

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.5L (LCV) - Description and Operation - Impala

DESCRIPTION AND OPERATION

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

Circuit/System Description

The camshaft position actuator solenoid valve - Intake and camshaft position actuator solenoid valve - exhaust system enables the engine control module (ECM) to change camshaft timing while the engine is running. The camshaft position actuator assembly varies camshaft position in response to directional changes in oil pressure. The camshaft position actuator solenoid valve - Intake and camshaft position actuator solenoid valve - exhaust controls the oil pressure that is applied to advance or retard the camshaft. Modifying camshaft timing under changing engine demand provides better balance between the following performance concerns:

- Engine power output
- Fuel economy
- Lower exhaust emissions

The ECM uses information from the following sensors in order to calculate the desired camshaft position:

- The engine coolant temperature (ECT) sensor
- The mass air flow (MAF) sensor
- The throttle position sensor
- The vehicle speed sensor (VSS)

Camshaft Position Actuator System Operation

The ECM operates the camshaft position actuator solenoid valve - Intake and camshaft position actuator solenoid valve - exhaust by pulse width modulation (PWM) of the solenoid coil. The higher the PWM duty cycle, the larger the change in camshaft timing. Oil pressure that is applied to the advance side of the fixed vanes will rotate the camshaft in a clockwise direction. The clockwise movement of the camshaft will advance the timing up to a maximum of 21° . When oil pressure is applied to the return side of the vanes, the camshaft will rotate counterclockwise until returning to 0° .

Oil flowing to the camshaft position actuator solenoid valve - intake and camshaft position actuator solenoid valve - exhaust housing from the camshaft position actuator solenoid valve - Intake and camshaft position actuator solenoid valve - exhaust advance passage applies pressure to the advance side of the vane wheel in the camshaft position actuator assembly. At the same time the camshaft position actuator solenoid valve - Intake and camshaft position actuator solenoid valve - exhaust retard passage is open, allowing oil pressure to decrease on the retard side of the vane wheel. These two simultaneous actions cause the vane wheel to rotate clockwise, advancing camshaft advance timing.

When the oil flowing to the camshaft position actuator solenoid valve - Intake and camshaft position actuator solenoid valve - exhaust housing is from the camshaft position actuator solenoid valve - Intake and camshaft position actuator solenoid valve - exhaust retard passage, oil pressure is applied to the retard side of the vane wheel. Because the solenoid advance passage is open, allowing oil pressure to decrease on the advance side of the vane wheel, the camshaft position retards.

The ECM can also command the camshaft position actuator solenoid valve - Intake and camshaft position actuator solenoid valve - exhaust to stop oil flow from both passages in order to hold the current camshaft position. The ECM is continuously comparing camshaft position sensor - intake and camshaft position sensor - exhaust input with camshaft position actuator solenoid valve - Intake and camshaft position actuator solenoid valve - exhaust input in order to monitor camshaft position and detect any

system malfunctions. The following table provides camshaft phase commands for common driving conditions:

Driving Conditions	Change in Camshaft Position	Objective	Result
Idle	No change	Minimize valve overlap	Stabilize idle speed
Light engine load	Retard valve timing	Decrease valve overlap	Stable engine output
Medium engine load	Advance valve timing	Increase valve overlap	Better fuel economy with lower emissions
High RPM with heavy load	Retard valve timing	Retard intake valve closing	Improve engine output

Intake Camshaft Mid Park Lock (if Equipped)

The intake camshaft position actuator park lock solenoid valve is supplied a dedicated ground control circuit from the ECM and an ignition voltage supply circuit. The ECM operates the intake camshaft position actuator park lock solenoid valve by applying ground to the solenoid valve control circuit to control the oil flow that applies the pressure to disengage the intake camshaft actuator park pin. This allows the ECM to advance or retard the camshaft. When the ECM determines that cam phasing is not desired, it will command the camshaft to the lock position at 0°. At that stage, the ECM control circuit ground is then removed from the solenoid, oil pressure is unapplied, and the camshaft actuator park pin will re-engage preventing cam phasing. The ECM can also determine if the park pin is engaged by applying a slight amount of camshaft advance or retard to verify if movement is present.

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).

EVAPORATIVE EMISSION CONTROL SYSTEM DESCRIPTION

Typical Evaporative Emission (EVAP) System Hose Routing Diagram

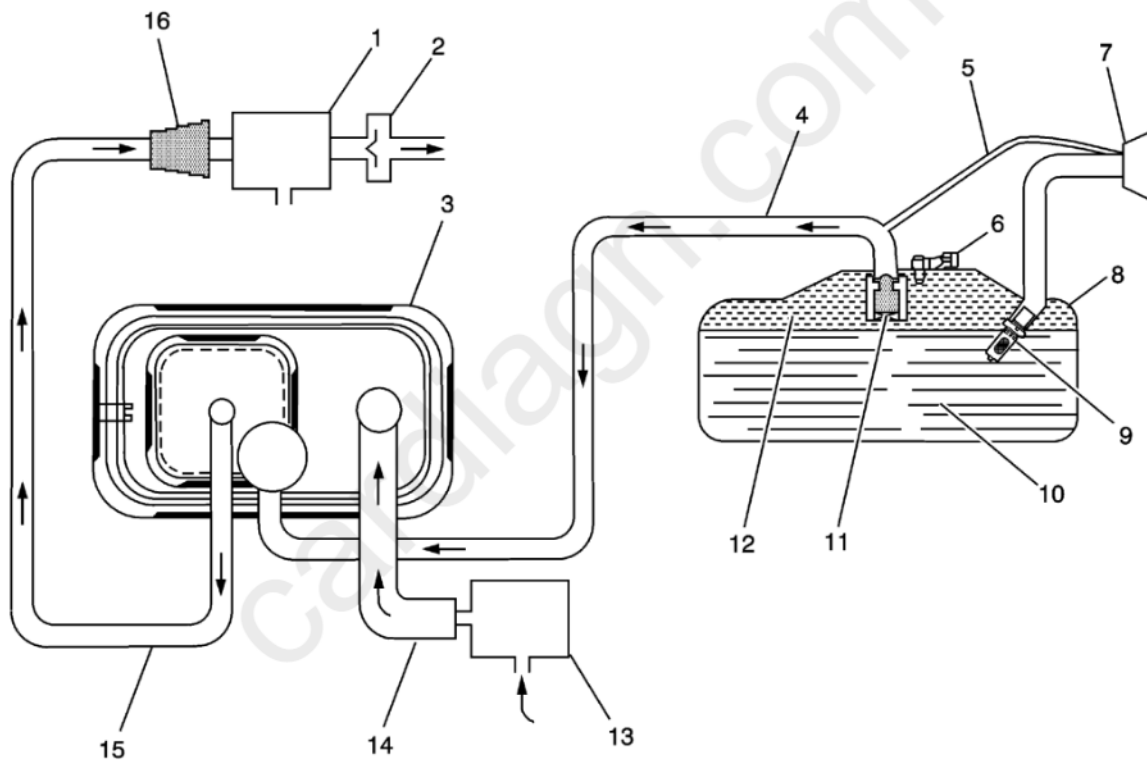


Fig. 1: Typical Evaporative Emission (EVAP) System Hose Routing Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Evaporative Emissions (EVAP) Purge Solenoid Valve
2	Purge Tube Check Valve, Turbo-Charged Applications Only
3	EVAP Canister
4	EVAP Vapor Tube
5	Vapor Recirculation Tube (ORVR)
6	Fuel Tank Pressure Sensor
7	Fuel Filler Cap (Some Vehicles May Have A Capless Design)

Callout	Component Name
8	Fuel Tank
9	Fuel Fill Pipe Inlet Check Valve
10	Liquid Fuel
11	Fill Limit Vent Valve (FLVV)
12	Fuel Vapor
13	EVAP Canister Vent Solenoid Valve
14	Vent hose
15	EVAP Purge Tube
16	EVAP Canister Purge Tube Connector

EVAP System Operation

The 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 sensor for an increase in vacuum. The ECM will set a DTC 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 fuel tank pressure sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time. Failure to achieve the expected level of vacuum indicates the presence of a large leak in the EVAP system or a restriction in the purge path. The ECM will set a DTC 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 fuel tank pressure sensor for an increase in vacuum. If the vacuum increases more than the expected amount, in a set amount of time, a fault will be logged by the ECM.

Small Leak Test

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

NOTE: **The presence of this one-way check valve prevents pressure testing the EVAP system for leaks at the EVAP canister purge tube connector.**

Turbocharged vehicles have a check valve in the purge tube between the EVAP purge solenoid valve and the intake manifold to prevent pressurization of the EVAP system under boost conditions. Some applications may have this check valve between the EVAP purge solenoid valve and the EVAP canister.

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.

The On-Board Refueling Vapor Recovery System is an on-board vehicle system designed to recover fuel vapors during the vehicle refueling operation. The flow of liquid fuel down the fuel filler pipe provides a liquid seal which prevents vapor from leaving the fuel filler pipe. An EVAP pipe transports the fuel vapor to the EVAP canister for use by the engine.

Fuel Tank Pressure Sensor

The fuel tank pressure sensor measures the difference between the pressure or vacuum in the fuel tank and outside air pressure. 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. A high fuel tank pressure sensor voltage indicates a low fuel tank pressure or vacuum. A low fuel tank pressure sensor voltage indicates a high fuel tank pressure.

Fuel Fill Pipe Check Valve

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

EVAP 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 like large leak and engine off natural vacuum test.

Fuel Fill Cap

The fuel fill cap is equipped with a seal and a vacuum relief valve and is tethered. A torque-limiting device prevents the cap from being over tightened. To install the cap, turn the cap clockwise until you

hear clicks. This indicates that the cap is correctly torqued and fully seated. A built-in device indicates that the fuel filler cap is fully seated. A fuel filler cap that is not fully seated may cause a malfunction in the emission system.

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.

Fill Limit Vent Valve

This acts as a shut off valve during refueling. This will vary based on fuel tank design. The fuel limit vent valve has the following functions:

- The fuel limit vent valve is located on the inside top of the fuel tank
- This valve is not serviced separately
- Controls the fuel tank fill level by closing the primary vent from the fuel tank and forcing the fuel fill nozzle to shut off.
- Prevents liquid fuel from exiting the fuel tank via the EVAP pipe to the canister.
- Provides fuel-spillage protection in the event of a vehicle rollover by closing the vapor path from the tank to the EVAP canister.

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 near each cylinder with short integrated boots or high tension wires 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 uses engine speed, the mass air flow (MAF) sensor signal, and position information from the crankshaft position and the camshaft position sensors to control 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 reluctor wheel on the crankshaft (front mounted crankshaft position sensor) or a reluctor wheel that is part of the flywheel (rear mounted crankshaft position sensor). The 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. 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 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.

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

Knock Sensor

The knock sensor system enables the ECM 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 ECM receives the knock sensor signal through the high and low signal circuits.

The ECM 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 ECM 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 ECM 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 ECM has determined that knock is present, it will retard the ignition timing to attempt to eliminate the knock. The ECM 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 ECM, 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 has an ignition voltage feed and a ground circuit. The engine control module (ECM) supplies a low reference and an ignition control (IC) circuit. Each ignition coil contains a solid state driver module. The ECM will command the IC circuit ON, which allows the current to flow through the primary coil windings. When the ECM commands the IC circuit OFF, this will interrupt current flow through the primary coil windings. The magnetic field created by the primary coil windings will collapse across the secondary coil windings, which induces a high voltage across the spark plug electrodes.

Engine Control Module (ECM)

The 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) sensors
- Intake air temperature (IAT) sensors
- Vehicle speed sensor (VSS)
- Transmission gear position or range information sensors
- Engine knock sensors
- Ambient pressure sensors (BARO)

FUEL SYSTEM DESCRIPTION

Fuel System Overview

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

The fuel tank stores the fuel supply. 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 fuel injection system. The fuel tank fuel pump module contains a reverse flow check valve. The check valve maintains fuel pressure in the fuel feed pipe and the fuel rail in order to prevent long cranking times.

Electronic Returnless Fuel System

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

Chassis Control Module

The chassis control module is a serviceable GMLAN module. The chassis 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 chassis 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 A. A liquid fuel pressure sensor provides fuel pressure feedback to the chassis control module.

Fuel Pressure Sensor

The fuel pressure sensor is a serviceable 5 V, 3-pin device. It is located on the fuel feed line forward of the fuel tank, and receives power and ground from the chassis control module through a vehicle wiring harness. The sensor provides a fuel pressure signal to the chassis 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 are attached to the underbody. The fuel tank is molded from high-density polyethylene.

Fuel Tank Fuel Pump Module

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

- The fuel level sensor
- The fuel pump
- The fuel strainer
- The pressure relief regulator valve
- The jet pump

Fuel Level Sensor

The fuel level sensor consists of a float, a wire float arm, and a ceramic resistor card. The position of the float arm indicates the fuel level. The fuel level sensor contains a variable resistor which changes resistance in correspondence with the position of the float arm. The ECM sends the fuel level signal via a High Speed CAN-Bus signal to the body control module (BCM). The BCM then sends the information via a Low Speed CAN-Bus signal to the instrument cluster to display the fuel level. When the fuel level falls below 11% the instrument cluster illuminates the low fuel level indicator. The ECM also monitors the fuel level input for various diagnostics.

Fuel Pump

The fuel pump is mounted in the fuel tank fuel pump module reservoir. The fuel pump is an electric pump. Fuel is pumped to the fuel injection system 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.

Fuel Strainer

The fuel strainer is attached to the lower end of the fuel tank fuel pump module. The fuel strainer is made of woven plastic. The functions of the fuel strainer are to filter contaminants and to wick away fuel. Normally, the fuel strainer does not require maintenance. Fuel stoppage at this point indicates that the fuel tank contains an abnormal amount of sediment or contamination.

Jet Pump

The jet pump is located in the fuel tank fuel pump module. Fuel pump flow loss, caused by vapor expulsion in the pump inlet chamber, is diverted to the jet pump through a restrictive orifice located on the pump cover. The jet pump fills the reservoir of the fuel tank fuel pump module.

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 chassis control module defaulting to 100% 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: Refer to [Fuel and Evaporative Emission Pipe Warning](#).

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

Quick-Connect Fittings

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

Fuel Rail Assembly

The fuel rail assembly is attached to the engine intake manifold. The fuel rail assembly performs the following functions:

- Positions the injectors in the intake manifold
- Distributes fuel evenly to the injectors

Fuel Injectors

The fuel injector assembly is a solenoid device controlled by the ECM that meters pressurized fuel to a single engine cylinder. The ECM energizes the high-impedance, 12 Ω , injector solenoid to open a ball valve, normally closed. This allows fuel to flow into the top of the injector, past the ball valve, and through a director plate at the injector outlet. The director plate has machined holes that control the flow of fuel, generating a spray of finely atomized fuel at the injector tip. Fuel from the injector tip is directed

at the intake valve, causing the fuel to become further atomized and vaporized before entering the combustion chamber. This fine atomization improves fuel economy and emissions.

Fuel Metering Modes of Operation

The ECM monitors voltages from several sensors in order to determine how much fuel to feed to 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 chassis control module when the ECM detects that the ignition is ON. The voltage from the ECM to the chassis control module remains active for 2 s, unless the engine is in Crank or Run. While this voltage is being received, the chassis 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 is flooded with fuel during starting and will not start, the clear flood mode can be manually enabled. To enable Clear Flood Mode, press the accelerator to wide open throttle (WOT). The ECM will completely turn OFF the fuel injectors and will maintain this mode as long as the ECM detects a WOT condition with engine speed below a predetermined value.

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).

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

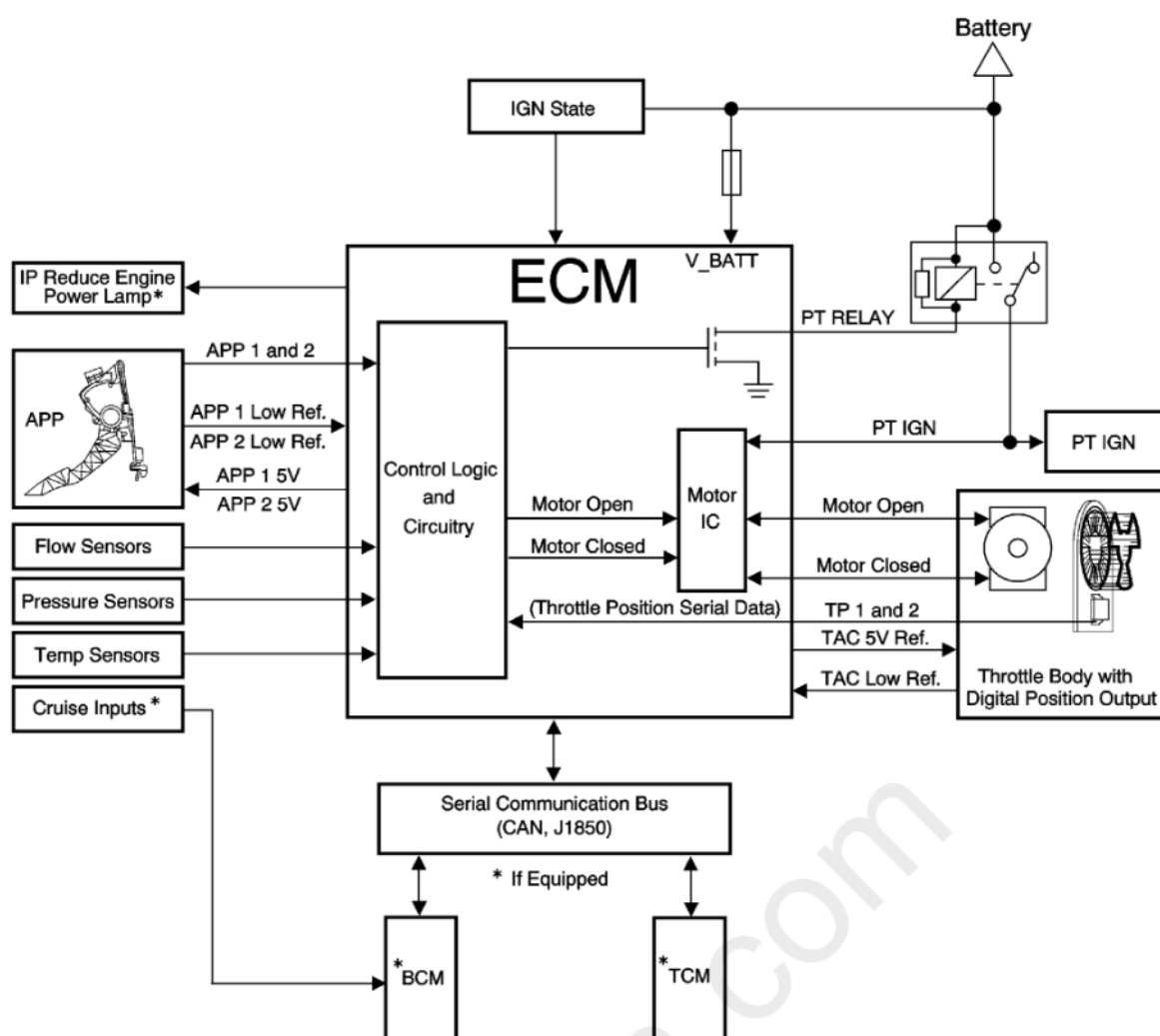


Fig. 2: Throttle Actuator Control (TAC) System Diagram
Courtesy of GENERAL MOTORS COMPANY

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 actions listed below:
 - 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.

If the throttle blade becomes stuck, a DTC will set. Depending on the position of the throttle blade, the ECM may enter Engine Shutdown Mode. If the condition remains present during the next ignition cycle, the ECM may disable engine cranking. Inspect the throttle body assembly for a stuck throttle blade if a throttle actuator DTC is current and the engine won't crank.

Throttle/Idle Learn or Throttle Body Idle Air Flow Compensation Reset

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 unlearn the coking. To accelerate the process, the scan tool has the ability to reset the learned value back to zero. A new ECM will also have values set to zero. Cleaning the throttle body when the ECM is replaced can reduce the time it take for the ECM to relearn the minimum idle speed.

The idle may be unstable or a DTC may set if the learned values do not match the actual airflow.

A un-metered air leak in the induction system or a small vacuum leak may not set a DTC. If the condition goes undetected, the ECM may learn an incorrect Throttle Body Idle Airflow Compensation value over time. The incorrectly learned value may cause various symptoms to occur such as rough or unstable idle speeds, and/or engine stall. If this condition is detected and repaired it will be necessary perform the Throttle/Idle Learn or Throttle Body Idle Air Flow Compensation Reset procedure to ensure any symptoms are corrected.

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.5L (LCV) - Diagnostic Information and Procedures - Impala

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0010, P0013, OR P2088-P2091: INTAKE/EXHAUST CAMSHAFT POSITION ACTUATOR SOLENOID VALVE CONTROL CIRCUIT

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

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 Valve Control Circuit Low Voltage

DTC P2089

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage

DTC P2090

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage

DTC P2091

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0010, P0013, P2088, P2090	P0010, P0013, P2089, P2091	P0010, P0013, P2089, P2091 *	P0011, P0014 *
Low Reference	-	P0010, P0013, P2089, P2091	-	P0011, P0014 *
*Additional DTCs may set.				

Circuit/System Description

For an overview of the component/system, refer to: [Camshaft Actuator System Description](#)

Circuit	Description

Circuit	Description
Control	The output circuit is switched to 12 V to activate the component.
Low Reference	Grounded through the control module.

Component	Description
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
Q6 Camshaft Position Actuator Solenoid Valve	A solenoid valve is an electro-mechanically operated valve. The valve is controlled by an electric current through the solenoid.

The solenoid valve controls the flow of engine oil to the hydraulic actuator that adjusts the angle of the camshaft relative to the position of the crankshaft.

Conditions for Running the DTC

P0010, P0013, P2088, P2089, P2090, P2091

- Camshaft Position Actuator Solenoid Valve = On
- Ignition Switch Position = Run/Crank
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

P0011, P0014

- DTC P0010, P0013, P0016, P0017, P0335, P0336, P0340, P0341, P0365, P0366 = Not set
- Desired Camshaft Position & Camshaft Position = 6 to 29°
- Desired Camshaft Position = Does not vary greater than 3° - For greater than 3 s
- Engine = Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P0010, P0013, P2088, P2089, P2090, P2091

Control Circuit = Commanded state does not match the actual state - For greater than 5 s

P0011, P0014

Desired Camshaft Position & Camshaft Position = Not within 6° of each other - For greater than 13.5 s

Actions Taken When the DTC Sets

{With Turbocharger} DTCs listed in the DTC Descriptor Category = Type A DTC

{Without Turbocharger} DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

DTC P0011, P0014 = Type C DTC

Conditions for Clearing the DTC

{With Turbocharger} DTCs listed in the DTC Descriptor Category = Type A DTC

{Without Turbocharger} DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

DTC P0011, P0014 = Type C DTC

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

NOTE:

- The engine oil level and the oil pressure are critical to the correct operation of the system. Verify 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 valve and the mechanical camshaft actuator operation. Inspect for dirty or degraded engine oil.
- If a crankshaft or camshaft position sensor DTC is set, the scan tool camshaft position actuator output control will be disabled.

1. Ignition - On / Vehicle - In Service Mode

2. Verify DTC P0335, P0336, P0340, P0341, P0365, 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. Verify the following conditions do not exist:

- Engine Oil - Contaminated/Dirty/Fill Level = Low
- Engine Oil Pressure - Low - Refer to: **Oil Pressure Diagnosis and Testing**
- **If a condition exists**

Repair as necessary

- **If no condition exists**

4. Engine - Idling

5. Perform the appropriate scan tool control function:

- Exhaust Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Intake Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Verify the scan tool parameter:
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status = OK or Not Run
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status = OK or Not Run
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
- **If not the specified state**

Refer to: Circuit/System Testing

- **If the specified state**

6. Perform the scan tool control function:

- Exhaust Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Intake Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Verify the scan tool parameter:
- Exhaust Camshaft Position Variance = Less than 2° - During each of the commanded states
- Intake Camshaft Position Variance = Less than 2° - During each of the commanded states
- **If 2° or greater**

Refer to: Circuit/System Testing

- **If less than 2°**

7. Verify the scan tool parameter:

- Intake Camshaft Position Variance = Less than 2°
- Exhaust Camshaft Position Variance = Less than 2°
- Perform the action while monitoring the parameter:
- Wiggle the harness and connector: Q6 Camshaft Position Actuator Solenoid Valve
- Wiggle the harness and connector: K20 Engine Control Module
- **If 2° or greater**

Repair as necessary - Wiring / Terminal(s) / Electrical Connector(s)

- **If less than 2°**

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.

Verify the DTC does not set.

- **If the DTC sets**

Refer to: Circuit/System Testing

- If the DTC is not set

9. All OK.

Circuit/System Testing

NOTE: It may take up to 2 min for all vehicle systems to power down before an accurate ground or low reference circuit continuity test can be performed.

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the appropriate electrical connector: Q6 Camshaft Position Actuator Solenoid Valve
3. Test for less than 10 ohms between the test points: Low Reference circuit terminal 2/B & Ground

- **If 10 ohms or greater**

1. Disconnect the appropriate electrical connector: K20 Engine Control Module
2. Test for less than 2 ohms between the test points: Low Reference circuit terminal 2/B @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component: K20 Engine Control Module

- **If less than 10 ohms**

4. Ignition - On / Vehicle - In Service Mode

5. Perform the scan tool control function:

- Exhaust Camshaft Position Actuator Solenoid Valve - Off
- Intake Camshaft Position Actuator Solenoid Valve - Off

Verify a test lamp does not turn On between the test points: Control circuit terminal 1/A & Ground

- **If the test lamp turns On**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the appropriate electrical connector: K20 Engine Control Module
3. Ignition - On / Vehicle - In Service Mode
4. Test for less than 1 V between the test points: Control circuit terminal 1/A @ Component harness & Ground
 - If 1 V or greater - Repair the short to voltage on the circuit.
 - If less than 1 V - Replace the component: K20 Engine Control Module

- **If the test lamp does not turn On**

6. Remove - Test Lamp

7. Perform the scan tool control function:

- Exhaust Camshaft Position Actuator Solenoid Valve - On
- Intake Camshaft Position Actuator Solenoid Valve - On
- Verify the scan tool parameter:
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run

- **If not the specified state**

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: K20 Engine Control Module
3. Test for infinite resistance between the test points: Control circuit terminal 1/A @ Component harness & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance - Replace the component: K20 Engine Control Module

- **If the specified state**

8. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 1/A & Ground

9. Perform the scan tool control function:

- Exhaust Camshaft Position Actuator Solenoid Valve - On
- Intake Camshaft Position Actuator Solenoid Valve - On
- Verify the scan tool parameter:
- Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = Malfunction
- Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status = Malfunction

• **If not the specified state**

1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
2. Disconnect the appropriate electrical connector: K20 Engine Control Module
3. Test for less than 2 ohms between the test points: Control circuit terminal 1/A @ Component harness & The other end of the circuit @ Control module harness
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Replace the component: K20 Engine Control Module

• **If the specified state**

10. Verify DTC P0011, P0014 is not set.

• **If the DTC is set**

1. Ignition/Vehicle - Off
2. Remove the component: Q6 Camshaft Position Actuator Solenoid Valve
3. Verify the condition does not exist with the component: Q6 Camshaft Position Actuator Solenoid Valve
 - Engine Oil - Leaking @ Harness Connector
 - Screen - Misaligned/Missing/Restricted/Torn
 - Valve - Scored/Visual Damage
 - If a condition exists - Replace the component: Q6 Camshaft Position Actuator Solenoid Valve
 - If no condition exists

NOTE: It may be necessary to use jumper wires if the connector indexing is different between the connectors.

1. Swap the two components:

- Q6E Camshaft Position Actuator Solenoid Valve - Exhaust
- Q6F Camshaft Position Actuator Solenoid Valve - Intake

2. Engine - Running

NOTE:

- **This step is testing the mechanical camshaft position actuator for the camshaft that set the DTC.**
- **Perform this test at the original location that set the DTC.**

3. Perform the scan tool control function:

- Exhaust Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Intake Camshaft Position Actuator - From 0 to 20° and back to 0°.
- Verify the scan tool parameter:
- Exhaust Camshaft Position Variance = Less than 2° - During each of the commanded states
- Intake Camshaft Position Variance = Less than 2° - During each of the commanded states
- If 2° or greater - Replace the component: Camshaft Position Actuator

- If less than 2A° - Replace the component: Q6 Camshaft Position Actuator Solenoid Valve - The original component that set the DTC

- **If the DTC is not set**

11. Test or replace the component: Q6 Camshaft Position Actuator Solenoid Valve

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the appropriate electrical connector: Q6 Camshaft Position Actuator Solenoid Valve
3. Test for 5 to 12 ohms between the test points: Control terminal 1/A & Low Reference terminal 2/B
 - **If not between 5 and 12 ohms**
Replace the component: Q6 Camshaft Position Actuator Solenoid Valve
 - **If between 5 and 12 ohms**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
 - **If less than infinite resistance**
Replace the component: Q6 Camshaft Position Actuator Solenoid Valve
 - **If infinite resistance**
5. All OK.

Dynamic Test

1. Ignition/Vehicle - Off
 2. Disconnect the appropriate electrical connector: Q6 Camshaft Position Actuator Solenoid Valve
 3. Connect a jumper wire between the test points: Low Reference terminal 2/B & Ground
 4. Momentarily connect a 7.5 A fused jumper wire between the test points: Control terminal 1/A & B+
- Verify the component turns On and Off when connecting and disconnecting the jumper wire: Q6 Camshaft Position Actuator Solenoid Valve
- **If the component does not turn On and Off**
Replace the component: Q6 Camshaft Position Actuator Solenoid Valve
 - **If the component turns On and Off**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: [Diagnostic Repair Verification](#)

- Refer to [Camshaft Position Actuator and Camshaft Replacement - Exhaust](#)
- Refer to [Intake Camshaft Replacement Camshaft Position Intake Actuator Replacement](#)
- Refer to [Camshaft Position Actuator Exhaust Solenoid Valve Replacement](#)
- Refer to [Camshaft Position Actuator Intake Solenoid Valve Replacement](#)
- For control module replacement, programming, and setup refer to: [Control Module References](#)

DTC P0011 OR P0014: INTAKE/EXHAUST CAMSHAFT POSITION SYSTEM PERFORMANCE

Diagnostic Instructions

- Perform the [Diagnostic System Check Instructions](#) prior to using this diagnostic procedure.
- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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
Control	P0010, P0013, P2088, P2090	P0010, P0013	P0010, P0013, P055B	P0010, P0013, P2089, P2091	P0011, P0014
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 valves are each supplied a dedicated pulse width modulated (PWM) control circuit and low reference circuit from the ECM. The ECM operates each camshaft position actuator solenoid valve by controlling the amount of solenoid valve signal duty cycle to control 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 3.0 degrees for at least 3 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 29 degrees or less than 6 degrees.

The DTCs 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 listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

If equipped with a turbocharger = Type A DTC

- The Auto Stop and Auto Start function of the hybrid system is disabled.

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

If equipped with a turbocharger = Type A DTC

Diagnostic Aids

- A low oil level or condition may set this DTC.
- 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

Component View Reference

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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. Verify the engine has the proper oil condition, level, and pressure. Refer to **Oil Pressure Diagnosis and Testing**.

- **If the oil condition, level, and oil pressure are not correct**

Repair as necessary.

- **If the oil condition, level, and oil pressure are correct**

2. Verify DTC P0010, P0011, P0013, P0014, P0016, P0017, P0335, P0336, P0340, P0341, P0365, P0366, P2088, P2089, P2090 or P2091 is not set.

- **If any DTCs other than P0011 or P0014 are set**

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

- **If only DTC P0011 or P0014 is set**

1. 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.

2. Verify the DTC does not set.

- If the DTC sets, refer to Circuit/System Testing.
- If the DTC does not set, all OK.

• **If none of the DTCs are set**

3. All OK.

Circuit/System Testing

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

1. Ignition OFF, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve, ignition ON.
2. Verify a test lamp illuminates between the control circuit terminal 1 or A and ground when commanding the appropriate Camshaft Position Actuator Solenoid Valve On with a scan tool.

• **If the test lamp does not illuminate**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the control circuit end to end.
- If 2 Ω or greater, repair the open/high resistance or short to ground in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

• **If the test lamp illuminates**

3. Ignition OFF.
4. Remove the appropriate Q6 Camshaft Position Actuator Solenoid Valve. Inspect the Camshaft Position Actuator Solenoid Valve and mounting area for the following conditions:
 - For a torn, restricted, incorrect positioned, or missing screens at the Q6 Camshaft Position Actuator Solenoid Valve
 - For engine oil leaks between the oil sealing lands of the Q6 Camshaft Position Actuator Solenoid Valve
 - For oil seepage at the Q6 Camshaft Position Actuator Solenoid Valve connector
 - **If a condition is found**

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

NOTE: This step is testing the mechanical operation of the camshaft position actuator solenoid valve that set the DTC.

5. Exchange the suspected Q6 Camshaft Position Actuator Solenoid Valve with a Q6 Camshaft Position Actuator Solenoid Valve that is operating correctly.
6. Engine Running.
7. Command the appropriate camshaft position actuator from 0 degrees to 20 degrees and back to zero while observing the appropriate scan tool Intake/Exhaust Camshaft Position Variance parameters. The Intake/Exhaust Camshaft Position Variance should be less than 2 degrees in each of the commanded states.
 - **If the Camshaft Position Variance parameter is greater than 2 degrees**

Replace or repair the mechanical camshaft position actuator.
 - **If the Camshaft Position Variance parameter is less than 2 degrees**
8. 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 7 - 12 Ω between the control terminal 1 or A and the low reference circuit terminal 2 or B.

- **If not between 7 - 12 Ω**

Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If between 7 - 12 Ω**

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

- **If less than 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.

- Refer to [Camshaft Position Actuator Intake Solenoid Valve Replacement](#)
- Refer to [Camshaft Position Actuator Exhaust Solenoid Valve Replacement](#)
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0016 OR P0017: CRANKSHAFT POSITION - INTAKE/EXHAUST CAMSHAFT POSITION NOT PLAUSIBLE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 are not set.
- The engine is cranking or running.
- The crankshaft and camshaft position signals are synchronized.
- The camshaft position actuator solenoid valves are 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 9 degrees advanced or 12 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.
- A 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.

- Refer to [Camshaft Position Actuator Exhaust Solenoid Valve Replacement](#)
- Refer to [Camshaft Position Actuator Intake Solenoid Valve Replacement](#)
- Refer to [Camshaft Position Sensor Replacement - Exhaust](#)
- Refer to [Camshaft Position Sensor Replacement - Intake](#)
- Refer to [Crankshaft Position Sensor Replacement](#)
- Refer to [Timing Chain Tensioner Replacement](#)

DTC P0030-P0032, P0036-P0038, P0053, P0054, P0135, OR P0141: HO2S HEATERS

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0030

HO2S Heater Control Circuit Sensor 1

DTC P0031

HO2S Heater Control Circuit Low Voltage Sensor 1

DTC P0032

HO2S Heater Control Circuit High Voltage Sensor 1

DTC P0036

HO2S Heater Control Circuit Sensor 2

DTC P0037

HO2S Heater Control Circuit Low Voltage Sensor 2

DTC P0038

HO2S Heater Control Circuit High Voltage 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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Heater Voltage Supply	P0030, P0031, P0036, P0037, P0097, P00F4, P0102, P0132, P0134, P0135, P0138, P0141, P0443, P0458, P0597, P06DA, P11C2, P16D2, P2199, P2648, *	P0030, P0031, P0036, P0037, P0132, P0134, P0135, P0138, P0140, P0141, P0154, P0155, P0158, P0160, P0161	P0690	P0135, P0141
HO2S Heater Control	P0030, P0031, P0036, P0037, P0053, P0054, P0135, P0141	P0030, P0036, P0053, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0032, P0036, P0038, P0132, P0134, P0135, P0138, P0140, P0141, P0690	P0135, P0141
* Opens Fuse				

Typical Scan Tool Data**HO2S 1 Heater/HO2S 2 Heater**

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 0.2 - 1.5 A			
Voltage	0 A	0 A	0.2 - 2 A
Control	0 A	0 A	0 A

Circuit/System Description

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

Conditions for Running the DTC**P0030-P0032 or P0036-P0038**

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

P0053 or P0054

- DTCs P0112, P0113, P0117, P0118, or P2610 are not set.
- The ignition voltage is less than 32 V.
- The engine run time is less than 0.22 s.
- The ignition is OFF for greater than 8 h.

- The engine coolant temperature (ECT) is between -30 to +45Â°C (-22 to +113Â°F) at engine start-up.
- The ECT and the intake air temperature (IAT) are within 8Â°C (14Â°F) at engine start-up.
- The DTCs run once per drive cycle when the above conditions are met.

P0135 or P0141

- DTCs P0116, P0117, P0118, P0125, or P0128 are not set.
- The ignition voltage is between 10 - 32 V.
- The HO2S is at operating temperature.
- The DTCs run twice per drive cycle with a 30 s delay between tests and a 1 s execution rate when the above conditions are met for 120 s.

Conditions for Setting the DTC

P0030 or P0036

The engine control module detects an open in the heater circuits of the HO2S when the heater is commanded OFF for greater than 6 s.

P0031 or P0037

The engine control module detects a short to ground in the heater output low side driver circuit of the heated oxygen sensor when the heater is commanded OFF for greater than 6 s.

P0032 or P0038

The engine control module detects a short to voltage in the heater output low side driver circuit of the heated oxygen sensor when the heater is commanded ON for greater than 6 s.

P0053 or P0054

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

P0135 or P0141

The ECM detects that the HO2S heater current is greater than 2.5 A or less than 0.3 A for greater than 10 s.

Action Taken When the DTC Sets

DTCs P0030-P0032, P0036-P0038, P0053, P0054, P0135, and P0141 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0030-P0032, P0036-P0038, P0053, P0054, P0135, and P0141 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**

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 parameters listed below do not display Malfunction:
 - HO2S 1 or 2 Heater Control Circuit Low Voltage Test Status
 - HO2S 1 or 2 Heater Control Circuit Open Test Status
 - HO2S 1 or 2 Heater Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing
 - **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 DTC sets**

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B52 Heated Oxygen Sensor. Ignition ON.
2. Verify that a test lamp illuminates between the ignition voltage circuit terminal 2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is OK 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, test all components connected to the fuse and replace as necessary.
 - **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal 2 and the control circuit terminal 1.
 - **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 does not illuminate**

4. Remove the test lamp.
5. Verify the scan tool HO2S 1 or 2 Heater Control Circuit High Voltage Test Status parameter is OK when commanding the HO2S Heater Sensor 1 or 2 ON with a scan tool.

- **If OK is not displayed**

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 OK is displayed**

NOTE:

- **Less than 10 Ω of additional resistance on the ignition voltage circuit, or control circuit may set a DTC. If there is a 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.**

6. Install a 10 A fused jumper wire between the control circuit terminal 1 and the ignition voltage circuit terminal 2.

NOTE:

This test may only be performed once per key cycle. If test is repeated, ignition OFF, allow the engine control module to shut down completely, then ignition ON.

7. Verify the scan tool HO2S 1 or 2 Heater Control Circuit High Voltage Test Status parameter is Malfunction when commanding the HO2S Heater Sensor 1 or 2 ON with a scan tool.

- **If Malfunction is not displayed**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If Malfunction is displayed**

8. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Heated Oxygen Sensor Replacement - Sensor 1](#)
- Refer to [Heated Oxygen Sensor Replacement - Sensor 2](#)
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an Heated Oxygen Sensor.
- Refer to [Control Module References](#) for Engine Control Module replacement, programming and setup

DTC P0068 OR P1101: THROTTLE BODY AIR FLOW PERFORMANCE/INTAKE AIR FLOW SYSTEM PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0068

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) and when equipped: Turbocharger Boost Pressure sensor.

Conditions for Running the DTC

DTC P0068

- DTC P0102, P0103, P0107, P0108, or P0651 is not set
- The engine speed is at least 800 RPM.
- The Ignition signal is at least 6.0 V.
- The DTC runs continuously when the above conditions are met.

DTC P1101

- DTC P0102, P0103, P0107, P0108, P0117, P0118, P0128, P0335, or P0336 is not set
- The engine speed is between 400 - 6,000 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.

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

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 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 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 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 in 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.
 - **The MAF Sensor parameter does not change smoothly and gradually**
Refer to **DTC P0101** for further diagnosis.
 - **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 a DTC does not set.

- **If any DTC sets**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

- **If no DTCs set**

11. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0089, P00C6, P228C, OR P228D: FUEL PRESSURE REGULATOR PERFORMANCE/FUEL RAIL PRESSURE LOW DURING ENGINE CRANKING

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a three-lobe cam on the intake camshaft. This high pressure fuel 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 2,176 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 that prevents the pressure from exceeding 17.5 MPa (2, 538 PSI).

The fuel rail pressure sensor provides the feedback necessary to the ECM to control the high pressure fuel pump and the fuel injectors. This sensor is diagnosed separately from the fuel pressure control system.

The ECM monitors the fuel rail pressure sensor and the high pressure fuel pump actuator to determine if the commanded and actual pressures are within a predetermined range during engine cranking and at all times while the engine is running. The ECM also monitors the fuel pump actuator to make sure it is operating within expected limits.

Conditions for Running the DTC

P0089, P228C, or P228D

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0191, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0628, or P1682 is not set.
- The ignition voltage is greater than 8 V.
- The engine is running.
- The low side fuel pressure is greater than 250 kPa (36 PSI).
- The barometric (BARO) pressure is greater than 70 kPa.
- The intake air temperature (IAT) is warmer than -20°C (-4°F).
- The DTCs run continuously when the above conditions are met for 60 s.

P00C6

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0191, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0628, or P1682 is not set.
- The ignition voltage is greater than 8 V.
- The engine coolant temperature is less than 65°C (149°F).
- The low side fuel pressure is greater than 300 kPa (44 PSI).
- The diagnostic runs once for each engine start.

Conditions for Setting the DTC

P0089

The high pressure fuel pump has exceeded its control limits. This condition exists when the high pressure fuel pump actuator command is 0° or greater than 240° . The condition exists for greater than 10 s.

P00C6

The ECM detects that the fuel rail pressure is not rising greater than 3 MPa (435 PSI) or has fallen below 2 MPa (290 PSI) during engine cranking, depending on initial pressure when cranking begins.

P228C

The actual fuel rail pressure is 3 MPa (435 PSI) less than the desired fuel rail pressure. The condition exists for greater than 10 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 10 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

- Any problem with the camshaft may set fuel pressure DTCs due to the location and design of the high pressure fuel pump. If camshaft position control DTCs are current or in history, a cam control issue may be the root cause.
- A faulty valve, plunger, or solenoid in the high pressure fuel pump may set a DTC. High pressure fuel pump damage will most likely be undetectable upon visual inspection.
- A restricted fuel feed pipe between the fuel feed pipe fuel pressure sensor and the high pressure fuel pump may set a DTC.
- A leaking or restricted fuel injector may set a DTC.
- A leak in the high pressure fuel system may set a DTC.
- Vapor lock may set DTC P0089

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

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. Attempt to start and idle the engine.
2. Observe the DTC information with a scan tool. DTCs P0089, P00C6, P228C, and P228D should not set.
 - **If any of the DTCs are set**
Refer to Circuit/System Testing.
 - **If none of the DTCs are set**
3. Engine idling.
4. Verify the scan tool Fuel Rail Pressure Sensor parameter is approximately 1.9 - 5.0 MPa (276 - 725 PSI).
 - **If not between 1.9 - 5.0 MPa (276 - 725 PSI)**
Refer to Circuit/System Testing.

- If between 1.9 - 5.0 MPa (276 - 725 PSI)

WARNING:

Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

5. Road test the vehicle and perform a wide open acceleration from a stop until the transmission shifts into second gear. On manual transmission applications, shift to second gear or stop the test near 2,500 RPM. Repeat the test at least three times.
6. Verify DTCs P0089, P00C6, P228C, and P228D do not set.
 - **If any of the DTCs 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

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

1. Remove the G18 High Pressure Fuel Pump.
2. Verify the lobes on the camshaft do not have unusual wear or are worn.
 - **If the lobes have unusual wear or are worn**
Replace the Camshaft.
 - **If the lobes are OK**
3. Test or replace the G18 High Pressure Fuel Pump.

Component 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 Ω in order to prevent misdiagnosis.

2. Test for 0.3 - 0.7 Ω at 20 $\hat{A}$ $^{\circ}$ C (68 $\hat{A}$ $^{\circ}$ F) between the high control circuit terminal 1 and the low control circuit terminal 2.
 - **If not between 0.3 - 0.7 Ω**
Replace the G18 High Pressure Fuel Pump.
 - **If between 0.3 - 0.7 Ω**
3. Test for infinite resistance between each terminal and the G18 High Pressure Fuel Pump housing.
 - **If less than infinite resistance**
Replace the G18 High Pressure Fuel Pump.
 - **If infinite resistance**

Repair Instructions

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

- Refer to **Intake Camshaft Replacement**
- Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**
- Refer to **Fuel Pump Replacement** for G18 High Pressure Fuel Pump replacement
- Perform the Fuel Rail Pressure Relief Valve Reset procedure, if supported on the scan tool.

DTC P0090-P0092, P00C8, P00C9, OR P00CA: FUEL PRESSURE REGULATOR CONTROL CIRCUITS

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.
- Refer to **Diagnostic Procedure Instructions** to provide 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, P0092, P00C9	P0090, P00C8	P0092, P00CA	-
High Pressure Fuel Pump Actuator Low Control	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA	-

Circuit/System Description

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a three-lobe cam on the camshaft. This high pressure fuel 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 - 15 MPa (290 - 2,176

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.

It is important to note that the high pressure fuel pump is a trailing-edge control system, meaning that if 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 that prevents the pressure from exceeding 17.5 MPa (2,538 psi).

NOTE: **The fuel rail pressure sensor is diagnosed separately from the fuel pressure control system and should not be replaced for any codes referenced in this document.**

The fuel rail fuel pressure sensor operates on a 5 V reference circuit and it provides the feedback necessary to the ECM to control the high pressure fuel pump and the fuel injectors.

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.

Diagnostic Aids

- Before performing any circuit testing, ensure that the harness connector for the G18 High Pressure Fuel Pump is properly seated.
- Before performing any circuit testing, visually inspect the harness connector and the G18 High Pressure Fuel Pump connector for damage or bent pins.
- Circuit faults in the high pressure fuel control system may result in performance diagnostic failures, such as P0089, P00C6, P163A, P228C, or P228D. If any of the circuit DTCs referenced in this document are active, they take priority over any fuel system performance diagnostic. Always attempt to diagnose and repair circuit faults first, before reviewing other system DTCs.

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 P0685 or P1682 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. 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
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If OK or Not Run is displayed**

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 G18 High Pressure Fuel Pump.
2. Ignition ON, verify that a test lamp does not illuminate between the high control circuit terminal 1 and ground and the low control circuit terminal 2 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 appropriate 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**
3. Verify that a test lamp does not illuminate between the high control circuit terminal 1 and B+ and the low control circuit terminal 2 and B+.
 - **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 appropriate 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 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
4. Connect a 3 A fused jumper wire between the high control circuit terminal 1 and ground.
5. Verify the Fuel Pressure Regulator High Control Circuit Open Test Status transitions from Malfunction to OK and the Fuel Pressure Regulator High Control Circuit Low Voltage Test Status transitions from OK to Malfunction.
 - **The parameters do not change**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the high control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **The parameters change**
6. Connect a 3 A fused jumper wire between the low control circuit terminal 2 and B+.
7. Verify the Fuel Pressure Regulator Control Circuit Open Test Status transitions from Malfunction to OK and the Fuel Pressure Regulator Control Circuit High Voltage Test Status transitions from OK to Malfunction.
 - **The parameters do not change**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low control circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **The parameters change**

8. Test or replace the G18 High Pressure Fuel Pump.

Component 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 Ω in order to prevent misdiagnosis.

2. Test for 0.3 - 0.7 Ω at 20 $^{\circ}$ C (68 $^{\circ}$ F) between the high control circuit terminal 1 and the low control circuit terminal 2.

- **If not between 0.3 - 0.7 Ω**

Replace the G18 High Pressure Fuel Pump.

- **If between 0.3 - 0.7 Ω**

3. Test for infinite resistance between each terminal and the G18 High Pressure Fuel Pump housing.

- **If less than infinite resistance**

Replace the G18 High Pressure Fuel Pump.

- **If infinite resistance**

4. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Fuel Pump Replacement](#)
- Refer to [Control Module References](#) for K20 Engine Control Module replacement, setup, and programming
- Perform the Fuel Rail Pressure Relief Valve Reset procedure, if supported on the scan tool.

DTC P0096 OR P0111: INTAKE AIR TEMPERATURE (IAT) SENSOR 1/2 PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0096

Intake Air Temperature (IAT) Sensor 2 Performance

DTC P0111

Intake Air Temperature (IAT) Sensor 1 Performance

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0097*, P0113, P0114, P00F4, P2199	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199	P0113*, P0114	-

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P0102, P00F4, P2199	P0096, P0097, P0102, P00F4, P2199	-	P0096
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096*, P0097, P00F4, P2199	P0096
Ground	-	P0096, P0097, P0102, P00F4, P2199	-	P0096

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*

*Internal ECM or sensor damage may occur if the circuit is shorted to B+

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F)* 10 Hz
Ground	-	-40Â°C (-40Â°F) 10 Hz	-

*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 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 Â°C (Â°F).

The IAT sensor 2 produces a frequency signal based on the inlet air temperature very close to the humidity sensor within the sensor bore. The signal varies with inlet air temperature and is displayed by the scan tool as $^{\circ}\text{C}$ ($^{\circ}\text{F}$) and Hertz (Hz). The ECM applies 5 V to the circuit. The signal circuit is shared by the IAT sensor 2 and the humidity sensor. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for these sensors:

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage
Cold	High	High
Warm	Low	Low

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	45 Hz	-40°C (-40°F)
Warm	302 Hz	104°C (219°F)

Conditions for Running the DTCs

P0096 and P0111

- DTCs P0097, P0098, P0112, P0113, P0117, P0118, P0119, or P1682 are not set.
- The vehicle has been OFF at least 8 hours.
- The Ignition signal is at least 11 V for longer than 0.9 s.
- These DTCs run once per ignition cycle when the enabling conditions are met.

Conditions for Setting the DTCs

P0096

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than 30°C (54°F).

AND

- The absolute difference between ECT start-up temperature and the IAT sensor 2 start-up temperature is greater or equal to the absolute difference between ECT start-up temperature and the IAT sensor 1 start-up temperature.
- This DTC runs once per ignition cycle when the enabling conditions are met.

P0111

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than 30°C (54°F).

AND

- The absolute difference between ECT start-up temperature and the IAT sensor 1 start-up temperature is greater or equal to the absolute difference between ECT start-up temperature and

the IAT 2 start-up temperature.

- This DTC runs once per ignition cycle when the enabling conditions are met.

Action Taken When the DTCs Set

DTCs P0096 and P0111 are Type B DTCs.

Conditions for Clearing the DTCs

DTCs P0096 and P0111 are Type B DTCs.

Diagnostic Aids

The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40°C (-40°F), and there are also Humidity Sensor DTCs, check for a circuit problem.

Reference Information

Schematic Reference

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

Special Tools

EL-38522 Variable Signal Generator

For equivalent regional tools, refer to [Special Tools](#) .

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 30°C (54°F) of each other.
 - Start-Up IAT Sensor 1
 - IAT Sensor 2
 - Start-up ECT Sensor
 - **If not within 30°C (54°F)**

Refer to Circuit/System Testing.

- **If within 30Â°C (54Â°F)**

3. Engine idling, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).

- IAT Sensor 1
- IAT Sensor 2
- ECT Sensor
- **If not between: -38 and +149Â°C (-36 and +300Â°F)**

Refer to Circuit/System Testing.

- **If between: -38 and +149Â°C (-36 and +300Â°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 DTCs do not set.

- **If any of the DTCs set**

Refer to Circuit/System Testing.

- **If none of the DTCs set**

6. 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:

- A restricted or collapsed air intake duct
- An intake manifold leak
- Improper operation of the positive crankcase ventilation system
- A MAP sensor seal that is leaking, missing, or damaged
- A restricted or collapsed air intake duct
- A misaligned or damaged air intake duct
- 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 B75C Multifunction Intake Air 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 Ω between the low reference circuit terminal 3 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open or high resistance in the circuit.
- If less than 2 Ω replace the K20 Engine Control Module.

- **If less than 2 Ω**

4. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than $2\ \Omega$ in the ground circuit end to end.
 - If $2\ \Omega$ or greater, repair the open or high resistance in the circuit.
 - If less than $2\ \Omega$, repair the open/high resistance in the ground connection.
- **If less than $2\ \Omega$**
5. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 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 $2\ \Omega$ in the ignition voltage circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, 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, test all components connected to the ignition circuit, replace as necessary.
 - **If a test lamp illuminates**
6. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature signal 1 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 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 $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, 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, test for 4.8 - 5.2 V between the intake air temperature signal 2 circuit terminal 8 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 $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, 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**
8. Ignition OFF, connect the leads of the **EL-38522** Variable Signal Generator as follows:
 - Red lead to the signal circuit terminal 8 at the harness connector
 - Black leads to ground
 - Battery voltage supply lead to B+
9. Set the **EL-38522** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Duty Cycle switch to 50% (Normal)
 - Frequency switch to 30 Hz
10. Ignition ON, verify the scan tool IAT Sensor 2 parameter is between 28 - 32 Hz.
 - **If not between 28 - 32 Hz**

Replace the K20 Engine Control Module.
 - **If between 28 - 32 Hz**
11. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.

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

2. Test the IAT sensor 1 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 not within the specified range**

Replace the B75C Multifunction Intake Air sensor
 - **If within the specified range**
3. All OK.

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.
 - **If not within the specified range**

Replace the B75C Multifunction Intake Air sensor
 - **If within the specified range**
2. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) for multifunction intake air sensor replacement

- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0097, P0098, OR P0099: INTAKE AIR TEMPERATURE (IAT) SENSOR 2 CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0097

Intake Air Temperature (IAT) Sensor 2 Circuit Low Voltage

DTC P0098

Intake Air Temperature (IAT) Sensor 2 Circuit High Voltage

DTC P0099

Intake Air Temperature (IAT) Sensor 2 Circuit Intermittent

Diagnostic Fault Information

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P0102, P00F4, P2199	P0096, P0097, P0102, P00F4, P2199	-	P0096
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096*, P0097, P00F4, P2199	P0096
Ground	-	P0096, P0097, P0102, P00F4, P2199	-	P0096

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F)* 10 Hz
Ground	-	-40Â°C (-40Â°F) 10 Hz	-

*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 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 $^{\circ}\text{C}$ ($^{\circ}\text{F}$).

The IAT sensor 2 produces a frequency signal based on the inlet air temperature very close to the humidity sensor within the sensor bore. The signal varies with inlet air temperature and is displayed by the scan tool as $^{\circ}\text{C}$ ($^{\circ}\text{F}$) and Hertz (Hz). The ECM applies 5 V to the circuit. The signal circuit is shared by the IAT sensor 2 and the humidity sensor. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for these sensors:

- IAT sensor 2
- Humidity sensor
- Mass Air Flow (MAF) sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	45 Hz	-40°C (-40°F)
Warm	302 Hz	104°C (219°F)

Conditions for Running the DTCs

P0097, P0098, and P0099

- The ignition is ON, or the engine is running.
- The Ignition signal is at least 11 V for longer than 0.9 s.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P0097

NOTE: The scan tool display range is between -40 and $+150^{\circ}\text{C}$ (-40 and $+302^{\circ}\text{F}$).

The ECM detects that the sensor signal is less than 13 Hz, colder than -60°C (-76°F), for greater than 5 s.

P0098

The ECM detects that the sensor signal is greater than 390 Hz, warmer than 150°C (302°F), for greater than 5 s.

P0099

The ECM monitors the sensor signal every 0.1 s, to determine if the signal has changed more than 125°C (257°F) during a 4 s time period.

Action Taken When the DTC Sets

- DTCs P0097, P0098, and P0099 are Type B DTCs.
- The ECM commands the cooling fans ON.

Conditions for Clearing the MIL/DTCs

DTCs P0097, P0098, and P0099 are Type B DTCs.

Diagnostic Aids

- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor 2 will gradually increase the scan tool IAT Sensor 2 parameter. This is due to the heat that is generated by the MAF sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40°C (-40°F), and there are also Humidity Sensor DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Schematics

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-38522 Variable Signal Generator

For equivalent regional tools, refer to [Special Tools](#).

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. Engine idling, verify the following scan tool parameters are between: between -38 and +149°C (-36 and +300°F).
 - IAT Sensor 1
 - IAT Sensor 2
 - **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)**
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 DTCs do not set.
 - **If any of the DTCs set**

- **If none of the DTCs set**

4. All OK

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Ignition OFF, all systems OFF. It may take up to for 2 minutes for all vehicle systems to power down. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
 - **If 2 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.
 - **If less than 2 Ω**
3. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.
 - **If 2 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 2 Ω**
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 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 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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, test all components connected to the ignition circuit, replace as necessary.
 - **If a test lamp illuminates**
5. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature sensor 2 signal circuit terminal 8 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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**
6. Ignition OFF, connect the leads of the **EL-38522** Variable Signal Generator as follows:
 - Red lead to the signal circuit terminal 8 at the harness connector
 - Black leads to ground
 - Battery voltage supply lead to B+
7. Set the **EL-38522** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Duty Cycle switch to 50% (Normal)
 - Frequency switch to 30 Hz
8. Ignition ON, observe the scan tool IAT Sensor 2 parameter. The scan tool parameter should be between 28 - 32 Hz.
 - **If not between 28 - 32 Hz**

Replace the K20 Engine Control Module.
 - **If between 28 - 32 Hz**
9. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.
 - **If not within the specified range**

Replace the B75C Multifunction Intake Air sensor
 - **If within the specified range**
2. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) for multifunction intake air sensor replacement.
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P00F4-P00F6: INTAKE AIR HUMIDITY SENSOR CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P00F4

Intake Air Humidity Sensor Circuit Low Voltage

DTC P00F5

Intake Air Humidity Sensor Circuit High Voltage

DTC P00F6

Intake Air Humidity Sensor Circuit Erratic

Diagnostic Fault Information**Intake Air Humidity**

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P0102, P00F4, P2199	P0096, P0097, P0102, P00F4, P2199	-	P0096
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096*, P0097, P00F4, P2199	P0096
Ground	-	P0096, P0097, P0102, P00F4, P2199	-	P0096

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P0102, P00F4, P2199	P0096, P0097, P0102, P00F4, P2199	-	P0096
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096*, P0097, P00F4, P2199	P0096
Ground	-	P0096, P0097, P0102, P00F4, P2199	-	P0096

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data**Intake Air Humidity**

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient humidity and temperature; and engine bay conditions			
Ignition Voltage	0 %	0 %	-
Signal	100 %	0 %	0 %*
Ground	-	0 %	-

*Internal ECM or sensor damage may occur if the circuit is shorted to B+

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F)* 10 Hz
Ground	-	-40Â°C (-40Â°F) 10 Hz	-

*Internal ECM or sensor damage may occur if the circuit is shorted to B+

Circuit/System Description

The humidity sensor measures the ambient humidity of the air in the sensor bore. The signal varies with intake air humidity and is displayed by the scan tool as duty cycle %. The ECM applies 5 V to the circuit. The signal circuit is shared by the humidity sensor and the intake air temperature (IAT) sensor 2. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for these sensors:

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

Conditions for Running the DTCs

P00F4, P00F5, and P00F6

- DTC P1682 is not set
- The ignition is ON.
- The Ignition signal is at least 11 V for longer than 0.9 s.
- These DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P00F4

The ECM detects that the sensor signal is less than or equal to 5% for greater than 5 s.

P00F5

The ECM detects that the sensor signal is greater than or equal to 95% for greater than 5 s.

P00F6

The ECM monitors the sensor signal every 0.1 s, to determine if the signal has changed more than 40% during a 4 s time period.

Action Taken When the DTC Sets

DTCs P00F4, P00F5, P00F6 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P00F4, P00F5, P00F6 are Type B DTCs.

Diagnostic Aids

- The Intake Air Humidity Signal parameter displays the measured humidity within the air intake system and may differ from atmospheric humidity measured outside the air intake system.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the Intake Air Humidity parameter displays the value: 0% or 100%, and there are also IAT Sensor 2 DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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- [Connector Repairs](#)
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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-38522 Variable Signal Generator

For equivalent regional tools, refer to [Special Tools](#) .

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 30Â°C (54Â°F) of each other.
 - Start-Up IAT Sensor 1
 - IAT Sensor 2
 - Start-Up ECT Sensor
 - **If not within 30Â°C (54Â°F)**
Refer to Circuit/System Testing.
 - **If within 30Â°C (54Â°F)**
3. Engine idling, verify the scan tool Intake Air Humidity parameter is between 5 and 90%.
 - **If not between 5 and 90%**
Refer to Circuit/System Testing.
 - **If between 5 and 90%**
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 DTCs do not set.

- **If any of the DTCs set**

Refer to Circuit/System Testing.

- **If none of the DTCs set**

6. All OK

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.

2. Ignition OFF, all systems OFF. It may take up to for 2 minutes for all vehicle systems to power down. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open or high resistance in the circuit.
- If less than 2 Ω replace the K20 Engine Control Module.

- **If less than 2 Ω**

3. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

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

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

- **If less than 2 Ω**

4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 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 Ω in the ignition voltage circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , 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, test all components connected to the ignition circuit, replace as necessary.

- **If a test lamp illuminates**

5. Ignition ON, test for 4.8 - 5.2 V between the humidity signal circuit terminal 8 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 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , 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**
6. Ignition OFF, connect the leads of the **EL-38522** Variable Signal Generator as follows:
 - Red lead to the signal circuit terminal 8 at the harness connector
 - Black leads to ground
 - Battery voltage supply lead to B+
7. Set the **EL-38522** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Frequency switch to 250 Hz
 - Duty Cycle switch to 50% (Normal)
8. Ignition ON, observe the scan tool Intake Air Humidity parameter. The scan tool parameter should be between 45 - 55%.
 - **If not between 45 - 55%.**

Replace the K20 Engine Control Module.
 - **If between 45 - 55%.**
9. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Test the Intake Air Humidity Sensor by varying the air humidity in the intake duct near the sensor, while observing the scan tool Intake Air Humidity Sensor parameter. The parameter should change and be within 5 - 95%.
 - **If not within the specified range**

Replace the B75C Multifunction Intake Air sensor
 - **If within the specified range**
2. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) for multifunction intake air sensor replacement
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0101: MASS AIR FLOW (MAF) SENSOR PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0101

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 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: 2,000 - 10,000 Hz			
Ignition Voltage	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

Circuit Description

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

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

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

Conditions for Running the DTCs

- DTC P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0128, P0335, or P0336 is not set.
- The engine speed is between 575 - 6,600 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

- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will impair the response of the sensor to airflow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.
- 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.
- Driveability concerns and erratic transmission shifting may be caused by an excessively oiled aftermarket air cleaner that is contaminating the MAF sensor.

Reference Information

Schematic Reference

Engine Controls Schematics

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-38522 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.

5. 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%**

6. 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**

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 [DTC P0106](#) for further diagnosis.

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

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
- Improper operation of the positive crankcase ventilation system
- 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 Multifunction Intake Air sensor element
- **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 B75C Multifunction Intake Air 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 Ω between the ground circuit terminal 7 and ground.
 - **If 2 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 2 Ω**
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 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 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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, test all components connected to the ignition circuit, replace as necessary.
 - **If a test lamp illuminates**
5. Ignition ON, test for 4.8 - 5.2 volts between the signal circuit terminal 6 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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. Ignition OFF, connect the leads of the **EL-38522** Variable Signal Generator as follows:

- Red lead to the signal circuit terminal 6 at the harness connector
- Black leads to ground
- Battery voltage supply lead to B+

7. Set the **EL-38522** 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, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950 - 5,050 Hz.

- **If not 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. Test or replace the B75C Multifunction Intake Air sensor.

Repair Instructions

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

- Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement.
- Refer to **Control Module References** for engine control module replacement, programming, and setup

DTC P0102 OR P0103: MASS AIR FLOW (MAF) SENSOR CIRCUIT LOW/HIGH FREQUENCY

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.
- Refer to **Diagnostic Procedure Instructions** to provide 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	-	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

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions Parameter Normal Range: 2,000 - 10,000 Hz			
Ignition 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 multifunction intake air 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 multifunction intake air sensor's internal circuits for these sensors:

- Intake Air Temperature (IAT) sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

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 11 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 500 Hz (about 0.25 g/s) for at least 250 cylinder firing events.

P0103

The ECM detects that the MAF Sensor signal parameter is at least 11,000 Hz (about 328 g/s) for at least 250 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.

Schematic 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

Special Tools

EL-38522 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 - 5.0 g/s.

- **If not between 2.5 - 5.0 g/s**

Refer to Circuit/System Testing.

- **If between 2.5 - 5.0 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. 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**

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 B75C Multifunction Intake Air 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 Ω between the ground circuit terminal 7 and ground.
 - **If 2 Ω or greater**
 1. Ignition OFF. Disconnect the sensor chassis ground.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the chassis ground connection.
 - **If less than 2 Ω**
3. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 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 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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, test all components connected to the ignition circuit, replace as necessary.
 - If 2 Ω 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 volts between the signal circuit terminal 6 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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. Ignition OFF, connect the leads of the **EL-38522** Variable Signal Generator as follows:
 - Red lead to the signal circuit terminal 6 at the harness connector
 - Black leads to ground
 - Battery voltage supply lead to B+

6. Set the **EL-38522** Variable Signal Generator to the following specifications.

- Signal switch to 5 V
- Frequency switch to 5 kHz
- Duty Cycle switch to 50% (Normal)

7. Engine idling, verify the scan tool MAF Sensor parameter is between 4,950 - 5,050 Hz.

- **If not 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.**

8. Test or replace the B75C Multifunction Intake Air sensor.

Repair Instructions

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

- Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement.
- Refer to **Control Module References** for engine control module replacement, programming, and setup

DTC P0106: MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR PERFORMANCE

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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

Diagnostic Fault Information

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

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: 12 - 103 kPa (1.7 - 14.9 PSI)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	104 kPa (15.1 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	104 kPa (15.1 PSI)*
Low Reference	-	80 - 103 kPa (11.6 - 14.9 PSI)	-

Circuit	Short to Ground	Open	Short to Voltage
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

MAP Sensor, if equipped with Turbocharger

Circuits	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions Parameter Normal Range: 12 - 225 kPa (1.7 - 32.6 PSI) (varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)*
Low Reference	-	255 kPa (36.9 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

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, 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 P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0335, P0336, P2227, P2228, P2229, and P2230 are not set.
- The engine speed is between 575 and 6,600 RPM.
- The ECT Sensor is between -7 and +125Â°C (+19 and +257Â°F).
- The IAT Sensor is between -20 and +125Â°C (-4 and +257Â°F).
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM determines if the MAP Sensor is not within the normal operating range. It accomplishes this by running 3 different models within the software to determine the values, for greater than 0.5 S.

Action Taken When the DTC Sets

DTC P0106 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0106 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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, P0236, or P1101 refer to Circuit/System Testing.
4. 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%**
5. 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**
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 Circuit/System Testing.

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

8. Engine idling.

9. 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](#) for further diagnosis.

- **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
- Improper operation of turbocharger wastegate actuator or bypass valve; if equipped
- Loose or improper installation of the turbocharger and the charge air cooler, including the flexible ductwork; if equipped
- An air flow restriction
- Any vacuum leak
- Improperly routed vacuum hoses
- A restriction in the MAP Sensor port, or the BARO port; where equipped
- Proper operation of the positive crankcase ventilation 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 Ω between the low reference circuit terminal 2 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If less than 2 Ω**

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 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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. 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, ignition ON
2. 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. 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 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. 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 4.5 V**

9. Test or replace the B74 Manifold Absolute Pressure Sensor.

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.
3. Apply 17 kPa (5.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A**.
4. Verify the scan tool MAP 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).**
5. Apply 34 kPa (10.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A**.
6. Verify the scan tool MAP 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).**
7. 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**.
7. Verify the voltage changes, without any spikes or dropouts and is 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**
8. All OK.

Repair Instructions

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

- Refer to **Control Module References** for ECM replacement, programming, and setup
- Refer to **Manifold Absolute Pressure Sensor Replacement**.

DTC P0107 OR P0108: MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR CIRCUIT LOW/HIGH VOLTAGE

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.

- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0107, P0697	P0106, P0107	P0107	P0106, P0108, P0697	P0106
Signal	P0106, P0107, P0697	P0106, P0107	P0107	P0106, P0108*	P0106, P1101
Low Reference	-	P0106, P0108	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 running at various operating conditions Parameter Normal Range: 12 - 103 kPa (1.7 - 14.9 PSI) (Varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	104 kPa (15.1 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	104 kPa (15.1 PSI)*
Low Reference	-	80 - 103 kPa (11.6 - 14.9 PSI)	-

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

MAP Sensor, if equipped with Turbocharger

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions Parameter Normal Range: 12 - 225 kPa (1.7 - 32.6 PSI) (Varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)*
Low Reference	-	255 kPa (36.9 PSI)	-

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

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, 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 0.15 V for more than 13 ms.

P0108

The ECM detects that the MAP Sensor voltage is more than 4.50 V for greater than 13 ms.

Action Taken When the DTC Sets

DTCs P0107 and P0108 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0107 and P0108 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - 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

For equivalent regional tools, refer to [Special Tools](#)

Circuit/System Verification

1. Ignition ON, verify that DTC P0641, P0651, P0697, P06A3, or P06D2 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**

2. Determine the current vehicle testing altitude.

3. 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**

4. Verify the engine is equipped with a turbocharger.

- **If not equipped with a turbocharger**

Refer to Step 6.

- **If equipped with a turbocharger**

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**

Refer to Step 7.

6. Engine idling, verify the scan tool MAP Sensor voltage parameter is between 0.2 - 4.5 V and changes with accelerator pedal input.

- **If not between 0.2 - 4.5 V or does not change**

Refer to Circuit/System Testing.

- **If between 0.2 - 4.5 V and changes**

7. 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.

8. Verify the DTC does not set.

- **If any DTC sets**

Refer to Circuit/System Testing.

- **If no DTC sets**

9. 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 Ω between the low reference circuit terminal 2 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

• **If less than 2 Ω**

3. Ignition ON, 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 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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**

4. 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**

5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1.

6. 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

• **If greater than 4.5 V**

7. 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 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 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** Vacuum Pump. Verify the voltage changes, without any spikes or dropouts and is 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.

- Refer to [Manifold Absolute Pressure Sensor Replacement](#) .
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0112, P0113, OR P0114: INTAKE AIR TEMPERATURE (IAT) SENSOR 1 CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0112

DTC P0113

Intake Air Temperature (IAT) Sensor 1 Circuit High Voltage

DTC P0114

Intake Air Temperature (IAT) Sensor 1 Circuit Intermittent

Diagnostic Fault Information**IAT Sensor 1**

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0097*, P0113, P0114, P00F4, P2199	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199	P0113*, P0114	-

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P0102, P00F4, P2199	P0096, P0097, P0102, P00F4, P2199	-	P0096
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096*, P0097, P00F4, P2199	P0096
Ground	-	P0096, P0097, P0102, P00F4, P2199	-	P0096

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data**IAT Sensor 1**

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*

*Internal ECM or sensor damage may occur if the circuit is shorted to B+

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F)* 10 Hz

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Ground	-	-40Â°C (-40Â°F) 10 Hz	-
*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 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 Â°C (Â°F).

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Mass Air Flow (MAF) sensor
- BARO pressure sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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 +150Â°C (-40 and +302Â°F).

The ECM detects that the sensor signal is warmer than 150Â°C (302Â°F) for at least 5 s.

P0113

NOTE: The scan tool display range is between -40 and +150Â°C (-40 and +302Â°F).

The ECM detects that the sensor signal is colder than -60Â°C (-76Â°F) for at least 5 s.

P0114

The ECM monitors the sensor signal every 0.1 s, to determine if the signal has changed more than 125Â°C (257Â°F) during a 4 s time period.

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, when the engine is cold and not running, 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 multifunction intake air sensor internal heating elements.
- Depending on the ambient temperature, an IAT sensor 1 signal circuit or low reference circuit that is shorted to the MAF sensor signal circuit can cause a DTC P0113 and/or P0114 to set. This condition causes a rapid fluctuation in the IAT Sensor 1 parameter.

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 30Â°C (54Â°F) of each other.
 - Start-Up IAT Sensor 1
 - IAT Sensor 2
 - Start-up ECT
 - **If not within 30Â°C (54Â°F)**

Refer to Circuit/System Testing.
 - **If within 30Â°C (54Â°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
 - IAT Sensor 1
 - IAT Sensor 2
 - ECT Sensor
 - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

Refer to Circuit/System Testing.

- **If between: -38 and +149A°C (-36 and +300A°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 DTCs do not set.
 - **If any of the DTCs set**
Refer to Circuit/System Testing.
 - **If none of the DTCs set**
6. All OK

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Ignition OFF all systems OFF. It may take up to for 2 minutes for all vehicle systems to power down. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
 - **If 2 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.
 - **If less than 2 Ω**
3. Ignition ON, test for 4.8 - 5.2 V between the intake air temperature sensor 1 signal 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 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.

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

2. Test the IAT sensor 1 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 not within the specified range**

Replace the B75C Multifunction Intake Air sensor

- **If within the specified range**

3. All OK.

Repair Instructions

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

- Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement.
- Refer to **Control Module References** for Engine Control Module replacement, programming, and setup

DTC P0116: ENGINE COOLANT TEMPERATURE (ECT) SENSOR PERFORMANCE

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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0116

Engine Coolant Temperature (ECT) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118, P0119	P0118, P0119	P0116, P0128
Low Reference	-	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	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°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 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 P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0502, P0503, P0601, or P2610 is not set.
- The vehicle has had a minimum ignition OFF time of 8 h.
- The ignition is ON.
- The start-up IAT is warmer than -7°C ($+19^{\circ}\text{F}$).
- The Fuel Level Sensor parameter is greater than 2.5%.
- 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 (86°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 (61°F) warmer than the IAT sensor, and NO engine block heater was detected.

OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 16°C (61°F) warmer than the IAT sensor, the engine cranked for greater than 10 s without starting and NO engine block heater was detected.

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 - Engine Coolant Temperature Sensor 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

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 the scan tool ECT Sensor parameter is warmer than -40°C (-40°F) and colder than 150°C (302°F) and changes with engine run time.
 - **If colder than -39°C (-38°F) or warmer than 149°C (300°F) or does not change**

Refer to Circuit/System Testing.
 - **If warmer than -40°C (-40°F) and colder than 150°C (302°F) and changes**
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.
 - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than $5\ \Omega$ between the low reference terminal A or 2 and ground.
 - **If $5\ \Omega$ or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than $2\ \Omega$ in the low reference circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **If less than $5\ \Omega$**
3. Ignition ON.
4. Verify the scan tool ECT 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 B or 1 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 colder than -39°C (-38°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149°C (300°F).
 - **If 149°C (300°F) or colder**
 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
3. Ignition OFF
 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If warmer than 149 $^{\circ}$ C (300 $^{\circ}$ F)**
 7. 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.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#) table. The resistance values should be in range of the table values.
 - **If not within the specified range**
Replace the B34 Engine Coolant Temperature Sensor.
 - **If within the specified range**
3. Test for infinite resistance between each terminal and the sensor housing.
 - **If less than infinite resistance**
Replace the B34 Engine Coolant Temperature Sensor.
 - **If infinite resistance**
4. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

- Refer to [Engine Coolant Temperature Sensor Replacement](#)
- Refer to [Control Module References](#) for engine control module replacement, setup, and programming

DTC P0117, P0118, OR P0119: ENGINE COOLANT TEMPERATURE (ECT) SENSOR CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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

DTC P0119

Engine Coolant Temperature (ECT) Sensor Circuit Intermittent

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118	P0118*, P0119	P0116, P0128
Low Reference	-	P0113, P0118, P2199, P2227, P2229	-	P0128

*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 running at various operating conditions			
Parameter Normal Range: Varies with coolant temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°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. This diagnostic checks for an open, short to ground or an intermittent circuit condition between the ECM and ECT sensor.

Conditions for Running the DTC

P0117

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

P0118

- The ignition is ON.
- OR
- The engine is running for greater than 10 s.
- OR
- The engine run time is less than 10 s when the IAT is warmer than -7Â°C (19Â°F).
 - This DTC runs continuously within the enabling conditions.

P0119

- No active DTCs set.
- The ignition is ON.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

P0117

The ECM detects that the ECT is warmer than 149Â°C (300Â°F) for greater than 5 s.

P0118

The ECM detects that the ECT is colder than -39Â°C (-38Â°F) for greater than 5 s.

P0119

The ECM detects that the ECT is intermittent or has abruptly changed for greater than 3 seconds.

Action Taken When the DTC Sets

- DTC P0117, P0118 or P0119 are a Type B DTC.
- The cooling fans will be commanded ON.
- The Engine Coolant Temperature Gauge is inoperative.
- The AC compressor will be commanded OFF.

Conditions for Clearing the DTC

DTC P0117, P0118 or P0119 are a Type B DTC.

Diagnostic Aids

NOTE: The engine coolant temperature (ECT) sensor 1 is mounted on the engine and the engine coolant temperature (ECT) sensor 2, radiator coolant temperature (RCT) sensor, is mounted on the radiator.

- The engine coolant temperature gauge will display full cold when an ECT DTC set's.
- After starting the engine, the engine coolant temperature (ECT) sensor 1 temperature should rise steadily, then stabilize after the thermostat opens.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling System Description and Operation

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 the scan tool ECT Sensor parameter is warmer than -40Â° C (- 40Â° F) and colder than 150Â° C (302Â° F) and changes with engine run time.

- **If colder than -39°C (-38°F) or warmer than 149°C (300°F) or does not change**

Refer to Circuit/System Testing.

- **If warmer than -40°C (-40°F) and colder than 150°C (302°F) and changes**

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.

- **If the DTC does not set**

5. All OK.

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.
2. Test for less than $5\ \Omega$ between the low reference circuit terminal A or 2 and ground.
 - **If $5\ \Omega$ or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than $2\ \Omega$ in the low reference circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **If less than $5\ \Omega$**
3. Ignition ON.
4. Verify the scan tool ECT 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 B or 1 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 colder than -39°C (-38°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149°C (300°F).
 - **If 149°C (300°F) or colder**
 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 $2\ \Omega$ in the signal circuit end to end.
 - If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - **If warmer than 149°C (300°F)**
7. 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.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [**Temperature Versus Resistance - Engine Coolant Temperature Sensor**](#) table. The resistance values should be in range of the table values.

- **If not within the specified range**

Replace the B34 Engine Coolant Temperature Sensor.

- **If within the specified range**

3. Test for infinite resistance between each terminal and the sensor housing.

- **If less than infinite resistance**

Replace the B34 Engine Coolant Temperature Sensor.

- **If infinite resistance**

4. All OK.

Repair Instructions

Perform the [**Diagnostic Repair Verification**](#) after completing the repair.

- Refer to [**Engine Coolant Temperature Sensor Replacement**](#)
- Refer to [**Control Module References**](#) for ECM replacement, programming, and setup.

DTC P0121-P0123, P0222, P0223, P16A0-P16A2, OR P2135: THROTTLE POSITION SENSORS 1-2/SENSOR COMMUNICATION CIRCUIT

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.
- Refer to [**Diagnostic Procedure Instructions**](#) to provide 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	5.0 V	5.0 V	5.0 V
Signal	5.0 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	0.0 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 throttle position 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 -7 to +125Â°C (19 - 257Â°F).
- The intake air temperature (IAT) is -20 to +125Â°C (-4 to +257Â°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 sensors 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

NOTE: If you were sent here from DTC P0068, P0101, P0106, or P1101 refer to Circuit/System Testing.

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**
Replace the Q38 Throttle Body.
 - **If DTC P16A0, P16A1, or P16A2 is set with any of the DTCs**
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**
Replace the Q38 Throttle Body.
 - **If Agree is displayed**
6. Verify DTC 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. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 4 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 5 Ω**
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 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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. Replace the Q38 Throttle Body.

Repair Instructions

- Refer to [Throttle Body Assembly Replacement](#)
- Refer to [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.
 - **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: ENGINE COOLANT TEMPERATURE (ECT) BELOW THERMOSTAT REGULATING TEMPERATURE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

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 149Â°C (-38 to 300Â°F)			
ECT Sensor Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)

Circuit/System Description

The purpose of this diagnostic is to analyze the performance of the thermostat by using the engine coolant temperature (ECT) sensor to determine if the engine coolant will increase at the correct rate, and also to meet the calibrated target temperatures under various operating conditions.

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, and engine run time are also factored in to determine if the ECT does increase normally and reach the calibrated target temperatures.

Conditions for Running the DTC

- DTCs P00B3, P00B6, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117 or P0118 are not set.
- The engine OFF time is greater than 30 m.
- The start-up ECT sensor is between -40Â° to 66Â°C (-40Â° to 151Â°F).
- Engine run time between 30 s and 30 m.
- The Ethanol in the fuel is less than 87%.
- The vehicle has traveled greater than 0.8 kilometers (0.5 miles).
- The DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

- The ECM determines that the ECT has not met its calibrated target of 71Â° C (160 Â°F) when the start-up ambient temperature was between 10 and 52Â° C (50 and 126Â° F), for greater than 1 s.

OR

- The ECM determines that the ECT has not met its calibrated target of 55Â° C (131 Â°F) when the start-up ambient temperature was between - 7 and 10Â° C (19 and 50Â° F), for greater than 1 s.

Action Taken When the DTC Sets

- DTC P0128 is a Type B DTC.
- 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.
- 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

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling System Description and Operation

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 P00B3, P00B6, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117 or P0118 is not set.
 - **If DTC P00B3, P00B6, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117 or P0118 is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**
 - **If DTC P00B3, P00B6, P0101, P0102, P0103, P0111, P0112, P0113, P0116, P0117 or P0118 is not set**
2. Verify the cooling system is filled to the correct coolant level. Refer to **Cooling System Draining and Filling (Vacuum and Fill)**, **Cooling System Draining and Filling (Static)**, and **Loss of Coolant**.
 - **If the coolant level is not correct**

Repair as necessary
 - **If the coolant level is correct**
3. Engine running for 15 min with the A/C OFF, increase the engine speed to 3,000 RPM.
4. Verify the scan tool ECT Sensor parameter is greater than 80°C (176°F).
 - **If less than 80°C (176°F)**

Replace the Engine Coolant Thermostat.

- **If greater than 80Â°C (176Â°F)**

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 B34 Engine Coolant Temperature sensor harness connector at the sensor. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 5 Ω between the low reference circuit terminal A or 2 and ground.

- **If 5 Ω or greater**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If less than 5 Ω**

3. Ignition ON.

4. Verify the scan tool ECT Sensor parameter is colder than -39Â°C (-38Â°F).

- **If warmer than -39Â°C (-38Â°F)**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the signal circuit terminal B or 1 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 colder than -39Â°C (-38Â°F)**

5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.

6. Verify the scan tool ECT sensor parameter is warmer than 149Â°C (300Â°F).

- **If 149Â°C (300Â°F) or colder**

1. Ignition OFF, remove the jumper wire, 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

3. Ignition OFF.

4. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If warmer than 149Â°C (300Â°F)**

7. Test the B34 Engine Coolant Temperature Sensor.

Refer to Component Testing.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#) table. The resistance values should be in range of the table values.

- **If not within the specified range**

Replace the B34 Engine Coolant Temperature Sensor.

- **If within the specified range**

3. Test for infinite resistance between each terminal and the sensor housing.

- **If less than infinite resistance**

Replace the B34 Engine Coolant Temperature Sensor.

- **If infinite resistance**

4. Refer to [Thermostat Diagnosis](#).

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

- Refer to [Engine Coolant Temperature Sensor Replacement](#)
- Refer to [Engine Coolant Thermostat Housing Replacement \(LCV\)](#)
- Refer to [Control Module References](#) for ECM replacement, setup and programming

DTC P0131, P0132, P0137, OR P0138: HO2S CIRCUIT LOW/HIGH VOLTAGE SENSOR 1-2

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 P0137

HO2S Circuit Low Voltage Sensor 2

DTC P0138

HO2S Circuit High Voltage Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137	P0132, P0138	P0132, P0138	P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, P2271

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Low Signal	P0131, P0137, P0171	P0132, P0138	P0132, P0138	P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, P2271

Typical Scan Tool Data

HO2S Sensor 1 or 2

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200 - 800 mV			
HO2S High Signal	0.00 V	1.7 - 2.1 V	1.7 - 2.1 V
HO2S Low Signal	0.00 V	1.7 - 2.1 V	1.7 - 2.1 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 - 1,000 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 or P0137

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition voltage is between 10 - 32 V.
- Ignition is OFF for greater than 8 h.
- The fuel system is operating in Closed Loop.
- Device controls are not active.
- The fuel level is greater than 10 percent.
- The throttle position (TP) is between 3 - 70 percent.
- Ethanol content is less than 87 percent.
- Decel fuel cut-off is not active.
- The DTCs run continuously when the above conditions are met for 5 s.

P0132 or P0138

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition voltage is between 10 - 32 V.
- Ignition is OFF for greater than 8 h.
- The fuel system is operating in Closed Loop.

- Ethanol content is less than 87 percent.
- The fuel level is greater than 10 percent.
- The engine run time is greater than 20 s.
- The DTCs run continuously when the above conditions are met for 5 s.

Conditions for Setting the DTC

P0131 or P0137

The engine control module detects that the heated oxygen sensor voltage is less than 50 mV and the circuit is shorted to ground for greater than 50 s.

P0132 or P0138

The engine control module detects that the heated oxygen sensor voltage is greater than 1,050 mV and the circuit is shorted to voltage for greater than 13 s.

Action Taken When the DTC Sets

DTCs P0131, P0132, P0137, and P0138 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0131, P0132, P0137, and P0138 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. 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 4 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 terminal 4 and ground.

- If less than infinite resistance repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the high signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , 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 terminal 4 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 3 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 4 and the low signal circuit terminal 3.

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 Ω in the low signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω
3. Test for less than 1 V between the low 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 0.0 V**
 6. Verify none of the conditions listed below exist:
 - Water intrusion in the B52 Heated Oxygen Sensor 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**

Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Heated Oxygen Sensor Replacement - Sensor 1](#)
- Refer to [Heated Oxygen Sensor Replacement - Sensor 2](#)
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an HO2S.
- Refer to [Control Module References](#) for ECM replacement, programming and setup

DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, OR P2271: HO2S

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 P015A

DTC P015B

HO2S Delayed Response Lean to Rich Sensor 1

DTC P2270

HO2S Signal Stuck Lean Sensor 2

DTC P2271

HO2S Signal Stuck Rich Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P013A, P013B, P013E, P013F, P015A, P015B
HO2S Low Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P013A, P013B, P013E, P013F, P015A, P015B

Typical Scan Tool Data**HO2S Sensor 1 or 2**

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0.00 V	1.7-2.1 V	1.7-2.1 V
HO2S Low Signal	0.00 V	1.7-2.1 V	1.7-2.1 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 0-1,000 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**

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0131, P0132, P0134, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P1104, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P1516, P16F3, P2100-P2103, P2119, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2227-P2230 are not set.

- The Ignition voltage is between 10-32 V.
- The engine is OFF for greater 8 hours.
- The engine coolant temperature (ECT) is warmer than 70Â°C (158Â°F).
- The intake air temperature (IAT) is warmer than -40Â°C (-40Â°F).
- The fuel level is greater than 10%.
- The engine run time is greater than 120 s.
- The engine speed is between 1,000-3,500 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 10-40 g/s.
- The fuel system is in Closed Loop.
- Device controls are not active.
- Ethanol content is less than 87%.
- Fuel control is not in power enrichment.
- Decel fuel cut-off is not active.
- The DTCs run once per drive cycle when the above conditions are met for 3 s.

P013A or P013E

- Before the ECM can report DTC P013A, or P013C failed, DTCs P013E, P014A, P2270, and P2272 must run and pass.
- Before the ECM can report DTC P013E, or P014A failed, DTCs P2270 and P2272 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201-P0208, P0220, P0222, P0223, P0300-P0308, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The Ignition voltage is between 10-32 V.
- The engine is OFF for greater 8 hours.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- After the above conditions are met decel fuel cut-off continues without driver initiated pedal input.
- The DTCs run once per ignition cycle, during decel fuel cut-off (DFCO), when the above conditions are met.

P013B or P013F

- Before the ECM can report DTC P013B, or P013D failed, DTCs P013A, P013C, P013E, P013F, P014A, P014B, P2270, P2271, P2272, and P2273 must run and pass.
- Before the ECM can report DTC P013F, or P014B failed, DTCs P013A, P013C, P013E, P014A, P2270, P2271, P2272, and P2273 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201-P0208, P0220, P0222, P0223, P0300-P0308, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The Ignition voltage is between 10-32 V.
- The engine is OFF for greater 8 hours.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- After the above conditions are met, fuel enrich mode is continued.
- The DTCs run once per ignition cycle when the above conditions are met.

P015A or P015B

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The Ignition voltage is between 10-32 V.
- The engine is OFF for greater than 8 hours.
- The engine coolant temperature (ECT) is warmer than 70°C (158°F).
- The intake air temperature (IAT) is warmer than -40°C (-40°F).
- The fuel level is greater than 10%.
- The engine run time is greater than 120 s.
- The engine speed is between 1,250-2,300 RPM.
- The vehicle speed is between 56-119 km/h (35-74 mph).
- The mass airflow (MAF) is between 3-12 g/s.
- The fuel system is in Closed Loop.
- Device controls are not active.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The heated oxygen sensor 1 heater is on for greater than 40 s.
- The heated oxygen sensor 2 heater is on for greater than 175 s.
- After the above conditions are met for 1 s the fuel mixture is forced rich.
- At the end of the forced rich fuel state, the heated oxygen sensor 1 is greater than 0.690 V and decel fuel cut-off is active.
- The DTCs run once per drive cycle when the above conditions are met.

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%.
- The pedal position is less than 4%.
- The engine speed is between 1,250-2,300 RPM.
- The engine airflow is between 3-12 g/s.
- The vehicle speed is between 55-120 km/h (35-74 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 600-850°C (1,112-1,562°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%.
- The engine speed is between 1,250-2,300 RPM.
- The engine airflow is between 3-12 g/s.
- The vehicle speed is between 55-120 km/h (34.2-74.6 mph).
- The fueling state is in Closed Loop.

- The evaporative emission (EVAP) diagnostics are not in control of purge.
- Power take-off is not active.
- The heated oxygen sensor heaters have been on more than 180 s.
- The predicted catalyst temperature is between 600-850Â°C (1,112-1,562Â°F).
- DTCs P013A, P013E, and P2270 have run and passed.

THEN

- Decel fuel cut-off is active.
- The accelerator pedal position is stable.
- This DTC runs once per trip when the above conditions are met for 3 s.

Conditions for Setting the DTC

P0133, P015A or P015B

The engine control module detects that the heated oxygen sensor rich-to-lean or lean-to-rich average response time is greater than a calibrated value.

The DTCs set within 60 s when the above condition is met.

P013A

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

P013B

The engine control module detects that the accumulated mass air flow monitored during lean-to-rich transitions between 300-600 mV is greater than 75 grams.

P013E

The engine control module detects that the heated oxygen sensor voltage has not decreased below 450 mV within a calibrated value of accumulated air flow.

P013F

The engine control module detects that the heated oxygen sensor voltage has not increased above 300 mV within a calibrated value of accumulated air flow.

P2270

The engine control module does not detect a heated oxygen sensor voltage greater than 825 mV before accumulated mass air flow exceeds a calibrated value.

P2271

The engine control module does not detect an heated oxygen sensor voltage less than 100 mV before accumulated mass air flow exceeds a calibrated value.

Action Taken When the DTC Sets

- DTCs P0133, P013E, P013F, P2270, and P2271 are Type B DTCs.
- DTCs P013A, P013B, P015A, and P015B are Type A DTCs.

Conditions for Clearing the DTC

- DTCs P0133, P013E, P013F, P2270, and P2271 are Type B DTCs.
- DTCs P013A, P013B, P015A, and P015B are Type A DTCs.

Reference Information

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.
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. Verify none of the conditions listed below exist:

- Lean or rich fuel injectors - Refer to Fuel Injector Diagnosis .
- 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
- Engine vacuum leaks
- Engine oil consumption - Refer to Oil Consumption Diagnosis .
- Engine coolant consumption - Refer to Loss of Coolant .
- **If any of the above conditions exist**

Repair as necessary.

- **If none of the conditions exist**

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.

5. Verify the DTC does not reset.

- **If the DTC sets**

Test or replace the appropriate B52 HO2S.

- **If the DTC does not set**

6. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Heated Oxygen Sensor Replacement - Sensor 1](#)
- Refer to [Heated Oxygen Sensor Replacement - Sensor 2](#)
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an HO2S.
- Refer to [Control Module References](#) for ECM replacement, programming and setup

DTC P0171 OR P0172: FUEL TRIM SYSTEM LEAN/RICH

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 a Closed Loop 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 values. The short term fuel trim values change rapidly in response to the HO2S signal voltages. These changes fine tune the engine fueling. The long term fuel trim values change in response to trends in the short term fuel trim. The long term fuel trim makes coarse adjustments to fueling in order to re-center and restore control to short term fuel trim. The ideal fuel trim values are around 0%. A positive fuel trim value indicates that the ECM is adding fuel in order to compensate for a lean condition. A negative fuel trim 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 P0030, P0053, P0101, P0102, P0103, P0106, P0107, P0108, P0131 - P0135, P015A, P015B, P0178, P0179, P0201 - P0204, P0236, P0237, P0238, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300 - P0304, P0411, P0442, P0455, P0458, P0496, P0506, P0507, 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 diagnostic intrusive test, post 02 diagnostic intrusive test, device control, and evaporative emission leak test are not active.
- The engine coolant temperature (ECT) is between -20 and +130Â°C (-4 and +266Â°F).
- The intake air temperature (IAT) is between -20 and +150Â°C (-4 and +302Â°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%.
- This diagnostic runs continuously when the above conditions have been met.

Conditions for Setting the DTC

- The average long term fuel trim weighted average value is greater or less than a calibrated value.
- The above condition is present for approximately 3 min after the Conditions for Running the DTC have been met.

Action Taken When the DTC Sets

DTCs P0171 and P0172 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0171 and P0172 are Type B DTCs.

Diagnostic Aids

- Allow the engine to reach operating temperature. With the engine running, observe the HO2S parameter with a scan tool. The HO2S value should vary from approximately 40 mV to approximately 900 mV, and respond to fueling changes.
- The normal Short Term Fuel Trim and Long Term Fuel Trim parameters should be between +10 and -10% with 0% the optimum, with the engine running at operating temperature.
- Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks.
- A MAF sensor condition can cause this DTC without setting a MAF DTC. If there is a MAF sensor condition, the MAF sensor parameters will appear to be within range.
- Verify that the air filter is the correct one for this application. Verify that the engine oil fill cap is in place and that it is tight. Verify that the engine oil dip stick is fully seated.
- 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

Component View Reference

Powertrain Component Views

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no other DTCs are set.

- **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

- **If no other DTCs are set**

3. Verify DTC P0171 or P0172 is not set.

- **If a DTC is set**

Refer to Circuit/System Testing.

- **If no DTC is set**

4. 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.

5. Verify DTC P0171 or P0172 is not set.

- **If any of the DTCs set**

Refer to Circuit/System Testing.

- **If none of the DTCs set**

6. All OK.

Circuit/System Testing

1. Ignition ON.

2. Verify the manifold absolute pressure sensor is within the range specified for your altitude. Refer to [Altitude Versus Barometric Pressure](#)

- **If not within the specified range**

Refer to [DTC P0106](#)

- **If within the specified range**

3. Engine running at the operating temperature.

4. Verify the Long Term Fuel Trim parameter is between -10% and +10%.

- **If greater than +10%**

1. Ignition OFF.

2. Inspect for the conditions listed below:

- Mass air flow (MAF) sensor signal skewed. If the Short Term Fuel Trim parameter changes greater than 20% when the MAF sensor is disconnected, refer to [DTC P0101](#).
- Fuel contamination. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
- Missing, restricted, or leaking exhaust components. Refer to [Symptoms - Engine Exhaust](#).
- Malfunctioning fuel injectors. Refer to [Fuel Injector Diagnosis](#).
- Split, kinked or improperly connected vacuum hoses.
- Insufficient fuel in the tank
- Low fuel pressure. Refer to [Fuel System Diagnosis](#).
- Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
- Leaks in the air induction system and the air intake ducts
- Missing air filter element
- Cracked EVAP canister
- Evaporative pipes obstructed or leaking
- Leaks in the crankcase ventilation system. Refer to [Crankcase Ventilation System Inspection/Diagnosis](#).
 - If a condition is found, repair as necessary.
 - If no condition is found, inspect the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#).

- **If less than -10%**

1. Ignition OFF.

2. Inspect for the conditions listed below:

- Mass air flow (MAF) sensor signal skewed. If the Short Term Fuel Trim parameters for both banks changes greater than 20% when the MAF sensor is disconnected, refer

to [DTC P0101](#).

- Fuel contamination - Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#) .
 - Missing, restricted, or leaking exhaust components - Refer to [Symptoms - Engine Exhaust](#) .
 - Malfunctioning fuel injectors - Refer to [Fuel Injector Diagnosis](#)
 - Collapsed or restricted air intake duct
 - Excessive fuel pressure - Refer to [Fuel System Diagnosis](#)
 - Dirty or restricted air filter
 - Objects blocking the throttle body
 - Improper operation of the evaporative emissions control system
 - Excessive fuel in the crankcase. Change the engine oil as necessary.
 - If a condition is found, repair as necessary.
 - If no condition is found, inspect the engine for a mechanical condition. Refer to [Symptoms - Engine Mechanical](#) .
 - **If between -10% and +10%**
5. 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.
6. Verify DTC P0171 or P0172 is not set.
- **If any of the DTCs set**

Refer to conditions listed above.
 - **If none of the DTCs set**
7. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Perform the scan tool Fuel Trim Reset after completing the repair.

DTC P018B-P018D: FUEL PRESSURE SENSOR (CHASSIS 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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
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 chassis 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 chassis 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 Ω between the low reference circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If less than 10 Ω**
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 K38 Chassis 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 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis 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 K38 Chassis 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 K38 Chassis 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 K38 Chassis 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 K38 Chassis 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis 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.

Refer to [Control Module References](#) for chassis control module replacement, programming and setup

DTC P0191, P0192, OR P0193: FUEL RAIL PRESSURE SENSOR

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0191

Fuel Rail Pressure Sensor Performance

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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P018C, P0192, P0340, P0365, P0452, P0506, P0522, P0532, P055C, P0641, P2227, P2228	P0192	P018D, P0193, P0453, P0523, P0533, P055D, P0641, P2227	P0191
Fuel Rail Pressure Sensor Signal	P0192, P0506	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

P0191 - Condition 1

- 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 250 kPa (36 psi).
- The Accelerator Pedal Position is 0 percent for 2.5 s.
- The engine is running for greater than 30 s.

P0191 - Condition 2 and 3

- The engine is not cranking.
- The ignition voltage is greater than 11 V.
- The engine speed is between 1,000 - 3,000 RPM.
- The vehicle speed is greater than or equal to 35 km/h (22 mph).
- The low side fuel pressure is greater than or equal to 250 kPa (36 psi).
- The Desired Fuel Rail Pressure is between 4 - 6 MPa (580 - 870 psi).
- The Accelerator Pedal Position is greater than or equal to 10 percent.
- The engine is running for greater than 30 s.

P0191 - Condition 4

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, 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, P0628, P0697, P06A3, P0722, P0723, P1248, P1249, P124A, P124B, P1682, P2122, P2123, P2127, P2128, P2135, P2138, 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.
- The barometric (BARO) pressure is greater than 70 kPa.
- The intake air temperature (IAT) is warmer than -20Â°C (-4Â°F).

P0192 or P0193

- 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

P0191 - Condition 1

The difference between the low side fuel pressure and the high side fuel pressure is less than or equal to -1 MPa (-145 psi) or greater than or equal to 1 MPa (145 psi) with the high pressure fuel pump actuator commanded OFF. The condition exists for greater than 3 s.

P0191 - Condition 2

The difference between the relief pressure and the measured high pressure is less than or equal to -1.6 MPa (-232 psi) with the high pressure fuel pump actuator commanded ON. The condition exists for greater than 2 s.

P0191 - 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 1.6 MPa (232 psi) with the high pressure fuel pump actuator commanded ON. The condition exists for greater than 3 s.

P0191 - 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 30 s with the engine running or greater than 10 s with the engine cranking.

P0192

The ECM detects that the fuel rail fuel pressure sensor signal voltage is low for greater than 5 s.

P0193

The ECM detects that the fuel rail fuel pressure sensor signal voltage is high for greater than 5 s.

Action Taken When the DTC Sets

- DTCs P0191, P0192, and P0193 are Type A DTCs.
- A message center or an indicator may display Reduced Engine Power.

Conditions for Clearing the DTC

DTCs P0191, P0192 and P0193 are Type A DTCs.

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 P0641 is not set.
 - **If the DTC is set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If the DTC is not set**
3. Engine idling.
4. Verify DTC P0191, P0192 or P0193 is not set.
 - **If any of the DTCs are set**
Refer to Circuit/System Testing.
 - **If none of the DTCs are set**
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
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 fuel injector multi-way harness connector X160. It may take up to 2 minutes for all vehicle systems to power down.

NOTE: Testing for steps 2 through 7 is performed on the ECM side of the multi-way harness connector.

2. Test for less than 5 Ω between the low reference circuit terminal 5 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 11 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 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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 the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
 - **If 0.02 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 12 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 0.02 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 12 and the 5 V reference circuit terminal 11.
7. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.
 - **If 4.96 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 12 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 4.96 V**
8. Ignition OFF, remove the intake manifold.
9. Connect the fuel injector multi-way harness connector X160.
10. Disconnect the B47B fuel rail fuel pressure sensor connector.

NOTE: **Testing for steps 11 through 17 is performed at the fuel rail fuel pressure sensor connector.**

11. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
 - **If 5 Ω or greater**
 - 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 - 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 5 Ω**
12. Ignition ON.
13. 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 Ω in the 5 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , 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**

14. Ignition ON.

15. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.

- **If 0.02 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 12 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 0.02 V**

16. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the 5 V reference circuit terminal 1.

17. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is greater than 4.96 V.

- **If 4.96 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 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 4.96 V**

18. Replace the B47B fuel rail fuel pressure sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

- Refer to [Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement](#)
- Refer to [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: CYLINDER 1-4 INJECTOR CONTROL CIRCUITS

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.

- Refer to [Diagnostic Procedure Instructions](#) to provide 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

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
Fuel Injector 1 Control +	P2147	P0201	P2148	P1248
Fuel Injector 1 Control -	P0261	P0201	P0262, P2148	P1248
Fuel Injector 2 Control +	P2150	P0202	P2151	P1249
Fuel Injector 2 Control -	P0264	P0202	P0265, P2151	P1249
Fuel Injector 3 Control +	P2153	P0203	P2154	P124A
Fuel Injector 3 Control -	P0267	P0203	P0268, P2154	P124A
Fuel Injector 4 Control +	P2156	P0204	P2157	P124B
Fuel Injector 4 Control -	P0270	P0204	P0271, P2157	P124B

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the high control circuits. The ECM energizes each fuel injector by grounding the low control circuit of the fuel injector. The ECM monitors the status of the fuel injector 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 fuel injector control circuit is open for greater than 2 s.

P0261, P0264, P0267, or P0270

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

P0262, P0265, P0268, or P0271

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

P1248, P1249, P124A, or P124B

The ECM detects the fuel injector control + circuit is shorted to the fuel injector control - circuit for greater than 2 s.

P2147, P2150, P2153, or P2156

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

P2148, P2151, P2154, or P2157

The ECM detects the fuel injector control + 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 Diagnosis](#).
- 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 Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Powertrain Component View

Powertrain Component Views

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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. Ignition ON.
2. Verify DTC P0685 or P1682 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**

NOTE: The engine must be running for the scan tool Cylinder 1 - 4 Injector Control Circuit Status parameters to function.

3. Engine idling.
4. Verify with a scan tool the parameters listed below do not increment.
 - Cylinder 1 Current Misfire Counter
 - Cylinder 2 Current Misfire Counter
 - Cylinder 3 Current Misfire Counter
 - Cylinder 4 Current Misfire Counter
 - **If a parameter increments**
Refer to Circuit/System Testing.
 - **If a parameter does not increment**
5. Verify with a scan tool the parameters listed below display OK or Not Run.
 - Cylinder 1 Injector Control Circuit Status
 - Cylinder 2 Injector Control Circuit Status
 - Cylinder 3 Injector Control Circuit Status
 - Cylinder 4 Injector Control Circuit Status
 - **If OK or Not Run is not displayed**
Refer to Circuit/System Testing.
 - **If OK or Not Run is displayed**
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, all vehicle systems OFF, disconnect the harness connector at the K20 Engine Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for infinite resistance between the appropriate Q17 Fuel Injector control + circuit and ground.
 - **If less than infinite resistance**
 1. Disconnect the harness connector of the Q17 Fuel Injector.
 2. Test for infinite resistance between the Q17 Fuel Injector control + circuit and ground.
 - If less than infinite, repair the short to ground in the circuit.
 - If infinite resistance
 3. Test for infinite resistance between the Q17 Fuel Injector control - circuit and ground.
 - If less than infinite, repair the short to ground in the circuit.
 - If infinite, replace the Q17 Fuel Injector.
 - **If infinite resistance**
3. Ignition ON.
4. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
 - **If 1 V or greater**
 1. Disconnect the harness connector of the Q17 Fuel Injector, ignition ON.
 2. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, repair the short to voltage on the control - circuit.
 - **If less than 1 V**
5. Ignition OFF.
6. Test for less than 3 Ω between the Q17 Fuel Injector control + circuit and control - circuit.
 - **If 3 Ω or greater**
 1. Disconnect the harness connector of the Q17 Fuel Injector.
 2. Test for less than 2 Ω on the control + circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 3. Test for less than 2 Ω on the control - circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the Q17 Fuel Injector.
 - **If less than 3 Ω**
7. Replace the K20 Engine Control Module.

Component Testing

Refer to [Fuel Injector Diagnosis](#)

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

- Refer to [Control Module References](#) for ECM replacement, setup, and programming
- Refer to [Fuel Injector Replacement](#)

DTC P0231, P0232, OR P023F: FUEL PUMP CONTROL CIRCUIT (CHASSIS 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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 chassis control module when the ECM detects that the ignition is on. The voltage from the ECM to the chassis control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the chassis 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 chassis control module is inactive for 4 seconds after engine has been shut off.

Conditions for Setting the DTC

The chassis 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

Engine Controls Schematics

Connector End View 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 Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor Assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If less than 10 Ω**
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 K38 Chassis 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 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis 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 K38 Chassis Control Module.

- If the test lamp turns ON and OFF

6. Replace the A7 Fuel Pump and Level Sensor Assembly.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Fuel Tank Fuel Pump Module Replacement \(NT5, NT7\)](#), [Fuel Tank Fuel Pump Module Replacement \(NU6\)](#).
- Refer to [Control Module References](#) for chassis control module replacement, programming and setup

DTC P025A: FUEL PUMP CONTROL MODULE ENABLE CIRCUIT (CHASSIS 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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 chassis control module when the ECM detects that the ignition is on. The voltage from the ECM to the chassis control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the chassis 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 chassis control module does not agree with the state of the control enable voltage signal supplied from the ECM to the chassis 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.

Diagnostic Aids

Beginning in the 2014 model year the K27 Fuel Pump Control Module (FPCM) will now be called the chassis control module (CCM). The component code for the chassis control module will be K38. The

chassis control module name will be used in Service Information, the Global Diagnostic System and the Service Programming System.

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: 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 **Strategy Based Diagnosis**.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K38 Chassis 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 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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 K38 Chassis Control Module.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Control Module References](#) for ECM or chassis control module replacement, programming and setup

DTC P0300-P0304: MISFIRE DETECTED

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 sensor to determine when a engine cylinder misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM can detect individual cylinder misfire events.

Extreme cylinder misfire events can cause catalytic converter damage. The malfunction indicator lamp (MIL) will flash when the conditions for catalytic converter damage are present. DTCs P0301 through P0304 correspond to cylinders 1 through 4. When the ECM detects that one or more specific cylinders are misfiring, the DTC for the respective misfiring cylinder will set and up to 2 of the corresponding fuel injectors are disabled for a minimum of 30 s. The ECM will then re-enable the fuel injector and, after approximately 200 engine revolutions, will determine if the misfire is still present. If the misfire is still present, the ECM will disable the fuel injector again repeating the process. If the misfire is not present, the fuel injector will remain enabled by the ECM. In Spark Ignition Direct Injection (SIDI) system applications, if a fuel injector fault DTC is set during a misfire event, the ECM will not re-enable the injector.

Conditions for Running the DTC

- DTC P0010, P0011, P0013, P0014, P0016, P0017, P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0122, P0123, P0191, P0192, P0193, P0222, P0223, P0335, P0336, P0340, P0341, P0365, P0366, P0601, P0604, P0606, P0651, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2227, P2228, P2229, or P2230 is not set.

- The engine speed is less than 1,000 RPM and DTC P0315 is set.
- The engine speed is greater than 1,050 RPM.
- The crankshaft position and camshaft position sensors are synchronized.
- The engine coolant temperature (ECT) is between -12 and 127°C (10 - 261°F).
- If the ECT is colder than -12°C (10°F) at start-up, this diagnostic will not run until the ECT is between 21 - 127°C (70 - 261°F).
- The battery voltage is between 9 - 32 V.
- The ECM is not detecting a rough road signal.
- The fuel level is at least 11%.
- The ECM is not in fuel cut-off or deceleration fuel cut-off mode.

The DTCs run continuously when the above conditions are met.

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 or a misfire rate high enough to cause catalyst damage.

P0301, P0302, P0303, or 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 will flash the malfunction indicator lamp (MIL) when a catalyst damaging level of misfire is present.
- If a hybrid application, engine idle speed will increase to between 1750-2500 RPM.

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 conditions listed below:
 - 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 or defective accessory drive component or belt
- High resistance in the circuits of the injectors may set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- If the condition is intermittent, observing the scan tool IC Circuit Test and Fuel Injector Circuit Test Status parameters may help isolate the condition. The circuit test status parameters will change from OK or Not Run to Fault/Malfunction if a condition exists.
- A condition in the heated O2 sensor (HO2S) heater control circuits may set a DTC P0300.

Reference Information

Description and Operation

- [Electronic Ignition System Description](#)

- [Fuel System Description](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Special Tools

EL26792 Spark Tester

For equivalent regional tools, refer to [Special Tools](#) .

[Circuit/System Verification](#)

NOTE:

Before starting the engine, review the freeze frame failure records data to determine if the misfire sets during a cold start or at operating temperature. If there is a cold start condition and the engine is started, the engine will need to be cooled down before the next attempt to start the engine within the fail conditions.

If this a hybrid application and the hybrid battery is fully charged, the engine runs at a very low load since the hybrid battery cannot accept any additional charge. At this very low engine load, engine misfire may not be detected. It may be necessary to drive the vehicle in battery only propulsion mode in order to discharge the hybrid battery before diagnosis can be performed.

1. If this is a hybrid application, skip to step 4.
2. Engine Running at normal operating temperature.
3. Verify there is no abnormal engine noise.
 - **If abnormal engine noise is present**
Refer to [Symptoms - Engine Mechanical](#) .
 - **If abnormal engine noise is not present**
4. Perform the scan tool [Crankshaft Position Variation Learn](#) procedure.
5. Verify no DTCs are set.
 - **If any DTCs other than P0300 - P0304 are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If DTC P0300 - P0304 is set**
Refer to Circuit/System Testing.
 - **If no DTCs are set**
6. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter parameters do not increment.
 - **If increments**
Refer to Circuit/System Testing.
 - **If does not increment**
7. Engine Running, perform the Cylinder Power Balance Test with a scan tool.
8. Verify the engine speed changes when each injector is disabled and then enabled.
 - **If engine speed does not change**
Refer to Circuit/System Testing.

- **If engine speed does change**

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.

- **If the DTC does not set**

11. All OK.

Circuit/System Testing

1. Verify none of the following conditions listed below exist:

- Damage, carbon tracking, or fluid intrusion of the spark plug boots and/or spark plugs
- 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 a condition exists**

Repair or replace as necessary.

- **If no conditions exist**

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

2. Ignition OFF, remove the appropriate T 8 Ignition Coil from the spark plug and connect the **EL 26792** HEI Spark Tester to the spark plug boot, engine Cranking.

3. Verify the spark output.

- **If no output or the output is weak**

Refer to [Electronic Ignition System Diagnosis](#) .

- **If the output is good**

4. Ignition OFF.

5. Verify the conditions listed below. Refer to [Ignition System Specifications](#) .

- The correct spark plug type
- The correct spark plug gap
- The correct spark plug torque
- **If a condition exists**

Repair or replace as necessary.

- **If no conditions exist**

6. Exchange the suspect spark plug with another cylinder that is operating correctly.

7. Engine Running.

8. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter does not increment for the cylinder where the suspect spark plug was installed.

- **If increments**

Replace the spark plug.

- **If does not increment**

9. Test or inspect for the conditions listed below:

- A lean or rich Q17 Fuel Injector - Refer to [Fuel Injector Diagnosis](#) .
- An engine mechanical condition - Refer to [Symptoms - Engine Mechanical](#) .

Repair Instructions

- Refer to [Ignition Coil Replacement](#)
- Refer to [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. Engine Running, verify the scan tool Cylinder 1 - 4 Current Misfire Counter parameters do not increment.
 - If the misfire counter parameters increment, a misfire condition still exists.
7. 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 [DTC P0420](#) .

DTC P0315: CRANKSHAFT POSITION SYSTEM VARIATION NOT LEARNED

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0315

Crankshaft Position System Variation Not Learned

Circuit/System Description

The crankshaft position 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

Engine is Running.

The DTC runs continuously when the above condition is met.

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Perform the scan tool [Crankshaft Position 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 the DTC sets**
Replace the K20 Engine Control Module.
 - **If the DTC does not set**
4. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0324, P0326, P0331, P06B6, OR P06B7: KNOCK SENSORS

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0324

Knock Sensor System Performance

DTC P0326

Knock Sensor 1 Performance

DTC P0331

Knock Sensor 2 Performance

DTC P06B6

Control Module Knock Sensor Processor 1 Performance

DTC P06B7

Control Module Knock Sensor Processor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor 1 High Signal	P0327, P06B6	P0325	P0328	P0324*, P0326**
Knock Sensor 2 High Signal	P0332, P06B7	P0330	P0333	P0324*, P0331**
Knock Sensor 1 Low Signal	P0327	P0325	P0328	P0324*, P0326**
Knock Sensor 2 Low Signal	P0332	P0330	P0333	P0324*, P0331**
* Signal Performance High				
** Signal Performance Low				

Circuit/System Description

The knock sensors enable 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 sensors produce an alternating current (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 two knock sensor signals. The ECM receives each knock sensor signal through a dedicated circuit. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges and monitors the normal knock sensor signal. The ECM monitors the internal knock sensor processor test circuits which perform the open circuit diagnostic.

Conditions for Running the DTCs

P0324

- Engine is running for 2 s or greater.
- Engine speed is 8,500 RPM or less.
- Engine air flow is between 0 - 2000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.
- The intake air temperature (IAT) sensor is -40Â°C (-40Â°F) or warmer.

AND

- Engine speed is 550 RPM or greater for 300 or more cumulative revolutions.

OR

- Engine speed is 8500 RPM or greater for 400 or more cumulative revolutions.

P0326 and P0331

- Engine is running for 2 s or greater.
- Engine speed is 8,500 RPM or less.
- Engine air flow is between 20 - 2000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.
- The intake air temperature (IAT) sensor is -40Â°C (-40Â°F) or warmer.

AND

- Engine speed is 500 RPM or greater for 200 or more cumulative revolutions.

OR

- Engine speed is 2000 RPM or greater for 200 or more cumulative revolutions.

OR

- Engine speed is 8500 RPM or greater for 200 or more cumulative revolutions.

P06B6 and P06B7

- Engine is running for 2 s or greater.
- Engine speed is between 500 - 8,000 RPM for 200 or more cumulative revolutions.
- Engine air flow is between 0 - 2000 mg per cylinder.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0324

The ECM detects that either knock sensor signal performance is out of the normal calibrated range due to excessive engine knock on a per cylinder basis.

P0326

The ECM detects that the knock sensor 1 signal performance is out of the normal calibrated range due to a low signal level.

P0331

The ECM detects that the knock sensor 2 signal performance is out of the normal calibrated range due to a low signal level.

P06B6 and P06B7

The ECM has detected a fault in the knock sensor processor open circuit diagnostic internal test circuit.

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

DTCs P0324, P0326, P0331, P06B6, and P06B7 are Type B DTCs.

Reference Information

Description and Operation

Electronic Ignition 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. Engine Running.
2. Verify DTC P0325, P0327, P0328, P0330, P0332, P0333, P06B6, or P06B7 is not set.
 - **If DTC P0325, P0327, P0328, P0330, P0332, or P0333 is set with P06B6 or P06B7**
Refer to [DTC P0325, P0327, P0328, P0330, P0332, or P0333](#).
 - **If only DTC P06B6 or P06B7 is set**
Replace the K20 Engine Control Module.
 - **If none of the DTCs are set**
3. Ignition OFF.
4. Verify none of the conditions listed below exist:
 - B68 Knock Sensor or wiring harness damage.
 - Incorrect B68 Knock Sensor installation. Refer to [Fastener Specifications](#).
 - B68 Knock Sensor and engine mounting surface burrs, casting flash, and foreign material.
 - Close proximity of hoses, brackets, and engine wiring.
 - Loose brackets.
 - Loose or broken accessory drive belts, brackets, components.
 - An engine mechanical condition. Refer to [Symptoms - Engine Mechanical](#).
 - Contaminated or poor quality fuel.
 - **If a condition exists**
Repair or replace as necessary.
 - **If no conditions exist**
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 sets**
Test or replace the appropriate B68 Knock Sensor.
 - **If the DTC does not set**
6. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Knock Sensor Replacement](#)
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup.

DTC P0325, P0327, P0328, P0330, P0332, OR P0333: KNOCK SENSOR CIRCUITS

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0325

Knock Sensor 1 Circuit

DTC P0327

DTC P0328

Knock Sensor 1 Circuit High Voltage

DTC P0330

Knock Sensor 2 Circuit

DTC P0332

Knock Sensor 2 Circuit Low Voltage

DTC P0333

Knock Sensor 2 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor 1 High Signal	P0327, P06B6	P0325	P0328	P0324*, P0326**
Knock Sensor 2 High Signal	P0332, P06B7	P0330	P0333	P0324*, P0331**
Knock Sensor 1 Low Signal	P0327	P0325	P0328	P0324*, P0326**
Knock Sensor 2 Low Signal	P0332	P0330	P0333	P0324*, P0331**
* Signal Performance High				
** Signal Performance Low				

Circuit/System Description

The knock sensors enable 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 sensors produce an alternating current (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 two knock sensor signals. The ECM receives each knock sensor signal through a dedicated circuit. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges and monitors the normal knock sensor signal. The ECM monitors the internal knock sensor processor test circuits which perform the open circuit diagnostic.

Conditions for Running the DTCs**P0325 and P0330**

- Engine is running for 2 s or greater.
- Engine speed is between 550 - 8,500 RPM for 200 or more cumulative revolutions.
- Engine air flow is between 20 - 2000 mg per cylinder.
- The engine coolant temperature (ECT) is -40°C (-40°F) or warmer.
- The intake air temperature (IAT) sensor is -40°C (-40°F) or warmer.

P0327, P0328, P0332, and P0333

Engine speed is less than 8,500 RPM.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs**P0325**

The ECM detects knock sensor 1 signal circuit is open.

P0327

The ECM detects knock sensor 1 signal circuit is shorted to ground.

P0328

The ECM detects knock sensor 1 signal circuit is shorted to voltage.

P0330

The ECM detects knock sensor 2 signal circuit is open.

P0332

The ECM detects knock sensor 2 signal circuit is shorted to ground.

P0333

The ECM detects knock sensor 2 signal circuit is shorted to voltage.

Action Taken When the DTCs Set

- DTCs P0325, P0327, P0328, P0330, P0332, and P0333 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, P0328, P0330, P0332, and P0333 are Type B DTCs.

Diagnostic Aids

The following conditions listed below may cause a knock sensor DTC to set:

- Sensor damage.
- Knock sensor and engine mounting surface burrs, casting flash, and foreign material.
- Close proximity of hoses, brackets, and engine wiring.
- Loose brackets.
- Loose or broken accessory drive belts, brackets, components.
- An engine mechanical condition. Refer to [Symptoms - Engine Mechanical](#) .

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](#)

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 mounting bolt is properly tightened. Refer to Fastener Specifications .
 - **If not tightened to the correct specification**

Repair a necessary.
 - **If tightened to the correct specification**
4. Verify the scan tool parameters listed below display No while moving the related harnesses and connectors of the B68 Knock Sensor.
 - Cylinder 1 Knock Detected
 - Cylinder 2 Knock Detected
 - Cylinder 3 Knock Detected
 - Cylinder 4 Knock Detected
 - **If No is not displayed**

Repair the wiring harness or connectors.
 - **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.
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, disconnect the harness connector at the B68 Knock Sensor, ignition ON.
2. Test for 1 - 2 V between the low signal circuit terminal 2 or B and ground.
 - **If less than 1 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 2 or B and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 Ω in the low signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.

- **If greater than 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 low 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 - 2 V**
- 3. Test for 2 - 4 V between the high signal circuit terminal 1 or A and ground.
 - **If less than 2 V**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the high signal circuit terminal 1 or A and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
 3. Test for less than 2 Ω in the high signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 4 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 2 - 4 V**
- 4. Test or replace the B68 Knock Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Knock Sensor Replacement](#)
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup.

DTC P0335 OR P0336: CRANKSHAFT POSITION SENSOR

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0335, P0557, P057C, P0651, P118C	P0335	P0558, P0651, P118C	P0336
Signal	P0335, P0506	P0335, P0506	P0335	P0336
Low Reference	-	P0335, P0506	-	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 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 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.
- 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

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 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 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.

- **If 5 Ω or greater**
 1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If 2 Ω or less, replace the K20 Engine Control Module.
- **If less than 5 Ω**
- 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 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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.

- Refer to **Crankshaft Position Sensor Replacement**
 - Refer to **Control Module References** for engine control module replacement, programming, and setup
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2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.5L (LCV) - Diagnostic Information and Procedures - Impala

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0340, P0341, P0365, OR P0366: INTAKE/EXHAUST CAMSHAFT POSITION SENSOR

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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	P018C, P0192, P0452, P0522, P0532, P0641, P2227, P2228	P0340, P0365	P018D, P0193, P0453, P0523, P0641, P2227	-
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

- DTCs P0101, P0102, and P0103 are not set.
- The airflow into the engine is greater than 3 g/s.

OR

- The starter is engaged and the engine control module detects camshaft position sensor pulses.

Condition 2

- DTC P0651 is not set.
- The engine is running and the starter is not engaged.

Condition 3

- DTC P0335, P0336, P0641, or P0651 are not set.
- The crankshaft is synchronized.
- The starter is engaged.

Condition 4

- The crankshaft is synchronized.

P0341 or P0366 Condition 1

- DTC P0335, P0336, P0641, or P0651 are not set.
- The crankshaft is synchronized.
- The starter is engaged.

Condition 2

- DTC P0335, P0336, P0641, or P0651 are not set.
- The crankshaft is synchronized.

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.

Condition 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.

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 all 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 min for all vehicle systems to power down.

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

- **If 5 Ω or greater**

1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If 2 Ω or less, replace the K20 Engine Control Module.

- **If less than 5 Ω**

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 Ω in the 5 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , 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 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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.

- Refer to [Camshaft Position Sensor Replacement - Exhaust](#)
- Refer to [Camshaft Position Sensor Replacement - Intake](#)
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P034A OR P034B: CRANKSHAFT POSITION SENSOR

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P034A

Crankshaft Position Sensor - Engine Start Position Incorrect

DTC P034B

Crankshaft Position Sensor - Crankshaft Direction Incorrect

Circuit/System Description

These DTCs are used to verify that the crankshaft position has been detected correctly and to monitor the number of crankshaft reversals detected from the bi-directional crankshaft position sensor during an auto-start event.

Conditions for Running the DTC

P034A

- DTC P0335, P0336, or P0651 is not set.
- The engine has started rotating during an auto-start event.
- The crankshaft position is being verified.

The DTC runs each time the engine is started once the above conditions are met.

P034B

- DTC P0335, P0336, or P0651 is not set.
- Engine speed is between 400 - 2000 RPM.
- The airflow into the engine is greater than 3 g/s.
- The engine control module (ECM) detects crankshaft position sensor pulses.

The DTC runs continuously once the above conditions are met.

Conditions for Setting the DTC

P034A

- The crankshaft position is incorrect by greater than 3 crankshaft reluctor wheel teeth during 2 out of 3 auto-start events.
- The crankshaft position is incorrect by at least 1 crankshaft reluctor wheel tooth during 4 out of 5 auto-start events.

P034B

The crankshaft position sensor detects more than 3 engine rotation reversals within less than 10 s.

Action Taken When the DTC Sets

DTC P034A and P034B are Type B DTCs.

Conditions for Clearing the DTC

DTC P034A and P034B are Type B DTCs.

Diagnostic Aids

These DTCs do not necessarily indicate there is a condition with the crankshaft position sensor or the engine control module (ECM).

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Ignition ON.

2. Verify DTC P0335, P0336, or P0651 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. 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**

Replace the B26 Crankshaft Position Sensor.

- **If the DTC does not set**

5. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Crankshaft Position Sensor Replacement](#)

DTC P0351-P0354, P2300, P2301, P2303, P2304, P2306, P2307, P2309, OR P2310: IGNITION COIL 1-4 CONTROL CIRCUITS

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0351

Ignition Coil 1 Control Circuit

DTC P0352

Ignition Coil 2 Control Circuit

DTC P0353

Ignition Coil 3 Control Circuit

DTC P0354

Ignition Coil 4 Control Circuit

DTC P2300

Ignition Coil 1 Control Circuit Low Voltage

DTC P2301

Ignition Coil 1 Control Circuit High Voltage

DTC P2303

Ignition Coil 2 Control Circuit Low Voltage

DTC P2304

DTC P2306

Ignition Coil 3 Control Circuit Low Voltage

DTC P2307

Ignition Coil 3 Control Circuit High Voltage

DTC P2309

Ignition Coil 4 Control Circuit Low Voltage

DTC P2310

Ignition Coil 4 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Coil 1 Control	P0300, P2300	P0300, P0351	P0300, P2301	P0300, P0351
Ignition Coil 2 Control	P0300, P2303	P0300, P0352	P0300, P2304	P0300, P0352
Ignition Coil 3 Control	P0300, P2306	P0300, P0353	P0300, P2307	P0300, P0353
Ignition Coil 4 Control	P0300, P2309	P0300, P0354	P0300, P2310	P0300, P0354
Ground	-	P2301, P2304, P2307, P2310	-	-

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

Action Taken When the DTC Sets

DTCs P0351, P0352, P0353, P0354, P2300, P2301, P2303, P2304, P2306, P2307, P2309, and P2310 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0351, P0352, P0353, P0354, P2300, P2301, P2303, P2304, P2306, P2307, P2309, and P2310 are Type B DTCs.

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

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.
 - **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTCs. 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.
 - **If the DTC does not set**
5. All OK.

Circuit/System Testing

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 Ω between the ground circuit terminal 1 and ground.
 - **If 5 Ω or greater**

1. Ignition OFF.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 5 Ω**
3. Engine Running.
4. 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**
5. 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**
6. Ignition OFF, install a 3 A fused jumper wire between the control circuit terminal 3 and ground, engine Running.
7. 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 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
8. 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.

- Refer to [Ignition Coil Replacement](#)
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0420: CATALYST SYSTEM LOW EFFICIENCY

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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, P0053, P0054, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0141, P015A, P015B, P0171, P0172, P0201, P0202, P0203, P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P1248, P1249, P124A, P124B, P16F3, P2101, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2270, or P2271 is not set.
- The engine speed is between 950 - 2,950 RPM to enable the catalyst diagnostic. Once the engine speed is in range, the engine speed must be between 900 - 3,050 RPM to keep the test enabled.
- Accelerator pedal position is at most 4%.
- Ethanol estimation is not active.
- Evaporative emission (EVAP) purge is not active.
- Post HO₂S heater is ON for greater than 180 s.
- Mass air flow (MAF) is between 2 - 13 g/s.
- System voltage is between 10 - 32 V.
- Vehicle speed is between 64 - 126 km/h (40 - 78 MPH) to enable the catalyst diagnostic. To keep the test enabled the vehicle speed is between 56 - 132 km/h (35 - 82 MPH).
- Catalyst calculated temperature is between 500 - 900Å,Å°C (932 - 1,652Å,Å°F).
- Engine is operating in closed loop.
- Engine is operating in DFCO.

This diagnostic attempts one test during each valid OFF-idle period once the above conditions have been met. This diagnostic attempts up to 4 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:

- Engine misfire
- High engine oil or high coolant consumption
- Retarded spark timing
- Weak or poor spark
- Lean fuel mixture
- Rich fuel mixture
- 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 other DTCs are set**
Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
 - **If no other DTCs are 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. Verify the Catalyst Monitor Test Result parameter displays Passed when performing the steps listed below:
 1. 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 will increment by one and the Catalyst Monitor Test Result will indicate Passed, Failed or No Result.

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

3. Verify the scan tool Catalyst Monitor Test Result displays Passed.

- **If No Result is displayed**

Repeat steps 3 - 5 until the Test Result parameter indicates Passed or Failed

- **If Failed is displayed**

Refer to Circuit/System Testing

- **If Passed is displayed**

6. 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
- Restrictions
- 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. Replace the catalytic converter.

Repair Instructions

- Refer to [Catalytic Converter Replacement](#)
- Refer to [Exhaust Leakage](#)
- Refer to [Heated Oxygen Sensor Replacement - Sensor 2](#)
- Perform the HO2S Heater Learn procedure with a scan tool after replacing a heated oxygen sensor.
- Refer to [Restricted Exhaust](#)

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. Verify the Catalyst Monitor Test Result displays Passed when performing the steps listed below:
 1. 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 will increment by one and the Catalyst Monitor Test Result will indicate Passed, Failed or No Result.

2. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.
3. Verify the scan tool Catalyst Monitor Test Result displays Passed.

- **If No Result is displayed**

Repeat steps 5 - 7 until the Test Result indicates Passed or Failed

- **If Failed is displayed**

Refer to Circuit /System Testing

- **If Passed is displayed**

8. All OK.

DTC P0442: EVAPORATIVE EMISSION (EVAP) SYSTEM SMALL LEAK DETECTED

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 engine control module (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 P010B, P012B, P012C, P012D, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P012B, P012C, P012D, P0222, P0223, P0236, P0237, P0238, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0461, P0462, P0463, P0496, P0498, P0499, P0502, P0503, P0722, P0723, P111E, P117D, P017C, P017D, P017B, P117B, P117F, P117E, P117C, P2066, P2067, P2068, P1221, P222B, P222C, P222D, P222E, P262B. are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant sensor (ECT) is greater than 63°C (145°F)
- 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 (14°F).
- The engine run time before shut-off was greater than 10 min.
- The drive distance before engine shut-off was greater than 5 km (3 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 control module will not make more than 2 test attempts per day. The time since the last completed engine off natural vacuum 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 engine off natural vacuum 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

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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

- **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 Not Venting or 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 if there is a leak.
 - **If a leak is detected**
 1. 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** .
 - If leak is detected, repair or replace the affected component as necessary.
 - **If no leak is detected**
5. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

DTC P0443, P0458, OR P0459: EVAPORATIVE EMISSION (EVAP) PURGE SOLENOID VALVE CONTROL CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0443

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit

DTC P0458

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit Low Voltage

DTC P0459

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Ignition	P0443	P0443, P0458	P0690
Control	P0443, P0458	P0443, P0458	P0459

Circuit/System Description

The evaporative emission (EVAP) purge solenoid valve is used to purge fuel vapor from the EVAP canister to the intake manifold. The EVAP purge solenoid valve is pulse width modulated (PWM). Ignition voltage is supplied directly to the EVAP purge solenoid valve. The engine control module (ECM) controls the solenoid valve 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 a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. A scan tool will display the amount of ON time as a percentage.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0443

The ECM detects the EVAP Purge Solenoid Valve control circuit is open for greater than 0.25 s.

P0458

The ECM detects the EVAP Purge Solenoid Valve control circuit is shorted to ground for greater than 0.25 s.

P0459

The ECM detects the EVAP Purge Solenoid Valve control circuit is shorted to voltage for greater than 0.25 s.

Action Taken When the DTC Sets

DTC P0443, P0458 and P0459 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0443, P0458 and P0459 are Type B DTCs.

Reference Information

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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 Verification

NOTE: 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.

1. Ignition ON, verify DTC P0690 is not set.

- **If the DTC is set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

- **If the DTC is not set**

2. Command the EVAP Purge Solenoid Valve from 0 to 50% and back to 0% with a scan tool while observing the following control circuit status parameters:

- EVAP Purge Solenoid Valve Control Circuit Open Test Status
- EVAP Purge Solenoid Valve Control Circuit Low Voltage Test Status
- EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Refer to Circuit/System Testing

- **If Malfunction is not displayed**

3. Verify the EVAP Purge Solenoid Valve control circuit parameters above do not display Malfunction when moving the related harnesses and connectors of the Q12 Evaporative Emission Purge Solenoid Valve.

- **If Malfunction is displayed**

Refer to Circuit/System Testing

- **If Malfunction is not displayed**

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 Q12 Evaporative Emission Purge Solenoid Valve. Ignition ON,

2. Verify that a test lamp illuminates between the ignition voltage circuit terminal A or 1 and ground.

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

1. Ignition OFF, remove the test lamp and disconnect any component connected to the ignition circuit.

2. Test for less than 2 Ω in the ignition circuit end to end.

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

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, test all components connected to the ignition voltage circuit for a short and replace as necessary.

- **If the test lamp illuminates**

3. Verify that a test lamp does not illuminate between the ignition circuit terminal A or 1 and the control circuit terminal B or 2.

- **If the test lamp illuminates**

1. Ignition OFF, remove the test lamp, 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 does not illuminate**

4. Remove the test lamp.

5. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the EVAP Purge Solenoid Valve to 50% with a scan tool.

- **If OK is not displayed**

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 OK is displayed**

6. Install a 3 A fused jumper wire between the control circuit terminal B or 2 and the ignition circuit terminal A or 1.

7. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the EVAP Purge Solenoid Valve to 50% with a scan tool.

- **If Malfunction is not displayed**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.

- **If Malfunction is displayed**

8. Test or replace the Q12 Evaporative Emission Purge Solenoid Valve.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the Q12 Evaporative Emission Purge Solenoid Valve.
2. Test for 10-30 Ω between the control terminal B or 2 and the ignition circuit terminal A or 1.
 - **If not between 10-30 Ω**
Replace the Q12 Evaporative Emission Purge Solenoid Valve.
 - **If between 10-30 Ω**
3. All OK.

Dynamic Test

1. Ignition OFF, disconnect the harness connector at the Q12 Evaporative Emission Purge Solenoid Valve.
2. Install a 3 A fused jumper wire between the ignition, terminal A or 1 and 12 V. Install a jumper wire between the control terminal B or 2 and ground.
3. Verify the Evaporative Emission Purge Solenoid Valve turns on & off/clicks and flows vacuum.
 - **If it does not turn on & off/click or flow vacuum.**
Replace the Q12 Evaporative Emission Purge Solenoid Valve.
 - **If it does turn on & off/clicks and flows vacuum.**
4. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Evaporative Emission Canister Purge Solenoid Valve Replacement](#)
- Refer to [Control Module References](#) for control module replacement, programming and setup

DTC P0446: EVAPORATIVE EMISSION (EVAP) VENT SYSTEM PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0446

Evaporative Emission (EVAP) Vent System Performance

Fuel Tank Pressure Sensor Signal Voltage	Fuel Tank Pressure
1.5 V	Atmospheric Pressure / BARO
Less than 1.5 V	Positive Pressure
Greater 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. There are two parts to this test.

- Part one uses the fuel tank pressure sensor to indicate vacuum comes within a calibrated value.
- The second part of this test looks for excessive vacuum which would indicate a restriction. The duration of this second part of is a function of purge volume through the system.

The table listed below 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, P00CA, P0068, P0090, P0091, P0092, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P012B, P012C, P012D, P017B, P017C, P017D, P0222, P0223, P0443, P0449, P0452, P0453, P0454, P0458, P0459, P0498, P0499, P0502, P0503, P0606, P0722, P0723, P0191, P0192, P0193, P06A3, P06DB, P06DE, P0A1D, P0601, P0604, P0697, P111E, P160D, P160E, P1682, P16A0, P16A1, P16A2, P16F3, P1104, P117B, P117C, P117D, P117E, P117F, P127A, P127C, P127D, P15F2, P1221, P2100, P2101, P2102, P2103, P2122, P2123, P2127, P2128, P2135, P2138, P215B, P2176, P2227, P2228, P2229, P2230, P228C, P228D, U0073, U0074, U0293, U1817 are not set.
- The ignition voltage is between 11 - 32 V.
- 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 $\text{\AA}$, $\text{\AA}$ $^{\circ}\text{C}$ (95 $\text{\AA}$, $\text{\AA}$ $^{\circ}\text{F}$).
- The startup intake air temperature (IAT) is between 4 - 34 $\text{\AA}$, $\text{\AA}$ $^{\circ}\text{C}$ (39 - 95 $\text{\AA}$, $\text{\AA}$ $^{\circ}\text{F}$).
- DTC P0446 runs once per cold start.

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 0.62 kPa (2.5 in H₂O) of pressure or less than 1.24 kPa (5 in H₂O) of vacuum for 60 s.

OR

- If fuel tank pressure sensor reading is less than 2.98 kPa (12 in H₂O) of vacuum for 5 s before 10 L (2.6 gal) of purge volume has passed through the system.
- 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
- Pinched vent hose

A blockage in the vent system may also cause a poor fuel fill problem.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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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

- **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 parameter is between 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.

- **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.

- **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 1.24 kPa (5.0 in H20).

7. Verify the scan tool Fuel Tank Pressure Sensor parameter is 0 kPa (0 in H20) when commanding the EVAP Vent Solenoid Valve to OFF.

- **If not 0 in H20**

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 H20**

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.

- Refer to [Evaporative Emission Canister Solenoid Replacement](#) for EVAP Vent Solenoid Valve replacement
- Refer to [Evaporative Emission Canister Replacement](#)
- Refer to [Fuel Tank Pressure Sensor Replacement \(NT5, NT7, NU5\)](#) [Fuel Tank Pressure Sensor Replacement \(NU6\)](#)

DTC P0449, P0498, OR P0499: EVAPORATIVE EMISSION (EVAP) VENT SOLENOID VALVE CONTROL CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0449

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit

DTC P0498

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit Low Voltage

DTC P0499

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
B+	P0449	P0449	-
Control	P0498	P0449	P0499

Circuit/System Description

The evaporative emission (EVAP) vent solenoid valve is a normally open valve. Battery voltage is supplied to the EVAP vent solenoid valve through a fuse. The engine control module (ECM) grounds the EVAP vent solenoid valve control circuit through an internal switch called a driver. The evaporative emission (EVAP) vent solenoid valve is a normally open valve. Battery voltage is supplied to the EVAP vent solenoid valve through a fuse. 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 system voltage is greater than 11 V.

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

Conditions for Setting the DTC

P0449

The ECM detects the EVAP Vent Solenoid Valve control circuit is open for greater than 0.25 s.

P0498

The ECM detects the EVAP Vent Solenoid Valve control circuit is shorted to ground for greater than 0.25 s.

P0499

The ECM detects the EVAP Vent Solenoid Valve control circuit is shorted to voltage for greater than 0.25 s.

Action Taken When the DTC Sets

DTC P0449, P0498 and P0499 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0449, P0498 and P0499 are Type B DTCs.

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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

NOTE: An audible click may be heard when performing step 2 below.

1. Ignition ON.

2. Command the EVAP Vent Solenoid Valve to ON (Not Venting) and OFF (Venting) with a scan tool while observing the following control circuit status parameters:
 - EVAP Vent Solenoid Valve Control Circuit Open Test Status
 - EVAP Vent Solenoid Valve Control Circuit Low Voltage Test Status
 - EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing
 - **If Malfunction is not displayed**
3. Verify the EVAP Vent Solenoid Valve control circuit parameters above do not display Malfunction when moving the related harnesses and connectors of the Q13 Evaporative Emission Vent Solenoid Valve.
 - **If Malfunction is displayed**

Refer to Circuit/System Testing
 - **If Malfunction is not displayed**
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 Q13 Evaporative Emission Vent Solenoid Valve, Ignition ON,
2. Verify that a test lamp illuminates between the B+ circuit terminal B or 2 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 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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.
 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, test all components connected to the B+ circuit for a short and replace as necessary.
 - **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the B+ circuit terminal B or 2 and the control circuit terminal A or 1.
 - **If the test lamp illuminates**
 1. Ignition OFF, remove the test lamp, 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 does not illuminate**
4. Remove the test lamp.

5. Verify the scan tool EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the EVAP Vent Solenoid Valve to ON (Not Venting) with a scan tool.
- **If OK is not displayed**
 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 OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal A or 1 and the B+ circuit terminal B or 2.
7. Verify the scan tool EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the EVAP Vent Solenoid Valve to ON (Not Venting) with a scan tool.
- **If Malfunction is not displayed**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
8. Test or replace the Q13 Evaporative Emission Vent Solenoid Valve.

Component Testing

1. Ignition OFF, disconnect the harness connector at the Q13 Evaporative Emission Vent Solenoid Valve.
2. Test for 10-30 Ω between the control terminal A or 1 and the B+ circuit terminal B or 2.
 - **If not between 10-30 Ω**

Replace the Q13 Evaporative Emission Vent Solenoid Valve.
 - **If between 10-30 Ω**
3. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Control Module References](#) for ECM replacement, programming and setup
- Refer to [Evaporative Emission Canister Solenoid Replacement](#) for EVAP Vent Solenoid Valve replacement.

DTC P0451-P0454: FUEL TANK PRESSURE SENSOR

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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
5 V Reference	P018C, P0192, P0340, P0365, P0452, P0522, P0532, P055C, P0641, P2227, P2228	P0451	P0446, P0452	P018D, P0193, P0453, P0523, P0533, P055D, P0641, P2227	-
Signal	P0452	P0451	P0452, P0453	P0453	P0451, P0454
Low Reference	-	P0446, P0451	P0446, P0453, P0463	-	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			
5 V Reference	0 V	0 V	4.2 - 5 V
Signal	0 V	0 V	5 V
Low Reference	-	4.5 V	-

Circuit/System Description

The fuel tank pressure sensor measures vapor 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 fuel tank pressure sensor. The fuel tank pressure sensor signal voltage varies depending on EVAP system pressure or vacuum. The controller also uses this fuel tank pressure signal to determine atmospheric pressure for use in the engine-off small leak test, DTC P0442. Before using this signal as an atmospheric reference it must first be re-zeroed.

Conditions for Running the DTC

P0451

- DTC P0451 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- The number of times this test runs can range from 0 - 2 per engine-off period. The length of the test can be up to 10 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. A refueling event is confirmed if the fuel level has a persistent change of 10% for 30 s during a 10 min refueling rationality test.

Conditions for Setting the DTC

P0451

This DTC will set if the controller is unable to re-zero the fuel tank pressure sensor voltage within a calibrated range during the engine-off small leak test, P0442.

P0452

The fuel tank pressure sensor voltage is less than 0.15 V for greater than 10 s.

P0453

The fuel tank pressure sensor voltage is greater than 4.9 V for greater than 10 s.

P0454

If, during the engine-off natural vacuum small leak test, P0442, the ECM detects an abrupt fuel tank pressure signal change, other than a refueling event, this DTC will set. An abrupt change is defined as a change of greater than 0.45 in H₂O (0.11 kPa) in the span of 1 s but less than 1 in H₂O (0.25 kPa) in 12.5 ms. This test must fail twice to set this DTC.

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 DTC to set.
- Ensure that the reference port on the fuel tank pressure sensor is unobstructed.
- An fuel tank pressure sensor that is skewed or does not have a linear transition from low to high may cause this DTC to set. Scan tool control functions, 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** while taking a snapshot.

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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)

For equivalent regional tools, refer to [Special Tools](#) .

Circuit/System Verification

1. Remove the fuel cap.
2. Ignition ON, engine OFF.
3. Verify the scan tool Fuel Tank Pressure sensor parameter is between 1.3 and 1.7 V.
 - **If not between 1.3 - 1.7 V**

Refer to Circuit/System Testing.
 - **If between 1.3 - 1.7 V**
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, all vehicle systems OFF, this may take up to 2 min, for all vehicle systems to power down. Disconnect the harness connector at the B150 Fuel Tank Pressure Sensor.
2. Test for less than 5 Ω of resistance between the low reference circuit terminal 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 5 Ω**
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 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 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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 the scan tool Fuel Tank Pressure 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 1 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 0.2 V**
 6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3.
 7. Verify the scan tool Fuel Tank Pressure sensor parameter is greater than 4.7 V.
 - **If 4.7 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 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 4.7 V**
 8. Test or replace the B150 Fuel Tank Pressure Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Control Module References](#) for ECM replacement, programming and setup
- Refer to [Fuel Tank Pressure Sensor Replacement \(NT5, NT7, NU5\)](#) [Fuel Tank Pressure Sensor Replacement \(NU6\)](#)

DTC P0455: EVAPORATIVE EMISSION (EVAP) SYSTEM LARGE LEAK DETECTED

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0455

Evaporative Emission (EVAP) System Large Leak Detected

Circuit/System Description

The engine control module (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 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, P010C, P010D, P16A0, P16A1, P16A2, P160E, P160D, P16F3, P0068, P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0122, P0123, P0125, P0128, P0191, P0192, P0193, P0222, P0223, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0601, P0604, P0606, P0722, P0723, P1104, P1682, P2100, P2101, P2102, P2103, P2135, P2176, P2227, P2228, P2229, P2230 are not set.
- The ignition voltage is between 11 - 32 V.
- The barometric pressure (BARO) is greater 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 within 8Å,Å°C (14Å,Å°F).
- The startup engine coolant temperature (ECT) is less than 35Å,Å°C (95Å,Å°F).
- The startup intake air temperature (IAT) is between 4 - 34Å,Å°C (39 - 93Å,Å°F).
- DTC P0455 runs once per cold start, shortly after purge is enabled followed by vent system performance test P0446.

Conditions for Setting the DTC

- The EVAP system is not able to achieve or maintain a calibrated level of vacuum before a calibrated amount of purge volume has passed through the system.
- 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 pass if tank vacuum is greater than 2.74 kPa (11 in H2O). 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. For example, when injecting smoke at the service port remove the fuel fill cap, or temporarily leave the vent open, until smoke is observed, then close the system and continue testing. If using a fuel cap adapter at the filler neck, use the **J-41413-VLV** at the service port to allow the system to fill faster.
- 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 **J-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 Fuel Tank Pressure Sensor parameter for vacuum decay.

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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

- **CH-48096** EVAP Service Access Port Tool
- **GE-41413-A** Evaporative Emissions System Tester
- **GE-41413-SPT** High Intensity White Light
- **GE-41415-30** Fuel Tank Cap Adapter
- **GE-41415-60** Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter
- **J-41413-300** EVAP Cap and Plug Kit
- **J-41413-311** EVAP Plug (Brass Nozzle)
- **J-41413-VLV** EVAP Service Port Vent Fitting

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

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 operation manual for detailed instructions in [Evaporative Emission System Diagnosis](#).

1. Disconnect the purge tube at the quick connector on the EVAP canister side of the purge solenoid valve and install the **CH-48096**.
2. Connect the **GE-41413-A** to the vehicle EVAP service port adapter.
3. Ignition ON, command the EVAP Purge/Seal function to Not Venting or System Seal with a scan tool to seal the EVAP system.
4. Verify that there is no leak in the EVAP system using the flow meter on the **GE-41413-A**, calibrated to 0.51 mm (0.020 in).
 - **If a leak is detected**
 1. Apply smoke to the EVAP system at the service access port adapter with the **GE-41413-A**.
 2. Locate the leak using the **GE-41413-SPT**.
 - When the leak is located, repair or replace the affected component as necessary.
 - **If no leak detected**

NOTE: The steps below test for a restriction in the purge path.

5. Connect the **GE-41413-A** nitrogen/smoke hose to the **J-41413-311** or **GE-41415-60** for capless vehicles.
6. Disconnect the hose at the fuel cap end of the **GE-41415-30** and connect to the **J-41413-311**.
7. Install the **GE-41415-30** or **GE-41415-60**, filler neck end only, to the vehicle.
8. Engine idling, command the Purge/Seal function to Not Venting or System Seal with a scan tool to seal the system.

NOTE: The scan tool will abort purge when a predetermined value is reached. This is to prevent damage to the fuel tank.

9. Command the EVAP Purge Solenoid Valve to 10-30% with a scan tool.
10. Verify the vacuum/pressure gauge on the **GE-41413-A** and the scan tool Fuel Tank Pressure Sensor parameter both show vacuum.
 - **If the vacuum/pressure gauge shows vacuum but the Fuel Tank Pressure Sensor parameter does not show vacuum**
Replace the B150 Fuel Tank Pressure Sensor.
 - **If both do not show vacuum**
Repair the restriction in the purge path.
 - **If both show vacuum**
11. Verify that the Fuel Tank Pressure Sensor parameter increases to greater than 3.2 V, and the pressure values are similar between the scan tool Fuel Tank Pressure Sensor and the vacuum/pressure gauge on the **GE-41413-A**.
 - **If not within the specified range**
Replace the B150 Fuel Tank Pressure Sensor.
 - **If within the specified range**
12. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Fuel Tank Pressure Sensor Replacement \(NT5, NT7, NU5\)](#) [Fuel Tank Pressure Sensor Replacement \(NU6\)](#)
- Refer to [Control Module References](#) for control module replacement, programming and setup.

DTC P0496: EVAPORATIVE EMISSION (EVAP) SYSTEM FLOW DURING NON-PURGE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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, P010C, P010D, P16A0, P16A1, P16A2, P160E, P160D, P16F3, P0068, P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0122, P0123, P0125, P0128, P0191, P0192, P0193, P0222, P0223, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0601, P0604, P0606, P0722, P0723, P1104, P1682, P2100, P2101, P2102, P2103, P2135, P2176, 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

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

Circuit/System Verification

1. 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.
2. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing

- **If the DTC does not set**

3. All OK

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.

- **If not within specifications**

Replace the Q12 Evaporative Emission Purge Solenoid Valve

- **If within Specifications**

5. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

Refer to [Evaporative Emission Canister Purge Solenoid Valve Replacement](#)

DTC P0506 OR P0507: IDLE SPEED LOW/HIGH

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0506

Idle Speed Low

DTC P0507

Idle Speed High

Circuit/System Description

The throttle actuator control (TAC) motor is a DC motor that is part of the throttle body assembly. The TAC motor drives the throttle valve. The engine control module (ECM) controls the TAC motor based on throttle position sensor input. The idle speed is controlled by the ECM based on various inputs. The ECM commands the TAC motor to open or close the throttle valve in order to maintain the desired idle speed.

Conditions for Running the DTC

- DTCs P0068, P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0171, P0172, P0174, P0175, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300 - P0306, P0351 - P0356, P0461 - P0464, P0496, P0627, P0628, P0629, P0722, P1516, P2066 - P2068, are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant temperature (ECT) is greater than 60°C (140°F).
- The engine run time is greater than 60 s.
- The ignition voltage is between 11 - 32 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 5 s.
- The DTCs run when the above conditions are met.

Conditions for Setting the DTC

P0506

The actual engine speed is 94 RPM less than the desired idle speed for 10 s.

P0507

The actual engine speed is 188 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

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 there are no other DTCs set.
 - **If any other DTCs are set**
Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
 - **If no other DTCs are set**
3. 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. 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.
 - **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.

- **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.

- **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](#) .
- **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.

Refer to [Throttle Body Assembly Replacement](#)

DTC P050D: COLD START ROUGH IDLE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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, P0117 - 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, P0628, P0697, P06A3, P0722, P0723, P1248, P1249, P124A, P124B, P182E, P1915, P2122, P2123, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157 are not set.
- The catalyst temperature is less than 500 $\tilde{\text{A}}$, $\tilde{\text{A}}$ $^{\circ}\text{C}$ (932 $\tilde{\text{A}}$, $\tilde{\text{A}}$ $^{\circ}\text{F}$).
- The engine coolant temperature is warmer than -12 $\tilde{\text{A}}$, $\tilde{\text{A}}$ $^{\circ}\text{C}$ (10.4 $\tilde{\text{A}}$, $\tilde{\text{A}}$ $^{\circ}\text{F}$).
- The barometric pressure is greater than 75 kPa.
- The engine speed is between 250 - 3000 RPM.
- The accelerator pedal position is less than 1 percent.
- The engine is running for less than 20 s and a cold start has been detected.
- DTC P050D runs once per cold start.

Conditions for Setting the DTC

This DTC will set if the ECM detects variations in crankshaft rotation speed caused by the lack of adequate fuel delivery during dual-pulse mode.

Action Taken When the DTC Sets

- DTC P050D is a Type B DTC.
- The ECM disables dual pulse mode and energizes the fuel injector as it would for a warm engine.

Conditions for Clearing the DTC

DTC P050D is a Type B DTC.

Diagnostic Aids

- This DTC may be set with a misfire DTC, however the existence of this DTC is a higher priority and indicates the condition to diagnose is related to fuel and/or injectors, not the ignition/spark system.
- A restricted fuel injector may cause this DTC to set.
- High resistance in the circuits of the injectors could set this DTC without setting an injector DTC. Test the injector circuits of the affected cylinders for a high resistance if you suspect a condition.
- A drop in system voltage during cold start may set this DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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: **Circuit/System Verification 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 verify that the scan tool Cylinder 1-4 Current Misfire Counters are not incrementing during first 500 engine cycles.
 - **If Cylinder 1-4 Current Misfire Counters are incrementing**
Refer to Circuit/System Testing.
 - **If Cylinder 1-4 Current Misfire Counters are not incrementing**
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 Circuit/System Testing.
 - **If the DTC does not set**
4. All OK.

Circuit/System Testing

1. Verify that the fuel pressure is not too low or too high - Refer to [Fuel System Diagnosis](#).
 - If a condition is found, repair or replace components as necessary.
 - If the fuel pressure is OK
2. Verify that the fuel is not contaminated - Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
 - If the fuel is contaminated, clean the fuel system - Refer to [Fuel System Cleaning](#) .
 - If the fuel is not contaminated
3. Replace fuel injectors as indicated by high misfire counts.

Repair Instructions

Refer to [Fuel Injector Replacement](#)

Repair Verification

NOTE: **Repair Verification requires cold start.**

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 seconds.
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.

DTC P057B-P057D: BRAKE PEDAL POSITION SENSOR

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P057B

Brake Pedal Position Sensor Performance

DTC P057C

Brake Pedal Position Sensor Circuit Low Voltage

DTC P057D

Brake Pedal Position Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P057C	P057C	P057D	P057B
5 V Reference	P057C P0651	P057C	P0651	-
Low Reference	-	P057D	P057D	-

Typical Scan Tool Data

Brake Pedal Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. Normal Range: 0.25 - 4.75 V			
5 V Reference	0 V	0 V	-
Signal	0 V	0 V	5 V
Low Reference	-	5 V	-

Circuit/System Description

The brake pedal position (BPP) sensor is part of the engine brake pedal override feature. The engine control module (ECM) continuously monitors the vehicle speed and the position of the brake pedal. These two main inputs, along with other ECM inputs are used to determine if the vehicle is decelerating at the proper speed and rate with the brake pedal applied. When the engine brake pedal override system is active, the ECM reduces engine torque to assist in reducing vehicle speed.

The BPP sensor is a six wire sensor, and is part of a dual brake position sensor. One BPP Sensor is used for the stop lamps and the other BPP Sensor is used for the engine brake pedal override feature. The

BPP Sensor for engine brake pedal override communicates with the ECM. The ECM supplies a 5 V reference circuit, low reference circuit, and signal circuit to the BPP sensor. The BPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage greater than 0.25 V when the brake pedal is released to a voltage less than 4.75 V when the brake pedal is fully applied.

For information on the Stop Lamps side of the BPP Sensor, refer to [Exterior Lighting Systems Description and Operation](#).

Conditions for Running the DTC

P057B

- DTCs P057C, or P057D are not set.
- Ignition voltage is greater than 10 V.
- Shift lever has been in Park at least once during key ON.
- Shift lever is not in Park.
- Vehicle speed is 8 km/h (5 MPH) or greater.
- Accelerator Pedal Position is less than 5%.
- DTC runs continuously when above condition is met.

P057C or P057D

- Ignition voltage is greater than 10 V.
- DTC runs continuously when above condition is met.

Conditions for Setting the DTC

P057B

ECM detects the brake pedal position sensor signal is stuck in a range.

P057C

ECM detects the brake pedal position sensor voltage is less than 0.25 V for 1 s.

P057D

ECM detects the brake pedal position sensor voltage is greater than 4.75 V for 1 s.

Action Taken When the DTC Sets

- P057B, P057C, and P057D are Type A DTCs.
- Brake Pedal Position Sensor parameter defaults to 0%.

Conditions for Clearing the DTC

P057B, P057C, and P057D are Type A DTCs

Reference Information

Schematic Reference

- [Engine Controls Schematics](#)
- [Exterior Lights Schematics](#)

Connector End View Reference

- [COMPONENT CONNECTOR END VIEWS - INDEX](#)
- [INLINE HARNESS 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: The Brake Pedal Position sensor scan tool data is located in the ECM automatic transmission data list.

1. Ignition ON.
2. Verify DTC P0641, P0651, P0697, or P06A3 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. Transmission in Park, and service brake pedal released.
4. Verify the scan tool Brake Pedal Position Sensor parameter in the ECM displays greater than 0.25 V.
 - **If 0.25 V or less**
Refer to Circuit/System Testing.
 - **If greater than 0.25 V**
5. Verify the scan tool Brake Pedal Position Sensor parameter voltage changes as the brake pedal is applied and displays less than 4.75 V when the brake pedal is fully applied.
 - **If the voltage does not change, or is greater than 4.74 V**
Refer to Circuit/System Testing.
 - **If the voltage changes and less than 4.75 V**
6. Verify the scan tool Brake Pedal Position Sensor Learned Release Position parameter is within 0.1 V of the Brake Pedal Position Sensor parameter when the brake pedal is fully released.
 - **If difference is greater than 0.1 V**
Perform the [Brake Pedal Position Sensor Learn](#).
 - **If difference is 0.1 V or less**
7. Verify the Brake Pedal Position Sensor parameter transitions smoothly without any spikes or dropouts when slowly applying and releasing the brake pedal.
 - **If parameter does not transition smoothly or has spikes or dropouts**
Refer to Circuit/System Testing.
 - **If parameter transitions smoothly and there are no spikes or dropouts**
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.
9. Verify the DTC does not set.
 - **If the DTC sets**

- **If the DTC does not set**

10. All OK.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B22 Brake Pedal Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

NOTE: All terminal references are for the vehicle harness brake pedal position sensor connector.

2. Test for less than 10 Ω between the low reference circuit terminal 5 and ground.
 - **If 10 Ω or greater**
 1. Disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 6 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 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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 the scan tool Brake Pedal Position Sensor parameter is less than 0.25 V.
 - **If 0.25 V or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 0.25 V between the signal circuit terminal 4 and ground.
 - If 0.25 V or greater, repair the short to voltage on the circuit.
 - If less than 0.25 V, replace the K20 Engine Control Module.
 - **If less than 0.25 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 6.
7. Verify the scan tool Brake Pedal Position Sensor parameter is greater than 4.8 V.
 - **If 4.8 V or less**
 1. Ignition OFF, remove the jumper wire, and disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance.
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **If greater than 4.8 V**
8. Replace the B22 Brake Pedal Position Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Brake Pedal Position Sensor Replacement](#)
- Perform the [Brake Pedal Position Sensor Learn](#) following the replacement of the ECM or BPP sensor, or any repair that effects the BPP sensor alignment.
- Refer to [Control Module References](#) for Engine Control Module replacement, programming and setup.

DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, OR P262B: CONTROL MODULE (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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each of the 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 P262B

Control Module Power 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.

Conditions for Running the DTCs

P0601, P0602, P0630

These DTCs run continuously when the ignition is in ON.

P0603, P062F

These DTCs run once per ignition cycle.

P0604

DTC P0604 runs continuously when the ignition is ON for greater than 30 s.

P0606, P062B

These DTCs run continuously when Ignition 1 Signal voltage is greater than 11 V.

P16F3

- The engine speed is greater than 650 RPM.
- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P2227, P2228, P2229, or P2230 are not set.
- DTC P16F3 runs continuously when the above conditions are met.

P262B

DTC P262B runs during ECM power down.

Conditions for Setting the DTCs

The ECM detects an internal failure or incomplete programming for more than 10 s.

Actions Taken When the DTC Sets

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630, and P16F3 are Type A DTCs.
- DTCs P262B and P062F are Type B DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630, and P16F3 are Type A DTCs.
- DTCs P262B and P062F are Type B DTCs.

Diagnostic Aids

Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set. Verify the following:

- The battery cables are clean and tight, and the battery is fully charged. Refer to [**Battery Inspection/Test**](#).
- The ECM ground circuits do not have an open or high resistance.
- The ECM power circuits do not have an open, short to ground, or high resistance.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON, clear the DTC information with a scan tool.
2. Verify no other DTCs are set.
 - **If any other DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If no other DTCs are set**
3. Observe the DTC information with a scan tool. Verify DTC P0602 or P0630 is not set.
 - **If any of the DTCs are set**
 1. Program the K20 Engine Control Module. Refer to [Control Module References](#).
 2. Verify DTC P0602 or P0630 is not set.
 - If any of the DTCs are set, replace the K20 Engine Control Module.
 - If none of the DTCs are set
 - 3. All OK.
 - **If none of the DTCs are set**
4. Verify DTC P0601, P0603, P0604, P0606, P062B, P062F, P16F3, or P262B is not set.
 - **If any of the DTCs are set**
Replace the K20 Engine Control Module.
 - **If none of the DTCs are set**
5. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Control Module References](#) for engine control module replacement, programming and setup.

DTC P0627-P0629: FUEL PUMP ENABLE CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0627

Fuel Pump Enable Circuit

DTC P0628

Fuel Pump Enable Circuit Low Voltage

DTC P0629

Fuel Pump Enable Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P069E, P0628	P069E, P0627, P0629	-	-

Circuit/System Description

The engine control module (ECM) provides ignition voltage to the chassis control module whenever the engine is cranking or running. The ECM enables the chassis 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 chassis 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 or equal to 11 V.
- The fuel pump enable circuit is commanded ON.
- 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 for 2.5 s.

Action Taken When the DTC Sets

DTCs P0627, P0628, and P0629 are Type C DTCs.

Conditions for Clearing the DTC

DTCs P0627, P0628, and P0629 are Type C DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Powertrain Component View

Powertrain Component Views

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 that DTC P0627, P0628, or P0629 is not set.
 - **If a DTC is set**
Refer to Circuit/System Testing.
 - **If a DTC is not set**
3. Verify the parameters listed below do not display Malfunction when commanding the Fuel Pump Enable On and Off with a scan tool.
 - Fuel Pump Enable Circuit Low Voltage Test Status
 - Fuel Pump Enable Circuit Open Test Status
 - Fuel Pump Enable Circuit High Voltage Test Status
 - **If Malfunction is displayed**
Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
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 K38 Chassis Control Module harness connector.
2. Ignition ON for 10 s.
3. Verify that a test lamp does not illuminate between the control circuit terminal 20 and ground.
 - **If the test lamp illuminates**

1. Ignition OFF, remove the test lamp, 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**
4. Remove the test lamp.
5. Verify the scan tool Fuel Pump Enable Circuit Low Voltage Test Status parameter is OK when commanding the Fuel Pump Enable On with a scan tool.
 - **If OK is not displayed**
 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 OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal 20 and ground.
7. Verify the scan tool Fuel Pump Enable Circuit Low Voltage Test Status parameter is Malfunction when commanding the Fuel Pump Enable On with a scan tool.
 - **If Malfunction is not displayed**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If Malfunction is displayed**
8. Test or replace the K38 Chassis Control Module.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Chassis Control Module Replacement](#)
- Refer to [Control Module References](#) for control module replacement, programming and setup

DTC P0641, P0651, P0697, OR P06A3: 5V REFERENCE 1-4 CIRCUITS (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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0641

5V Reference 1 Circuit

DTC P0651

5V Reference 2 Circuit

DTC P0697

5V Reference 3 Circuit

DTC P06A3

Circuit/System Description

The engine control module (ECM) has 4 internal 5V reference circuits. Each internal reference circuit provides external 5V reference circuits for more than one sensor. A short to ground or short to voltage on one external 5V reference circuit can affect all the components connected to the same internal 5V 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 ECM detects a short to ground or voltage on any of the 5V reference circuits for greater than 0.5 s.

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

The 5V reference 1 circuit provides 5 V to the sensors listed below:

- Air conditioning (A/C) refrigerant pressure sensor
- Exhaust and intake camshaft position sensors
- Engine oil pressure sensor
- Fuel rail pressure sensor
- Fuel tank pressure sensor
- Multifunction intake air sensor

The 5V reference 2 circuit provides 5 V to the sensors listed below:

- Brake booster vacuum sensor
- Brake pedal position sensor
- Crankshaft position sensor

The 5V reference 3 circuit provides 5 V to the sensors listed below:

- Accelerator pedal position sensor 2
- Manifold absolute pressure sensor

The 5V reference 4 circuit provides 5 V to the sensors listed below:

- Accelerator pedal position sensor 1
- Throttle position sensor 1 and 2

Disconnecting one component at a time from the affected 5V reference circuit while observing the scan tool 5V Reference Circuit Status parameter may help locate the fault. The scan tool parameter will change from Malfunction to OK when the source of the fault is disconnected. If all 5V 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

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify all scan tool 5V Reference Circuit Status parameters do not display Malfunction.
 - **If Malfunction is displayed**
Refer to Circuit/System Testing.
 - **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 DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
5. All OK.

Circuit/System Testing

NOTE: Additional DTCs will set when disconnecting the components.

1. Ignition OFF, disconnect the harness connector at all appropriate sensors for the applicable DTC.
Refer to Diagnostic Aids.
2. Ignition ON.
3. Test for 4.8 - 5.2 V between one of the 5V reference circuits and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
 2. Test for infinite resistance between the 5V reference circuit for each applicable component 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 greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.

2. Test for less than 1 V between the 5V reference circuit for each applicable component 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**

NOTE: A short to voltage or ground on the signal circuit of certain components may cause this DTC to set.

4. Verify the appropriate scan tool 5V Reference 1, 2, 3, or 4 Circuit Status parameter displays OK while connecting each component associated with the 5V reference circuit one at a time.

- **If OK is not displayed when a component is connected**

Test the signal circuit of that component for a short to ground or voltage. If the circuit tests normal, replace the component.

- **If OK is displayed after all components have been connected**

5. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Accelerator Pedal with Position Sensor Assembly Replacement](#)
- Refer to [Air Conditioning \(A/C\) Refrigerant Pressure Sensor Replacement](#)
- Refer to [Brake Pedal Position Sensor Replacement](#)
- Refer to [Camshaft Position Sensor Replacement - Intake](#)
- Refer to [Camshaft Position Sensor Replacement - Exhaust](#)
- Refer to [Crankshaft Position Sensor Replacement](#)
- Refer to [Engine Oil Pressure Sensor Replacement](#)
- Refer to [Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement](#)
- Refer to [Fuel Tank Pressure Sensor Replacement \(NT5, NT7, NU5\) Fuel Tank Pressure Sensor Replacement \(NU6\)](#)
- Refer to [Manifold Absolute Pressure Sensor Replacement](#)
- Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) for multifunction intake air sensor replacement.
- Refer to [Power Brake Booster Vacuum Sensor Replacement](#)
- Refer to [Throttle Body Assembly Replacement](#)
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup.

DTC P0641 OR P06A6: 5V REFERENCE CIRCUIT/5V REFERENCE 1 PERFORMANCE (CHASSIS 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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0641

5V Reference Circuit

DTC P06A6

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to 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 chassis 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 chassis 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

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 Ω between the low reference circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If less than 10 Ω**
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 K38 Chassis 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 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the harness connector at the K38 Chassis 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 K38 Chassis 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 K38 Chassis 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 K38 Chassis 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 K38 Chassis 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis 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.

Refer to [Control Module References](#) for chassis control module replacement, programming and setup

DTC P0650, P263A, OR P263B: MALFUNCTION INDICATOR LAMP (MIL) CONTROL CIRCUIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P0650

Malfunction Indicator Lamp (MIL) Control Circuit

DTC P263A

Malfunction Indicator Lamp (MIL) Control Circuit Low Voltage

DTC P263B

Malfunction Indicator Lamp (MIL) Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0650	P0650	-	-
Control	P0650, P263A*	P0650, P263A	P263B	-
* 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 powertrain 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.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P0650 or P263A

The ECM detects low voltage during the MIL control circuit driver OFF state. This indicates either a shorted to ground or an open MIL control circuit.

DTC P263B

The ECM detects high voltage on the MIL control circuit during the driver ON state. This indicates a shorted to voltage MIL control circuit.

Action Taken When the DTC Sets

DTC P0650, P263A, and P263B are Type B DTCs.

Conditions for Clearing the DTC

DTC P0650, P263A, and P263B are Type B DTCs.

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 change from OK or Not Run to Malfunction if there is a condition with a circuit or a connection.
- If the ECM detects low voltage on the MIL control circuit during the control circuit driver OFF state, DTCs P0650 and DTC P263A may set simultaneously.

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.
2. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
 - The MIL Control Circuit Low Voltage Test Status
 - The MIL Control Circuit Open Test Status
 - The MIL Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing.
 - **If Malfunction is not displayed**
3. Engine running.

4. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.

- The MIL Control Circuit Low Voltage Test Status
- The MIL Control Circuit Open Test Status
- The MIL Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

5. Verify the malfunction indicator lamp turns ON and OFF when commanding the Malfunction Indicator Lamp On and Off with a scan tool.

- **If the malfunction indicator lamp does not turn ON and OFF**

Refer to Circuit/System Testing.

- **If the malfunction indicator lamp turns ON and OFF**

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.

- **If the DTC sets**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

1. Ignition OFF.

2. Disconnect the X1 harness connector at the K20 Engine Control Module.

3. Ignition ON, verify the malfunction indicator lamp does not illuminate.

- **If the malfunction indicator lamp illuminates**

1. Test for infinite resistance between the control circuit terminal X1 71 and ground.

- If less than infinite resistance, repair the short to ground in the circuit.
- If infinite resistance, replace the P16 Instrument Cluster.

- **If the malfunction indicator lamp does not illuminate**

4. Connect a 3 A fused jumper wire between the control circuit terminal X1 71 and ground.

5. Verify the malfunction indicator lamp illuminates.

- **If the malfunction indicator lamp illuminates**

Replace the K20 Engine Control Module.

- **If the malfunction indicator lamp does not illuminate**

1. Test for less than 1 V between the control circuit terminal X1 71 and ground.

- If 1 V or greater, repair the short to voltage in the circuit.
- If less than 1 V

2. Ignition OFF.

3. Test for less than 2 Ω in the control circuit end to end.

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

6. Ignition OFF, disconnect the X1 harness connector at the instrument cluster.

7. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal 8 and ground.

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

1. Ignition OFF.

2. Test for infinite resistance between the ignition voltage circuit and ground.
 - If less than infinite resistance, repair the short to ground in the circuit.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - **If the test lamp illuminates**
8. Replace the P16 Instrument Cluster.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Instrument Cluster Replacement](#)
- Refer to [Control Module References](#) for control module replacement, programming, and setup

DTC P0685-P0687, P0689, P0690, OR P1682: ENGINE CONTROLS IGNITION RELAY/IGNITION 1 SWITCH CIRCUIT 2

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P0685

Engine Controls Ignition Relay Control Circuit

DTC P0686

Engine Controls Ignition Relay Control Circuit Low Voltage

DTC P0687

Engine Controls Ignition Relay Control Circuit High Voltage

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	P0689, P1682	P0685, P0689, P1682	-
Relay Control Circuit	P0686, P0690	P0685, P0689, P1682	P0685, P0687, P0689, P1682
Relay Feedback Circuit	P0689, P1682	P0689, P1682	P0690

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 Status and Not Run for High Voltage Test Status • Component ON - Not Run for Open/Low Voltage Test Status and OK for High Voltage Test Status			
B+	Malfunction	Malfunction	-
Control	Malfunction	Malfunction	Not Run

Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status - Component Commanded ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded ON Parameter Normal Range: The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage Test Status and Not Run for High Voltage Test Status • Component ON - Not Run for Open/Low Voltage Test Status and OK for High Voltage Test Status			
B+	Not Run	Not Run	-
Control	Not Run	Not Run	Malfunction

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 main relay. The ECM monitors and compares the ignition voltage supplied by the 2 relays.

Conditions for Running the DTC

P0685, P0686, P0687

The DTC runs when Ignition 1 signal voltage is greater than 11 V.

P0689

- DTC P0685 is not set.
- The engine controls ignition relay is commanded ON.
- Ignition 1 signal voltage is greater than 11 V.
- The DTC runs continuously when the above conditions are met.

P0690

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

P1682

- The engine controls ignition relay is commanded ON.

- 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.

P0686

The ECM detects a short to ground on the control circuit for greater than 2 s.

P0687

The ECM detects a short to voltage on the control circuit for greater than 2 s.

P0689

The ECM detects the engine controls ignition relay feedback circuit is less than 5 V.

P0690

The ECM detects the engine controls ignition relay feedback circuit is greater than 4 V for greater than 5 s.

P1682

The ECM detects that the voltage level difference is greater than 3 V between the 2 ignition voltage circuits for greater than 1 s.

Action Taken When the DTC Sets

- DTCs P0685, P0686, P0687, and P0690 are Type B DTCs.
- DTC P0689 is a Type C DTC.
- DTC P1682 is a Type A DTC.

Conditions for Clearing the DTC

- DTCs P0685, P0686, P0687, and P0690 are Type B DTCs.
- DTC P0689 is a Type C DTC.
- DTC P1682 is a Type A 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 main relay may also be labeled the run/crank relay, the ignition run relay, the ignition 1 relay, or the ignition relay.

Reference Information

Schematic Reference

- [Engine Controls Schematics](#)
- [Power Distribution Schematics](#)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

- [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 any other DTC is set, diagnose that DTC first.
- If you were sent here from Engine Cranks But Does Not Run, proceed to Circuit/System Testing.

1. Ignition ON, observe the scan tool DTC information. Verify DTC P0685, P0686, P0687, P0689, P0690, or P1682 is not set.

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

Refer to Circuit/System Testing.

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

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.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

3. All OK.

[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 a test lamp illuminates between ground and the B+ terminals listed below:

- Terminal 85
- Terminal 30
- **If the test lamp does not illuminate**

Replace the front compartment fuse block.

- **If the test lamp illuminates**

NOTE:

- High resistance in the circuit/underhood fuse block for either the KR75 Engine Controls Ignition Relay or the KR73 Ignition Main Relay can cause DTC P1682 to set.

- **A short to voltage on any of the circuits supplied by the engine controls ignition relay can cause DTC P0690 to set.**

3. Ignition ON.

4. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal 87 and ground.

- **If the test lamp illuminates**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.

2. Ignition ON.

3. Test for less than 1 V between ground and connector terminal 73.

- 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 the test lamp does not illuminate**

5. Ignition OFF, connect a 20 A fused jumper wire between the B+ circuit terminal 30 and the ignition voltage circuit terminal 87.

6. Ignition ON.

7. Verify the scan tool Engine Controls Ignition Relay Feedback Signal parameter displays B+.

- **If B+ is not displayed**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module

2. Test for less than 2 Ω in the relay switch ignition voltage circuit end to end.

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

3. Test for infinite resistance between the relay switch ignition voltage 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 B+ is displayed**

8. Ignition OFF, connect a DMM, set to the diode setting, between control circuit terminal 86 and ground.

9. Verify the DMM displays OL.

- **If OL is not displayed**

1. Disconnect the X1 harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between ground and the relay control circuit.

- If less than infinite resistance, repair the short to ground in the circuit.
- If infinite resistance, replace the K20 Engine Control Module.

- **If OL is displayed**

10. Ignition ON.

11. Verify the DMM displays less than 1 V.

- **If 1 V or greater**

1. Ignition OFF, disconnect the X1 connector at the K20 Engine Control Module.

2. Ignition ON.

3. Test for less than 1 V on the relay control circuit.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V

4. Test for less than 2 Ω in the control circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- if less than 2 Ω , replace the K20 Engine Control Module.

- **If less than 1 V**

12. Test or replace the KR75 Engine Controls Ignition Relay.

Relay Test

1. Ignition OFF, disconnect the KR75 Engine Controls Ignition Relay.
2. Test for 70 - 110 Ω between terminals 85 and 86:

- **If less than 70 Ω or greater than 110 Ω**

Replace the KR75 Engine Controls Ignition Relay.

- **If between 70 - 110 Ω**

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 KR75 Engine Controls Ignition Relay.

- **If infinite resistance**

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.

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

- **If 2 Ω or greater**

Replace the KR75 Engine Controls Ignition Relay.

- **If less than 2 Ω**

6. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Front Compartment Fuse Block Replacement](#).
- Refer to [Relay Replacement \(Attached to Wire Harness\)](#) [Relay Replacement \(Within an Electrical Center\)](#)
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup.

DTC P069E: FUEL PUMP CONTROL MODULE REQUESTED MIL ILLUMINATION

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P069E

Fuel Pump Control Module Requested MIL Illumination

Circuit/System Description

The chassis control module, sometimes called the fuel pump control module, constantly monitors the fuel pump control system for any condition which may adversely affect vehicle emissions. If a condition is detected, the chassis control module sets a DTC and sends a serial data message to the engine control

module (ECM). The ECM sets DTC P069E to inform the technician that the chassis control module has set the emission related DTC. The serial data message sent by the chassis control module also contains a request for the ECM to illuminate the malfunction indicator lamp (MIL).

The technician can observe the DTC that was set by the chassis control module by reviewing the ECM Freeze Frame records on the scan tool. The ECM Freeze Frame records also contain the engine operating conditions present when the chassis control module DTC set.

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 ECM receives a serial data message from the chassis control module indicating that an emission related DTC has set in the chassis control module.

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 chassis 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 chassis control module will cause the chassis control module to request DTC P069E to be set in the ECM.
- On some vehicle applications the chassis control module may control components other than the fuel pump, such as the active grille air shutter system. Therefore, all DTCs that may be set in the chassis control module should be investigated whenever DTC P069E is 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 chassis 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 the DTCs are set only as History in the chassis control module.

- If a DTC is not set only as History

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

- If a DTC is set only as History

Refer to [Testing for Intermittent Conditions and Poor Connections](#) .

- 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: TRANSMISSION CONTROL MODULE REQUESTED MIL ILLUMINATION

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each of the diagnostic category.

DTC Descriptor

DTC P0700

Transmission Control Module Requested MIL Illumination

Circuit/System Description

The Transmission Control Module (TCM) constantly monitors the transmission system for any condition which may adversely affect vehicle emissions. If a condition is detected, the TCM sets a DTC and sends a serial data message to the ECM. The ECM sets DTC P0700 to inform the technician that the TCM has set the emission related DTC. The serial data message sent by the TCM also contains a request for the ECM to illuminate the Malfunction Indicator Lamp (MIL)

The technician can observe the DTC that was set by the TCM by reviewing the ECM Freeze Frame records on the scan tool. The ECM Freeze Frame records also contain the engine operating conditions present when the transmission DTC set.

Conditions for Running the DTC

- The ignition is ON or the engine is running.
- DTC P0700 runs continuously.

Conditions for Setting the DTC

The ECM receives a serial data message from the TCM indicating that an emission related DTC has set in the TCM.

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 P1255 OR P064A: FUEL PUMP CONTROL MODULE (CHASSIS 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.
- Refer to Diagnostic Procedure Instructions to provide 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 chassis control module when the ECM detects that the ignition is on. The voltage from the ECM to the chassis control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the chassis 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 chassis 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.

Beginning in the 2014 model year the K27 Fuel Pump Control Module (FPCM) will now be called the chassis control module (CCM). The component code for the chassis control module will be K38. The chassis control module name will be used in Service Information, the Global Diagnostic System and the Service Programming System.

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

[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 K38 Chassis Control Module is located is free of debris, clutter, or any insulating material that would cause the K38 Chassis Control Module to overheat.
 - **If any debris, clutter, or other material is found**
 1. Clear the area where the K38 Chassis 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 K38 Chassis 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 K38 Chassis Control Module.
 - **If DTC P1255 or P064A is not set.**
6. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Control Module References](#) for chassis control module replacement, programming and setup

DTC P135A: IGNITION COIL SUPPLY VOLTAGE CIRCUIT BANK 1

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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

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.

- **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.

- **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.

2. Connect a 3 A fused jumper wire between the control circuit terminal 72 and ground, ignition ON.

3. 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 Ω in the ignition circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , 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**

4. Replace the K20 Engine Control Module.

Repair Instructions

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

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

DTC P1400: COLD START EMISSION REDUCTION CONTROL SYSTEM

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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

DTC Descriptor

DTC P1400

Cold Start Emission Reduction Control System

Circuit/System Description

The catalyst must be warmed to efficiently reduce the emissions. The cold start strategy is to reduce the amount of time it takes to warm the catalyst. During a cold start, the engine spark timing is altered to allow the catalyst to warm quickly. This diagnostic monitors the following to build an exhaust energy model:

- Spark advance
- Engine airflow
- Engine coolant temperature
- Engine run time

The actual model is then compared to the expected exhaust energy model.

Conditions for Running the DTC

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0114, P0116, P0117, P0118, P0121, P0122, P0123, P0201, P0202, P0203, P0204, P0222, P0223, P0300, P0301, P0302, P0303, P0304, P0335, P0336, P0351, P0352, P0353, P0354, P0641, P0651, P0697, P06A3, P2122, P2123, P2127, P2128, P2135, and P2138 are not set.
- The engine coolant temperature (ECT) is between -12 to $+56^{\circ}\text{C}$ (10 - 132°F).
- The calculated 3-way catalyst temperature is colder than 500°C (932°F).
- The barometric (BARO) pressure is greater than 75 kPa.
- The engine control module (ECM) will exit the diagnostic if the calculated 3-way catalyst temperature is greater than $1,000^{\circ}\text{C}$ (1832°F) when the engine run time is greater than 17 s.
- Vehicle speed is less than 1.6 km/h (1 mph).
- The accelerator pedal is not depressed.
- The ECM will exit the diagnostic if the engine run time is greater than a calibrated value.
- This DTC runs within the first 15 s 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 DTC

DTC P1400 is a Type 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. Vehicle OFF, allow the engine to cool to be within the temperatures listed in the Conditions for Running the DTC.
2. Engine running.
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 the DTC does not set.
 - **If the DTC sets**
 1. Verify that none of the conditions listed below exists with the air intake system:
 - Damage, restriction, or modification
 - Dirty or deteriorating air filter element
 - Crankcase ventilation system for correct operation
 - Water intrusion
 - Vacuum leak and other unmetered air downstream of the mass air flow (MAF) sensor
 - Intake manifold leak
 - If any of the conditions exist
Repair as necessary.
 - If none of the conditions exist
 2. Verify that none of the conditions listed below exists with the exhaust system:
 - Exhaust leak
 - Damaged, restricted, or modified exhaust system - Refer to [Symptoms - Engine Exhaust](#).
 - If any of the above conditions exist
Repair as necessary.
 - If none of the conditions exist
 3. If all of the above conditions test normal, inspect for an engine mechanical condition that could alter the air flow into the combustion chamber. Refer to [Symptoms - Engine Mechanical](#).
 - **If the DTC does not set**
5. All OK.

[Repair Instructions](#)

Perform the [Diagnostic Repair Verification](#) after completing the repair.

DTC P150C: TRANSMISSION CONTROL MODULE ENGINE SPEED REQUEST SIGNAL MESSAGE COUNTER INCORRECT

[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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P150C

Transmission Control Module Engine Speed Request Signal Message Counter Incorrect

Circuit/System Description

To improve vehicle shift feel, the transmission control module (TCM) is constantly sending the ECM serial data messages with requests to modify engine speed or torque. These 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 P150C when it detects a discrepancy in the structure of this message causing its integrity to be questioned.

An intermittent fault in the controller area network (CAN) circuits will cause DTC P150C to set.

Conditions for Running the DTC

- DTCs P0506, P0507, or U0101 are not set.
- The engine is running for greater than 0.5 s.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the TCM engine speed request does not match the expected engine speed request.

Action Taken When the DTC Sets

DTC P150C is a Type B DTC.

Conditions for Clearing the DTC

DTC P150C is a Type B DTC.

Reference Information

Description and Operation

Data Link Communications Description and Operation

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 P150C is an informational DTC.**
- **Diagnose all other engine control module DTCs prior to DTC P150C.**

1. Verify that no other DTCs are set except for DTC P150C.

- **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .

- **If only DTC P150C is set**

2. Replace the K71 Transmission Control Module.
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**

Replace the K20 Engine Control Module.

- **If the DTC does not set**

5. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Control Module References](#) for ECM or TCM replacement, programming, and setup

DTC P1516, P2101, P2119, OR P2176: THROTTLE ACTUATOR CONTROL (TAC) 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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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	P1516, P2101	P1516, P2101	P0690, P1516, P2101	P1516, P2101, P2176
TAC Motor Control Open	P1516, P2101, P2119	P1516, P2101	P1516, P2101	P0690, P1516, P2101	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 into a representation of voltage signals that are occurring in the throttle body. The information is then 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

- DTC P0606, P1682 is not set.
- The run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- DTC P1516 runs continuously when the above conditions are met.

P2101

- DTC P0606, P1682 is not set.
- The run/crank or powertrain relay voltage is greater than 6.41 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 5.5 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

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

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

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.

- **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 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. Clear the DTCs with a scan tool.

5. Ignition OFF and all vehicle systems OFF. It may take up to 2 min 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.

- **If Enabled is not displayed**

Refer to Circuit/System Testing.

- **If Enabled is displayed**

8. Verify DTC P1516, P2101, P2119, or P2176 is not set.

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

Refer to Circuit/System Testing.

- **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 Enabled is not displayed**

Test or replace the Q38 Throttle Body Assembly.

- **If Enabled is displayed**

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.

- 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:

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

Replace the Q38 Throttle Body.

- If a condition is not found

NOTE: Disconnecting the throttle body harness connector may cause additional DTCs to set.

3. Disconnect the harness connector at the Q38 Throttle Body Assembly, ignition ON.

NOTE: The test lamp may illuminate briefly when the ignition switch is turned on, but should not remain illuminated.

4. Verify that a test lamp does Not illuminate continuously between each motor control circuit listed below and ground.

- TAC Motor Control Closed circuit terminal 1
- TAC Motor Control Open circuit terminal 2
- If the test lamp is always ON

1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module, ignition ON

2. Test for less than 1 V between the motor 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

5. Verify that a test lamp does not illuminate between each motor control circuit listed below and B+.

- TAC Motor Control Closed circuit terminal 1

- TAC Motor Control Open circuit terminal 2
 - **If the test lamp illuminates**
 1. Ignition OFF, disconnect the harness connector X2 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 does not illuminate**
6. Ignition OFF, set the DMM to the 40 V scale, select the Min/Max Recording Mode, and set the Peak Min/Max response time to 1 ms.

NOTE:

- **The test lamp must be connected to circuit before turning ignition on or incorrect diagnosis may occur.**
 - **The ignition must be OFF and the ECM completely powered down before testing each circuit or a lower voltage will be recorded. It may take up to 2 min for all vehicle systems to power down.**
 - **The DMM Min/Max Recording Mode and the response time of 1 ms must be reset after testing each circuit or a lower voltage will be recorded.**
7. 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 Closed circuit terminal 1
 - TAC Motor Control Open circuit terminal 2
 - **If not within 3 V of B+**
 1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If within 3 V of B+**
 8. Replace the Q38 Throttle Body.

Repair Instructions

- Refer to [**Throttle Body Assembly Replacement**](#)
- Refer to [**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 min 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 Enabled is not displayed**

Test or replace the Q38 Throttle Body Assembly.
 - **If Enabled 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 P163A: CONTROL MODULE FUEL PRESSURE REGULATOR 1 CONTROL SYSTEM CIRCUITRY PERFORMANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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

- DTC P0016, P0017, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0191, P0192, P0193, P0335, P0336, P0340, P0341, P0365, P0366, P0628, or P1682 is not set.
- The engine is running.
- The ignition voltage is greater than 11 V.
- The low side fuel pressure is greater than 250 kPa (36 psi).
- The barometric (BARO) pressure is greater than 70 kPa.
- The intake air temperature (IAT) is warmer than -20°C (-4°F).
- 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 greater than 11 A or less than 0.1 A 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

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, disconnect the harness connector at the G18 High Pressure Fuel Pump.

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

2. Test for 0.3 - 0.7 Ω at 20 Å , $\text{Å}^{\circ}\text{C}$ (68 Å , $\text{Å}^{\circ}\text{F}$) between the high control circuit terminal 1 and the low control circuit terminal 2 on the G18 High Pressure Fuel Pump.

- **If not between 0.3 - 0.7 Ω**

Replace the G18 High Pressure Fuel Pump.

- **If between 0.3 - 0.7 Ω**

3. Test for infinite resistance between each terminal on the G18 High Pressure Fuel Pump and the G18 High Pressure Fuel Pump housing.

- **If less than infinite resistance**

Replace the G18 High Pressure Fuel Pump.

- **If infinite resistance**

4. Ignition ON, verify that a test lamp does not illuminate between the high control circuit terminal 1 and ground and the low control circuit terminal 2 and ground at the ECM side of the harness connector.

- **If the test lamp illuminates**

1. Ignition OFF, disconnect the harness connector at the ECM, ignition ON.

2. Test for less than 1 V between the appropriate 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. Verify that a test lamp does not illuminate between the high control circuit terminal 1 and B+ and the low control circuit terminal 2 and B+.

- **If the test lamp illuminates**

1. Ignition OFF, disconnect the harness connector at the ECM.

2. Test for infinite resistance between the appropriate 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 Ω in the control circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If the test lamp does not illuminate**
6. Connect a 3 A fused jumper wire between the high control circuit terminal 1 and ground.
 7. Verify the Fuel Pressure Regulator High Control Circuit Open Test Status transitions from Malfunction to OK and the Fuel Pressure Regulator High Control Circuit Low Voltage Test Status transitions from OK to Malfunction.
 - **The parameters do not change**
 1. Ignition OFF, disconnect the harness connector at the ECM.
 2. Test for less than 2 Ω in the high control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **The parameters change**
 8. Connect a 3 A fused jumper wire between the low control circuit terminal 2 and B+.
 9. Verify the Fuel Pressure Regulator Control Circuit Open Test Status transitions from Malfunction to OK and the Fuel Pressure Regulator Control Circuit High Voltage Test Status transitions from OK to Malfunction.
 - **The parameters do not change**
 1. Ignition OFF, disconnect the harness connector at the ECM.
 2. Test for less than 2 Ω in the low control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **The parameters change**
- Replace the K20 Engine Control Module.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

- Refer to [Fuel Pump Replacement](#)
- Refer to [Control Module References](#) for engine control module replacement, setup, and programming
- Perform the Fuel Rail Pressure Relief Valve Reset procedure, if supported on the scan tool.

DTC P2096 OR P2097: POST CATALYST FUEL TRIM SYSTEM LOW/HIGH LIMIT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2096

Post Catalyst Fuel Trim System Low Limit

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, P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P015A, P015B, P0178, P0179, P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0340, P0341, P0365, P0366, P0411, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0496, P0498, P0499, P111E, P1133, 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°C and +200°C (-4 and +392°F).
- The start up engine coolant temperature is warmer than - 20°C (-4°F).
- The fuel control intrusive diagnostics are not active.
- The engine is operating under light acceleration, heavy acceleration, or cruise conditions.
- DTCs P2096 and P2097 run continuously when the conditions above have been met.

Conditions for Setting the DTC

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

Action Taken when the DTC Sets

DTCs P2096 and P2097 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2096 and P2097 are Type B DTCs.

Diagnostic Aids

- 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

Component View Reference

Powertrain Component Views

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)

- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

[Circuit/System Verification](#)

1. Ignition ON.
2. Verify no other HO2S or fuel trim DTC is set.
 - **If any other HO2S or fuel trim DTC is set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.
 - **If no other HO2S or fuel trim DTC is set**
3. Verify DTC P2096 or P2097 is not set.
 - **If a DTC is set**
Refer to Circuit/System Testing.
 - **If no DTC is set**
4. 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.
5. Verify DTC P2096 or P2097 is not set.
 - **If a DTC is set**
Refer to Circuit/System Testing.
 - **If no DTC is set**
6. All OK.

[Circuit/System Testing](#)

Inspect for the conditions listed below:

P2096

- Air intake duct collapsed or restricted.
- Air filter 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 Diagnosis](#).
- Excessive fuel system pressure. Refer to [Fuel System Diagnosis](#).
- Fuel contamination. 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](#).
- Improperly operating crankcase ventilation system. Refer to [Crankcase Ventilation System Inspection/Diagnosis](#).

P2097

- Exhaust system leaks. Refer to [Symptoms - Engine Exhaust](#).
- Split, kinked, or improperly connected vacuum hoses
- Insufficient fuel in the tank

- Leaks in the air induction system and air intake ducts
- Missing air filter element
- Cracked evaporative canister
- Evaporative pipes plugged, obstructed, or leaking
- Crankcase ventilation system leaking. Refer to [Crankcase Ventilation System Inspection/Diagnosis](#).
- Engine vacuum leaks
- Low fuel system pressure. Refer to [Fuel System Diagnosis](#).
- Contaminated fuel. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
- Lean fuel injectors. Refer to [Fuel Injector Diagnosis](#).
- If a condition is found

Repair as necessary.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Perform the scan tool Fuel Trim Reset after completing the repair.

DTC P2122, P2123, P2127, P2128, OR P2138: ACCELERATOR PEDAL POSITION (APP) SENSOR 1-2

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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
APP Sensor 1 5 V Reference	P06A3	P2138	P2122	P06A3	P2138

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
APP Sensor 2 5 V Reference	P0108, P0697	P2138	P2127	P0107, P0522, P0532, P0697	P2138
APP Sensor 1 Signal	P2122	P2138	P2122	P2123	P2138
APP Sensor 2 Signal	P2127	P2138	P2127	P2128	P2138
APP Sensor 1 Low Reference	-	P2138	P2123	-	P2138
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 - 4 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 - 3 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.

Conditions for Running the DTC

P2122, P2123, P2127, P2128

- DTC P0697 and P06A3 are not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.0 V and reduced power is not active.
- DTC P2122, P2123, P2127, P2128 run continuously when the above conditions are met.

P2138

- DTC P0697, P06A3, P2122, P2123, P2127, and P2128 are not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.0 V and reduced power is not active.
- DTC P2138 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2122

The ECM detects the APP sensor 1 voltage is less than 0.46 V for greater than 1 s.

P2123

The ECM detects the APP sensor 1 voltage is greater than 4.75 V for greater than 1 s.

P2127

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

P2128

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

P2138

The ECM detects the voltage difference between APP sensor 1 and APP sensor 2 exceeds a predetermined value for greater than 1 s.

Action Taken When the DTC Sets

- DTCs P2122, P2123, P2127, P2128, and P2138 are Type A DTCs.
- The control module 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 P2122, P2123, P2127, P2128, and P2138 are Type A DTCs.

Diagnostic Aids

A high resistance condition on the accelerator pedal sensor 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 scan tool APP Sensor 1 Circuit Status and APP Sensor 2 Circuit Status parameters display OK.
 - **If OK is not displayed**

Refer to Circuit/System Testing.
 - **If OK is displayed**
4. Verify the scan tool APP Sensor 1 and 2 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
 - **If Agree**
5. Verify that DTC P2122, P2123, 2127, P2128, or P2138 is not set.
 - **If any of the DTCs are set**

Refer to Circuit/System Testing
 - **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
 - **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 Position Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the appropriate low reference circuit terminal listed below and ground.
 - APP sensor 1 low reference circuit terminal 4
 - APP sensor 2 low reference circuit terminal 5
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 5 Ω**

3. Ignition ON.

4. Test for 4.8 - 5.2 V between the appropriate 5 V reference circuit terminal listed below and ground.

- APP sensor 1 5 V reference circuit terminal 2
- APP sensor 2 5 V reference circuit terminal 1

• **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 Ω in the 5 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , 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 the scan tool APP sensor 1 and APP sensor 2 voltage parameters are less than 0.3 V.

• **If 0.3 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
- APP sensor 2 signal circuit terminal 6
- 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 0.3 V**

6. Install a 3 A fused jumper wire between the appropriate signal circuit terminal listed below and the 5 V reference circuit terminal 1.

- APP sensor 1 signal circuit terminal 3
- APP sensor 2 signal circuit terminal 6

7. Verify the scan tool APP sensor 1 or APP sensor 2 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 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

• **If greater than 4.8 V**

8. Test or replace the B107 Accelerator Pedal Position Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Accelerator Pedal with Position Sensor Assembly Replacement](#)

- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P2199: INTAKE AIR TEMPERATURE (IAT) SENSORS 1-2 NOT PLAUSIBLE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P2199

Intake Air Temperature (IAT) Sensors 1-2 Not Plausible

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0097*, P0113, P0114, P00F4, P2199	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199	P0113*, P0114	-

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P0102, P00F4, P2199	P0096, P0097, P0102, P00F4, P2199	-	P0096
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096*, P0097, P00F4, P2199	P0096
Ground	-	P0096, P0097, P0102, P00F4, P2199	-	P0096

*Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient temperature			
Signal	150Ã,Ã°C (302Ã,Ã°F)	-40Ã,Ã°C (-40Ã,Ã°F)	-40Ã,Ã°C (-40Ã,Ã°F)*
Low Reference	-	-40Ã,Ã°C (-40Ã,Ã°F)	-40Ã,Ã°C (-40Ã,Ã°F)*

*Internal ECM or sensor damage may occur if the circuit is shorted to B+

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			
Parameter Normal Range: Varies with ambient temperature			
Ignition Voltage	-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{C}$ (-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{F}$) 10 Hz	-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{C}$ (-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{F}$) 10 Hz	-
Signal	-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{C}$ (-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{F}$) 10 Hz	-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{C}$ (-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{F}$) 10 Hz	-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{C}$ (-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{F}$)* 10 Hz
Ground	-	-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{C}$ (-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{F}$) 10 Hz	-
*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 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 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{C}$ ($\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{F}$).

The IAT sensor 2 produces a frequency signal based on the inlet air temperature very close to the humidity sensor within the sensor bore. The signal varies with inlet air temperature and is displayed by the scan tool as $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{C}$ ($\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{F}$) and Hertz (Hz). The ECM applies 5 V to the circuit. The signal circuit is shared by the IAT sensor 2 and the humidity sensor. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for these sensors:

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage
Cold	High	High
Warm	Low	Low

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	45 Hz	-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{C}$ (-40 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{F}$)
Warm	302 Hz	104 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{C}$ (219 $\tilde{\text{A}}$, $\hat{\text{A}}^{\circ}\text{F}$)

Conditions for Running the DTC

- The ignition is ON.
- The Ignition signal is at least 11 V for at least 0.9 s.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

The ECM detects that the absolute difference between the IAT sensor 1 and the IAT sensor 2 temperatures is greater than 55Å,Å°C (99Å,Å°F) for longer than 5 s.

Action Taken When the DTC Sets

DTC P2199 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2199 is a Type B DTC.

Diagnostic Aids

- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor 2 will gradually increase the scan tool IAT Sensor 2 parameter. This is due to the heat that is generated by the multifunction intake air sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40Å,Å°C (-40Å,Å°F), and there are Humidity Sensor DTCs, check for a circuit problem.

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 Variable Signal Generator

For equivalent regional tools, refer to [Special Tools](#) .

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 30Å,Å°C (54Å,Å°F) of each other.
 - Start-Up IAT Sensor 1
 - IAT Sensor 2
 - Start-Up ECT Sensor

- **If not within 30Å,Å°C (54Å,Å°F)**

Refer to Circuit/System Testing.

- **If within 30Å,Å°C (54Å,Å°F)**

3. Engine idling, verify the following scan tool parameters are between: -38 and +149Å,Å°C (-36 and +300Å,Å°F).

- Start-Up IAT Sensor 1
- IAT Sensor 2
- ECT Sensor
- **If not between: -38 and +149Å,Å°C (-36 and +300Å,Å°F)**

Refer to Circuit System Testing.

- **If between: -38 and +149Å,Å°C (-36 and +300Å,Å°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 DTCs do not set.

- **If any of the DTCs set**

Refer to Circuit/System Testing.

- **If none of the DTCs 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 or collapsed air intake duct
- An intake manifold leak
- A MAP sensor seal that is leaking, missing, or damaged
- A misaligned or damaged air intake duct
- 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 the component as appropriate.

- **If no condition exists**

2. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.

3. Ignition OFF, all systems OFF. It may take up to for 2 minutes for all vehicle systems to power down. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the low reference circuit end to end.

- If 2 Ω or greater, repair the open or high resistance in the circuit.
- If less than 2 Ω replace the K20 Engine Control Module.

- **If less than 2 Ω**

4. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open or high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
- **If less than 2 Ω**
5. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 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 Ω in the ignition voltage circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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 Ω between the ignition voltage circuit terminal 5 and ground.
 - If less than 2 Ω , repair the short to ground on the circuit.
 - If greater than 2 Ω , 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 1 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 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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, test for 4.8 - 5.2 V between the Intake Air Temperature sensor 2 signal circuit terminal 8 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 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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**
8. Ignition OFF, connect the leads of the **EL-38522** Variable Signal Generator as follows:
 - Red lead to the signal circuit terminal 8 at the harness connector
 - Black leads to ground
 - Battery voltage supply lead to B+
9. Set the **EL-38522** Variable Signal Generator to the following specifications.
 - Signal switch to 5 V
 - Duty Cycle switch to 50% (Normal)
 - Frequency switch to 30 Hz
10. Ignition ON, verify the scan tool IAT Sensor 2 parameter is between 28 - 32 Hz.
 - **If not between 28 - 32 Hz**
Replace the K20 Engine Control Module.
 - **If between 28 - 32 Hz**
11. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.

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

2. Test the IAT sensor 1 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 not within the specified range**
Replace the B75C Multifunction Intake Air sensor
 - **If within the specified range**
3. All OK.

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.
 - **If not within the specified range**
Replace the B75C Multifunction Intake Air sensor
 - **If within the specified range**
2. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) for multifunction intake air sensor replacement
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P219A: FUEL TRIM CYLINDER BALANCE

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptor

DTC P219A

Fuel Trim Cylinder Balance

Circuit/System Description

The Fuel Trim Cylinder Balance 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 P0016, P0017, P0030, P0036, P0053, P0054, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0019, P0122, P0123, P0128, P0131 - P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201 - P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301 - P0304, P0340, P0341, P0365, P0366, P0411, P0442, P0455, P0458, P0496, P111E, P1133, P1248, P1249, P124A, P124B, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2270, P2271, P2440, P2444 or P2A00 are not set.
- The evaporative emission system device control and 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.
- The engine coolant temperature (ECT) is warmer than -20°C (-4°F).
- The engine speed is between 1,200 - 4,000 RPM.
- The mass air flow is between 0 - 100 g/s.
- The secondary air injection pump (if equipped) is not ON.
- The Exhaust Camshaft Position and Intake Camshaft Position are between 0 - 35 degrees.
- 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 fuel trim cylinder balance 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

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Component View Reference

Powertrain Component Views

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- [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 Verification

1. Ignition ON.
2. Verify no other DTCs are set.

- **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) for further diagnosis.

- **If no other DTCs are set**

3. Verify DTC P219A is not set.

- **If a DTC is set**

Refer to Circuit/System Testing.

- **If no DTC is set**

4. 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.

5. Verify DTC P219A is not set.

- **If a DTC is set**

Refer to Circuit/System Testing.

- **If no DTC is set**

6. All OK.

Circuit/System Testing

1. Engine idling, transmission in Park or Neutral, verify the manifold absolute pressure (MAP) sensor parameter is between 20 - 48 kPa.

- **If not within the specified range .**

Refer to [DTC P0106](#) .

- **If within the specified range, inspect for the conditions listed below:**

- Modified, damaged, leaking, or restricted air induction system components.
- Improperly operating crankcase ventilation system. Refer to [Crankcase Ventilation System Inspection/Diagnosis](#) .
- Split, kinked, or improperly connected vacuum hoses.
- Restricted, damaged, leaking, or modified exhaust system from the catalytic converter forward. Refer to [Symptoms - Engine Exhaust](#) .
- Improperly operating fuel injectors. Refer to [Fuel Injector Diagnosis](#).
- Fuel contamination. Refer to [Alcohol/Contaminants-in-Fuel Diagnosis](#).
- Excessive fuel in the crankcase due to leaking injectors. Change engine oil as necessary.
- Improperly operating ignition system. Refer to [Electronic Ignition System Diagnosis](#).
- **If a condition is found**

Repair as necessary.

- **If no condition is found**

2. 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 repair.

Perform the scan tool Fuel Trim Reset after completing the repair.

DTC P2227-P2230: BAROMETRIC PRESSURE (BARO) SENSOR

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2227

Barometric Pressure (BARO) Sensor Performance

DTC P2228

Barometric Pressure (BARO) Sensor Circuit Low Voltage

DTC P2229

Barometric Pressure (BARO) Sensor Circuit High Voltage

DTC P2230

Barometric Pressure (BARO) Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0192, P0452, P0532, P0641, P2227, P2228	P2227, P2228	P018D, P0193, P0641, P2227, P2229	P2227
Signal	P2227, P2228	P2227, P2228	P2227, P2229	P2227
Low Reference	-	P0113, P2199, P2227, P2229	-	P2227

Typical Scan Tool Data

BARO

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF Parameter Normal Range: 56 - 105 kPa (8.1 - 15.2 psi), varies with altitude			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	64 kPa (9.3 psi)
Signal	0 kPa (0 psi)	0 kPa (0 psi)	128 kPa (18.6 psi)
Low Reference	-	127 kPa (18.4 psi)	-

Circuit/System Description

The barometric pressure (BARO) sensor is integral to the multifunction intake air sensor and responds to changes in altitude and atmospheric conditions. This gives the ECM an indication of barometric pressure. The ECM uses this information to calculate fuel delivery. The BARO sensor provides a voltage signal to the ECM relative to the atmospheric pressure changes. The ECM monitors the BARO sensor signal for a voltage outside of the normal range.

Conditions for Running the DTC

P2227

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P1516, P2101, P2135, P2228, or P2229 is not set.
- Engine is running for greater than 30 s.

OR

- DTC P0106, P0107, P0108, P2228, P2229, P2230, or P2610 is not active.
- DTC P0107, P0108, P2228, or P2229 is not pending.
- Engine is OFF for at least 7 min.
- Ignition is ON
- DTC P2227 runs continuously when the above conditions are met.

P2228 or P2229

- Engine is running for greater than 30 s.

- The DTCs run continuously when the above condition is met.

P2230

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P1516, P2101, P2135, P2228, or P2229 is not set.
- Ignition is ON
- DTC P2230 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2227

- The engine is running.
- The ECM detects that the difference between the actual BARO and the calculated BARO is greater than a calibrated threshold.

OR

- Ignition ON, engine OFF
- The ECM detects that the BARO pressure is less than 50 kPa (7.3 psi) or greater than 115 kPa (16.7 psi).

P2228

The ECM detects that the BARO sensor voltage is less than 2 V for greater than 5 s.

P2229

The ECM detects that the BARO sensor voltage is greater than 4.5 V for greater than 5 s.

P2230

The ECM detects that the cumulative difference between BARO sensor readings, over a specific length of time, is greater than a calibrated threshold.

Action Taken When the DTC Sets

DTCs P2227, P2228, P2229, and P2230 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2227, P2228, P2229, and P2230 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

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

DTC Type Reference

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool BARO pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.
 - **If the BARO is not within the specified range**

Refer to Circuit/System Testing.
 - **If the BARO is within the specified range**
3. 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.
4. Verify the DTC does not set.
 - **If the DTC sets**

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

Circuit/System Testing

1. Verify the conditions listed below do not exist with the B75C Multifunction Intake Air Sensor:
 - Damage
 - Restrictions in the inlet port
 - **If a condition exists**

Repair or replace the B75C Multifunction Intake Air Sensor as necessary.
 - **If none of the conditions exist**
2. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
3. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If greater than the specified value, repair the open or high resistance in the circuit.
 - If 2 Ω or less replace the K20 Engine Control Module.
 - **If less than 5 Ω**
4. Ignition ON.
5. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 2 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 Ω in the 5 V reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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**
6. Verify the scan tool BARO Sensor 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 4 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 0.2 V**
7. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 2.
8. Verify the scan tool BARO Sensor parameter is greater than 4.5 V.
 - **If 4.5 V or less**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
 - **If greater than 4.5 V**
9. Test or replace the B75C Multifunction Intake Air Sensor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Mass Airflow Sensor with Intake Air Temperature Sensor Replacement](#) for multifunction intake air sensor replacement
- Refer to [Control Module References](#) for engine control module replacement, programming, and setup

DTC P2544: TRANSMISSION TORQUE REQUEST CIRCUIT MESSAGE COUNTER INCORRECT

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

DTC Descriptors

DTC P2544

Transmission Torque Request Circuit 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 requests to modify engine speed or torque. These 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.

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.

Diagnostic Aids

An intermittent fault in the CAN circuits will cause the ECM to set DTC P2544.

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 that no other DTCs are set except for DTC P2544.

- **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .

- **If only DTC P2544 is set**

2. Replace the K71 Transmission Control Module.

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 DTC sets**

Replace the K20 Engine Control Module.

- **If DTC does not set**

5. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Control Module References](#) for ECM or TCM replacement, programming, and setup

DTC P2618 OR P2619: CRANKSHAFT POSITION SIGNAL OUTPUT CIRCUIT LOW/HIGH VOLTAGE

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P2618

Crankshaft Position Signal Output Circuit Low Voltage

DTC P2619

Crankshaft Position Signal Output Circuit High Voltage

Conditions for Running the DTC

- Ignition Voltage = Greater than 11 V
- Ignition = On
- Crankshaft Position Sensor Circuit = Active

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P2618

Crankshaft Position Signal Output Circuit = Short to Ground or Open - For greater than 5 s

P2619

Crankshaft Position Signal Output Circuit = Short to Voltage - For greater than 5 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type C DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type C DTC

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Engine - Running
2. Verify there are no DTCs/symptoms related to the following system/component, if equipped:
 - K71 Transmission Control Module
 - K103 Fuel Injector Control Module
 - T3 Audio Amplifier

- T6 Power Inverter Module
- If a DTC or symptom exists

Refer to:

- [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
- [Symptoms - Vehicle](#)
- If no DTC or symptom exists

3. All OK.

DTC P2635: FUEL PUMP FLOW PERFORMANCE (CHASSIS 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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 chassis control module when the ECM detects that the ignition is on. The voltage from the ECM to the chassis control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the chassis 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 chassis 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 chassis control module based on a history DTC P2635. The DTC P2635 may be stored but that does not indicate a failure of the chassis 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 A7 Fuel Pump and Level Sensor Assembly.
 - **If the fuel system pressure test is normal**
4. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor Assembly. It may take up to 2 minutes for all vehicle systems to power down.
5. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.

- **If 10 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.

- **If less than 10 Ω**

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 K38 Chassis 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 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K38 Chassis Control Module.

- **If the test lamp is always On**

1. Ignition OFF, disconnect the harness connector at the K38 Chassis 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 K38 Chassis Control Module.

- **If the test lamp turns On and Off**

9. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Fuel Tank Fuel Pump Module Replacement \(NT5, NT7\)](#) [Fuel Tank Fuel Pump Module Replacement \(NU6\)](#).
- Refer to [Control Module References](#) for chassis 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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 the malfunction indicator lamp (MIL) is operating correctly. Use the scan tool to command the lamp ON and OFF.
- Verify there are no DTCs that are stored.

- Verify 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 the control module grounds are clean, tight, and correctly located.
- Verify the vacuum hoses are not split or kinked, and are properly connected.
- Verify the air filter is clean and free from restrictions.
- Verify there is no water intrusion in connectors terminals and components.
- Inspect the air intake ducts for the conditions listed below:
 - Collapsed
 - Damaged areas
 - Looseness
 - Incorrect installation
 - Leaking

If any condition listed above has allowed non-metered air to enter the air induction system, the [Throttle or Idle Learn](#) procedure must be performed after the repair is complete.

- 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, Fuel Odor, 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:
 - Incorrect system operation or fuel pressure - Refer to [Fuel System Diagnosis](#).
 - Leaking or incorrectly operating fuel injectors - Refer to [Fuel Injector Diagnosis](#).
 - Contaminated or poor quality fuel - 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:
 - Non-metered air flow into the air induction system. If a leak is found, repair as necessary. The [Throttle or Idle Learn](#) procedure must be performed when the repair is complete.
 - Incorrectly operating transmission torque converter clutch (TCC) - The scan tool should indicate an engine speed drop when the TCC is commanded ON. Refer to [Torque Converter Diagnosis](#).
 - Incorrectly operating 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](#) for more information.
 - Slow responding heated oxygen sensors (HO2S) - The HO2S should respond quickly to different throttle positions - Refer to [DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, or P2271](#) for more information.

CAUTION: Refer to [Heated Oxygen and Oxygen Sensor Caution](#).

- Water intrusion in the HO2S connector

NOTE: The embossed arrows on the mass air flow (MAF) sensor indicate the direction of the intake air flow. The arrows must point toward the engine.

- Incorrect mass air flow sensor installation. A mass air flow sensor that is incorrectly 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](#).
- Incorrect mass air flow sensor connections.
- A MAF sensor contaminated by an excessively oiled aftermarket air filter. Some aftermarket air filters require oil to be added to the air filter element. If the MAF sensor becomes contaminated as the result of an excessively oiled aftermarket air filter, a variety of driveability concerns and/or erratic transmission shifting may occur.
- Engine oil contaminated by fuel
- Split or kinked vacuum hoses - Verify that the routing and connections are correct.
- Excessive knock sensor system spark retard activity - Observe the Knock Retard parameter on the scan tool for activity more than 0Å, Å°.

- Electromagnetic interference (EMI) on the reference circuit, which may 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.
- Incorrectly operating crankcase ventilation valve - Refer to [Crankcase Ventilation System Inspection/Diagnosis](#).
- Inspect the engine cooling system for the following conditions:
 - A thermostat with incorrect heat range. Refer to [Thermostat Diagnosis](#).
 - Incorrect engine coolant level - If the level is low, refer to [Loss of Coolant](#).

For more information, refer to [Symptoms - Engine Cooling](#).

- Inspect 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](#).

- Inspect for the following engine mechanical conditions:
 - 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, if necessary. Follow the instructions on the can.
 - Incorrect engine parts

For more information, refer to [Symptoms - Engine Mechanical](#).

- 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](#), list. If the reading is not in the range specified in the list, test the resistance of the ECT sensor. Refer to [Temperature Versus Resistance - Engine Coolant Temperature Sensor](#), for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to [Engine Coolant Temperature Sensor Replacement](#). If the sensor is within the specification, test the ECT 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.

ECM Commanded Reduced Engine Power

Under certain conditions the ECM 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 ECM will illuminate the reduced engine power lamp on the instrument panel cluster, however a DTC may not be set.

A repair may not be necessary. Observe the scan tool Reduced Engine Power History parameter or refer to [K20 Engine Control Module: Scan Tool Information](#) 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. 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 oil or coolant to overheat. 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 ECM 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.
- Reduced engine power 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.
- A high pressure fuel system condition. Refer to [Fuel System Diagnosis](#), and [Fuel System Description](#) to verify high pressure fuel system operation and fuel pressure.
- Intake air temperature out of range too high. Observe the scan tool IAT Sensor 1 and IAT Sensor 2 parameters. The readings should be within 9[°]C (16[°]F) of each other.
- Fuel temperature out of range too high. Observe the scan tool Fuel Temperature Sensor parameter.
- If equipped with automatic transmission, an incorrect learned brake pedal position (BPP) sensor. Verify the following actions have not occurred:
 - An engine control module has been replaced
 - A BPP sensor has been replaced
 - A BPP sensor is misaligned or incorrectly installation

If any of the above actions have occurred, perform the [Brake Pedal Position Sensor Learn](#) .

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 Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and clean, if necessary. Refer to [Throttle Body Cleaning](#) .

- Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within $\pm 3^{\circ}\text{C}$ (5°F). If the 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 - Engine Coolant Temperature Sensor](#), 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.
- Verify that the fuel system has adequate pressure for engine start-up. The fuel pump should turn ON for 2 s when the ignition is turned ON. Refer to [Fuel System Description](#), and [Fuel System Diagnosis](#).
- 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](#), and [Engine Mechanical Specifications](#).

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](#), and [Engine Mechanical Specifications](#).

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 20 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 Position Actuator Exhaust Solenoid Valve Replacement](#), [Camshaft Position Actuator Intake Solenoid Valve Replacement](#), and [Camshaft Actuator System Description](#).

Lack of Power, Sluggishness, or Sponginess

- Inspect the engine electrical system for incorrect 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 20 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 Position Actuator Exhaust Solenoid Valve Replacement](#) , [Camshaft Position Actuator Intake Solenoid Valve Replacement](#) , and [Camshaft Actuator System Description](#) .

Poor Fuel Economy

- Observe the Throttle Body Idle Airflow Compensation parameter with a scan tool. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and clean, if necessary. Refer to [Throttle Body Cleaning](#) .
- Inspect for heavy loads being carried or towed
- Inspect for acceleration rate too much or too often
- Inspect for incorrect operation of the speedometer.
- Verify that the engine coolant temperature (ECT) has not shifted in value. Allow the engine to run and reach operating temperature. Observe the ECT Sensor parameter with a scan tool and compare the reading to that parameter listed on the [K20 Engine Control Module: Scan Tool Information](#) , 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 - Engine Coolant Temperature Sensor](#) , 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

- 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.
- Engine idle speed be unstable or the engine may stall if the ECM has learned an incorrect idle/airflow compensation value. A DTC may also set. 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. If the throttle body needs cleaning, refer to [Throttle Body Inspection and Cleaning](#) .

The actions listed below may also cause the ECM to learn an incorrect idle value:

- The engine control module (ECM) has been replaced
- The throttle body has been replaced
- The throttle body has been cleaned but the idle learn procedure was not performed after completing the cleaning
- The air induction system was leaking, allowing non-metered air to enter the combustion chamber. The leak was repaired, but the idle learn procedure was not performed after repairing the leak.

If any of the actions listed above have occurred, the [Throttle or Idle Learn](#) procedure must be performed.

- 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 for looseness, damage and wear. Refer to [Engine Mount Inspection](#) .
- Inspect the intake and exhaust manifolds for casting flash.

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 HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The PCM reduces the amount of fuel delivered to the engine, causing a driveability condition. Refer to [DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, or P2271](#) for more information.

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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 powertrain 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 change from OK or Not Run to Malfunction if there is a condition with a 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.
2. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.

- The MIL Control Circuit Low Voltage Test Status
- The MIL Control Circuit Open Test Status
- The MIL Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

3. Engine running.

4. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.

- The MIL Control Circuit Low Voltage Test Status
- The MIL Control Circuit Open Test Status
- The MIL Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

5. Verify the malfunction indicator lamp turns ON and OFF when commanding the Malfunction Indicator Lamp On and Off with a scan tool.

- **If the malfunction indicator lamp does not turn ON and OFF**

Refer to Circuit/System Testing.

- **If the malfunction indicator lamp turns ON and OFF**

6. All OK.

Circuit/System Testing

1. Ignition OFF.

2. Disconnect the X1 harness connector at the K20 Engine Control Module.

3. Ignition ON, verify the malfunction indicator lamp does not illuminate.

- **If the malfunction indicator lamp illuminates**

1. Test for infinite resistance between the control circuit terminal X1 46 and ground.

- If less than infinite resistance, repair the short to ground in the circuit.
- If infinite resistance, replace the P16 Instrument Cluster.

- **If the malfunction indicator lamp does not illuminate**

4. Connect a 3 A fused jumper wire between the control circuit terminal X1 46 and ground.

5. Verify the malfunction indicator lamp illuminates.

- **If the malfunction indicator lamp illuminates**

Replace the K20 Engine Control Module.

- **If the malfunction indicator lamp does not illuminate**

1. Test for less than 1 V between the control circuit terminal X1 46 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V

2. Ignition OFF.

3. Test for less than 2 Ω in the control circuit end to end.

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

6. Ignition OFF, disconnect the X1 harness connector at the instrument cluster.

7. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal 8 and ground.

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

1. Ignition OFF.

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

1. Ignition OFF.

2. Test for less than 2 Ω in the ignition voltage circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.

- **If the test lamp illuminates**

8. Replace the P16 Instrument Cluster.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- Refer to [Instrument Cluster Replacement](#)
- Refer to [Control Module References](#) for control module replacement, programming, and setup

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

The engine control module (ECM) supplies voltage to the chassis control module when the ECM detects that the ignition is ON. The voltage from the ECM to the chassis control module remains active for 2 s, unless the engine is in Crank or Run. While this voltage is being received, the chassis control module closes the ground switch of the fuel pump 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 fuel tank fuel pump module inside the fuel tank. The fuel pump supplies fuel through the fuel feed pipe and the fuel feed front pipe check valve to the high pressure fuel pump. The fuel pump also supplies fuel to a venturi pump located on the bottom of the fuel tank fuel pump module. The function of the venturi pump is to fill the fuel tank fuel pump module reservoir. The fuel tank fuel pump module contains a reverse flow check valve. Both check valves maintain fuel pressure in the fuel feed pipe in order to prevent long cranking times.

Diagnostic Aids

- A faulty fuel feed front pipe check valve may cause a rattle, tick, knock, or buzz noise. The noise may be more pronounced at idle, approximately 600-800 RPM.
- An erratic low side fuel pressure reading may be caused by a faulty fuel feed front pipe check valve.
- Observe the Misfire Counters or perform the Fuel Injector Diagnosis 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-41769** Fuel Line Quick Disconnect Separator
- **EN 37287** Fuel Line Shut-off Adapter

For equivalent regional tools, refer to [Special Tools](#) .

[Circuit/System Verification](#)

NOTE:

- Repair all fuel system related DTCs, except P2635, 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.
- 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%.

1. Ignition ON, engine OFF, command the Fuel Pump Enable On several times with a scan tool.
2. Verify that the scan tool Fuel Pressure Sensor parameter is between 345 - 650 kPa (50 - 94 PSI).
 - **If less than 345 kPa (50 PSI)**
Refer to Circuit/System Testing - Fuel Pressure Low.
 - **If greater than 650 kPa (94 PSI)**
Replace the G12 Fuel Pump.
 - **If between 345 - 650 kPa (50 - 94 PSI)**
3. Verify that the scan tool Fuel Pressure Sensor parameter, after the fuel pump is turned off, decreases to less than 600 kPa (87 PSI).
 - **If greater than 600 kPa (87 PSI)**
Replace the G12 Fuel Pump
 - **If less than 600 kPa (87 PSI)**
4. Verify that the scan tool Fuel Pressure Sensor parameter does not decrease greater than 34 kPa (5 PSI) in 1 min.
 - **If greater than 34 kPa (5 PSI)**
Refer to Circuit/System Testing - Fuel Pressure Leaks Down.

- **If less than 34 kPa (5 PSI)**
5. Engine idling.
 6. Verify that the scan tool Fuel Pressure Sensor parameter is between 300 - 400 kPa (43 - 58 PSI).
 - **If less than 300 kPa (43 PSI)**

Refer to Circuit/System Testing - Fuel Pressure Low.
 - **If greater than 400 kPa (58 PSI)**

Replace the G12 Fuel Pump.
 - **If between 300 - 400 kPa (43 - 58 PSI)**
 7. Verify that the scan tool Short Term Fuel Pump Trim and the Long Term Fuel Pump Trim when multiplied together are less than 1.5.
 - **If greater than 1.5**

Refer to Circuit/System Testing - Fuel Pressure Low.
 - **If less than 1.5**
 8. Verify that the scan tool Fuel Pressure Sensor and the Desired Fuel Pressure are within 45 kPa (6.5 PSI) at 300 kPa (43.5 PSI) request or 60 kPa (8.7 PSI) at 400 kPa (58 PSI) request of each other while operating the vehicle through varying loads.
 - **If greater than 45 kPa (6.5 PSI) / 60 kPa (8.7 PSI)**

Refer to Circuit/System Testing - Fuel Pressure Drops Off.
 - **If less than 45 kPa (6.5 PSI) / 60 kPa (8.7 PSI)**
 9. If the fuel system components test normal, refer to [Symptoms - Engine Controls](#), and [Fuel Injector Diagnosis](#).

Circuit/System Testing

Fuel Pressure Low

1. Verify none of the conditions listed below exist:
 - Restricted or dislocated fuel feed front pipe check valve
 - Restricted fuel feed pipe
 - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
 - **If a condition exists**

Repair as necessary.
 - **If no conditions exist**

Replace the G12 Fuel Pump.

Fuel Pressure Leaks Down

1. Ignition OFF, relieve the fuel pressure. Refer to [Fuel Pressure Relief](#) .
2. Install the **EN-37287** between the chassis fuel feed hose and the engine compartment fuel feed pipe.
3. Open the valve on the **EN-37287** .
4. Ignition ON, command the Fuel Pump Enable On and then Off with a scan tool.
5. Close the valve on the **EN-37287** .
6. Verify that the scan tool Fuel Pressure Sensor parameter does not decrease more than 34 kPa (5 PSI) in 1 min.
 - **If greater than 34 kPa (5 PSI)**

Replace the G12 Fuel Pump.

- **If less than 34 kPa (5 PSI)**

7. Test for a faulty fuel feed front pipe check valve.

- **If a condition exists**

Replace the fuel feed front pipe.

- **If no condition exists**

8. Test for a leaking G18 High Pressure Fuel Pump.

- **If a condition exists**

Replace the G18 High Pressure Fuel Pump.

- **If no condition exists**

Locate and replace the leaking Q17 Fuel Injector.

Fuel Pressure Drops Off

1. Verify none of the conditions listed below exist:

- Restricted or dislocated fuel feed front pipe check valve
- Restricted fuel feed pipe
- Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
- **If a condition exists**

Repair as necessary.

- **If no conditions exist**

Replace the G12 Fuel Pump.

Repair Instructions

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

- Refer to **Fuel Feed Pipe Replacement (At Tank)** **Fuel Feed Pipe Replacement (Engine to Chassis)**
- Refer to **Fuel Feed Front Pipe Replacement**
- Refer to **Fuel Feed Intermediate Pipe Replacement**
- Refer to **Fuel Injector Replacement**
- Refer to **Fuel Pump Replacement**
- Refer to **Fuel Tank Fuel Pump Module Replacement (NT5, NT7)** **Fuel Tank Fuel Pump Module Replacement (NU6)**

FUEL INJECTOR 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.
- Refer to **Diagnostic Procedure Instructions** to provide 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.

The scan tool 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 fuel 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 fuel injector.

Diagnostic Aids

- Monitoring the scan tool Cylinder 1-4 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.

Reference Information

Schematic Reference

Engine Controls Schematics

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Fuel Injector Coil Test

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 Ω in order to prevent mis-diagnosis.

1. Remove the intake manifold and disconnect the appropriate Q17 Fuel Injector.
2. Test for 1.35 - 1.65 Ω at 20 $^{\circ}\text{C}$ (68 $^{\circ}\text{F}$) between the high voltage supply circuit terminal 2 and the high voltage control circuit terminal 1 at the Q17 Fuel Injector.
 - **If not between 1.35 - 1.65 Ω**
Replace the Q17 Fuel Injector.
 - **If between 1.35 - 1.65 Ω**
3. Test for infinite resistance between each terminal at the Q17 Fuel Injector and the Q17 Fuel Injector housing/case.
 - **If less than infinite resistance**
Replace the Q17 Fuel Injector.
 - **If infinite resistance**
4. All OK. Perform the Fuel Injector Balance Test.

Fuel Injector Balance Test

NOTE:

- **DO NOT** perform this test if the engine coolant temperature (ECT) is

above 60A, A°C (140A, A°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 with Scan Tool

1. Verify the correct low side fuel pressure. Refer to [Fuel System Diagnosis](#).
2. Engine idling, verify the scan tool Fuel Rail Pressure Sensor parameter is approximately 3 MPa (435 psi).

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

3. Select the Fuel Injector Balance function within the Control Functions menu of a scan tool.
4. Select and test an injector. Repeat for each injector.
5. Obtain and record a pressure drop value for each injector.
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.
9. Verify the difference between any individual pressure drop and the average pressure drop is not greater than the acceptable variance.

- **If greater than the acceptable variance**

Replace the appropriate Q17 Fuel Injector(s).

- **If within the acceptable variance**

10. Perform the [Fuel Injector Circuit Diagnosis](#).

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

Refer to [Fuel Injector Replacement](#)

FUEL INJECTOR CIRCUIT DIAGNOSIS

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Injector 1 Control +	P2147	P0201	P2148	P1248
Fuel Injector 1 Control -	P0261	P0201	P2148	P1248
Fuel Injector 2 Control +	P2150	P0202	P2151	P1249
Fuel Injector 2 Control -	P0264	P0202	P2151	P1249
Fuel Injector 3 Control +	P2153	P0203	P2154	P124A
Fuel Injector 3 Control -	P0267	P0203	P2154	P124A
Fuel Injector 4 Control +	P2156	P0204	P2157	P124B
Fuel Injector 4 Control -	P0270	P0204	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 injector high voltage control circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Diagnosis**.
- 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 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

Powertrain Component View

Powertrain Component Views

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

Circuit/System Verification

NOTE: Do Not perform this procedure unless directed here from the Fuel Injector Balance Test.

1. Engine idling.
2. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter parameters do not increment.

- **If the Cylinder 1 - 4 Current Misfire Counters increment**

Refer to Circuit/System Testing.

- **If the Cylinder 1 - 4 Current Misfire Counters do not increment**

3. Verify the scan tool Cylinder 1 - 4 Injector Control Circuit Status parameters display OK.

- **If the Cylinder 1 - 4 Injector Control Circuit Status parameters do not display OK**

- **If the Cylinder 1 - 4 Injector Control Circuit Status parameters display OK**

4. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the harness connector at the K20 Engine Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for infinite resistance between the appropriate Q17 Fuel Injector control + circuit and ground.
 - **If less than infinite resistance**
 1. Disconnect the harness connector of the Q17 Fuel Injector.
 2. Test for infinite resistance between the Q17 Fuel Injector control + circuit and ground.
 - If less than infinite, repair the short to ground in the circuit.
 - If infinite resistance
 3. Test for infinite resistance between the Q17 Fuel Injector control - circuit and ground.
 - If less than infinite, repair the short to ground in the circuit.
 - If infinite, replace the Q17 Fuel Injector.
 - **If infinite resistance**
3. Ignition ON.
4. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
 - **If 1 V or greater**
 1. Disconnect the harness connector of the Q17 Fuel Injector, ignition ON.
 2. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, repair the short to voltage on the control - circuit.
 - **If less than 1 V**
5. Ignition OFF.
6. Test for less than 3 Ω between the Q17 Fuel Injector control + circuit and control - circuit.
 - **If 3 Ω or greater**
 1. Disconnect the harness connector of the Q17 Fuel Injector.
 2. Test for less than 2 Ω on the control + circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω
 3. Test for less than 2 Ω on the control - circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the Q17 Fuel Injector.
 - **If less than 3 Ω**
7. Replace the K20 Engine Control Module.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the diagnostic repair.

- Refer to [Control Module References](#) for ECM replacement, programming and setup,
- Refer to [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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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, if available

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, If Available

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 min 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 min 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.

- Refer to [Fuel System Cleaning](#)
- Refer to [Fuel Tank Draining](#)

EVAPORATIVE EMISSION SYSTEM DIAGNOSIS

Special Tools

EN-41413-VLV EVAP Service Port Vent Fitting

Operating Instructions for the Evaporative Emission System Tester

Vehicle Setup

WARNING: Refer to [Fuel and Evaporative Emission Pipe Warning](#) .

CAUTION: Refer to [Clean, Dry, Low Pressure Gas Source Caution](#) .

NOTE: When servicing the evaporative emission (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.

NOTE: A large difference between the vehicle temperature and shop temperature will seriously affect the accuracy of the tests. Always allow at least 15 min 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

CAUTION: Refer to [Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution](#) .

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 EVAP system leaks.
3. Press and release the remote switch to activate the tester.

NOTE: The tester will time out after about 15 min. You may press the remote switch to reactivate the tester as desired.

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 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 on-board refueling vapor recovery pipe and orifice.**

7. Press and release the remote switch to activate the nitrogen flow and fill the system.
8. Verify the stable floating indicator position to the red flag.

- **Above the red flag, result is unacceptable - fail**

Go to the Smoke Procedure

- **Below the red flag - pass. Test complete**

9. Press and release the remote switch to deactivate the tester.

Smoke Procedure - Locate the Leak

NOTE:

It is not recommended to use the tester in an outside repair bay area because wind and sunlight may affect temperature and your ability to see the smoke.

1. Turn OFF any fans that may cause air movement around or near the vehicle.

NOTE:

Completely unwind the nitrogen/smoke hose from the bracket to optimize the tester's performance.

2. Connect the nitrogen/smoke hose to the vehicle as directed in the service procedures. Some vehicles require that the nitrogen/smoke hose be connected at the front of the EVAP system at the EVAP service port. An adapter may be necessary. Other vehicles require the connection be made at the rear of the system using an adapter at the fuel fill cap or capless fuel fill. Consult the service procedures for DTCs that relate to 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.

NOTE:

- **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**

until smoke is observed then remove the vent fitting tool and close the system to continue with the test.

- Inject smoke in less than 2 min 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 until leak source is identified.
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.

- **Smoke seen leaking**

Repair or replace the affected component.

- **No smoke seen leaking**

9. All OK

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 emission 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 in. H₂O (0.5 PSI) 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.

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.
- Refer to [Diagnostic Procedure Instructions](#) to provide an overview of each diagnostic category.

Circuit/System Description

This ignition system uses an individual coil 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 coils 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 Ω between the ground circuit terminal 1 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 5 Ω**
3. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
 - **If 5 Ω or greater**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for less than 2 Ω in the low reference circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω , replace the K20 Engine Control Module.
 - **If less than 5 Ω**
4. Ignition ON.
 5. Verify a test lamp illuminates between the ignition circuit terminal 4 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp illuminates**
 6. Ignition OFF, exchange the suspect T8 Ignition Coil with the T8 Ignition Coil of a known functioning cylinder.
 7. Engine Running.
 8. Verify the scan tool Cylinder 1 - 4 Current Misfire Counter does not increment for the same cylinder that the suspect T8 Ignition Coil was removed from.
 - **If increments**
Replace the K20 Engine Control Module.
 - **If does not increment**
 9. Test or replace the T8 Ignition Coil.

Component Testing

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 good**
4. All OK.

Repair Instructions

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

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

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.
- Refer to **Diagnostic Procedure Instructions** to provide an overview of each diagnostic category.

Description

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and inspection/maintenance (I/M) emission inspections in order to renew license plates. This is accomplished by viewing the Inspection/Maintenance System Status or Data display on a scan tool.

Using a scan tool, the technician can observe the I/M 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 malfunction indicator lamp (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 by disconnecting power to the controller. I/M Test DTCs are supported by all emissions related electronic control units (ECUs), such as engine control modules (ECMs), transmission control modules (TCMs), fuel pump control modules (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

NOTE: **New vehicles may not report an Inspection/Maintenance System Check pass or fail status for certain post catalyst oxygen sensor or heated oxygen sensor 2 diagnostics prior to 700 miles. After replacing a catalytic converter on a vehicle with greater than 700 miles, it may require up to an additional 700 miles to prevent a false failure status.**

Each system requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a 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 MIL. Once all of the tests are completed, the Inspection/Maintenance System Status or Data will indicate YES in the Completed or Value 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 Inspection/Maintenance System Status or Data will indicate NO under the Completed or Value column when any of the required tests for that system have not run. The following is a list of conditions that would set the Inspection/Maintenance System Status or Data 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 I/M Test DTCs. 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 off due to 3 passing drive cycles, and the 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, therefore the DTC must PASS and not FAIL during the drive cycle. 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 greater than 600 s.
 - Cumulative vehicle operation above 40 km/h (25 mph) over 300 s.
 - Continuous vehicle idle greater than 30 s.
 - Ignition OFF for 5 s to allow the code to clear.

Monitored Emission Control Systems

The OBD II system monitors all emission control systems that are on-board, but 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 Inspection/Maintenance System Status or Data 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 Inspection/Maintenance System Status or Data information may be useful for a technician to determine if diagnostics have run when verifying repairs.

Circuit/System Verification

Review the Inspection/Maintenance System Status or Data indicators. All Inspection/Maintenance System Status or Data 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 Inspection/Maintenance System Status or Data 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 Inspection/Maintenance System Status or Data indicators.
 - If any Inspection/Maintenance System Status or Data 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 Inspection/Maintenance System Status or Data 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 Inspection/Maintenance System Status or Data 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.
- Refer to [Diagnostic Procedure Instructions](#) to provide 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

1. Verify that all I/M System Status indicators report YES, and that no I/M Test DTCs are present.
 - **If any I/M Test DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
 - **If no I/M Test DTCs are set**
2. All OK.

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.

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

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 Inspection/Maintenance Complete System Set Procedure, 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	DTC P0420
ECR/CMP	DTC P0011 or P0014
EVAP	• DTC P0442 • DTC P0446 • DTC P0455
Fuel System	DTC P219A
HO2S	DTC P0030-P0032, P0036-P0038, P0053, P0054, P0135, or P0141
H02S/02S	DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, or P2271

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.5L (LCV) - Repair Instructions - Impala

REPAIR INSTRUCTIONS

WIRE TO WIRE REPAIR - ENGINE CONTROLS AND FUEL

Special Tools

- **EL-38125-10** Splice Sleeve Crimping Tool (non GMNA)
- **J-38125-5A** Ultra Torch Special Tool
- **J-38125-8** Splice Sleeve Crimping Tool (GMNA)

For equivalent regional tools, refer to [Special Tools](#).

WARNING: In order to reduce the risk of personal injury, loss of high voltage isolation to ground and higher system impedance, do not attempt to repair any HV wiring, connector, or terminal that is damaged. High voltage coaxial type cables are not repairable. Never attempt to repair a coaxial type cable. The entire cable/harness or component must be replaced. In order to maintain system integrity and personal safety, never attempt to repair any high voltage wiring, cables, or terminals. Performing this procedure on high voltage circuits may result in serious injury or death.

NOTE: If the wiring harness internal to the transmission is damaged, the wiring harness must be replaced. The use of splice sleeves in an attempt to repair the internal transmission wires, connectors, or terminals could result in performance issues.

NOTE: Do not splice wires in Door Harness Grommets.

NOTE: The DuraSeal splice sleeves have the following 2 critical features:

- A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.
- A cross hatched (knurled) core crimp provides the necessary low resistance contact integrity for these sensitive, low energy circuits.

Use only DuraSeal splice sleeves to form a one-to-one splice on all types of insulation except high voltage and specialty cables. Use DuraSeal splice sleeves where there are special requirements such as moisture sealing. Follow the instructions below in order to splice copper wire using DuraSeal splice sleeves.

Splice Sleeve Selection

Splice Sleeve Color	Crimp Tool Nest Color		Wire Gauge mm ² / (AWG)
	3 Crimp Nests	4 Crimp Nests	
Salmon (Yellow-Pink) 19300089	Red (1) or Red/Green (1)	Red (2)	0.22 - 0.8/(18 - 26)
Blue 19168447	Blue (2)	Blue (3)	1.0 - 2.0/(14 - 16)
Yellow 19168448	Yellow (3)	Yellow (4)	3.0 - 5.0/(10 - 12)

NOTE:

You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.

1. Open the harness by removing any tape:

- Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
- Use the DuraSeal splice sleeves on all types of insulation except Tefzel and coaxial.
- Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.

2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches, or connectors.

3. Strip the insulation:

- When adding a length of wire to the existing harness, use the same size wire as the original wire.
- Perform one of the following items in order to find the correct wire size:
 - Find the wire on the schematic and convert to regional wiring gauge size.
 - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.
- Strip approximately 5.0 mm (0.20 in) of insulation from each wire to be spliced.
- Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
- If the wire is damaged, repeat this procedure after removing the damaged section.

4. For high temperature wiring, slide a section of high temperature SCT1 shrink tubing down the length of wire to be spliced. Ensure that the shrink tubing will not interfere with the splice procedure.

5. Select the proper DuraSeal splice sleeve according to the wire size. Refer to the above table at the beginning of the repair procedure for the color coding of the DuraSeal splice sleeves and the crimp tool nests.

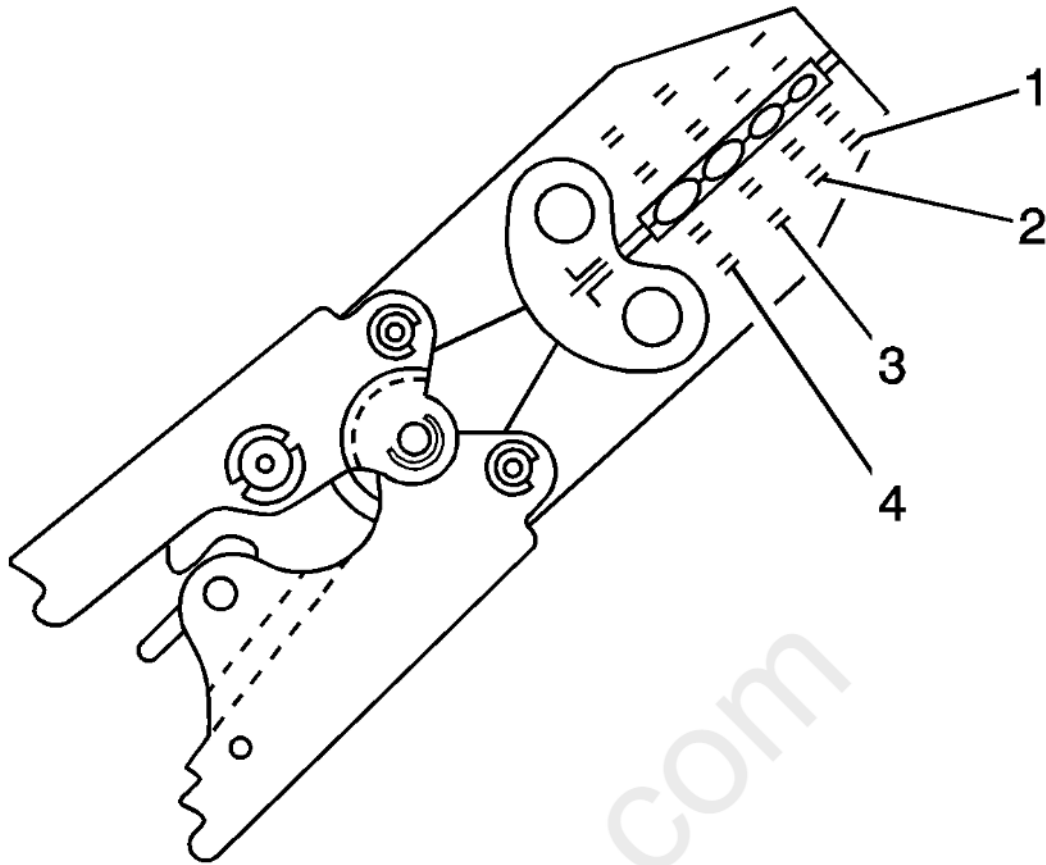


Fig. 1: Splice Sleeve Crimping Tool With 4 Crimp Nests

Courtesy of GENERAL MOTORS COMPANY

6. The **EL-38125-10** splice sleeve crimping tool has four crimp nests. The largest crimp nest (4) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (3) is used for crimping 14 and 16 gauge wires. The third largest crimp nest (2) is used for crimping 18 and 20 gauge wires. The smallest crimp nest (1) is used for crimping 22 to 26 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.

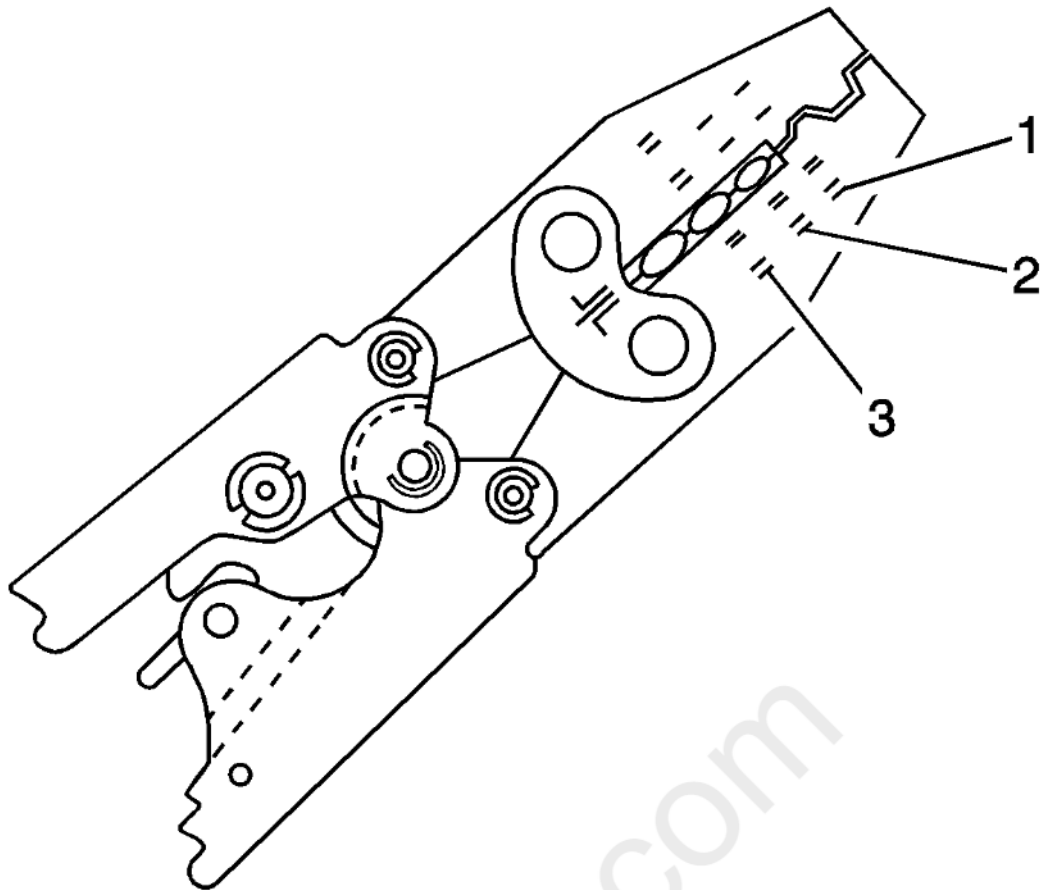


Fig. 2: Splice Sleeve Crimping Tool With 3 Crimp Nests
Courtesy of GENERAL MOTORS COMPANY

7. The **J-38125-8** splice sleeve crimping tool has three crimp nests. The largest crimp nest (3) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (2) is used for crimping 14 and 16 gauge wires. The smallest crimp nest (1) is used for crimping 18 to 20 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.
8. Use the splice sleeve crimp tool in order to position the DuraSeal splice sleeve in the proper color nest of the splice sleeve crimp tool. For the four crimp nest tool, use the three largest crimp nests to crimp the splice sleeves. For the three crimp nest tool, use all three crimp nests to crimp the splice sleeves. Use the four and three crimp tool diagrams (above) and the table (farther above) to match the splice sleeve with the correct crimp nest. The crimp tool diagram callout numbers match the numbers in the table (under crimp tool nest color).

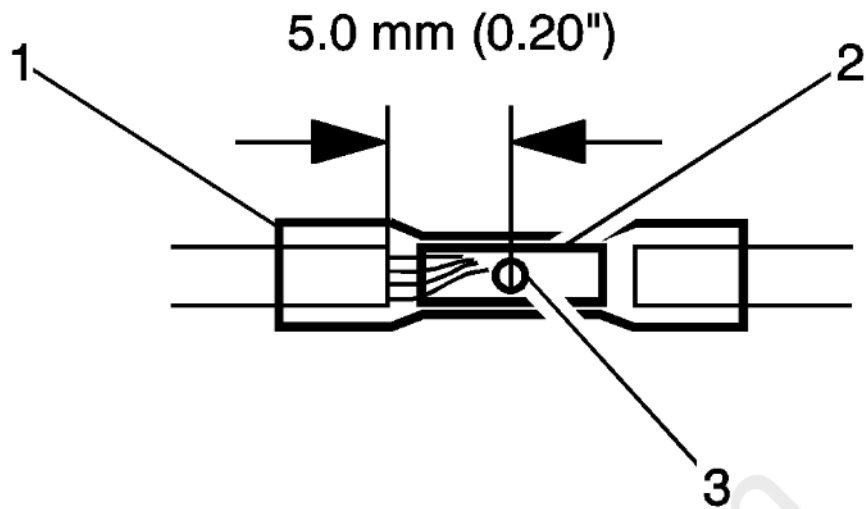


Fig. 3: Identifying DuraSeal Splice Sleeve

Courtesy of GENERAL MOTORS COMPANY

9. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.



Fig. 4: Crimped DuraSeal Splice Sleeve

Courtesy of GENERAL MOTORS COMPANY

10. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.
11. Tightly close the handles of the crimp tool until the crimper handles open when released.

The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 6 for the opposite end of the splice.



Fig. 5: Heated Splice Sleeve

Courtesy of GENERAL MOTORS COMPANY

12. Using the heat torch, apply heat to the crimped area of the barrel.
13. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

Weatherpack™ Wiring Repair

NOTE: Some replacement pigtail connectors may be delivered without the terminated leads installed into the connector. For Weatherpack™ connectors, all terminated leads included in the package should to be installed into the connector. If the connector end view shows that a terminal is not occupied, the extra terminated lead(s) need to be installed and the end(s) sealed using a DuraSeal splice sleeve and taped back into the harness.

1. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop. Refer to **Folded-Over Wire Repair** for splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes) and for splicing wires of different gauges.

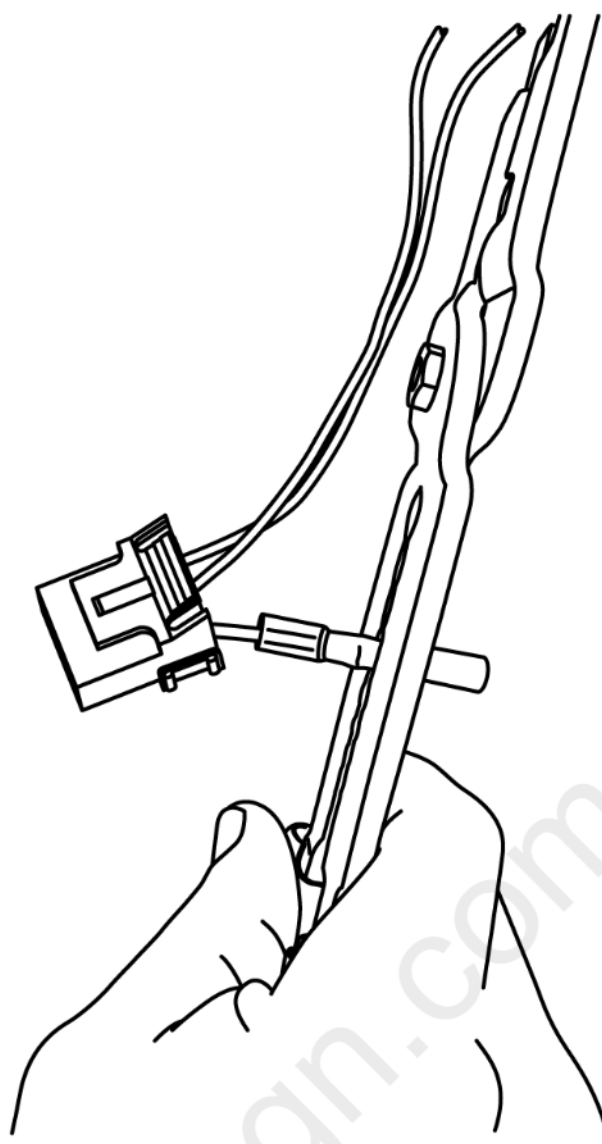


Fig. 6: Tightly Close Handles Of Crimp Tool

Courtesy of GENERAL MOTORS COMPANY

2. Tightly close the handles of the crimp tool until the crimper handles open when released.

The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Holding the DuraSeal with one hand gently tug on the wire to ensure it is crimped in the DuraSeal.

3. Using the heat torch, apply heat to the crimped area of the barrel.

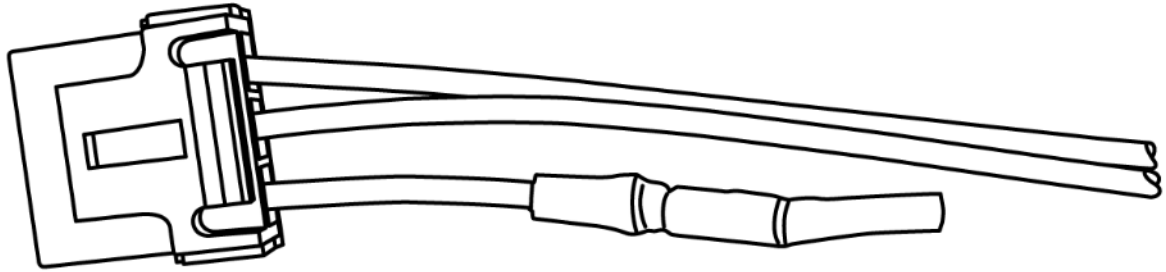


Fig. 7: Heat To Crimped Area Of Barrel

Courtesy of GENERAL MOTORS COMPANY

4. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.



Fig. 8: Taping Extra Terminated Leads Back Into Harness
Courtesy of GENERAL MOTORS COMPANY

5. Tape the extra terminated lead(s) back into the harness.

High Temperature Wiring Repairs

Use the following procedures to perform high temperature wiring repairs:

1. Center the high temperature SCT1 shrink tube over the DuraSeal splice sleeve.
2. Using the heat torch, apply heat to the high temperature heat shrink tubing.
3. Gradually move the heat from the center to the open end of the tubing:
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.
4. Replace any reflective tape and clips that may have been removed during the repair.

CONNECTOR RECONNECTION - ENGINE CONTROLS AND FUEL

Special Tools

EL-35616 Terminal Test Probe Kit

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

When the condition is not currently present, but is indicated in DTC history, the cause may be intermittent. An intermittent may also be the cause when there is a customer complaint, but the symptom cannot be duplicated. Refer to the Symptom Table of the system that is suspect of causing the condition before trying to locate an intermittent condition.

Most intermittent conditions are caused by faulty electrical connections or wiring. Inspect for the following items:

- Loose, corroded, or painted terminal stud/fastener
- Wiring broken inside the insulation
- Poor connection between the male and female terminal at a connector
- A terminal not seated all the way into the connector body
- Poor terminal to wire connection - Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself, and corrosion in the wire to terminal contact area, etc.
- Pierced or damaged insulation can allow moisture to enter the wiring causing corrosion. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
- Wiring which has been pinched, cut, or its insulation rubbed through may cause an intermittent open or short as the bare area touches other wiring or parts of the vehicle.
- Wiring that comes in contact with hot or exhaust components
- Refer to [**Inducing Intermittent Fault Conditions**](#) in order to duplicate the conditions required, in order to verify the customer concern.
- Refer to [**Testing for Electrical Intermittents**](#) for test procedures to detect intermittent open, high resistance, short to ground, and short to voltage conditions.
- Refer to [**Scan Tool Snapshot Procedure**](#) for advanced intermittent diagnosis and Vehicle Data Recorder operation.

Testing for Terminal Fretting

Some intermittent conditions can be caused by wire terminal fretting corrosion. Fretting corrosion is a build-up of insulating, oxidized wear debris that can form when there is a small motion between electrical contacts. The oxidized wear debris can pile up enough at the electrical contact spots that the electrical resistance across the connection increases. Movement between the contacting surfaces as small as 10 to 100 microns can cause fretting. To put this in perspective, a sheet of paper is about 100 microns thick, so fretting motion is small and hard to see. Vibration and thermal expansion/contraction are the main sources that create fretting motion. Since vehicles vibrate and can experience large temperature swings, they are a good source for fretting motion. Tin, copper, nickel, and iron surfaces are all susceptible to fretting corrosion. Fretting corrosion can be difficult to see but it looks like small, dark smudges on the terminals contact surface.

To correct a fretting condition disconnect the suspect connector and add dielectric grease/lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to both sides of the connector terminals. Then reconnect the connector and wipe away any excess lubricant. This will correct the additional terminal contact resistance due to the terminal fretting corrosion.

Testing for Proper Terminal Contact

It is important to test terminal contact at the component and any inline connectors before replacing a suspect component. Mating terminals must be inspected to ensure good terminal contact. A poor connection between the male and female terminal at a connector may be the result of contamination or deformation.

Contamination may be caused by the connector halves being improperly connected. A missing or damaged connector seal, damage to the connector itself, or exposing the terminals to moisture and dirt can also cause contamination. Contamination, usually in the underhood or underbody connectors, leads to terminal corrosion, causing an open circuit or intermittently open circuit.

Deformation is caused by probing the mating side of a connector terminal without the proper adapter. Always use the **EL-35616** kit when probing connectors. Other causes of terminal deformation are improperly joining the connector halves, or repeatedly separating and joining the connector halves. Deformation, usually to the female terminal contact tang, can result in poor terminal contact causing an open or intermittently open circuit.

Testing for Proper Terminal Contact in Bussed Electrical Centers

It is very important to use the correct test adapter when testing for proper terminal contact of fuses and relays in a bussed electrical center. Use the **EL-35616** kit to test for proper terminal contact. Failure to use the **EL-35616** kit can result in improper diagnosis of the bussed electrical center.

Follow the procedure below in order to test terminal contact:

1. Separate the connector halves.
2. Visually inspect the connector halves for contamination. Contamination may result in a white or green build-up within the connector body or between terminals. This causes high terminal resistance, intermittent contact, or an open circuit. An underhood or underbody connector that shows signs of contamination should be replaced in its entirety: terminals, seals, and connector body.
3. Using an equivalent male terminal/terminated lead, verify that the retention force is significantly different between a known good terminal and the suspect terminal. Replace the female terminal in question.

Flat Wire Connectors

There are no serviceable parts for flat wire connectors on the harness side or the component side.

Follow the procedure below in order to test terminal contact:

1. Remove the component in question.
2. Visually inspect each side of the connector for signs of contamination. Avoid touching either side of the connector as oil from your skin may be a source of contamination as well.
3. Visually inspect the terminal bearing surfaces of the flat wire circuits for splits, cracks, or other imperfections that could cause poor terminal contact. Visually inspect the component side connector to ensure that all of the terminals are uniform and free of damage or deformation.
4. Insert the appropriate adapter into the flat wire harness connector in order to test the circuit in question.

Control Module/Component Voltage and Grounds

Poor voltage or ground connections can cause widely varying symptoms.

- Test all control module voltage supply circuits. Many vehicles have multiple circuits supplying voltage to a control module. Other components in the system may have separate voltage supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the voltage source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Operate the component to test the ability of the circuit to carry sufficient current. Refer to [Circuit Testing](#) , and [Power Distribution Schematics](#) .
- Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point (screw or stud). Inspect the connections at the component and in splice packs, where applicable. Operate the component to test the ability of the circuit to carry sufficient current. Refer to [Circuit Testing](#) , and [Ground Distribution Schematics](#) .

Temperature Sensitivity

- An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold, or only when the component/connection is hot.
- Freeze Frame, Failure Records, Snapshot, or Vehicle Data Recorder data may help with this type of intermittent condition, where applicable.
- If the intermittent is related to heat, review the data for a relationship with the following:
 - High ambient temperatures
 - Underhood/engine generated heat
 - Circuit generated heat due to a poor connection, or high electrical load

- Higher than normal load conditions, towing, etc.
- If the intermittent is related to cold, review the data for the following:
 - Low ambient temperatures - In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion.
 - The condition only occurs on a cold start.
 - The condition goes away when the vehicle warms up.
- Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
- If temperature is suspected of causing an intermittent fault condition, attempt to duplicate the condition. Refer to [Inducing Intermittent Fault Conditions](#) in order to duplicate the conditions required.

Electromagnetic Interference and Electrical Noise

Some electrical components/circuits are sensitive to electromagnetic interference or other types of electrical noise. Inspect for the following conditions:

- A mis-routed harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator etc. - These components may induce electrical noise on a circuit that could interfere with normal circuit operation.
- Electrical system interference caused by a malfunctioning relay, or a control module driven solenoid or switch - These conditions can cause a sharp electrical surge. Normally, the condition will occur when the malfunctioning component is operating.
- Installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. - These accessories may create interference in other circuits while operating and the interference would disappear when the accessory is not operating. Refer to [Checking Aftermarket Accessories](#).
- Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.
- The generator may be allowing AC noise into the electrical system.

Incorrect Control Module

- There are only a few situations where reprogramming a control module is appropriate:
 - A new service control module is installed.
 - A control module from another vehicle is installed.
 - Revised software/calibration files have been released for this vehicle.

NOTE: **DO NOT re-program the control module with the SAME software/calibration files that are already present in the control module. This is not an effective repair for any type of concern.**

- Verify that the control module contains the correct software/calibration. If incorrect programming is found, reprogram the control module with the most current software/calibration. Refer to [Control Module References](#) for replacement, setup, and programming.

BRAKE PEDAL POSITION SENSOR LEARN

Calibration Criteria

NOTE: **Do not apply the brake pedal during the brake pedal position sensor calibration procedure. Any movement of the brake pedal during this procedure will cause the calibration procedure to fail. If this occurs, the brake pedal position sensor calibration must be repeated.**

Brake pedal position sensor calibration must be performed after the brake pedal position sensor, body control module (BCM), or engine control module (ECM) have been serviced. The calibration procedure will set the brake pedal position sensor home value. This value is used by the BCM and ECM to

determine the action of the driver applying the brake system and to provide this information to the vehicle subsystems via serial data.

Calibration Procedure

1. Apply the parking brake.
2. Ignition ON, engine OFF, place the transmission in the PARK position for automatic transmission or NEUTRAL position for manual transmission.
3. Install a scan tool.
4. Clear all DTCs before proceeding.
5. Navigate to the Configuration/Reset Functions menu of the BCM.
6. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.
7. Navigate to the Configuration/Reset Functions menu of the ECM.
8. Select the Learn Functions menu.
9. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.

THROTTLE OR 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 unlearn 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, P0697, P06A3, P06D2, P1248, P1249, P124A, P124B, P1516, P16A0-P16A2, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, or P2322 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, P0697, P06A3, P06D2, P1248, P1249, P124A, P124B, P1516, P16A0-P16A2, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, or P2322 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.

Diagnostic Aids

A un-metered air leak in the induction system or a small vacuum leak may not set a DTC. If the condition goes undetected, the ECM may learn an incorrect Throttle Body Idle Airflow Compensation value over time. The incorrectly learned value may cause various symptoms to occur such as rough or unstable idle speeds, and/or engine stall. If this condition is detected and repaired it will be necessary perform the Idle Learn procedure to ensure any symptoms are corrected.

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, verify the scan tool Throttle Body Idle Airflow Compensation value is equal 0% and the engine is 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 any DTCs are set.

1. Engine idling for 3 min.
2. The ECM will start to learn the new idle cells and the scan tool Desired Idle Speed should start to decrease.
3. Ignition OFF for 60 s.
4. Start and idle the engine for 3 min.
5. Verify the engine is idling normally.
 - If the engine idle is not correct

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.

1. Operate the vehicle at speeds above 70 km/h (44 mph) with several decelerations and extended idles.
2. Verify the engine is idling normally.
 - If the engine idle is not correct.
Ignition OFF for 60 s, repeat step 5.1.
 - If the engine idle is correct.
3. Clear any DTCs and return to the diagnostic that referred you here.
 - If the engine idle is correct
6. Clear any DTCs and return to the diagnostic that referred you here.

CRANKSHAFT POSITION VARIATION LEARN

The Crankshaft Position Variation Learn procedure is required when the following service procedures have been performed, regardless of whether DTC P0315 is set:

- An engine replacement.

- A engine control module (ECM) replacement.
- A crankshaft balancer replacement.
- A crankshaft replacement.
- A crankshaft position sensor replacement.
- Any engine repairs which disturb the crankshaft to crankshaft position sensor relationship.

The ECM monitors certain component signals to determine if all the conditions are met to continue with the Crankshaft Position Variation Learn procedure. The scan tool only displays the condition that inhibits the procedure. The scan tool displays the signals of the components listed below:

- Crankshaft position sensors activity: If there is a crankshaft position sensor condition, refer to the applicable DTC set.
- Camshaft position sensor signal activity: If there is a camshaft position sensor signal condition, refer to the applicable DTC set.
- Engine coolant temperature (ECT): If the engine coolant temperature is not warm enough, idle the engine until the engine coolant temperature reaches the correct temperature.

1. Verify no DTCs are set.

- **If any DTCs other than P0300 - P0308, or P0315 are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .

- **If DTC P0300 - P0308, P0315, or no DTCs are set**

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

2. Engine Running at normal operating temperature, perform the scan tool Crankshaft Position Variation Learn procedure and follow the on screen instructions.

3. Verify the scan tool displays Test Passed Successfully when completed.

- **If Test Passed Successfully is not displayed**

Verify that none of the conditions listed below exist:

- 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.
- Interference in the signal circuit of the crankshaft position sensor.
- Debris between the crankshaft position sensor and the reluctor wheel.
- A damaged or misaligned reluctor wheel.
- Worn crankshaft main bearings.
- Excessive crankshaft runout.
- A damaged crankshaft.
- If a condition is exists, repair or replace as necessary.
- If no conditions exist, replace the K20 Engine Control Module.

- **If Test Passed Successfully is displayed**

4. Clear all DTCs.

5. Engine Running.

6. Verify a DTC is not set.

- **If a DTC is set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .

- **If a DTC is not set**

7. All OK.

Callout	Component Name
1	Electronic Control Module WARNING: Refer to Safety Glasses Warning . CAUTION: Always turn the ignition off when installing or removing the ECM connectors in order to prevent damage to the components. 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. Release the retaining tab. 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.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

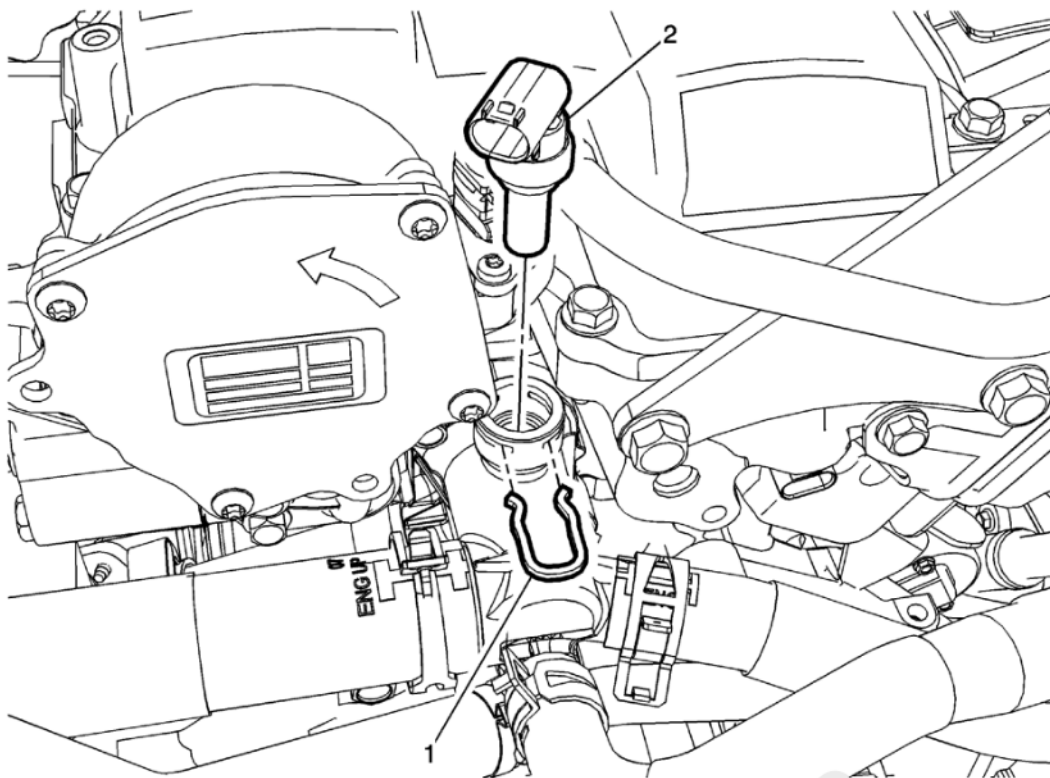


Fig. 10: Engine Coolant Temperature Sensor
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to Cooling System Draining and Filling (Vacuum and Fill) Cooling System Draining and Filling (Static) . 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .	
1	Engine Coolant Temperature Sensor Retaining Clip
2	Engine Coolant Temperature Sensor Procedure 1. Disconnect the engine wiring harness electrical connector from the engine coolant temperature sensor. 2. Remove the engine coolant temperature sensor from the thermostat housing. 3. Install a NEW seal if not replacing the sensor.

ENGINE OIL PRESSURE SENSOR REPLACEMENT

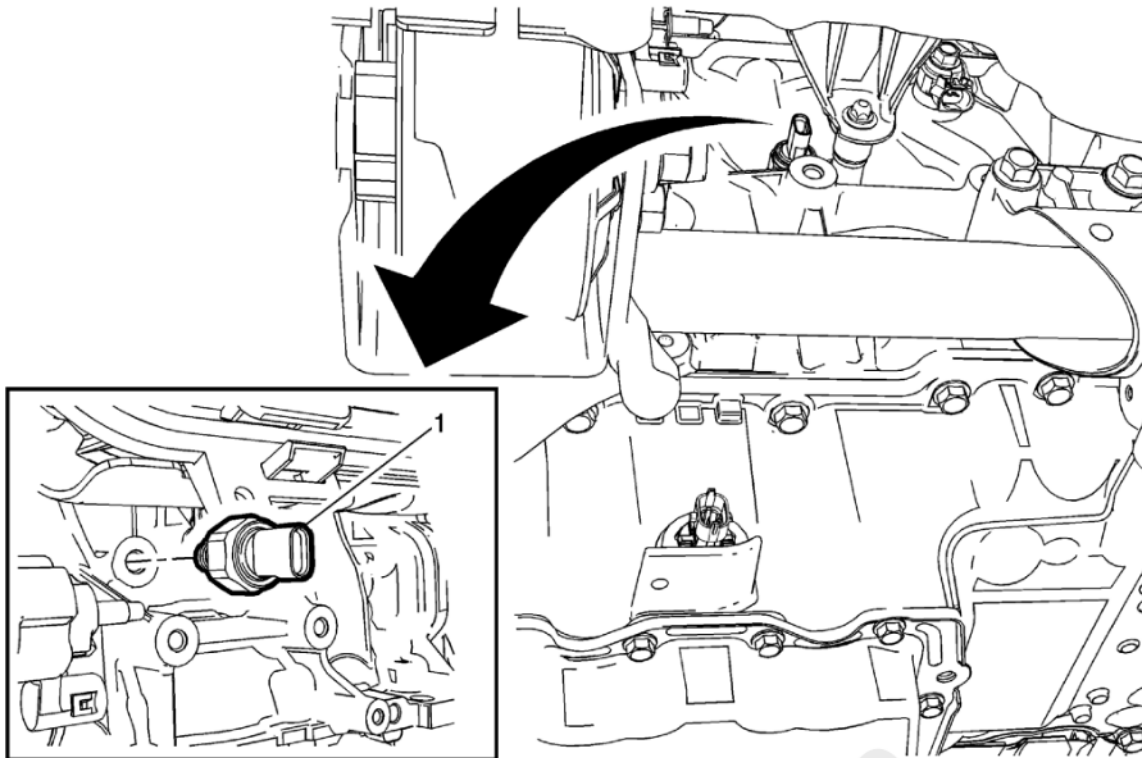


Fig. 11: Engine Oil Pressure Sensor

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Lifting and Jacking the Vehicle	
1	Engine Oil Pressure Sensor CAUTION: Refer to Component Fastener Tightening Caution . Procedure Disconnect the electrical connector. Tighten 35 N.m (26 lb ft)

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

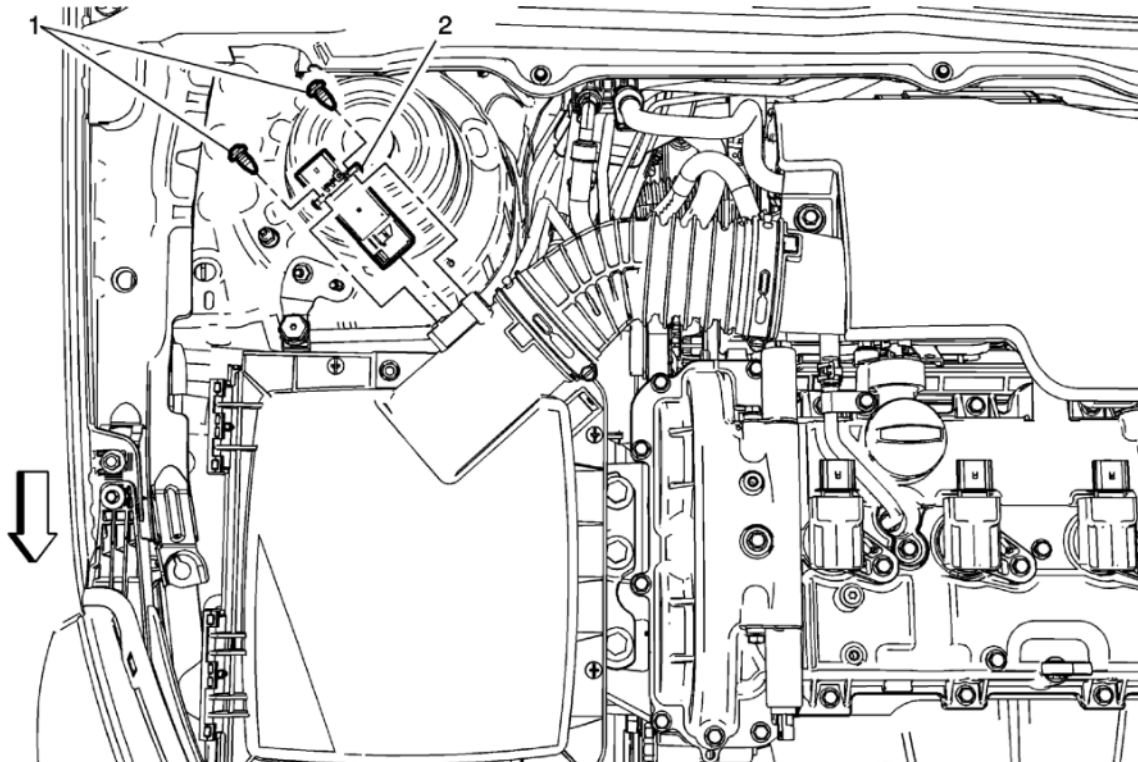


Fig. 12: Mass Airflow Sensor with Intake Air Temperature Sensor (LCV)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Mass Air Flow Sensor Fasteners (Qty: 2) CAUTION: Refer to Fastener Caution .
2	Mass Air Flow Sensor Procedure Disconnect the electrical connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

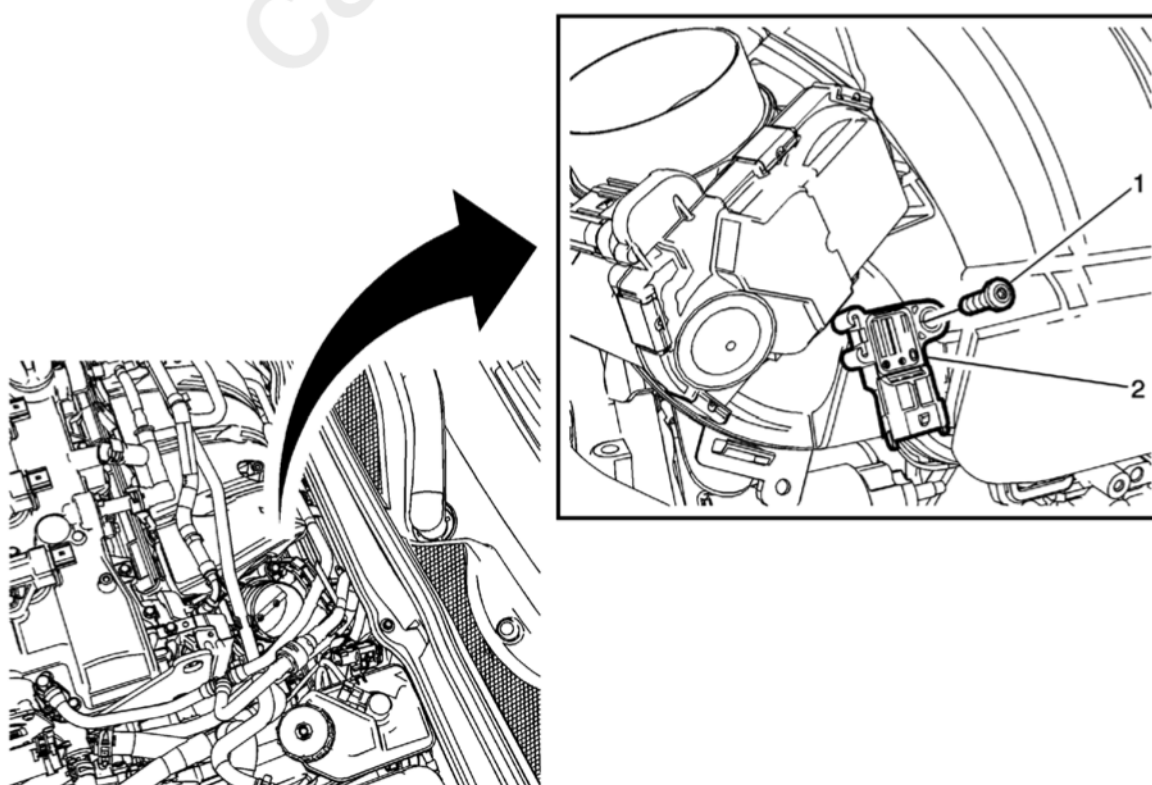


Fig. 13: Manifold Absolute Pressure Sensor
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove Air Cleaner Resonator and Outlet Duct. Refer to Air Cleaner Resonator and Outlet Duct Replacement	
1	Manifold Absolute Pressure Sensor Retaining Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Manifold Absolute Pressure Sensor NOTE: Install a NEW O-ring seal. Procedure 1. Disconnect the engine wiring harness electrical connector from the manifold absolute pressure sensor. 2. Remove the manifold absolute pressure sensor from the intake manifold.

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 1

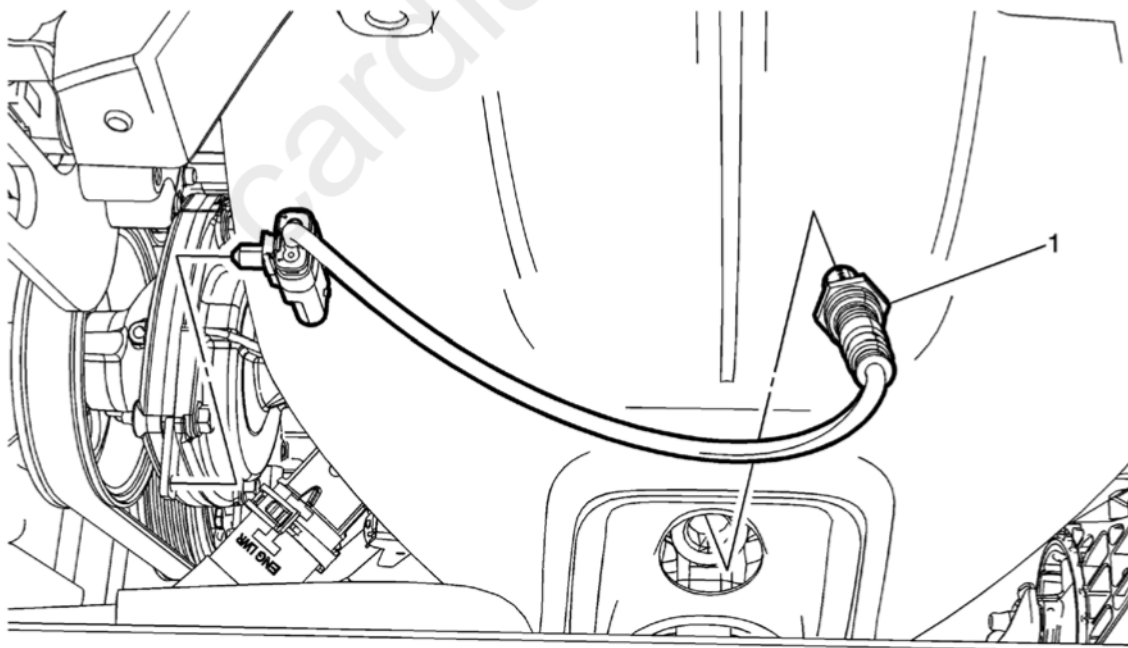


Fig. 14: Heated Oxygen Sensor - Sensor 1 (LCV)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
1	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution . CAUTION: Refer to Component Fastener Tightening Caution . Procedure Disconnect the electrical connector. NOTE: • The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S). • The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F). • A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation. Refer to Adhesives, Fluids, Lubricants, and Sealers . Tighten 42 N.m (31 lb ft) Special Tools J 39194 Oxygen Sensor Wrench For equivalent regional tools, refer to Special Tools .

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 2

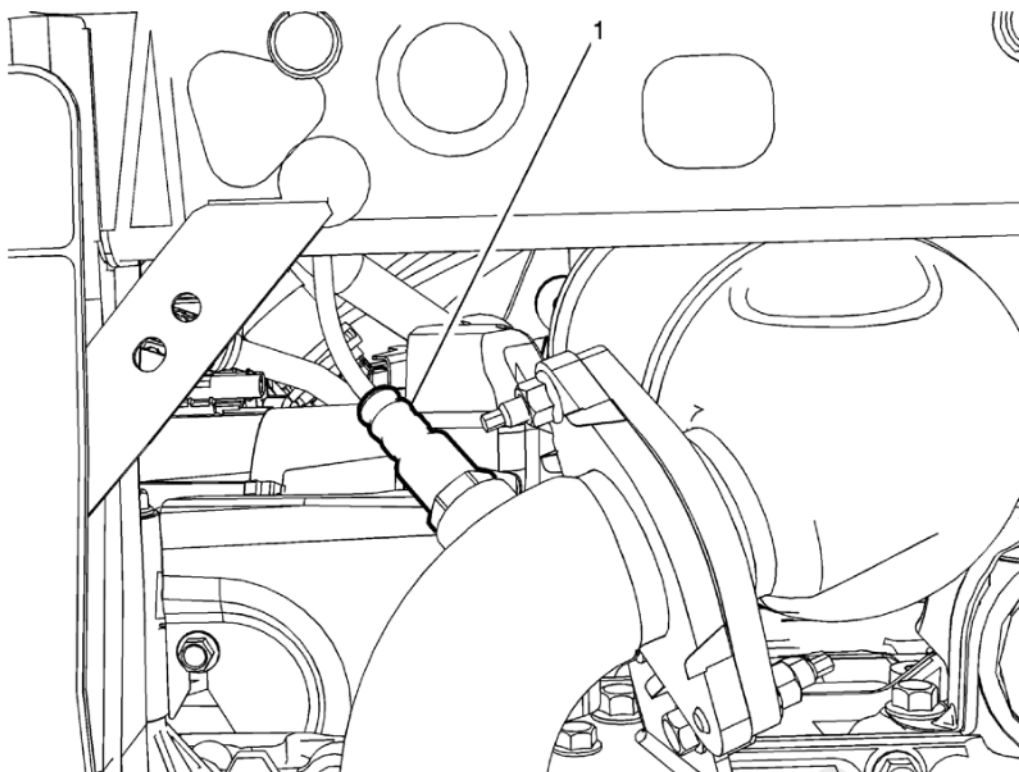


Fig. 15: Heated Oxygen Sensor - Sensor 2 (LCV)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and properly support the vehicle. Refer to Lifting and Jacking the Vehicle .	

Callout	Component Name
1	Heated Oxygen Sensor CAUTION: The oxygen sensor uses a permanently attached pigtail and connector. Do not remove the pigtail from the oxygen sensor. Damage to or removal of the pigtail connector could affect proper operation of the oxygen sensor. CAUTION: The use of excessive force may damage the threads in the exhaust manifold/pipe. CAUTION: Refer to Heated Oxygen Sensor Resistance Learn Reset Caution . CAUTION: Refer to Component Fastener Tightening Caution . Procedure Disconnect the electrical connector. NOTE: • The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S). • The HO2S may be difficult to remove when the engine temperature is less than 48°C (120°F). • A special anti-seize compound is used on the HO2S threads. The compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or service sensors will have the compound applied to the threads. If a sensor is removed and is to be reinstalled, the threads must have an anti-seize compound applied before installation. Refer to Adhesives, Fluids, Lubricants, and Sealers . Tighten 42 N.m (31 lb ft) Special Tools J 39194 Oxygen Sensor Wrench For equivalent regional tools, refer to Special Tools .

ACCELERATOR PEDAL WITH POSITION SENSOR ASSEMBLY REPLACEMENT

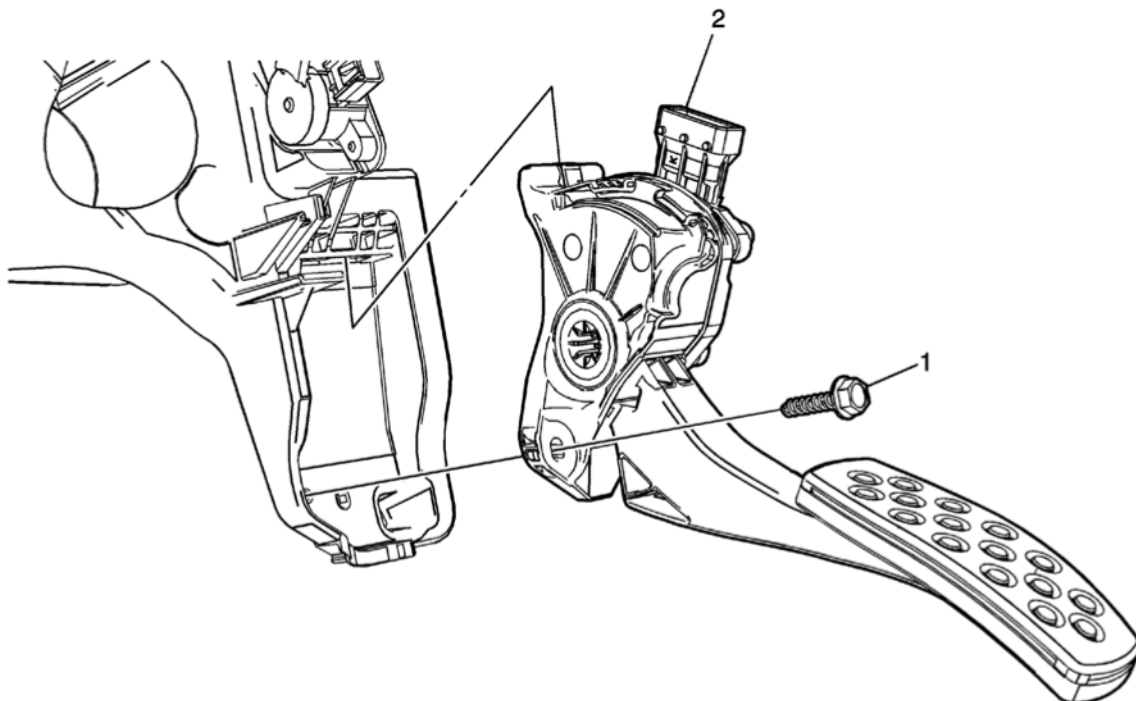


Fig. 16: Identifying Accelerator Pedal With Position Sensor Assembly
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Accelerator Pedal Position Sensor Bolt CAUTION: Refer to Fastener Caution Tighten 9 N.m (80 lb in)
2	Accelerator Pedal Position Sensor Procedure Disconnect the accelerator pedal position sensor harness.

THROTTLE BODY ASSEMBLY REPLACEMENT

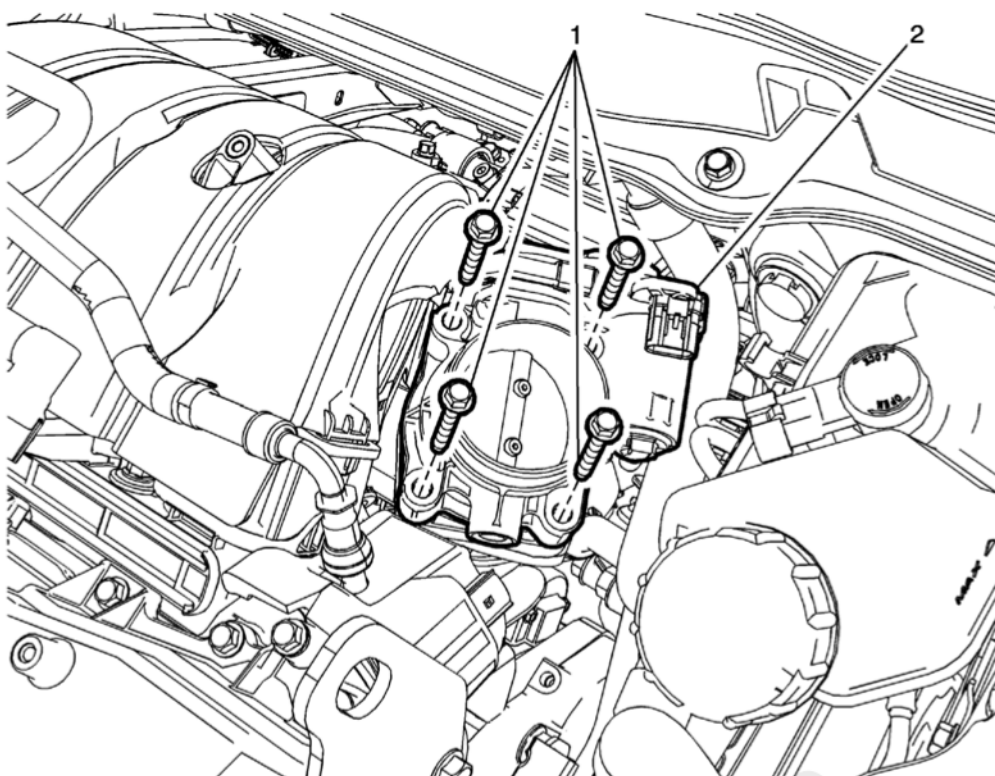


Fig. 17: Throttle Body Assembly

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
CAUTION: Do not use solvent of any type when cleaning the gasket surfaces on the intake manifold and the throttle body assembly, as damage to the gasket surfaces and throttle body assembly may result. Use care in cleaning the gasket surfaces on the intake manifold and the throttle body assembly, as sharp tools may damage the gasket surfaces. CAUTION: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components. 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). Preliminary Procedure Air Cleaner Resonator and Outlet Duct Replacement	
1	Throttle Body Assembly Fasteners (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)

Callout	Component Name
2	Throttle Body Assembly Procedure 1. Disconnect the engine wiring harness electrical connector from the throttle body assembly. 2. Inspect the throttle body gasket, and replace if necessary. 3. Perform the throttle learn procedure. Refer to Throttle or Idle Learn.

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 and approved cleaner.
4. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
5. Perform the Throttle/Idle Learn Procedure. Refer to [Throttle or 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

- J 34730-1A Fuel Pressure Gauge
- CH-37287 - 1A Fuel Pressure Gauge Adapter

For equivalent regional tools, refer to [Special Tools](#).

Installation Procedure

WARNING: Fuel/gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in

an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

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.

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

1. Relieve the fuel pressure. Refer to [Fuel Pressure Relief](#).
2. Disconnect the quick connect coupling of the fuel feed hose from the fuel feed pipe of the fuel rail. Use a shop towel in order to catch any remaining fuel that may leak. Refer to [Metal Collar Quick Connect Fitting Service](#).
3. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
4. Install the CH-37287 - 1A adapter between the fuel feed pipe of the fuel rail and of the fuel feed hose.

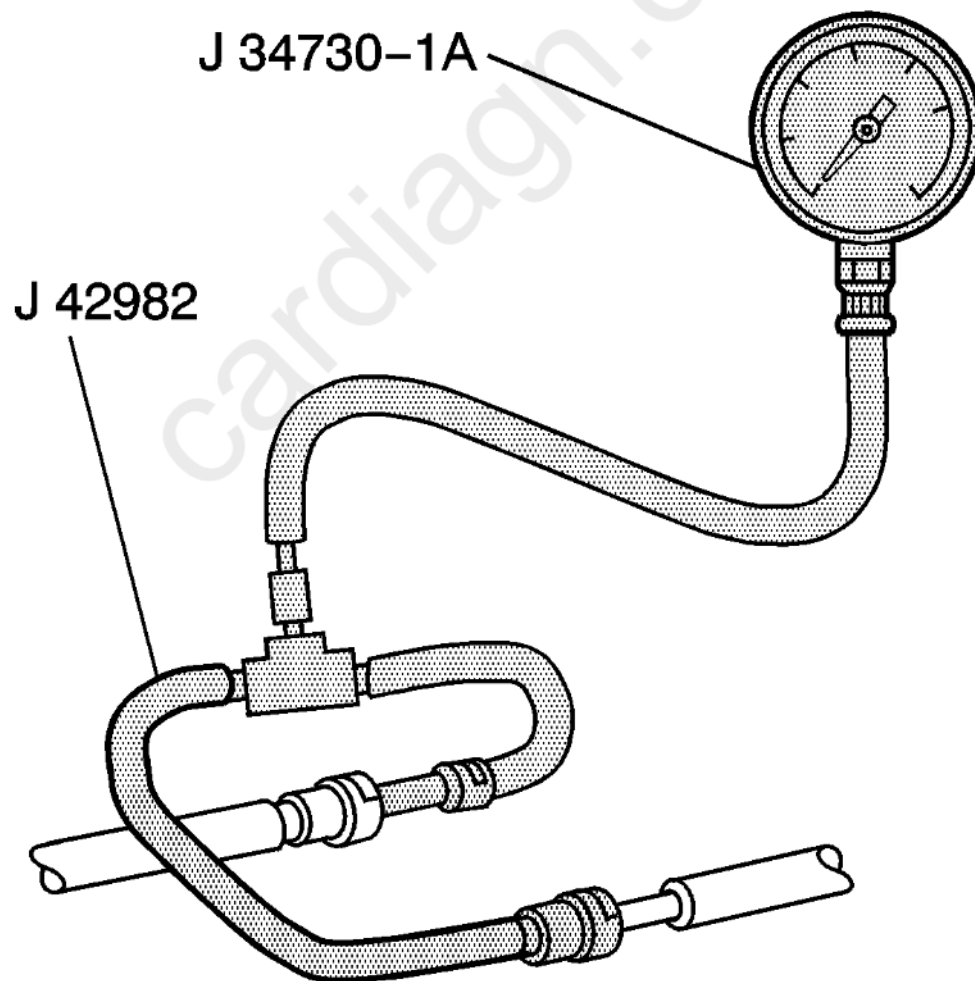


Fig. 18: Fuel Pressure Gauge
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#).

5. Install the **J 34730-1A** gauge to the **CH-37287 - 1A** adapter, and tighten securely.
6. Turn ON the ignition in order to pressurize the fuel system.
7. Turn OFF the ignition.
8. Check for any fuel leaks.

Removal Procedure

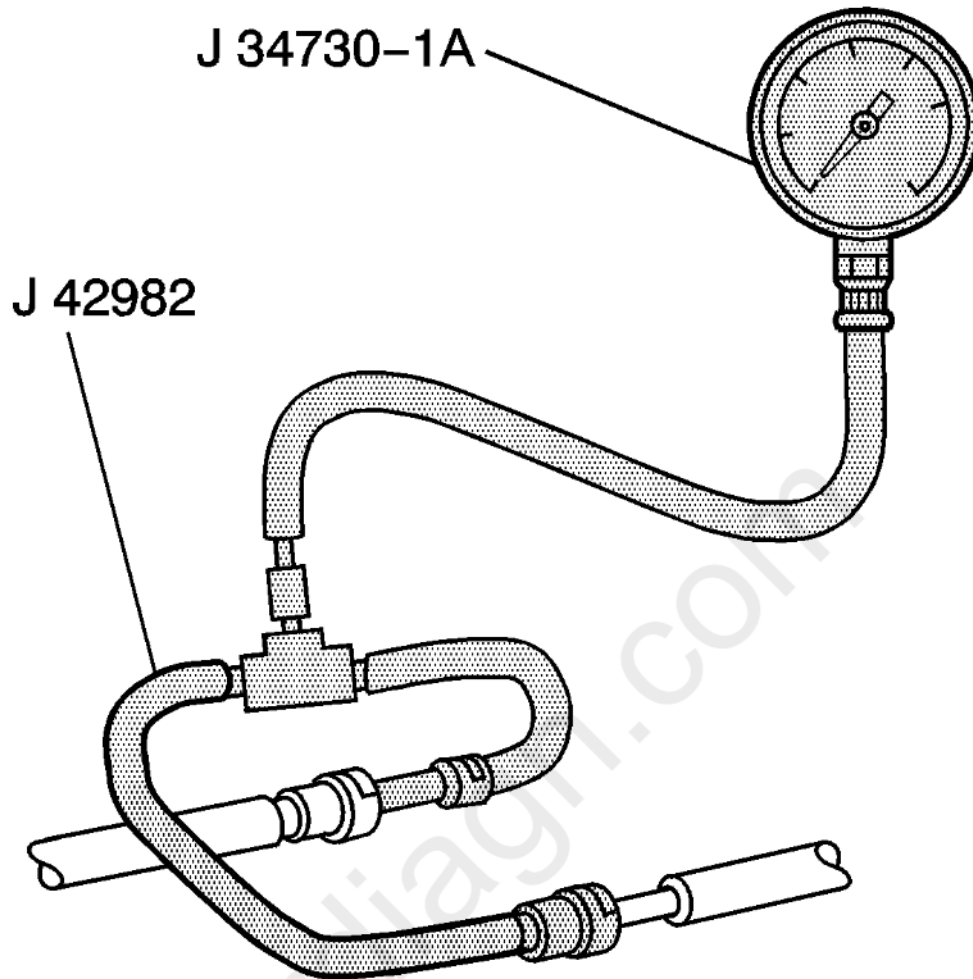


Fig. 19: Fuel Pressure Gauge

Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel pressure. Refer to the [Fuel Pressure Relief](#).
2. Remove the **J 34730-1A** gauge from the **CH-37287 - 1A** adapter.
3. Disconnect the quick connect couplings of the **CH-37287 - 1A** Fuel Pressure Gauge Adapter. Use a shop towel in order to catch any remaining fuel that may leak. Refer to [Metal Collar Quick Connect Fitting Service](#).
4. Connect the quick-connect fitting of the fuel feed hose to the fuel feed pipe of the fuel rail.
5. Turn ON the ignition in order to pressurize the fuel system.
6. Turn OFF the ignition.
7. Check for any fuel leaks.
8. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

- **CH-41769** Fuel Line Disconnect Tool Set
- **CH-44581** Fuel Line Disconnect Tool

For equivalent regional tools, refer to [Special Tools](#).

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#).

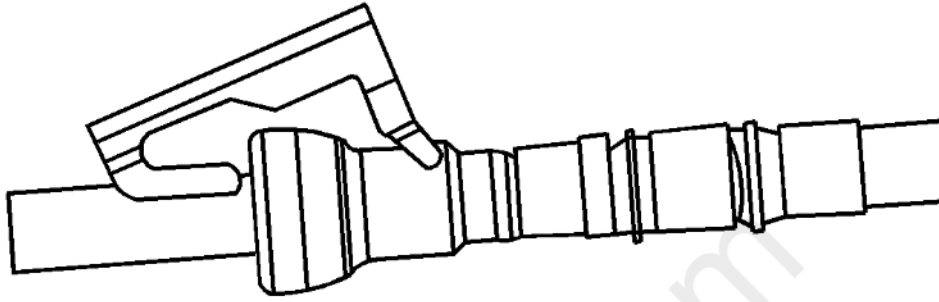


Fig. 20: Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Remove the retainer from the quick-connect fitting.

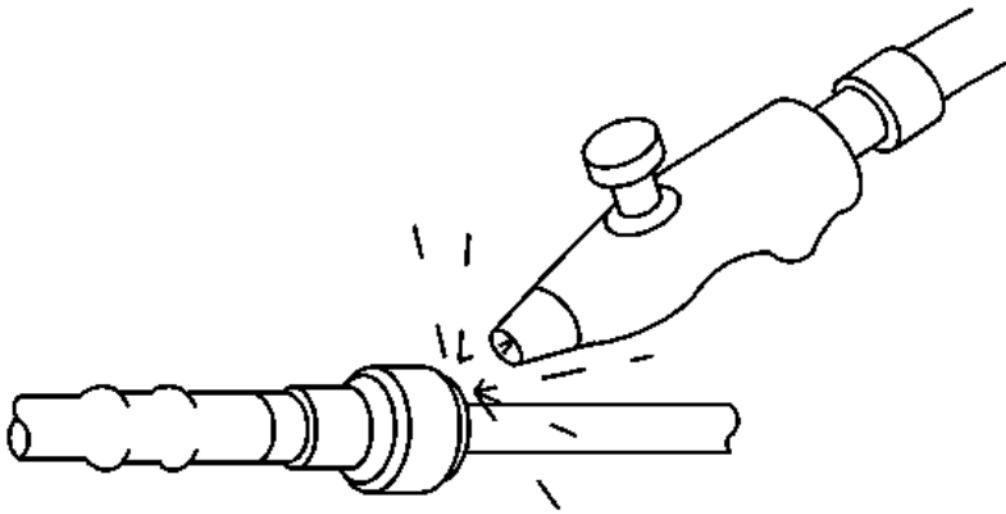


Fig. 21: Blowing Dirt Out Of Fitting.(Metal Collar)

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.

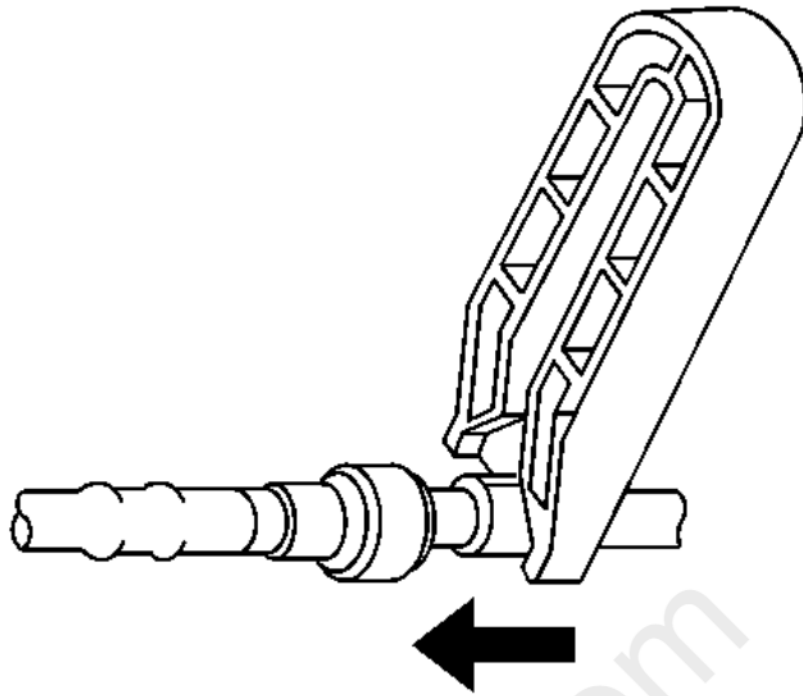


Fig. 22: Releasing Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

4. Depending on the fuel line size and ability to access the fitting, choose the appropriate tool: **CH-41769** fuel line disconnect tool set or **CH-44581** fuel line disconnect tool. Insert the **CH-41769** fuel line disconnect tool set or **CH-44581** fuel line disconnect tool into the female connector, then push inward to release the locking tabs.

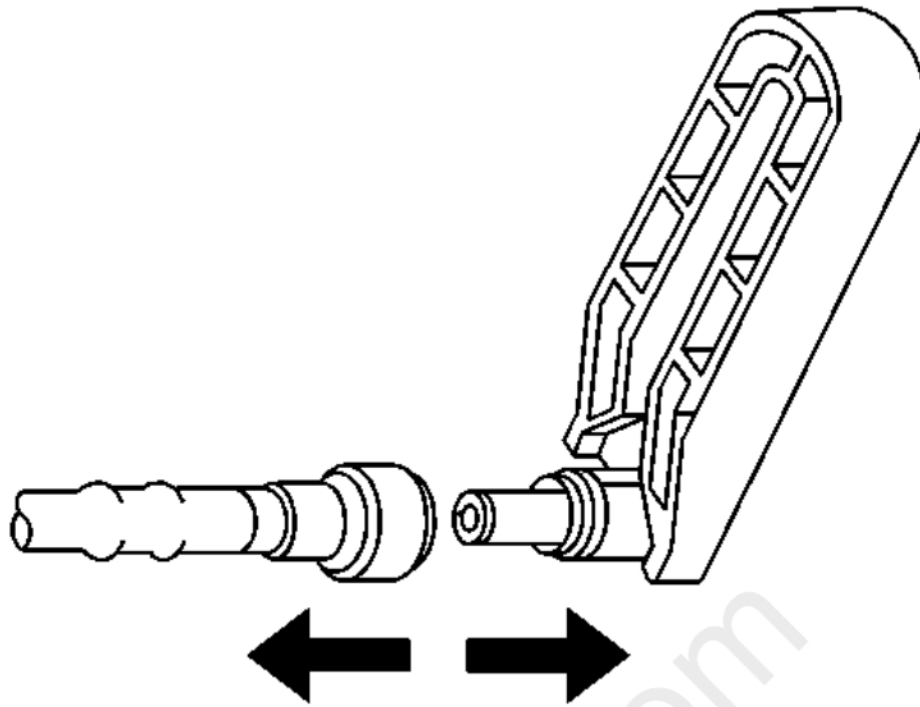


Fig. 23: Pulling Connection Apart (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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. Using a clean shop towel, wipe off the male pipe end.

7. Inspect both ends of the fitting for dirt and burrs.

8. Clean or replace the components as required.

Installation Procedure

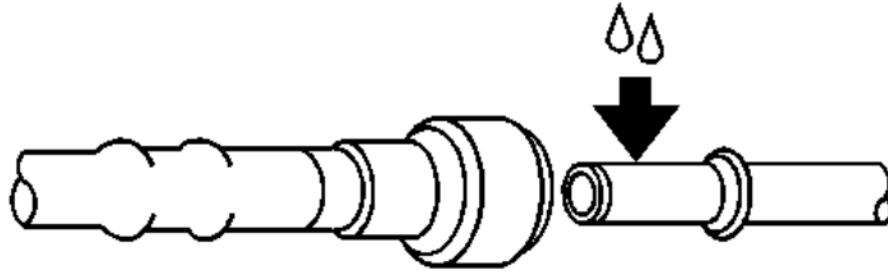


Fig. 24: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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.

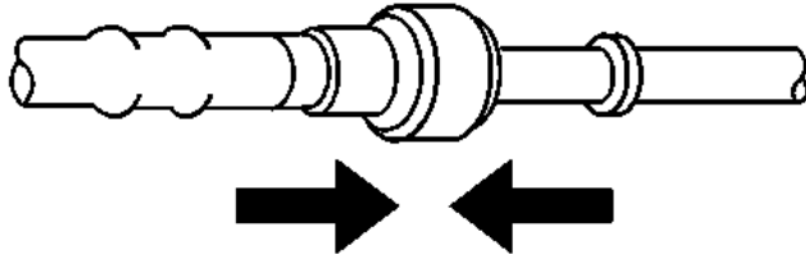


Fig. 25: Pushing Connectors Together (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together to cause the retaining tabs to snap into place.

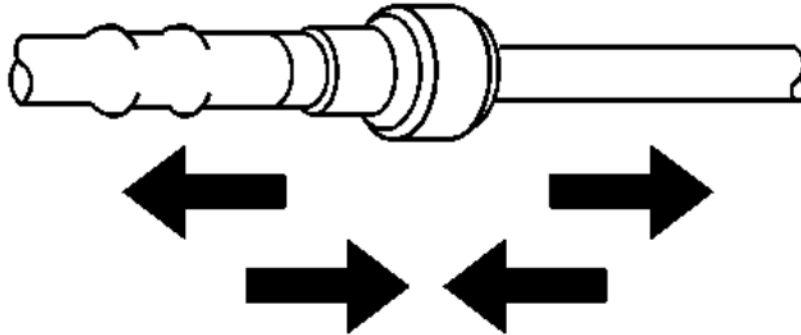


Fig. 26: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

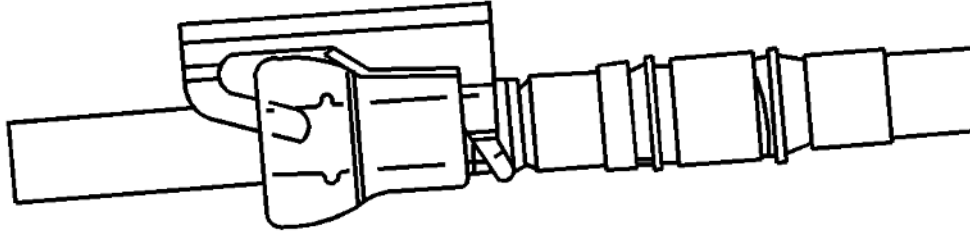


Fig. 27: Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install the retainer to the quick-connect fitting.
5. Inspect for leaks using the following procedure:
 1. Turn the ignition ON, with the engine OFF for 2 seconds.
 2. Turn the ignition OFF, for 10 seconds.
 3. Turn the ignition ON, with the engine OFF for 2 seconds.
 4. Turn the ignition OFF.
 5. Inspect for leaks.

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Removal Procedure

WARNING: Refer to [Gasoline/Gasoline Vapors Warning](#) .

NOTE: If servicing a fuel system, insure the fuel pressure has been relieved.

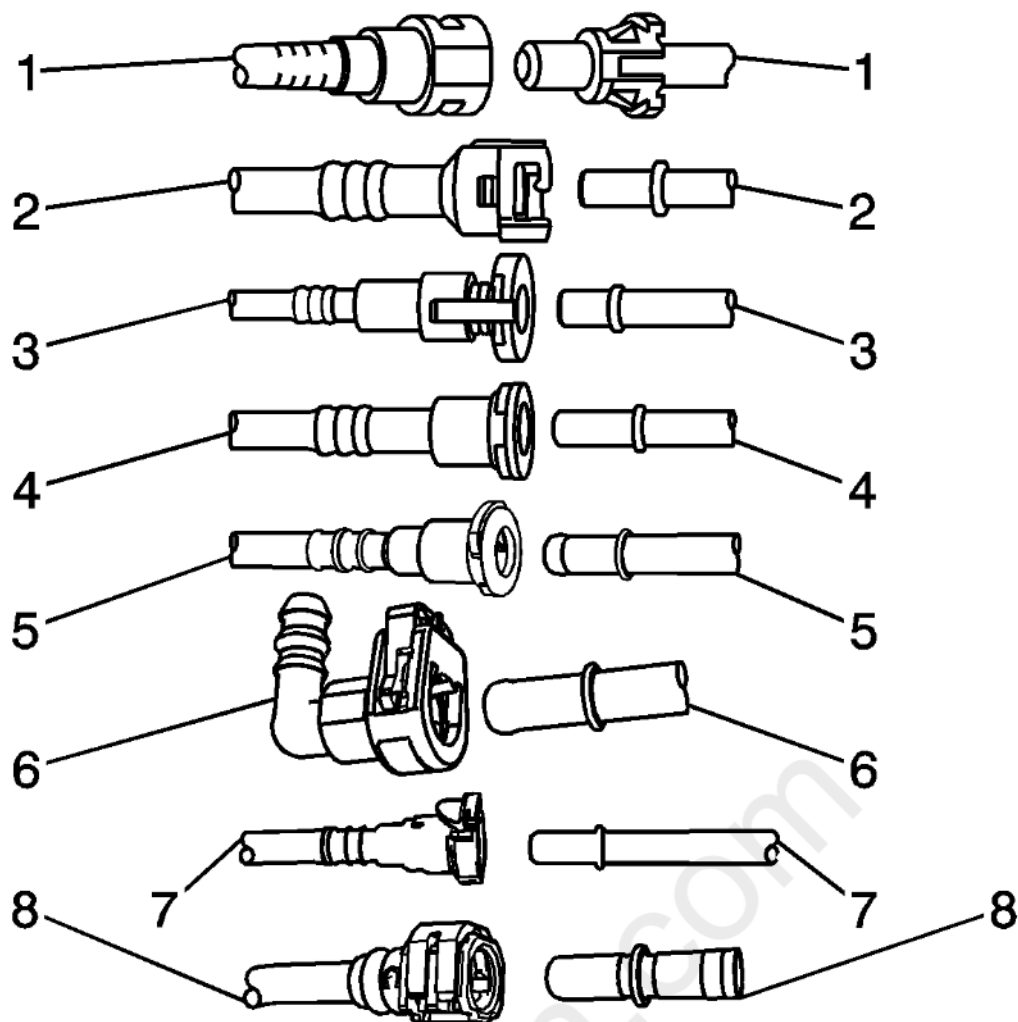


Fig. 28: Identifying Plastic Collar Quick Connect Fitting Types

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.

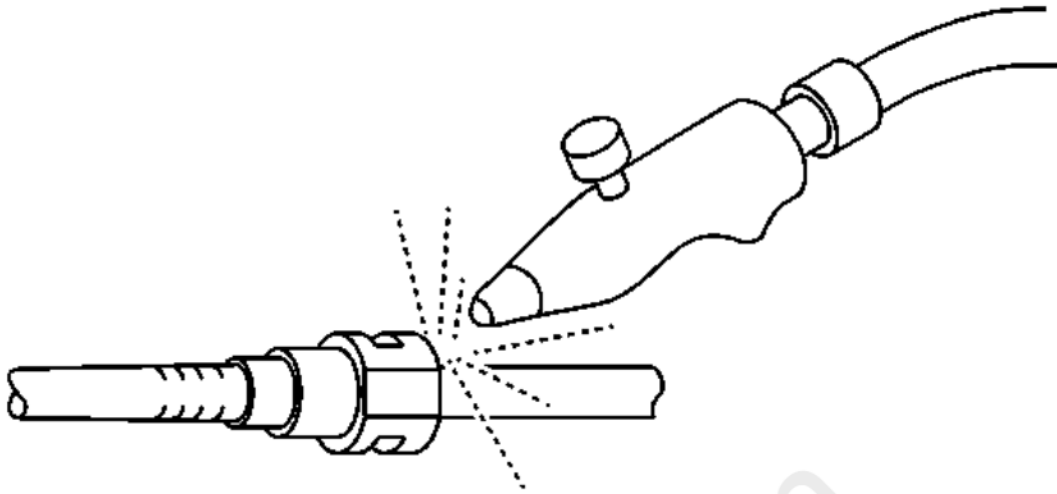


Fig. 29: Blowing Dirt Out Of Fitting (Plastic Collar)

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.

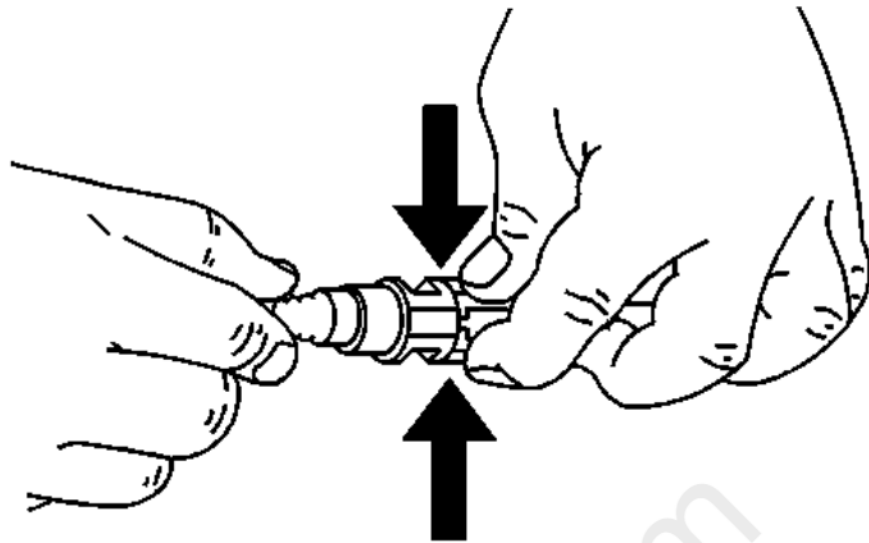


Fig. 30: Squeezing Quick Connect Fitting Release Tabs (Plastic Collar)

Courtesy of GENERAL MOTORS COMPANY

2. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick-connect fitting release tabs.

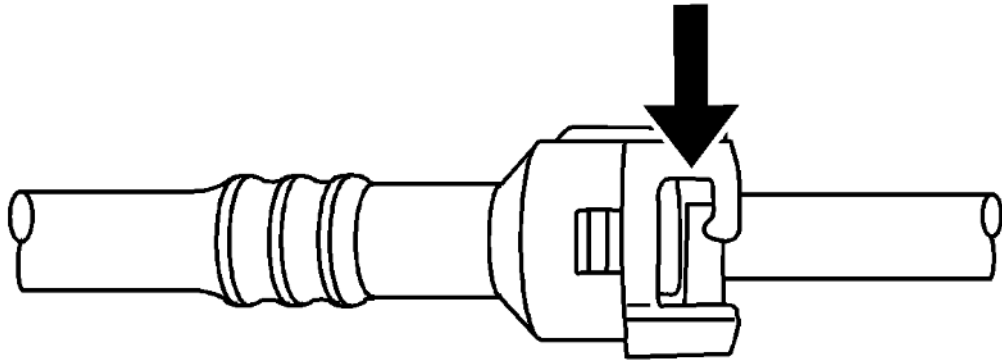


Fig. 31: Q Release Style Connector (Plastic Collar)

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.

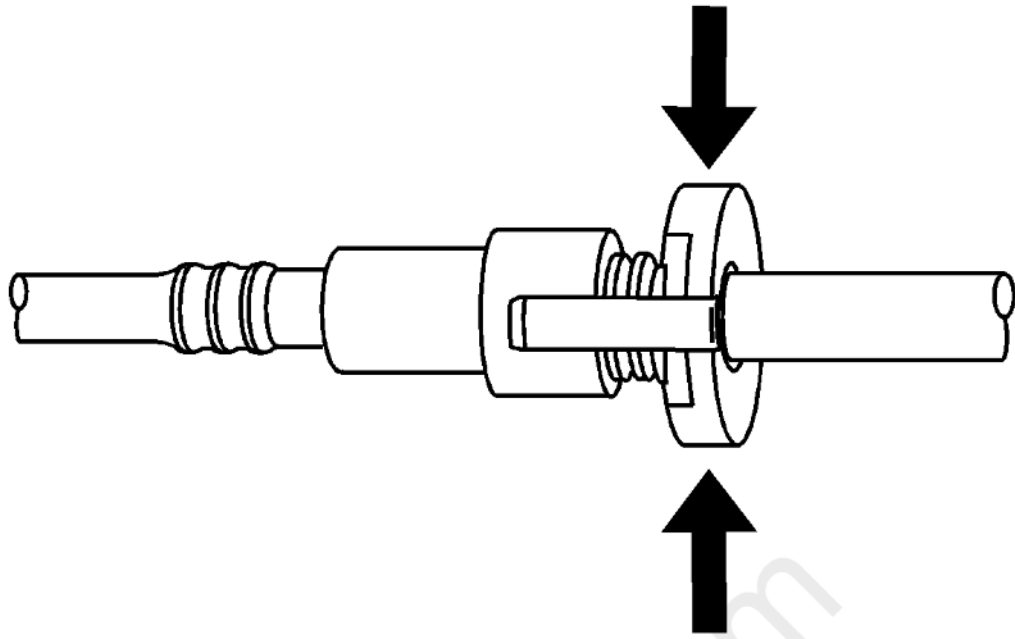


Fig. 32: Squeeze To Release Quick Connect Fitting (Plastic Collar)

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.

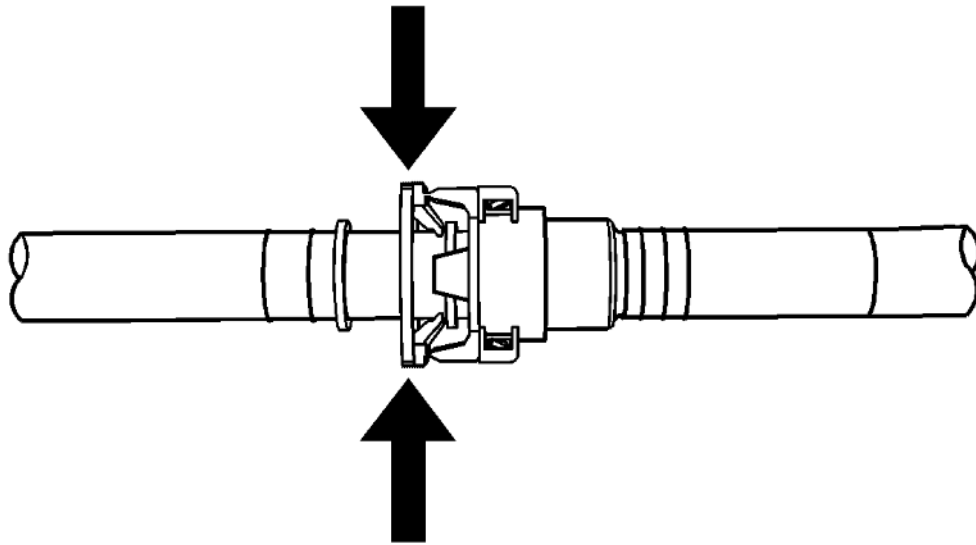


Fig. 33: Pushing In Male Side Of Connector - Squeeze To Release
 Courtesy of GENERAL MOTORS COMPANY

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.

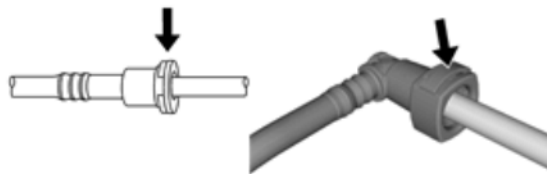


Fig. 34: Identifying Variants Of Sliding Retainer Style Connectors
 Courtesy of GENERAL MOTORS COMPANY

NOTE: There are two variants of sliding retainer style connectors shown above, both have the same release and installation procedure.

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.

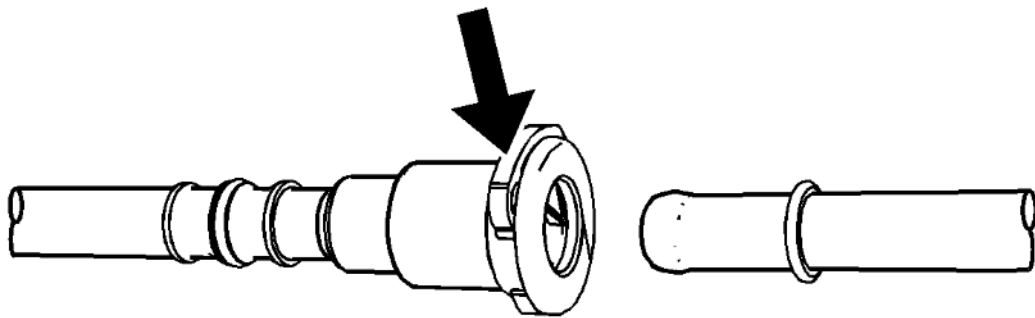


Fig. 35: Global Connector Style

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.

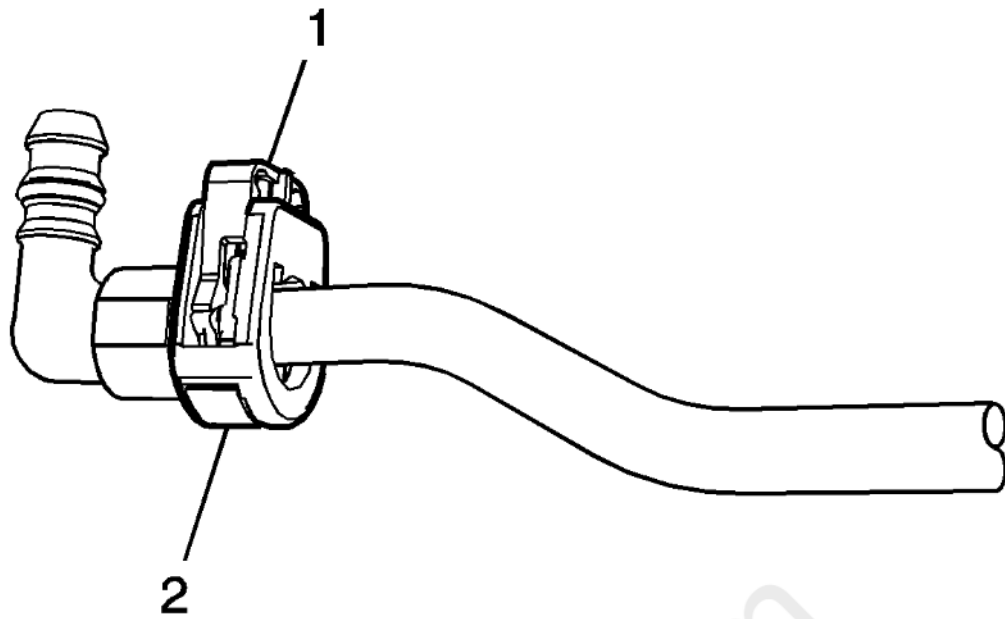


Fig. 36: Redundant Latch And Release Mechanism - TI Loc Style
Courtesy of GENERAL MOTORS COMPANY

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.

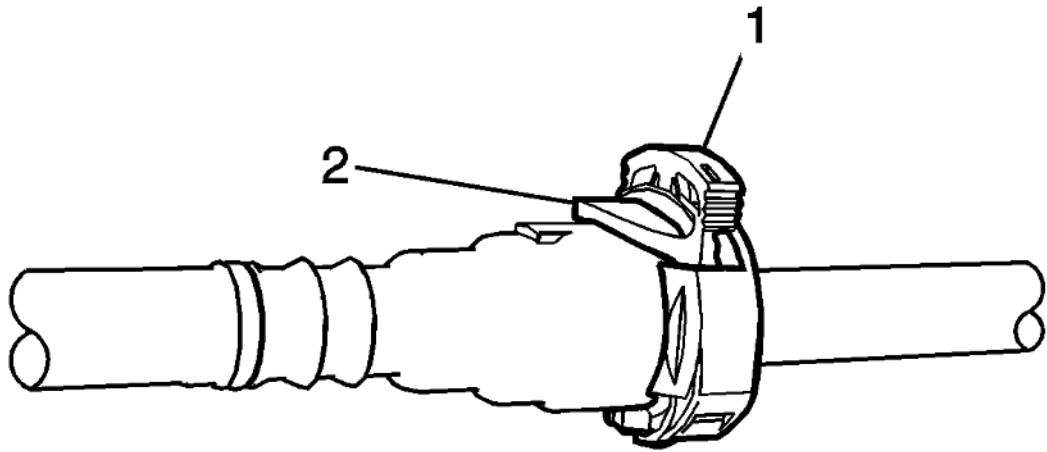


Fig. 37: Second Latch And Release Mechanism - Safe Lock Style
Courtesy of GENERAL MOTORS COMPANY

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.

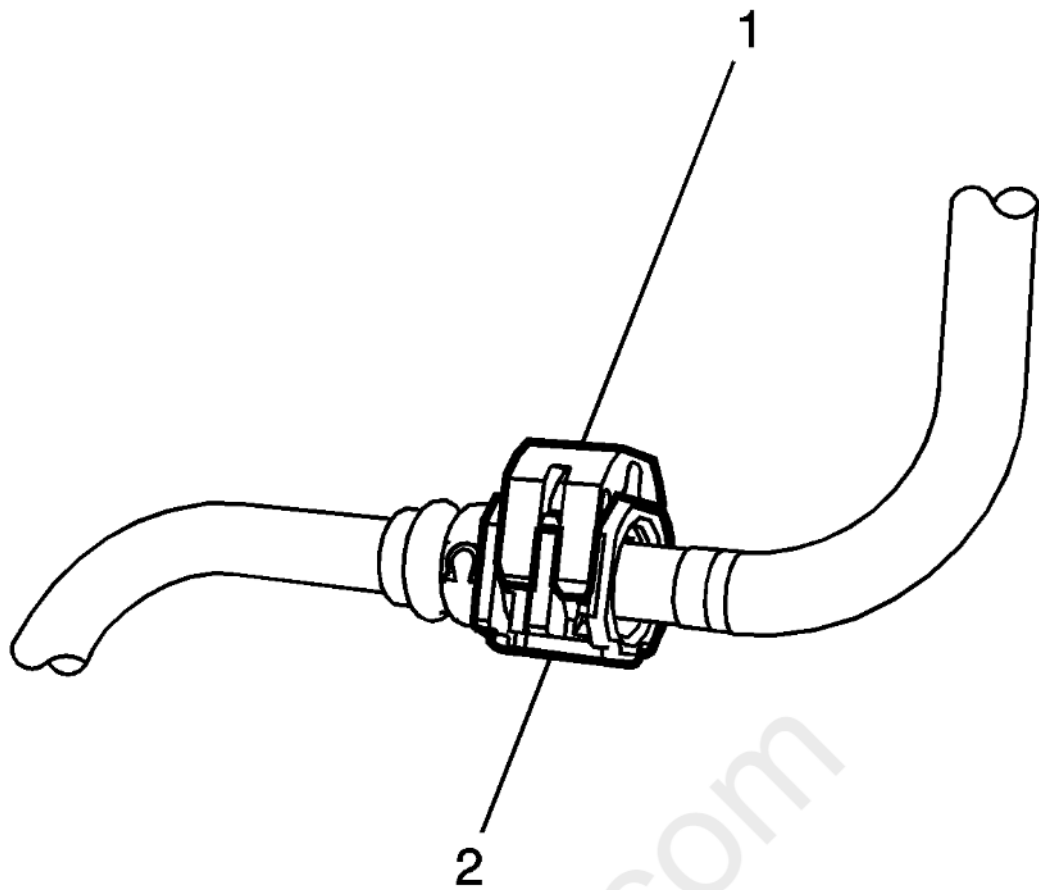


Fig. 38: Latch And Connector - Plastic Connector Style 8

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

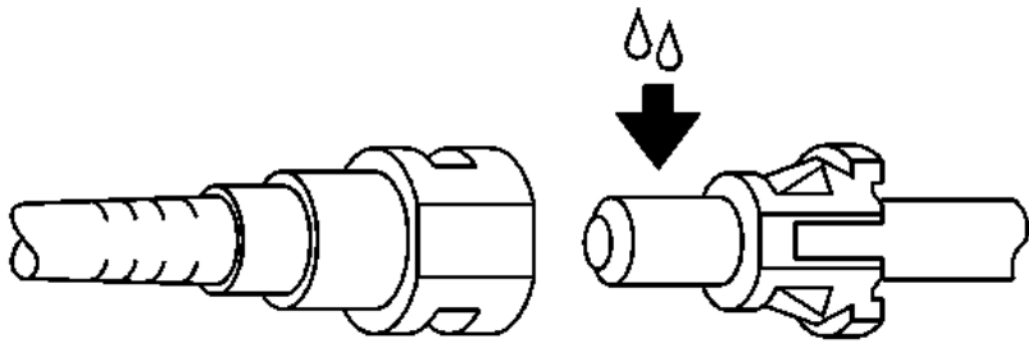


Fig. 39: Lubricating Male Pipe End

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.

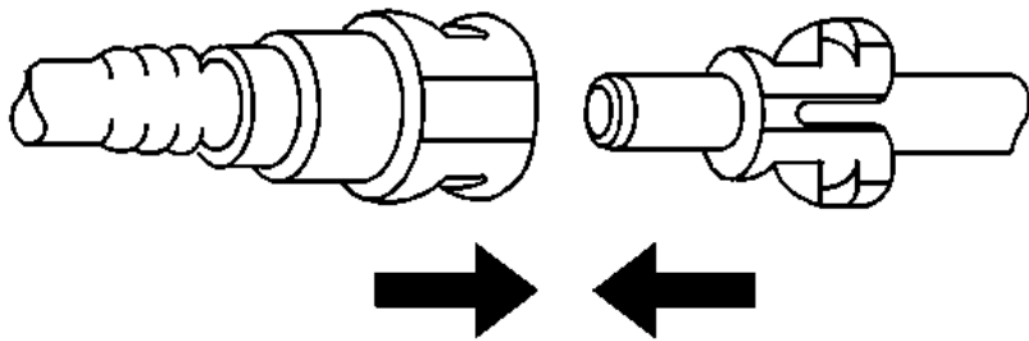


Fig. 40: Connecting Quick-Connect Fittings (Plastic Collar)

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.

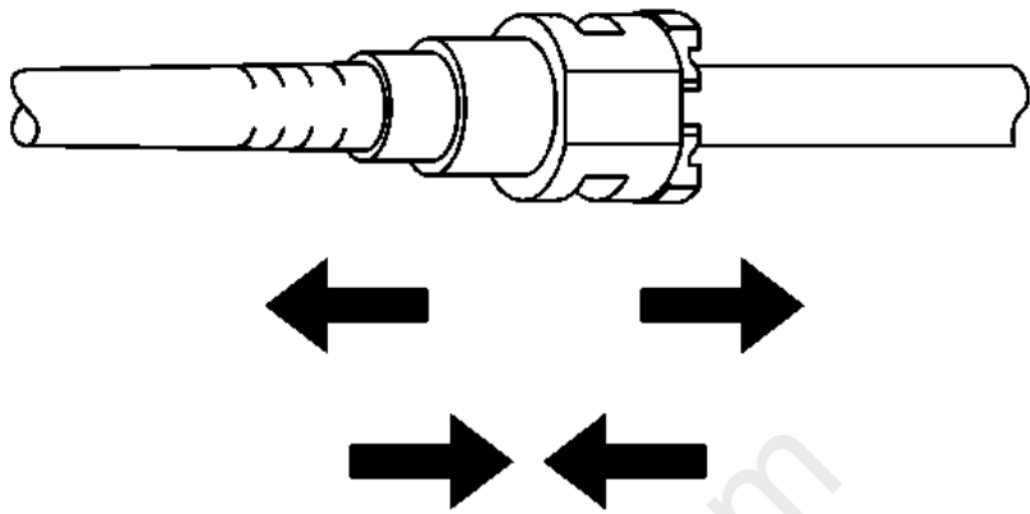


Fig. 41: Ensuring Secure Connection (Plastic Collar)

Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

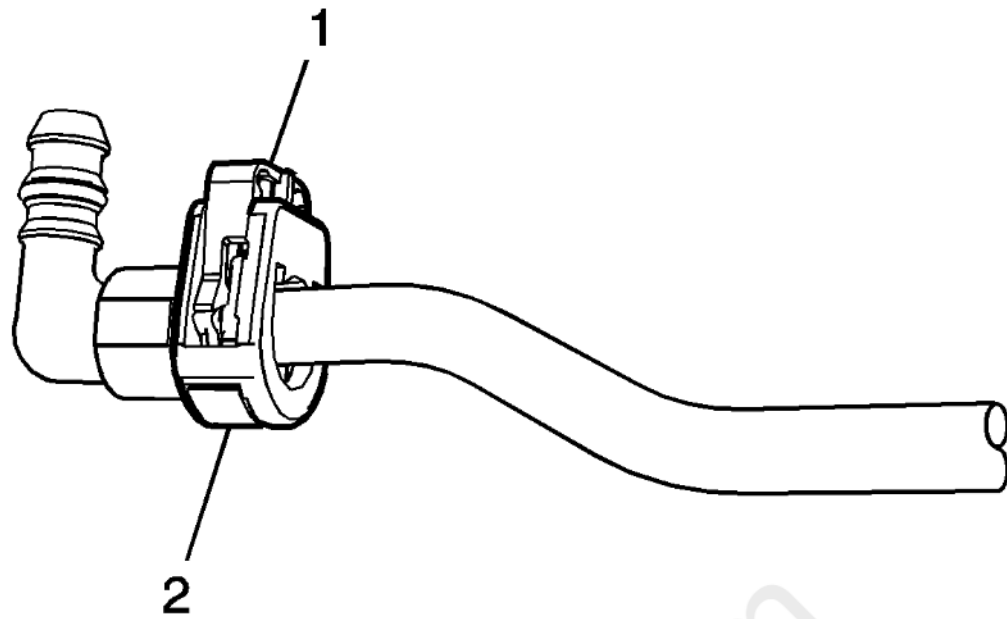


Fig. 42: Redundant Latch And Release Mechanism - TI Loc Style
Courtesy of GENERAL MOTORS COMPANY

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.

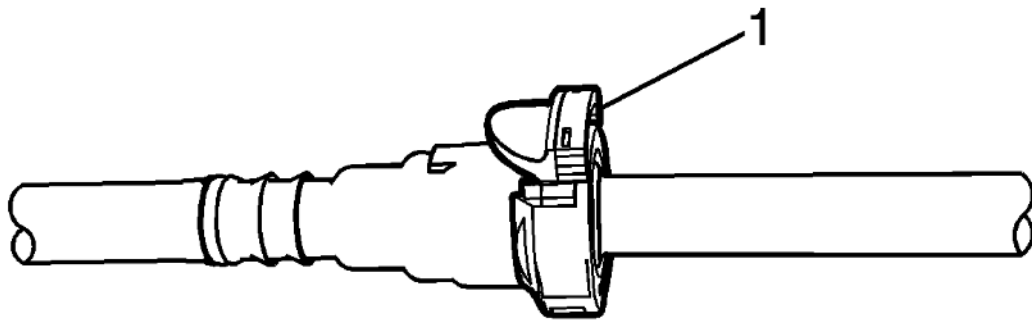


Fig. 43: Second Latch - Safe Lock Style

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.

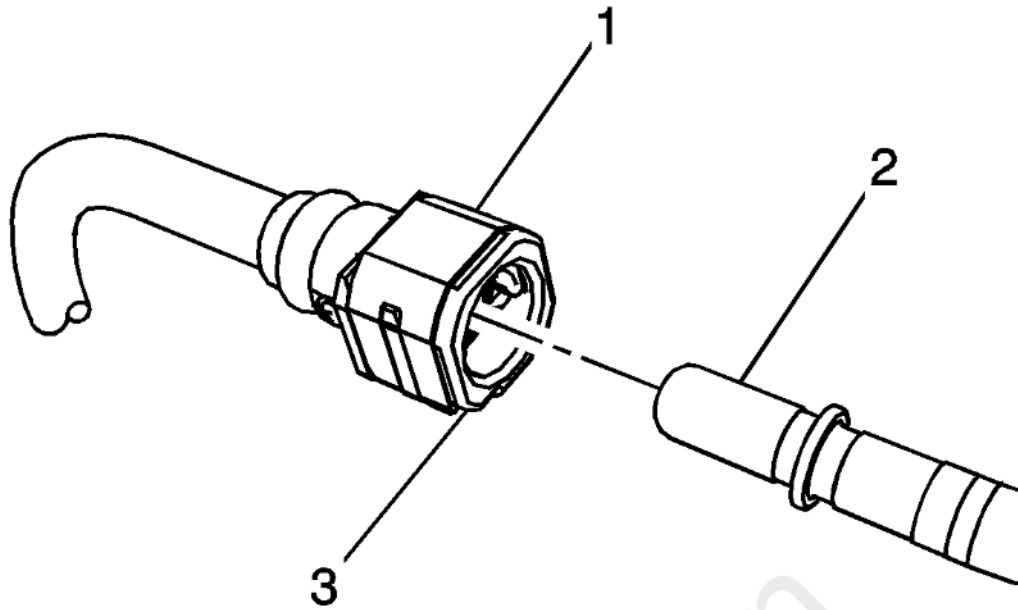


Fig. 44: Latch And Connector - Plastic Connector Type 8

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

- DT 36850 Transjel Lubricant
- CH 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](#)

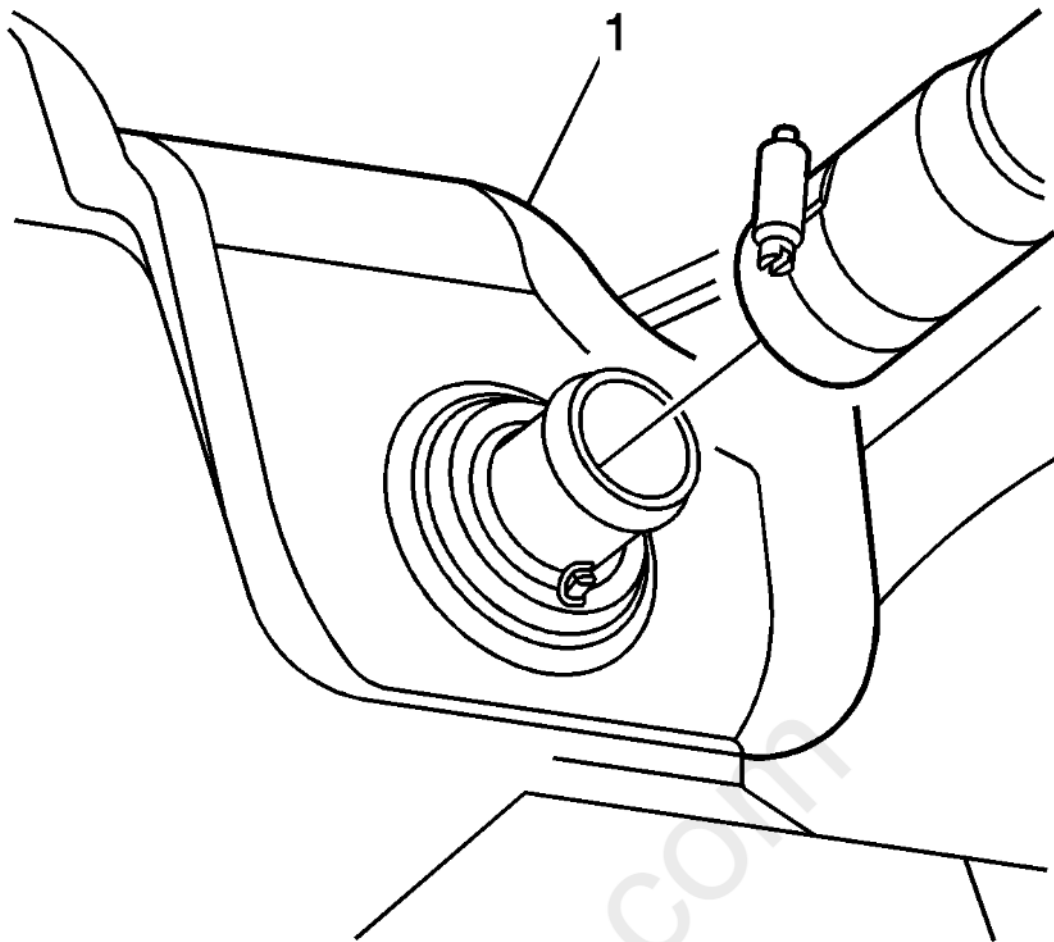


Fig. 45: Fuel Tank, Fill Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

NOTE: Lubricate the fuel drain hose with DT 36850 Transjel Lubricant or equivalent to aid in hose insertion. Do not use an unapproved lubricant.

2. Loosen the lower fuel tank filler hose clamp in order to separate the filler hose from the fuel tank (1).
3. Insert the **CH 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

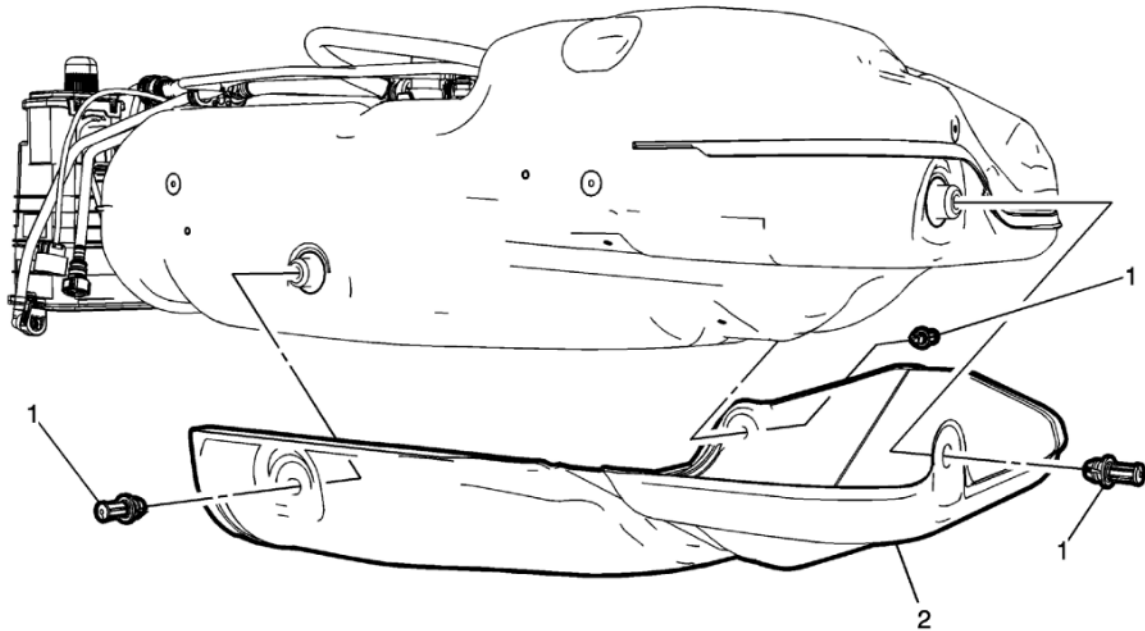


Fig. 46: Fuel Tank Protector & Retainers
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove the left fuel tank strap. Refer to Fuel Tank Replacement .	
1	Fuel Tank Protector Retainers (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.
- When performing work in the engine compartment or under the vehicle, ensure that the hood is fully open, or opened to its secondary latch. When the hood is opened to the secondary latch, the vehicle will disable the remote start features from the key fob and OnStar mobile app. Failure to open the hood, or open the hood to the secondary latch while doing a repair in the engine compartment or under the vehicle can result in inadvertent vehicle starting which could result in personal injury or damage to a vehicle.

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](#).
3. Remove the exhaust muffler. Refer to [Exhaust Muffler with Resonator, Exhaust, and Tail Pipe Replacement](#) .

4. Remove the left and right side rear air deflectors. Refer to [Underbody Rear Air Deflector Replacement - Left Side](#) , and [Underbody Rear Air Deflector Replacement - Right Side](#) .

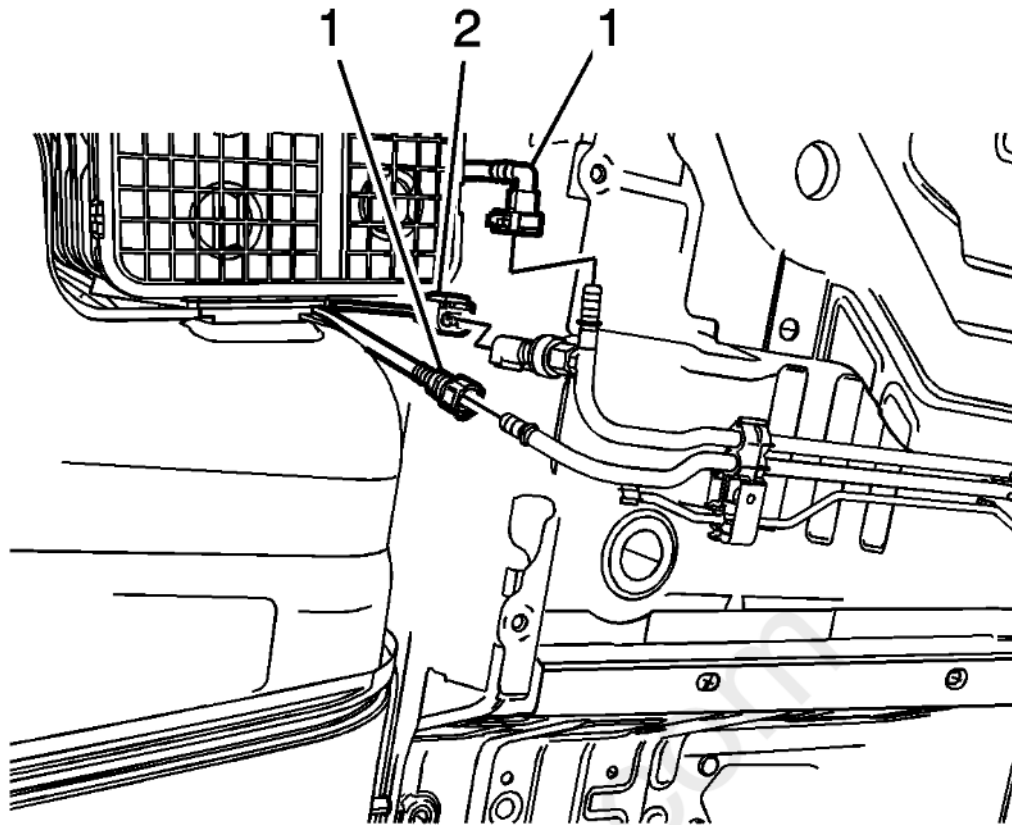


Fig. 47: Evaporative Emission, Fuel Pipes And Fuel Pressure Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the evaporative emission and fuel pipes (1). Refer to [Plastic Collar Quick Connect Fitting Service](#).
6. Disconnect the fuel pressure sensor electrical connector (2).

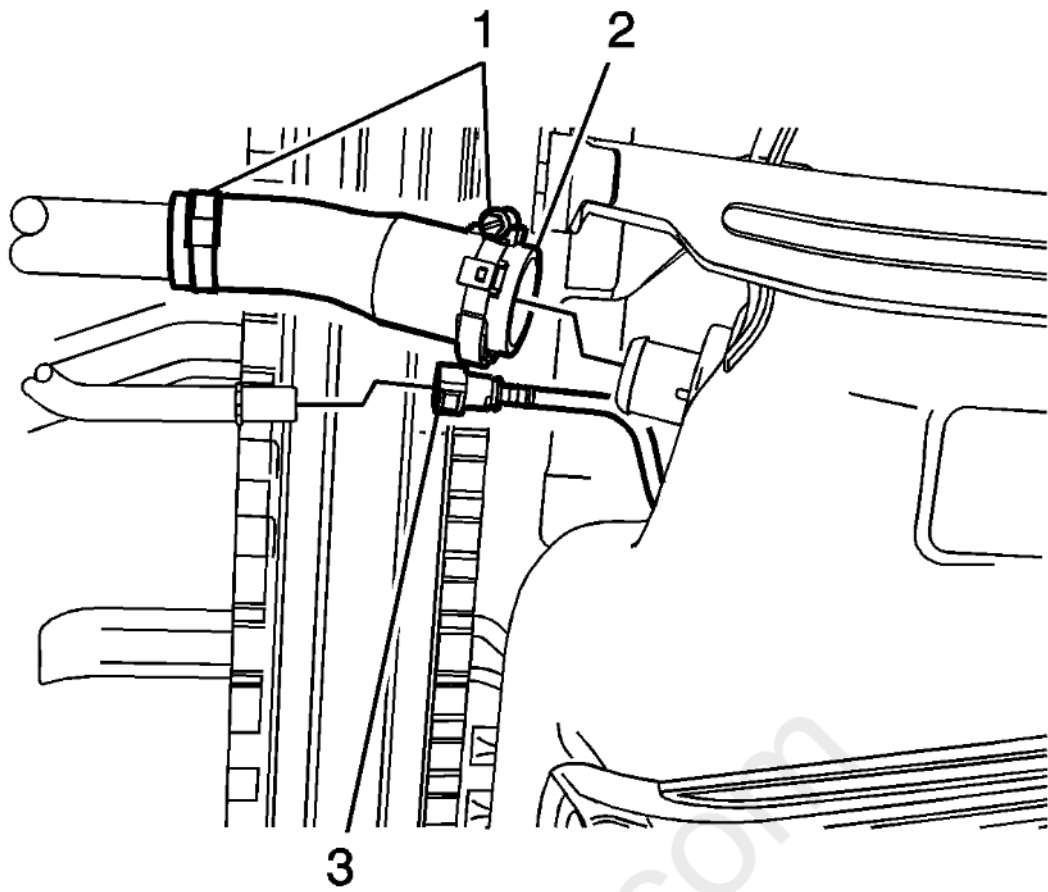


Fig. 48: Hose Clamps, Filler Tube And Evaporative Emission Line
Courtesy of GENERAL MOTORS COMPANY

7. Loosen the hose clamps (1) and remove the filler tube (2).
8. Disconnect the evaporative emission line (3). Refer to [**Plastic Collar Quick Connect Fitting Service**](#).

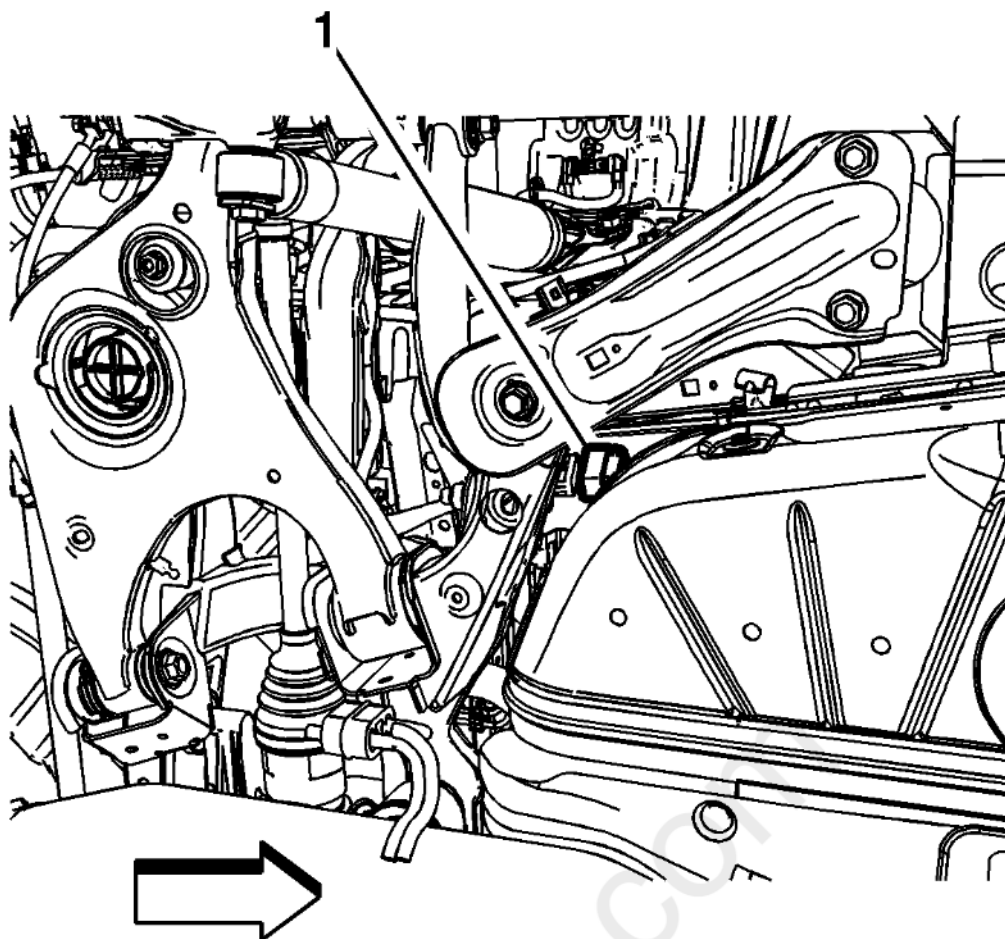


Fig. 49: Fuel Pump Module Wiring Harness Connector
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the fuel tank harness electrical connector (1).

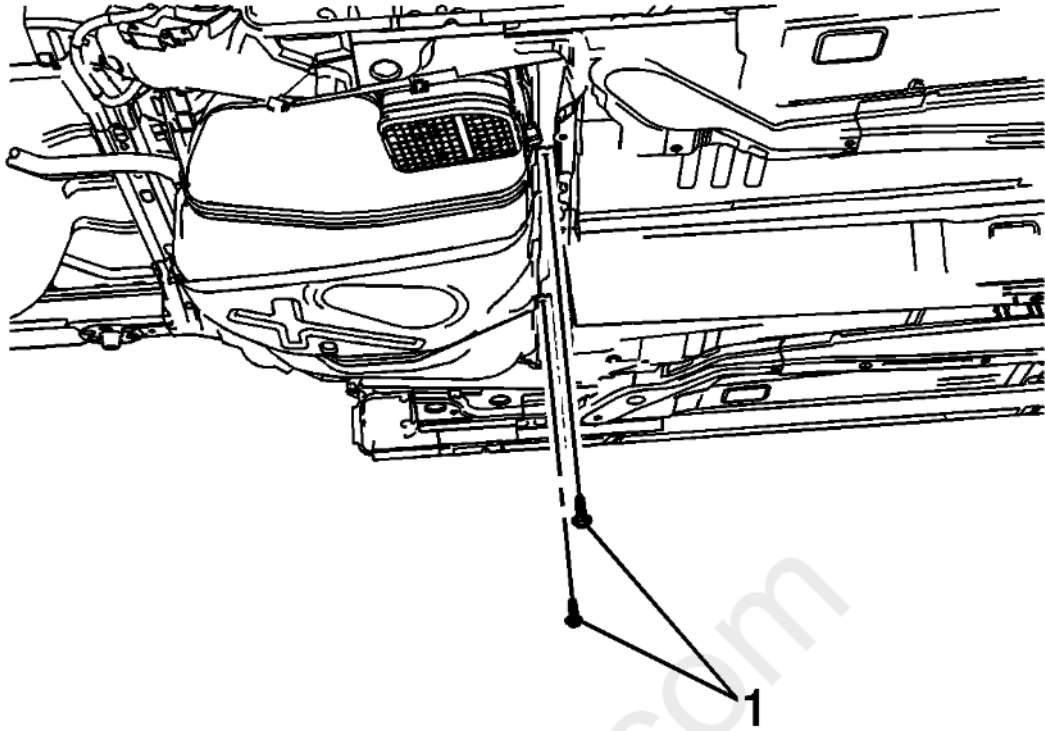


Fig. 50: Fuel Tank Strap Bolts

Courtesy of GENERAL MOTORS COMPANY

10. Support the fuel tank with a suitable jack.
11. Remove the fuel tank strap bolts (1).

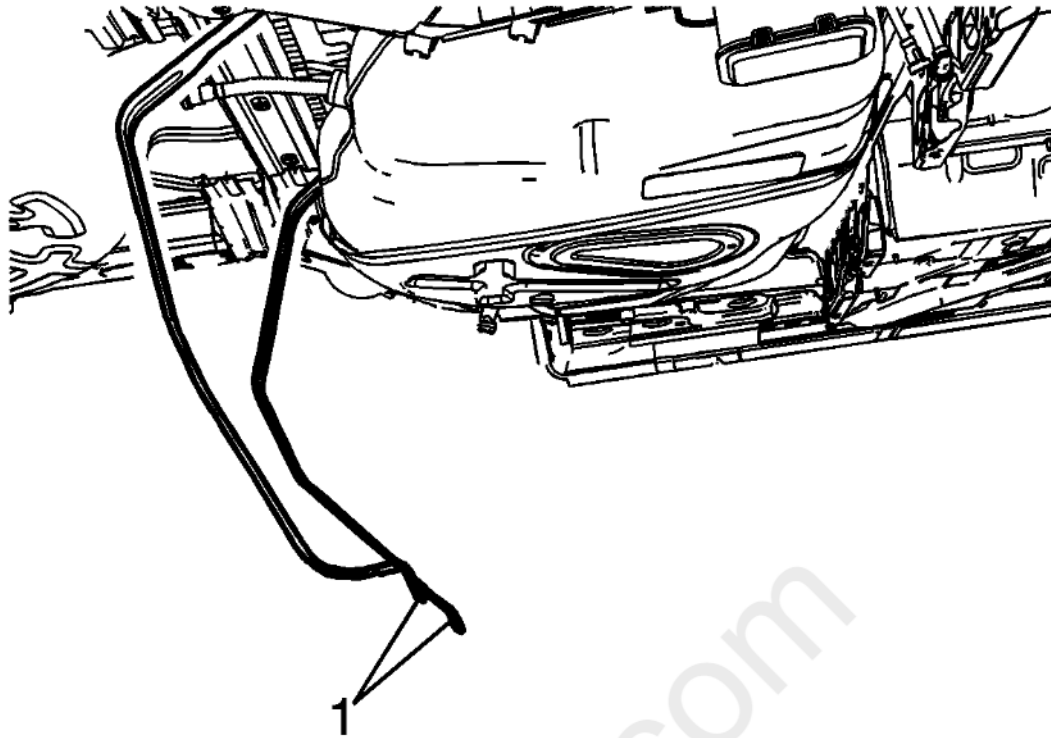


Fig. 51: Fuel Tank Straps

Courtesy of GENERAL MOTORS COMPANY

12. Swing the fuel tank straps (1) out of the way.

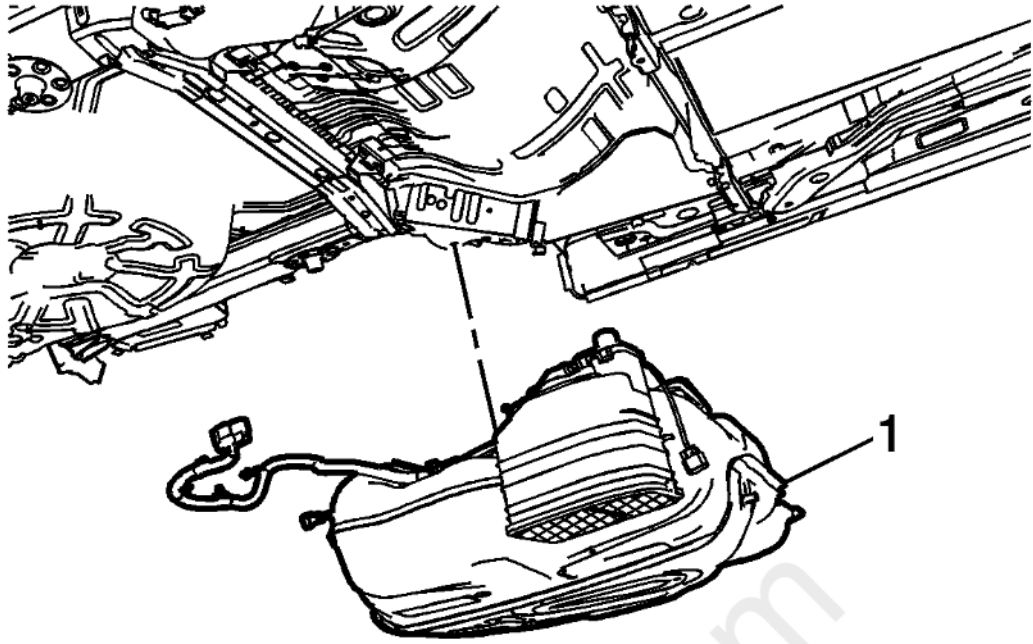


Fig. 52: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

13. Remove the fuel tank (1).
14. Remove the following components if replacing just the fuel tank.
 1. Fuel tank fuel pump module. Refer to [**Fuel Tank Fuel Pump Module Replacement \(NT5, NT7\)**](#)[**Fuel Tank Fuel Pump Module Replacement \(NU6\)**](#).
 2. Evaporative emission carbon canister. Refer to [**Evaporative Emission Canister Replacement**](#).
 3. Transfer components as necessary.

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 \(NT5, NT7\)**](#)[**Fuel Tank Fuel Pump Module Replacement \(NU6\)**](#).
 2. Evaporative emission carbon canister. Refer to [**Evaporative Emission Canister Replacement**](#).

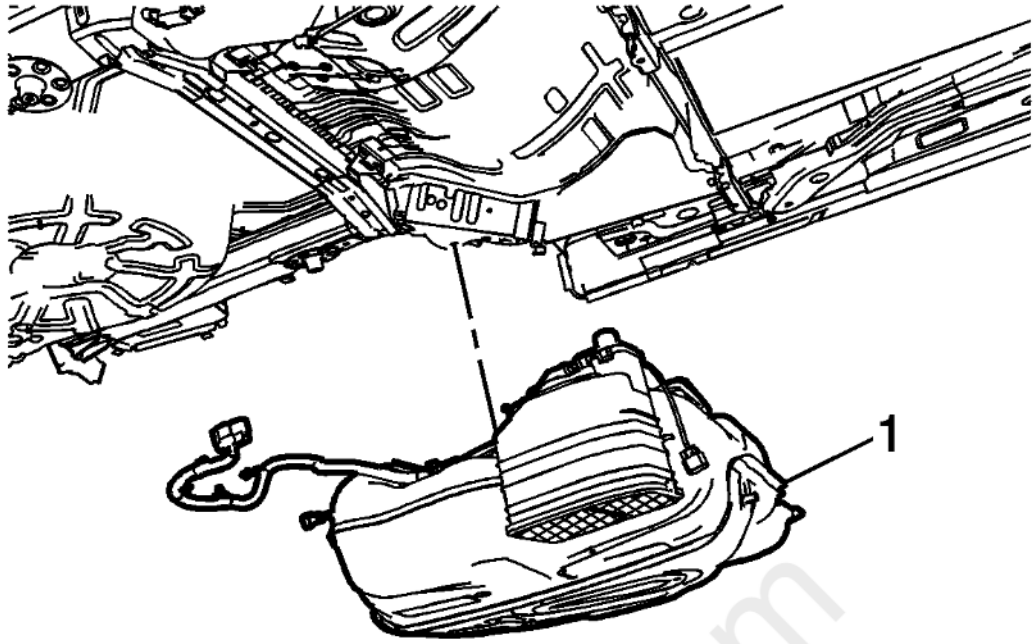


Fig. 53: Fuel Tank

Courtesy of GENERAL MOTORS COMPANY

2. Use a suitable jack and install the fuel tank (1).

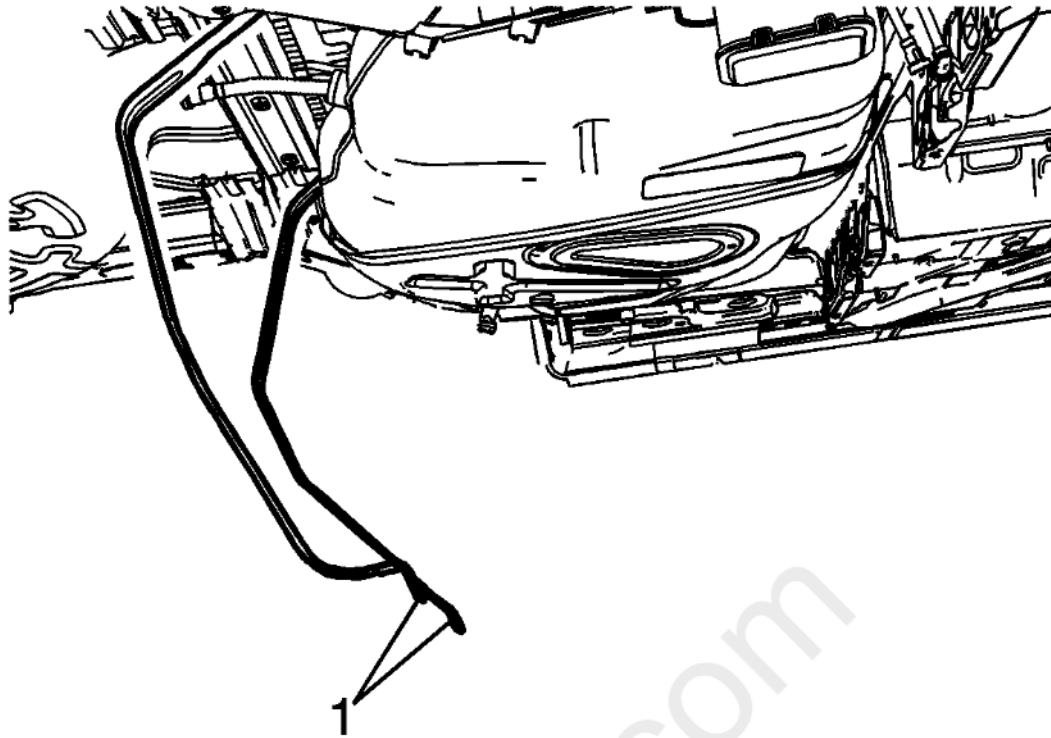


Fig. 54: Fuel Tank Straps

Courtesy of GENERAL MOTORS COMPANY

3. Reposition the fuel tank straps (1).

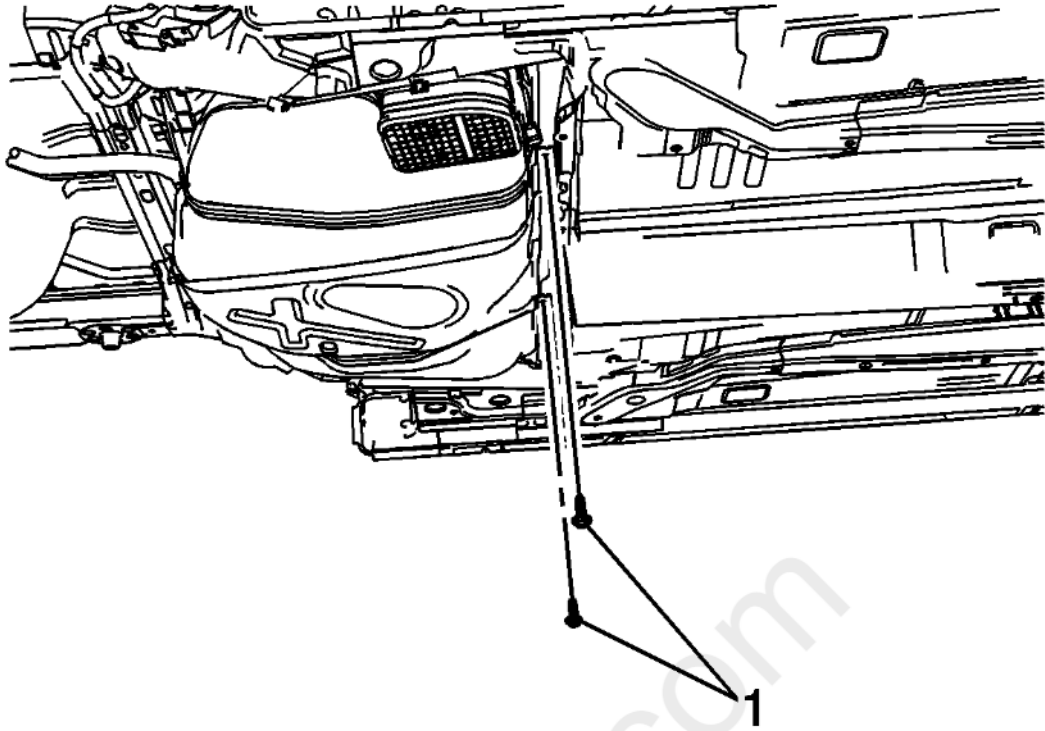


Fig. 55: Fuel Tank Strap Bolts

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

4. Install the fuel tank strap bolts (1) and tighten to 27 N.m (20 lb ft).

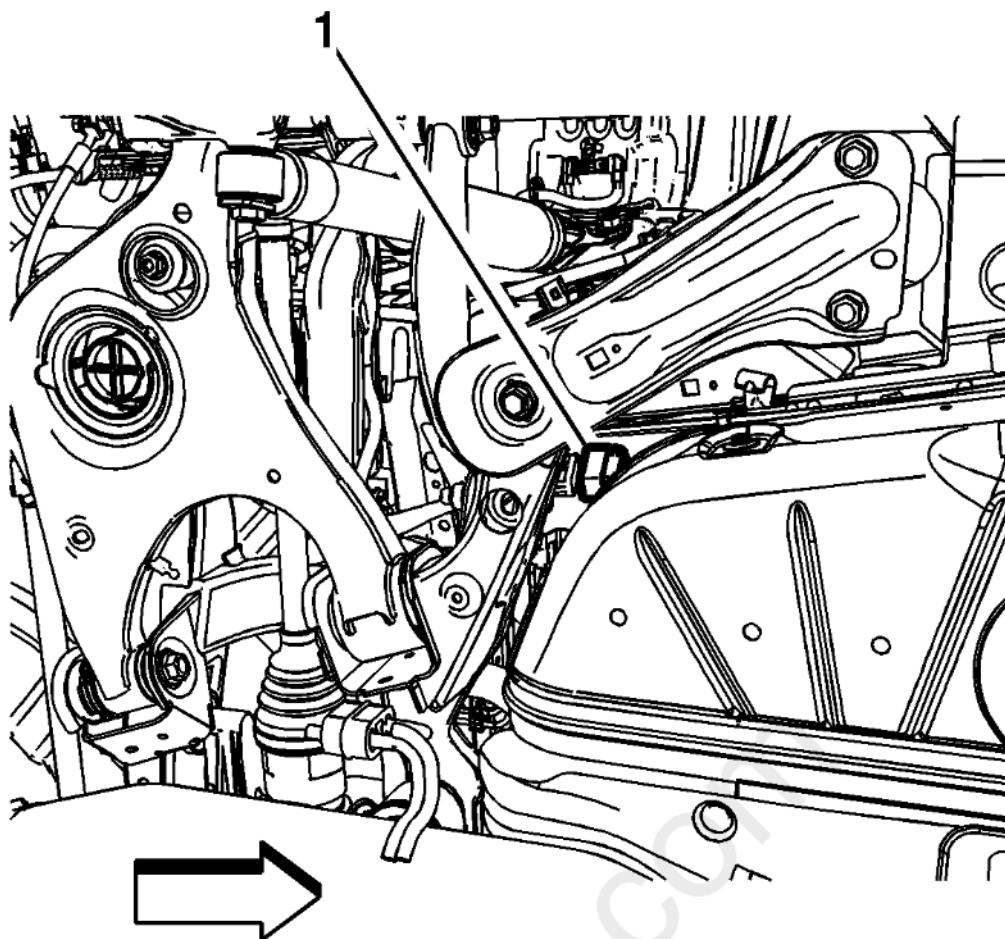


Fig. 56: Fuel Pump Module Wiring Harness Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect the fuel tank harness electrical connector (1).

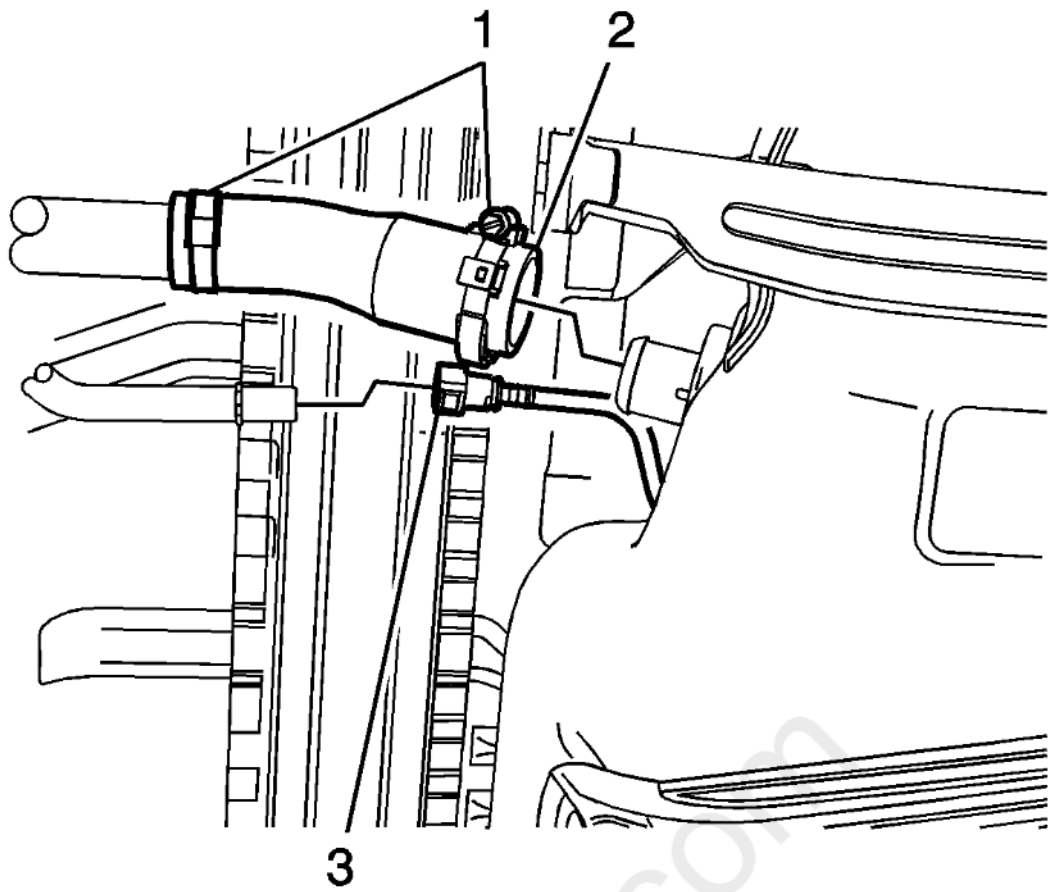


Fig. 57: Hose Clamps, Filler Tube And Evaporative Emission Line

Courtesy of GENERAL MOTORS COMPANY

6. Install the filler tube (2) and tighten the hose clamps (1) to 4 N.m (35 lb in).
7. Connect the evaporative emission line (3). Refer to [**Plastic Collar Quick Connect Fitting Service**](#).

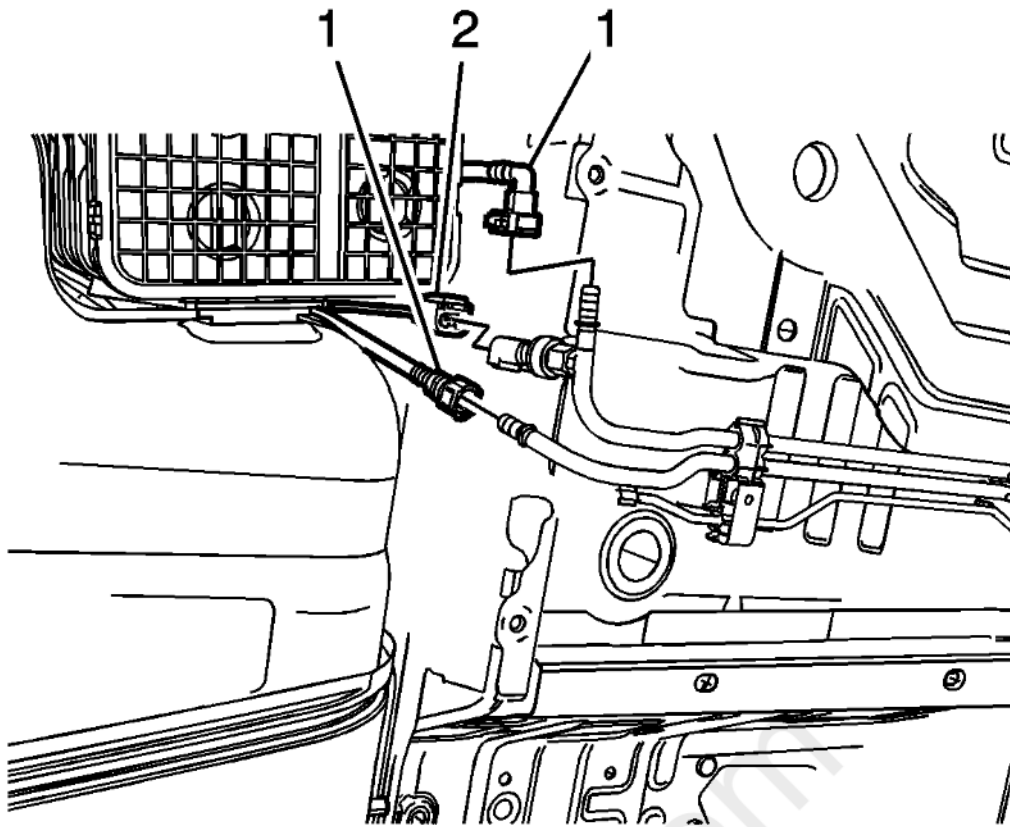


Fig. 58: Evaporative Emission, Fuel Pipes And Fuel Pressure Sensor Electrical Connector
 Courtesy of GENERAL MOTORS COMPANY

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 left and right side rear air deflectors. Refer to [Underbody Rear Air Deflector Replacement - Left Side](#) , and [Underbody Rear Air Deflector Replacement - Right Side](#) .
11. Install the exhaust muffler. Refer to [Exhaust Muffler with Resonator, Exhaust, and Tail Pipe Replacement](#) .
12. Refill the fuel tank.
13. Inspect for fuel leaks.

FUEL SYSTEM CLEANING

NOTE: When flushing the fuel tank, treat the fuel and water mixture as a hazardous material. Handle the material in accordance with all local, state and federal laws and regulations.

NOTE: Whenever the fuel tank is cleaned, inspect the fuel pump fuel strainer. If the fuel pump fuel strainer is contaminated, replace the fuel pump fuel strainer and inspect the fuel pump.

NOTE: Always maintain cleanliness when servicing fuel system components.

1. Remove the fuel tank fuel pump module. Refer to [Fuel Tank Fuel Pump Module Replacement \(NT5, NT7\)Fuel Tank Fuel Pump Module Replacement \(NU6\)](#).
2. Inspect the fuel pump inlet for dirt and debris. If dirt and debris are found, replace the fuel pump.
3. Flush fuel tank with hot water.

4. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to ensure that the removal of the water from the fuel tank is complete.
5. Allow tank to dry completely before reassembly.
6. Install the fuel tank fuel pump module. Refer to [Fuel Tank Fuel Pump Module Replacement \(NT5, NT7\)](#)[Fuel Tank Fuel Pump Module Replacement \(NU6\)](#).

FUEL TANK FUEL PUMP MODULE REPLACEMENT (NT5, NT7)

Special Tools

CH 45722 Fuel Sender Lock Ring Wrench

For equivalent regional tools, refer to [Special Tools](#)

Removal Procedure

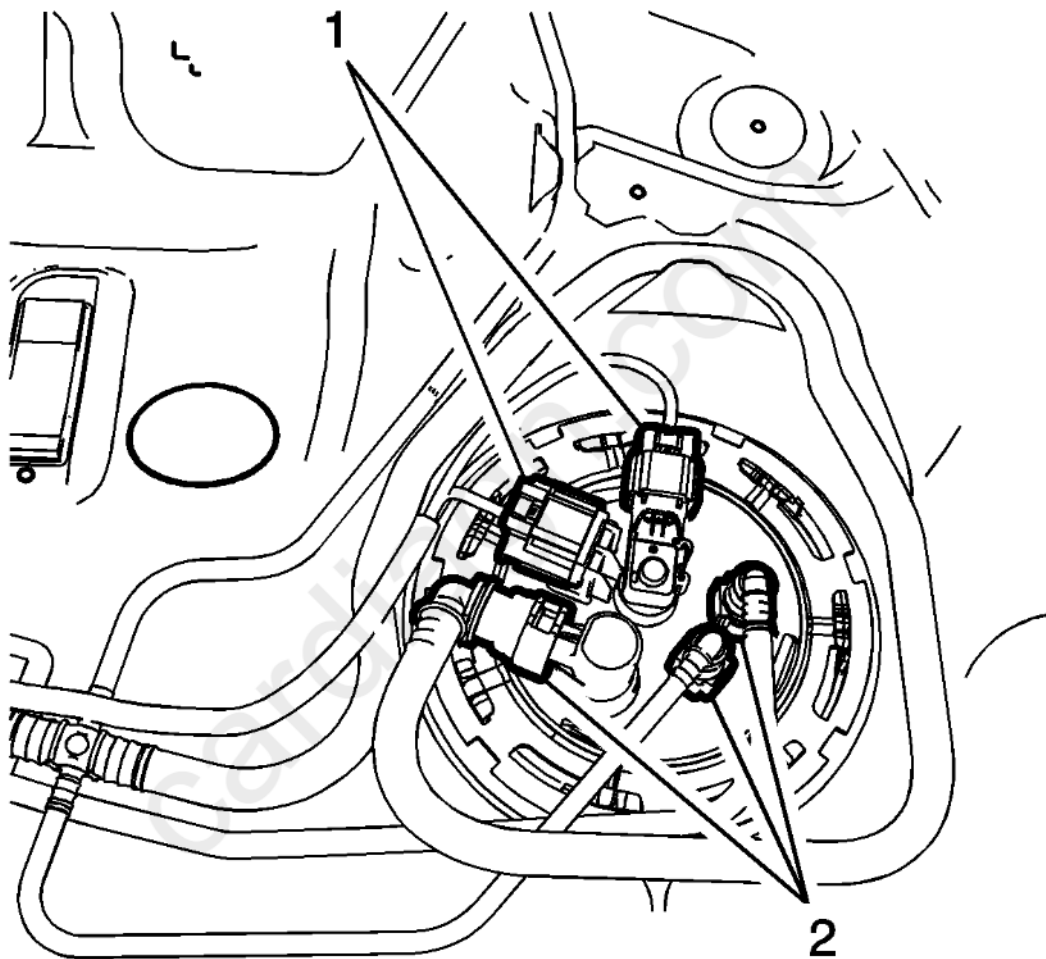


Fig. 59: Fuel Pump Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

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](#).

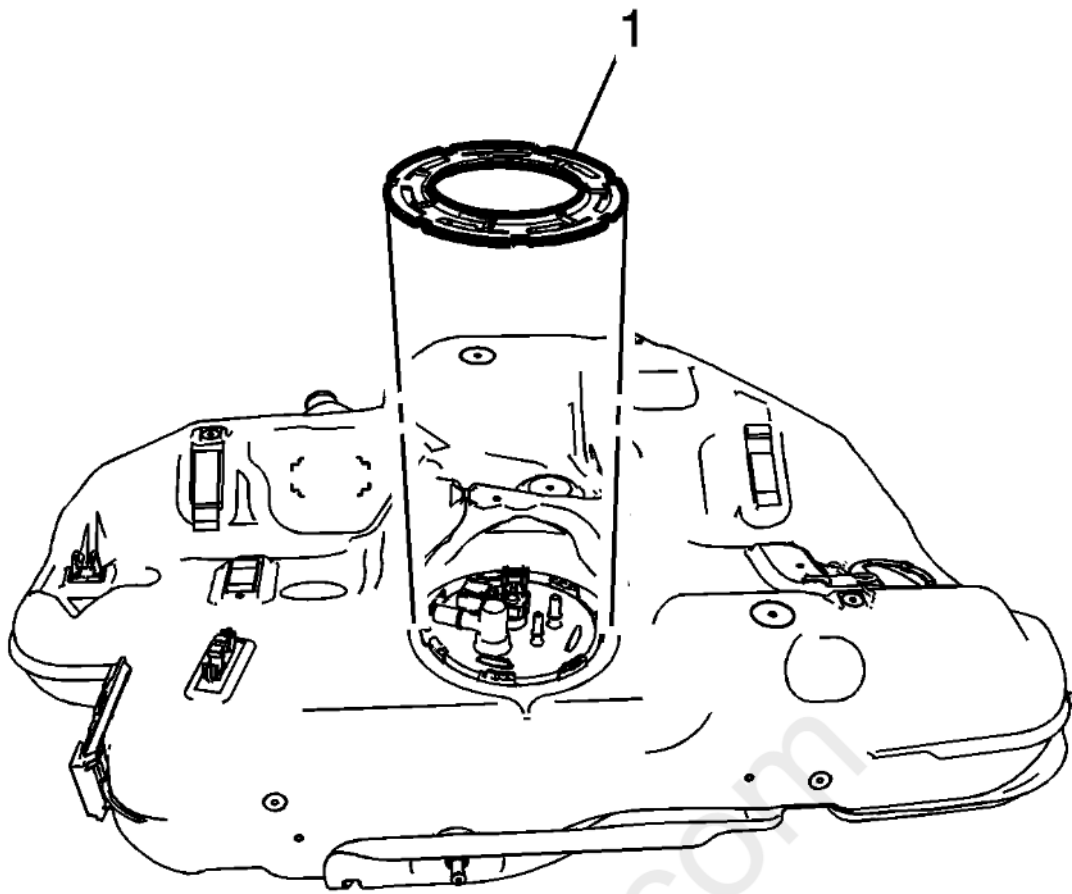


Fig. 60: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning counter clockwise and remove the lock ring (1).

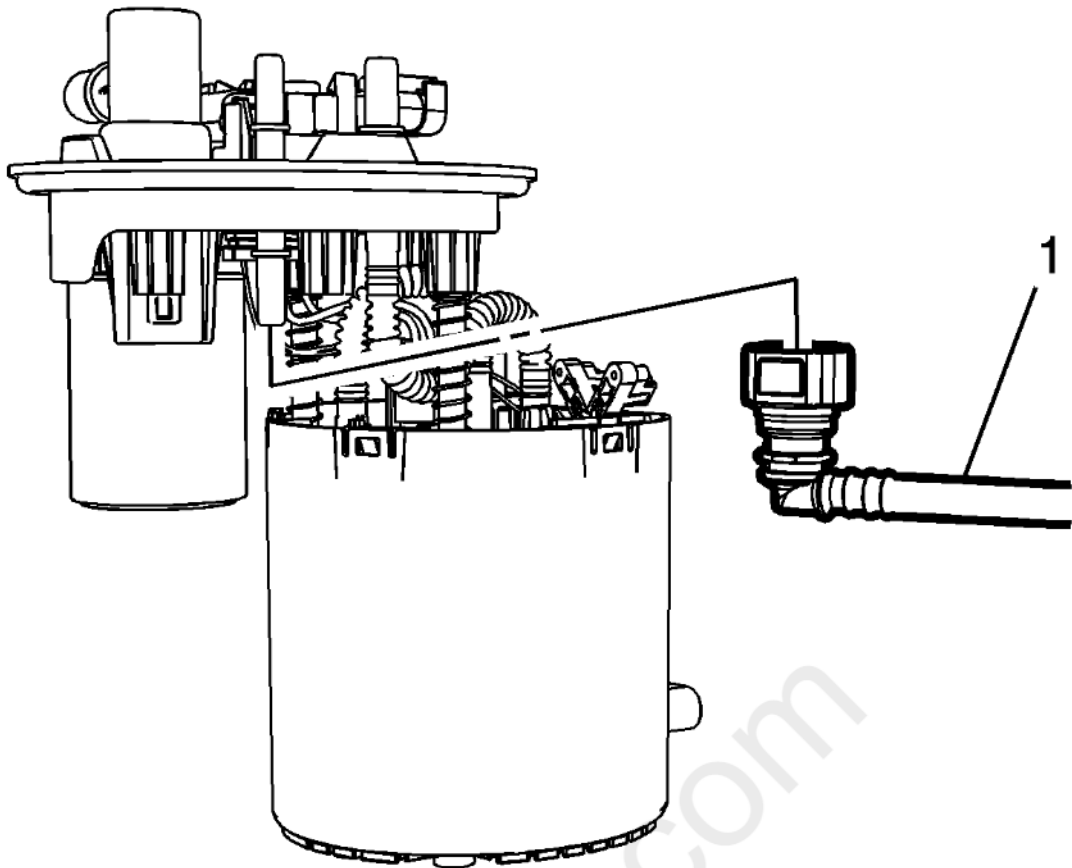


Fig. 61: Fuel Pump Vent Hose

Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel pump vent hose. Refer to [Plastic Collar Quick Connect Fitting Service](#).

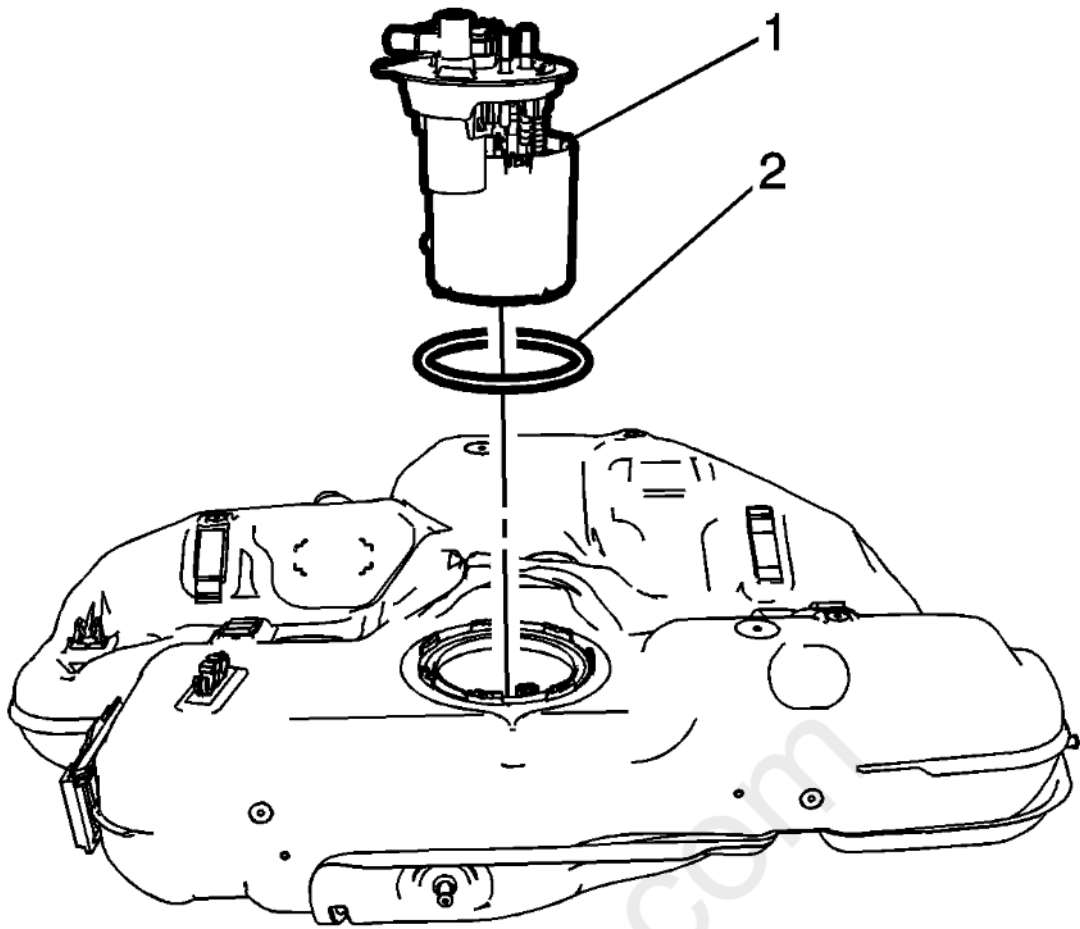


Fig. 62: Fuel Tank Module And O-Ring
Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel tank module (1) and the O-ring (2).

Installation Procedure

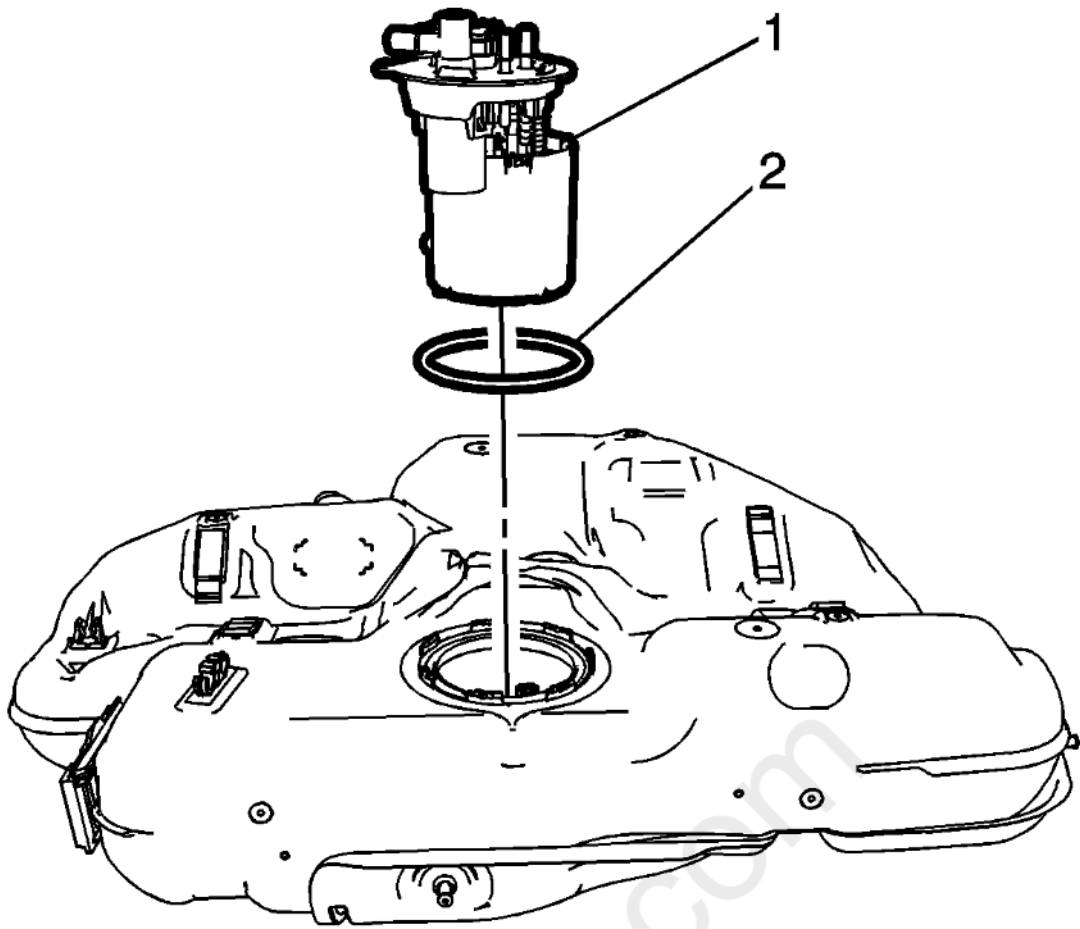


Fig. 63: Fuel Tank Module And O-Ring

Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW seal (2) and the fuel tank module (1).

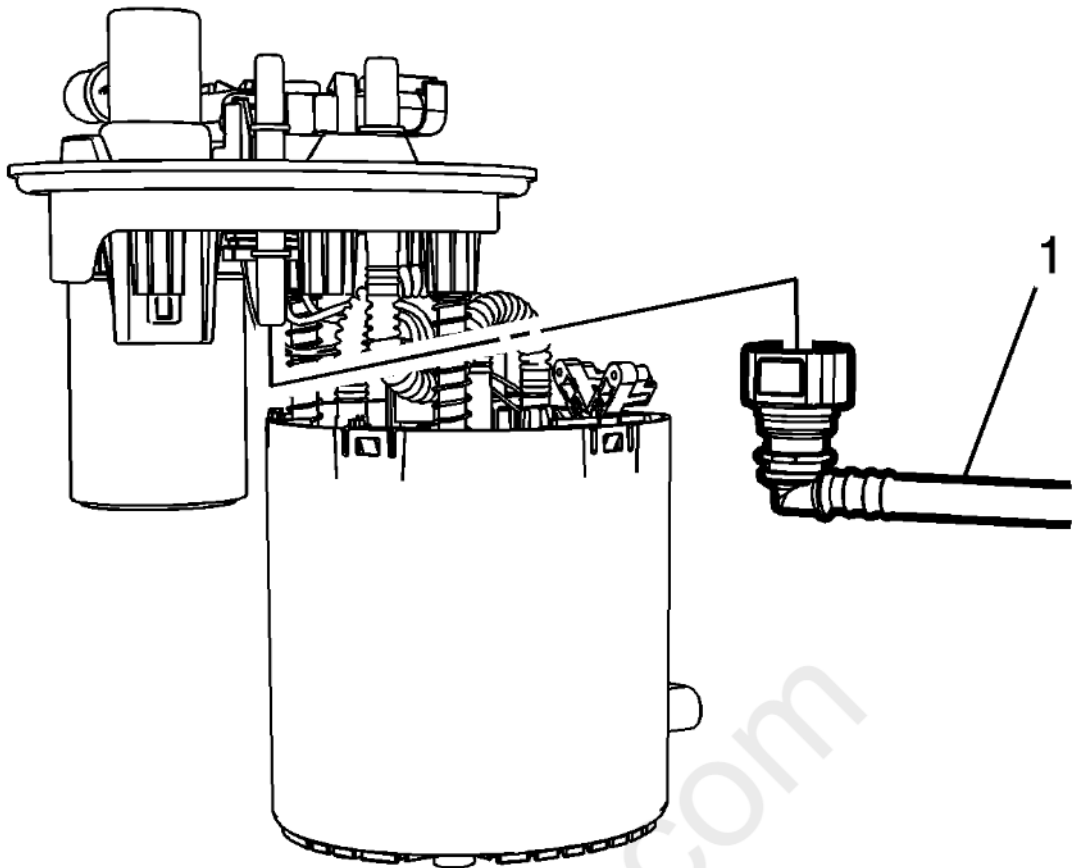


Fig. 64: Fuel Pump Vent Hose

Courtesy of GENERAL MOTORS COMPANY

2. Connect the fuel pump vent hose. Refer to [**Plastic Collar Quick Connect Fitting Service**](#).

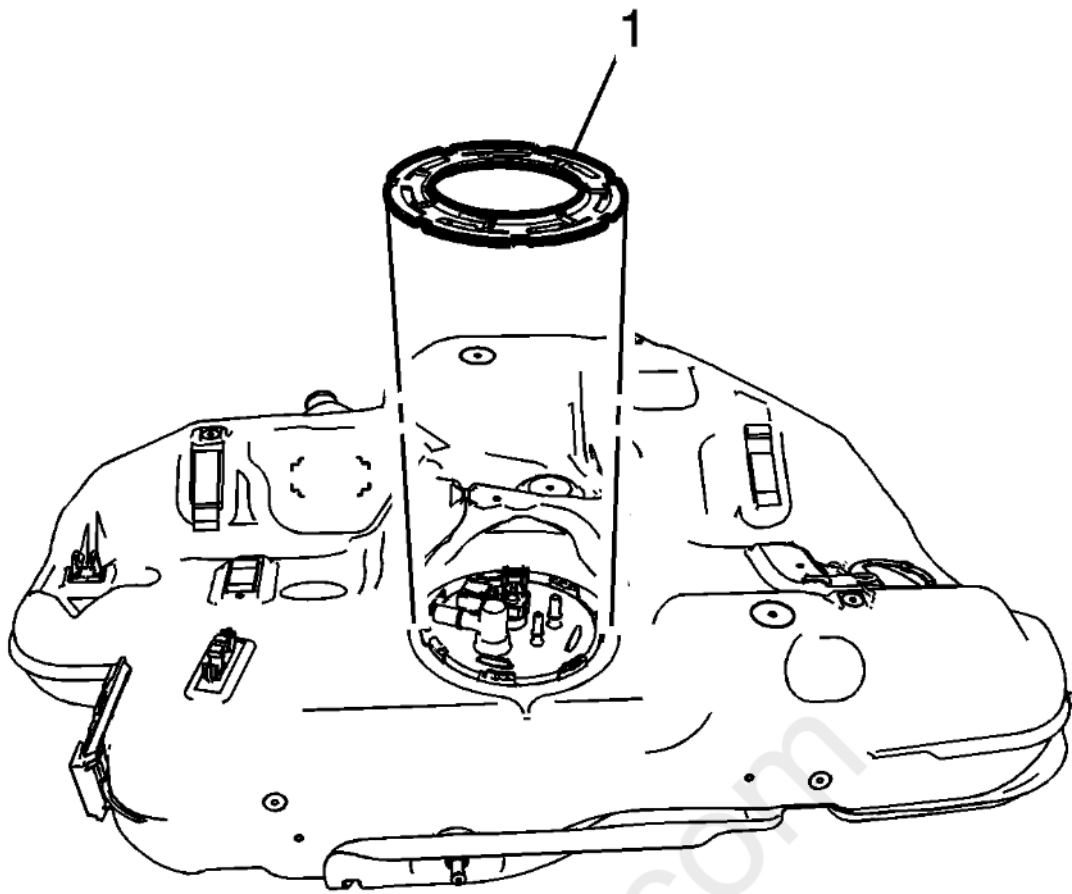


Fig. 65: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning clockwise and install the lock ring (1).

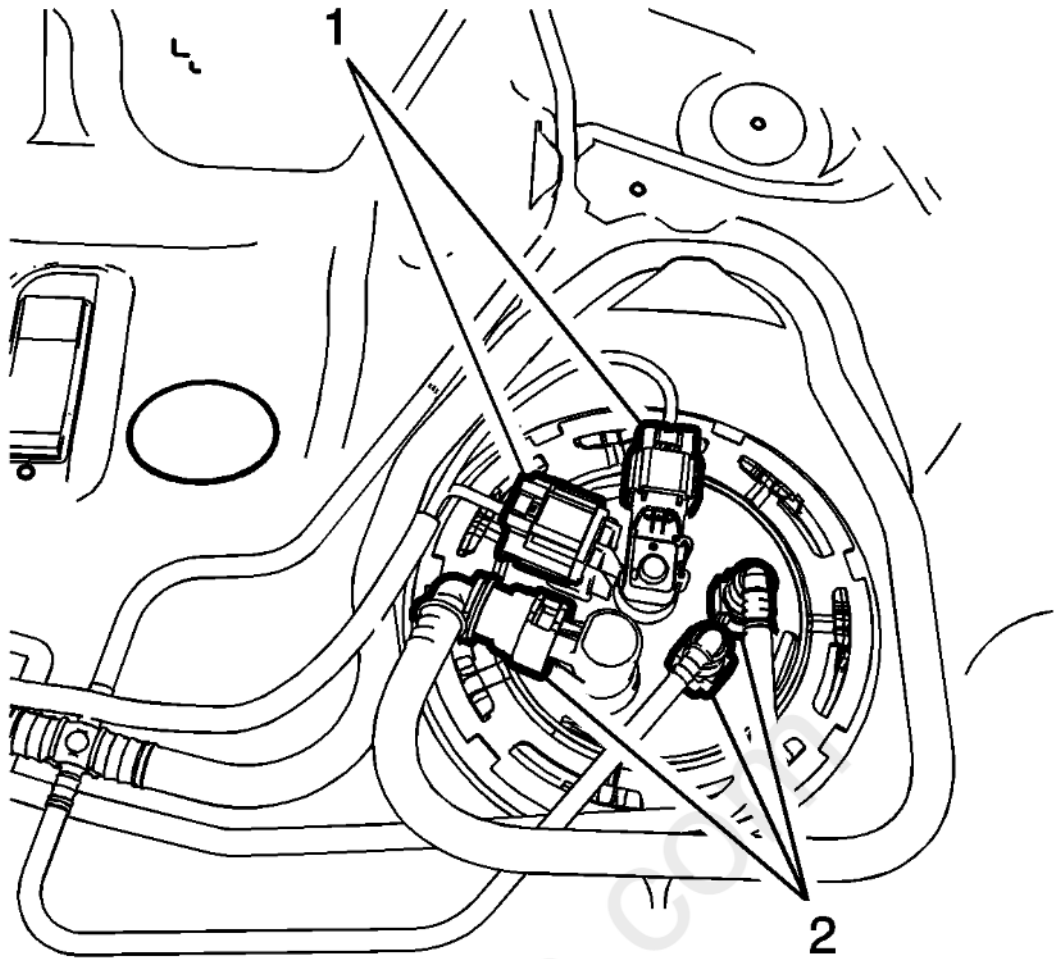


Fig. 66: Fuel Pump Electrical Connectors

Courtesy of GENERAL MOTORS COMPANY

4. Connect the fuel pump electrical connector (1) and the quick connects (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).
5. Install the fuel tank. Refer to [Fuel Tank Replacement](#).

FUEL TANK FUEL PUMP MODULE REPLACEMENT (NU6)

Special Tools

CH 45722 Fuel Sender Lock Ring Wrench

For equivalent regional tools, refer to [Special Tools](#)

Removal Procedure

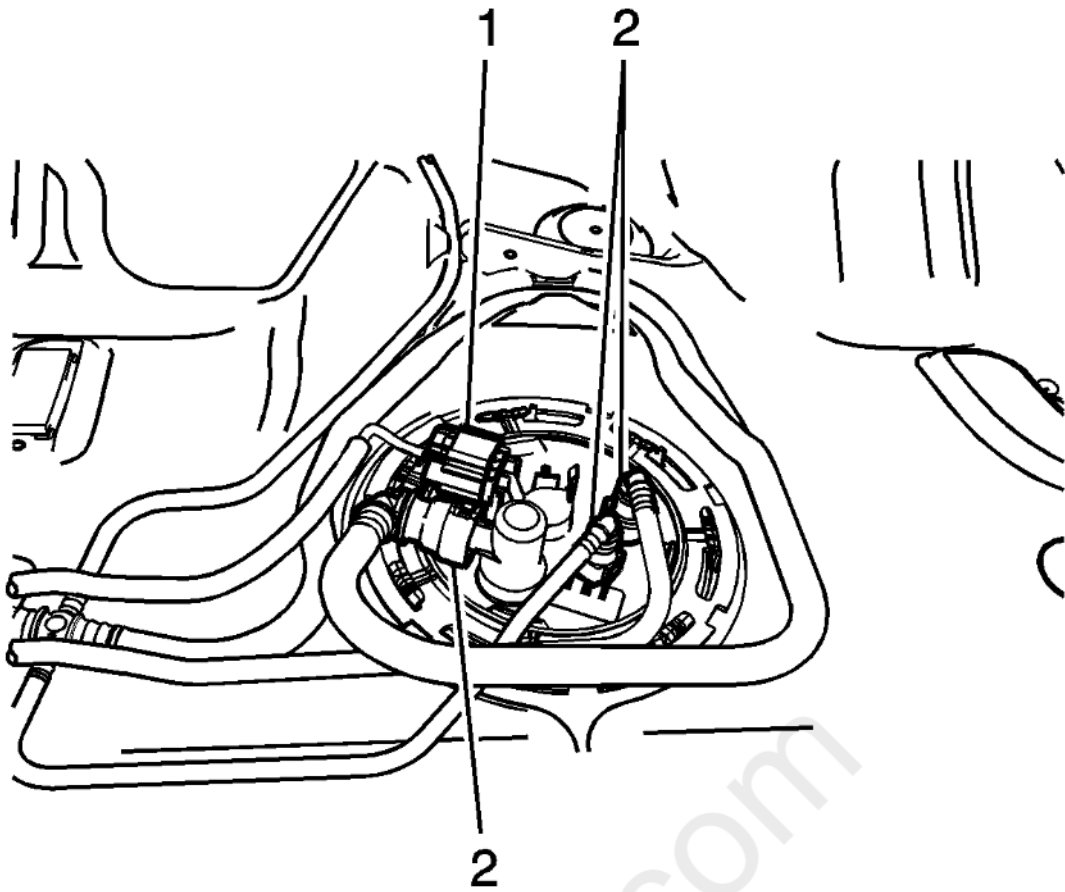


Fig. 67: Fuel Pump Electrical Connector & Quick Connects
Courtesy of GENERAL MOTORS COMPANY

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](#).

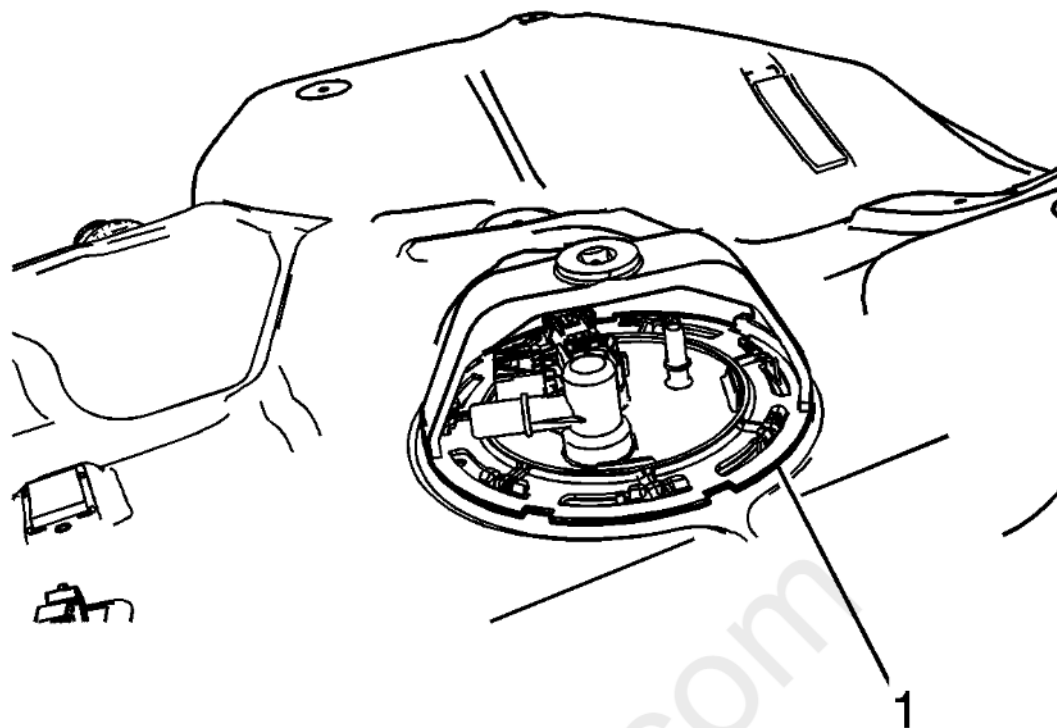


Fig. 68: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning counter clockwise and remove the lock ring (1).

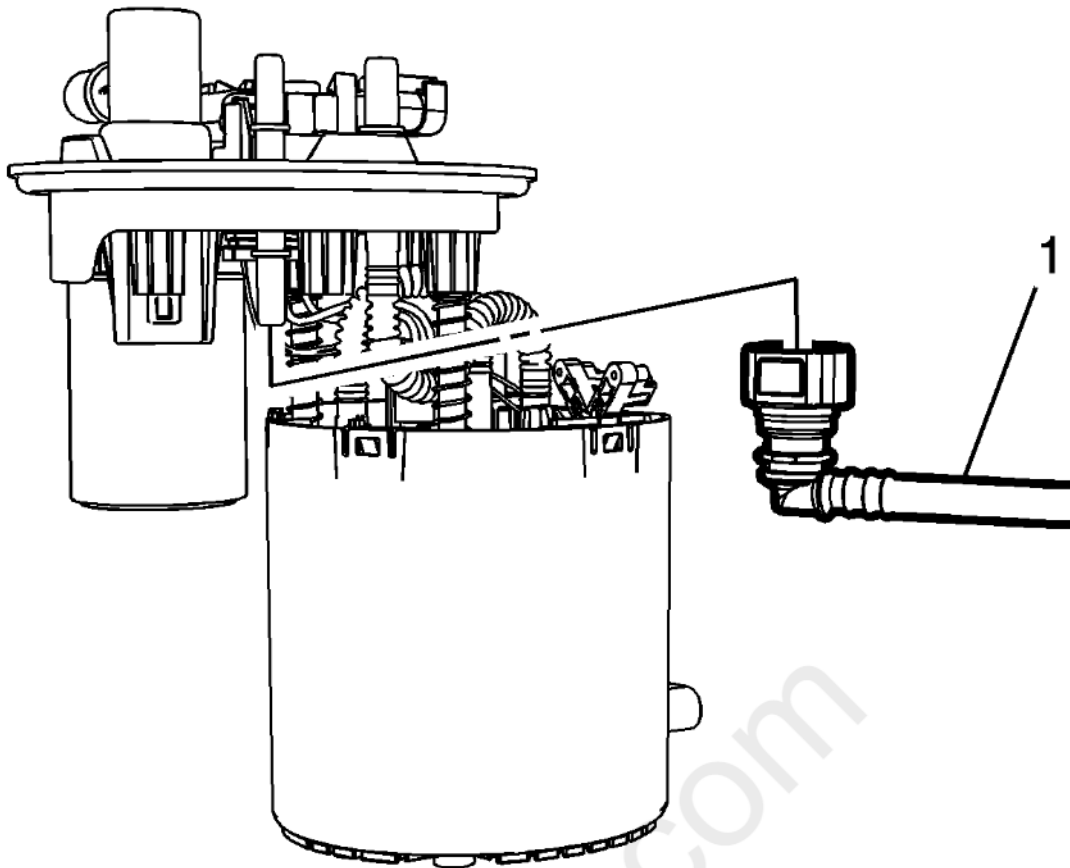


Fig. 69: Fuel Pump Vent Hose

Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel pump vent hose from the fuel tank fuel pump module. Refer to **Plastic Collar Quick Connect Fitting Service**.

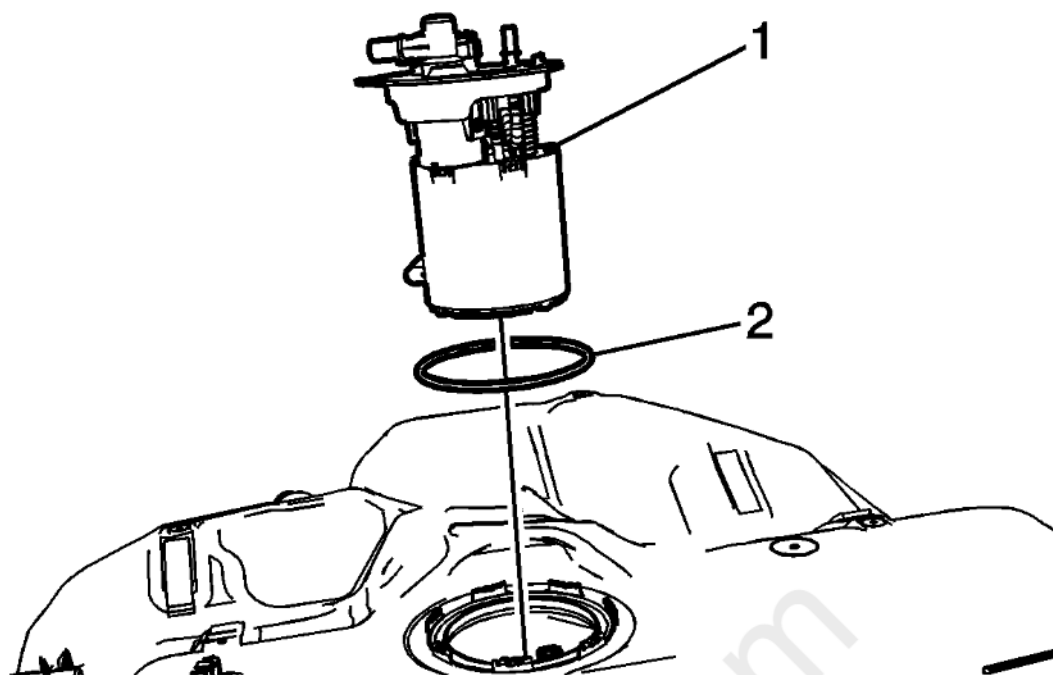


Fig. 70: Fuel Tank Module & O-Ring

Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel tank module (1) and the O-ring (2).

Installation Procedure

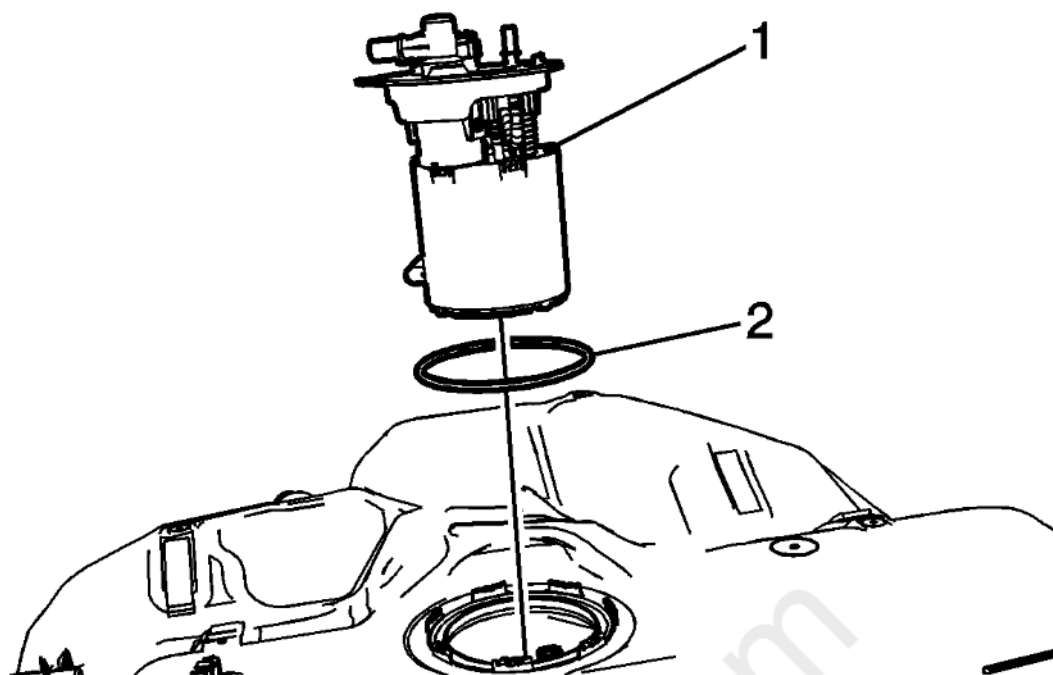


Fig. 71: Fuel Tank Module & O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW seal (2) and the fuel tank module (1).

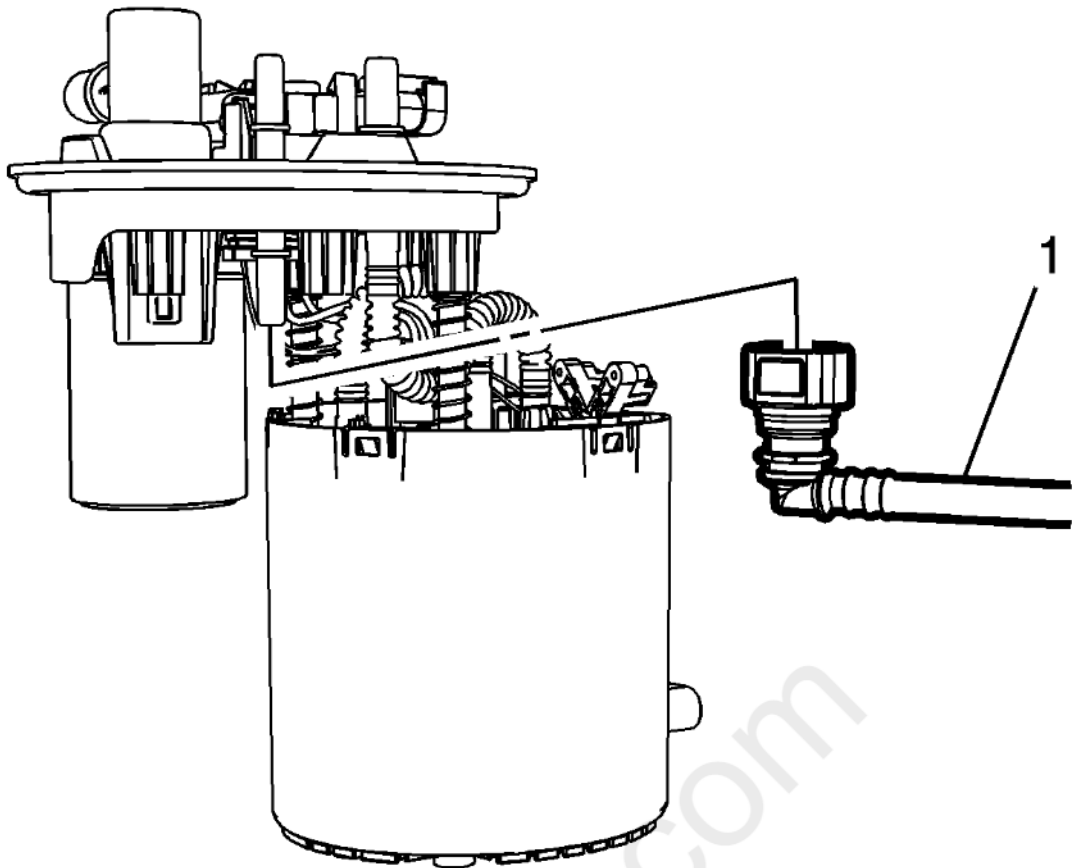


Fig. 72: Fuel Pump Vent Hose

Courtesy of GENERAL MOTORS COMPANY

2. Connect the fuel pump vent hose to the fuel tank fuel pump module. Refer to [**Plastic Collar Quick Connect Fitting Service**](#).

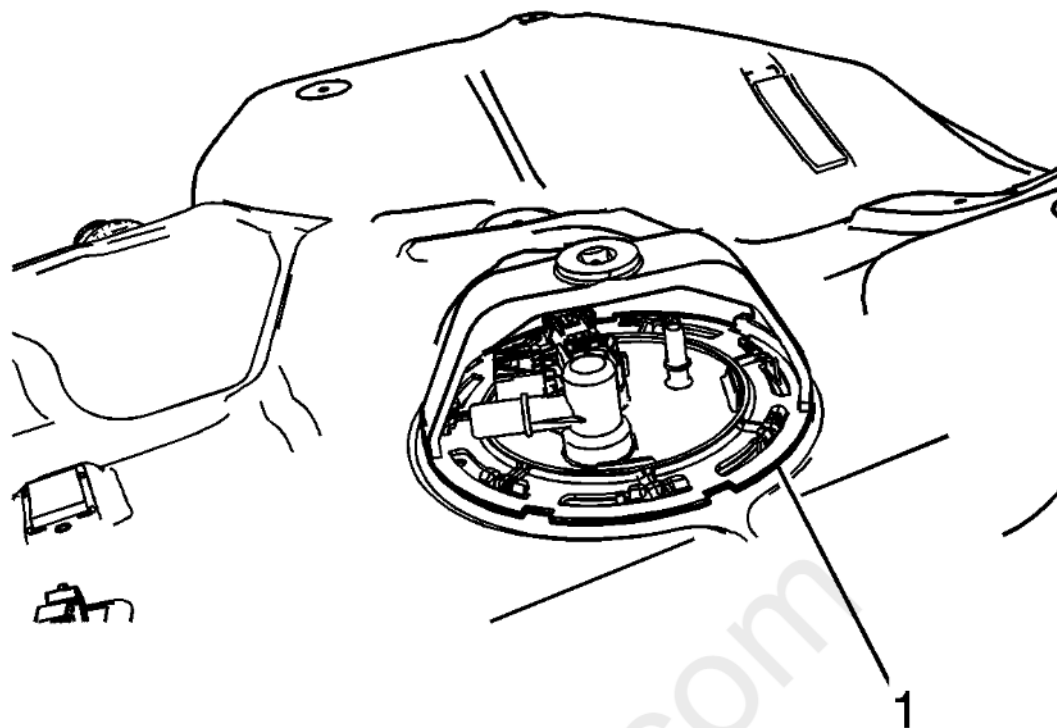


Fig. 73: Lock Ring

Courtesy of GENERAL MOTORS COMPANY

3. Use the **CH 45722** wrench by turning clockwise and install the lock ring (1).

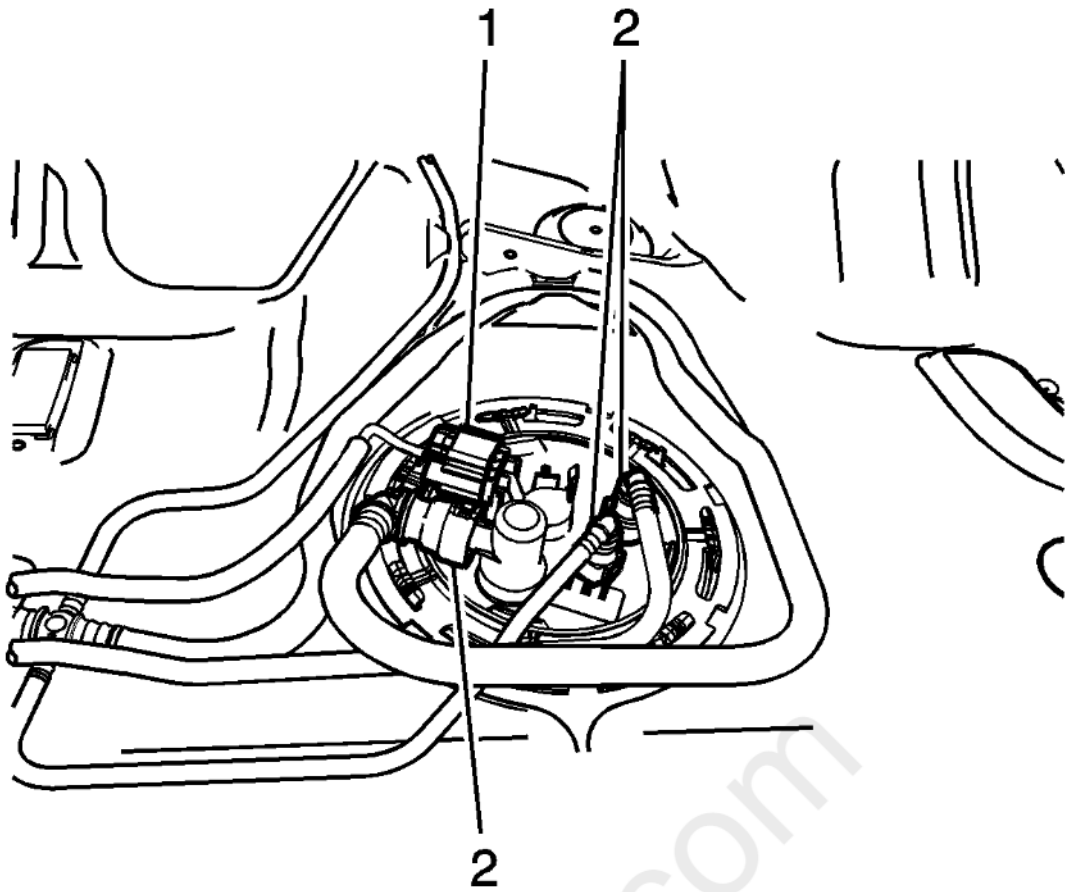


Fig. 74: Fuel Pump Electrical Connector & Quick Connects

Courtesy of GENERAL MOTORS COMPANY

4. Connect the fuel pump electrical connector (1) and the quick connects (2). Refer to [Plastic Collar Quick Connect Fitting Service](#).
5. Install the fuel tank. Refer to [Fuel Tank Replacement](#).

CHASSIS CONTROL MODULE REPLACEMENT

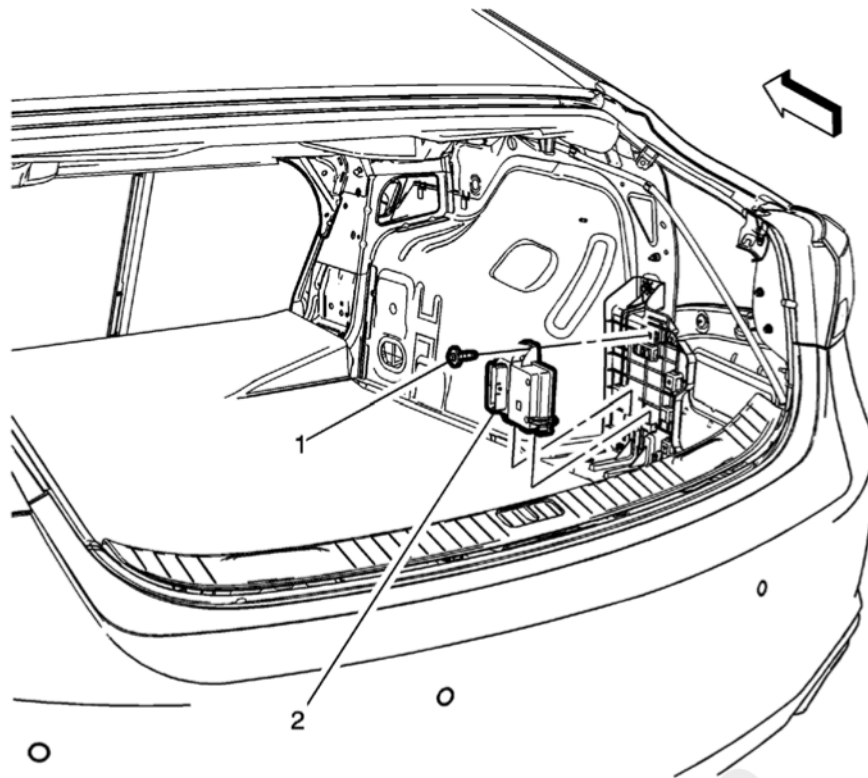


Fig. 75: Chassis Control Module

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Reposition the passenger rear side trim panel. Refer to Rear Compartment Side Trim Replacement - Right Side .	
1	Chassis Control Module Fastener (Qty: 1) CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Chassis Control Module Procedure 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to Control Module References .

FUEL TANK PRESSURE SENSOR REPLACEMENT (NT5, NT7, NU5)

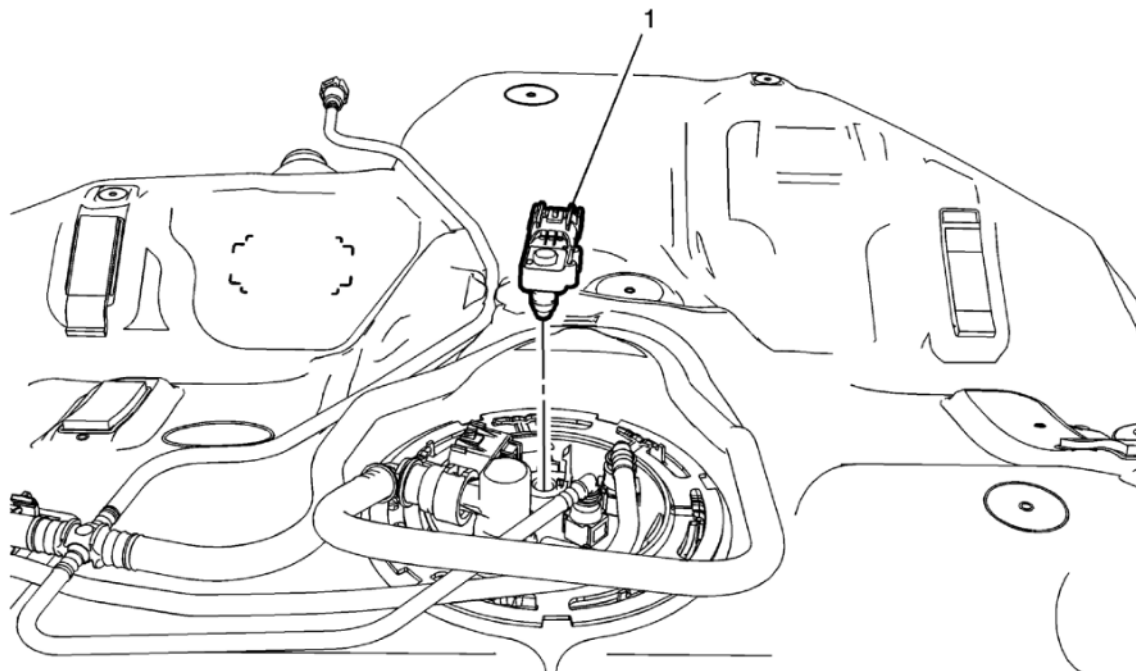


Fig. 76: Fuel Tank Pressure Sensor (NT5, NT7, NU5)

Courtesy of GENERAL MOTORS COMPANY

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)

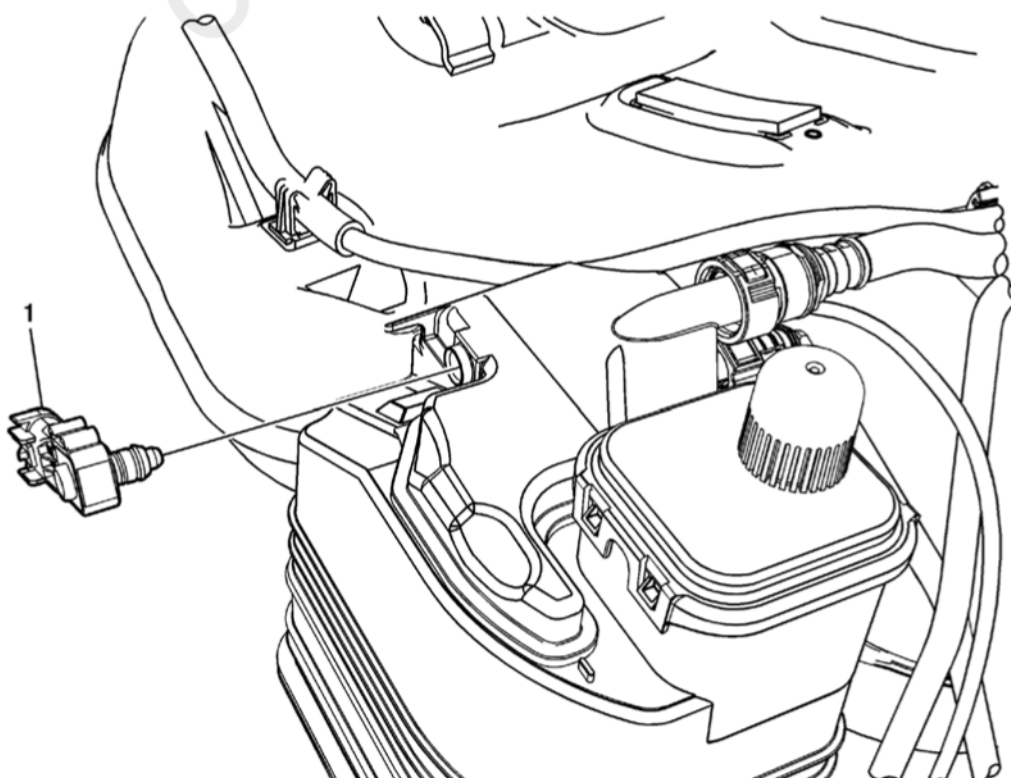


Fig. 77: Fuel Tank Pressure Sensor (NU6)
Courtesy of GENERAL MOTORS COMPANY

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.

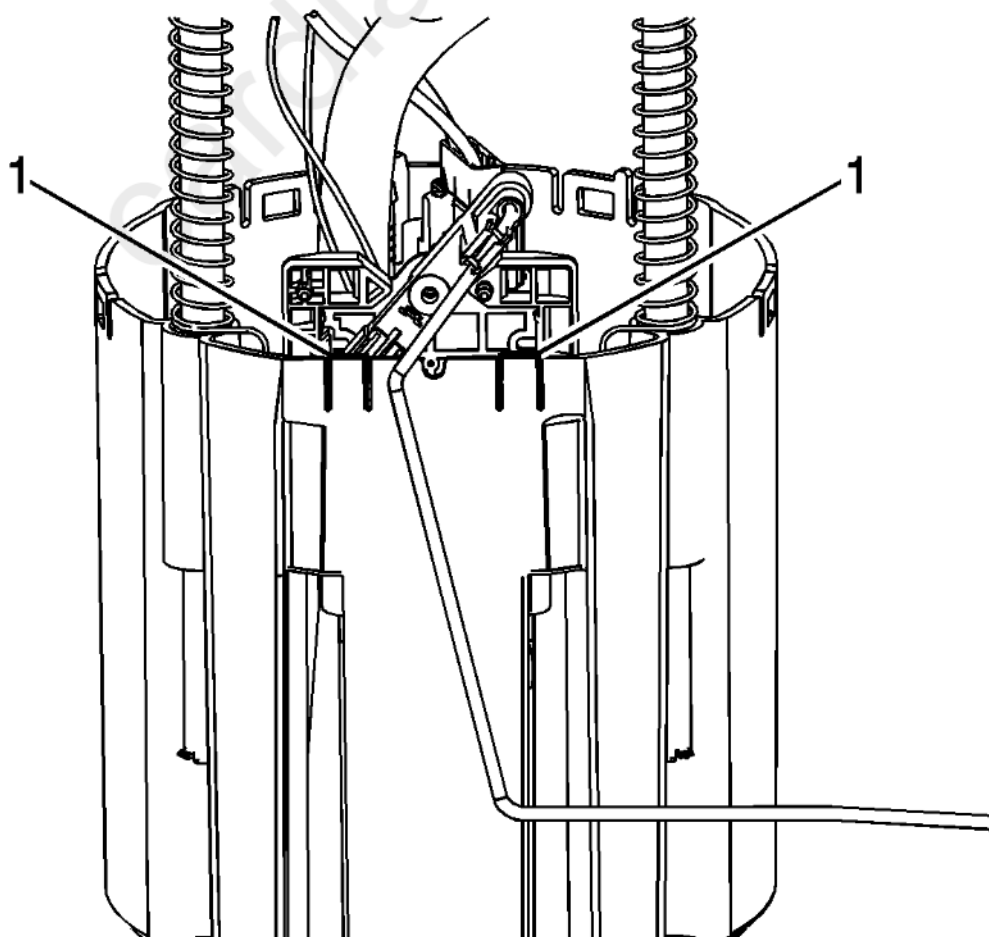


Fig. 78: Fuel Level Sensor Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel tank pump module. Refer to **Fuel Tank Fuel Pump Module Replacement (NT5, NT7)****Fuel Tank Fuel Pump Module Replacement (NU6)**.
2. Using two flat-bladed tools, carefully pull both locking tabs (1) outward while simultaneously lifting the level sensor.

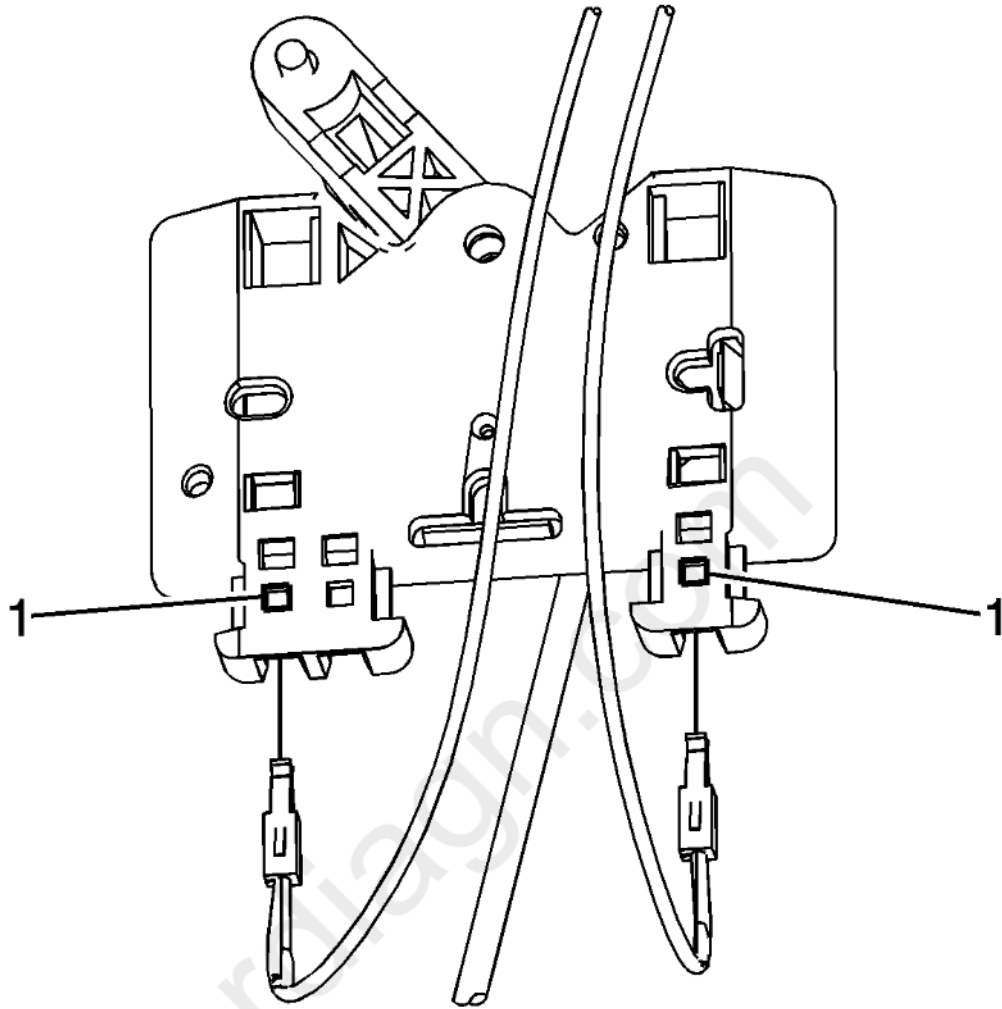


Fig. 79: Electrical Terminals
Courtesy of GENERAL MOTORS COMPANY

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

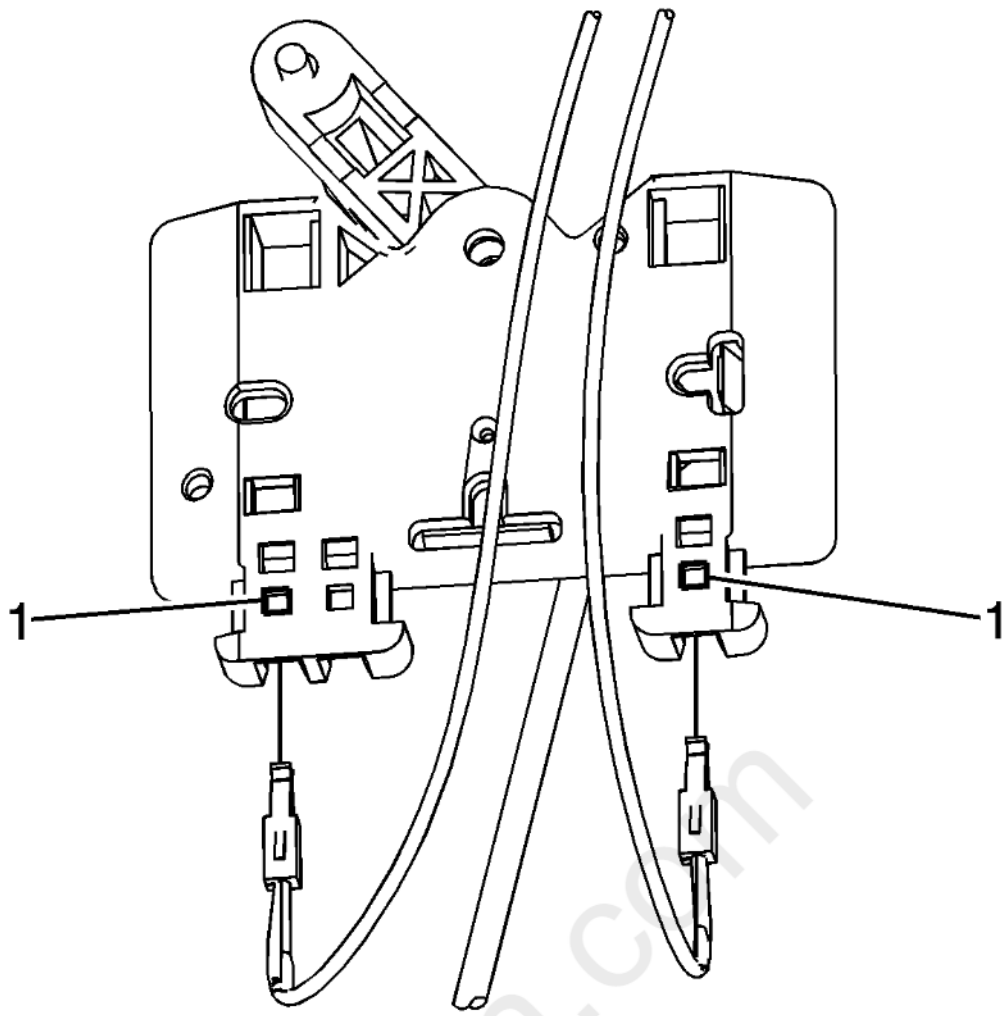


Fig. 80: Electrical Terminals

Courtesy of GENERAL MOTORS COMPANY

1. Push in the electrical terminals (1) and ensure the terminals are secure.

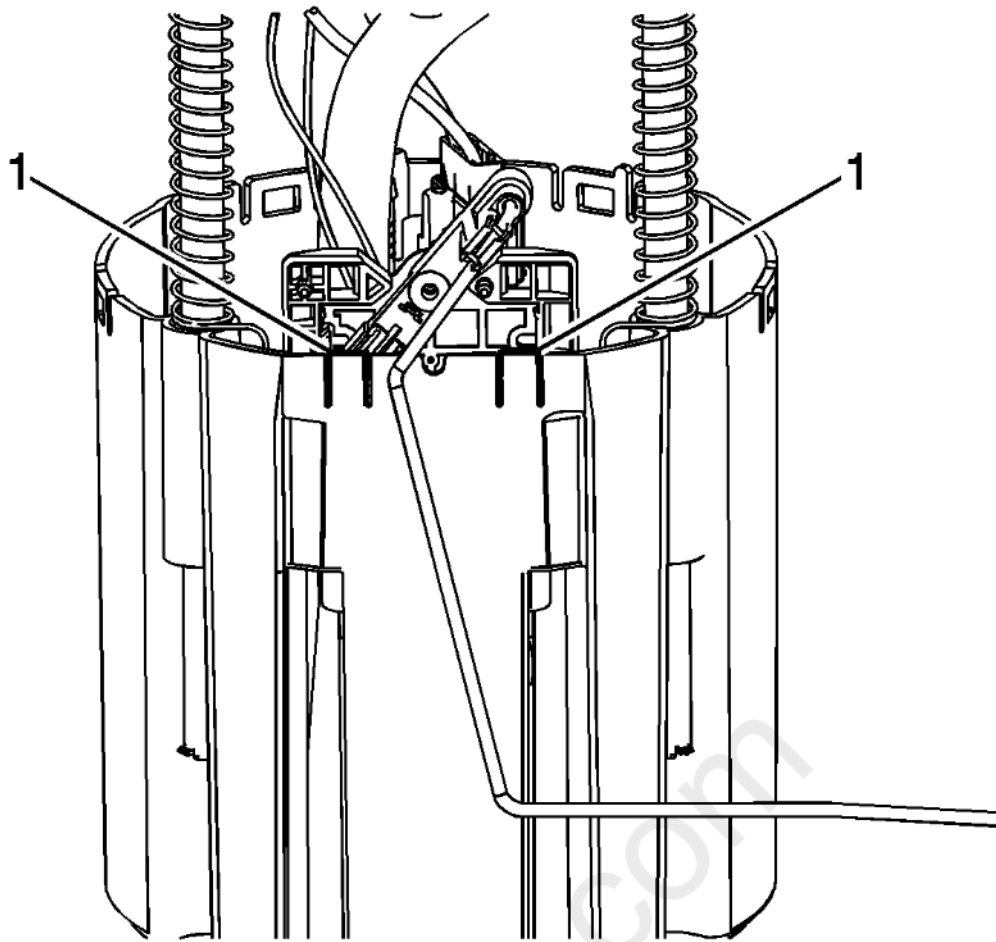


Fig. 81: Fuel Level Sensor Locking Tabs

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 (NT5, NT7)****Fuel Tank Fuel Pump Module Replacement (NU6)**.

FUEL TANK FILLER PIPE REPLACEMENT

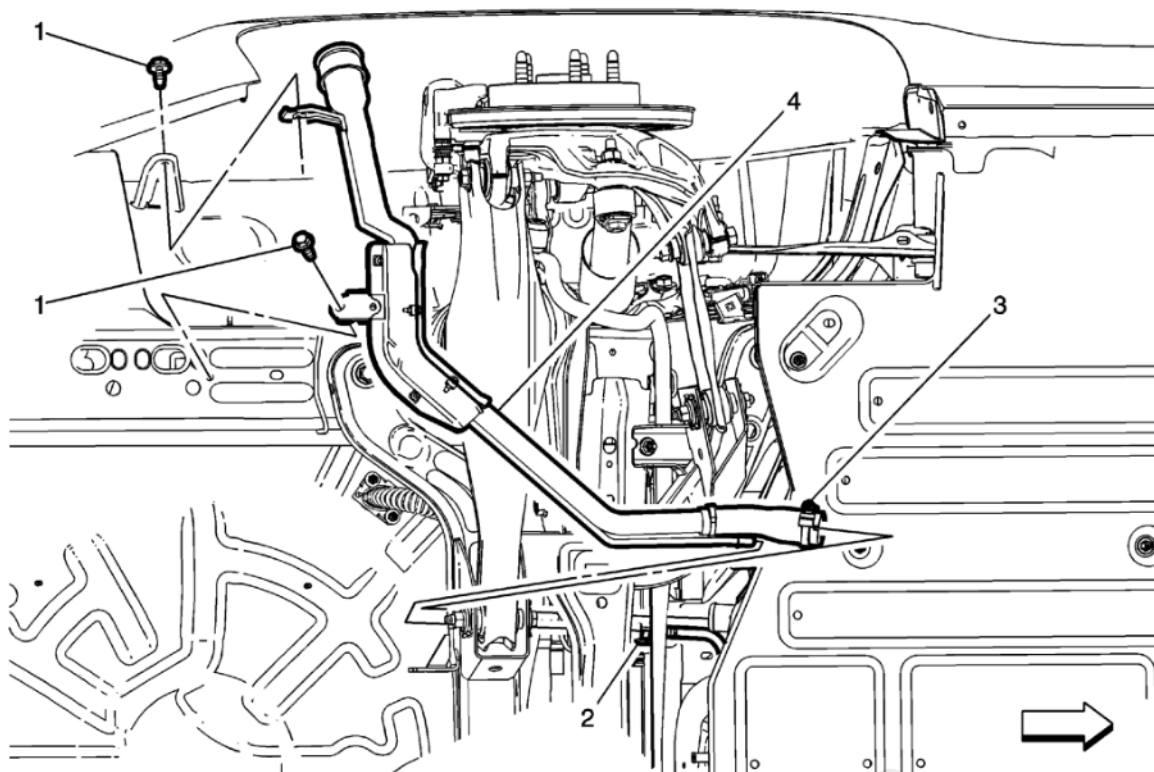


Fig. 82: Fuel Tank Filler Pipe

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the filler pipe housing. Refer to Fuel Tank Filler Pipe Housing Replacement .	
1	Filler Pipe Fastener (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Rear Evaporative Emission Pipe Procedure Disconnect the quick connect fitting. Refer to Plastic Collar Quick Connect Fitting Service .
3	Hose Clamp Tighten 4 N.m (35 lb in)
4	Fuel Tank Filler Pipe

FUEL PUMP COVER REPLACEMENT

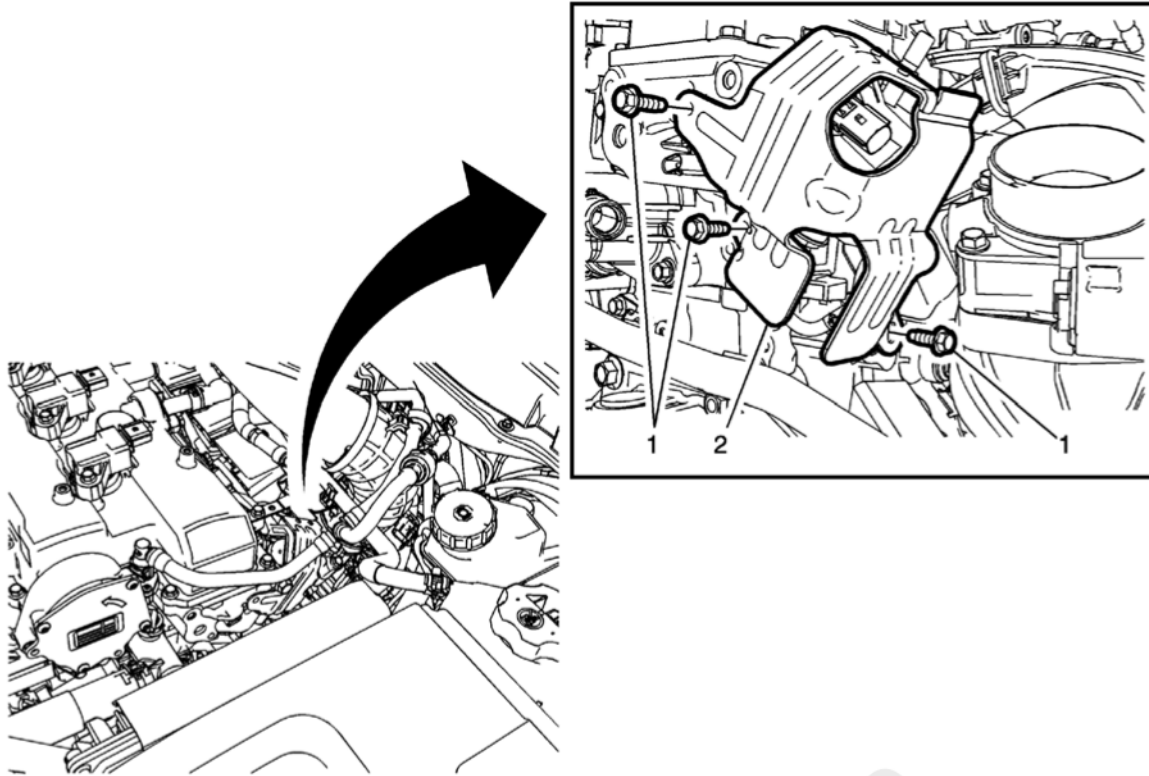


Fig. 83: Fuel Pump Cover

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Throttle Body Assembly. Refer to Throttle Body Assembly Replacement	
1	Fuel Pump Cover Fasteners (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Fuel Pump Cover Procedure Disconnect the electrical wiring harness connector from the fuel pump.

FUEL PUMP INSULATOR REPLACEMENT

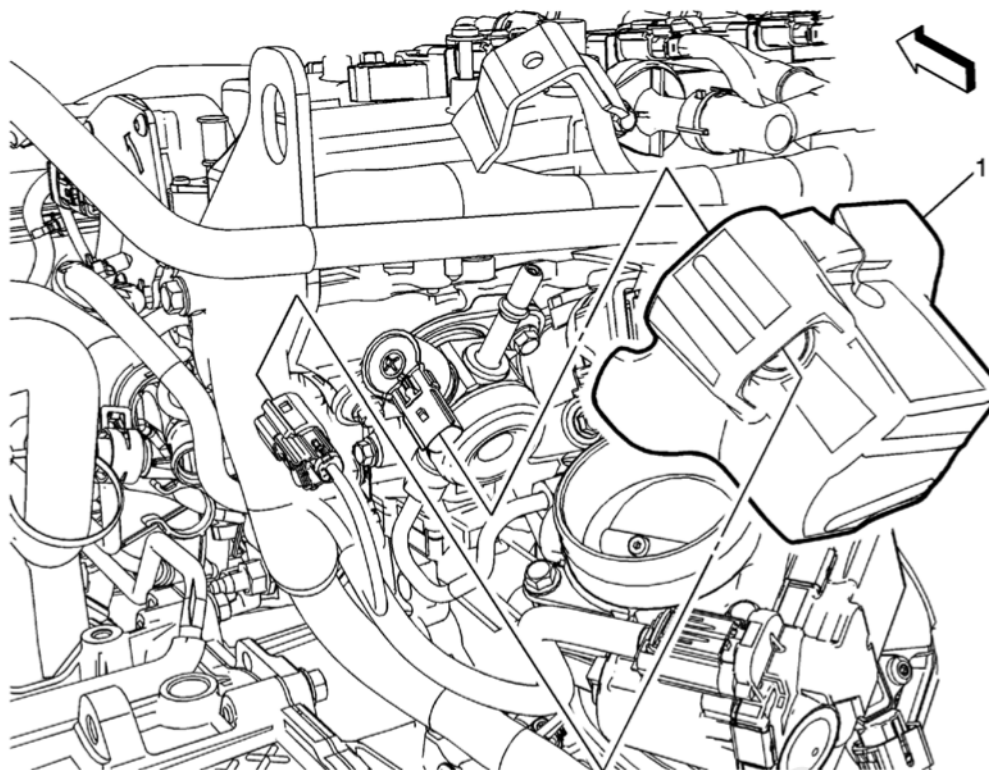


Fig. 84: Fuel Pump Insulator

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Fuel Pump Cover. Refer to Fuel Pump Cover Replacement 2. Disconnect the electrical connector.	
1	Fuel Pump Insulator WARNING: The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death. NOTE: The fuel pump insulator snaps into place.

FUEL FEED PIPE REPLACEMENT (AT TANK)

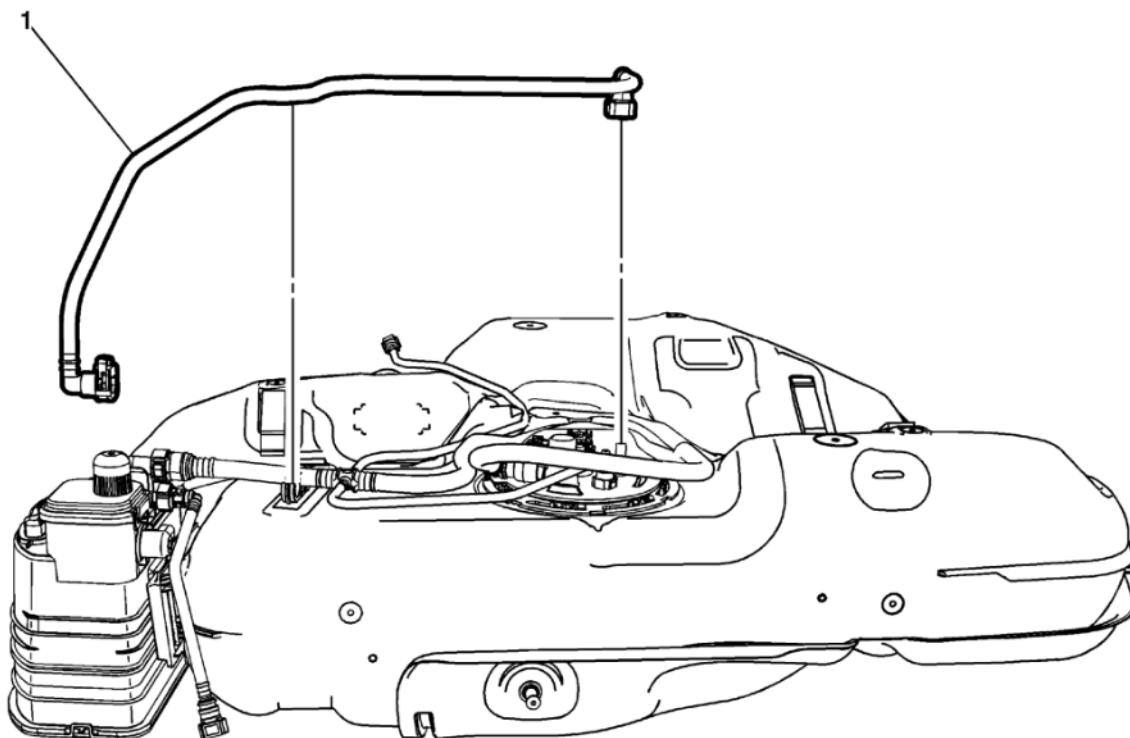


Fig. 85: Fuel Feed Pipe (At Tank)

Courtesy of GENERAL MOTORS COMPANY

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 (ENGINE TO CHASSIS)

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. Remove the fuel feed front pipe. Refer to [Fuel Feed Front Pipe Replacement](#).

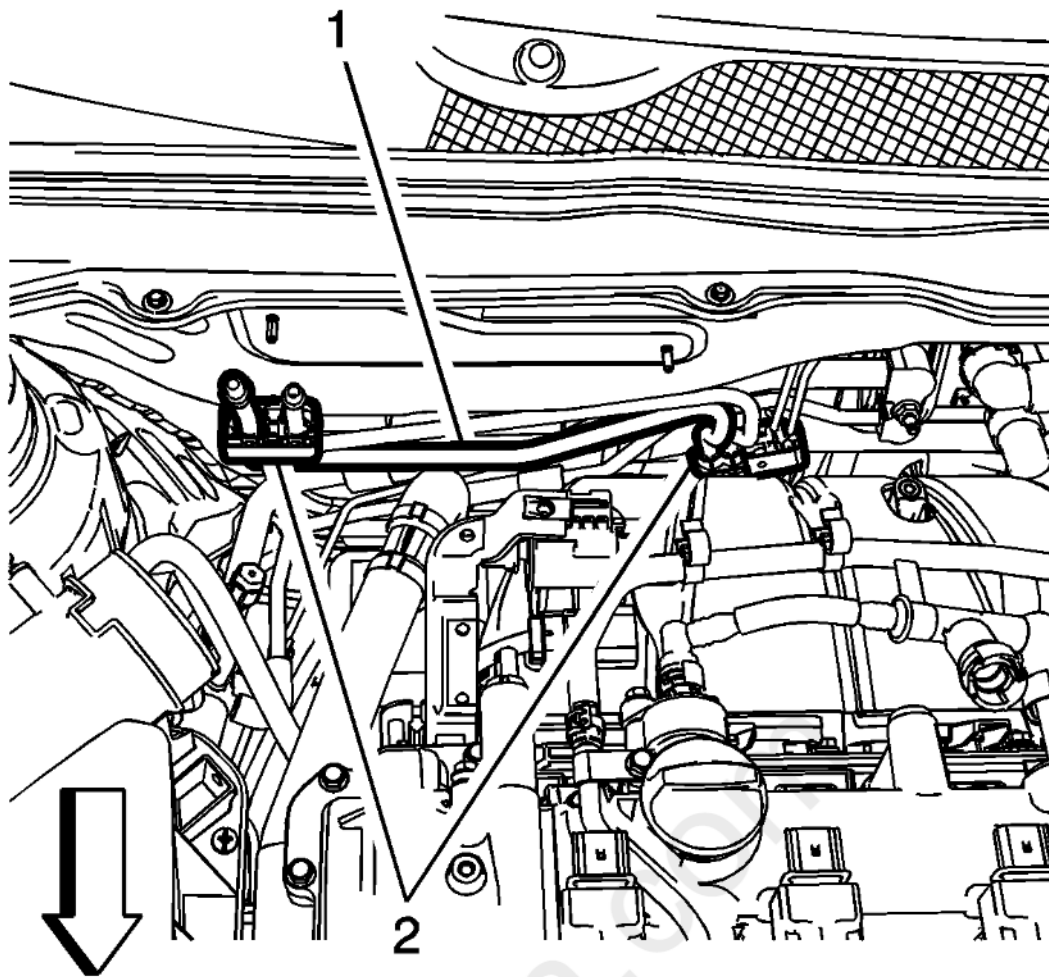


Fig. 86: Fuel Feed Pipe And Retainers

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](#).
5. Disconnect the fuel pressure sensor electrical connector.

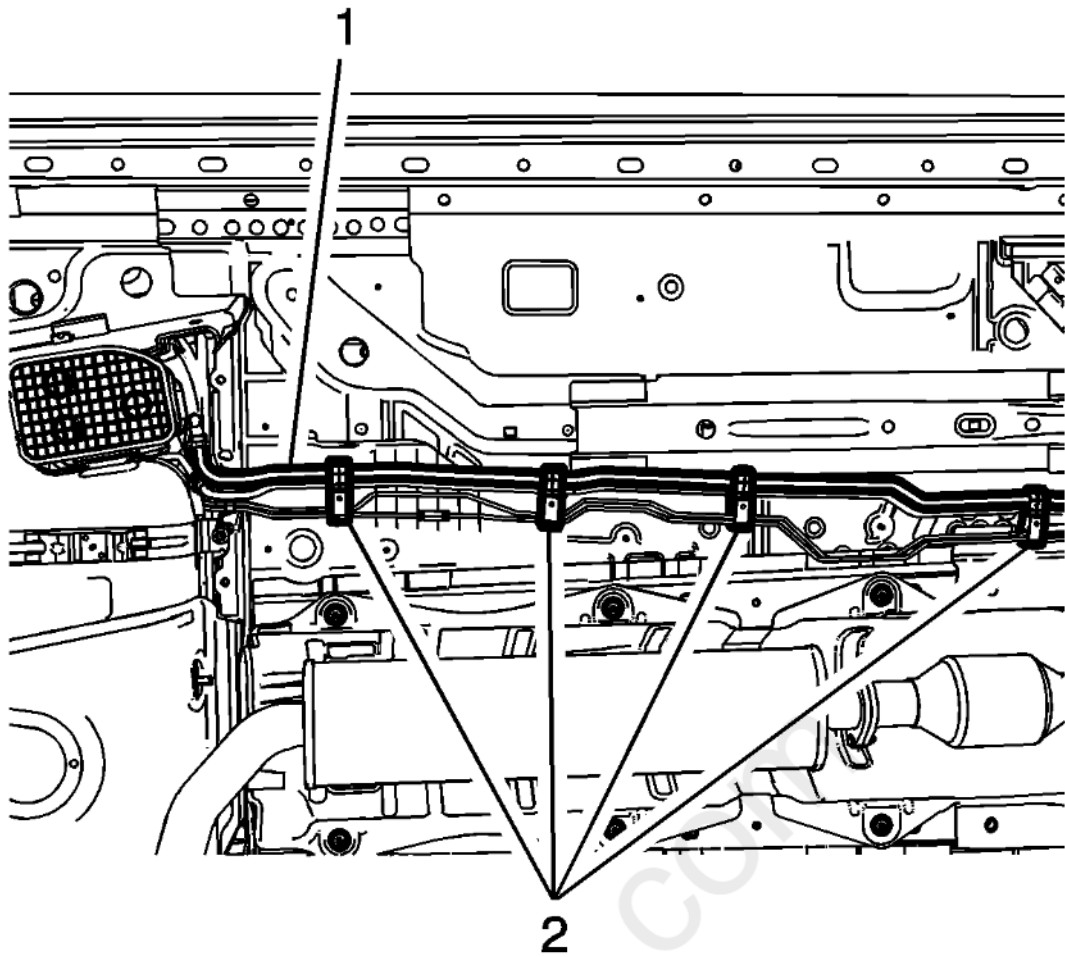


Fig. 87: Fuel Feed Pipe And Retainers

Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the fuel feed pipe (1) and remove from retainers (2). Refer to [**Plastic Collar Quick Connect Fitting Service**](#).
7. Remove the fuel feed pipe (1) from the vehicle.

Installation Procedure

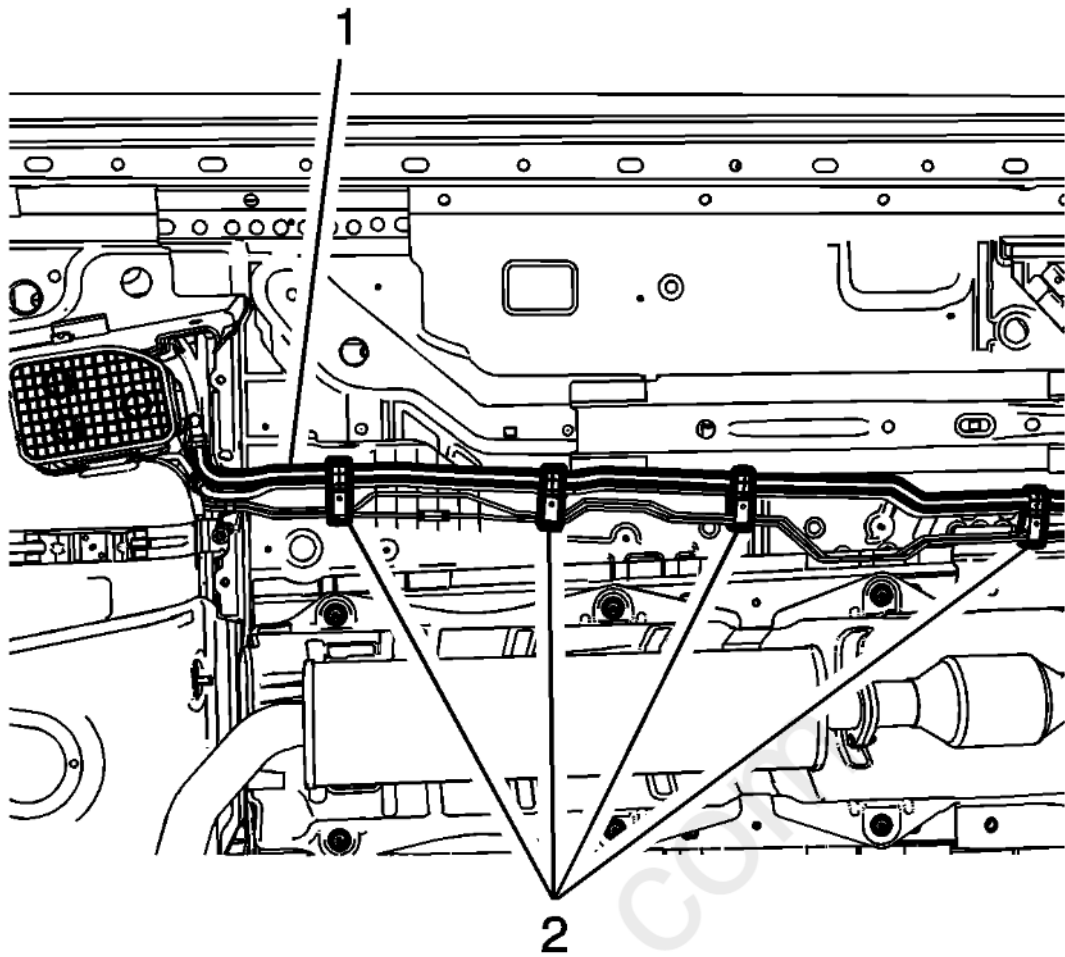


Fig. 88: Fuel Feed Pipe And Retainers

Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel feed pipe (1) to the vehicle.
2. Connect the fuel feed pipe (1) and install to the retainers (2). Refer to [**Plastic Collar Quick Connect Fitting Service**](#).
3. Connect the electrical connector to the fuel pressure sensor.
4. Lower the vehicle.

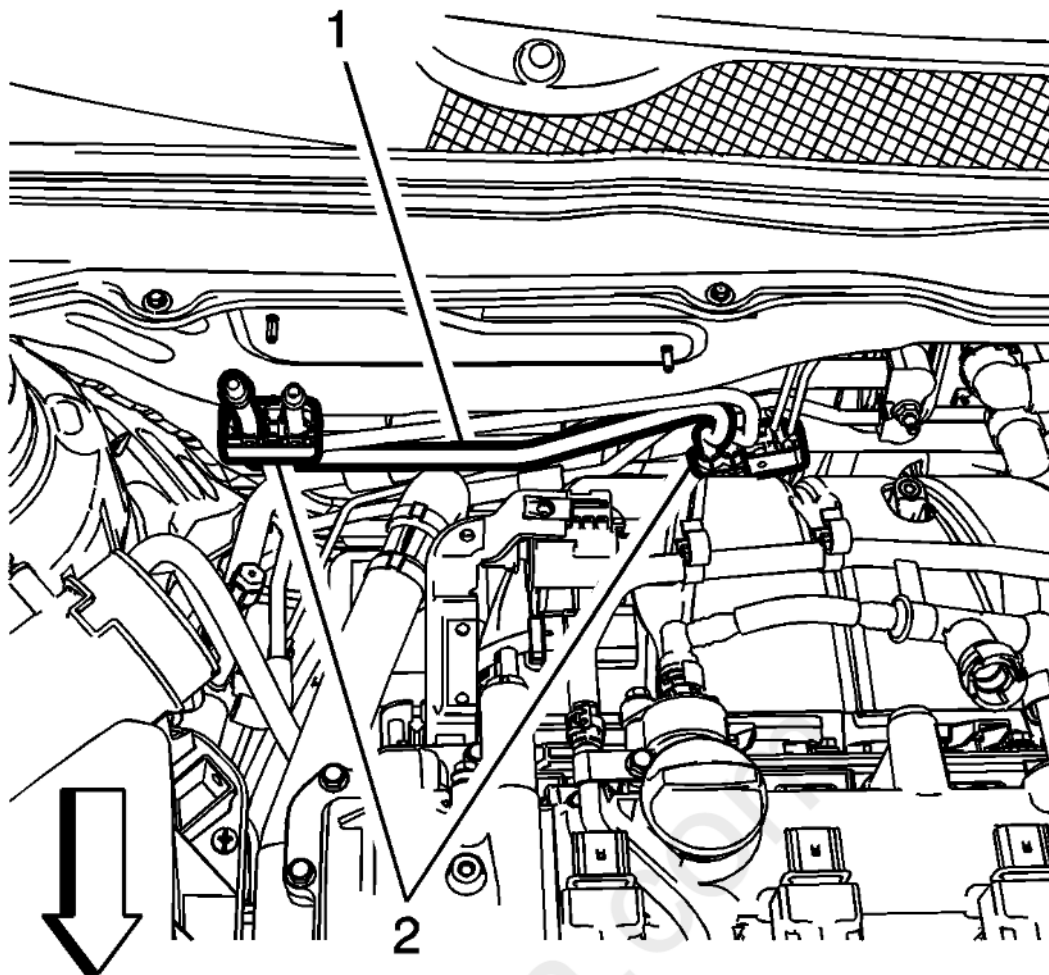


Fig. 89: Fuel Feed Pipe And Retainers

Courtesy of GENERAL MOTORS COMPANY

5. Install the fuel feed pipe (1) to the retainers (2).
6. Install the fuel feed front pipe. Refer to **Fuel Feed Front Pipe Replacement**.
7. Cycle the ignition on to run the fuel pump and check for fuel leaks.

FUEL FEED FRONT PIPE REPLACEMENT

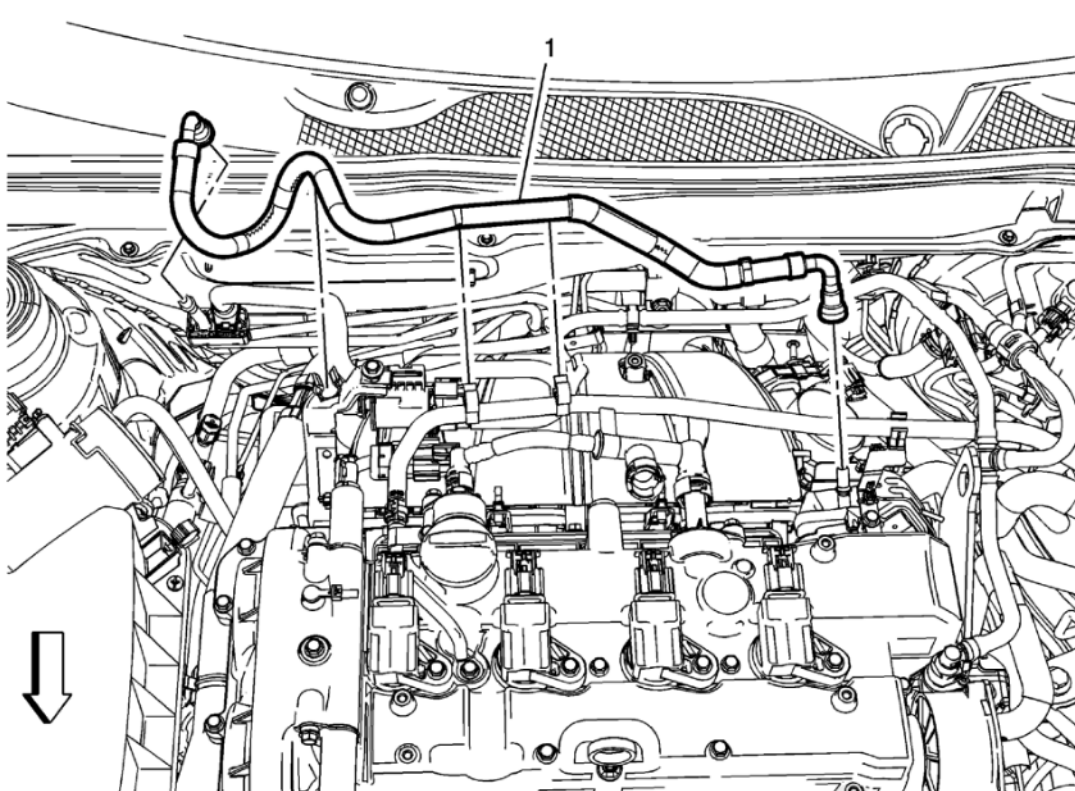


Fig. 90: Fuel Feed Front Pipe (LCV)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Relieve the system fuel pressure. Refer to Fuel Pressure Relief. 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement. 3. Remove the air cleaner resonator and outlet duct. Refer to Air Cleaner Resonator and Outlet Duct Replacement.	
1	Fuel Feed Front Pipe Procedure 1. Disconnect the fuel feed front pipe from the retainers. 2. Disconnect the fuel feed front pipe from the pump and line. Refer to Metal Collar Quick Connect Fitting Service.

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

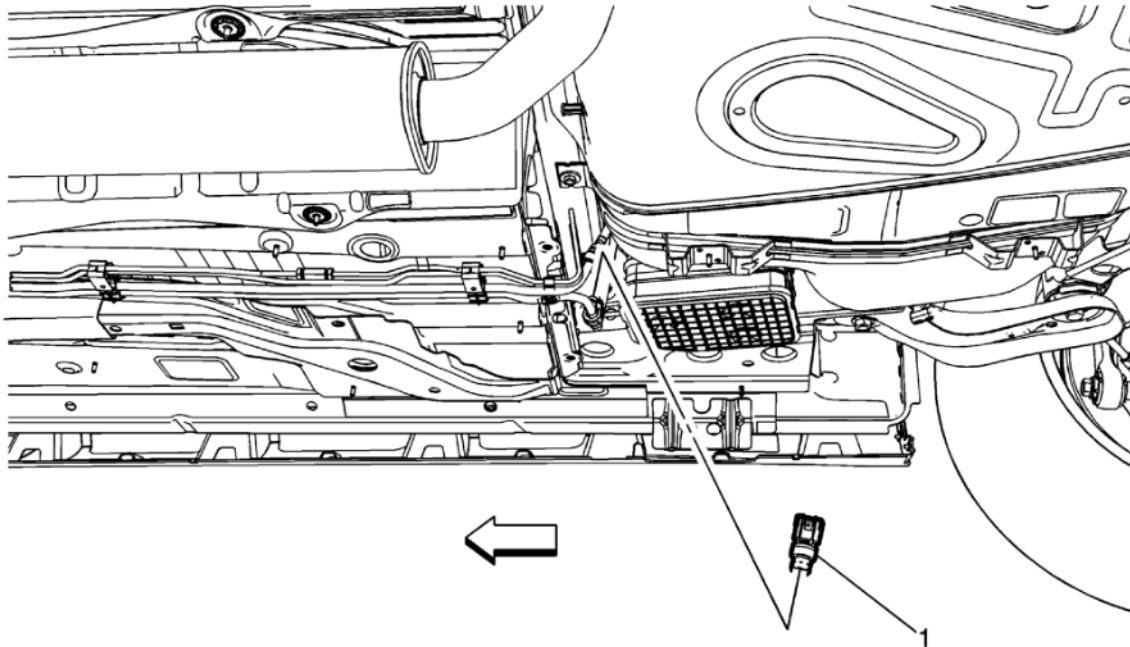


Fig. 91: Fuel Pressure Sensor - Fuel Feed Pipe
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to Fuel Pressure Relief. 2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle. 3. Remove the right side rear air deflector. Refer to Underbody Rear Air Deflector Replacement - Right Side.	
1	Fuel Pressure Sensor CAUTION: Refer to Component Fastener Tightening Caution . Procedure 1. Disconnect the electrical connector. 2. Use a NEW O-ring whenever the sensor is removed. Tighten 15 N.m (11 lb ft)

FUEL FEED INTERMEDIATE PIPE REPLACEMENT

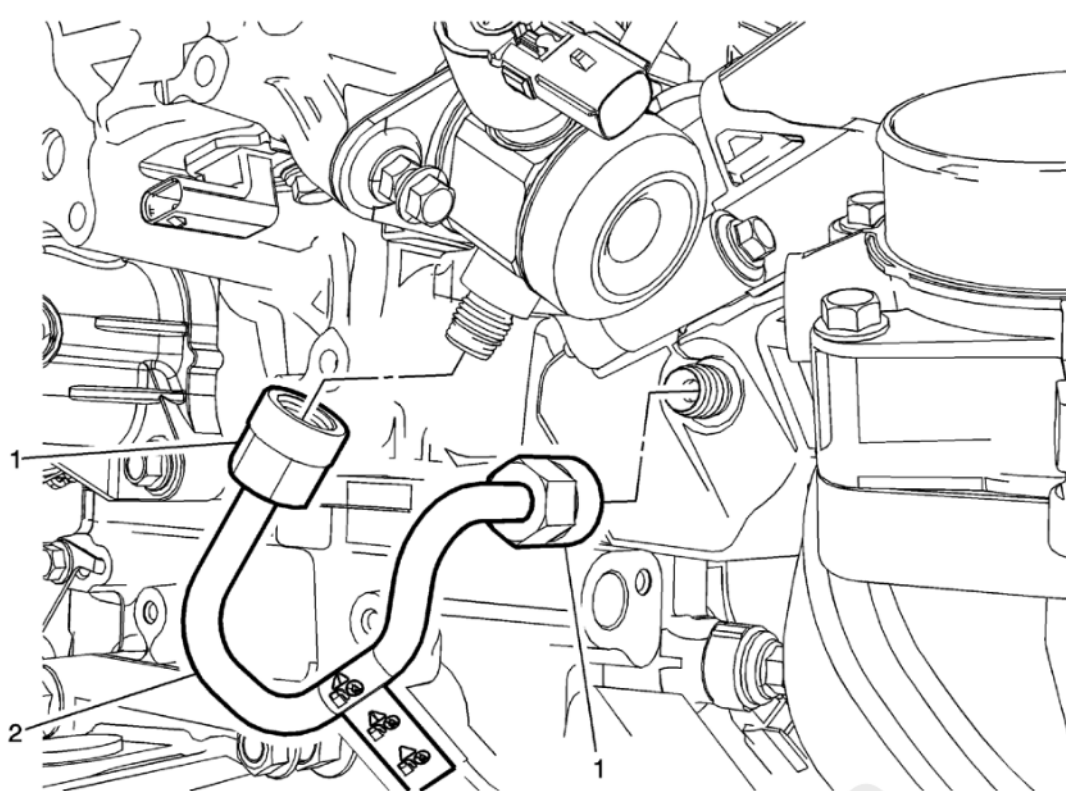


Fig. 92: Fuel Feed Intermediate Pipe

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Gasoline/Gasoline Vapors Warning .	
Preliminary Procedure 1. Relieve the fuel pressure. Refer to Fuel Pressure Relief. 2. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement . 3. Remove the air cleaner resonator and outlet duct. Refer to Air Cleaner Resonator and Outlet Duct Replacement. 4. Remove the fuel pump cover. Refer to Fuel Pump Cover Replacement.	
	Fuel Pump Intermediate Pipe Fittings (Qty: 2) CAUTION: Refer to Component Fastener Tightening Caution . Procedure 1 Hand start both ends of the NEW fuel feed intermediate pipe (2). Tighten 1. Tighten the fitting nut to the fuel rail to 15 N.m (11 lb ft). 2. Tighten the fitting nut to the fuel pump to 15 N.m (11 lb ft). 3. Tighten the fitting nut to the fuel rail a final pass to 30 N.m (22 lb ft). 4. Tighten the fitting nut to the fuel pump a final pass to 30 N.m (22 lb ft).

Callout	Component Name
2	Fuel Pump Intermediate Pipe NOTE: The threaded fuel pipes are one time use, always install a NEW fuel pump intermediate pipe.

FUEL TANK VENT PIPE REPLACEMENT

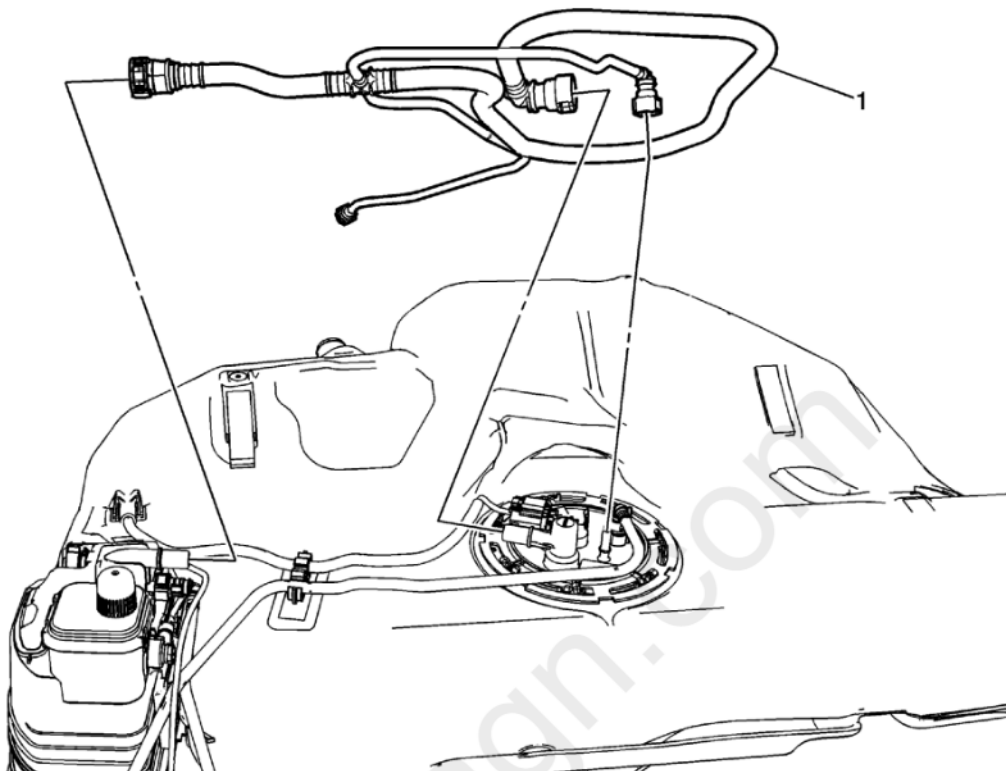


Fig. 93: Fuel Tank Vent Pipe

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to Fuel Tank Replacement .	
1	Fuel Tank Vent Pipe Procedure Disconnect the fuel tank vent pipe quick connects. Refer to Plastic Collar Quick Connect Fitting Service .

FUEL PUMP REPLACEMENT

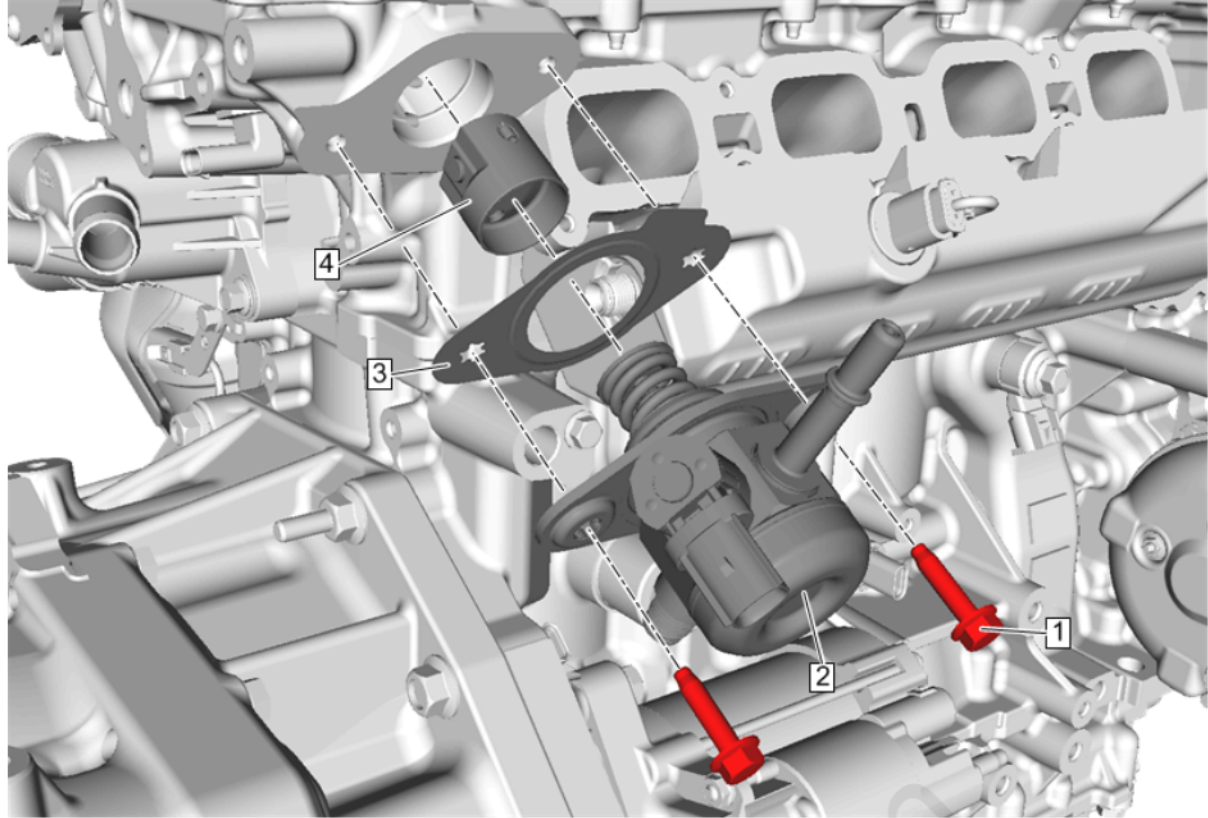


Fig. 94: Fuel Pump

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to Gasoline/Gasoline Vapors Warning .	
Preliminary Procedures 1. Relieve the fuel pressure. Refer to Fuel Pressure Relief 2. Remove Fuel Pump Insulator. Refer to Fuel Pump Insulator Replacement 3. Remove Fuel Feed Intermediate Pipe. Refer to Fuel Feed Intermediate Pipe Replacement 4. Disconnect the fuel pump fuel feed hose from the fuel pump. Refer to Metal Collar Quick Connect Fitting Service	
Special Tools EN-50790 HP Fuel Pump Installation Alignment GaugeEquivalent regional tools: Special Tools	

Callout	Component Name
1	Fuel Pump Bolt (Qty: 2) CAUTION: Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without even side-to-side tightening may result in pump plunger damage. CAUTION: Refer to Fastener Caution . CAUTION: Refer to Torque-to-Yield Fastener Caution . Procedure 1. Add thread locker to the fuel pump fastener threads prior to installing the NEW bolts. Refer to Adhesives, Fluids, Lubricants, and Sealers 2. Tighten 1. First Pass: 8 N.m (71 lb in) 2. Second Pass: + 50 Degrees
2	Fuel Pump Gasket NOTE: Install a NEW fuel pump gasket. Ensure the fuel pump housing gasket is properly aligned with the tab upward at the 2 o'clock position.
3	Fuel Pump NOTE: To aid installation of the fuel pump, rotate the engine so that the fuel pump lobe of the intake cam is at it's lowest point. Use the EN-50790 alignment gauge to ensure that the camshaft lobe is in the base circle position. At the base circle position, the tool will be flush with the head. Lubricate the high pressure fuel pump cylinder head bore with clean engine oil. Refer to Adhesives, Fluids, Lubricants, and Sealers
4	Valve Lifter Follower NOTE: The valve lifter follower may slide out of the cylinder head upon fuel pump removal. NOTE: Lubricate the high pressure fuel pump roller with clean engine oil prior to installation. Refer to Adhesives, Fluids, Lubricants, and Sealers

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT

Special Tools

- EN-49248 Fuel Rail Assembly Remover
- EN-47909 Injector Bore and Sleeve Cleaning Kit

For equivalent regional tools, refer to [Special Tools](#) .

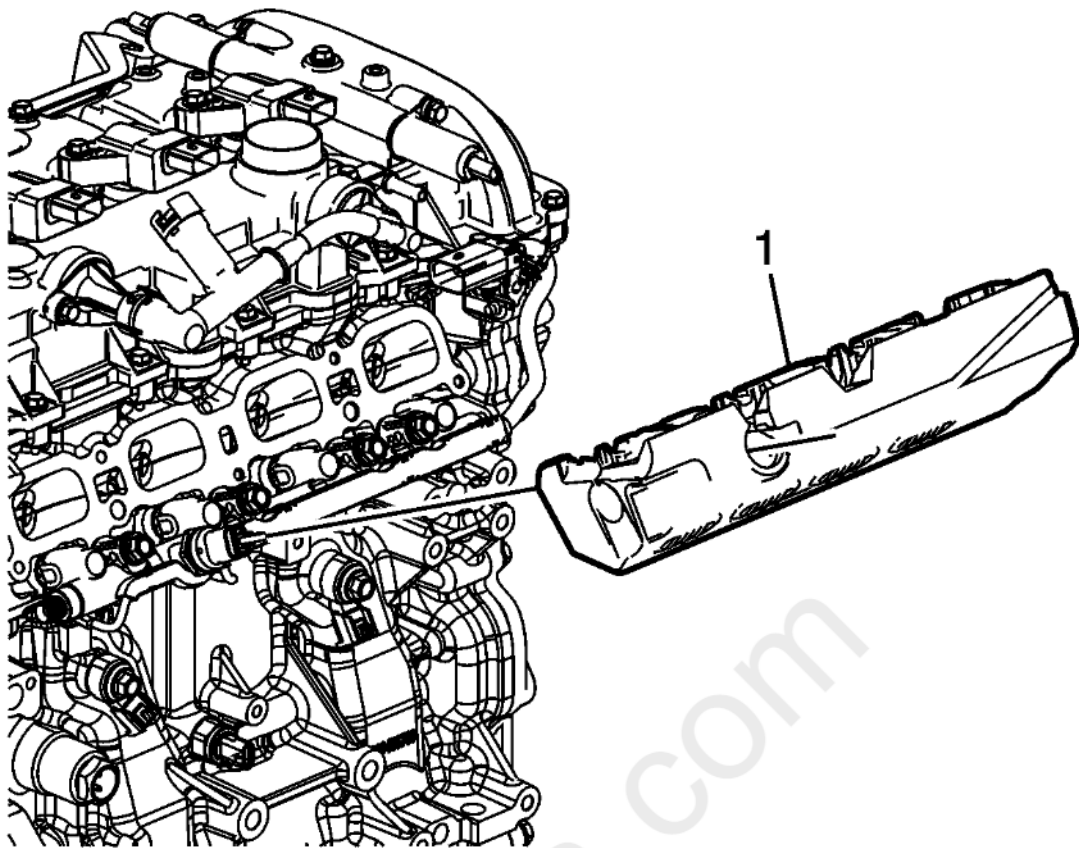


Fig. 95: Fuel Injection Fuel Rail Noise Shield

Courtesy of GENERAL MOTORS COMPANY

WARNING: The noise cancelling foam component **MUST** be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

1. Remove the fuel injection fuel rail noise shield (1). Refer to [**Fuel Injection Fuel Rail Noise Shield Replacement**](#).
2. Remove the fuel feed intermediate pipe. Refer to [**Fuel Feed Intermediate Pipe Replacement**](#).
3. Remove the fuel injection fuel rail pressure sensor. Refer to [**Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**](#).
4. Disconnect the electrical harness from the fuel rail harness connection.
5. Remove the fuel rail assembly retaining bolts and upper rubber grommets, if necessary.

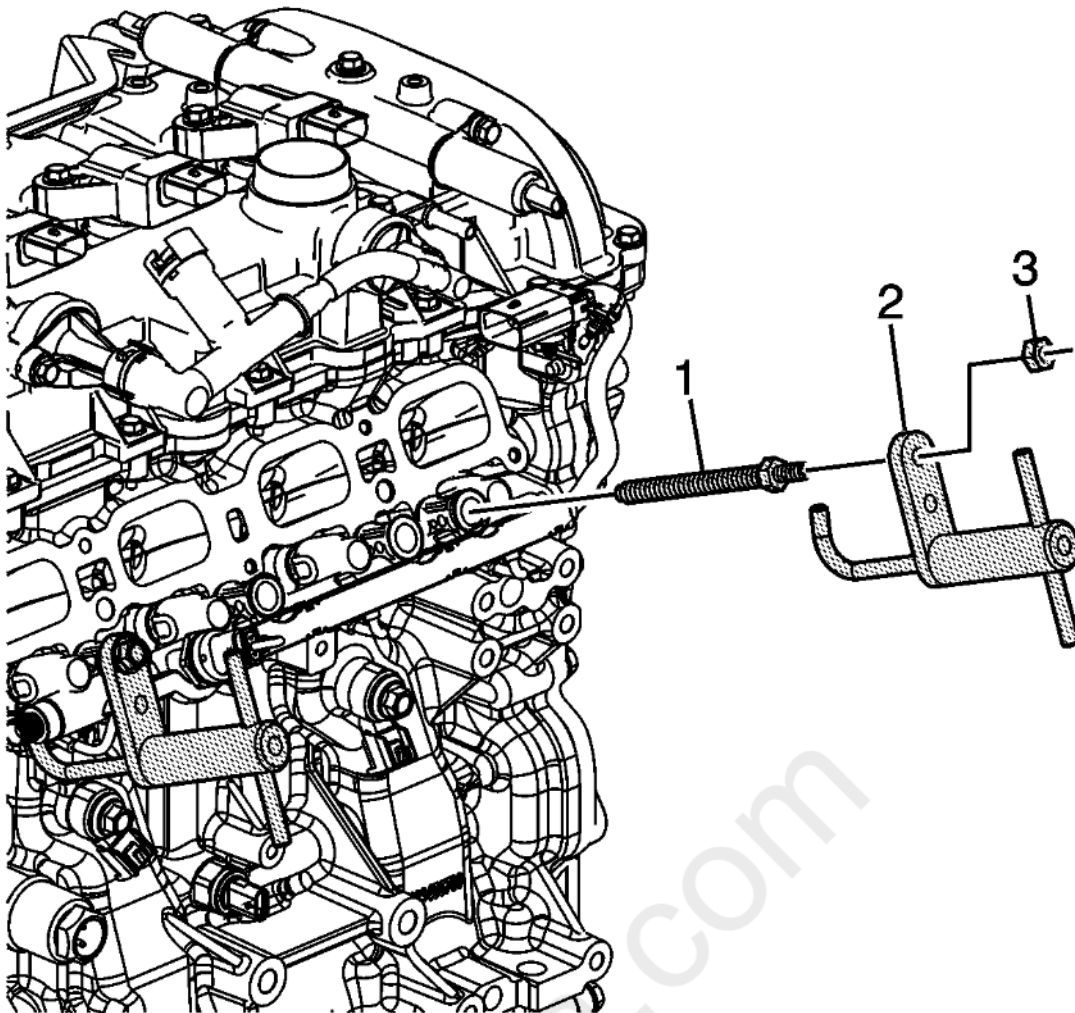


Fig. 96: Fuel Rail Assembly Remover And Studs

Courtesy of GENERAL MOTORS COMPANY

NOTE: Use care to avoid contact with the fuel rail harness during special tool installation and fuel rail removal.

6. Install **EN-49248** studs (1) into the 2 outermost fuel rail assembly retaining bolt locations. Tighten the studs to 22 N.m (16 lb ft).
7. Install **EN-49248** remover (2) onto each stud, and engage the hooks to the fuel rail. Install the nuts (3) retaining the remover onto the studs and tighten until snug.

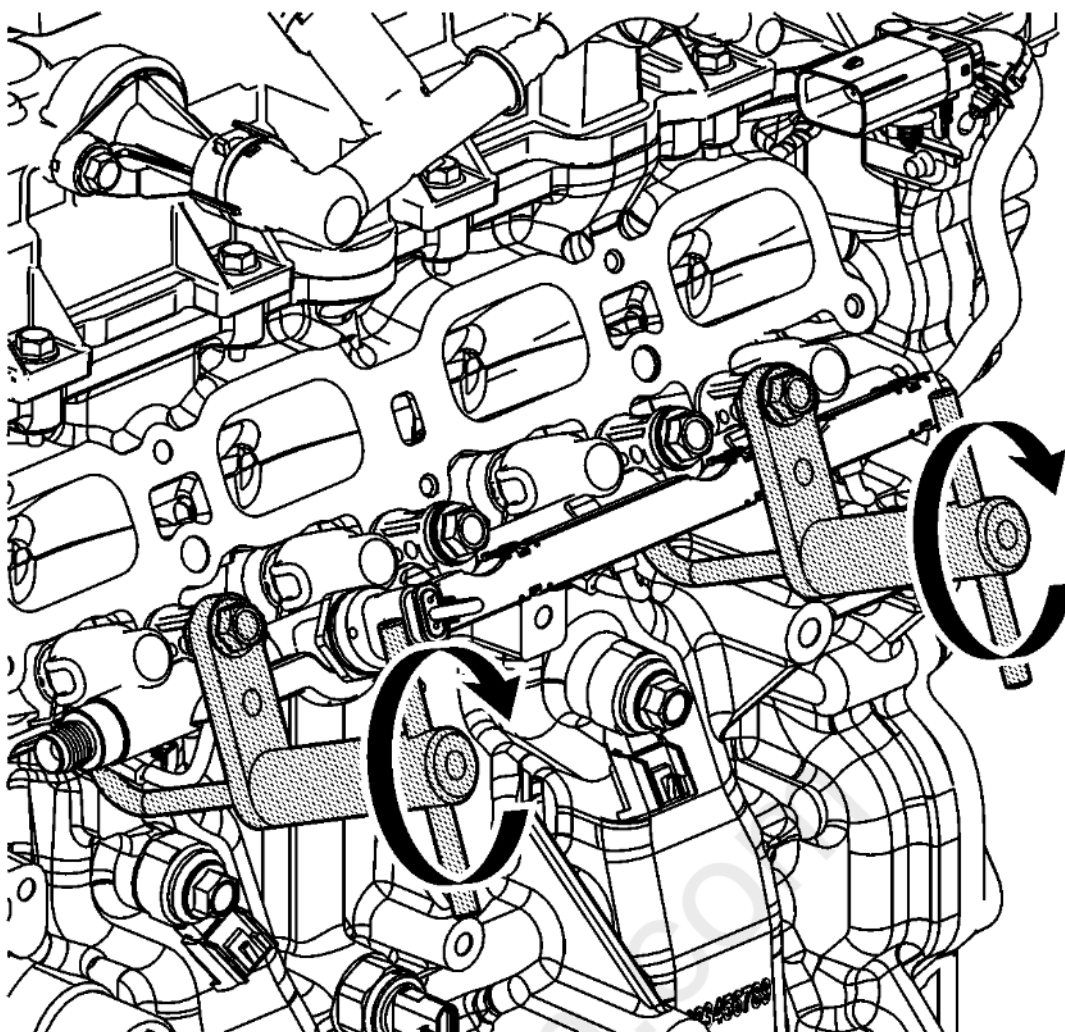


Fig. 97: Removing Fuel Rail Assembly Using Fuel Rail Assembly Remover

Courtesy of GENERAL MOTORS COMPANY

NOTE: EN-49248 will assist in the proper removal of the fuel rail assembly. Ensure that the following conditions are met:

- Turn the handles simultaneously in order to pull the fuel rail straight out along the fuel injector axis.
- DO NOT twist when pulling out on the fuel rail and injector assembly.

8. Using EN-49248 remover, remove the fuel rail assembly.

Installation Procedure

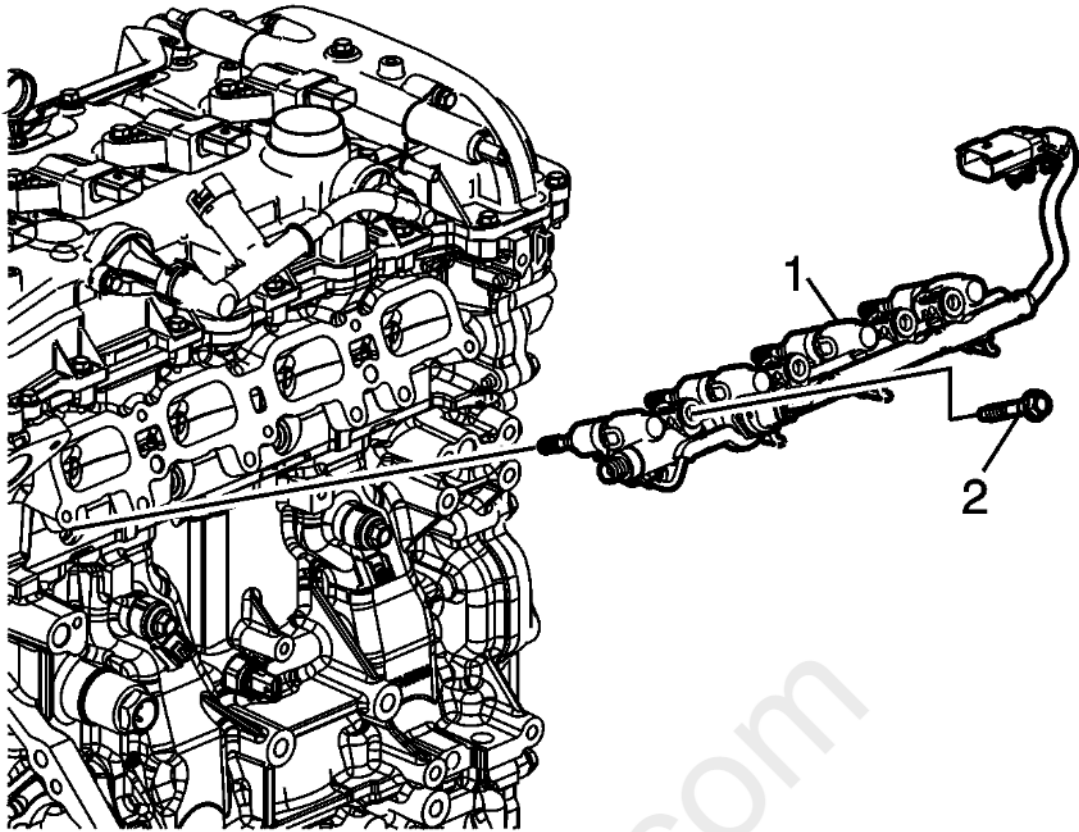


Fig. 98: Fuel Rail And Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Clean the fuel injector bore in the cylinder head using the **EN-47909** kit.
2. Install NEW fuel injector spacers and O-rings. Refer to **Fuel Rail and Injectors Cleaning and Inspection**
3. Replace the fuel rail insulators, if necessary. Refer to **Fuel Rail and Injectors Cleaning and Inspection**
4. Install the fuel rail (1) with injectors into the cylinder head evenly.

NOTE: Mount the bolts evenly to avoid cocking of the fuel injectors during installation.

5. Hand start the 2 outer fuel rail bolts (2) to seat the injectors into the injector bores.
6. Hand start the remaining fuel rail bolts.

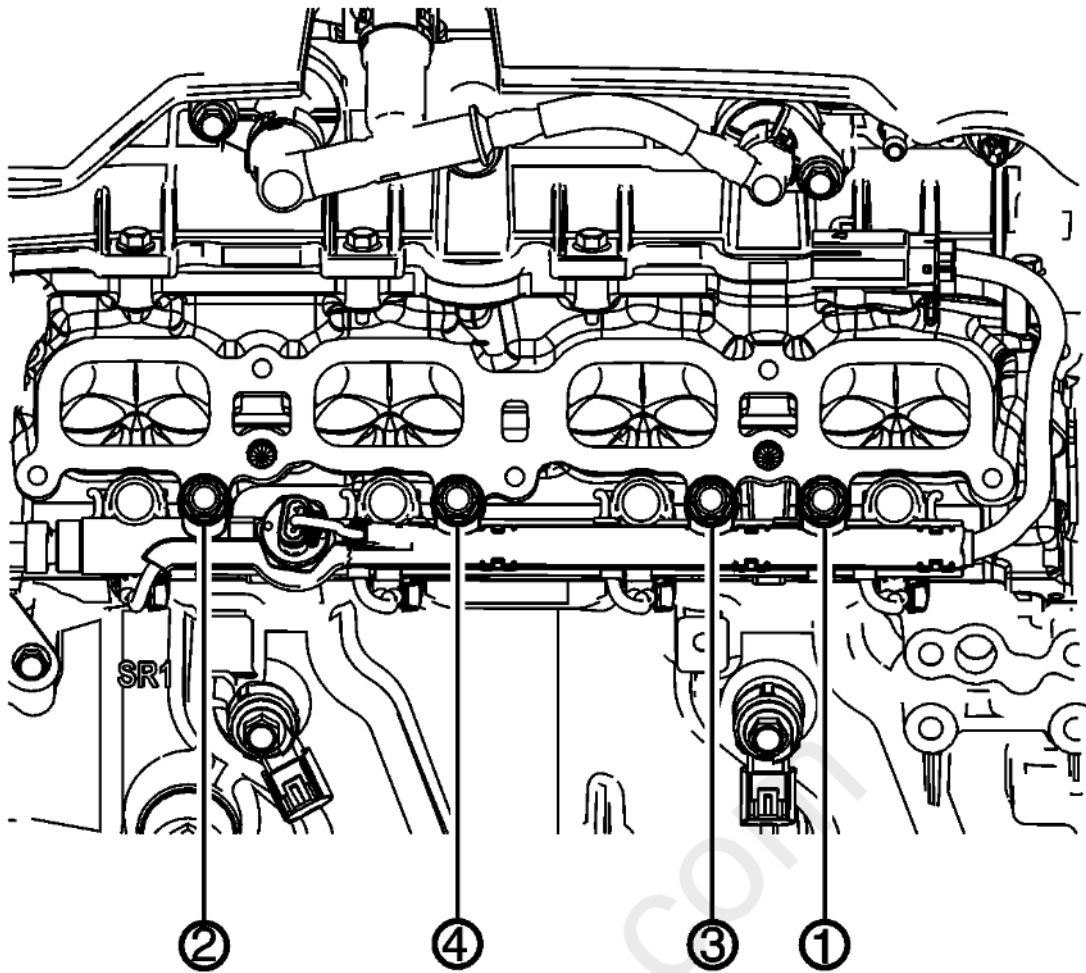


Fig. 99: Fuel Rail Bolt Tightening Sequence

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

7. Tighten the fuel rail bolts in sequence to 25 N.m (18 lb ft).
8. Connect the electrical harness to the fuel rail harness connections.
9. Install the fuel injection fuel rail pressure sensor. Refer to [Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement](#).
10. Install the fuel feed intermediate pipe. Refer to [Fuel Feed Intermediate Pipe Replacement](#).

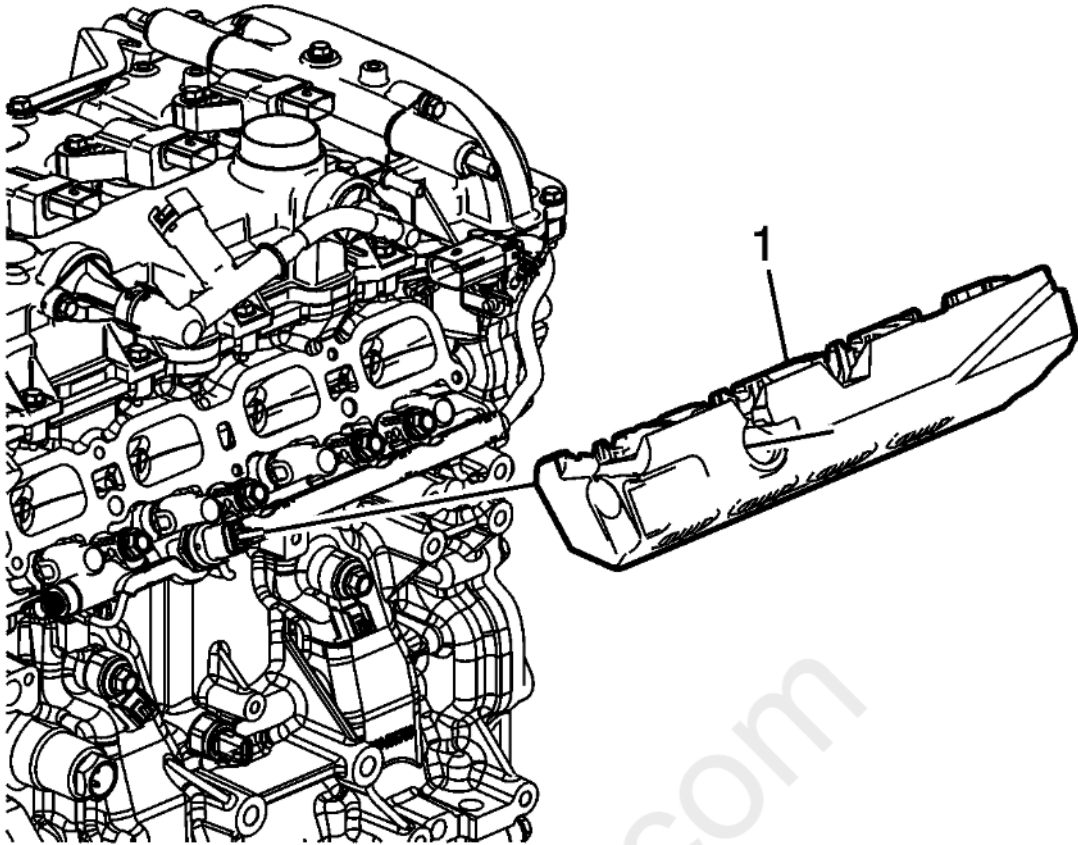
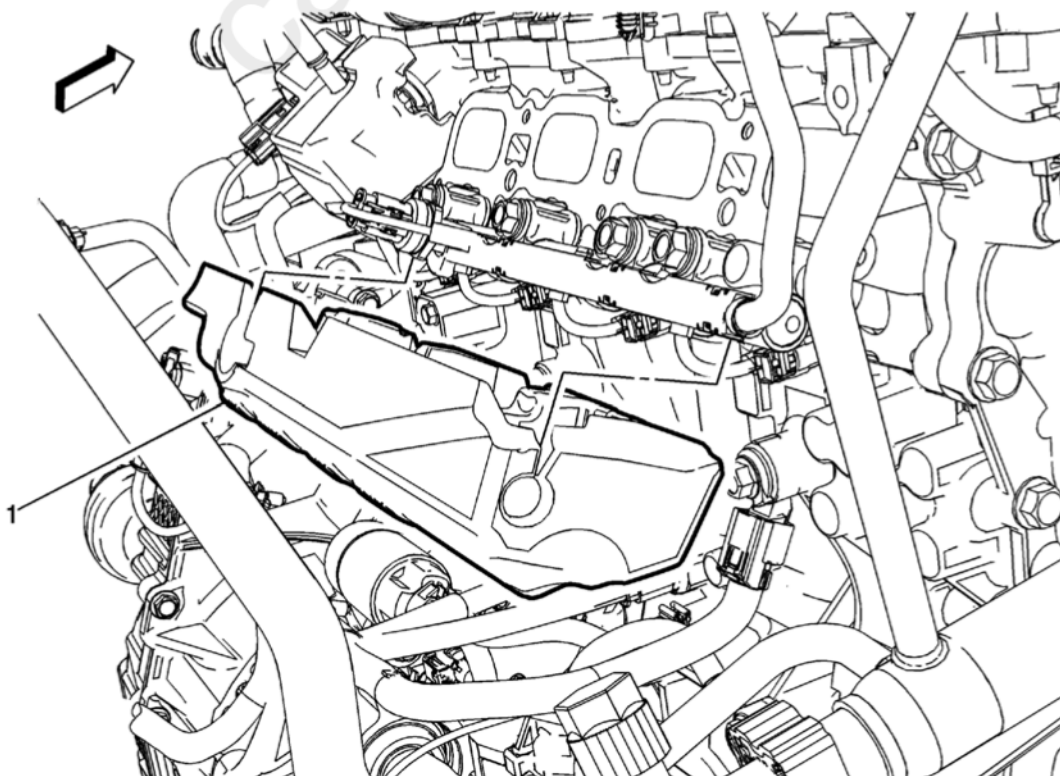


Fig. 100: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

11. Install the fuel injection fuel rail noise shield (1). Refer to **Fuel Injection Fuel Rail Noise Shield Replacement**.

FUEL INJECTION FUEL RAIL NOISE SHIELD REPLACEMENT



Callout	Component Name
Preliminary Procedure Remove Intake Manifold. Refer to Intake Manifold Replacement	
1	Fuel Injection Fuel Rail Noise Shield WARNING: The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death. NOTE: The fuel injection fuel rail noise shield snaps into place.

FUEL INJECTION FUEL RAIL FUEL PRESSURE SENSOR REPLACEMENT

Removal Procedure

1. Relieve the fuel system pressure. Refer to [Fuel Pressure Relief](#)

NOTE: It is NOT necessary to completely remove the intake manifold to gain access to the fuel injection fuel rail fuel pressure sensor.

2. Reposition Intake Manifold. Refer to [Intake Manifold Replacement](#)
3. Reposition Fuel Injection Fuel Rail Noise Shield. Refer to [Fuel Injection Fuel Rail Noise Shield Replacement](#)

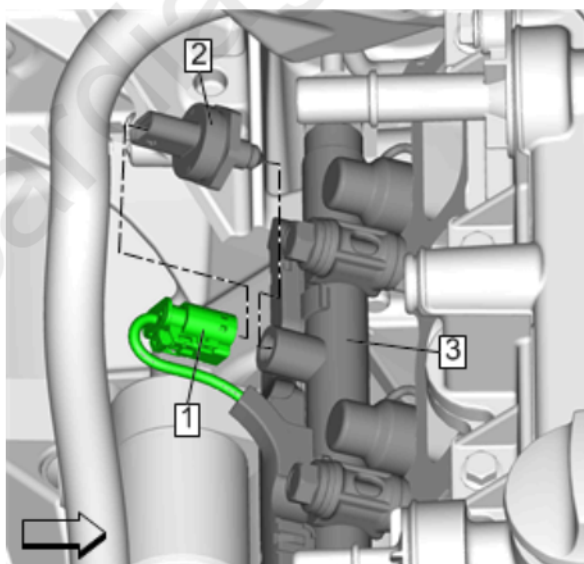


Fig. 102: Fuel Injection Fuel Rail, Fuel Rail Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector (1).

CAUTION: Refer to [Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution](#) .

NOTE:

- Do NOT apply force to the plastic housing of the fuel injection fuel rail fuel pressure sensor. ONLY apply force to the attached hexagon.

- Some fuel may leak from the fuel injection fuel rail orifice after the sensor is removed. Dry the area around the orifice using a lint free cloth.
- After removal, the area around the fuel injection fuel rail sealing surface should be inspected. The surface should be free of fuel, dirt, debris, and burrs.

5. Remove and DISCARD the fuel injection fuel rail fuel pressure sensor (2).

Installation Procedure

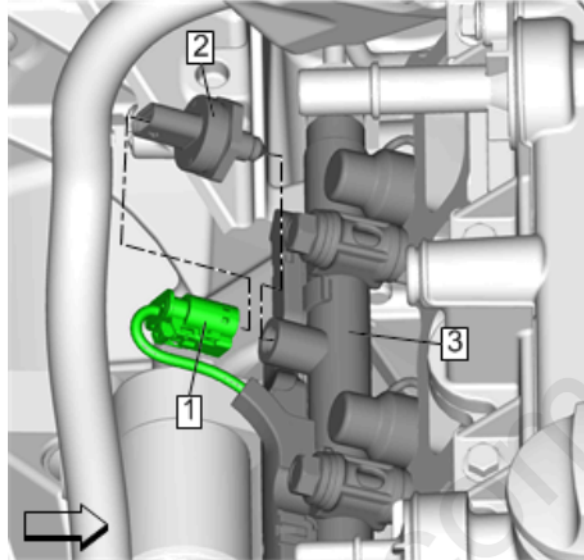


Fig. 103: Fuel Injection Fuel Rail, Fuel Rail Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Component Fastener Tightening Caution](#) .

NOTE:

- Do NOT apply force to the plastic housing of the fuel injection fuel rail fuel pressure sensor. ONLY apply force to the attached hexagon.
- BEFORE installation of the fuel injection fuel rail fuel pressure sensor, the fuel injection fuel rail threads MUST be clean and free of any fuel or the sensor will NOT seal properly.

1. To install the NEW fuel injection fuel rail fuel pressure sensor (2) properly, perform the following steps:
 1. Lubricate the sensor threads and sealing surface with one drop of clean engine oil.
 2. Install the sensor and hand tighten.
 3. Remove the sensor.
 4. Re-lubricate the sensor threads and sealing surface with one drop of clean engine oil.
 5. Install the sensor and tighten to 33 N.m (24 lb ft).
2. Connect the electrical connector (1).

NOTE: If a fuel leak occurs at the fuel injection fuel rail, the fuel rail will need to be replaced.

3. Pressurize the fuel system and inspect for leaks.
4. Install Fuel Injection Fuel Rail Noise Shield. Refer to [Fuel Injection Fuel Rail Noise Shield Replacement](#)
5. Install Intake Manifold. Refer to [Intake Manifold Replacement](#)

FUEL INJECTOR REPLACEMENT

Special Tools

- EN-47909 Injector Bore and Sleeve Cleaning Kit
- EN-49245 Fuel Injector Seal Installer and Sizer
- EN-50791 Fuel Injector Nozzle Installer
- EN-51105 Fuel Injector Seal Installer

Equivalent regional tools: [Special Tools](#)

CAUTION: Use care in removing the fuel injectors in order to prevent damage to the fuel injector electrical connector pins or the fuel injector nozzles. Do not immerse the fuel injector in any type of cleaner. The fuel injector is an electrical component and may be damaged by this cleaning method.

1. Remove Fuel Injection Fuel Rail. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#)

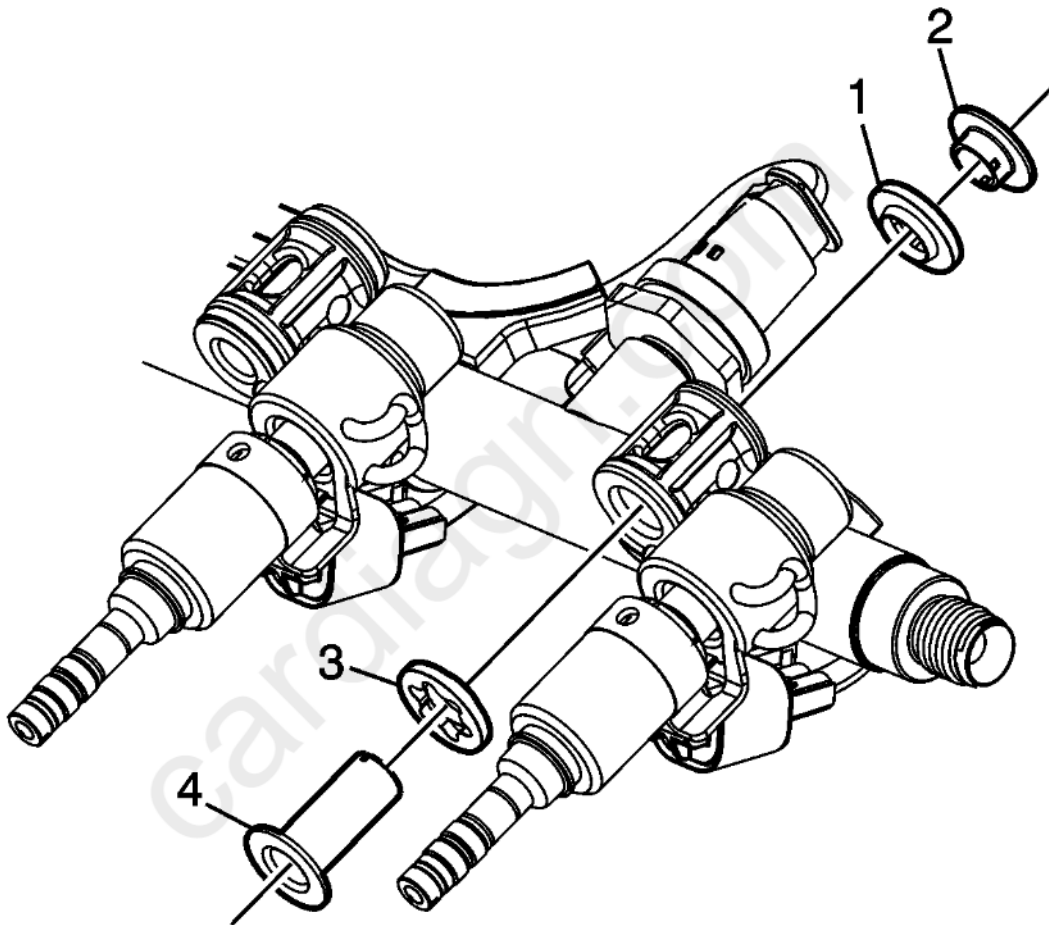


Fig. 104: Fuel Rail Insulator Assemblies

Courtesy of GENERAL MOTORS COMPANY

2. Remove and inspect the fuel rail insulator assemblies (1 - 4). Replace the entire assembly if any components show signs of wear or the insulators (4) show the following conditions:
 - Dry or cracked appearance
 - Flattened or misshapen appearance

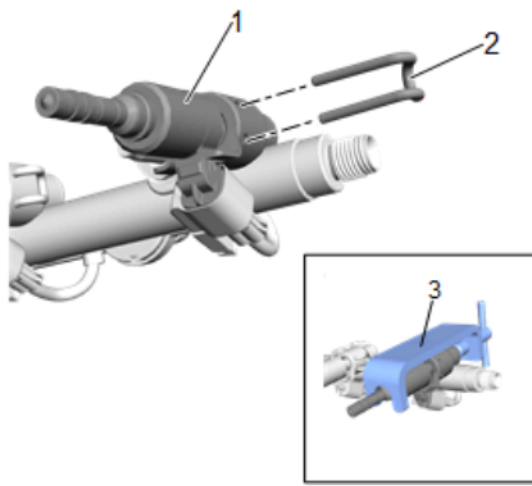


Fig. 105: Fuel Injector, Installer And Retaining Pin

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the electrical connectors from the fuel injectors.
4. Use the **EN-50791** installer (3) to compress the fuel injector (1) and relieve pressure on the retaining pin (2). Remove the fuel injector retaining pin (2). Remove the **EN-50791** installer once the retaining pin is removed.

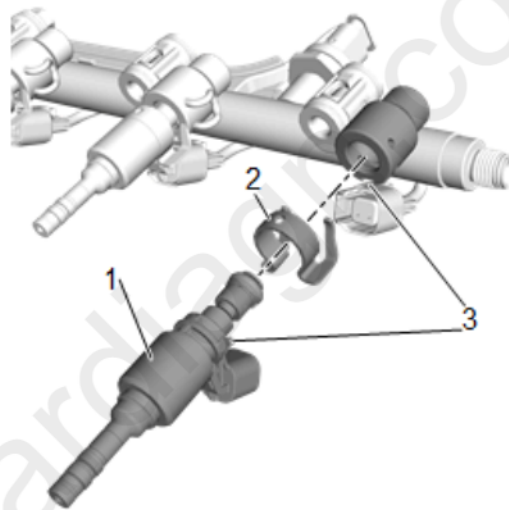


Fig. 106: Injectors, Holding Clamp And Fuel Rail Slot

Courtesy of GENERAL MOTORS COMPANY

NOTE:

- Support the fuel injector at the widest point.
- Support the fuel injection fuel rail along the bottom.
- Do NOT support or hold the fuel injector by the tip or connector.
- Do NOT tilt or excessively twist the fuel injector during removal.

5. Remove the fuel injector (1) from the fuel injection fuel rail by pulling it straight out along the fuel injector axis. Slight rotation of the fuel injector is acceptable as long as excessive force is not applied to the fuel injector tab while engaged in the fuel rail slot (3).
6. Remove the fuel injector holding clamp (2) from the rear of the fuel injector.

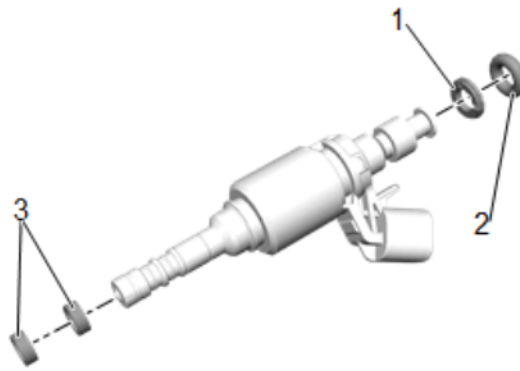


Fig. 107: Fuel Injector O-Ring, Plastic Spacer And Seals
 Courtesy of GENERAL MOTORS COMPANY

7. Remove and DISCARD the fuel injector O-ring (2) and spacer (1).
8. Remove and DISCARD the fuel injector seals (3).

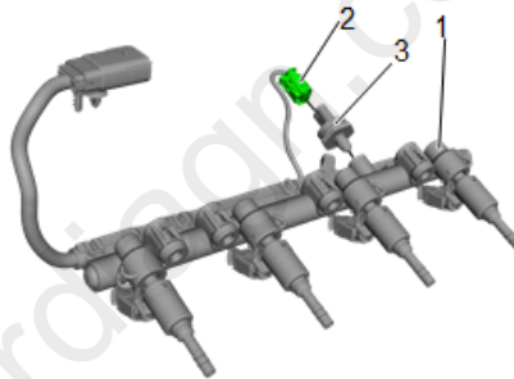


Fig. 108: Fuel Rail, Fuel Pressure Sensor And Harness Connector
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT soak or submerge the fuel injection fuel rail or the fuel injectors in solvent. Do NOT use solvent on the fuel rail label.

9. Clean the exterior of the fuel injection fuel rail (1) and the fuel injectors in solvent.
10. Use the **EN-47909** cleaning kit to clean the fuel injector bores and sleeves.
11. Inspect the fuel injection fuel rail and components for the following conditions:
 - Damage, debris, or restrictions to the fuel rail
 - Damage, debris, or restrictions to the fuel ports in the fuel rail
 - Damage to the mounting area for the fuel rail
 - Damage to the fuel rail mounting bolts
 - Damage to the threads on the fuel rail fuel feed fitting
12. Replace the fuel injection fuel rail if ANY damage is found. Do NOT attempt to repair a fuel rail.

CAUTION: Refer to **Fastener Caution** .

NOTE: Remove and inspect the fuel injection fuel rail fuel pressure sensor **ONLY** if the sensor is suspect.

13. Remove and inspect the fuel injection fuel rail fuel pressure sensor (3) for damage using the following procedure:

1. Disconnect the wiring harness connector from the fuel injection fuel rail fuel pressure sensor.
2. Remove the fuel injection fuel rail fuel pressure sensor. Dry the pressure sensor bore in the fuel rail with a lint free cloth. The bore should be free of fuel, debris, and burrs.
3. Lubricate the fuel injection fuel rail fuel pressure sensor bore with clean engine oil.
4. Lubricate the threads and sealing area on the fuel injection fuel rail fuel pressure sensor with clean engine oil.
5. Install the fuel injection fuel rail fuel pressure sensor hand tight.
6. Remove the fuel injection fuel rail fuel pressure sensor and re-lubricate the bore, threads, and sealing area.
7. Install the fuel injection fuel rail fuel pressure sensor and tighten to 33 N.m (24 lb ft).
8. Connect the wiring harness connector to the fuel injection fuel rail fuel pressure sensor.

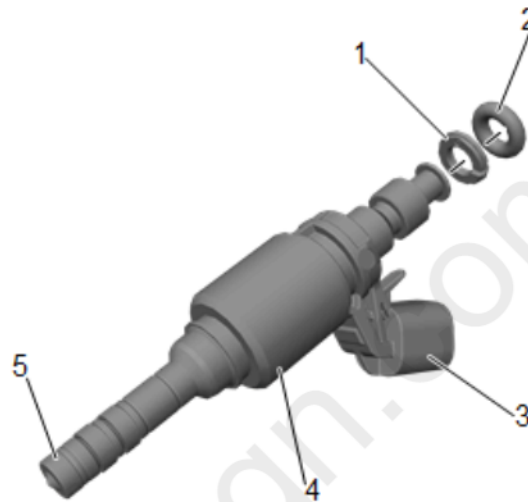


Fig. 109: Inspecting Fuel Injectors

Courtesy of GENERAL MOTORS COMPANY

14. Inspect the fuel injectors for the following conditions:

- Damage to the fuel injector connector (3)
- Damage to the fuel injector harness connector
- Damage to the fuel injector tip (5)
- Damage to the fuel injector (4)

15. Replace the fuel injector if ANY damage is found. Do NOT attempt to repair a fuel injector.

16. Install the NEW fuel injector spacer (1).

NOTE: Lubricate the NEW fuel injector O-ring with clean engine oil.

17. Install the NEW fuel injector O-ring.

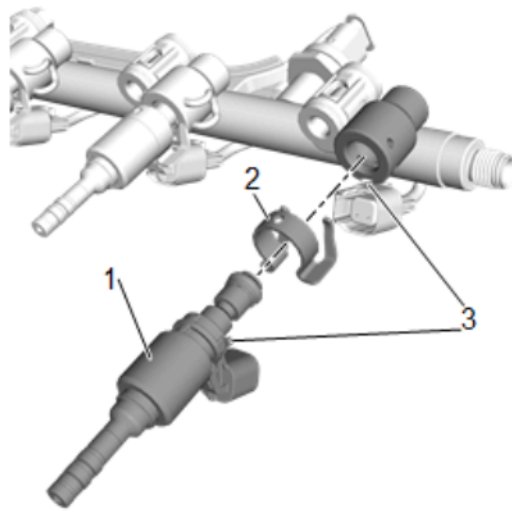


Fig. 110: Injectors, Holding Clamp And Fuel Rail Slot
 Courtesy of GENERAL MOTORS COMPANY

18. Install the fuel injector holding clamp (2) onto the rear of the fuel injector.
19. Hand install the fuel injector (1) to the fuel injection fuel rail, carefully aligning the fuel injector tab to the slot in the fuel rail (3).

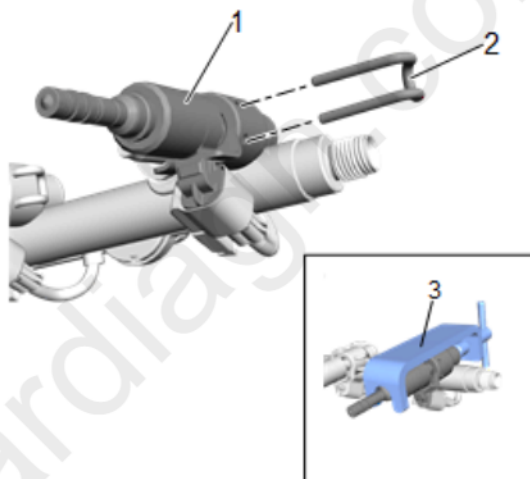


Fig. 111: Fuel Injector, Installer And Retaining Pin
 Courtesy of GENERAL MOTORS COMPANY

NOTE: The fuel injector **MUST** be fully installed and properly aligned with the fuel injection fuel rail before installing the retaining pin.

20. Use the **EN-50791** installer (3) to compress the fuel injector (1) into the fuel injection fuel rail.
21. Ensure the fuel injector is fully seated in the fuel injection fuel rail and install the fuel injector retaining pin (4).
22. Ensure the fuel injector retaining pin is fully seated in the fuel injector fuel rail and remove **EN-50791** installer.
23. Repeat the process until all fuel injectors are properly installed to the fuel rail.

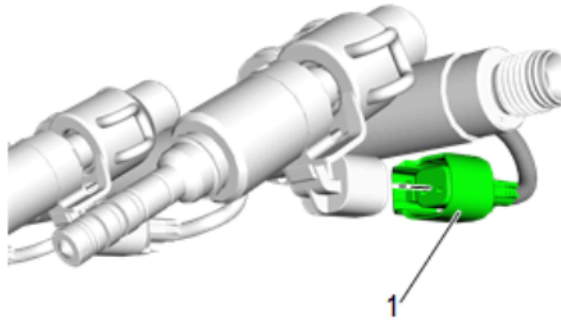


Fig. 112: Fuel Rail Harness Connectors

Courtesy of GENERAL MOTORS COMPANY

24. Connect the electrical connectors (1) to the fuel injectors.

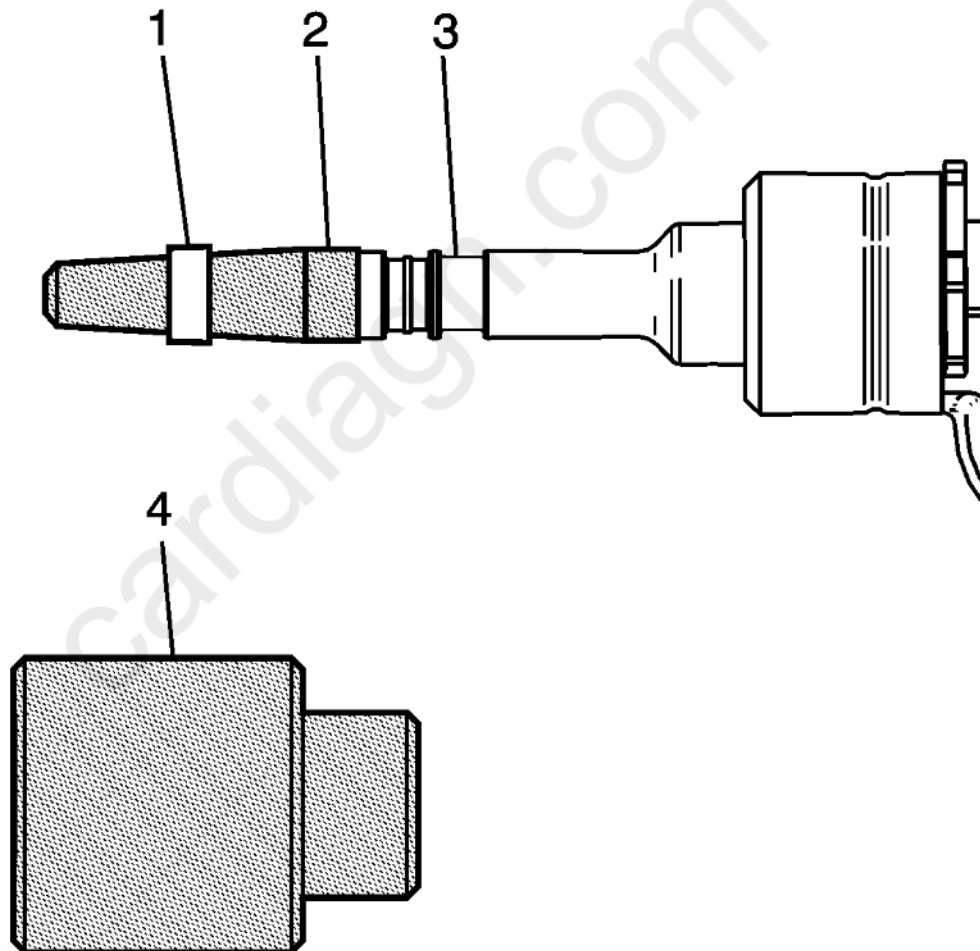


Fig. 113: Installing NEW Seals On Fuel Injectors

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT use any type of lubricant when installing the NEW fuel injector seals on the fuel injector tip.

25. Install the **EN-51105 - 1** long protector (2) onto the fuel injector tip.

26. Place a NEW fuel injector seal (1) onto the **EN-51105 - 1** long protector.

27. Use the **EN-49245** pusher to install the NEW fuel injector seal into the second recessed area (3) of the fuel injector.
28. Remove the **EN-51105 - 1** long protector.
29. Compress the NEW fuel injector seal with your fingers, then resize the seal using the **EN-49245** pusher (4).
- NOTE:** Do NOT use any type of lubricant when installing the NEW fuel injector seals on the fuel injector tip.
30. Install the **EN-51105 - 2** short protector (2) onto the fuel injector tip.
31. Place a NEW fuel injector seal (1) onto the **EN-51105 - 2** short protector.
32. Use the **EN-49245** pusher to install the NEW fuel injector seal into the remaining recessed area of the fuel injector.
33. Remove the **EN-51105 - 2** short protector.
34. Compress the NEW fuel injector seal with your fingers, then resize the seal using the **EN-49245** pusher (4).
35. Install Fuel Injection Fuel Rail. Refer to [Fuel Injection Fuel Rail Assembly Replacement](#)

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

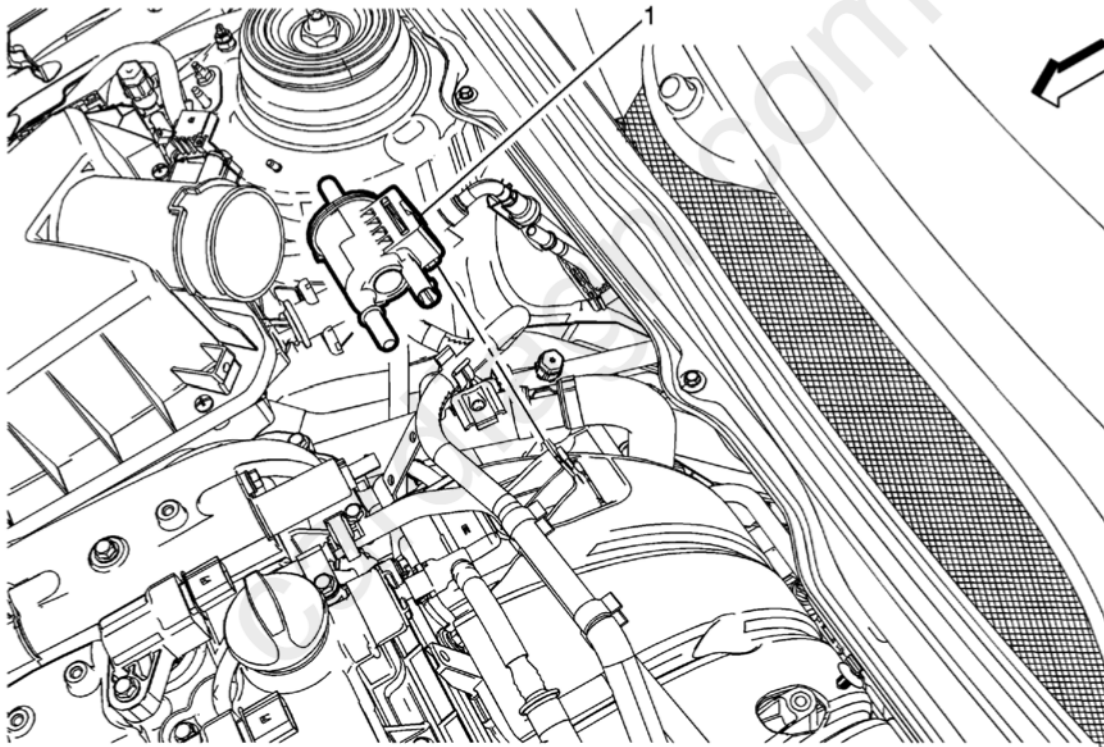


Fig. 114: Evaporative Emission Canister Purge Solenoid Valve (LCV)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
1. Remove the air cleaner resonator and outlet duct. Refer to Air Cleaner Resonator and Outlet Duct Replacement .	
2. Disconnect the EVAP hoses. Refer to Plastic Collar Quick Connect Fitting Service .	

Callout	Component Name
1	Evaporative Emission Canister Purge Solenoid Valve
	Procedure 1. Disconnect the electrical connector. 2. Release the retaining tab.

EVAPORATIVE EMISSION CANISTER PURGE PIPE REPLACEMENT

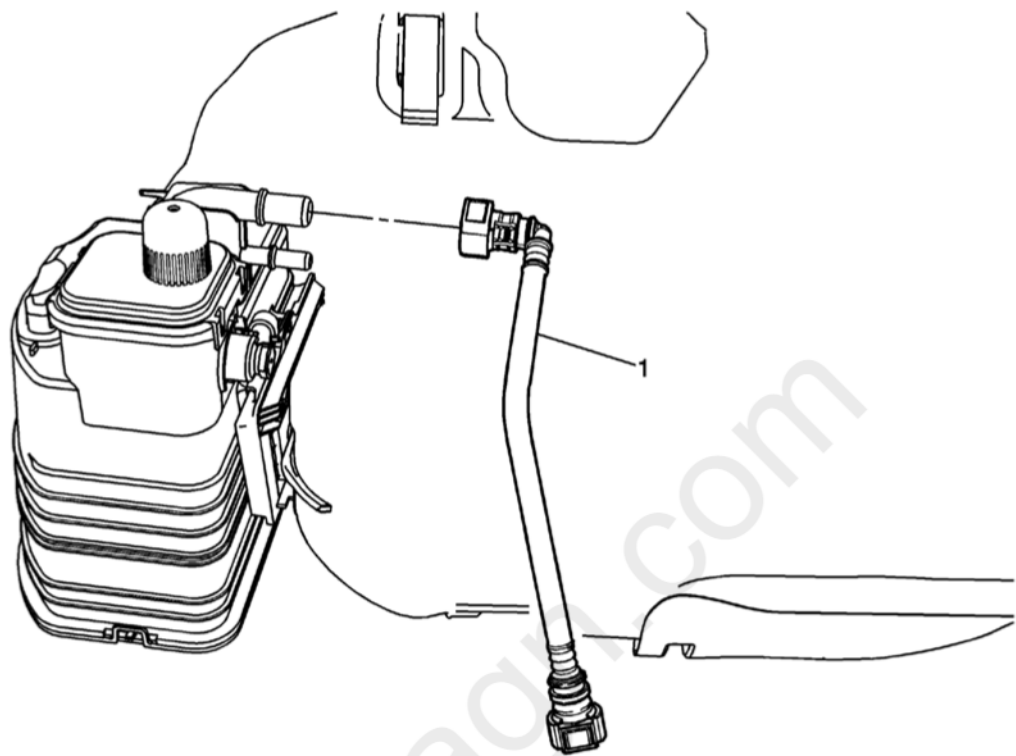


Fig. 115: Evaporative Emission Canister Purge Pipe
 Courtesy of GENERAL MOTORS COMPANY

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 Plastic Collar Quick Connect Fitting Service .

EVAPORATIVE EMISSION CANISTER PURGE TUBE REPLACEMENT

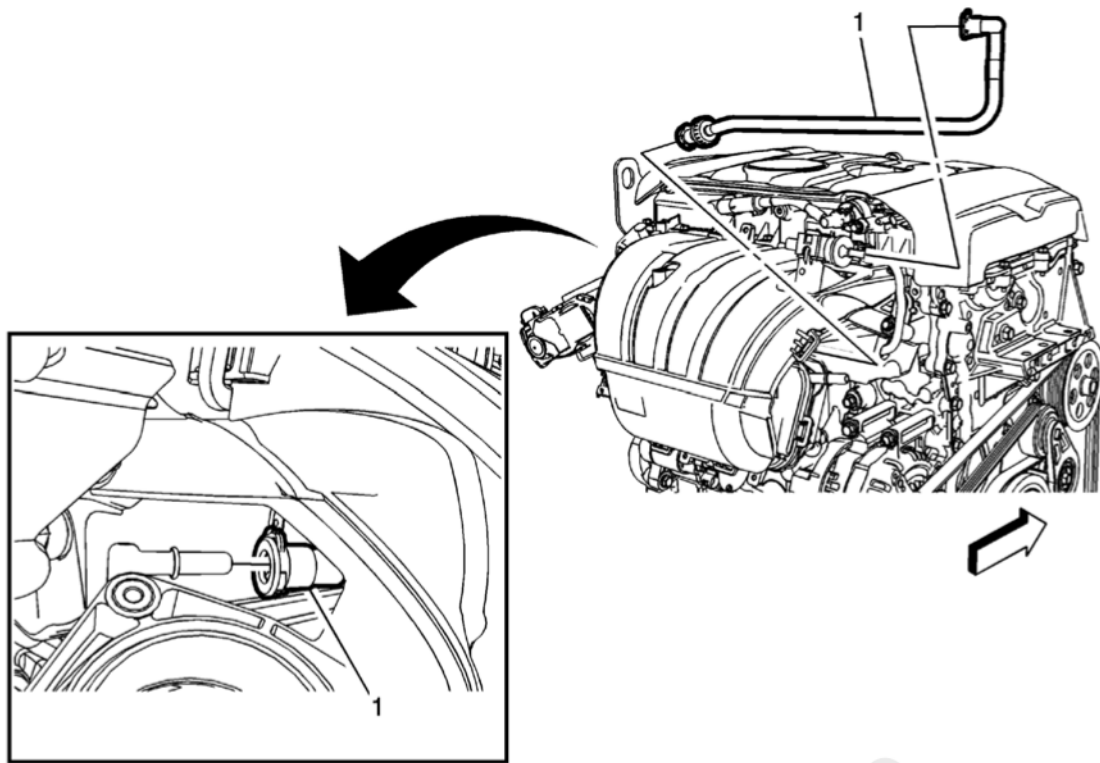


Fig. 116: Evaporative Emission Canister Purge Tube

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove Throttle Body Assembly. Refer to Throttle Body Assembly Replacement	
Evaporative Emission Canister Purge Tube	
Procedure	
1	1. Disconnect the evaporative emission canister purge tube from the evaporative emission canister purge valve. Refer to Plastic Collar Quick Connect Fitting Service 2. Disconnect the evaporative emission canister purge tube from the intake manifold. Refer to Plastic Collar Quick Connect Fitting Service

EVAPORATIVE EMISSION CANISTER SOLENOID REPLACEMENT

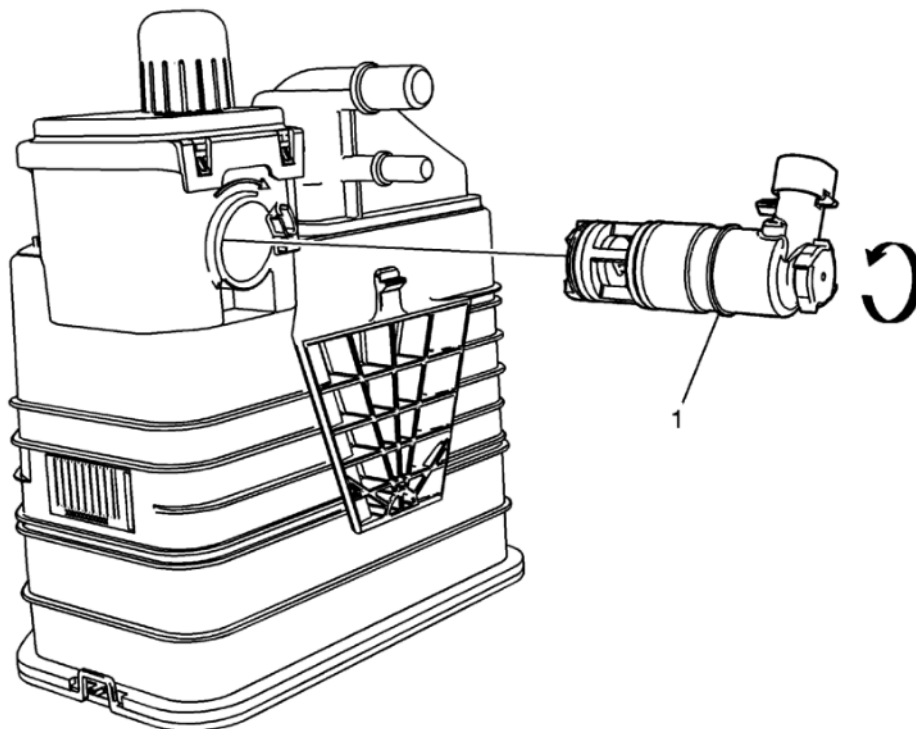


Fig. 117: Evaporative Emission Canister Solenoid
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the evaporative emission canister. Refer to Evaporative Emission Canister Replacement .	
1	Evaporative Emission Canister Solenoid Procedure Disconnect the electrical connector.

EVAPORATIVE EMISSION FRONT PIPE REPLACEMENT

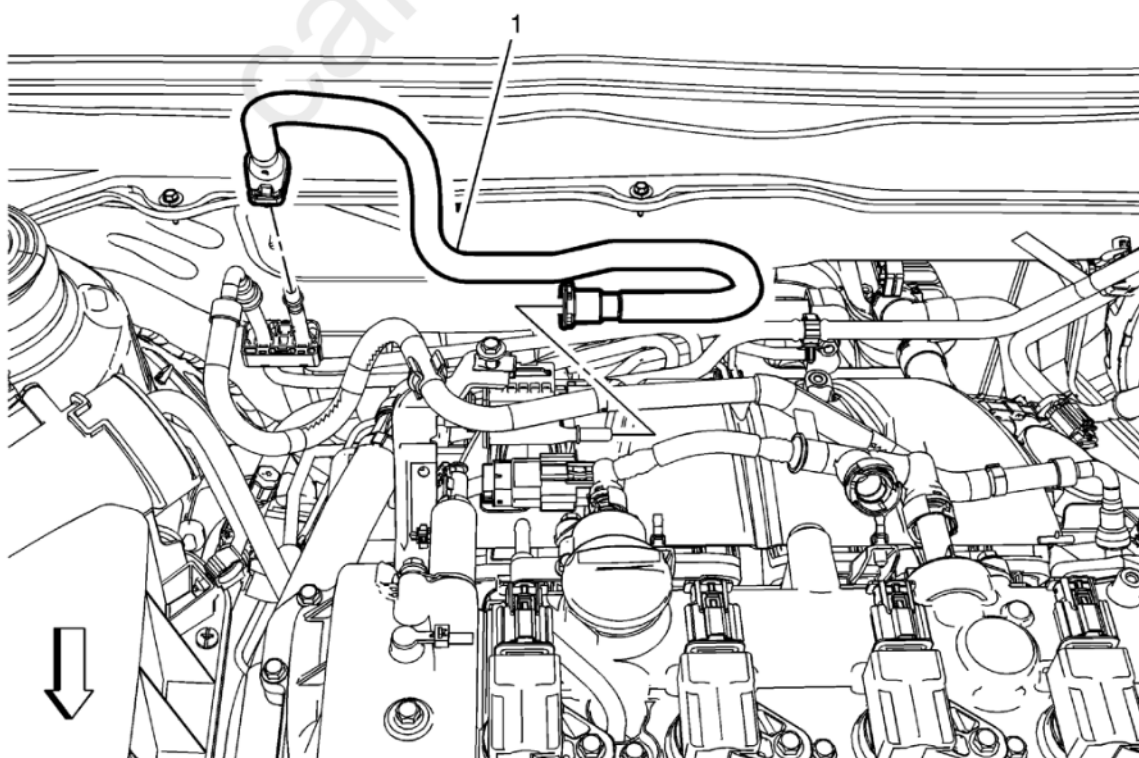


Fig. 118: Evaporative Emission Front Pipe (LCV)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement . 2. Remove the air cleaner resonator and outlet duct. Refer to Air Cleaner Resonator and Outlet Duct Replacement.	
1	Evaporative Emission Front Pipe Procedure Disconnect the evaporative emission front pipe from the purge valve and line. Refer to Plastic Collar Quick Connect Fitting Service .

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 evaporative emission front pipe. Refer to [Evaporative Emission Front Pipe Replacement](#).

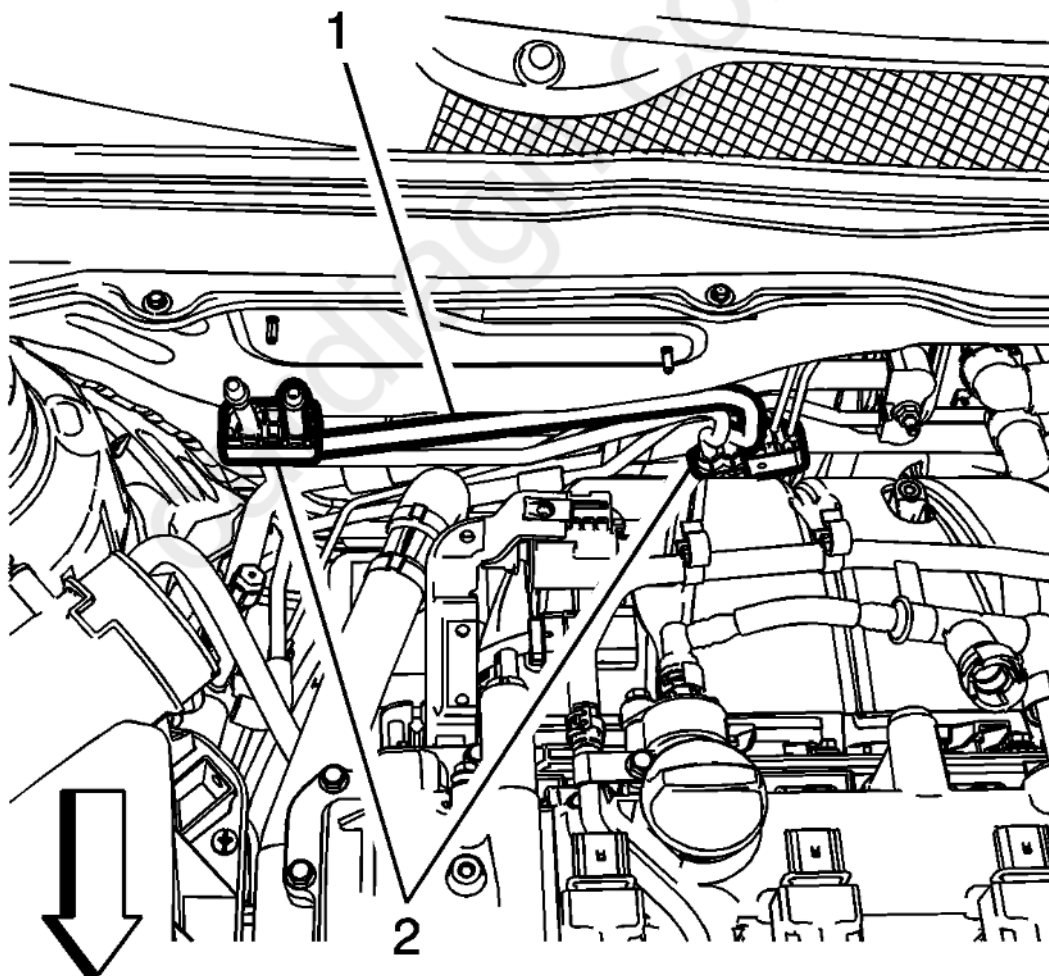


Fig. 119: Evaporative Emission Pipe And Retainers

Courtesy of GENERAL MOTORS COMPANY

2. Remove the evaporative emission pipe (1) from the retainers (2).
3. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

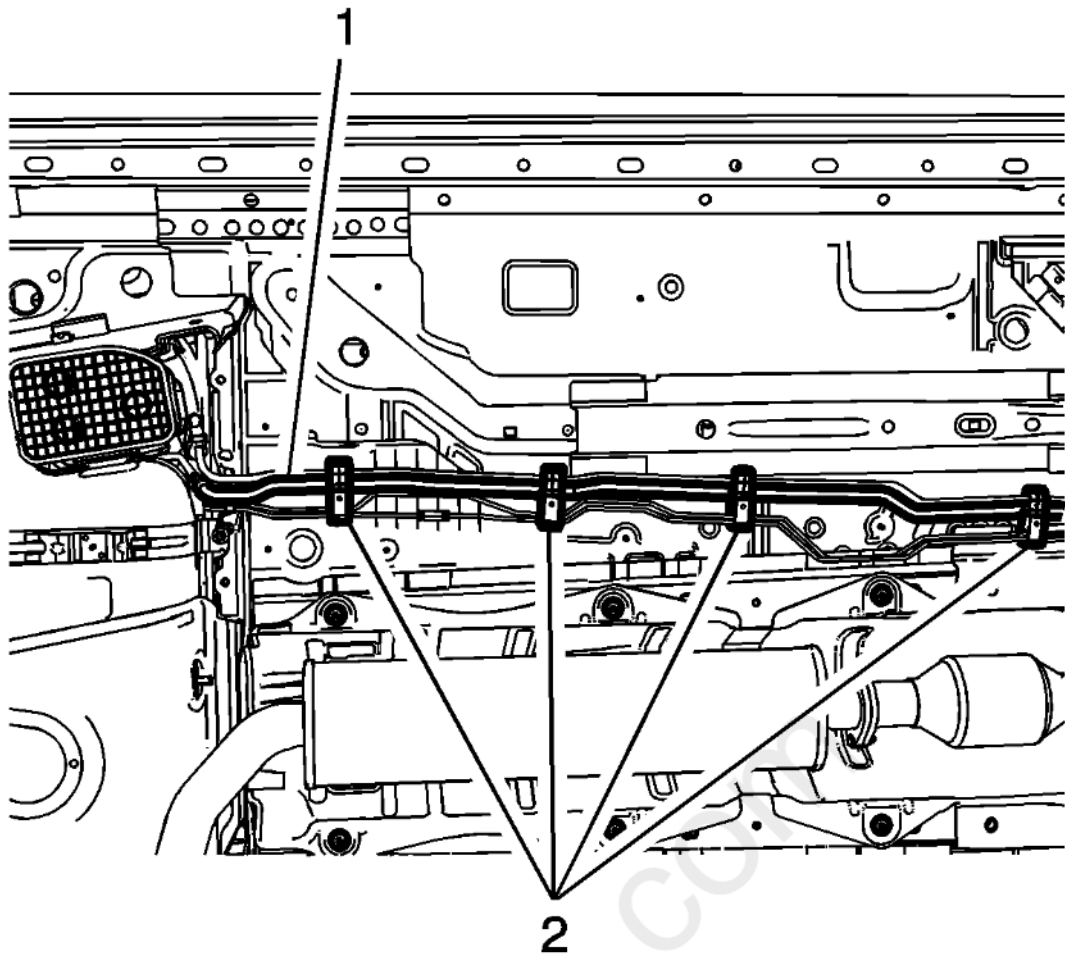


Fig. 120: Evaporative Emission Pipe And Retainers

Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the evaporative emission pipe (1) and remove from retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Remove the evaporative emission pipe (1) from the vehicle.

Installation Procedure

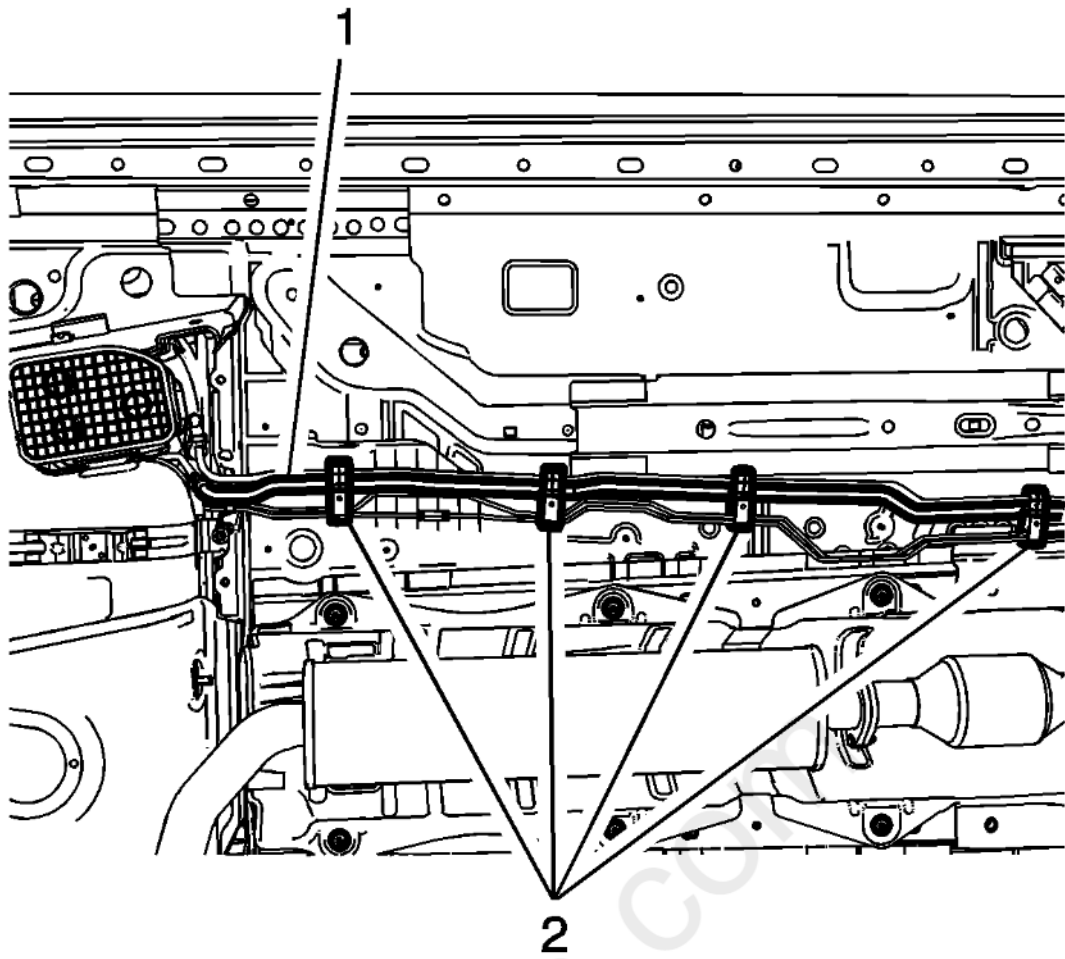


Fig. 121: Evaporative Emission Pipe And Retainers

Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission pipe (1) to the vehicle.
2. Connect the evaporative emission pipe (1) and install to the retainers (2). Refer to [**Plastic Collar Quick Connect Fitting Service**](#).
3. Lower the vehicle.

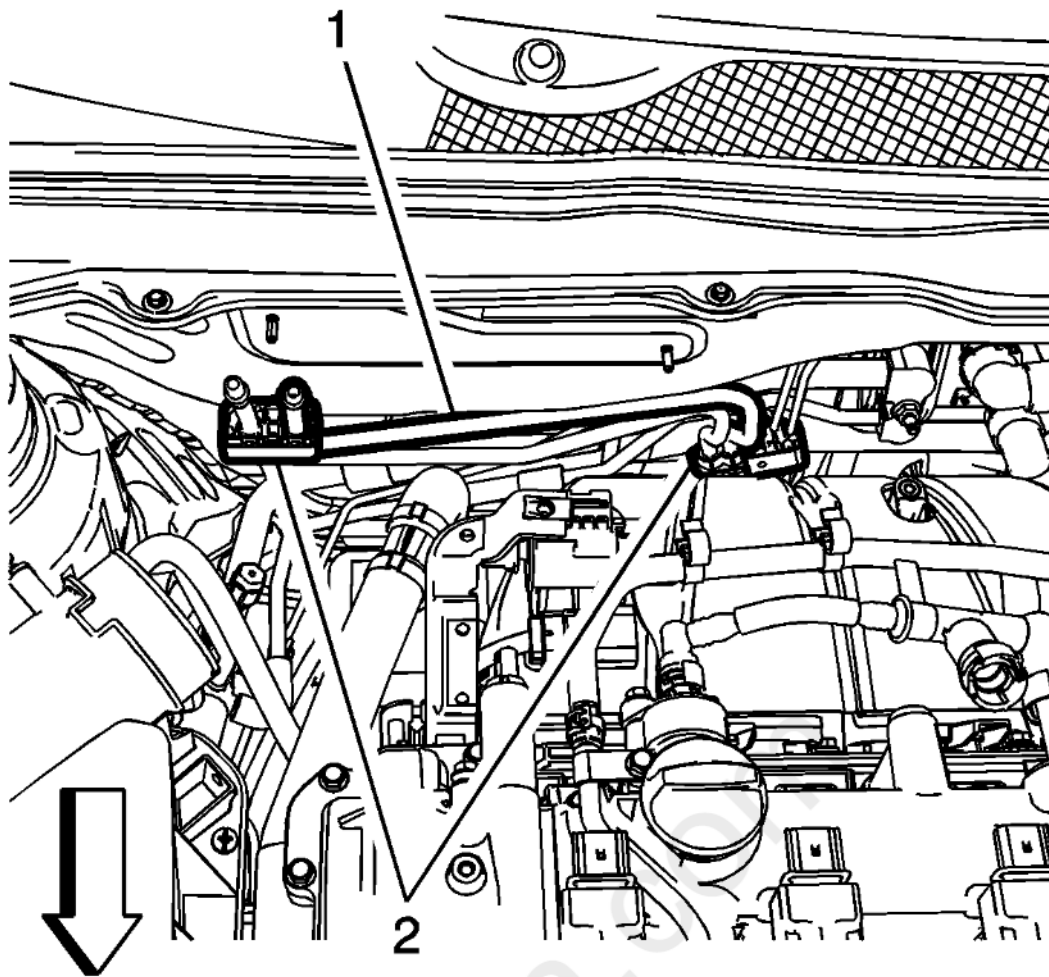


Fig. 122: Evaporative Emission Pipe And Retainers

Courtesy of GENERAL MOTORS COMPANY

4. Install the evaporative emission pipe (1) to the retainers (2).
5. Install the evaporative emission front pipe. Refer to [**Evaporative Emission Front Pipe Replacement**](#).

EVAPORATIVE EMISSION CANISTER REPLACEMENT

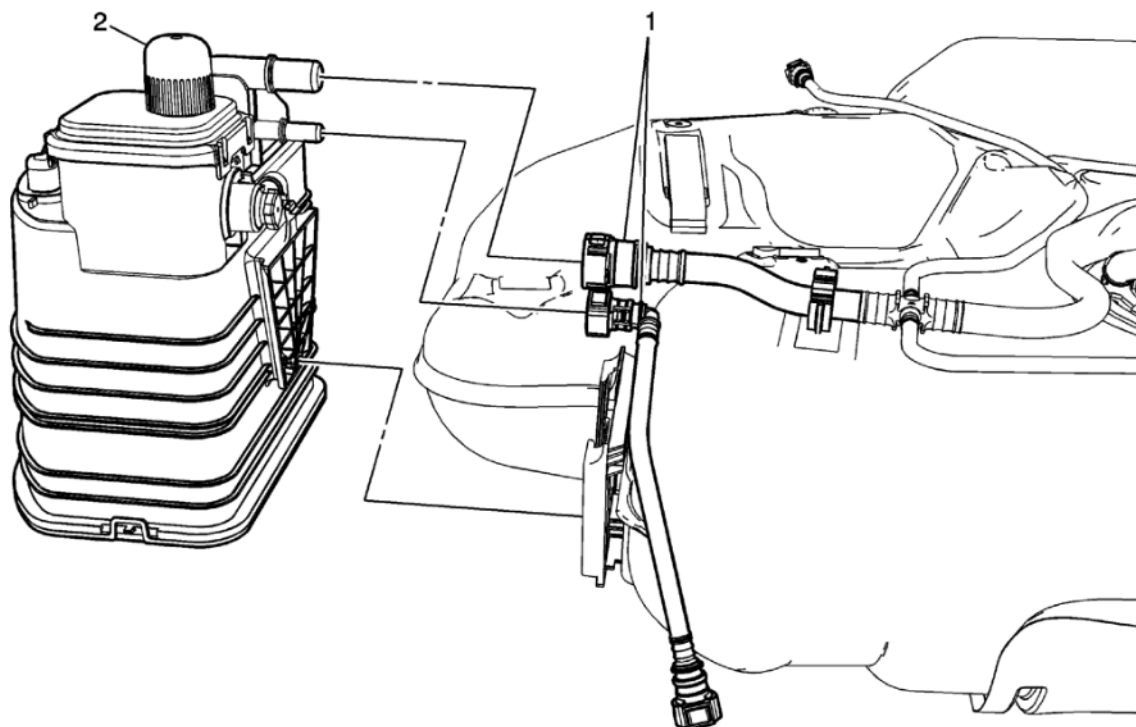


Fig. 123: Evaporative Emission Canister & Hoses

Courtesy of GENERAL MOTORS COMPANY

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

GE 41413 - 200 Evaporative Pressure and Purge Station

For equivalent regional tools, refer to [Special Tools](#) .

Inspection Procedure

CAUTION: Use the Evaporative Emission (EVAP) System Tester 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 **GE 41413 - 200** station.

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

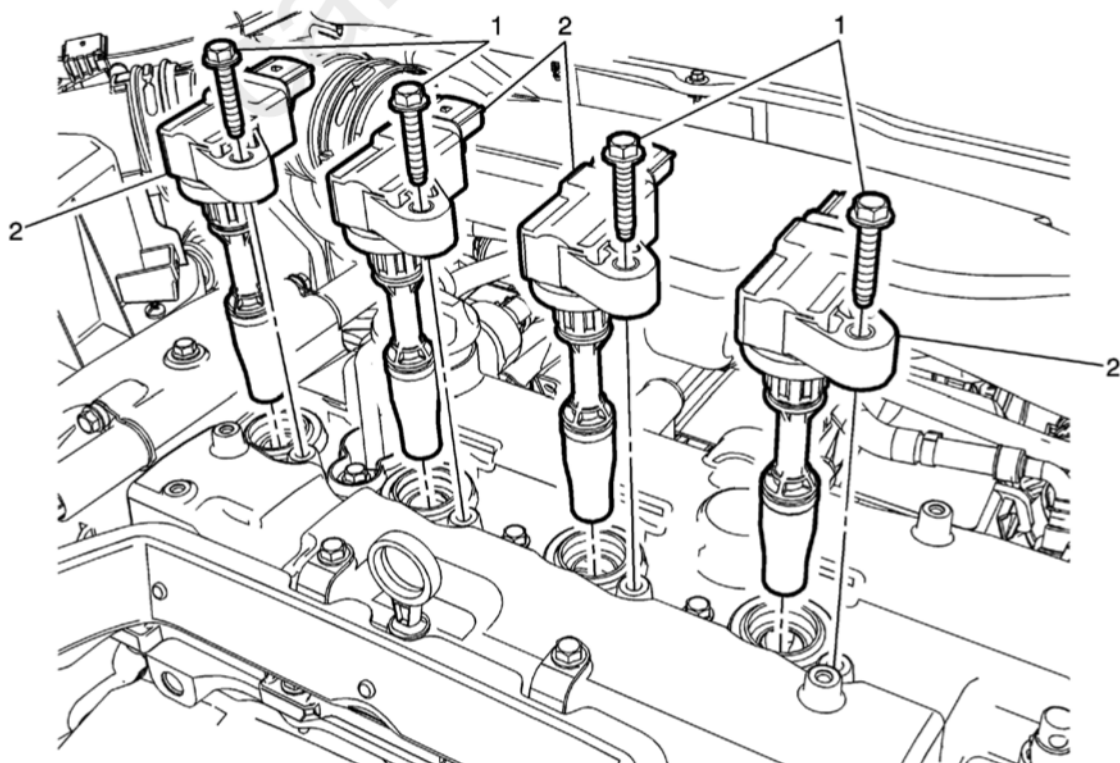


Fig. 124: Ignition Coil

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Intake Manifold Cover. Refer to Intake Manifold Cover Replacement 2. Disconnect the electrical connectors.	
1	Ignition Coil Fastener (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Ignition Coil (Qty: 4) Procedure 1. Inspect the inside of the ignition coil boot for a thin, even coat of dielectric grease. If there is no grease present or additional grease is necessary, continue to the next step. 2. Apply a thin coating of dielectric grease to the inside of the ignition coil boot up to a depth of 15 mm (0.60 in) from the end of the boot. Refer to Adhesives, Fluids, Lubricants, and Sealers 3. Remove any excess dielectric grease from around the end of the ignition coil boot and ensure there is not an excessive amount within the boot.

SPARK PLUG REPLACEMENT

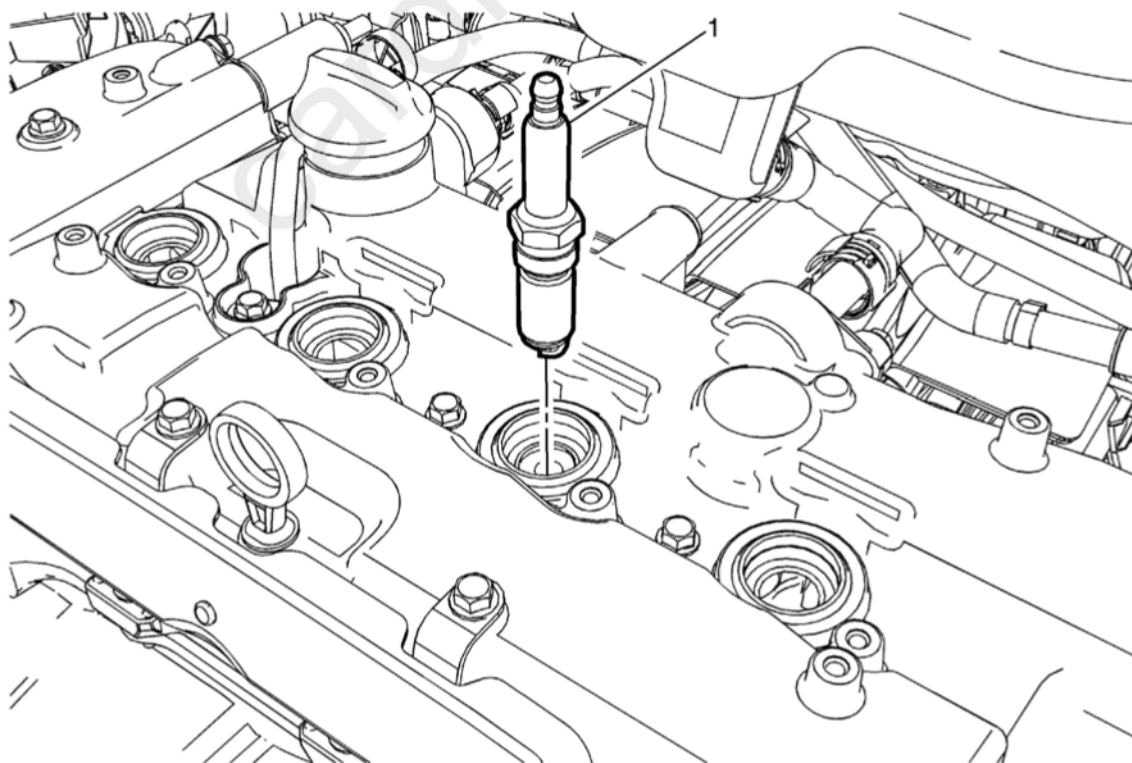


Fig. 125: Spark Plug

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
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.	
Preliminary Procedure Remove Ignition Coils. Refer to Ignition Coil Replacement	
1	Spark Plug (Qty: 4) CAUTION: Refer to Component Fastener Tightening Caution . Procedure 1. If reusing the spark plugs, inspect for wear or damage. Refer to Spark Plug Inspection 2. If using NEW spark plugs, do NOT attempt to check the spark plug gap. The plugs come pre-gapped. 3. Tighten 20 N.m (15 lb ft)

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.

Spark Plug Inspection

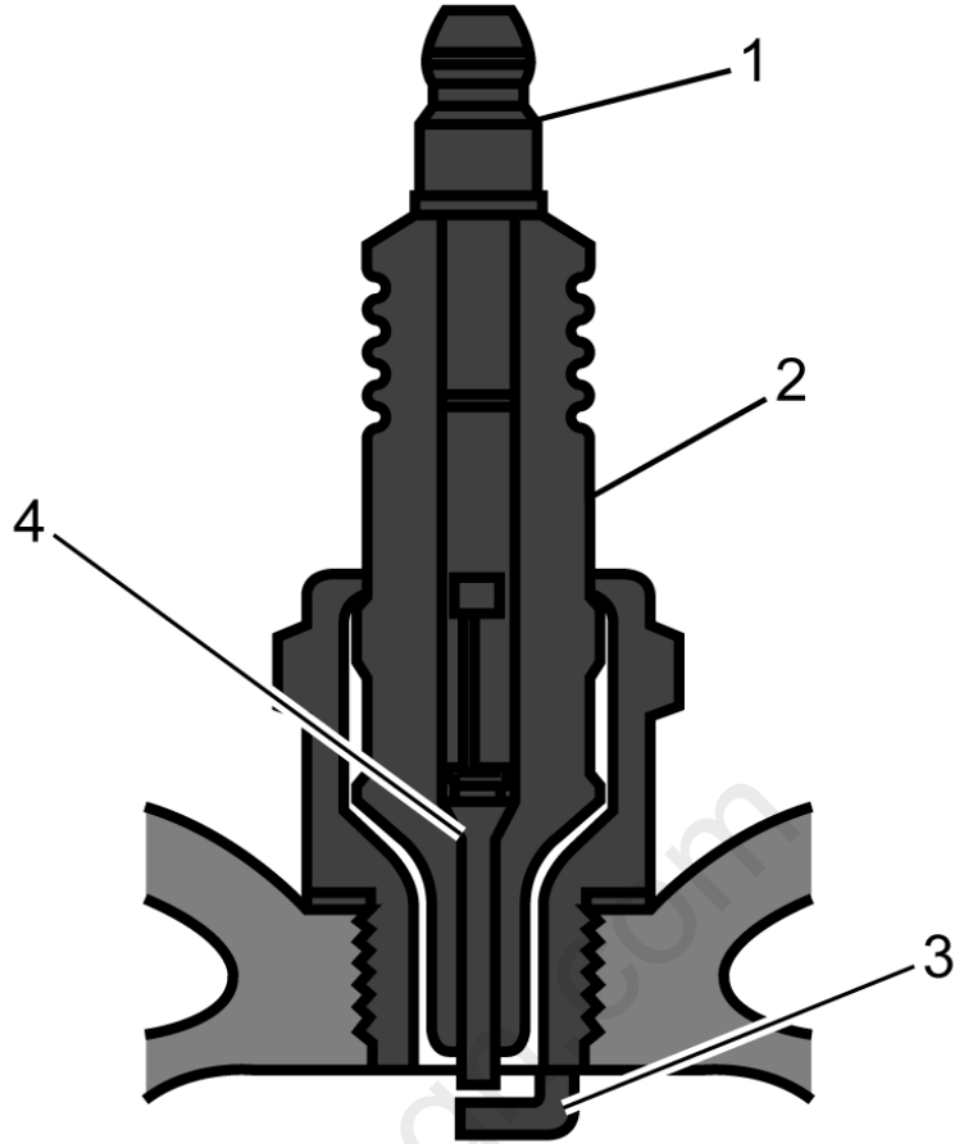


Fig. 126: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

- 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.
- Inspect the insulator (2) for flashover or carbon tracking, soot. This condition is often mistakenly identified as a cracked insulator. 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.
- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).
- Inspect for evidence of improper arcing.
 - Measure the gap between the center electrode (4) and the side electrode (3) terminals. This must be done carefully in order to avoid damaging the small diameter Iridium center electrode. 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. Reddish orange deposits can indicate MMT fuel additive which is still used in some markets around the world (will cause misfire and cannot be burned off). MMT fuel additive use should be avoided.
- 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.

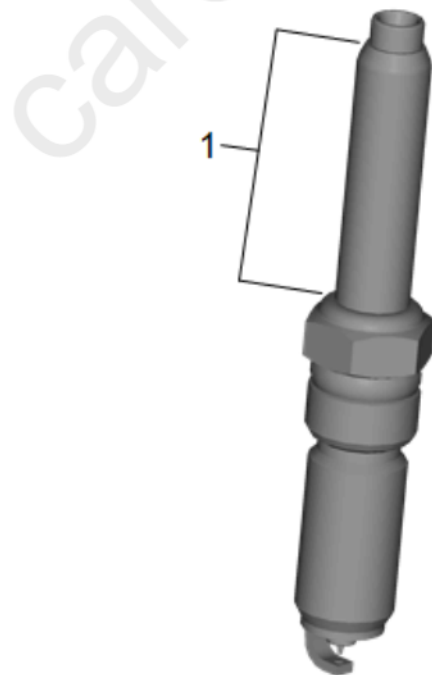


Fig. 127: Inspect For Carbon On Spark Plug Tower
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Carbon on spark plug tower means carbon will also be on inside of spark plug wire boot or coil boot and will cause both new spark plug

and spark plug wire or coil boot to fail again.

-
- If carbon tracking occurs on spark plug tower (1), replace spark plug and spark plug wire or coil boot.

CRANKSHAFT POSITION SENSOR REPLACEMENT

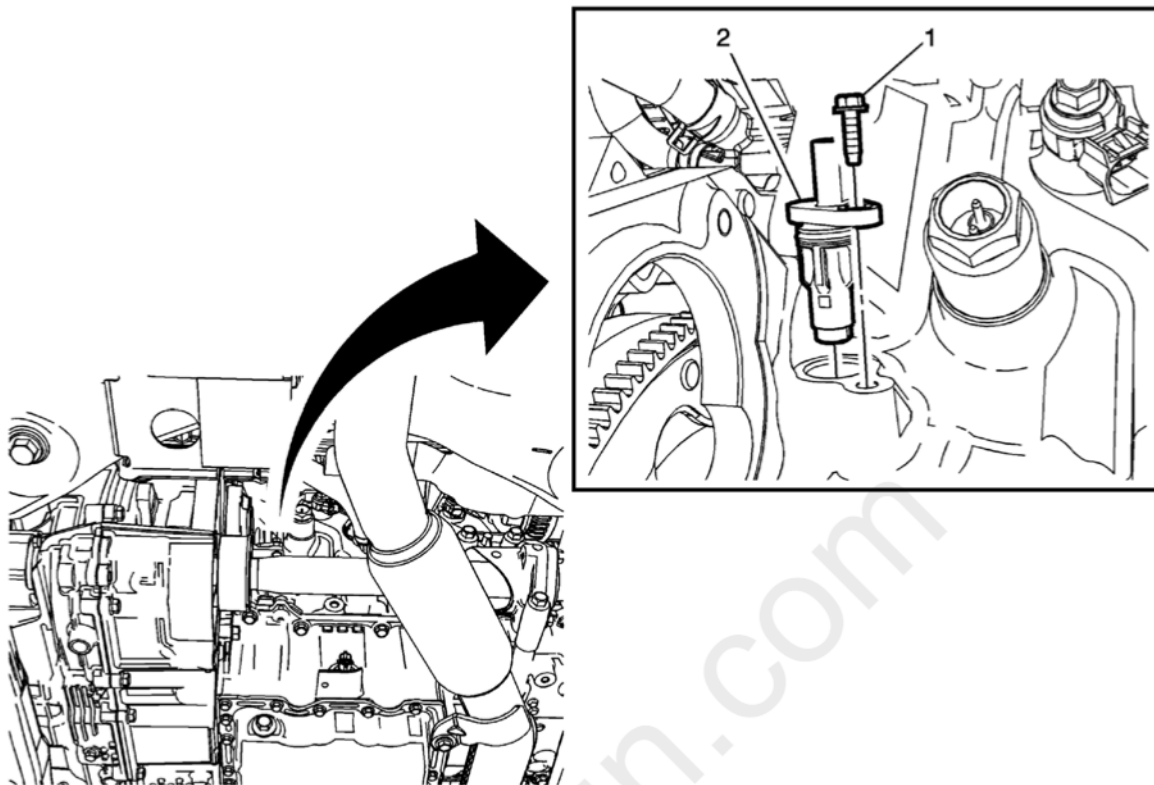


Fig. 128: Crankshaft Position Sensor

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Starter. Refer to Starter Replacement (LCV)	
1	Crankshaft Position Sensor Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Crankshaft Position Sensor Procedure 1. Disconnect the electrical connector. 2. If NOT replacing the component, install a NEW seal. 3. If installing a NEW crankshaft position sensor, perform the crankshaft position system variation learn procedure. Refer to Crankshaft Position Variation Learn

CAMSHAFT POSITION SENSOR REPLACEMENT - INTAKE

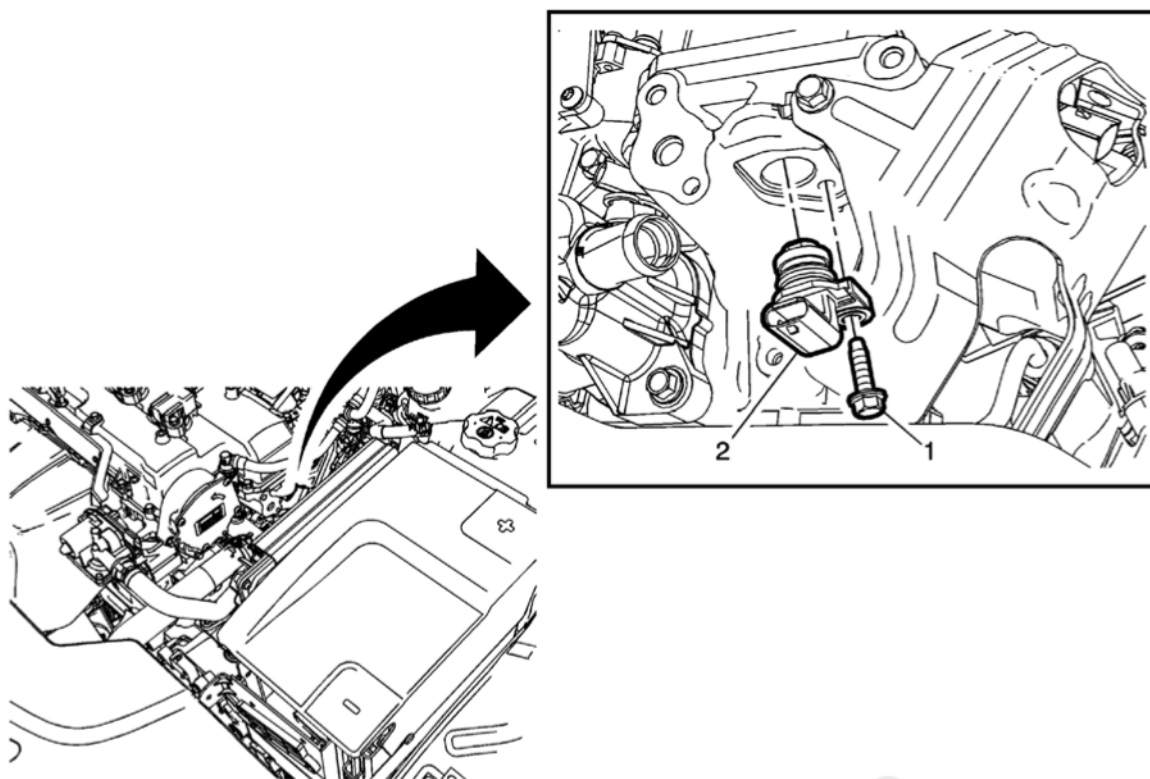


Fig. 129: Camshaft Position Sensor - Intake
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure 1. Disconnect the electrical wiring harness connector from the camshaft position sensor. 2. Install a NEW seal if not replacing the sensor.

CAMSHAFT POSITION SENSOR REPLACEMENT - EXHAUST

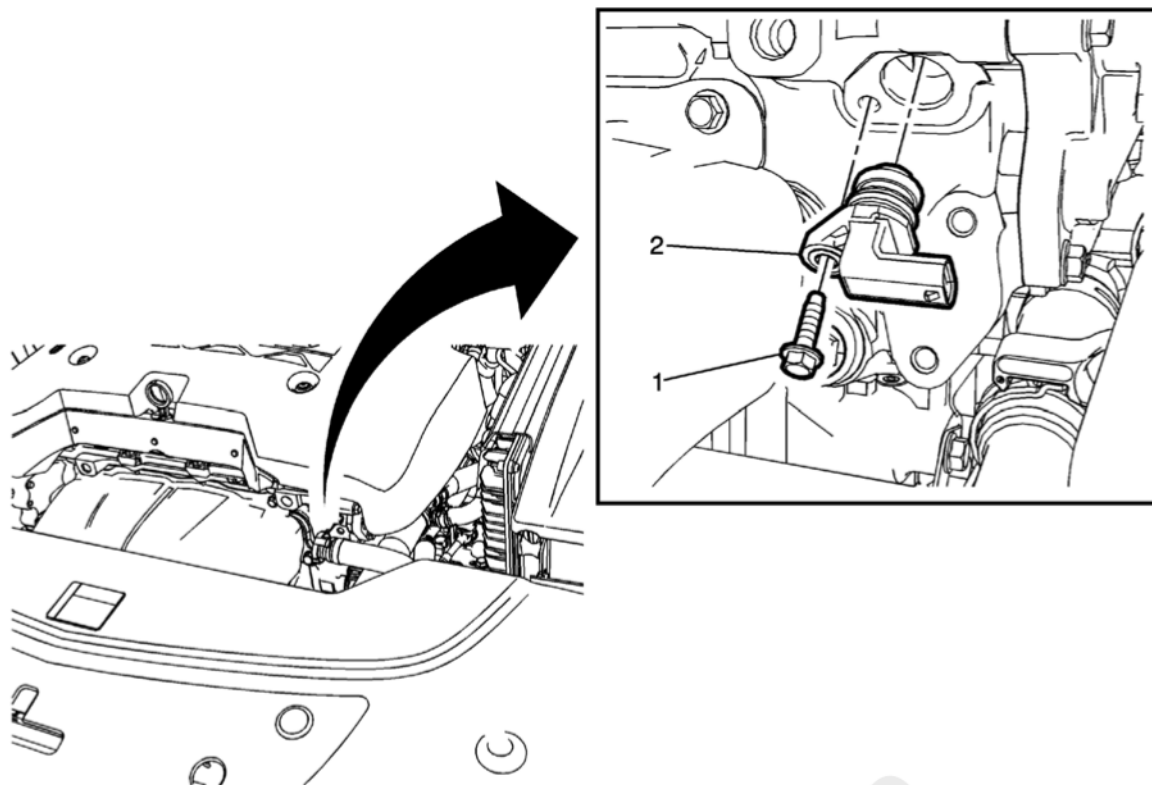


Fig. 130: Camshaft Position Sensor - Exhaust
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .	
1	Camshaft Position Sensor Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Camshaft Position Sensor Procedure 1. Disconnect the electrical wiring harness connector from the camshaft position sensor. 2. Install a NEW seal if not replacing the sensor.

CAMSHAFT POSITION ACTUATOR EXHAUST SOLENOID VALVE REPLACEMENT

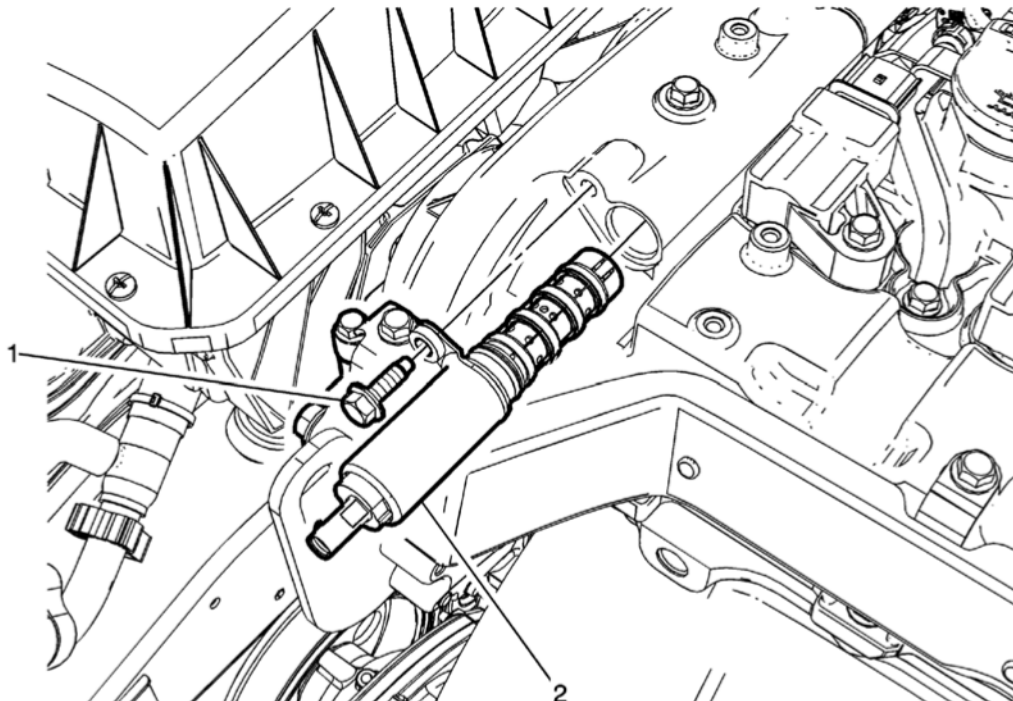


Fig. 131: Camshaft Position Actuator Exhaust Solenoid Valve
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Intake Manifold Cover. Refer to Intake Manifold Cover Replacement 2. Disconnect the electrical connector.	
1	Camshaft Position Actuator Exhaust Solenoid Valve Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Camshaft Position Actuator Exhaust Solenoid Valve Procedure If reusing the OLD solenoid valve, install a NEW seal. NOTE: A NEW solenoid valve will come with a NEW seal.

CAMSHAFT POSITION ACTUATOR INTAKE SOLENOID VALVE REPLACEMENT

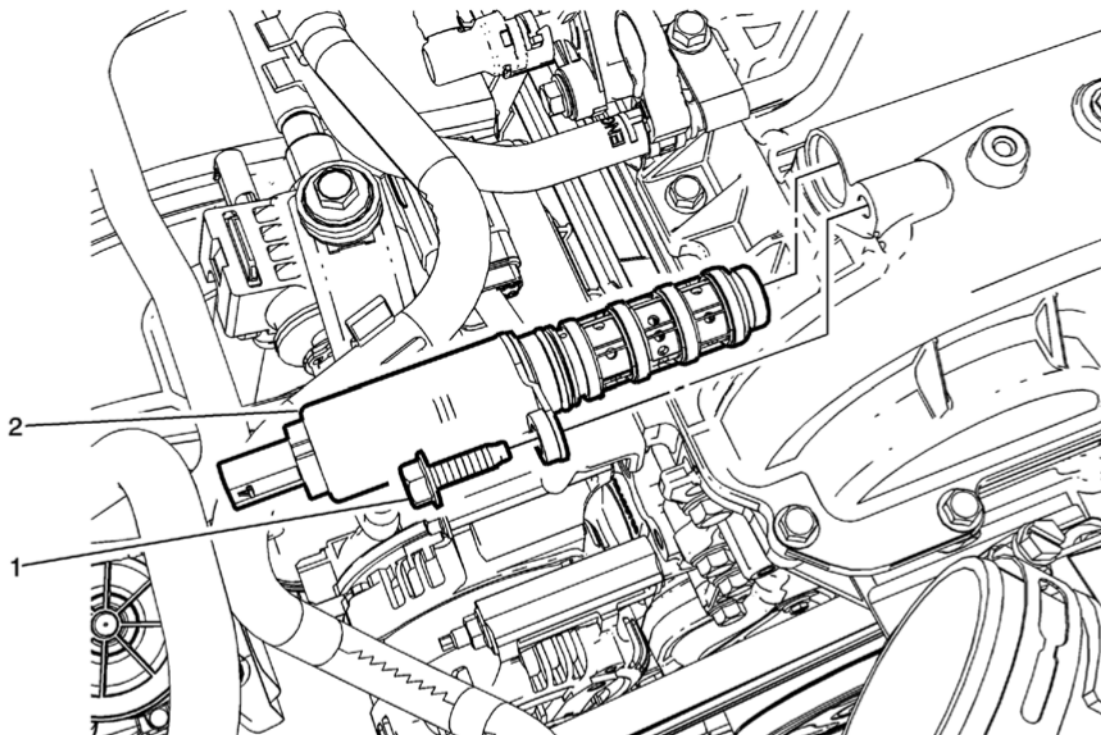


Fig. 132: Camshaft Position Actuator Intake Solenoid Valve

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Intake Manifold Cover. Refer to Intake Manifold Cover Replacement 2. Disconnect the electrical connector.	
1	Camshaft Position Actuator Intake Solenoid Valve Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Camshaft Position Actuator Intake Solenoid Valve Procedure If reusing the OLD solenoid valve, install a NEW seal. NOTE: A NEW solenoid valve will come with a NEW seal.

KNOCK SENSOR REPLACEMENT

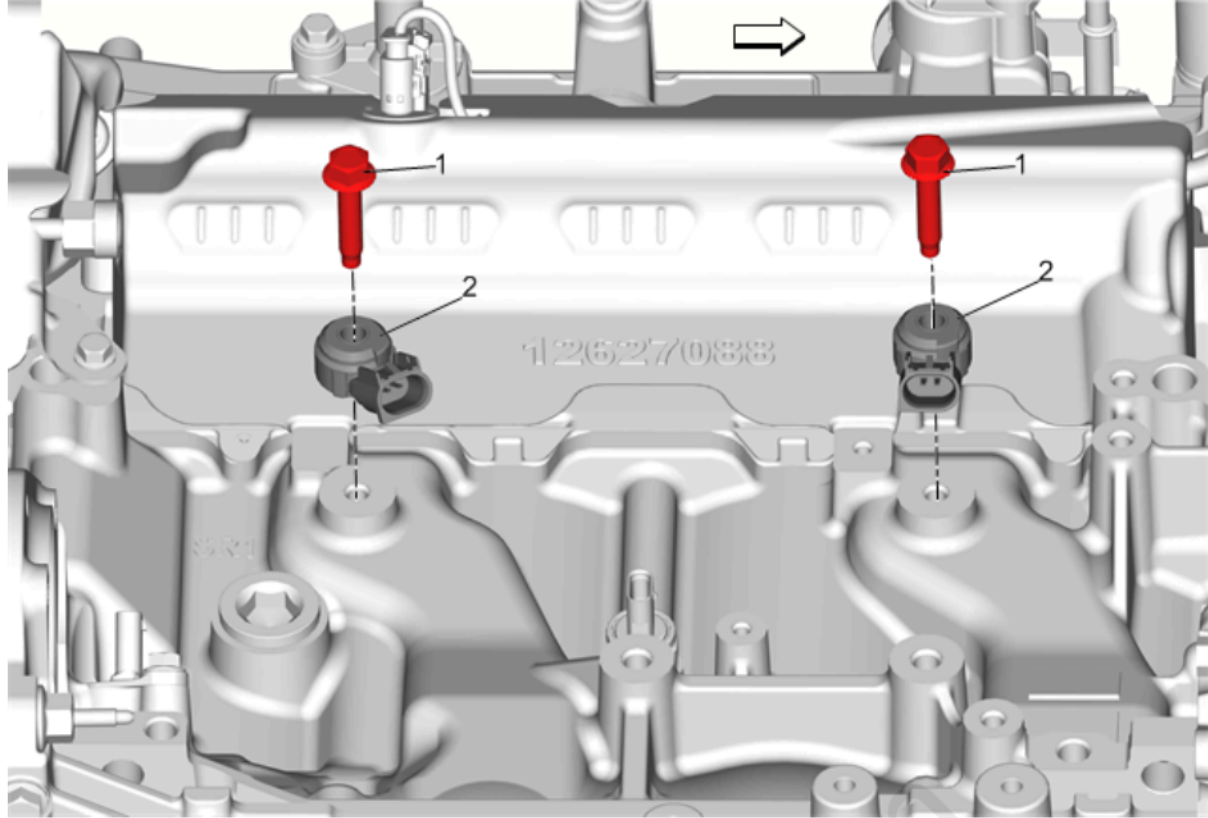


Fig. 133: Knock Sensors

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Raise and support vehicle. Refer to Lifting and Jacking the Vehicle 2. If replacing the rear knock sensor, remove the Starter. Refer to Starter Replacement (LCV)	
1	Knock Sensor Fastener (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 25 N.m (18 lb ft)
2	Knock Sensor Procedure Disconnect the electrical connector.

OIL PUMP FLOW CONTROL VALVE REPLACEMENT

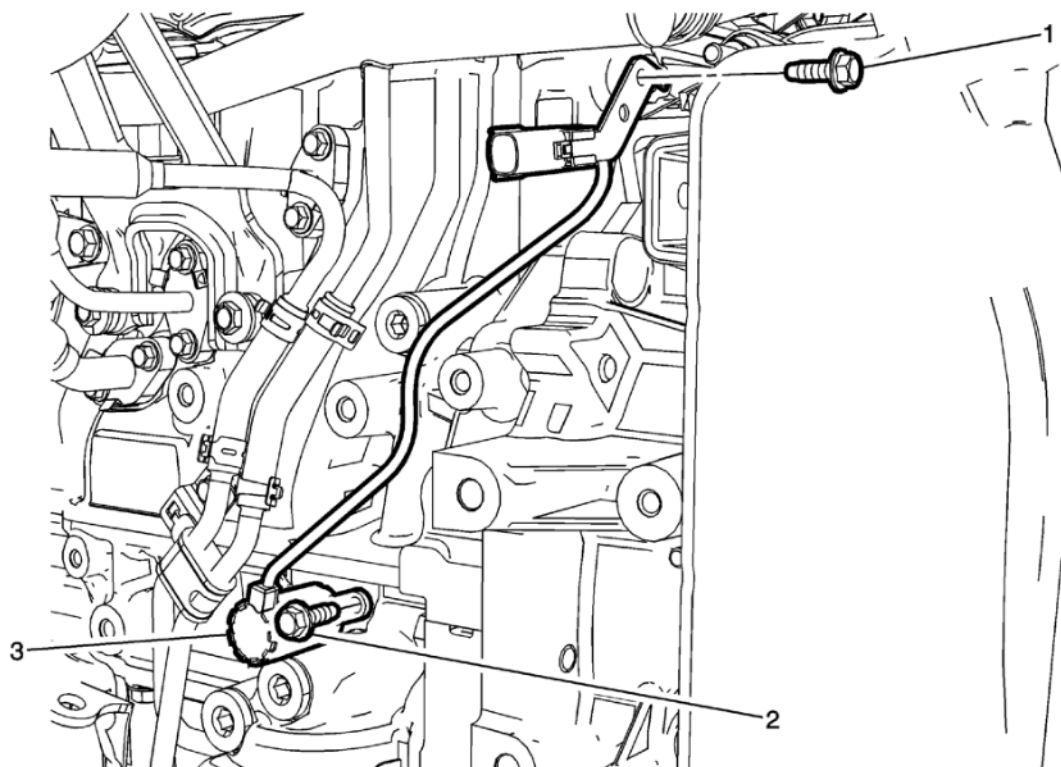


Fig. 134: Oil Pump Flow Control Valve

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Oil Pump Flow Control Valve Heat Shield. Refer to Oil Pump Flow Control Valve Heat Shield Replacement	
1	Oil Pump Flow Control Valve Electrical Wiring Harness Connector Bracket Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Oil Pump Flow Control Valve Fastener CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
3	Oil Pump Flow Control Valve Procedure Disconnect the electrical wiring harness connector from the oil pump flow control valve.

OIL PUMP FLOW CONTROL VALVE HEAT SHIELD REPLACEMENT

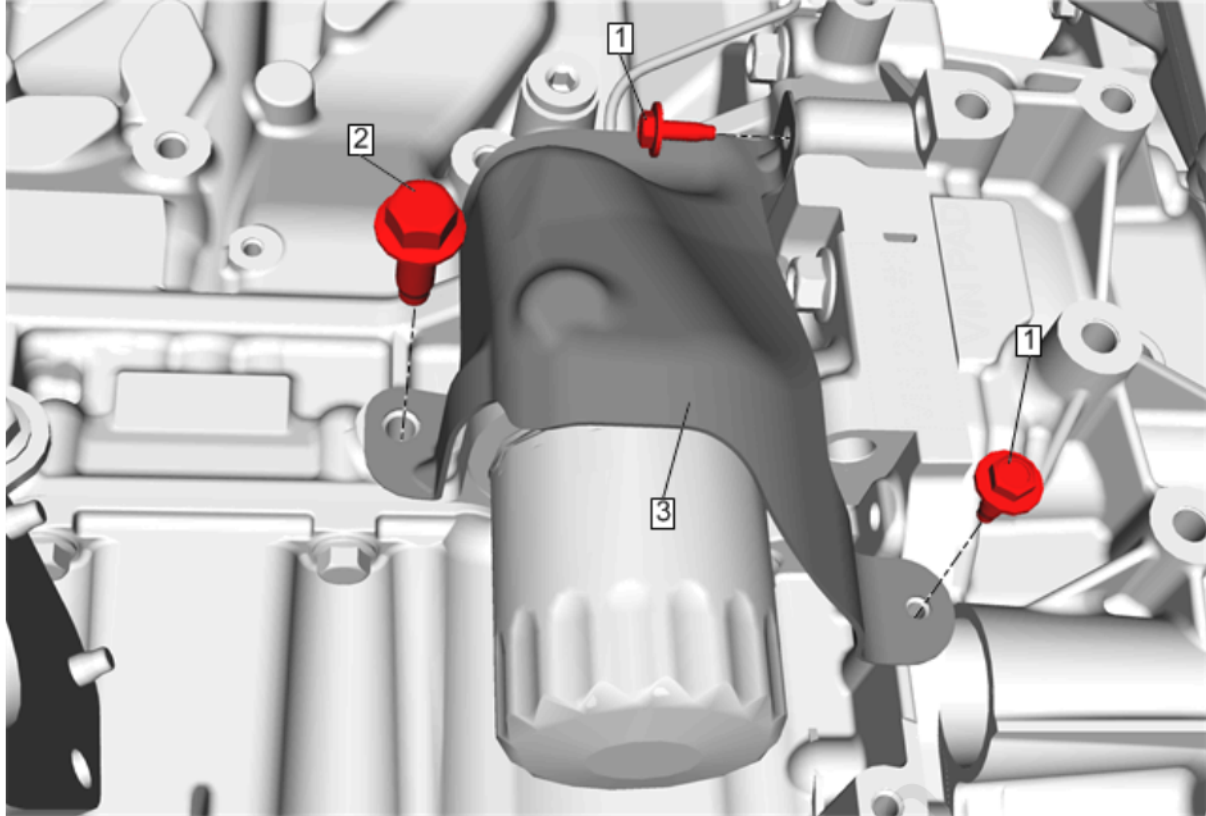


Fig. 135: Oil Pump Flow Control Valve Heat Shield

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Raise and support vehicle. Refer to Lifting and Jacking the Vehicle	
1	Pump and Component Oil Heat Shield Bolt (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Oil Pump Flow Control Valve Heat Shield Fastener Tighten 58 N.m (43 lb ft)
3	Oil Pump Flow Control Valve Heat Shield

VACUUM PUMP REPLACEMENT

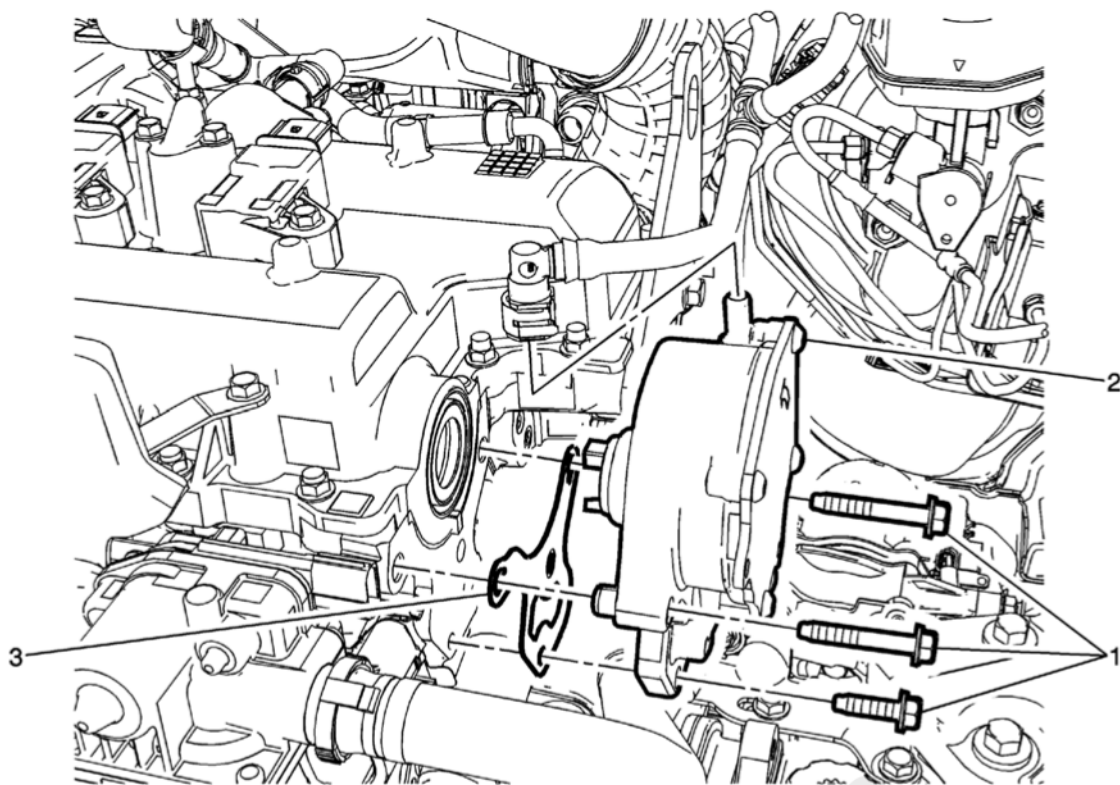


Fig. 136: Vacuum Pump & Mounting Components
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement 2. Disconnect the vacuum hose from the vacuum pump. Refer to Plastic Collar Quick Connect Fitting Service	
1	Vacuum Pump Fastener (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 10 N.m (89 lb in)
2	Vacuum Pump Procedure 1. Lubricate the vacuum pump seal with clean engine oil. Refer to Adhesives, Fluids, Lubricants, and Sealers 2. Align the vacuum pump drive with the slot in the camshaft. NOTE: Inspect the vacuum pump seal and replace as necessary.
3	Vacuum Pump Gasket Procedure Inspect the vacuum pump gasket and replace as necessary.

AIR CLEANER ELEMENT REPLACEMENT

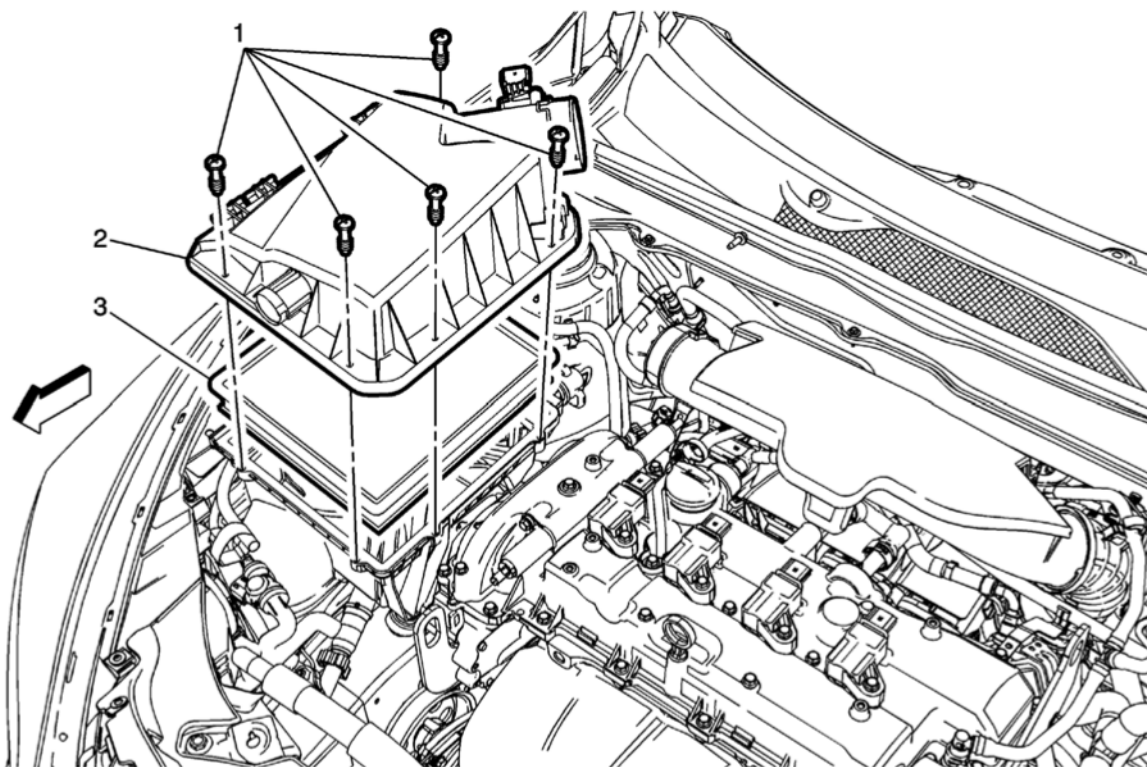


Fig. 137: Air Cleaner Element (LCV)
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Disconnect Air Cleaner Outlet Duct. Refer to Air Cleaner Outlet Duct Replacement 2. Disconnect the mass airflow sensor electrical connector and disconnect the harness from the 2 retainers.	
1	Air Cleaner Assembly Fasteners (Qty: 5) CAUTION: Refer to Fastener Caution .
2	Air Cleaner Upper Cover
3	Air Cleaner Element

AIR CLEANER ASSEMBLY REPLACEMENT

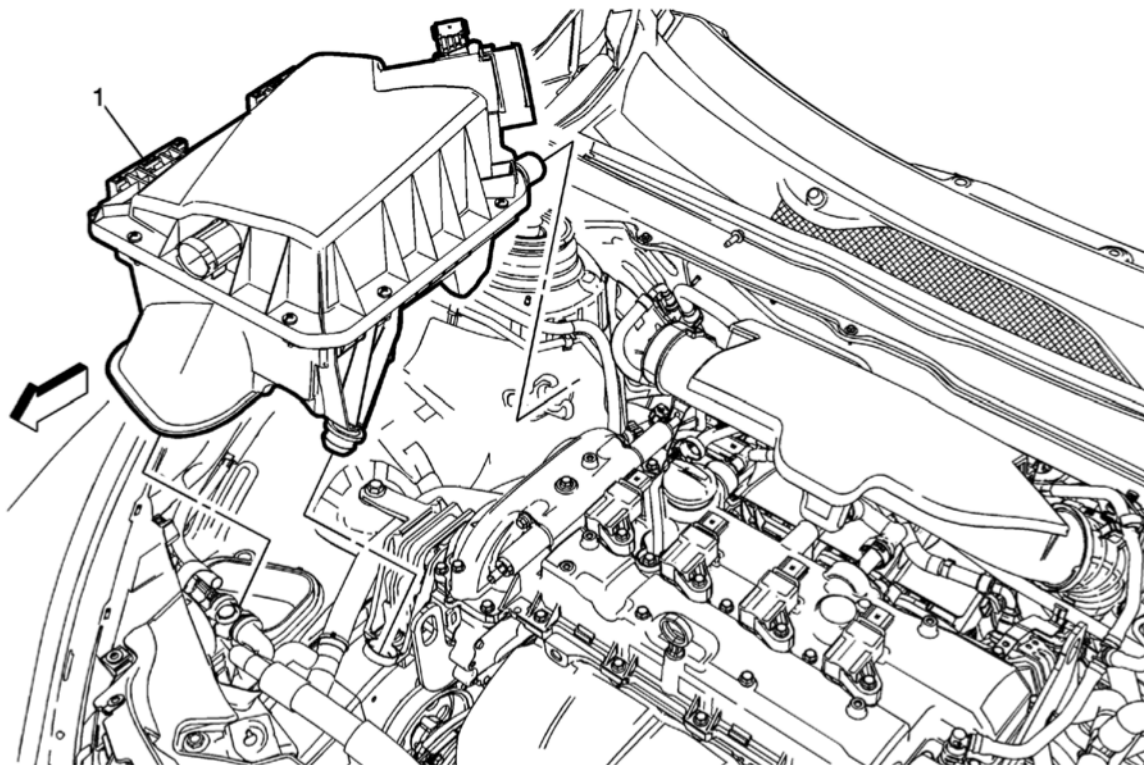


Fig. 138: Air Cleaner Assembly (LCV)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Disconnect Air Cleaner Outlet Duct. Refer to Air Cleaner Outlet Duct Replacement 2. Disconnect the mass airflow sensor electrical connector and disconnect the harness from the 2 retainers.	
1	Air Cleaner Assembly Procedure 1. Remove the air cleaner housing from the retainers, while guiding the housing out of the inlet duct. 2. Transfer parts as necessary.

AIR CLEANER OUTLET DUCT REPLACEMENT

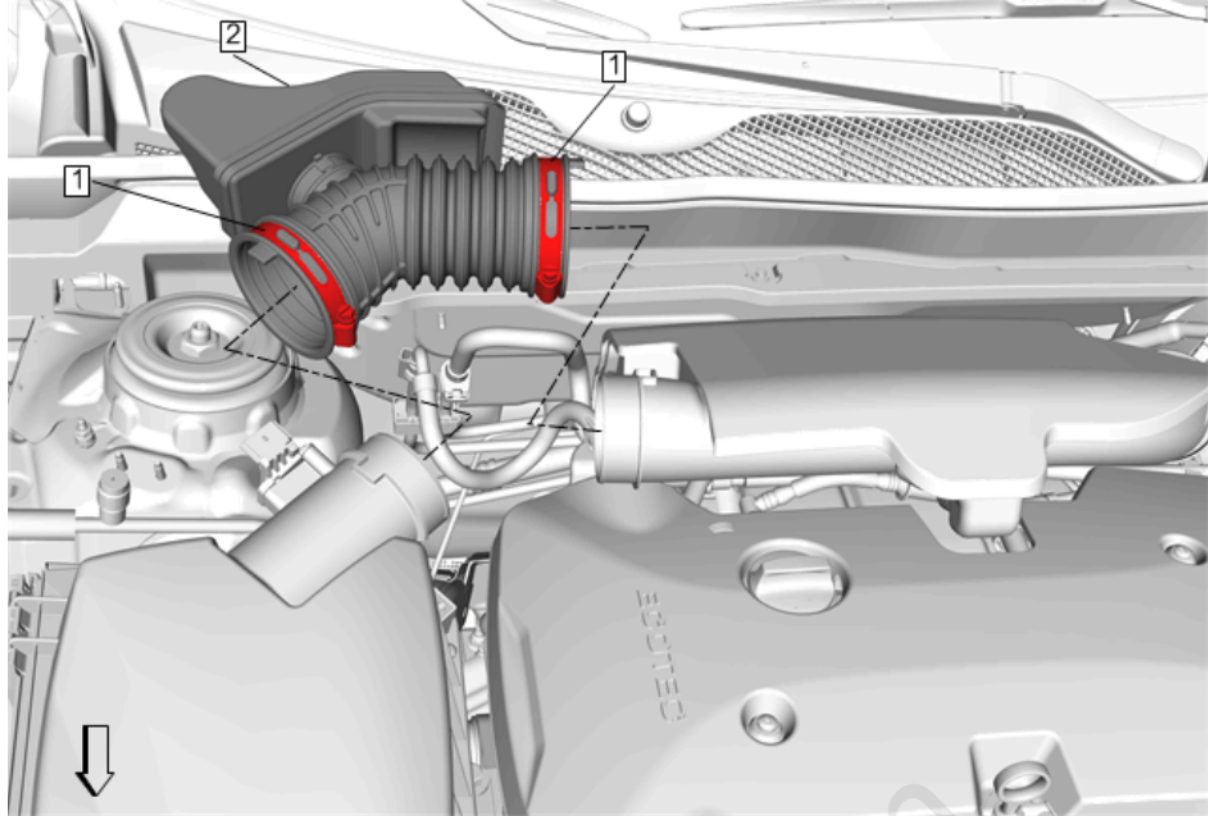


Fig. 139: Air Cleaner Outlet Duct

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Air Cleaner Outlet Duct Clamp (Qty: 2) CAUTION: Refer to Fastener Caution . NOTE: Ensure the outlet duct is fully seated to the mating surfaces before clamping. Verify that the cuff is not rolled under.
2	Air Cleaner Outlet Duct

AIR CLEANER RESONATOR AND OUTLET DUCT REPLACEMENT

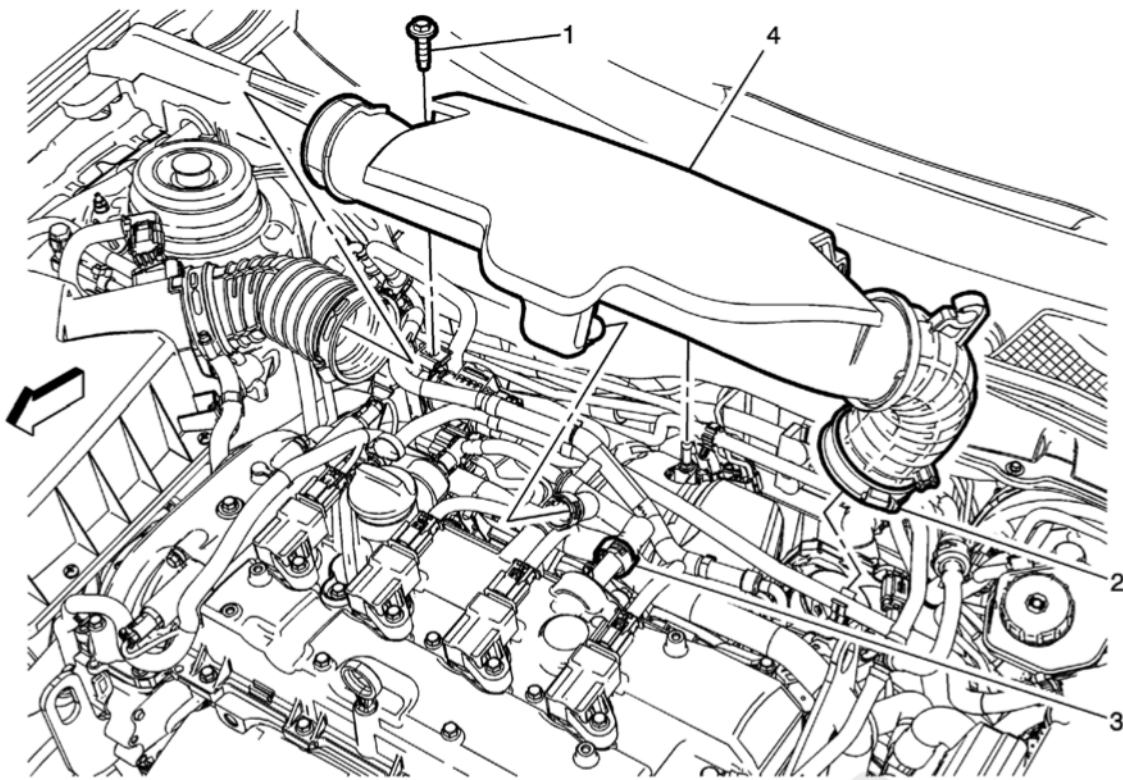


Fig. 140: Air Cleaner Resonator and Outlet Duct (LCV)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement . 2. Disconnect the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement. 3. Unclip the brake booster vacuum pipe from the duct.	
1	Air Cleaner Resonator and Outlet Duct Bolt CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Air Cleaner Resonator and Outlet Duct Clamp NOTE: Ensure the outlet duct is fully seated to the mating surfaces before clamping. Verify that the cuff is not rolled under.
3	PCV Tube
4	Air Cleaner Resonator and Outlet Duct

AIR CLEANER INLET DUCT REPLACEMENT

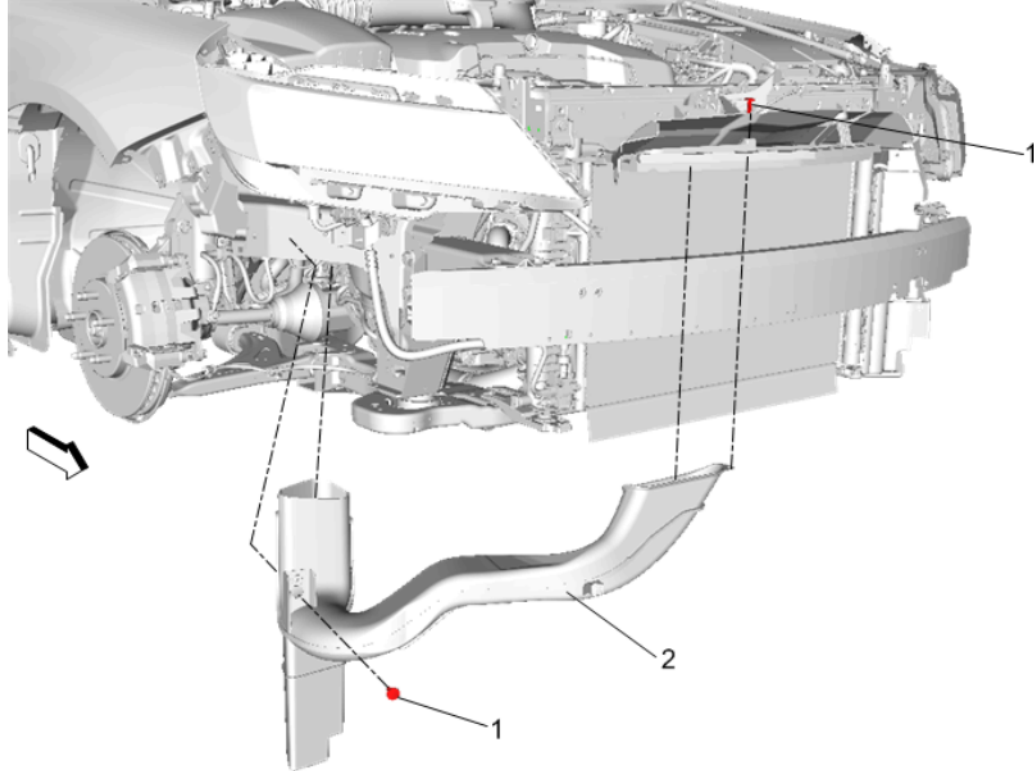


Fig. 141: Air Cleaner Inlet Duct

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Front Bumper Fascia. Refer to Front Bumper Fascia Replacement 2. Remove Front Bumper Fascia Reinforcement - Right Side. Refer to Front Bumper Fascia Reinforcement Replacement - Right Side	
1	Air Cleaner Inlet Duct Retainer (Qty: 2) CAUTION: Refer to Fastener Caution .
2	Air Cleaner Inlet Duct NOTE: Remove the front intake air duct and deflector together as an assembly. Separate after the assembly is removed from the vehicle. NOTE: Ensure that all duct(s) have been routed, installed and secured properly.

FRONT INTAKE AIR DUCT DEFLECTOR REPLACEMENT

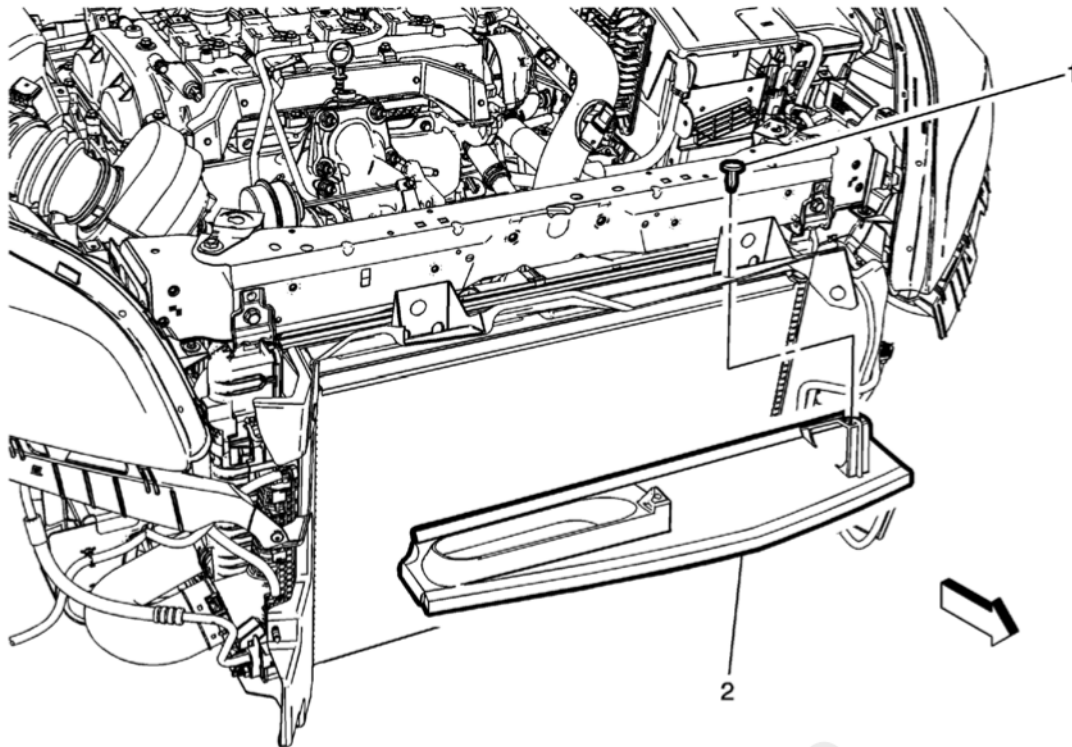


Fig. 142: Front Intake Air Duct Deflector

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove the air cleaner inlet duct. Refer to Air Cleaner Inlet Duct Replacement .	
1	Front Intake Air Duct Deflector Retainer
2	Front Intake Air Duct Deflector

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.5L (LCV) - Schematic and Routing Diagrams - Engine Controls Schematics - Impala

SCHEMATIC WIRING DIAGRAMS

ENGINE CONTROLS WIRING SCHEMATICS

Power, Ground, Serial Data, and MIL

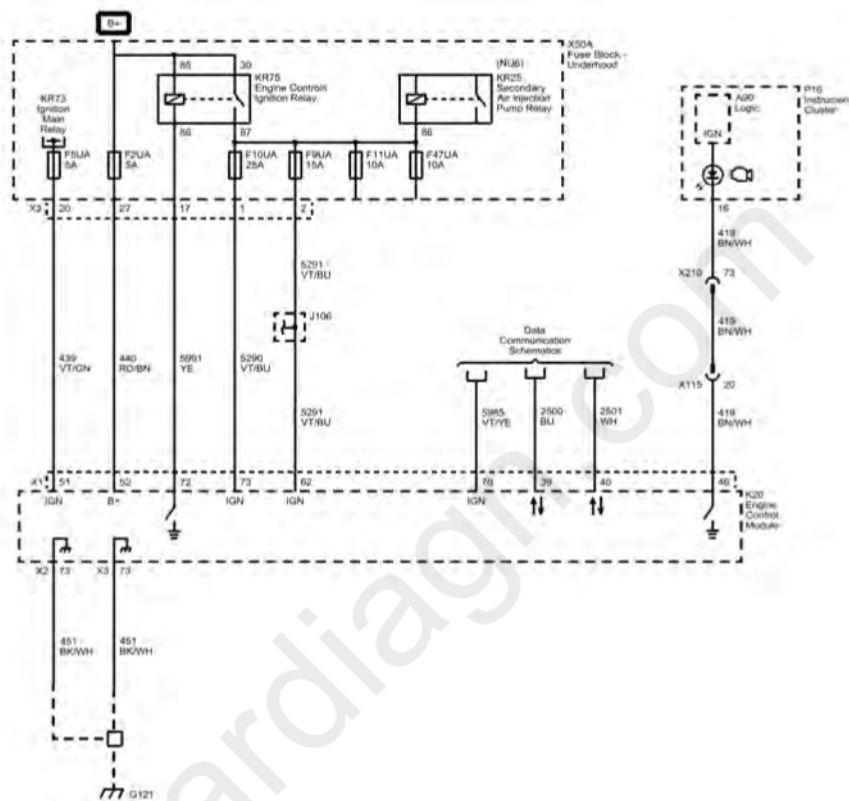


Fig. 1: Power, Ground, Serial Data, and MIL
Courtesy of GENERAL MOTORS COMPANY

5V1, and Low Reference Bus (1 of 3)

Low Reference Bus (3 of 3)

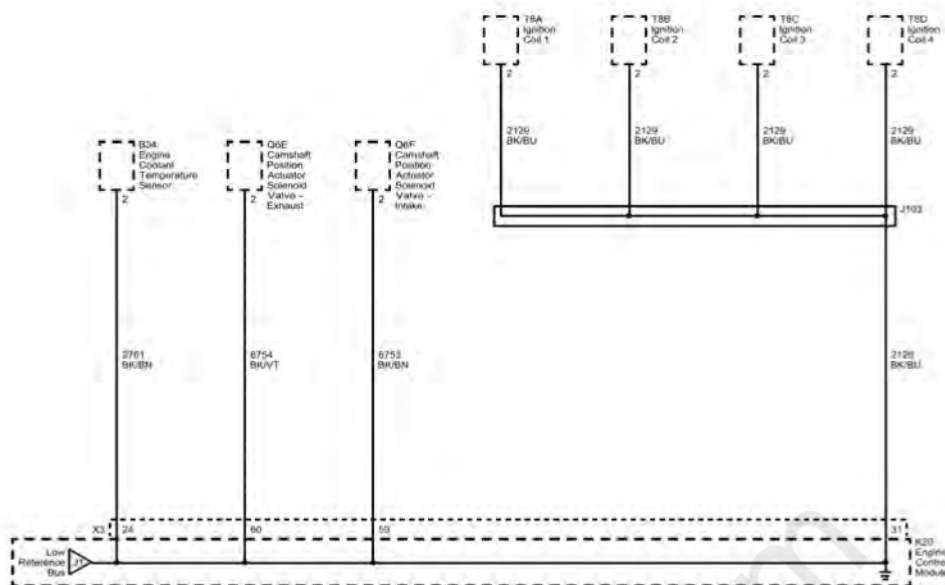
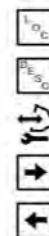


Fig. 4: Low Reference Bus (3 of 3)
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Pressure and Temperature

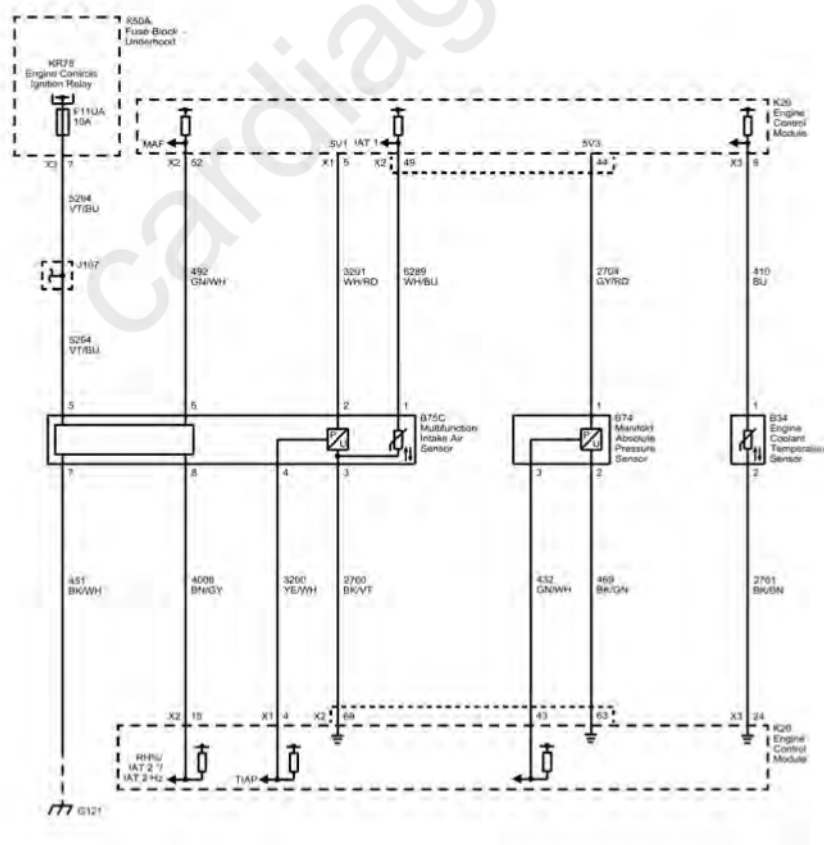


Fig. 5: Engine Data Sensors - Pressure and Temperature
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Oxygen Sensors

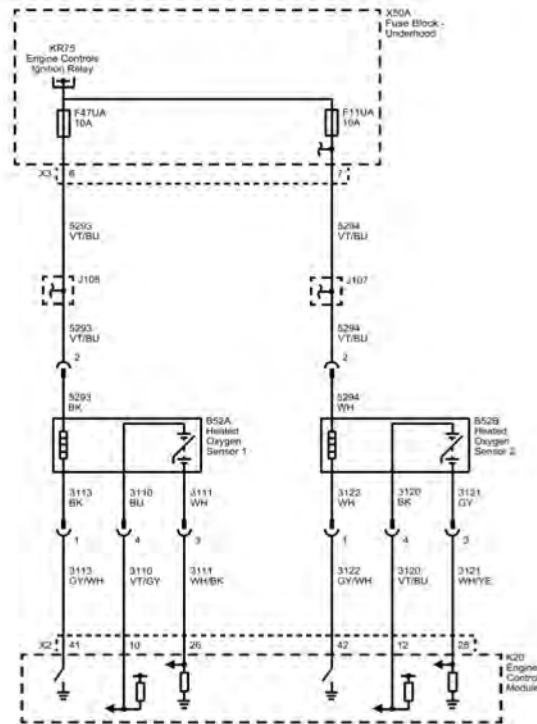


Fig. 6: Engine Data Sensors - Oxygen Sensors
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Throttle Controls and Override

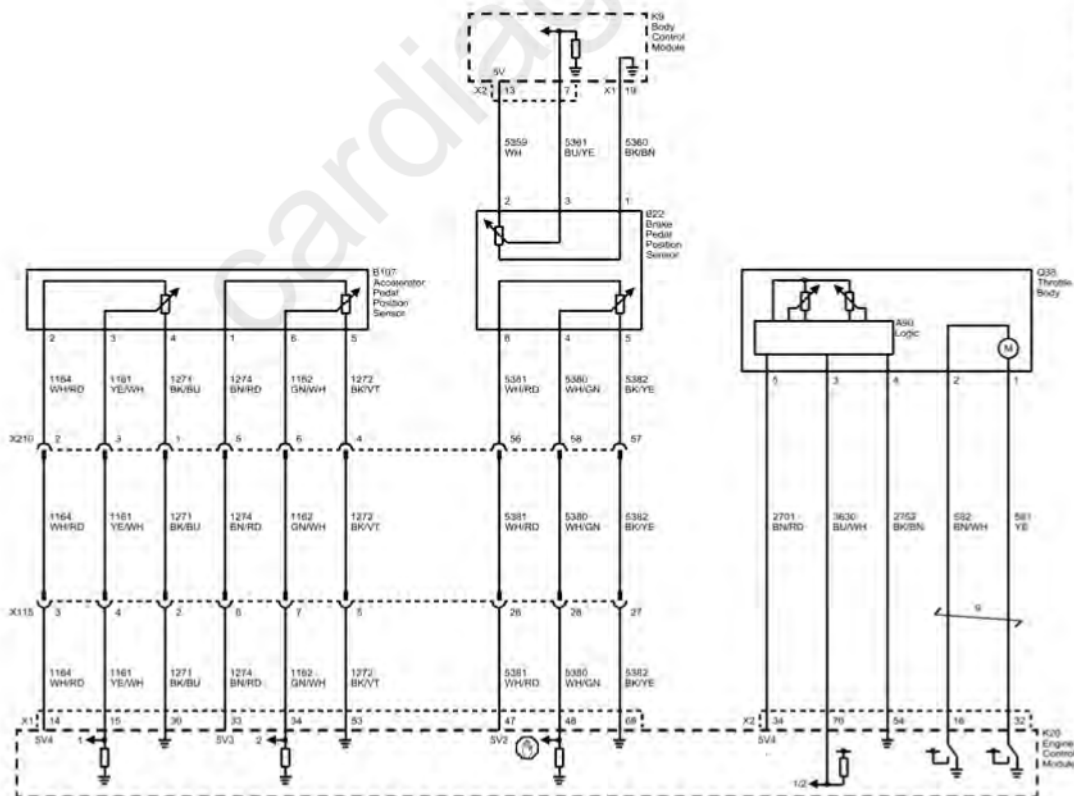


Fig. 7: Engine Data Sensors - Throttle Controls and Override
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Ignition System

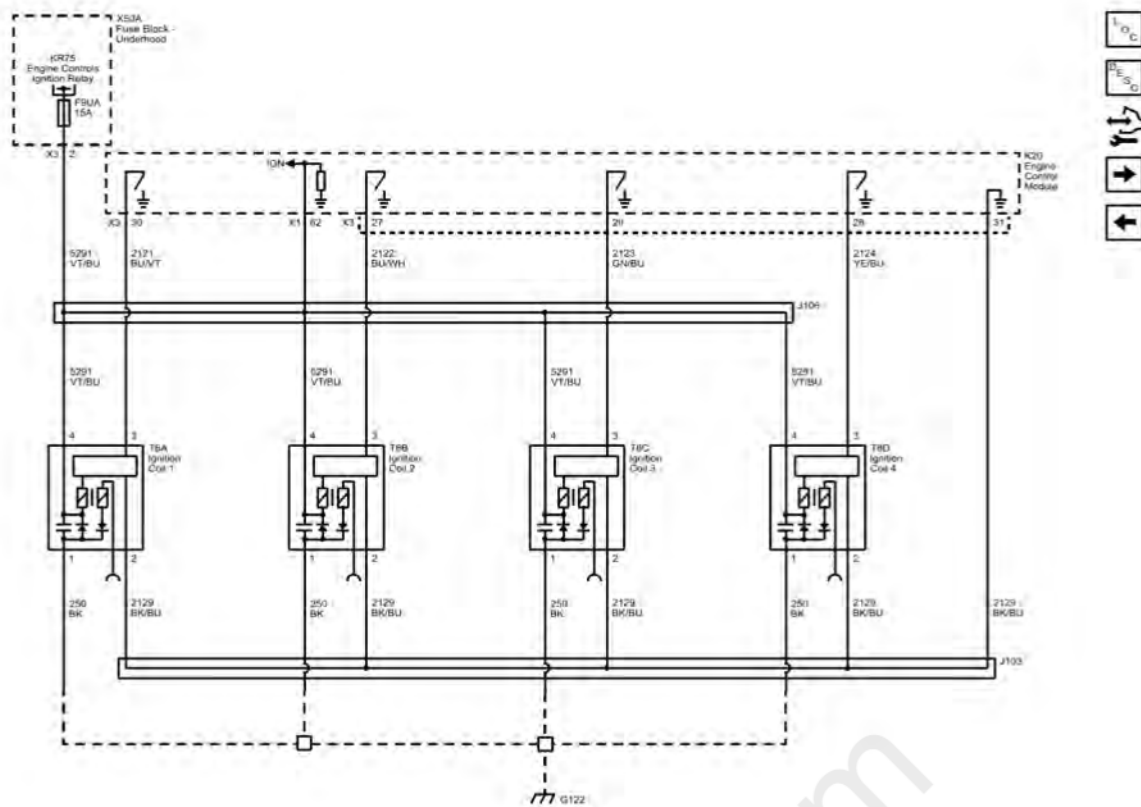


Fig. 8: Ignition Controls - Ignition System
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Camshaft Solenoids and Ignition Sensors

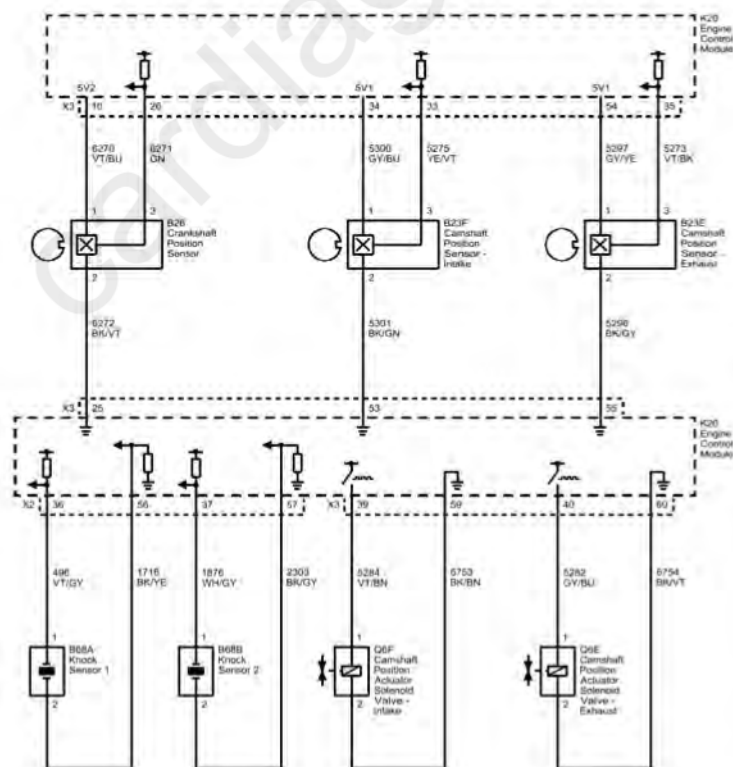


Fig. 9: Ignition Controls - Camshaft Solenoids and Ignition Sensors
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Injectors and High Pressure

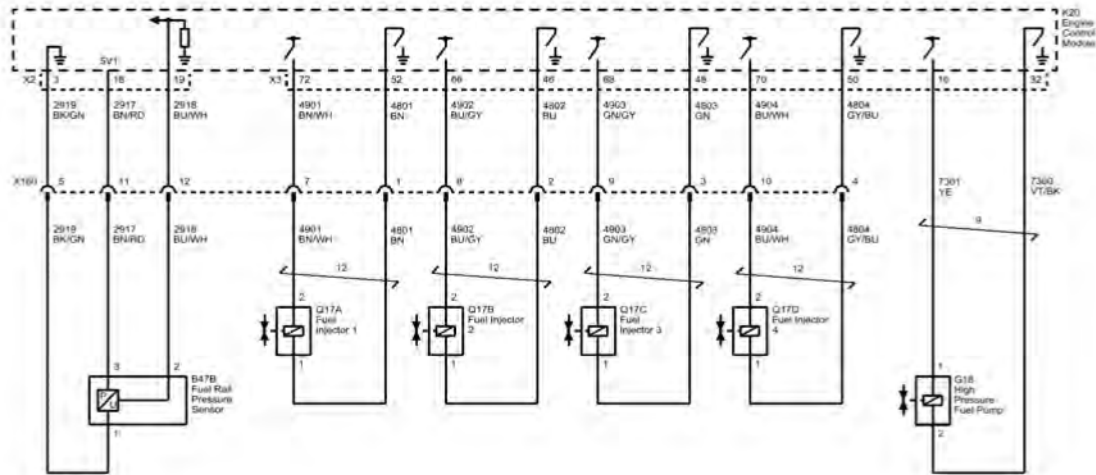


Fig. 10: Fuel Controls - Injectors and High Pressure
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Pump Controls

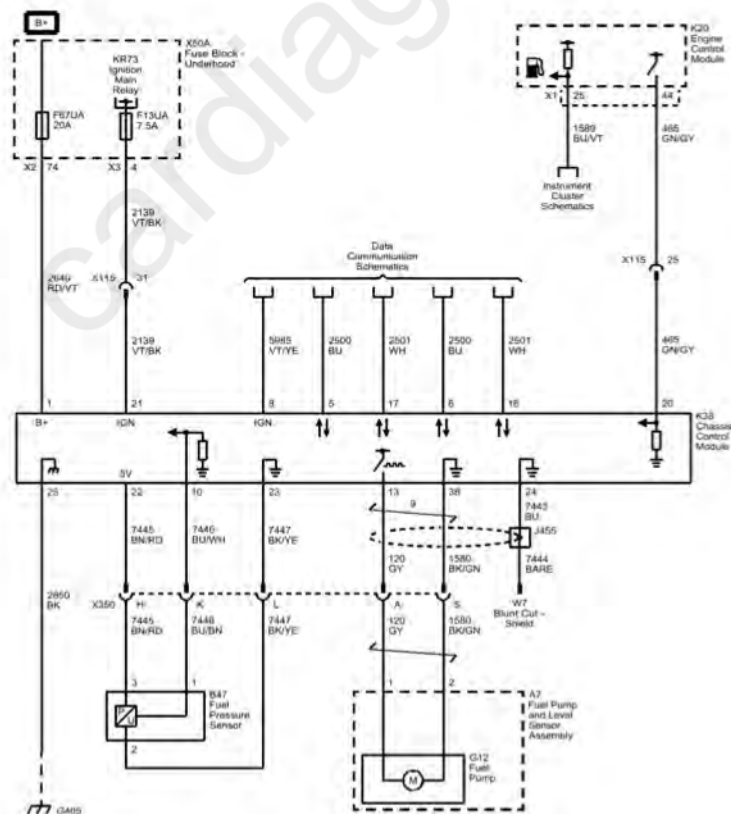
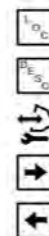
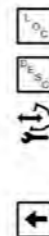


Fig. 11: Fuel Controls - Fuel Pump Controls
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Evaporative Emission Controls



Controlled/Monitored Subsystem References



Courtesy of GENERAL MOTORS COMPANY

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.5L (LCV) - Special Tools and Equipment - Special Tools - Impala

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

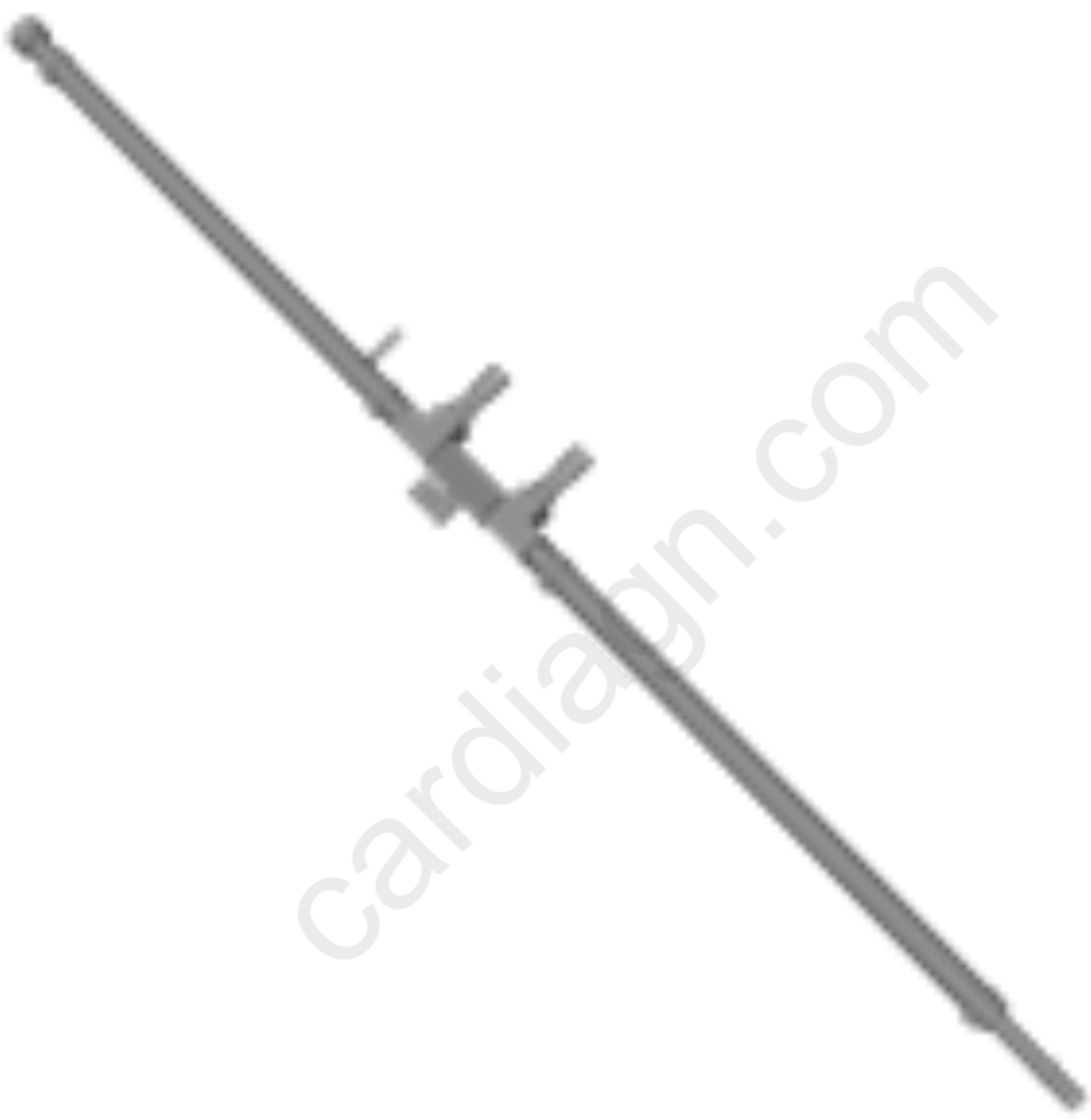
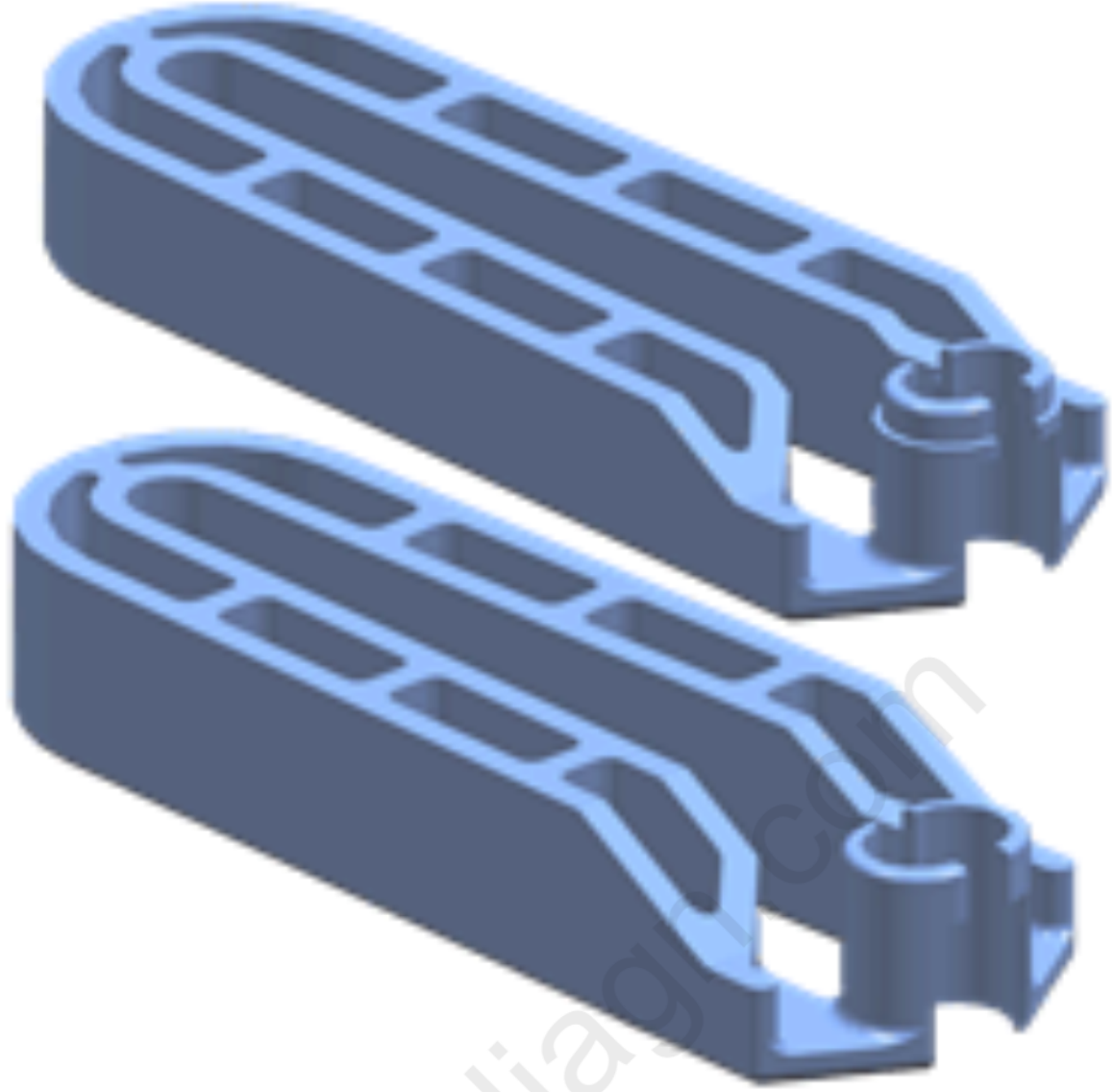
Illustration	Tool Number/Description
	CH-37287-1A Fuel Pressure Gauge Adapter 3/8"

Illustration	Tool Number/Description
	CH-41769 J-41769 Fuel Line Disconnect Tool Set 3/8"

cardia group

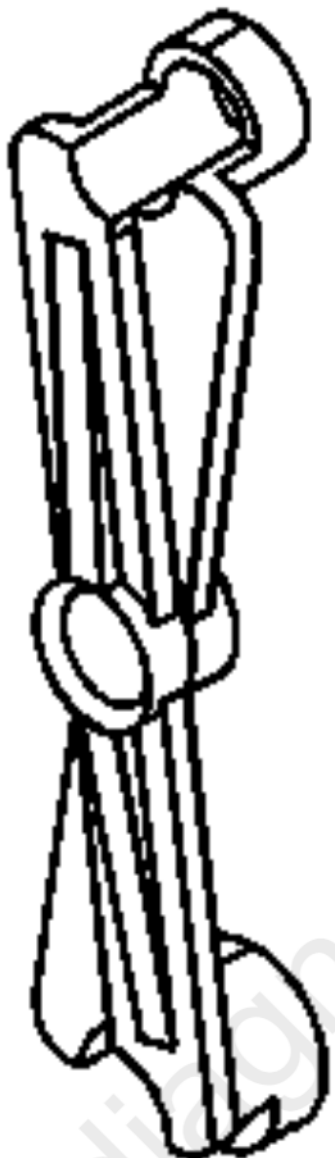
Illustration	Tool Number/Description
	CH-44581 J-44581 Fuel Line Disconnect Tool

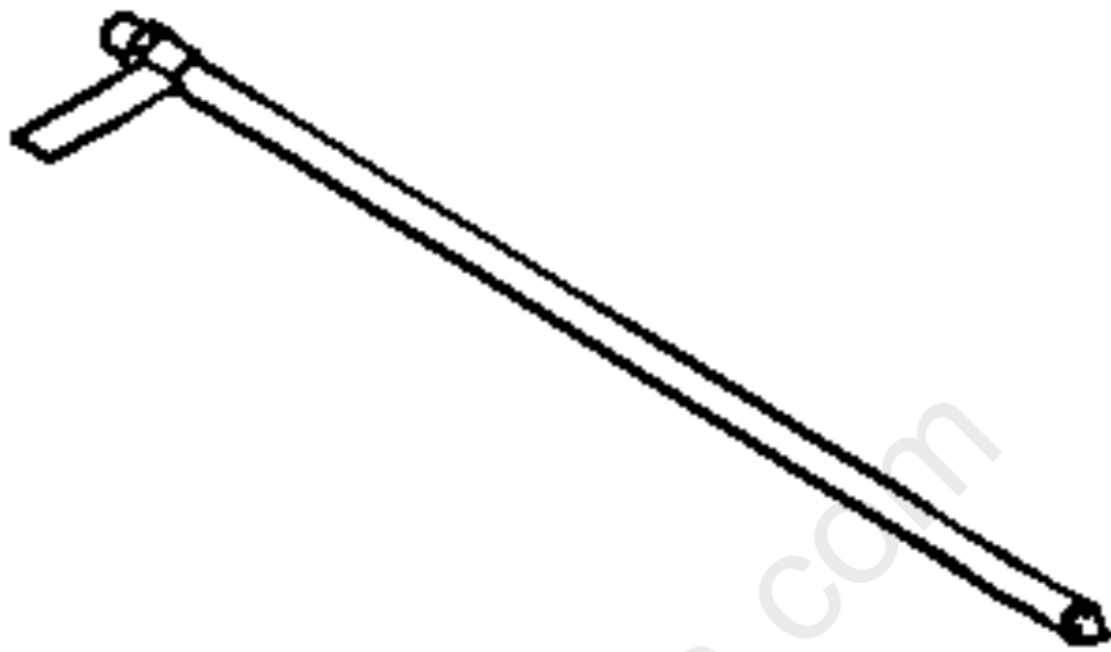
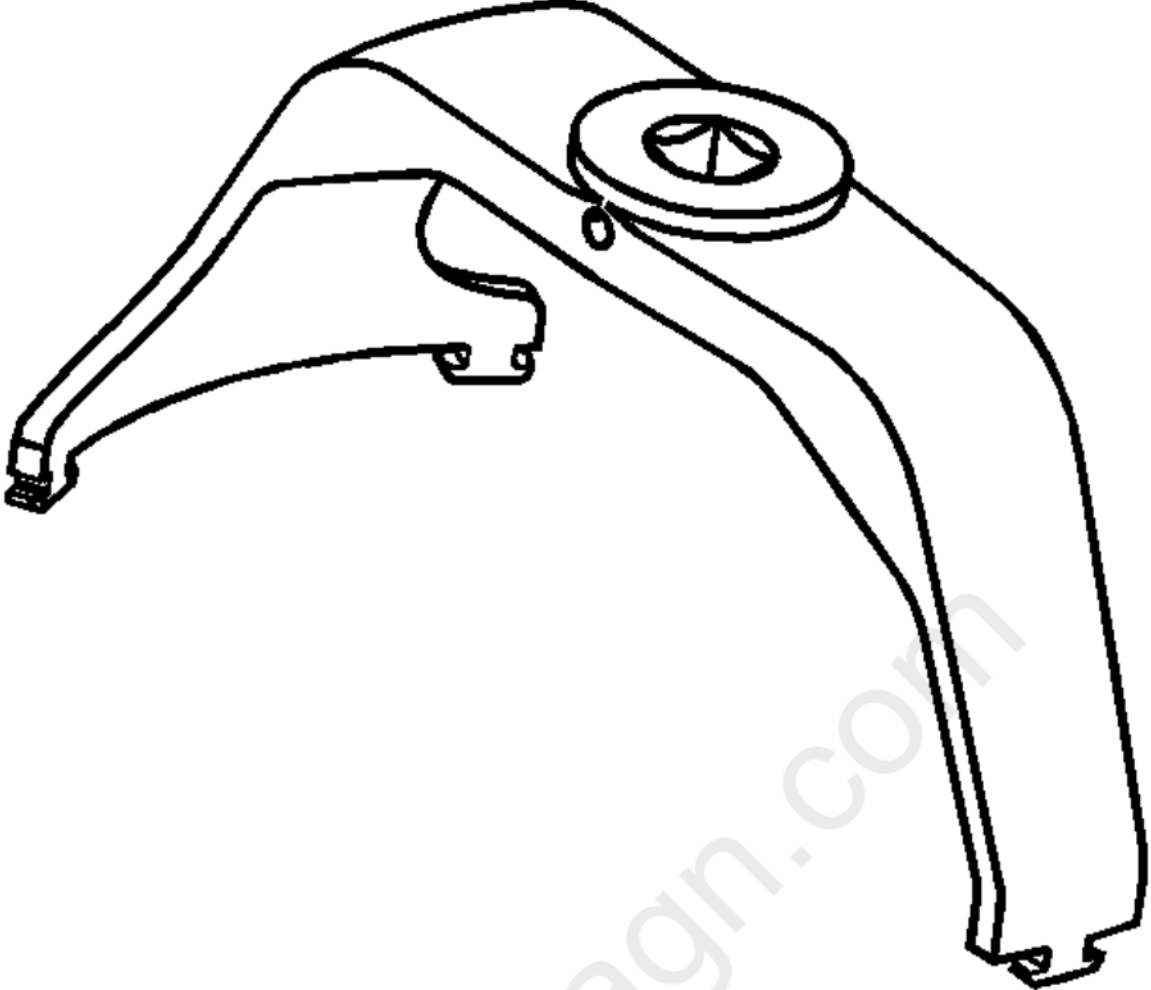
Illustration	Tool Number/Description
	CH-45004 J-45004 Fuel Tank Drain Hose

Illustration	Tool Number/Description
	CH-45722 J-45722 Fuel Sender Lock Ring Wrench

cardiagn.com

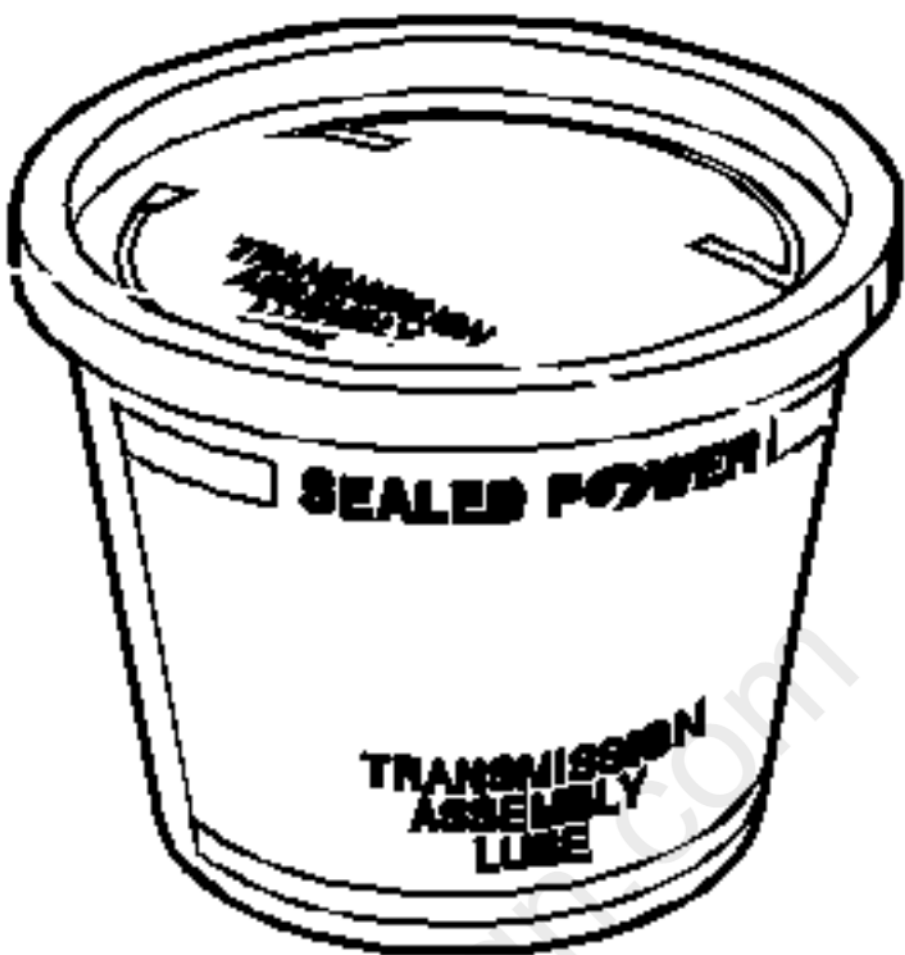
Illustration	Tool Number/Description
	DT-36850 J-36850 Transjel Lubricant
	EN-47909 Injector Bore and Sleeve Cleaning Kit

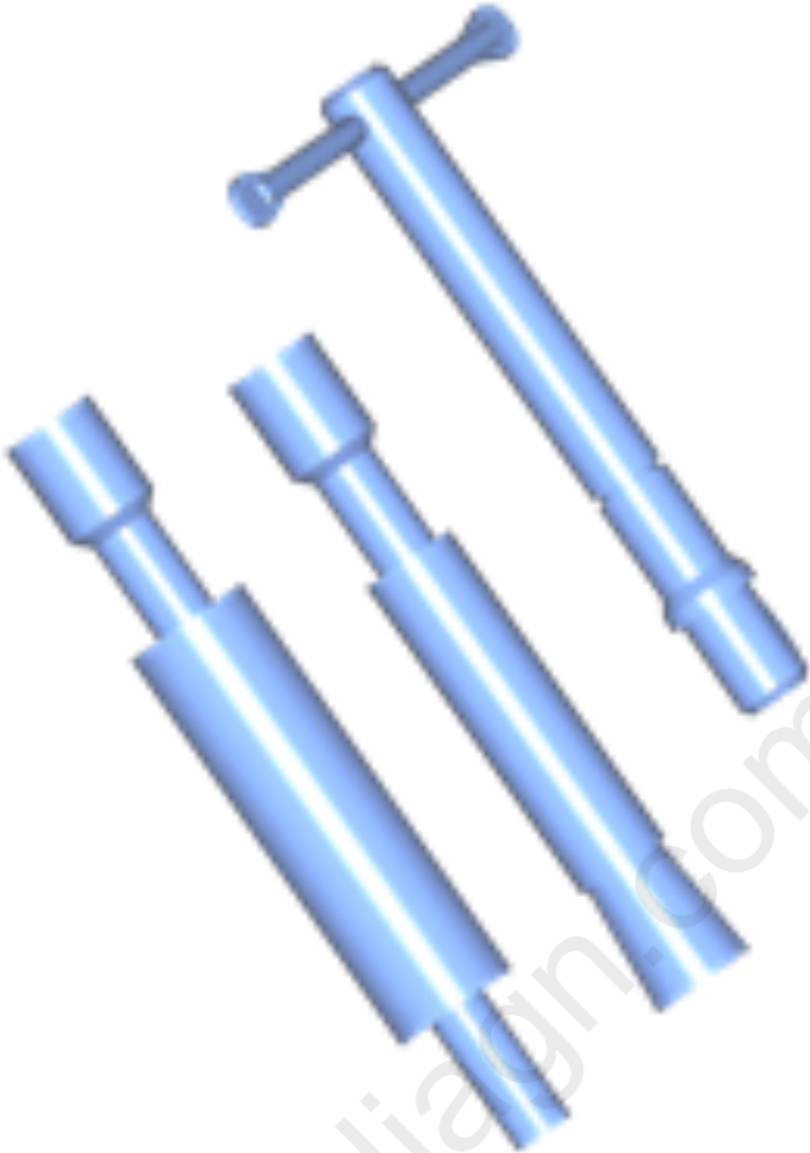
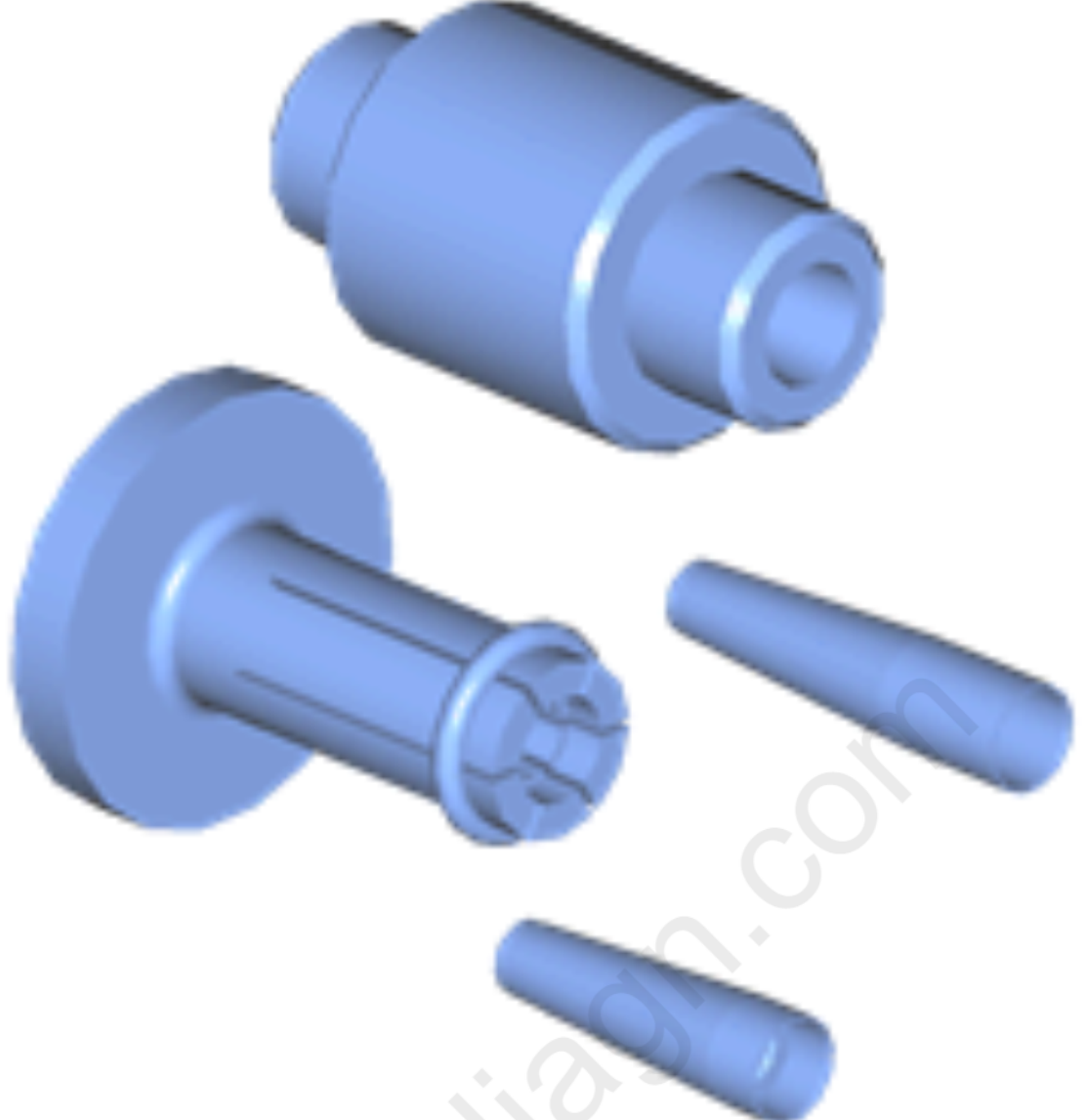
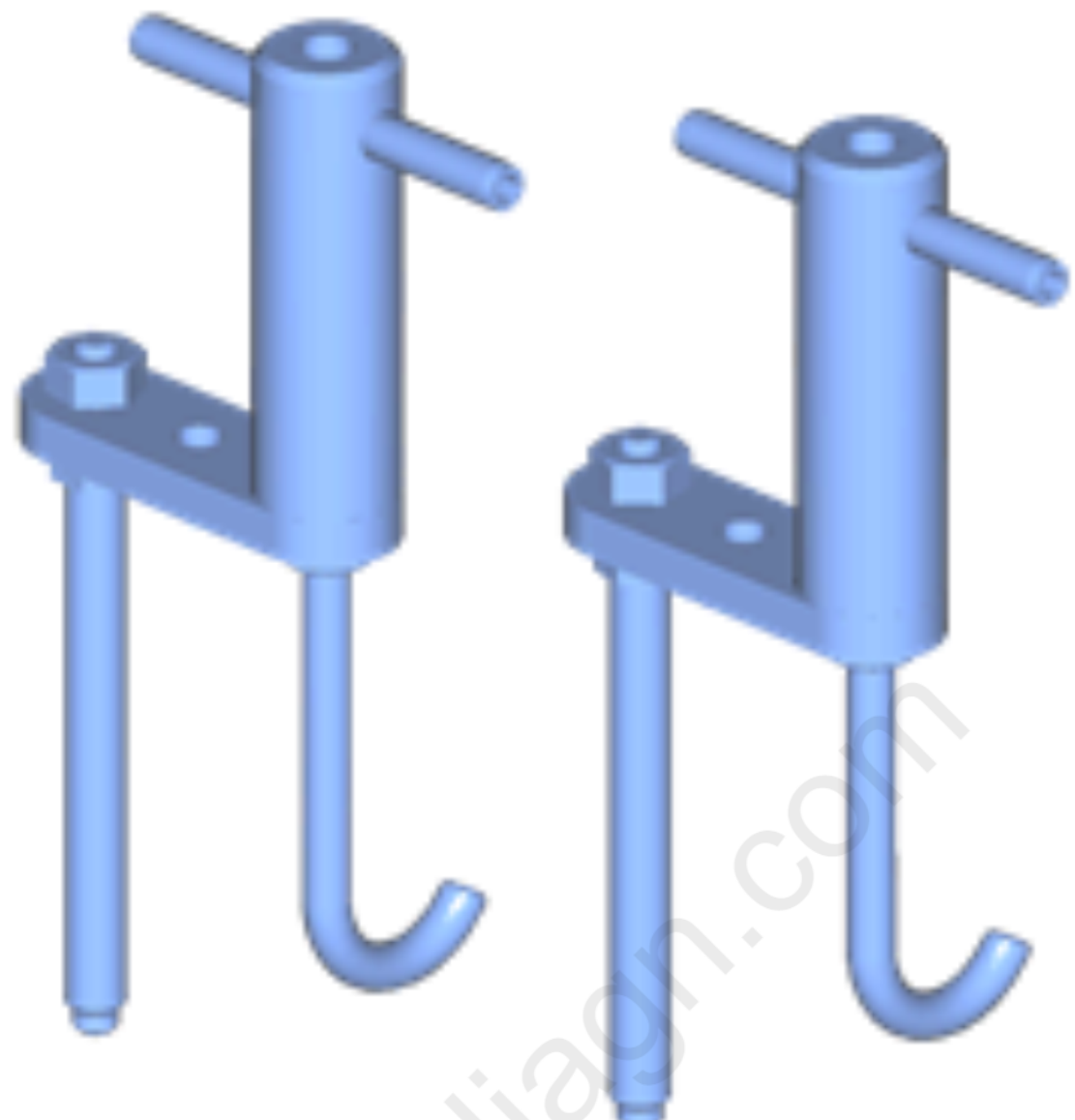
Illustration	Tool Number/Description
 The illustration shows three blue medical tools. The top tool is a long rod with a T-shaped handle at one end. Below it are two shorter rods, each with a flange or collar near one end. A large, light gray watermark 'cardiagn.com' is diagonally across the image.	

Illustration	Tool Number/Description
	EN-49245 Fuel Injector Seal Installer and Sizer

cardia9n.com

Illustration	Tool Number/Description
	EN-49248 Fuel Rail Assembly Remover

cardiaon.com

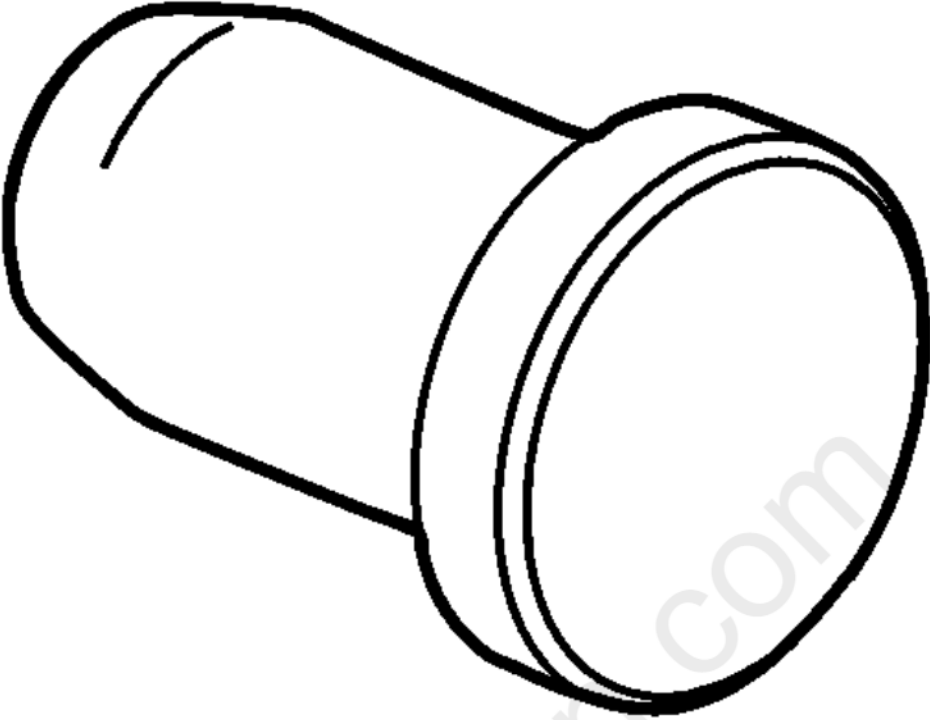
Illustration	Tool Number/Description
	EN-50790 HP Fuel Pump Installation Alignment Gauge

Illustration	Tool Number/Description
	EN-50791 Fuel Injector Nozzle Installer
	J-34730-1A Fuel Pressure Gauge

Illustration

Tool
Number/Description

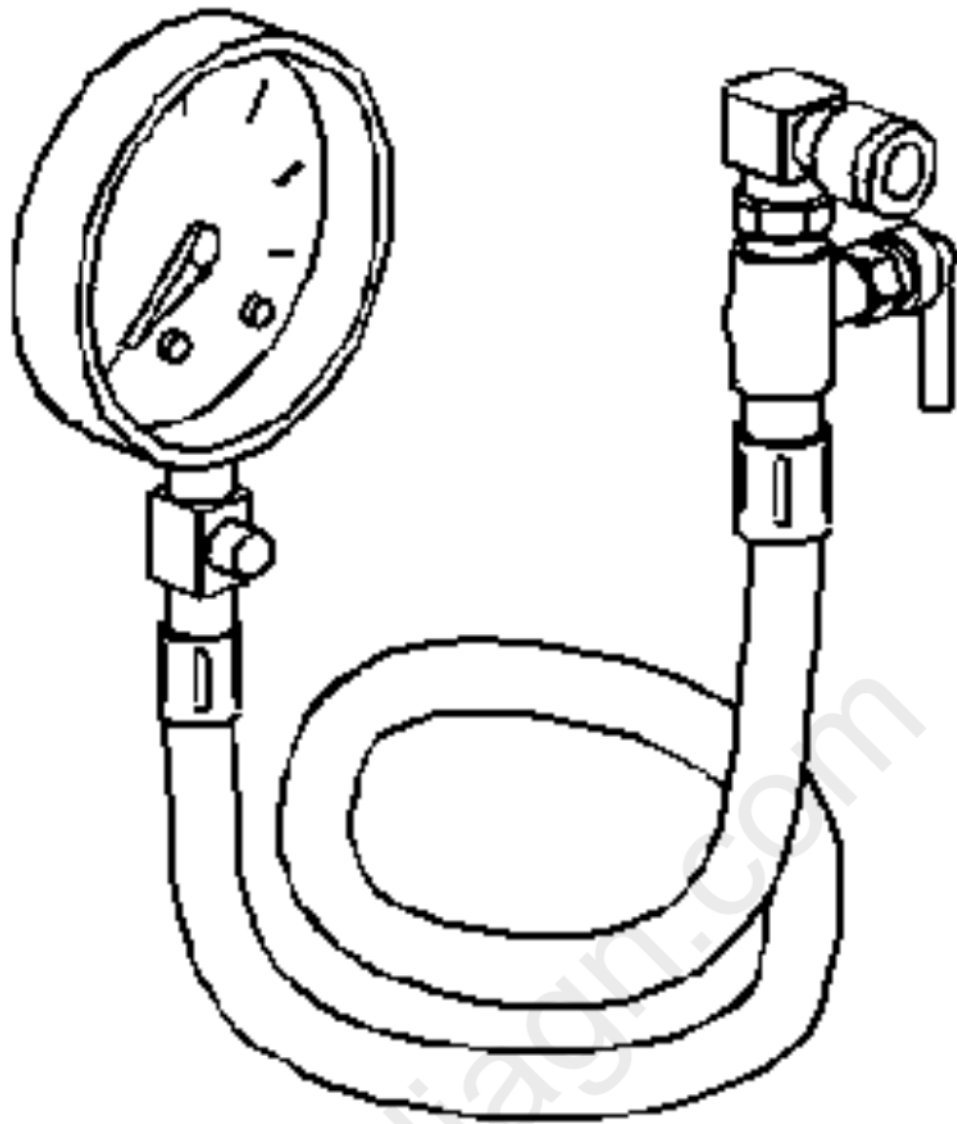
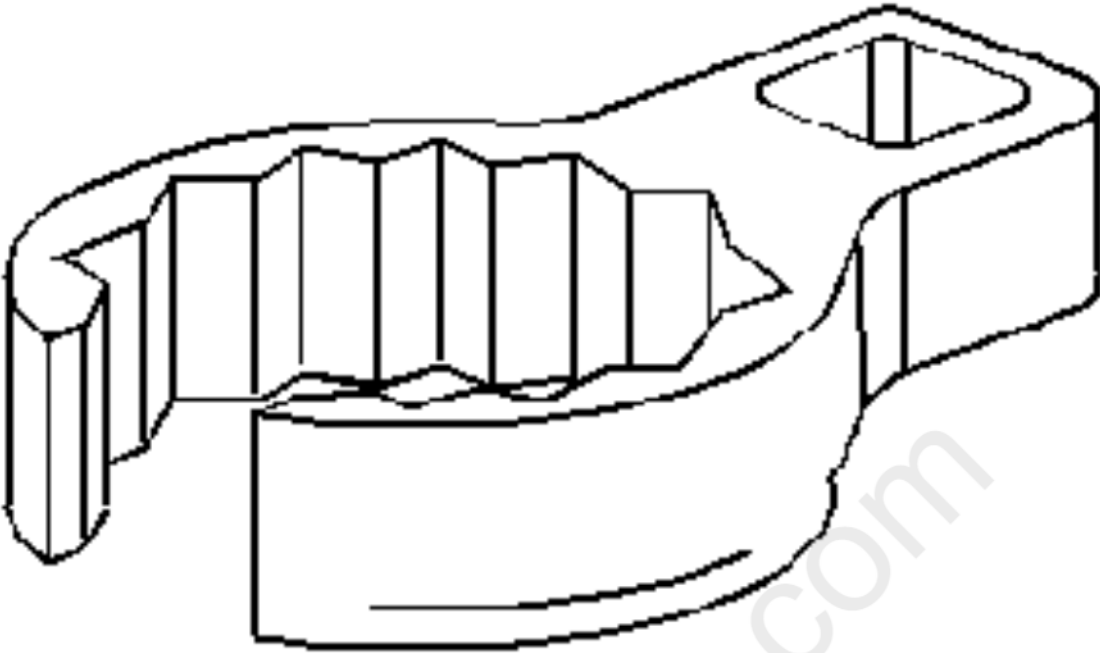


Illustration	Tool Number/Description
	J-39194 Oxygen Sensor Wrench

2017 ENGINE PERFORMANCE

Engine Controls and Fuel - 2.5L (LCV) - Specifications - Impala

SPECIFICATIONS

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

TEMPERATURE VERSUS RESISTANCE - ENGINE COOLANT TEMPERATURE SENSOR

Temperature	Resistance
150°C (302°F)	47 to 49 ohms
140°C (284°F)	58 to 62 ohms
130°C (266°F)	76 to 80 ohms
120°C (248°F)	98 to 104 ohms
110°C (230°F)	130 to 136 ohms
100°C (212°F)	174 to 182 ohms
90°C (194°F)	237 to 247 ohms
80°C (176°F)	327 to 341 ohms
70°C (158°F)	459 to 479 ohms
60°C (140°F)	656 to 686 ohms
50°C (122°F)	958 to 1002 ohms
45°C (113°F)	1167 to 1223 ohms
40°C (104°F)	1430 to 1500 ohms
35°C (95°F)	1763 to 1849 ohms
30°C (86°F)	2185 to 2295 ohms
25°C (77°F)	2725 to 2865 ohms
20°C (68°F)	3418 to 3604 ohms
15°C (59°F)	4318 to 4564 ohms
10°C (50°F)	5493 to 5823 ohms
5°C (41°F)	7041 to 7485 ohms
0°C (32°F)	9097 to 9701 ohms
-5°C (23°F)	11844 to 12678 ohms
-10°C (14°F)	15540 to 16700 ohms

Temperature	Resistance
-15Â°C (5Â°F)	20559 to 22183 ohms
-20Â°C (-4Â°F)	27439 to 29725 ohms
-30Â°C (-22Â°F)	50264 to 54924 ohms
-40Â°C (-40Â°F)	95953 to 105777 ohms

ALTITUDE VERSUS BAROMETRIC PRESSURE

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)	Barometric Pressure Measured in Pounds Per Square Inch (PSI)
Determine your altitude by contacting a local weather station or by using another reference source.			
4,267	14,000	56 - 64	8.1 - 9.3
3,962	13,000	58 - 66	8.4 - 9.6
3,658	12,000	61 - 69	8.8 - 10.0
3,353	11,000	64 - 72	9.3 - 10.4
3,048	10,000	66 - 74	9.6 - 10.7
2,743	9,000	69 - 77	10.0 - 11.2
2,438	8,000	71 - 79	10.3 - 11.5
2,134	7,000	74 - 82	10.7 - 11.9
1,829	6,000	77 - 85	11.2 - 12.3
1,524	5,000	80 - 88	11.6 - 12.8
1,219	4,000	83 - 91	12.0 - 13.2
914	3,000	87 - 95	12.6 - 13.8
610	2,000	90 - 98	13.1 - 14.2
305	1,000	94 - 102	13.6 - 14.8
0	0 Sea Level	96 - 104	13.9 - 15.1
-305	-1,000	101 - 105	14.6 - 15.2

IGNITION SYSTEM SPECIFICATIONS

Application	Specification
Ignition Type	Individual Ignition Coils
Firing Order	1 - 3 - 4 - 2
Spark Plug Torque	Refer to Fastener Specifications
Spark Plug Gap	Refer to Engine Mechanical Specifications
Spark Plug Type	Refer to Electronic Parts Catalog

FASTENER SPECIFICATIONS

Single Use Non-Threaded Fasteners/Components

NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application
Camshaft Position Actuator Exhaust Solenoid Valve Seal
Camshaft Position Actuator Intake Solenoid Valve Seal
Camshaft Position Sensor Seal
Crankshaft Position Sensor Seal
Engine Coolant Temperature Sensor Seal
Fuel Injector O-ring Seal
Fuel Injector Spacer

NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application
Fuel Pressure Sensor O-ring
Fuel Pump Gasket
Fuel Tank Module Seal
Manifold Absolute Pressure Sensor O-ring

Single Use Threaded Fastener/Component Tightening Specifications**NOTE:**

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application	Specification
	Metric (English)
Fuel Feed Intermediate Pipe	
• First Pass:	15 N.m (11 lb ft)
• Final Pass:	30 N.m (22 lb ft)
Fuel Injection Fuel Rail Fuel Pressure Sensor	33 N.m (24 lb ft)

Reusable Threaded Fastener Tightening Specifications**NOTE:**

All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Accelerator Pedal Position Sensor Bolt	9 N.m (80 lb in)
Air Cleaner Resonator and Outlet Duct Bolt	9 N.m (80 lb in)
Camshaft Position Actuator Exhaust Solenoid Valve Fastener	10 N.m (89 lb in)
Camshaft Position Actuator Intake Solenoid Valve Fastener	10 N.m (89 lb in)
Camshaft Position Sensor Fastener	10 N.m (89 lb in)
Chassis Control Module Fastener	9 N.m (80 lb in)
Crankshaft Position Sensor Fastener	10 N.m (89 lb in)
Engine Oil Pressure Sensor	35 N.m (26 lb ft)
Filler Pipe Fastener	9 N.m (80 lb in)
Filler Tube Hose Clamp	4 N.m (35 lb in)
Fuel Pressure Sensor	15 N.m (11 lb ft)
Fuel Pump Bolt	
First Pass:	8 N.m (71 lb in)
Final Pass:	+50 degrees
Fuel Pump Cover Fastener	10 N.m (89 lb in)
Fuel Rail Bolt	25 N.m (18 lb ft)
Fuel Tank Filler Pipe Hose Clamp	4 N.m (35 lb in)
Fuel Tank Strap Bolt	27 N.m (20 lb ft)
Heated Oxygen Sensor	42 N.m (31 lb ft)
Ignition Coil Fastener	10 N.m (89 lb in)
Knock Sensor Fastener	25 N.m (18 lb ft)

NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Manifold Absolute Pressure Sensor Retaining Fastener	10 N.m (89 lb in)
Oil Pump Flow Control Valve Electrical Wiring Harness Connector Bracket Fastener	10 N.m (89 lb in)
Oil Pump Flow Control Valve Fastener	10 N.m (89 lb in)
Oil Pump Flow Control Valve Heat Shield Fastener -	58 N.m (43 lb ft)
Pump and Component Oil Heat Shield Bolt	9 N.m (80 lb in)
Spark Plug	20 N.m (15 lb ft)
Throttle Body Assembly Fastener	10 N.m (89 lb in)
Vacuum Pump Fastener	10 N.m (89 lb in)

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-20 Oil	GM P/N 19259486 (Canadian P/N 19259783)
Fuel Injection Fuel Rail Bolts	Sealant	GM P/N 12345382 (Canadian P/N 10953489)
High Pressure Fuel Pump Bolt	Threadlocker	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)