 - P2091 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 Test Status parameters for the component. The Circuit Test 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 - INDEX

Component View Reference

Powertrain Component 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.
2. Verify DTC P0335, P0336, P0340, or P0341 is not set.
 - **If any of the DTCs are set**

If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

- **If none of the DTCs are set**
3. Observe the appropriate control circuit status parameters listed below with a scan tool:
 - Exhaust/Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open test status
 - Exhaust/Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage test status

- Exhaust/Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage test status
- **If Malfunction is displayed**

Refer to Circuit/System Testing below.

- **If Malfunction is not displayed**

4. Engine idling at normal operating temperature.
5. Verify the scan tool parameters listed below do not display Malfunction when commanding the appropriate scan tool Camshaft Position Actuator from 0-20° and back to 0° with a scan tool:
 - Camshaft Position Actuator Solenoid Valve Control Circuit Open test status
 - Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage test status
 - Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage test status
- **If Malfunction is displayed**

Refer to Circuit/System Testing

- **If Malfunction is not displayed**

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.
7. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

8. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal B or 2 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit
 - If less than 2 ohms, replace the K20 Engine Control Module
 - **If less than 5 ohms**
3. Ignition ON.

NOTE: A test lamp must be used for this test. The control circuit is pulled-up to a low current voltage, 1.5-3.5 V on the control circuit is normal.

4. Verify that a test lamp does not illuminate between the control circuit terminal A or 1 and ground.
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
5. Remove the test lamp.
6. Connect the DMM black lead to the control circuit terminal A or 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**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance or short to ground in the circuit
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If the circuit voltage corresponds to the specified values**
7. 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 8-13 ohms between the control terminal 1 and the low reference terminal 2.
 - **If not between 8-13 ohms**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If between 8-13 ohms**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
 - **If not infinite resistance**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If infinite resistance**
4. All OK.

Repair Instructions

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

-
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P0011 OR P0014

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

DTC P0014

Exhaust Camshaft Position System Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Camshaft Position Actuator Solenoid Valve High Control	P0010, P0013, P2088, P2090	P0010, P0013	P0010, P0013	P0010, P0013, P2089, P2091	P0011, P0014
Camshaft Position Actuator Solenoid Valve Low Reference	-	P0010, P0013	P0010, P0013	-	-

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, P0016, P0017, P0335, P0336, P0340, P0341, P0365, or P0366 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 25 degrees or less than 5 degrees.
- DTCs P0011 and P0014 run continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects the difference between the desired camshaft position angle and the actual camshaft position angle is greater than 6 degrees for greater 13.5 s.

Action Taken When the DTC Sets

- DTCs P0011 and P0014 are Type B DTCs.
- The Auto Stop and Auto Start function of the hybrid system is disabled.

Conditions for Clearing the DTC

DTCs P0011 and P0014 are Type B DTCs.

Diagnostic Aids

- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this DTC. 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 Remaining parameter. Advise the customer an oil change may be required.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, 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 - INDEX

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.
- 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 Remaining parameter. Advise the customer an oil change may be required.

1. Ignition ON.
2. Verify the engine has the correct oil level and pressure. Refer to Oil Pressure Diagnosis and Testing .
 - If the oil level and the oil pressure are not correct

Repair as necessary

- If the oil level and the oil pressure are correct

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

3. Verify that DTC P0010, P0013, P0016, P0017, P0335, P0336, P0340, P0341, P0365, or P0366 is not set.
 - If any of the DTCs are set

Refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.

- **If none of the DTCs are set**

4. Engine idling.
5. Verify the scan tool parameters are less than 2° in each of the commanded states when commanding the Camshaft Position Actuator from 0-20° and back to 0° with the scan tool.
 - Intake Camshaft Position Variance
 - Exhaust Camshaft Position Variance
- **If 2° or greater**

Refer to Circuit/System Testing.

- **If less than 2°**

6. Verify that DTC P0011 or P0014 is not set.
 - **If any of the DTCs are set**

Refer to Circuit/System Testing.

- **If none of the DTCs set**

7. 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.
8. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal B and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 5 ohms**
3. Ignition ON.

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.

4. Verify that a test lamp does not illuminate between the control circuit terminal A and ground.
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
5. Remove the test lamp.
6. Verify the scan tool parameters listed below do not display Malfunction when commanding the appropriate Camshaft Position Actuator Solenoid Valve ON with a scan tool.
 - Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status
 - Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status
 - Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status
 - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status
 - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status
 - Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status
 - **If Malfunction is displayed**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance or short to ground in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If Malfunction is not displayed**
7. Ignition OFF, remove the Q6 Camshaft Position Actuator Solenoid Valve.
8. Verify the conditions listed below do not exist with the Q6 Camshaft Position Actuator Solenoid Valve:
 1. Torn, restricted, mis-positioned, or missing screens.
 2. Engine oil leak between the oil sealing lands of the solenoid. Inspect the lands of the solenoid for nicks.
 3. Oil seepage at the solenoid connector.
 - **If a condition is found**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.
 - **If a condition is not found**

NOTE: **After swapping toe solenoids, install jumper wires to the appropriate terminals of the harness connectors and the solenoids.**

9. Ignition OFF, swap the Q6 Camshaft Position Actuator Solenoid Valve with the Q6 Camshaft Position Actuator Solenoid Valve that is operating correctly.
10. Engine idling.

11. Verify the scan tool Camshaft Position Variance parameter is less than 2° in each of the commanded states when commanding the Camshaft Position Actuator from 0-20° and back to 0° with a scan tool.

- **If 2° or greater**

Replace the mechanical camshaft position actuator.

- **If less than 2°**

12. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

Component Testing

1. Ignition OFF, disconnect the harness connector at the Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 8-13 ohms between the control terminal 2 and the low reference circuit terminal 1.

- **If not between 8-13 ohms**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If between 8-13 ohms**

3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.

- **If not infinite resistance**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If infinite resistance**

4. All OK

Repair Instructions

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

- **Camshaft Position Intake Actuator Replacement**
- **Camshaft Position Exhaust Actuator Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0016 OR P0017

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

DTC P0017

Crankshaft Position - Exhaust Camshaft Position Not Plausible

Circuit/System Description

The engine control module (ECM) uses the crankshaft position sensor, intake camshaft position sensor, and exhaust camshaft position sensor information to monitor the correlation between the crankshaft, intake camshaft, and exhaust camshaft position.

Conditions for Running the DTC

- DTC P0335, P0336, P0340, P0341, P0365, P0366, P0641, and P0651 is not set.
- The engine is cranking or running.
- The crankshaft and camshaft position signals are synchronized.
- The camshaft position actuator is in the parked position.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects a camshaft that is greater than 10 degrees advanced or 10 degrees retarded in relationship to the crankshaft.

Action Taken When the DTC Sets

DTCs P0016 and P0017 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0016 and P0017 are type B DTCs.

Diagnostic Aids

- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed timing chain can cause this DTC to set.
- An camshaft position actuator solenoid valve that is in the full advance or retard position can cause this DTC to set.

Reference Information

Description and Operation

Camshaft Actuator 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.
2. Verify DTC P0010, P0013, P0335, P0336, P0340, P0341, P0365, or P0366 is not set.
 - **If any of the DTCs are set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**
3. Engine Running at normal operating temperature.
 4. Verify DTC P0016 or P0017 is not set.
 - **If the DTC is set**

Inspect for the following and repair as necessary:

- A Q6 Camshaft Position Actuator Solenoid Valve that is stuck in the full advance or retard position.
 - The correct installation of the Q6 Camshaft Position Actuator Solenoid Valves.
 - The correct installation of the B23 Camshaft Position Sensors.
 - The correct installation of the B26 Crankshaft Position Sensor.
 - A timing chain tensioner condition.
 - An incorrectly installed timing chain.
 - Excessive play in the timing chain.
 - A timing chain that jumped teeth.
 - A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC) on the crankshaft.
 - **If the DTC is not set**
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.
 6. Verify the DTC does not set.
 - **If the DTC sets**

A mechanical condition listed above still exists.

- If the DTC does not set

7. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Camshaft Position Actuator Exhaust Solenoid Valve Replacement
- Camshaft Position Actuator Intake Solenoid Valve Replacement
- Camshaft Position Sensor Replacement - Exhaust
- Camshaft Position Sensor Replacement - Intake
- Camshaft Timing Chain and Sprocket Cleaning and Inspection
- Camshaft Timing Chain, Sprocket, and Tensioner Replacement
- Crankshaft Position Sensor Replacement

DTC P0030, P0036, P0053, P0054, P0135, OR P0141

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 Sensor 1

DTC P0036

HO2S Heater Control Circuit Sensor 2

DTC P0053

HO2S Heater Resistance Sensor 1

DTC P0054

HO2S Heater Resistance Sensor 2

DTC P0135

HO2S Heater Performance Sensor 1

DTC P0141

HO2S Heater Performance Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S Heater Voltage Supply	P0030, P0036, P0132, P0135, P0138, P0141, *	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0690	P0135, P0141
HO2S Heater Control	P0030, P0036, P0053, P0054, P0135, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0135, P0141
* Opens fuse					

Circuit Description

The heated oxygen sensor (HO2S) heater reduces the time required for the oxygen sensor to reach operating temperature and maintains the operating temperature during extended idle periods. When the ignition is turned to the ON position, ignition voltage is supplied directly to the sensor heater. The engine control module (ECM) controls the heater operation by first modulating the control circuit to ground when the sensors are cold. This prevents the possibility of thermal shock to the sensor, from condensation build-up on the sensor, by controlling the sensors rate of heating. After a predetermined amount of time, the ECM commands the heaters ON continuously. Once the sensor reaches operating temperature, the ECM may modulate the heater control circuit to ground, to maintain a desired temperature.

The ECM controls the heater by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the DTC

P0030 or P0036

- The ignition voltage is between 11-32 V.
- The engine speed is greater than 400 RPM.

- The DTCs run continuously once the above conditions are met for 10 s.

P0053 or P0054

- DTCs P0112, P0113, P0117, P0118, P0128, P2610 are not set.
- The engine is running.
- Ignition voltage is less than 32 V.
- The ignition is OFF for more than 8 h.
- The Engine Coolant Temperature (ECT) Sensor parameter is between -30 to +45°C (-22 to +113°F) at engine start-up.
- DTCs P0053 and P0054 run once per drive cycle when the above conditions are met.

P0135

- DTCs P0116, P0117, P0118, P0128 are not set.
- The ECT Sensor parameter is more than 70°C (158°F).
- The Ignition 1 Signal parameter is between 10-32 V.
- DTC P0135 runs twice per drive cycle when the above conditions are met for 2 min.

P0141

- DTCs P0116, P0117, P0128 are not set.
- The ECT Sensor parameter is more than 70°C (158°F).
- The Ignition 1 Signal parameter is between 10-32 V.
- DTC P0141 runs twice per drive cycle when the above conditions are met for 2 min.

Conditions for Setting the DTC

P0030 or P0036

- The ECM detects that the affected HO2S heater low control circuit voltage is not within a specified range.
- DTCs P0030 and P0036 set within 3 s when the above condition is met.

P0053 or P0054

- The ECM detects that the affected HO2S heater low control circuit resistance is not within a specified range at engine start-up.
- DTCs P0053 and P0054 set within 1 s when the above condition is met.

P0135

- The ECM detects that the affected HO2S 1 heater current parameter is more than 2.5 A or less than 0.3 A.
- DTC P0135 sets within 60 s when the above condition is met.

P0141

- The ECM detects that the affected HO2S 2 heater current parameter is more than 2.5 A or less than 0.3 A.
- DTC P0141 sets within 60 s when the above condition is met.

Action Taken When the DTC Sets

DTCs P0030, P0036, P0053, P0054, P0135, and P0141 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0030, P0036, P0053, P0054, P0135, and P0141 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 test status parameters for the component. The circuit test status parameters change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.
- An open fuse in the HO2S heater circuit may be caused by the heater element in one of the sensors. The condition may not be present until the sensor operates for a period of time. If no fault is present in the heater circuit, monitor the amperage of each heater using the DMM to determine if one of the heater elements is the cause of the open fuse. Inspect the sensor pigtail or the harness for contacting the exhaust system.

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- **Wiring Repairs**

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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 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 Instructions

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

- **Heated Oxygen Sensor Replacement - Sensor 1**
- **Heated Oxygen Sensor Replacement - 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 Air Flow 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 at least 800 RPM.
- The ignition voltage is at least 6.4 V.
- The throttle actuator control system is not in reduced power mode.
- The DTC runs continuously when the above conditions are met.

DTC P1101

- DTC P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0335, or P0336 is not set
- The engine speed is between 500-6, 400 RPM
- The engine coolant temperature (ECT) is between -7 to +125°C (+19 to +257°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 DTCs

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

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
 - **If a DTC is set**

Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.

- **If the DTC is not set**

3. Ignition ON, verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
 - **If 90 % or greater**

Refer to **Throttle Body Cleaning** .

- **If less than 90 %**

4. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

- **If Disagree**

Refer to **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135** for further diagnosis.

- **If Agree**

5. Determine the current vehicle testing altitude.
6. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.

- **If the MAP Sensor parameter is not in range**

Refer to **DTC P0106** for further diagnosis.

- **If the MAP Sensor parameter is within range**

7. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26-52 kPa (3.8-7.5 PSI) and changes with accelerator pedal input.

- **If not between 26-52 kPa (3.8-7.5 PSI) or does not change**

Refer to **DTC P0106** for further diagnosis.

- **If between 26-52 kPa (3.8-7.5 PSI) and changes**

8. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.

1. Engine idling
2. Perform the scan tool snapshot function.
3. Increase the engine speed slowly to 3, 000 RPM and then back to idle.

4. Exit from the scan tool snapshot and review the data.
5. Observe the MAF Sensor parameter frame by frame with a scan tool.
 - **If the MAF Sensor parameter does not change smoothly and gradually**

Refer to **DTC P0101** for further diagnosis.

- **If the MAF Sensor parameter changes smoothly and gradually**
9. 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.
 10. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing for further diagnosis.

- **If the DTC does not set**
11. All OK

Circuit/System Testing

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

1. Verify the integrity of the entire air induction system by verifying that none of the following conditions exist:
 - Any damaged components
 - Improperly installed components
 - Collapsed, restricted, or damaged components
 - Loose clamps, cracks, or other damage
 - An air flow restriction
 - Restricted air filter
 - Splits, kinks, leaks, or improper connections at the vacuum hoses
 - Vacuum leaks at the intake manifold, MAP sensor, and throttle body
 - Water intrusion
 - Any snow or ice buildup, in cold climates
 - Contamination of the MAF sensor element
 - Missing, restricted, or leaking exhaust components-Refer to **Symptoms - Engine Exhaust** for further diagnosis.
 - **If a condition is found**

Repair or replace component as appropriate.

- **If no condition is found**

2. Test the engine for a mechanical condition. Refer to **Symptoms - Engine Mechanical** for diagnosis.

○ **If a condition is found**

Repair or replace component as appropriate.

○ **If no condition is found**

3. All OK

Repair Instructions

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

Control Module References for Engine Control Module replacement, programming, and setup

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 Control Performance - Low Pressure

DTC P228D

Fuel Pressure Regulator 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 P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0112, P0113, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629 or P1682 is not set.
- The ignition voltage is more than 11 V.
- The engine is running.
- The low side fuel pressure is more than 275 kPa (40 psi).
- The DTC runs continuously when the above conditions are met for 60 s.

P00C6

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0112, P0113, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0627, P0628, P0629 or P1682 is not set.
- The ignition voltage is more than 8 V.
- The engine coolant temperature is between -100 and +80°C (-148 and +176°F).
- The low side fuel pressure is more than 300 kPa (43.5 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 is greater than or equal to 240 ° or less than or equal to 0 °. 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 3 MPa (435 psi) less than the desired fuel pressure. The condition exists for greater than 5 s.

P228D

The actual fuel rail pressure is 3 MPa (435 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.
- Scan tool control of the high pressure fuel pump is inhibited.

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 the fuel pump flow control module may set a DTC.
- A skewed fuel rail pressure sensor, or an intermittent condition in the fuel rail pressure sensor circuits may set a DTC.
- A leaking or restricted fuel injector may set a DTC.
- 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.

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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.
 - 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 2.96-3.24 Mpa (429-470 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 Pressure Sensor parameter. Command an increase in Fuel Pressure with a scan tool. Verify the scan tool Fuel Pressure Sensor parameter increases to greater than 414 kPa (60 psi) as commanded.

- If less than the specified range, refer to **Fuel System Diagnosis**.
- 2. Remove the G18 high pressure fuel pump and visually inspect the lobes on the camshaft for unusual wear.
 - If the lobes appear normal, replace the G18 high pressure fuel pump.
 - 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 Instructions

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

- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**
- **Fuel Pump Replacement**
- **Intake Camshaft and Valve Lifter 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, P0690	-
High Pressure Fuel Pump Actuator Low Control	P0091, P00C9	P0090, P00C8	P0092, P00CA, P0690	-

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 greater than 11 V.
- The engine speed is greater than 50 RPM.
- 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.

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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** for further diagnosis.
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. 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 ON, verify that a test lamp does not illuminate between the high control circuit terminal 2 and ground and the low control circuit terminal 1 and ground.
 - If the test lamp illuminates, test the appropriate control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
3. Verify that a test lamp does not illuminate between the high control circuit terminal 2 and B+ and the low control circuit terminal 1 and B+.
 - If the test lamp illuminates, test the appropriate control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.
4. Connect a 3 A fused jumper wire between the high control circuit terminal 2 and ground. The Fuel Pressure Regulator High Control Circuit Open Test Status should transition from Malfunction to OK and the Fuel Pressure Regulator High Control Circuit Low Voltage Test Status should transition from OK to Malfunction.
 - If not the specified value, test the high control circuit for an open/high resistance.
5. Connect a 3 A fused jumper wire between the low control circuit terminal 1 and B+. The Fuel Pressure Regulator Control Circuit Open Test Status should transition from Malfunction to OK and the Fuel Pressure Regulator Control Circuit High Voltage Test Status should transition from OK to Malfunction.
 - If not the specified value, test the low control circuit for an open/high resistance.
6. 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 at the G18 high pressure fuel pump.
 - 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 Instructions

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

Mass Air Flow (MAF) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0102	P0101	P0102	-	P0101, P0103
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: 1, 500-10, 000 Hz			
Ignition Voltage	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

Circuit Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, and barometric pressure (BARO). A diaphragm within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance. The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5 V reference circuit. The ECM supplies a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the BARO. When the vehicle is operated at wide-open throttle (WOT), the pressure in the intake manifold is close to BARO. The lowest manifold pressure occurs when the vehicle is idling or decelerating. The ECM monitors the MAP sensor signal for pressure outside of the normal range.

Conditions for Running the DTCs

- DTCs P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0335 or P0336 are not set.
- The engine speed is between 500-6, 400 RPM
- The engine coolant temperature (ECT) is between -7 and +125°C (+19 and +257°F).
- The intake air temperature (IAT) 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

- Certain aftermarket air filters may cause this DTC to set.
- Certain aftermarket air induction systems may cause this DTC to set.
- Modifications to the air induction system may cause this DTC to set.

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Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**

Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.

- **If none of the DTCs are set**

3. If you were sent here from DTC P0068, P0106, P0121, or P1101; refer to Circuit/System Testing.
4. Ignition ON, verify the scan tool TB Idle Airflow Compensation parameter is less than 90 %.
 - **90 % or greater**

Refer to **Throttle Body Cleaning** .

- **If less than 90 %**

5. Verify the scan tool TP Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
 - **If Disagree**

Refer to **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135** for further diagnosis.

- **If Agree**

6. Determine the current vehicle testing altitude.
7. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.
 - **If the MAP Sensor parameter is not in range**

Refer to **Altitude Versus Barometric Pressure** for further diagnosis.

- **If the MAP Sensor parameter is within range**

8. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26-52 kPa (3.8-7.5 PSI) and changes with accelerator pedal input.

- **If not between 26-52 kPa (3.8-7.5 PSI) or does not change**

Refer to **DTC P0106** for further diagnosis.

- **If between 26-52 kPa (3.8-7.5 PSI) and changes**

9. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.

1. Engine idling
2. Perform the scan tool snapshot function.
3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
4. Exit from the scan tool snapshot and review the data.
5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **If the MAF Sensor parameter does not change smoothly and gradually**

Refer to Circuit/System Testing.

- **If the MAF Sensor parameter changes smoothly and gradually**

10. 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.

11. Verify a DTC does not set.

- **If any DTC sets**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

- **If no DTCs set**

12. All OK

Circuit/System Testing

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

1. Verify the integrity of the entire air induction system by verifying that none of the following conditions exist:
 - Any damaged components
 - Improperly installed components
 - Collapsed, restricted, or damaged components
 - Loose clamps, cracks, or other damage
 - An air flow restriction
 - Restricted air filter

- Splits, kinks, leaks, or improper connections at the vacuum hoses
- Vacuum leaks at the intake manifold, MAP sensor, and throttle body
- Water intrusion
- Any snow or ice buildup, in cold climates
- Contamination of the Mass Air Flow/Intake Air Temperature sensor element
- **If a condition is found**

If a condition is found, repair or replace component as appropriate.

- **If no condition is found**

2. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow/Intake Air Temperature sensor.
3. Ignition OFF and all systems OFF. It may take up to for 2 minutes for all vehicle systems to power down. Test for less than 2 ohms between the ground circuit terminal B and ground.

- **If 2 ohms or greater**

1. Ignition OFF, disconnect the sensor chassis ground.

Test for less than 2 ohms in the ground circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 2 ohms**

4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal C and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
2. Test for less than 2 ohms in the ignition voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for greater than 2 ohms between the ignition voltage circuit terminal C and ground.
 - If less than 2 ohms, repair the short to ground on the circuit.
 - If greater than 2 ohms, test all the components connected to the circuit and repair or replace as necessary.

- **If a test lamp illuminates**

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

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
6. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
 - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
1. Replace the K20 Engine Control Module.
2. 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.
3. Verify the DTC does not set.
 - **If the DTC sets**
- Refer to step 10.
- **If no DTCs set**
4. Circuits, ECM, and the sensor tests OK, refer to step 11.
 - **EL-38522-A, Variable Signal Generator; or equivalent is available**
7. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
 - Red lead to the signal circuit terminal A at the harness connector
 - Black leads to ground
 - Battery voltage supply lead to B+
8. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Frequency switch to 5 kHz
 - Duty Cycle switch to 50 % (Normal)
9. Engine idling, verify the scan tool MAF Sensor parameter is between 4, 950-5, 050 Hz.
 - **If not between 4, 950-5, 050 Hz.**

Replace the K20 Engine Control Module.

- If between 4,950-5,050 Hz.

10. Circuits and ECM test OK. Test or replace the B75B Mass Air Flow/Intake Air Temperature sensor.
11. All OK.

Repair Instructions

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

- **Engine Coolant Temperature Sensor Replacement**
- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

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

Mass Air Flow (MAF) Sensor Circuit High Frequency

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition Voltage	P0102	P0101	P0102	P0690	P0101, P0103
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: 1,500-10,000 Hz			
Ignition Voltage	0 Hz	0 Hz	-

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 in the sensor bore. 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 ECM applies 5 V to the MAF sensor on the MAF sensor signal circuit. The sensor uses the voltage to produce a variable frequency signal based on the inlet air flow through the sensor bore. The signal varies with engine load and is displayed by the scan tool as Hertz (Hz) and grams per second (g/s). Ignition voltage and ground circuits are also supplied to the sensor's internal circuits.

Conditions for Running the DTC

- The engine is running for at least 1 s.
- The engine speed is at least 300 RPM.
- The ignition signal is at least 8 V.
- The above conditions are met for at least 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 100 Hz (about 0.15 g/s) for at least 500 cylinder firing events.

P0103

The ECM detects that the MAF Sensor signal parameter is at least 14, 500 Hz (about 270.2 g/s) for at least 500 cylinder firing events.

Action Taken When the DTCs Set

DTCs P0102 and P0103 are Type B DTCs.

Conditions for Clearing the MIL/DTCs

DTCs P0102 and P0103 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 2.5-5.5 g/s.
 - **If not between 2.5-5.5 g/s**

Refer to Circuit/System Testing.
 - **If between 2.5-5.5 g/s**
2. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
 1. Engine idling
 2. Perform the scan tool snapshot function.
 3. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
 4. Exit from the scan tool snapshot and review the data.
 5. Observe the MAF Sensor parameter frame by frame with a scan tool.
 - **The MAF Sensor parameter does not change smoothly and gradually**

Refer to Circuit/System Testing.

- **The MAF Sensor parameter changes smoothly and gradually**

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.
4. Verify a DTC does not set.
 - **If any DTC sets**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

- **If no DTCs set**

5. All OK

Circuit/System Testing

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

1. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow/Intake Air Temperature sensor.
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 2 ohms between the ground circuit terminal B and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF. Disconnect the sensor chassis ground.
 2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the chassis ground connection.
 - **If less than 2 ohms**
3. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal C and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for less than 2 ohms in the ignition voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
 2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for greater than 2 ohms between the ignition voltage circuit terminal C and ground.

- If less than 2 ohms, repair the short to ground on the circuit.
 - If greater than 2 ohms, test all the components connected to the circuit and repair or replace as necessary.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If the circuit tests normal and the fuse is open, test all the components connected to the circuit and repair or replace as necessary.
 - **If a test lamp illuminates**
4. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal A and ground.
- **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
5. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
- **EL-38522-A, Variable Signal Generator; or equivalent is not available**
 1. Replace the K20 Engine Control Module.
 2. 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.
 3. Verify the DTC does not set.
 - **If the DTC sets**

Refer to step 9.
 - **If no DTCs set**
 - **EL-38522-A, Variable Signal Generator; or equivalent is available**
6. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
- Red lead to the signal circuit terminal A at the harness connector
 - Black leads to ground
 - Battery voltage supply lead to B+

7. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Frequency switch to 5 kHz
 - Duty Cycle switch to 50 % (Normal)
8. Engine idling, verify the scan tool MAF Sensor parameter is between 4, 950-5, 050 Hz.
 - **If not between 4, 950-5, 050 Hz.**

Replace the K20 Engine Control Module.

- **If between 4, 950-5, 050 Hz.**
9. Circuits and ECM test OK. Test or replace the B75B Mass Air Flow/Intake Air Temperature sensor.
 10. All OK.

Repair Instructions

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

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

DTC P0106

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	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0107, P0697	P0106, P0107	P0108, P0697	P0106
Signal	P0107	P0106, P0107	P0108*	P0106
Low Reference	-	P0106, P0108	-	P0106
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in closed loop, idling, and accessories OFF			
Parameter Normal Range: 26-52 kPa (3.8-7.6 PSI) (varies with altitude)			
5V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)
Signal	10 kPa (1.5 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)*
Low Reference	-	127 kPa (18.4 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, barometric pressure (BARO) and if equipped, turbocharger output. A diaphragm within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance.

The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5 V reference circuit. The ECM supplies a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the BARO. If equipped, a turbocharger can increase the pressure above BARO, when the vehicle is operated at wide-open throttle (WOT). The lowest manifold pressure occurs when the vehicle is idling or decelerating. The ECM monitors the MAP sensor signal for pressure outside of the normal range.

Conditions for Running the DTC

- DTCs P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0335, P0336 are not set.
- The engine speed is between 575-6600 RPM.
- The engine coolant temperature (ECT) sensor is between -7 to +125°C (19.4-257°F).
- The intake air temperature (IAT) sensor is between -20 to +125°C (-4 to +257°F).
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the MAP Sensor pressure is not within range of the calculated pressure that is derived from the system of models for more than 0.5 s.

Action Taken When the DTC Sets

DTC P0106 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0106 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

GE-23738-A Vacuum Pump

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**

Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.

- **If none of the DTCs are set**
3. If you were sent here from DTC P0068, P0101, P0121, or P1101; refer to Circuit/System Testing.
4. Ignition ON.
5. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90%.

- **If 90% or greater**

Refer to **Throttle Body Cleaning** .

- **If less than 90%**

6. Verify the scan tool Throttle Body Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

- **If Disagree**

Refer to **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135** for further diagnosis.

- **If Agree**

7. Determine the current vehicle testing altitude.

8. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.

- **If the MAP Sensor parameter is not in range**

Refer to Circuit/System Testing.

- **If the MAP Sensor parameter is in range**

9. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26-52 kPa (3.8-7.5 PSI) and changes with accelerator pedal input.

- **If not between 26-52 kPa (3.8-7.5 PSI) or does not change**

Refer to Circuit/System Testing.

- **If between 26-52 kPa (3.8-7.5 PSI) and changes**

10. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.

1. Engine idling
2. Perform the scan tool snapshot function.
3. Increase the engine speed slowly to 3000 RPM and then back to idle.
4. Exit from the scan tool snapshot and review the data.
5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **The MAF Sensor parameter does not change smoothly and gradually**

Refer to **DTC P0101**.

- **The MAF Sensor parameter changes smoothly and gradually**

11. 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.

12. Verify a DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

○ **If the DTC does not set**

13. All OK.

Circuit/System Testing

1. Verify the integrity of the entire air induction system and verify that none of the following conditions exist:
 - Any damaged components
 - An air flow restriction
 - Any vacuum leak
 - Improperly routed vacuum hoses
 - A restriction in the MAP Sensor port or the BARO port
 - Proper operation of the Positive Crankcase Ventilation (PCV) system
 - Missing, restricted or leaking exhaust components. Refer to **Symptoms - Engine Exhaust**.
 - Engine mechanical condition; for example: low compression or incorrect timing chain installation. Refer to **Symptoms - Engine Mechanical**.

○ **If a condition is found**

If a condition is found, repair or replace the component as appropriate.

○ **If no condition is found**

2. Ignition OFF, and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down. Disconnect the harness connector at the B74 Manifold Absolute Pressure Sensor.
3. Test for less than 2 ohms between the low reference circuit terminal 2 and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 2 ohms**
4. Ignition ON.
5. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K20 Engine Control Module.

NOTE: If the signal circuit is shorted to a voltage the ECM or the MAP Sensor may be damaged.

-
- **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**
 6. Ignition ON, verify the scan tool MAP Sensor parameter is less than 0.5 V.
 - **If 0.5 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition ON, test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than 0.5 V**
 7. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1.
 8. Ignition ON, verify the scan tool MAP Sensor voltage parameter is greater than 4.5 V.
 - **If 4.5 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Remove the jumper wire, test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 4.5 V**
 9. Test or replace the B74 Manifold Absolute Pressure 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 Sensor Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply 17 kPa (5.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A**. Verify the scan tool MAP Sensor pressure parameter decreases between 13-21 kPa (1.8-3.0 PSI).
 - **If the parameter does not decrease between 13-21 kPa (1.8-3.0 PSI)**

Replace the B74 Manifold Absolute Pressure Sensor.
 - **If the parameter does decrease between 13-21 kPa (1.8-3.0 PSI)**
3. Apply 34 kPa (10.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A**. Verify the scan tool MAP Sensor pressure parameter decreases between 30-38 kPa (4.4-5.5 PSI).
 - **If the parameter does not decrease between 30-38 kPa (4.4-5.5 PSI)**

Replace the B74 Manifold Absolute Pressure Sensor.
 - **If the parameter does decrease between 30-38 kPa (4.4-5.5 PSI)**
4. All OK.

Erratic Signal Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply between 0-15 kPa (0-4.4 in Hg) of vacuum to the sensor with the **GE-23738-A**. Verify the voltage changes, without any spikes or dropouts, between 0.2-4.9 V.
 - **If not between 0.2-4.9 V or has spikes or dropouts**

Replace the B74 Manifold Absolute Pressure Sensor.
 - **If between 0.2-4.9 V and there are no spikes or dropouts**
7. All OK.

Repair Instructions

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

- **Manifold Absolute Pressure Sensor Replacement**
- **Control Module References** for ECM replacement, programming, and setup

DTC P0107 OR P0108

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 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	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0107, P0697	P0106, P0107	P0108, P0697	P0106
Signal	P0107	P0106, P0107	P0108*	P0106
Low Reference	-	P0106, P0108	-	P0106
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in closed loop, idling, and accessories OFF. Parameter Normal Range: 26-52 kPa (3.8 to 7.6 PSI) (Varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)
Signal	10 kPa (1.5 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)*
Low Reference	-	127 kPa (18.4 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, barometric pressure (BARO) and if equipped turbocharger output. A diaphragm within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance.

The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5 V reference circuit. The ECM supplies a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the BARO. If equipped, a turbocharger can increase the pressure above BARO, when the vehicle is operated at wide-open throttle (WOT). The lowest manifold pressure occurs when the vehicle is idling or decelerating. The ECM monitors the MAP sensor signal for pressure outside of the normal range.

Conditions for Running the DTC

P0107

This DTC runs continuously.

P0108

This DTC runs continuously.

Conditions for Setting the DTC

P0107

The ECM detects that the MAP Sensor voltage is less than 0.05 V for greater than 5 s.

P0108

The ECM detects that the MAP Sensor voltage is more than 4.9 V for greater than 5 s.

Action Taken When the DTC Sets

DTCs P0107 and P0108 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0107 and P0108 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

GE-23738-A Vacuum Pump

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
 - **If any of the DTCs are set**

Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.

- **If none of the DTCs are set**
3. Determine the current vehicle testing altitude.
 4. Verify the scan tool MAP Sensor parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.
 - **If the MAP Sensor parameter is not in range**

Refer to Circuit/System Testing for further diagnosis.

- **If the MAP Sensor parameter is within range**
5. Engine idling, verify the scan tool MAP Sensor voltage parameter is between 0.3-4.8 V and changes with accelerator pedal input.
 - **If not between 0.3-4.8 V or does not change**

Refer to Circuit/System Testing.

- **If between 0.3-4.8 V and changes**

6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
7. Verify the DTC does not set.

- **If any DTC sets**

Refer to Circuit/System Testing.

- **If no DTC sets**

8. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B74 Manifold Absolute Pressure Sensor.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down. Test for less than 2 ohms between the low reference circuit terminal 2 and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 2 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

-

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**
- 5. Ignition ON, verify the scan tool MAP Sensor parameter is less than 0.5 V.
 - **If 0.5 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Ignition ON, test for less than 1 V between the signal circuit terminal 3 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than 0.5 V**
- 6. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1.
- 7. Ignition ON, verify the scan tool MAP voltage parameter is greater than 4.5 V.
 - **If 4.5 V or less**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Remove the jumper wire, test for infinite resistance between the signal circuit terminal 3 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 4.5 V**
- 8. Test or replace the B74 Manifold Absolute Pressure 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 Sensor Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply 17 kPa (5.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A**. Verify the scan tool MAP Sensor pressure parameter decreases between 13-21 kPa (1.8-3.0 PSI).
 - **If the parameter does not decrease between 13-21 kPa (1.8-3.0 PSI)**

Replace the B74 Manifold Absolute Pressure Sensor.
 - **If the parameter does decrease between 13-21 kPa (1.8-3.0 PSI)**

3. Apply 34 kPa (10.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A**. Verify the scan tool MAP Sensor pressure parameter decreases between 30-38 kPa (4.4-5.5 PSI).

- **If the parameter does not decrease between 30-38 kPa (4.4-5.5 PSI)**

Replace the B74 Manifold Absolute Pressure Sensor.

- **If the parameter does decrease between 30-38 kPa (4.4-5.5 PSI)**

4. All OK.

Erratic Signal Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply between 0-15 kPa (0-4.4 in Hg) of vacuum to the sensor with the **GE-23738-A**. Verify the voltage changes, without any spikes or dropouts, between 0.2-4.9 V.

- **If not between 0.2-4.9 V or has spikes or dropouts**

Replace the B74 Manifold Absolute Pressure Sensor.

- **If between 0.2-4.9 V and there are no spikes or dropouts**

7. All OK.

Repair Instructions

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

- **Manifold Absolute Pressure Sensor Replacement**
- **Control Module References** for ECM replacement, programming, and setup

DTC P0111

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 P0111

Intake Air Temperature (IAT) Sensor Performance

Diagnostic Fault Information

IAT Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114	P0111, P0113, P0114	P0113*, P0114	P0111
Low Reference	-	P0111, P0113, P0114	P0113*, P0114	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient temperature			
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 that measures the temperature of the air in the sensor bore. The IAT is integrated with the mass air flow (MAF) sensor. The engine control module (ECM) supplies 5 V to the IAT sensor signal circuit and a ground for the IAT sensor low reference circuit. The signal varies with inlet air temperature and is displayed by the scan tool as °C (°F).

IAT Sensor - Temperature, Resistance, Voltage Table

IAT Sensor	IAT Sensor Resistance	IAT Sensor Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTC

- DTCs P0112, P0113, P0117, P0118, P0119, or P1682 are not set.
- The vehicle has been OFF at least 8 hours.
- Ignition 1 voltage is at least 11 V.
- The ignition is ON, or the engine is running.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

- The absolute difference between ECT start-up temperature and the IAT sensor start-up temperature is greater than 60°C (108°F).
- This DTC runs once per ignition cycle when the enabling conditions are met.

Action Taken When the DTCs Set

DTC P0111 is a Type B DTC.

Conditions for Clearing the DTCs

DTC P0111 is a Type B DTC.

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 MAF sensor heating elements.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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: To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 1 and 2 of this verification procedure only if the ignition has been OFF for 8 hours or more.

1. Ignition ON.
2. Verify the following scan tool parameters are within 60°C (108°F) of each other.
 - Start-Up IAT Sensor
 - Start-Up ECT
 - **If not within 60°C (108°F)**

Refer to Circuit/System Testing.

- **If within 60°C (108°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149°C (-36 and +300°F).
 - IAT Sensor
 - ECT
 - **If not between: -38 and +149°C (-36 and +300°F)**

Refer to Circuit/System Testing.

- **If between: -38 and +149°C (-36 and +300°F)**
4. 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.
5. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**
6. All OK

Circuit/System Testing

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

1. Verify none of the following conditions exist:
 - A restricted, collapsed, misaligned, or damaged air intake duct
 - An intake manifold leak
 - A MAP sensor seal that is leaking, missing, or damaged
 - Any water intrusion in the induction system
 - An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing

- **If a condition exists**

Repair or replace component as appropriate.

- **If no condition exists**

2. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow/Intake Air Temperature sensor.
3. Ignition OFF, and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Test for less than 2 ohms between the low reference circuit terminal D and ground.

- **If 2 ohms or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms replace the K20 Engine Control Module.

- **If less than 2 ohms**

4. Ignition OFF, all vehicle systems OFF, test for less than 2 ohms between the ground circuit terminal B and ground.

- **If 2 ohms or greater**

1. Ignition OFF. Disconnect the sensor chassis ground.
2. Test for less than 2 ohms in the ground circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms, repair the open/high resistance in the ground connection.

- **If less than 2 ohms**

5. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal C and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
2. Test for less than 2 ohms in the ignition voltage circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for greater than 2 ohms between the ignition voltage circuit terminal C and ground.
 - If less than 2 ohms, repair the short to ground on the circuit.
 - If greater than 2 ohms, test all the components connected to the circuit and repair or replace as necessary.

- **If a test lamp illuminates**

6. Ignition ON, test for 4.8-5.2 V between the intake air temperature signal circuit terminal E and ground.

○ **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

○ **If greater than 5.2 V**

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.

○ **If between 4.8-5.2 V**

7. Ignition ON, verify the scan tool IAT Sensor parameter is colder than -39°C (-38°F).

○ **If warmer than -39°C (-38°F).**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal E and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

○ **If colder than -39°C (-38°F).**

8. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal E and the low reference circuit terminal D.

9. Verify the scan tool IAT Sensor parameter is warmer than 148°C (298°F).

○ **If colder than 148°C (298°F).**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
3. Ignition OFF.

4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If warmer than 148°C (298°F).**

10. Test or replace the B75B Mass Air Flow/Intake Air Temperature sensor.

Component Testing

Mass Air Flow/Intake Air Temperature

1. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow/Intake Air Temperature sensor.

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

2. Test the IAT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor) table for Hitachi Sensors. The resistance values should be in range of the table values.

- **If the values are not within range of the table values.**

Replace the B75B Mass Air Flow/Intake Air Temperature sensor.

- **If the values are within range of the table values.**

3. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Mass Airflow Sensor with Intake Air Temperature Sensor Replacement
- Control Module References for engine control module replacement, programming, and setup.

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
Signal	P0112	P0113	P0113	P0114
Low Reference	-	P0113	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			
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 1 is a variable resistor that measures the temperature of the air in the Mass Air Flow (MAF) sensor bore. The engine control module (ECM) supplies 5 V to the IAT sensor 1 signal circuit and a ground for the IAT sensor 1 low reference circuit. The signal varies with inlet air temperature and is displayed by the scan tool as °C (°F).

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTCs

P0112, P0113, and P0114

- The ignition is ON, or the engine is running.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0112

NOTE: The scan tool display range is between -40 and +150°C (-40 and +302°F).

The ECM detects that the IAT sensor signal is warmer than 150°C (302°F) for at least 5 s.

P0113

NOTE: The scan tool display range is between -40 and +150°C (-40 and +302°F).

The ECM detects that the IAT sensor signal is colder than -60°C (-76°F) for at least 5 s.

P0114

The ECM monitors the IAT sensor signal every 0.1 s, to determine if the signal has changed more than 80°C (176°F). The DTC fails when the condition exists for longer than 4 s.

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Diagnostic Aids

With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor 1 will gradually increase the scan tool IAT Sensor 1 parameter. This is due to the heat that is generated by the MAF sensor heating elements.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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: To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 1 and 2 of this verification procedure only if the ignition has been OFF for 8 hours or more.

1. Ignition ON.
2. Verify the following scan tool parameters are within 55°C (99°F) of each other.
 - Start-Up IAT Sensor 1
 - Start-Up ECT
 - **If not within 55°C (99°F)**
Refer to Circuit/System Testing.
 - **If within 55°C (99°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149°C (-36 and +300°F).
 - IAT Sensor 1
 - Start-Up ECT
 - **If not between: -38 and +149°C (-36 and +300°F)**
Refer to Circuit/System Testing.
 - **If between: -38 and +149°C (-36 and +300°F)**
4. 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.
5. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
6. All OK

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow/Intake Air Temperature sensor.
2. Ignition OFF, and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Test for less than 2 ohms between the low reference circuit terminal D and ground.
 - **If 2 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open or high resistance in the circuit.
 - If less than 2 ohms replace the K20 engine control module.
 - **If less than 2 ohms**
3. Ignition ON, test for 4.8-5.2 V between the intake air temperature sensor 1 signal circuit terminal E and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 engine control module.
 - **If greater than 5.2 V**

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 engine control module.
- **If between 4.8-5.2 V**
4. Ignition ON, verify the scan tool IAT Sensor parameter is colder than -39°C (-38°F).
 - **If warmer than -39°C (-38°F).**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal E and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K20 Engine Control Module.
 - **If colder than -39°C (-38°F).**
- 5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal E and the low reference circuit terminal D.
- 6. Verify the scan tool IAT Sensor parameter is warmer than 148°C (298°F).
 - **If colder than 148°C (298°F).**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Ignition OFF.
 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If warmer than 148°C (298°F).**
- 7. Test or replace the B75B Mass Air Flow/Intake Air Temperature sensor.

Component Testing

Mass Air Flow/Intake Air Temperature

1. Ignition OFF, disconnect the harness connector at the B75B Mass Air Flow/Intake Air Temperature sensor.

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

2. Test the IAT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** table for Hitachi Sensors. The resistance values should be in range of the table values.

- **If the values are not with in range of the table values.**

Replace the B75B Mass Air Flow/Intake Air Temperature sensor.

- **If the values are within range of the table values.**

3. All OK.

Repair Instructions

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

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P0116

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	High Resistance	Open	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117	P0118	P0118	P0118	P0116, P0128
Low Reference	-	P0118	P0118	P0118	P0128

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running at various operating conditions			
Parameter Normal Range: 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)

Circuit/System 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 volts to the ECT sensor signal circuit and a ground for the low reference circuit.

The ECM uses this high side coolant rationality diagnostic to determine if the input from the ECT sensor is skewed warmer than normal. The internal clock of the ECM will record the amount of time the ignition is OFF. If the calibrated ignition OFF time is met at start-up, the ECM will compare the temperature difference between the ECT and the intake air temperature (IAT) to determine if the temperatures are within an acceptable operating range of each other.

Conditions for Running the DTC

- DTC P0112, P0113, P0117, P0118, P0128, P0502, P0503, P0601, P1621 or P2610 is not set.
- The vehicle has had a minimum ignition OFF time of 8 hours.

- The ignition is ON.
- The IAT Sensor parameter is warmer than -7°C ($+19^{\circ}\text{F}$).
- The Fuel Level Sensor parameter is greater than 10 percent.
- This DTC runs once per ignition cycle within the enabling conditions.

Conditions for Setting the DTC

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 30°C (54°F) warmer than the IAT sensor.

OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 16°C (29°F) warmer than the IAT sensor, and the time spent cranking the engine is greater than 10 seconds when the fuel level is greater than 10 percent.

OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 16°C (29°F) warmer than the IAT sensor. Then the vehicle must be driven for greater than 6 minutes and 40 seconds at greater than 24 km/h (15 mph). If the IAT sensor then decreases greater than 5°C (9°F), an engine block heater was detected and the test is aborted. If the IAT sensor does not decrease, an engine block heater was not detected and DTC P0116 will set.

Action Taken When the DTC Sets

DTC P0116 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0116 is a Type B DTC.

Diagnostic Aids

- Engine coolant that is leaking through the sensor will create a high resistance short to ground. This condition results in less voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a warmer ECT.
- An IAT sensor that is skewed colder at various ambient temperatures due to greater resistance than is normal will increase the range between these two sensors. Measure and record the resistance of the IAT sensor at various ambient temperatures, then compare those measurements to the **Temperature Versus Resistance** table.
- A slight to moderate resistance in the IAT sensor signal circuit or low reference circuit will increase the range between these two sensors. This condition results in a greater voltage on the IAT sensor signal circuit, which is interpreted by the ECM as a colder IAT.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 OFF, inspect the cooling system surge tank for the proper coolant level. Refer to **Cooling System Leak Testing** , and **Cooling System Draining and Filling (GE 47716)** , **Cooling System Draining and Filling (Static Fill)** .
2. Ignition OFF for 8 hours or greater.
3. Ignition ON, observe the scan tool ECT Sensor and IAT Sensor parameters. The ECT, IAT, and ambient temperature should be within 15°C (27°F) of each other.
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 and all vehicle systems OFF, disconnect the B34 engine coolant temperature sensor harness connector at the sensor. 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 A 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 engine control module.
2. Ignition ON, verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).
 - If warmer than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the K20 engine control module.

3. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool ECT Sensor 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 engine control module.
4. If the circuits test normal, test or replace the B34 engine coolant temperature sensor.

Component Testing

1. Ignition off, remove the B34 engine coolant temperature sensor.

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

2. Test the B34 engine coolant temperature sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the Temperature Versus Resistance table.
 - If not within the specified range, replace the B34 engine coolant temperature sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

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

DTC P0117 OR P0118

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	High Resistance	Open	Short to Voltage	Signal Performance

ECT Sensor Signal	P0117	P0118	P0118	P0118	P0116, P0128
Low Reference	-	P0118	P0118	P0118	P0128

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running at various operating conditions			
Parameter Normal Range: 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)

Circuit/System 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 sensor signal circuit and a ground for the low reference circuit.

Conditions for Running the DTC

P0117

- The ignition is ON.
- This DTC runs continuously.

P0118

- The ignition is ON.
- The engine is running for greater than 10 seconds.

OR

- The IAT is warmer than 0.0°C (32°F)
- This DTC runs continuously.

Conditions for Setting the DTC

P0117

The ECM detects that the ECT is warmer than 149°C (300°F) for greater than 5 seconds.

P0118

The ECM detects that the ECT is colder than -39°C (-38°F) for greater than 5 seconds.

Action Taken When the DTC Sets

DTCs P0117 and P0118 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0117 and P0118 are Type B DTCs.

Diagnostic Aids

An ECT sensor signal circuit or low reference circuit that is shorted to another 5-volt reference circuit will cause a DTC P0118 to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 ECT Sensor parameter. The reading should be between -39 to +120°C (-38 to +248°F).
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.

2. Ignition OFF for 90 seconds, 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. If the circuit tests normal, replace the K20 ECM.
3. Ignition ON, verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).
 - If warmer than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the K20 ECM.
4. Install a 3A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool ECT Sensor 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 the circuits test normal, test or replace the B34 ECT sensor.

Component Testing

Measure and record the resistance of the ECT sensor at various ambient temperatures, then compare those measurements to the **Temperature Versus Resistance** table.

Repair Instructions

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

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

DTC P0119

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 P0119

Engine Coolant Temperature (ECT) Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117, P0119	P0116, P0118, P0119	P0118*	P0116, P0128

Low Reference	-	P0116, P0118, P0119	P0118*	P0128
* Internal ECM or 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 volts to the ECT signal circuit and supplies a ground to the low reference circuit. The ECM monitors the performance of the ECT sensor. If the ECM detects excessive noise or rapid fluctuations in the ECT signal, 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

- DTC P0117 or P0118 is not set.
- The ignition is ON or the engine is operating.
- DTC P0119 runs continuously once the above conditions are met.

Conditions for Setting the DTC

- The ECM detects that the ECT changed $\pm 5^{\circ}\text{C}$ ($\pm 9^{\circ}\text{F}$) greater than the expected value during a calibrated amount of time.
- The condition exists for approximately 1 minute.

Action Taken When the DTC Sets

DTC P0119 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0119 is a Type B DTC.

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**.
- 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 on either the ECT sensor signal circuit or the ECT sensor low reference circuit could set a DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 engine coolant temperature (ECT) sensor parameter, while moving the ECT sensor connector and the K20 ECM connector. The ECT sensor parameter should not fluctuate while moving the related harnesses and connectors.
 - Repair the suspected harness or connection if the ECT parameter fluctuates greater than 3°C (5°F) while moving the related harnesses and connectors.

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 engine coolant temperature 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 A and ground.
 - o If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K20 engine control module.
3. Ignition ON, verify the scan tool ECT Sensor parameter is colder than -40°C (-40°F).
 - o If warmer than the specified value, test the signal circuit terminal 1 for a short to ground. If the circuit tests normal, replace the K20 engine control module.
4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the scan tool ECT Sensor parameter is warmer than 150°C (302°F).
 - o If less 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 engine control module.
5. If all circuits test normal, test or replace the B34 engine coolant temperature sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 engine coolant temperature 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 table and verify that the resistance is within 5 percent of the specification.
 - o If not within the specified range, replace the B34 engine coolant temperature sensor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

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

DTC P0121-P0123, P0222, P0223, P16A0-P16A2, OR P2135

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 1 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 P16A0

Sensor Communication Circuit Low Voltage

DTC P16A1

Sensor Communication Circuit High Voltage

DTC P16A2

Sensor Communication Circuit Performance

DTC P2135

Throttle Position Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P06A3	P0122*, P0222*, P16A0	P06A3	P0121*, P16A2, P2135*

Signal	P0122*, P0222*, P16A0	P0122*, P0222*, P16A1	P0123*, P0223*, P16A0**, P16A1**, P16A2**	P0121*, P16A2, P2135*
Low Reference	-	P0123*, P0223*, P16A1	-	P0121*, P16A2, P2135*
* This DTC set indicates an internal throttle body condition. ** A short to voltage causes P16A1 to set. If DTC P16A0, P16A1, and P16A2 set at the same time, an intermittent circuit condition exists.				

Typical Scan Tool Data

Throttle Position Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. Parameter Normal Range: Throttle Position Sensor 1 3.75-4.75 V			
5 V Reference	0.0 V	5.0 V	5.0 V
Signal	0.0 V	0.0 V	0.0 V
Low Reference	-	0.0 V	-

Throttle Position Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. Parameter Normal Range: Throttle Position Sensor 2 0.45-0.90 V			
5 V Reference	0.0 V	0.0 V	0.0 V
Signal	5.0 V	5.0 V	5.0 V
Low Reference	-	5.0 V	-

Circuit/System Description

The throttle body assembly contains a contact-less inductive throttle position sensing element that is managed by a customized integrated circuit. The throttle position sensor is mounted within the throttle body assembly and is not serviceable. The Engine Control Module (ECM) supplies the throttle body with a 5 V reference circuit, a low reference circuit, an H-bridge motor directional control circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the throttle body to the ECM. The throttle body cannot receive data from the ECM over the signal/serial data circuit. The throttle position sensor provides a signal voltage that changes relative to throttle blade angle. The customized integrated circuit translates the voltage based position information into serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The throttle position sensor information is transmitted between the throttle body and the ECM on the signal/serial data circuit. The ECM decodes the serial data signal into separate voltages which are displayed on a scan tool as the voltage inputs from TP sensors 1 and 2.

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 575-6, 600 RPM.
- The engine coolant temperature (ECT) is between -7 to +125°C (19-257°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 run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- The DTCs run continuously when the above condition are met.

P16A0, P16A1, or P16A2

- DTC P06A3 is not set.
- The ignition is ON or the engine is operating.
- The run/crank voltage is greater than 6.41 V.
- The DTCs run continuously once the above conditions are met for greater than 1 s.

P2135

- DTCs P0122, P0123, P0222, P0223, or P06A3 are not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0121

The ECM detects that the throttle position sensor 1 voltage is stuck within normal operating range for greater than 1 s.

P0122

The ECM detects the throttle position sensor 1 signal voltage is less than 0.32 V for greater than 1 s.

P0123

The ECM detects the throttle position sensor 1 signal voltage is greater than 4.75 V for greater than 1 s.

P0222

The ECM detects the throttle position sensor 2 signal voltage is less than 0.25 V for greater than 1 s.

P0223

The ECM detects the throttle position sensor 2 signal voltage is greater than 4.59 V for greater than 1 s.

P16A0

The ECM detects a low voltage circuit condition on the throttle position sensor signal circuit for greater than 1 s.

P16A1

The ECM detects a high voltage circuit condition on the throttle position sensor signal circuit for greater than 1 s.

P16A2

The ECM detects an incorrect message was received over the throttle position sensor signal circuit for greater than 1 s.

P2135

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

Action Taken When the DTC Sets

- DTCs P0121 is a Type B DTC.
- DTCs P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 are Type A DTCs.
- The ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions, the ECM commands the engine OFF.

Conditions for Clearing the DTC

- DTCs P0121 is a Type B DTC.
- DTCs P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 are Type A DTCs.

Diagnostic Aids

- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- If the accelerator pedal is pressed to the wide open throttle position, the throttle blade angle or Throttle Position angle is limited to less than 40 percent.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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,
2. Verify that DTC P0601-P0606, P06A3, and P16F3 is not set.

- **If a DTC is set**

Refer to Diagnostic Trouble Code (DTC) List - Vehicle for further diagnosis.

- **If a DTC is not set**

3. Verify the scan tool Throttle Body Idle Air flow Compensation parameter is less than 90 %.
- **If 90 % or greater**

Refer to Throttle Body Cleaning .

- **If less than 90 %**

4. Verify that DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, or P2135 are not set.

- **If DTC P0122, P0123, P0222, P0223, or P2135 are the only DTCs set**

Test or replace the Q38 Throttle Body Assembly.

- **If any of the DTCs are set**

Refer to Circuit/System Testing.

- **If none of the DTCs are set**

5. Verify the Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

- **If Agree is not displayed**

Test or replace the Q38 Throttle Body Assembly.

- **If Agree is displayed**

6. Verify DTC P0121, P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 is not set.

- **If a DTC is set**

Refer to Circuit/System Testing.

- **If a DTC is not set**

7. Determine the current vehicle testing altitude.

8. Verify the scan tool MAP Sensor pressure parameter is within range specified in the **Altitude Versus Barometric Pressure** table.

- **If the MAP Sensor pressure is not in range**

Refer to **DTC P0106**.

- **If the MAP Sensor pressure is within range**

9. Engine idling.

10. Verify the scan tool MAP Sensor pressure parameter is between 26-52 kPa (3.8-7.5 psi) and changes with accelerator pedal input.

- **If not between 26-52 kPa (3.8-7.5 psi) or does not change**

Refer to **DTC P0106**.

- **If between 26-52 kPa (3.8-7.5 psi) and changes**

11. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.

1. Engine idling
2. Perform the scan tool snapshot function.
3. Increase the engine speed slowly to 3,000 RPM and then back to idle.

4. Exit from the scan tool snapshot and review the data.
5. Observe the MAF Sensor parameter frame by frame with a scan tool.
 - **If the MAF Sensor parameter does not change smoothly and gradually**

Refer to **DTC P0101**.

- **If the MAF Sensor parameter changes smoothly and gradually**
12. 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.
 13. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**
14. All OK.

Circuit/System Testing

NOTE: **Disconnecting the throttle body harness connector causes additional DTCs to set.**

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at Q38 Throttle Body Assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal 4 and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 5 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 5 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**
- 5. Ignition ON.
- 6. Test for 4.8-5.2 V between the signal circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - **If infinite resistance**
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
- 7. Test or replace the Q38 Throttle Body Assembly.

Repair Instructions

- **Throttle Body Assembly Replacement**
- **Control Module References** for Engine Control Module replacement, programming, and setup

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
5. Ignition ON.
6. Verify the Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

- If Agree is not displayed

Test or replace the Q38 Throttle Body Assembly.

- If Agree is displayed

7. If the repair was 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 set.

- If DTC sets

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

- If DTC does not set

8. All OK.

DTC P0128

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	P0117, P0119	P0118	P0118	P0116, P0119, P0128
Low Reference	-	P0118, P0119	-	P0119, P0128

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The ignition is ON, or the engine is running Parameter Normal Range: Varies with ambient temperature, within a range of -39 to +120°C (-38 to +248°F)			
ECT Sensor Signal	140°C (284°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)

Circuit/System 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 sensor signal circuit and a ground for the low reference circuit.

The purpose of this diagnostic is to analyze the performance of the thermostat by comparing the measured ECT to a modeled ECT using information from the following inputs:

- ECT
- Engine load
- Intake air temperature (IAT)
- Mass air flow (MAF)
- Vehicle speed (VS)

The ECM uses the start-up ECT and the start-up intake air temperature (IAT) to begin the diagnostic calculation. The air flow into the engine is accumulated, and vehicle speed, distance, engine load, and engine run time are also factored in to determine if the ECT does increase normally and then maintains that temperature within a calibrated range of the modeled ECT.

Conditions for Running the DTC

- DTC P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0221, P0222, P0223, P0335, P0336, or P0501 is not set.
- The decrease in ECT after engine start is within a calibrated range.
- The decrease in IAT after engine start is within a calibrated range.
- The engine idle time is less than 40 %.
- The engine run time is greater than 8 s.
- The engine run time at minimum load is less than 50 %.
- The engine run time at maximum load is less than 90 %.
- The ignition voltage is greater than 10 V.
- The start-up ECT is between -10 and +75°C (14-167°F).
- The start-up IAT is warmer than -10°C (14°F).
- The DTC runs once per drive cycle within the enabling conditions.

Conditions for Setting the DTC

The ECM determines that the modeled ECT has met the calibrated target of 92°C (198°F) and the measured ECT is less than 81°C (178°F) for greater than 2 s.

Action Taken When the DTC Sets

- DTC P0128 is a Type B DTC.
- The Engine Coolant Temperature Gauge is inoperative.

- The cooling fans will be commanded ON.
- The AC compressor will be commanded OFF.

Conditions for Clearing the MIL/DTC

DTC P0128 is a Type B DTC.

Diagnostic Aids

- DTC P0128 occurring with insufficient vehicle interior heating is an indication of improper thermostat operation.
- Corrosion on the ECT sensor terminals or the ECT harness connector results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.
- A slight to moderate resistance in the ECT sensor signal circuit or low reference circuit will affect this diagnostic. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

Reference Information

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 the cooling system is filled to the correct coolant level. Refer to Cooling System Leak Testing , and Cooling System Draining and Filling (GE 47716) , Cooling System Draining and Filling (Static Fill) .

- If the coolant level is not correct

Repair as necessary

- If the coolant level is correct

NOTE: A critical analysis of the operation of the thermostat is necessary to properly diagnose this DTC.

2. Verify the proper heat range and the operation of the thermostat. Refer to Thermostat Diagnosis .

- If a condition is found

Replace the Thermostat.

○ **If a condition is not found**

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.

4. Verify the DTC does not set.

○ **If the DTC sets**

Refer to Step 1.

○ **If the DTC does not set**

5. All OK.

Repair Instructions

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

- **Engine Coolant Thermostat Replacement (LUK)**
- **Control Module References** for ECM replacement, setup and programming

DTC P0131, P0132, P0134, P0137, P0138, P0140, OR P2A00

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 Sensor 1

DTC P0132

HO2S Circuit High Voltage Sensor 1

DTC P0134

HO2S Circuit Insufficient Activity Sensor 1

DTC P0137

HO2S Circuit Low Voltage Sensor 2

DTC P0138

HO2S Circuit High Voltage Sensor 2

DTC P0140

HO2S Circuit Insufficient Activity Sensor 2

DTC P2A00

HO2S Performance Sensor 1

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140, P2A00	P0133, P013A, P013B, P013E, P013F, P015A, P015B, P1133
HO2S Low Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140, P2A00	P0133, P013A, P013B, P013E, P013F, P015A, P015B, P1133

Typical Scan Tool Data

HO2S 1 or 2 Voltage

Circuit	Short to Ground	Open	Short to Voltage
HO2S High Signal	0 V	1700-2100 mV	1700-2100 mV
HO2S Low Signal	0 V	1700-2100 mV	1700-2100 mV

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 and P0137

- DTCs P0106, P0107, P0108, P0201, P0202, P0203, P0204, P0411, P0412, P0418, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0496 are not set.
- The engine is operating in Closed Loop.
- The Ignition voltage is between 10-32 V.
- The fuel level is greater than 10 percent.
- The ethanol content is less than 87 percent.
- Device controls are not active.
- Decel fuel cut-off is not active.
- DTC P0131 runs when the above conditions are met for 5 s.

P0132

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0201, P0202, P0203, P0204, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0496 are not set.
- The engine is operating in Closed Loop.
- The Ignition voltage is between 10-32 V.
- The fuel level is greater than 10 percent.
- Engine run time is greater than 195 s.
- The ethanol content is less than 87 percent.
- Fuel control state is not in power enrichment.
- DTC P0132 runs when the above conditions are met for 5 s.

P0134 and P0140

- DTCs P0068, P0101, P0102, P0103, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition voltage is between 10-32 V.
- The engine run time is greater than 150 s.
- The fuel composition is less than 87 percent ethanol.
- DTCs P0134 and P0140 run continuously when the above conditions are met.

P0138

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0201, P0202, P0203, P0204, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0496 are not set.
- The engine is operating in Closed Loop.
- The Ignition voltage is between 10-32 V.
- The fuel level is greater than 10 percent.

- Engine run time is greater than 110 s.
- Ethanol content is less than 87 percent.
- Fuel control state is not in power enrichment.
- DTC P0138 runs when the above conditions are met for 5 s.

P2A00

- DTCs P0068, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0131, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine run time is greater than 100 s.
- The engine speed is between 500-3, 400 RPM.
- The Ignition voltage is between 10-32 V.
- The Mass Airflow (MAF) is between 3.2-30 g/s.
- The ECT is hotter than 70°C (158°F).
- DTC P2A00 runs continuously when the above conditions are met for 5 s.

Conditions for Setting the DTC

P0131

- The ECM detects that the HO2S 1 voltage parameter is less than 50 mV.
- DTC P0131 sets within 50 s when the above condition is met.

P0132

- The ECM detects that the HO2S 1 voltage parameter is more than 1, 050 mV.
- DTC P0132 sets within 15 s when the above condition is met.

P0134

- The ECM detects that the HO2S 1 voltage is greater than 1, 700 mV.
- DTC P0134 sets within 100 s when the above conditions are met.

P0137

- The ECM detects that the HO2S 2 voltage parameter is less than 50 mV.
- DTC P0137 sets within 50 s when the above condition is met.

P0138

- The ECM detects that the HO2S 2 voltage parameter is more than 1, 050 mV.
- DTC P0138 sets within 15 s when the above condition is met.

P0140

- The ECM detects that the HO2S 2 voltage is greater than 1, 700 mV.
- DTC P0140 sets within 25 s when the above conditions are met.

P2A00

- The ECM detects that the engine is operating in Open Loop.
- DTC P2A00 sets within 50 s when the above condition is met.

Action Taken When the DTC Sets

DTCs P0131, P0132, P0134, P0137, P0138, P0140, and P2A00 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0131, P0132, P0134, P0137, P0138, P0140, and P2A00 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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
2. Verify no HO2S heater DTCs are set.
 - **If a DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If a DTC is not set**

3. Engine running.
4. Verify the scan tool HO2S 1 or 2 parameters are between 50-1, 050 mV.

- **If not between 50-1, 050 mV**

Refer to Circuit/System Testing.

- **If between 50-1, 050 mV**

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.
6. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate B52 Heated Oxygen Sensor harness connector. It may take up to 2 minutes for all vehicle systems to power down. Ignition ON.
2. Test for 1.7-3.0 V between the high signal circuit terminal B and ground.

- **If less than 1.7 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the high signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the high signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- **If greater than 3.0 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module. Ignition ON.
2. Test for less than 1 V between the high signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.

- **If between 1.7-3.0 V**

3. Verify the scan tool HO2S 1 or 2 parameter is between 1.7-2.1 V.
 - **If less than 1.7 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the low signal circuit terminal A and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module.
 - **If between 1.7-2.1 V**
4. 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 engine control module. A voltage of 0.0-1.10 V on the low signal circuit is normal.**

5. Verify the scan tool HO2S 1 or 2 parameter displays 0.0 V.
 - **If greater than 0.0 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module. Ignition ON.
 2. Test for less than 2 ohms in the low signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms
 3. Test for less than 1 V between the low signal circuit terminal A and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If 0.0 V**
6. Verify none of the following conditions exist:
 - 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
 - Engine vacuum leaks
 - **If any of the conditions exist**

Repair as necessary.
 - **If none of the conditions exist**
7. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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

- **Heated Oxygen Sensor Replacement - Sensor 1**
- **Heated Oxygen Sensor Replacement - Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing a HO2S.

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

DTC P0133, P013A, P013B, P013E, P013F, P1133, P2270, OR P2271

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 Sensor 1

DTC P013A

HO2S Slow Response Rich to Lean Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Sensor 2

DTC P013F

HO2S Delayed Response Lean to Rich Sensor 2

DTC P1133

HO2S Insufficient Switching Sensor 1

DTC P2270

HO2S Signal Stuck Lean Sensor 2

DTC P2271

HO2S Signal Stuck Rich Sensor 2

Diagnostic Fault Information

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Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P013A, P013B, P013E, P013F, P1133, P2A00
HO2S Low Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P013A, P013B, P013E, P013F, P1133, P2A00
HO2S Heater Voltage Supply	P0030, P0036, P0132, P0135, P0138, P0141, *	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0690	P0135, P0141
HO2S Heater Control	P0030, P0036, P0053, P0054, P0135, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0135, P0141

* Opens fuse

Typical Scan Tool Data

HO2S Sensor 1 Voltage

Circuit	Normal Range	Short to Ground	Open	Short to Voltage
HO2S High Signal	200-800 mV	0 V	Approximately 1.9 V	Approximately 1.9 V
HO2S Low Signal	200-800 mV	0 V	Approximately 1.9 V	Approximately 1.9 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

P0133 and P1133

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0128, P0131, P0132, P0134, P0201, P0202, P0203, P0204, P0300, P0411, P0412, P0418, P0442, P0443, P0446, P0449, P0451, P0452, P0453, P0454, P0455, P0496 are not set.
- The engine coolant temperature (ECT) is hotter than 70°C (158°F).
- The Ignition voltage is between 10-32 V.
- The fuel level is greater than 10 percent.
- The engine run time is greater than 120 s.
- The engine speed is between 1, 000-3, 500 RPM.
- The device controls are not active.
- The HO2S heaters have been ON for greater than 40 s.
- The intake air temperature (IAT) is hotter than -40°C (-40°F).
- The fuel composition is less than 87 percent ethanol.
- The barometric pressure is greater than 70 kPa.
- The fuel control is not in power enrichment.
- Decel fuel cut-off is not active.
- The Mass Airflow (MAF) Sensor parameter is between 14-40 g/s.
- The fuel state is in Closed Loop.
- DTCs P0133 and P1133 runs once per drive cycle when the above conditions are met for 3 s.

P013A

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10-32 V.
- The fuel level is greater than 10 percent.
- Engine run time is equal to or more than 40 s.
- DTCs P013E and P2270 have run and passed.

THEN

- DFCO is active.
- The accelerator pedal position (APP) is stable.

- This DTC runs once per trip.

P013B and P013F

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10-32 V.
- The fuel level is greater than 10 percent.
- DTCs P013A, P013E, P013F, P2270, and P2271 have run and passed.
- DTCs P013B and P013F run once per trip.

P013E

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10-32 V.
- The fuel level is greater than 10 percent.
- DTC P2270 has run and passed.

THEN

- DFCO is active.
- The APP is stable.
- This DTC runs once per trip.

P2270

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.
- The system voltage is between 10-32 V.
- The fuel level is greater than 10 percent.
- The pedal position is less than 4 percent.
- The engine speed is between 1, 250-2, 300 RPM.
- The engine airflow is equal to or more than 3 g/s and equal to or less than 12 g/s.
- The vehicle speed is equal to or more than 55 km/h (34.2 mph) and equal to or less than 120 km/h (74.6 mph).
- The fuel state is in Closed Loop.

- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The HO2S heaters are ON for more than 180 s.
- The predicted catalytic converter temperature is between 600-900°C (1, 112-1, 652°F).
- This DTC runs once per trip when all of the above conditions have been met for 1 s.

P2271

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270 are not set.
- The system voltage is between 10-32 V.
- The fuel level is greater than 10 percent.
- The engine speed is 1, 250-2, 300 RPM.
- The engine air flow is between 3-12 g/s.
- The vehicle speed is between 55-120 kph (34.2-74.6 mph).
- The fueling state is in Closed Loop.
- The EVAP is not in control of purge.
- Power take-off is not active.
- The HO2S heaters have been on more than 180 s.
- The predicted catalyst temperature is between 600-900°C (1, 112-1, 652°F).
- DTCs P013A, P013E, and P2270 have run and passed.

THEN

- DFCO is active.
- The APP is stable.
- This DTC runs once per trip when the above conditions are met for 3 s.

Conditions for Setting the DTC

P0133

- The ECM detects that the HO2S 1 average response time is greater than a calculated value.
- DTC P0133 sets within 60 s when the above condition is met.

P013A

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

P013B

The ECM detects that the accumulated mass air flow monitored during lean-to-rich transitions between 300-600 mV is greater than a calibrated value.

P013E

The ECM detects that the O2 sensor cannot achieve voltage below 450 mV within a calibrated value of accumulated air flow.

P013F

The ECM detects that the O2 sensor cannot achieve voltage above 300 mV within a calibrated value of accumulated air flow.

P1133

- The ECM detects that the HO2S 1 rich-to-lean counts, or the lean-to-rich counts are less than a calibrated value.
- DTC P1133 sets within 60 s when the above condition is met.

P2270

- The ECM detects that the O2 sensor cannot achieve voltage equal to or more than 775 mV.

AND

- The ECM detects that the accumulated mass air flow monitored during the Stuck Lean Voltage Test is more than a calibrated value.

P2271

- The ECM detects that the O2 sensor cannot achieve voltage equal to or less than 100 mV.

AND

- The ECM detects that the accumulated mass air flow monitored during the Stuck Rich Voltage Test is more than a calibrated value.

Action Taken When the DTC Sets

- DTCs P0133, P013E, P013F, P1133, P2270, and P2271 are Type B DTCs.
- DTCs P013A, and P013B are Type A DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0133, P013E, P013F, P1133, P2270, and P2271 are Type B DTCs.
- DTCs P013A, and P013B are Type A DTCs.

- DTCs P0133, P013E, P013F, P2270, and P2271 are Type B DTCs.
- DTCs P013A, P013B, P015A, and P015B are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 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. Verify none of the following conditions exist:
 - Lean or rich fuel injectors-Refer to Fuel Injector Solenoid Coil Test .
 - 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-Refer to Exhaust Leakage .
 - Engine vacuum leaks
 - Engine oil consumption
 - Engine coolant consumption-Refer to Loss of Coolant .
 - If you find any of the above conditions, repair as necessary.
3. If all conditions test normal, test or replace the appropriate HO2S.
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.

Repair Instructions

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

- **Heated Oxygen Sensor Replacement - Sensor 1**
- **Heated Oxygen Sensor Replacement - Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing a HO2S.
- **Control Module References** for engine control module (ECM) replacement, programming and setup.

DTC P0171 OR P0172

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

DTC P0172

Fuel Trim System Rich

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. The ECM monitors the heated oxygen sensor (HO2S) signal voltage and adjusts the fuel delivery based on the signal voltage while in Closed Loop. A change made to the fuel delivery changes the long and short term fuel trim (FT) values. The short term FT values change rapidly in response to the HO2S voltage signals. These changes fine tune the engine fueling. The long term FT makes coarse adjustments in order to maintain an optimum air/fuel ratio. The ideal FT values are around zero percent. A positive FT value indicates that the ECM is adding fuel in order to compensate for a lean condition. A negative FT value indicates that the ECM is reducing the amount of fuel in order to compensate for a rich condition.

Conditions for Running the DTC

- DTCs P0053, P0101, P0102, P0103, P0106, P0107, P0108, P0131, P0132, P0133, P0134, P0135, P0178, P0179, P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301-P0304, P0411, P0442, P0443, P0455, P0496, P0506, P0507, P1133, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2269, P2440, P2444, or P2A00 are not set.

- The engine is in Closed Loop status.
- The catalyst monitor intrusive test is not active.
- The post O2 sensor intrusive test is not active.
- The device controls are not active.
- The EVAP leak test is not active.
- The engine coolant temperature (ECT) is between -20 and +150°C (-4 and +302°F).
- The intake air temperature (IAT) is between -20 and +150°C (-4 and +302°F).
- The manifold absolute pressure (MAP) is between 15-255 kPa (2.2-37 PSI).
- The engine speed is between 400-6, 600 RPM.
- The mass air flow (MAF) is between 1-512 g/s.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 PSI).
- The fuel level is greater than 10 percent.
- These DTCs run continuously when the above conditions have been met.

Conditions for Setting the DTC

- The long term FT weighted average value is greater or less than a calibrated value.
- The above condition is present for approximately 3 minutes after the conditions for running the DTC have been met.

Action Taken When the DTC Sets

DTCs P0171 and P0172 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0171 and P0172 are Type B DTCs.

Diagnostic Aids

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

- The normal Short Term FT parameter should be between +10 percent and -10 percent, with near 0 percent the optimum, with the engine running at operating temperature.
- The Long Term FT parameter should be between +10 percent and -10 percent, with near 0 percent the optimum, with the engine running at operating temperature.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

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 no other DTCs are set.
 - If any other DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle .
2. Ignition ON, 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 .
 - If the MAP sensor does not indicate the correct barometric pressure, refer to DTC P0106.
3. With the engine idling, observe the mass air flow (MAF) sensor parameter. The MAF sensor parameter should be between 2-6 g/s at idle.
 - If the MAF sensor parameter is not between 2-6 g/s at idle, refer to DTC P0101, or DTC P0102 or P0103.

P0171

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

Allow the engine to reach operating temperature. With the engine running, observe the Long Term FT parameter with a scan tool. The reading should be between 0-29 percent.

- If greater than the specified range, inspect for the following:
 - 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 .
 - 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-Refer to **Crankcase Ventilation System Inspection/Diagnosis (Without Turbocharger)** .
- 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

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

Allow the engine to reach operating temperature. With the engine running, observe the Long Term FT parameter with a scan tool. The reading should be between -16 and 0 percent.

- If less than the specified range, inspect for the following:
 - 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 EVAP 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** .
 - 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
 - Malfunctioning engine components-Refer to **Symptoms - Engine Mechanical** .

Repair Instructions

Perform the **Diagnostic Repair Verification** after performing the 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	P018C, P0641, P06A6	P018C	P018D	P06A6
Signal	P018C	P018C	P018D	P018B
Low Reference	-	P018D	-	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 pressure of at least 30 kPa (4.4 psi) when the fuel pump is operating. The fuel pressure sensor performance diagnostic provides a means to detect fuel

pressure sensor output that is stuck within the normal operating range of the sensor.

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.
- 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 resets before proceeding with the circuit system testing. If the DTC does not reset, refer to diagnostic aids.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

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 Verification

1. Engine running.
2. Verify the scan tool Fuel Pressure Sensor Voltage parameter is between 0.2-4.8 V.
 - **If not between 0.2-4.8 V**

Refer to Circuit/System Testing.

- **If between 0.2-4.8 V**
3. All OK.

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 resets before proceeding with the circuit system testing. If the DTC does not reset, refer to diagnostic aids.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B47 fuel pressure sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K27 fuel pump control module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K27 fuel pump control module.
 - **If less than 10 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K27 Fuel Pump Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module, ignition ON.

2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K27 Fuel Pump Control Module.
 - **If between 4.8-5.2 V**
5. Verify the scan tool Fuel Pressure Sensor Voltage parameter is less than 1 V.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit terminal 1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K27 Fuel Pump Control Module.
 - **If less than 1 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.
7. Verify the scan tool Fuel Pressure Sensor Voltage parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module.
 2. Test for infinite resistance between the signal circuit terminal 1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K27 Fuel Pump Control Module.
 - **If greater than 4.8 V**
8. Test or replace the B47 fuel pressure sensor.

Repair Instructions

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

- **Fuel Pressure Sensor Replacement - Fuel Feed Pipe**
- **Control Module References** for fuel pump control module replacement, programming and setup

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 Descriptors

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, P0641	P0192	P0641	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0192	P0193	P0191
Low Reference	-	P0193, P0506	-	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 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

- DTC P0016, P0017, P0068, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0128, P0192, P0193, P0201, P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0335, P0336, P0340, P0341, P0351-P0354, P0365, P0366, P0506, P0507, P0627, P0628, P0629, P0722, P0723, P1248, P1249, P124A, P124B, P1682, P16F3, P2101, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157 is not set.
- The engine is not cranking.
- The ignition voltage is greater than 11 V.
- The vehicle speed is less than or equal to 1 km/h (0.62 mph).
- The low side fuel pressure is greater than or equal to 275 kPa (40 psi).
- The Accelerator Pedal Position is 0 percent for 12.5 s.
- DTC P0191 runs continuously when the above conditions have been met.

Condition 2 and 3

- DTC P0016, P0017, P0068, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0128, P0192, P0193, P0201,

P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0335, P0336, P0340, P0341, P0351-P0354, P0365, P0366, P0506, P0507, P0627, P0628, P0629, P0722, P0723, P1248, P1249, P124A, P124B, P1682, P16F3, P2101, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157 is not set.

- The engine is not cranking.
- The ignition voltage is greater than 11 V.
- The engine speed is between 1, 000-2, 200 RPM.
- The vehicle speed is greater than or equal to 45 km/h (27.96 mph).
- The low side fuel pressure is greater than or equal to 275 kPa (40 psi).
- The Desired Fuel Rail Pressure is between 7-8 MPa (1, 015-1, 160 psi).
- DTC P0191 runs continuously when the above conditions have been met.

Condition 4

- DTC P0016, P0017, P0068, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0128, P0192, P0193, P0201, P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0335, P0336, P0340, P0341, P0351-P0354, P0365, P0366, P0506, P0507, P0627, P0628, P0629, P0722, P0723, P1248, P1249, P124A, P124B, P1682, P16F3, P2101, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157 is not set.
- The engine is not cranking.
- The vehicle speed is greater than or equal to 30 km/h (18.64 mph).
- The engine speed is greater than or equal to 2, 000 RPM.
- DTC P0191 runs continuously when the above conditions have been met.

Conditions for Setting the DTC

Condition 1

The difference between the low side fuel pressure and the high side fuel pressure is less than or equal to -0.65 MPa (-94 psi) or greater than or equal to 0.6 MPa (87 psi) with the high pressure fuel pump actuator commanded OFF. The condition exists for greater than 3 s.

Condition 2

The difference between the relief pressure and the measured high pressure is less than or equal to -5 MPa (-725 psi) with the high pressure fuel pump actuator commanded ON. The condition exists for greater than 2 s.

Condition 3

The difference between the commanded high pressure and the measured high pressure is greater than or equal to 3 MPa (435 psi) and the modeled injection pressure is greater than or equal to 3 MPa (435 psi) with the high pressure fuel pump actuator commanded ON. The condition exists for greater than 3 s.

Condition 4

The difference between the measured maximum high pressure and the measured minimum high pressure is less than or equal to 0.1 MPa (14.5 psi) with the high pressure fuel pump actuator commanded ON. The condition exists for greater than 60 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 - INDEX

Description and Operation

Fuel 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. Observe the scan tool DTC information, verify DTC P0627, P0628, P0629, P0641, P069E or U0109 is not set.
 - o 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 2.96-3.24 MPa (429-470 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 B47B fuel rail fuel pressure sensor and verify the engine does not stumble, stall, or change engine speed.
 - o 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 fuel injector multi-way harness connector X160.

NOTE: **Testing for steps 2 through 5 is performed on the ECM side of the multi-way harness connector.**

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 5 and ground.
 - o 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 11 and ground.
 - o 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.
 - o 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. Ignition ON, verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
 - o If greater than 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 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.
 - o 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.
6. Ignition OFF, remove the intake manifold.

7. Connect the fuel injector multi-way harness connector X160.

NOTE: **Testing for steps 9 through 12 is performed at the fuel rail fuel pressure sensor connector.**

8. Disconnect the B47B fuel rail fuel pressure sensor connector.
9. 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.
10. 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.
11. 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.
12. 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.
13. If all circuits test normal, replace the B47B fuel rail fuel pressure sensor.

Repair Instructions

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

- **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**
- **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

Fuel Rail Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0192, P0193, P0641	P0192	P0641	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0192	P0193	P0191
Low Reference	-	P0193, P0506	-	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 greater than 11 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 for greater than 6 s.

P0193

The ECM detects that the fuel rail fuel pressure sensor signal voltage is high for greater than 6 s.

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

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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 fuel injector multi-way harness connector X160.

NOTE: **Testing for steps 2 through 5 is performed on the ECM side of the multi-way harness connector.**

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 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.

3. 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.
4. 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.
5. 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.
6. Ignition OFF, remove the intake manifold.
7. Connect the fuel injector multi-way harness connector X160.

NOTE: **Testing for steps 9 through 12 is performed at the fuel rail fuel pressure sensor connector.**

8. Disconnect the B47B fuel rail fuel pressure sensor connector.
9. 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.
10. 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.
11. 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.
12. 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.
13. If all circuits test normal, replace the B47B fuel rail fuel pressure sensor.

Repair Instructions

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

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

DTC P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, OR P2157

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 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 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 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

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, P2148	P1248
Direct Fuel Injector High Voltage Supply Cylinder 2	P2150	P0202	P2151	P1249
Direct Fuel Injector High Voltage Control Cylinder 2	P0264	P0202	P0265, P2151	P1249
Direct Fuel Injector High Voltage Supply Cylinder 3	P2153	P0203	P2154	P124A
Direct Fuel Injector High Voltage Control Cylinder 3	P0267	P0203	P0268, P2154	P124A
Direct Fuel Injector High Voltage Supply Cylinder 4	P2156	P0204	P2157	P124B
Direct Fuel Injector High Voltage Control Cylinder 4	P0270	P0204	P0271, P2157	P124B

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

- DTC P062B is not set.
- The engine is running for greater than 5 s.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0201, P0202, P0203, or P0204

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, or P0270

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

P0262, P0265, P0268, or P0271

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

P1248, P1249, P124A, or P124B

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

P2147, P2150, P2153, or P2156

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

P2148, P2151, P2154, or P2157

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 P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, and P2157 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, and P2157 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

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Engine Controls Schematics

Connector End View Reference

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- **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, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157 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 1-4 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 fuel injector multi-way harness connector X160.

2. Ignition ON, observe the appropriate scan tool Cylinder 1-4 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

- **Fuel Injector Solenoid Coil Test**
- **Fuel Injector Balance Test**

Repair Instructions

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

- **Direct Fuel Injector Replacement**
- **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/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 line 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 11 V or greater than 18 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.

On vehicles equipped with a high pressure mechanical pump on Direct Fuel Injection engines, the vehicle may continue to run even though the pump in the fuel tank is not operating.

Reference Information

Schematic Reference

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- **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 and all vehicle systems OFF, disconnect the harness connector at the G12 fuel pump. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K27 fuel pump control module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K27 fuel pump control module.
 - **If less than 10 ohms**
3. Connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
4. Ignition ON.
5. Verify the test lamp turns ON and OFF when commanding the fuel pump ON and OFF using the scan tool ECM fuel pump enable control function.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K27 fuel pump control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K27 fuel pump control module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K27 fuel pump control module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K27 fuel pump control module.
 - **If the test lamp turns ON and OFF**
6. Replace the G12 fuel pump.

Repair Instructions

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

- **Fuel Tank Fuel Pump Module Replacement (NU6)** , **Fuel Tank Fuel Pump Module Replacement (NT7)**
- **Control Module References** for fuel pump control module replacement, programming and setup

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/High Resistance	Short to Voltage	Signal Performance
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 line 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.

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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 resets before proceeding with the circuit system testing. If the DTC does not reset, refer to diagnostic aids.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K27 fuel pump control module, ignition ON.
2. Connect a test lamp between the control circuit terminal 20 and ground.
3. Verify the test lamp turns ON and OFF when commanding the fuel pump ON and OFF using the scan tool ECM fuel pump enable control function.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms, replace the K20 engine control module.
- **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K20 engine control module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 engine control module.
- **If the test lamp turns ON and OFF**
 4. Test or replace the K27 fuel pump control module.

Repair Instructions

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

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

DTC P0300-P0304

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

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 P0304 correspond to cylinders 1 through 4. 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 3 crankshaft revolutions when the misfire is not current. The ECM will re-enable the fuel injector after 6 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.
- The evaporative emissions (EVAP) leak detection is not active.
- 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 at least 11 %.
- The ECM is not in fuel cut-off or decel fuel cut-off mode.
- DTCs P0300 through P0304 run continuously when the above conditions exist for at least 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

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-P0304 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-P0304 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 ; remove the belt and safely operate the engine to evaluate
- 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 Malfunction 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

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- Powertrain Component Views

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. Verify that no other DTCs are set.
 - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Engine idling at the normal operating temperature. Verify there is no abnormal engine noise.
 - If there is an abnormal engine noise, refer to **Symptoms - Engine Mechanical** .
3. Observe the scan tool Current Misfire Cyl. 1-4 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. Operate the engine under the conditions in which the misfire occurred. Observe the Misfire Current Counters with a scan tool. 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-Refer to **Fuel Injector Solenoid Coil Test** .
 - An engine mechanical condition-Refer to **Symptoms - Engine Mechanical** .

Repair Instructions

- **Ignition Coil Replacement**
- **Spark Plug Replacement**

Repair Verification

- 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 OFF the ignition for 60 s.
- 5. If the repair was 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 the **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. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

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 - INDEX

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, after 5 Crankshaft Position System Variation Learn Procedure attempts, the scan tool did not display Learned Successful;** 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
 - **If a condition exists**
 - Repair or replace the affected component as necessary.
 - Perform the Crankshaft Position System Variation Learn Procedure.
 - **If no conditions exist**
 - Replace the K20 Engine Control Module.
 - Perform the Crankshaft Position System Variation Learn Procedure.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within

the conditions that you observed in the Freeze Frame/Failure Records data.

3. Verify the DTC is not set.

○ **If any of DTC sets**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

○ **If none of the DTCs set**

4. All OK.

Repair Instructions

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

Control Module References for engine control module replacement, programming, and setup

DTC P0324, P0326, OR P06B6

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 P0326

Knock Sensor Performance

DTC P06B6

Control Module Knock Sensor Processor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0327, P06B6	P0325	P0328, P06B6	P0326
Low Reference	P0327	-	P0328	-

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. The ECM learns a minimum knock sensor noise level for all of the RPM range. The ECM monitors for a normal knock sensor signal. The ECM generates a 20 KHz signal on the output circuit and monitors that it is sent back and detected on the return circuit. The ECM processes the return signal to verify the internal knock sensor processor.

Conditions for Running the DTCs

P0324 and P0326-Condition 1

- Engine speed is between 400-8, 500 RPM.
- Engine is running for greater than 2 s.
- The engine coolant temperature (ECT) is warmer than -40°C (-40°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F).
- The DTCs run continuously when the above conditions are met.

P0326-Condition 2

- Engine speed is between 2, 200-8, 500 RPM.
- Engine is running for greater than 2 s.
- 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

- Engine speed is between 400-3, 500 RPM.
- Engine is running for greater than 2 s.
- The engine coolant temperature (ECT) is warmer than -40°C (-40°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTCs

P0324

The ECM detects that the knock sensor signal's performance is out of the normal expected range due to an excessive engine knock, or abnormal noise, or a flat signal; for greater than 10 s for at least 1 single cylinder.

P0326

- The ECM detects that the knock sensor signal indicates the harness is connected, but the sensor is not properly bolted to the engine.
- The above condition exist for greater than 10 s.

OR

- The ECM detects that the knock sensor signal indicates an excessive engine knock is present.
- The above condition exist for greater than 10 s.

P06B6

The ECM has detected an internal knock sensor processor fault.

Action Taken When the DTC Sets

- DTCs P0324, P0326, P0328, and P06B6 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, P0326, P0328, and P06B6 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Electronic Ignition System Description

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- **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
2. Verify DTC P0325, P0327, P0328 or P06B6 is not set.
 - **IF DTC P0325, P0327, or P0328 is set with P06B6**

Refer to **DTC P0325, P0327, or P0328** for further diagnosis.

- **If only DTC P06B6 is set**

Verify that no external knock sensor circuit issues exist, then; replace the K20 Engine Control Module.

- **If none of the DTCs is set**

3. Vehicle OFF, inspect for the following:

- The affected B68 Knock Sensor for physical damage. A sensor that is dropped or damaged may cause a DTC to set
- The sensor for proper installation. A sensor that is loose or not at the correct torque may cause a DTC to set. Refer to **Symptoms - Engine Mechanical** .
- The sensor mounting surface for burrs, casting flash, and foreign material
- The sensor must be clear of hoses, brackets, and engine electrical wiring
- Loose brackets
- Loose or broken accessory drive belts, brackets, components
- An engine mechanical condition-Refer to **Symptoms - Engine Mechanical**
- **If a condition exists**

Repair or replace component as appropriate.

- **If no conditions exist**

4. 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.

- **If any of the DTCs set**

Test or replace the B68 Knock Sensor.

- **If none of the DTCs set**

5. All OK.

Repair Instructions

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

- **Knock Sensor Replacement**
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P0325, P0327, OR P0328

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 P0325

Knock Sensor Circuit

DTC P0327

Knock Sensor Circuit Low Voltage

DTC P0328

Knock Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Sensor 1 Signal	P0327, P06B6	P0325	P0328, P06B6	P0326
Low Reference	P0327	-	P0328	-

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. The ECM learns a minimum knock sensor noise level for all of the RPM range. The ECM monitors for a normal knock sensor signal. The ECM generates a 20 KHz signal on the output circuit and monitors that it is sent back and detected on the return circuit. The ECM processes the return signal to verify the internal knock sensor processor.

Conditions for Running the DTCs

P0325

- Engine speed is between 400-8, 500 RPM.
- Engine is running at least 2 s.
- The engine coolant temperature (ECT) is warmer than -40°C (-40°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F).
- The DTC runs continuously when the above conditions are met.

P0327 and P0328

- Engine speed is less than 8, 500 RPM.
- The DTCs run continuously when the above condition is met.

Conditions for Setting the DTCs

P0325

The knock sensor signal circuits are open for least 6 s.

P0327

The knock sensor signal circuits are shorted to ground for least 6 s.

P0328

The knock sensor signal circuits are shorted to voltage for least 6 s.

Action Taken When the DTCs Set

- DTCs P0325, P0327, and P0328 are Type B DTCs.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

Conditions for Clearing the DTCs

DTCs P0325, P0327, and P0328 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 - INDEX

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- **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.
2. Verify DTC P0325, P0327, P0328, P0330, P0332, or P0333 is not set.
 - **If the DTC is set**

Refer to Circuit/System Testing.

- **If the DTC is not set**
3. Verify the appropriate B68 Knock Sensor is properly tightened. Refer to **Fastener Tightening Specifications**.
4. Verify the scan tool parameters below display NO while moving the related harnesses and connectors for the appropriate B68 Knock Sensor.
 - Cylinder 1 Knock Detected
 - Cylinder 2 Knock Detected
 - Cylinder 3 Knock Detected
 - Cylinder 4 Knock Detected

- **If NO is not displayed**

Refer to Circuit/System Testing.

- **If NO is displayed**

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.

- **If the DTC is set**

Refer to Circuit/System Testing.

- **If the DTC is not set**

6. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B68 Knock Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal B or 2 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If less than 10 ohms**
3. Test for 1-4 V between the signal circuit terminal A or 1 and ground.
 - **If greater than 4 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than 1 V**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If between 1-4 V**

4. Replace the B68 Knock Sensor.

Repair Instructions

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

- **Knock Sensor Replacement**
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P0335 OR P0336

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 P0335

Crankshaft Position Sensor Circuit

DTC P0336

Crankshaft Position Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P057C, P0335, P0651	P0335	P0651	P0336
Signal	P0335, P0506	P0335	P0335	P0336
Low Reference	-	P0335	-	P0336

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

P0335 Condition 1

- The starter is engaged and the engine control module detects camshaft position (CMP) sensor pulses.

Or

- DTCs P0101, P0102 and P0103 are not set.

And

- The airflow into the engine is greater than 3 g/s.

Condition 2

- The engine is running and the starter is not engaged.
- DTC P0651 is not set.

Condition 3

- The engine is running or the starter is engaged.
- DTCs P0365, P0366, P0641, and P0651 are not set.

P0336 Condition 1

- The airflow into the engine is greater than 3 g/s.
- Engine speed is greater than 450 RPM.
- DTCs P0335 or P0651 are not set.

Condition 2

- The engine is running and the starter is not engaged.
- DTC P0651 is not set.

Condition 3

- The starter is engaged and the engine control module detects camshaft position (CMP) sensor pulses.

Or

- DTCs P0101, P0102, and P0103 are not set.
- The airflow into the engine is greater than 3 g/s.

Condition 4

- The engine is running or the starter is engaged.
- DTCs P0365, P0366, P0641, and P0651, are not set.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0335 Condition 1

The ECM does not detect a crankshaft position sensor pulse for greater than 4 s.

Condition 2

The ECM does not detect a crankshaft position sensor pulse for greater than 1.0 s.

Condition 3

The ECM does not detect a crankshaft position sensor pulse for 2 out of 10 engine revolutions.

P0336 Condition 1

The ECM detects that 10 or more crankshaft resynchronization have occurred within 10.0 s.

Condition 2

The ECM does not detect the synchronization gap on the reluctor wheel for greater than 0.4 s.

Condition 3

The ECM does not detect the synchronization gap on the reluctor wheel for 1.5 s after the starter was engaged.

Condition 4

The ECM detects less than 51 or greater than 65 crankshaft position sensor pulses during 1 engine revolution for 8 out of 10 engine revolutions.

Action Taken When the DTC Sets

- DTCs P0335 and P0336 are Type B DTCs.
- An engine driveability issue occurs after the first failure.
- The camshaft position sensor is used to determine engine position.

- The camshaft actuators are commanded to the parked position.

Conditions for Clearing the DTC

DTCs P0335 and P0336 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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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.
2. Verify DTC P0651 is not set.
 - **If the DTC is set**

Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .

- **If the DTC is not set**

3. Engine running.

4. Verify the scan tool Crankshaft Position Active Counter parameter increments.

- **If the counter does not increment**

Refer to Circuit/System Testing.

- **If the counter increments**

5. Verify the scan tool Crankshaft Position Resync Counter parameter displays 0 counts and the engine does not stumble or stall while moving the related harness/connectors of the B26 Crankshaft Position Sensor.

- **If greater than 0 counts and the engine stumbles or stalls**

Refer to Circuit/System Testing.

- **If 0 counts and the engine does not stumble or stall**

6. 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.

7. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

8. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B26 Crankshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

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

- **If 5 ohms or greater**

1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.

2. Test for less than 2 ohms in the low reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If 2 ohms or less, replace the K20 Engine Control Module.

- **If less than 5 ohms**

3. Ignition ON.

4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the 5 V reference circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance

3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the 5 V reference and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
5. Test for 4.8-5.2 V between the signal circuit terminal 3 and ground.
 - **If less than 4.8 V**
1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
6. Ignition OFF, connect a 3 A fused jumper wire to the signal circuit terminal 3, ignition ON.

NOTE: Additional DTCs may set when performing this test.

7. Verify the scan tool Crankshaft Position Sensor Active Counter parameter increments while rapidly tapping the fused jumper wire end to ground.
 - **If the counter does not increment**

Replace the K20 Engine Control Module.

 - **If the counter increments**
8. Verify DTC P0336 is not set.
 - **If the DTC is set**

Inspect for the conditions listed below:

- Excessive play or looseness of the B26 Crankshaft Position Sensor or the reluctor wheel
- Improper installation of the B26 Crankshaft Position Sensor
- Foreign material passing between the B26 Crankshaft Position Sensor and the reluctor wheel
- Damaged reluctor wheel
- Excessive air gap between the B26 Crankshaft Position Sensor and the reluctor wheel
- Engine oil for debris
- Timing chain, tensioner, and sprockets for wear or damage
- If any of the conditions above are found, repair as necessary.
- If all components test normal, test or replace the B26 Crankshaft Position Sensor.
- **If the DTC is not set**

9. Test or replace the B26 Crankshaft Position Sensor.

Repair Instructions

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

- **Crankshaft Position Sensor Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0340, P0341, P0365, OR P0366

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

DTC P0341

Intake Camshaft Position Sensor Performance

DTC P0365

Exhaust Camshaft Position Sensor Circuit

DTC P0366

Exhaust Camshaft Position Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0107, P0452, P0532, P0641	P0340, P0365	P0641	-
Signal	P0340, P0365	P0340, P0365	P0340, P0365	P0341, P0366
Low Reference	-	P0340, P0365	P0340, P0365	-

Circuit/System Description

The camshaft position sensors each have 3 circuits consisting 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 uses the cylinder 1 exhaust camshaft position sensor to determine injector and ignition system synchronization. The intake and exhaust camshaft position sensors are also used to determine camshaft to crankshaft relationship. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft to control camshaft phasing and limp-home operation.

Conditions for Running the DTC

P0340 or P0365 Condition 1

- The starter is engaged and the engine control module detects camshaft position sensor pulses.

OR

- DTCs P0101, P0102, and P0103 are not set.
- The airflow into the engine is greater than 3 g/s.

Condition 2

- The engine is running and the starter is not engaged.
- DTC P0651 is not set.

Condition 3

- The crankshaft is synchronized.

- The starter is engaged.
- DTC P0335, P0336, P0641, or P0651 are not set.

Condition 4

- The crankshaft is synchronized.
- DTC P0335, P0336, P0641, or P0651 are not set.

P0341 or P0366 Condition 1

- The crankshaft is synchronized.
- The starter is engaged.
- DTC P0335, P0336, P0641, or P0651 are not set.

Condition 2

- The crankshaft is synchronized.
- DTC P0335, P0336, P0641, or P0651 are not set.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0340 or P0365 Condition 1

- The ECM does not detect a camshaft position sensor pulse for greater than 5.5 s.

OR

- The ECM does not detect a camshaft position sensor pulse for greater than 4.0 s since the time the starter has been engaged.

Condition 2

The ECM detects less than 4 camshaft position sensor pulse for greater than 3.0 s.

Condition 3

The ECM does not detect a camshaft position sensor pulse during the first 2 engine revolutions.

Condition 4

The ECM does not detect a camshaft position sensor pulse during 200 engine revolutions.

P0341 or P0366 Condition 1

- The ECM detects less than 4 camshaft position sensor pulses during 2 engine revolutions.

OR

- The ECM detects greater than 10 camshaft position sensor pulses during 2 engine revolutions.

Contion 2

The ECM detects less than 398 or greater than 402 camshaft position sensor pulses during 200 engine revolutions.

Action Taken When the DTC Sets

- DTCs P0340, P0341, P0365, and P0366 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 limp home mode.
- With a DTC set, the engine may crank for an extended period of time at start-up.

Conditions for Clearing the MIL/DTC

DTCs P0340, P0341, P0365, and P0366 are Type B DTCs.

Diagnostic Aids

- With a DTC set, the engine may crank for an extended period of time at start-up
- The exhaust camshaft position sensor is used for injector and ignition system synchronization. A stalling condition will occur if the camshaft position sensor signal is intermittent and a DTC may not set. Inspect the intake and exhaust camshaft position sensor circuits for poor connections.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Ignition ON.
2. Verify DTC P0641 or P0651 is not set.
 - **If any of the DTCs are set**

Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .

- **If none of the DTCs are set**
3. Engine running.
 4. Verify the scan tool parameters listed below increment:
 - Exhaust Camshaft Position Active Counter
 - Intake Camshaft Position Active Counter
 - **If any counter does not increment**

Refer to Circuit/System Testing.

- **If all counters increment**
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.
 6. Verify the DTC does not set.
 - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B23 Camshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 5 ohms between the low reference circuit terminal B and ground.
 - **If 5 ohms or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If 2 ohms or less, replace the K20 Engine Control Module.
 - **If less than 5 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If between 4.8-5.2 V**
5. Test for 4.8-5.2 V between the signal circuit terminal C and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**

6. Verify DTC P0341 or P0366 is not set.

- **If any of the DTCs are set**

Inspect for the conditions listed below:

- Excessive play or looseness of the B23 Camshaft Position Sensor or the reluctor wheel
- Improper installation of the B23 Camshaft Position Sensor
- Foreign material passing between the B23 Camshaft Position Sensor and the reluctor wheel
- Damaged reluctor wheel
- Excessive air gap between the B23 Camshaft Position Sensor and the reluctor wheel
- Engine oil for debris
- Timing chain, tensioner, and sprockets for wear or damage
- If any of the conditions above are found, repair as necessary.
- If all components test normal, test or replace the B23 Camshaft Position Sensor.
- **If none of the DTCs are set**

7. Test or replace the B23 Camshaft Position Sensor.

Repair Instructions

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

- **Camshaft Position Sensor Replacement - Exhaust**
- **Camshaft Position Sensor Replacement - Intake**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0351-P0354

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Coil 1 Control	P0300, P0351	P0300, P0351	P0300, P0351	P0300, P0351
Ignition Coil 2 Control	P0300, P0352	P0300, P0352	P0300, P0352	P0300, P0352
Ignition Coil 3 Control	P0300, P0353	P0300, P0353	P0300, P0353	P0300, P0353
Ignition Coil 4 Control	P0300, P0354	P0300, P0354	P0300, P0354	P0300, P0354

Circuit/System Description

The ignition system on this engine uses an individual coil for each cylinder. The engine control module (ECM) controls the spark event for each cylinder through the individual ignition coil 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. The ECM monitors each ignition control circuit for improper voltage levels.

Conditions for Running the DTC

- The engine is cranking or running.
- Ignition voltage greater than 5 V.

The DTCs run continuously when the above condition are met.

Conditions for Setting the DTC

The engine control module detects that the voltage command state of the driver and the actual state of the control circuit do not match.

Action Taken When the DTC Sets

DTCs P0351, P0352, P0353, and P0354 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0351, P0352, P0353, and P0354 are Type B DTCs.

Reference Information

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Connector End View Reference

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- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 26792 HEI Spark Tester

For equivalent regional tools, refer to Special Tools .

Circuit/System Verification

1. Engine Running.
2. Verify the scan tool parameters listed below do not display Malfunction:
 - Ignition Coil 1-4 Control Circuit High Voltage Test Status
 - Ignition Coil 1-4 Control Circuit Low Voltage Test Status
 - Ignition Coil 1-4 Control Circuit Open Test Status

- **If Malfunction is displayed**

Refer to Circuit/System Testing below.

- **If Malfunction is not displayed**

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.
4. Verify the DTC does not set.

- **If the DTCs sets**

Refer to Circuit/System Testing below.

- **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate T8 Ignition Coil.
2. Engine Running.
3. Verify the appropriate scan tool Ignition Coil Control Circuit Low Voltage Test Status does not display Malfunction.

- **If Malfunction is displayed**

1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the control circuit.
 - If infinite resistance, replace the K20 Engine Control Module.

- **If Malfunction is not displayed**

4. Verify the appropriate scan tool Ignition Coil Control Circuit High Voltage Test Status does not display Malfunction.

- **If Malfunction is displayed**

1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage in the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.

- **If Malfunction is not displayed**

5. Ignition OFF, install a 3 A fused jumper wire between the control circuit terminal C and ground, engine Running.
6. Verify the appropriate scan tool Ignition Coil Control Circuit Low Voltage Test Status displays Malfunction.

- **If Malfunction is not displayed**

1. Ignition OFF, remove the fused jumper, and disconnect the X3 harness connector at the K20

Engine Control Module.

2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
7. Test or replace the T8 Ignition Coil.

Component Test

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

1. Ignition OFF, connect the **EL 26792** HEI Spark Tester to the appropriate T8 Ignition Coil.
2. Engine Running.
3. Verify the spark output of the T8 Ignition Coil.
 - **If no output or the output is weak**

Replace the T8 Ignition Coil.

- **If the output is normal**
4. All OK.

Repair Instructions

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

- **Ignition Coil Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

2013 ENGINE PERFORMANCE

Engine Controls/Fuel - 2.4L (LUK) - Malibu

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC P0010, P0013, or P2088-P2091</u>	DTC P0010 Intake Camshaft Position Actuator Solenoid Valve Control Circuit DTC P0013 Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit DTC P2088 Intake Camshaft Position Actuator Solenoid Control Circuit Low Voltage DTC P2089 Intake Camshaft Position Actuator Solenoid Control Circuit High Voltage DTC P2090 Exhaust Camshaft Position Actuator Solenoid Control Circuit Low Voltage DTC P2091 Exhaust Camshaft Position Actuator Solenoid Control Circuit High Voltage
<u>DTC P0011 or P0014</u>	DTC P0011 Intake Camshaft Position System Performance DTC P0014 Exhaust Camshaft Position System Performance
<u>DTC P0016 or P0017</u>	DTC P0016 Crankshaft Position - Intake Camshaft Position Not Plausible DTC P0017 Crankshaft Position - Exhaust Camshaft Position Not Plausible
<u>DTC P0030, P0036, P0053, P0054, P0135, or P0141</u>	DTC P0030 HO2S Heater Control Circuit Sensor 1 DTC P0036 HO2S Heater Control Circuit Sensor 2 DTC P0053 HO2S Heater Resistance Sensor 1 DTC P0054 HO2S Heater Resistance Sensor 2 DTC P0135 HO2S Heater Performance Sensor 1 DTC P0141 HO2S Heater Performance Sensor 2
<u>DTC P0068 or P1101</u>	DTC P0068 Throttle Body Air Flow Performance DTC P1101 Intake Air Flow System Performance
<u>DTC P0089, P00C6, P228C, or P228D</u>	DTC P0089 Fuel Pressure Regulator Performance DTC P00C6 Fuel Rail Pressure Low During Engine Cranking DTC P228C Fuel Pressure Regulator Control Performance - Low Pressure DTC P228D Fuel Pressure Regulator Control Performance - High Pressure
	DTC P0090 Fuel Pressure Regulator Control Circuit Low Voltage DTC P0091 Fuel Pressure Regulator Control Circuit Low Voltage

<u>DTC P0090-P0092, P00C8, P00C9, or P00CA</u>	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
<u>DTC P0101</u>	DTC P0101 Mass Air Flow (MAF) Sensor Performance
<u>DTC P0102 or P0103</u>	DTC P0102 Mass Air Flow (MAF) Sensor Circuit Low Frequency DTC P0103 Mass Air Flow (MAF) Sensor Circuit High Frequency
<u>DTC P0106</u>	DTC P0106 Manifold Absolute Pressure (MAP) Sensor Performance
<u>DTC P0107 or P0108</u>	DTC P0107 Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage DTC P0108 Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage
<u>DTC P0111</u>	DTC P0111 Intake Air Temperature (IAT) Sensor Performance
<u>DTC P0112, P0113, or P0114</u>	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
<u>DTC P0116</u>	DTC P0116 Engine Coolant Temperature (ECT) Sensor Performance
<u>DTC P0117 or P0118</u>	DTC P0117 Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage DTC P0118 Engine Coolant Temperature (ECT) Sensor Circuit High Voltage
<u>DTC P0119</u>	DTC P0119 Engine Coolant Temperature (ECT) Sensor Circuit Intermittent
<u>DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135</u>	DTC P0121 Throttle Position Sensor 1 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 P16A0 Sensor Communication Circuit Low

	Voltage DTC P16A1 Sensor Communication Circuit High Voltage DTC P16A2 Sensor Communication Circuit Performance DTC P2135 Throttle Position Sensors 1-2 Not Plausible
<u>DTC P0128</u>	DTC P0128 Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature
<u>DTC P0131, P0132, P0134, P0137, P0138, P0140, or P2A00</u>	DTC P0131 HO2S Circuit Low Voltage Sensor 1 DTC P0132 HO2S Circuit High Voltage Sensor 1 DTC P0134 HO2S Circuit Insufficient Activity Sensor 1 DTC P0137 HO2S Circuit Low Voltage Sensor 2 DTC P0138 HO2S Circuit High Voltage Sensor 2 DTC P0140 HO2S Circuit Insufficient Activity Sensor 2 DTC P2A00 HO2S Performance Sensor 1
<u>DTC P0133, P013A, P013B, P013E, P013F, P1133, P2270, or P2271</u>	DTC P0133 HO2S Slow Response Sensor 1 DTC P013A HO2S Slow Response Rich to Lean Sensor 2 DTC P013B HO2S Slow Response Lean to Rich Sensor 2 DTC P013E HO2S Delayed Response Rich to Lean Sensor 2 DTC P013F HO2S Delayed Response Lean to Rich Sensor 2 DTC P1133 HO2S Insufficient Switching Sensor 1 DTC P2270 HO2S Signal Stuck Lean Sensor 2 DTC P2271 HO2S Signal Stuck Rich Sensor 2
<u>DTC P0171 or P0172</u>	DTC P0171 Fuel Trim System Lean DTC P0172 Fuel Trim System Rich
<u>DTC P018B-P018D</u>	DTC P018B Fuel Pressure Sensor Performance DTC P018C Fuel Pressure Sensor Circuit Low Voltage DTC P018D Fuel Pressure Sensor Circuit High Voltage
<u>DTC P0191</u>	DTC P0191 Fuel Rail Pressure Sensor Performance
<u>DTC P0192 or P0193</u>	DTC P0192 Fuel Rail Pressure Sensor Circuit Low Voltage DTC P0193 Fuel Rail Pressure Sensor Circuit High Voltage
	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 P0261 Cylinder 1 Injector Control Circuit Low

<u>DTC P0201-P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157</u>	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 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 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
<u>DTC P0231, P0232, or P023F</u>	DTC P0231 Fuel Pump Control Circuit Low Voltage DTC P0232 Fuel Pump Control Circuit High Voltage DTC P023F Fuel Pump Control Circuit
<u>DTC P025A</u>	DTC P025A Fuel Pump Control Module Enable Circuit
	DTC P0300 Engine Misfire Detected DTC P0301 Cylinder 1 Misfire Detected

<u>DTC P0300-P0304</u>	DTC P0302 Cylinder 2 Misfire Detected DTC P0303 Cylinder 3 Misfire Detected DTC P0304 Cylinder 4 Misfire Detected
<u>DTC P0315</u>	DTC P0315 Crankshaft Position System Variation Not Learned
<u>DTC P0324, P0326, or P06B6</u>	DTC P0324 Knock Sensor System Performance DTC P0326 Knock Sensor Performance DTC P06B6 Control Module Knock Sensor Processor Performance
<u>DTC P0325, P0327, or P0328</u>	DTC P0325 Knock Sensor Circuit DTC P0327 Knock Sensor Circuit Low Voltage DTC P0328 Knock Sensor Circuit High Voltage
<u>DTC P0335 or P0336</u>	DTC P0335 Crankshaft Position Sensor Circuit DTC P0336 Crankshaft Position Sensor Performance
<u>DTC P0340, P0341, P0365, or P0366</u>	DTC P0340 Intake Camshaft Position Sensor Circuit DTC P0341 Intake Camshaft Position Sensor Performance DTC P0365 Exhaust Camshaft Position Sensor Circuit DTC P0366 Exhaust Camshaft Position Sensor Performance
<u>DTC P0351-P0354</u>	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
<u>DTC P0411</u>	DTC P0411 Secondary Air Injection System Incorrect Air Flow Detected
<u>DTC P0412 or P0418</u>	DTC P0412 Secondary Air Injection Valve Control Circuit DTC P0418 Secondary Air Injection Pump Relay Control Circuit
<u>DTC P0420</u>	DTC P0420 Catalyst System Low Efficiency
<u>DTC P0442</u>	DTC P0442 Evaporative Emission (EVAP) System Small Leak Detected
<u>DTC P0443 or P0449</u>	DTC P0443 Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit DTC P0449 Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit
<u>DTC P0446</u>	DTC P0446 Evaporative Emission (EVAP) Vent System Performance
<u>DTC P0451-P0454</u>	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 Circuit

	Intermittent
<u>DTC P0455</u>	DTC P0455 Evaporative Emission (EVAP) System Large Leak Detected
<u>DTC P0496</u>	DTC P0496 Evaporative Emission (EVAP) System Flow During Non-Purge
<u>DTC P0506 or P0507</u>	DTC P0506 Idle Speed Low DTC P0507 Idle Speed High
<u>DTC P050D</u>	DTC P050D Cold Start Rough Idle
<u>DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P2610 (ECM)</u>	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
<u>DTC P0601-P0604, P0606, or P062F (Fuel Pump Control Module)</u>	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 P062F Control Module Long Term Memory Performance
<u>DTC P0627 or P0628</u>	DTC P0627 Fuel Pump Enable Circuit DTC P0628 Fuel Pump Enable Circuit Low Voltage
<u>DTC P0641, P0651, P0697, or P06A3 (ECM)</u>	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
<u>DTC P0641 or P06A6 (Fuel Pump Control Module)</u>	DTC P0641 5 V Reference Circuit DTC P06A6 5 V Reference 1 Performance
<u>DTC P0650</u>	DTC P0650 Malfunction Indicator Lamp (MIL) Control Circuit

<u>DTC P0685, P0689, P0690, or P1682</u>	DTC P0685 Engine Controls Ignition Relay Control Circuit DTC P0689 Engine Controls Ignition Relay Feedback Circuit Low Voltage DTC P0690 Engine Controls Ignition Relay Feedback Circuit High Voltage DTC P1682 Ignition 1 Switch Circuit 2
<u>DTC P069E</u>	DTC P069E Fuel Pump Control Module Requested MIL Illumination
<u>DTC P0700</u>	DTC P0700 Transmission Control Module Requested MIL Illumination
<u>DTC P0AC4</u>	DTC P0AC4 Hybrid/EV Powertrain Control Module Requested MIL Illumination
<u>DTC P1255 or P064A</u>	DTC P064A Fuel Pump Control Module Performance DTC P1255 Fuel Pump Control Module Driver High Temperature
<u>DTC P135A</u>	DTC P135A Ignition Coil Supply Voltage Circuit Bank 1
<u>DTC P1400</u>	DTC P1400 Cold Start Emission Reduction Control System
<u>DTC P1516, P2101, P2119, or P2176</u>	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 Minimum Throttle Position Not Learned
<u>DTC P15F9</u>	DTC P15F9 Hybrid/EV System Engine Speed Control Intervention Request Type Signal Message Counter Incorrect
<u>DTC P15FB</u>	DTC P15FB Brake Pedal Position Sensor Signal Message Counter Incorrect
<u>DTC P163A</u>	DTC P163A Control Module Fuel Pressure Regulator 1 Control System Circuitry Performance
<u>DTC P2096</u>	DTC P2096 Post Catalyst Fuel Trim System Low Limit
<u>DTC P2097</u>	DTC P2097 Post Catalyst Fuel Trim System High Limit
<u>DTC P2122, P2123, P2127, P2128, or P2138</u>	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)

	Sensors 1-2 Not Plausible
<u>DTC P219A</u>	DTC P219A Fuel Trim Cylinder Balance
<u>DTC P2430, P2431, P2435, or P2436</u>	DTC P2430 Secondary Air Injection System Pressure Sensor Circuit - Bank 1 (Left Hand) DTC P2431 Secondary Air Injection System Pressure Sensor Performance - Bank 1 (Left Hand) DTC P2435 Secondary Air Injection System Pressure Sensor Circuit Bank 2 - (Right Hand) DTC P2436 Secondary Air Injection System Pressure Sensor Performance Bank 2 - (Right Hand)
<u>DTC P2432, P2433, P2437, or P2438</u>	DTC P2432 Secondary Air Injection System Pressure Sensor Circuit Low Voltage - Bank 1 (Left Hand) DTC P2433 Secondary Air Injection System Pressure Sensor Circuit High Voltage - Bank 1 (Left Hand) DTC P2437 Secondary Air Injection System Pressure Sensor Circuit Low Voltage Bank 2 - (Right Hand) DTC P2438 Secondary Air Injection System Pressure Sensor Circuit High Voltage Bank 2 - (Right Hand)
<u>DTC P2440</u>	DTC P2440 Secondary Air Injection System Cut-Off Valve Stuck Open
<u>DTC P2444</u>	DTC P2444 Secondary Air Injection System Pump Stuck On
<u>DTC P2534 (Fuel Pump Control Module)</u>	DTC P2534 Ignition On/Start Switch Circuit Low Voltage
<u>DTC P2544</u>	DTC P2544 Transmission Torque Request Signal Message Counter Incorrect
<u>DTC P2635 (Fuel Pump Control Module)</u>	DTC P2635 Fuel Pump Flow Performance

2013 ENGINE PERFORMANCE

Engine Controls/Fuel - 2.4L (LUK) - Repair Instructions - Malibu

REPAIR INSTRUCTIONS

ENGINE CONTROL MODULE REPLACEMENT

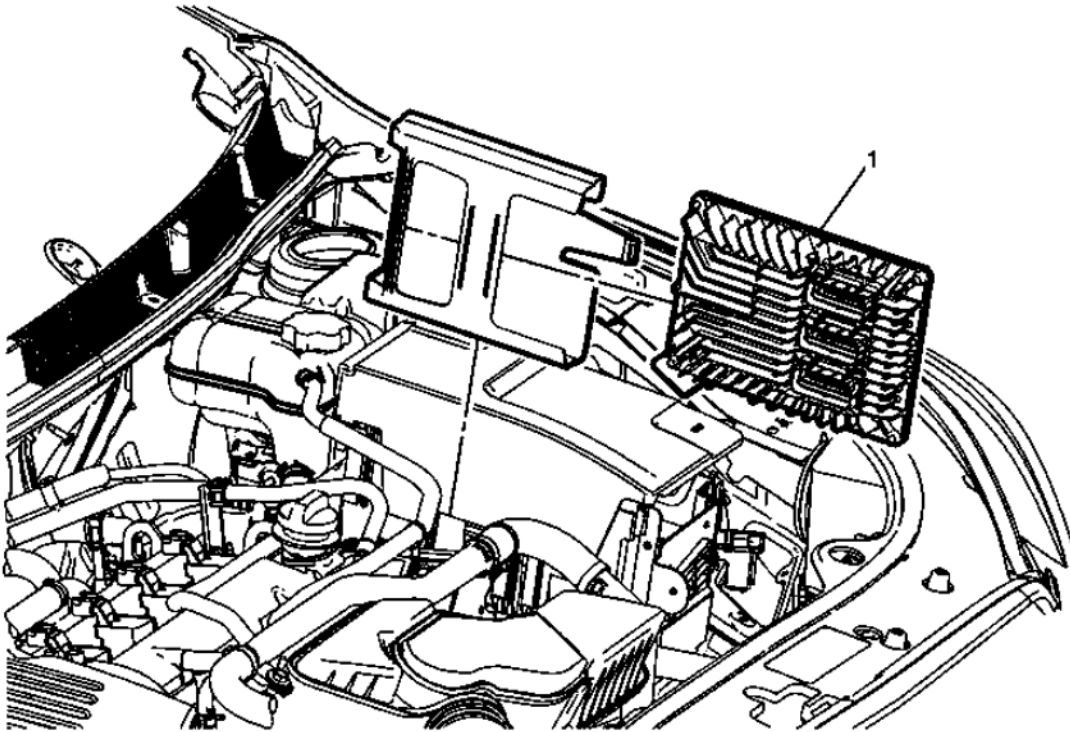


Fig. 1: Engine Control Module
Courtesy of GENERAL MOTORS COMPANY

Engine Control Module Replacement

Callout	Component Name
Preliminary Procedure Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> .	
	Electronic Control Module WARNING: Refer to <u>Safety Glasses Warning</u> . CAUTION: Always turn the ignition off when installing or removing the ECM connectors in order to prevent damage to the components.

1

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.

Procedure

1. Disconnect the electrical connectors.
2. Pull upward on the engine control bracket to remove the bracket from the battery tray. Release the retaining tab to release ECM from bracket.
3. If replacing, program the ECM. Refer to **Control Module References**.

NOTE:

Before removing the engine control module (ECM), record the oil life percentage remaining. Use the scan tool to reset the Engine Oil Life remaining back to the original percentage recorded.

CRANKSHAFT POSITION SYSTEM VARIATION LEARN

NOTE: The Crankshaft Position 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) or body control module (BCM) replacement
- A crankshaft balancer replacement
- A crankshaft removal and/or replacement
- A crankshaft position sensor disturbance/removal and/or 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 Variation Learn procedure.

1. Ignition ON, observe the DTC information with a scan tool. Verify no other DTCs are set, except DTCs P0300-P0304, or P0315.
 - If DTCs are set, except DTCs P0300-P0304, or P0315, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Select the Crankshaft Position Variation Learn Procedure with a scan tool and follow the on screen instructions:
3. Verify DTC P0315 does not set.
 - If DTC P0315 set, or another DTC is present refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
 - If the DTC does not set
4. All OK.

Q38 THROTTLE BODY: THROTTLE/IDLE LEARN

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

Scan tool Idle Learn or Idle Learn Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, 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).

Service Bay/On Road Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, 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

Scan Tool Idle Learn or Idle Learn Reset Procedure - Performed after the throttle body is cleaned or replaced

1. Ignition ON, engine OFF, perform the Idle Learn or Idle Learn Reset in Configuration/Reset or Module Setup.
2. Engine idling, observe the scan tool Throttle Body Idle Airflow Compensation parameter. The Throttle Body Idle Airflow Compensation value should equal 0 % and the engine should be idling at a normal idle speed.
3. Clear the DTCs and return to the diagnostic that referred you here.

Service Bay/On Road Idle Learn Procedure - Performed after the ECM is programmed or replaced

NOTE: Do NOT perform this procedure if DTCs are set. Refer to Diagnostic Trouble Code (DTC) List - Vehicle.

1. Engine idling for 3 minutes.
2. Observe the scan tool Desired Idle Speed and the actual Engine Speed parameters.
3. The ECM will start to learn the new idle cells and the 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

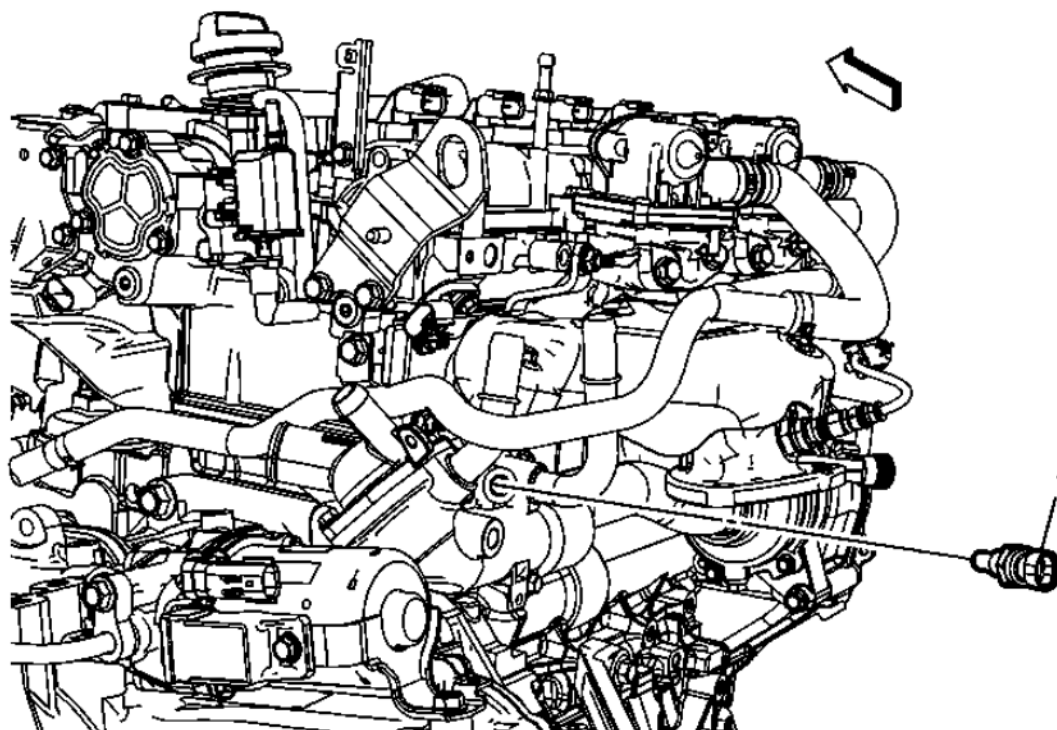


Fig. 2: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Temperature Sensor Replacement

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to <u>Cooling System Draining and Filling (GE 47716)</u> , <u>Cooling System Draining and Filling (Static Fill)</u> .	
1	Engine Coolant Temperature Sensor CAUTION: Refer to <u>Component Fastener Tightening Caution</u> . Procedure Disconnect the electrical connector. Tighten 20 N.m (15 lb ft)

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

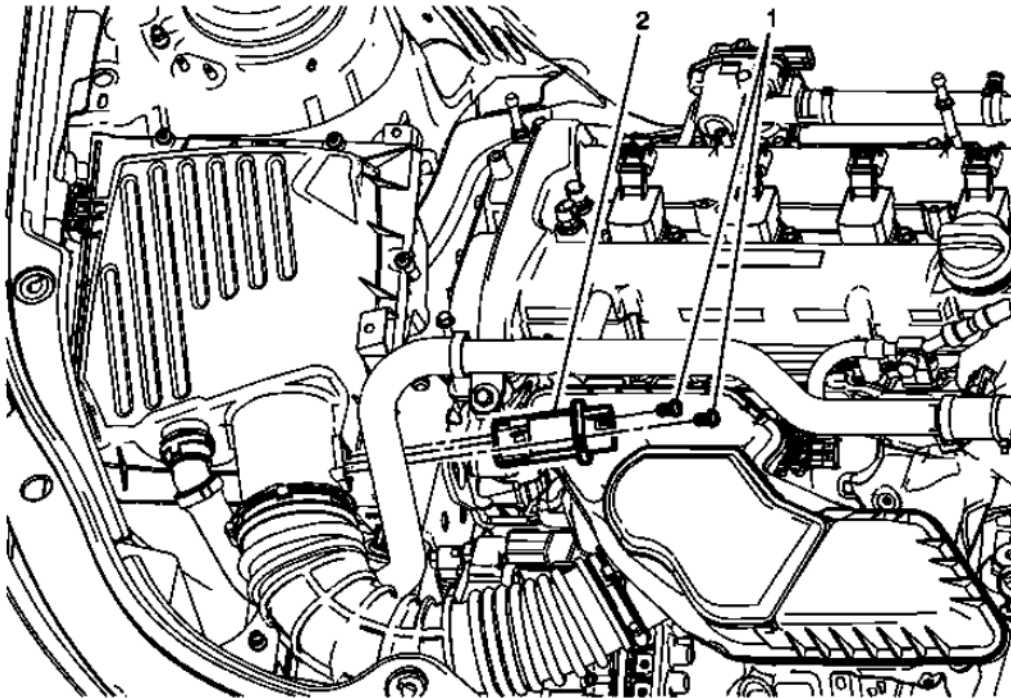


Fig. 3: Mass Airflow Sensor with Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Mass Airflow Sensor with Intake Air Temperature Sensor Replacement

Callout	Component Name
1	Mass Airflow Sensor Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 1.5 N.m(13 lb in)
2	Mass Airflow Sensor Procedure Disconnect the electrical connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

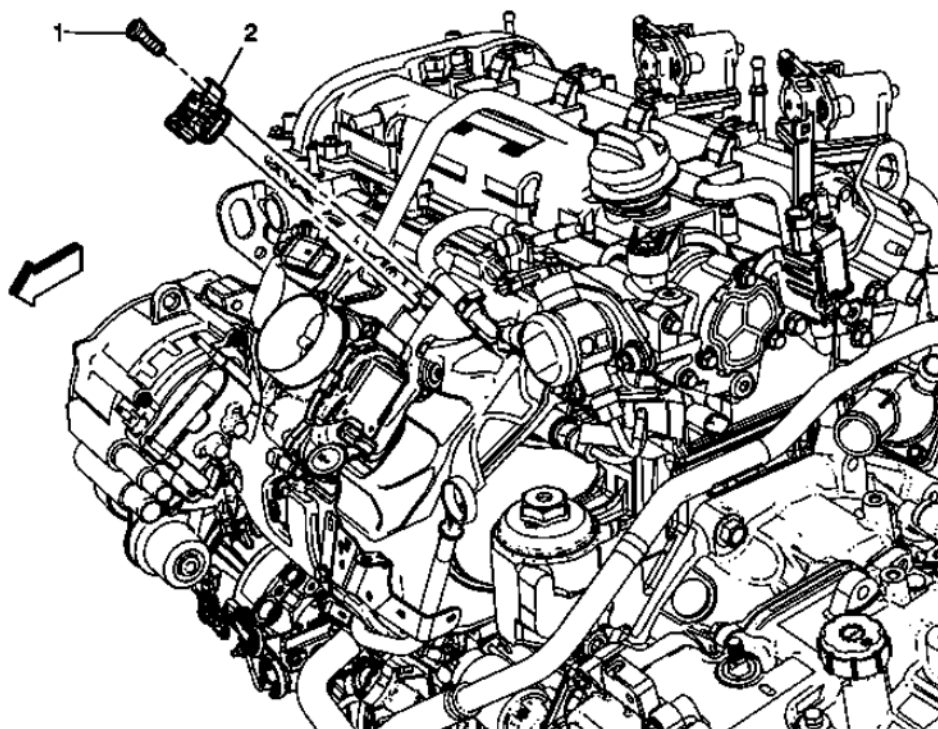


Fig. 4: Manifold Absolute Pressure Sensor
 Courtesy of GENERAL MOTORS COMPANY

Manifold Absolute Pressure Sensor Replacement

Callout	Component Name
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

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 1

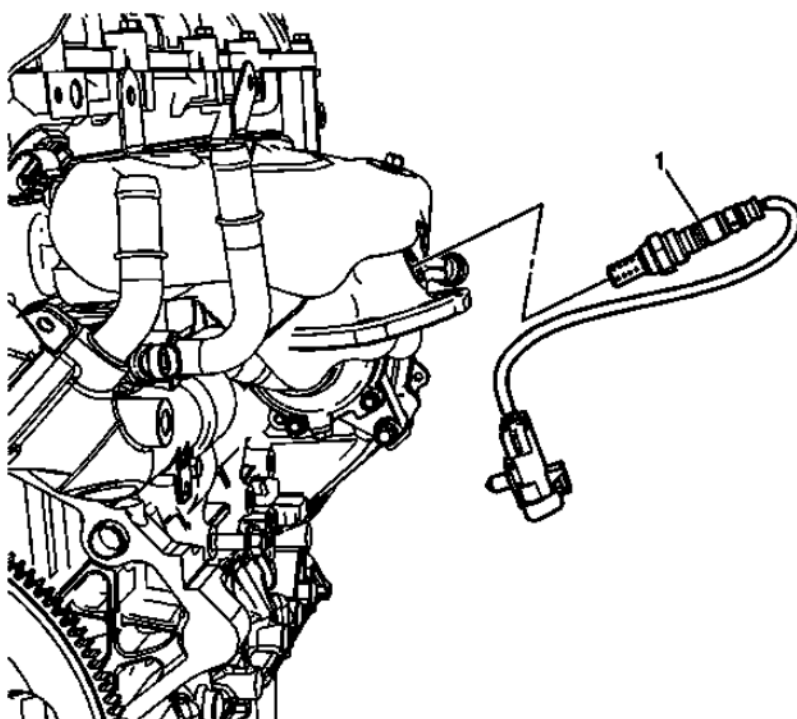


Fig. 5: Heated Oxygen Sensor - Sensor 1
 Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Sensor 1

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 1. Disconnect the heated oxygen sensor harness connector. 2. If reinstalling the old sensor, coat the threads with anti-seize 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 graphite and glass beads. The graphite 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-seize compound applied before reinstallation.

Tighten

42 N.m (31 lb ft)

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 2

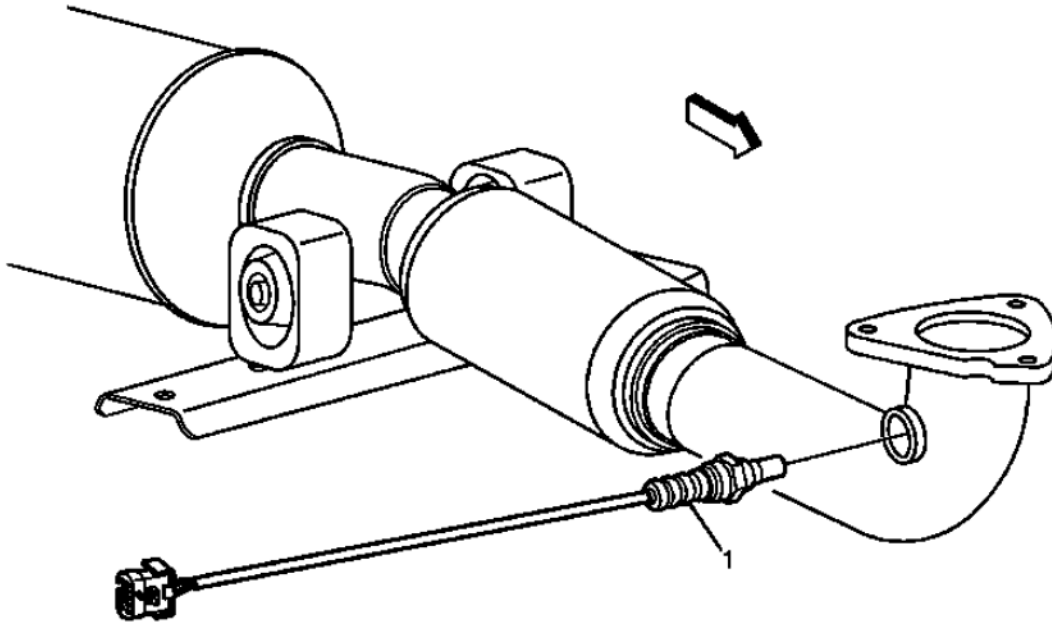


Fig. 6: Heated Oxygen Sensor - Sensor 2
Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Sensor 2

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 <u>Fastener Caution</u> .
	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 graphite and glass beads. The graphite 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-seize compound applied before reinstallation.

Tighten

42 N.m (31 lb ft)

ACCELERATOR PEDAL WITH POSITION SENSOR ASSEMBLY REPLACEMENT

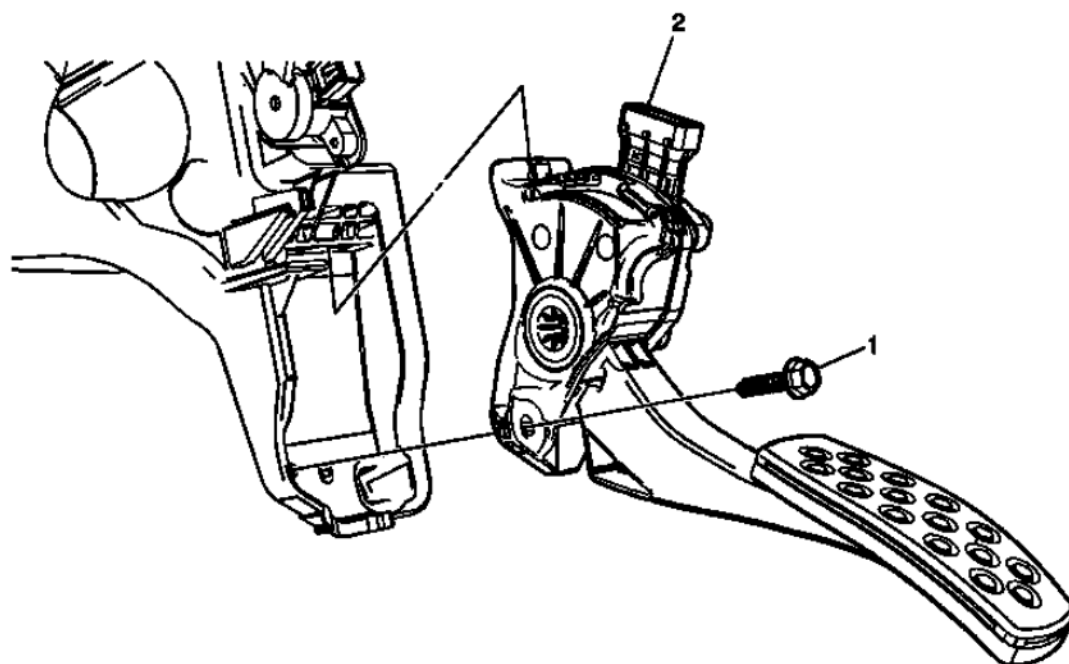


Fig. 7: Identifying Accelerator Pedal With Position Sensor Assembly
Courtesy of GENERAL MOTORS COMPANY

Accelerator Pedal with Position Sensor Assembly Replacement

Callout	Component Name
	Accelerator Pedal Position Sensor Bolt
CAUTION:	

1	Refer to Fastener Caution
2	Accelerator Pedal Position Sensor

THROTTLE BODY ASSEMBLY REPLACEMENT

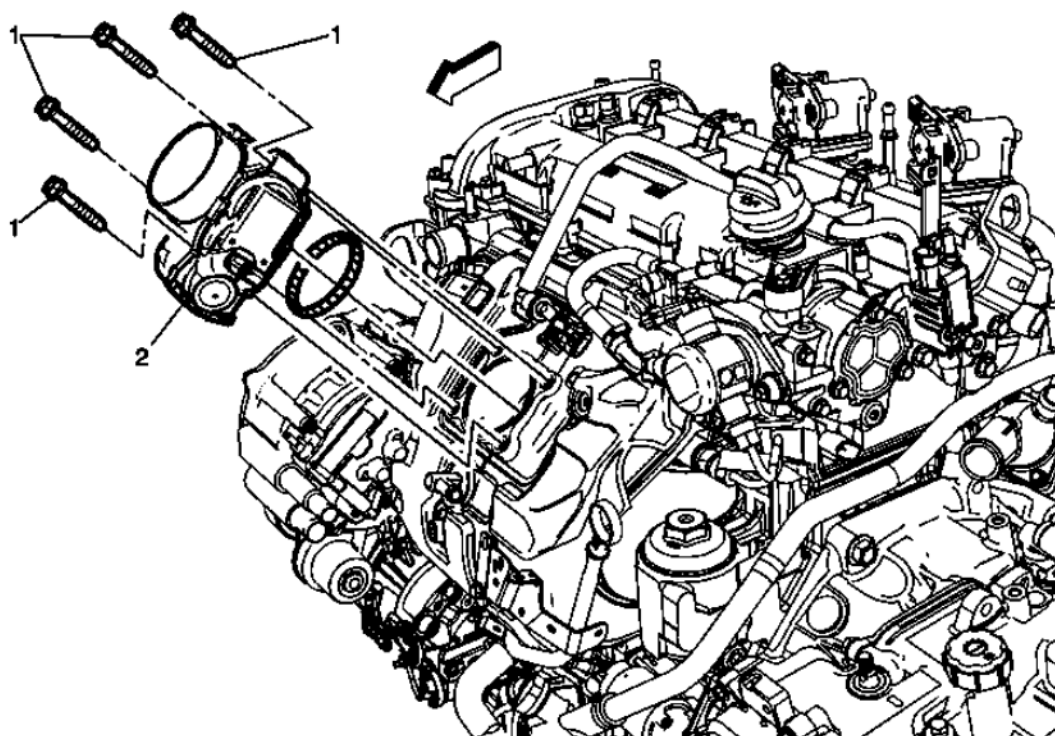


Fig. 8: Throttle Body Assembly
Courtesy of GENERAL MOTORS COMPANY

Throttle Body Assembly Replacement

Callout	Component Name
Preliminary Procedure Remove the outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Throttle Body Assembly Fastener (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)

2	Throttle Body Assembly Procedure 1. Disconnect the electrical connector. 2. Use a NEW throttle body O-ring. 3. Perform the throttle learn procedure. Refer to <u>Q38 Throttle Body: Throttle/Idle Learn</u>.
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THROTTLE BODY CLEANING

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.

CAUTION: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

NOTE: DO NOT prop open the throttle blade with the ignition key in the ON position as it may set a diagnostic trouble code (DTC).

2. Inspect the throttle body bore and the throttle valve plate for deposits. You must open the throttle valve in order to inspect all of the surfaces.
3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with Top Engine Cleaner P/N 1052626 (Canadian P/N 993026), ACDelco® P/N X66, or an equivalent product.
4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
5. Perform the Throttle/Idle Learn procedure. Refer to **Q38 Throttle Body: Throttle/Idle Learn**.

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.

1. Remove the fuel pump control module 20A fuse from the underhood electrical center. Refer to **Electrical Center Identification Views**.
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.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

CH-48027 Digital Pressure Gauge

For equivalent regional tools, refer to **Special Tools** .

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.

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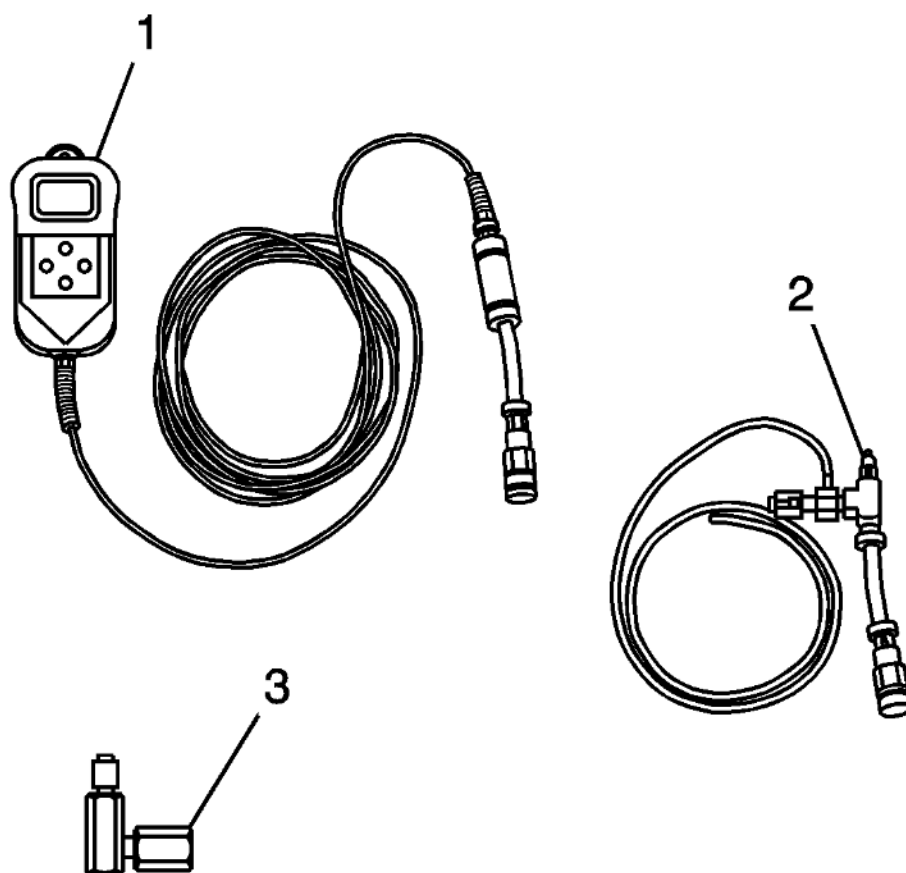


Fig. 9: Digital Fuel Pressure Gauge And Components
Courtesy of GENERAL MOTORS COMPANY

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 pump feed pipe 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** digital pressure gauge, refer to the manufacture's directions.

Removal Procedure

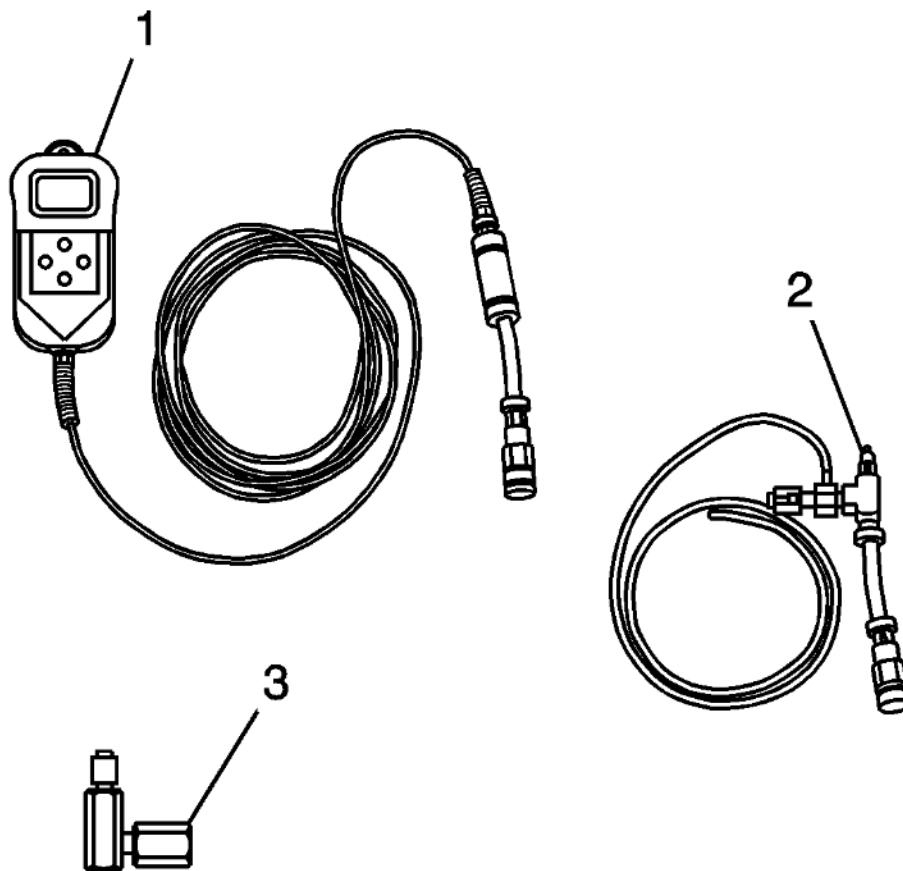


Fig. 10: Digital Fuel Pressure Gauge And Components
Courtesy of GENERAL MOTORS COMPANY

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 pump feed pipe 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 Pump feed pipe service port.
5. Install the service port cap.
6. Install the engine cover, if required.
7. Tighten the fuel fill cap.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tool

EN 41769 Fuel Line Disconnect Tool Set

Removal Procedure

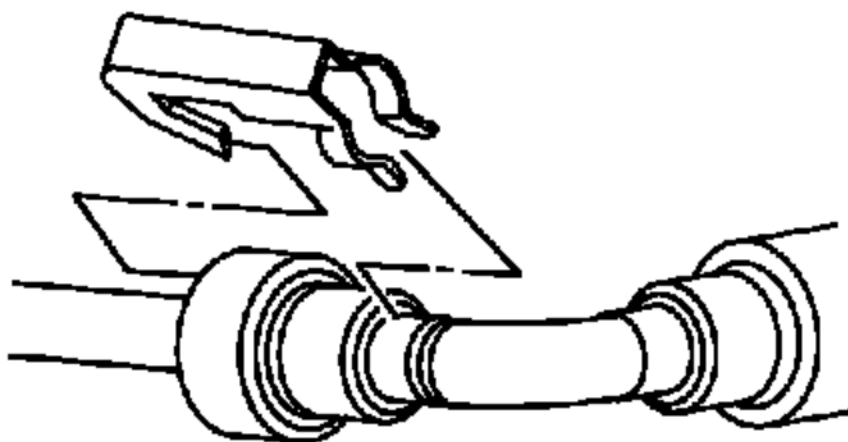


Fig. 11: View Of Quick-Connect Fitting Retainer (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to the **Fuel Pressure Relief**.
2. Remove the retainer from the quick-connect fitting.

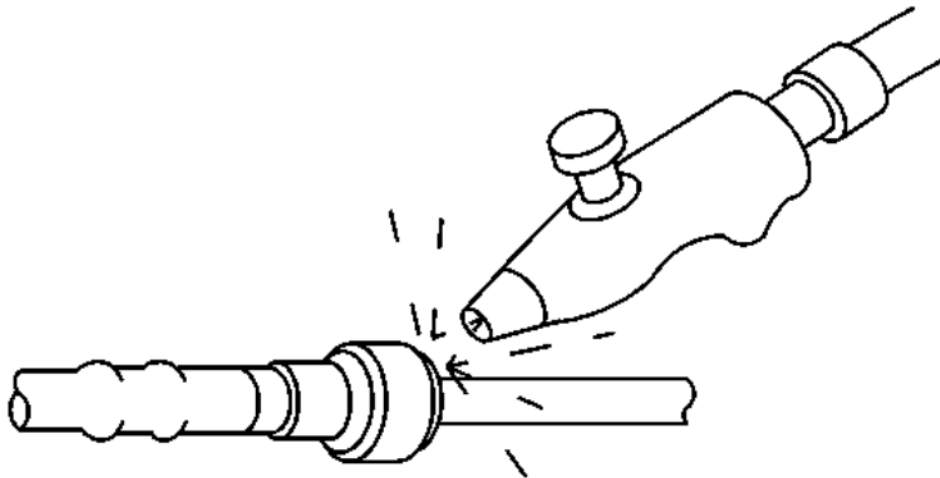


Fig. 12: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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.

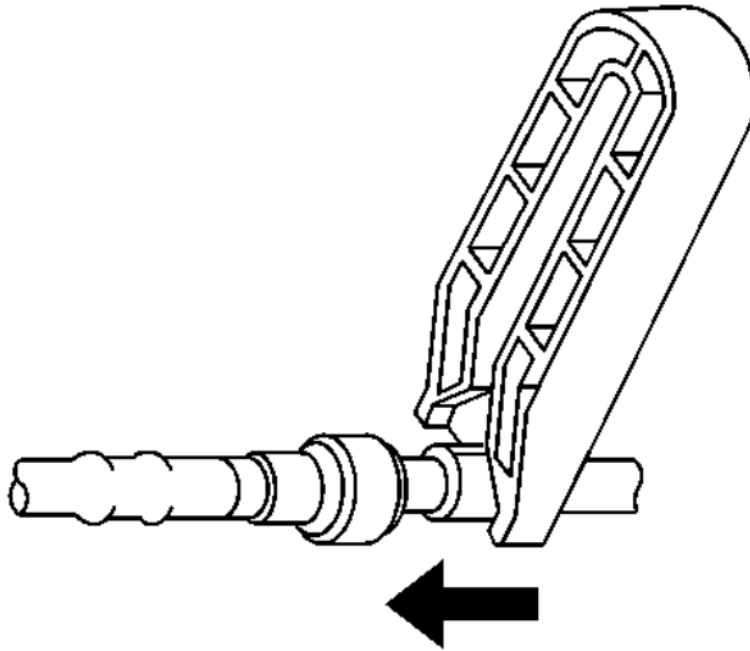


Fig. 13: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

4. Choose the correct tool from the **EN 41769** set for the size of the fitting. Insert the tool into the female connector, then push inward in order to release the locking tabs.

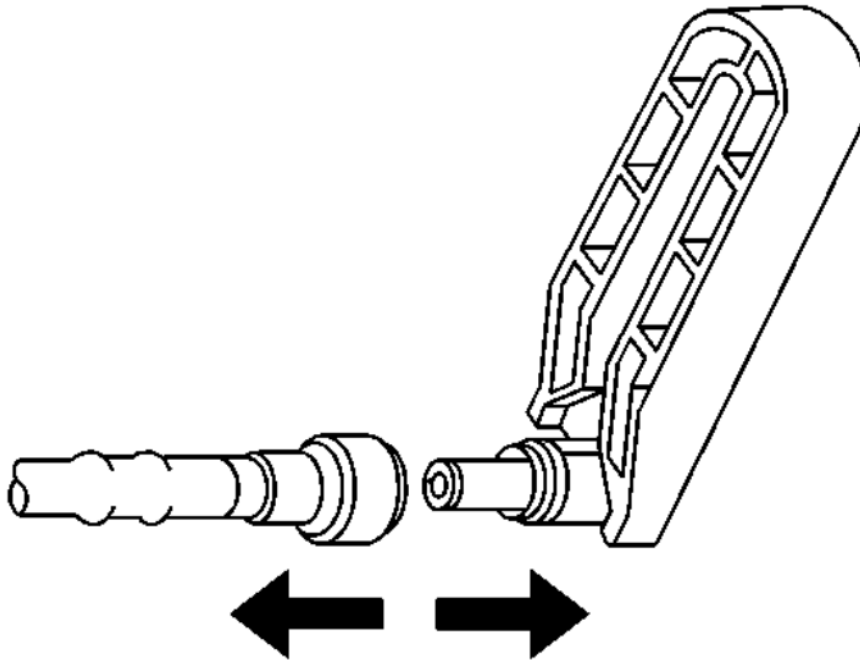


Fig. 14: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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. Use a clean shop towel in order to wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.

Installation Procedure

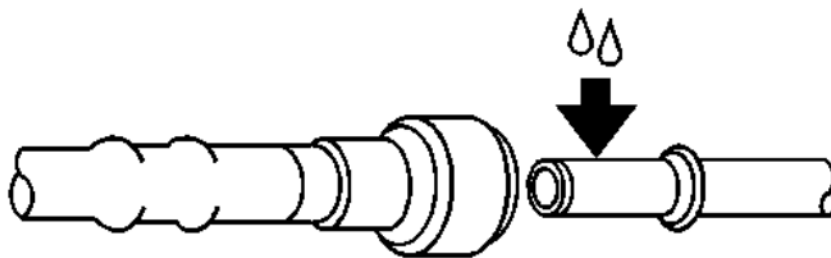


Fig. 15: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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.

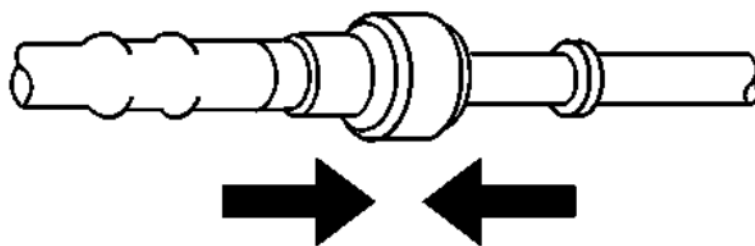


Fig. 16: View Of Connectors (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the fitting together in order to snap the retaining tabs into place.

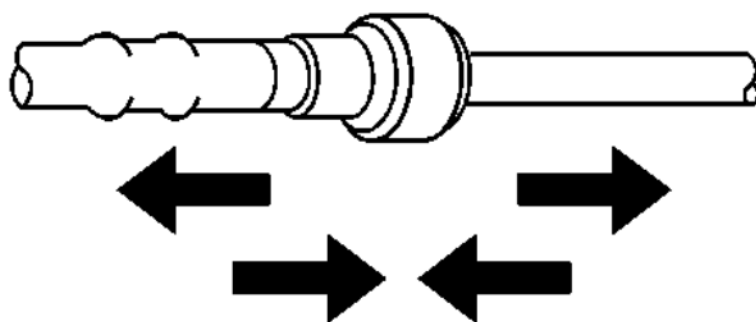


Fig. 17: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the fitting in order to make sure the connection is secure.

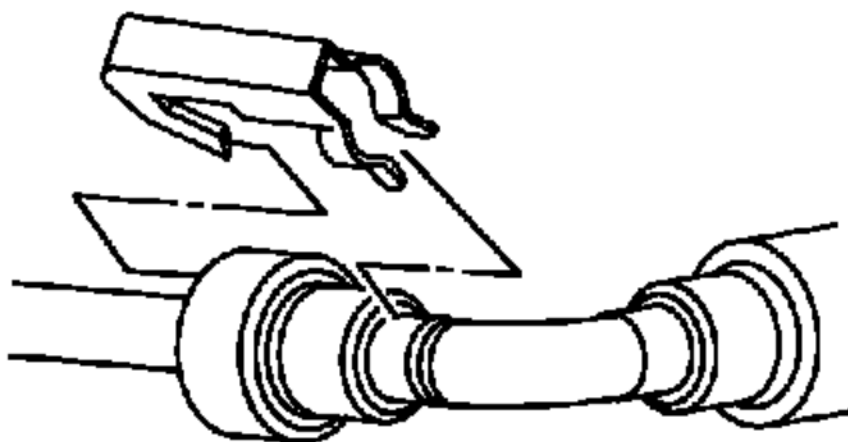


Fig. 18: View Of Quick-Connect Fitting Retainer (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

4. Install the retainer to the quick-connect fitting.

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

NOTE: If servicing a fuel system, insure the fuel pressure has been relieved.

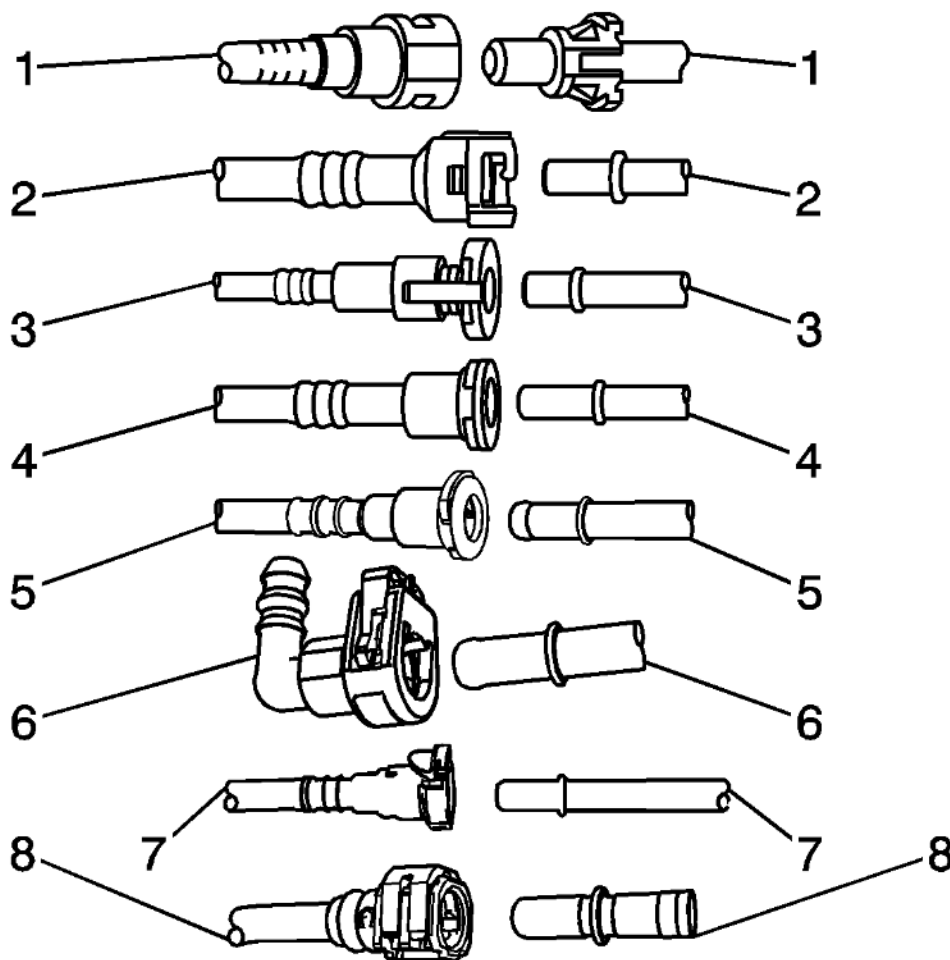


Fig. 19: Plastic Collar Quick Connect Fitting Service
 Courtesy of GENERAL MOTORS COMPANY

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)
- Plastic Connector (8)

The following instructions apply to all of these types of plastic collar quick connect fittings except where indicated.

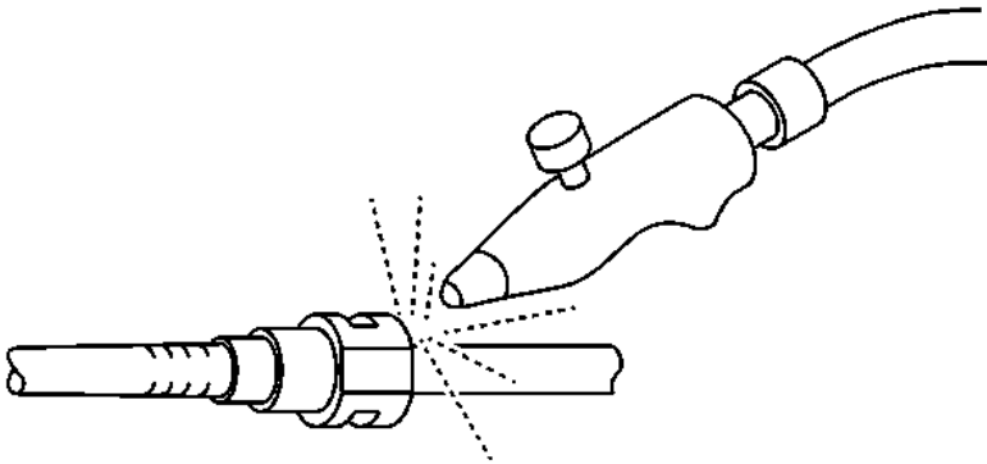


Fig. 20: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.

1. Using compressed air, blow any dirt out of the quick-connect fitting.

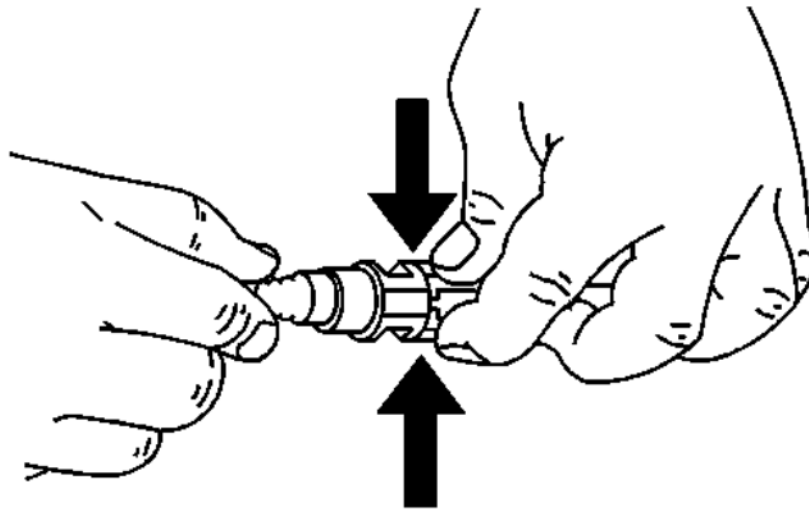


Fig. 21: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

2. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick-connect fitting release tabs.

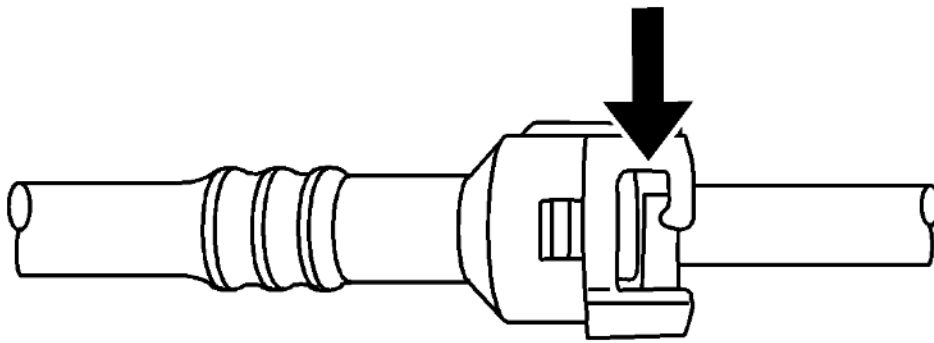


Fig. 22: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

3. 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.

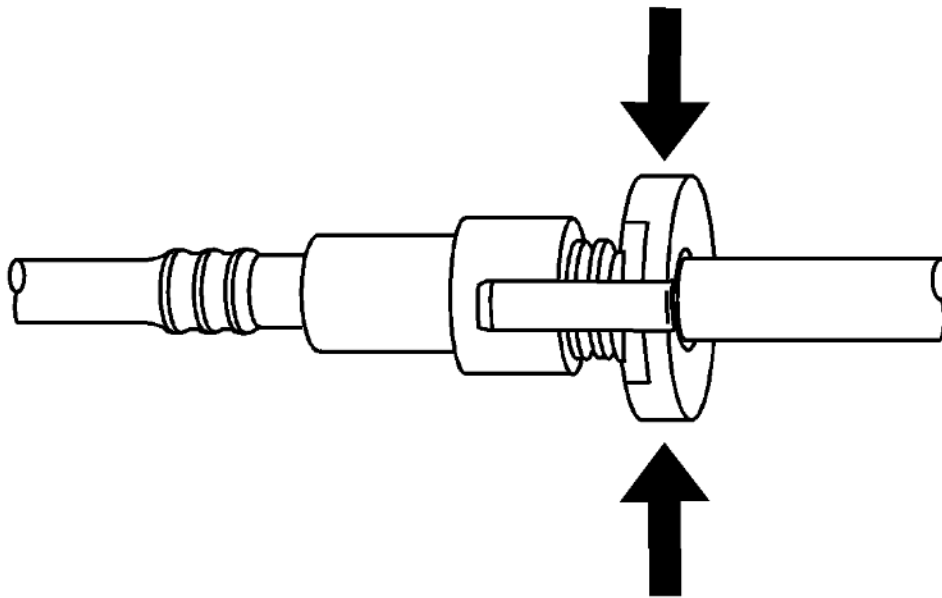


Fig. 23: Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

4. 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.

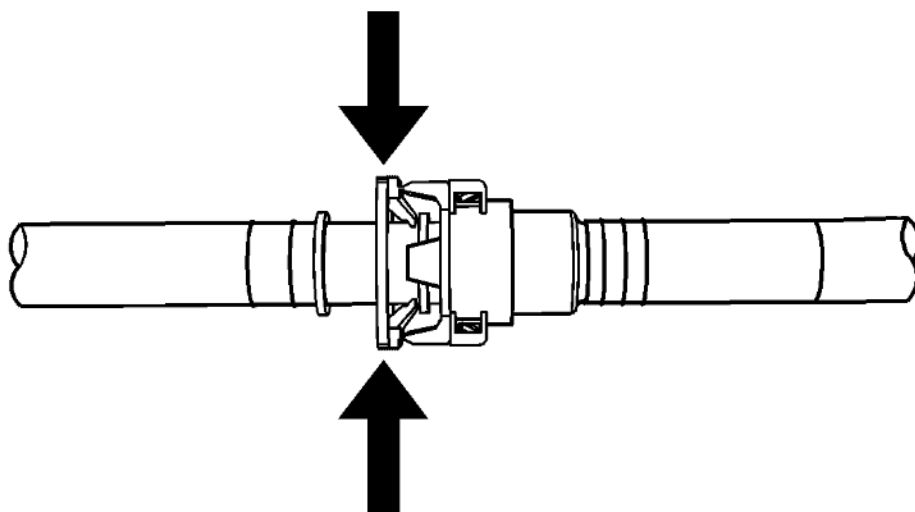


Fig. 24: Pushing In Male Side Of Connector
Courtesy of GENERAL MOTORS COMPANY

5. 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.

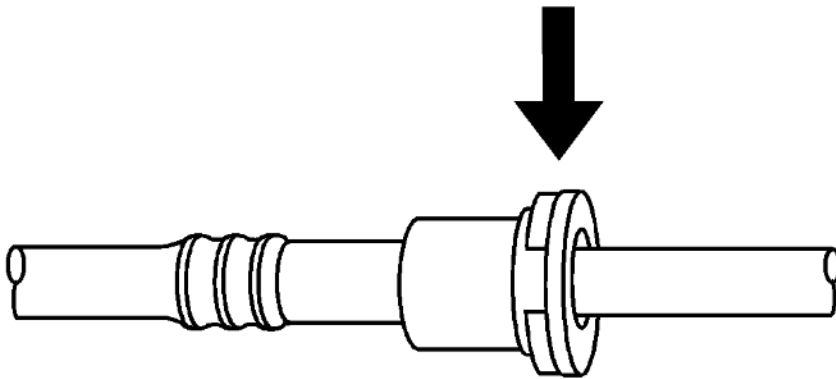


Fig. 25: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS COMPANY

6. 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.

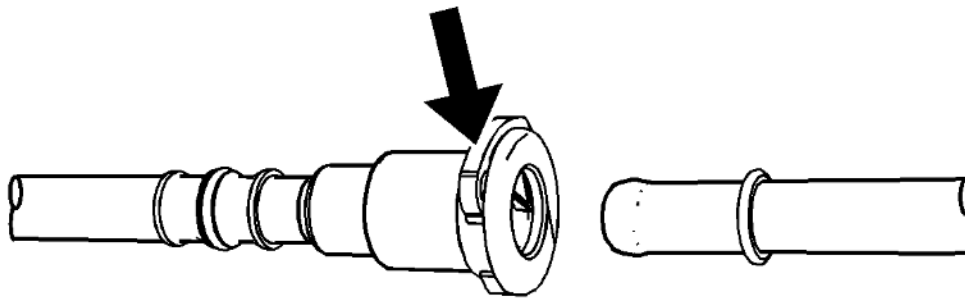


Fig. 26: Global Connector Style

Courtesy of GENERAL MOTORS COMPANY

7. 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.

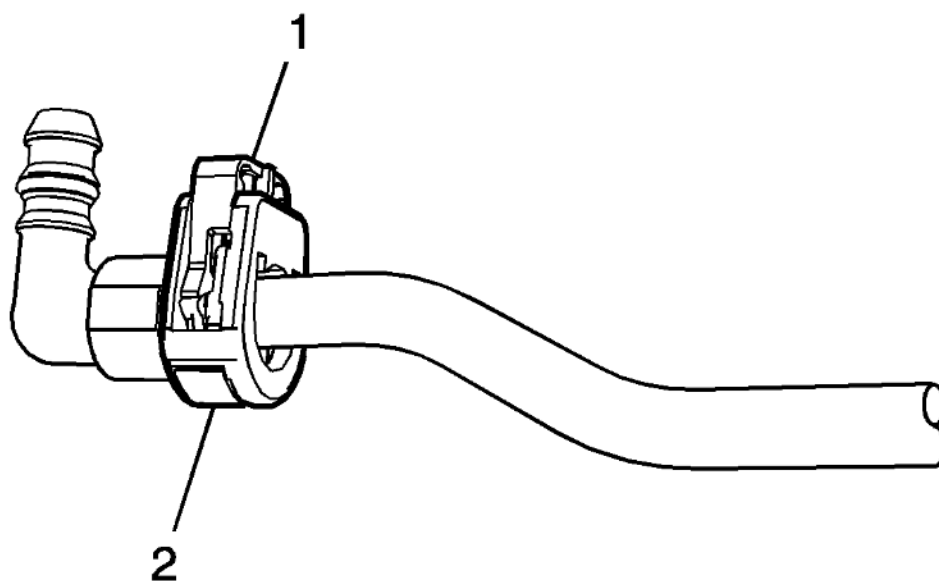


Fig. 27: TI Loc style

Courtesy of GENERAL MOTORS COMPANY

8. 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.

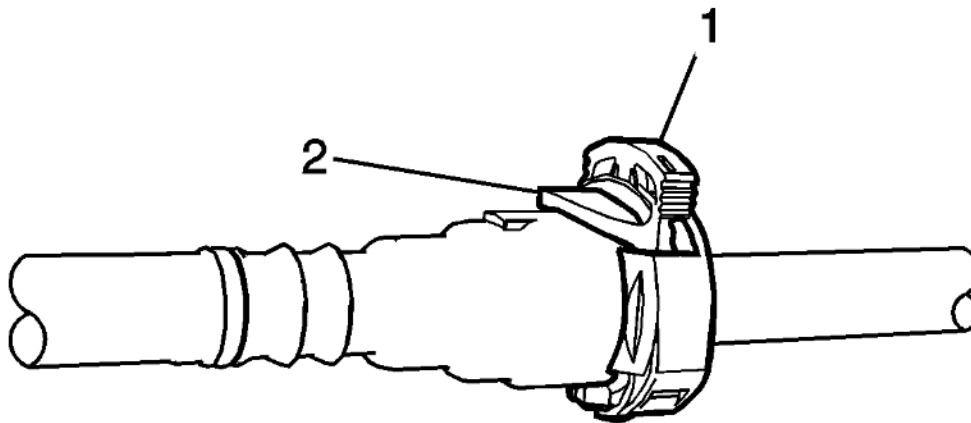


Fig. 28: Safe Lock Style

Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Relieving Fuel Pressure Warning .

9. 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.

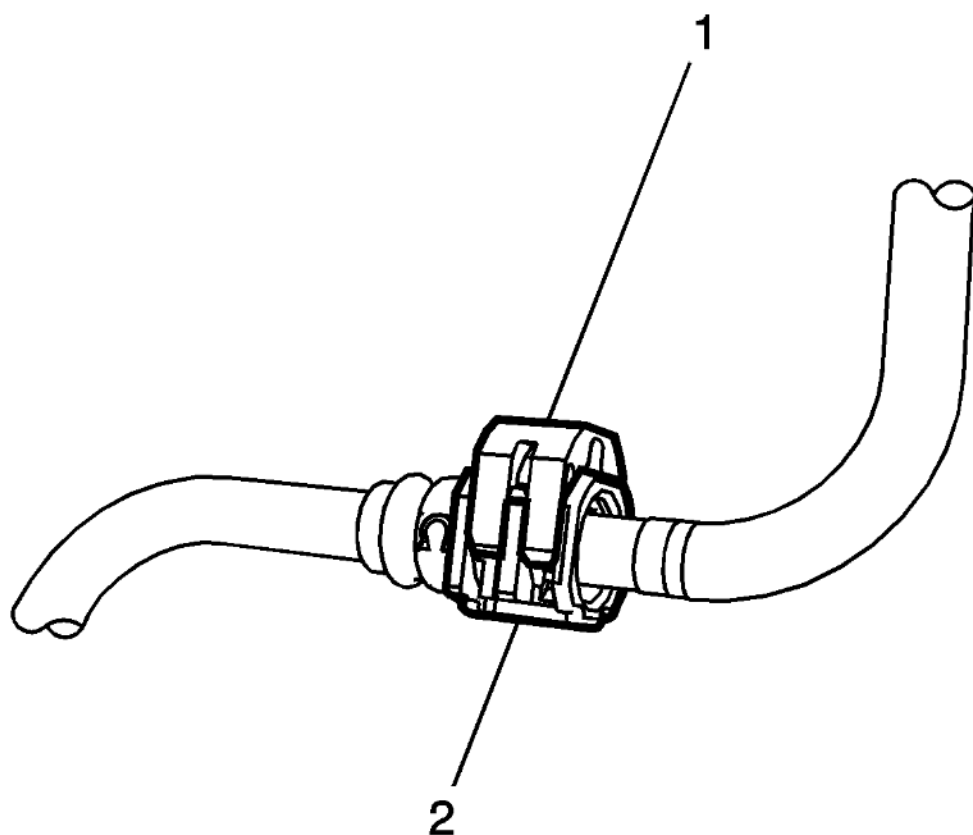


Fig. 29: Releasing Latch And Pulling Connector Straight Out
Courtesy of GENERAL MOTORS COMPANY

10. This step applies to the Plastic Connector style 8, push the connector toward the tube in order to release the pressure. Press the latch (1) inward in order to release the pipe, while pulling the connector (2) 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

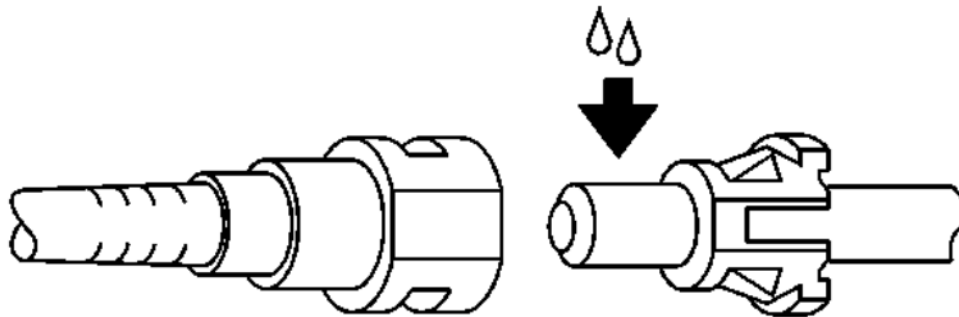


Fig. 30: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

WARNING: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.

1. Apply a few drops of clean engine oil to the male pipe end.

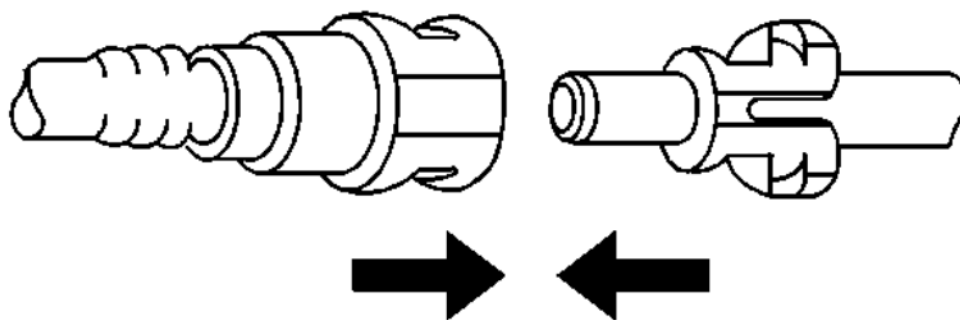


Fig. 31: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

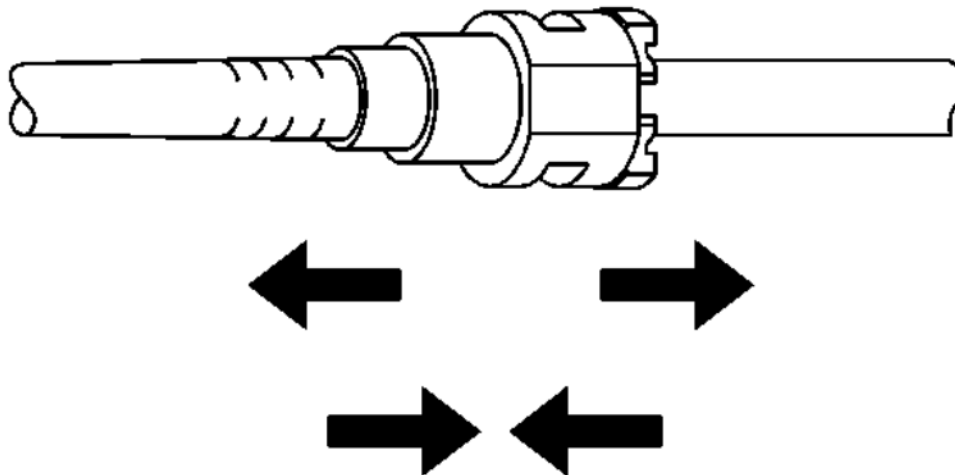


Fig. 32: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

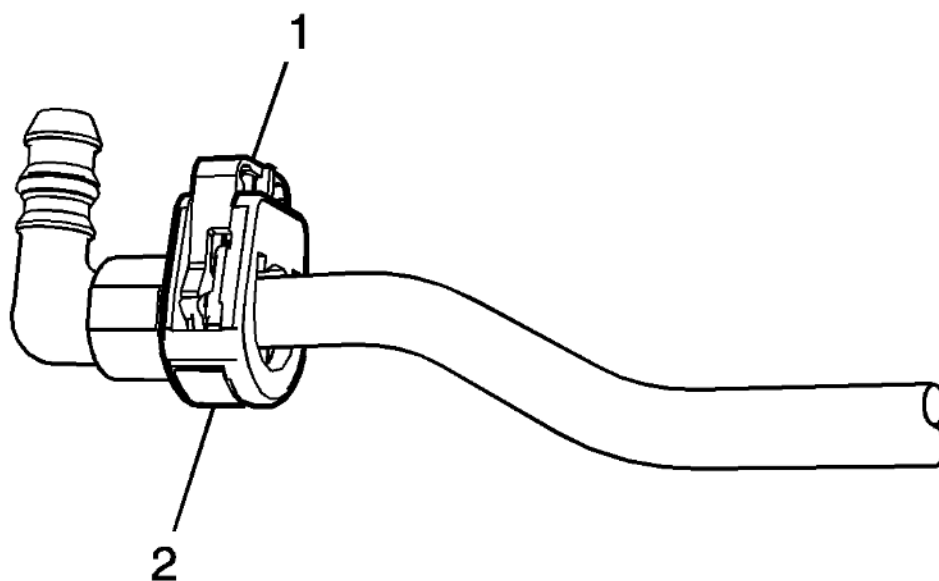


Fig. 33: TI Loc style

Courtesy of GENERAL MOTORS COMPANY

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.

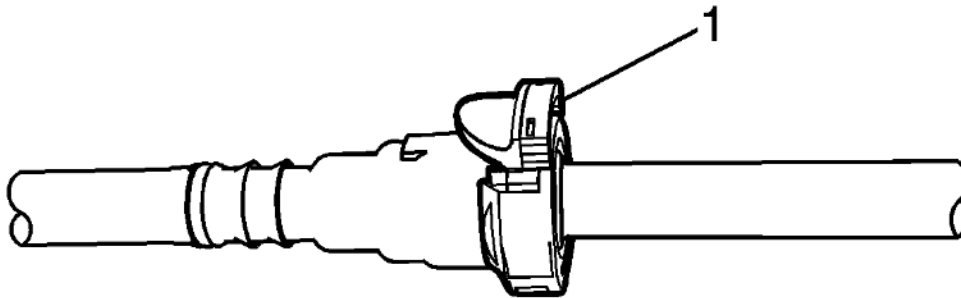


Fig. 34: Push Down On Redundant Latch (1) Until It Is Fully Engaged And Snapped Into Position.
Courtesy of GENERAL MOTORS COMPANY

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.

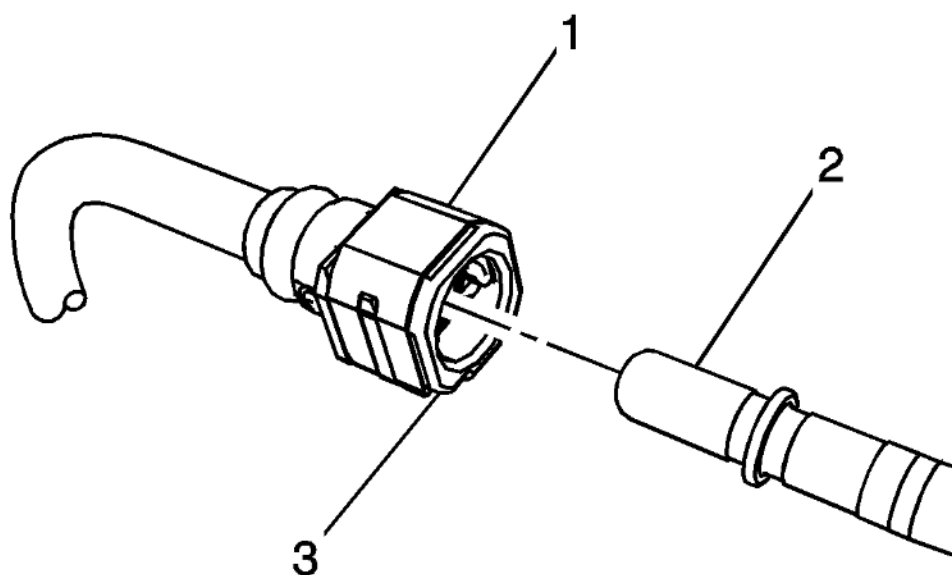


Fig. 35: Latch And Connector

Courtesy of GENERAL MOTORS COMPANY

8. For the plastic connector type 8, depress the latch (1) while inserting the connector (3) on to the pipe (2).
9. Move the latch (1) upward in order to secure the connection.
10. 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

- **J 36850** Transjel Lubricant

- **J 45004** Fuel Tank Drain Hose

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.

1. Raise and Support the Vehicle. Refer to Lifting and Jacking the Vehicle

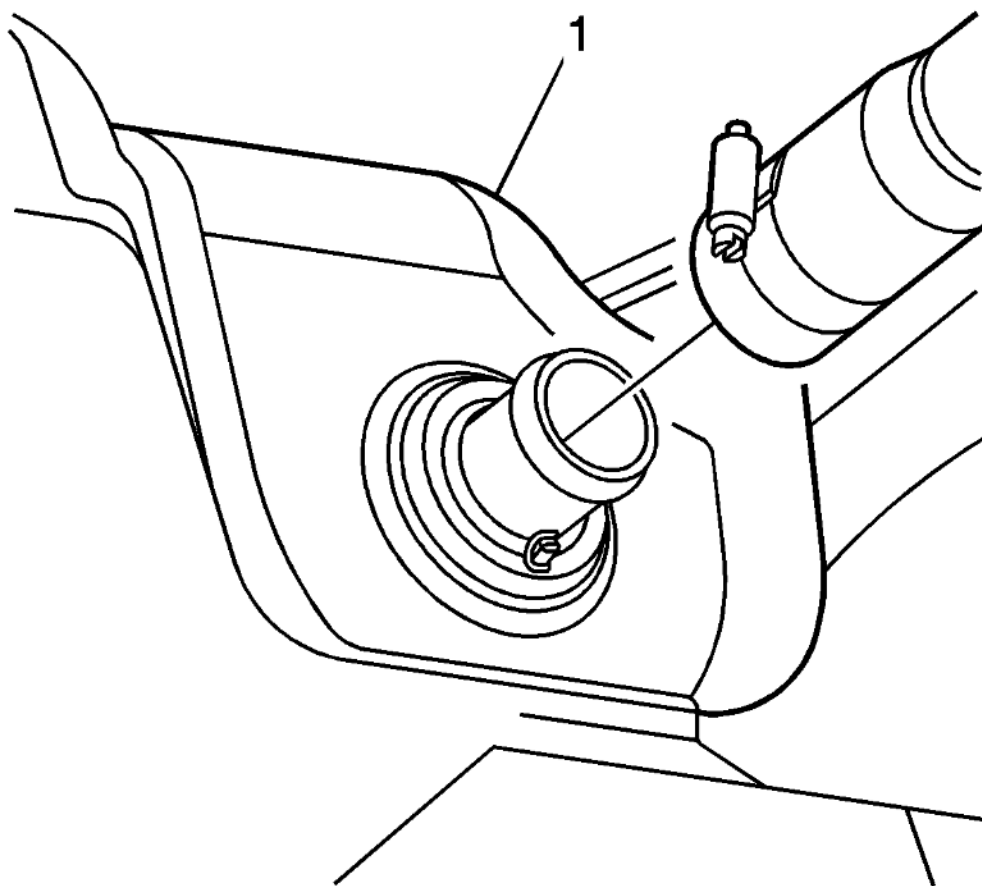


Fig. 36: Fuel Tank & Drain Hose

Courtesy of GENERAL MOTORS COMPANY

NOTE: Lubricate the fuel drain hose with J 36850 transjel lubricant or equivalent to aid in hose insertion. Do not use an unapproved lubricant.

2. Loosen the lower fill hose clamp in order to separate the fill hose from the fuel tank (1).
3. Insert the **J 45004** fuel tank drain hose into the fuel tank (1) until the hose reaches the bottom of the fuel tank.
4. Use a hand or air operated pump device in order to drain as much fuel from the fuel tank as possible.

FUEL TANK PROTECTOR REPLACEMENT

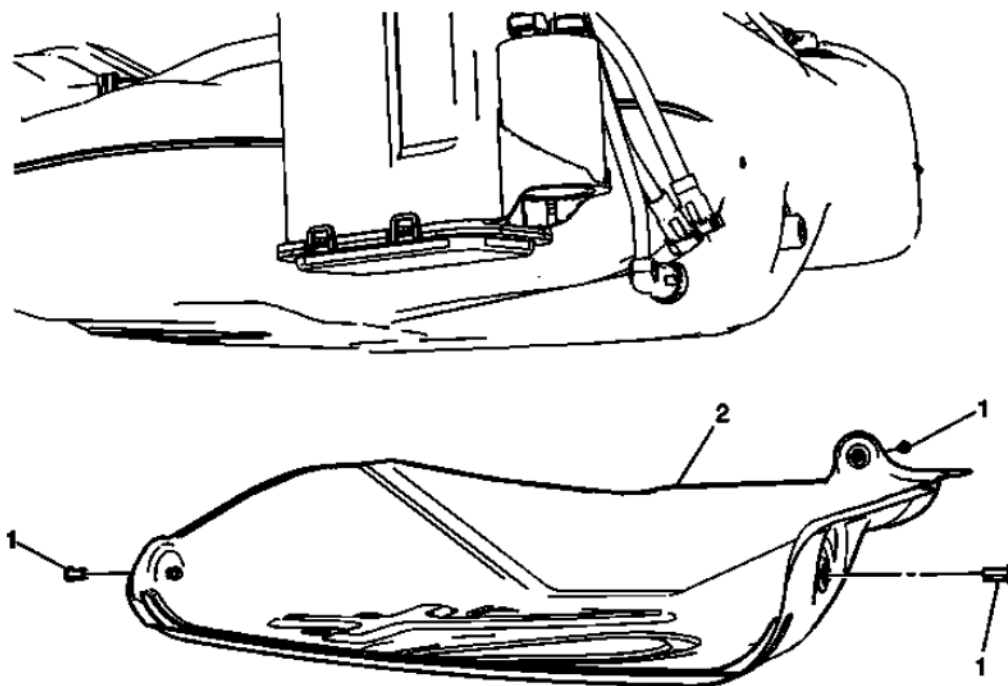


Fig. 37: Fuel Tank Protector & Retainers
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Protector Replacement

Callout	Component Name
Preliminary Procedure	
1.	Remove the underbody rear air deflector right side. Refer to <u>Underbody Rear Air Deflector Replacement - Right Side</u>
2.	Remove the underbody rear air deflector left side. Refer to <u>Underbody Rear Air Deflector Replacement - Left Side</u>
3.	Remove the exhaust muffler. Refer to <u>Exhaust Muffler Replacement (LCV, LUK)</u>
4.	Support the fuel tank with jack stands.
5.	Remove the left fuel tank strap. Refer to <u>Fuel Tank Replacement</u> .
NOTE:	

Loosen the right fuel tank strap and lower the fuel tank just enough to disengage the left shield retainer.

6. Disengage shield retainers.

1	Fuel Tank Protector Retainer (Qty: 3)
2	Fuel Tank Protector

FUEL TANK REPLACEMENT

Removal Procedure

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Relieve the system fuel pressure. Refer to Fuel Pressure Relief.
2. Drain the fuel tank. Refer to Fuel Tank Draining.

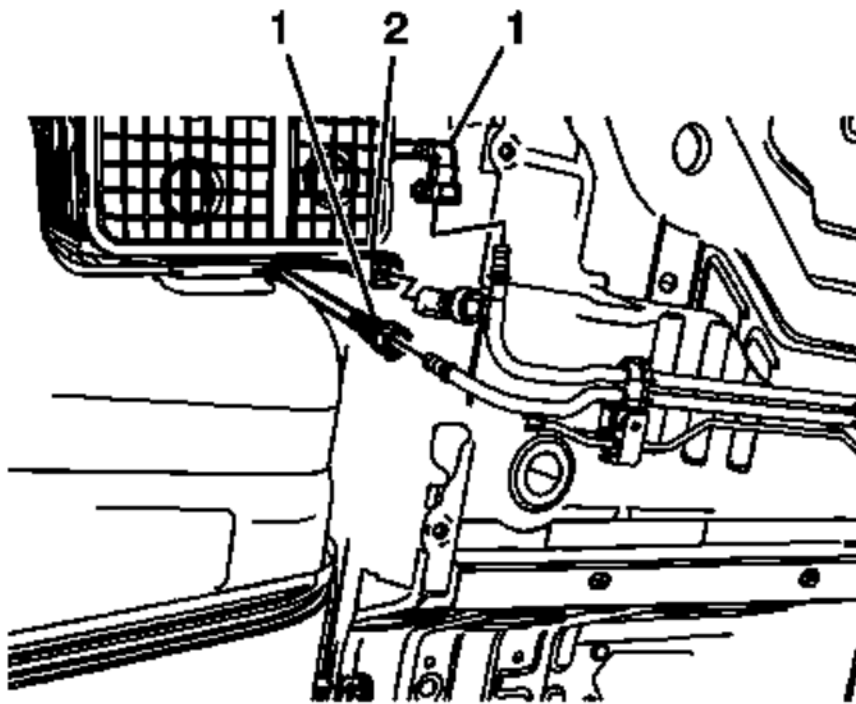


Fig. 38: Evaporative Emission, Fuel Pipes And Fuel Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the evaporative emission and fuel pipes (1). Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Disconnect the fuel pressure sensor electrical connector (2).

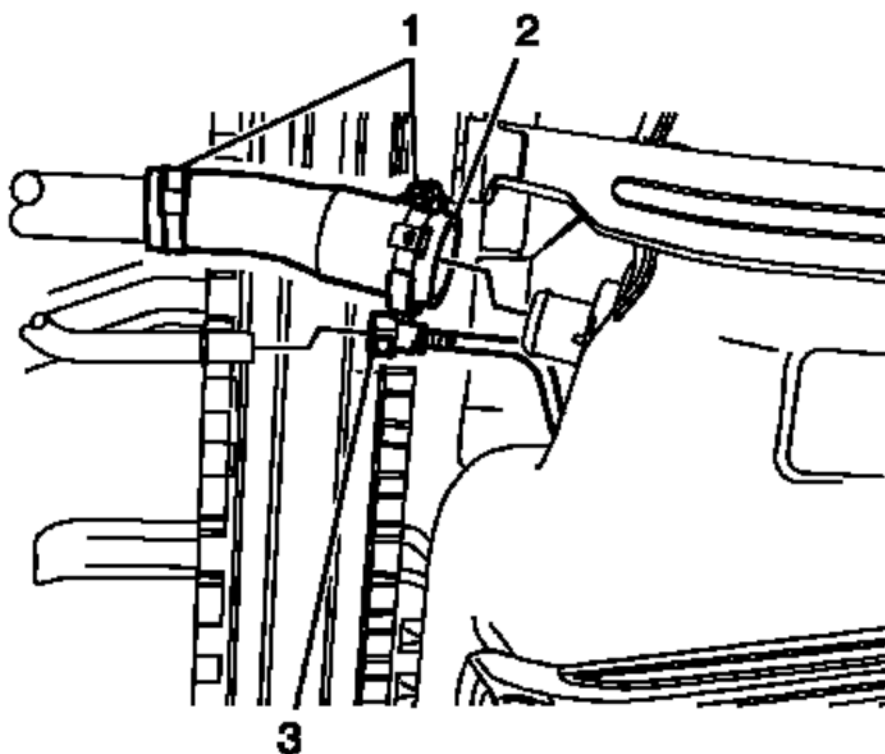


Fig. 39: Hose Clamps & Filler Tube

Courtesy of GENERAL MOTORS COMPANY

5. Loosen the hose clamps (1) and remove the filler tube (2).
6. Disconnect the evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service**.

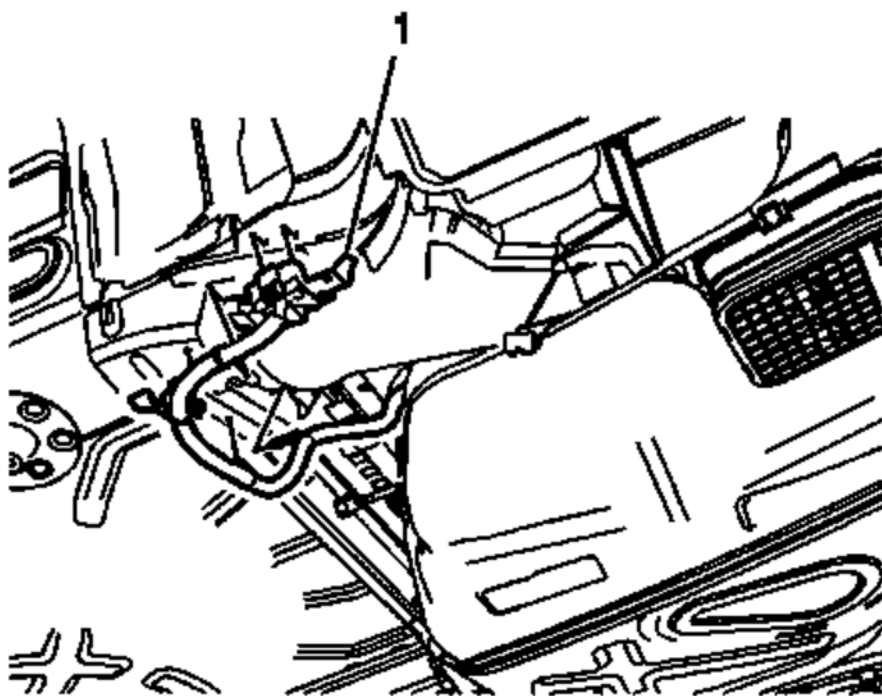


Fig. 40: Fuel Tank Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the fuel tank harness electrical connector (1).

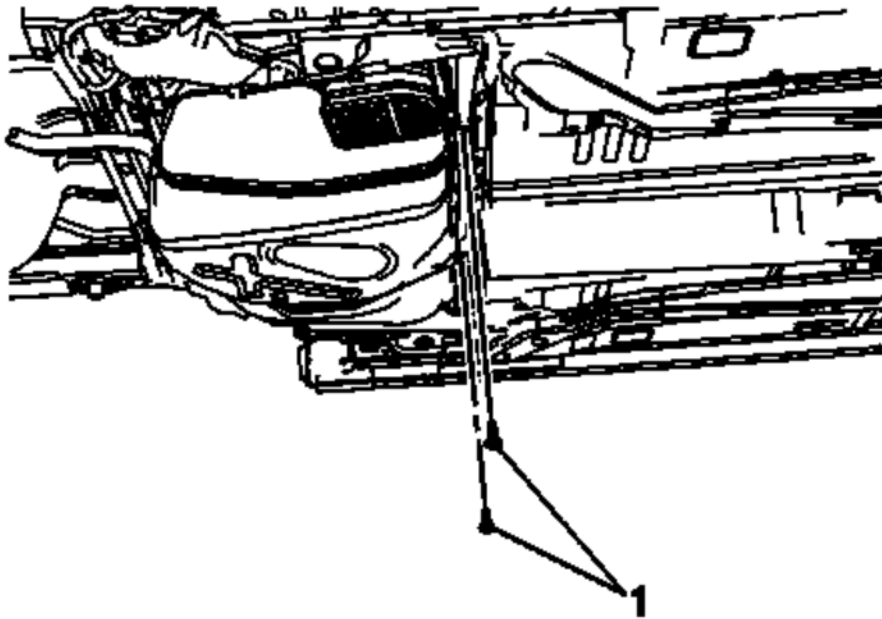


Fig. 41: Fuel Tank Strap Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Support the fuel tank with a suitable jack.
9. Remove the fuel tank strap bolts (1).

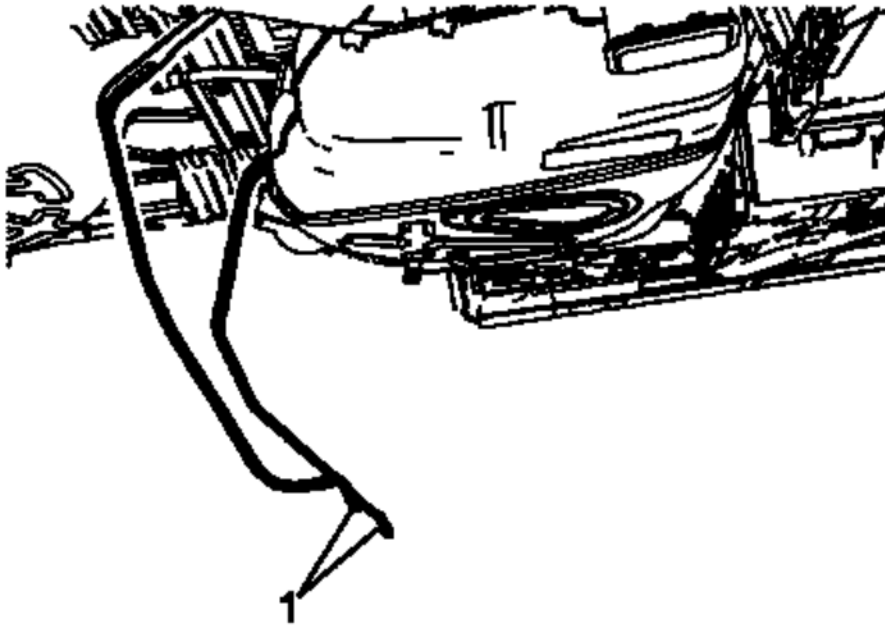


Fig. 42: Fuel Tank Straps

Courtesy of GENERAL MOTORS COMPANY

10. Swing the fuel tank straps (1) out of the way.

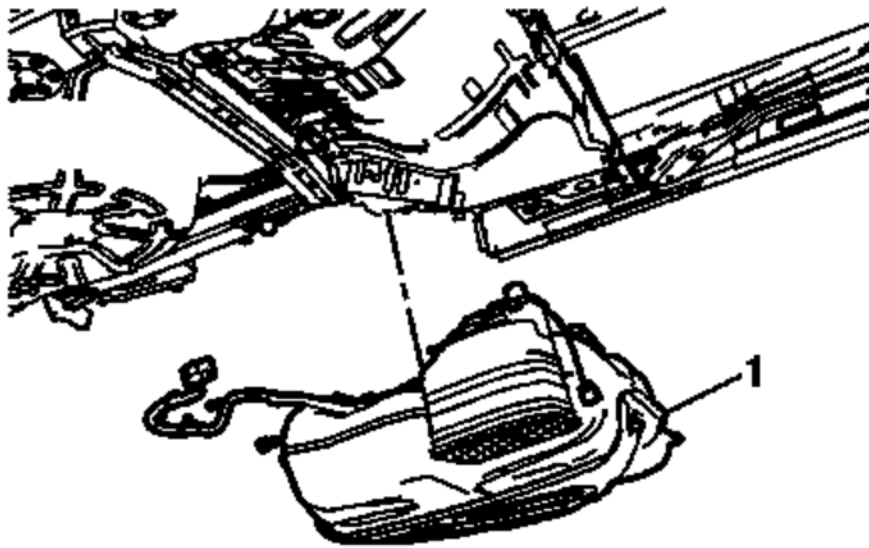


Fig. 43: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

11. Remove the fuel tank (1).
12. Remove the following components if replacing just the fuel tank.
 1. Fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement (NU6)**, **Fuel Tank Fuel Pump Module Replacement (NT7)**.
 2. Evaporative emission carbon canister. Refer to **Evaporative Emission Canister Replacement**.
 3. Transfer components as necessary.
 4. Remove the fuel tank protector. Refer to **Fuel Tank Protector Replacement**

Installation Procedure

1. Install the following components if fuel tank replacement was necessary:
 1. Fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement (NU6)**, **Fuel Tank Fuel Pump Module Replacement (NT7)**.
 2. Evaporative emission carbon canister. Refer to **Evaporative Emission Canister Replacement**.
 3. Install the fuel tank protector. Refer to **Fuel Tank Protector Replacement**

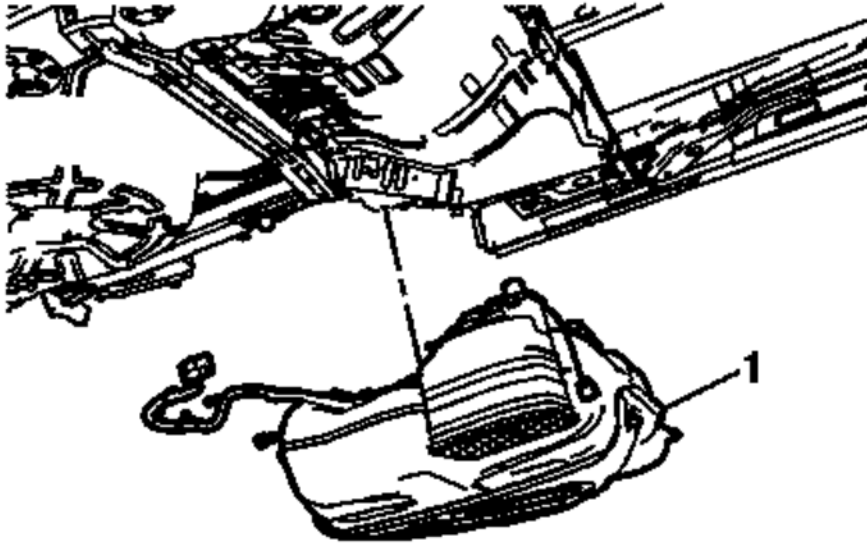


Fig. 44: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

2. Use a suitable jack and install the fuel tank (1).

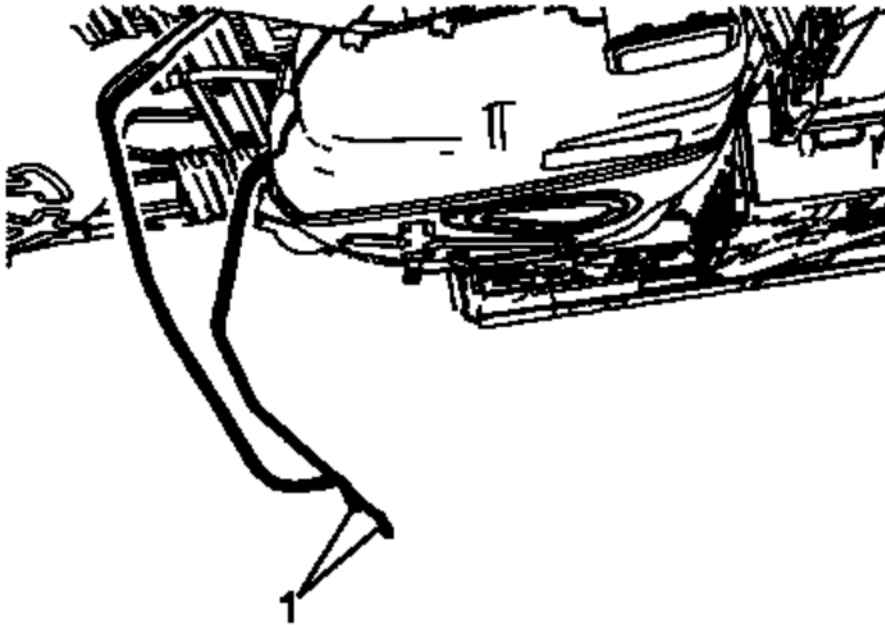


Fig. 45: Fuel Tank Straps

Courtesy of GENERAL MOTORS COMPANY

3. Reposition the fuel tank straps (1).

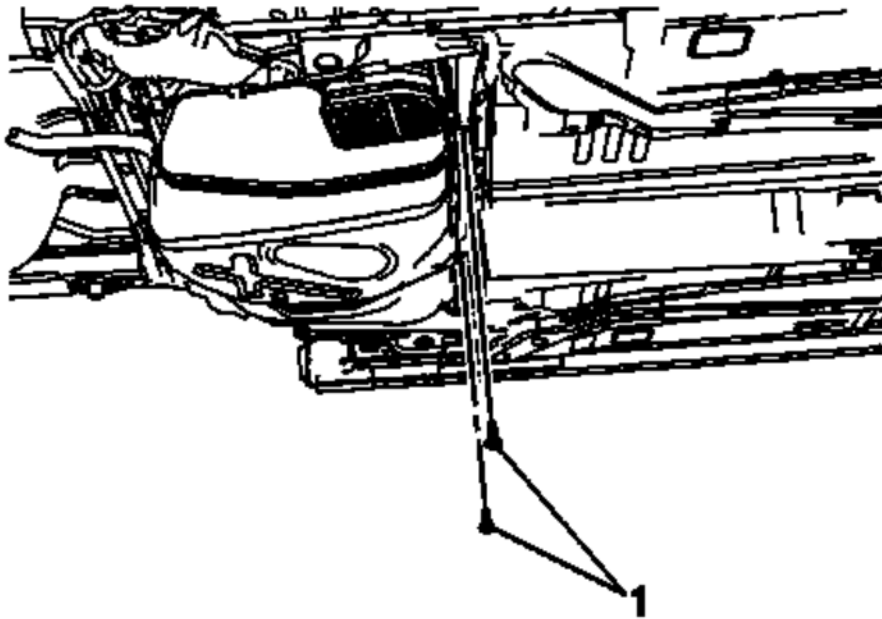


Fig. 46: Fuel Tank Strap Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the fuel tank strap bolts (1) and tighten to 20 N.m (15 lb ft).

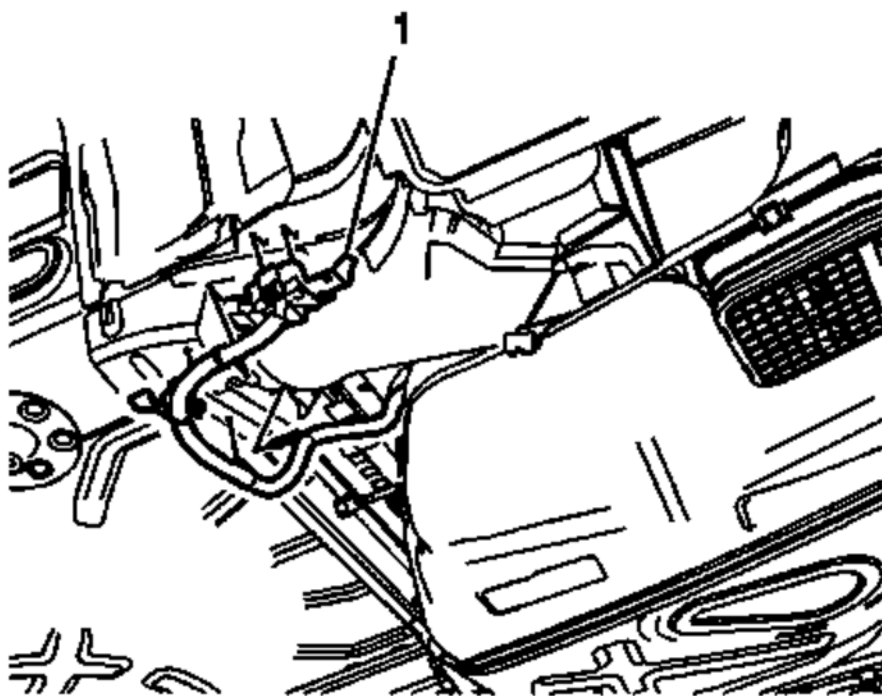


Fig. 47: Fuel Tank Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect the fuel tank harness electrical connector (1).

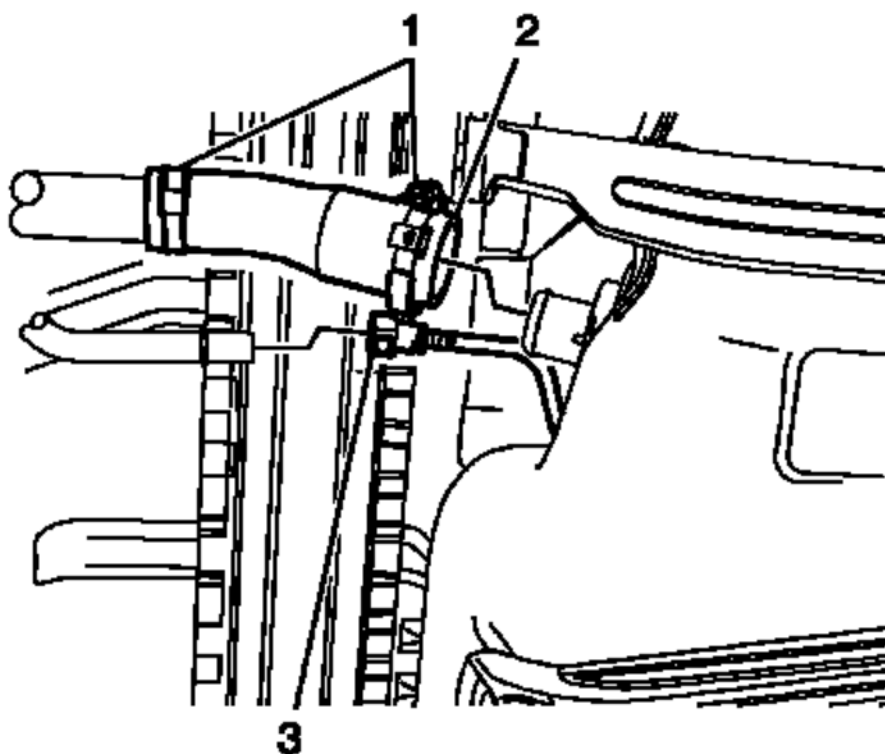


Fig. 48: Hose Clamps & Filler Tube

Courtesy of GENERAL MOTORS COMPANY

6. Install the filler tube (2) and tighten the hose clamps (1) to 4Y(35 lb in).
7. Connect the evaporative emission line (3). Refer to **Plastic Collar Quick Connect Fitting Service**.

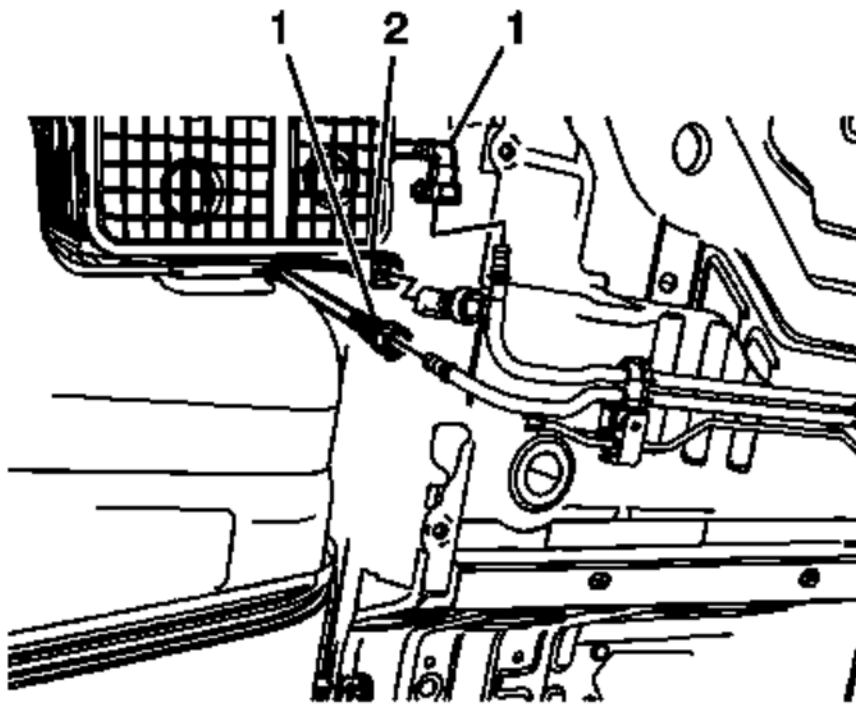


Fig. 49: Evaporative Emission, Fuel Pipes And Fuel Pressure Sensor Electrical Connector
 Courtesy of GENERAL MOTORS COMPANY

8. Connect the evaporative emission and fuel pipes (1). Refer to Plastic Collar Quick Connect Fitting Service.
9. Connect the fuel pressure sensor electrical connector (2).
10. Install the fuel tank protector. Refer to Fuel Tank Protector Replacement
11. Refill the fuel tank.
12. Inspect for fuel leaks.

FUEL SYSTEM CLEANING

1. Remove the fuel tank. Refer to Fuel Tank Replacement.
2. Remove the fuel pump module. Refer to Fuel Tank Fuel Pump Module Replacement (NU6), Fuel Tank Fuel Pump Module Replacement (NT7).
3. Inspect the fuel pump module strainer. Replace the pump module assembly if the fuel strainer is contaminated.

NOTE: When flushing the fuel tank, handle the fuel and water mixture as a hazardous material. Handle the fuel and water in accordance with all

applicable local, state, and federal laws and regulations.

4. Flush the fuel tank with hot water.
5. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to be sure that the removal of the water from the fuel tank is complete.
6. Allow the tank to dry completely before reassembly.
7. Disconnect the fuel feed pipe at the engine fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.

NOTE: **Only use oil-free compressed air to blow out the fuel pipes.**

8. Clean the fuel pipes by applying air pressure in the opposite direction of the fuel flow.
9. Connect the fuel feed pipe to the engine fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
10. Install the fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement (NU6)**, **Fuel Tank Fuel Pump Module Replacement (NT7)**.
11. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL TANK FUEL PUMP MODULE REPLACEMENT (NU6)

Special Tools

J 45722 Fuel Sender Lock Ring Wrench

For equivalent regional tools, refer to **Special Tools**

Removal Procedure

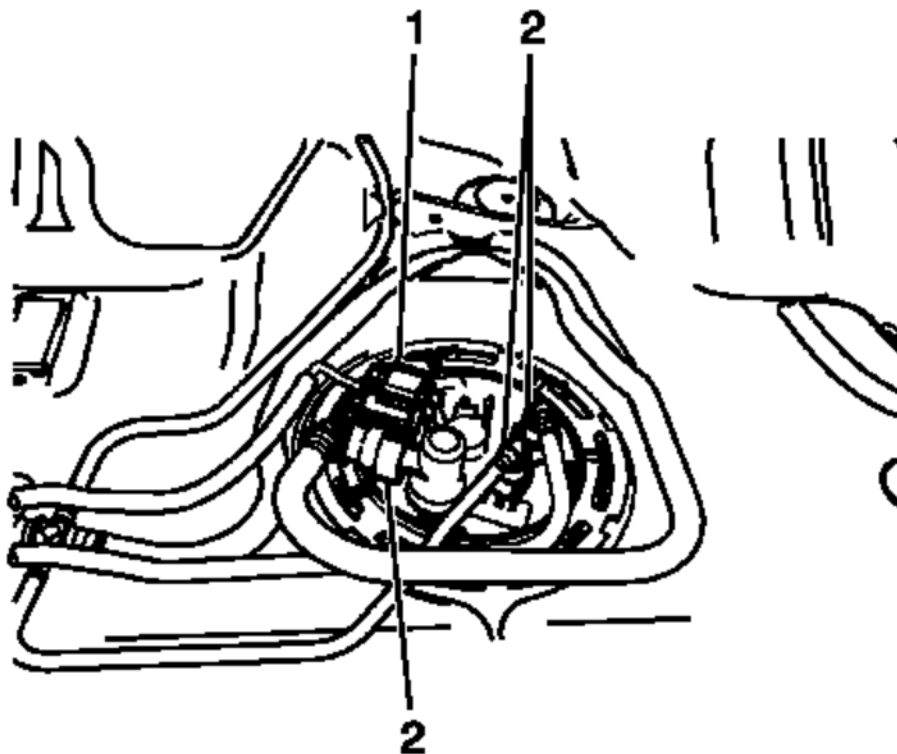


Fig. 50: Fuel Pump Electrical Connector & Quick Connects
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Remove the fuel tank. Refer to Fuel Tank Replacement.
2. Disconnect the fuel pump electrical connector (1) and the quick connects (2). Refer to Plastic Collar Quick Connect Fitting Service.

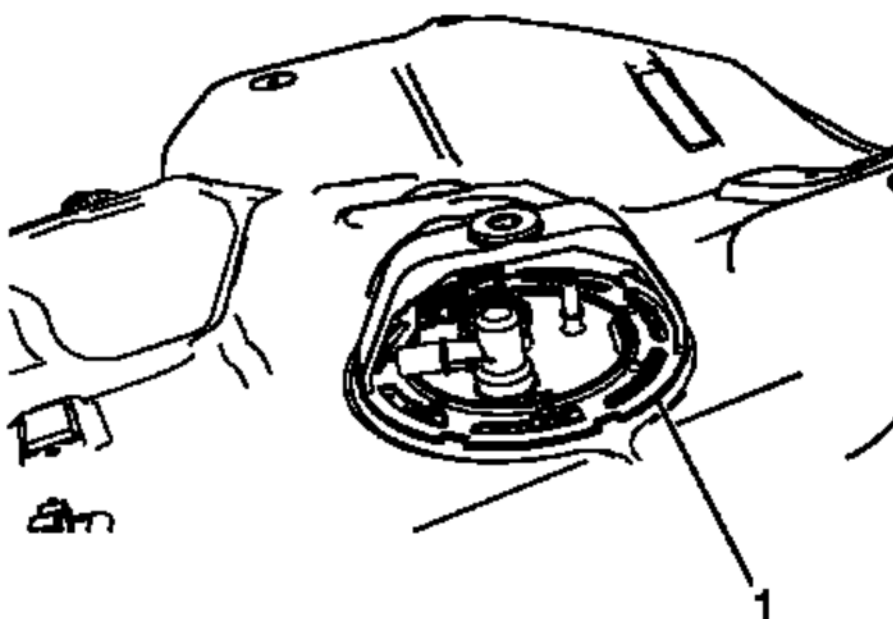


Fig. 51: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Use the **J 45722** wrench by turning counter clockwise and remove the lock ring (1).

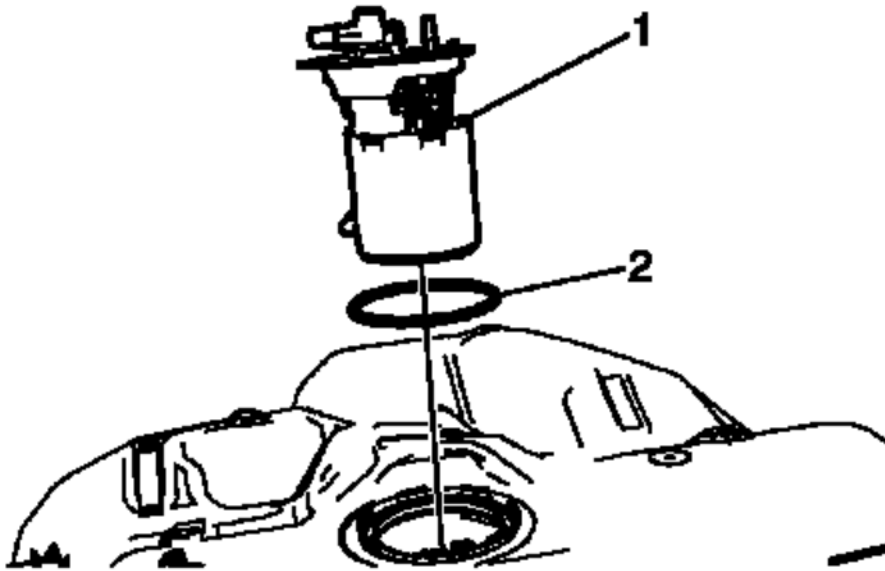


Fig. 52: Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel tank module (1) and the O-ring (2).

Installation Procedure

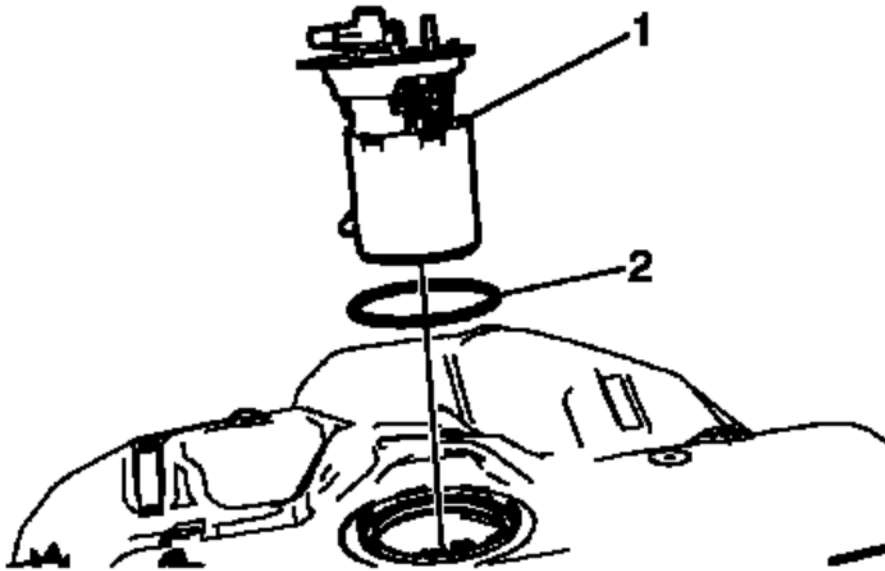


Fig. 53: Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW seal (2) and the fuel tank module (1).

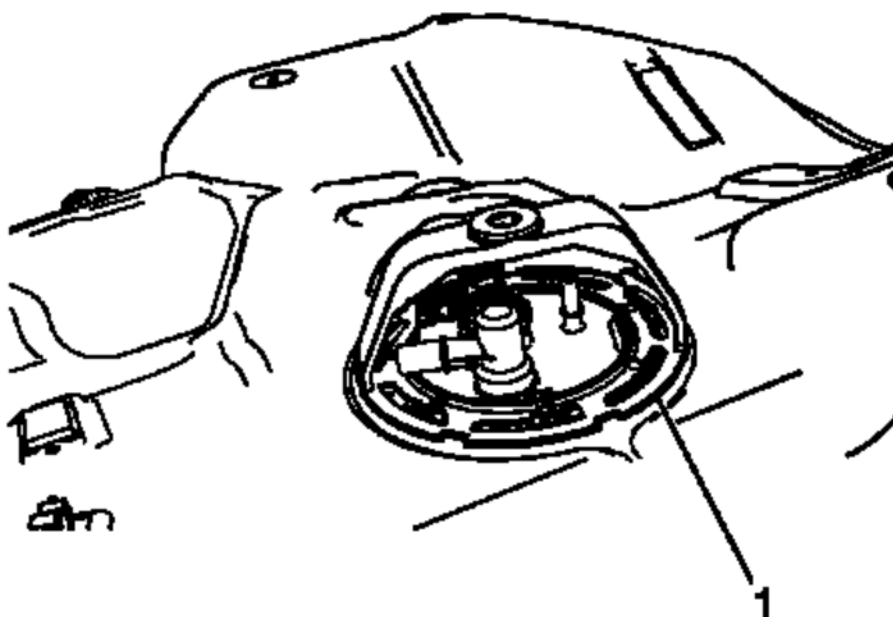


Fig. 54: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

2. Use the **J 45722** wrench by turning clockwise and install the lock ring (1).

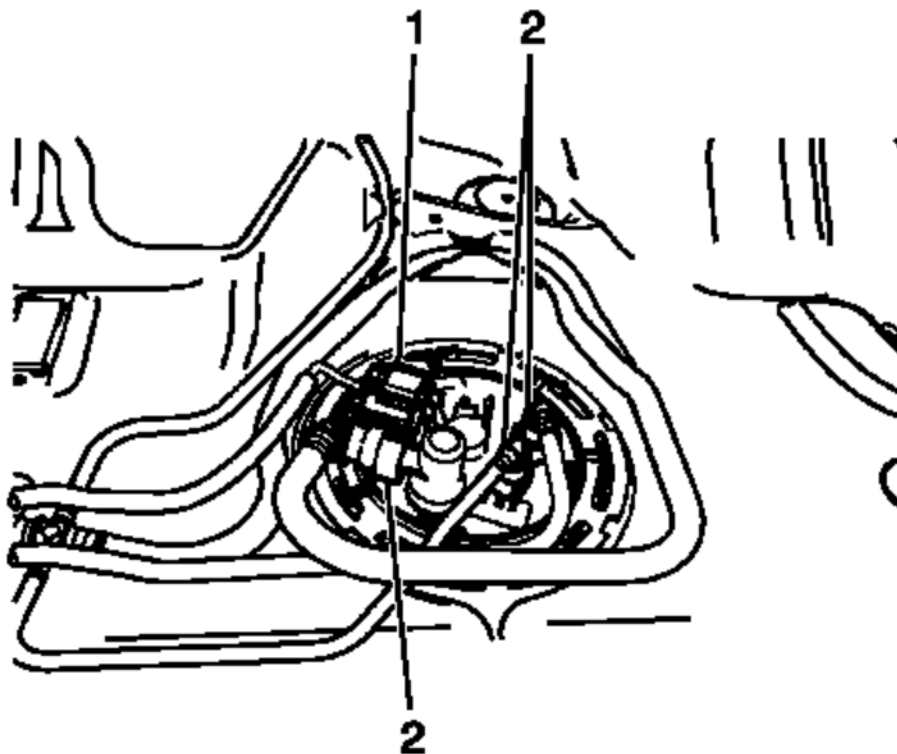


Fig. 55: Fuel Pump Electrical Connector & Quick Connects
Courtesy of GENERAL MOTORS COMPANY

3. Connect the fuel pump electrical connector (1) and the quick connects (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL TANK FUEL PUMP MODULE REPLACEMENT (NT7)

Special Tools

J 45722 Fuel Sender Lock Ring Wrench

For equivalent regional tools, refer to **Special Tools**

Removal Procedure

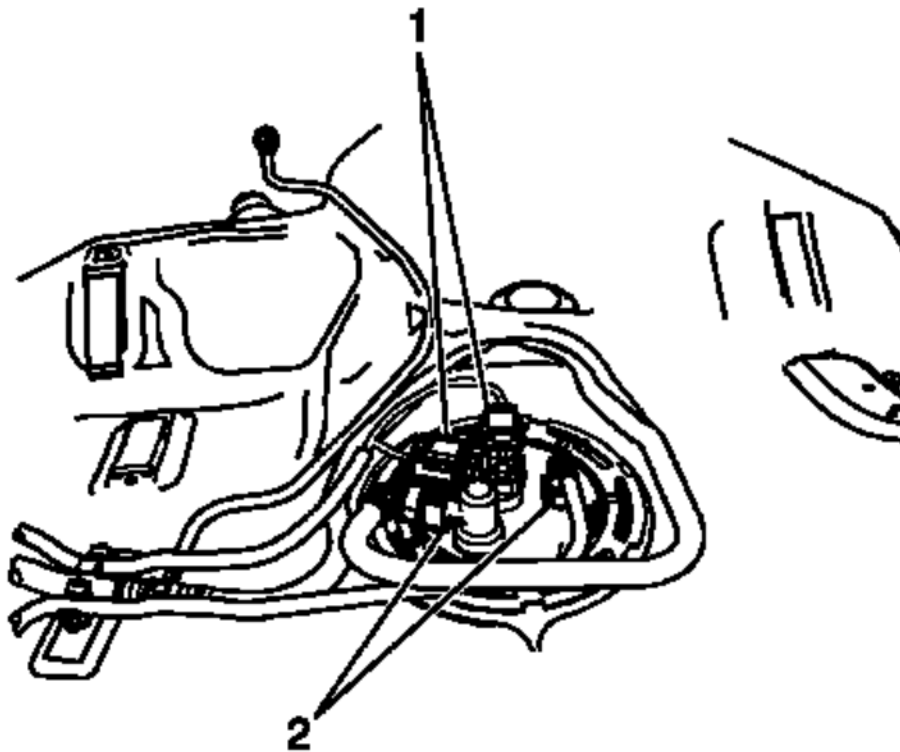


Fig. 56: Fuel Pump Electrical Connector & Quick Connects
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Remove the fuel tank. Refer to Fuel Tank Replacement.
2. Disconnect the fuel pump electrical connector (1) and the VPS connector (1) and the quick connects (2). Refer to Plastic Collar Quick Connect Fitting Service.

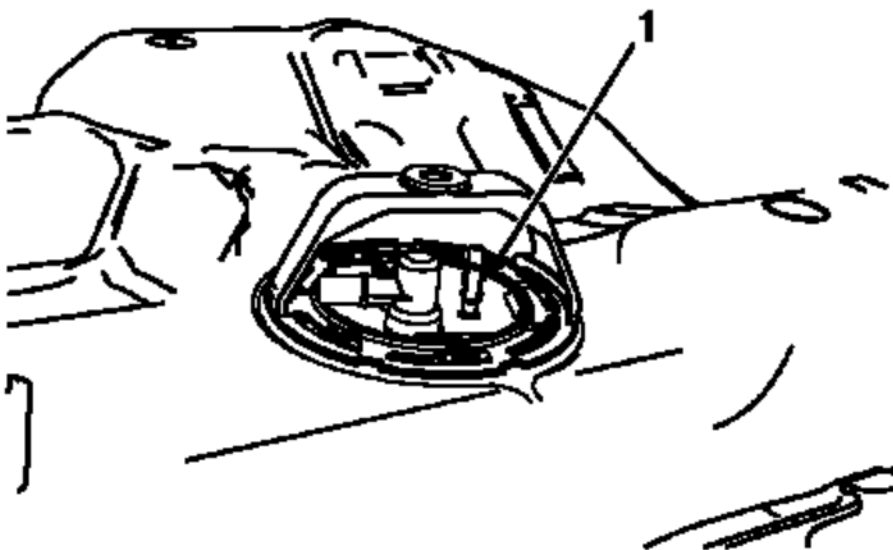


Fig. 57: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Use the **J 45722** wrench by turning counter clockwise and remove the lock ring (1).

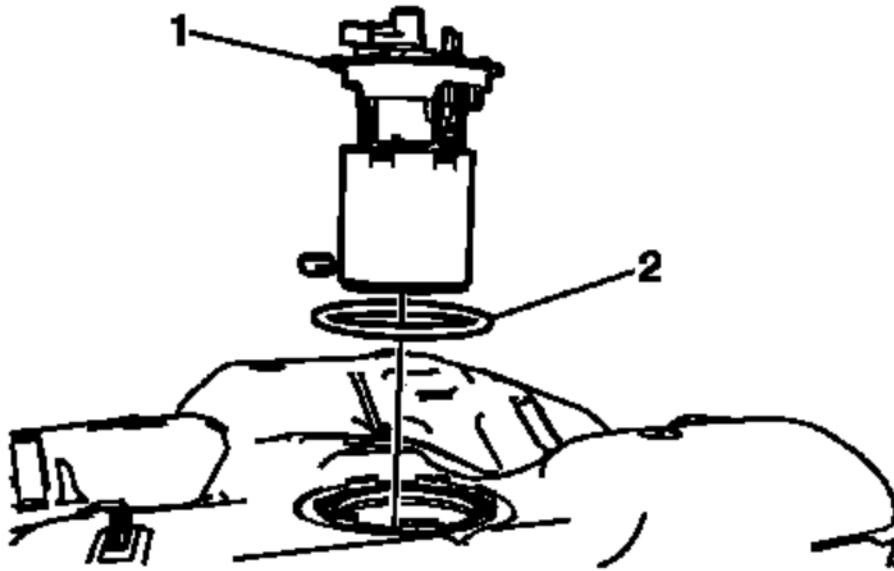


Fig. 58: Fuel Tank Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel tank module (1) and the O-ring (2).

Installation Procedure

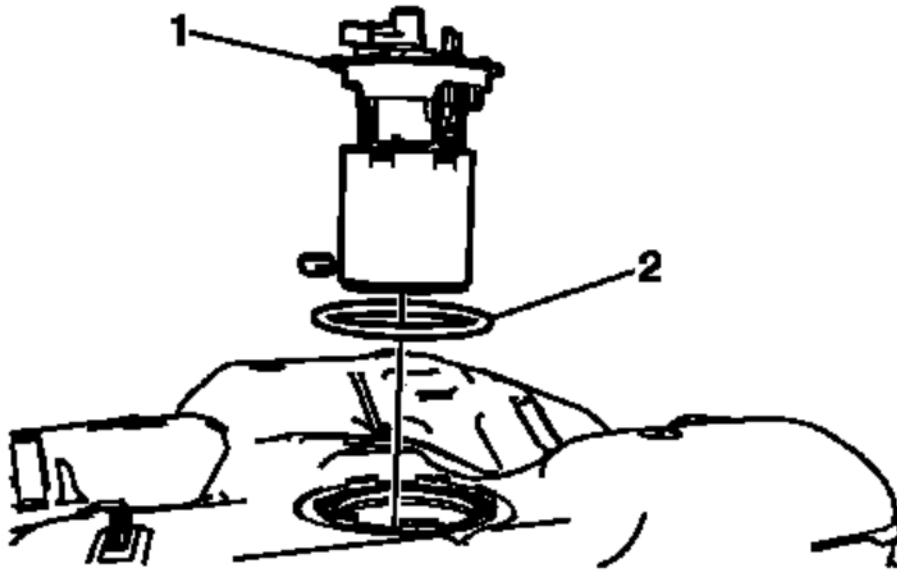


Fig. 59: Fuel Tank Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW seal (2) and the fuel tank module (1).

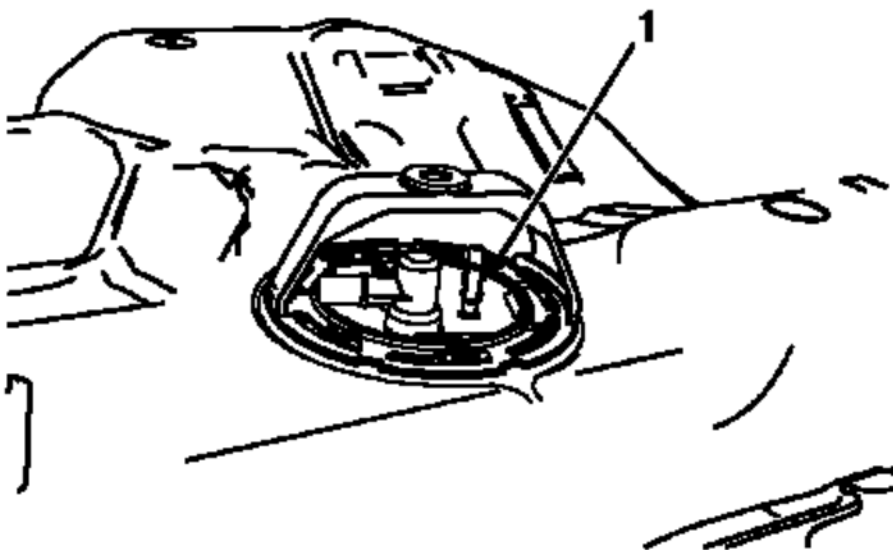


Fig. 60: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

2. Use the **J 45722** wrench by turning clockwise and install the lock ring (1).

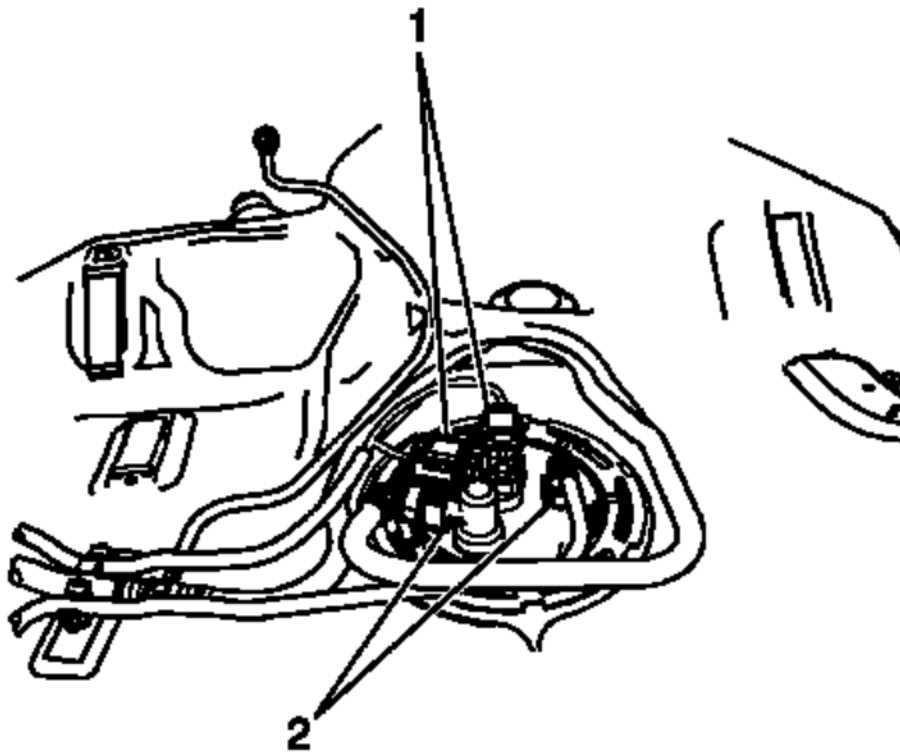


Fig. 61: Fuel Pump Electrical Connector & Quick Connects
Courtesy of GENERAL MOTORS COMPANY

3. Connect the fuel pump electrical connector (1) and the VPS connector (1) and the quick connects (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT

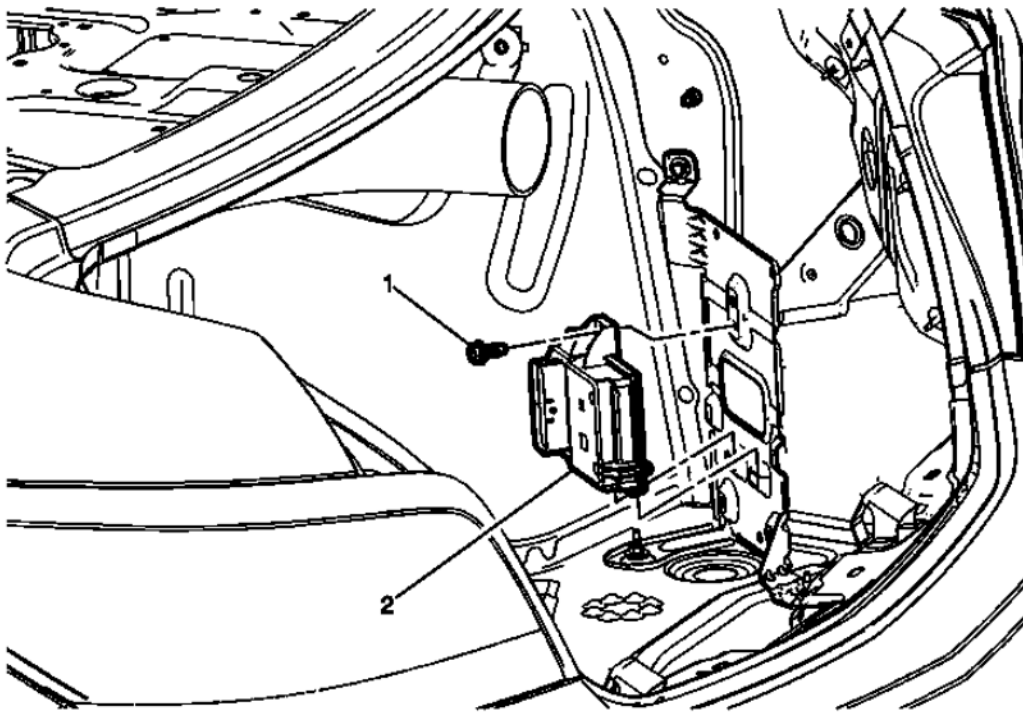


Fig. 62: Fuel Pump Flow Control Module
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Flow Control Module Replacement

Callout	Component Name
Preliminary Procedure Remove the passenger rear side trim panel. Refer to <u>Rear Compartment Side Trim Panel Replacement (without HP6)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Left Side)</u> , <u>Rear Compartment Side Trim Panel Replacement (HP6, Right Side)</u> .	
1	Fuel Pump Flow Control Module Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in)
2	Fuel Pump Flow Control Module Procedure 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to <u>Control Module References</u> .

FUEL TANK PRESSURE SENSOR REPLACEMENT (NT7)

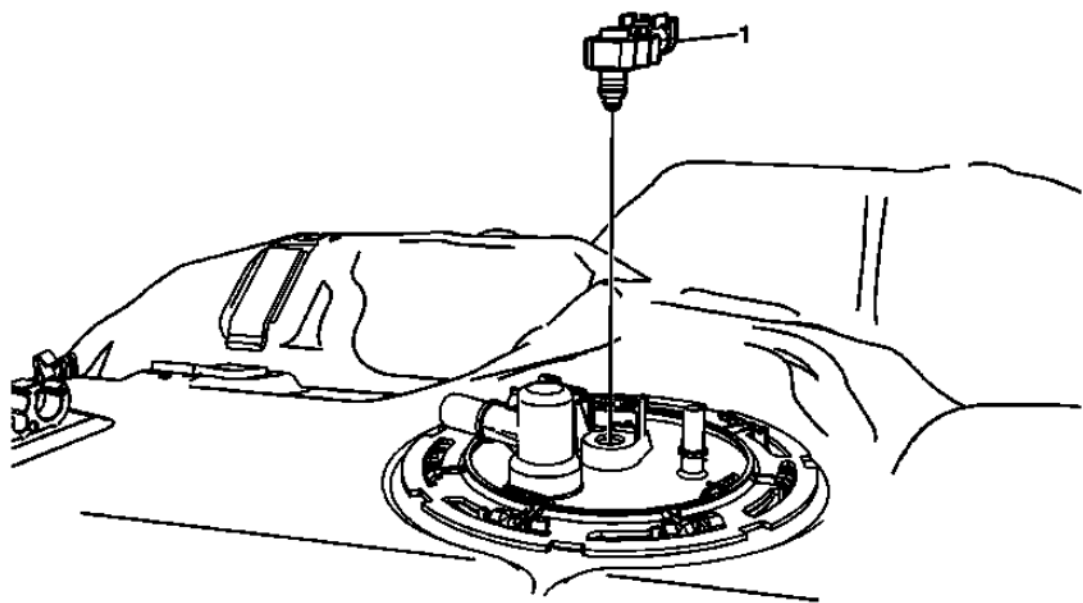


Fig. 63: Fuel Tank Pressure Sensor (NU6)
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Pressure Sensor Replacement (NT7)

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Fuel Tank Pressure Sensor Procedure 1. Disconnect the electrical connector. 2. Release the retaining tab.

FUEL TANK PRESSURE SENSOR REPLACEMENT (NU6)

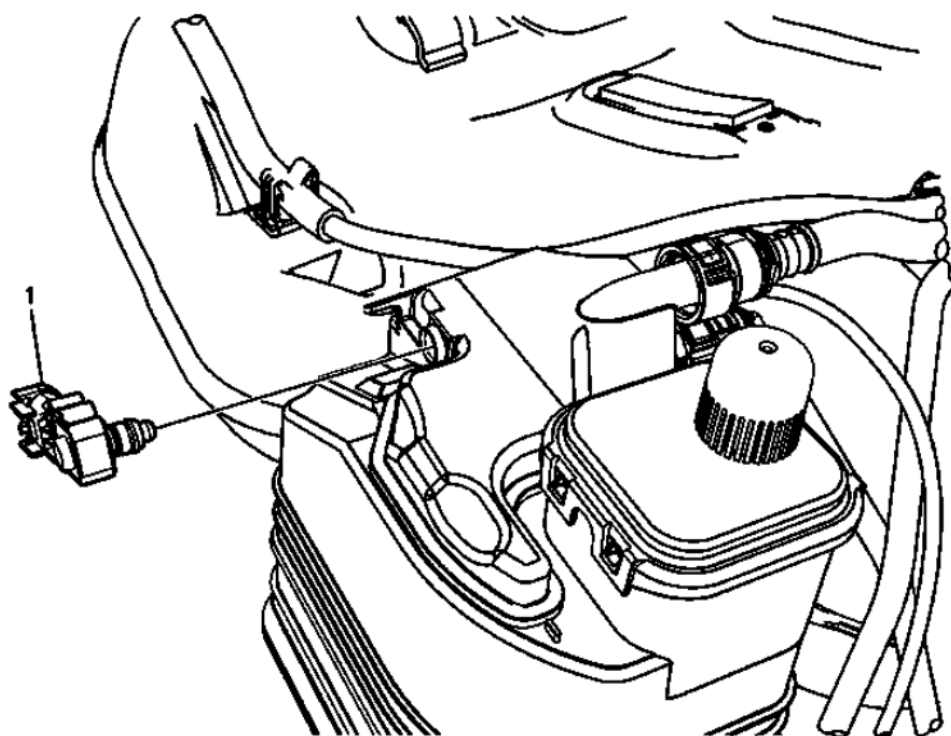


Fig. 64: Fuel Tank Pressure Sensor (NU6)
 Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Pressure Sensor Replacement (NU6)

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Fuel Tank Pressure Sensor Procedure 1. Disconnect the electrical connector. 2. Release the retaining tab.

FUEL LEVEL SENSOR REPLACEMENT

Removal Procedure

WARNING: Fuel Vapors can collect while servicing fuel system parts in enclosed areas such as a trunk. To reduce the risk of fire and increased exposure to vapors:

- Use forced air ventilation such as a fan set outside of the trunk.
- Plug or cap any fuel system openings in order to reduce fuel vapor formation.

- Clean up any spilled fuel immediately.
- Avoid sparks and any source of ignition.
- Use signs to alert others in the work area that fuel system work is in process.

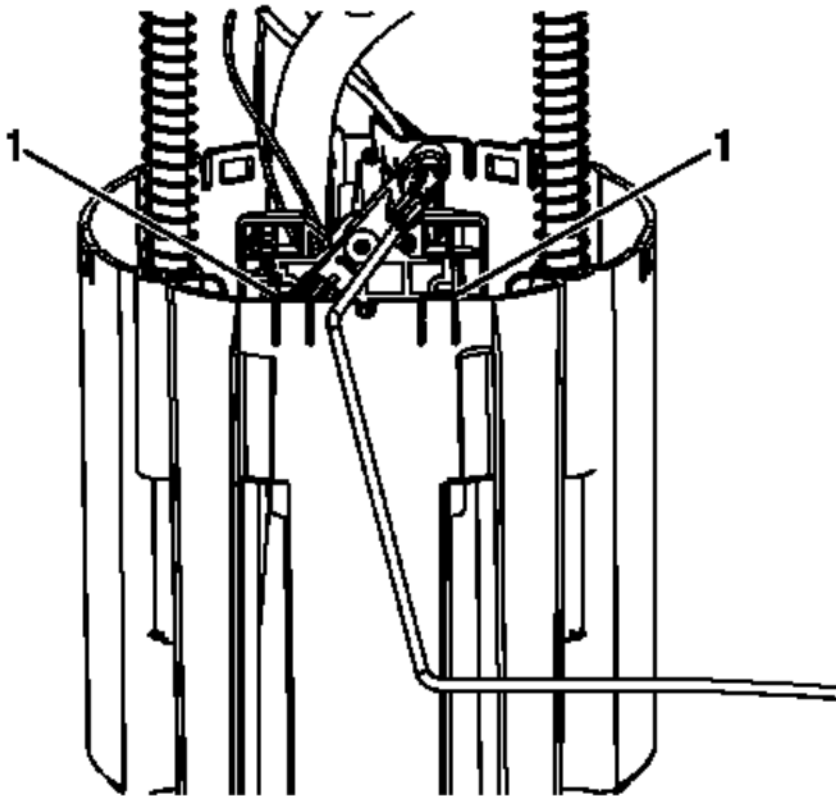


Fig. 65: Identifying Locking Tabs

Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel tank pump module. Refer to **Fuel Tank Fuel Pump Module Replacement (NU6)**, **Fuel Tank Fuel Pump Module Replacement (NT7)**.
2. Using two flat-bladed tools, carefully pull both locking tabs (1) outward while simultaneously lifting the level sensor.

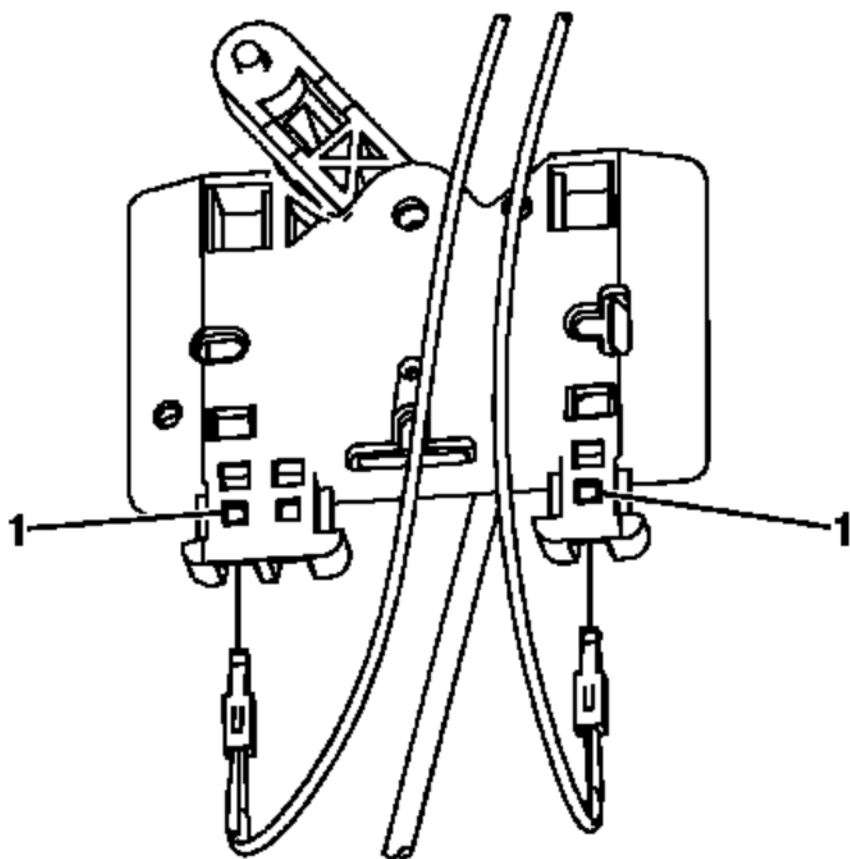


Fig. 66: Identifying Electrical Terminals
Courtesy of GENERAL MOTORS COMPANY

3. Using a small bladed tool, gently release the retaining tabs on the electrical terminals (1) while simultaneously pulling the terminals out.
4. Inspect the terminals for bending and reposition as necessary.

Installation Procedure

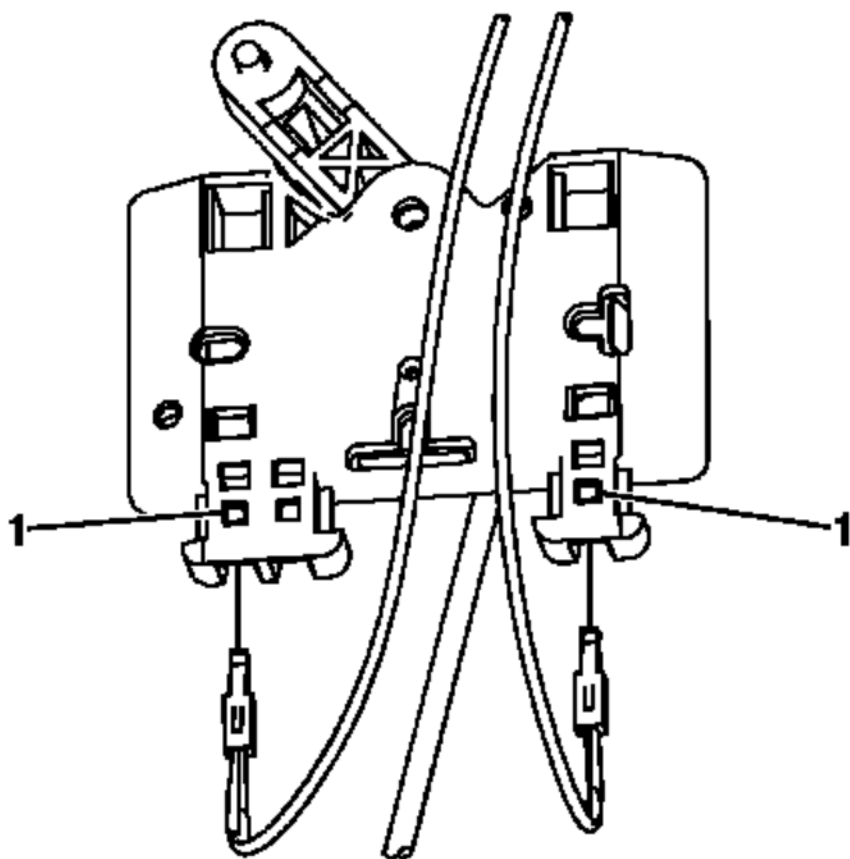


Fig. 67: Identifying Electrical Terminals
Courtesy of GENERAL MOTORS COMPANY

1. Push in the electrical terminals (1) and ensure the terminals are secure.

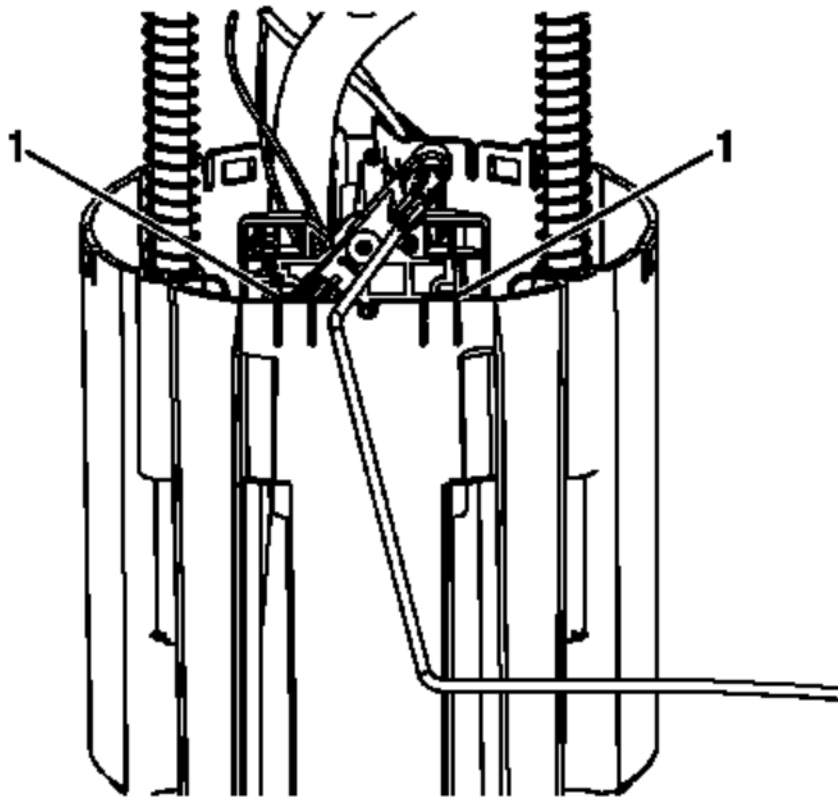


Fig. 68: Identifying Locking Tabs

Courtesy of GENERAL MOTORS COMPANY

2. Carefully insert the level sensor until the locking tabs (1) snap into the locking position.
3. Install the fuel tank pump module. Refer to **Fuel Tank Fuel Pump Module Replacement (NU6)**, **Fuel Tank Fuel Pump Module Replacement (NT7)**.

FUEL TANK FILLER PIPE REPLACEMENT

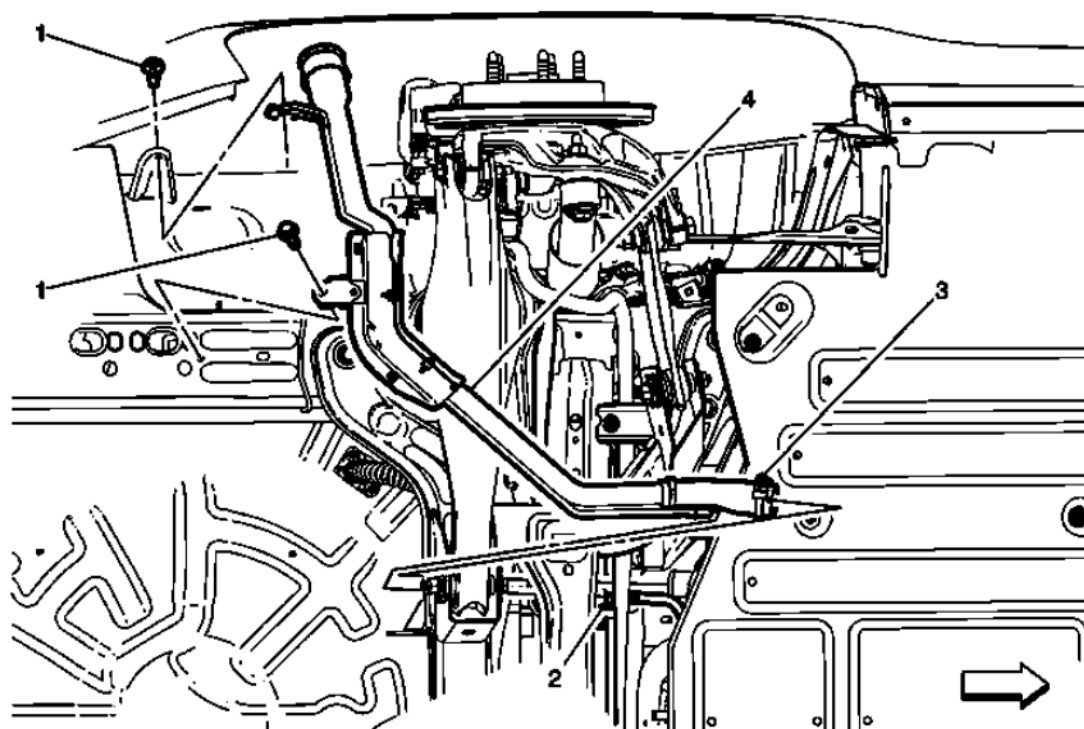


Fig. 69: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Filler Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the right rear wheelhouse panel liner. Refer to <u>Rear Wheelhouse Liner Replacement</u> .	
1	Filler Pipe Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 9 N.m (80 lb in)
2	Rear Evaporative Emission Pipe Procedure Disconnect the quick connect fitting. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .
3	Hose Clamp Tighten 4 N.m (35 lb in)
4	Fuel Tank Filler Pipe Procedure Slide the filler pipe out of the fuel tank filler pipe housing.

FUEL PUMP COVER REPLACEMENT

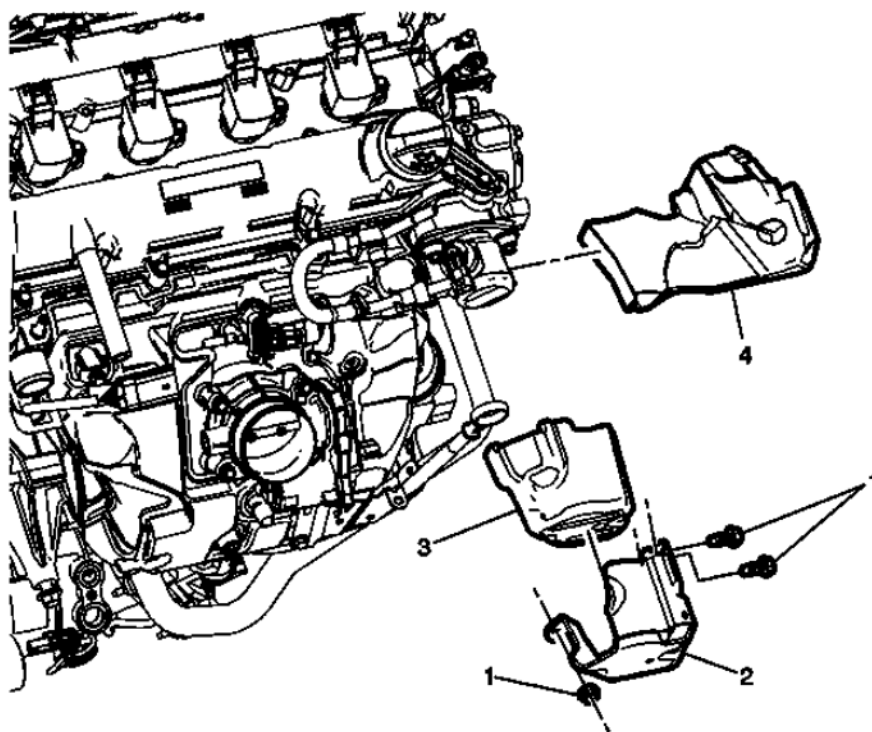


Fig. 70: Fuel Pump Cover
Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Cover Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Unclip the electrical wiring harness from the fuel pump cover. 3. Unclip and reposition the high voltage cable from the pump cover. 4. Unclip and reposition the surge tank vent hose from the pump cover. 5. Unclip and reposition the vacuum booster hose from the pump cover. 6. Disconnect the fuel pump electrical harness connector.	
1	Fuel Pump Cover Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m(89 lb in)
2	Fuel Pump Cover

3	Fuel Pump Insulator
4	Fuel Injector Fuel Rail Noise Shield

FUEL FEED PIPE REPLACEMENT (ENGINE)

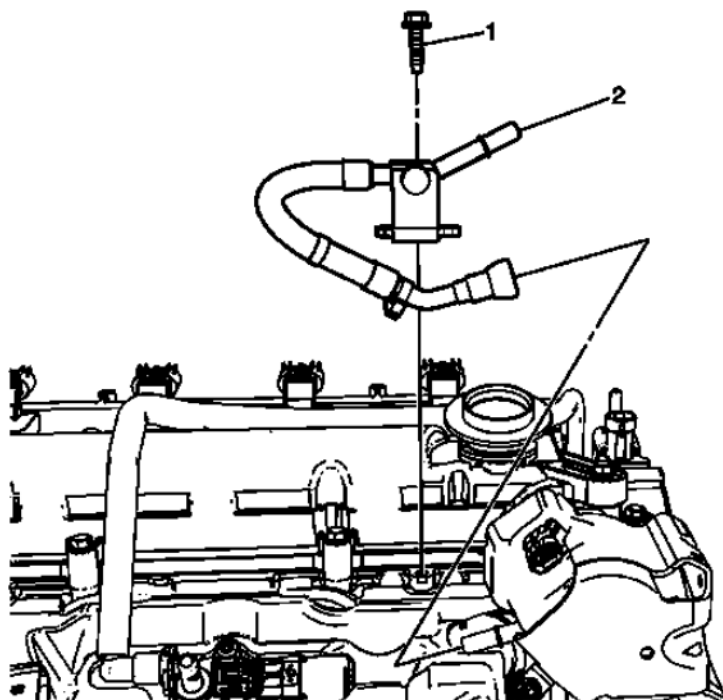


Fig. 71: Fuel Feed Pipe (LAF)

Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Pipe Replacement (Engine)

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Disconnect the fuel lines. Refer to <u>Metal Collar Quick Connect Fitting Service</u>.	
1	Fuel Feed Pipe Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Fuel Feed Pipe

FUEL FEED PIPE REPLACEMENT (FUEL TANK)

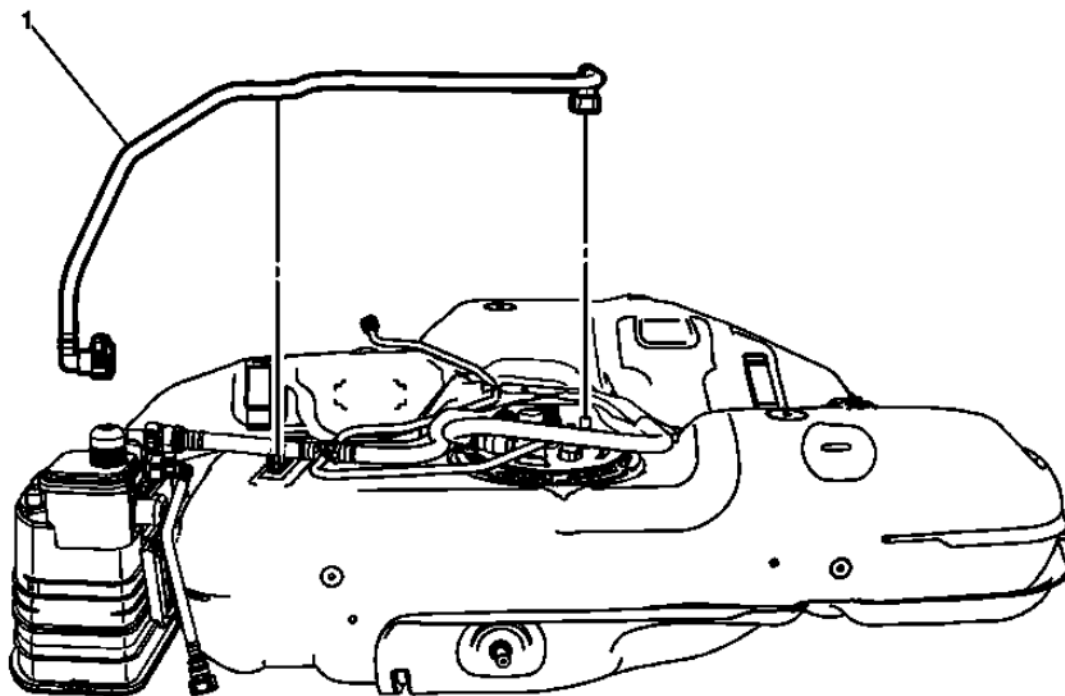


Fig. 72: Fuel Feed Pipe (At Tank FWD)
Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Pipe Replacement (Fuel Tank)

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Fuel Feed Pipe Procedure 1. Disconnect the fuel feed pipe from the fuel tank retainer. 2. Disconnect the fuel feed pipe from the fuel pump module. Refer to Plastic Collar Quick Connect Fitting Service.

FUEL FEED PIPE REPLACEMENT (CHASSIS TO ENGINE)

Removal Procedure

WARNING: Refer to **Gasoline/Gasoline Vapors Warning** .

WARNING: Refer to Safety Glasses Warning .

1. Relieve the system fuel pressure. Refer to Fuel Pressure Relief.
2. Disconnect the engine fuel feed front pipe from the chassis fuel feed front pipe. Refer to Plastic Collar Quick Connect Fitting Service.

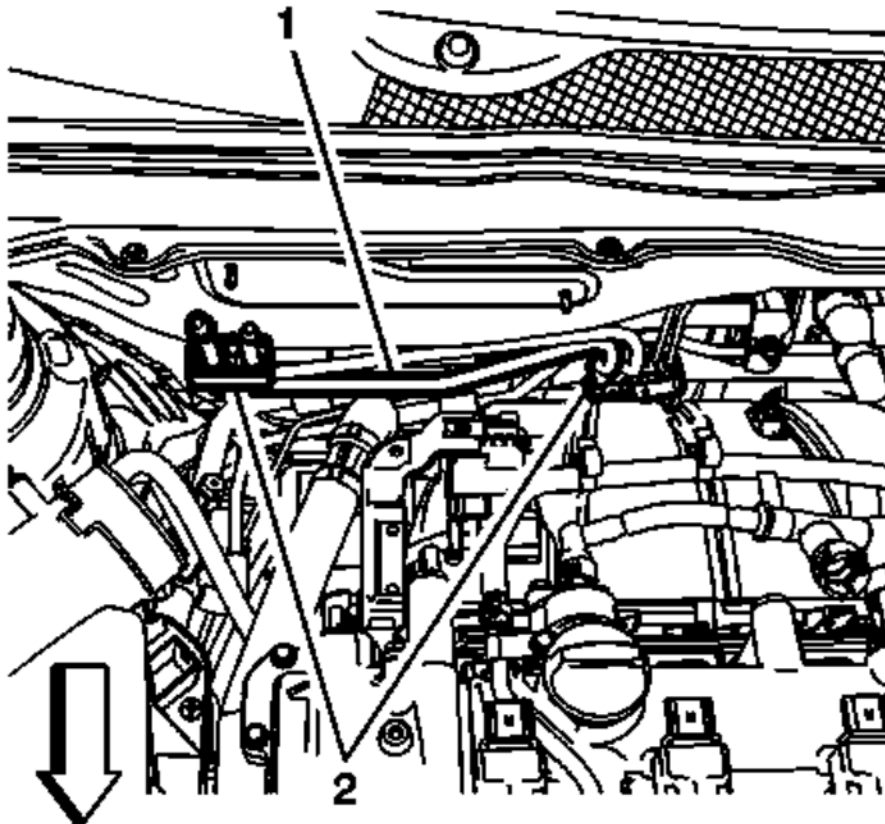


Fig. 73: Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fuel feed pipe (1) from the retainers (2).
4. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle .

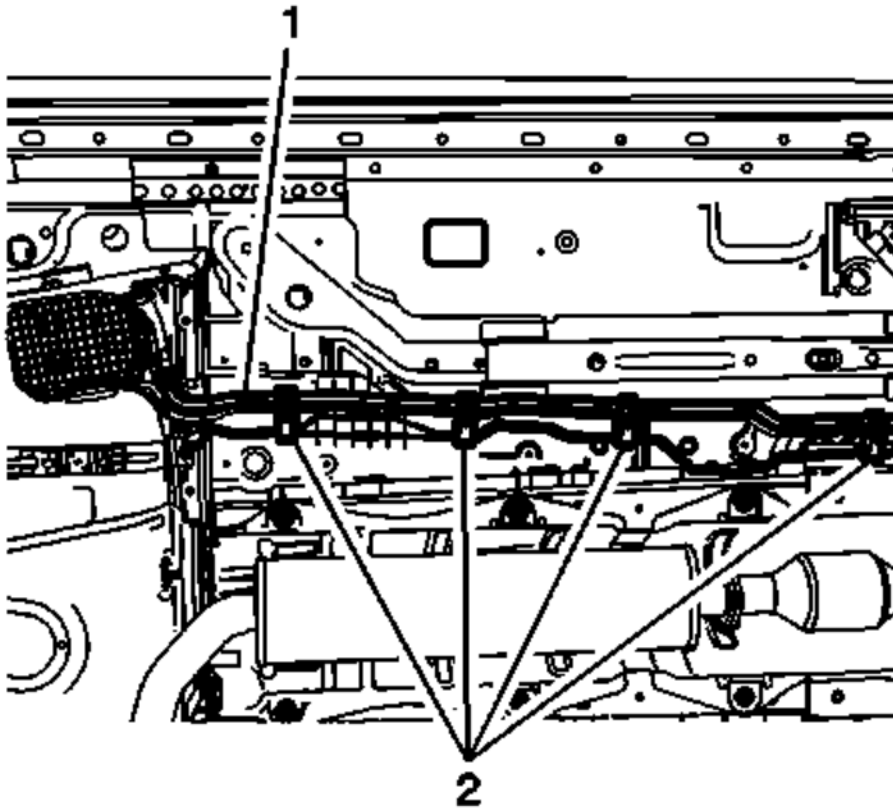


Fig. 74: Fuel Feed Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the chassis fuel feed pipe (1) from the fuel tank fuel feed pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Disconnect the fuel pressure sensor connector.
7. Disconnect the chassis fuel feed pipe from the brake bundle retainers (2) and remove the pipe (1) from the vehicle.
8. Transfer parts as necessary.

Installation Procedure

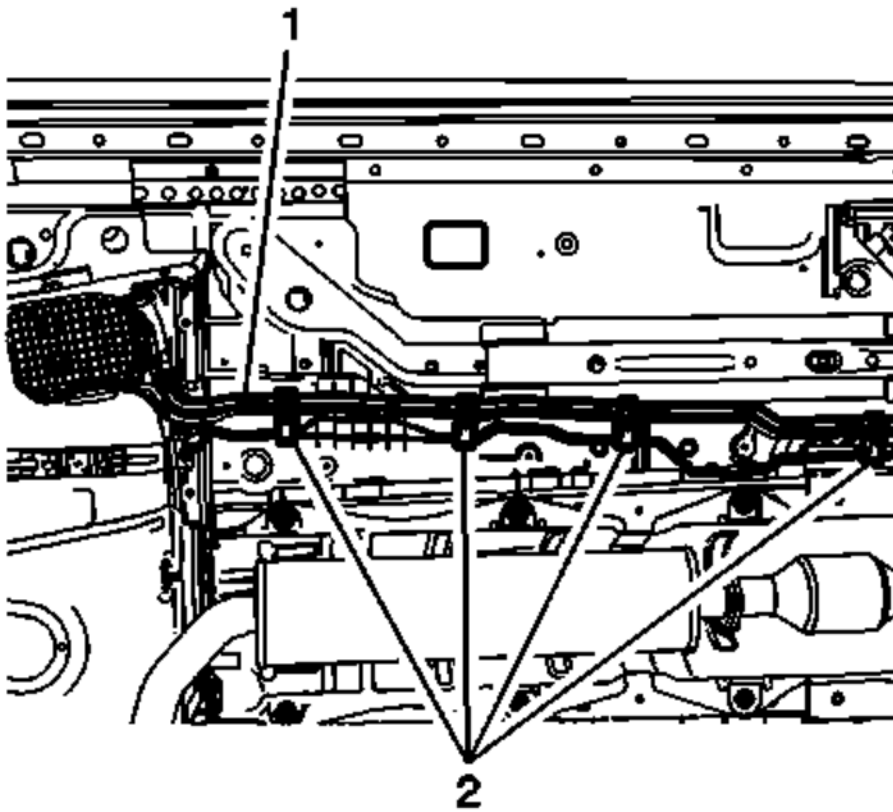


Fig. 75: Fuel Feed Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel feed pipe (1) to the brake bundle retainers (2).
2. Connect the chassis fuel feed pipe (1) to the fuel tank fuel feed pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Connect the fuel pressure sensor connector.
4. Lower the vehicle.

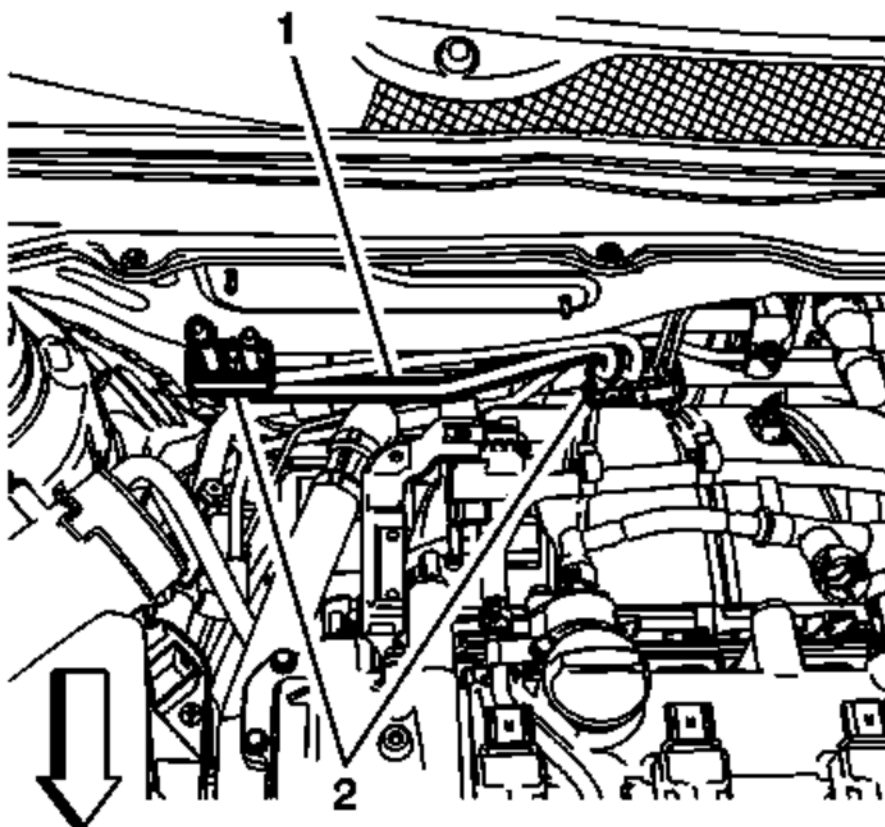


Fig. 76: Fuel Feed Pipe

Courtesy of GENERAL MOTORS COMPANY

5. Install the fuel feed pipe (1) to the retainers (2).
6. Connect the engine fuel feed front pipe to the chassis fuel feed pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Turn the ignition to the on position and check for fuel leaks.

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

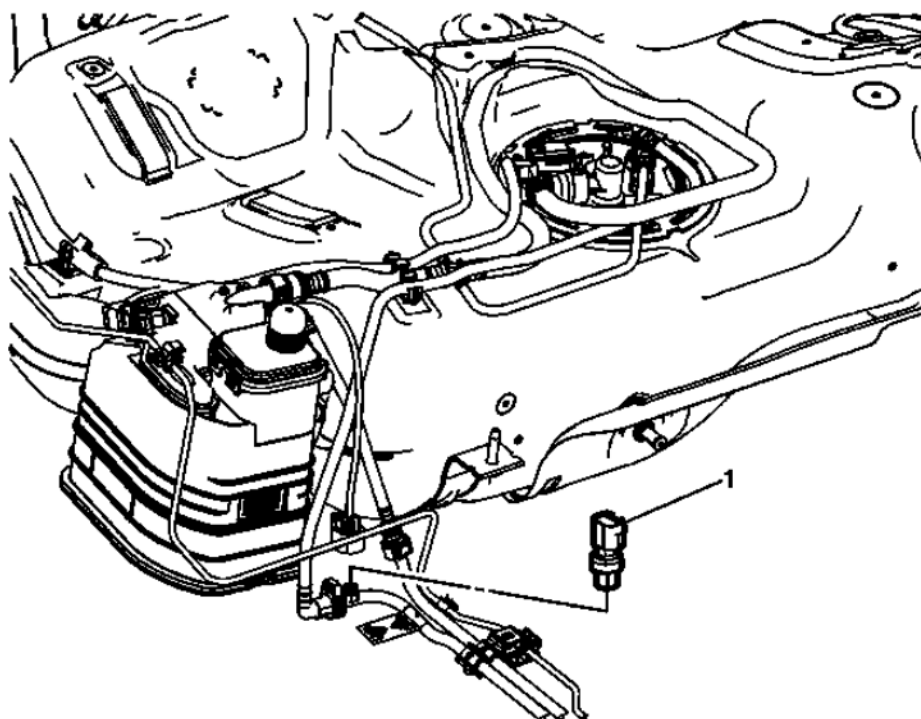


Fig. 77: Fuel Pressure Sensor - Fuel Feed Pipe
 Courtesy of GENERAL MOTORS COMPANY

Fuel Pressure Sensor Replacement - Fuel Feed Pipe

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>. 3. Remove the underbody rear air deflector right side. Refer to <u>Underbody Rear Air Deflector Replacement - Right Side</u>	
1	Fuel Pressure Sensor CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. Disconnect the electrical connector. 2. Use a NEW O-ring whenever the sensor is removed. Tighten 9Y (80 lb in)

FUEL FEED INTERMEDIATE PIPE REPLACEMENT

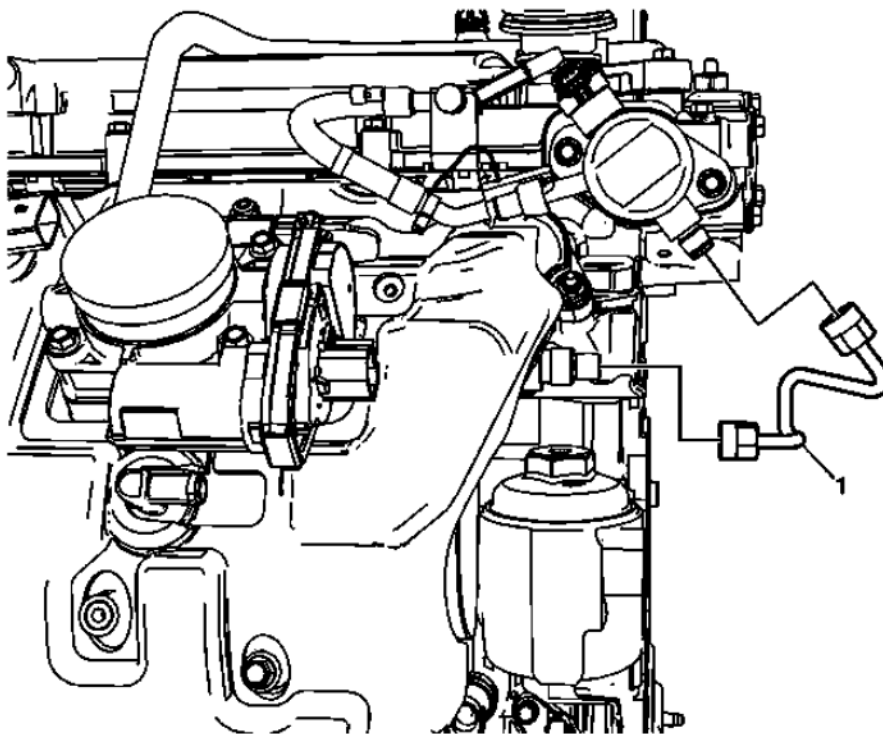


Fig. 78: Fuel Feed Intermediate Pipe
Courtesy of GENERAL MOTORS COMPANY

Fuel Feed Intermediate Pipe Replacement

Callout	Component Name
Preliminary Procedures	
1. Relieve the system pressure. Refer to <u>Fuel Pressure Relief</u>. 2. Remove the fuel pump cover. Refer to <u>Fuel Pump Cover Replacement</u>.	
1	Fuel Feed Intermediate Pipe CAUTION: Refer to <u>Fastener Caution</u> . Procedure 1. DISCARD the pipe when removed, and install a NEW pipe. 2. Lubricate the pipes with silicon free engine oil. Refer to <u>Adhesives, Fluids, Lubricants, and Sealers</u> . 3. Pressurize the fuel system and inspect for leaks. NOTE:

The pipe fittings are a one time use, always install a NEW fuel pump intermediate pipe.

Tighten
30 N.m (22 lb ft)

FUEL TANK VENT PIPE REPLACEMENT

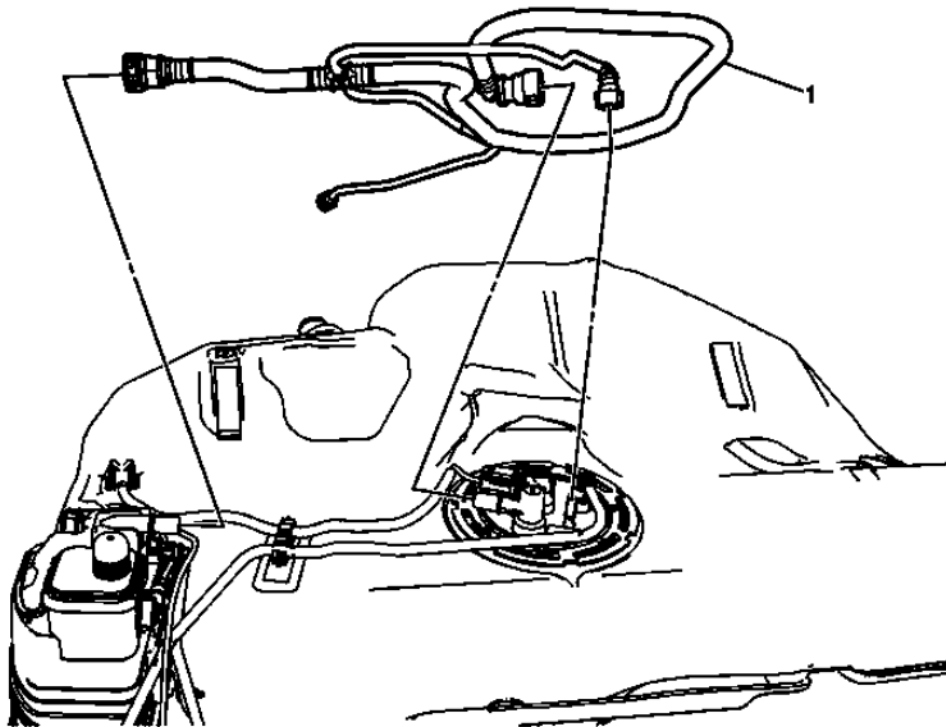


Fig. 79: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Vent Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Evaporative Emission Canister Vent Front Pipe Procedure Disconnect the evaporative emission quick connects. Refer to Plastic Collar Quick Connect Fitting Service .

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**.

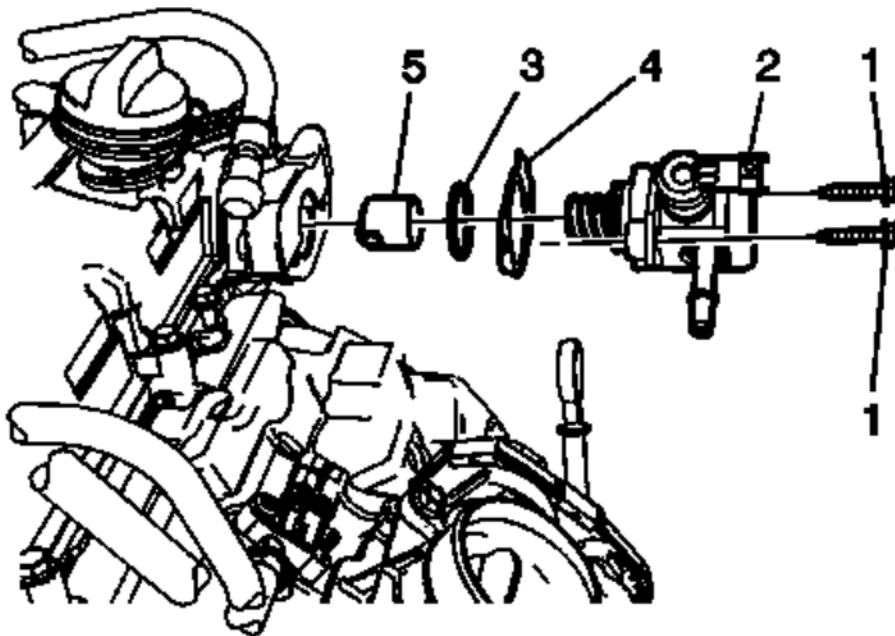


Fig. 80: High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.
3. Remove the low pressure feed pipe. Refer to **Fuel Feed Pipe Replacement (Engine)**, **Fuel Feed Pipe Replacement (Fuel Tank)**, **Fuel Feed Pipe Replacement (Chassis to Engine)**.
4. Remove the high pressure pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**. Discard this pipe.
5. Remove and discard the high pressure fuel pump bolts (1).
6. Remove the high pressure fuel pump (2).
7. Remove and discard the high pressure fuel pump O-ring (3).
8. Remove and discard the high pressure fuel pump gasket (4).
9. 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 GM P/N 12345501 (Canadian P/N 992704) or equivalent.

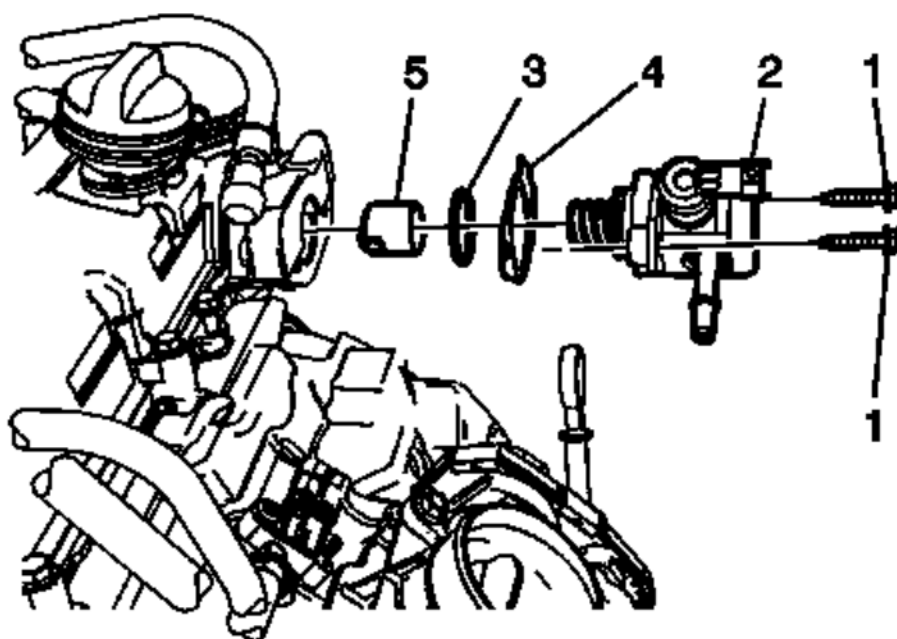


Fig. 81: High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: The high pressure fuel pump gasket has a retaining feature to hold the pump retaining bolts in place.

3. Install the high pressure fuel pump roller lifter (5).
4. Install a NEW high pressure fuel pump O-ring (3).
5. Position the NEW high pressure fuel pump gasket (4) and bolts (1) to the fuel pump.
6. Install the high pressure fuel pump (2). Force will be required while hand tightening the bolts.

CAUTION: Refer to Fastener Caution .

7. Tighten the high pressure fuel pump retaining bolts to 15 N.m (11 lb ft).
8. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.
9. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
10. Install the fuel feed pipe to the high pressure fuel pump. Refer to **Fuel Feed Pipe Replacement (Engine)**, **Fuel Feed Pipe Replacement (Fuel Tank)**, **Fuel Feed Pipe Replacement (Chassis to Engine)**.
11. Connect the high pressure fuel pump wiring harness.
12. Install the fuel tank cap.

NOTE: **If a fuel leak accrues at the fuel rail, the fuel rail will need to be replaced.**

13. 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.
14. Install the pressure relief cap to the fuel feed pipe.
15. Install the high pressure fuel pump cover. Refer to **Fuel Pump Cover Replacement**.

FUEL PUMP FUEL FEED HOSE REPLACEMENT

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.
2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

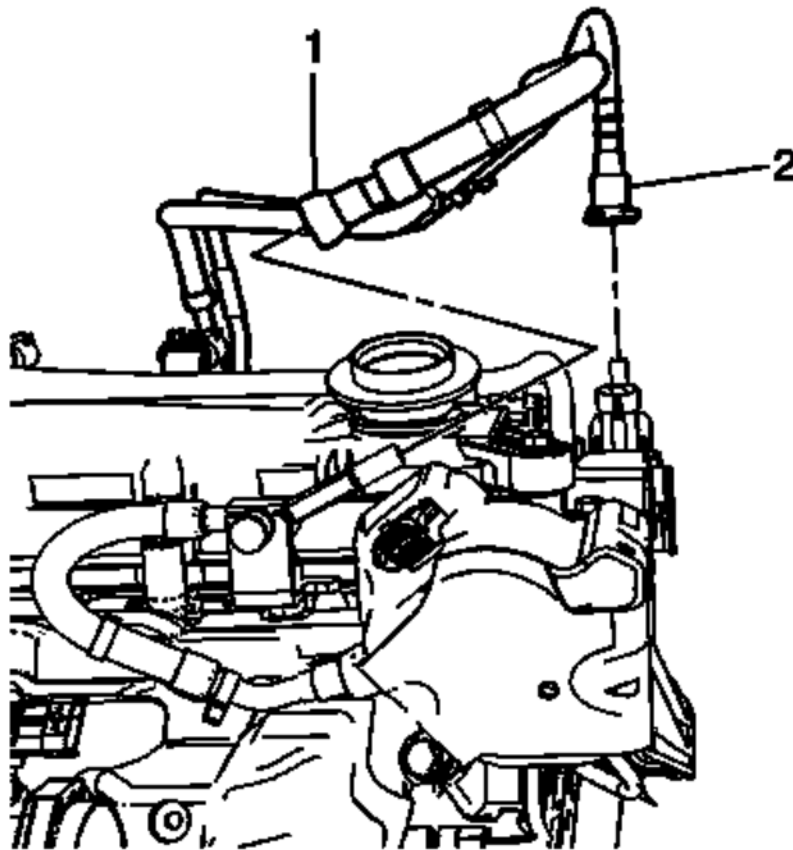


Fig. 82: Fuel Feed Pipe Quick Connect Fitting And Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the fuel feed pipe quick connect fitting (1) and the evaporative emission pipe (2). Refer to **Metal Collar Quick Connect Fitting Service**, and **Plastic Collar Quick Connect Fitting Service**.
4. Disengage the fuel line retainer at the valve cover.
5. Disengage fuel and brake pipe retainer at cowl panel.
6. Remove the cowl panel heat shield.
7. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
8. Remove the right side rear underbody air deflector. Refer to **Underbody Rear Air Deflector Replacement - Right Side** .
9. Remove the right side front underbody air deflector. Refer to **Underbody Front Air Deflector Replacement - Right Side** .
10. Remove the right side engine frame reinforcement. Refer to **Drivetrain and Front Suspension Frame Replacement** .

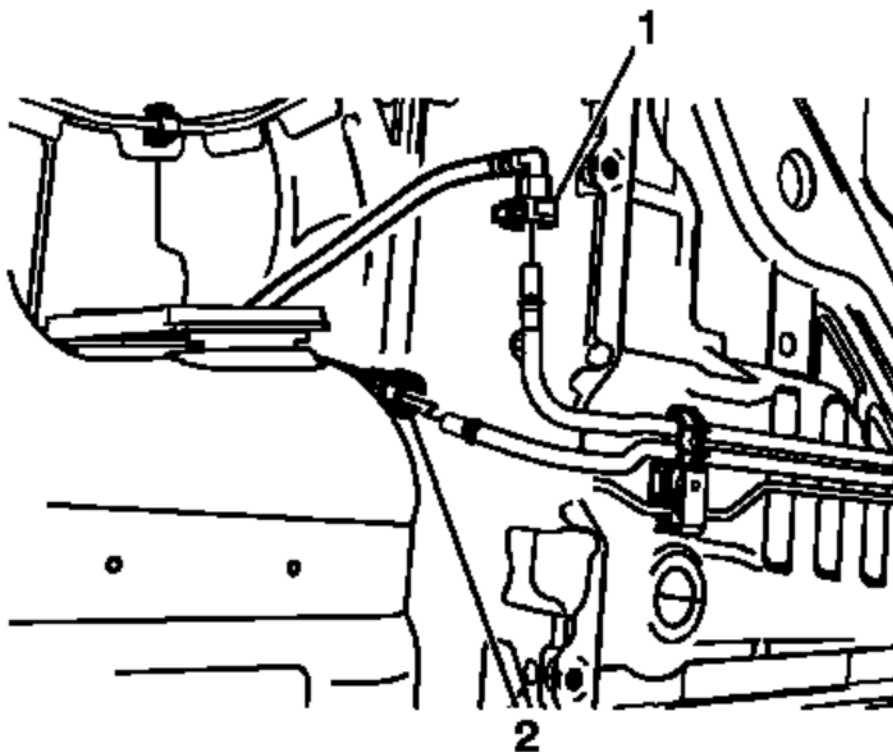


Fig. 83: Fuel Feed Pipe Quick Connect Fitting And Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect the fuel feed pipe quick connect fitting (1) and the evaporative emission pipe (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
12. Plug or cap the fuel feed pipe to prevent fuel loss or contamination.
13. Disconnect the brake pipes from the plastic retainers.

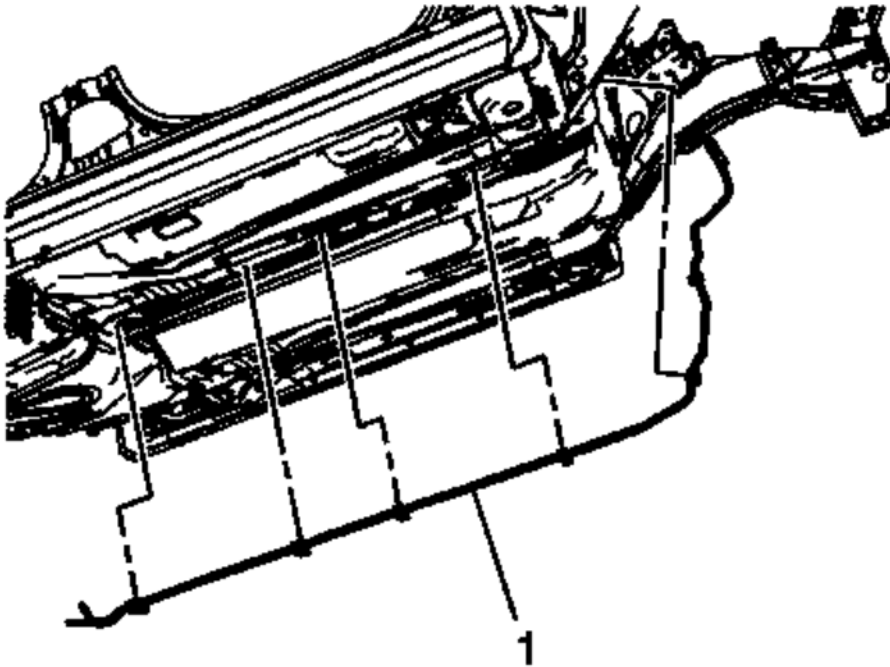


Fig. 84: Fuel Feed And Evaporative Emission Pipes
Courtesy of GENERAL MOTORS COMPANY

14. Remove the fuel feed and evaporative emission pipes (1) as an assembly from the vehicle.

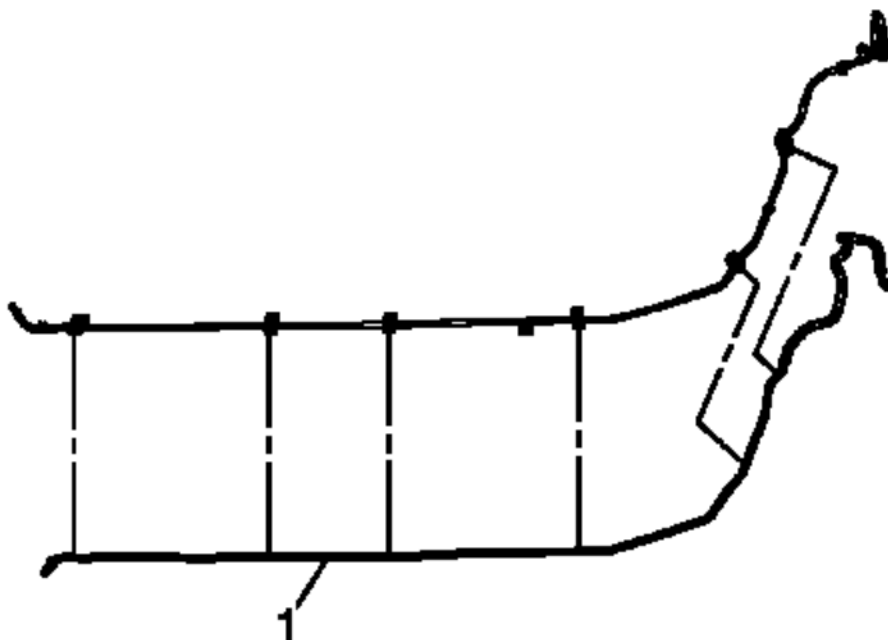


Fig. 85: Fuel Feed Pipe And Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

15. Separate the fuel feed pipe (1) from the evaporative emission pipe.

Installation Procedure

CAUTION: Refer to Fastener Caution .

1. Ensure that the fuel feed pipe and fittings are clean and dry prior to assembly.

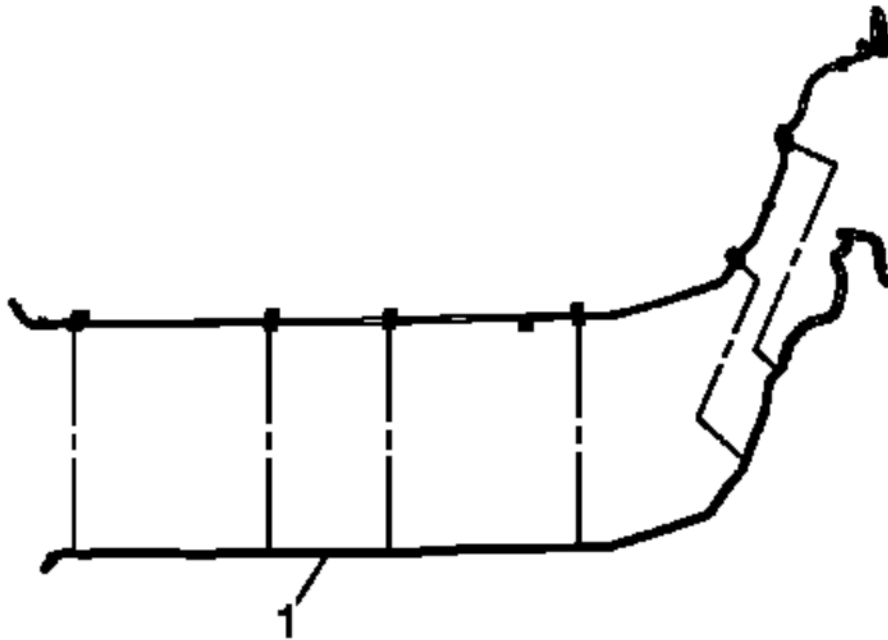


Fig. 86: Fuel Feed Pipe And Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Install the fuel feed pipe (1) to the evaporative emission pipe.

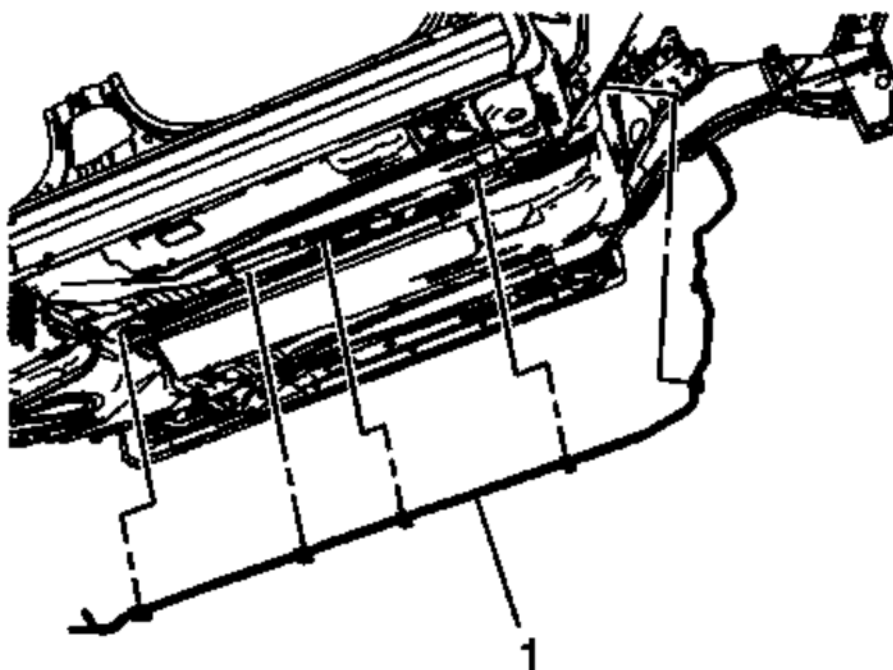


Fig. 87: Fuel Feed And Evaporative Emission Pipes
Courtesy of GENERAL MOTORS COMPANY

3. Install the fuel feed and evaporative emission pipes (1) as an assembly to the vehicle.

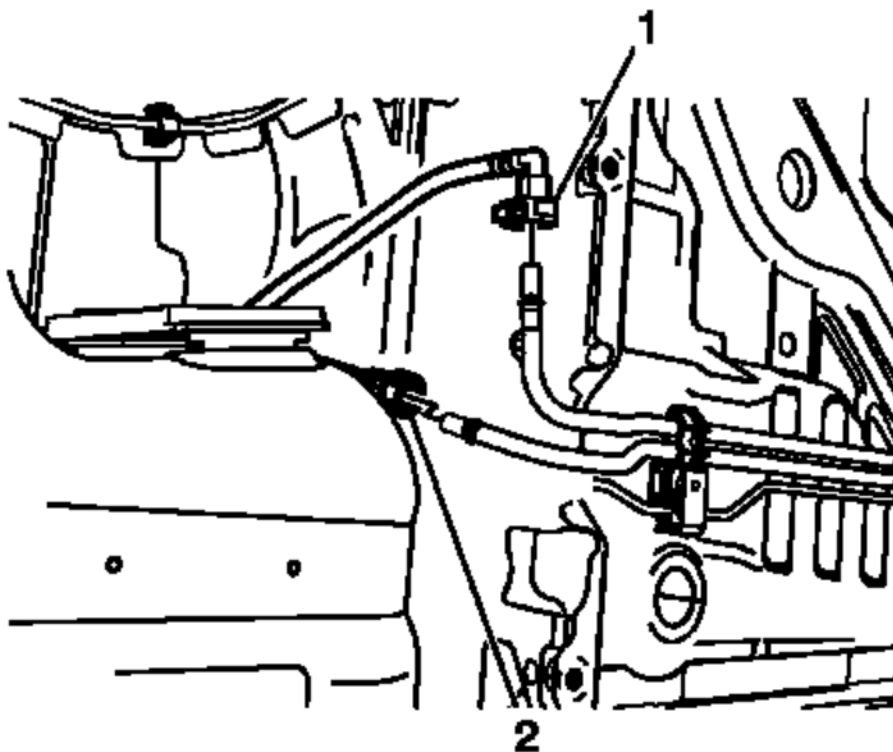


Fig. 88: Fuel Feed Pipe Quick Connect Fitting And Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Connect the brake pipes to the plastic retainers.
5. Install the cowl panel heat shield.
6. Remove the plug or cap from the fuel feed pipe.
7. Connect the fuel feed pipe quick connect fitting (1) and the evaporative emission pipe (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Install the fuel tank protector. Refer to **Fuel Tank Protector Replacement**.

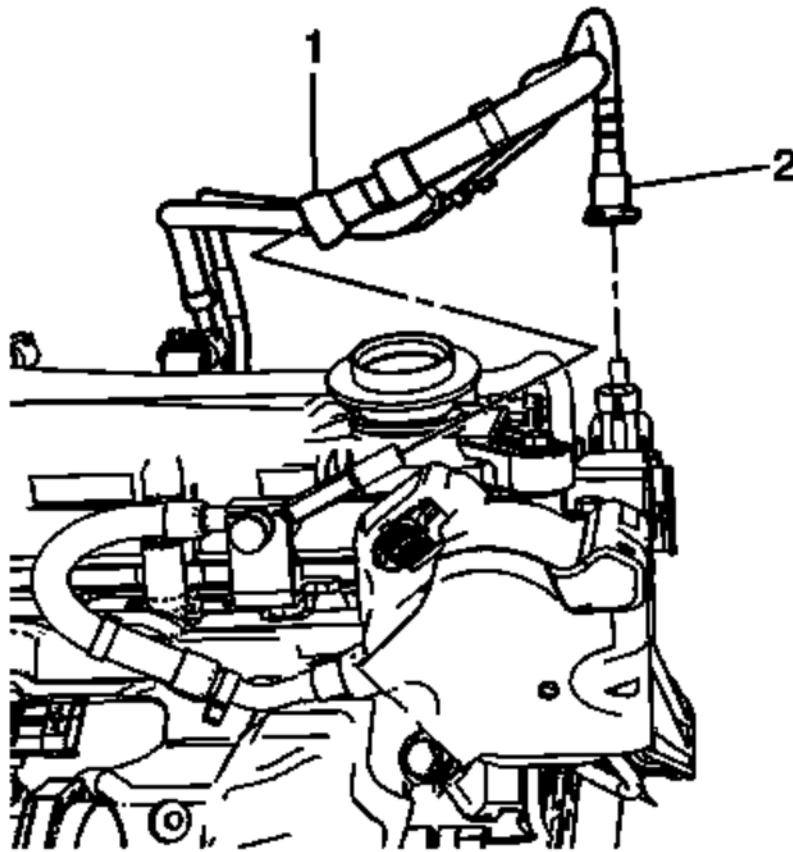


Fig. 89: Fuel Feed Pipe Quick Connect Fitting And Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

9. Connect the fuel feed pipe quick connect fitting (1) and the evaporative emission pipe (2). Refer to **Metal Collar Quick Connect Fitting Service**, and **Plastic Collar Quick Connect Fitting Service**.
10. Install the right side engine frame reinforcement. Refer to **Drivetrain and Front Suspension Frame Replacement**.
11. Install the right side rear underbody air deflector. Refer to **Underbody Rear Air Deflector Replacement - Right Side**.
12. Install the right side front underbody air deflector. Refer to **Underbody Front Air Deflector Replacement - Right Side**.
13. 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.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT

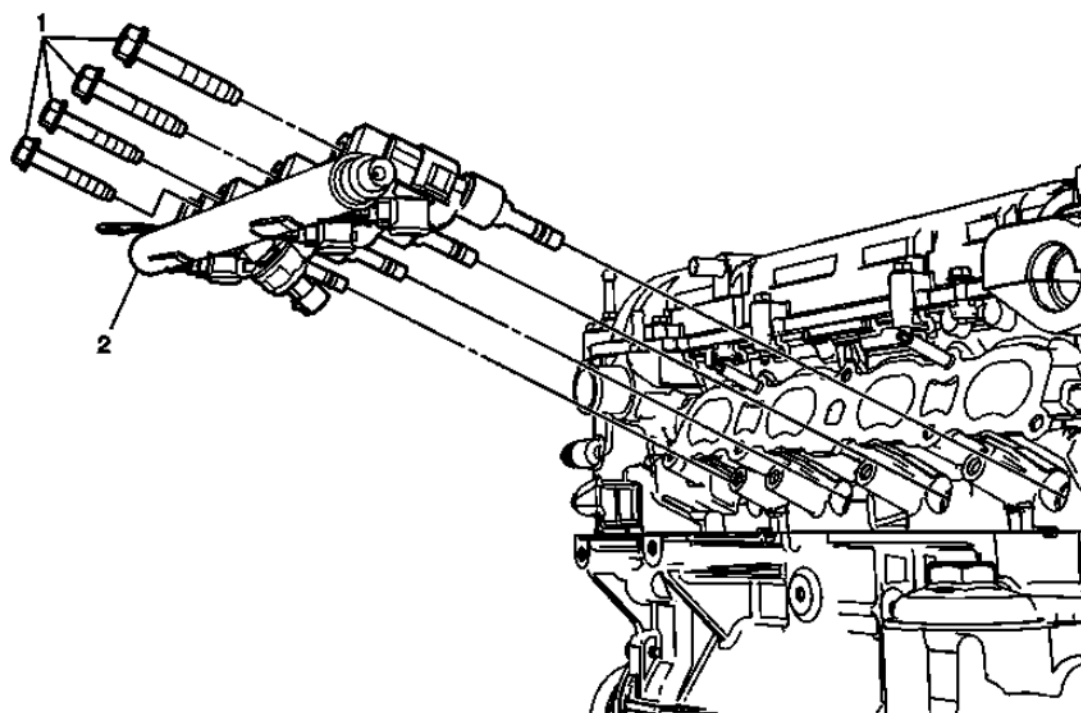


Fig. 90: Fuel Injector And Fuel Rail
 Courtesy of GENERAL MOTORS COMPANY

Fuel Injection Fuel Rail Assembly Replacement

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief. 2. Remove the intake manifold. Refer to Intake Manifold Replacement. 3. Remove the fuel feed pipe. Refer to Fuel Feed Intermediate Pipe Replacement.	
1	Fuel Injection Fuel Rail Fastener (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 25 Y (18 lb ft)
2	Fuel Injection Fuel Rail Procedure 1. Disconnect the electrical connector. 2. It is necessary to rebuild the fuel injectors. Refer to Direct Fuel

FUEL INJECTION FUEL RAIL FUEL PRESSURE SENSOR REPLACEMENT

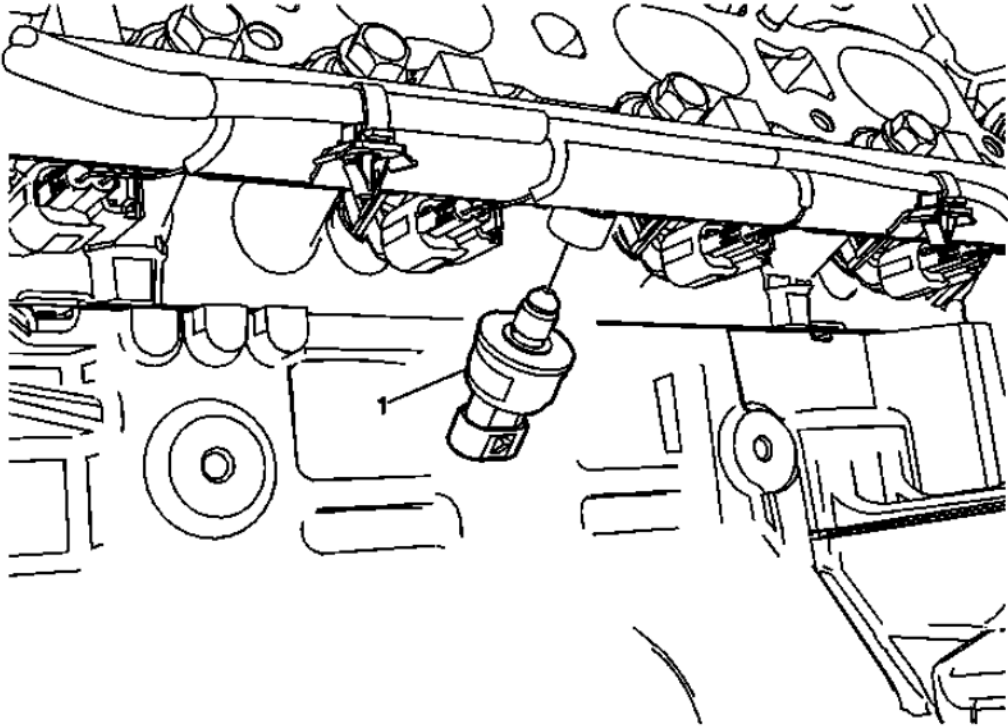


Fig. 91: Fuel Injection Fuel Rail Fuel Pressure Sensor (LAF)
Courtesy of GENERAL MOTORS COMPANY

Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement

Callout	Component Name
Preliminary Procedures	
1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief .	
2. Remove the intake manifold. Refer to Intake Manifold Replacement .	
1	Fuel Pressure Sensor CAUTION: Refer to Fastener Caution. Procedure Disconnect the electrical connector. Tighten 32 N.m (24 lb ft)

DIRECT FUEL INJECTOR REPLACEMENT

Removal Procedure

1. Relieve the high side fuel system pressure. Refer to Fuel Pressure Relief.

NOTE: The fuel injectors have an alignment feature, note the position of the injectors alignment for installation.

2. Remove the fuel injection fuel rail assembly. Refer to Fuel Injection Fuel Rail Assembly Replacement.

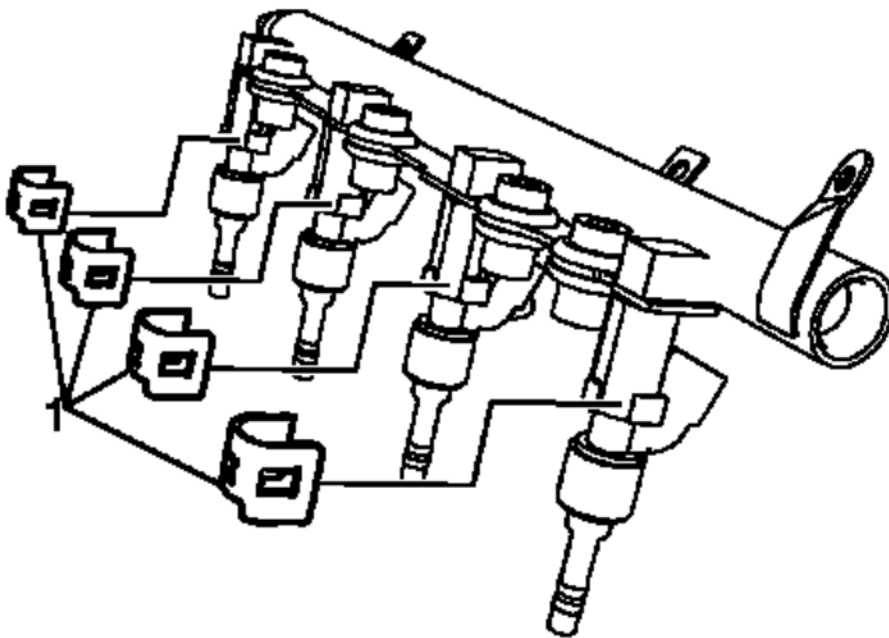


Fig. 92: Fuel Injector Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the fuel injector retainers (1).
4. Clean and inspect the fuel rail and injectors. Refer to Fuel Rail and Injectors Cleaning and Inspection (LAF, LEA, or LUK).

Installation Procedure

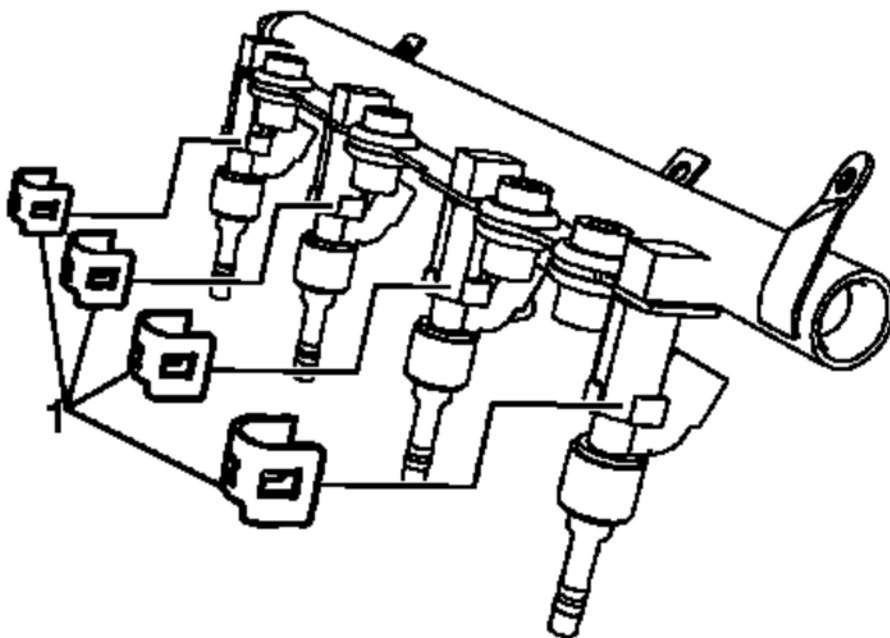


Fig. 93: Fuel Injector Retainers

Courtesy of GENERAL MOTORS COMPANY

1. Install NEW fuel injector retainers (1).

NOTE: The fuel injectors have an alignment feature and must be reinstalled as noted during removal.

2. Install the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement**.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

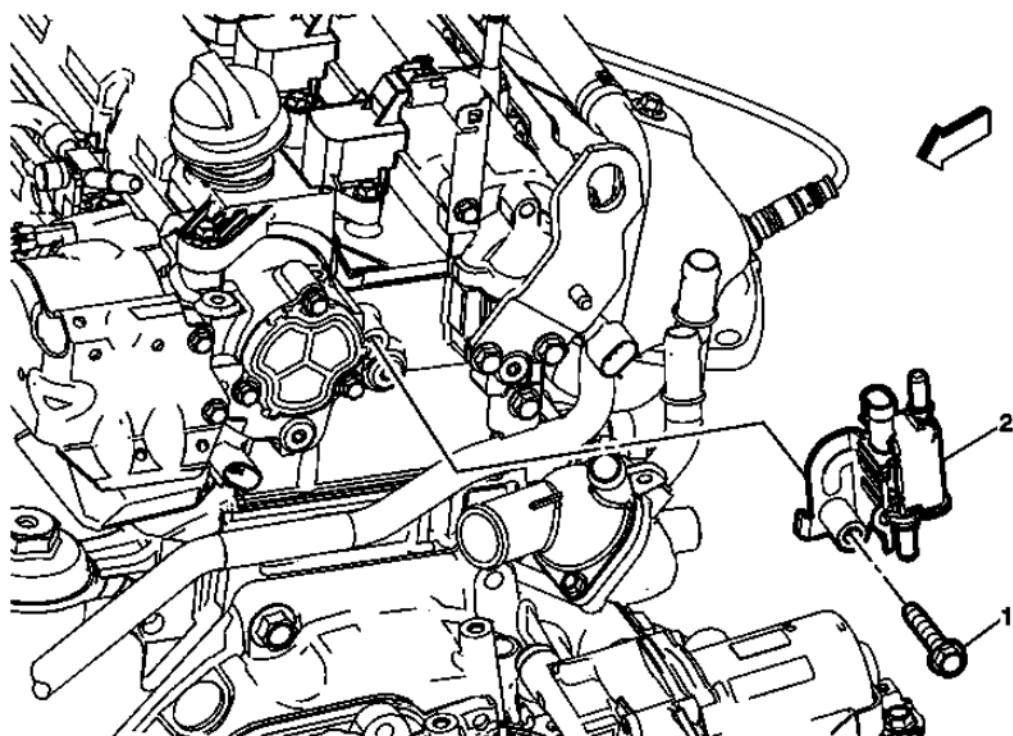


Fig. 94: Evaporative Emission Canister Purge Solenoid Valve
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Disconnect the evaporative emission pipes. Refer to <u>Plastic Collar Quick Connect Fitting Service</u>.	
1	Evaporative Emission Canister Purge Solenoid Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 N.m(18 lb ft)
2	Evaporative Emission Canister Purge Solenoid Procedure Disconnect the electrical connector.

EVAPORATIVE EMISSION CANISTER PURGE PIPE REPLACEMENT

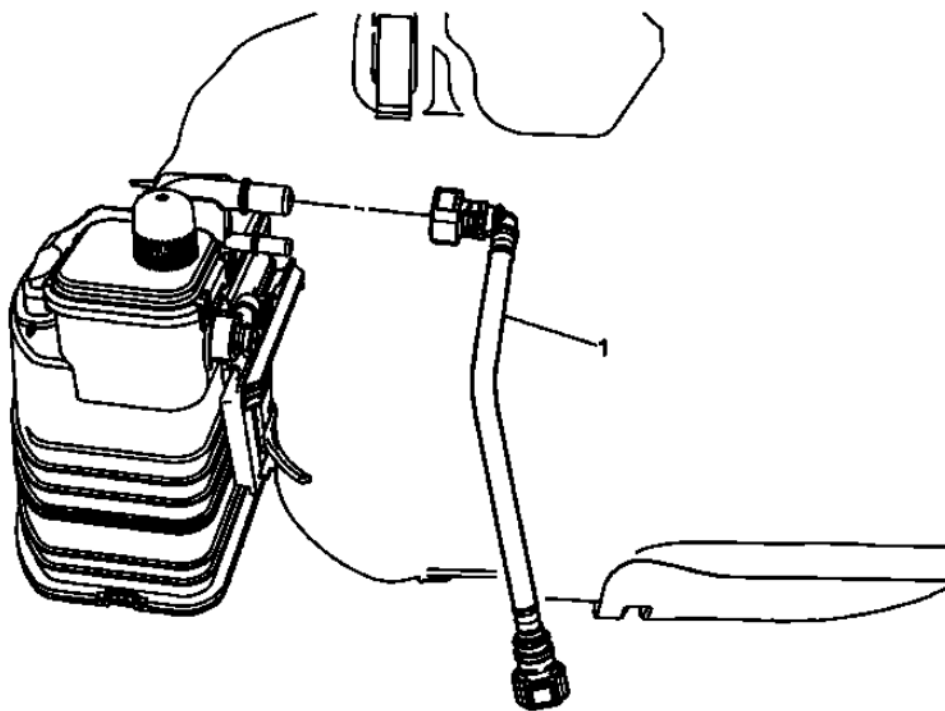


Fig. 95: Evaporative Emission Canister Purge Pipe
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Evaporative Emission Canister Purge Pipe Procedure Disconnect the evaporative emission quick connects. Refer to Fuel Tank Replacement .

EVAPORATIVE EMISSION CANISTER PURGE TUBE REPLACEMENT

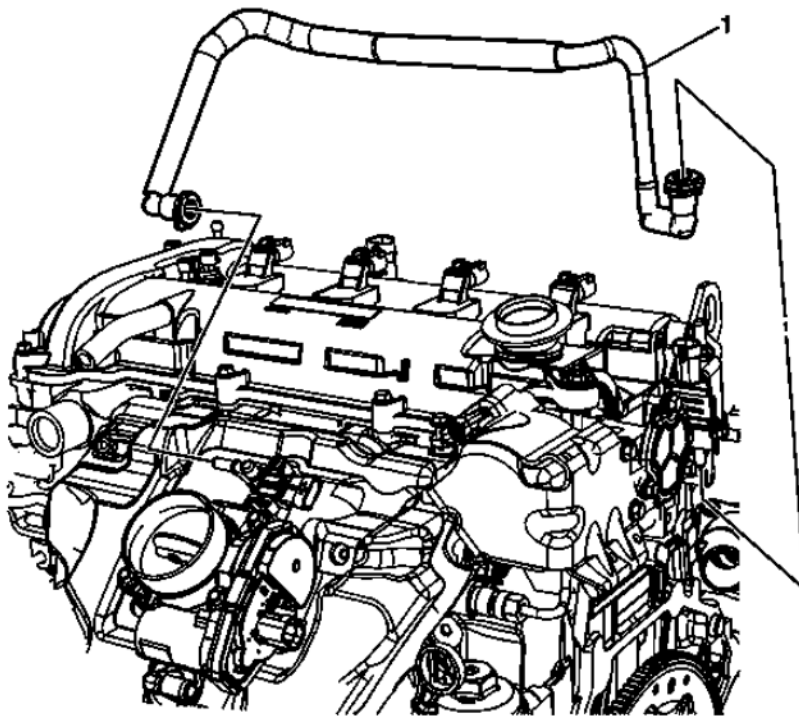


Fig. 96: Evaporative Emission Canister Purge Tube
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Purge Tube Replacement

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
2. Disconnect the plastic quick connectors. Refer to <u>Plastic Collar Quick Connect Fitting Service</u> .	
1	Evaporative Emission Canister Purge Tube

EVAPORATIVE EMISSION CANISTER SOLENOID REPLACEMENT

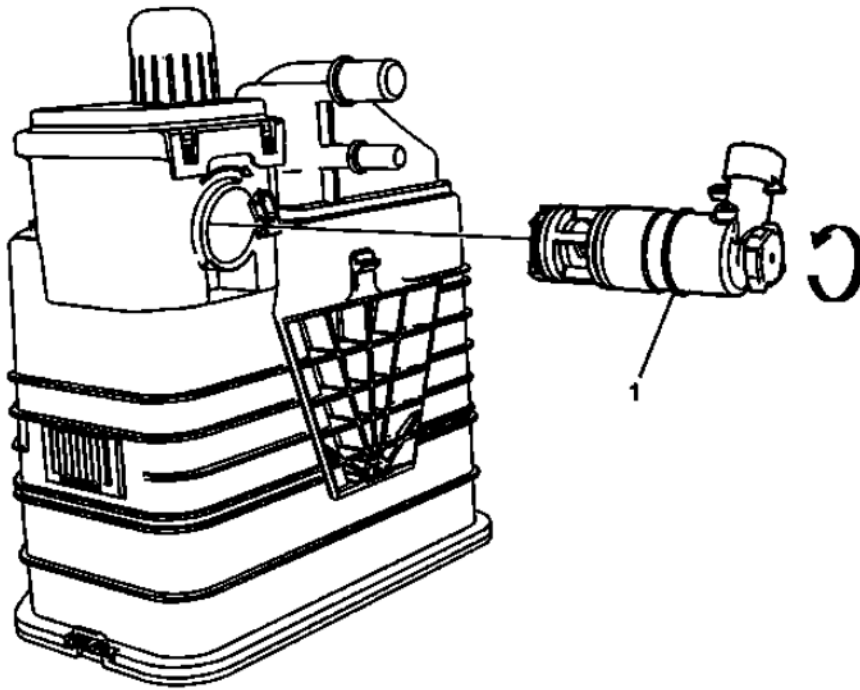


Fig. 97: Evaporative Emission Canister Vent Solenoid Valve
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Solenoid Replacement

Callout	Component Name
Preliminary Procedure Remove the carbon canister. Refer to <u>Evaporative Emission Canister Replacement</u> .	
1	Evaporative Canister Vent Solenoid Valve Procedure Disconnect the electrical connector.

EVAPORATIVE EMISSION LINE REPLACEMENT - ENGINE TO CHASSIS

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Glasses Warning .

1. Remove the Intake Manifold Cover. Refer to Intake Manifold Cover Replacement .
2. Disconnect the evaporative emission line from the canister purge solenoid valve. Refer to Plastic Collar Quick Connect Fitting Service.

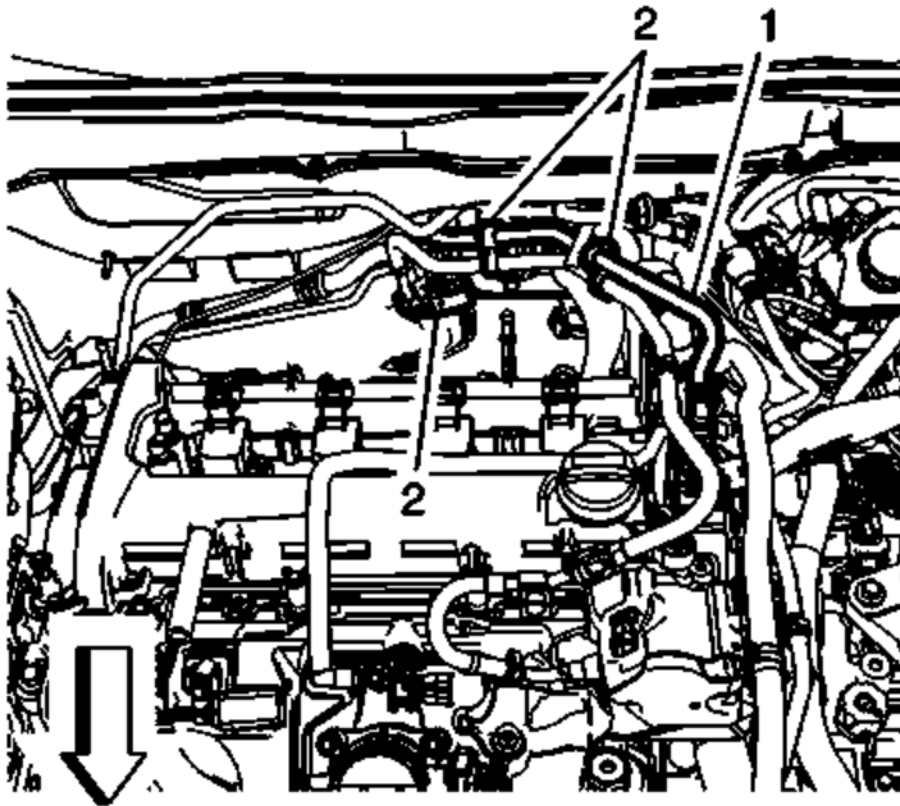


Fig. 98: Evaporative Emission Line
Courtesy of GENERAL MOTORS COMPANY

3. Remove the evaporative emission line (1) from the retainers (2).
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the underbody front air deflector. Refer to **Underbody Front Air Deflector Replacement - Left Side** .
6. Remove the underbody rear air deflector. Refer to **Underbody Rear Air Deflector Replacement - Left Side** .
7. Disconnect the evaporative emission line from the evaporative emission canister purge pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.

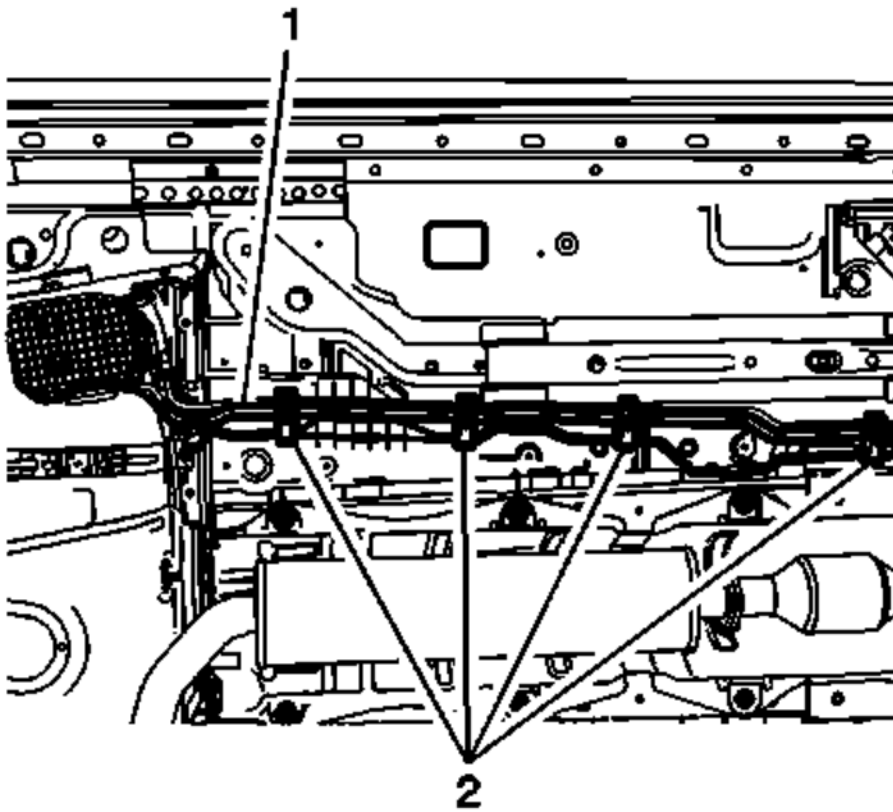


Fig. 99: Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the evaporative emission line (1) from the brake bundle retainers (2) and remove the line from the vehicle.

Installation Procedure

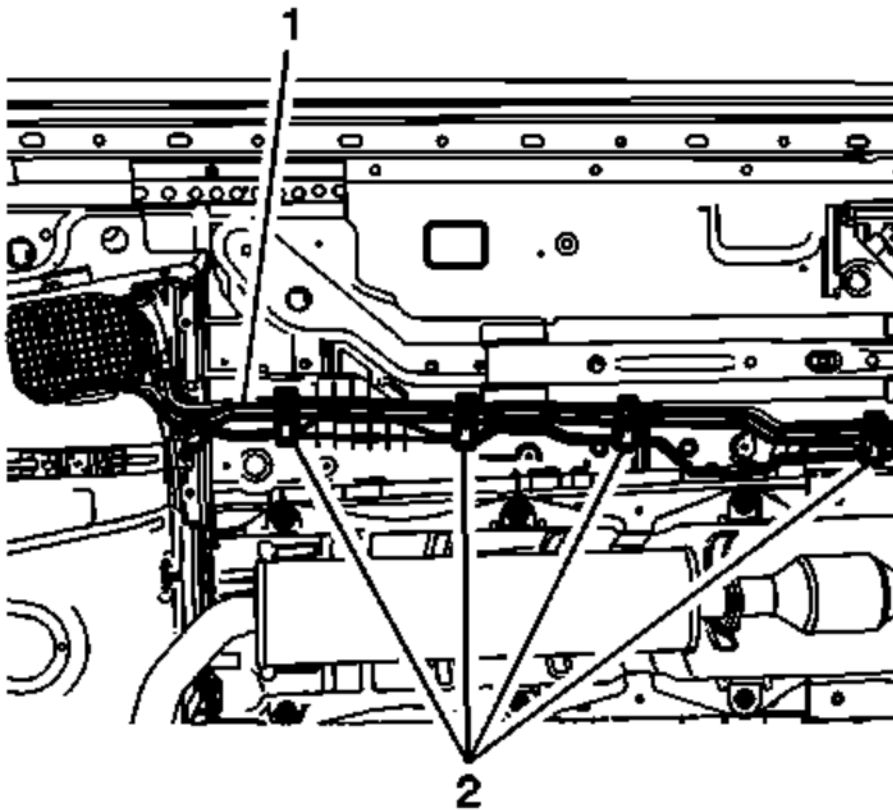


Fig. 100: Evaporative Emission Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission line (1) and connect the brake bundle retainers (2).
2. Connect the evaporative emission line to the canister purge pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Install the underbody rear air deflector. Refer to **Underbody Rear Air Deflector Replacement - Left Side**.
4. Install the underbody front air deflector. Refer to **Underbody Front Air Deflector Replacement - Left Side**.
5. Lower the vehicle.

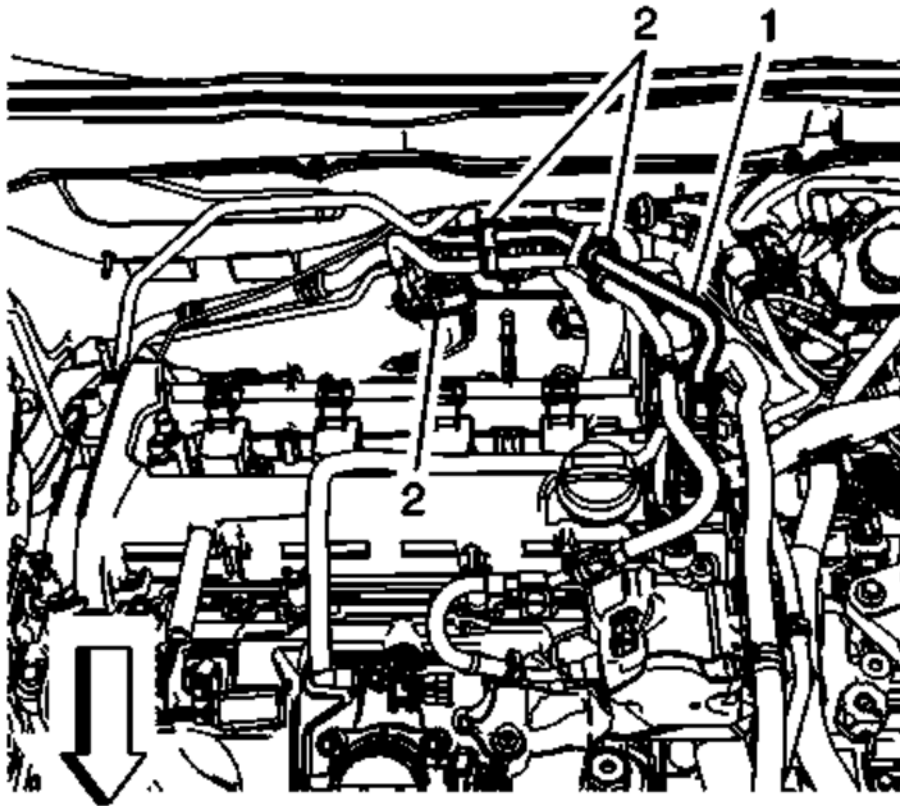


Fig. 101: Evaporative Emission Line
Courtesy of GENERAL MOTORS COMPANY

6. Install the evaporative emission line (1) into the retainers (2).
7. Connect the evaporative emission line to the canister purge solenoid valve. Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Install the Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement** .

EVAPORATIVE EMISSION CANISTER REPLACEMENT

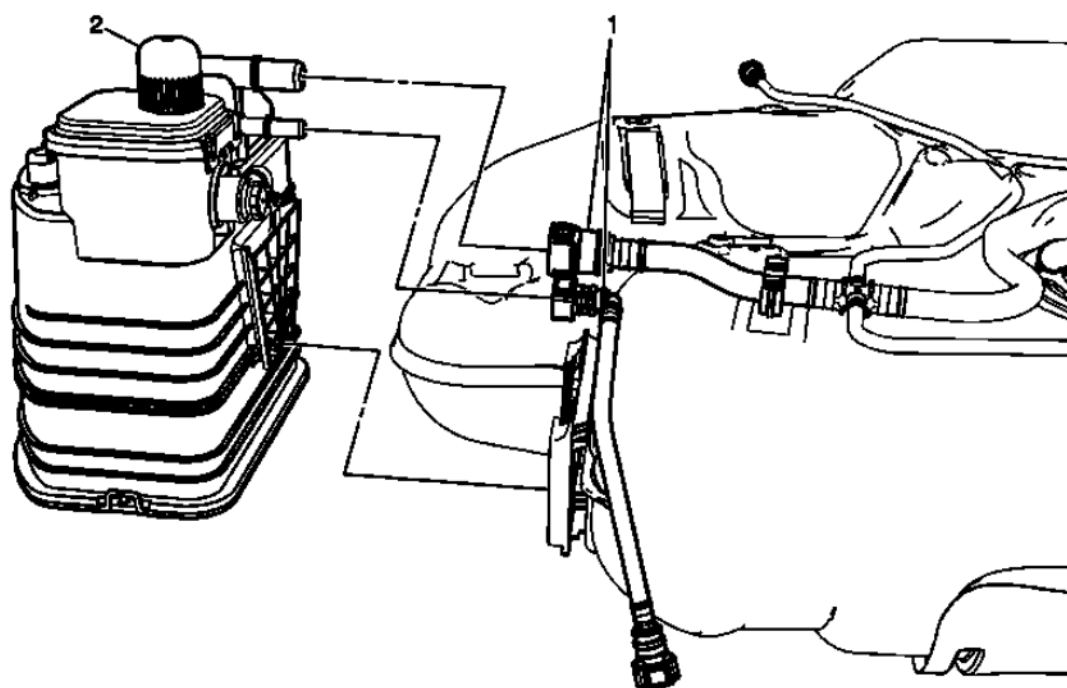


Fig. 102: Evaporative Emission Canister & Hoses
 Courtesy of GENERAL MOTORS COMPANY

Evaporative Emission Canister Replacement

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Evaporative Emission Hose (Qty: 2) Procedure Disconnect the quick connects. Refer to Plastic Collar Quick Connect Fitting Service .
2	Evaporative Emission Canister Procedure 1. Disconnect the electrical connector. 2. Release the retaining tab.

EVAPORATIVE EMISSION SYSTEM CLEANING

Special Tools

J 41413-200 Evaporative Emission System Tester

For equivalent regional tools, refer to **Special Tools** .

Inspection Procedure

CAUTION: Use the Evaporative Emission (EVAP) System Tester (EEST) GE 41413-A in order to provide a clean, dry, low pressure nitrogen gas source. Do not substitute any other pressurized source, gas or otherwise. Damage may result to the EVAP system, test equipment or cause a safety risk.

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.
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** evaporative emission system tester.
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.
13. Return to the diagnostic table that sent you here.

IGNITION COIL REPLACEMENT

Removal Procedure

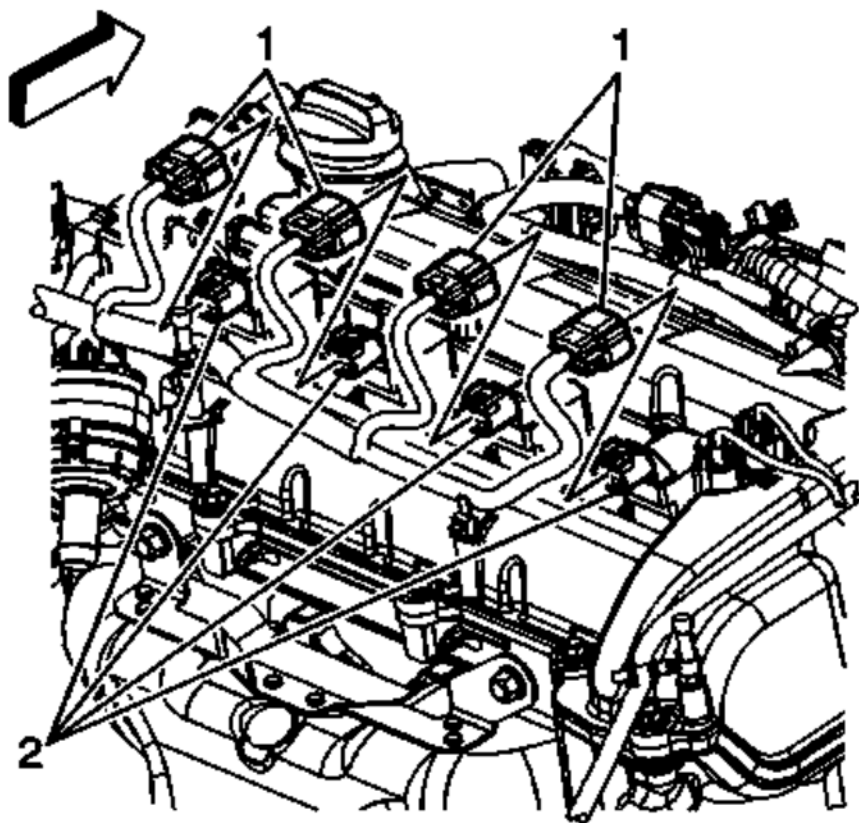


Fig. 103: View Of Ignition Coils & Connectors
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Disconnect the engine wiring harness electrical connectors (1) from the ignition coil(s) (2).

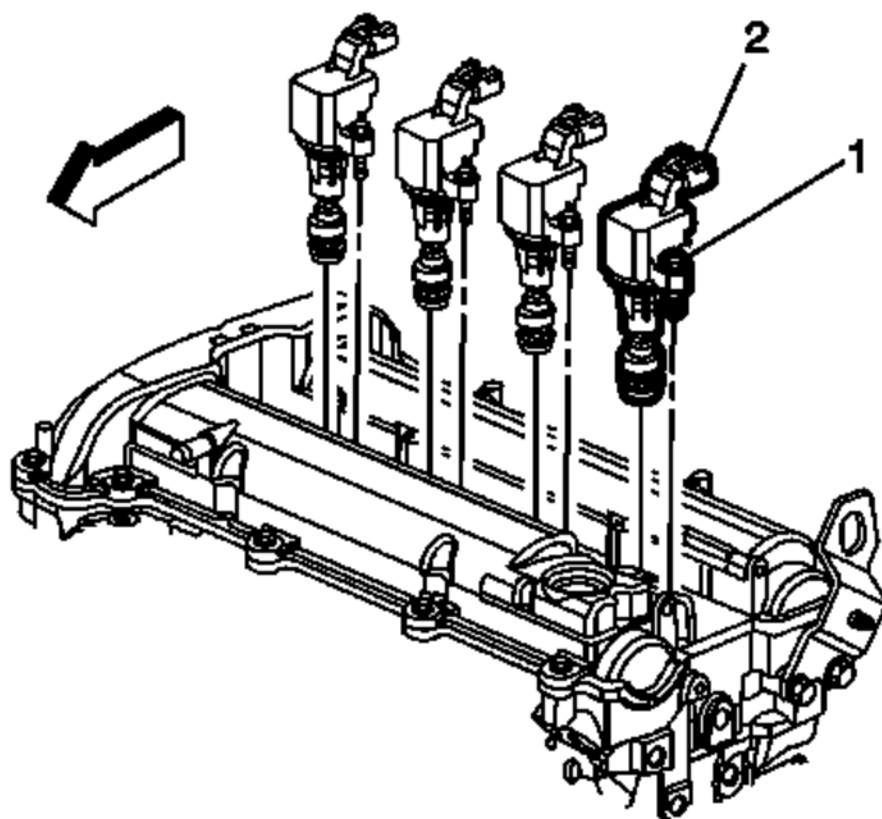


Fig. 104: Ignition Coil Bolts

Courtesy of GENERAL MOTORS COMPANY

3. Remove the ignition coil bolt(s) (1).
4. Remove the ignition coil(s) (2).

Installation Procedure

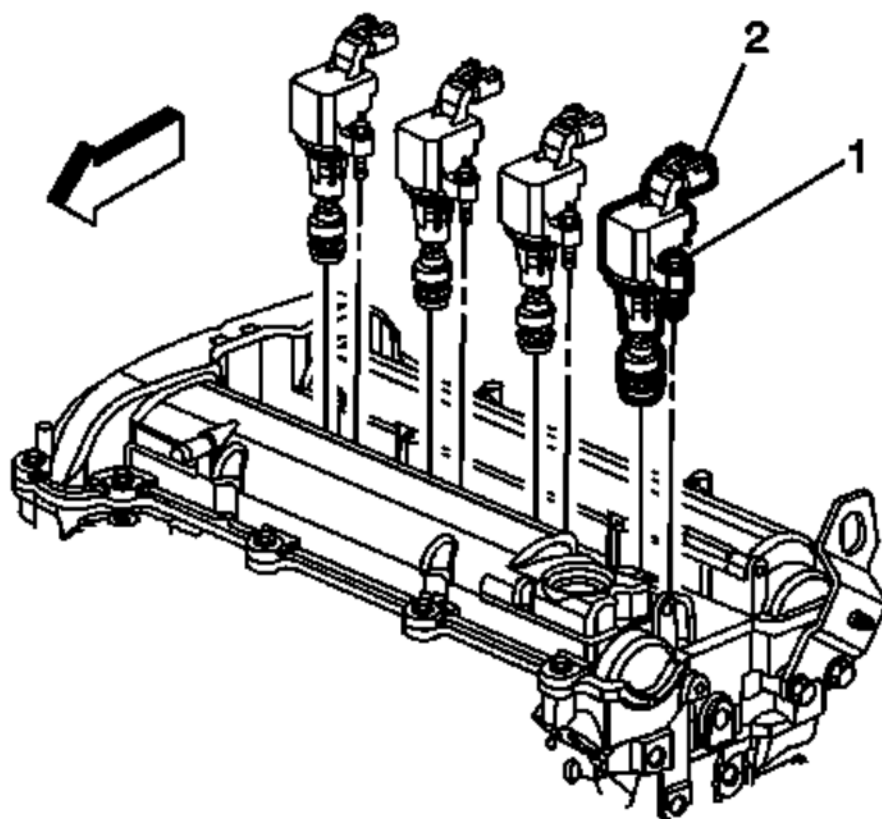


Fig. 105: Ignition Coil Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil(s) (2).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s) (1) and tighten to 10 N.m (89 lb in).

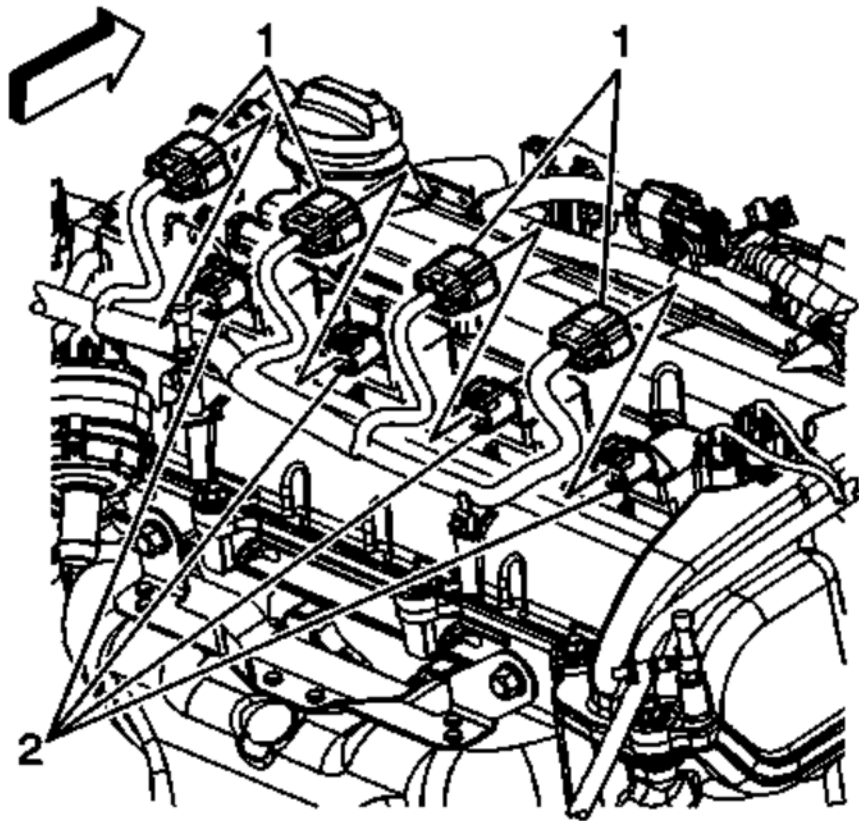


Fig. 106: View Of Ignition Coils & Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine wiring harness electrical connector(s) (1) to the ignition coil(s) (2).
4. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

SPARK PLUG REPLACEMENT

Removal Procedure

CAUTION: This engine has aluminum cylinder heads. Do not remove the spark plugs from a hot engine, allow it to cool first. Removing the spark plugs from a hot engine may cause spark plug thread damage or cylinder head damage.

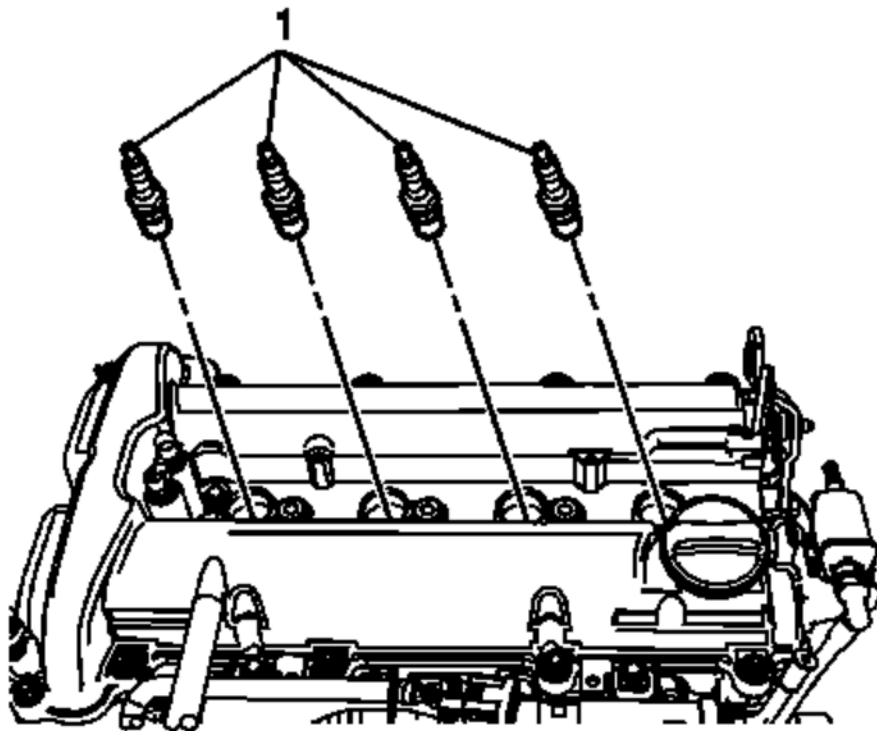


Fig. 107: Spark Plugs

Courtesy of GENERAL MOTORS COMPANY

1. Remove the ignition coil(s). Refer to Ignition Coil Replacement.

NOTE: Make sure that any water and/or debris is blown out of the spark plug holes prior to removing the spark plugs.

2. Remove the spark plugs (1) using a 5/8 inch spark plug socket.

Installation Procedure

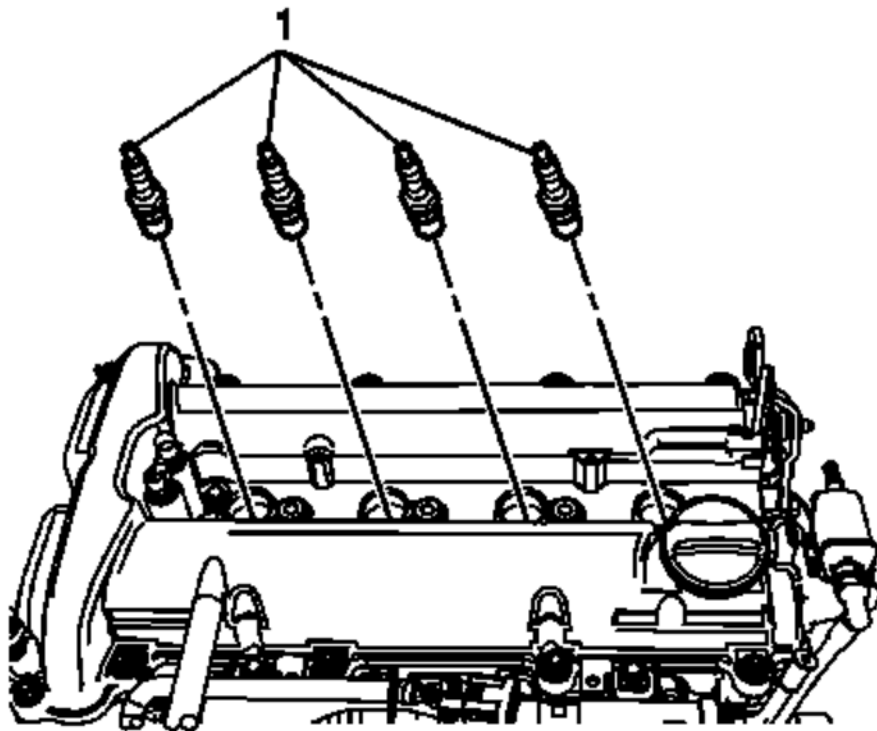


Fig. 108: Spark Plugs

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

CAUTION: Do not coat spark plug threads with anti-seize compound. If anti-seize compound is used and spark plugs are over-torqued, damage to the cylinder head threads may result.

1. Install the spark plugs (1).

Specification

The spark plug gap is 1.0 mm (0.040 in).

Tighten

Tighten the plugs to 20 N.m (15 lb ft).

2. Install the ignition coil(s). Refer to Ignition Coil Replacement.

SPARK PLUG INSPECTION

Spark Plug Usage

- Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to the Electronic Parts Catalog.
- 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

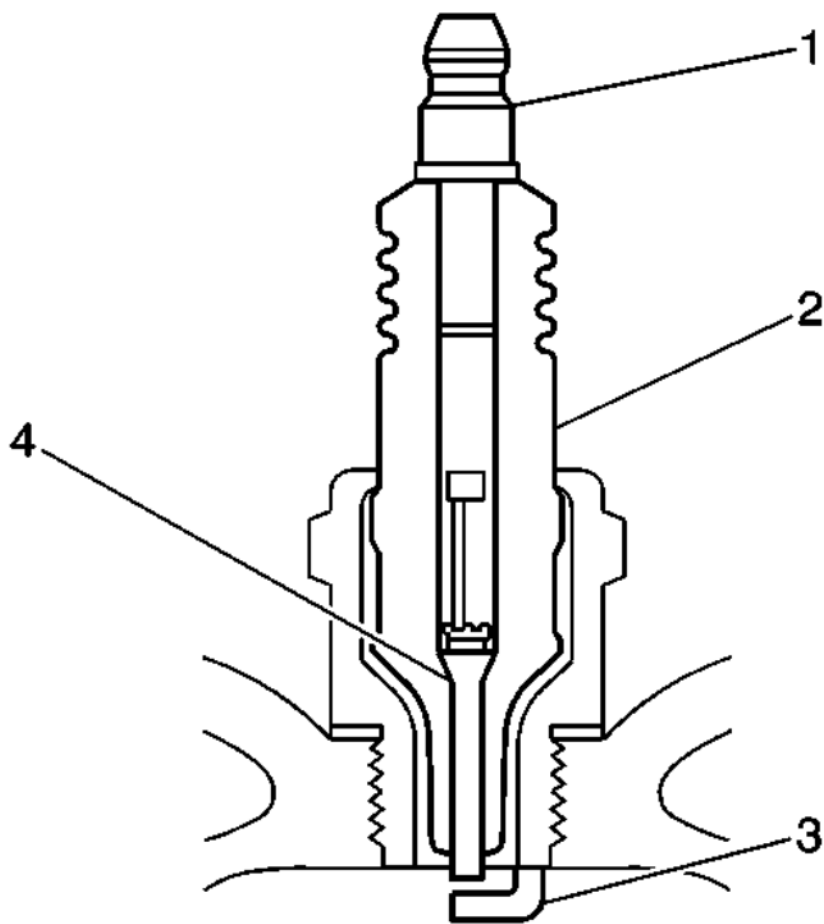


Fig. 109: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

- 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.

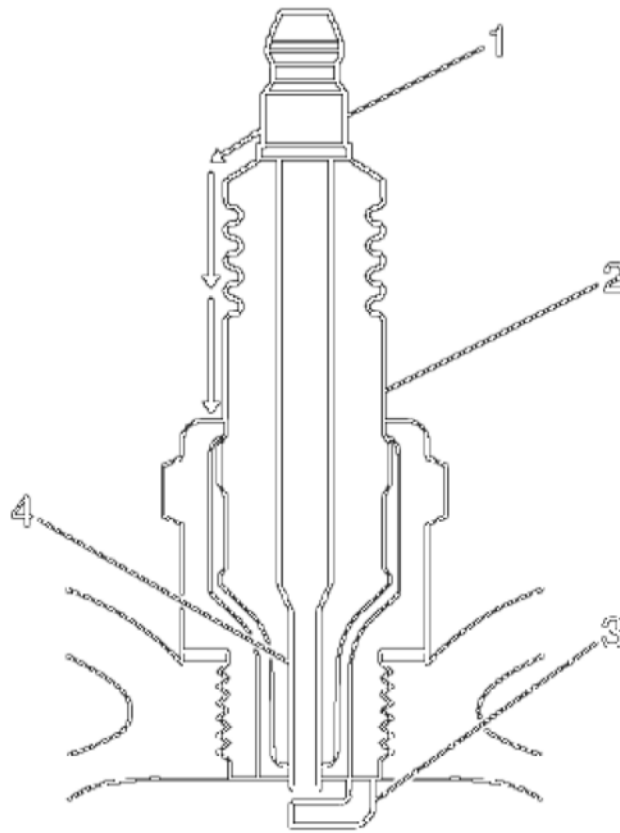


Fig. 110: Identifying Points For Inspecting Spark Plug For Flashover Or Carbon Tracking Soot
Courtesy of GENERAL MOTORS COMPANY

- 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.

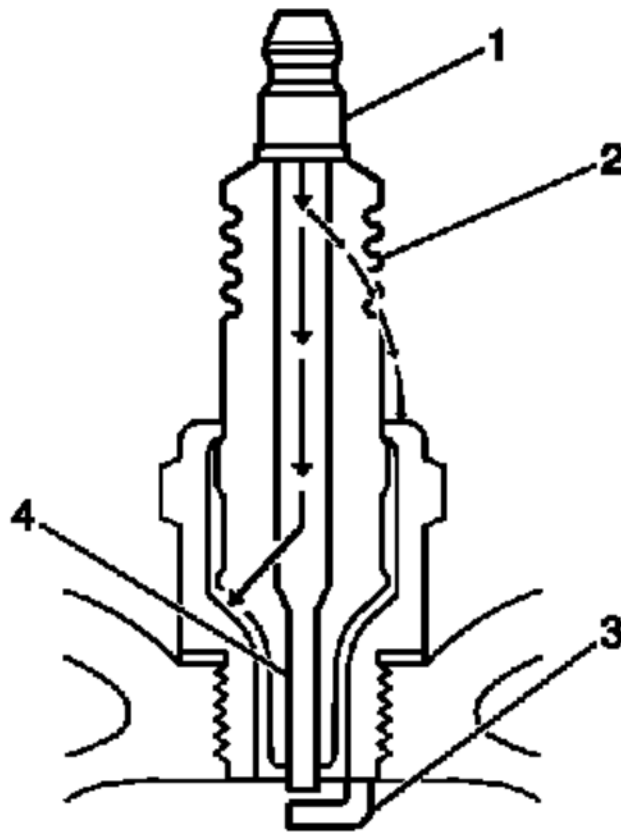


Fig. 111: Inspecting Spark Plug Insulator
Courtesy of GENERAL MOTORS COMPANY

- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).

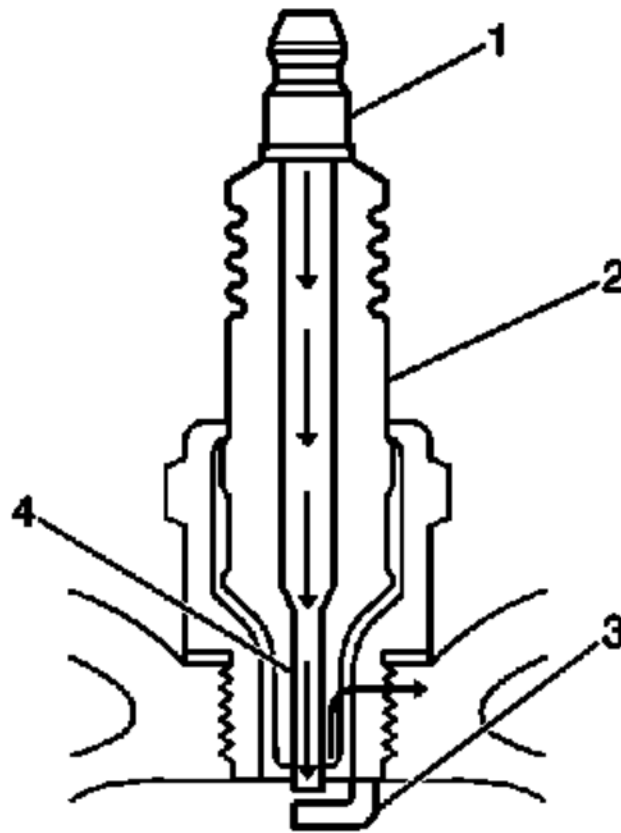


Fig. 112: Cutaway/Description View Of Spark Plug
 Courtesy of GENERAL MOTORS COMPANY

- 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.

CRANKSHAFT POSITION SENSOR REPLACEMENT

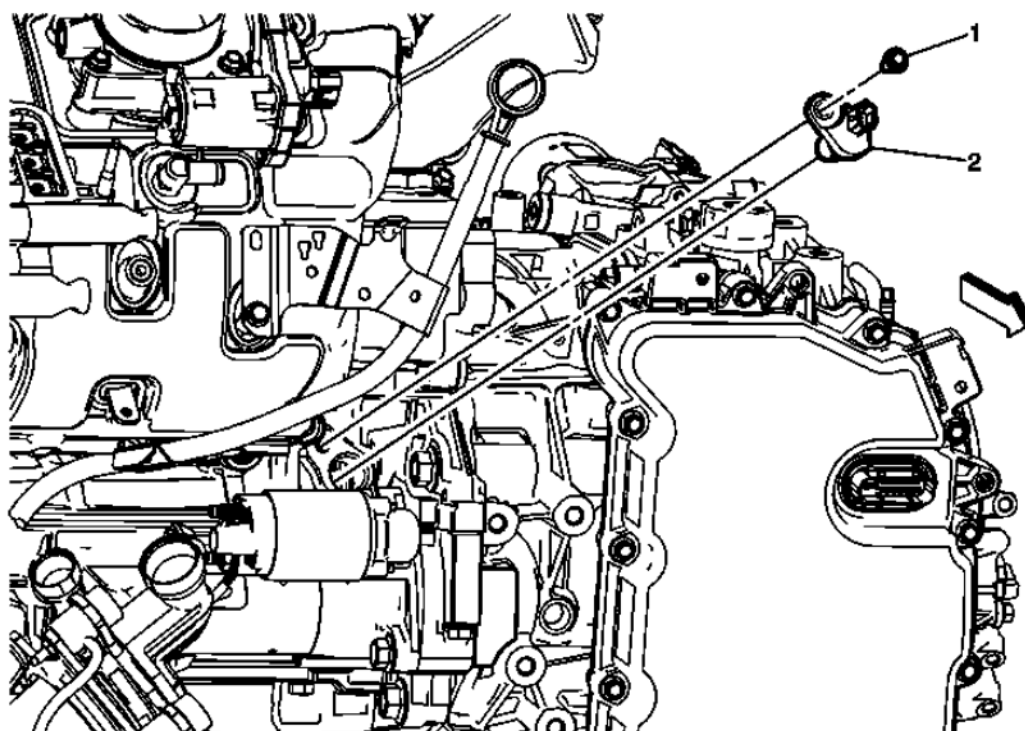


Fig. 113: Crankshaft Position Sensor
 Courtesy of GENERAL MOTORS COMPANY

Crankshaft Position Sensor Replacement

Callout	Component Name
Preliminary Procedure 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 3. Remove the starter motor. Refer to <u>Starter Replacement (LUK)</u> .	
1	Crankshaft Position Sensor Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Crankshaft Position Sensor Procedure 1. Disconnect the electrical connector.

2. Perform the crank position sensor variation learn. Refer to [Control Module References](#) .

CAMSHAFT POSITION SENSOR REPLACEMENT - INTAKE

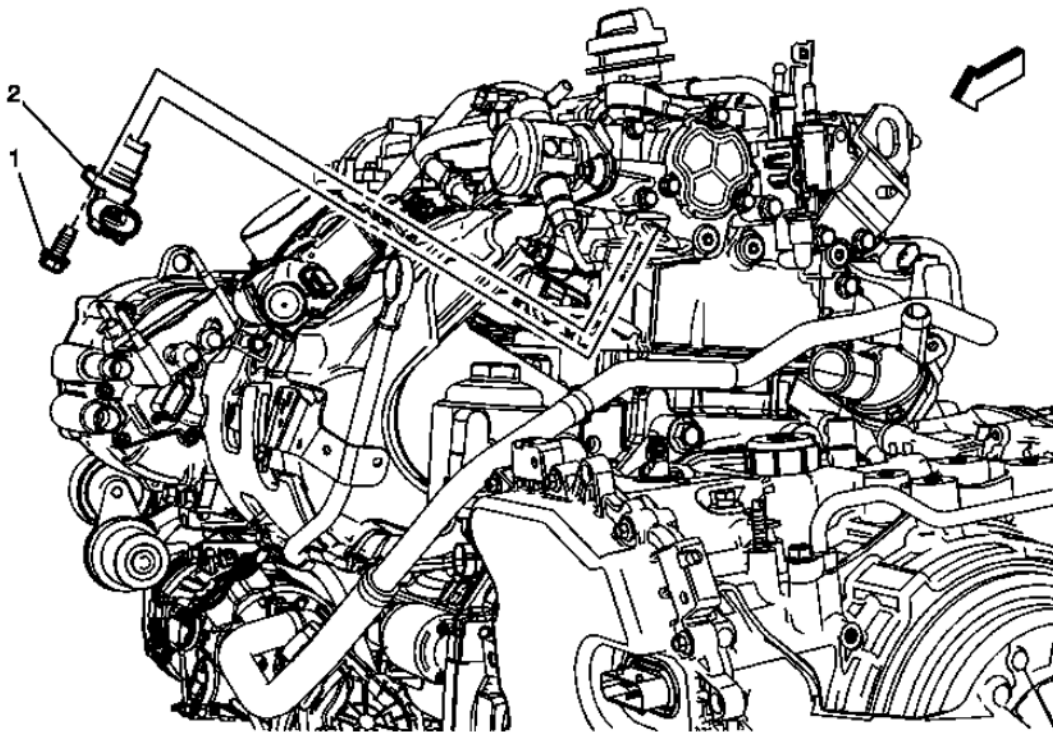


Fig. 114: Camshaft Position Sensor - Intake
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Replacement - Intake

Callout	Component Name
Preliminary Procedure Remove and reposition the engine control module. Refer to Engine Control Module Replacement . It is not necessary to disconnect the harness connectors.	
1	Camshaft Position Sensor Fastener CAUTION: Refer to Fastener Caution Tighten 10 (89 lb in)
2	Camshaft Position Sensor Procedure Disconnect the electrical connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - EXHAUST

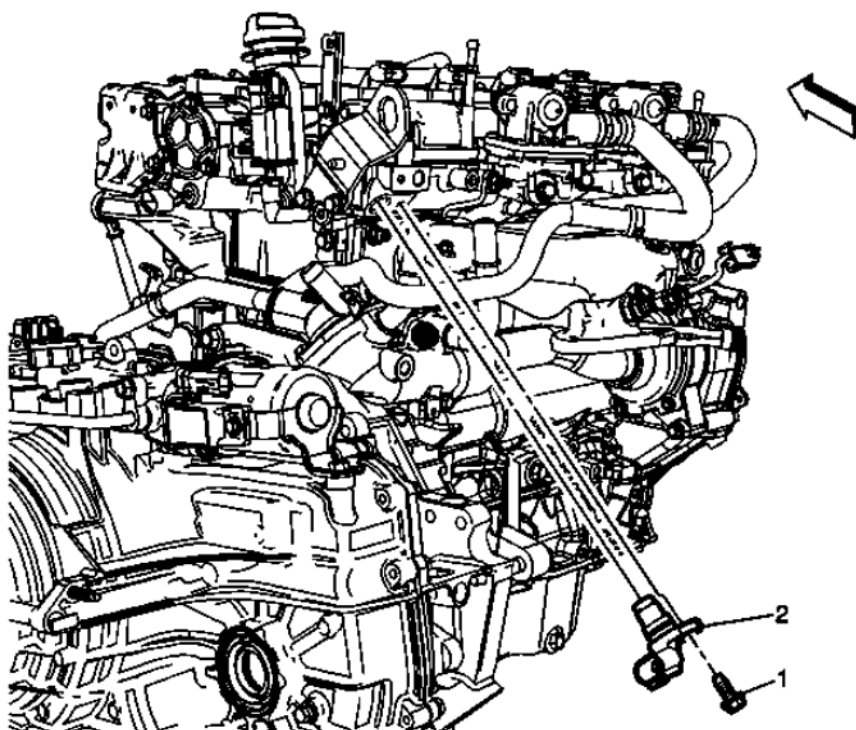


Fig. 115: Camshaft Position Sensor - Exhaust
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Replacement - Exhaust

Callout	Component Name
Preliminary Procedures Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Camshaft Position Sensor Exhaust Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
2	Camshaft Position Sensor Exhaust Procedure Disconnect the electrical connector.

CAMSHAFT POSITION ACTUATOR EXHAUST SOLENOID VALVE REPLACEMENT

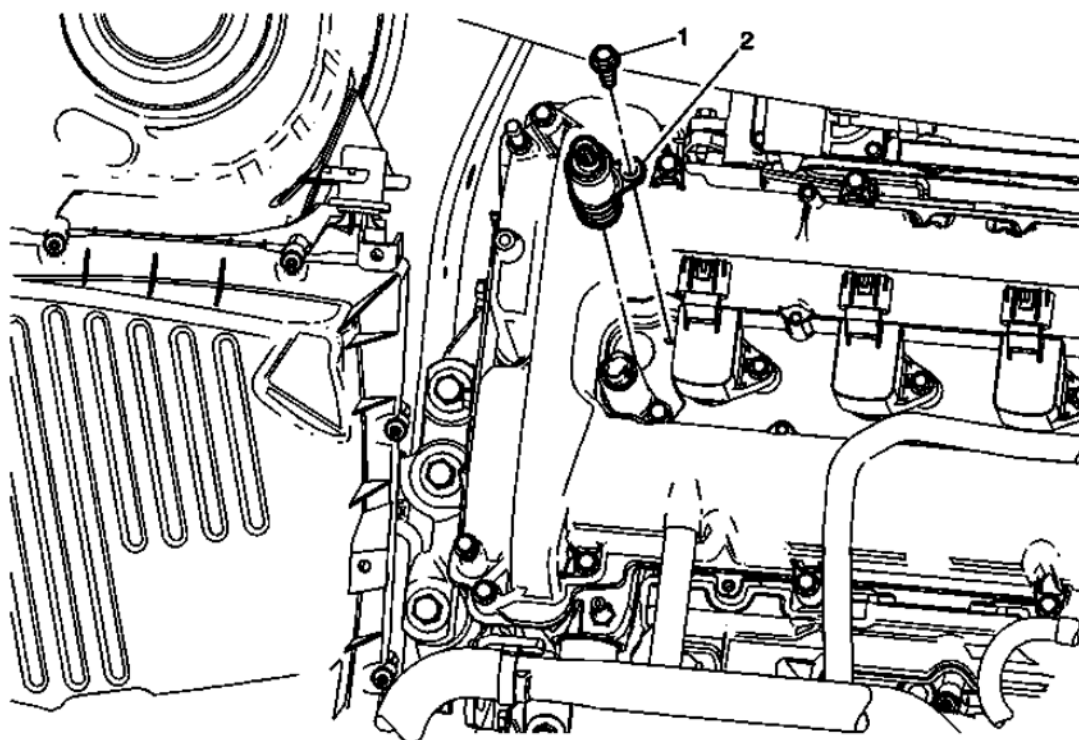


Fig. 116: Camshaft Position Actuator Exhaust Solenoid Valve
 Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Actuator Exhaust Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>	
1	Camshaft Position Actuator Exhaust Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> Tighten 10 N.m (89 lb in)
2	Camshaft Position Actuator Exhaust Solenoid Valve Procedure 1. Disconnect the camshaft position actuator solenoid valve harness connector. 2. Clean the cylinder head mating surfaces before assembly. 3. Lubricate the camshaft position actuator solenoid valve O-ring seals with clean engine oil.

CAMSHAFT POSITION ACTUATOR INTAKE SOLENOID VALVE REPLACEMENT

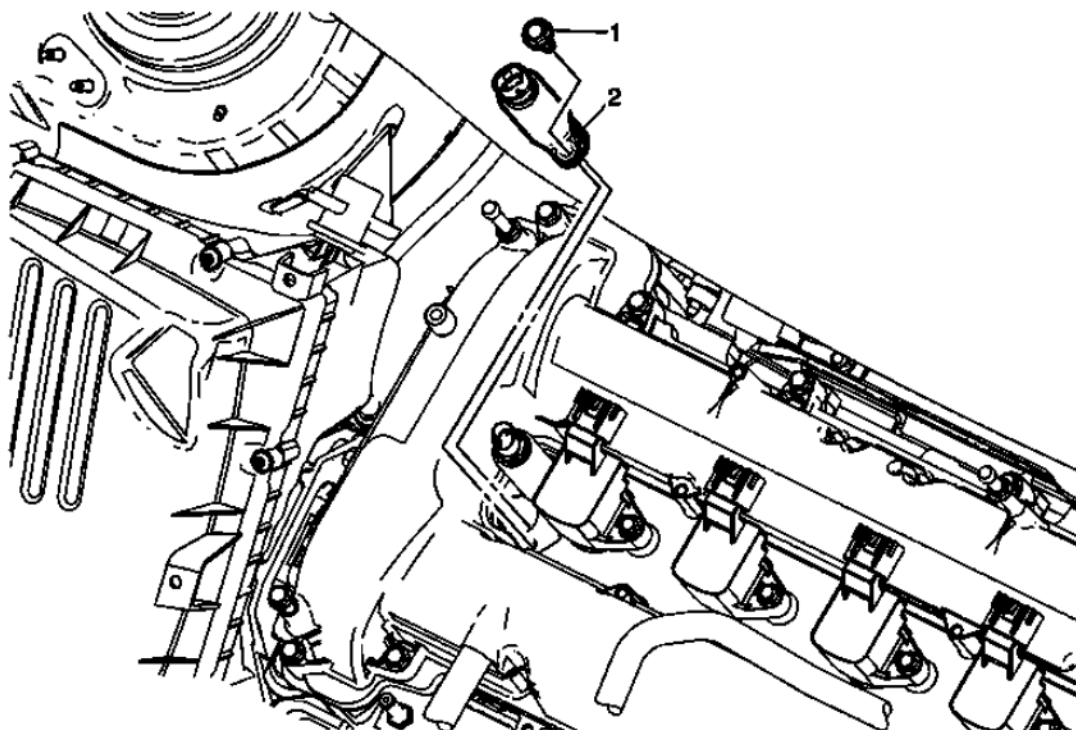


Fig. 117: Camshaft Position Actuator Intake Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Actuator Intake Solenoid Valve Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u>	
1	Camshaft Position Actuator Intake Solenoid Valve Fastener CAUTION: Refer to <u>Fastener Caution</u> Tighten 10 N.m (89 lb in)
2	Camshaft Position Actuator Intake Solenoid Valve Procedure 1. Disconnect the camshaft position actuator solenoid valve harness connector. 2. Clean the cylinder head mating surfaces before assembly.

3. Lubricate the camshaft position actuator solenoid valve O-ring seals with clean engine oil.

KNOCK SENSOR REPLACEMENT

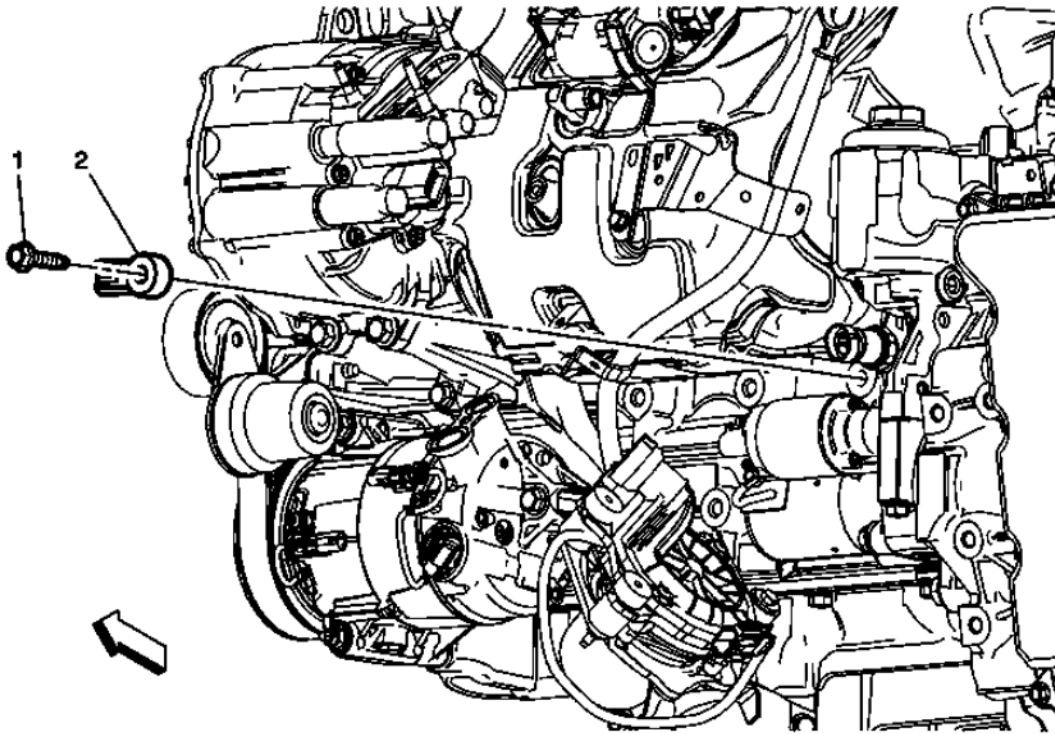


Fig. 118: Knock Sensor & Bolt
Courtesy of GENERAL MOTORS COMPANY

Knock Sensor Replacement

Callout	Component Name
Preliminary Procedure 1. Disconnect the negative battery cable. Refer to <u>Battery Negative Cable Disconnection and Connection</u> . 2. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 3. Disconnect and reposition the battery positive cable from the starter. Refer to <u>Starter Replacement (LUK)</u> .	
1	Knock Sensor Bolt CAUTION: Refer to <u>Fastener Caution</u> . Tighten

	28 N.m(18 lb in)
2	Knock Sensor Procedure Disconnect the electrical connector.

SECONDARY AIR INJECTION CHECK VALVE REPLACEMENT - LEFT SIDE

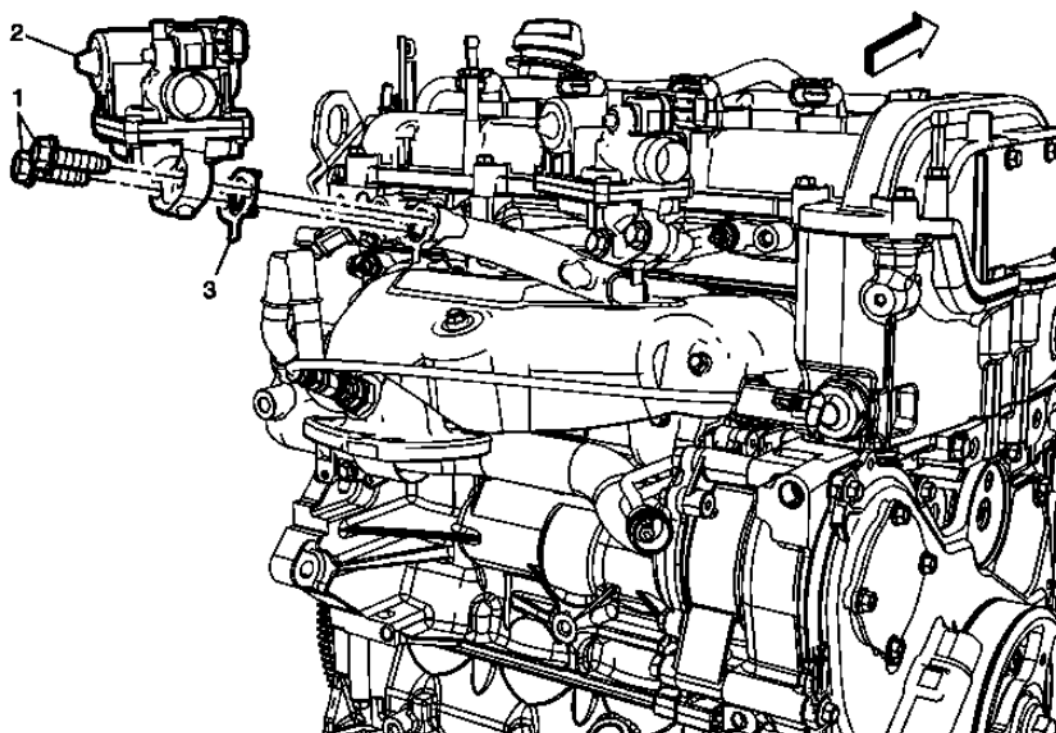


Fig. 119: Secondary Air Injection Check Valve - Left Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Check Valve Replacement - Left Side

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Disconnect the secondary air injection pipe hose from the secondary air injection check valve.	
1	Secondary Air Injection Check Valve Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)

2	Secondary Air Injection Check Valve Procedure Disconnect the electrical connector.
3	Secondary Air Injection Check Valve Gasket

SECONDARY AIR INJECTION CHECK VALVE REPLACEMENT - RIGHT SIDE

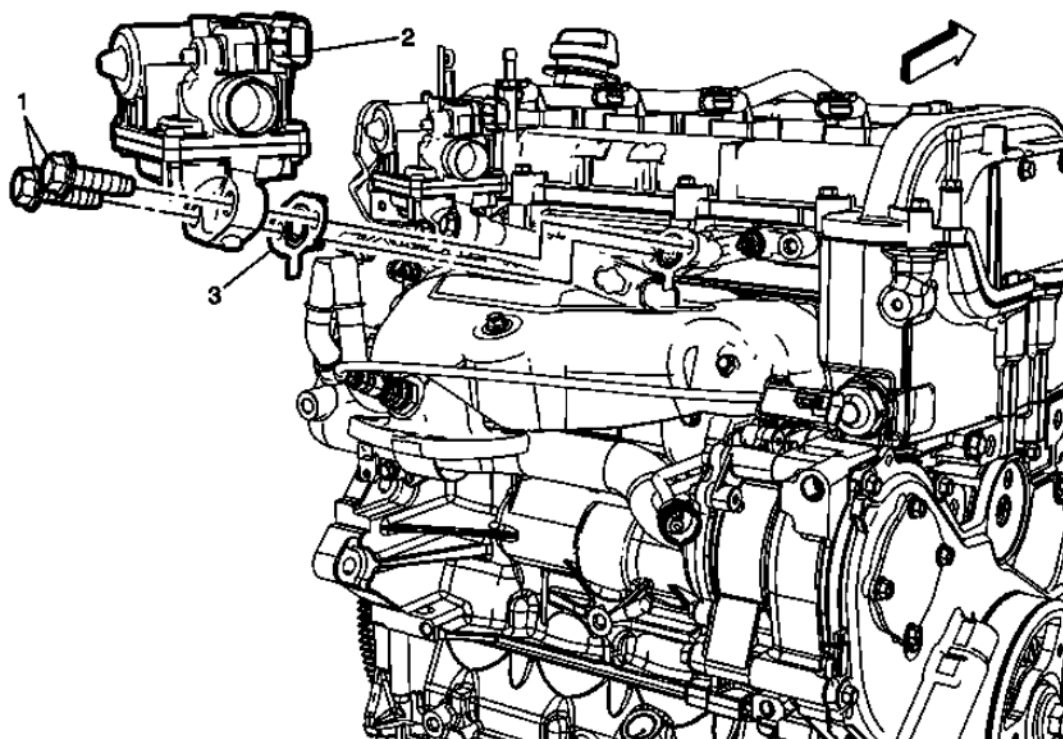


Fig. 120: Secondary Air Injection Check Valve Pipe, Bolts & Nuts - Right Side (LUK)
Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Check Valve Replacement - Right Side

Callout	Component Name
Preliminary Procedure	
1. Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> . 2. Disconnect the secondary air injection pipe hose from the secondary air injection check valve.	
1	Secondary Air Injection Check Valve Bolt (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)

2	Secondary Air Injection Check Valve Procedure Disconnect the electrical connector.
3	Secondary Air Injection Check Valve Gasket

SECONDARY AIR INJECTION CHECK VALVE PIPE ADAPTER REPLACEMENT - LEFT SIDE

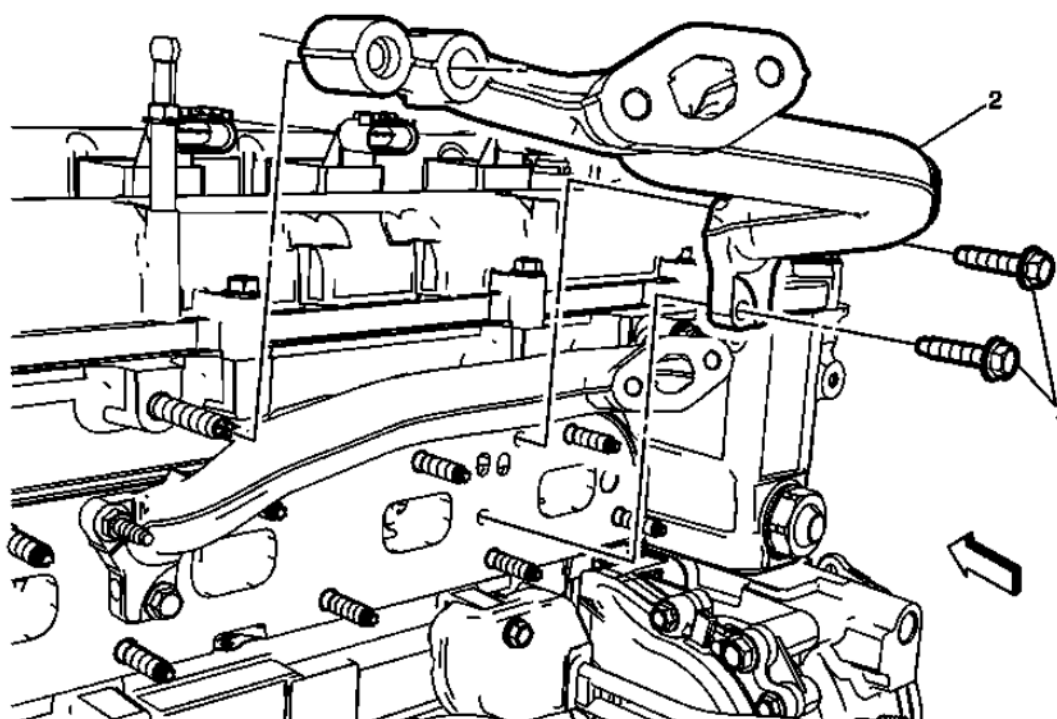


Fig. 121: Secondary Air Injection Check Valve Pipe Adapter - Left Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Check Valve Pipe Adapter Replacement - Left Side

Callout	Component Name
Preliminary Procedure	
1. Remove the secondary air injection check valve bracket. Refer to Secondary Air Injection Check Valve Bracket Replacement .	
2. Remove the exhaust manifold. Refer to Exhaust Manifold Replacement (LUK)	
1	Secondary Air Injection Check Valve Pipe Adapter Fastener (Qty: 2) Tighten 10 (89 lb in)
	Secondary Air Injection Check Valve Pipe Adapter Procedure 1. Remove the right secondary air injection check valve pipe adaptor.

Refer to Secondary Air Injection Check Valve Pipe Adapter Replacement - Right Side

2. Install a new exhaust manifold gasket.

2

NOTE:

The secondary air injection check valve pipe adaptors share the use of the exhaust manifold gasket. Both adaptors must be removed in order to replace the exhaust manifold gasket.

SECONDARY AIR INJECTION CHECK VALVE PIPE ADAPTER REPLACEMENT - RIGHT SIDE

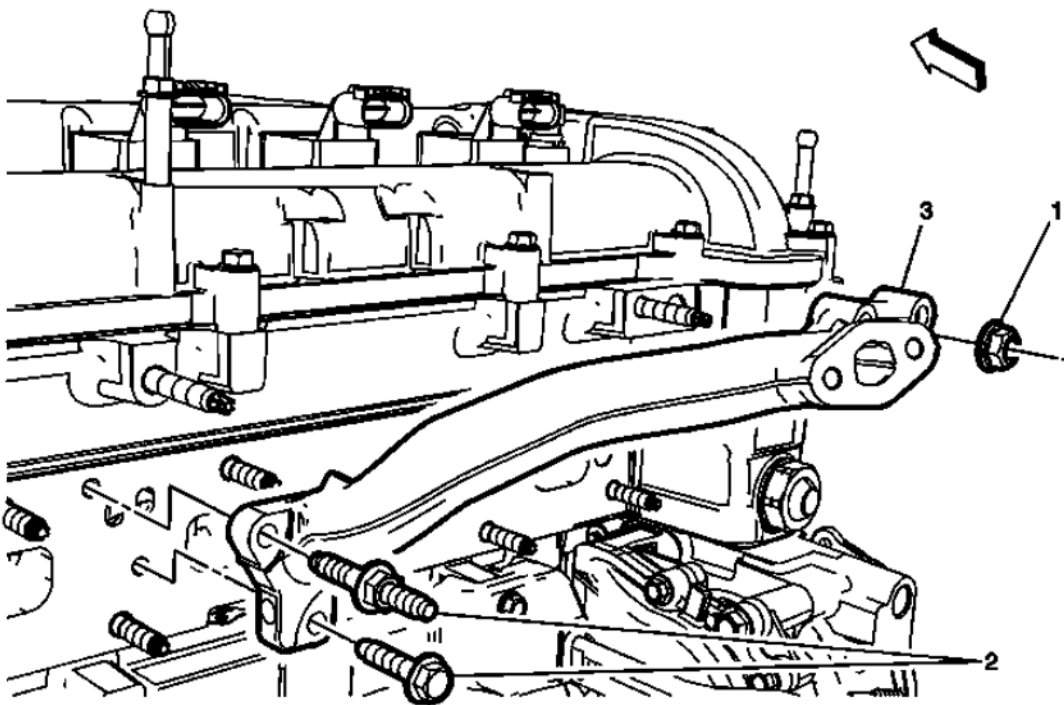


Fig. 122: Secondary Air Injection Check Valve Pipe Adapter - Right Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Check Valve Pipe Adapter Replacement - Right Side

Callout	Component Name
Preliminary Procedure	
Remove the left secondary air injection check valve pipe adaptor. Refer to <u>Secondary Air Injection Check Valve Pipe Adapter Replacement - Left Side</u> .	
1	Secondary Air Injection Check Valve Pipe Adapter Fastener Tighten 25 (18 lb ft)
2	Secondary Air Injection Check Valve Pipe Adapter Fastener (Qty: 2) Tighten 10 (89 lb in)

SECONDARY AIR INJECTION CHECK VALVE BRACKET REPLACEMENT

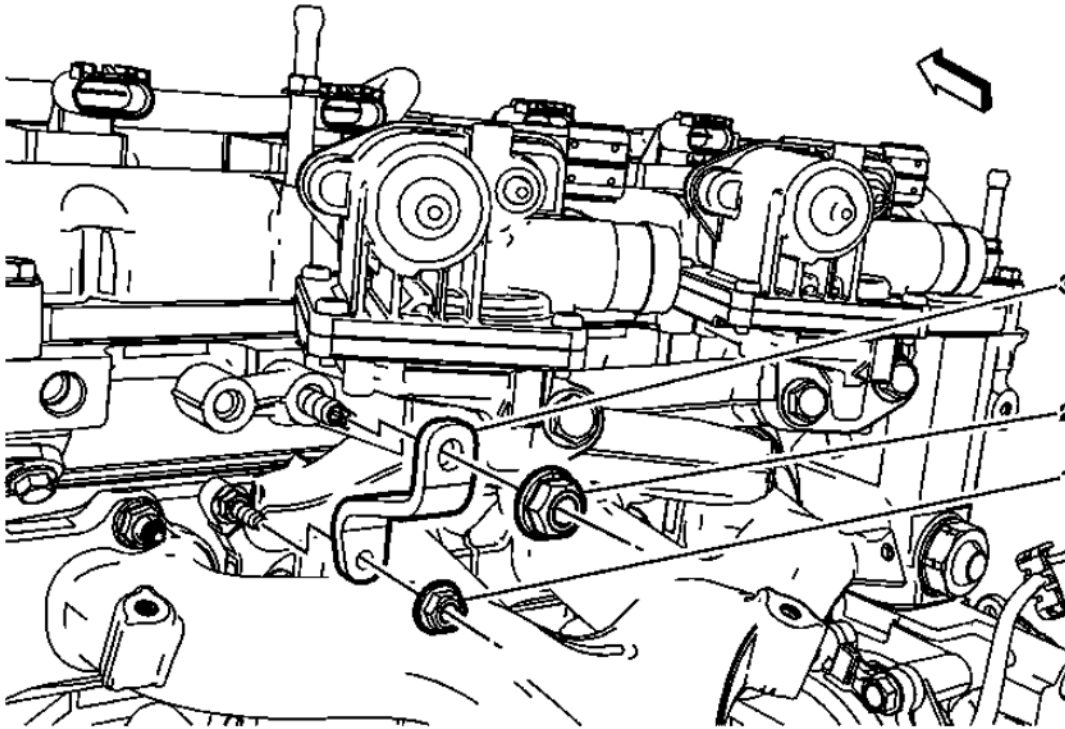


Fig. 123: Secondary Air Injection Check Valve Bracket & Fasteners (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Check Valve Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to <u>Intake Manifold Cover Replacement</u> .	
1	Secondary Air Injection Check Valve Bracket Upper Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 25 (18 lb ft)
2	Secondary Air Injection Check Valve Bracket Lower Fastener Tighten 10 (89 lb in)
3	Secondary Air Injection Check Valve Bracket

SECONDARY AIR INJECTION PIPE REPLACEMENT

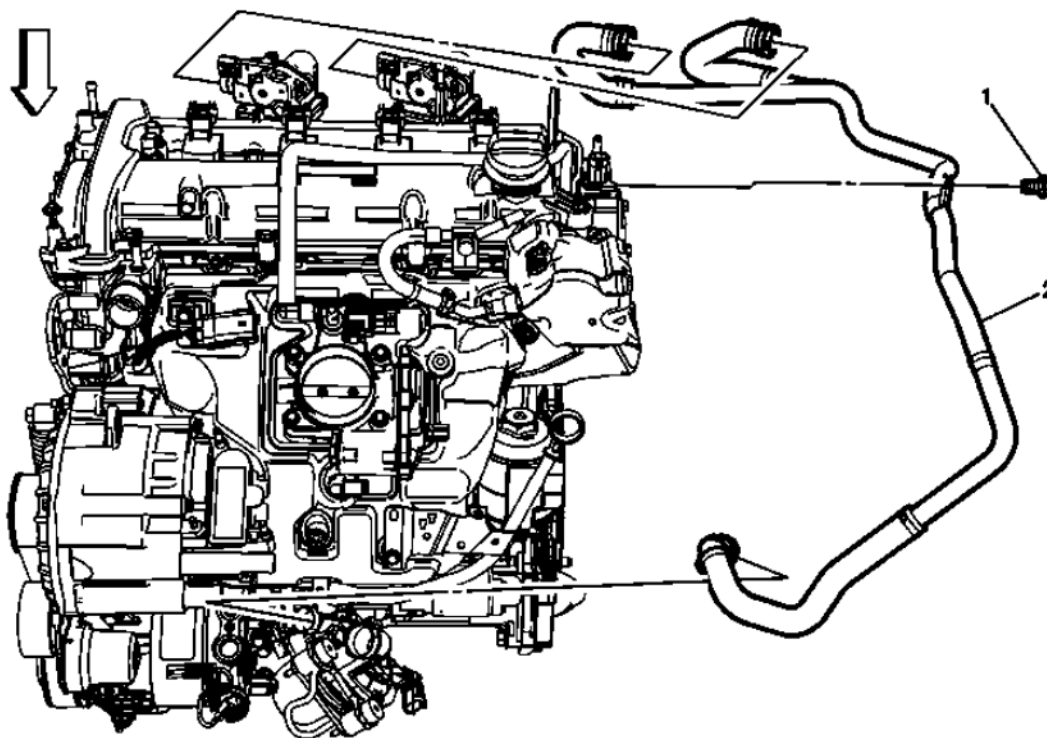


Fig. 124: Secondary Air Injection Check Valve Pipe & Fastener (LUK)
 Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Pipe Replacement

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .	
1	Secondary Air Injection Pipe Fastener CAUTION: Refer to Fastener Caution . Tighten 22 N.m (16 lb ft).
2	Secondary Air Injection Pipe Procedure Disconnect the quick connect fittings by squeezing both sides.

SECONDARY AIR INJECTION PUMP INLET HOSE REPLACEMENT

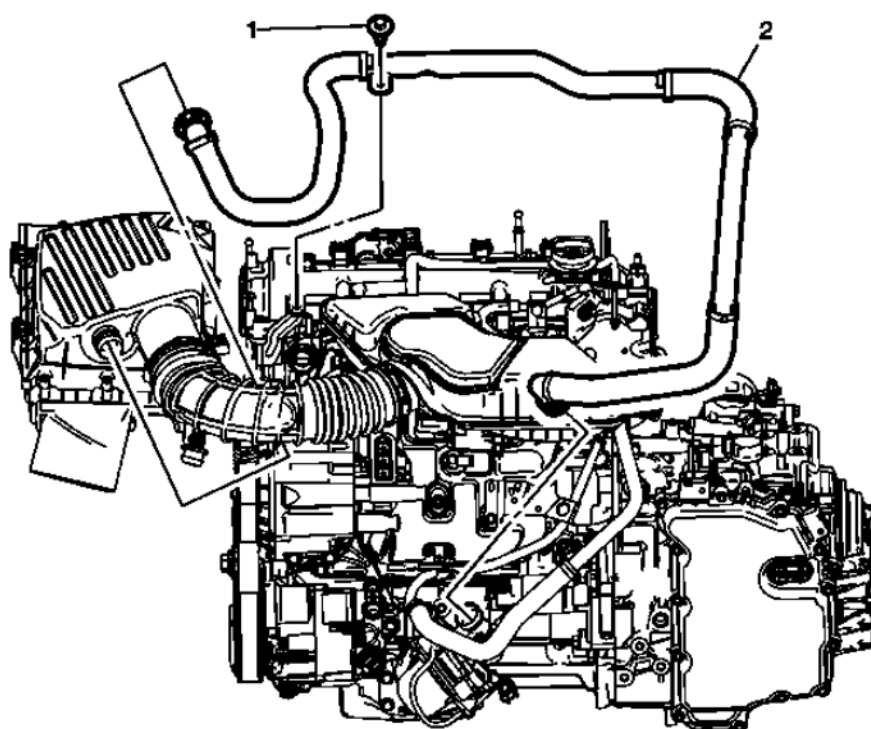


Fig. 125: Secondary Air Injection Pump Inlet Hose & Fastener
 Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Pump Inlet Hose Replacement

Callout	Component Name
1	Secondary Air Injection Inlet Pump Hose Fastener CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m(16 lb ft).
2	Secondary Air Injection Inlet Pump Hose Procedure Disconnect the quick connect fittings by squeezing both sides.

SECONDARY AIR INJECTION PUMP REPLACEMENT

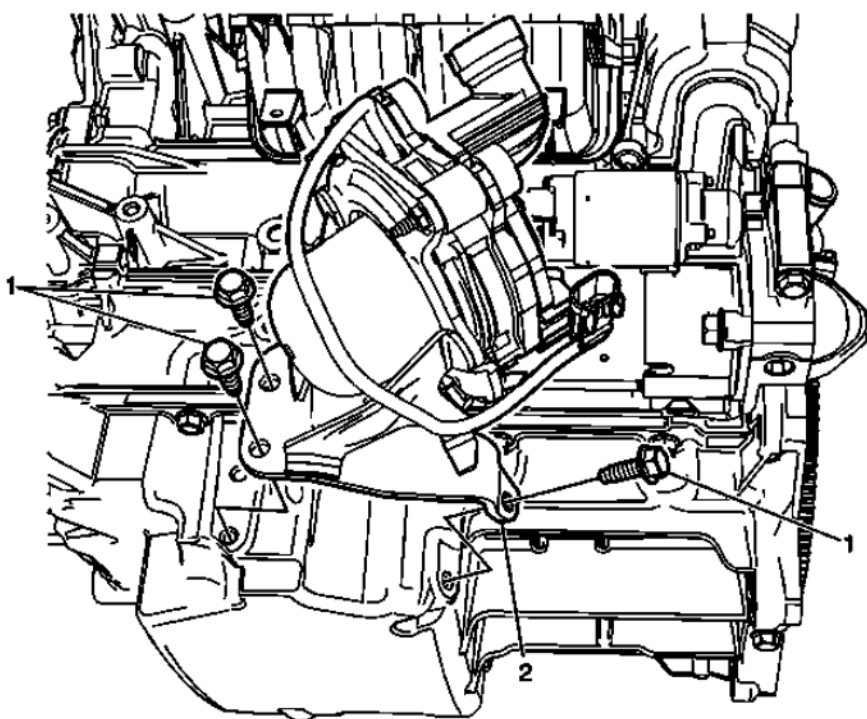


Fig. 126: Secondary Air Injection Pump Replacement & Bolts
 Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Pump Replacement

Callout	Component Name
Preliminary Procedure 1. Raise and support the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> . 2. Disconnect the secondary injection pump inlet hose. Refer to <u>Secondary Air Injection Pump Inlet Hose Replacement</u> 3. Disconnect the secondary injection pipe. Refer to <u>Secondary Air Injection Pipe Replacement</u>	
1	Secondary Air Injection Pump Bolt (Qty: 3) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 30 N.m (22 lb ft).
2	Secondary Air Injection Pump

AIR CLEANER ELEMENT REPLACEMENT

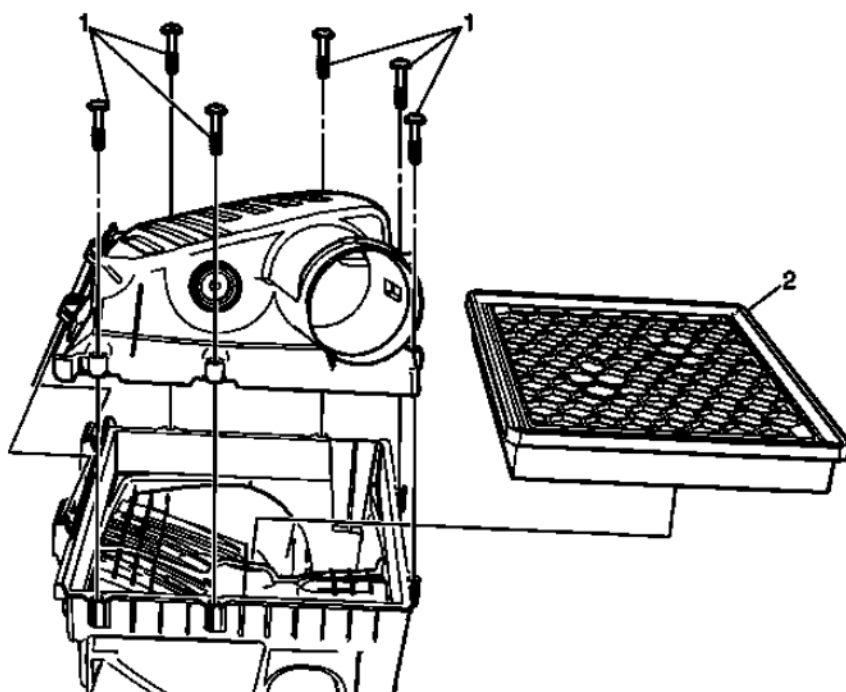


Fig. 127: Air Cleaner Element & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Element Replacement

Callout	Component Name
1	Air Cleaner Element Fasteners CAUTION: Refer to <u>Fastener Caution</u> . Tighten 5 N.m(44 lb in)
2	Air Cleaner Element Procedure 1. Loosen the outlet duct clamp at the air cleaner. 2. Disconnect the mass airflow electrical connector along with the mass airflow harness from the air cleaner.

AIR CLEANER ASSEMBLY REPLACEMENT

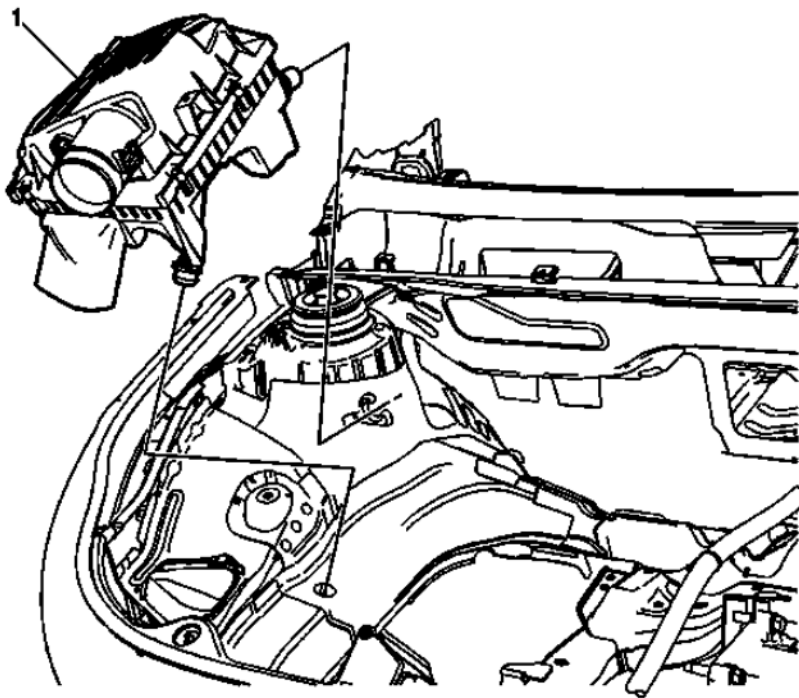


Fig. 128: Air Cleaner Assembly
 Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Assembly Replacement

Callout	Component Name
Preliminary Procedure 1. Remove the mass airflow sensor. Refer to <u>Mass Airflow Sensor with Intake Air Temperature Sensor Replacement</u>. 2. Disconnect the outlet duct from the air cleaner assembly. Refer to <u>Air Cleaner Outlet Duct Replacement</u>.	
1	Air Cleaner Assembly Procedure: In order to service the air cleaner assembly, disengage the rear attachment first by moving in the cross car direction prior to lifting the air cleaner assembly from the vehicle.

AIR CLEANER OUTLET DUCT REPLACEMENT

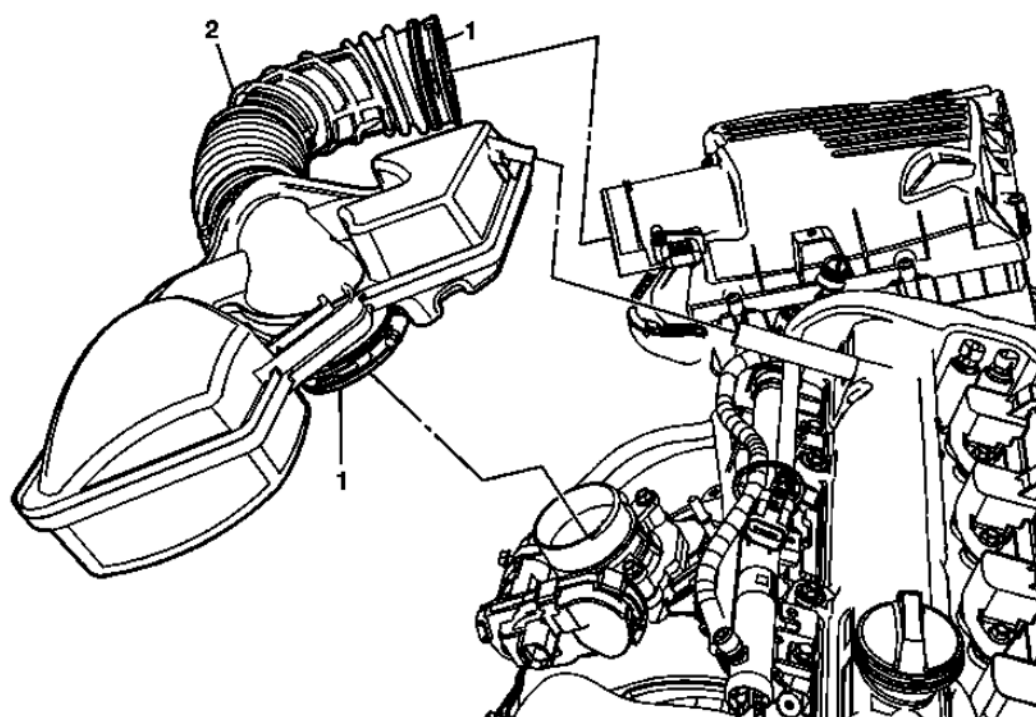


Fig. 129: Air Cleaner Outlet Duct & Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Outlet Duct Replacement

Callout	Component Name
1	Air Cleaner Outlet Duct Fastener (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 4 N.m (35 lb in)
2	Air Cleaner Outlet Duct with Resonator

2013 ENGINE PERFORMANCE

Engine Controls/Fuel - 2.4L (LUK) - Specifications - Malibu

SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE

Temperature Versus Resistance

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
150	302	47
140	284	60
130	266	77
120	248	100
110	230	132
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

TEMPERATURE VERSUS RESISTANCE - INTAKE AIR TEMPERATURE SENSOR (HITACHI SENSOR)

Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)

Temperature C°/F°	Resistance Minimum Ohms	Resistance Maximum Ohms
Hitachi Intake Air Temperature (IAT) Sensor		
-40/-40	37, 527	49, 882
-20/-4	13, 110	16, 329
-10/14	8, 145	9, 851
0/32	5, 205	6, 122
20/68	2, 298	2, 570
25/77	1, 900	2, 100
40/104	1, 073	1, 226
60/140	537	639
80/176	289	356
100/212	165	210
120/248	99	129
140/284	62	83
150/302	49	67

ALTITUDE VERSUS BAROMETRIC PRESSURE

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

Ignition System Specifications

Application	Specification
Ignition Type	Individual Ignition Coils
Firing Order	1-3-4-2
Spark Plug Torque	Refer to Fastener Tightening Specifications
Spark Plug Gap	Refer to Engine Mechanical Specifications (LAF, LEA, or LUK)
Spark Plug Type	Refer to Electronic Parts Catalog

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Pedal Bolt	10 N.m	89 lb in
Air Cleaner Housing Rear Bolt	10 N.m	89 lb in
Air Cleaner Intake Duct Bolt	10 N.m	89 lb in
Air Cleaner Outlet Duct Clamp	4 N.m	35 lb in
Camshaft Position (CMP) Actuator Solenoid Valve Bolt	10 N.m	89 lb in
Camshaft Position (CMP) Sensor Bolt	10 N.m	89 lb in
Crankshaft Position (CKP) Sensor Bolt	10 N.m	89 lb in
Engine Coolant Temperature (ECT) Sensor	20 N.m	15 lb ft
Frame (Rear) Bolt- First Pass	100 N.m	74 lb ft
Frame (Rear) Bolt- Final Pass	90 Degrees	
Fuel Fill Pipe Hose Clamp	4 N.m	35 lb in
Fuel Rail Bolt	10 N.m	89 lb in
Fuel Tank Fill Pipe Bracket Bolt	9 N.m	80 lb in
Fuel Tank Fill Pipe to Fuel Tank Fill Pipe Housing Screw	1.5 N.m	13 lb in
Fuel Tank Strap Bolt	20 N.m	15 lb ft
Heated Oxygen Sensor (HO2S)	42 N.m	31 lb ft
Ignition Coil Bolt	10 N.m	89 lb in
Knock Sensor (KS)	25 N.m	18 lb ft
Mass Airflow Sensor Fastener	1.5 N.m	13 lb in
Secondary Air Injection Check Valve Bolt	10 N.m	89 lb in
Secondary Air Injection Check Valve Nut	25 N.m	18 lb ft
Secondary Air Injection Pipe Bolt	10 N.m	89 lb in
Secondary Air Injection Pump Bolt	30 N.m	22 lb ft
Spark Plug	20 N.m	15 lb ft
Throttle Body Bolt	10 N.m	89 lb in

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number
Anti-Seize Compound	Lubricant	GM P/N 88862477 (Canadian P/N 88862478)
Camshaft Gear Access Hole Plug	Sealant	GM P/N 12346004 (Canadian P/N 10953480)
Coolant Temperature Sensor Threads	Sealant	GM P/N 12346004 (Canadian P/N 10953480)
Engine Oil	5W-30 Oil	GM P/N 19293000 (Canadian P/N 19286321)
Fuel Injection Fuel Rail Bolts	Sealant	GM P/N 12345382 (Canadian P/N 10953489)
Intake Air Temperature Sensor Threads	Sealant	GM P/N 12346004 (Canadian P/N 10953480)
Top Engine Cleaner	Cleaner	GM P/N 1052626 (Canadian P/N 993026)

2013 ENGINE PERFORMANCE

Engine Controls/Fuel - 2.4L (LUK) - Schematic and Routing Diagrams - Engine Controls Schematics - Malibu

SCHEMATIC WIRING DIAGRAMS

ENGINE CONTROLS WIRING SCHEMATICS

Module Power, Ground, Serial Data, and MIL Wiring Schematics

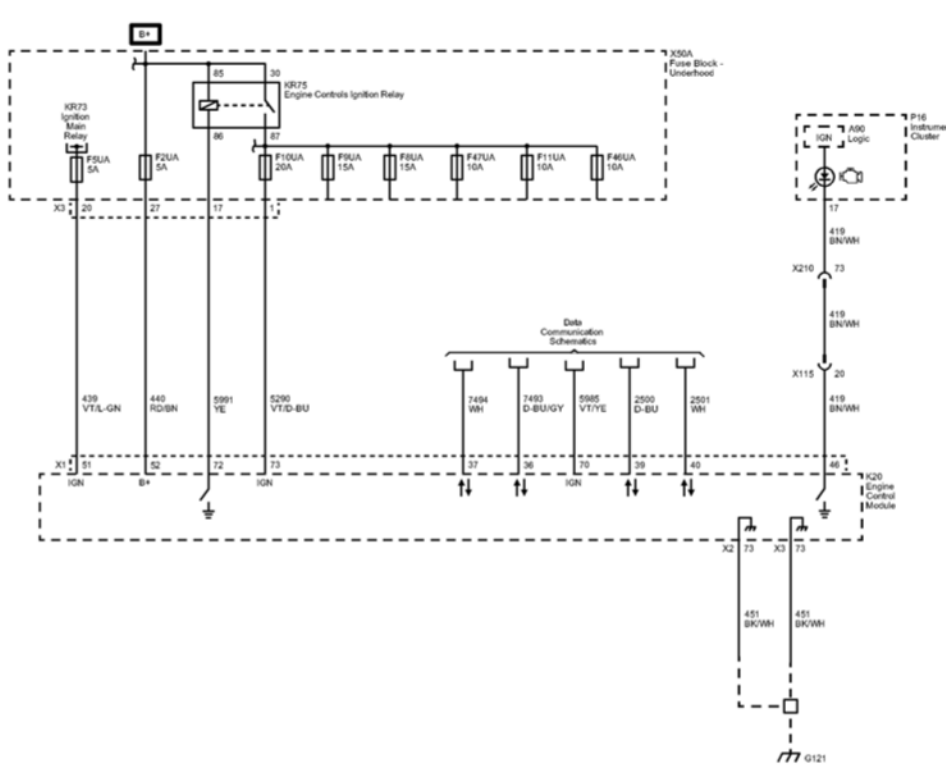


Fig. 1: Module Power, Ground, Serial Data, and MIL Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

5V1, and Low Reference Bus (1 of 2) Wiring Schematics

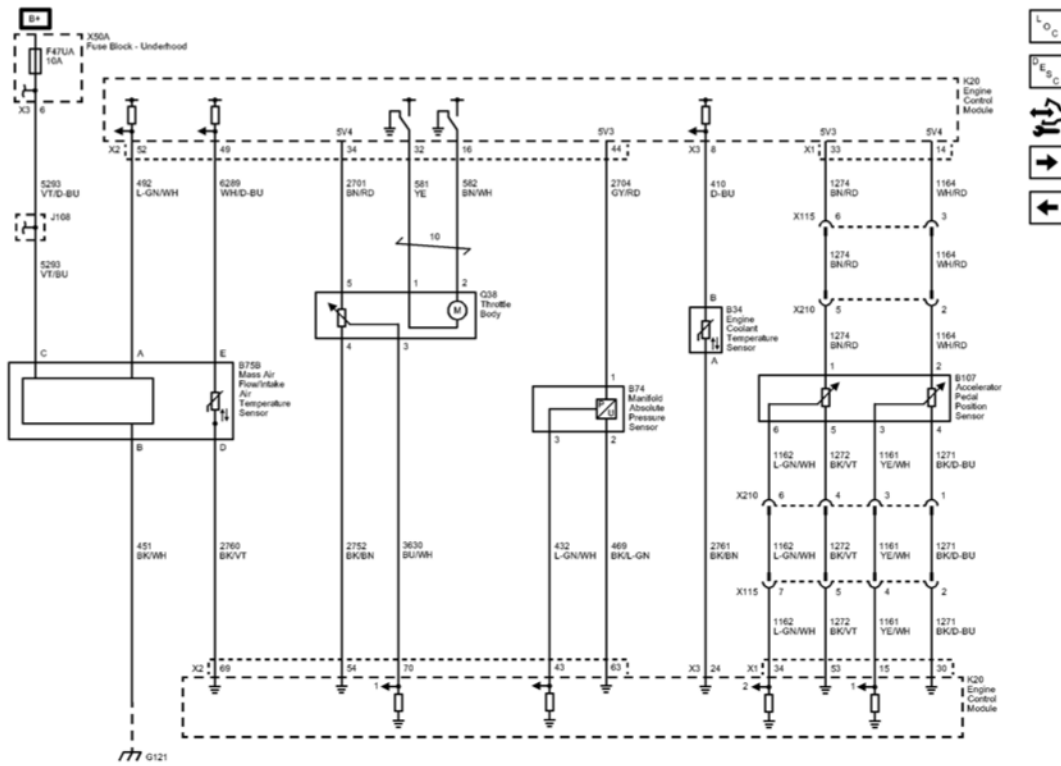


Fig. 4: Engine Data Sensors - Pressure, Temperature, and Throttle Controls Wiring Schematics
 Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Oxygen Sensors Wiring Schematics

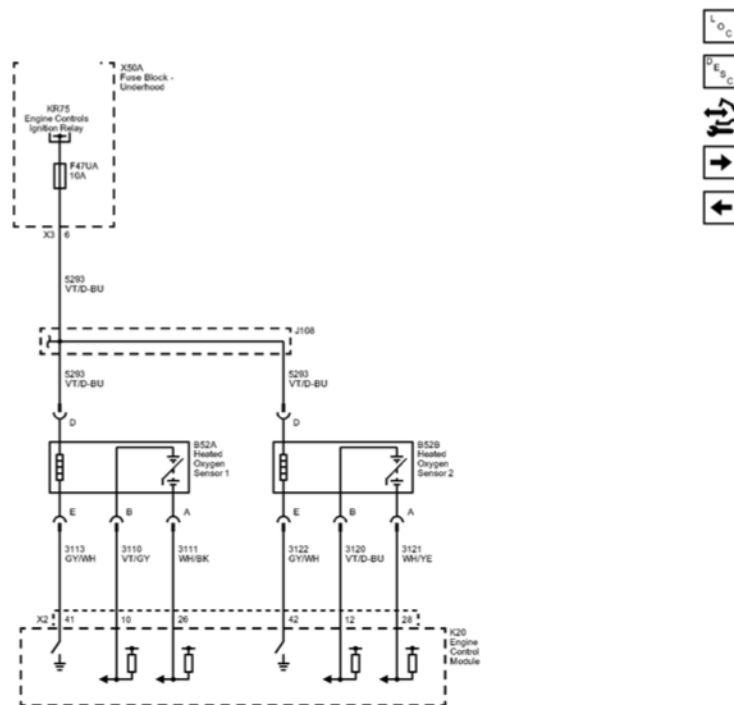


Fig. 5: Engine Data Sensors - Oxygen Sensors Wiring Schematics
 Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Ignition System Wiring Schematics

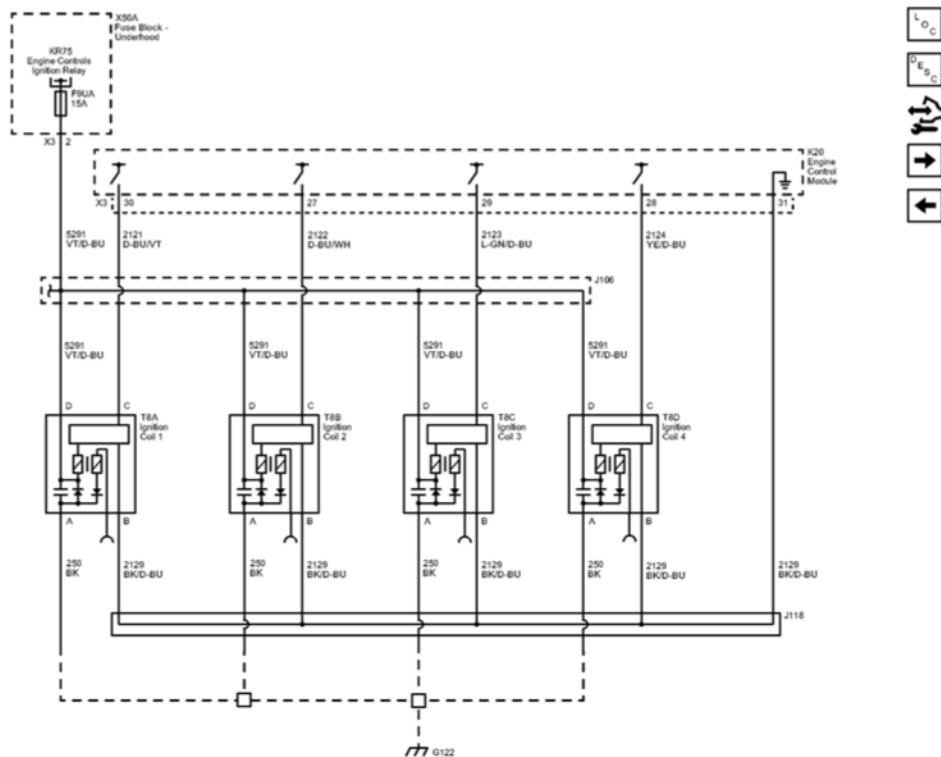


Fig. 6: Ignition Controls - Ignition System Wiring Schematics
 Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Camshaft Solenoids, Camshaft, Crankshaft and Knock Sensors Wiring Schematics

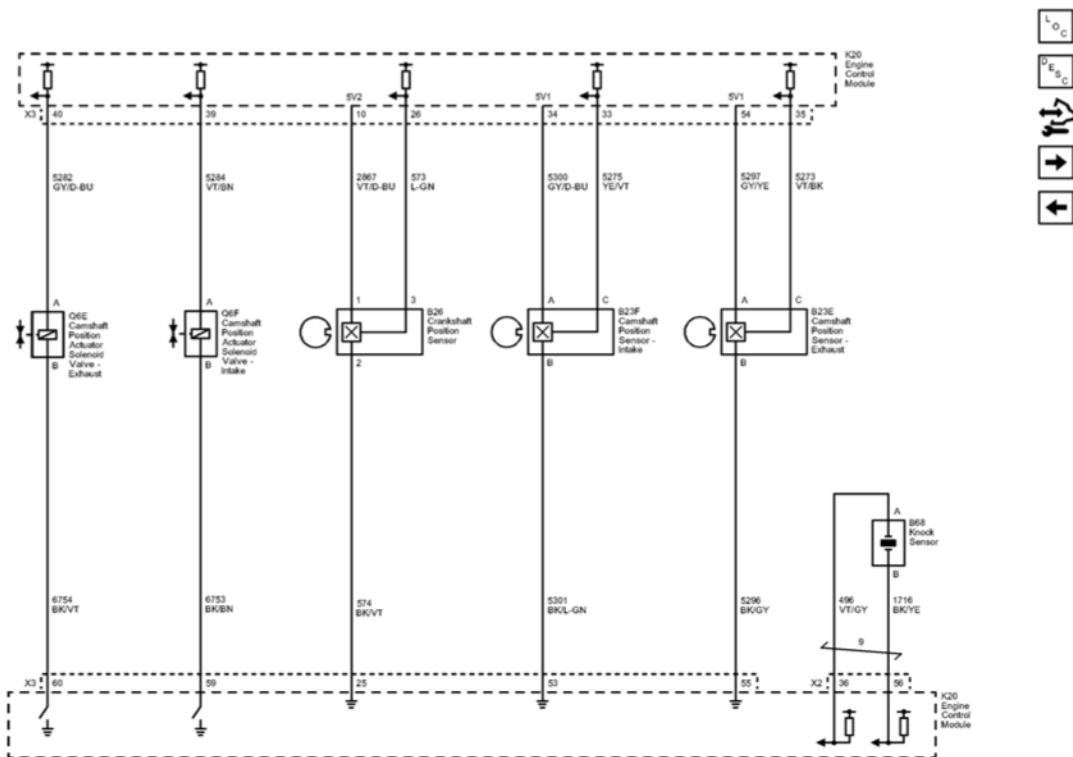


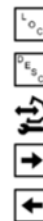
Fig. 7: Ignition Controls - Camshaft Solenoids, Camshaft, Crankshaft and Knock Sensors Wiring Schematics

Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Injectors and Fuel Pressure Wiring Schematics



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Fuel Controls - Evaporative Emission Controls Wiring Schematics

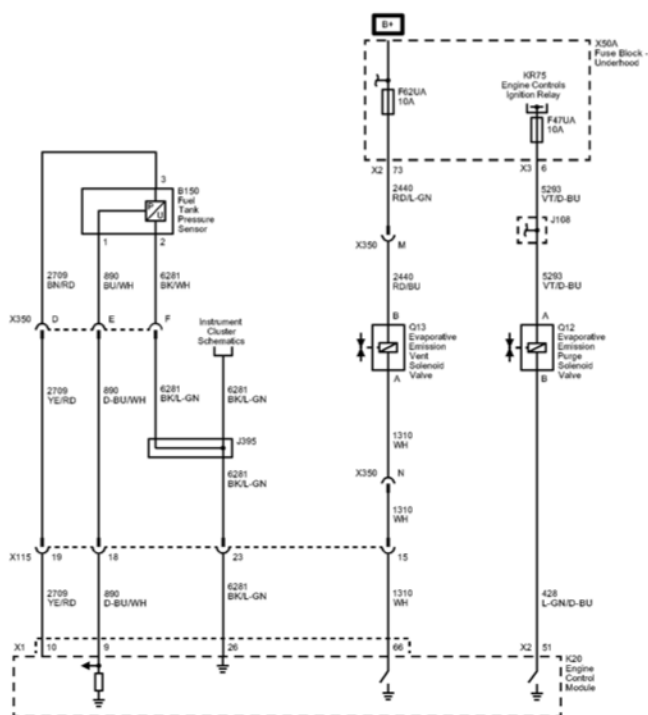


Fig. 10: Fuel Controls - Evaporative Emission Controls Wiring Schematics
 Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection (NU6) Wiring Schematics

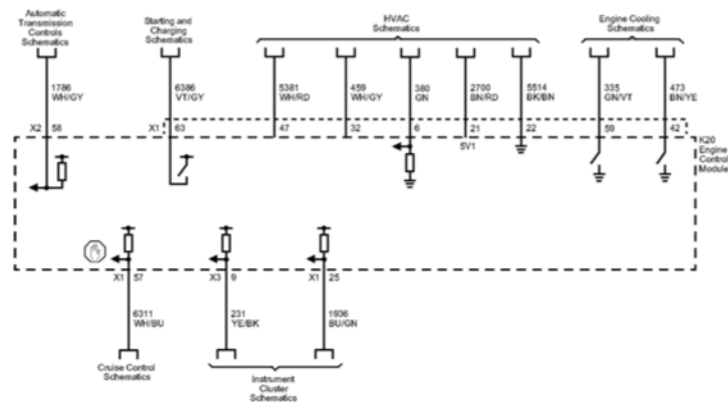


Fig. 12: Controlled/Monitored Subsystem References Wiring Schematics
 Courtesy of GENERAL MOTORS COMPANY