ENGINE PERFORMANCE

Engine Controls and Fuel - 5.3L (L83) or 6.2L (L86) - Description and Operation - Escalade, Suburban, Tahoe, Yukon

DESCRIPTION AND OPERATION

ENGINE CONTROL MODULE DESCRIPTION

The Engine Control Module (ECM) interacts with many emission related components and systems, and monitors emission related components and systems for deterioration. OBD II diagnostics monitor the system performance and a diagnostic trouble code (DTC) sets if the system performance degrades. The ECM is part of a network and communicates with various other vehicle control modules.

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

The ECM is the control center of the engine controls system. Review the components and wiring diagrams in order to determine which systems are controlled by the ECM.

The ECM constantly monitors the information from various sensors and other inputs, and controls the systems that affect engine performance and emissions. The ECM also performs diagnostic tests on various parts of the system and can turn on the MIL when it recognizes an operational problem that affects emissions. When the ECM detects a malfunction, the ECM stores a DTC. The condition area is identified by the particular DTC that is set. This aids the technician in making repairs.

ECM Function

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

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

EEPROM

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

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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.

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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).

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DESCRIPTION

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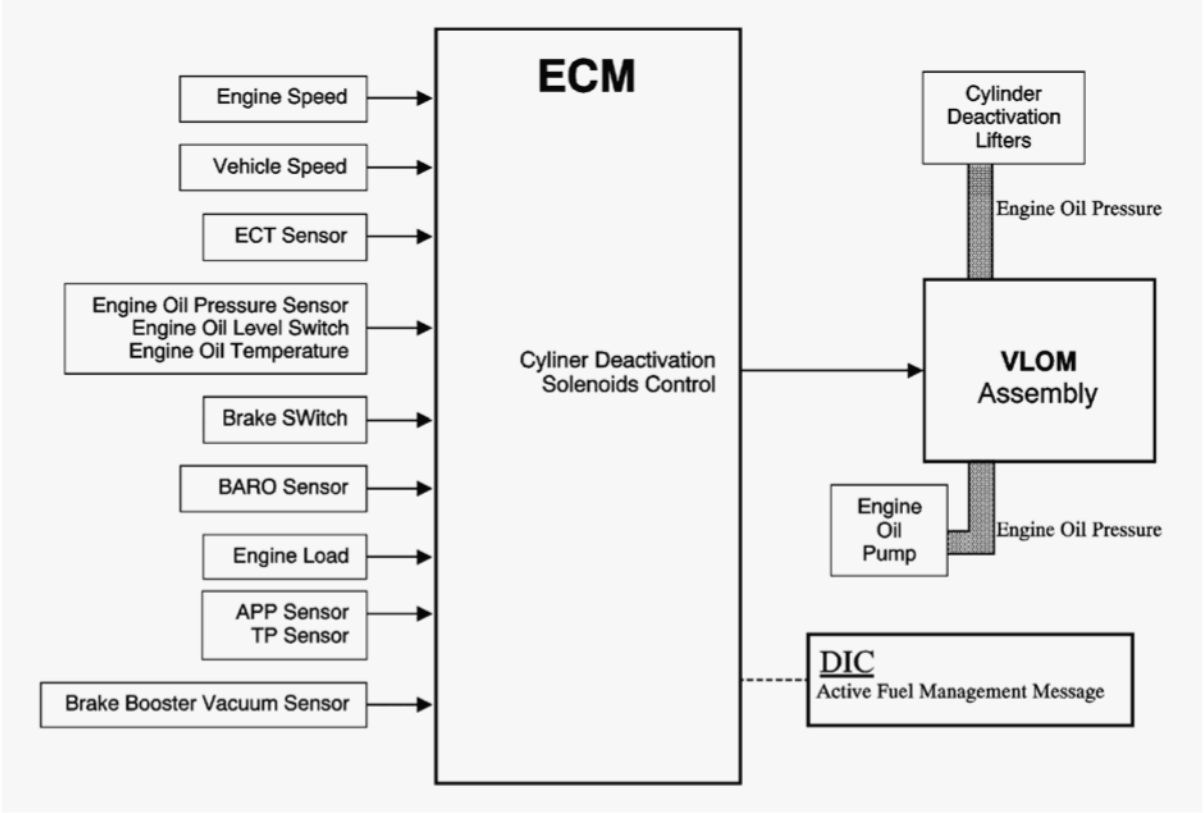


Fig. 1: Cylinder Deactivation (Active Fuel Management) System Diagram
Courtesy of GENERAL MOTORS COMPANY

To provide maximum fuel economy under light load driving conditions, the engine control module (ECM) will command the cylinder deactivation system ON to deactivate engine cylinders 1, 7, 6, and 4, switching to a V4 mode. The engine will operate on 8 cylinders, or V8 mode, during engine starting, engine idling, and medium to heavy throttle applications.

Manifold absolute pressure (MAP) and the conditions listed below determine when cylinder deactivation is enabled.

- Engine has been running for greater than 30 s
- Engine speed is between 700 and 2800 rpm
- Engine oil pressure is between 187-455 kPa (27-66 psi)
- Engine coolant temperature is between 40-129Â°C (100-264Â°F)
- Engine oil temperature is between 16-128Â°C (61-263Â°F)

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- Throttle angle is 6% or less
- Ignition voltage is greater than 11 V
- Transmission is not in first, second, or reverse gear
- Vehicle speed is greater than 25 kph (15.5 mph)
- Brake booster pressure is greater than 42.0 kPa (6 psi)
- Vehicle is not in fuel shut of mode
- Vehicle is not in heater performance mode
- Vehicle is not in tip in bump acceleration mode
- Vehicle is not in oil aeration mode
- Vehicle is not in low range (if equipped)

When cylinder deactivation is commanded, the ECM will determine what cylinder is firing and begin deactivation on the next closest deactivated cylinder in firing order sequence. For example, if cylinder number 1 is on its combustion event when cylinder deactivation is commanded ON, the next cylinder in the firing order sequence that can be deactivated is cylinder number 7. If cylinder number 5 is on its combustion event when cylinder deactivation is commanded ON, then the next cylinder in the firing order sequence that can be deactivated is cylinder number 4.

Cylinder deactivation is accomplished by not allowing the intake and exhaust valves to open on the selected cylinders by using special valve lifters. The deactivation lifters contain spring loaded locking pins that connect the internal pin housing of the lifter to the outer housing.

The pin housing contains the lifter plunger and pushrod seat which interfaces with the pushrod. The outer housing contacts the camshaft lobe through a roller. During V8 mode, when all cylinders are active, the locking pins are pushed outward by spring force, locking the pin housing and outer housing together causing the lifter to function as a normal lifter. When cylinder deactivation is commanded ON, the locking pins are pushed inward with engine oil pressure directed from the valve lifter oil manifold assembly solenoids. When the lifter pin housing is unlocked from the outer housing, the pin housing will remain stationary, while the outer housing will move with the profile of the camshaft lobe, which results in the valve remaining closed. One valve lifter oil manifold assembly solenoid controls both the intake and exhaust valves for each deactivating cylinder. There are 2 distinct oil passages going to each cylinder deactivation lifter bore, one for the hydraulic lash-adjusting feature of the lifter, and one for controlling the locking pins used for cylinder deactivation.

Although both intake and exhaust valve lifters are controlled by the same solenoid in the valve lifter oil manifold assembly, the intake and exhaust valves do not become deactivated at the same time. Cylinder deactivation is timed so that the cylinder is on an intake event. During an intake event, the intake cam lobe is pushing the valve lifter upwards to open the intake valve against the force of the valve spring. The force exerted by the valve spring is acting on the side of the lifter locking pins, preventing them from moving until the intake valve has closed. When the intake valve lifter reaches the base circle of the camshaft lobe, the valve spring force is reduced, allowing the locking pins to move, deactivating the intake valve. However, when cylinder deactivation is commanded ON, the exhaust valve for the deactivated cylinder is in the closed position, allowing the locking

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pins on the valve lifter to move immediately, and deactivate the exhaust valve.

By deactivating the exhaust valve first, this allows the capture of a burnt air/fuel charge, or exhaust gas charge, in the combustion chamber. The capture of exhaust gases in the combustion chamber will contribute to a reduction in oil consumption, noise and vibration levels, and exhaust emissions when operating in V4 mode cylinder deactivation mode.

During the transition from V8 to V4 mode, the Fuel Injectors will be turned OFF on the deactivated cylinders. To help prevent spark plug fouling, the ignition system secondary voltage or spark is still present across the spark plug electrodes on the deactivated cylinders. If all enabling conditions are met and maintained for cylinder deactivation operation, the ECM calibrations will limit cylinder deactivation to a cycle time of 10 minutes in V4 mode, then return to V8 mode for 1 minute.

Switching between V8 and V4 modes is accomplished in less than 250 milliseconds, making the transitions seamless and transparent to the vehicle operator. The 250 milliseconds includes the time for the ECM to sequence the transitions, the response time for the valve lifter oil manifold assembly solenoids to energize, and the time for the valve lifters to deactivate, all within 2 revolutions of the engine crankshaft.

Valve Lifter Oil Manifold Assembly

The cylinder deactivation system uses an electro-hydraulic actuator device called the valve lifter oil manifold assembly. The valve lifter oil manifold assembly is bolted to the top of the engine valley, below the intake manifold assembly. The valve lifter oil manifold assembly consists of 4 electrically operated normally closed solenoids. Each solenoid controls the application of engine oil pressure to the intake and exhaust valve lifters on the cylinders selected to deactivate. Engine oil pressure is routed to the valve lifter oil manifold assembly from an internal oil passage on the rear of the cylinder block.

All 4 valve lifter oil manifold assembly solenoids are connected in parallel to a fused ignition 1 voltage circuit, supplied by the powertrain relay. The ground or control circuit for each solenoid is connected to a low side driver internal to the engine control module (ECM).

When all enabling conditions are met for cylinder deactivation, the ECM will ground each solenoid control circuit in firing order sequence, allowing current to flow through the solenoid windings. With the coil windings energized, the solenoid valve opens, redirecting engine oil pressure through the valve lifter oil manifold assembly into 8 separate vertical passages in the engine lifter valley. The 8 vertical passages, 2 per cylinder, are connected to the valve lifter bores of the cylinders to be deactivated. When vehicle-operating conditions require a return to V8 mode, the ECM will turn OFF the control circuit for the solenoids, allowing the solenoid valves to close. With the solenoid valves closed, engine oil pressure in the control ports is exhausted through the body of the solenoids into the engine block lifter valley. The housing of the valve lifter oil manifold assembly incorporates several bleeds in the oil passages to purge any air trapped in the valve lifter oil manifold assembly or engine block.

To help control contamination to the hydraulic circuits, a small replaceable oil screen is located in the valve lifter oil manifold assembly oil inlet passage, below the oil pressure sensor. The oil pressure sensor is a 3-wire sensor which provides oil pressure information to the ECM.

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During service, use extreme care in keeping the valve lifter oil manifold assembly free of any contamination or foreign material.

Cylinder deactivation may be inhibited for many reasons including the following:

- Engine coolant temperature out of range for cylinder activation
- Engine vacuum out of range
- Brake booster vacuum out of range
- Transmission gear incorrect or shift in progress
- Accelerator pedal out of range or rate of pedal application to fast
- Engine oil pressure and temperature out of range
- Engine speed out of range
- Vehicle speed out of range
- Minimum time in V8 mode not met
- Maximum V4 mode time exceeded
- Decel fuel cutoff is active
- Reduced engine power is active
- Torque management is active
- Catalytic converter over temperature protection is active
- Piston protection is active, knock detected
- Cylinder deactivation solenoid driver circuit faults

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

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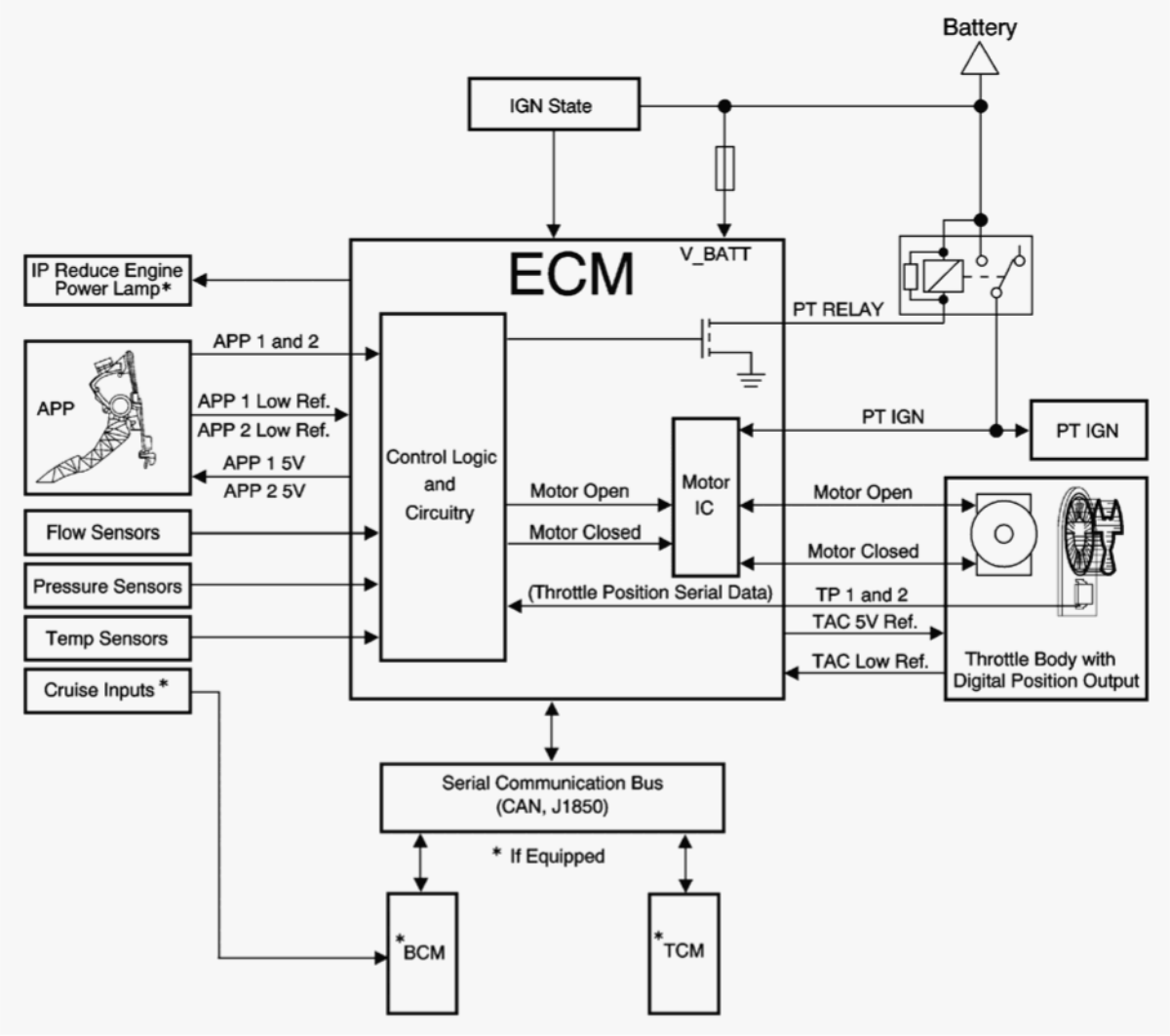


Fig. 2: Throttle Actuator Control (TAC) System Diagram
Courtesy of GENERAL MOTORS COMPANY

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

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Normal Mode

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

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

Reduced Engine Power Mode

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

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

Throttle/Idle Learn

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.

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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.

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.

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

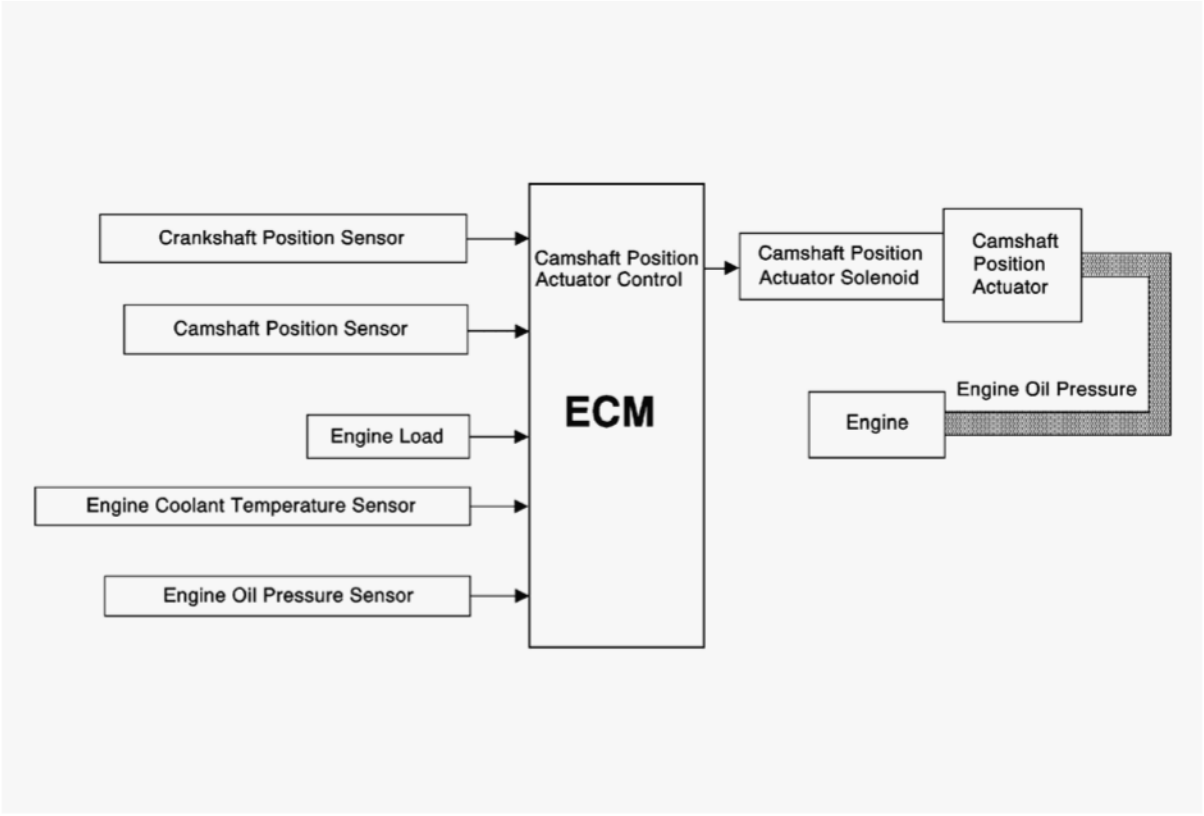


Fig. 3: Camshaft Actuator System Diagram
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position (CMP) Actuator System

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The camshaft position (CMP) actuator system is used for a variety of engine performance enhancements. These enhancements include lower emission output through exhaust gas recirculation (EGR) control, a wider engine torque range, improved gas mileage, and improved engine idle stability. The CMP actuator system commanded by the ECM accomplishes these enhancements by controlling the valve timing relative to piston position.

CMP Actuator System Operation

The camshaft position (CMP) actuator system is controlled by the control module. The control module sends a pulse width modulated signal to a CMP actuator solenoid in order to control the amount of engine oil flow to a camshaft actuator passage. There are 2 different passages for oil to flow through, a passage for CAM advance and a passage for CAM retard. The camshaft actuator is attached to the front of the camshaft, and is hydraulically operated in order to change the angle of the camshaft relative to crankshaft position (CKP). Engine oil pressure (EOP), viscosity, temperature, engine oil level, and aftermarket engine oil additives can have an adverse affect on camshaft phaser performance.

CMP Actuator Solenoid Circuit Diagnostic

The engine control module (ECM) monitors the control circuit of the camshaft position (CMP) actuator solenoid for electrical faults. The control module has the ability to determine if a control circuit is open, shorted high, or shorted low. If the control module detects a fault with the CMP actuator solenoid control, DTC P0010 will set.

CMP Actuator System Performance Diagnostic

The engine control module (ECM) monitors the performance of the camshaft position (CMP) actuator system by monitoring the calibrated desired position and the actual position of the camshaft, through the 4X signal of the CMP sensor. If the difference between the actual and the desired position is greater than a calibrated angle for a calibrated amount of time, DTC P0011 will set.

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.

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

Electronic Returnless Fuel System

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

Fuel Pump Driver Control Module

The fuel pump driver control module is a serviceable GMLAN module. The fuel pump driver control module receives the desired fuel pressure message from the engine control module (ECM) and controls the fuel pump located within the fuel tank to achieve the desired fuel pressure. The fuel pump driver 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 22 A.

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 engine control module through a vehicle wiring harness. The sensor provides a fuel pressure signal to the engine control module, which is used to provide Closed Loop fuel pressure control.

Flexible Fuel Sensor

The flexible fuel sensor measures the ethanol-gasoline ratio of the fuel being used in a flexible fuel vehicle. Flexible fuel vehicles can be operated with a blend of ethanol and gasoline, up to 85 percent ethanol. In order to adjust the ignition timing and the fuel quantity to be injected, the engine management system requires information about the percentage of ethanol in the fuel.

The flexible fuel sensor uses quick-connect style fuel connections, an incoming fuel connection, and an outgoing fuel connection. All fuel passes through the flexible fuel sensor before continuing on to the fuel rail. The flexible fuel sensor measures two different fuel related parameters, and sends an electrical signal to the engine control module (ECM) to indicate ethanol percentage, and fuel temperature.

The flexible fuel sensor has a three-wire electrical harness connector. The three wires provide a ground circuit, a power source, and a signal output to the ECM. The power source is ignition positive voltage and the ground circuit connects to a chassis ground. The signal circuit carries both the ethanol percentage and fuel temperature within the same signal, on the same wire.

The flexible fuel sensor uses a microprocessor inside the sensor to measure the ethanol percentage and fuel temperature, and changes the output signal accordingly. The electrical characteristic of the flexible fuel sensor signal is a square-wave digital signal. The signal is both variable frequency and variable pulse width. The frequency of the signal indicates the ethanol percentage, and the pulse width indicates the fuel temperature. The ECM provides an internal pull-up to 5 V on the signal circuit, and the flexible fuel sensor pulls the 5 V to ground in pulses. The output frequency is linear to the percentage of ethanol content in the fuel. The normal range of operating frequency is between 50 and 150 Hz, with 50 Hz representing 0

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percent ethanol, and 150 Hz representing 100 percent ethanol. The normal pulse width range of the digital pulses is between 1 and 5 ms, with 1 ms representing -40Â°C (-40Â°F), and 5 ms representing 151.25Â°C (304.25Â°F).

The microprocessor inside the sensor is capable of a certain amount of self-diagnosis. An output frequency of 180 Hz indicates either that the fuel is contaminated, or that an internal sensor electrical fault has been detected. Certain substances dissolved in the fuel can cause the fuel to be contaminated, raising the output frequency higher than the actual ethanol percentage should indicate. Examples of these substances include water, sodium chloride (salt), and methanol.

It should be noted that it is likely that the Flexible Fuel Sensor will indicate a slightly lower ethanol percentage than what is advertised at the fueling station. This is not a fault of the sensor. The reason has to do with government requirements for alcohol-based motor fuels. Government regulations require that alcohol intended for use as motor fuel be denatured. This means that 100 percent pure ethanol is first denatured with approximately 4 1/2 percent gasoline, before being mixed with anything else. When an ethanol gasoline mixture is advertised as E85, the 85 percent ethanol was denatured before being blended with gasoline, meaning an advertised E85 fuel contains only about 81 percent ethanol. The Flexible Fuel Sensor measures the actual percentage of ethanol in the fuel.

Fuel Tank

The fuel tank is molded from high density polyethylenes and stores the fuel supply. The fuel tank is located on the left side of the vehicle and held in place by 2 metal straps that attach to the frame.

Fuel Tank Fuel Pump Module

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

The fuel tank fuel pump module is located inside of the fuel tank. The fuel tank fuel pump module consists of the following major components:

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

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level sensor contains a variable resistor which changes resistance in correspondence with the position of the float arm. The engine control module (ECM) sends the fuel level information via high speed CAN-bus to the body control module (BCM). The BCM then sends the fuel level percentage via low speed CAN-bus to the instrument panel cluster (IPC) in order to control the fuel gauge. The control module monitors the signal circuit of the fuel level sensor in order to determine the fuel level.

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

Pressure Relief Regulator Valve

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

Primary Jet Pump

The primary 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 primary jet pump through a restrictive orifice located on the pump cover. The primary jet pump fills the reservoir of the fuel tank fuel pump module.

Nylon Fuel Pipes

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

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

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ensure proper reconnection and prevent a possible fuel leak. (During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.)

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

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

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

Quick-Connect Fittings

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

High Pressure Fuel Pump

The high 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 under the intake manifold 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 to 15 MPa (290 to 2, 176 psi), depending on engine speed and load. Output drivers in the ECM provide the high pressure fuel pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by opening and closing 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. The high pressure fuel pump is normally closed and will not deliver an increase in fuel pressure when the control solenoid is NOT powered. 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 21.5 MPa (3, 118 psi).

Fuel Rail Assembly

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

- The direct fuel injectors
- The fuel rail pressure sensor

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Fuel Injectors

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

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

Fuel Rail Pressure Sensor

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

Fuel Metering Modes of Operation

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

Starting Mode

The ECM supplies voltage to the fuel pump control module when the ECM detects that the ignition is ON. The voltage from the ECM to the fuel pump control module remains active for 2 s, unless the engine is in Crank or Run. While this voltage is being received, the fuel pump control module closes the ground switch of the fuel tank fuel pump module and also supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line pressure. The ECM calculates the air/fuel ratio based on inputs from the engine coolant temperature (ECT), manifold absolute pressure (MAP), mass air flow (MAF), and throttle position sensors. The system stays in starting mode until the engine speed reaches a predetermined RPM.

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.

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Clear Flood Mode

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

Run Mode

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

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

Specific values for the above conditions exist for each different engine, and are stored in the electrically erasable programmable read-only memory (EEPROM). The system begins Closed Loop operation after reaching these values. In Closed Loop, the ECM calculates the air/fuel ratio, injector ON time, based upon the signal from various sensors, but mainly from the HO2S. This allows the air/fuel ratio to stay very close to 14.7:1.

Acceleration Mode

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

Deceleration Mode

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

Battery Voltage Correction Mode

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

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

Fuel Cutoff Mode

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

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

Fuel Trim

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

EVAPORATIVE EMISSION CONTROL SYSTEM DESCRIPTION

Typical Evaporative Emission (EVAP) System Hose Routing Diagram

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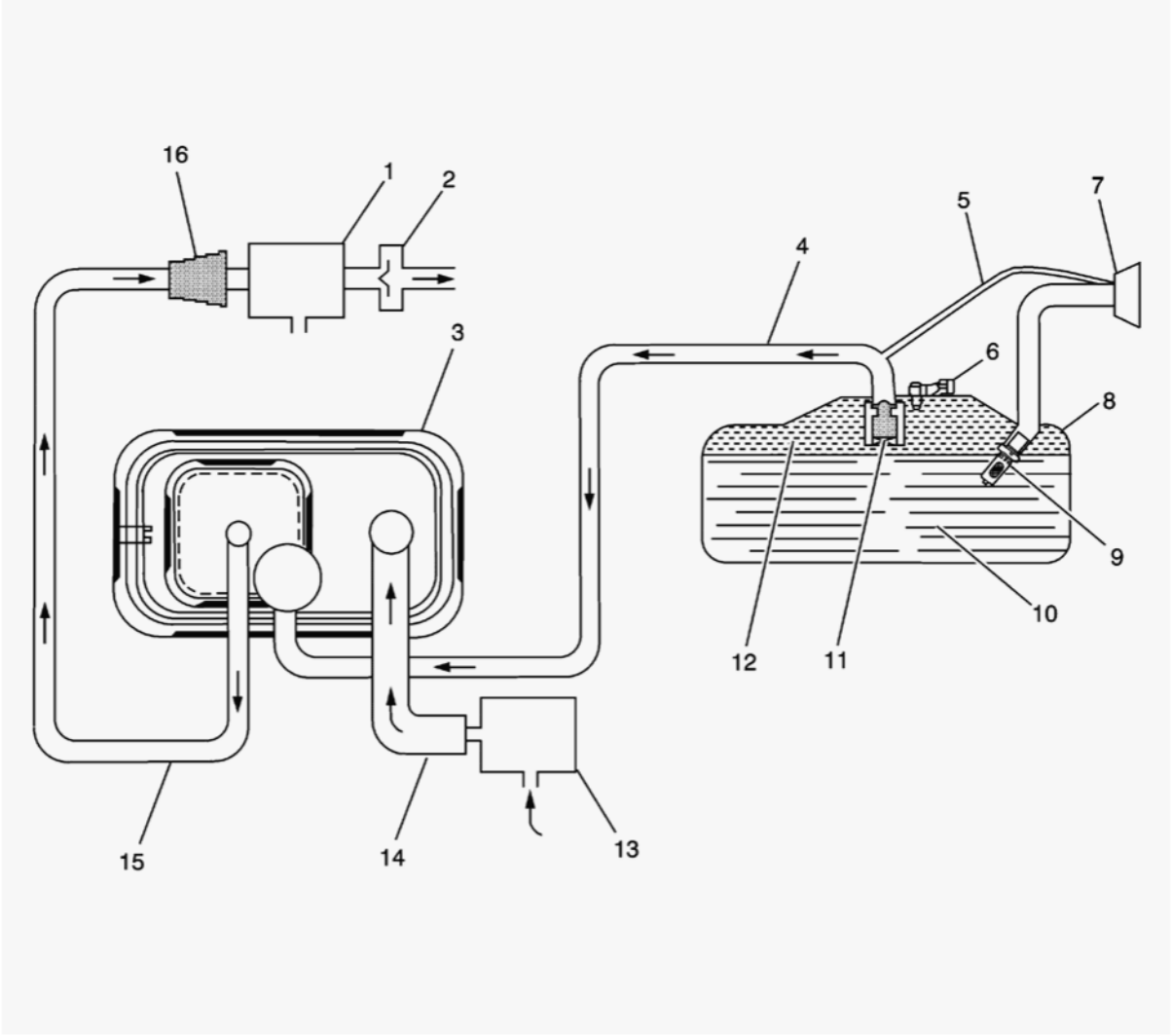


Fig. 4: Typical Evaporative Emission (EVAP) System Hose Routing Diagram
Courtesy of GENERAL MOTORS COMPANY

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

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Callout	Component Name
5	Vapor Recirculation Tube (ORVR)
6	Fuel Tank Pressure Sensor
7	Fuel Filler Cap (Some Vehicles May Have A Capless Design)
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

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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.**

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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

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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

Electronic Ignition System Operation

The electronic ignition system produces and controls the high energy secondary spark. This spark ignites the compressed air/fuel mixture at precisely the correct time, providing optimal performance, fuel economy, and control of exhaust emissions. The engine control module (ECM) primarily collects information from the crankshaft position and camshaft position sensors to control the sequence, dwell, and timing of the spark.

Crankshaft Position Sensor

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 the reluctor wheel on the crankshaft. The reluctor wheel is spaced at 60-tooth spacing, with two missing teeth for the reference gap. The reference gap is used to identify the crankshaft position at each start-up. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The crankshaft position sensor sends a digital signal to the ECM as each tooth on the reluctor wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed 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.

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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

The camshaft position sensor detects magnetic flux changes between the four narrow and wide tooth slots on the reluctor wheel. The camshaft position sensor provides a digital ON/OFF DC voltage of varying frequency per each camshaft revolution. The ECM will recognize the narrow and wide tooth patterns to identify camshaft position, or which cylinder is in compression and which is in exhaust. The information is then used to determine the correct time and sequence for fuel injection and ignition spark events.

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 engine control module (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 one or two flat response 2-wire sensors. The sensor uses piezo-electric crystal technology that produces an AC voltage signal of varying amplitude and frequency based on the engine vibration or noise level. The amplitude and frequency are dependant upon the level of knock that the knock sensor detects. The ECM receives the knock sensor signal through two isolated signal circuits for each knock sensor.

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

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

Ignition Coils

Each ignition coil has an ignition 1 voltage feed and a ground circuit. The engine control module (ECM) supplies a low reference and an ignition control circuit. Each ignition coil contains a solid state driver module. The ECM will command the ignition control circuit ON, which allows the

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current to flow through the primary coil windings. When the ECM commands the ignition control 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 Misfire Detection

The crankshaft position sensor is used to determine when an engine misfire is occurring. The camshaft position sensor is used to determine which cylinder is misfiring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. For accurate detection of engine misfire, the ECM must distinguish between crankshaft deceleration caused by actual misfire and deceleration caused by rough road conditions. The antilock brake system (ABS) can detect if the vehicle is on a rough road based on wheel acceleration/deceleration data supplied by the wheel speed sensors. If the ABS detects rough road above a predetermined threshold, this information is sent to the ECM. The ECM uses the rough road information when calculating engine misfire. Under certain driving conditions, a misfire rate can be high enough to cause the 3-way catalytic converter to overheat damaging the converter. The malfunction indicator lamp (MIL) will flash ON and OFF when converter overheating, damaging conditions are present.

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ENGINE PERFORMANCE

Engine Controls and Fuel - 5.3L (L83) or 6.2L (L86) - Specifications - Escalade, Suburban, Tahoe, Yukon

SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE - INTAKE AIR TEMPERATURE SENSOR

Temperature CÂ°/FÂ°	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 (ECT)

Temperature	Resistance
150Â°C (302Â°F)	47 to 49 ohms
140Â°C (284Â°F)	58 to 62 ohms
130Â°C (266Â°F)	76 to 80 ohms
120Â°C (248Â°F)	98 to 104 ohms
110Â°C (230Â°F)	130 to 136 ohms

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Temperature	Resistance
100Â°C (212Â°F)	174 to 182 ohms
90Â°C (194Â°F)	237 to 247 ohms
80Â°C (176Â°F)	327 to 341 ohms
70Â°C (158Â°F)	459 to 479 ohms
60Â°C (140Â°F)	656 to 686 ohms
50Â°C (122Â°F)	958 to 1002 ohms
45Â°C (113Â°F)	1167 to 1223 ohms
40Â°C (104Â°F)	1430 to 1500 ohms
35Â°C (95Â°F)	1763 to 1849 ohms
30Â°C (86Â°F)	2185 to 2295 ohms
25Â°C (77Â°F)	2725 to 2865 ohms
20Â°C (68Â°F)	3418 to 3604 ohms
15Â°C (59Â°F)	4318 to 4564 ohms
10Â°C (50Â°F)	5493 to 5823 ohms
5Â°C (41Â°F)	7041 to 7485 ohms
0Â°C (32Â°F)	9097 to 9701 ohms
-5Â°C (23Â°F)	11844 to 12678 ohms
-10Â°C (14Â°F)	15540 to 16700 ohms
-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

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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)
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	1-8-7-2-6-5-4-3
Spark Plug Wire Resistance	170-220 Ω per 25.4 mm (1.0 in)
Spark Plug Torque	Refer to **Fastener Specifications**
Spark Plug Gap	Refer to **Engine Mechanical Specifications (L83)** **Engine Mechanical Specifications (L86)**
Spark Plug Type	Refer to Electronic Parts Catalog

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number
Anti-Seize Compound	Lubricant	GM P/N 88862477 (Canadian P/N 88862478)

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Application	Type of Material	GM Part Number
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	0W-20 Oil	GM P/N 19259487 (Canadian P/N 19259784)
Fuel Injection Fuel Rail Bolts	Sealant	GM P/N 12345382 (Canadian P/N 10953489)
Intake Air Temperature Sensor Threads	Sealant	GM P/N 12346004 (Canadian P/N 10953480)
Top Engine Cleaner	Cleaner	GM P/N 1052626 (Canadian P/N 993026)

FASTENER SPECIFICATIONS

Application	Specifications	
	Metric	English
Accelerator Pedal Bolt	9 N.m	80 lb in
Air Cleaner Bracket Bolts	9 N.m	80 lb in
Air Cleaner Housing Screw	3 N.m	27 lb in
Camshaft Position (CMP) Sensor Fastener	25 N.m	18 lb ft
Crankshaft Position (CKP) Sensor Fastener	25 N.m	18 lb ft
Camshaft Position (CMP) Actuator Fasteners	10 N.m	89 lb in
Chassis Control Module Fastener	9 N.m	80 lb in
Engine Coolant Temperature (ECT) Sensor	20 N.m	15 lb ft
Engine Oil Pressure Sensor	35 N.m	26 lb ft
Evaporative Emission (EVAP) Canister Bracket Bolt	25 N.m	18 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Fastener	10 N.m	89 lb in
Fuel Feed and Evaporative Emission (EVAP) Hose Nut	25 N.m	18 lb ft
Fuel Feed Intermediate Pipe Fastener	10 N.m	89 lb in
Fuel Feed Intermediate Pipe Fitting	28 N.m	21 lb ft

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Application	Specifications	
	Metric	English
Fuel Feed Pipe Bracket Fastener	10 N.m	89 lb in
Fuel Fill Pipe Bracket Bolt	12 N.m	106 lb in
Fuel Pressure Sensor	15 N.m	11 lb ft
Fuel Pump Bolt	25 N.m	18 lb ft
Fuel Pump Cover Fastener	25 N.m	18 lb ft
Fuel Pump Power Control Module Fastener	9 N.m	80 lb in
Fuel Injection Fuel Rail Bolt	25 N.m	18 lb ft
Fuel Injection Fuel Rail Fuel Pressure Sensor	33 N.m	24 lb ft
Fuel Tank Filler Housing to Body Screw	10 N.m	89 lb in
Fuel Tank Fill Hose Clamp	4 N.m	35 lb in
Fuel Tank Strap Bolt	40 N.m	30 lb ft
Ground Wire to Engine Block Fastener	43 N.m	32 lb ft
Heated Oxygen Sensor (HO2S)	42 N.m	31 lb ft
Ignition Coil Fastener	10 N.m	89 lb in
Knock Sensor (KS) Fastener	25 N.m	18 lb ft
Knock Sensor (KS) Shield Fastener	25 N.m	18 lb ft
Manifold Absolute Pressure Sensor Fastener	4.5 N.m	40 lb in
Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Bolt	1.5 N.m	13 lb in
Spark Plug	20 N.m	15 lb ft
Throttle Body Fastener	10 N.m	89 lb in
Vacuum Pump Fastener	25 N.m	18 lb ft

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	English
Fuel Tank Capacity - Long Wheelbase	119.2 L	31.5 gal
Fuel Tank Capacity - Short Wheelbase	98.4 L	26.0 gal

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ENGINE PERFORMANCE

Engine Controls and Fuel - 5.3L (L83) or 6.2L (L86) - Diagnostic Information and Procedures - Escalade, Suburban, Tahoe, Yukon

DIAGNOSTIC INFORMATION AND PROCEDURES

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

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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**

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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.

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

6. Ignition OFF, disconnect the 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 (Chevrolet / GMC)** **Instrument Cluster Replacement (Cadillac)**
- Refer to **Control Module References** for control module replacement, programming, and setup

ENGINE CRANKS BUT DOES NOT RUN

Diagnostic Instructions

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

Circuit/System Description

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but does not continue to run. This diagnostic directs the service technician to the appropriate system diagnosis.

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Diagnostic Aids

Inspect for any of the following conditions:

- Insufficient fuel can cause a no start condition. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition.
- There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Observe all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known good vehicle.
- Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200-300 RPM while cranking. If erratic values such as sudden spikes in the engine speed are displayed, the engine reference signal is not stable enough for the engine to start and run properly.
- Inspect the engine for good secure electrical grounds.
- If the engine almost starts and then stalls, inspect for an open in the ground circuits of the CKP sensor and the camshaft position (CMP) sensor.
- Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 minutes in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.
- A vehicle that starts and runs after being brought to the repair shop for a no start condition may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring while cranking the engine to help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Electrical Center Identification Views** **Electrical Center Identification Views**

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J26792 HEI Spark Tester

Circuit/System Verification

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

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

1. Crank the engine for up to 15 seconds.
2. Verify that DTC P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0201-P0208, P0222, P0223, P0300-P0308, P0335, P0336, P0351-P0358, P0601-P0604, P0606, P062B, P062F, P0630, P0633, P0685-P0687, P0689, P0690, P1631, P1682, P16A0, P16A1, P16A2, P16F3, P2135, or P262B, 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**

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3. Ignition ON.
4. Verify the security indicator illuminates momentarily.
    - **If the security indicator stays ON or is flashing**

      Review the **Diagnostic Trouble Code (DTC) List - Vehicle** , for immobilizer system DTCs. Refer to **Immobilizer Description and Operation** for additional information.

    - **If the security indicator does not stay ON and is not flashing**
5. Verify the scan tool Engine Speed parameter displays greater than 0 RPM while cranking the engine.
    - **If 0 RPM**

      Refer to **DTC P0335 or P0336** .

    - **If greater than 0 RPM**
6. Ignition OFF.

NOTE: **Perform the spark test on at least 1 cylinder of each cylinder bank.**

7. Install the **J26792** HEI Spark Tester between the boot of a spark plug wire and ground.
8. Verify the spark tester sparks while cranking the engine.
    - **If there is no spark**

      Refer to **Electronic Ignition System Diagnosis**.

    - **If there is spark**
9. Ignition ON.

NOTE: **If the engine is too hot, high fuel pressure readings may result due to hot soak fuel boiling. Do not attempt to record fuel pressure readings until the engine coolant temperature is below 60Â°C (150Â°F).**

10. Command the Fuel Pump Enable ON several times with a scan tool.
11. Verify that the scan tool Fuel Pressure Sensor parameter is between 320-580 kPa (46-84 psi) with the fuel pump running.
    - **If not within the specified range**

      Refer to **Fuel System Diagnosis**.

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12. Verify that the fuel pressure decreases to 468-544 kPa (68-79 psi) after the pump is turned off and does not decrease greater than 34 kPa (5 psi) in 1 minute.
    - **If not within the specified range**

      Refer to **Fuel System Diagnosis**.

    - **If within the specified range**
13. Verify the following conditions do not exist:
    - Collapsed air intake duct to the throttle body
    - Restricted air filter element
    - Spark plugs for being fouled
    - A skewed manifold absolute pressure (MAP) sensor - Refer to **DTC P0106** .
    - A skewed engine coolant temperature (ECT) sensor - Refer to **DTC P0116** .
    - Exhaust system restricted - Refer to **Restricted Exhaust** .
    - Fuel contamination - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
    - Engine mechanical condition such as worn timing chain and gears or low compression - Refer to **Symptoms - Engine Mechanical** , or **Engine Compression Test** .
    - **If a condition exists**

      Refer to the appropriate diagnostic or repair the condition as necessary.

    - **If no conditions exist**
14. All OK.

Repair Instructions

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

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

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Problem	Causes
	• 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

FUEL INJECTOR DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

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- 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 ECM initially opens each fuel injector with 65 V. This high voltage is controlled by a boost capacitor in the ECM. During the 65 V boost phase, the capacitor is discharged through a fuel injector, allowing for initial fuel injector opening. The fuel injector is then held open with 12 V. The ECM varies the amount of time each fuel injector is open to provide proper combustion under all engine load conditions.

A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

Reference Information

Schematic Reference

Engine Controls Schematics

Electrical Information Reference

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

Component Testing

NOTE:

- **The resistance test must be performed at the fuel injector or mis-diagnosis will occur.**
- **The DMM and test leads must be calibrated to 0 Ω in order to prevent mis-diagnosis.**

1. Test for 1.06 Ω +/- 10% @ 20Â°C (68Â°F) between the high voltage supply circuit terminal 2 and the high voltage control circuit terminal 1 at the Q17 Fuel Injector.
   - **If not within the specified range**

     Replace the Q17 Fuel Injector.

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- **If within the specified range**

2. Test for infinite resistance between each terminal at the Q17 Fuel Injector and the Q17 Fuel Injector housing/case.
   - **If not infinite resistance**

     Replace the Q17 Fuel Injector.

   - **If infinite resistance**

3. All OK, perform the **Fuel Injector Balance Test**.

Repair Instructions

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

Refer to **Fuel Injector Replacement**

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 fuel pump driver control module when the ECM detects that the ignition is ON. The voltage from the ECM to the fuel pump driver control module remains active for 2 s, unless the engine is in Crank or Run. While this voltage is being received, the fuel pump driver control module closes the ground switch of the fuel tank fuel pump module and also supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line pressure.

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

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

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Diagnostic Aids

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

Reference Information

Description and Operation

Fastener Specifications

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-37287-1A Fuel Pressure Gauge Adapter

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service Tools)** .

Circuit/System Verification

NOTE:

- **Repair all fuel system related DTCs before performing this diagnostic.**
- **Inspect the fuel system for damage or external leaks before proceeding.**
- **Verify that adequate fuel is in the fuel tank before proceeding.**
- **The Fuel Pump Enable may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.**
- **DO NOT perform the Fuel System Diagnosis if the engine coolant temperature is above 60Â°C (150Â°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) Â± 5 percent.**

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1. Ignition ON, engine OFF, command the Fuel Pump Enable ON several times with a scan tool.
2. Verify the scan tool Fuel Pressure Sensor parameter is between 320-580 kPa (46-84 psi) with the fuel pump running.
    - **If less than 320 kPa (46 psi)**

      Refer to Circuit/System Testing - Fuel Pressure Low.

    - **If greater than 580 kPa (84 psi)**

      Replace the G12 Fuel Pump.

    - **If between 320-580 kPa (46-84 psi)**

NOTE: **The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.**

3. Verify that the fuel pressure decreases to 468-544 kPa (68-79 psi) after the fuel pump is turned off.
    - **If the fuel pressure does not decrease to 468-544 kPa (68-79 psi)**

      Replace the G12 Fuel Pump.

    - **If the fuel pressure decreases to 468-544 kPa (68-79 psi)**
4. Verify that the fuel pressure does not decrease greater than 34 kPa (5 psi) in 1 minute.
    - **If the fuel pressure decreases greater than 34 kPa (5 psi)**

      Refer to Circuit/System Testing - Fuel Pressure Leaks Down.

    - **If the fuel pressure does not decrease greater than 34 kPa (5 psi)**
5. Relieve the fuel pressure to 69 kPa (10 psi), refer to **Fuel Pressure Relief** .
6. Verify that the fuel pressure does not decrease greater than 14 kPa (2 psi) in 5 minutes.
    - **If the fuel pressure decreases greater than 14 kPa (2 psi)**

      Replace the G12 Fuel Pump.

    - **If the fuel pressure does not decrease greater than 14 kPa (2 psi)**

WARNING: **Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any**

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maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

7. Operate the vehicle within the conditions of the customer's concern while monitoring the Fuel Pressure Sensor parameter with a scan tool.
8. Verify the fuel pressure does not drop off during acceleration, cruise or hard cornering.
    - **If the fuel pressure drops off**

      Refer to Circuit/System Testing - Fuel Pressure Drops OFF.

    - **If the fuel pressure does not drop off**
9. If the fuel system components test normal, refer to **Symptoms - Engine Controls** , **Fuel Injector Diagnosis**, and **Fuel Injector Balance Test** for further diagnosis.

Circuit/System Testing

Fuel Pressure Low

1. Verify none of the conditions listed below exist:
    - Restricted fuel feed pipe
    - Restricted or plugged strainer
    - Poor connections at the fuel pump harness connector and the ground circuits.
    - **If a condition exist**

      Repair as necessary.

    - **If a condition does not exist**
2. Test or replace the G12 Fuel Pump.

Fuel Pressure Leaks Down

1. Ignition OFF, relieve the fuel pressure. Refer to **Fuel Pressure Relief** .
2. Install the **CH-37287-1A** Fuel Pressure Gauge Adapter between the fuel feed pipe and the fuel rail.
3. Open both of the valves on the **CH-37287-1A** Fuel Pressure Gauge Adapter.
4. Ignition ON, command the Fuel Pump Enable ON with a scan tool.

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5. Close one of the valves on the **CH-37287-1A** Fuel Pressure Gauge Adapter.
6. Verify that the Fuel Pressure Sensor parameter does not decrease greater than 34 kPa (5 psi) in 1 minute.
    - **If the fuel pressure drops**

      Test or replace the G12 Fuel Pump.

    - **If the fuel pressure does not drop**
7. Locate and replace the leaking Q17 Fuel Injector.

Fuel Pressure Drops OFF

1. Verify none of the conditions listed below exist:
    - Restricted fuel feed pipe
    - Restricted or plugged strainer
    - Poor connections at the Fuel Pump harness connector and the ground circuit.
    - **If a condition exist**

      Repair as necessary.

    - **If a condition does not exist**
2. Test or replace the G12 Fuel Pump.

Repair Instructions

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

- Refer to **Fuel Feed Pipe Replacement (At Engine)** **Fuel Feed Pipe Replacement (At Tank)**
- Refer to **Fuel Injector Replacement**
- Refer to **Fuel Feed Hose Replacement**
- Refer to **Fuel Tank Fuel Pump Module Replacement (SWB)** **Fuel Tank Fuel Pump Module Replacement (LWB)** for G12 Fuel Pump replacement

FUEL INJECTOR BALANCE TEST

Diagnostic Instructions

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- 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

Two methods of testing fuel injector balance are available, the Active Fuel Injector Tester (AFIT) or a scan tool. The Active Fuel Injector Tester and SIDI adaptor connects to the engine control module harness connectors to test the high pressure fuel pump performance, fuel injector wiring, and fuel injector operation. The AFIT displays step by step instructions to precisely determine pressure drop of each fuel injector. 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 -8 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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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- **CH-47976** Active Fuel Injector Tester
- **CH-47976-500** Active Fuel Injection Tester (AFIT) SIDI Adapter Kit

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service Tools)**

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Fuel Remaining parameter is greater than 10%.
   - **If the Fuel Remaining parameter is less than 10%** , add fuel to the fuel tank.
   - **If the Fuel Remaining parameter is 10% or greater**
3. Verify the scan tool ECT Sensor parameter is less than 60Â°C (140Â°F).
   - **If the ECT Sensor parameter is greater than 60Â°C (140Â°F)** , allow the engine temperature to cool.
   - **If the ECT Sensor parameter is 60Â°C (140Â°F) or less**
4. Verify the battery is fully charged and all accessories are Off.
   - **If the battery is not fully charged** , charge or repair battery as necessary.
   - **If the battery is fully charged**
5. Preform the appropriate Fuel Injector Balance Test in Circuit System Testing.

Circuit System Testing

Fuel Injector Balance Test with Active Fuel Injector Tester

1. Ignition OFF, all vehicle systems OFF. Install the **CH-47976** Active Fuel Injector Tester and the **CH-47976-500** Active Fuel Injection Tester (AFIT) SIDI Adapter Kit, refer to the Active Fuel Injector Tester User Guide. It may take up to 2 minutes for all vehicle systems to power down.
2. Turn ON the Active Fuel Injector Tester and select the vehicle.
3. Ignition ON, perform the Injector Test with the Active Fuel Injector Tester.
   - **If the Active Fuel Injector Tester aborts testing due to fuel pressure or fuel leak down**

     Refer to **Fuel System Diagnosis**.

   - **If the Active Fuel Injector Tester does not abort testing**
4. Compare the test results with the appropriate recommended tolerance.

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- **If any fuel injector exceeds the recommended tolerance**

  Replace the appropriate Q17 Fuel Injector(s).

- **If all fuel injectors are within the recommended tolerance**

5. Perform **Fuel Injector Circuit Diagnosis**.

Fuel Injector Balance Test with Scan Tool

1. Ignition ON.
2. Command the Fuel Pump Enable ON with a scan tool.
3. Verify the fuel pressure is between 320-580 kPa (46-84 PSI) with the fuel pump running.
   - **If not within 320-580 kPa (46-84 PSI)**

     Refer to **Fuel System Diagnosis**.

   - **If within 320-580 kPa (46-84 PSI)**

   NOTE: **The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.**

4. Verify the fuel pressure does not decrease greater than 34 kPa (5 PSI) within 1 minute.
   - **If greater than the specified value**

     Refer to **Fuel System Diagnosis**.

   - **If less than the specified value**
5. Engine idling.
6. Verify the scan tool Fuel Rail Pressure Sensor 1 parameter is between 1.9-5.0 MPa (276-725 PSI).
   - **If not between 1.9-5.0 MPa (276-725 PSI)**

     Refer to **Fuel System Diagnosis**.

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

   NOTE: **The engine speed must be between 600-1,000 RPM to perform this test.**

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7. Select the Fuel Injector Balance function within the Control Functions menu of a scan tool.
8. Select and test a Q17 Fuel Injector. Repeat for each Q17 Fuel Injector.
9. Obtain and record a pressure drop value for each Q17 Fuel Injector.
10. Add all of the individual pressure drop values except for the fuel injector suspected of being faulty. This is the total pressure drop.
11. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop.
12. Multiply the average pressure drop by 0.20. This is the acceptable variance from the average pressure drop, 20%.
13. 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 Q17 Fuel Injector.

    - **If within the acceptable variance**
14. Perform **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	P0262	P1248
Fuel Injector 2 Control +	P2150	P0202	P2151	P1249

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Injector 2 Control -	P0264	P0202	P0265	P1249
Fuel Injector 3 Control +	P2153	P0203	P2154	P124A
Fuel Injector 3 Control -	P0267	P0203	P0268	P124A
Fuel Injector 4 Control +	P2156	P0204	P2157	P124B
Fuel Injector 4 Control -	P0270	P0204	P0271	P124B
Fuel Injector 5 Control +	P216B	P0205	P216C	P124C
Fuel Injector 5 Control -	P0273	P0205	P0274	P124C
Fuel Injector 6 Control +	P216E	P0206	P216F	P124D
Fuel Injector 6 Control -	P0276	P0206	P0277	P124D
Fuel Injector 7 Control +	P217B	P0207	P217C	P124E
Fuel Injector 7 Control -	P0279	P0207	P0280	P124E
Fuel Injector 8 Control +	P217E	P0208	P217F	P124F
Fuel Injector 8 Control -	P0282	P0208	P0283	P124F

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

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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**

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 1-8 Current Misfire Counter parameters do not increment.
   - **If the Cylinder 1-8 Current Misfire Counters increment**

     Refer to Circuit/System Testing.

   - **If the Cylinder 1-8 Current Misfire Counters do not increment**
3. Verify the scan tool Cylinder 1-8 Injector Control Circuit Status parameters display OK.
   - **If the Cylinder 1-8 Injector Control Circuit Status parameters do not display OK**

     Refer to Circuit/System Testing.

   - **If the Cylinder 1-8 Injector Control Circuit Status parameters display OK**

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4. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the X3 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 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

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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 repair.

- Refer to **Fuel Injector Replacement**
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

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.

Circuit/System 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% in non-blended gasoline or greater than 85% with E85 blended gasoline for flexible fuel applications can cause driveability conditions such as hesitation, lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

Reference Information

Special Tools

CH 44175-A Alcohol Tester Kit, if available

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For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service Tools)** .

Circuit/System Verification

1. Remove a sample of fuel from the bottom of the fuel tank and place in a clean, clear container.
2. Place the sample on a level surface for 2 min.
3. Verify the sample is clear and bright in color.
    - **If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample**

      Refer to Circuit/System Testing - Particulate Contaminants in Fuel.

    - **If alcohol contamination is suspected**

      Refer to Circuit/System Testing - Alcohol in Fuel Testing.

    - **If the sample remains clear and bright**
4. All OK.

Circuit/System Testing

Alcohol in Fuel Testing with Special Tool, If Available

1. Test the fuel composition using **CH 44175-A** Alcohol Tester Kit and Instruction Manual.
2. Verify no water appears in the fuel sample.
    - **If water appears in the fuel sample**

      Clean the fuel system.

    - **If no water appears in the fuel sample**
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
4. Verify the non-blended gasoline fuel sample does not measure greater than 15% or an E85 blended gasoline fuel sample measures greater than 91% ethanol.
    - **If greater than the specified value**
    1. Add fresh regular gasoline to the vehicle's fuel tank.
    2. Remove a new sample of fuel from the tank.

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3. Test the fuel composition using **CH 44175-A** Alcohol Tester Kit and Instruction Manual.
4. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
5. Verify the non-blended gasoline fuel sample does not measure greater than 15% or an E85 blended gasoline fuel sample measures greater than 91% ethanol.
    - If additional testing indicates that the ethanol percentage is still above 15% for a non-blended gasoline sample, drain and replace the vehicle's fuel. Refer to **Fuel Tank Draining** .
    - If additional testing indicates that the E85 blended gasoline sample still measures above 91%, continue adding fresh, regular gasoline until the ethanol content is 85% or less.

- **If the specified value or less**

5. All OK.

Alcohol in Fuel Testing without Special Tool

NOTE: **This procedure is for non-blended gasoline only. If excessive alcohol content is suspected with E85 fuel add 15% tank volume of fresh, regular gasoline to the fuel tank.**

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 s.
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 s.
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% 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.
7. Verify the non-blended gasoline fuel sample does not measure greater than 15%.
    - **If greater than the specified value**
    1. Add fresh regular gasoline to the vehicle's fuel tank.
    2. Remove a new sample of fuel from the tank.
    3. Test the fuel composition of the new sample.
    4. Verify the non-blended gasoline fuel sample does not measure greater than 15%.

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- If greater than the specified value, drain and replace the vehicle's fuel. Refer to **Fuel Tank Draining** .
- If the specified value or less, all OK.

- **If the specified value or less**

8. All OK.

Particulate Contaminants in Fuel

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel from the bottom of the fuel tank.
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. Verify there are no physical contaminants or water present in the fuel sample.
   - **If any physical contaminants or water are present**

     Clean the fuel system.

   - **If no physical contaminants or water are present**
4. All OK.

Repair Instructions

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

Refer to **Fuel System Cleaning**

ELECTRONIC IGNITION SYSTEM DIAGNOSIS

Diagnostic Instructions

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

Circuit/System Description

This ignition system uses an individual ignition coil for each cylinder. The engine control module (ECM) controls the spark events by transmitting

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the timing pulses on the ignition control (IC) circuits to the individual ignition coil in firing order sequence.

Diagnostic Aids

- This engine application may use 2 fuses, one for each bank, to supply ignition voltage to the ignition module/coil assemblies and also to the fuel injectors. A good indication that a fuse is open is that all misfire counters are incrementing on one side of the engine.
- 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

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For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service Tools)** .

Circuit/System Verification

Verify the following conditions. Refer to **Spark Plug Wire Inspection** , and **Ignition System Specifications** .

- The ignition coils and spark plug wires are correctly connected
- The spark plug wire resistance is within specifications
- The correct spark plug type
- The correct spark plug gap
- The correct spark plug torque

- **If a condition was found**

  Repair or replace as necessary.

- **If a condition was not found**

  Refer to Circuit/System Testing.

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.

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- **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 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.
    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 1-8 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, engine Running.
2. Verify the spark output of the T8 Ignition Coil.

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

  Replace the T8 Ignition Coil

- **If the output is good**

3. All OK.

Repair Instructions

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

- Refer to **Ignition Coil Replacement**
- Refer to **Spark Plug Replacement**
- Refer to **Spark Plug Wire Replacement**
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

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 H20 (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.**

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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.**

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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.**

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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 21Â°C (70Â°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. H20 (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

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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.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) 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 Description

To provide maximum fuel economy under light load driving conditions, the engine control module (ECM) will command the valve lifter oil manifold assembly solenoids ON, to deactivate engine cylinders 1 and 7 on the left bank, and cylinders 4 and 6 on the right bank. The valve lifter oil manifold assembly consists of 4 electrically operated normally closed solenoids, which directs pressurized engine oil to 8 deactivating valve lifters. All 4 valve lifter oil manifold assembly solenoids are connected in parallel to a fused ignition circuit supplied by the powertrain relay. The control circuit for each solenoid is connected to an individual low side driver internal to the ECM. When enabling conditions for V4 mode are met, the ECM will command each low side driver to turn ON, in engine firing order sequence.

Diagnostic Aids

- Observe the scan tool Cylinder Deactivation Inhibit reasons to assist in determining the cause of the concern.
- Review scan tool Cylinder Deactivation Disable History to determine reason for disabling cylinder deactivation.
- A restricted valve lifter oil filter may cause a cylinder deactivation system concern. Inspect the valve lifter oil filter for a restriction or blockage. Refer to **Valve Lifter Oil Filter Replacement** .

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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Cylinder Deactivation (Active Fuel Management) System Description

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the engine oil level is within the specified level.
    - **If not within the specified level**

      Repair as necessary.

    - **If within the specified level**
2. Verify the engine oil pressure is within the specified range, refer to **Oil Pressure Diagnosis and Testing** .
    - **If not within the specified range**

      Repair as necessary.

    - **If within the specified range**
3. Ignition ON.
4. Verify no DTCs are set.
    - **If DTCs are set**

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

    - **If no DTCs are set**
5. Engine idling at the normal operating temperature.

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6. Verify there is no abnormal engine noise.
    - **If there is an abnormal engine noise**

      Refer to **Symptoms - Engine Mechanical** for further diagnosis.

    - **If no abnormal engine noise**
7. Perform the **Cylinder Deactivation (Active Fuel Management) System Test** .
    - **If system test failed**

      Test the Q43 Valve Lifter Oil Manifold Assembly, refer to **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing** .

    - **If system test passes**
8. Refer to Circuit/System Testing.

Circuit/System Testing

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.

1. Operate the vehicle within the conditions of the customer's concern while monitoring the Cylinder Deactivation Inhibit parameters.
2. Verify all Cylinder Deactivation Inhibit parameters display NO.
    - **If any parameter displays YES**

      Refer to the appropriate vehicle system to determine the cause for cylinder deactivation inhibit.

    - **Symptoms - Engine Controls**
    - **Symptoms - Engine Cooling**
    - **Symptoms - Engine Electrical**
    - **Symptoms - Engine Mechanical**
    - **If none of the parameters display YES**
3. Refer to **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing** .

Repair Instructions

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

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 the inspection/maintenance (I/M) emission inspection in order to renew license plates. This is accomplished by viewing the I/M System Status display on a scan tool. Using a scan tool, the technician can observe the I/M System Status in order to verify that the vehicle meets the criteria that comply with the local area requirements.

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 monitor requires at least one, and sometimes several diagnostic tests. The result of each test is reported by a DTC. A system monitor is complete when either all of the DTCs composing the monitor have Run and Passed, or when any one of the DTCs comprising the monitor has illuminated the malfunction indicator lamp (MIL). Once the system monitor is complete, the I/M System Status display will indicate YES in the Completed column.

For example, when the HO2S Heater Status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has 4 heated oxygen sensors, either all 4 heater circuit tests have passed or one of the heater circuit tests has illuminated the MIL. The I/M System Status will indicate NO under the Completed column when any of the required tests for that system have not run. The following is a list of conditions that would set the I/M System Status indicator to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the tests.
- The battery has been disconnected or discharged below operating voltage.
- The control module power or ground has been interrupted.
- The control module has been reprogrammed.

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- The control module DTCs have been cleared.

Monitored Emission Control Systems

The OBD II System monitors all emission control systems that are on-board. The OBD II regulations require monitoring of the following:

- 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 fuel delivery, 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.

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.

Circuit/System Testing

NOTE: **Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the I/M System Status indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.**

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1. Verify no I/M DTCs are present.
    - **If an I/M DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing.**

      Refer to **Inspection/Maintenance (I/M) System DTC Table**.

    - **If no I/M DTCs are set**
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** after repair.

    - **If no repair is required**
3. Observe the I/M System Status indicators.
    - **If any I/M System Status indicators report NO**

      Perform the **Inspection/Maintenance Complete System Set Procedure**.

    - **If no I/M System Status indicators report NO**
4. All OK.

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 (I/M) Complete System Set Procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics and complete the 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 I/M Complete System Set Procedure if any I/M System Status indicators are set to NO.

Conditions for Meeting a Cold Start

- The ignition voltage between 11-18 volts.

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- The barometric pressure (BARO) is more than 75 kPa.
- The start-up engine coolant temperature (ECT) is between 4-30Â°C (39-86Â°F).
- The start-up intake air temperature (IAT) is between 4-30Â°C (39-86Â°F).
- The difference between the IAT and the ECT is less than or equal to 6Â°C (10.8Â°F).
- The ambient air temperature is between 4-30Â°C (39-86Â°F).
- The fuel level is between 15-85 percent.

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 (I/M) 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 minutes to allow the sensors to cool before continuing with the test. Once 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 (EVAP) I/M System Status indicator should display YES.
   - If the EVAP I/M System Status indicator displays NO, perform the EVAP Service Bay Test, if applicable. If the EVAP Service Bay Test is NOT available, it may take up to 6 drive cycles, with up to 17 hours between drive cycles, for the EVAP I/M System Status indicator to transition to YES.
3. The O2S Heater I/M System Status indicator should display YES.
   - If the O2S Heater I/M System Status indicator displays NO, ensure that the ignition has been turned OFF for at least 10 hours.
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.

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7. Start and idle the engine for at least 2 minutes and until 65Â°C (149Â°F) is achieved.
8. Run the engine for 6.5 minutes 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 minutes:
    - Depress the accelerator pedal until throttle position (TP) sensor angle is more than 2 percent.
    - Mass air flow (MAF) 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 TP 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 minutes.
12. Quickly depress the accelerator pedal until TP sensor angle is more than 8 percent and return to idle, repeat 3 times.
13. Allow engine to idle for at least 2 minutes.

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

14. Release the parking brake and drive vehicle at 24 km/h (15 mph) or slower for 2 minutes.
15. Continue to drive the vehicle for at least 5.5 miles 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 seconds. This will allow the vehicle to enter decel fuel cut-off.
17. Depress the accelerator pedal until the TP sensor angle is increased 3-20 percent and maintain a safe speed for 1 minute.
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 minutes.
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.**

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20. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 60 minutes.
21. Observe the Inspection/Maintenance (I/M) System Status with a scan tool. All of the I/M System Status indicators should display YES.
    - If the EVAP I/M System Status indicator displays NO, turn OFF the ignition for 17 hours, ensure that the vehicle meets the conditions for a cold start, and repeat steps 12-18 six more times, or until the EVAP I/M System Status indicator transitions to YES. If the indicator continues to display NO, refer to the **Inspection/Maintenance (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 EVAP I/M System Status indicator
    - If any of the I/M System Status indicators display NO, refer to the **Inspection/Maintenance (I/M) System DTC Table** for the indicator which did not display YES. The I/M System DTC Table identifies the DTCs associated with each I/M System Status Indicator. Follow the Conditions for Running the DTC in order to set the associated status indicator.
22. Observe the engine DTC information with a scan tool. Verify no DTCs are present.
    - If a DTC is set, diagnose using the **Diagnostic Trouble Code (DTC) List - Vehicle** . After repairs, perform the **Inspection/Maintenance Complete System Set Procedure** to verify no further DTCs are set.

INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE

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 or P0430**
EVAP	• **DTC P0442** • **DTC P0446** • **DTC P0455**
Fuel System	**DTC P219A or P219B**
Oxygen Sensor	• **DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, or P0158** • **DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, or P0161**
Oxygen Sensor Heater	**DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, or P0161**
Camshaft System	**DTC P0011**

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ENGINE PERFORMANCE

Engine Controls and Fuel - 5.3L (L83) or 6.2L (L86) - Diagnostic Information and Procedures - Escalade, Suburban, Tahoe, Yukon

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0010, P2088, OR P2089: CAMSHAFT POSITION ACTUATOR 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 Descriptor

DTC P0010

Camshaft Position Actuator Solenoid Valve Control Circuit

DTC P2088

Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage

DTC P2089

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, P2088	P0010, P2089	P0010, P0011, P0016, P0106, P0107, P0690, P2089	P0011

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Reference	-	P0010, P0011, P2089	-	P0011

Circuit/System Description

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshaft while the engine is operating. The ECM controls the camshaft position actuator magnet duty cycle by controlling the amount of On time. The magnet controls the amount of engine oil flow to the CMP actuator by extending a pintle within the solenoid. The pintle acts against a spool valve in the CMP actuator mechanism which is attached to the front of the camshaft. As the spool valve is moved, oil is directed to the CMP actuator, which rotates the camshaft. The ECM can only command the camshaft position actuator to retard the valve timing from the camshaft park position, or advance the valve timing back to the park position.

The ECM controls the camshaft position actuator magnet by supplying a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

Conditions for Running the DTC

- The ignition switch is in the crank or run position.
- The system voltage is between 11-18 V.
- The CMP actuator is command On.
- 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 for greater than 5 s.

Action Taken When the DTC Sets

- DTC P0010, P2088 and P2089 are Type B DTCs.
- The camshaft position actuator is commanded to the park position.

Conditions for Clearing the DTC

DTC P0010, P2088 and P2089 are Type B DTCs.

Diagnostic Aids

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A stuck camshaft position actuator causing the valve timing to be retarded may result in setting DTC P00C6 along with a crank/no start condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

NOTE: **If a crankshaft or camshaft position sensor DTC is set, the scan tool Camshaft Position Actuator output**

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control will not function.

1. Ignition On. Verify that DTC P0335, P0336, P0340, or P0341 is not set.
   - **If any of the DTCs are set**

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

   - **If none of the DTCs are set**
2. Verify the scan tool parameters listed below do not display Malfunction:
   - Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status.
   - Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status.
   - Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status.
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not displayed**
3. Engine idling at normal operating temperature.
4. Verify the scan tool parameters listed below do not display Malfunction when commanding the scan tool Camshaft Position Actuator from 0-25Â° and back to 0Â° with a scan tool:
   - Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status.
   - Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status.
   - Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status.
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not displayed**
5. Operate the vehicle within the Conditions for Running. 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.

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- **If the DTC does not set**

6. All OK.

Circuit/System Testing

1. Ignition Off and all vehicle systems Off, disconnect the harness connector at the Q6 Camshaft Position Actuator Solenoid Valve. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 1 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**

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

3. Ignition On.
4. Verify that a test lamp does not illuminate between the 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 control circuit and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.
   - **If the test lamp does not illuminate**
5. Remove the test lamp.
6. Connect the DMM negative lead to the control circuit terminal 2. Connect the DMM positive lead to B+. Set the DMM on the diode setting. Command the Camshaft Position Actuator Solenoid On and Off with a scan tool. The DMM should transition from OL when commanded Off to less than 1 V when commanded On.
   - **If the parameter does not correspond to the specified values**

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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 parameter corresponds to the specified values**

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

Component Testing

Static Test

1. Ignition Off, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 Ω between the control terminal 2 and the low reference terminal 1.
    - **If not between 5-12 Ω**

      Replace the Q6 Camshaft Position Actuator Solenoid Valve.

    - **If between 5-12 Ω**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
    - **If not infinite resistance**

      Replace the camshaft position actuator magnet and camshaft position actuator solenoid valve.

    - **If infinite resistance**
4. All OK.

Dynamic Test

1. Remove the camshaft position actuator magnet.

NOTE:

- **The camshaft position actuator magnet pintle should be facing downward for this test.**
- **Do not allow electrical current to flow through the camshaft position actuator magnet for greater than 1-2 s.**

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2. Install a fused jumper wire between the control circuit terminal 2 and 12 V. Momentarily install a jumper wire between the low reference terminal 1 and ground. The pintle should extend.
    - **If the function does not perform as specified**

      Replace the camshaft position actuator magnet and camshaft position actuator solenoid valve.

    - **If the function does perform as specified**
3. All OK.

Repair Instructions

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

- Refer to **Camshaft Position Actuator Solenoid Valve Replacement**
- Refer to **Camshaft Position Actuator Magnet Replacement**
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P0011: INTAKE CAMSHAFT POSITION 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 P0011

Intake Camshaft Position System Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Camshaft Position Actuator Solenoid High Control	P0010, P2088	P0010	P0010, P0011, P0016, P0106,	P0011

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
			P0107, P0690, P2089	
Low Reference	-	P0010, P0011	-	P0011

Circuit/System Description

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshaft while the engine is operating. The ECM controls the camshaft position actuator magnet duty cycle by controlling the amount of On time. The magnet controls the amount of engine oil flow to the CMP actuator by extending a pintle within the solenoid. The pintle acts against a spool valve in the CMP actuator mechanism which is attached to the front of the camshaft. As the spool valve is moved, oil is directed to the CMP actuator, which rotates the camshaft. The ECM can only command the camshaft position actuator to retard the valve timing from the camshaft park position, or advance the valve timing back to the park position.

The ECM controls the camshaft position actuator magnet by supplying a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

Conditions for Running the DTC

- DTC P0010, P0016, P0335, P0336, P0340, and P0341 is not set.
- The engine is running.
- The system voltage is between 11-32 V.
- The CMP actuator is enabled and commanded greater than 0 degrees.
- The power take off (PTO) is not active - If equipped.
- The desired camshaft position does not vary greater than 7.5 degrees for 2 s.
- DTC P0011 runs continuously when 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 8 degrees for greater than 20 s

Action Taken When the DTC Sets

- DTC P0011 is a Type B DTC.

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- The CMP actuator is commanded to the park position.

Conditions for Clearing the DTC

DTC P0011 is a Type B DTC.

Diagnostic Aids

- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this DTC. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life parameter. Advise the customer an oil change may be required.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain can cause this DTC to set.
- A stuck camshaft position actuator causing the valve timing to be retarded may result in setting DTC P00C6 along with a crank/no start condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

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

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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

NOTE:

- **The engine oil level and the oil pressure are critical to the correct operation of the camshaft position (CMP) actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.**
- **The engine oil condition has a major impact on the camshaft actuator system. Debris in the oil can interfere with the camshaft position actuator solenoid and the mechanical camshaft actuator operation. Inspect for dirty or degraded crankcase oil. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life Remaining parameter. Advise the customer an oil change may be required.**

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

     Repair as necessary

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

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

3. Verify that DTC P0010, P0016, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390 or P0391, is not set.
   - **If any of the DTCs are set**

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

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

4. Engine idling.
5. Verify the scan tool Desired Camshaft parameter and the Camshaft Position angle parameter match when commanding the Camshaft Position Actuator to 20 degrees with a scan tool.
   - **If the parameters do not match**

     Refer to Circuit/System Testing.

   - **If the parameters match**
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 Q6 Camshaft Position Actuator Solenoid Valve. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 1 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**

NOTE: **A test lamp must be used for this test. The control circuit is pulled-up to a low current voltage. The current**

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is too low to illuminate a test lamp. A voltage on the control circuit is normal.

3. Ignition On.
4. Verify that a test lamp does not illuminate between the 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 control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
    - **If the test lamp does not illuminate**
5. Remove the test lamp.
6. Connect the DMM negative lead to the control circuit terminal 2. Connect the DMM positive lead to B+. Set the DMM on the diode setting. Command the Camshaft Position Actuator Solenoid On and Off with a scan tool. The DMM should transition from OL when commanded Off to less than 1 V when commanded On.
    - **If the parameter does not correspond to the specified values**
    1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 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 parameter corresponds to the specified values**
7. Remove the camshaft position actuator magnet. Perform the **Camshaft Position Actuator Magnet Cleaning and Inspection** . The camshaft position actuator magnet should pass the inspection.
    - **If the inspection does not pass**

      Replace the camshaft position actuator magnet

    - **If the inspection does pass**
8. Perform the **Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing** . The camshaft position actuator solenoid valve should pass the inspection.
    - **If the test does not pass**

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Replace the camshaft position actuator solenoid valve

- **If the test does pass**

9. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve and magnet.

Component Testing

Static Test

1. Ignition Off, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 Ω between the control terminal 1 and the low reference terminal 2.
   - **If not between 5-12 Ω**

     Replace the Q6 Camshaft Position Actuator Solenoid Valve.

   - **If between 5-12 Ω**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
   - **If not infinite resistance**

     Replace the Q6 Camshaft Position Actuator Solenoid Valve.

   - **If infinite resistance**
4. Ignition Off, remove the camshaft position actuator magnet.
5. Test for 5.0-9.0 Ω between the solenoid control terminal 2 and the low reference terminal 1 at the camshaft position actuator magnet.
   - **If not within the specified range**

     Replace the camshaft position actuator magnet

   - **If within the specified range**
6. Test for infinite resistance between each terminal of the magnet and the magnet housing.
   - **If not within the specified value**

     Replace the camshaft position actuator magnet

   - **If within the specified value**

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7. All OK.

Dynamic Test

1. Remove the camshaft position actuator magnet.

NOTE:

- **The camshaft position actuator magnet pintle should be facing downward for this test.**
- **Do not allow electrical current to flow through the camshaft position actuator magnet for greater than 1-2 s.**

2. Install a 20 A fused jumper wire between the control circuit terminal 2 and 12 V. Momentarily install a jumper wire between the low reference terminal 1 and ground. The pintle should extend.
   - **If the function does not perform as specified**

     Replace the camshaft position actuator magnet

   - **If the function does perform as specified**
3. All OK.

Repair Instructions

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

- Refer to **Camshaft Position Actuator Cleaning and Inspection**
- Refer to **Camshaft Position Actuator Magnet Replacement**
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup.

DTC P0016: CRANKSHAFT POSITION - 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 Descriptor

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DTC P0016

Crankshaft Position - Camshaft Position Not Plausible

Circuit/System Description

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

Conditions for Running the DTC

- DTC P0335, P0336, P0340, or P0341 is not set.
- Crankshaft and camshaft position signals are synchronized.
- The engine is cranking or running.
- The camshaft position actuator solenoid valve is in the parked position.
- Time since last execution of the diagnostic is less than 1 s.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects that 2 camshaft position sensor pulses occur more than 11 crank degrees before or 11 crank degrees after the nominal position in 1 camshaft revolution during 2 out of 3 tests.

Action Taken When the DTC Sets

DTC P0016 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0016 is a Type B DTC.

Reference Information

Description and Operation

Camshaft Actuator System Description

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0335, P0336, P0340, or P0341 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 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 (if equipped).
   - The correct installation of the Q6 Camshaft Position Actuator Solenoid Valve (if equipped).
   - The correct installation of the B23 Camshaft Position Sensor.
   - 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 or sprockets.
   - A timing chain that jumped teeth.
   - **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.

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- **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 Cleaning and Inspection**
- Refer to **Camshaft Position Actuator Magnet Cleaning and Inspection**
- Refer to **Camshaft Position Actuator Solenoid Valve Inspection**
- Refer to **Camshaft Position Sensor Replacement**
- Refer to **Camshaft Timing Chain and Sprocket Cleaning and Inspection**
- Refer to **Crankshaft Position Sensor Replacement**

DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, OR P0161: HO2S HEATER CONTROL CIRCUITS/HO2S HEATER RESISTANCE/HO2S HEATER 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 P0030

HO2S Heater Control Circuit Bank 1 Sensor 1

DTC P0031

HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 1

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DTC P0032

HO2S Heater Control Circuit High Voltage Bank 1 Sensor 1

DTC P0036

HO2S Heater Control Circuit Bank 1 Sensor 2

DTC P0037

HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 2

DTC P0038

HO2S Heater Control Circuit High Voltage Bank 1 Sensor 2

DTC P0050

HO2S Heater Control Circuit Bank 2 Sensor 1

DTC P0051

HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 1

DTC P0052

HO2S Heater Control Circuit High Voltage Bank 2 Sensor 1

DTC P0053

HO2S Heater Resistance Bank 1 Sensor 1

DTC P0054

HO2S Heater Resistance Bank 1 Sensor 2

DTC P0056

HO2S Heater Control Circuit Bank 2 Sensor 2

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DTC P0057

HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 2

DTC P0058

HO2S Heater Control Circuit High Voltage Bank 2 Sensor 2

DTC P0059

HO2S Heater Resistance Bank 2 Sensor 1

DTC P0060

HO2S Heater Resistance Bank 2 Sensor 2

DTC P0135

HO2S Heater Performance Bank 1 Sensor 1

DTC P0141

HO2S Heater Performance Bank 1 Sensor 2

DTC P0155

HO2S Heater Performance Bank 2 Sensor 1

DTC P0161

HO2S Heater Performance Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Heater Ignition Voltage	P0030, P0031, P0036, P0037, P0050, P0051,	P0030, P0031, P0036, P0037, P0050, P0051, P0056, P0057, P0132,	P0690	P0135, P0141, P0155, P0161

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
	P0056, P0057, P0102, P0132, P0134, P0135, P0138, P0141, P0152, P0154, P0155, P0158, P0161, P0300, P0443, P0458, P06DA, P3401, P3403, P3425, P3441, P3443, P3449, P3451, *	P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0157, P0158, P0160, P0161		
HO2S Heater Control	P0030, P0031, P0036, P0037, P0050, P0051, P0053, P0054, P0056, P0057, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0031, P0036, P0037, P0050, P0051, P0053, P0054, P0056, P0057, P0059, P0060, P0132, P0134, P0135, P0138, P0140, P0141, P0151, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0032, P0036, P0038, P0050, P0052, P0056, P0058, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0157, P0158, P0160, P0161, P0506, P0690	P0135, P0141, P0155, P0161
* Opens Fuse				

Typical Scan Tool Data

HO2S Heater Bank 1 or 2 Sensor 1 or 2

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

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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, P0036-P0038, P0050-P0052, or P0056-P0058

- The ignition voltage is between 11-32 V.
- The engine speed is greater than 400 RPM.
- The DTCs run continuously when the above conditions are met.

P0053, P0054, P0059, or P0060

- DTCs P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0125, P0128, or P2610 are not set.
- The engine run time is less than 0.4 s.
- The ignition voltage is less than 32 V.
- 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, P0141, P0155, or P0161

- 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 HO2S is commanded ON.
- The DTCs run once per drive cycle when the above conditions are met for 120 s.

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Conditions for Setting the DTC

P0030, P0036, P0050, or P0056

The engine control module detects an open circuit in the heater output low side driver circuit of the heated oxygen sensor when the heater is commanded OFF for greater than 5 s.

P0031, P0037, P0051, or P0057

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 5 s.

P0032, P0038, P0052, or P0058

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 5 s.

P0053, P0054, P0059, or P0060

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

P0135 or P0155

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

P0141 or P0161

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

Action Taken When the DTC Sets

DTCs P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141. P0155, and P0161 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141. P0155, and P0161 are Type B DTCs.

Reference Information

Schematic Reference

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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. Engine Running.
2. Verify the parameters listed below do not display Malfunction when commanding the HO2S Heater Bank 1 or 2 Sensor 1 or 2 to 0% and 100% with a scan tool:
   - HO2S Heater Control Circuit Low Voltage Test Status Bank 1 or 2 Sensor 1 or 2
   - HO2S Heater Control Circuit Open Test Status Bank 1 or 2 Sensor 1 or 2
   - HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2
   - **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.

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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 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, 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 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.

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5. Ignition On.
6. Verify the scan tool HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2 parameter is OK.
    - **If the parameter is not OK**
    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 Parameter is OK**

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.**

7. 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.**

8. Verify the scan tool HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2 parameter is Malfunction.
    - **If the Parameter is not Malfunction**
    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 the Parameter is Malfunction**
9. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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

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- Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- Refer to **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- Refer to **Heated Oxygen Sensor Replacement - Bank 2 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 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

Throttle Body Air Flow Performance

DTC P1101

Intake Air Flow System Performance

Circuit/System Description

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

Conditions for Running the DTC

DTC P0068

- The engine speed is greater than 800 RPM.
- The ignition voltage is greater than 6.5 V.
- The DTC runs continuously when the above conditions are met.

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DTC P1101

- DTCs P001, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114. P0116, P0117, P0118, P0128, P0335, or P0336 are not set
- The engine speed is between 500-6,800 RPM
- The engine coolant temperature (ECT) is between -7 to +150Â°C (+19 to +302Â°F).
- The intake air temperature (IAT) sensor 1 is between -20 to +125Â°C (-4 to +257Â°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. 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** 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%.
   - **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.

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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. 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**
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**

     Refer to Circuit/System Testing.

   - **If the DTC does not set.**
10. 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 conditions listed below exist:
   - Any damaged, improperly installed, collapsed, or restricted components

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- Loose clamps, cracks, or other damage
- An air flow restriction
- Restricted air filter
- Splits, kinks, leaks, or improper connections at the vacuum hoses
- Vacuum leaks at the intake manifold, MAP sensor, and throttle body
- Water intrusion
- Any snow or ice buildup, in cold climates
- Contamination of the MAF sensor element
- Improper operation of the crankcase ventilation system - Refer to **Crankcase Ventilation System Inspection/Diagnosis** for further diagnosis.
- Missing, restricted, or leaking exhaust components - Refer to **Symptoms - Engine Exhaust** for further diagnosis.
- **If a condition is found**

  Repair or replace component as appropriate.

- **If no condition is found**

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

     Repair or replace component as appropriate.

   - **If no condition is found**
3. All OK

Repair Instructions

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

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

DTC P0089, P228C, OR P228D: FUEL PRESSURE REGULATOR PERFORMANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

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- 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 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 under the intake manifold 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 to 15 MPa (290 to 2, 176 PSI), depending on engine speed and load. Output drivers in the ECM provide the high pressure fuel pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by opening and closing 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. The high pressure fuel pump is normally closed and will not deliver an increase in fuel pressure when the control solenoid is NOT powered. 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 21.5 MPa (3,118 PSI).

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

The ECM monitors the fuel rail pressure sensor and the high pressure fuel pump solenoid 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 high pressure fuel pump solenoid to make sure it is operating within expected limits.

Conditions for Running the DTC

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- DTCs P0010, P0011, P0016, P0089, P0090, P0091, P0092, P0096, P0097, P0098, P0099, P00C8, P00C9, P00CA, P0117, P0118, P0178, P0179, P018B, P018C, P018D, P0191, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341, or P1682 are not present.
- Fuel rail pressure is greater than 0.275 MPa (40 PSI).
- Battery voltage is greater than 11 V.
- Fuel temperature is between -10Â°C (14Â°F) and 100Â°C (212Â°F).
- Intake air temperature is greater than -10Â°C (14Â°F).
- The engine has been running for greater than 2 m.
- Barometer pressure is greater than 70 kPa.
- Vehicle is not in a low fuel state.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0089

- The high pressure fuel pump has exceeded the control limits. This condition exists when the high pressure fuel pump actuator command is 0Â° or greater than 130Â°.
- The above condition exists for 750 out of 938 counts, approximately 30 seconds at idle or 7 seconds at 2,700 RPM.

P228C

- The fuel rail pressure is greater than 3.00 MPa (435 PSI) below the desired fuel rail pressure.
- The above condition exists for 750 out of 938 counts, approximately 30 seconds at idle or 7 seconds at 2,700 RPM.

P228D

- The fuel rail pressure is greater than 3.00 MPa (435 PSI) above the desired fuel rail pressure.
- The above condition exists for 750 out of 938 counts, approximately 30 seconds at idle or 7 seconds at 2,700 RPM.

Action Taken When the DTC Sets

- DTC P0089 is a Type B DTC.
- DTCs P228C and P228D are Type A DTCs.

Conditions for Clearing the DTC

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- DTC P0089 is a Type B DTC.
- DTCs P228C and P228D are Type A DTCs.

Diagnostic Aids

- A leak in the high pressure fuel system may set a DTC.
- 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 high pressure fuel pump and the fuel rail pressure sensor may set a DTC.
- 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 leaking or restricted fuel injector may set the DTC.
- As little as 2 Ω on either circuit of the high pressure fuel pump solenoid will cause a DTC to set. Test the circuits of the high pressure fuel pump solenoid for a high resistance if you suspect a condition.
- Vapor lock may set DTC P0089

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**

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0010, P0011, P0016, P0090, P0091, P0092, P00C8, P00C9, P00CA, P018B, P018C, P018D, P0191, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341, P127C, P127D, or P163A are not set.
   - **If the DTC is set**

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

   - **If the DTC is not set**
3. Engine at idle.
4. Verify the Fuel Rail Pressure Sensor parameter is between 1.9-6.0 MPa (276-870 PSI).
   - **If not between 1.9-6.0 MPa (276-870 PSI)**

     Refer to Circuit/System Testing.

   - **If between 1.9-6.0 MPa (276-870 PSI)**
5. Verify the scan tool Fuel Rail Pressure parameter increases or decreases while commanding an increase and decrease in Fuel Rail Pressure with a scan tool.
   - **If the pressure does not increase or decrease with each command**

     Refer to Circuit/System Testing.

   - **If the pressure increases or decreases with each command**

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.

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6. Verify the scan tool Fuel Pressure Sensor parameter does not drop off during acceleration, cruise or hard cornering.
    - **If the pressure drops off**

      Refer to **Fuel System Diagnosis** .

    - **If the pressure does not drop off**
7. 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 5,600 RPM. Repeat the test at least three times.
8. Verify DTC P0089, P228C, or P228D is not set.
    - **If the DTC is set**

      Refer to Circuit/System Testing.

    - **If the DTC is not set**
9. 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.
10. Verify DTC P0089, P228C, or P228D is not set.
    - **If the DTC is set**

      Refer to Circuit/System Testing.

    - **If the DTC is not set**
11. 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. Disconnect the harness connector at the G18 High Pressure Fuel Pump.
3. Test for less than 2 Ω between G18 High Pressure Fuel Pump connector terminal 1 and the K20 Engine Control Module high control circuit terminal 16.
    - **If greater than 2 Ω**

      Repair the high resistance in the circuit.

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- **If 2 Ω or less**

4. Test for less than 2 Ω between the G18 High Pressure Fuel Pump connector terminal 2 and the K20 Engine Control Module low control circuit terminal 32.
   - **If greater than 2 Ω**

     Repair the high resistance in the circuit.

   - **If 2 Ω or less**
5. Remove the G18 High Pressure Fuel Pump.
6. Verify the lobes on the camshaft does not have unusual wear or are worn.
   - **If the lobes have unusual wear or are worn**

     Replace the Camshaft.

   - **If the lobes do not have unusual wear or are not worn**
7. 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 0.34 - 0.44 Ω at 20Â°C (68Â°F) between the low control circuit terminal 2 and the high control circuit terminal 1.
   - **If not within the specified range**

     Replace the G18 High Pressure Fuel Pump.

   - **If within the specified range**
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**

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4. All OK.

Repair Instructions

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

- Refer to **Fuel Pump Replacement** for G18 High Pressure Fuel Pump replacement.
- Refer to **Camshaft Replacement**

NOTE: **Some vehicles do not support the Fuel Rail Pressure Relief Valve Reset procedure. Applications not supporting this procedure will return an error message stating "Parameter ID not supported. Check for proper vehicle selection."**

- Perform the Fuel Rail Pressure Relief Valve Reset procedure.

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

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Fuel Pressure Regulator High Control Circuit Open

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 Control	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA, P0690	P0089, P226C, P226D
Low Control	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA, P0690	P0089, P226C, P226D

Circuit/System Description

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

Conditions for Running the DTC

- DTCs P0010, P0011, P0016, P0089, P0090, P0091, P0092, P0096, P0097, P0098, P0099, P00C8, P00C9, P00CA, P0117, P0118, P0178, P0179, P018B, P018C, P018D, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341, or P1682 are not present.
- 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

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P0090

- The engine control module 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 engine control module 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 engine control module 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 engine control module 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 engine control module 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 engine control module 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

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

Reference Information

Schematic Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTCs P0090, P0091, P0092, P00C8, P00C9, and P00CA is not set.
    - **If any of the DTCs are set**

      Refer to Circuit/System Testing.

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

3. Engine at idle.
4. Verify the parameters listed below do not display Malfunction when commanding an increase and decrease in Fuel Rail Pressure with a scan tool:
   - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
   - Fuel Pressure Regulator Control Circuit Open Test Status
   - Fuel Pressure Regulator Control Circuit High Voltage Test Status
   - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
   - Fuel Pressure Regulator High Control Circuit Open Test Status
   - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not 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, all vehicle systems OFF, disconnect the X3 harness connector at the K20 Engine Control Module. It may take up to 2 min for all vehicle systems to power down.

NOTE:

- **The DMM and test leads must be calibrated to 0 Ω in order to prevent misdiagnosis.**
- **To prevent terminal damage, verify the proper test adaptors are used according to the Component Connector End View list.**

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2. Verify less than 5 Ω between the X3 harness connector high control circuit terminal 32 and the low control circuit terminal 16.
    - **If 5 Ω or greater**
    1. Disconnect the harness connector at the G18 High Pressure Fuel Pump.
    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
    3. 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, test or replace the G18 High Pressure Fuel Pump.
    - **If less than 5 Ω**
3. Test for infinite resistance between the X3 harness connector low control circuit terminal 16 and ground.
    - **If less than infinite resistance**
    1. Disconnect the harness connector at the G18 High Pressure Fuel Pump.
    2. Test for infinite resistance between the low control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for infinite resistance between the high control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, test or replace the G18 High Pressure Fuel Pump.
    - **If infinite resistance**
4. Ignition ON.
5. Verify less than 1 V between the X3 harness connector low control circuit terminal 16 and ground.
    - **If 1 V or greater**
    1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.
    2. Ignition ON.
    3. Test for less than 1 V between the low control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the low control circuit.
        - If less than 1 V, repair the short to voltage on the high control circuit.
    - **If less than 1 V**

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6. Replace the K20 Engine Control Module.

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 0.34 - 0.44 Ω at 20Â°C (68Â°F) between the low control circuit terminal 2 and the high control circuit terminal 1.
   - **If not within the specified range**

     Replace the G18 High Pressure Fuel Pump.

   - **If within the specified range**
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** for G18 High Pressure Fuel Pump replacement.
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

NOTE: **Some vehicles do not support the Fuel Rail Pressure Relief Valve Reset procedure. Applications not supporting this procedure will return an error message stating "Parameter ID not supported. Check for proper vehicle selection."**

- Perform the Fuel Rail Pressure Relief Valve Reset procedure.

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

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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
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0113, P0114, P2199*	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199, P2229, P2230	P0113, P0114, P2199, P2227, P2229*	-
*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, P00F4, P0102, P0178, P2199	P0096, P0097, P00F4, P0101, P0102, P2199, P2230	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096

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

ECT Sensor

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running			

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Circuit	Short to Ground	Open or High Resistance	Short to Voltage
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)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The sensors listed below are integrated within the multifunction intake air sensor:

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

The intake air temperature (IAT) sensor 1 is a variable resistor that changes the voltage on the engine control module (ECM) supplied 5 V signal circuit. The signal varies with inlet air temperature in the sensor bore and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 2 and the humidity sensor share the same circuit. The IAT sensor 2 signal is displayed by the scan tool as Hertz (Hz) and Â°C (Â°F).

The sensors listed below share an ECM supplied 5 V reference circuit:

- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

The sensors listed below share an ECM supplied low reference circuit:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

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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	-40Â°C (-40Â°F)
Warm	302 Hz	104Â°C (219Â°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.
- Ignition voltage is at least 11 V.
- 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 10Â°C (50Â°F).

  AND

- The absolute difference between ECT start-up temperature and the IAT sensor 2 start-up temperature is greater than 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 10Â°C (50Â°F).

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AND

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

- With the ignition ON, when the engine is OFF and cold; properly functioning IAT sensors 1 and 2 will gradually increase the scan tool IAT Sensor 1 and 2 parameters. This is due to the heat that is generated by the multifunction intake air sensor internal 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; -40Â°C (-40Â°F), and there are also Humidity Sensor DTCs, check for a circuit problem.

Reference Information

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service 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 25Â°C (45Â°F) of each other.
   - Start-Up IAT Sensor 1
   - Start-Up IAT Sensor 2
   - Start-Up ECT
   - **If not within 25Â°C (45Â°F)**

     Refer to Circuit/System Testing.

   - **If within 25Â°C (45Â°F)**
3. Engine idling, verify the following scan tool parameters are between -38 to +149Â°C (-36 to +300Â°F).
   - IAT Sensor 1
   - IAT Sensor 2

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- ECT Sensor
- **If not between -38 to +149Â°C (-36 to +300Â°F)**

  Refer to Circuit/System Testing.

- **If between -38 to +149Â°C (-36 to +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 DTC sets**

     Refer to Circuit/System Testing.

   - **If no DTC sets**
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 conditions listed below exist:
   - 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 and all systems OFF, it may take up to for 2 min for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
3. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
   - **If 2 Ω or greater**

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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 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. 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 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, test all components connected to the ignition circuit, replace as necessary.

- **If a test lamp illuminates**

6. Ignition ON.
7. Verify the scan tool IAT Sensor 1 parameter is colder than -39Â°C (-38Â°F).

- **If warmer than -39Â°C (-38Â°F).**

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.

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- 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 colder than -39Â°C (-38Â°F).**

8. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3, ignition ON.
9. Verify the scan tool IAT Sensor 1 parameter is warmer than 149Â°C (300Â°F).
    - **If colder than 149Â°C (300Â°F).**

    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 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).**

10. 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 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**

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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, 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**

11. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.

- **EL-38522-A, Variable Signal Generator; or equivalent is not available**

1. Test or replace the B75C Multifunction Intake Air Sensor.
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**

      Replace the K20 Engine Control Module.

    - **If no DTCs set**
4. All OK.

- **EL-38522-A, Variable Signal Generator; or equivalent is available**

12. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as listed below:
    - Red lead to the signal circuit terminal 8 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
13. Set the **EL-38522-A** Variable Signal Generator to the specifications listed below:
    - Signal switch to 5 V
    - Duty Cycle switch to 50% (Normal)
    - Frequency switch to 30 Hz
14. Ignition ON.
15. Verify the scan tool IAT Sensor 2 parameter is between 28-32 Hz.

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- **If not between 28-32 Hz**

  Replace the K20 Engine Control Module.

- **If between 28-32 Hz**

16. Test or replace the B75C Multifunction Intake Air Sensor.

Component Testing

Multifunction Intake Air Sensor - IAT Sensor 1

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** table for Hitachi Sensors. The resistance values should be in range of the table values.
   - **If not within the table values.**

     Replace the B75C Multifunction Intake Air sensor.

   - **If within the table values.**
3. All OK

Multifunction Intake Air Sensor - IAT Sensor 2

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 5%**

     Replace the B75C Multifunction Intake Air sensor.

   - **If within 5%**
2. All OK.

Repair Instructions

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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, P00F4, P0102, P0178, P2199	P0096, P0097, P00F4, P0101, P0102, P2199, P2230	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ground	-	P0096, P0097, P00F4, P0102, P2199, P2230	-	P0096, P0102
*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 sensors listed below are integrated within the mass air flow/multifunction intake air sensor:

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

The IAT sensor 2 and the humidity sensor share the same circuit. The IAT sensor 2 signal is displayed by the scan tool as Hertz (Hz) and Â°C (Â°F).

The sensors listed below share an ECM supplied 5 V reference circuit:

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- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

The sensors listed below share an ECM supplied low reference circuit:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) 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	-40Â°C (-40Â°F)
Warm	302 Hz	104Â°C (219Â°F)

Conditions for Running the DTCs

P0097, P0098, and P0099

- The ignition is ON, or the engine is running.
- The Ignition voltage is at least 11 V.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P0097

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

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The ECM detects that the IAT sensor 2 signal is less than 13 Hz, colder than -60Â°C (-76Â°F), for greater than 5 s.

P0098

The ECM detects that the IAT sensor 2 signal is greater than 390 Hz, warmer than 150Â°C (302Â°F), for greater than 5 s.

P0099

The ECM detects that the IAT sensor 2 signal is intermittent or has abruptly changed for longer than 5 s.

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/DTC

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

Diagnostic Aids

- With the ignition ON, the engine OFF and 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; -40Â°C (-40Â°F), and there are also Humidity Sensor DTCs, check for a circuit problem.

Reference Information

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service Tools)** .

Circuit/System Verification

1. Engine idling.
2. Verify the scan tool IAT Sensor 2 parameter is between -38 to +149Â°C (-36 to +300Â°F).
   - **If not between -38 to +149Â°C (-36 to +300Â°F)**

     Refer to Circuit System Testing.

   - **If between -38 to +149Â°C (-36 to +300Â°F)**
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 does set**

     Refer to Circuit/System Testing.

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- **If the DTC does not set**

5. All OK

Circuit/System Testing

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

1. Ignition OFF and all systems OFF, it may take up to for 2 min for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
2. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
   - **If 2 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 or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **If less than 2 Ω**
3. Test for less than 2 Ω between the ground circuit terminal 7 and ground.
   - **If 2 Ω or greater**
   1. 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 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.
5. 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.

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- **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 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, 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. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.

- **EL-38522-A, Variable Signal Generator; or equivalent is not available**

1. Test or replace the B75C Multifunction Intake Air Sensor.
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.

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- **If the DTC sets**

  Replace the K20 Engine Control Module.

- **If no DTCs set**

4. All OK.

- **EL-38522-A, Variable Signal Generator; or equivalent is available**

8. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as listed below:
   - 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-A** Variable Signal Generator to the specifications listed below:
   - Signal switch to 5 V
   - Duty Cycle switch to 50% (Normal)
   - Frequency switch to 30 Hz
10. Ignition ON.
11. 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**
12. Test or replace the B75C Multifunction Intake Air Sensor.

Component Testing

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 5%**

     Replace the B75C Multifunction Intake Air Sensor.

   - **If within 5%**

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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 P00C6: 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 P00C6

Fuel Rail Pressure Low During Engine Cranking

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Pressure Fuel Pump Actuator High Control	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA, P0690	P0089, P226C, P226D
High Pressure Fuel Pump Actuator Low Control	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA, P0690	P0089, P226C, P226D

Circuit/System Description

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

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(PWM) the low control circuit to ground. Before the engine is started the engine control module determines fuel rail pressure and engine coolant temperature (ECT) before the engine is cranked. If the fuel rail pressure is less than the target set point before the engine is cranked, the Pressure Rise Diagnostic is used. If the fuel rail pressure is greater than the target set point before the engine is cranked, the Pressure Fall Diagnostic is used. If the fuel rail pressure does not match the target set point in a calibrated time the DTC may set.

Conditions for Running the DTC

P00C6

- DTCs P0010, P0011, P0016, P0089, P0090, P0091, P0092, P0096, P0097, P0098, P0099, P00C8, P00C9, P00CA, P0117, P0118, P0178, P0179, P018B, P018C, P018D, P0191, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341, or P1682 are not present.
- Run/Crank voltage is greater than 8 V.
- Engine coolant temperature is between -100Â°C (-148Â°F) and 65Â°C (149Â°F).
- Low side fuel pressure is greater than 0 kPa (0 PSI).
- Engine is not running
- Vehicle is not in a low fuel condition
- Barometric pressure is greater than 70.0 kPa
- Intake air temperature is greater the -10Â°C (14Â°F)
- The DTC runs once for each engine start.

Conditions for Setting the DTC

Condition 1

- If the fuel rail pressure is less than the target set point before the engine is cranked, the pressure rise diagnostic is used.
- The pressure rise diagnostic will fail if the fuel pressure has not increased to the target set point within 10 seconds at -10Â°C (14Â°F) ECT or within 5 s if ECT is greater than 0Â°C (32Â°F).

Condition 2

- If the fuel rail pressure is greater than the target set point before the engine is cranked, the pressure fall diagnostic is used.
- The pressure fall diagnostic will fail if the fuel rail pressure has dropped below 2 MPa (290 PSI) for 10 engine cycles if the ECT is less than -10Â°C (14Â°F) or 0.6 MPa (87 PSI) for 10 engine cycle if the ECT is between -10Â°C (14Â°F) and 16Â°C (60Â°F) and 0.45 MPa (65 PSI) for 10 cycles if ECT is greater than 16Â°C (60Â°F).

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The above conditions must occur for two consecutive starts for the DTC to set.

Action Taken When the DTC Sets

DTC P00C6 is a Type B DTC

Conditions for Clearing the DTC

DTC P00C6 is a Type B DTC

Diagnostic Aids

- A restricted fuel feed pipe between the fuel feed pipe fuel pressure sensor and the high pressure fuel pump may set a DTC.
- A condition with the fuel tank fuel pump module or the fuel pump driver control module may set a DTC.
- A skewed fuel rail pressure sensor, or an intermittent condition in the fuel rail pressure sensor circuits may set a DTC.
- A leaking or restricted fuel injector may set a DTC.
- A short to voltage in the crankshaft position signal circuit may set a DTC.
- A short to voltage in the camshaft position actuator solenoid valve control circuit may set a DTC.
- A stuck camshaft position actuator may cause the fuel pump synchronization logic to fail and set DTC P00C6.

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**

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **If vehicle is a no start, refer to Engine Cranks But Does Not Run .**

1. Ignition ON.
2. Verify DTCs P0010, P0011, P0016, P0089, P0090, P0091, P0092, P0096, P0097, P0098, P0099, P00C8, P00C9, P00CA, P0117, P0118, P0178, P0179, P018B, P018C, P018D, P0191, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341, P1682 are not present.
   - **If any of the DTCs are set**

     Refer to Diagnostic Trouble Code (DTC) List - Vehicle

   - **If none of the DTCs are set**
3. Verify the scan tool Fuel Pressure Sensor parameter is between 320-580 kPa (46-84 PSI) while commanding the Fuel Pump Enable ON several times with a scan tool.
   - **If less than 320 kPa (46 PSI)**

     Refer to Fuel System Diagnosis

   - **If greater than 580 kPa (84 PSI)**

     Replace the G12 Fuel Pump.

   - **If between 320-580 kPa (46-84 PSI)**

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NOTE: **The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.**

4. Verify that the fuel pressure decreases to 468-544 kPa (68-79 PSI) after the fuel pump is turned off.
   - **If the fuel pressure does not decrease to 468-544 kPa (68-79 PSI)**

     Replace the G12 Fuel Pump.

   - **If the fuel pressure decreases to 468-544 kPa (68-79 PSI)**
5. Verify DTC P00C6 is not set.
   - **If the DTC is set**

     Refer to Circuit/System Testing.

   - **If the DTC is not set**
6. Engine at idle.
7. Verify the parameters listed below do not display Malfunction when commanding an increase and decrease in Fuel Rail Pressure with a scan tool:
   - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
   - Fuel Pressure Regulator Control Circuit Open Test Status
   - Fuel Pressure Regulator Control Circuit High Voltage Test Status
   - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
   - Fuel Pressure Regulator High Control Circuit Open Test Status
   - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not displayed**
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**

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Refer to Circuit/System Testing.

- **If the DTC does not set**

10. All OK.

Circuit/System Testing

1. Clear the DTCs.

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.**

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

2. 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 6,000 RPM. Repeat the test at least three times.
3. Verify the scan tool Fuel Rail Pressure Sensor parameter displays between 14-17 MPa (2,031-2,466 PSI) while the engine speed is near 5,600 RPM.
   - **If not between 14-17 MPa (2,031-2,466 PSI)**

     Replace the G18 High Pressure Fuel Pump.

   - **If between 14-17 MPa (2,031-2,466 PSI)**
4. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump, ignition ON.
5. Verify that a test lamp does not illuminate between the high control circuit terminal 1 and ground.
   - **If the test lamp illuminates**
   1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the high 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**
6. Verify that a test lamp does not illuminate between the low control circuit terminal 2 and ground.
   - **If the test lamp illuminates**

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1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the low 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**

7. Verify that a test lamp does not illuminate between the high control circuit terminal 1 and B+.

- **If the test lamp illuminates**

1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the high 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**

8. Verify that a test lamp does not illuminate between the low control circuit terminal 2 and B+.

- **If the test lamp illuminates**

1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the low 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**

9. Remove the test lamp, connect a 3 A fused jumper wire between the high control circuit terminal 1 and ground.
10. Verify the Fuel Pressure Regulator High Control Circuit Low Voltage Test Status transitions from OK to Malfunction.

- **If Malfunction is not displayed**

1. Ignition OFF, remove the fused jumper, disconnect the X3 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.

- **If Malfunction is displayed**

11. Connect a 3 A fused jumper wire between the low control circuit terminal 2 and B+.
12. Verify the Fuel Pressure Regulator Control Circuit High Voltage Test Status transitions from OK to Malfunction.

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- **If Malfunction is not displayed**

1. Ignition OFF, remove the fused jumper, disconnect the X3 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.

- **If Malfunction is displayed**

13. Verify none of the conditions listed below exist:
    - Restricted fuel feed pipe
    - Restricted or plugged strainer
    - Poor connections at the high pressure fuel pump solenoid
    - **If a condition exist**

      Repair as necessary.

    - **If a condition does not exist**
14. 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 0.34 - 0.44 Ω at 20Â°C (68Â°F) between the low control circuit terminal 2 and the high control circuit terminal 1.
    - **If not within the specified range**

      Replace the G18 High Pressure Fuel Pump.

    - **If within the specified range**
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.

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- **If infinite resistance**

4. All OK.

Repair Instructions

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

- Refer to **Fuel Feed Pipe Replacement (At Engine)** **Fuel Feed Pipe Replacement (At Tank)**
- Refer to **Fuel Pump Replacement** for G18 High Pressure Fuel Pump replacement
- Refer to **Fuel Tank Fuel Pump Module Replacement (SWB)** **Fuel Tank Fuel Pump Module Replacement (LWB)** for G12 Fuel Pump replacement
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P00C7: INTAKE AIR PRESSURE MEASUREMENT SYSTEM - MULTIPLE SENSORS 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 P00C7

Intake Air Pressure Measurement System - Multiple Sensors Not Plausible

Circuit/System Description

The Intake Air Pressure Measurement System consists of (2) sensors, the barometric pressure (BARO) sensor, the manifold absolute pressure (MAP) sensor.

Conditions for Running the DTC

- Before the ECM can report that DTC P00C7 failed, DTCs P0107, P0108, P2228, and P2229 must run and pass.
- DTC P0106, P0107, P0108, P2227, P2228, P2229, P2230, or P2610 is not set.
- The ignition is ON, engine OFF.

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- The time between the current ignition cycle and the previous drive cycle is greater than 5 s
- The manifold absolute pressure (MAP) is between 50-115 kPa (7.25-16.67 PSI).
- The barometric pressure (BARO) is between 50-115 kPa (7.25-16.67 PSI).
- DTC P00C7 runs continuously when the conditions above exist.

Conditions for Setting the DTC

P00C7

The ECM detects an inconsistency between pressure sensors in the induction system in which a particular sensor cannot be identified as the failed sensor. The difference between them is greater than 10 kPa (1.5 PSI).

Action Taken When the DTC Sets

DTC P00C7 is a Type B DTC.

Conditions for Clearing the DTC

DTC P00C7 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Electrical Information Reference

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

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0106, P0107, P0108, P2227, P2228, P2229, or P2230 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 parameters listed below are within range of the **Altitude Versus Barometric Pressure** table.
   - BARO Sensor
   - MAP Sensor
   - **If a sensor parameter is not within range**

     Refer to the appropriate diagnostic listed below for further diagnosis.

   - BARO Sensor, refer to **DTC P2227-P2230** .
   - MAP Sensor, refer to **DTC P0106**.
   - **If the parameters are within range**
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 P00F4-P00F6: INTAKE AIR HUMIDITY SENSOR CIRCUIT

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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, P0178, P2199	P0096, P0097, P0101, P0102, P00F4, P2199	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P0102, P00F4, P2199, P2230	-	P0096, P0102
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Intake Air Humidity

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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	0 %	0 %	-
Signal	100 %	0 %	0 %*
Ground	-	0 %	-
*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 voltage is at least 11 V.

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- These DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P00F4

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

P00F5

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

P00F6

The ECM detects that the humidity sensor signal is intermittent or has abruptly changed over a period of time greater than 5 s.

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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Component View Reference

Powertrain Component Views

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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

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service 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 25Â°C (45Â°F) of each other.
    - Start-Up IAT Sensor 1
    - Start-Up IAT Sensor 2
    - Start-Up ECT
    - **If not within 25Â°C (45Â°F)**

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Refer to Circuit/System Testing.

- **If within 25Â°C (45Â°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 DTC sets**

     Refer to Circuit/System Testing.

   - **If no DTCs set**
6. All OK

Circuit/System Testing

1. Ignition OFF and all systems OFF, it may take up to for 2 min for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
2. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
   - **If 2 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 or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **If less than 2 Ω**
3. Test for less than 2 Ω between the ground circuit terminal 7 and ground.
   - **If 2 Ω or greater**
   1. Disconnect the sensor chassis ground.

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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.**

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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**

6. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.

- **EL-38522-A, Variable Signal Generator; or equivalent is not available**

1. Test or replace the B75C Multifunction Intake Air Sensor.
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**

      Replace the K20 Engine Control Module.

    - **If no DTCs set**
4. All OK.

- **EL-38522-A, Variable Signal Generator; or equivalent is available**

7. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as listed below:
    - Red lead to the signal circuit terminal 8 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
8. Set the **EL-38522-A** Variable Signal Generator to the specifications listed below:
    - Signal switch to 5 V
    - Frequency switch to 250 Hz
    - Duty Cycle switch to 50% (Normal)
9. Ignition ON.
10. Verify the scan tool Intake Air Humidity Sensor parameter is between 45-55%.

- **If not between 45-55%.**

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Replace the K20 Engine Control Module.

- **If between 45-55%.**

11. 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 5-95%, or the parameter does not change.**

     Replace the K20 Engine Control Module.

   - **If within 5-95% and the parameter does change**
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

Mass Air Flow (MAF) Sensor Performance

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P2199	P0096, P0097, P00F4, P0101, P0102, P2199	P0690	P0096, P0101, P0103
Signal	P0102	P0102	P0102*	P0101, P0103, P1101
Ground	-	P0096, P0097, P00F4, P0102, P2199	-	P0096, P0102
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

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

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 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

- DTCs P001, P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114. P0116, P0117, P0118, P0128, P0335, or P0336 are not set
- The engine speed is between 500 and 6,800 RPM.
- The engine coolant temperature (ECT) is between -7 to +150Â°C (+19 to +302Â°F).

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- The intake air temperature (IAT Sensor 1) is between -20 to +125Â°C (-4 to +257Â°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 air flow from the MAF, MAP, and throttle position sensors is not within range of the calculated air flow 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 air flow 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.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service 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** 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%.
   - **90% or greater**

     Refer to **Throttle Body Cleaning** .

   - **If less than 90%**

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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.
8. Verify the scan tool MAP Sensor parameter is between 26-52 kPa (3.8-7.5 PSI) and changes with accelerator pedal input.
    - **If the MAP Sensor parameter is not between 26-52 kPa (3.8-7.5 PSI) or does not change**

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

    - **If the MAP Sensor parameter is between 26-52 kPa (3.8-7.5 PSI) and changes**
9. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
    1. Engine idling
    2. Perform the scan tool snapshot function.
    3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
    4. Exit from the scan tool snapshot and review the data.
    5. Observe the MAF Sensor parameter frame by frame with a scan tool.
    - **The MAF Sensor parameter does not change smoothly and gradually**

      Refer to Circuit/System Testing for further diagnosis.

    - **The MAF Sensor parameter changes smoothly and gradually**

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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 for further diagnosis.

    - **If the DTC does not 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 conditions listed below exist:
    - Any damaged components
    - Improperly installed components
    - Collapsed, restricted, or damaged components
    - Loose clamps, cracks, or other damage
    - An air flow restriction
    - Restricted air filter
    - Splits, kinks, leaks, or improper connections at the vacuum hoses
    - Vacuum leaks at the intake manifold, MAP sensor, and throttle body
    - Water intrusion
    - Any snow or ice buildup, in cold climates
    - Contamination of the 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. Test for less than 2 Ω between the ground circuit terminal 7 and ground.

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- **If 2 Ω or greater**

1. 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 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 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, ignition ON.

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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. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.

- **EL-38522-A, Variable Signal Generator; or equivalent is not available**

1. Test or replace the B75C Multifunction Intake Air Sensor.
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**

      Replace the K20 Engine Control Module.

    - **If no DTCs set**
4. All OK.

- **EL-38522-A, Variable Signal Generator; or equivalent is available**

7. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as listed below:
    - Red lead to the signal circuit terminal 6 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
8. Set the **EL-38522-A** Variable Signal Generator to the specifications listed below:
    - Signal switch to 5 V
    - Frequency switch to 5 kHz
    - Duty Cycle switch to 50% (Normal)
9. Engine idling.
10. 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.

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

11. 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

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	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P2199	P0096, P0097, P00F4, P0101, P0102, P2199	P0690	P0096, P0101, P0103
Signal	P0102	P0102	P0102*	P0101, P0103, P1101

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ground	-	P0096, P0097, P00F4, P0102, P2199	-	P0096, P0102
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

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

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 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

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

Conditions for Running the DTC

- The engine speed is greater than 300 RPM.
- The engine is running for greater than 1 s.
- The ignition signal is greater than 10 V.
- The above conditions are met for greater than 1 s.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0102

The ECM detects that the MAF Sensor Signal is less than 800 Hz (about 1.34 g/s) for greater than 10 s.

P0103

The ECM detects that the MAF Sensor Signal is greater than 14,500 Hz (about 1233 g/s) for greater than 10 s.

Action Taken When the DTC Sets

DTCs P0102 and P0103 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0102 and P0103 are Type B DTCs.

Reference Information

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service Tools)** .

Circuit/System Verification

1. Ignition ON.
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.

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

1. Ignition OFF and all systems OFF. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
2. Test for less than 2 Ω between the ground circuit terminal 7 and ground.
   - **If 2 Ω or greater**
   1. 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.
4. 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.

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- 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 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, 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. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.

- **EL-38522-A, Variable Signal Generator; or equivalent is not available**

1. Test or replace the B75C Multifunction Intake Air Sensor.
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.

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- **If the DTC sets**

  Replace the K20 Engine Control Module.

- **If no DTCs set**

4. All OK.

- **EL-38522-A, Variable Signal Generator; or equivalent is available**

7. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as listed below:
   - Red lead to the signal circuit terminal 6 at the harness connector
   - Black leads to ground
   - Battery voltage supply lead to B+
8. Set the **EL-38522-A** Variable Signal Generator to the specifications listed below:
   - Signal switch to 5 V
   - Frequency switch to 5 kHz
   - Duty Cycle switch to 50% (Normal)
9. Engine idling.
10. 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.**
11. 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

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- 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

Circuits	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P0697	P0106, P0107	P0107	P0106, P0108, P0107, P0697	P0106
Signal	P0106, P0107 P0697	P0106, P0107	P0106, P0107	P0106, P0108*, P0697	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

Circuits	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) (varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	128 kPa (18.6 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	128 kPa (18.6 PSI)*
Low Reference	-	80-128 kPa (11.6-18.6 PSI)	-
* 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			

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Circuits	Short to Ground	Open	Short to Voltage
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/System Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, barometric pressure (BARO) and if equipped, turbocharger output. A diaphragm within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance.

The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5 V reference circuit. The ECM supplies a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

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

Conditions for Running the DTC

- DTCs P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0335, P0336 or P0401 are not set.
- The engine speed is between 450-5,400 RPM.
- The engine coolant temperature (ECT) sensor is between -7 to 129Â°C (19 to 264Â°F).
- The intake air temperature (IAT) sensor is between -20 to 129Â°C (-4 to 264Â°F).
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM determines if the MAP Sensor is stuck within the normal operating range. It accomplishes this by running 3 different models within the software to determine the values.

Action Taken When the DTC Sets

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DTC P0106 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0106 is a Type B DTC.

Reference Information

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Connector End View Reference

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DTC Type Reference

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Scan Tool Reference

Control Module References for scan tool information

Special Tools

GE-23738-A Vacuum Pump

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For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service 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** for further diagnosis.

   - **If none of the DTCs are set**
3. If you were sent here from DTC P0068, P0101, P0121, or P1101; refer to Circuit/System Testing.
4. 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%**
5. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep 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 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 within range**
8. Engine idling.
9. Verify the scan tool MAP Sensor parameter is between 26-52 kPa (3.8-7.5 PSI) and changes with accelerator pedal input.

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- **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 parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
    1. Engine idling
    2. Perform the scan tool snapshot function.
    3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
    4. Exit from the scan tool snapshot and review the data.
    5. Observe the MAF Sensor parameter frame by frame with a scan tool.
    - **If the MAF Sensor parameter does not change smoothly and gradually**

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

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

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- Any vacuum leak
- Improperly routed vacuum hoses
- In cold climates, inspect for any snow or ice buildup at the BARO port on the ECM, if equipped
- A restriction in the MAP Sensor port or the BARO port, if equipped
- Proper operation of the Positive Crankcase Ventilation (PCV) system
- Missing, restricted or leaking exhaust components. Refer to **Restricted Exhaust** .
- Engine mechanical condition, for example: low compression or incorrect timing chain installation. Refer to **Symptoms - Engine Mechanical**
- **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 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.

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- 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. Verify the scan tool MAP Sensor 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/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

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- **If greater than 4.5 V**

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

Component Testing

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

Skewed Sensor Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON.
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 Sensor pressure parameter decreases between 13-21 kPa (1.8-3.0 PSI).
   - **If the parameter does not decrease between 13-21 kPa (1.8-3.0 PSI)**

     Replace the B74 Manifold Absolute Pressure Sensor.

   - **If the parameter does decrease between 13-21 kPa (1.8-3.0 PSI)**
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 Sensor pressure parameter decreases between 30-38 kPa (4.4-5.5 PSI).
   - **If the parameter does not decrease between 30-38 kPa (4.4-5.5 PSI)**

     Replace the B74 Manifold Absolute Pressure Sensor.

   - **If the parameter does decrease between 30-38 kPa (4.4-5.5 PSI)**
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.

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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, 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

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

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Circuits	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0107, P0697	P0106, P0107	P0107	P0107, P0108, P0697	P0106
Signal	P0106, P0107, P0697	P0106, P0107	P0106, P0107	P0106, P0108*, P0697	P0106
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

Circuits	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in closed loop, idling, and accessories OFF. **Parameter Normal Range:** 26-52 kPa (3.8 to 7.6 PSI) (Varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)*
Low Reference	-	127 kPa (18.4 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

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 to 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/System Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, barometric pressure (BARO); and if equipped turbocharger output. A diaphragm within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance.

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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

The DTC's run continuously.

Conditions for Setting the DTC

P0107

The ECM detects that the MAP Sensor voltage is less than 0.15 V for greater 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 DTC

DTCs P0107 and P0108 are Type B DTCs.

Reference Information

Schematic Reference

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Connector End View Reference

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Powertrain Component View

Powertrain Component Views

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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

Special Tools

GE-23738-A Vacuum Pump

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service 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** for further diagnosis.

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

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Refer to Circuit/System Testing for further diagnosis.

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

4. Engine idling, verify the scan tool MAP Sensor voltage parameter is between the specified value listed below:

   0.3-4.8 V and changes with accelerator pedal input - Without turbocharger

   0.2-4.5 V and changes with accelerator pedal input - With turbocharger

   - **If not between the specified value or does not change**

     Refer to Circuit/System Testing.

   - **If between the specified value and changes**

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 the DTC does not set.
   - **If any DTC sets**

     Refer to Circuit/System Testing.

   - **If no DTC sets**
7. All OK.

Circuit/System Testing

1. 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.
2. 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**

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3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 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**
5. 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**
6. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1.
7. Verify the scan tool MAP Sensor voltage parameter is greater than 4.5 V.

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- **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**

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

Component Testing

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

Skewed Sensor Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON.
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 Sensor pressure parameter decreases between 13-21 kPa (1.8-3.0 PSI).
    - **If the parameter does not decrease between 13-21 kPa (1.8-3.0 PSI)**

      Replace the B74 Manifold Absolute Pressure Sensor.

    - **If the parameter does decrease between 13-21 kPa (1.8-3.0 PSI)**
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 Sensor pressure parameter decreases between 30-38 kPa (4.4-5.5 PSI).
    - **If the parameter does not decrease between 30-38 kPa (4.4-5.5 PSI)**

      Replace the B74 Manifold Absolute Pressure Sensor.

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- **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, 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 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.

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DTC Descriptors

DTC P0112

Intake Air Temperature (IAT) Sensor 1 Circuit Low Voltage

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	P0113, P0114, P2199*	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199, P2227, P2228, P2229	P0113, P0114, P2199, P2227, P2229*	-
*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	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+			

Circuit/System Description

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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 engine run time is greater than 0 s.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0112

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

The ECM detects that the IAT sensor 1 signal is warmer than 150Â°C (302Â°F) for greater than 5 s.

P0113

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

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The ECM detects that the IAT sensor 1 signal is colder than -60Â°C (-76Â°F) for greater than 5 s.

P0114

The ECM detects that the IAT sensor 1 signal is intermittent or has abruptly changed for greater than 5 s.

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Diagnostic Aids

With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor 1 will gradually increase the scan tool IAT Sensor 1 parameter. This is due to the heat that is generated by the MAF sensor heating elements.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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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

1. Engine idling.
2. Verify the scan tool IAT Sensor 1 parameter is between -38 to +149Â°C (-36 to +300Â°F).
   - **If not between -38 to +149Â°C (-36 to +300Â°F)**

     Refer to Circuit/System Testing.

   - **If between -38 to +149Â°C (-36 to +300Â°F)**
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 systems OFF, it may take up to for 2 min for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
2. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
   - **If 2 Ω or greater**
   1. Disconnect the harness connector at the K20 Engine Control Module.

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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.
4. 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, 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**

5. Verify the scan tool IAT Sensor 1 parameter is colder than -39Â°C (-38Â°F).
- **If warmer than -39Â°C (-38Â°F).**

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

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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 colder than -39Â°C (-38Â°F).**

6. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3, ignition ON.
7. Verify the scan tool IAT Sensor 1 parameter is warmer than 149Â°C (300Â°F).
    - **If colder than 149Â°C (300Â°F).**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 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).**
8. 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** table for Hitachi Sensors. The resistance values should be in range of the table values.
    - **If not within the table values.**

      Replace the B75C Multifunction Intake Air sensor.

    - **If within the table values.**

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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	High Resistance	Open	Short to Voltage	Signal Performance
Signal	P0117	P0118	P0118	P0118	P0116, P0128
Low Reference	-	P0118	P0118	P0118	P0128

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running at normal operating temperature **Parameter Normal Range:** 91 to 93Â°C (196 to 200Â°F)			
ECT Sensor	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)

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

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

- DTCs P0111, P0112, P0113, P0114, P0117, P0118, P0128, P0502, P0503, P0601, P1621, or P2610 are not set.
- The vehicle has had a minimum ignition OFF time of 8 hours.
- The Ignition is ON.
- The start-up IAT is warmer than -7Â° C (+19Â° F).
- Fuel level is greater than 2.5%
- This DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 30Â° C (86Â° F) warmer than the IAT sensor for less than 1 s.

  OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 15Â° C (59Â° F) warmer than the IAT sensor, and NO engine block heater was detected for less than 1 s.

  OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 15Â° C (59Â° F) warmer than the IAT sensor, the engine cranked for greater than 10 s without starting and NO engine block heater was detected for less than 1 s.

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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 - Intake Air 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

Description and Operation

Cooling System Description and Operation

Electrical Information Reference

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

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify 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 -39Â° C (-38Â° F) or warmer than 149Â° C (300Â° F) or does not change**

     Refer to Circuit/System Testing.

   - **If warmer than -40Â° C (-40Â°F) and colder than 150Â° C (302Â° 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 Ω between the low reference terminal A 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.

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- 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 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal B 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)**

CAUTION: If the fuse in the jumper wire opens, the signal circuit may have a short to a voltage or a short to ground and the sensor might be damaged.

5. Install a 1 A fused jumper wire between the signal circuit terminal B and ground.
6. Verify the scan tool ECT sensor parameter is warmer than 149Â°C (300Â°F).
   - **If colder than the 149Â°C (300Â°F)**
   1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V
   3. Ignition OFF
   4. Test for less than 2 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 or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

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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 (ECT)** 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

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DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DTC P0119

Engine Coolant Temperature (ECT) Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118	P0118, P0119	P0118, P0119	P0119, P0128
Low Reference	-	P0118	P0118, P0119	-	P0116, P0128

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running at normal operating temperature **Parameter Normal Range:** 91 to 93Â°C (196 to 200Â°F)			
ECT Sensor	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
*ECM or sensor damage may occur if the circuit is shorted to B+.			

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

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- 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 IAT Sensor 1 is warmer than -7Â°C (19Â°F).
- This DTC runs continuously within the enabling conditions.

P0119

- DTC P0117 or P0118 is not 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 Sensor is warmer than 149Â°C (300Â°F) for greater than 5 s.

P0118

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

P0119

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

Action Taken When the DTC Sets

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- DTCs P0117, P0118 and P0119 are Type B DTCs
- The cooling fans will be commanded ON.
- The Engine Coolant Temperature Gauge is inoperative.
- The A/C compressor will be commanded OFF.

Conditions for Clearing the DTC

DTCs P0117, P0118 and P0119 are Type B DTCs

Diagnostic Aids

- 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 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

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
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 -39Â° C (-38Â° F) or warmer than 149Â° C (300Â° F) or does not change**

     Refer to Circuit/System Testing.

   - **If warmer than -40Â° C (-40Â°F) and colder than 150Â° C (302Â° 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 Ω between the low reference circuit terminal A or 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.

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- 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 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)**

CAUTION: If the fuse in the jumper wire opens, the signal circuit may have a short to a voltage or a short to ground and the sensor might be damaged.

5. Install a 1 A fused jumper wire between the signal circuit terminal B and ground.
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 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 or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

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

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2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance (ECT)** 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 SENSOR 1/THROTTLE POSITION SENSOR 2/SENSOR COMMUNICATION CIRCUIT/THROTTLE POSITION 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 Descriptors

DTC P0121

Throttle Position Sensor 1 Performance

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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*

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0122*, P0222*, P16A0	P0122*, P0222*, P16A1	P0123*, P0223*, P16A1**	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)

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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 and is used as voltages for throttle position sensor 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 500-6,800 RPM.
- The engine coolant temperature (ECT) is -7 to +126Â°C (19-259Â°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

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P0121

The ECM detects that the throttle position sensor 1 voltage is stuck in 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 4.7 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 4.6 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.

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- 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**

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. If you were sent here from DTC P0068, P0101, P0106, or P1101 refer to Circuit/System Testing.
3. Verify that DTC P0601-P0606, P06A3, and P16F3 is not set.
   - **If any of the DTCs are set**

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

   - **If none of the DTCs are set**
4. 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 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**
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.

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- **If Agree is not displayed**

  Replace the Q38 Throttle Body.

- **If Agree is displayed**

7. Verify DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, or P2135 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

   - **If none of the DTCs are set**
8. Determine the current vehicle testing altitude.
9. Verify the scan tool MAP Sensor pressure parameter is within range specified in the **Altitude Versus Barometric Pressure** table.
   - **If the pressure is not in range**

     Refer to **DTC P0106**.

   - **If the pressure is within range**
10. Engine idling.
11. 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 within the specified range or does not change**

      Refer to **DTC P0106**.

    - **If within the specified range and changes**
12. 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 parameter does not change smoothly and gradually**

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Refer to **DTC P0101**.

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

13. 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.
14. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

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

Circuit/System Testing

NOTE: Disconnecting the throttle body harness connector causes additional DTCs to set.

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at Q38 Throttle Body Assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 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.

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- 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. 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**

6. Test or replace the Q38 Throttle Body Assembly.

Repair Instructions

- Refer to **Throttle Body Assembly Replacement**

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- 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 Assembly.

   - **If Agree is displayed**
7. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not set.
   - **If DTC sets**

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

   - **If DTC does not set**
8. All OK

DTC P0128: 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

DTC P0128

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Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118, P0119	P0118*	P0116, P0128
Low Reference	-	P0118, P0119	-	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 **Parameter Normal Range:** Varies with coolant 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)	-

Circuit/System Description

The purpose of this diagnostic is to analyze the performance of the thermostat by using the 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

- DTC P0068, P0071, P0072, P0073, P0074, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0223, P0502, P0503, P1101, P1516, P2101, P2135 is not set.
- The start-up ECT is between -40Â° and 60Â°C (-40Â° and 140Â°F).
- The engine OFF time is greater than 30 m.
- The engine run time is between 75 s and 25 m.
- The vehicle has traveled greater than 1.2 km (.75 mi).

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- The fuel ethanol percentage is less than 87%.
- This 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 65Â°C (149Â°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 50Â°C (122Â°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 Engine Coolant Temperature Gauge defaults to cold.
- The A/C is commanded OFF and inoperative.
- The Cooling Fans are commanded ON.

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.
- Inspect the ECT sensor terminals and the ECT harness connector for corrosion. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.
- A slight to moderate resistance in the ECT sensor signal circuit or low reference circuit will affect this diagnostic. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

Reference Information

Schematic Reference

Engine Controls Schematics

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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. Verify the DTC P0116, P0117, P0118, or P0119 is not set.
   - **If a DTC is set**

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

   - **If a DTC is not set**
2. Verify the cooling system is filled to the correct coolant level. Refer to **Cooling System Draining and Filling (Vac N Fill L83 L86)** **Cooling System Draining and Filling (Static Fill L83 L86)** , and **Loss of Coolant (L86 L83)** .
   - **If the coolant level is not correct**

     Repair as necessary

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- **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 80Â°C (176Â°F).
   - **If less than 80Â°C (176Â°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 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)**

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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 -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 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 (ECT)** 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.

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- **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 repair.

- Refer to **Engine Coolant Temperature Sensor Replacement**
- Refer to **Engine Coolant Thermostat Housing Replacement (L83, L86)** , for engine coolant thermostat replacement.
- Refer to **Control Module References** for engine control module replacement, programming and setup.

DTC P0131, P0132, P0137, P0138, P0151, P0152, P0157, OR P0158: HO2S CIRCUIT LOW VOLTAGE/HO2S CIRCUIT 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 P0131

HO2S Circuit Low Voltage Bank 1 Sensor 1

DTC P0132

HO2S Circuit High Voltage Bank 1 Sensor 1

DTC P0137

HO2S Circuit Low Voltage Bank 1 Sensor 2

DTC P0138

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HO2S Circuit High Voltage Bank 1 Sensor 2

DTC P0151

HO2S Circuit Low Voltage Bank 2 Sensor 1

DTC P0152

HO2S Circuit High Voltage Bank 2 Sensor 1

DTC P0157

HO2S Circuit Low Voltage Bank 2 Sensor 2

DTC P0158

HO2S Circuit High Voltage Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157, P0174	P0132, P0138, P0152, P0158	P0132, P0137, P0138, P0152, P0158, P0300	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D, P2270, P2271, P2272, P2273
HO2S Low Signal	P0131, P0137, P0151, P0157, P0506	P0132, P0137, P0138, P0152, P0158, P0172, P0300, P0506	P0132, P0137, P0138, P0152, P0158	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D, P2270, P2271, P2272, P2273

Typical Scan Tool Data

HO2S Bank 1 or 2 Sensor 1 or 2

Circuit	Short to Ground	Open	Short to Voltage

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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, P0137, P0151, or P0157

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The ignition voltage is between 10-32 V.
- The fuel system is operating in Closed Loop.
- The fuel level is greater than 10%.
- Ethanol content is less than 87%.
- Decel fuel cut off is not active.
- The DTCs run continuously when the above conditions are met for 2 s.

P0132, P0138, P0152, or P0158

- DTCs P0030, P0031, P0032, 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,

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P0496, P1516, P2101, P2119, P2135, P2176 are not set.

- The ignition voltage is between 10-32 V.
- The oxygen sensor heater resistance has been learned.
- The fuel level is greater than 10%.
- Engine run time is greater than 5 s.
- The DTCs run continuously when the above conditions are met for 3 s.

Conditions for Setting the DTC

P0131, P0137, P0151, or P0157

- The engine control module detects that the heated oxygen sensor is shorted to ground if the HO2S voltage is less than 50 mV.
- The DTCs set within 6 s when the above condition is met.

P0132, P0138, P0152, or P0158

- The engine control module detects that the heated oxygen sensor has an open circuit or is shorted to voltage if the HO2S voltage is greater than 1,050 mV.
- The DTCs set within 13 s when the above condition is met.

Action Taken When the DTC Sets

DTCs P0131, P0132, P0137, P0138, P0151, P0152, P0157 and P0158 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0131, P0132, P0137, P0138, P0151, P0152, P0157 and P0158 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no HO2S heater DTCs are set.
   - **If a DTC is set.**

     Refer to **DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, or P0161**.

   - **If a DTC is not set.**
3. Engine running.
4. Verify the scan tool HO2S Bank 1 or 2 Sensor 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. 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.**

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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 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit and replace fuse.
        - 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 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 heated oxygen sensor Bank 1 or 2 Sensor 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**

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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 Bank 1 or 2 Sensor 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**
7. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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

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- Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- Refer to **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- Refer to **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing a Heated Oxygen Sensor.
- Refer to **Control Module References** for Engine Control Module replacement, programming and setup

DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D, OR P2270-P2273: HO2S SLOW RESPONSE/HO2S DELAYED RESPONSE/HO2S SIGNAL STUCK

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 Bank 1 Sensor 1

DTC P013A

HO2S Slow Response Rich to Lean Bank 1 Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Bank 1 Sensor 2

DTC P013C

HO2S Slow Response Rich to Lean Bank 2 Sensor 2

DTC P013D

HO2S Slow Response Lean to Rich Bank 2 Sensor 2

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DTC P013E

HO2S Delayed Response Rich to Lean Bank 1 Sensor 2

DTC P013F

HO2S Delayed Response Lean to Rich Bank 1 Sensor 2

DTC P014A

HO2S Delayed Response Rich to Lean Bank 2 Sensor 2

DTC P014B

HO2S Delayed Response Lean to Rich Bank 2 Sensor 2

DTC P0153

HO2S Slow Response Bank 2 Sensor 1

DTC P015A

HO2S Delayed Response Rich to Lean Bank 1 Sensor 1

DTC P015B

HO2S Delayed Response Lean to Rich Bank 1 Sensor 1

DTC P015C

HO2S Delayed Response Rich to Lean Bank 2 Sensor 1

DTC P015D

HO2S Delayed Response Lean to Rich Bank 2 Sensor 1

DTC P2270

HO2S Signal Stuck Lean Bank 1 Sensor 2

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DTC P2271

HO2S Signal Stuck Rich Bank 1 Sensor 2

DTC P2272

HO2S Signal Stuck Lean Bank 2 Sensor 2

DTC P2273

HO2S Signal Stuck Rich Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0138, P0152, P0158	P0132, P0138, P0152, P0158,	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D, P2270, P2271, P2272, P2273
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0138, P0152, P0158	P0132, P0138, P0152, P0158	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D, P2270, P2271, P2272, P2273

Typical Scan Tool Data

HO2S Bank 1 or 2 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

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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 or P0153

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0131, P0132, P0151, P0152, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0411, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0496, P0498, P0499, P1104, P1248, P1249, P124A-P124F, P1516, P16F3, P2100-P2103, P2119, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2176, P217B, P217C, P217E, P217F, P2440, P2444 are not set.
- The ignition voltage is between 10-32 V.
- The intake air temperature (IAT) is warmer than -40Â°C (-40Â°F)
- The engine coolant temperature (ECT) is greater than 50Â°C (122Â°F).
- The fuel level is greater than 10%.
- The engine run time is greater than 30 s.
- The engine speed is between 1,000-3,000 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 20-55 g/s.
- The fuel system is in Closed Loop.
- The fuel control state is not in power enrichment.
- Device controls not active.
- Fuel state is not in decel fuel cut-off mode.
- The DTCs run once per drive cycle when the above conditions are met for greater than 3.5 s.

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P013A P013C, P013E, or P014A

- Before the ECM can report DTC P013A, or P013C failed, DTCs P013E, P014A, P2270, and P2272 must run and pass.
- Before the ECM can report DTC P013E, or P014A failed, DTCs P2270 and P2272 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111-P0114, P0116-P0118, P0120, P0121, P0122, P0123, P0125, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300 - P0308, P0411, P0442, P0443, P0446, P0449, P0455, P0496, P0498, P0499, P1104, P1248, P1249, P124A - P124F, P1174, P1516, P16F3, P2100-P2103, P2119, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2176, P217B, P217C, P217E, P217F, P2270, P2271, P2440, P2444 are not set.
- The ignition voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- The engine run time is equal to or greater than 5 min.
- The accelerator pedal is steady.
- The DTCs run once per ignition cycle, during decel fuel cut-off (DFCO), when the above conditions are met.

P013B P013D, P013F, or P014B

- Before the ECM can report DTC P013B, or P013D failed, DTCs P013A, P013C, P013E, P013F, P014A, P014B, P2270, P2271, P2272, and P2273 must run and pass.
- Before the ECM can report DTC P013F, or P014B failed, DTCs P013A, P013C, P013E, P014A, P2270, P2271, P2272, and P2273 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The ignition voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- The engine run time is equal to or greater than 5 min.
- The DTCs run once per ignition cycle when the above conditions are met.

P015A, P015B, P015C or P015D

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- 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 intake air temperature (IAT) is warmer than -40Â°C (-40Â°F)
- The engine coolant temperature (ECT) is warmer than 50Â°C (122Â°F).
- The fuel level is greater than 10%.
- The engine run time is greater than 30 s.
- The engine speed is between 1,000-2,500 RPM.
- The vehicle speed is between 63-119 km/h (39-74 mph).
- The mass airflow (MAF) is between 4-20 g/s.
- The fuel system is in Closed Loop.
- Evap is not in control of purge.
- Device controls are not active.
- Oxygen sensor heater on for greater than 60 s.
- Calculated catalyst temperature is between 600-900Â°C (1,122-1,652Â°F).
- When all of the above conditions are met for 1 s, the fuel mixture is forced rich and the HO2S Bank 1 or 2 Sensor 1 is greater than 690 mV, then decel fuel cut-off (DFCO) is entered.
- The DTCs run once per drive cycle when the above conditions are met.

P2270 or P2272

- 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 ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine speed is between 1,000-2,500 RPM.
- The vehicle speed is between 63-119 km/h (39-74 mph).
- The engine airflow is between 4-20 g/s.
- The fuel state is in Closed Loop.

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- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The heated oxygen sensor heaters are ON for greater than 60 s.
- The predicted catalytic converter temperature is between 600-900Â°C (1,112-1,652Â°F).
- This DTC runs once per trip when all of the above conditions have been met for 1 s.

P2271 or P2273

- 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 ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine speed is between 1,000-2,500 RPM.
- The vehicle speed is between 63-119 km/h (39-74 mph).
- The engine airflow is between 4-20 g/s.
- 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 for greater than 60 s.
- The predicted catalytic converter temperature is between 600-900Â°C (1,112-1,652Â°F).
- DTCs P013A, P013C, P013E, P014A, P2270, and P2272 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.

Conditions for Setting the DTC

P0133, P0153, P015A, P015B, P015C or P015D

- The ECM detects that the HO2S 1 rich-to-lean or lean-to-rich average response time is greater than a calibrated value.

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

P013A or P013C

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

P013B or P013D

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

P013E or P014A

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

P013F or P014B

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

P2270 or P2272

The ECM does not detect a HO2S voltage greater than 800 mV before accumulated mass air flow exceeds a calibrated value.

P2271 or P2273

The ECM does not detect an HO2S voltage less than 100 mV before accumulated mass air flow exceeds a calibrated value.

Action Taken When the DTC Sets

- DTCs P0133, P013E, P013F, P014A, P014B, P0153, P2270, P2271, P2272, and P2273 are Type B DTCs.
- DTCs P013A, P013B, P013C, P013D, P015A, P015B, P015C, and P015D are Type A DTCs.

Conditions for Clearing the DTC

- DTCs P0133, P013E, P013F, P014A, P014B, P0153, P2270, P2271, P2272, and P2273 are Type B DTCs.
- DTCs P013A, P013B, P013C, P013D, P015A, P015B, P015C, and P015D are Type A DTCs.

Diagnostic Aids

When DTCs P013E, P014A, P015A, and P015C are all set at the same time, fuel saturation of the EVAP system is a possible cause.

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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 **DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, or P0161**.

   - **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

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- Low or high fuel system pressure - Refer to **Fuel System Diagnosis** .
- Fuel that is contaminated - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
- Fuel saturation of the evaporative emission (EVAP) canister
- Exhaust leaks - Refer to **Exhaust Leakage** .
- Engine vacuum leaks
- Engine oil consumption - Refer to **Oil Consumption Diagnosis** .
- Engine coolant consumption - Refer to **Loss of Coolant (L86 L83)** .
- **If any of the conditions exist**

  Repair as necessary.

- **If none of the conditions exist**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Test or replace the appropriate B52 Heated Oxygen Sensor.

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

Repair Instructions

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

- Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- Refer to **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- Refer to **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing a Heated Oxygen Sensor.
- Refer to **Control Module References** for Engine Control Module replacement, programming and setup

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DTC P0171, P0172, P0174, OR P0175: FUEL TRIM SYSTEM LEAN/FUEL TRIM SYSTEM 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 Bank 1

DTC P0172

Fuel Trim System Rich Bank 1

DTC P0174

Fuel Trim System Lean Bank 2

DTC P0175

Fuel Trim System Rich Bank 2

Circuit/System Description

The engine control module (ECM) controls 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, P0050, P0053, P0059, P0101, P0102, P0103, P0106, P0107, P0108, P0131-P0135, P0151-P0155, P015A, P015B, P015C,

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P015D, P0178, P0179, P0201-P0208, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0442, P0455, P0458, P0496, P0506, P0507, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2227, P2228, P2229, P2230, or P2269 are not set.

- The engine is in Closed Loop status.
- The catalyst monitor diagnostic intrusive test, post HO2S diagnostic intrusive test, device control, and EVAP leak test are not active.
- The engine coolant temperature is between -40 and +150Â°C (-40 and +302Â°F).
- The intake air temperature is between -20 and +150Â°C (-4 and +302Â°F).
- The manifold absolute pressure is between 10-255 kPa (1.5-37 psi).
- The engine speed is between 375-7,000 RPM.
- The mass air flow is between 1-510 g/s.
- The barometric pressure 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, P0172, P0174, and P0175 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0171, P0172, P0174, and P0175 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.

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- 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.
- Inspect the air filter for being the correct one for this application. Make sure 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

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

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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, P0172, P0174, or P0175 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, P0172, P0174, or P0175 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 MAP sensor pressure parameter 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.

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4. Verify the Long Term Fuel Trim Bank 1 or 2 parameter is between -25.5% and +34.5%.
   - **If greater than +34.5%:**
   1. Ignition OFF.
   2. Inspect for the conditions listed below:
      - Mass air flow 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**.
      - Contamination of the mass air flow sensor with oil or other foreign material.
      - 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** .
      - Vacuum hoses for splits, kinks, and improper connections.
      - Insufficient fuel in the tank.
      - Partial blockage of the air filter element or other conditions that alter air flow to the mass air flow sensor.
      - 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.
      - The crankcase ventilation system for leaks - 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 -25.5%**
   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**.
      - Contamination of the mass air flow sensor with oil or other foreign material.
      - Fuel contamination - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .

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- 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 -25.5% and +34.5%**

5. 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 P0178 OR P0179: FUEL COMPOSITION 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 Descriptor

DTC P0178

Fuel Composition Sensor Circuit Low Frequency

DTC P0179

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Fuel Composition Sensor Circuit High Frequency

Circuit/System Description

Alcohol content information is supplied to the engine control module (ECM) from the fuel composition sensor. The fuel composition sensor has an ignition positive circuit, a signal circuit, and a ground circuit. The fuel composition sensor uses a microprocessor inside the sensor to measure the ethanol percentage and changes the output signal accordingly. The signal circuit carries the ethanol percentage via the frequency signal. The ECM provides an internal pull up to 5 V on the signal circuit, and the fuel composition sensor pulls the 5 V to ground in pulses. The normal range of operating frequency is between 50-150 Hz. The microprocessor inside the sensor is capable of a certain amount of self-diagnosis. An output frequency between 180 Hz and 190 Hz indicates that the fuel is contaminated.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

P0178

The engine control module detects that the fuel composition sensor output frequency is less than 45 Hz for greater than 6 s.

P0179

The engine control module detects that the fuel composition sensor output frequency is between 155-185 Hz for greater than 6 s.

Action Taken When the DTC Sets

DTC P0178 and P0179 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTC P0178 and P0179 are Type B DTCs.

Diagnostic Aids

- The fuel composition sensor scan tool parameter reacts immediately to any change in the fuel composition sensor circuits, but may not react long enough to set a DTC.
- An intermittent condition may not be detected because the sensor does not immediately power down and the connection may be restored before

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voltage drops below the operating threshold.

- If this DTC will not reset and the parameters are steady, thoroughly inspect all fuel composition sensor circuits for an intermittent open.
- A momentary slug of water in the fuel system may set DTC P0179.

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

Special Tools

- **J 38522-A** Variable Signal Generator
- **J 44175-A** Fuel Composition Tester

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For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service Tools)** .

Circuit/System Verification

1. Engine running,
2. Verify the scan tool Fuel Composition Sensor parameter is between 50-150 Hz.
    - **If not between 50-150 Hz**

      Refer to Circuit/System Testing.

    - **If between 50-150 Hz**
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. Verify that there are no contaminants, water, or too high of a concentration of ethanol in the fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** and the **J44175-A** Instruction Manual.
2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B198 Fuel Composition Sensor. It may take up to 2 min for all vehicle systems to power down.
3. Test for less than 5 Ω between the ground circuit terminal 2 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**

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4. Ignition ON.
5. Verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is OK**
    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 OK 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 in the circuit.
        - If infinite resistance, replace the B198 Fuel Composition Sensor.
    - **If the test lamp illuminates**
6. Remove the test lamp, ignition ON.
7. 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 X1 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 in 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 X1 harness connector at the K20 Engine Control Module.
    2. Ignition ON.
    3. 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.

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- **If between 4.8-5.2 V**

8. Ignition OFF, connect the **J 38522-A** Variable Signal Generator as instructed below:
    1. Connect the red lead to the signal circuit terminal 3 at the B198 Fuel Composition Sensor harness connector.
    2. Connect the battery voltage supply lead to B+.
    3. Connect the black lead to ground.
    4. Set the signal to 5 V.
    5. Set the frequency to 60 Hz.
    6. Set the Duty Cycle to Normal.
    7. Ignition ON.
9. Verify the scan tool Fuel Composition Sensor parameter is at 60 Hz.
    - **If not at 60 Hz**

      Replace the K20 Engine Control Module.

    - **If at 60 Hz**
10. Test or replace the B198 Fuel Composition Sensor.

Component Testing

1. Test the fuel composition using the **J 44175-A** Fuel Composition Tester and the J 44175-A Instruction Manual. Record the frequency.
2. Compare the special tool test frequency and the scan tool Fuel Composition Sensor frequency parameter.
3. Verify the difference between the tool and the sensor is 12 Hz or less.
    - **If greater then 12 Hz**

      Replace the B198 Fuel Composition Sensor.

    - **If 12 Hz or less**
4. All OK.

Repair Instructions

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

- Refer to **Flexible Fuel Sensor Replacement** for B198 Fuel Composition Sensor replacement

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- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P018B-P018D: FUEL 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 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, P0192, P0532, P0641, P2228	P018C	P018D, P0193, P0523, P0641, P2227	P018B
Signal	P018C	P018C	P018D	P018B
Low Reference	-	P018D	P018D	P018B

Circuit/System Description

The fuel pressure sensor is located on the chassis fuel pipe. The fuel pressure sensor provides a fuel pressure signal to the ECM, which is used to provide Closed Loop fuel pressure control.

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Conditions for Running the DTC

DTC P018B

- DTCs P018C, P018D, P0231, P0232, P023F, P0641, P1255, P129D, or P12A6 are not set.
- Engine is running
- Fuel pressure is greater than 0 psi
- The DTC runs continuously when the condition above is met.

DTC P018C or P018D

- The engine is cranking or running.
- The DTCs run continuously when the condition above is met.

Conditions for Setting the DTC

P018B

The engine 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 detects a fuel pressure sensor output that is stuck within the normal operating range of the sensor.

P018C

The engine control module detects that the fuel pressure sensor voltage is less than 0.14 V for 1 s.

P018D

The engine control module detects that the fuel pressure sensor voltage is greater than 4.86 V for 1 s.

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

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- 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.
- Inspect the fuel system for damage, kinks, or restrictions.

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. Ignition ON.
2. Verify DTC U18A2 is not set or stored in history.

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- **If DTC U18A2 is set or stored in history**

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

- **If DTC U18A2 is not set or stored in history**

3. Engine running.
4. Verify the scan tool Fuel Pressure Sensor 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**
5. Verify the scan tool Fuel Pressure Sensor parameter increases or decreases when commanding an increase and decrease in Fuel Pressure with a scan tool.
   - **If the pressure does not change**

     Refer to Circuit/System Testing.

   - **If the pressure changes**
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 B47 Fuel Pressure 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**

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1. Ignition OFF, disconnect the X1 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 X1 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 X1 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 Pressure Sensor parameter is less than 1 V.

- **If 1 V or greater**

1. Ignition OFF, disconnect the X1 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 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 s.

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7. Verify the scan tool Fuel Pressure Sensor parameter is 4.8 V or greater.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X1 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 4.8 V or greater**
8. Test or replace the B47 Fuel Pressure Sensor.

Repair Instructions

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

- Refer to **Fuel Pressure Sensor Replacement (Fuel Pipe)**
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P0191: FUEL RAIL PRESSURE 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 Descriptors

DTC P0191

Fuel Rail Pressure Sensor Performance

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0192, P0193, P0340, P0345, P0365, P0390, P0506, P0641, P2227	P0192	P0193, P0641, P2227, P2229	P0191
Fuel Rail Pressure Sensor Signal 1	P0192	P0192, P0193	P0193	P0191
Fuel Rail Pressure Sensor Signal 2	P127C	P127C, P127D	P127D	P0191
Low Reference	-	P0193	P0193	P0191

Circuit/System Description

The fuel rail pressure sensor is a dual analog sensor that provides two fuel rail pressure signals to the engine control module (ECM). The ECM provides a 5 V reference voltage on the 5 V reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on both the fuel rail pressure sensor 1 and fuel rail pressure sensor 2 signal circuits. The ECM monitors the voltage on both of the fuel rail pressure sensor circuits and compares the values to determine if the sensors are accurate. If fuel rail pressure sensor 1 and fuel rail pressure sensor 2 voltage signals do not closely match DTC P0191 may set.

Conditions for Running the DTC

- DTCs P0192, P0193, P127C, and P127D are not set.
- Engine is running.
- Commanded fuel pressure rate of change is greater than 0.70 MPa (101 PSI) for greater than 1.25 s.
- Desired fuel pressure is greater than 0 PSI.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

NOTE: Both Condition 1 and Condition 2 must be present to set DTC P0191.

Condition 1

The engine control module detects fuel rail pressure sensor 1 value is 1 MPa (145 PSI) greater than or less than fuel rail pressure Sensor 2 value for greater than 1.5 s.

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Condition 2

The engine control module detects the square root of (fuel rail pressure sensor 1 value divided by fuel rail pressure sensor 2 value) is greater than 1.22 or less than 0.86 for greater than 1.5 s.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

DTC P0191 is a Type A DTC.

Reference Information

Schematic Reference

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

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the scan tool Fuel Rail Pressure Sensor 1 and Fuel Rail Pressure Sensor 2 parameters display less than 1 MPa (145 PSI) difference.
   - **If 1 MPa (145 PSI) or greater**

     Refer to Circuit/System Testing.

   - **If less than 1 MPa (145 PSI)**
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 B47B Fuel Rail Pressure 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 3 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**

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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 X2 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 in 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 X2 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 2 parameter is less than 0.25 V.
    - **If 0.25 V or greater**
    1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit terminal 2 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 0.25 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the 5 V reference circuit terminal 1.
7. Verify the scan tool Fuel Rail Pressure Sensor 2 parameter is greater than 4.75 V.
    - **If 4.75 V or less**
    1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 2 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.

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- 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 4.75 V**

8. Verify the scan tool Fuel Rail Pressure Sensor 1 parameter is less than 0.25 V.
    - **If 0.25 V or greater**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit 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 0.25 V**
9. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 1.
10. Verify the scan tool Fuel Rail Pressure Sensor 1 parameter is greater than 4.75 V.
    - **If 4.75 V or less**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 2 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 4.75 V**
11. Test or replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

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

- Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement** for B47B Fuel Rail Pressure Sensor replacement

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- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P0192 OR P0193: FUEL RAIL PRESSURE SENSOR CIRCUIT 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 P0192

Fuel Rail Pressure Sensor Circuit Low Voltage

DTC P0193

Fuel Rail Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0192, P0193, P0340, P0345, P0365, P0390, P0506, P0641, P2227	P0192, P127C	P0193, P0641, P2227, P2229	P0191
Fuel Rail Pressure Sensor Signal 1	P0192	P0192, P0193	P0193	P0191
Fuel Rail Pressure Sensor Signal 2	P127C	P127C, P127D	P127D	P0191
Low Reference	-	P0193, P127C	P0193	P0191

Circuit/System Description

The fuel rail pressure sensor is a dual analog sensor that provides two fuel rail pressure signals to the engine control module (ECM). The ECM provides a 5 V reference voltage on the 5 V reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on

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both the fuel rail pressure sensor 1 and fuel rail pressure sensor 2 signal circuits. The ECM monitors the voltage on both of the fuel rail pressure sensor circuits and compares the values to determine if the sensors are accurate.

Conditions for Running the DTC

- Engine is running.
- Ignition voltage is greater than 11 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0192

The engine control module detects that the fuel rail pressure sensor 1 signal voltage is less than 0.25 V for greater than 2.5 s.

P0193

The Engine Control Module detects that the fuel rail pressure sensor 1 signal voltage is greater than 4.75 V for greater than 2.5 s.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

DTCs P0192 and P0193 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the scan tool Fuel Rail Pressure Sensor parameter is between 0.25-4.75 V.
   - **If not between 0.25-4.75 V**

     Refer to Circuit/System Testing.

   - **If between 0.25-4.75 V**
3. Verify the scan tool Fuel Rail Pressure Sensor parameter increases or decreases when commanding an increase and decrease in Fuel Pressure with a scan tool.
   - **If the pressure does not increase or decrease with each command**

     Refer to Circuit/System Testing.

   - **If the pressure increases or decreases with each command**
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.

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- **If the DTC sets**

  Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at the B47B Fuel Rail Pressure 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 3 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. 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 X2 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 in 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 X2 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.

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- 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 parameter is less than 0.25 V.
   - **If 0.25 V or greater**
   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 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 0.25 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 1.
7. Verify the scan tool Fuel Rail Pressure Sensor parameter is greater than 4.75 V.
   - **If 4.75 V or less**
   1. Ignition OFF, disconnect the X2 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 4.75 V**
8. Test or replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

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

- Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement** for B47B Fuel Rail Pressure Sensor replacement
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P0201-P0208, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, OR P0283:

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CYLINDER INJECTOR CONTROL CIRCUITS (1-8)

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 P0205

Cylinder 5 Injector Control Circuit

DTC P0206

Cylinder 6 Injector Control Circuit

DTC P0207

Cylinder 7 Injector Control Circuit

DTC P0208

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Cylinder 8 Injector Control Circuit

DTC P0261

Cylinder 1 Injector Control Circuit Low Voltage

DTC P0262

Cylinder 1 Injector Control Circuit High Voltage

DTC P0264

Cylinder 2 Injector Control Circuit Low Voltage

DTC P0265

Cylinder 2 Injector Control Circuit High Voltage

DTC P0267

Cylinder 3 Injector Control Circuit Low Voltage

DTC P0268

Cylinder 3 Injector Control Circuit High Voltage

DTC P0270

Cylinder 4 Injector Control Circuit Low Voltage

DTC P0271

Cylinder 4 Injector Control Circuit High Voltage

DTC P0273

Cylinder 5 Injector Control Circuit Low Voltage

DTC P0274

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Cylinder 5 Injector Control Circuit High Voltage

DTC P0276

Cylinder 6 Injector Control Circuit Low Voltage

DTC P0277

Cylinder 6 Injector Control Circuit High Voltage

DTC P0279

Cylinder 7 Injector Control Circuit Low Voltage

DTC P0280

Cylinder 7 Injector Control Circuit High Voltage

DTC P0282

Cylinder 8 Injector Control Circuit Low Voltage

DTC P0283

Cylinder 8 Injector Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Control Cylinder 1	P0261	P0201	P0262	P1248
High Control Cylinder 1	P2147	P0201	P2148	P1248
Low Control Cylinder 2	P0264	P0202	P0265	P1249
High Control Cylinder 2	P2150	P0202	P2151	P1249
Low Control Cylinder 3	P0267	P0203	P0268	P124A
High Control Cylinder 3	P2153	P0203	P2154	P124A
Low Control Cylinder 4	P0270	P0204	P0271	P124B

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Control Cylinder 4	P2156	P0204	P2157	P124B
Low Control Cylinder 5	P0273	P0205	P0274	P124C
High Control Cylinder 5	P216B	P0205	P216C	P124C
Low Control Cylinder 6	P0276	P0206	P0277	P124D
High Control Cylinder 6	P216E	P0206	P216F	P124D
Low Control Cylinder 7	P0279	P0207	P0280	P124E
High Control Cylinder 7	P217B	P0207	P217C	P124E
Low Control Cylinder 8	P0282	P0208	P0283	P124F
High Control Cylinder 8	P217E	P0208	P217F	P124F
DTC P0300 may also be present for all fault conditions				

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
- Engine is running.
- Ignition voltage is greater than 11 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P0201, P0202, P0203, P0204, P0205, P0206, P0207, or P0208

The engine control module detects the fuel injector control circuit is open for greater than 2 s.

DTC P0261, P0264, P0267, P0270, P0273, P0276, P0279, or P0282

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

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DTC P0262, P0265, P0268, P0271, P0274, P0277, P0280, or P0283

The engine control module 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, P0205, P0206, P0207, P0208, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282 and P0283 are Type A DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282 and P0283 are Type A DTCs.

Diagnostic Aids

- The MIL indicator flashes when there is an engine misfire.
- High resistance in the circuits of the fuel injectors may set a misfire DTC without setting a fuel injector DTC. Test the fuel injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- 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

Description and Operation

Fuel System Description

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P062B is not set.
   - **If the DTC is set**

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

   - **If the DTC is not set**

NOTE: **The engine must be running for the injector circuit status parameters to function.**

3. Engine idling.
4. Verify with a scan tool 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
   - Cylinder 5 Injector Control Circuit Status
   - Cylinder 6 Injector Control Circuit Status

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- Cylinder 7 Injector Control Circuit Status
- Cylinder 8 Injector Control Circuit Status
- **If OK or Not Run is not displayed**

  Refer to Circuit/System Testing.

- **If OK or Not Run 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 set**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the X3 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 high 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 high 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 low control circuit and ground.
      - If less than infinite, repair the short to ground in the circuit.
      - If infinite, test or replace the Q17 Fuel Injector.
   - **If infinite resistance**
3. Ignition ON.

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4. Test for less than 1 V between the Q17 Fuel Injector high 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 high 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 low control circuit.
    - **If less than 1 V**
5. Ignition OFF.
6. Test for less than 10 Ω between the Q17 fuel injector high control circuit and low control circuit.
    - **If 10 Ω or greater**
    1. Disconnect the harness connector of the Q17 Fuel Injector.
    2. Test for less than 2 Ω on 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
    3. Test for less than 2 Ω on 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, test or replace the Q17 Fuel Injector.
    - **If less than 10 Ω**
7. Test or replace the K20 Engine Control Module.

Component Testing

NOTE: **The engine coolant temperature (ECT) sensor must be between 10-32Â°C (50-90Â°F) for an accurate measurement.**

1. Ignition OFF, disconnect the harness connector at the appropriate Q17 Fuel Injector.
2. Test for 1.06 Ω +/- 10% @ 20Â°C (68Â°F) between the terminals of the Q17 Fuel Injector.
    - **If not within the specified range**

      Replace the Q17 Fuel Injector.

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- **If within the specified range**

3. Test for infinite resistance between each terminal and the Q17 Fuel Injector housing/case.
    - **If less than infinite resistance**

      Replace the Q17 Fuel Injector.

    - **If infinite resistance**

4. All OK.

Repair Instructions

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

- Refer to **Fuel Injector Replacement**
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P0231, P0232, OR P023F: FUEL PUMP 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 P0231

Fuel Pump Control Circuit Low Voltage

DTC P0232

Fuel Pump Control Circuit High Voltage

DTC P023F

Fuel Pump Control Circuit

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0171, P0232, P023F	P0171, P0232, P023F	P0171, P0232, P023F	P023F, P2635
Low Reference	-	P0232, P023F, P0506	P0232, P023F, P0506	P023F, P2635

Circuit/System Description

The engine control module (ECM) supplies voltage to the fuel pump driver control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump driver control module remains active for 2 s, unless the engine is in crank or run. While this voltage is being received, the fuel pump driver control module supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line pressure. The fuel pump driver control module monitors the fuel pump voltage to determine if the fuel pump is functioning as commanded.

Conditions for Running the DTC

P0231

- The ignition voltage is greater than 11 V.
- The engine is cranking or running.
- The fuel pump enable circuit is commanded ON.
- The fuel pump power module output current is less than 75 A.
- The DTC runs continuously when the conditions above are met.

P0232

- The ignition voltage is greater than 7 V.
- The fuel pump enable circuit is commanded ON.
- The DTC runs continuously when the conditions above are met.

P023F

- The ignition voltage is greater than 7 V.
- The commanded duty cycle is between 30-60%.

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

Conditions for Setting the DTC

P0231

The fuel pump driver control module detects that the fuel pump current is greater than 14.48 A for 1 s.

P0232

The fuel pump driver control module detects that the fuel pump output circuit voltage is greater than 4.0 V for 1 s when the voltage should be 0 V.

P023F

The fuel pump driver control module detects that the fuel pump current is less than 1 A and the fuel pump duty cycle is approximately 30-60% for 1 s.

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.
- The fuel pump control module contains an internal protection diode on the fuel pump low reference circuit. The proper DMM must be used when testing the low reference circuit.

Reference Information

Schematic Reference

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Engine Controls Schematics

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the fuel pump turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
   - **If the fuel pump does not turn ON and OFF**

     Refer to Circuit/System Testing.

   - **If the fuel pump turns ON and OFF**
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.

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- **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 G12 Fuel Pump. Connect a test lamp between battery positive voltage and the G12 Fuel Pump harness connector terminal 2. It may take up to 2 min for all vehicle systems to power down.
2. Verify the test lamp illuminates.
   - **If the test lamp does not illuminate**
   1. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Driver 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, refer to Component Testing in this diagnostic.
   - **If the test lamp illuminates**
3. Ignition ON, connect a test lamp between the supply voltage circuit terminal 1 and the low reference circuit terminal 2.
4. Verify the test lamp turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
   2. Test for infinite resistance between the supply voltage 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 supply voltage circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, test or replace the K111 Fuel Pump Driver Control Module.
   - **If the test lamp is always ON**
   1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K111 Fuel Pump Driver Control Module, ignition ON.
   2. Test for less than 1 V between the supply voltage circuit and ground.

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- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, test or replace the K111 Fuel Pump Driver Control Module.

- **If the test lamp turns ON and OFF**

5. Test or replace the G12 Fuel Pump.

Component Testing

1. Ignition OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module.
2. Connect a DMM, set on diode setting, with the positive lead at terminal 16 and the negative lead at terminal 9 of the K111 Fuel Pump Driver Control Module.
3. Verify the DMM displays between 0.4-0.8 V.
   - **If not between 0.4-0.8 V**

     Replace the K111 Fuel Pump Driver Control Module.

   - **If between 0.4-0.8 V**
4. Connect a DMM, set on diode setting, with the positive lead at terminal 9 and the negative lead at terminal 16 of the K111 Fuel Pump Driver Control Module.
5. Verify the DMM displays OL.
   - **If not OL**

     Replace the K111 Fuel Pump Driver Control Module.

   - **If OL**
6. All OK.

Repair Instructions

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

- Refer to **Fuel Tank Fuel Pump Module Replacement (SWB)** **Fuel Tank Fuel Pump Module Replacement (LWB)** for G12 Fuel Pump replacement
- Refer to **Fuel Pump Power Control Module Replacement** for K111 Fuel Pump Driver Control Module replacement

DTC P0300-P0308: ENGINE MISFIRE DETECTED/CYLINDER MISFIRES DETECTED (1-8)

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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

DTC P0305

Cylinder 5 Misfire Detected

DTC P0306

Cylinder 6 Misfire Detected

DTC P0307

Cylinder 7 Misfire Detected

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DTC P0308

Cylinder 8 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 P0308 correspond to cylinders 1 through 8. 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, P0018, P0019, P0020, P0021, P0023, P0024, P0068, P0090, P0091, P0093, P00CA, 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, P0345, P0346, P0365, P0366, P0390, P0391, P0443, P0449, P0452, P0453, P0454, P0601, P0604, P0606, P0651, P0697, P2088, P2089, P2090, P2091, P2135, P2771, P3401, P3403, P3404, P3409, P3411, P3412, or P3417 is not set.
- DTC P0806, P0807, or P0808 is not set when equipped with manual transmission.
- The engine speed is less than 1,000 RPM and DTC P0315 is set.
- The engine speed is greater than 1,500 RPM.
- The crankshaft position and camshaft position sensors are synchronized.
- The engine coolant temperature (ECT) is between -7 and 130Â°C (19-266Â°F).
- If the ECT is colder than -7Â°C (19Â°F) at start-up, this diagnostic will not run until the ECT is between 21-130Â° (70-266Â°F).
- The battery voltage is between 9-32 V.
- The vehicle is not in a acceleration or deceleration condition.
- The ECM is not detecting a rough road signal.
- The fuel level is at least 11%.

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- 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, P0304, P0305, P0306, P0307, or P0308

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-P0308 are Type B DTCs.
- When a catalyst damaging level of misfire is present, the ECM may disable the fuel injectors for up to 2 misfiring cylinders and will flash the malfunction indicator lamp (MIL).

Conditions for Clearing the DTC

DTCs P0300-P0308 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
- Observe misfire counters after Active Fuel Management is commanded Off for a sticking lifter.

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- 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 HEI Spark Tester

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service 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.**

1. Engine Running at normal operating temperature.
2. Verify there is no abnormal engine noise.
    - **If abnormal engine noise is present**

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Refer to **Symptoms - Engine Mechanical** .

- **If abnormal engine noise is not present**

3. Perform the scan tool **Crankshaft Position Variation Learn** procedure.
4. Verify no DTCs are set.
   - **If any DTCs other than P0300-P0308 are set**

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

   - **If DTC P0300-P0308 is set**

     Refer to Circuit/System Testing.

   - **If no DTCs are set**
5. Verify the scan tool Cylinder 1-8 Current Misfire Counter parameters do not increment.
   - **If increments**

     Refer to Circuit/System Testing.

   - **If does not increment**
6. Engine Running, perform the Cylinder Power Balance Test with a scan tool.
7. 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**
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**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**

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10. 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.
3. Ignition OFF, connect the **EL 26792** HEI Spark Tester to the appropriate spark plug wire, engine Cranking.
4. Verify the spark output.
    - **If no output or the output is weak**

      Refer to **Electronic Ignition System Diagnosis** .

    - **If the output is good**
5. Ignition OFF.
6. 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

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- **If a condition exists**

  Repair or replace as necessary.

- **If no conditions exist**

7. Exchange the suspect spark plug with another cylinder that is operating correctly.
8. Engine Running.
9. Verify the scan tool Cylinder 1-8 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**
10. Test or inspect for the conditions listed below:
    - A lean or rich Q17 Fuel Injector - Refer to **Fuel Injector Balance Test** .
    - An engine mechanical condition - Refer to **Symptoms - Engine Mechanical** .

Repair Instructions

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 1-8 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 or DTC P0430. Refer to **DTC P0420 or P0430** .

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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

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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

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

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

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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 SENSOR PERFORMANCE/CONTROL MODULE KNOCK SENSOR PROCESSOR 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 P0324

Knock Sensor System Performance

DTC P0326

Knock Sensor Performance Bank 1

DTC P0331

Knock Sensor Performance Bank 2

DTC P06B6

Control Module Knock Sensor Processor 1 Performance

DTC P06B7

Control Module Knock Sensor Processor 2 Performance

Diagnostic Fault Information

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

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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 200-2000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.
- The intake air temperature (IAT) sensor 1 is -40Â°C (-40Â°F) or warmer.

AND

- Engine speed is 400 RPM or greater for 80 or more cumulative revolutions.

OR

- Engine speed is 8,500 RPM or greater for 100 or more cumulative revolutions.

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OR

- Engine speed is 8,500 RPM or greater for 20 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 200-2000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.
- The intake air temperature (IAT) sensor 1 is -40Â°C (-40Â°F) or warmer.

AND

- Engine speed is 400 RPM or greater for 167 or more cumulative revolutions.

OR

- Engine speed is 8,500 RPM or greater for 100 or more cumulative revolutions.

OR

- Engine speed is 8,500 RPM or greater for 5 or more cumulative revolutions.

P06B6 and P06B7

- Engine is running for 2 s or greater.
- Engine speed is between 400-4,000 RPM for 200 or more cumulative revolutions.
- Engine air flow is between 10-2000 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

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basis.

P0326

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

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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 DTCs sets**

      Test or replace the appropriate B68 Knock Sensor.

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

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Repair Instructions

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

- Refer to **Knock Sensor 1 Replacement**
- Refer to **Knock Sensor 2 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 Circuit

DTC P0327

Knock Sensor Circuit Low Voltage

DTC P0328

Knock Sensor Circuit High Voltage

DTC P0330

Knock Sensor 2 Circuit

DTC P0332

Knock Sensor 2 Circuit Low Voltage

DTC P0333

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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 400-5,500 RPM for 100 or more cumulative revolutions.
- Engine air flow is between 10-2000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.
- The intake air temperature (IAT) sensor 1 is -40Â°C (-40Â°F) or warmer.

P0327, P0328, P0332, and P0333

Engine speed is less than 8,500 RPM.

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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:

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- 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

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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

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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 as 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
   - Cylinder 5 Knock Detected
   - Cylinder 6 Knock Detected
   - Cylinder 7 Knock Detected
   - Cylinder 8 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.

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- **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 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 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 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 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.

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- **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 1 Replacement**
- Refer to **Knock Sensor 2 Replacement**
- Refer to **Control Module References** for engine control module replacement, programming, and setup.

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ENGINE PERFORMANCE

Engine Controls and Fuel - 5.3L (L83) or 6.2L (L86) - Diagnostic Information and Procedures - Escalade, Suburban, Tahoe, Yukon

DIAGNOSTIC INFORMATION AND PROCEDURES

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
5 V Reference	P057C, P0651	P0335	P0651	P0336
Signal	P0335	P0335	P0335	P0336
Low Reference	-	P0335	-	P0336

Circuit/System Description

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects

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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.
- The starter is not engaged.

Condition 3

- DTCs P0340 and P0341 are not set.
- The engine is running or the starter is engaged.

P0336 Condition 1

- DTCs P0335 is not set.
- The airflow into the engine is greater than 3 g/s.

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- Engine speed is greater than 450 RPM.

Condition 2

- The engine is running.
- The starter is not engaged.

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

- DTCs P0340 and P0341 are not set.
- The engine is running or the starter is engaged.

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 0.3 s.

Condition 3

The ECM does not detect a crankshaft position sensor pulse for 2 out of 10 engine revolutions.

P0336 Condition 1

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The ECM detects that 10 or more crankshaft resynchronizations 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

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Electronic Ignition System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0651 is not set.
   - **If the DTC is set**

     Refer to **DTC P0641, P0651, P0697, or P06A3**.

   - **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**

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6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B26 Crankshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 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 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 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.

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- **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 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 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 1, 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.

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- **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

DTC P0340 OR P0341: 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

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DTC P0340

Camshaft Position Sensor Circuit

DTC P0341

Camshaft Position Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0192, P0340, P0452, P0522, P0532, P0641, P127C, P2227, P2228	P0340	P018D, P0193, P0453, P0523, P0533, P0641, P127D, P2227	-
Signal	P0016, P0340	P0340	P0340, P0341	P0341
Low Reference	-	P0340	-	-

Circuit/System Description

The camshaft position sensor has 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 camshaft position sensor to determine injector and ignition system synchronization. The ECM 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 Condition 1

- DTCs P0101, P0102, and P0103 are not set.

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- 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

- The engine is running.
- The starter is not engaged.

Condition 3

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

Condition 4

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

P0341 Condition 1

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

Condition 2

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

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

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P0340 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 Condition 1

- The ECM detects less than 4 camshaft position sensor pulses during 2 engine revolutions.

  OR

- The ECM detects greater than 8 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 and P0341 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

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DTCs P0340 and P0341 are Type B DTCs.

Diagnostic Aids

- With a DTC set, the engine may crank for an extended period of time at start-up.
- The 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 will not set. Inspect all camshaft position sensor circuits for poor connections.

Reference Information

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Engine Controls Schematics

Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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1. Ignition ON.
2. Verify DTC P0641 is not set.
    - **If the DTC is set**

      Refer to **DTC P0641, P0651, P0697, or P06A3**.

    - **If the DTC is not set**
3. Engine Running.
4. Verify the scan tool Camshaft Position Active Counter parameter increments.
    - **If the counter does not increment**

      Refer to Circuit/System Testing.

    - **If the counter increments**
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 B23 Camshaft Position 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 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.

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- **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.

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- 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 is not set.
   - **If the DTC is 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 the DTC is not 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**
- Refer to **Control Module References** for engine control module replacement, programming, and setup

DTC P0351-P0358, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, OR P2322: IGNITION COIL CONTROL CIRCUITS (1-8)

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.

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- 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 P0355

Ignition Coil 5 Control Circuit

DTC P0356

Ignition Coil 6 Control Circuit

DTC P0357

Ignition Coil 7 Control Circuit

DTC P0358

Ignition Coil 8 Control Circuit

DTC P2300

Ignition Coil 1 Control Circuit Low Voltage

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DTC P2301

Ignition Coil 1 Control Circuit High Voltage

DTC P2303

Ignition Coil 2 Control Circuit Low Voltage

DTC P2304

Ignition Coil 2 Control Circuit High Voltage

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

DTC P2312

Ignition Coil 5 Control Circuit Low Voltage

DTC P2313

Ignition Coil 5 Control Circuit High Voltage

DTC P2315

Ignition Coil 6 Control Circuit Low Voltage

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DTC P2316

Ignition Coil 6 Control Circuit High Voltage

DTC P2318

Ignition Coil 7 Control Circuit Low Voltage

DTC P2319

Ignition Coil 7 Control Circuit High Voltage

DTC P2321

Ignition Coil 8 Control Circuit Low Voltage

DTC P2322

Ignition Coil 8 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
Ignition Coil 5 Control	P0300, P2312	P0300, P0355	P0300, P2313	P0300, P0355
Ignition Coil 6 Control	P0300, P2315	P0300, P0356	P0300, P2316	P0300, P0356
Ignition Coil 7 Control	P0300, P2318	P0300, P0357	P0300, P2319	P0300, P0357
Ignition Coil 8 Control	P0300, P2321	P0300, P0358	P0300, P2322	P0300, P0358
Ignition Coil 1 Ground	-	P0300, P0351	-	P0300, P0351
Ignition Coil 2 Ground	-	P0300, P0352	-	P0300, P0352
Ignition Coil 3 Ground	-	P0300, P0353	-	P0300, P0353
Ignition Coil 4 Ground	-	P0300, P0354	-	P0300, P0354

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Coil 5 Ground	-	P0300, P0355	-	P0300, P0355
Ignition Coil 6 Ground	-	P0300, P0356	-	P0300, P0356
Ignition Coil 7 Ground	-	P0300, P0357	-	P0300, P0357
Ignition Coil 8 Ground	-	P0300, P0358	-	P0300, P0358

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 8 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 is 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, P0355, P0356, P0357, P0358, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, and P2322 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P0357, P0358, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, and P2322 are Type B DTCs.

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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 (Diagnostic Tools)** **Special Tools (Service Tools)** .

Circuit/System Verification

1. Engine Running.

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2. Verify the scan tool parameters listed below do not display Malfunction:
    - Ignition Coil 1-8 Control Circuit High Voltage Test Status
    - Ignition Coil 1-8 Control Circuit Low Voltage Test Status
    - Ignition Coil 1-8 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 minutes 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 scan tool Ignition Coil Control Circuit Low Voltage Test Status does not display Malfunction.

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- **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 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 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.

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- **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 OR P0430: 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 Bank 1

DTC P0430

Catalyst System Low Efficiency Bank 2

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

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catalyst. The HO2S produces an output signal that the ECM uses to calculate the oxygen storage capacity of the catalyst. This indicates the ability of the catalyst to convert the exhaust emissions efficiently. The ECM monitors the efficiency of the catalyst by monitoring the HO2S during an off-idle, decel fuel cut off (DFCO) event. When the catalyst is functioning properly, the post catalyst HO2S response to the fuel conditions during the DFCO event is slow compared to the response of the pre catalyst HO2S. When the post HO2S response is near that of the pre HO2S, the oxygen storage capability and efficiency of the catalyst may be degraded below an acceptable threshold.

Conditions for Running the DTC

- DTC P0030, P0031, P0032, P0036, P0037, P0038, P0050, P0051, P0052, P0053, P0054, P0056, P0057, P0058, P0059, P0060, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0135, P0137, P0138, P013A, P013B, P013C, P013D, P013E, P013F, P0141, P014A, P014B, P0151, P0152, P0153, P0155, P0157, P0158, P015A, P015B, P015C, P015D, P0161, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P1248, P1249, P124A, P124B, P124C, P124D, P16F3, P2101, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216C, P216E, P216F, P2270, P2271, P2272, or P2273 is not set.
- Engine speed is between 1,000-2,500 RPM to enable the catalyst diagnostic. Once the engine speed is in range, the engine speed must be between 950-2,550 RPM to keep the test enabled.
- Accelerator pedal position is at most 100%.
- Ethanol estimation is not active.
- Evaporative emission (EVAP) purge is not active.
- Post HO2S heaters are ON for greater than 60 s.
- Mass air flow (MAF) is between 4-20 g/s.
- System voltage is between 10-32 V.
- Vehicle speed is between 62-120 km/h (38.5-74.6 MPH) to enable the catalyst diagnostic. To keep the test enabled the vehicle speed is between 58-125 km/h (36-77.7 MPH).
- Catalyst calculated temperature is between 600-900Â°C (1,112-1,652Â°F).
- Engine is operating in closed loop.
- Engine is operating in decel fuel cut off (DFCO).

This diagnostic attempts one test during each valid OFF-idle period once the above conditions have been met. This diagnostic attempts up to 3 tests during each drive cycle.

Conditions for Setting the DTC

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The ECM determines that the efficiency of the catalyst has degraded below a calibrated threshold.

Action Taken When the DTC Sets

DTC P0420 and P0430 are Type A DTCs.

Conditions for Clearing the DTC

DTC P0420 and P0430 are Type A DTCs.

Diagnostic Aids

Inspect for the following conditions, which may cause a catalytic converter to degrade:

- 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 a DTC is set**

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

- **If a DTC is not set**

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

     Refer to step 3.

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

NOTE: **When the test has completed, the Catalyst Monitor Test Counter Bank 1 and Bank 2 parameters will increment by one and the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters will indicate Passed, Failed or No Result.**

6. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.
   - **If the Catalyst Monitor Test Result Bank 1 or Bank 2 parameter indicates No Result**

     Repeat steps 3-6 until the Test Result parameters indicate Passed or Failed

   - **If the Catalyst Monitor Test Result Bank 1 or Bank 2 parameter indicates Failed**

     Refer to Circuit/System Testing

   - **If the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters indicate Passed**
7. All OK.

Circuit/System Testing

1. Verify the conditions listed below do not exist with either catalytic converter:
   - Dents
   - Severe discoloration caused by excessive temperatures
   - Road damage
   - Internal rattles caused by damaged catalyst substrate

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- Restrictions
  - **If a condition is found**

    Replace the catalytic converters.

  - **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 appropriate B52B heated oxygen sensor 2:
   - Not at the correct torque
   - Damage
     - **If a condition is found**

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

     - **If no condition is found**
4. Test or replace the catalytic converters.

Repair Instructions

- Refer to **Exhaust Leakage**
- Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- Refer to **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- Perform the HO2S Heater Learn procedure with a scan tool after replacing a heated oxygen sensor.
- Refer to **Restricted Exhaust**

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- Refer to **Three-Way Catalytic Converter Replacement** for catalytic converter replacement.

Repair Verification

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

     Refer to step 5.

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

   NOTE: **When the test has completed, the Catalyst Monitor Test Counter Bank 1 and Bank 2 parameters will increment by one and the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters will indicate Passed, Failed or No Result.**

8. Continue to monitor the parameter. When the parameter indicates Inactive, the Catalyst Monitor Test has completed.
   - **If the Catalyst Monitor Test Result Bank 1 or Bank 2 parameter indicates No Result**

     Repeat steps 5-8 until the Test Result parameters indicate Passed or Failed

   - **If the Catalyst Monitor Test Result Bank 1 or Bank 2 parameter indicates Failed**

     Refer to Circuit/System Testing

   - **If the Catalyst Monitor Test Result Bank 1 and Bank 2 parameters indicate Passed**
9. All OK.

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

Diagnostic Instructions

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- 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 test is the small leak detection diagnostic for the evaporative emission system. This diagnostic tests the evaporative emission (EVAP) system for a small leak when the key is turned OFF and the correct conditions are met. Heat from the exhaust system is transferred into the fuel tank while the vehicle is operating. Prior to running this test fuel volatility is analyzed then factored into this test. 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 fuel level is between 10-90%.
- The cold start-up engine coolant temperature (ECT) and the start-up intake air temperature (IAT) are within 8Â°C (14Â°F).
- The engine coolant temperature (ECT) is greater than 63Â°C (145Â°F).
- The engine run time before engine shut-off was greater than 10 min.
- The drive distance before engine shut-off was greater than 8 km (5 miles).
- The ambient air temperature at the end of the drive cycle is between 0-34Â°C (32-93Â°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.

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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 test 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 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 **EN 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 **GE 41413-300** .
- A condition may exist where a leak in the EVAP system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the EVAP system and then observe the FTP sensor parameter for vacuum decay.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

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Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48096** EVAP Service Access Port Tool
- **EN 41413-VLV** EVAP Service Port Vent Fitting
- **GE 41413-SPT** High Intensity White Light
- **GE 41413-A** Evaporative Emissions System Tester (EEST)
- **GE 41413-300** EVAP Cap and Plug Kit

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service 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.**

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- **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 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 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

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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	Signal Performance
Ignition	P0030, P0031, P0033, P0034, P0050, P0051, P0443, P0458, P06DA, P06DB, P3403, P3427, P3443, P03451	P0030, P0031, P0033, P0034, P0050, P0051, P0443, P0458, P06DA, P3403, P3427, P3443, P3451	P0690	-
Control	P0443, P0458	P0443, P0458	P0459, P0690	-

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.

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 within 0.25 s.

P0458

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The ECM detects the EVAP purge solenoid valve control circuit is shorted to ground within 0.25 s.

P0459

The ECM detects the EVAP purge solenoid valve control circuit is shorted to voltage within 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.

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **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.
2. Verify the EVAP Purge Solenoid Valve control circuit status parameters while commanding the solenoid from 0% to 50% and back to 0% with a scan tool:
   - 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**

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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 B or 1 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**
   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 B or 1 and the control circuit terminal A 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 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**

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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 2 and the ignition circuit terminal B or 1.
7. Verify the 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 A or 2 and the ignition, terminal B 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 B or 1 and 12 V. Install a jumper wire between the control terminal A or 2 and

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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 **Control Module References** for ECM replacement, programming and setup
- Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**

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

Typical Scan Tool Data

Fuel Tank Pressure Sensor Signal Voltage	Fuel Tank Pressure
1.5 V	Atmospheric Pressure / BARO
Less than 1.5 V	Positive Pressure
More than 1.5 V	Negative Pressure / Vacuum

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Circuit/System Description

This DTC tests the evaporative emission (EVAP) system for a restricted or blocked EVAP vent path that would cause excess amounts of vacuum to be developed in the EVAP system. The engine control module (ECM) commands the EVAP purge solenoid valve Open and the EVAP vent solenoid valve Closed. This allows vacuum to be applied to the EVAP system. Once a calibrated vacuum level has been reached, the ECM commands the EVAP purge solenoid valve Closed and the EVAP vent solenoid valve Open. The ECM monitors the fuel tank pressure (FTP) sensor for a decrease in vacuum. If the vacuum does not decrease to near 0 in H2O in a calibrated time, this DTC sets.

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, Not Venting
OFF	Closed	Open, Venting

Conditions for Running the DTC

- DTC P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0121, P0122, P0123, P0128, P0191, P0192, P0193, P0222, P0223, P0443, P0601, P0604, P0606, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2176, is not set.
- The ignition voltage is between 11-32 V.
- The start up intake air temperature (IAT) is between 4-34Â°C (39-93Â°F).
- The start up engine coolant temperature (ECT) is less than 35Â°C (95Â°F)
- The barometric pressure (BARO) is greater than 70 kPa.
- The fuel level is between 10-90%.
- This test will start and run once per cold start for no greater than 17 min.

Conditions for Setting the DTC

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

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

  OR

- If fuel tank pressure sensor reading is less than -12 in H2O of vacuum for 5 s before 10 L (2.6 gal) of purge volume.

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- 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 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

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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 (Diagnostic Tools)** **Special Tools (Service Tools)** .

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0449, P0498 or P0499 is not set.
   - **If any DTC is set**

     Refer to **DTC P0449, P0498, or P0499**.

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

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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 Not Venting with a scan tool to seal the EVAP system.
5. Turn the nitrogen/smoke valve on the GE 41413-A to nitrogen.

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

6. Use the remote switch to activate the GE 41413-A and pressurize the fuel tank to 5.0 in H20.
7. Verify the scan tool Fuel Tank Pressure Sensor parameter is 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 Replacement**
- Refer to **Evaporative Emission Canister Solenoid Replacement** for EVAP Vent Solenoid Valve replacement.
- Refer to **Fuel Tank Pressure Sensor Replacement (SWB)** **Fuel Tank Pressure Sensor Replacement (LWB)**

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.

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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	Signal Performance
B+	P0498	P0449	-	-
Control	P0498	P0449	P0499, P0690	-

Circuit/System Description

Battery voltage is supplied to the evaporative emission (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 ECM monitors the status of the driver. A scan tool will display the commanded state of the EVAP Vent Solenoid Valve as Not Venting (On) or Venting (Off).

Conditions for Running the DTC

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 within 0.25 s.

P0498

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The ECM detects the EVAP vent solenoid valve control circuit is shorted to ground within 0.25 s.

P0499

The ECM detects the EVAP vent solenoid valve control circuit is shorted to voltage within 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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DTC Type Reference

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. Verify the following control circuit status parameters while command the EVAP Vent Solenoid Valve to Not Venting and Venting with a scan tool:
   - 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. 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 harness connector at the Q13 Evaporative Emission Vent Solenoid Valve, Ignition ON.

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2. Verify that a test lamp illuminates between the B+ circuit terminal A 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 A or 2 and the control circuit terminal B 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 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 B or 1 and the B+ circuit terminal A or 2.

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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 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 B or 1 and the B+ circuit terminal A 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.

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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, P0452, P0522, P0532, P0641, P127C, P2227, P2228	P0451	P0446, P0452	P018D, P0193, P0453, P0523, P0533, P0641, P127D, P2227	-
Signal	P0192, P0452, P0641, P2230	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			

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Circuit	Short to Ground	Open	Short to Voltage
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 control module 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.

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- The ECM must complete several engine off natural vacuum test tests before the diagnostic can turn the MIL ON or OFF.

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 more than 4.85 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 in the span of 1 s but less than 1 in H2O in 12.5 ms.
- This test must fail twice in three samples 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 code to set.
- Ensure that the reference port on the fuel tank pressure sensor is unobstructed.
- An fuel tank pressure sensor that is skewed or does not have a linear transition from low to high may cause this 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

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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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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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GE 41413-A Evaporative Emission System Tester (EEST)

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service 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.

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- **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.

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- 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 (SWB)** **Fuel Tank Pressure Sensor Replacement (LWB)**

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 (FTP) sensor voltage to verify that the system is able to reach a predetermined level of vacuum before a calibrated amount of purge volume has passed through the system.

Conditions for Running the DTC

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- DTCs P0068, P00C8, P00C9, P00CA, 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, P0191, P0192, P0193, P0222, P0223, P06A3, P06DB, P06DE, P0A1D, P0443, P0449, P0452, P0454, P0453, P0458, P0459, P0498, P0499, P0502, P0503, P0601, P0604, P0606, P0697, P0722, P0723, P111E, P117B, P117C, P117D, P117E, P117F, P160D, P160E, P1682, P16A0, P16A1, P16A2, P16F3, P1104, 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 is not set.
- The ignition voltage is greater than 11 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 8Â°C (14Â°F)
- The engine coolant temperature (ECT) at start-up is less than 35Â°C (95Â°F)
- The intake air temperature (IAT) is between 4-34Â°C (39-93Â°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 less than 2.74 kPa (11 in H2O) 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 this DTC a second time.

Action Taken When the DTC Sets

DTC P0455 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0455 is a Type B DTC.

Diagnostic Aids

- Inspect for a loose, missing or damaged, capless fuel fill flappers.
- A blockage or restriction in the EVAP purge solenoid valve, purge pipe, 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 open the fuel fill flapper valves with **CH-44284-2** , or temporarily leave the vent open, until smoke is observed, then close the system and continue testing. If using the capless fuel fill adapter at the filler neck, use the **J-41413-VLV**

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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 **GE-41413-300** .
- When servicing the EVAP system, test pressure must not exceed 13 in H20 (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.

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

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

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Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH-44284-2** Fuel Flapper Door Holder
- **CH-48096** Evaporative Emissions Service Access Port Tool
- **GE-41415-60** Capless Fuel Fill Adapter
- **GE-41413-A** Evaporative Emissions System Tester (EEST)
- **GE-41413-SPT** High Intensity White Light
- **GE-41413-300** Evaporative Emissions Cap and Plug Kit
- **J-41413-VLV** Evaporative Emissions Service Port Vent Tool

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service Tools)** .

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

NOTE:

- **Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize.**
- **Refer to the GE-41413-A operation manual for detailed instructions in Evaporative Emission System Diagnosis .**

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NOTE: **This vehicle has a capless fuel fill design that requires the use of CH-44284-2 to hold the two flapper valves open.**

- **Install this tool so that the raised rib nests just inside the flapper door outer lip. The flappers will hold it in place.**
- **Be careful the force of the flapper doesn't push the tool back out.**
- **Do not insert tool any further into the fuel neck or it may get stuck or fall into the lower fill tube.**

NOTE: **The GE-41415-60 is a dual purpose tool used for EVAP testing and diesel induction leak testing. It has two positions for the rubber stopper, identified on the tube by a letter A and B. Slide the stopper to just above either line depending on the test performed.**

- **Letter A position line is for diesel induction leak testing**
- **Letter B position line is for EVAP testing**

1. Disconnect the purge tube at the quick connector on the EVAP canister side of the Q12 Evaporative Emission Purge Solenoid Valve. Install the **CH-48096** between the disconnected purge tube and the purge solenoid valve.
2. Connect the **GE-41413-A** to the **CH-48096** .
3. Command the EVAP Purge/Seal function to Not Venting 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 **CH-48096** 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.**

NOTE: **Install the GE-41415-60 , with the tube pointing toward the ground, into the capless fuel fill opening. Wedge the stopper into the opening with just enough force to retain this tools threaded end pointing out, parallel within the opening.**

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5. Install the **GE-41415-60** into the capless fuel fill opening.
6. Connect the **GE-41413-A** nitrogen/smoke hose to the **GE-41415-60** .
7. Engine idling, command the Purge/Seal function to Not Venting with a scan tool to seal the system.
8. Command the EVAP Purge Solenoid Valve to 30% with a scan tool.
9. 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**
10. 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**
11. All OK.

Repair Instructions

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

Refer to **Fuel Tank Pressure Sensor Replacement (SWB)** **Fuel Tank Pressure Sensor Replacement (LWB)**

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.

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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 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 P0068, P00C8, P00C9, P00CA, P0090, P0091, P0092, P0106, P0107, P0108, P0111, P0112, P0113, P0114 P0116, P0117, P0118, P0122, P0123, P0128, P0191, P0192, P0193, P0222, P0223, P06A3, P06DB, P06DE, P0A1D, P160D, P160E, P1682, P16A0, P16A1, P16A2, P16F3, P1104, P127A, P127C, P127D, P15F2, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0601, P0604, P0606, P0697, P2100, P2101, P2102, P2103, P2122, P2123, P2127, P2128, P2135, P2138, P215B, P2176, P228C, P228D, U0073, U0074, U0293, U1817 are not set.
- The ignition voltage is between 11-32 V.
- The engine OFF time is greater than 48 min,
- 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 35Â°C (95Â°F).
- The startup intake air temperature (IAT) is between 4-34Â°C (39-93Â°F).
- DTC P0496 runs once per cold start, for up to 17 min, when the above conditions are met. This test will run with the purge valve and the vent valve closed.

Conditions for Setting the DTC

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The ECM detects greater 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

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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

NOTE:

- **Vehicle and service department temperature and fuel level (vapor pressure) can affect the fuel tank pressure sensor parameter. Ensure the vehicle temperature has stabilized to service department temperature to ensure greatest accuracy.**
- **Be sure the EVAP Purge Solenoid Valve command is 0% or this test will not work.**

1. Ignition ON.
2. Command the EVAP Purge/Seal function to Not Venting with a scan tool.
3. Engine Running.
4. Verify the Fuel Tank Pressure Sensor parameter is less than 1.9 V for greater than 90 s.
   - **If greater than 1.9 V**

     Replace the Q12 Evaporative Emission Purge Solenoid Valve

   - **If less than 1.9 V**
5. All OK

Repair Instructions

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

Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**

DTC P0506 OR P0507: IDLE SPEED

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** 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 controlled by the engine control module (ECM). The DC motor located in the throttle body drives the throttle blade. In order to decrease idle speed, along with spark and fuel delivery changes the ECM commands the throttle closed reducing air flow into the engine and the idle speed decreases. In order to increase idle speed, the ECM commands the throttle plate open allowing more air to pass the throttle plate.

Conditions for Running the DTC

- DTCs P0068, P0101, P0102, P0103, P0112, P0113, P0116, P0117, P0118, P0121, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0222, P0223, P0300-P0308, P0351-P0358, P0461-P0463, P0496, P0502, P0503, P0606, P0722, P0723, P0806-P0808, P1101, P1516, P2066-P2068, P2101, and P2135 are not set.
- The engine is operating for 60 s or greater.
- The engine is idling for greater than 5 s.
- The barometric pressure (BARO) is greater than 70 kPa (11 psi).

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- The engine coolant temperature (ECT) is warmer than 60Â°C (140Â°F).
- The intake air temperature (IAT) is warmer than -20Â°C (-4Â°F).
- The vehicle speed is less than 1.6 km/h (1 mph).
- The commanded engine speed is steady within 25 RPM.
- The transmission is not changing gears.
- The torque converter clutch (TCC) is not changing states.
- The manual transmission clutch pedal position is less than 25 percent or greater than 88 percent - If equipped.
- The manual transmission clutch is not depressed - If equipped.
- The power take-off (PTO) is not active - If equipped.
- The transfer case is not in 4WD Low - If equipped.
- A scan tool output control is not active.
- The system voltage is between 11-32 V.
- DTCs P0506 and P0507 run continuously when the above conditions are met for greater than 10 s.

Conditions for Setting the DTC

P0506

The actual idle speed is approximately 94 RPM lower than the desired idle speed.

P0507

The actual idle speed is approximately 188 RPM greater than the desired idle speed.

Action Taken When the DTC Sets

DTCs P0506 and P0507 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0506 and P0507 are Type B DTCs.

Diagnostic Aids

- A stalling condition can cause DTC P0506 to set.

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- An intermittent vehicle speed sensor (VSS) signal can cause DTC P0507 to set.
- An intermittent clutch pedal position sensor signal, if equipped, can cause DTC P0506 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 there are no other DTCs set.
    - **If any other DTCs are set**

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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.

NOTE: **The engine must run for greater than 60 s, then idle at a steady state for an additional 10 s before comparing the actual and desired engine speed parameters.**

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 or greater than the Desired Idle Speed**

     Refer to Circuit/System Testing.

   - **If within 200 RPM of 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 a DTC does not set.
   - **If a DTC sets**

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

   - **If no DTC sets**
9. All OK

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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**

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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 fuel 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 sensor 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, P0016, P0089, P0090-P0092, P00C6, P00C8, P00C9, P00CA, P0101-P0103, P0106-P0108, P0112-P0114, P0116-P0118, P0121-P0123, P0128, P0192, P0193, P0201-P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0315, P0335, P0336, P0351-P0356, P0628, P069E, P1248, P1249, P124A, P124B, P124C, P124D, P1258, P135A, P135B, P150C, P163A, P1762, P2122, P2123, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P228C, P228D, U0109 are not set.
- The catalyst temperature is less than 300Â°C (572Â°F).
- The engine coolant temperature is between 17-43Â°C (62-110Â°F).
- The barometric pressure is greater than 75 kPa.
- The engine speed is between 550-2000 RPM.
- The engine is running less than 100 seconds.
- Accelerator position is less than 1%.
- DTC P050D runs once per cold start.

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Conditions for Setting the DTC

This DTC will set if the engine control module 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 engine control module 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 fuel injectors could set this DTC without setting an injector DTC. Test the fuel injector circuits of the affected cylinders for a high resistance if you suspect a condition. Refer to **Fuel Injector Diagnosis** .
- A drop in system voltage during cold start may set this DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: **Circuit/System Testing requires cold start. Do not start vehicle prior to connecting scan tool and preparing to evaluate the condition during engine crank.**

1. Start the engine and observe the Cylinder 1-8 Current Misfire Counters during the first 500 engine cycles. The Cylinder 1-8 Current Misfire Counters should not be incrementing.
    - **If the misfire counters are incrementing on one or more cylinders**
    1. Ignition OFF.
    2. Verify that the following conditions do not exist:
    - Fuel pressure that is too low or too high - Refer to Fuel System Diagnosis .
    - Contaminated fuel - Refer to Alcohol/Contaminants-in-Fuel Diagnosis .
        - If a condition exist, repair as necessary.
        - If none of the conditions exist, replace the Q17 Fuel Injector(s) as indicated by high misfire counts.
    - **If the misfire counters are not incrementing**
2. All OK.

Repair Instructions

Refer to Fuel Injector Replacement

Repair Verification

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NOTE: **Repair Verification requires cold start.**

1. Ignition ON, engine OFF, clear the DTCs with a scan tool.
2. Start the engine.
3. Verify the DTC does not reset.

DTC P05CC: COLD START INTAKE CAMSHAFT POSITION 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 Descriptors

DTC P05CC

Cold Start Intake Camshaft Position System Performance

Circuit/System Description

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshaft while the engine is operating. The ECM controls the camshaft position actuator magnet duty cycle by controlling the amount of On time. The magnet controls the amount of engine oil flow to the CMP actuator by extending a pintle within the solenoid. The pintle acts against a spool valve in the CMP actuator mechanism which is attached to the front of the camshaft. As the spool valve is moved, oil is directed to the CMP actuator, which rotates the camshaft. The ECM can only command the camshaft position actuator to retard the valve timing from the camshaft park position, or advance the valve timing back to the park position.

The ECM controls the camshaft position actuator magnet by supplying a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

Conditions for Running the DTC

- DTC P0010, P0016, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390 or P0391, is not set.
- The ignition voltage is greater than 11 V.
- The engine is running.

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- The desired camshaft position is greater than 0 degrees.
- The desired camshaft position is not changing greater than 4.5 degrees for at least 1 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 20 degrees or less than 5 degrees.
- DTCs P05CC, runs 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 8 degrees for greater than 20 s

Action Taken When the DTC Sets

DTCs P05CC is a type B DTC.

Conditions for Clearing the DTC

DTCs P05CC is a type B DTC.

Diagnostic Aids

- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this DTC. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life parameter. Advise the customer an oil change may be required.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain can cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

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Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 35616-200 Test Lamp Kit

Circuit/System Verification

NOTE:

- **The engine oil level and the oil pressure are critical to the correct operation of the camshaft position (CMP) 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 correct oil pressure. Refer to **Oil Pressure Diagnosis and Testing** .

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

2. Ignition On.
3. Verify DTC P0010, P0016, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390 or P0391, is not set.
   - **If any of the DTCs are set**

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

   - **If none of the DTCs are set**
4. Engine idling at normal operating temperature.
5. Verify the Desired Camshaft Position parameter matches the Camshaft Position Angle parameter when commanding the Camshaft Position Actuator to 20 degrees with a scan tool.
   - **If the parameter does not match**

     Refer to Circuit/System Testing.

   - **If the parameter does match**
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 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 Q6 Camshaft Position Actuator Solenoid Valve. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
   - **If 5 Ω or greater**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.

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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**

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

3. Ignition On.
4. Verify that a test lamp does not illuminate between the 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 control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
    - **If the test lamp does not illuminate**
5. Remove the test lamp.
6. Connect the DMM negative lead to the control circuit terminal 2. Connect the DMM positive lead to B+. Set the DMM on the diode setting. Command the Camshaft Position Actuator Solenoid On and Off with a scan tool. The DMM should transition from OL when commanded Off to less than 1 V when commanded On.
    - **If the parameter does not correspond to the specified values**
    1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 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 parameter corresponds to the specified values**
7. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve and magnet.

Component Testing

Static Test

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1. Ignition Off, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 Ω between the control terminal 1 and the low reference terminal 2.
    - **If not between 5-12 Ω**

      Replace the Q6 Camshaft Position Actuator Solenoid Valve.

    - **If between 5-12 Ω**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
    - **If not infinite resistance**

      Replace the Q6 Camshaft Position Actuator Solenoid Valve.

    - **If infinite resistance**
4. Ignition Off, remove the camshaft position actuator magnet.
5. Test for 5.0-9.0 Ω between the solenoid control terminal 2 and the low reference terminal 1 at the camshaft position actuator magnet.
    - **If not within the specified range**

      Replace the camshaft position actuator magnet

    - **If within the specified range**
6. Test for infinite resistance between each terminal of the magnet and the magnet housing.
    - **If not within the specified value**

      Replace the camshaft position actuator magnet

    - **If within the specified value**
7. All OK.

Dynamic Test

1. Remove the camshaft position actuator magnet.

NOTE:

- **The camshaft position actuator magnet pintle should be facing downward for this test.**
- **Do not allow electrical current to flow through the camshaft position actuator magnet for greater than 1-2 s.**

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2. Install a 20 A fused jumper wire between the control circuit terminal 2 and 12 V. Momentarily install a jumper wire between the low reference terminal 1 and ground. The pintle should extend.
    - **If the function does not perform as specified**

      Replace the camshaft position actuator magnet

    - **If the function does perform as specified**
3. All OK.

Repair Instructions

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

- Refer to **Camshaft Position Actuator Cleaning and Inspection**
- Refer to **Camshaft Position Actuator Magnet Replacement** for camshaft position actuator magnet
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup.

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

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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	P0335, P0506, P057D, 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

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- 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 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

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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**

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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**

      Refer to Circuit/System Testing.

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- **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.

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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.

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- 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/VIN NOT PROGRAMMED OR MISMATCHED (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

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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 ON.

P0603, P062F

These DTCs run during ECM power up.

P0604

DTC P0604 runs continuously when the ignition is ON for greater than 30 s.

P0606, P062B

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

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P16F3

- The engine speed is greater than 520 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 P062F and P262B 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 P062F and P262B 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.

Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set. Verify the following:

Reference Information

Schematic Reference

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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.

   NOTE: **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B could be set as a default action taken from another DTC.**

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**

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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 P0628: FUEL PUMP ENABLE CIRCUIT LOW 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 Descriptor

DTC P0628

Fuel Pump Enable Circuit Low Voltage

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0171, P0506, P0628, P12A6	P0171, P0506, P12A6	-	P12A6

Circuit/System Description

The engine control module (ECM) provides ignition voltage to the fuel pump driver control module whenever the engine is cranking or running. The ECM enables the fuel pump driver control module as long as the engine is cranking or running, and ignition system reference pulses are received. While this enable voltage is being received, the fuel pump driver control module supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

- The engine speed is greater than 0 RPM.
- The ignition voltage is greater than 11 V.
- The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

The engine control module detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2.5 s.

Action Taken When the DTC Sets

DTC P0628 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0628 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

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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 that DTC P0628 is not set.
   - **If the DTC is set**

     Refer to Circuit/System Testing.

   - **If the 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

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- **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 K111 Fuel Pump Driver Control Module harness connector.
2. Ignition ON for 10 s.
3. Verify that a test lamp does not illuminate between the control circuit terminal 2 and ground.
   - **If the test lamp illuminates**
   1. Ignition OFF, remove the test lamp, disconnect the X1 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 X1 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.

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- 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 2 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 X1 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. Replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

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

- Refer to **Fuel Pump Power Control Module Replacement** for K111 Fuel Pump Driver Control Module replacement
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P0641, P0651, P0697, OR P06A3: 5V REFERENCE CIRCUITS (1-4)

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

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DTC P0651

5V Reference 2 Circuit

DTC P0697

5V Reference 3 Circuit

DTC P06A3

5V Reference 4 Circuit

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 voltage or ground 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 following sensors:

- Air conditioning (A/C) refrigerant pressure sensor
- Camshaft position sensor

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- Engine oil pressure sensor
- Fuel pressure sensor
- Fuel rail pressure sensor
- Fuel tank pressure sensor
- Multifunction intake air sensor

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

- Brake pedal position sensor
- Crankshaft position sensor

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

- Accelerator pedal position sensor 2
- Manifold absolute pressure sensor

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

- Accelerator pedal position sensor 1
- Throttle position sensor

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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

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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.

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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.

NOTE: You may have to operate the vehicle within the Conditions for Running the DTC or the conditions that you observed from the Freeze Frame/Failure Records data to duplicate the malfunction.

- **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.

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Repair Instructions

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

- Refer to **Accelerator Pedal Position Sensor Replacement**
- Refer to **Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement (L83 L86)**
- Refer to **Brake Pedal Position Sensor Replacement**
- Refer to **Camshaft Position Sensor Replacement**
- Refer to **Crankshaft Position Sensor Replacement**
- Refer to **Engine Oil Pressure Sensor Replacement**
- Refer to **Fuel Pressure Sensor Replacement (Fuel Pipe)**
- Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**
- Refer to **Fuel Tank Pressure Sensor Replacement (SWB)** **Fuel Tank Pressure Sensor Replacement (LWB)**
- 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 **Throttle Body Assembly Replacement**
- Refer to **Control Module References** for engine 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

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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 ignition voltage is between 11-32 V.
- Remote vehicle start is not active
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P0650 or DTC 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

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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

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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**

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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 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 harness connector at the instrument cluster.
7. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal 8 and ground.

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- **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 (Chevrolet / GMC)** **Instrument Cluster Replacement (Cadillac)**
- 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

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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

Typical Scan Tool Data

Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status - Component Commanded OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage Test 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

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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

These DTCs run when Ignition 1 signal voltage is greater than 11 V.

P0689

- DTCs P0685, P0686, or P0687 are 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

- DTCs P0685, P0686, or P0687 are not set.
- The engine controls ignition relay is commanded OFF.
- The DTC runs continuously when the above conditions are met.

P1682

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- 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.
- 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.

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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

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Center Identification Views** **Electrical Center Identification Views**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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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 86
   - Terminal 30
   - **If the test lamp does not illuminate**

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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**

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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.

Component Testing

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 relay.

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- **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 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 relay.

   - **If less than 2 Ω**
6. All OK.

Repair Instructions

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

- Refer to **Underhood Electrical Center or Junction Block Replacement** for 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 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.

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- 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.

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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**

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5. All OK.

Repair Instructions

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

DTC P1248-P124F: CYLINDERS (1-8) INJECTOR HIGH CONTROL CIRCUIT SHORTED TO 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 P1248

Cylinder 1 Injector High Control Circuit Shorted to Control Circuit

DTC P1249

Cylinder 2 Injector High Control Circuit Shorted to Control Circuit

DTC P124A

Cylinder 3 Injector High Control Circuit Shorted to Control Circuit

DTC P124B

Cylinder 4 Injector High Control Circuit Shorted to Control Circuit

DTC P124C

Cylinder 5 Injector High Control Circuit Shorted to Control Circuit

DTC P124D

Cylinder 6 Injector High Control Circuit Shorted to Control Circuit

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DTC P124E

Cylinder 7 Injector High Control Circuit Shorted to Control Circuit

DTC P124F

Cylinder 8 Injector High Control Circuit Shorted to Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Control Cylinder 1	P0261	P0201	P0262	P1248
High Control Cylinder 1	P2147	P0201	P2148	P1248
Low Control Cylinder 2	P0264	P0202	P0265	P1249
High Control Cylinder 2	P2150	P0202	P2151	P1249
Low Control Cylinder 3	P0267	P0203	P0268	P124A
High Control Cylinder 3	P2153	P0203	P2154	P124A
Low Control Cylinder 4	P0270	P0204	P0271	P124B
High Control Cylinder 4	P2156	P0204	P2157	P124B
Low Control Cylinder 5	P0273	P0205	P0274	P124C
High Control Cylinder 5	P216B	P0205	P216C	P124C
Low Control Cylinder 6	P0276	P0206	P0277	P124D
High Control Cylinder 6	P216E	P0206	P216F	P124D
Low Control Cylinder 7	P0279	P0207	P0280	P124E
High Control Cylinder 7	P217B	P0207	P217C	P124E
Low Control Cylinder 8	P0282	P0208	P0283	P124F
High Control Cylinder 8	P217E	P0208	P217F	P124F
DTC P0300 may also be present for all fault conditions				

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.

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Conditions for Running the DTC

- DTC P062B is not present.
- Engine is running.
- Ignition voltage is greater than 11 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The engine control module detects greater than 25 A on the low side driver. This indicates the high side driver is shorted to the low side driver.

Action Taken When the DTC Sets

DTCs P1248, P1249, P124A, P124B, P124C, P124D, P124E and P124F are Type A DTCs.

Conditions for Clearing the DTC

DTCs P1248, P1249, P124A, P124B, P124C, P124D, P124E and P124F 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

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P062B is not set.
   - **If the DTC is set**

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

   - **If the DTC is not set**

NOTE: **The engine must be running for the injector circuit status parameters to function.**

3. Engine idling.
4. Verify with a scan tool 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
   - Cylinder 5 Injector Control Circuit Status
   - Cylinder 6 Injector Control Circuit Status

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- Cylinder 7 Injector Control Circuit Status
- Cylinder 8 Injector Control Circuit Status
- **If OK or Not Run is not displayed**

  Refer to Circuit/System Testing.

- **If OK or Not Run 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 set**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the X3 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 greater than 3 Ω between the appropriate fuel injector high control circuit and direct low control circuit at the engine control module connector.
   - **If 3 Ω or less**
   1. Disconnect the Q17 Fuel Injector.
   2. Test for infinite resistance between the fuel injector high control circuit and low control circuit.
      - If less than infinite, repair the short in the circuit.
      - If infinite, test or replace the Q17 Fuel Injector.
   - **If greater than 3 Ω**
3. Test or Replace the K20 Engine Control Module.

Component Testing

NOTE: **The engine coolant temperature (ECT) sensor must be between 10-32Â°C (50-90Â°F) for an accurate**

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measurement.

1. Ignition OFF, disconnect the harness connector at the appropriate Q17 Fuel Injector.
2. Test for 1.06 Ω +/- 10% @ 20Â°C (68Â°F) between the terminals of the fuel injector.
    - **If not within the specified range**

      Replace the Q17 Fuel Injector.

    - **If within the specified range**
3. Test for infinite resistance between each terminal and the fuel injector housing/case.
    - **If less than infinite resistance**

      Replace the Q17 Fuel Injector.

    - **If infinite resistance**
4. All OK.

Repair Instructions

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

- Refer to **Fuel Injector Replacement**
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P1255: FUEL PUMP CONTROL MODULE DRIVER HIGH 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 Descriptors

DTC P1255

Fuel Pump Control Module Driver High Temperature

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Circuit/System Description

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

Conditions for Running the DTC

- The ignition voltage is greater than 7 V.
- The engine is cranking or running.
- The fuel pump enable circuit is commanded ON.
- The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

The fuel pump driver control module detects a driver temperature greater than 150Â°C (302Â°F) for less than 0.5 s.

Action Taken When the DTC Sets

DTC P1255 is a Type A DTC.

Conditions for Clearing the DTC

DTC P1255 is a Type A DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Fuel System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
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 K111 Fuel Pump Driver Control Module is located is free of debris, clutter, or any insulating material that would cause the fuel pump driver control module to overheat.
   - **If any debris, clutter, or other material is found**
   1. Clear the area where the K111 Fuel Pump Driver Control Module is located.
   2. Clear the DTC and test drive the vehicle.
   3. Verify the DTC does not set.

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- If the DTC sets, replace the K111 Fuel Pump Driver Control Module.
- If the DTC 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 the DTC does not set.
   - **If the DTC sets**

     Replace the K111 Fuel Pump Driver Control Module.

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

Repair Instructions

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

Refer to **Fuel Pump Power Control Module Replacement** for K111 Fuel Pump Driver Control Module replacement

DTC P127C OR P127D: FUEL RAIL PRESSURE SENSOR 2 CIRCUIT 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 P127C

Fuel Rail Pressure Sensor 2 Circuit Low Voltage

DTC P127D

Fuel Rail Pressure Sensor 2 Circuit High Voltage

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0192, P0193, P0340, P0345, P0365, P0390, P0506, P0641, P2227	P0192	P0193, P0641, P2227, P2229	P0191
Fuel Rail Pressure Sensor Signal 1	P0192	P0192, P0193	P0193	P0191
Fuel Rail Pressure Sensor Signal 2	P127C	P127C, P127D	P127D	P0191
Low Reference	-	P0193	P0193	P0191

Circuit/System Description

The fuel rail pressure sensor is a dual analog sensor that provides two fuel rail pressure signals to the engine control module (ECM). The ECM provides a 5 V reference voltage on the 5 V reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on both the fuel rail pressure sensor 1 and fuel rail pressure sensor 2 signal circuits. The ECM monitors the voltage on both of the fuel rail pressure sensor circuits and compares the values to determine if the sensors are accurate. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

Conditions for Running the DTC

- The engine is running.
- Battery voltage is greater than 11 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P127C

The engine control module detects that the fuel rail pressure sensor 2 signal voltage is less than 0.25 V for greater than 2.5 s.

P127D

The engine control module detects that the fuel rail pressure sensor 2 signal voltage is greater than 4.75 V for greater than 2.5 s.

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Action Taken When the DTC Sets

- DTCs P127C and P127D are Type A DTCs.
- A message center or an indicator may display Reduced Engine Power.

Conditions for Clearing the DTC

DTCs P127C and P127D are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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1. Ignition ON.
2. Verify DTC P0641 is not set.
    - **If the DTC is set**

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

    - **If the DTC is not set**
3. Engine at idle.
4. Verify the DTC does 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. 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 B47B Fuel Rail Pressure 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 3 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.

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- **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 X2 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 in 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 X2 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 2 parameter is less than 0.25 V.
    - **If 0.25 V or greater**
    1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit terminal 2 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 0.25 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 2 and the 5 V reference circuit terminal 1.
7. Verify the scan tool Fuel Rail Pressure Sensor 2 parameter is greater than 4.75 V.
    - **If 4.75 V or less**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 2 and ground.

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- 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 4.75 V**

8. Test or replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

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

- Refer to **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement** for B47B Fuel Rail Pressure Sensor replacement
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P129B OR P129C: FUEL PUMP DRIVER CONTROL MODULE SYSTEM 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 P129B

Fuel Pump Driver Control Module System Voltage Low Voltage

DTC P129C

Fuel Pump Driver Control Module System Voltage High Voltage

Diagnostic Fault Information

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

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		Resistance		
B+	P018B, P0506, P129B, P2635, U18A2	P018B, P0506, P129B, P2635, U18A2	P129C	-

Circuit/System Description

The fuel pump driver control module monitors the battery positive voltage circuit to verify the voltage is between the normal operating range. The DTC can set for a circuit or system voltage out of range.

Conditions for Running the DTC

P129B

- The engine is running.
- The ignition voltage is greater than 7 V.
- The fuel pump enable circuit is commanded ON.
- The DTC runs continuously when the conditions above are met.

P129C

- The engine is not running.
- The ignition voltage is greater than 7 V.
- The fuel pump enable circuit is commanded ON.
- The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

P129B

The fuel pump driver control module detects the battery positive voltage is less than 7 V for 1 s.

P129C

The fuel pump driver control module detects the battery positive voltage is greater than 18 V for 1 s.

Action Taken When the DTC Sets

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DTC P129B and P129C are Type C DTCs.

Conditions for Clearing the DTC

DTC P129B and P129C are Type C DTCs.

Reference Information

Schematic Reference

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 Verification

1. Ignition OFF.

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2. Test for 12.4-12.8 V at the battery terminals and record the reading. The battery voltage should stabilize after a few minutes of turning the ignition OFF.
    - **If not between 12.4 V-12.8 V**

      Refer to **Battery Inspection/Test** .

    - **If between 12.4 V-12.8 V**
3. Engine running, accessories OFF.
4. Test for 13.4-15 V at the battery terminals and record the reading.
    - **If not between 13.4-15 V**

      Refer to **Charging System Test** .

    - **If between 13.4-15 V**
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 K111 Fuel Pump Driver Control Module. 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 9 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.

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- **If less than 5 Ω**

3. Verify a test lamp illuminates between the B+ circuit terminal 1 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, replace the K111 Fuel Pump Driver Control Module.
    - **If the test lamp illuminates**
4. Replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

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

Refer to **Fuel Pump Power Control Module Replacement** for K111 Fuel Pump Driver Control Module replacement.

DTC P129D: FUEL PUMP DRIVER CONTROL MODULE IGNITION ON/START SWITCH CIRCUIT LOW 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 Descriptor

DTC P129D

Fuel Pump Driver Control Module Ignition On/Start Switch Circuit Low Voltage

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Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P129D	P129D	P129D	-

Circuit/System Description

The fuel pump driver control module monitors the ignition voltage circuit in order to determine if the voltage is within the normal operating range.

Conditions for Running the DTC

The DTC runs continuously when the modules are awake.

Conditions for Setting the DTC

The fuel pump driver control module Power Mode does not agree with the engine control module (ECM) Power Mode for 1 s.

Action Taken When the DTC Sets

DTC P129D is a Type A DTC.

Conditions for Clearing the DTC

DTC P129D is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the engine cranks.
    - **If the engine does not crank**

      Refer to **Starter Solenoid Does Not Click** .

    - **If the engine cranks**
2. Ignition ON.
3. Verify DTC P0562 is not set.
    - **If the DTC sets**

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

    - **If the DTC does not set**
4. Verify DTC P129D is not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**

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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 DTC P129D is not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

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

Circuit/System Testing

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

1. Ignition OFF, all vehicle systems OFF, disconnect the harness connector at the K111 Fuel Pump Driver Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Ignition ON.
3. Verify a test lamp illuminates between the ignition circuit terminal 6 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**
    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, replace the K111 Fuel Pump Driver Control Module.
    - **If the test lamp illuminates**
4. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
5. Verify a test lamp does not between the ignition circuit terminal 6 and ground.
    - **If the test lamp illuminates**

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Repair the short to voltage on the circuit.

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

6. Replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

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

Refer to **Fuel Pump Power Control Module Replacement** for K111 Fuel Pump Driver Control Module replacement

DTC P129E OR P12A8: FUEL PUMP DRIVER CONTROL MODULE SIGNAL MESSAGE COUNTER INCORRECT/FUEL PUMP CONTROL SIGNAL 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 P129E

Fuel Pump Driver Control Module Signal Message Counter Incorrect

DTC P12A8

Fuel Pump Control Signal Message Counter Incorrect

Circuit/System Description

The fuel pump power control module is in constant communication with the engine control module (ECM) regarding the operating state of the fuel pump power control system. Serial data messages are sent in a continuously repeating series of rolling counts with associated password protect samples. Each count/sample is assigned a value. When the ECM determines that too many of the counts/samples contain an error value, the ECM sets DTC P129E or P12A8.

Conditions for Running the DTC

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- The ignition voltage is greater than 7 V.
- The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

The ECM detects an error value for over 1 s.

Action Taken When the DTC Sets

DTC P129E and P12A8 are Type A DTCs.

Conditions for Clearing the DTC

DTC P129E and P12A8 are Type A DTCs.

Diagnostic Aids

An intermittent fault in the CAN circuits will cause the ECM to set DTC P129E or P12A8.

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:

- **DTC P129E and P12A8 are informational DTCs.**
- **Diagnose all other engine control module DTCs prior to DTC P129E or P12A8.**

1. Verify that no other DTCs are set except for DTC P129E or P12A8.
   - **If any other DTCs are set**

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

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- **If only DTC P129E or P12A8 is set**

2. Replace the K111 Fuel Pump Power Control Module.
3. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
   - **If DTC sets**

     Replace the K20 Engine Control Module.

   - **If DTC does not set**
4. All OK.

Repair Instructions

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

- Refer to **Fuel Pump Power Control Module Replacement** for K111 Fuel Pump Power Control Module Replacement
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P12A6: FUEL PUMP DRIVER CONTROL MODULE ENABLE CIRCUIT 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 P12A6

Fuel Pump Driver Control Module Enable Circuit Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0171, P0506, P0628, P12A6	P0171, P0506, P12A6	-	P12A6

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Circuit/System Description

The engine control module (ECM) provides ignition voltage to the fuel pump driver control module whenever the engine is cranking or running. The ECM enables the fuel pump driver control module as long as the engine is cranking or running, and ignition system reference pulses are received. While this enable voltage is being received, the fuel pump driver control module supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

- The ignition voltage is greater than 7 V.
- The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

The engine control module state of the fuel pump enable circuit does not match the state of the fuel pump enable circuit sensed by the fuel pump driver control module for 0.5 s.

Action Taken When the DTC Sets

DTC P12A6 is a Type A DTC.

Conditions for Clearing the DTC

DTC P12A6 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Description and Operation

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P12A6 is not set.
   - **If the DTC is set**

     Refer to Circuit/System Testing.

   - **If the 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.

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- **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, disconnect the harness connector at the K111 Fuel Pump Driver Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Ignition ON for 10 s.
3. Verify that a test lamp does not illuminate between the control circuit terminal 2 and ground.
   - **If the test lamp illuminates**
   1. Ignition OFF, remove the test lamp, disconnect the harness connector X1 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 X1 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 2 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.

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- **If Malfunction is not displayed**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector X1 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. Replace the K111 Fuel Pump Driver Control Module.

Repair Instructions

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

- Refer to **Fuel Pump Power Control Module Replacement** for K111 Fuel Pump Driver Control Module replacement.
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup.

DTC P135A OR P135B: IGNITION COIL SUPPLY VOLTAGE CIRCUIT BANK 1/IGNITION COIL SUPPLY VOLTAGE CIRCUIT BANK 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 Descriptor

DTC P135A

Ignition Coil Supply Voltage Circuit Bank 1

DTC P135B

Ignition Coil Supply Voltage Circuit Bank 2

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P135A, P135B, *	P0300, P135A, P135B, **	P0690	-
* The engine cranks but does not run and opens the fuse that supplies voltage to the ignition coils. ** The engine cranks but does not run or will misfire on the affected cylinder.				

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 engine does not start after 5 engine revolutions.
- 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.

Action Taken When the DTC Sets

DTC P135A and P135B are Type A DTCs.

Conditions for Clearing the DTC

DTC P135A and P135B are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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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 appropriate 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.

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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 appropriate ignition circuit terminal listed below and ground.
    - Terminal 62
    - Terminal 67
    - **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.

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- 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** 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
- Engine idle speed
- Catalyst temperature

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, P0125, P0128, P0201-P0208, P0222, P0223, P0261, P0262, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0279, P0280, P0282, P0283, P0300-P0308, P0335, P0336, P0351-P0358, P0502, P0503, P0506, P0507, P0641, P0651, P0697, P06A3, P0722, P0723, P182E, P1915, P2122,

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P2123, P2127, P2128, P2135, P2138, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2313, P2315, P2316, P2318, P2319, P2321, and P2322 are not set.

- The engine coolant temperature (ECT) is between -17-43Â°C (63-109Â°F).
- The calculated 3-way catalyst temperature is colder than 300Â°C (572Â°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 800Â°C (1472Â°F) when the engine run time is greater than 1 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 10 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**

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. 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. 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:

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- 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.

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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.

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- **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 THROTTLE ACTUATOR POSITION PERFORMANCE/MINIMUM THROTTLE POSITION 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 Descriptors

DTC P1516

Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance

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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	Open/High Resistance	Short to Voltage	Signal Performance
Control Closed	P2101	P2101	P0690, P2101	P1516, P2101, P2176
Control Open	P2119	P2101	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 (TP) 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 TP 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 TP sensor information is transmitted between the throttle body and the ECM on the signal/serial data circuit. The ECM decodes the serial data signal into separate voltages which are displayed on a scan tool as the voltage inputs from TP sensors 1 and 2.

The ECM controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the TP sensor signal/serial data circuit to determine the actual throttle valve position.

Conditions for Running the DTC

P1516

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- DTC 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 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 6.41 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 6.41 V and reduced power is not active.
- The throttle minimum learn is active.
- DTC P2176 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P1516

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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 (TP) sensors were greater than a predetermined voltage during the minimum throttle learn procedure for greater than 2 s.

Action Taken When the DTC Sets

- DTCs P1516, 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

- DTCs P1516, P2101, and P2176 are type A DTCs.
- DTC P2119 is a type C DTC.

Diagnostic Aids

- Depending on the scan tool Start-Up ECT parameter, 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 scan tool Desired and Actual Throttle positions should closely match.

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- Inspect for a condition in which the throttle valve may have been held open. For example, ice may have formed in the throttle bore causing the throttle valve not to close.
- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- A low battery condition may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

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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 minutes for all vehicle systems to power down.
6. Ignition ON.
7. Verify the scan tool TAC Motor parameter displays Enabled while slowly depressing the accelerator pedal.
   - **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.

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- **If Enabled is not displayed**

  Replace the Q38 Throttle Body.

- **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 Assembly:

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

   - A throttle blade that is not in the rest position
   - A throttle blade that is binding open or closed
   - A throttle blade that is free to move open or closed without spring pressure
   - **If a condition is found**

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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. Ignition OFF, disconnect the harness connector at the Q38 Throttle Body.

NOTE:
- **Before testing each circuit, the ignition must be OFF and the ECM completely powered down.**
- **The test lamp must be connected to the circuit before turning the ignition ON, or incorrect diagnosis may occur.**

4. Connect a test lamp between a motor control circuit listed below and ground.
   - TAC Motor Control Open circuit terminal 1
   - TAC Motor Control Closed circuit terminal 2

NOTE:
- **The test lamp should illuminate then immediately turn OFF as the ignition is switched to the ON position.**
- **Be prepared to observe the test lamp as the ignition is switched ON.**

5. Ignition ON, verify that a test lamp does not illuminate continuously after the ignition is switched to ON.
   - **If the test lamp illuminates continuously**
   1. Ignition OFF, disconnect the appropriate harness connector at the K20 Engine Control Module and remove the test lamp, ignition ON.
   2. Test for less than 1 V between the control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the appropriate harness connector at the K20 Engine Control Module and remove the test lamp.
   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.

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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 illuminates then turns OFF with ignition ON.**

6. Ignition OFF, remove the test lamp. Set the DMM to the 40 V scale or higher, select the Min/Max Recording Mode, and set the Peak Min/Max response time to 1 ms or faster.

NOTE:

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

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 and ground, as the ignition is turned ON.
    - TAC Motor Control Open circuit terminal 1
    - TAC Motor Control Closed circuit terminal 2
    - **If not within 3 V of B+**
    1. Ignition OFF, disconnect the appropriate 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 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.

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2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
5. Ignition ON.
6. Verify the scan tool TAC Motor parameter displays Enabled while performing the Throttle Sweep Test with a scan tool.
    - **If Enabled is not displayed**

      Test or replace the Q38 Throttle Body.

    - **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). The ECM monitors the current

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required to control fuel pressure regulator 1 and compares the current value to calibrated low and high thresholds.

Conditions for Running the DTC

- DTCs P0010, P0011, P0016, P0089, P0090, P0091, P0092, P0096, P0097, P0098, P0099, P00C8, P00C9, P00CA, P0117, P0118, P0178, P0179, P018B, P018C, P018D, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341, or P1692 are not present.
- Fuel rail pressure is greater than 0.275 MPa (40 PSI).
- Battery voltage is greater than 11 V.
- Fuel temperature is between -10Â°C (14Â°F) and 100Â°C (212Â°F).
- Intake air temperature is greater than -10Â°C (14Â°F).
- The engine has been running for greater than 2 m.
- Barometric pressure is greater than 70 kPa.
- Vehicle is not in a low fuel state.
- DTC P163A runs continuously when the above conditions are met.

Conditions for Setting the DTC

The engine control module detects a condition with the integrated circuits of the high pressure fuel pump actuator driver module or the engine control module detects that the current used to drive the high pressure fuel pump actuator is out of range for greater than 1 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

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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 DTCs P0010, P0011, P0016, P0089, P0090, P0091, P0092, P0096, P0097, P0098, P0099, P00C8, P00C9, P00CA, P0117, P0118, P0178, P0179, P018B, P018C, P018D, P0192, P0193, P0231, P0232, P023F, P0335, P0336, P0340, P0341, or P1682 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**

     Refer to Circuit/System Testing.

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- **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 G18 High Pressure Fuel Pump. It may take up to 2 min for all vehicle systems to power down.
2. Ignition ON.
3. Verify that a test lamp does not illuminate between the high control circuit terminal 1 and ground.
    - **If the test lamp illuminates**
    1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the high 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. Verify that a test lamp does not illuminate between the low control circuit terminal 2 and ground.
    - **If the test lamp illuminates**
    1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the low 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+.
    - **If the test lamp illuminates**
    1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the high 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. Verify that a test lamp does not illuminate between the low control circuit terminal 2 and B+.

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- **If the test lamp illuminates**

1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the low 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**

7. Remove the test lamp, connect a 3 A fused jumper wire between the high control circuit terminal 1 and ground.
8. Verify the Fuel Pressure Regulator 1 High Control Circuit Low Voltage Test Status transitions from OK to Malfunction.

- **If Malfunction is not displayed**

1. Ignition OFF, remove the fused jumper, disconnect the harness connector X3 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.

- **If Malfunction is displayed**

9. Connect a 3 A fused jumper wire between the low control circuit terminal 2 and B+.
10. Verify the Fuel Pressure Regulator 1 Control Circuit High Voltage Test Status transitions from OK to Malfunction.

- **If Malfunction is not displayed**

1. Ignition OFF, remove the fused jumper, disconnect the X3 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.

- **If Malfunction is displayed**

11. 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 0.34 - 0.44 Ω at 20Â°C (68Â°F) between the low control circuit terminal 2 and the high control circuit terminal 1.

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- **If not within the specified range**

  Replace the G18 High Pressure Fuel Pump.

- **If within the specified range**

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** for G18 High Pressure Fuel Pump replacement
- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

NOTE: **Some vehicles do not support the Fuel Rail Pressure Relief Valve Reset procedure. Applications not supporting this procedure will return an error message stating "Parameter ID not supported. Check for proper vehicle selection."**

- Perform the Fuel Rail Pressure Relief Valve Reset procedure.

DTC P2096-P2099: POST CATALYST FUEL TRIM 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 P2096

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Post Catalyst Fuel Trim System Low Limit Bank 1

DTC P2097

Post Catalyst Fuel Trim System High Limit Bank 1

DTC P2098

Post Catalyst Fuel Trim System Low Limit Bank 2

DTC P2099

Post Catalyst Fuel Trim System High Limit Bank 2

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, P0030, P0036, P0053, P0054, P0056, P0059, P0060, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0131-P0135, P0137, P0138, P013A, P013B, P013C, P013D, P013E, P013F, P0140, P0141, P0151- P0155, P0157, P0158, P015A, P015B, P015C, P015D, P0160, P0161, P0178, P0179, P0201-P0208, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0340, P0341, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0458, P0459, P0496, P0498, P0499, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P219A, P219B, P2227, P2228, P2229, P2269, P2270, P2271, P2272, or P2273 is not set.
- The barometric pressure is greater than 70 kPa (10.2 PSI).
- The manifold absolute pressure is between 0-200 kPa (0-29 PSI).
- The intake air temperature is between -20Â°C and +200Â°C (-4 and +392Â°F).
- The start up engine coolant temperature is warmer than -20Â°C (-4Â°F).
- The fuel control intrusive diagnostics are not active.
- The power take-off is not active, if equipped.
- The engine is operating under light acceleration, heavy acceleration, or cruise conditions.

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- DTCs P2096, P2097, P2098, and P2099 run continuously when the conditions above have been met.

Conditions for Setting the DTC

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

Action Taken when the DTC Sets

DTCs P2096, P2097, P2098, and P2099 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2096, P2097, P2098, and P2099 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**

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no other 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, P2097, P2098, or P2099 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, P2097, P2098, or P2099 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing.

   - **If no DTC is set**
6. All OK.

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Circuit/System Testing

Verify none of the conditions listed below exist:

P2096 or P2098

- Air intake duct collapsed or restricted.
- Air filter dirty or restricted.
- Contamination of the mass air flow sensor with oil or other foreign material
- 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** .
- Improper operation of the crankcase ventilation system.

P2097 or P2099

- Exhaust system leaks. Refer to **Symptoms - Engine Exhaust** .
- Split, kinked or improperly connected vacuum hoses.
- Contamination of the mass air flow sensor with oil or other foreign material
- 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.
- Engine vacuum leaks.

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- 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 SENSOR 1 CIRCUIT VOLTAGE/ACCELERATOR PEDAL POSITION SENSOR 2 CIRCUIT VOLTAGE/ACCELERATOR PEDAL POSITION 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 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

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Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

DTC P2138

Accelerator Pedal Position (APP) Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Accelerator Pedal Position (APP) Sensor 1 5 V Reference Circuit	P06A3	P2138	P2122	P06A3	P2138
Accelerator Pedal Position (APP) Sensor 2 5 V Reference Circuit	P0106, P0108, P0107, P0697	P2138	P2127	P0106, P0108, P0697	P2138
Accelerator Pedal Position (APP) Sensor 1 Signal	P2122	P2138	P2122	P2123, P2138	P2138
Accelerator Pedal Position (APP) Sensor 2 Signal	P2127	P2138	P2127	P2128, P2138	P2138
Accelerator Pedal Position (APP) Sensor 1 Low Reference	-	P2138	P2123	-	P2138
Accelerator Pedal Position (APP) Sensor 2 Low Reference	-	P2138	P2128	-	P2138

Typical Scan Tool Data

APP Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle. **Parameter Normal Range:** APP Sensor 1 0.88-1.08 V			
5 V Reference	0.00 V	0.00 V	2-3 V
Signal	0.00 V	0.00 V	4-5 V
Low Reference	-	4-5 V	-

APP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle.			

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Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: APP Sensor 2 0.39-0.59 V			
5 V Reference	0.00 V	0.00 V	1-3 V
Signal	0.00 V	0.00 V	2-5 V
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 change relative to pedal position. The engine control module (ECM) supplies each APP sensor with a 5 V reference circuit, a low reference circuit, and a signal circuit.

Both the APP sensors 1 and 2 signal percentages increase as the pedal is depressed, from approximately 0 percent at rest to above 95 percent when fully depressed.

Vehicles equipped with a M5U-8L90 transmission utilize a 2 stage APP sensor that contains an electro-mechanical switch. The switch signals the TCM to request a full detent downshift at or near wide open throttle (WOT).

Conditions for Running the DTC

P2122, P2123, P2127, or P2128

- DTC P06A3 or P0697 are not set.
- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 6.41 V.
- The DTCs run continuously when the above conditions are met.

P2138

- DTCs P06A3, P0697, P2122, P2123, P2127, or P2128 are not set.
- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 6.41 V.
- The ECM is not commanding reduced power.
- The DTC runs continuously when the above conditions are met.

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Conditions for Setting the DTC

P2122

The ECM detects that the APP sensor 1 voltage is less than 0.46 V for less than 1 s.

P2123

The ECM detects that the APP sensor 1 voltage is greater than 4.75 V for less than 1 s.

P2127

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

P2128

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

P2138

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

OR

The ECM detects that both APP sensor 1 and APP sensor 2 are 5 percent greater than the learned minimum position for less than 1 s.

Action Taken When the DTC Sets

- DTCs P2122, P2123, P2127, P2128, and P2138 are Type A DTCs.
- The ECM commands the TAC system to operate in a Reduced Engine Power mode.

Conditions for Clearing the DTC

DTCs P2122, P2123, P2127, P2128, and P2138 are Type A DTCs.

Diagnostic Aids

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

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and cause a DTC to set.

- Vehicles equipped with a M5U-8L90 transmission utilize a 2 stage APP sensor that contains an electro-mechanical switch. Additional effort is required to depress the pedal to WOT in order overcome the additional spring tension at or near 100% throttle.

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.

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

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

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

3. Verify the APP Sensor 1 Circuit Status and APP Sensor 2 Circuit Status displays OK.
   - **If OK is not displayed**

     Refer to Circuit/System Testing.

   - **If OK is displayed**
4. Verify the scan tool APP Sensor 1 and 2 Agree/Disagree parameter displays Agree while performing the tests listed below:
   - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
   - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.
   - **If Agree is not displayed**

     Refer to Circuit/System Testing.

   - **If Agree is displayed**
5. Verify that DTC P2122, P2123, P2127, P2128, or P2138 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

   - **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.

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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 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between each low reference circuit terminal listed below and ground.
    - Low reference circuit terminal F
    - Low reference circuit terminal A
    - **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 each 5 V reference circuit terminal listed below and ground.
    - 5 V reference circuit terminal D
    - 5 V reference circuit terminal C
    - **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.

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- If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**

5. Verify each APP sensor voltage parameter is less than 0.2 V.
   - **If 0.2 V or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit terminal listed below and ground.
   - APP sensor 1 signal circuit terminal E
   - APP sensor 2 signal circuit terminal B
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.
   - **If less than 0.2 V**
6. Install a 3 A fused jumper wire between the appropriate signal circuit terminal listed below and a 5 V reference circuit terminal D or C.
   - APP sensor 1 signal circuit terminal E
   - APP sensor 2 signal circuit terminal B
7. Verify the scan tool APP Sensor 1 or 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.

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

DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, OR P217F: CYLINDERS (1-8) INJECTOR HIGH CONTROL CIRCUIT 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 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

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Cylinder 4 Injector High Control Circuit Low Voltage

DTC P2157

Cylinder 4 Injector High Control Circuit High Voltage

DTC P216B

Cylinder 5 Injector High Control Circuit Low Voltage

DTC P216C

Cylinder 5 Injector High Control Circuit High Voltage

DTC P216E

Cylinder 6 Injector High Control Circuit Low Voltage

DTC P216F

Cylinder 6 Injector High Control Circuit High Voltage

DTC P217B

Cylinder 7 Injector High Control Circuit Low Voltage

DTC P217C

Cylinder 7 Injector High Control Circuit High Voltage

DTC P217E

Cylinder 8 Injector High Control Circuit Low Voltage

DTC P217F

Cylinder 8 Injector High Control Circuit High Voltage

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Control Cylinder 1	P0261	P0201	P0262	P1248
High Control Cylinder 1	P2147	P0201	P2148	P1248
Low Control Cylinder 2	P0264	P0202	P0265	P1249
High Control Cylinder 2	P2150	P0202	P2151	P1249
Low Control Cylinder 3	P0267	P0203	P0268	P124A
High Control Cylinder 3	P2153	P0203	P2154	P124A
Low Control Cylinder 4	P0270	P0204	P0271	P124B
High Control Cylinder 4	P2156	P0204	P2157	P124B
Low Control Cylinder 5	P0273	P0205	P0274	P124C
High Control Cylinder 5	P216B	P0205	P216C	P124C
Low Control Cylinder 6	P0276	P0206	P0277	P124D
High Control Cylinder 6	P216E	P0206	P216F	P124D
Low Control Cylinder 7	P0279	P0207	P0280	P124E
High Control Cylinder 7	P217B	P0207	P217C	P124E
Low Control Cylinder 8	P0282	P0208	P0283	P124F
High Control Cylinder 8	P217E	P0208	P217F	P124F
DTC P0300 may also be present for all fault conditions				

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 present.
- Engine is running.
- Ignition voltage is greater than 11 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

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P2147, P2150, P2153, P2156, P216B, P216E, P217B, or P217E

The engine control module detects the fuel injector high voltage supply circuit is shorted to ground for greater than 2 s.

P2148, P2151, P2154, P2157, P216C, P216F, P217C, or P217F

The engine control module detects the fuel injector high voltage supply circuit is shorted to voltage for greater than 2 s.

Action Taken When the DTC Sets

DTCs P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, and P217F are Type A DTCs.

Conditions for Clearing the DTC

DTCs P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, and P217F are Type A DTCs.

Diagnostic Aids

- The MIL indicator flashes when there is an engine misfire.
- High resistance in the circuits of the fuel injectors may set a misfire DTC without setting an injector DTC. Test the fuel injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- 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

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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 P062B is not set.
   - **If the DTC is set**

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

   - **If the DTC is not set**

   NOTE: The engine must be running for the injector circuit status parameters to function.

3. Engine idling.
4. Verify with a scan tool 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

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- Cylinder 4 Injector Control Circuit Status
- Cylinder 5 Injector Control Circuit Status
- Cylinder 6 Injector Control Circuit Status
- Cylinder 7 Injector Control Circuit Status
- Cylinder 8 Injector Control Circuit Status
- **If OK or Not Run is not displayed**

  Refer to Circuit/System Testing.

- **If OK or Not Run 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 set**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the X3 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 high 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 high control circuit and ground.
      - If less than infinite, repair the short to ground in the circuit.
      - If infinite, test or replace the Q17 Fuel Injector.
   - **If infinite resistance**
3. Ignition ON.

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4. Test for less than 1 V between the Q17 Fuel Injector high 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 high 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 low control circuit.
    - **If less than 1 V**
5. Test or replace the K20 Engine Control Module.

Component Testing

- Refer to **Fuel Injector Diagnosis**
- Refer to **Fuel Injector Balance Test**

Repair Instructions

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

- Refer to **Fuel Injector Replacement**
- Refer to **Control Module References** for K20 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

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IAT 1 Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0113, P0114, P2199*	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199, P2227, P2228, P2229	P0113, P0114, P2199, P2227, P2229*	-
*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, P00F4, P0102, P0178, P2199	P0096, P0097, P00F4, P0101, P0102, P2199, P2230	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P00F4, P0102, P2199, P2230	-	P0096, P0102
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT 1 Sensor

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature; and engine bay conditions			
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

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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 sensors listed below are integrated within the mass air flow/multifunction intake air sensor:

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

The intake air temperature (IAT) sensor 1 is a variable resistor that changes the voltage on the engine control module (ECM) supplied 5 V signal circuit. The signal varies with inlet air temperature in the sensor bore and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 2 and the humidity sensor share the same circuit. The IAT sensor 2 signal is displayed by the scan tool as Hertz (Hz) and Â°C (Â°F).

The sensors listed below share an ECM supplied 5 V reference circuit:

- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

The sensors listed below share an ECM supplied low reference circuit:

- IAT sensor 1

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- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) 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	-40Â°C (-40Â°F)
Warm	302 Hz	104Â°C (219Â°F)

Conditions for Running the DTC

- DTC P1682 is not set.
- The ignition is ON.
- Ignition voltage is at least 11 V.
- 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 55Â°C (99Â°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

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- With the ignition ON, the engine OFF and 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; -40Â°C (-40Â°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

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

Special Tools

EL-38522-A Variable Signal Generator

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For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service 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 25Â°C (45Â°F) of each other.
    - Start-Up IAT Sensor 1
    - Start-Up IAT Sensor 2
    - Start-Up ECT
    - **If not within 25Â°C (45Â°F)**

      Refer to Circuit/System Testing.

    - **If within 25Â°C (45Â°F)**
3. Engine idling, verify the following scan tool parameters are between -38 to +149Â°C (-36 to +300Â°F).
    - IAT Sensor 1
    - IAT Sensor 2
    - ECT Sensor
    - **If not between -38 to +149Â°C (-36 to +300Â°F)**

      Refer to Circuit System Testing.

    - **If between -38 to +149Â°C (-36 to +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 DTC does not set.
    - **If any DTC sets**

      Refer to Circuit/System Testing.

    - **If no DTC sets**

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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 conditions listed below exist:
   - 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 and all systems OFF, it may take up to for 2 min for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
3. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
   - **If 2 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 or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **If less than 2 Ω**
4. Test for less than 2 Ω between the ground circuit terminal 7 and ground.
   - **If 2 Ω or greater**
   1. 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 or high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.

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- **If less than 2 Ω**

5. Ignition ON.
6. 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**
7. Ignition ON.
8. Verify the scan tool IAT Sensor 1 parameter is colder than -39Â°C (-38Â°F).
    - **If warmer than -39Â°C (-38Â°F).**
    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 colder than -39Â°C (-38Â°F).**
9. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3, ignition ON.
10. Verify the scan tool IAT Sensor 1 parameter is warmer than 149Â°C (300Â°F).
    - **If colder than 149Â°C (300Â°F).**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.

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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).**

11. Ignition ON.
12. 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 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, 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**

13. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.

- **EL-38522-A, Variable Signal Generator; or equivalent is not available**

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1. Test or replace the B75C Multifunction Intake Air Sensor.
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**

      Replace the K20 Engine Control Module.

    - **If no DTCs set**
4. All OK.

- **EL-38522-A, Variable Signal Generator; or equivalent is available**

14. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as listed below:
    - Red lead to the signal circuit terminal 8 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
15. Set the **EL-38522-A** Variable Signal Generator to the specifications listed below:
    - Signal switch to 5 V
    - Duty Cycle switch to 50% (Normal)
    - Frequency switch to 30 Hz
16. Ignition ON.
17. 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**
18. Test or replace the B75C Multifunction Intake Air Sensor.

Component Testing

Multifunction Intake Air Sensor - IAT Sensor 1

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

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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** table for Hitachi Sensors. The resistance values should be in range of the table values.
   - **If not within the table values.**

     Replace the B75C Multifunction Intake Air sensor.

   - **If within the table values.**
3. All OK

Multifunction Intake Air Sensor - IAT Sensor 2

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 5%**

     Replace the B75C Multifunction Intake Air sensor.

   - **If within 5%**
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 OR P219B: 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.

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DTC Descriptor

DTC P219A

Fuel Trim Cylinder Balance Bank 1

DTC P219B

Fuel Trim Cylinder Balance Bank 2

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, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0122, P0123, P0128, P0201-P0208, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300, P0301-P0308, P0340, P0341, P0442, P0455, P0458, P0496, P1248, P1249, P124A, P124B, P124C, P124D, P124E, P124F, P16F3, P2101, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, or P217F are not set.
- The evaporative emission system device control and intrusive diagnostics are not active.
- The engine overspeed protection is not active.
- The power take-off is not active, if equipped.
- The engine is in closed loop status.
- The system voltage is greater than 10 V.
- The engine coolant temperature is warmer than -20Â°C (-4Â°F).
- The engine speed is between 800-3,750 RPM.
- The mass air flow is between 5-1,000 g/s.
- Engine run time is greater than 25 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

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Multiple samples of the pre-catalyst HO2S accumulated voltage are consistently greater than the desired value.

Action Taken When the DTC Sets

DTCs P219A and P219B are Type A DTCs.

Conditions for Clearing the MIL/DTC

DTCs P219A and P219B are Type A DTCs.

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

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- **Circuit Testing**
- **Troubleshooting with a Test Lamp**
- **Testing for Intermittent Conditions and Poor Connections**

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- **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 or P219B 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 or P219B is not set.
    - **If a DTC is set**

      Refer to Circuit/System Testing.

    - **If no DTC is set**
6. All OK.

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Circuit/System Testing

1. Engine idling, transmission in Park or Neutral, verify the manifold absolute pressure (MAP) sensor parameter is between 19-42 kPa (2.7-6 PSI).
    - **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.
    - Improper operation of the 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** .
    - Malfunctioning 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.
    - Malfunctioning 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.

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- 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, P0340, P0452, P0532, P0641, P127C, P2227, P2228	P2227, P2228	P018D, P0193, P0453, P0523, P0533, P0641, P127D, P2227, P2229	P2227
Signal	P2227, P2228	P2227, P2228	P2227, P2229	P2227
Low Reference	-	P0113, P2199, P2227, P2229	-	P2227

Typical Scan Tool Data

BARO

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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 engine control module (ECM) an indication of barometric pressure. The ECM uses this information to calculate fuel delivery. The BARO sensor provides a voltage signal to the ECM relative to the atmospheric pressure changes. The ECM monitors the BARO sensor signal for a voltage outside of the normal range.

Conditions for Running the DTC

P2227

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0222, P0223, P1516, P2101, P2135, P2228, or P2229 is not set.
- Engine is running for greater than 30 s.

OR

- DTC P0106, P0107, P0108, P0697, P06A3, P2122, P2123, P2127, P2128, P2138, P2228, P2229, P2230, or P2610 is not active.
- DTC P0107, P0108, P0697, P06A3, P2122, P2123, P2127, P2128, P2138, P2228, or P2229 is not pending.
- Engine is OFF for at least 5 s.
- 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

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- 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

- Engine running
- The ECM detects that the difference between the actual BARO and the calculated BARO is greater than 15 kPa when distance since last estimated BARO update is at most 0.1 km (0.6 mi).

  OR

- The ECM detects that the difference between the actual BARO and the calculated BARO is greater than 20 kPa when distance since last estimated BARO update is greater than 0.1 km (0.6 mi).

  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.

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Conditions for Clearing the MIL/DTC

DTCs P2227, P2228, P2229, and P2230 are Type B DTCs.

Reference Information

Schematic Reference

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Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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**

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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**

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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.

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- 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 P2269: WATER IN FUEL

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 P2269

Water in Fuel

Circuit/System Description

Alcohol content information is supplied to the engine control module (ECM) from the fuel composition sensor. The fuel composition sensor has a battery positive circuit, a signal circuit, and a ground circuit. The fuel composition sensor uses a microprocessor inside the sensor to measure the ethanol percentage and changes the output signal accordingly. The signal circuit carries the ethanol percentage via the frequency signal. The ECM provides an internal pull up to 5 V on the signal circuit, and the fuel composition sensor pulls the 5 V to ground in pulses. The normal range of operating frequency is between 50-150 Hz. The microprocessor inside the fuel composition sensor is capable of a certain amount of self-diagnosis. An output frequency between 180 Hz and 190 Hz indicates that the fuel is contaminated.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The DTC runs continuously when the above condition is met.

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Conditions for Setting the DTC

The engine control module detects that the fuel composition sensor output frequency is greater than 185 Hz for greater than 6 s.

Action Taken When the DTC Sets

DTC P2269 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2269 is a Type B DTC.

Diagnostic Aids

A momentary slug of water in the fuel system may set this DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **J 38522-A** Variable Signal Generator
- **J 44175-A** Fuel Composition Tester

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service Tools)** .

Circuit/System Verification

1. Engine running.
2. Verify the scan tool Fuel Composition Sensor parameter is between 50-150 Hz.
   - **If not between 50-150 Hz**

     Refer to Circuit/System Testing.

   - **If between 50-150 Hz**
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.
   - **If DTC is set**

     Refer to Circuit/System Testing.

   - **If DTC is not set**
4. All OK.

Circuit/System Testing

1. Verify that there are no contaminants, water, or too high of a concentration of ethanol in the fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** and the J 44175-A Instruction Manual.
   - **If the fuel tested is not within acceptable levels**

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Refer to **Fuel System Cleaning** .

- **If the fuel tested within acceptable levels**

2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B198 Fuel Composition Sensor. It may take up to 2 min for all vehicle systems to power down.
3. Test for less than 5 Ω between the ground circuit terminal 2 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 ground connection.
    - **If less than 5 Ω**
4. Ignition ON.
5. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
    - **If the test lamp does not illuminate and the fuse is not opened**
    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 good and voltage is supplied to the fuse.
    - **If the test lamp does not illuminate and the fuse is opened**
    1. Ignition OFF, remove the test lamp.
    2. Test for infinite resistance between the B+ circuit and ground
        - If less than infinite, repair the short to ground in the circuit.
        - If infinite, test all the components connected to the circuit, and repair or replace as necessary.
    - **If the test lamp illuminates**
6. Remove the test lamp.
7. Ignition ON, 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 X1 harness connector at the K20 Engine Control Module.

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2. 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, test or replace the K20 Engine Control Module.
- **If greater than 5.2 V**

1. Ignition OFF, disconnect the X1 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, test or replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**

8. Ignition OFF, connect the **J 38522-A** Variable Signal Generator as instructed below:
    1. Connect the red lead to the signal circuit terminal 3 at the B198 Fuel Composition Sensor harness connector.
    2. Connect the battery voltage supply lead to B+.
    3. Connect the black lead to ground.
    4. Set the signal to 5 V.
    5. Set the frequency to 60 Hz.
    6. Set the Duty Cycle to Normal.
    7. Ignition ON.
9. Verify the scan tool Fuel Composition Sensor parameter is at 60 Hz.
    - **If not 60 Hz**

      Test or replace the K20 Engine Control Module.

    - **If 60 Hz**
10. Test or replace the B198 Fuel Composition Sensor.

Component Testing

1. Test the fuel composition using the **J 44175-A** Fuel Composition Tester and the J 44175-A Instruction Manual. Record the frequency.
2. Compare the special tool test frequency and the scan tool Fuel Composition Sensor frequency parameter.
3. Verify the difference between the tool and the sensor is 12 Hz or less.
    - **If greater then 12 Hz**

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Replace the B198 Fuel Composition Sensor.

- **If 12 Hz or less**

4. All OK.

Repair Instructions

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

- Refer to **Flexible Fuel Sensor Replacement** for B198 Fuel Composition Sensor replacement
- Refer to **Fuel System Cleaning**
- Perform the scan tool Fuel Composition Reset after completing the repair
- Refer to **Control Module References** for K20 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.

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- 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** .

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- **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 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 P2618

Crankshaft Position Signal Output Circuit Low Voltage

DTC P2619

Crankshaft Position Signal Output Circuit High Voltage

Diagnostic Fault Information

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B0560 08, P2618	B0560 08	B0560 08, P2619	-

Circuit/System Description

The engine control module (ECM) has a dedicated crankshaft position sensor signal circuit to the audio amplifier which controls the active noise cancellation feature. This output is used for active noise cancellation control based on engine speed.

Conditions for Running the DTC

P2618

- Ignition ON.
- Engine not running.
- ECM crankshaft position sensor signal circuit is commanded high.

P2619

- Ignition ON.
- Engine not running.
- ECM crankshaft position sensor signal circuit is commanded low.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P2618

The ECM detects a short to ground in the dedicated crankshaft position sensor signal circuit to the audio amplifier.

P2619

The ECM detects a short to voltage in the dedicated crankshaft position sensor signal circuit to the audio amplifier.

Action Taken When the DTC Sets

DTCs P2618 and P2619 are Type C DTCs.

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Conditions for Clearing the DTC

DTCs P2618 and P2619 are Type C DTCs.

Reference Information

Schematic Reference

Active Noise Cancellation Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Active Noise Cancellation 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. Engine Running.
2. Verify the scan tool parameters listed below do not display Malfunction:
    - Crankshaft Position Signal Output Circuit Low Voltage Test Status

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- Crankshaft Position Signal Output Circuit Open Test Status
- Crankshaft Position Signal Output 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 set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X3 harness connector at the T3 Audio Amplifier.
2. Engine Running at 600-700 RPM.
3. Test for 550-750 Hz AC between the signal circuit terminal 2 and ground.
   - **If not between 550-750 Hz AC**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   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. 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.
   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.

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- If less than 2 Ω, replace the K20 Engine Control Module.
- **If between 550-750 Hz AC**

4. Replace the T3 Audio Amplifier.

Repair Instructions

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

Refer to **Control Module References** for engine control module (ECM) or audio amplifier replacement, programming, and setup

DTC P2635: FUEL PUMP FLOW 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 P2635

Fuel Pump Flow Performance

Circuit/System Description

The engine control module (ECM) supplies voltage to the fuel pump driver control module when the ECM detects that the ignition is on. The voltage from the ECM to the fuel pump driver control module remains active for 2 s, unless the engine is in crank or run. While this voltage is being received, the fuel pump driver control module closes the ground switch of the fuel pump. The fuel pump driver control module maintains correct fuel pressure based on the information from the fuel pressure sensor and varying the pulse width modulated controlled current to the fuel pump.

Conditions for Running the DTC

- DTC P018B, P018C, P018D, P0231, P0232, P023F, P0641, P0606, P1255, P129E, or P12A6 are not active.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The ignition voltage is between 11-32 V.
- The engine has been running for greater than 30 s.

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- The engine fuel flow is not 0.
- Low fuel level warning not present.
- The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

The fuel pump driver control module detects a difference of Â± 60 kPa (8.7 PSI) at 400 kPa (58 PSI) request or Â±45 kPa (6.5 PSI) at 300 kPa (43.5 PSI) request between the desired fuel pressure and the actual fuel pressure for approximately 10 s.

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

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Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC U18A2 is not set or stored in history.
   - **If DTC U18A2 is set or stored in history**

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

   - **If DTC U18A2 is not set or stored in history**
3. Verify that DTC P018B, P018C, P018D, P0231, P0232, P023F, P0641, P0606, P1255, P129E, or P12A6 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**
4. Verify 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.

   - **If less than 1.5**

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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. Verify 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.

   - **If less than 45 kPa (6.5 PSI)/60 kPa (8.7 PSI)**
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

NOTE: **Do not replace the Fuel Pump Driver Control Module based on a history DTC P2635. DTC P2635 may be stored but that does not indicate a failure of the Fuel Pump Driver Control Module. Refer to Strategy Based Diagnosis for further history DTC diagnostics.**

1. Verify the proper fuel system pressure. Refer to **Fuel System Diagnosis** .
   - **If the fuel pressure is not normal**

     Repair the fuel system as necessary.

   - **If the fuel pressure is normal**
2. All OK.

Repair Instructions

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

- Refer to **Fuel Feed Hose Replacement**
- Refer to **Fuel Injector Replacement**
- Refer to **Fuel Pump Replacement**
- Refer to **Fuel Tank Fuel Pump Module Replacement (SWB)** **Fuel Tank Fuel Pump Module Replacement (LWB)**
- Perform the Fuel Pump Trim Reset procedure with a scan tool after the repair.

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 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.

   - **If less than 1.5**

   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.

7. Verify 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.

   - **If less than 45 kPa (6.5 PSI)/60 kPa (8.7 PSI)**
8. All OK.

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DTC P3400: CYLINDER DEACTIVATION 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 P3400

Cylinder Deactivation System

Circuit/System Description

The cylinder deactivation system is used to deactivate 4 cylinders of the engine under light load driving conditions. The Engine Control Module (ECM) commands the cylinder deactivation solenoid valves ON to deactivate engine cylinders 1, 7, 6, and 4, switching to 4 cylinders or V4 mode. The cylinder deactivation solenoid valves control the oil flow to the appropriate valve lifters. The engine operates on 8 cylinders or V8 mode, during engine starting, engine idling, and medium to heavy throttle conditions.

Ignition voltage is supplied directly to the cylinder deactivation solenoid valves. The ECM controls the cylinder deactivation solenoid valves by grounding the control circuit with a solid state device called a driver.

The Cylinder Deactivation System Performance diagnostic is a test of the internal mechanical condition of the engine, during operation in V4 mode. The ECM determines the internal mechanical condition of the engine through the actual measured values of the Mass Air Flow (MAF) sensor, the intake Manifold Absolute Pressure (MAP) sensor, and the Throttle Position Sensor (TPS). The actual measured values of the 3 sensors are then compared to the calculated values for V4 mode and stored in the ECM. If the measured values are incorrect for V4 mode, the ECM may set this code and return to V8 mode operation.

Conditions for Running the DTC

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0119, P0335, and P0336 are not set.
- The engine speed is between 450-5,600 RPM.
- The Engine Coolant Temperature (ECT) Sensor parameter is between -7 to +129Â°C (19 to 264Â°F).
- The Intake Air Temperature (IAT) Sensor is between -20 to 129Â°C (-4 to 264Â°F).
- Time in V8 mode is greater than 2 s.

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- Time in V4 mode is greater than 2 s.
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The engine control module detects that the actual measured values from the MAF sensor, MAP sensor, and throttle position sensor, are not within the range of the calculated values for V4 mode.

Action Taken When the DTC Sets

- DTC P3400 is a Type B DTC.
- The engine will return to V8 mode.

Conditions for Clearing the DTC

DTC P3400 is a Type B DTC.

Diagnostic Aids

- This DTC will not set during engine idling conditions. The vehicle will need to be driven for the DTC to set.
- A restricted valve lifter oil filter may cause DTC P3400 to set. Inspect the valve lifter oil filter for a restriction or blockage. Refer to **Valve Lifter Oil Filter Replacement** .

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cylinder Deactivation (Active Fuel Management) System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0201-P0208, P0351-P0358, P3401, P3403, P3404, P3425, P3427, P3428, P3441, P3443, P3444, P3449, P3451, or P3452 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. Engine idling at the normal operating temperature.
4. Verify there is no abnormal engine noise.
   - **If there is an abnormal engine noise**

     Refer to **Symptoms - Engine Mechanical** for further diagnosis.

   - **If no abnormal engine noise**
5. Clear all DTCs using scan tool. 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**

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Refer to Circuit/System Testing.

- **If the DTC is not set**

7. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q43 Valve Lifter Oil Manifold Assembly.
2. Disconnect the X3 harness connector at the K20 Engine Control Module.
3. Test each cylinder deactivation solenoid valve control circuit for less than 5 Ω end to end.
    - **If 5 Ω or greater**

      Repair the open/high resistance in the circuit.

    - **If less than 5 Ω**

      NOTE: Cylinder Deactivation System command control function will not operate if any DTCs are set.

      Refer to **Cylinder Deactivation (Active Fuel Management) System Diagnosis** for further diagnosis.

Repair Instructions

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

- Refer to **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P3401, P3403, P3404, P3425, P3427, P3428, P3441, P3443, P3444, P3449, P3451, OR P3452: CYLINDERS (1, 4, 6, 7) DEACTIVATION SOLENOID VALVE 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 P3401

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Cylinder 1 Deactivation Solenoid Valve Control Circuit Open

DTC P3403

Cylinder 1 Deactivation Solenoid Valve Control Circuit Low Voltage

DTC P3404

Cylinder 1 Deactivation Solenoid Valve Control Circuit High Voltage

DTC P3425

Cylinder 4 Deactivation Solenoid Valve Control Circuit Open

DTC P3427

Cylinder 4 Deactivation Solenoid Valve Control Circuit Low Voltage

DTC P3428

Cylinder 4 Deactivation Solenoid Valve Control Circuit High Voltage

DTC P3441

Cylinder 6 Deactivation Solenoid Valve Control Circuit Open

DTC P3443

Cylinder 6 Deactivation Solenoid Valve Control Circuit Low Voltage

DTC P3444

Cylinder 6 Deactivation Solenoid Valve Control Circuit High Voltage

DTC P3449

Cylinder 7 Deactivation Solenoid Valve Control Circuit Open

DTC P3451

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Cylinder 7 Deactivation Solenoid Valve Control Circuit Low Voltage

DTC P3452

Cylinder 7 Deactivation Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Voltage	P3400, P3403, P3427, P3443, P3451	P3400, P3401, P3425, P3441, P3449	-	P3400
Cylinder 1 Deactivation Solenoid Valve Control	P3403	P3401	P3404	P3400
Cylinder 4 Deactivation Solenoid Valve Control	P3427	P3425	P3428	P3400
Cylinder 6 Deactivation Solenoid Valve Control	P3443	P3441	P3444	P3400
Cylinder 7 Deactivation Solenoid Valve Control	P3451	P3449	P3452	P3400

Typical Scan Tool Data

Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Test Status - Component Commanded OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Short to Gnd Test and Not Run for Short to Volts Test • Component ON - Not Run for Open/Short to Gnd Test and OK for Short to Volts Test			
Ignition Voltage	Malfunction	Malfunction	-
Cylinder 1, 4, 6, or 7 Deactivation Solenoid Control	Malfunction	Malfunction	Not Run

Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit 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:			

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Circuit	Short to Ground	Open	Short to Voltage
• Component OFF - OK for Open/Short to Gnd Test and Not Run for Short to Volts Test • Component ON - Not Run for Open/Short to Gnd Test and OK for Short to Volts Test			
Ignition Voltage	Not Run	Not Run	-
Cylinder 1, 4, 6, or 7 Deactivation Solenoid Control	Not Run	Not Run	Malfunction

Circuit/System Description

The cylinder deactivation system is used to deactivate 4 cylinders of the engine under light load driving conditions. The engine control module (ECM) commands the cylinder deactivation solenoid valves ON to deactivate engine cylinders 1, 4, 6, and 7, switching to 4 cylinders or V4 mode. The cylinder deactivation solenoid valves control the oil flow to the appropriate valve lifters. The engine operates on 8 cylinders or V8 mode, during engine starting, engine idling in gear, and medium to heavy throttle conditions.

Ignition voltage is supplied directly to the cylinder deactivation solenoid valves. The ECM controls the cylinder deactivation solenoid valves by grounding the control circuit with a solid state device called a driver.

Conditions for Running the DTC

- Engine speed is greater than 400 RPM.
- Ignition voltage is greater than 11 V.
- DTC P3401, P3403, P3404, P3425, P3427, P3428, P3441, P3443, P3444, P3449, P3451, and P3452 run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P3401, P3425, P3441, and P3449

The engine control module detects an open in the appropriate cylinder deactivation solenoid valve control circuit for greater than 5 s.

DTC P3403, P3427, P3443, and P3451

The engine control module detects an short to ground in the appropriate cylinder deactivation solenoid valve control circuit for greater than 5 s.

DTC P3404, P3428, P3444, and P3452

The engine control module detects an short to voltage in the appropriate cylinder deactivation solenoid valve control circuit for greater than 5 s.

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Action Taken When the DTC Sets

- DTCs P3401, P3403, P3404, P3425, P3427, P3428, P3441, P3443, P3444, P3449, P3451, and P3452 are Type B DTCs.
- The engine will return to V8 mode.

Conditions for Clearing the DTC

DTCs P3401, P3403, P3404, P3425, P3427, P3428, P3441, P3443, P3444, P3449, P3451, and P3452 are Type B DTCs.

Diagnostic Aids

The valve lifter oil manifold solenoid valves are assigned to the following engine cylinders:

- Cylinder Deactivation Solenoid Valve #1 = Cylinder #1
- Cylinder Deactivation Solenoid Valve #2 = Cylinder #4
- Cylinder Deactivation Solenoid Valve #3 = Cylinder #6
- Cylinder Deactivation Solenoid Valve #4 = Cylinder #7

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cylinder Deactivation (Active Fuel Management) System Description

Electrical Information Reference

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

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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

- **EN-46999** Displacement On Demand Tester
- **EN-46999-20** Active Fuel Management Tester Harness-Small Block V8

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service Tools)** .

Circuit/System Verification

NOTE: **DTC P3401, P3425, P3441, and P3449 set with an open ignition circuit fuse.**

1. Engine running.
2. Verify the follow parameters display OK or Not Run during each command.
   - Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit High Voltage Test Status
   - Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Open Test Status
   - Cylinder 1, 4, 6, or 7 Deactivation Solenoid Valve Control Circuit Low Voltage Test Status
   - **If any parameter displays Malfunction**

     Refer to Circuit/System Testing.

   - **If each parameter displays OK or Not Run**
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 P3401, P3403, P3404, P3425, P3427, P3428, P3441, P3443, P3444, P3449, P3451, or P3452 does not set.
   - **If a DTC set**

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Refer to Circuit/System Testing.

- **If a DTC does not set**

5. All OK.

Circuit/System Testing

NOTE: **If any of the scan tool circuit status parameters displayed "Malfunction" during the Circuit/System Verification, inspect the wiring harness for signs of binding, chaffing or pinching before intake manifold removal.**

1. Ignition OFF, disconnect the harness connector at the Q43 Valve Lifter Oil Manifold Assembly, ignition ON.
2. Verify that a test lamp illuminates between the ignition circuit terminal 4 and ground.
   - **If the test lamp does not illuminate and the fuse is good.**
   1. Ignition OFF, remove the test lamp.
   2. Test for less than 5 Ω between the ignition circuit terminal 4 and the fuse.
      - If 5 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 5 Ω, verify there is voltage at the fuse and the fuse is good.
   - **If the test lamp does not illuminate and the fuse is open**
   1. Ignition OFF, remove the test lamp.
   2. Disconnect all components on the circuit.
   3. Test for infinite resistance between the ignition circuit terminal 4 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test all the components connected to the ignition circuit and repair or replace as necessary.
   - **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the ignition circuit terminal 4 and the appropriate cylinder deactivation solenoid valve control circuit terminal listed below.
   - Cylinder 1 Deactivation Solenoid Valve 1 terminal 3
   - Cylinder 4 Deactivation Solenoid Valve 2 terminal 1
   - Cylinder 6 Deactivation Solenoid Valve 3 terminal 2
   - Cylinder 7 Deactivation Solenoid Valve 4 terminal 5

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- **If the test lamp illuminates**

1. Ignition OFF, remove the test lamp, disconnect the harness connector X3 at the K20 Engine Control Module.
2. Test for infinite resistance between the appropriate cylinder deactivation solenoid valve 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. Verify that a test lamp does not illuminate between ground and the appropriate cylinder deactivation solenoid valve control circuit terminal listed below.
    - Cylinder 1 Deactivation Solenoid Valve 1 terminal 3
    - Cylinder 4 Deactivation Solenoid Valve 2 terminal 1
    - Cylinder 6 Deactivation Solenoid Valve 3 terminal 2
    - Cylinder 7 Deactivation Solenoid Valve 4 terminal 5
    - **If the test lamp illuminates**

    1. Ignition OFF, remove the test lamp, disconnect the harness connector X3 at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the appropriate cylinder deactivation solenoid valve 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 illuminates**

5. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module.
6. Test the appropriate cylinder deactivation solenoid valve control circuit for less than 5 Ω end to end.
    - **If 5 Ω or greater**

      Repair the open/high resistance in the circuit.

    - **If less than 5 Ω**

7. Connect the **EN-46999** Displacement On Demand (DOD) Tester to the Q43 Valve Lifter Oil Manifold Assembly using **EN-46999-20** Active Fuel Management Tester Harness.
8. Connect the power leads from the DOD tester to B+ and ground.
9. With a DMM connected to the DOD tester, test for 10-24 Ω on each cylinder deactivation solenoid valve.
    - **If not between 10-24 Ω for each solenoid valve**

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Replace the Q43 Valve Lifter Oil Manifold Assembly.

- **If between 10-24 Ω for each solenoid valve**

10. Test for infinite resistance between each valve lifter oil manifold circuit terminal and the valve lifter oil manifold housing.
    - **If less than infinite resistance**

      Replace the Q43 Valve Lifter Oil Manifold Assembly.

    - **If infinite resistance**
11. Replace the K20 Engine Control Module.

Repair Instructions

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

- Refer to **Valve Lifter Oil Manifold Replacement**
- Refer to **Control Module References** for K20 Engine 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** provide an overview of each diagnostic category.

Symptoms Description

Symptoms cover conditions that are not covered DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause certain symptoms are listed separately under Additional Symptoms Test. Perform the Symptoms Testing before using the Additional Symptoms Tests.

Symptoms Definition

Backfire

Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

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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 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

Engine Control Module (ECM) 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.

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.

Hard Start

Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

Hesitation, Sag, Stumble

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 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

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The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

Surges/Chuggles

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 engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.
- 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

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- 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, as shown on the Vehicle Emission Control Information label.
- 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

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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/inspect the fuel system for the conditions listed below:
  - Incorrect system operation or fuel pressure - Refer to **Fuel System Diagnosis**
  - Fuel injectors leaking due to split or torn O-rings. With this condition, the engine may need to be cranked for an extended period of time before it will start. The smell of unburned fuel may also be present. Look for evidence of fuel injector leakage on the engine cylinder head and nearby components. Refer to **Fuel Rail and Injectors Cleaning and Inspection** if a leak is suspected.
  - Incorrectly operating fuel injectors - Refer to **Fuel Injector Diagnosis** .
  - Contaminated or poor quality fuel - Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
- Test/inspect the ignition system for the conditions listed below:
  - 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. 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** .
- Test/inspect for the conditions listed below:
  - 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.
  - Incorrectly operating A/C compressor
  - Items that can cause an engine to run rich or lean - Refer to **DTC P0171, P0172, P0174, or P0175** for more information.
  - Slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to different throttle positions - Refer to **DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D, or P2270-P2273** for more information.

    CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution .

  - Water intrusion in the HO2S connector
  - Incorrectly operating cylinder deactivation system, if equipped. Refer to **Cylinder Deactivation (Active Fuel Management) System Description** , and **Cylinder Deactivation (Active Fuel Management) System Diagnosis** .

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NOTE: **The embossed arrows on the mass airflow (MAF) sensor indicate the direction of the intake air flow. The arrows must point toward the engine.**

- Incorrect MAF sensor installation. A MAF sensor that is incorrectly installed may cause a hard start. Install the MAF in the proper direction. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .
- Incorrect MAF sensor connections.
- Engine oil contaminated by fuel
- Split, kinked, or incorrectly connected vacuum hoses.
- Excessive knock sensor (KS) system spark retard activity - Observe the Knock Retard parameter on the scan tool for activity more than 0Â°. For additional information, refer to **DTC P0324, P0326, P0331, P06B6, or P06B7** , and **DTC P0325, P0327, P0328, P0330, P0332, or P0333** .
- Electromagnetic interference (EMI) on the reference circuit, which can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuit if a condition exists.
- Incorrectly operating crankcase ventilation valve - Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
- A stuck open evaporative emission (EVAP) canister purge solenoid.
- 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.

- Test/inspect the engine cooling system for the conditions listed below:
  - A thermostat with incorrect heat range. Refer to **Thermostat Diagnosis** .
  - Incorrect engine coolant level - Refer to **Cooling System Draining and Filling (Vac N Fill L83 L86)** **Cooling System Draining and Filling (Static Fill L83 L86)** .

    For additional information, refer to **Symptoms - Engine Cooling** .

- Test/inspect the exhaust system components for the conditions listed below:
  - Physical damage or possible internal failure
  - Restricted three-way catalytic converters.

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

- Test/inspect the engine for the mechanical conditions listed below:

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- Excessive oil in the combustion chamber or leaking valve seals
- 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 additional 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

- Test the engine for an overheating condition. Refer to **Symptoms - Engine Cooling** .
- Inspect for excessive carbon buildup in the combustion chambers. Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.
- If there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicle minimum octane requirements.

Engine Control Module (ECM) Commanded Reduced Engine Power

Under certain conditions the 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 driven inappropriately. Towing heavy loads up an incline for an extended period of time or operating the vehicle at sustained,

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excessively high engine speeds 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 or conditions 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 ECM to reduce engine power. Refer to **Cooling Fan Description and Operation** , and **Cooling System Description and Operation** to verify correct operation of the cooling fan.
- Temporary 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.
- Fuel temperature out of range too high.
- High pressure fuel system condition. Refer to **Fuel System Diagnosis** , and **Fuel System Description** to verify high pressure fuel system pressure and operation.
- Reduced engine power due to OnStarÂ® remote command. Verify the vehicle is not in the OnStarÂ® initiated Stolen Vehicle Slowdown mode. Refer to **OnStar Stolen Vehicle Slowdown Active** , and **Remote Vehicle Speed Limiting Description and Operation** for additional information.
- Intake air temperature out of range too high. Engine running, observe the scan tool IAT sensor parameter. The readings should be between -40Â° C and +149Â° C (-40Â° F and +300Â° F. Refer to **DTC P0112, P0113, or P0114** for additional information.
- 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 that has been replaced
  - A BPP sensor is misaligned or incorrectly installed

  If any of the above actions have occurred, the **Brake Pedal Position Sensor Learn** procedure must be performed.

Fuel Odor

- Inspect for leaking, damaged, or deteriorated fuel lines and components.
- 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 TB 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 bore and clean, if necessary. Refer to **Throttle Body Cleaning** .

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- 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 Â± 3Â°C (5Â°F). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to **Temperature Versus Resistance (ECT)** , 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 circuits for a high resistance.
- Verify that the fuel pump operates and provides adequate pressure for engine startup. The fuel pump should turn ON for 2 s when the ignition is turned to ON. Refer to **Fuel System Diagnosis** for fuel pressure specifications and testing procedures.

Hesitation, Sag, Stumble

- Test the fuel pressure. Refer to **Fuel System Diagnosis** for fuel pressure specifications and testing procedures..
- Test the generator. Refer to **Symptoms - Engine Electrical** . Repair the charging system if the generator output voltage is less than 9 volts or more than 16 volts.
- Test the manifold absolute pressure (MAP) sensor. Refer to **DTC P0106** .

Poor Fuel Economy

- Observe the TB 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 bore 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 the brake system for brake drag.
- Inspect for incorrect operation of the speedometer.

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 may 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 Cleaning** .

  The actions listed below may also cause the ECM to learn an incorrect idle value.

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- The engine control module 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 engine mounts for looseness, wear, and damage - Refer to **Engine Mount Inspection** .

Surges/Chuggles

- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage - Refer to **DTC P0101** , and **DTC P0102 or P0103** for more information.
- Fuel injectors incorrectly connected. Verify each injector is connected to the correct fuel injector harness connector.
- 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 ECM reduces the amount of fuel delivered to the engine, causing a driveability condition - Refer to **DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D, or P2270-P2273** for more information.

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ENGINE

Engine Controls and Fuel - 5.3L (L83) or 6.2L (L86) - Repair Instructions - Engine Oil Pressure Sensor Replacement - Escalade, Suburban, Tahoe, Yukon

REPAIR INSTRUCTIONS

ENGINE OIL PRESSURE SENSOR REPLACEMENT

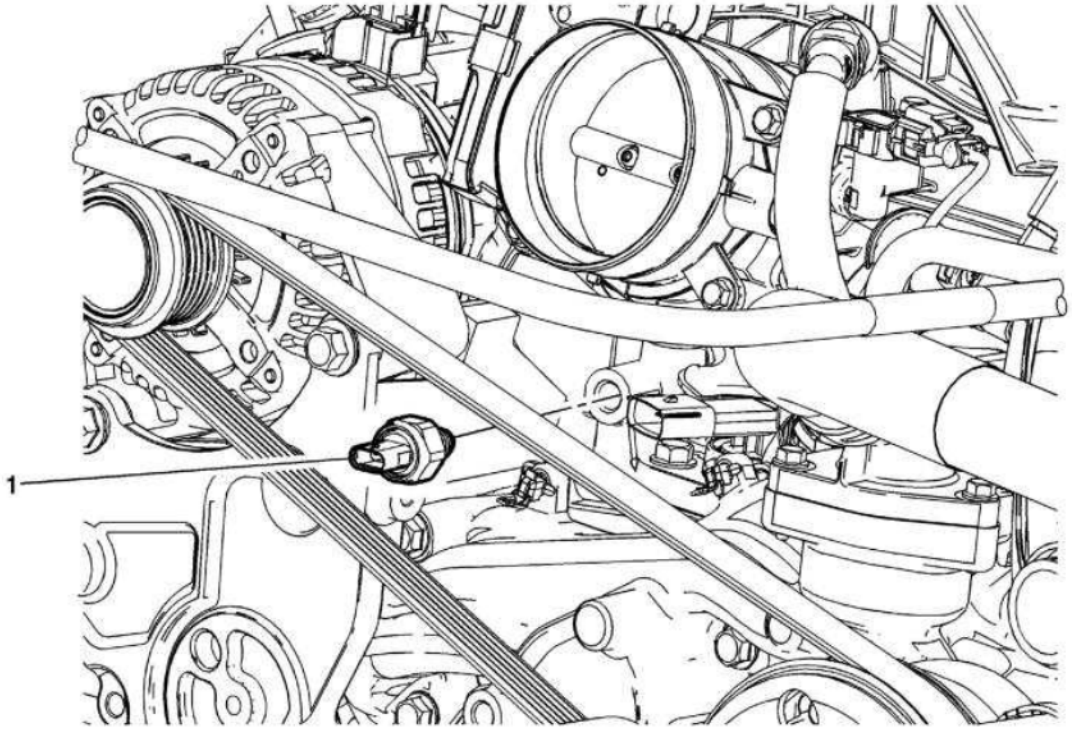


Fig. 1: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	

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Callout	Component Name
Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (Chevrolet and GMC)** **Air Cleaner Outlet Duct Replacement (Cadillac)** .	
1	Engine Oil Pressure Sensor **CAUTION:** **Refer to** **Component** **Fastener** **Tightening** **Caution** . **Procedure** Disconnect the engine oil pressure sensor electrical wiring harness connector. **Tighten** 35 N.m (26 lb ft)

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ENGINE PERFORMANCE

Engine Controls and Fuel - 5.3L (L83) or 6.2L (L86) - Repair Instructions - Escalade, Suburban, Tahoe, Yukon

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.**

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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.

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- 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.

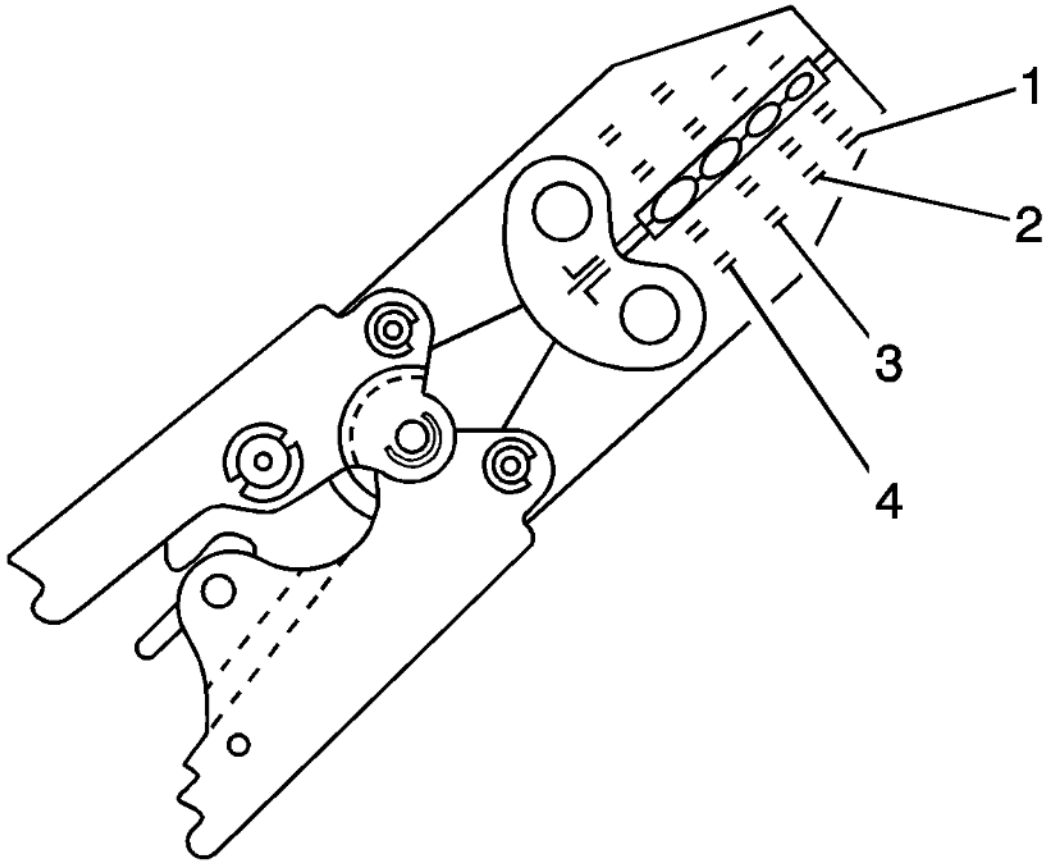


Fig. 1: Splice Sleeve Crimping Tool With 4 Crimp Nests

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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.

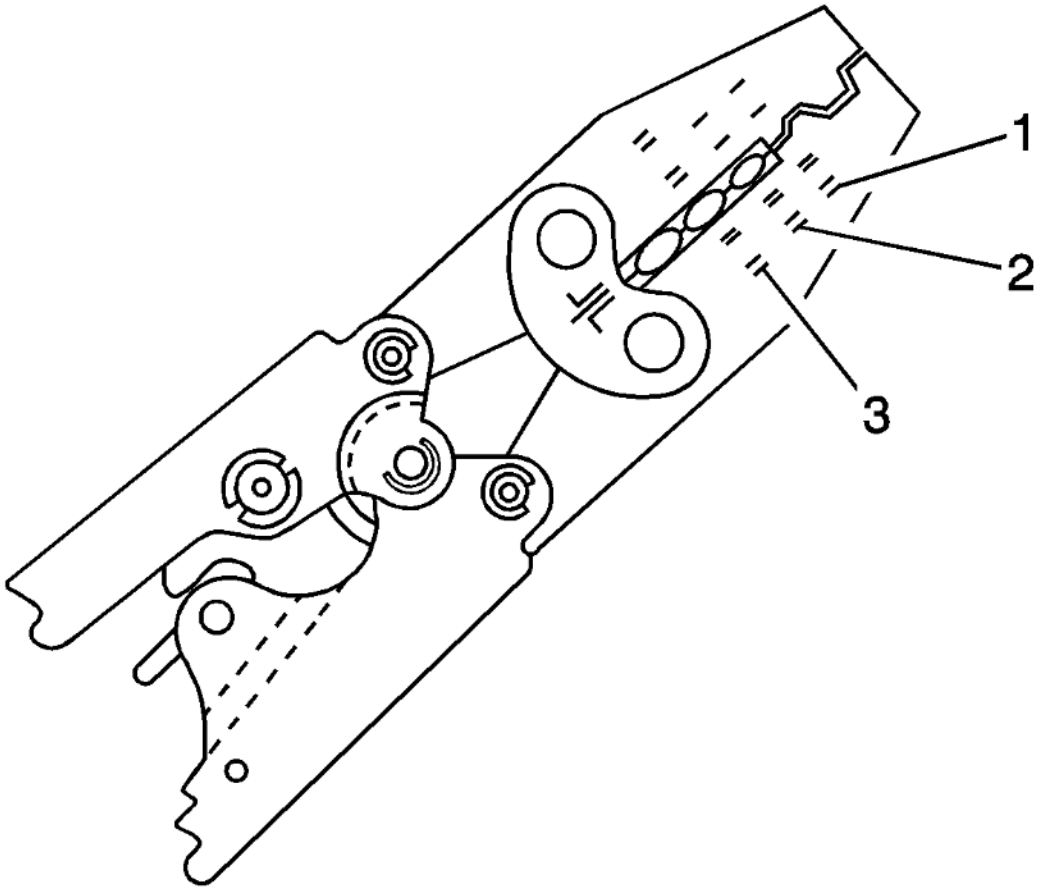


Fig. 2: Splice Sleeve Crimping Tool With 3 Crimp Nests

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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).

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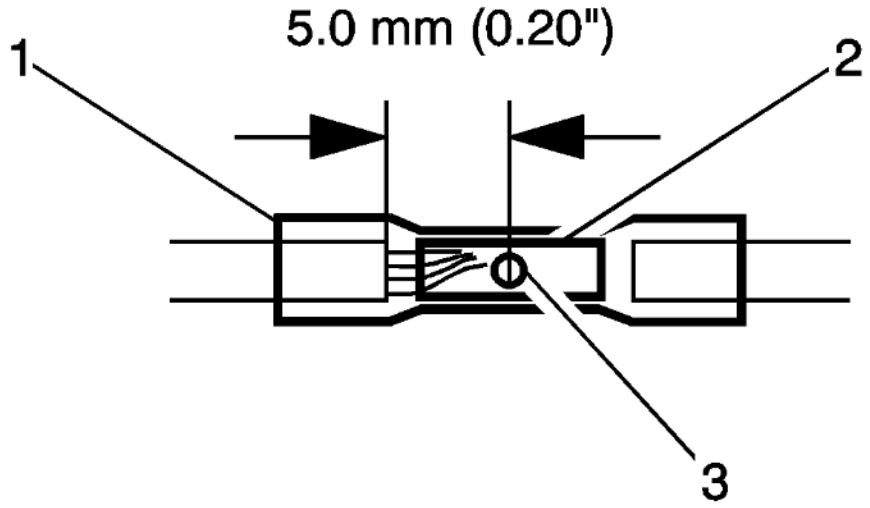


Fig. 3: Identifying Duraseal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

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.

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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.

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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.



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Fig. 5: Crimped Duraseal 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.

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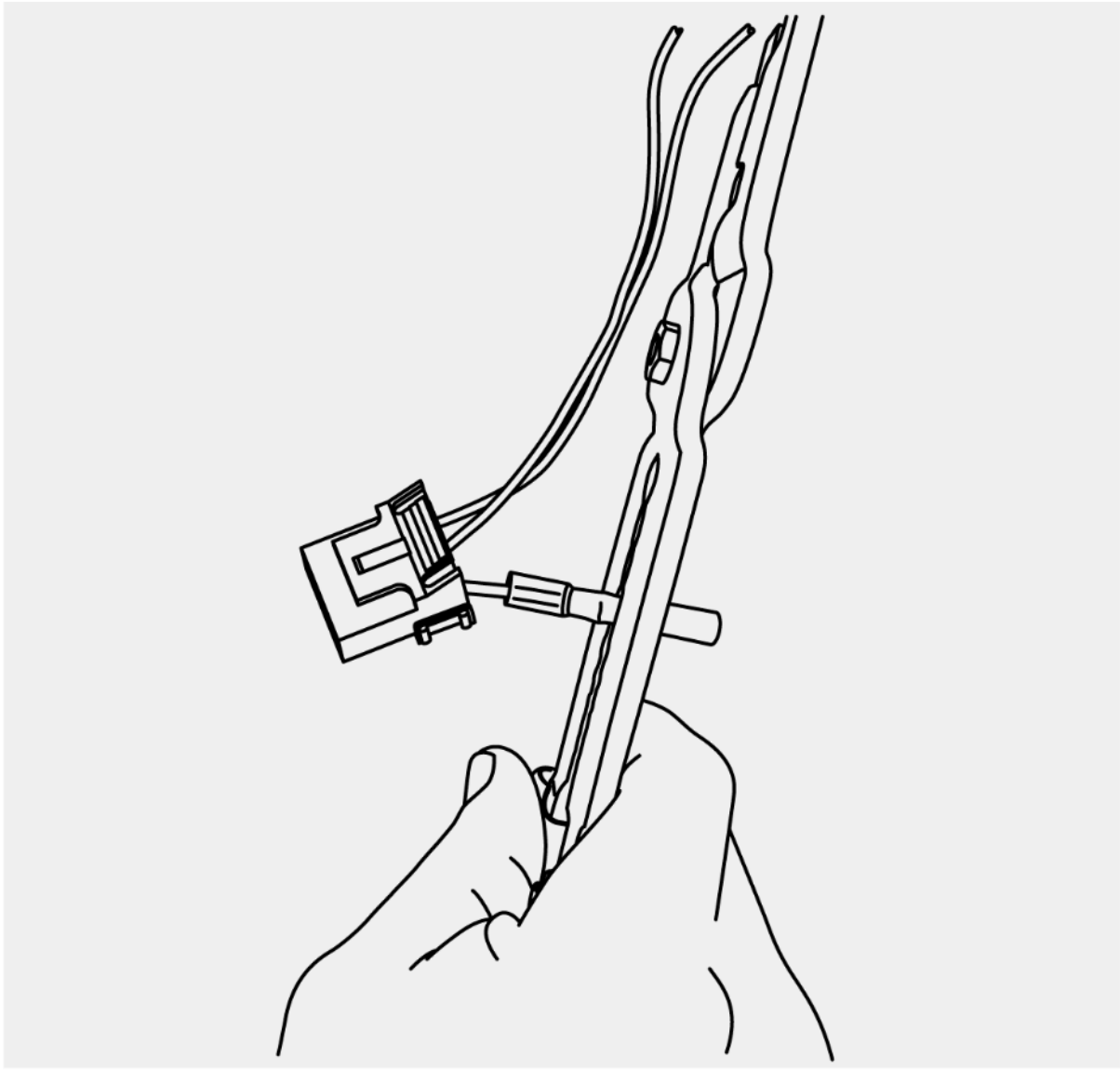


Fig. 6: Tightly Close Handles Of Crimp Tool
Courtesy of GENERAL MOTORS COMPANY

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

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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.

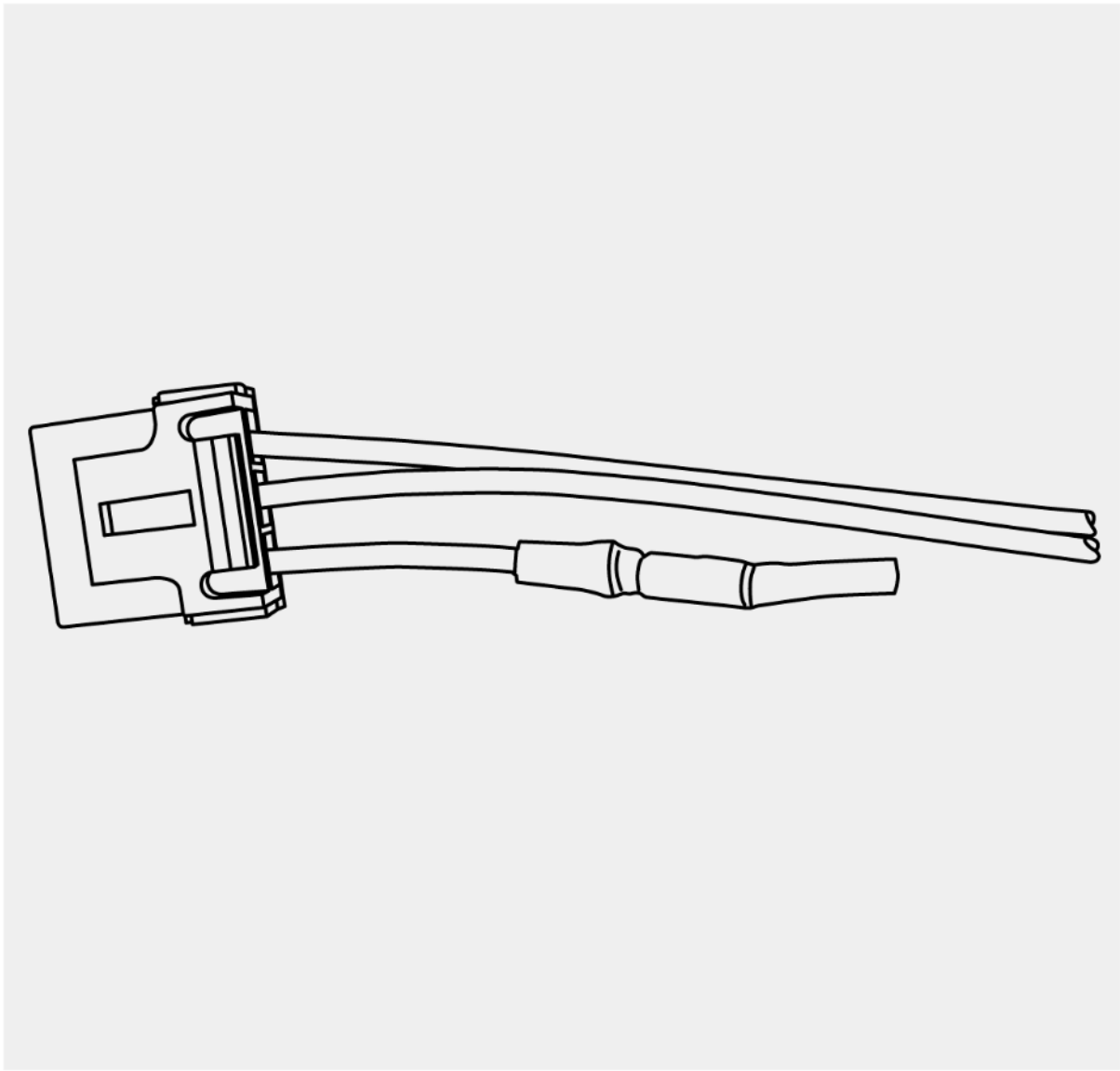


Fig. 7: Applying Heat To Crimped Area Of Barrel
Courtesy of GENERAL MOTORS COMPANY

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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.

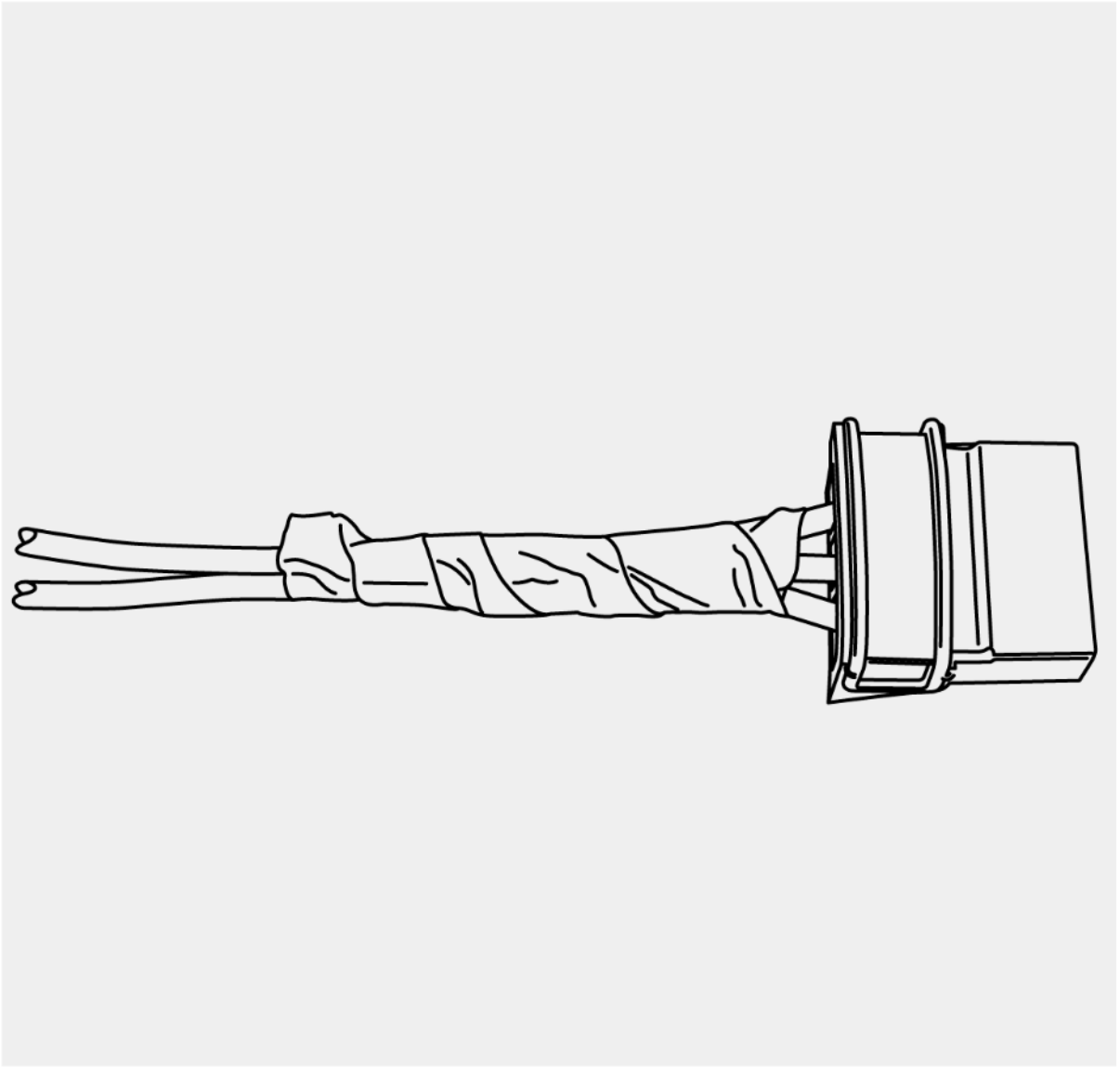


Fig. 8: Taping Extra Terminated Leads Back Into Harness
Courtesy of GENERAL MOTORS COMPANY

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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:

- 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

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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

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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.

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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** .

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- 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.

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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.

ENGINE CONTROL MODULE REPLACEMENT

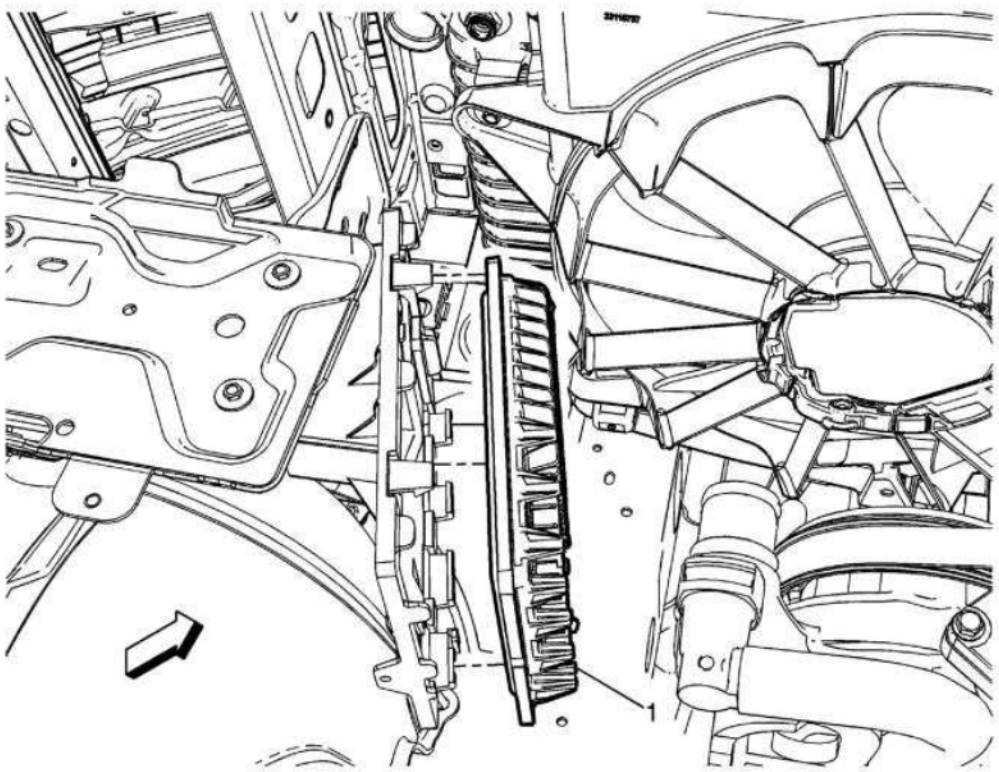


Fig. 9: Engine Control Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)** **Battery Negative Cable Disconnection and Connection (Single Battery)** .	

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Callout	Component Name
1	Electronic Control Module **WARNING:** **Refer to Safety Glasses Warning .** **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**

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Callout	Component Name
	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 no touch the connector pins or the soldered components on the circuit board. • Remove any debris from

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Callout	Component Name
	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 tabs. 3. If replacing, program the ECM. Refer to **Control Module References** .

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Callout	Component Name
	NOTE: Before removing the engine control module (ECM), record the Engine Oil Life percentage remaining. Use the scan tool to reset the Engine Oil Life remaining back to the original percentage recorded.

CHASSIS CONTROL MODULE REPLACEMENT (WITH ACTIVE AIR SHUTTER)

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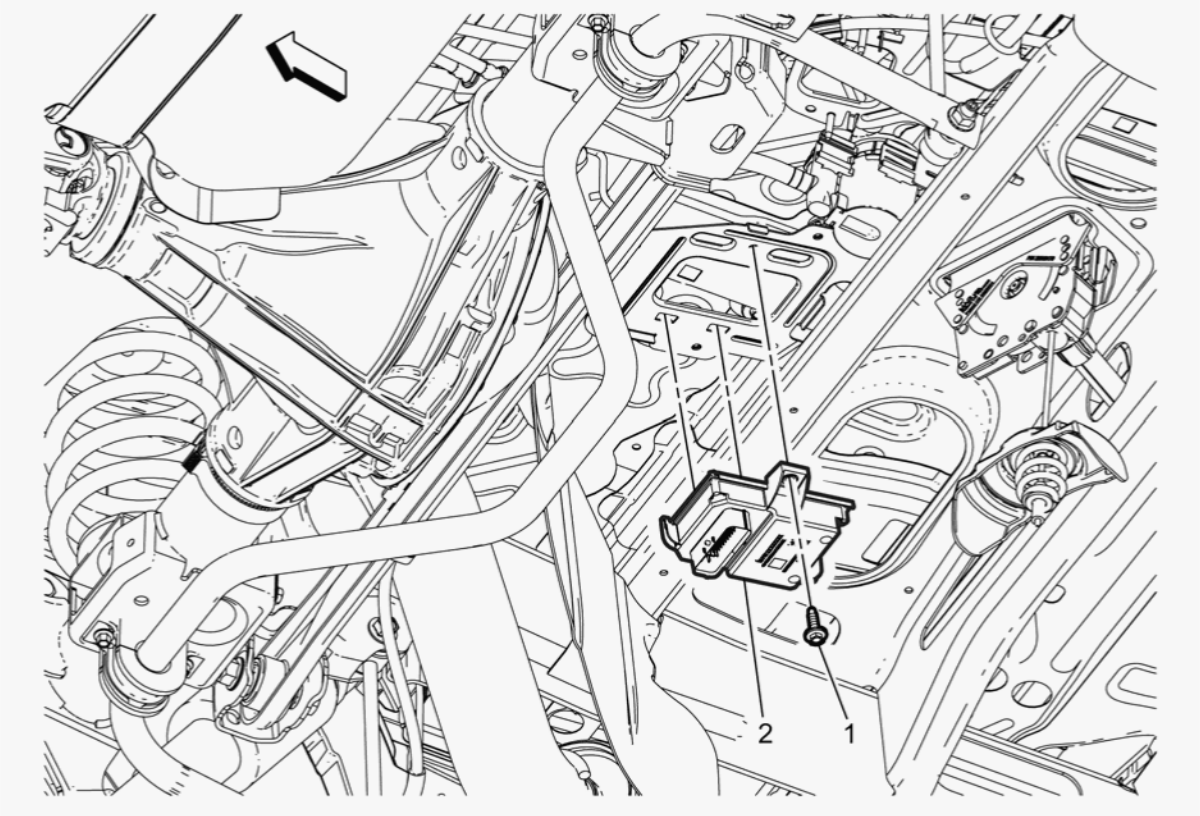


Fig. 10: Chassis Control Module (With Active Air Shutter)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the spare tire. Refer to **Spare Wheel Hoist Replacement** .	
1	Chassis Control Module Fastener **CAUTION:** **Refer to** **Fastener** **Caution** .

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Callout	Component Name
	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** .

CHASSIS CONTROL MODULE REPLACEMENT (WITHOUT ACTIVE AIR SHUTTER)

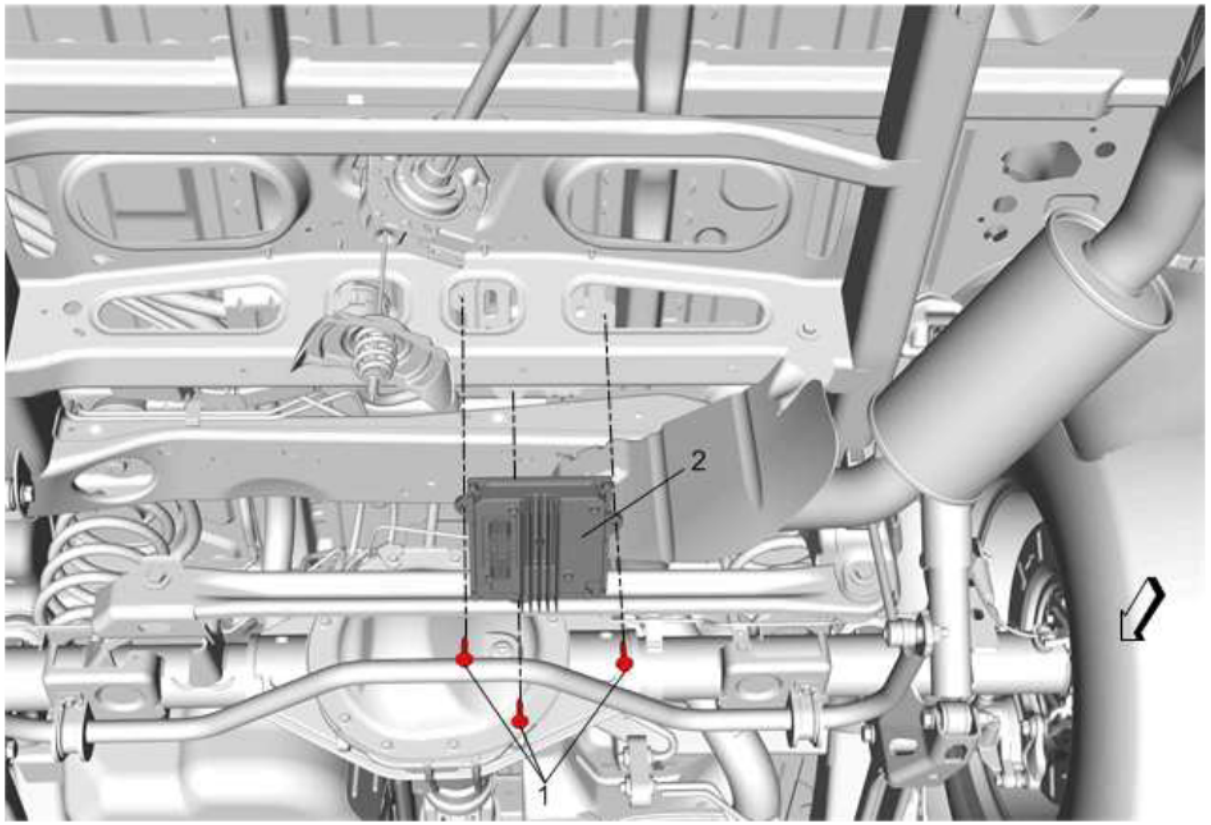


Fig. 11: Chassis Control Module (Without Active Air Shutter)

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Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the spare tire. Refer to **Spare Wheel Hoist Replacement** .	
1	Chassis Control Module Fastener (Qty: 3) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 9 N.m (80 lb in)
2	Chassis Power Control Module **Procedure** 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to **Control Module References** .

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.

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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.

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- 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.

Repair Instructions

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

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

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

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- 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.

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

1. Engine idling for 3 m.
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 m.
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.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

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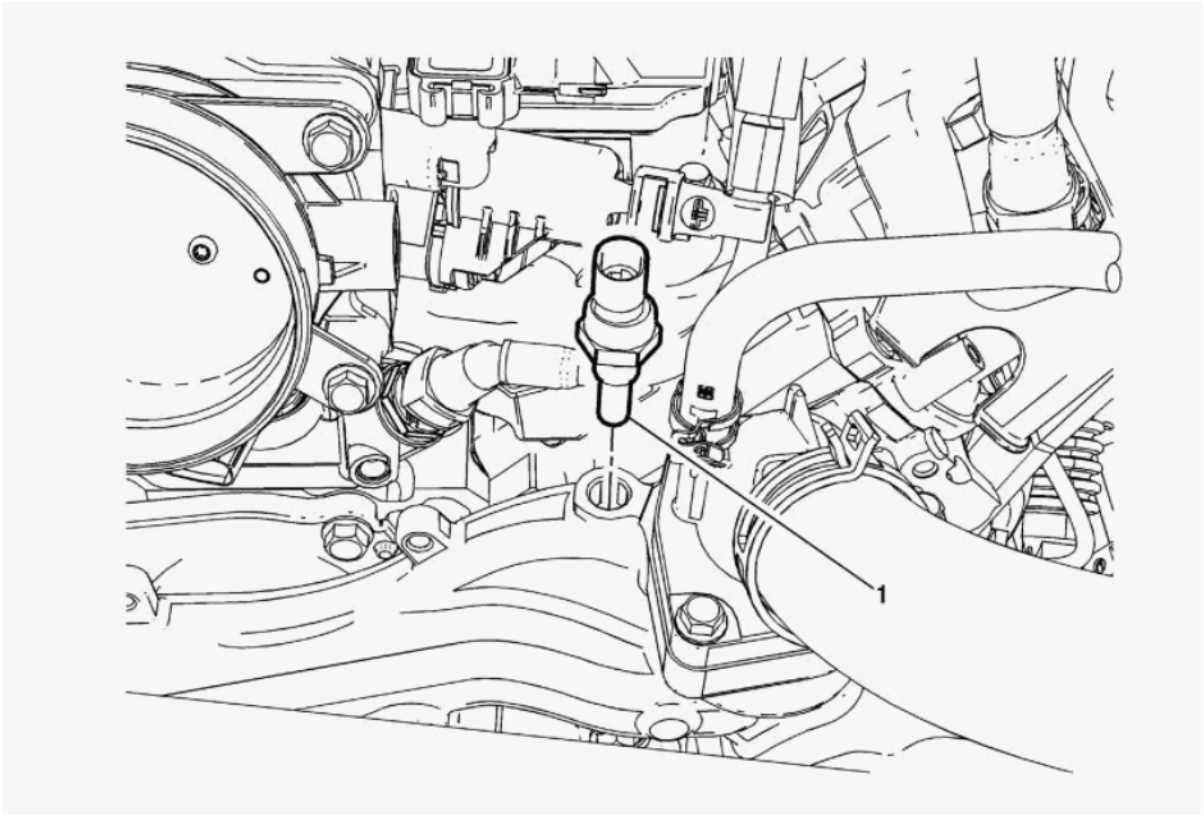


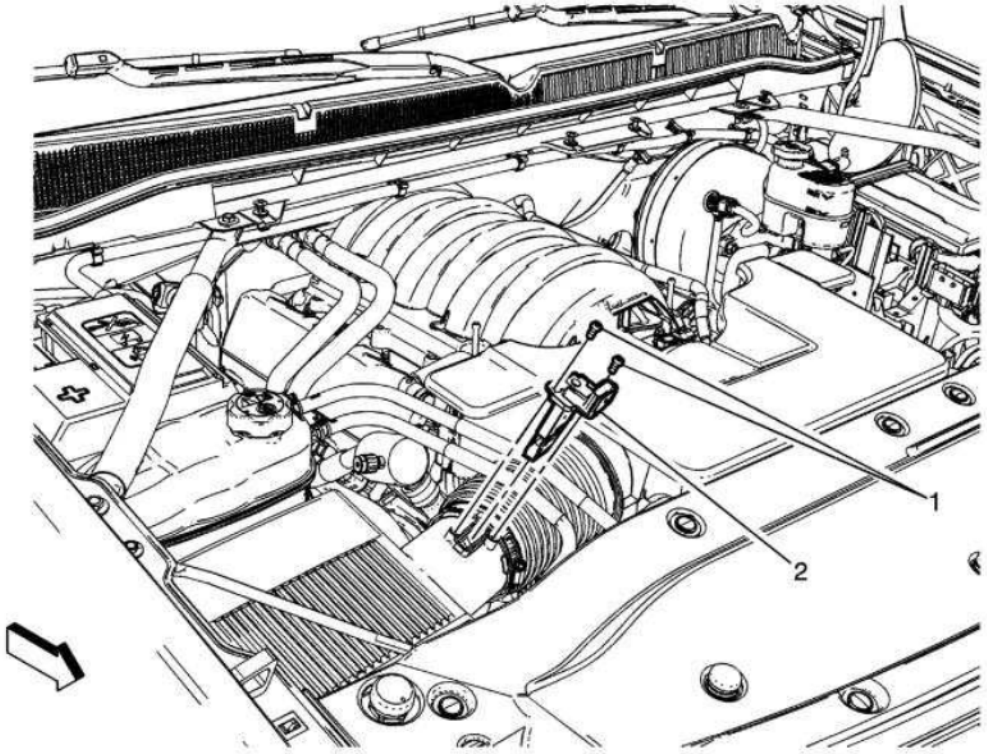
Fig. 12: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Partially drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill L96)** **Cooling System Draining and Filling (Vac N Fill L96)** **Cooling System Draining and Filling (Vac N Fill L83 L86)** **Cooling System Draining and Filling (Static Fill L83 L86)** . Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (Chevrolet and GMC)** **Air Cleaner Outlet Duct Replacement (Cadillac)**	
1	Engine Coolant Temperature Sensor **CAUTION:**

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Callout	Component Name
	Refer to **Component Fastener Tightening Caution** . **Procedure** Disconnect the engine coolant temperature sensor electrical wiring harness connector. **Tighten** 20 N.m (15 lb ft)

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT



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Fig. 13: Mass Airflow Sensor with Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Mass Airflow Sensor Screw (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 1.5 N.m (13 lb in)
2	Mass Airflow Sensor **Procedure** Disconnect the electrical connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

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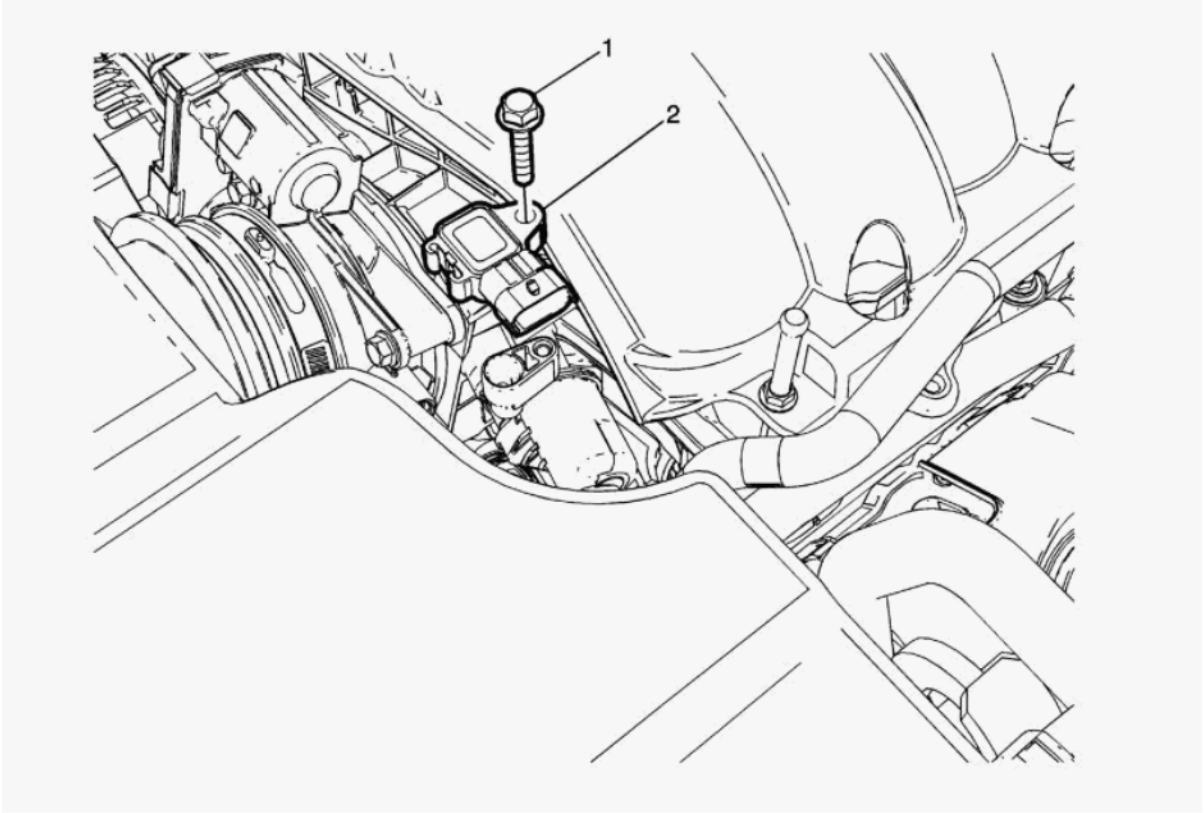


Fig. 14: Manifold Absolute Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure If equipped **Intake Manifold Cover Replacement**	
1	Manifold Absolute Pressure Sensor Fastener **CAUTION:** **Refer to Fastener Caution .**

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Callout	Component Name
	Tighten 4.5 N.m (40 lb in)
2	Manifold Absolute Pressure Sensor **Procedure** Disconnect the manifold absolute pressure sensor electrical wiring harness connector.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1

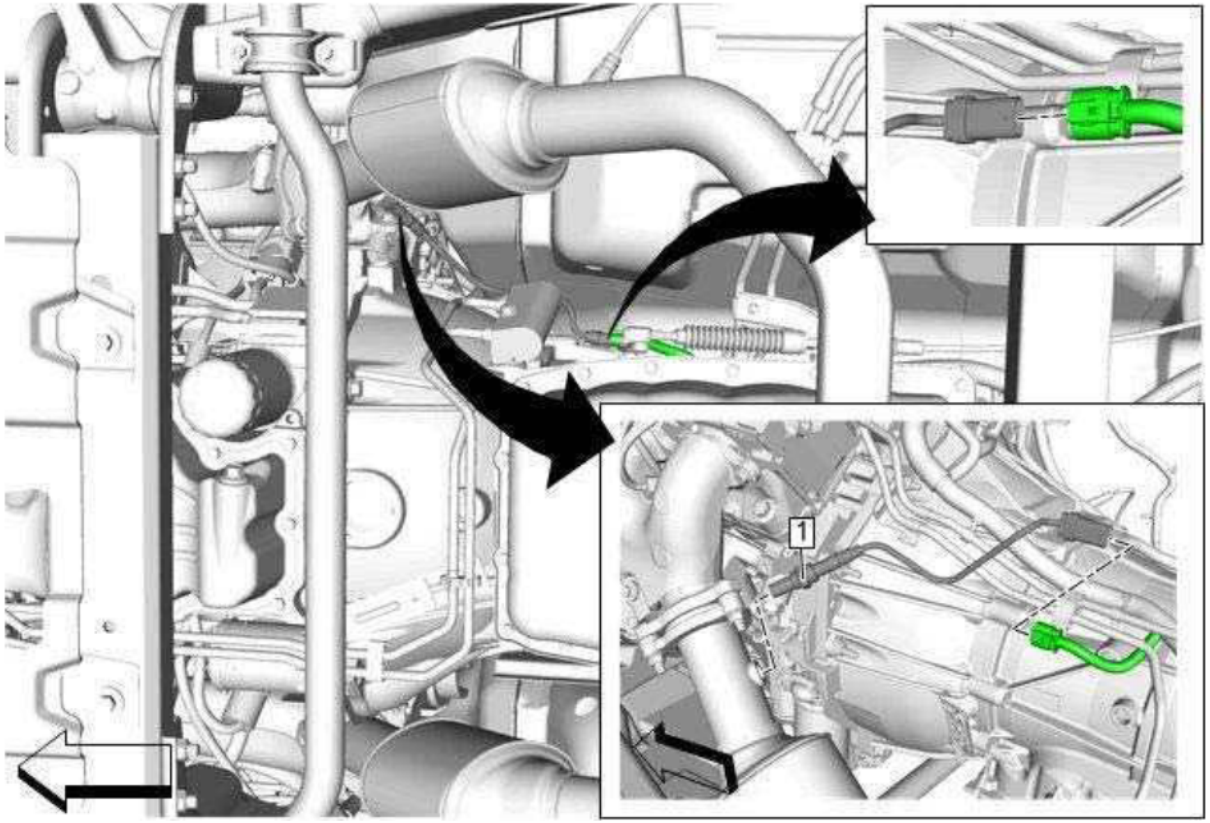


Fig. 15: Heated Oxygen Sensor - Bank 1 Sensor 1
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	

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Callout	Component Name
Lifting and Jacking the Vehicle	
1	Heated Oxygen Sensor **CAUTION:** **Refer to Heated Oxygen and Oxygen Sensor Caution .** **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** 1. Disconnect the heated oxygen sensor electrical connector. **NOTE:** **A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads.**

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Callout	Component Name
	The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

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Callout	Component Name
	2. If reinstalling the old sensor, coat the threads with anti-seize compound. **Tighten** 42 N.m (31 lb ft)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2

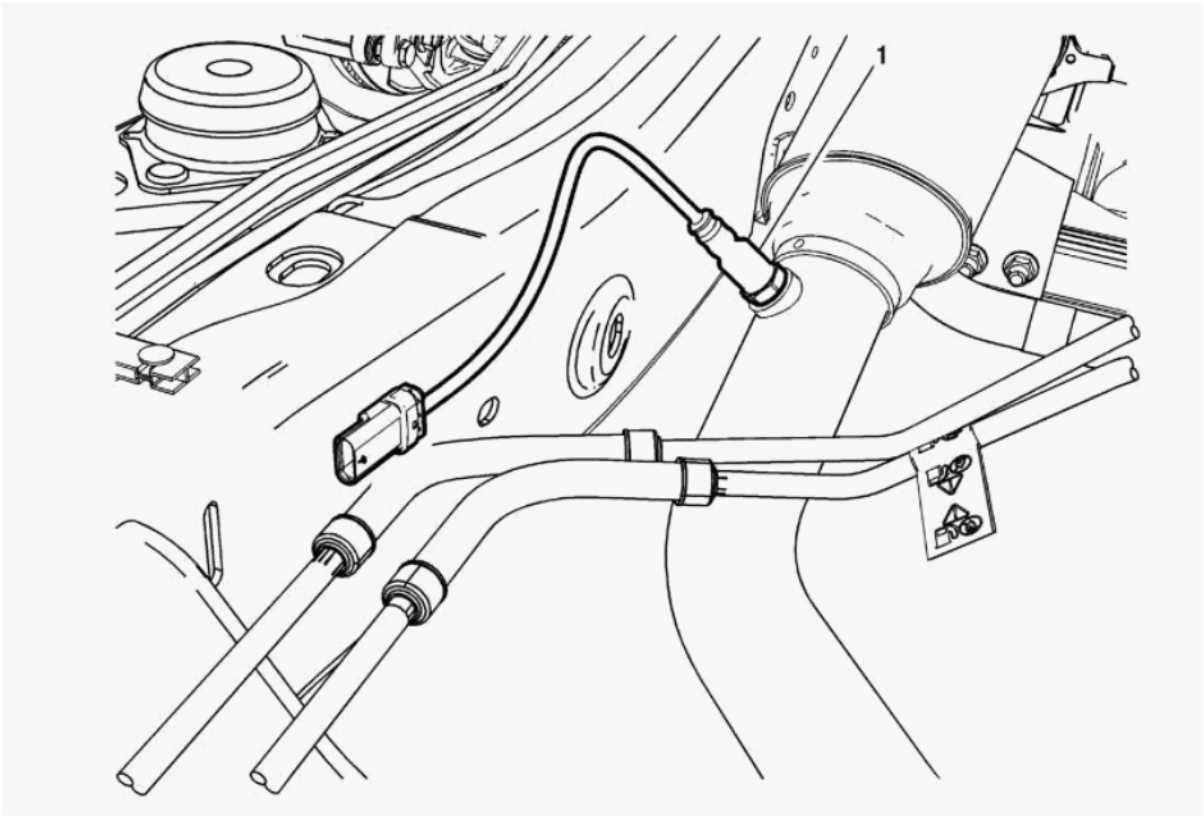


Fig. 16: Heated Oxygen Sensor - Bank 2 Sensor 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	

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Callout	Component Name
Raise and properly support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Heated Oxygen Sensor **CAUTION:** **Refer to Heated Oxygen and Oxygen Sensor Caution .** **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** 1. Disconnect the heated oxygen sensor harness connector. 2. If reinstalling the old sensor, coat the threads with anti-seize compound. **NOTE:** **A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and**

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Callout	Component Name
	glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

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Callout	Component Name
	Tighten 42 N.m (31 lb ft)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1

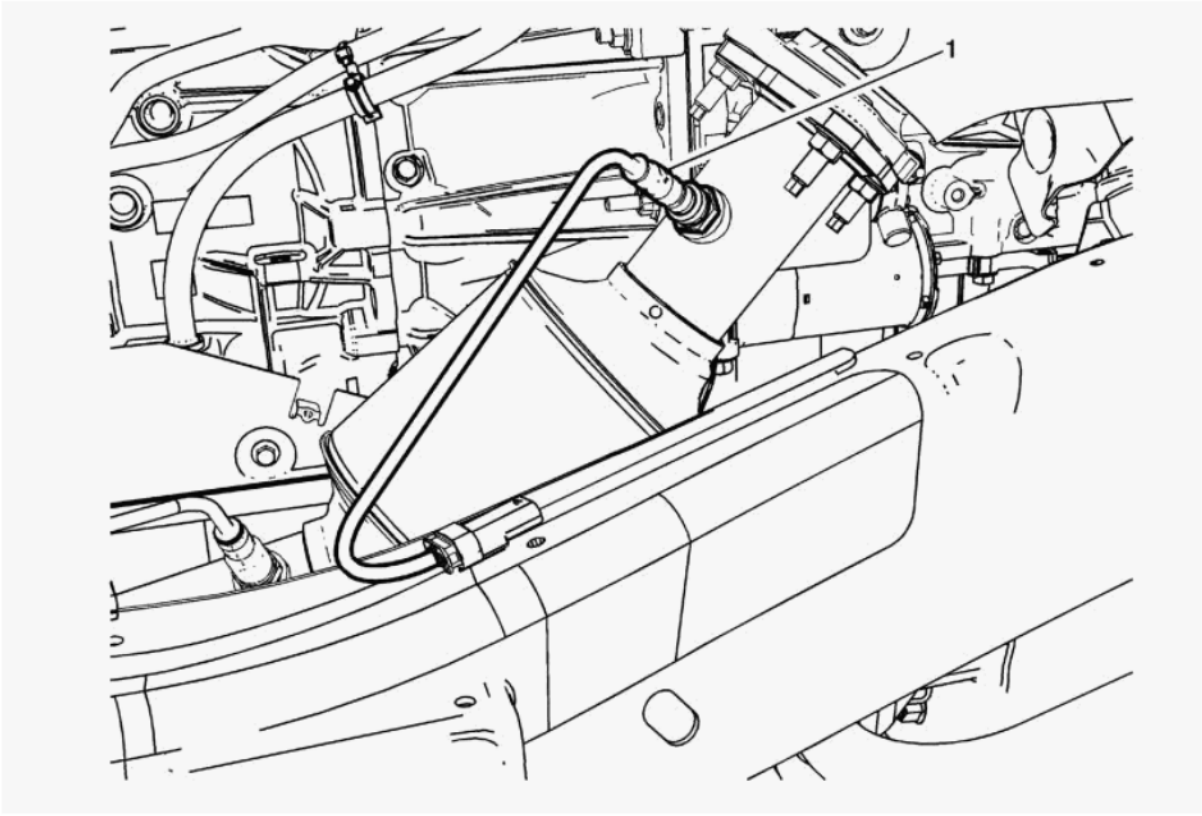


Fig. 17: Heated Oxygen Sensor - Bank 2 Sensor 1
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove the right front wheelhouse liner. **Front Wheelhouse Liner Replacement - Right Side (Cadillac)** **Front Wheelhouse Liner Replacement - Right Side (Chevrolet)** **Front Wheelhouse Liner Replacement - Right Side (GMC)** .	

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Callout	Component Name
	Heated Oxygen Sensor **CAUTION:** **Refer to Heated Oxygen and Oxygen Sensor Caution .** **CAUTION:** **Refer to Component Fastener Tightening Caution .**
1	**Procedure** 1. Disconnect the heated oxygen sensor harness connector. 2. If reinstalling the old sensor, coat the threads with anti-seize compound. **NOTE:** **A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads.**

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Callout	Component Name
	The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

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Callout	Component Name
	Tighten 42 N.m (31 lb ft)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2

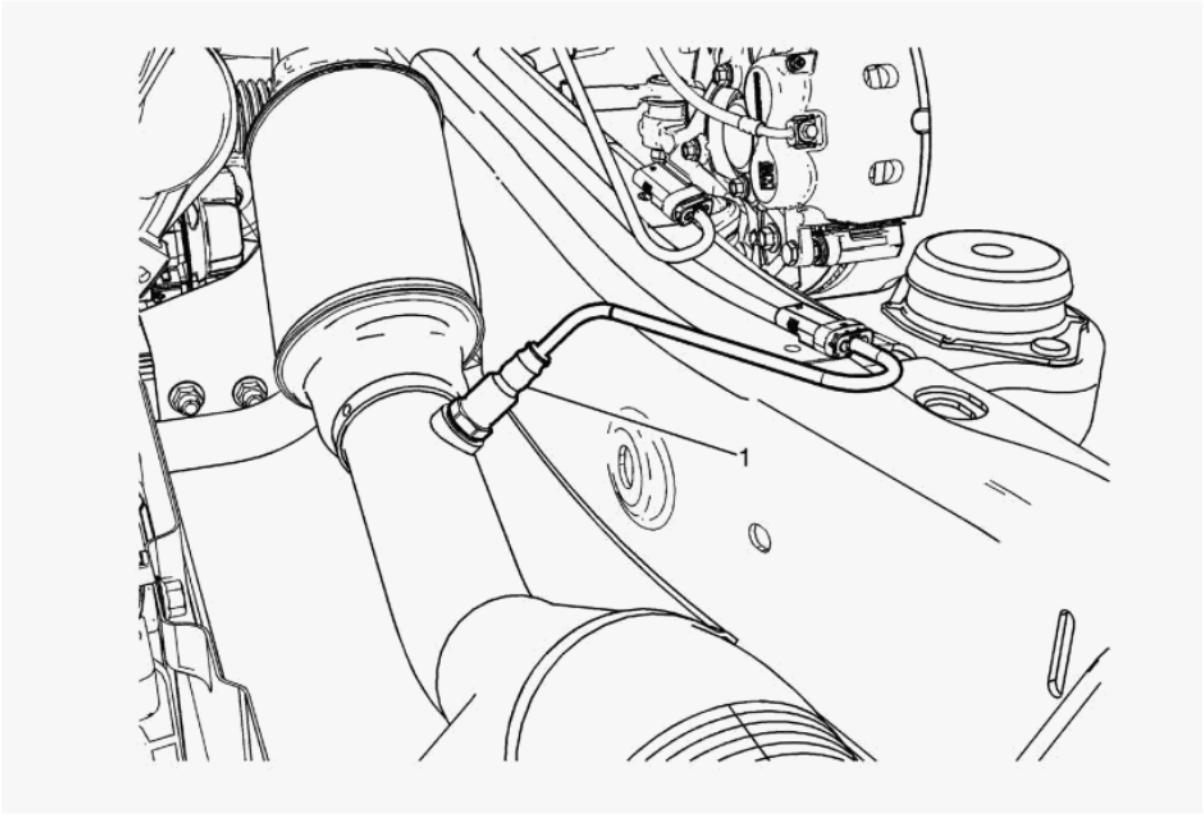


Fig. 18: Heated Oxygen Sensor - Bank 2 Sensor 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and properly support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	

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Callout	Component Name
	Heated Oxygen Sensor **CAUTION:** **Refer to Heated Oxygen and Oxygen Sensor Caution .** **CAUTION:** **Refer to Component Fastener Tightening Caution .**
1	**Procedure** 1. Disconnect the heated oxygen sensor harness connector. 2. If reinstalling the old sensor, coat the threads with anti-seize compound. **NOTE:** **A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads.**

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Callout	Component Name
	The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation.

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Callout	Component Name
	Tighten 42 N.m (31 lb ft)

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

Removal Procedure

CAUTION: **Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.**

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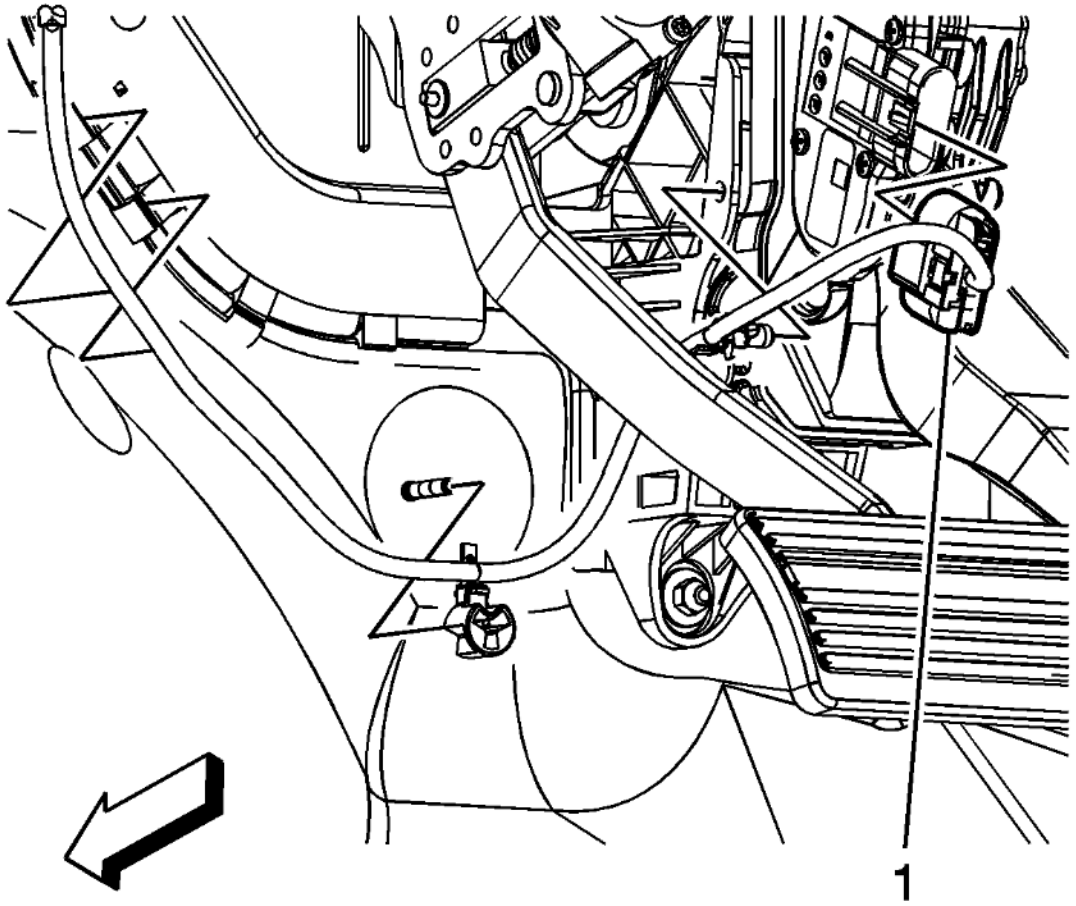


Fig. 19: View Of APP Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Push down the small tab and disconnect the accelerator pedal position (APP) sensor electrical connector (1).

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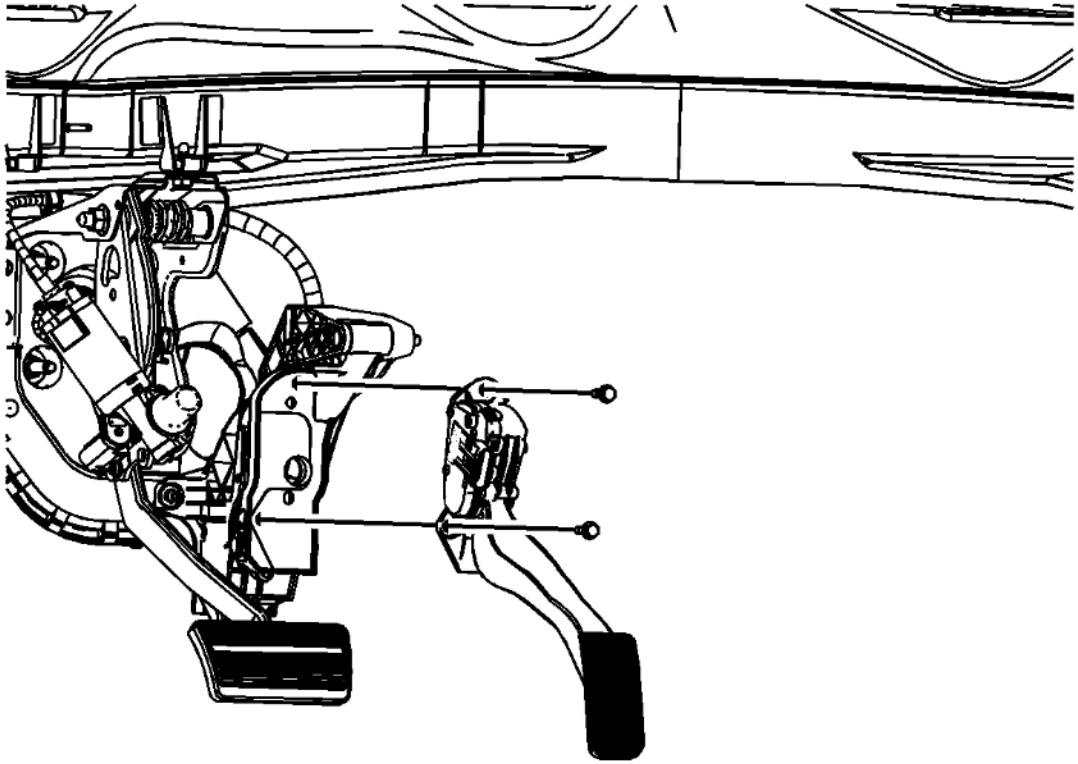


Fig. 20: View Of Accelerator Pedal Position Sensor Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Remove the accelerator pedal bolts.
3. Remove the accelerator pedal.

Installation Procedure

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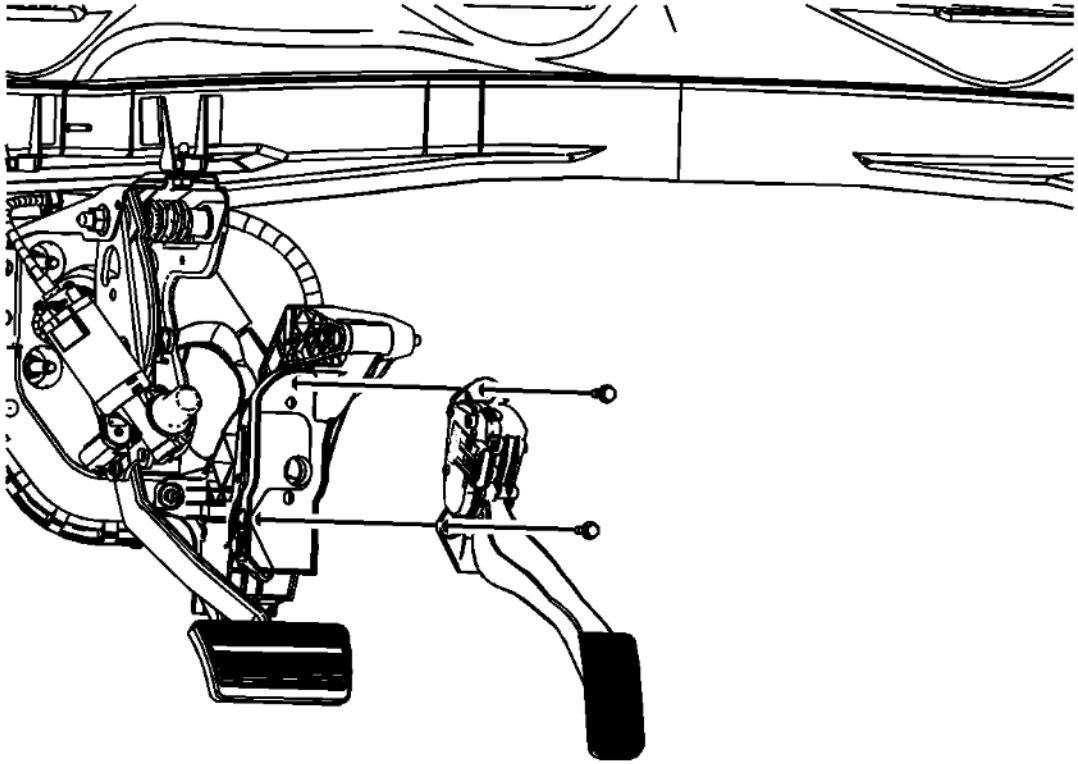


Fig. 21: View Of Accelerator Pedal Position Sensor Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Position the accelerator pedal to the accelerator pedal bracket.

CAUTION: **Refer to Fastener Caution .**

2. Install the accelerator pedal bolts and tighten to 9 N.m (80 lb in).

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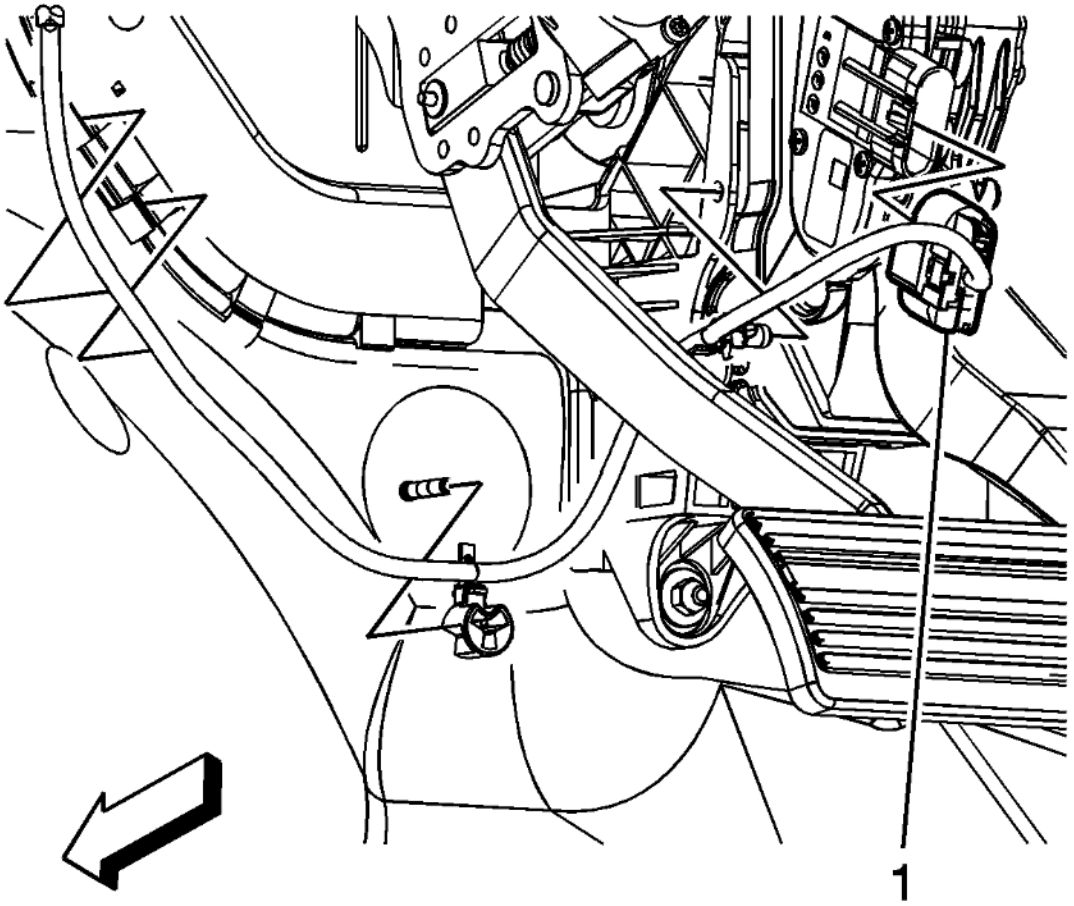


Fig. 22: View Of APP Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect the APP sensor electrical connector (1).
4. Connect a scan tool to the diagnostic port in order to test for proper throttle-opening and throttle-closing range.
5. Operate the accelerator pedal and monitor the throttle angles. The accelerator pedal should operate freely, without binding, between a closed throttle, and a wide open throttle (WOT).

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6. Verify that the vehicle meets the following conditions:
    - The vehicle is not in a reduced engine power mode.
    - The ignition is ON.
    - The engine is OFF.

THROTTLE BODY ASSEMBLY REPLACEMENT

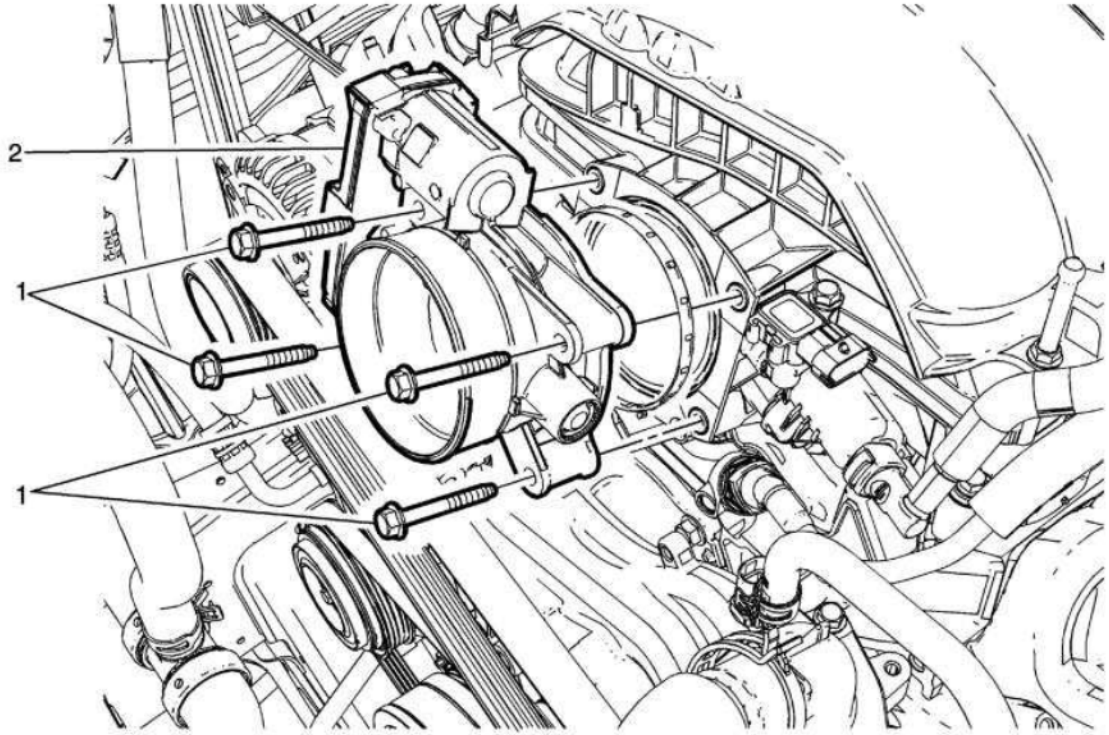


Fig. 23: Throttle Body Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (Chevrolet and GMC)Air Cleaner Outlet Duct Replacement (Cadillac)**.	

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Callout	Component Name
1	Throttle Body Assembly Fastener (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Throttle Body Assembly **Procedure** 1. Disconnect the electrical connectors. 2. Install a NEW throttle body seal. 3. Perform the throttle idle learn procedure. Refer to **Throttle or Idle Learn**.

THROTTLE BODY CLEANING

WARNING: Refer to Safety Glasses Warning .

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (Chevrolet and GMC)Air Cleaner Outlet Duct Replacement (Cadillac)**.
2. Fully open the throttle valve in order to Inspect the throttle body bore and the throttle valve plate for any deposits.

CAUTION: Do not subject a throttle body assembly which contains the following components to an immersion cleaner or a strong solvent:

- **Throttle position (TP) sensor**
- **Idle air control (IAC) valve**
- **Sealed throttle shaft bearings**

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The cleaners will damage the electric components or sensors.

The cleaners will damage some of these components that contain seals or O-rings.

Solvents can wash away or break down the grease used on non-serviceable throttle shaft bearings.

Never use a wire brush or scraper to clean the throttle body. A wire brush or sharp tools may damage the throttle body components.

Do not use a cleaner that contains methyl ethyl ketone. This extremely strong solvent may damage components and is not necessary for this type of cleaning.

3. Use a clean shop towel and an approved GM engine cleaner. Clean the throttle body bore and the throttle valve plate.

   If necessary, use a parts cleaning brush in order to remove heavy deposits.

4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement (Chevrolet and GMC)Air Cleaner Outlet Duct Replacement (Cadillac)**.
5. Perform the throttle idle learn procedure. Refer to **Throttle or Idle Learn**.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

- **CH-47831** Fuel Line Disconnect Tool
- **J 34730-1A** Fuel Pressure Gauge
- **J 42982** Fuel Pressure Gauge Adapter

Installation Procedure

WARNING: Gasoline or 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.

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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.
3. Install the **J 42982** adapter between the fuel feed pipe of the fuel rail and of the fuel feed hose.

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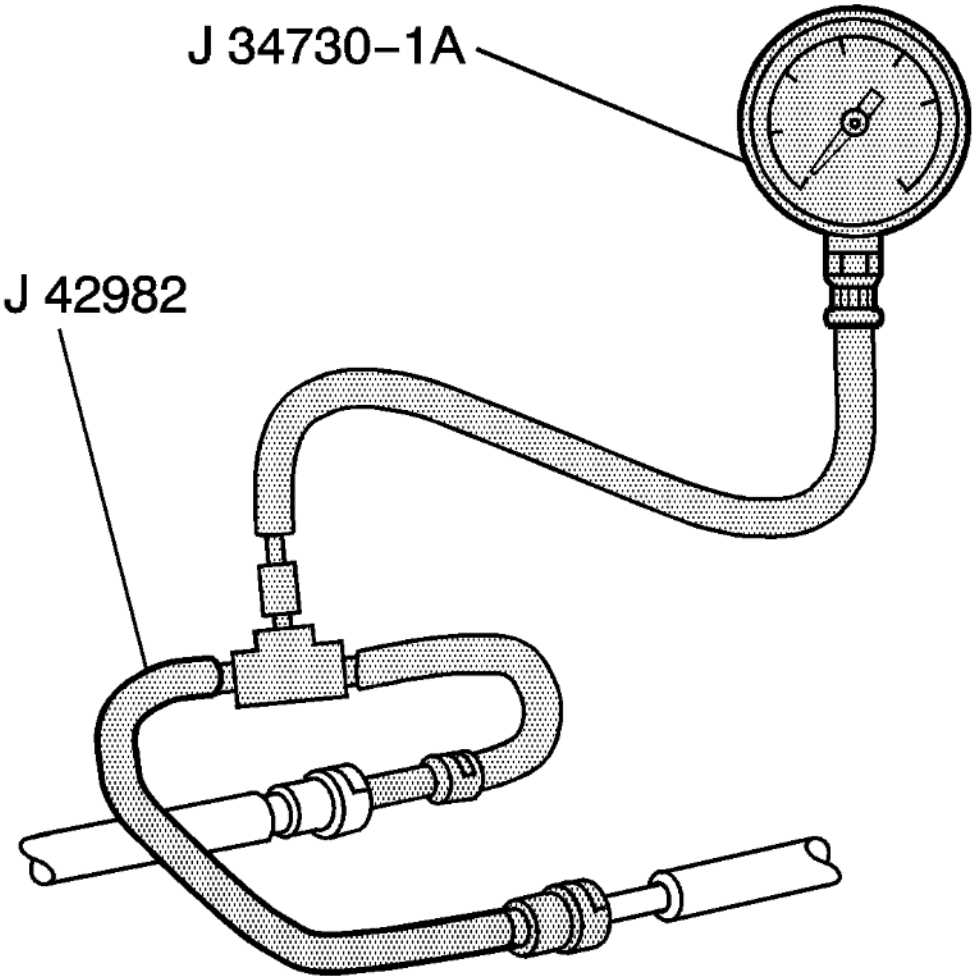


Fig. 24: Fuel Pressure Gage
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

4. Install the **J 34730-1A** gauge to the **J 42982** adapter, and tighten securely.
5. Turn ON the ignition in order to pressurize the fuel system.

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6. Turn OFF the ignition.
7. Check for any fuel leaks.

Removal Procedure

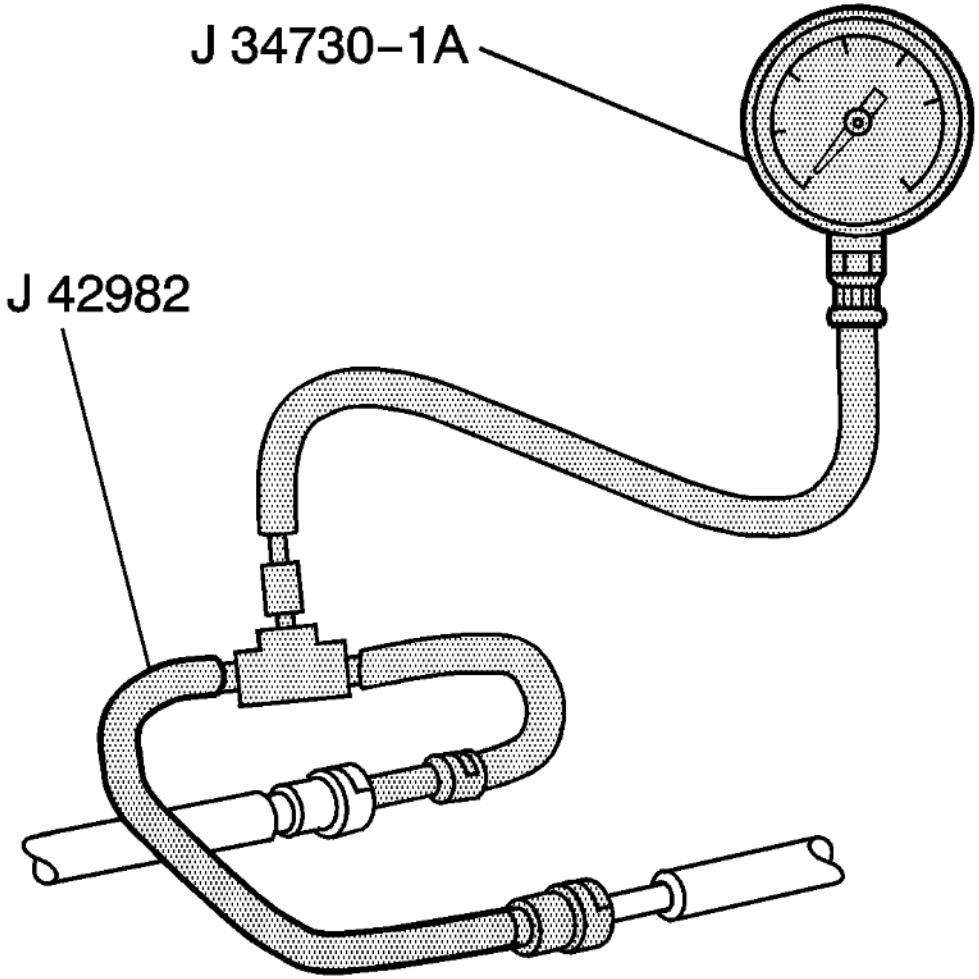


Fig. 25: Fuel Pressure Gage
Courtesy of GENERAL MOTORS COMPANY

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1. Relieve the fuel pressure. Refer to the **Fuel Pressure Relief**.
2. Remove the **J 34730-1A** gauge from the **J 42982** adapter.
3. Using the **CH-47831** tool, disconnect the quick connect coupling of the **J 42982** adapter from the fuel feed pipe of the fuel rail. Use a shop towel in order to catch any remaining fuel that may leak.
4. Disconnect the quick connect coupling of the fuel feed hose (3) from the **J 42982** adapter, and remove the adapter. Use a shop towel in order to catch any remaining fuel that may leak.
5. Connect the quick-connect fitting of the fuel feed hose (3) to the fuel feed pipe of the fuel rail.
6. Turn ON the ignition in order to pressurize the fuel system.
7. Turn OFF the ignition.
8. Check for any fuel leaks.

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.

WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

Scan Tool Method - Preferred

1. Install a scan tool and turn the ignition ON.
2. Using the scan tool, command the fuel pump OFF allowing the low pressure fuel pump to shut off.
3. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 5-20 seconds.
4. Repeat step 3. Using the scan tool, verify pressure has dropped to a minimal level.
5. Turn the ignition OFF.

Alternate Method - If a scan tool is not available

1. Disable the fuel pump by removing the B+ fuel pump control module fuse. Refer to **Electrical Center Identification Views** **Electrical Center Identification Views** .

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2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 5-20 seconds.
3. Attempt to restart the vehicle to ensure pressure has dropped to a minimal level.
4. Turn the ignition OFF.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

CH-41769 Fuel Line Quick Disconnect Tool

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Service Tools)** .

Disconnect Procedure

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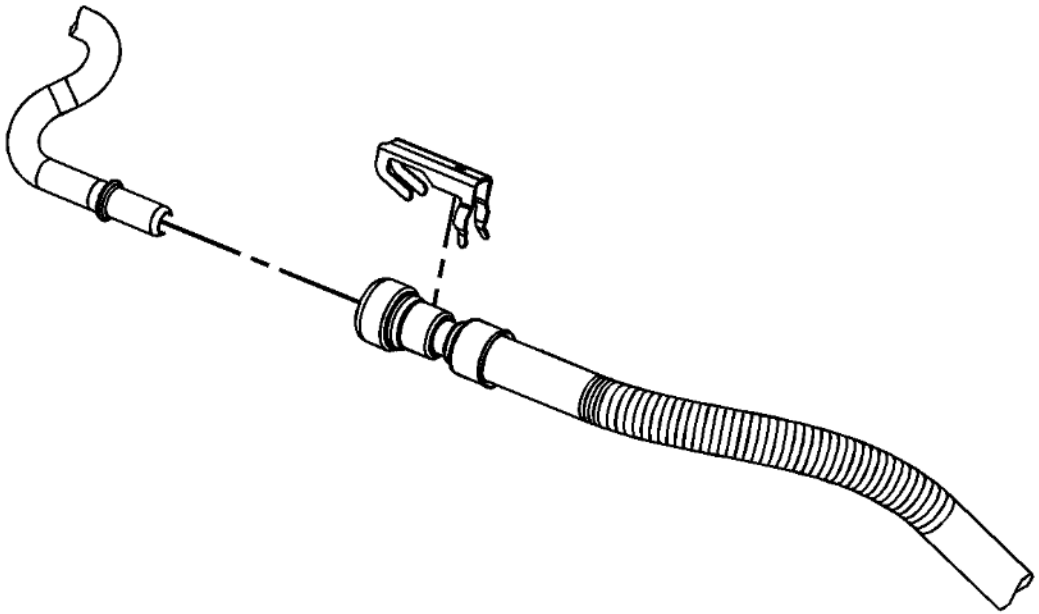


Fig. 26: Fuel Feed Line To Engine Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Remove the fuel line retainer.

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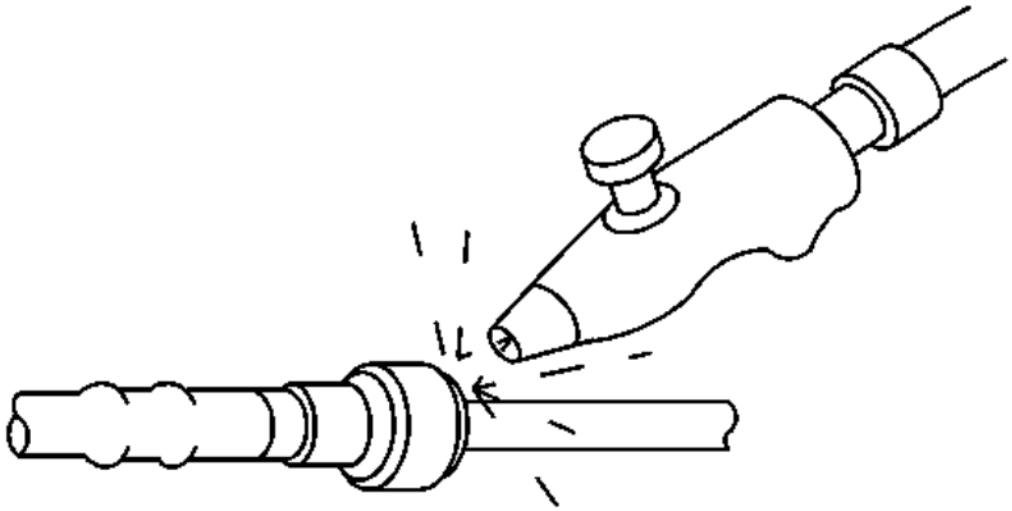


Fig. 27: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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WARNING: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

3. Using compressed air, blow any dirt or debris from around the connection.

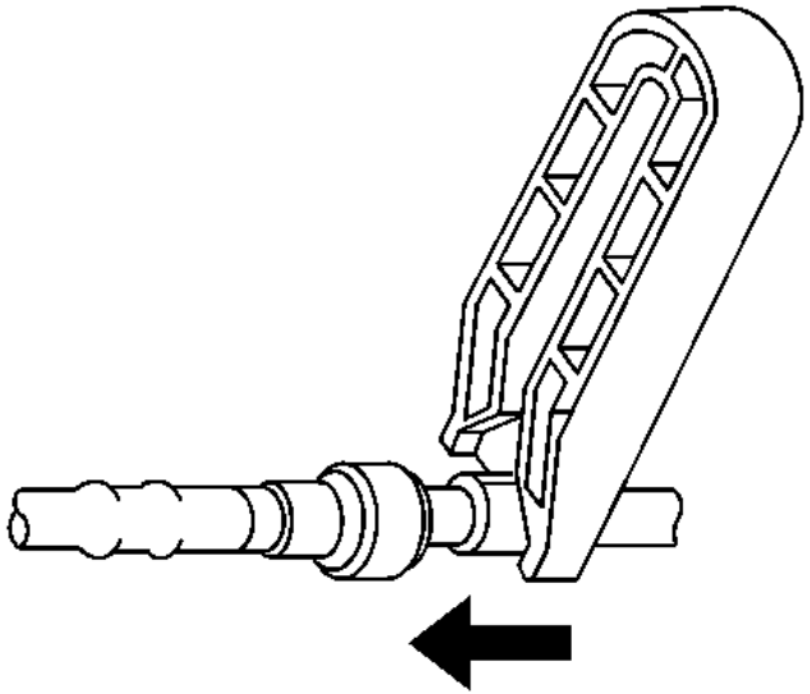


Fig. 28: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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4. Using the correct tool from the **CH-41769** disconnect tool, insert the tool into the female connector end, then push inward in order to release the quick connect locking tabs.

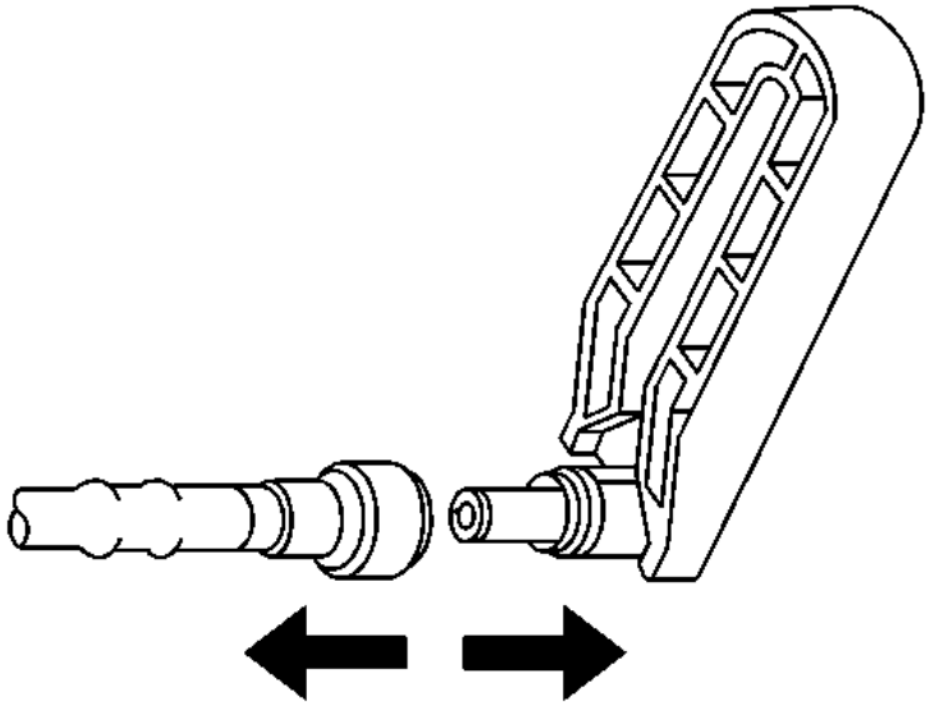


Fig. 29: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

5. Pull the fuel line connection apart.

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CAUTION: **If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.**

6. Use a clean shop towel in order to wipe off the male connection end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.

Connect Procedure

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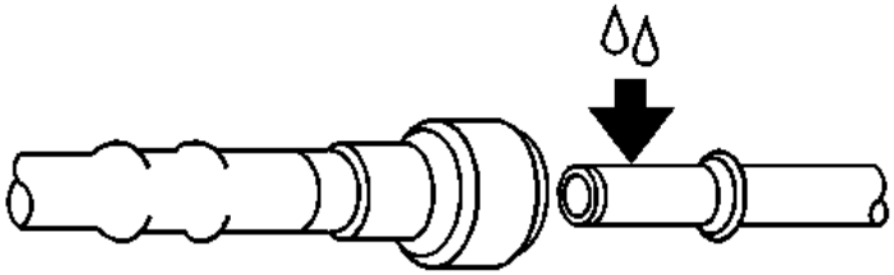


Fig. 30: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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.

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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 connection end.

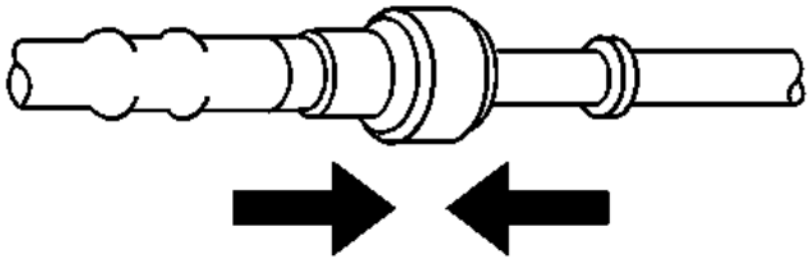


Fig. 31: View Of Connectors (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

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2. Push both sides of the fitting together in order to engage the retaining tabs.

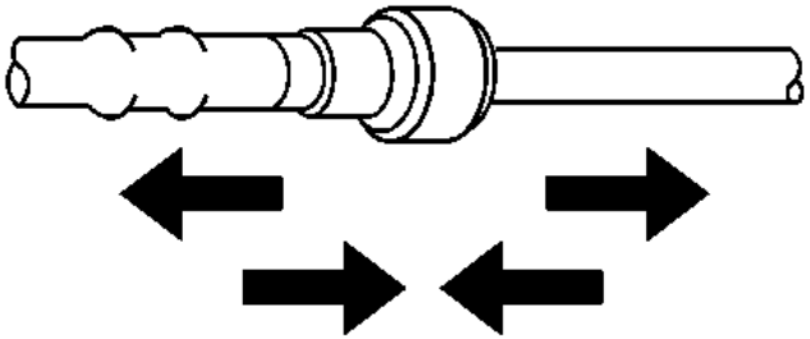


Fig. 32: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the connection in order to ensure the connection is secure.

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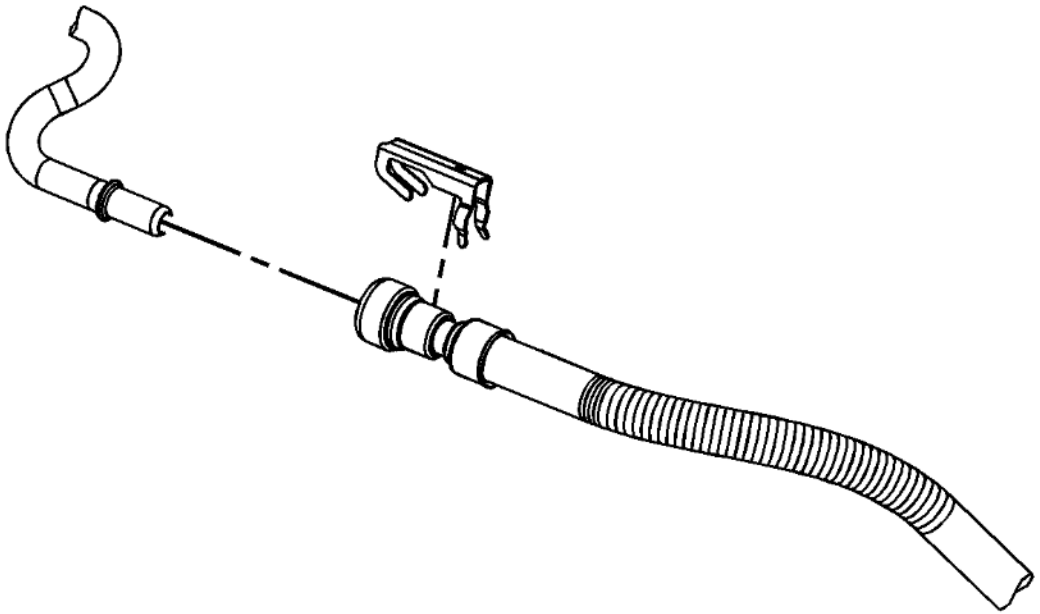


Fig. 33: Fuel Feed Line To Engine Quick-Connect Fitting Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install the fuel line retainer.

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Disconnect Procedure

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WARNING: Refer to Gasoline/Gasoline Vapors Warning .

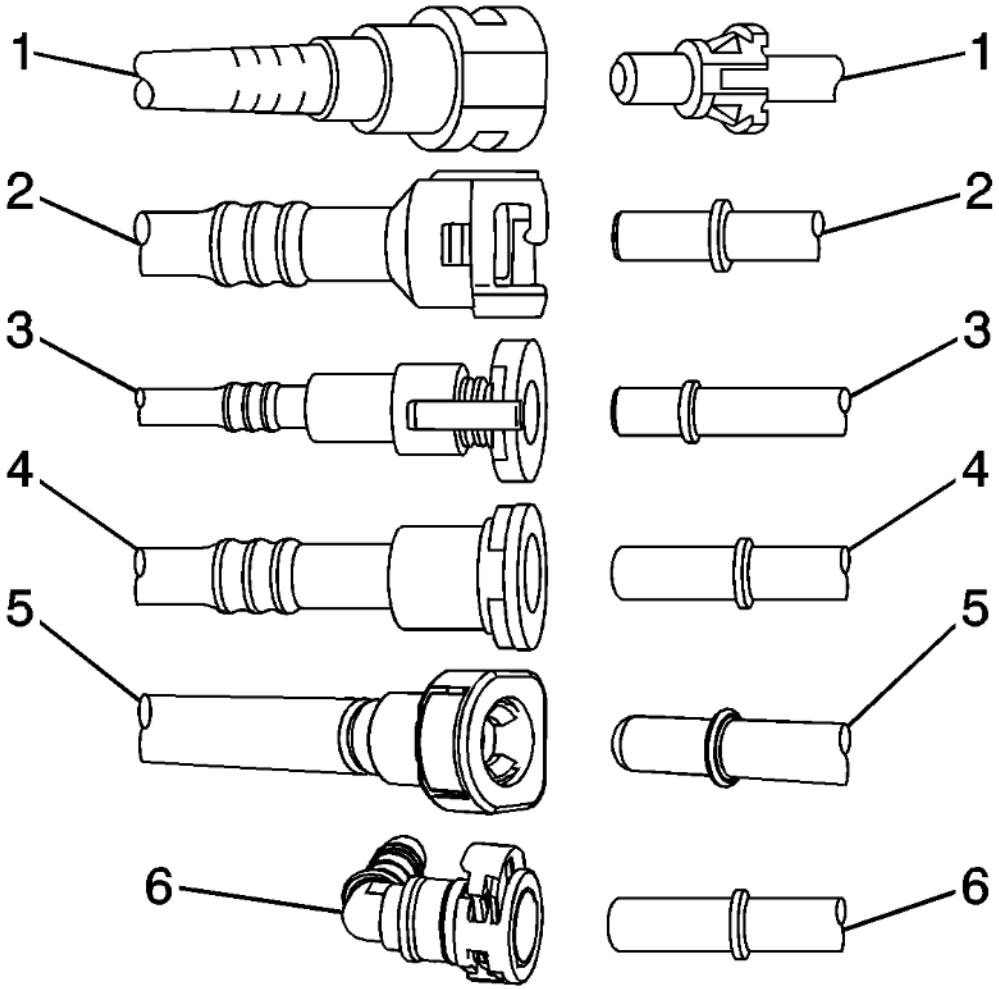


Fig. 34: Identifying Plastic Collar Fuel & Evaporative Emission Quick Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

NOTE: There are several types of Plastic Collar Fuel and Evaporative Emission Quick Connect Fittings used on this vehicle.

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- **Bartholomew (1)**
- **Q Release (2)**
- **Squeeze to Release (3)**
- **Sliding Retainer (4)**
- **Push Down Tl (5)**

The following instructions apply to all of these types of Plastic Collar Quick Connect Fittings except where indicated.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.

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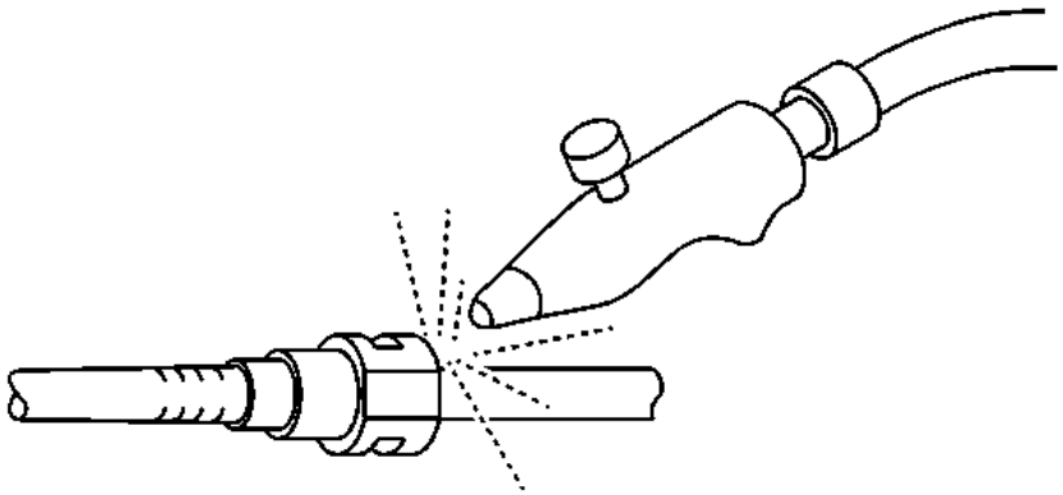


Fig. 35: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

CAUTION: Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .

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2. Using compressed air, blow any dirt or debris from around the connection.

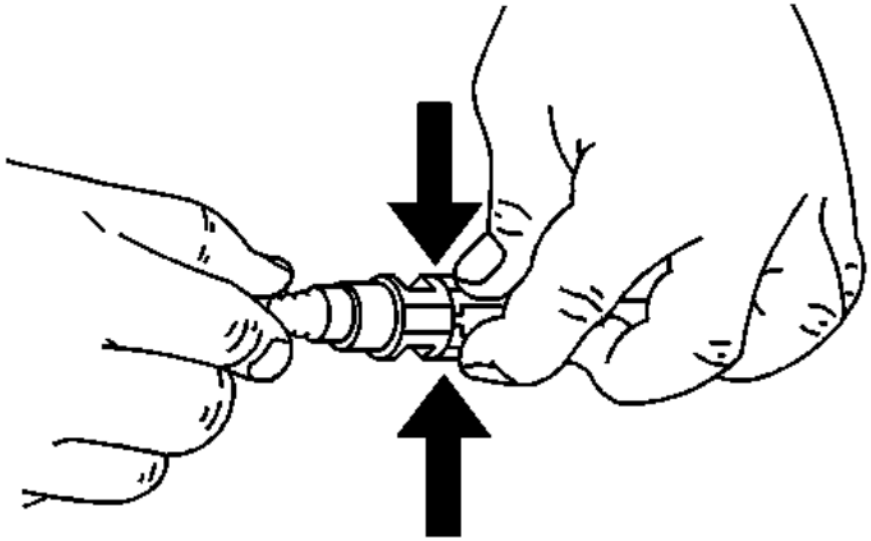


Fig. 36: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

3. This step applies to Bartholomew style connector ONLY. Squeeze the plastic quick connect fitting release tabs.

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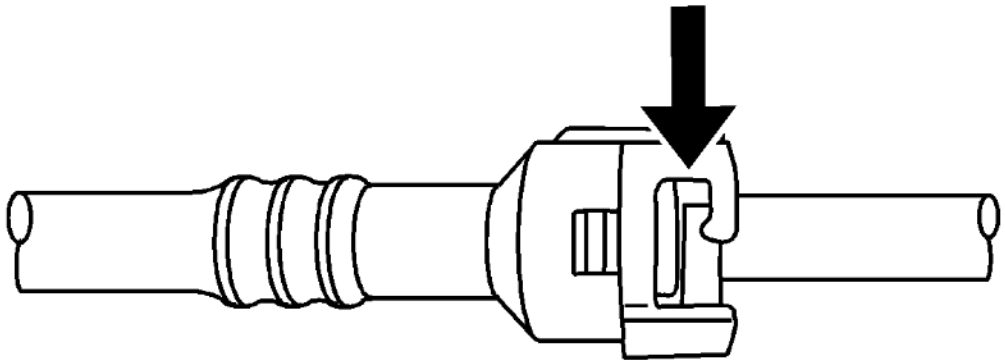


Fig. 37: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

4. This step applies to Release Tab style connector ONLY. Release the fitting by pushing the tab toward the other side of the slot in the fitting.

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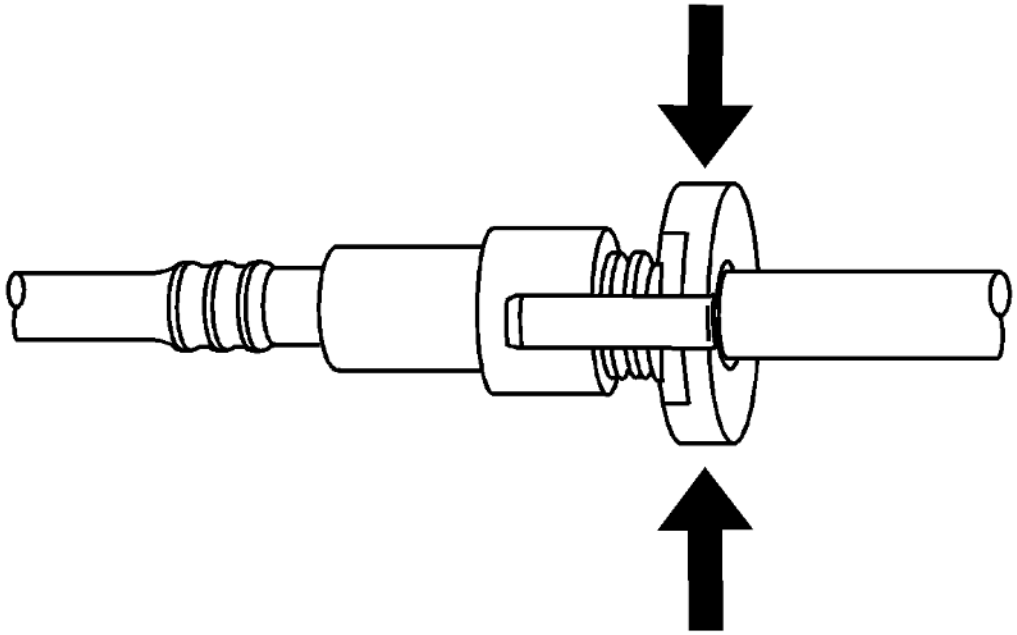


Fig. 38: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

5. This step applies to the Squeeze to Release style connector ONLY. Squeeze where indicated by the arrows shown above on both sides of the plastic ring surrounding the quick connect fitting.

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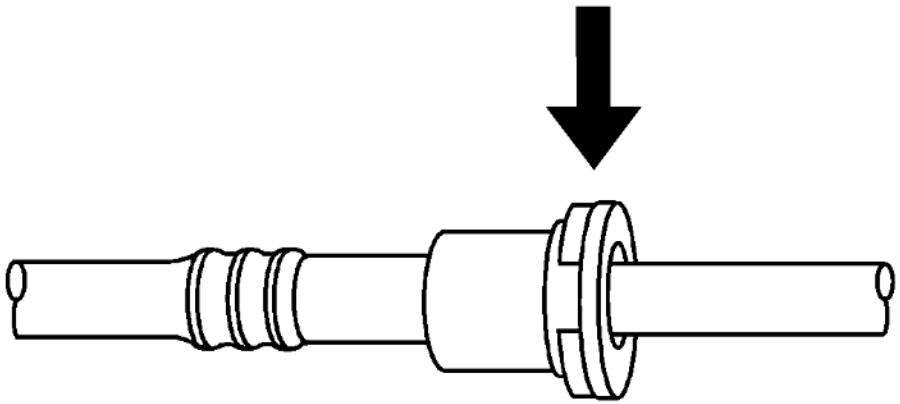


Fig. 39: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS COMPANY

6. This step applies to the Sliding Retainer style connector ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab does not move try pressing the tab in from the opposite side. The tab will only move in one direction.

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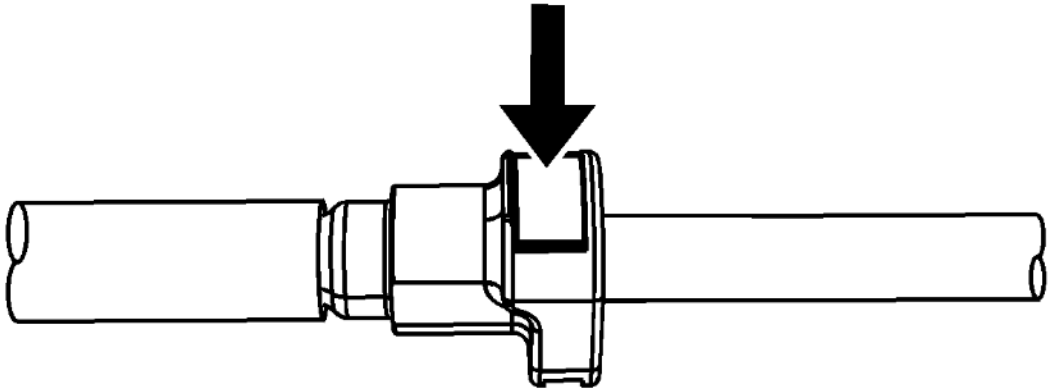


Fig. 40: View Of Push Down TI Style Connector
Courtesy of GENERAL MOTORS COMPANY

7. This step applies to the Push Down TI style connector ONLY. Release the fitting by pressing on the tab indicated by the arrow.

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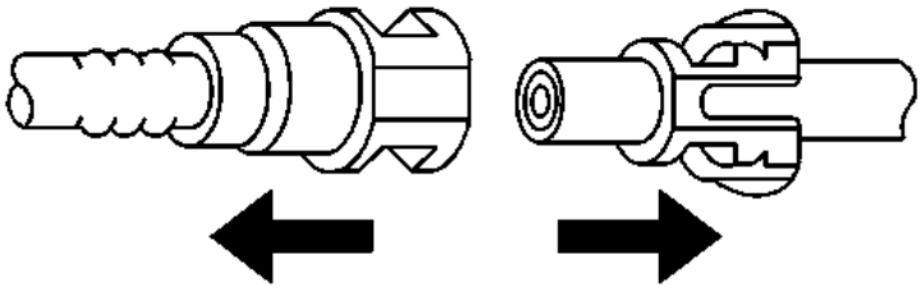


Fig. 41: View Of Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Relieving Fuel Pressure Warning .**

8. Pull the connection apart.

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Connect Procedure

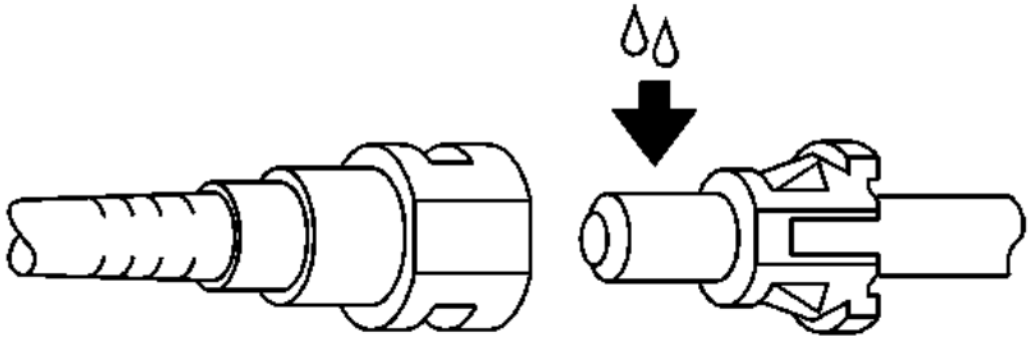


Fig. 42: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Fuel Pipe Fitting Warning

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1. Apply a few drops of clean engine oil to the male connection end.

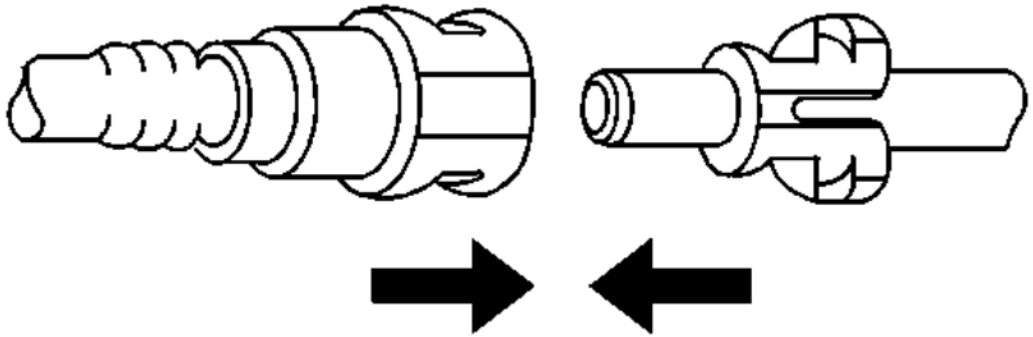


Fig. 43: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

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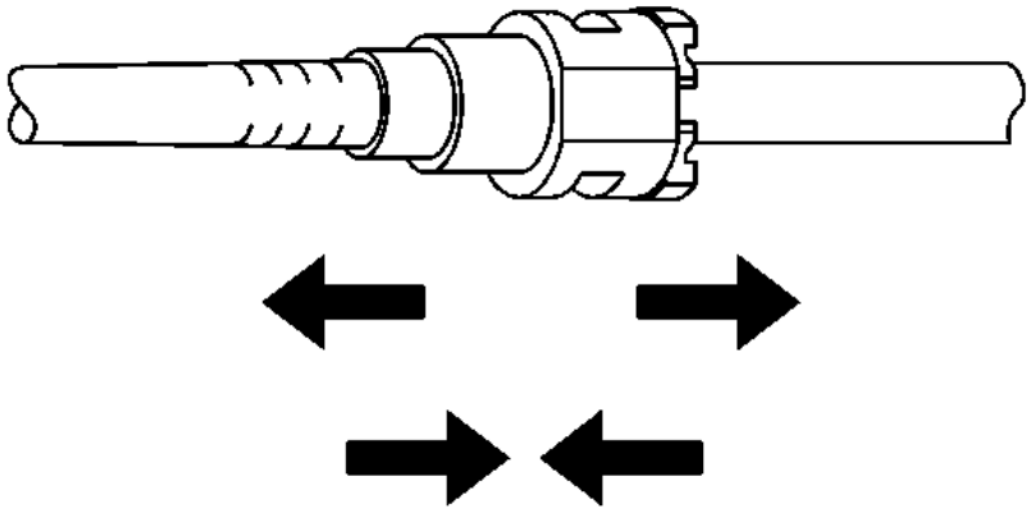


Fig. 44: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the connection in order to make sure the connection is secure.

FUEL TANK DRAINING

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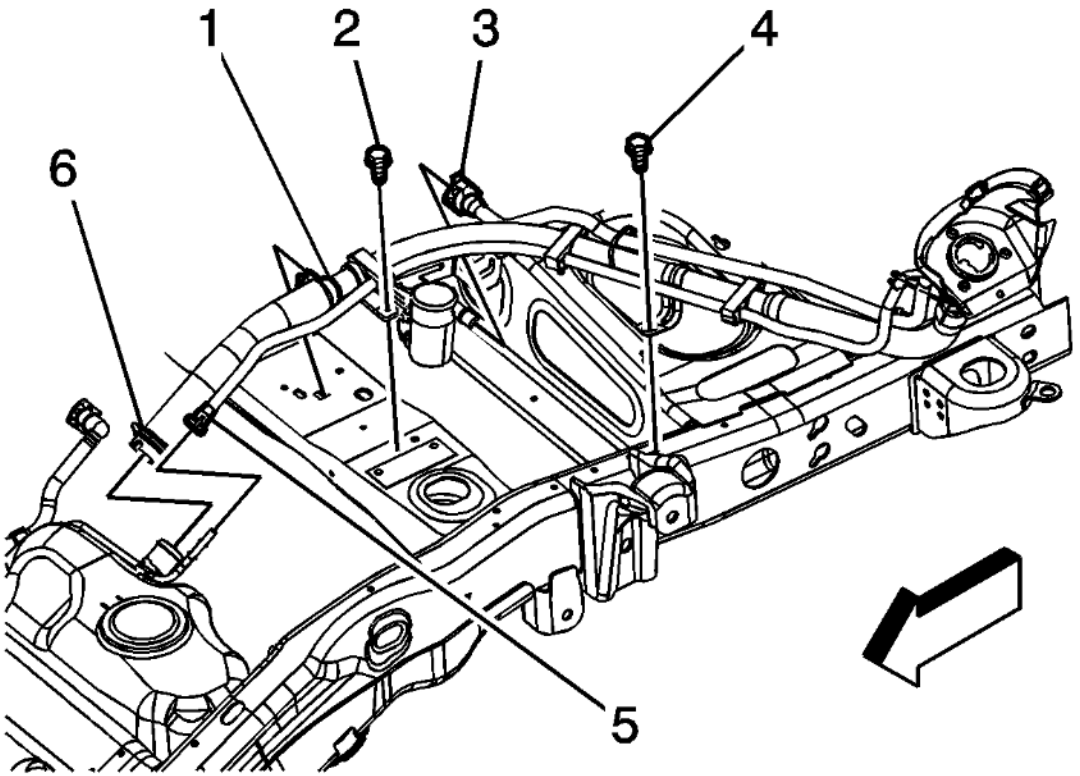


Fig. 45: Fuel Tank Vent Line Quick Connect Fitting, Hose Clamp, Bracket Bolts & Fill Hose
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

1. Loosen the fuel fill cap in order to relieve the fuel tank vapor pressure.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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3. Loosen the fuel fill hose clamp (6).
4. Remove the fuel fill hose from the fuel tank.
5. Insert the hose from the pump devise into the fuel tank.
6. Using a hand or air operated pump device, drain as much fuel from the tank as possible.

FUEL TANK FILLER HOSE REPLACEMENT

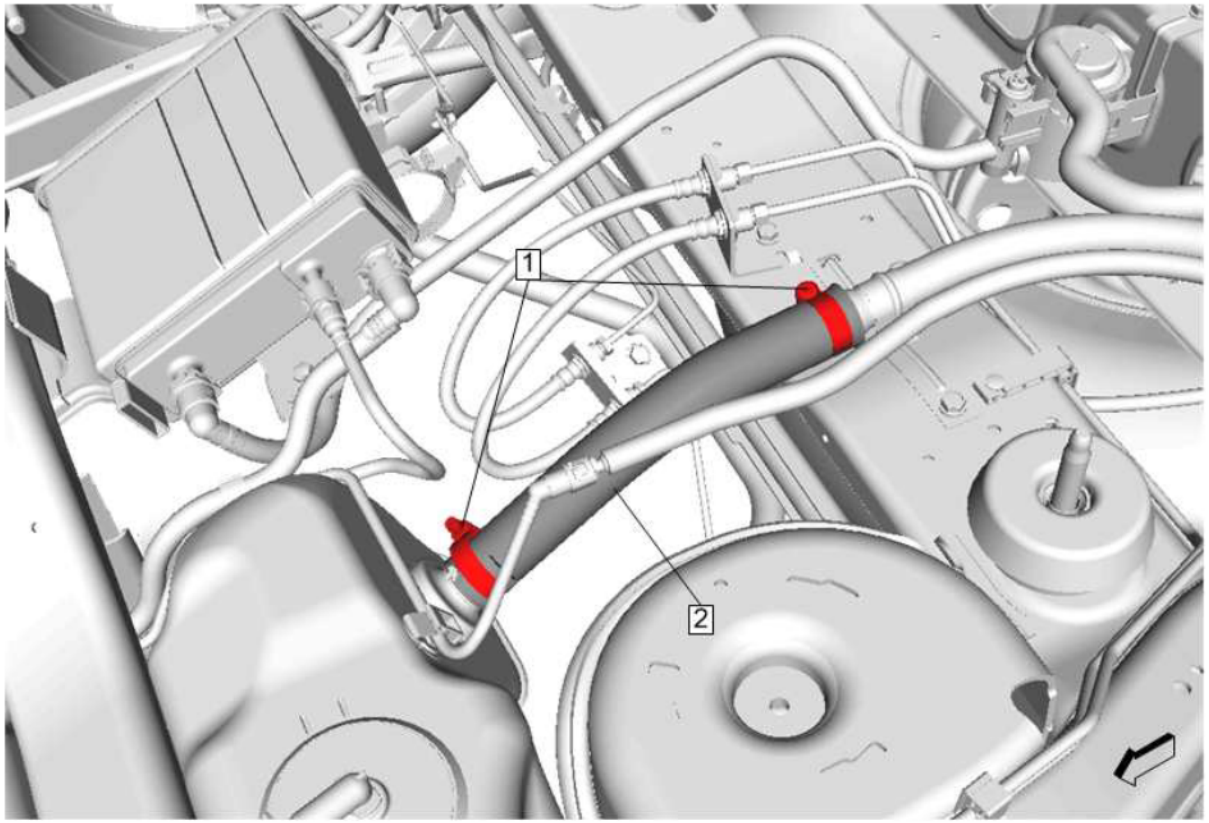


Fig. 46: Fuel Tank Filler Hose
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING:	

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Callout	Component Name
Refer to Gasoline/Gasoline Vapors Warning . **WARNING:** Refer to Safety Glasses Warning . **Preliminary Procedure** Lifting and Jacking the Vehicle	
1	Fuel Tank Filler Hose Clamp (Qty: 2) **CAUTION:** Refer to Fastener Caution . **Tighten** 4 N.m (35 lb in)
2	Fuel Tank Filler Hose **Procedure** If screen is in old hose, screen must be removed from old hose and installed in new hose if screen is not present in new hose.

FUEL TANK FILLER PIPE REPLACEMENT

Removal Procedure

NOTE: **Clean the fuel connections and surrounding areas prior to disconnecting the lines in order to avoid possible contamination.**

1. Remove Fuel Tank Filler Pipe Housing **Fuel Tank Filler Pipe Housing Replacement**

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2. Remove the fuel fill cap, if necessary.

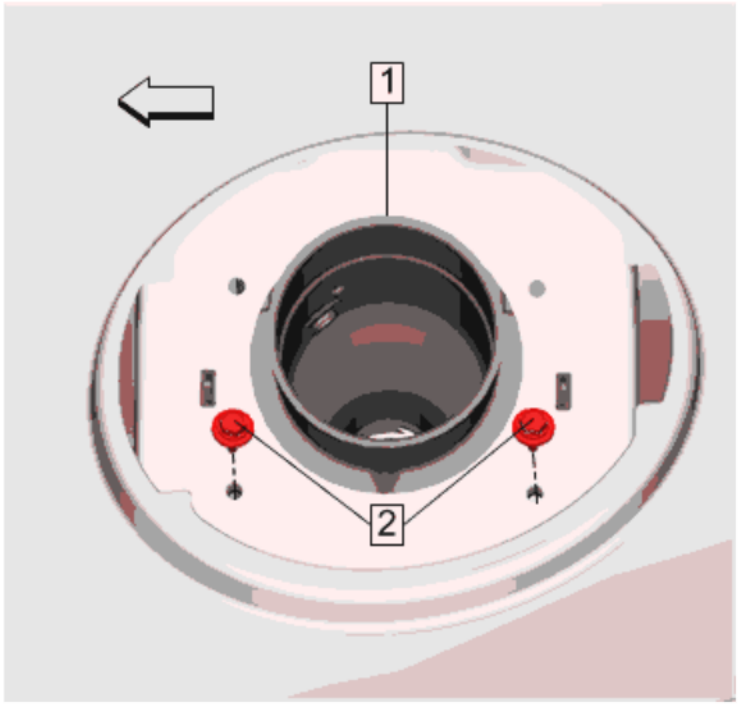


Fig. 47: Fuel Tank Filler Pipe Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove Fuel Tank Filler Pipe Bracket Bolt (2)
4. Remove the spare tire, if necessary.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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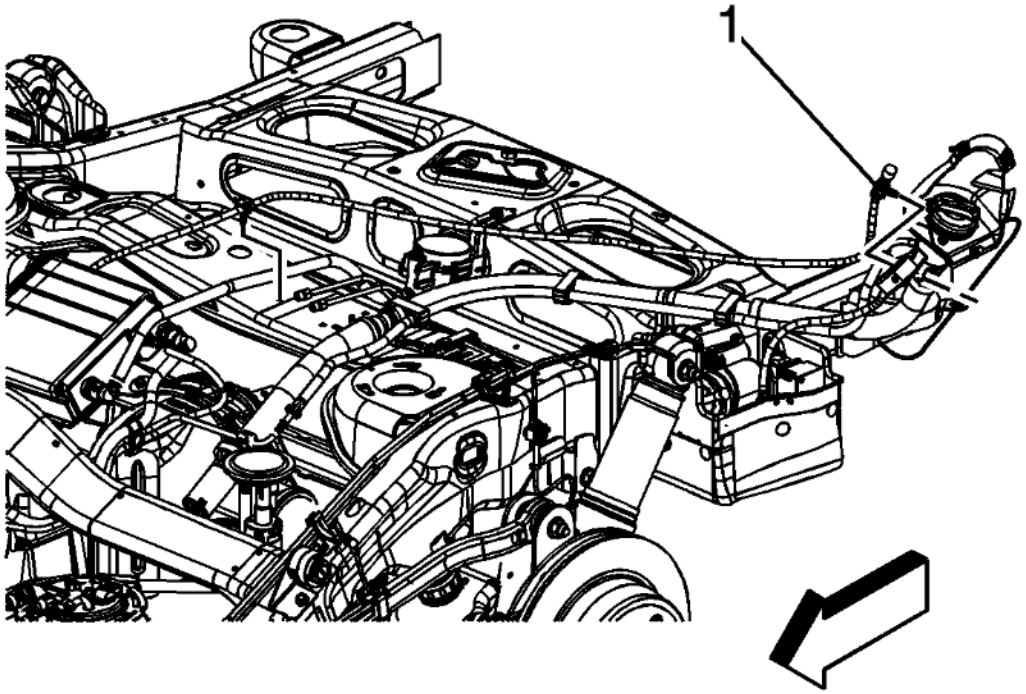


Fig. 48: View Of Rear Axle Vent Hose Clip
Courtesy of GENERAL MOTORS COMPANY

6. Remove the rear axle vent hose clip (1) from the fill pipe.
7. Remove Automatic Level Control Air Compressor Inlet Tube **Automatic Level Control Air Compressor Inlet Tube Replacement** .

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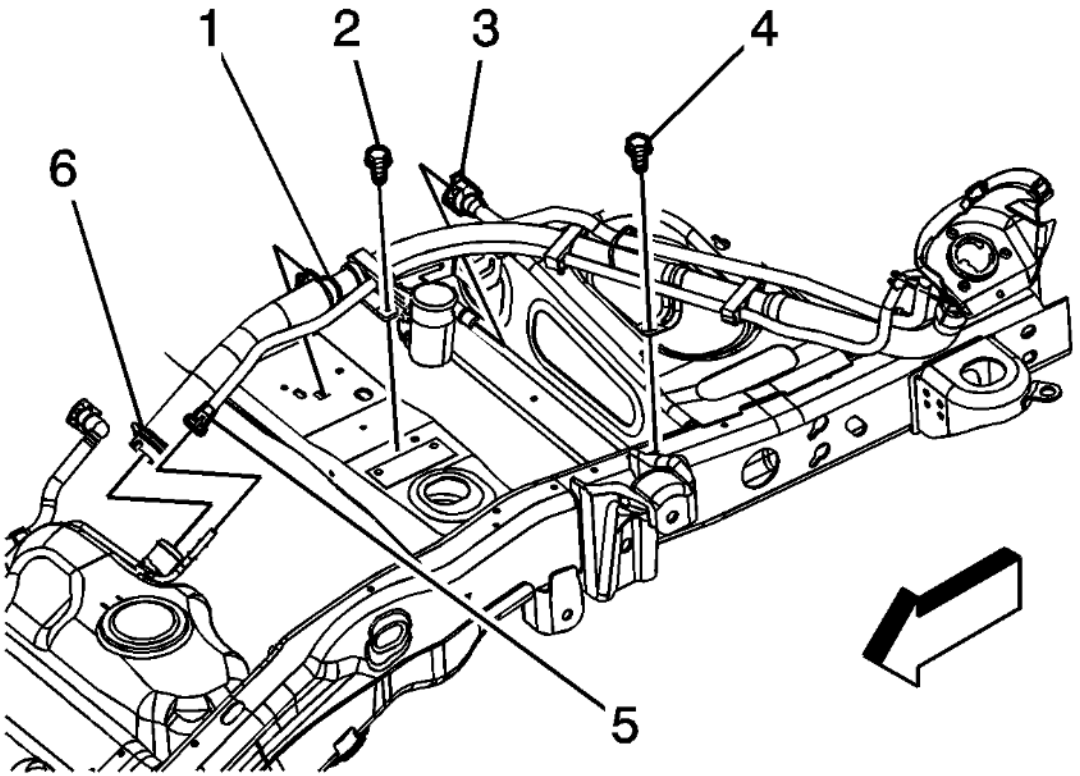


Fig. 49: Fuel Tank Vent Line Quick Connect Fitting, Hose Clamp, Bracket Bolts & Fill Hose
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the fuel tank vent line quick connect fitting (5) from the fill pipe line. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Disconnect the fuel fill hose vent line quick connect fitting (3) from the EVAP canister vent solenoid valve. Refer to **Plastic Collar Quick Connect Fitting Service**.
10. Loosen the fuel fill hose clamp (6).

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11. Remove the fuel fill pipe bracket bolts (2, 4).
12. Remove the fuel fill hose (1) from the fuel tank.

Installation Procedure

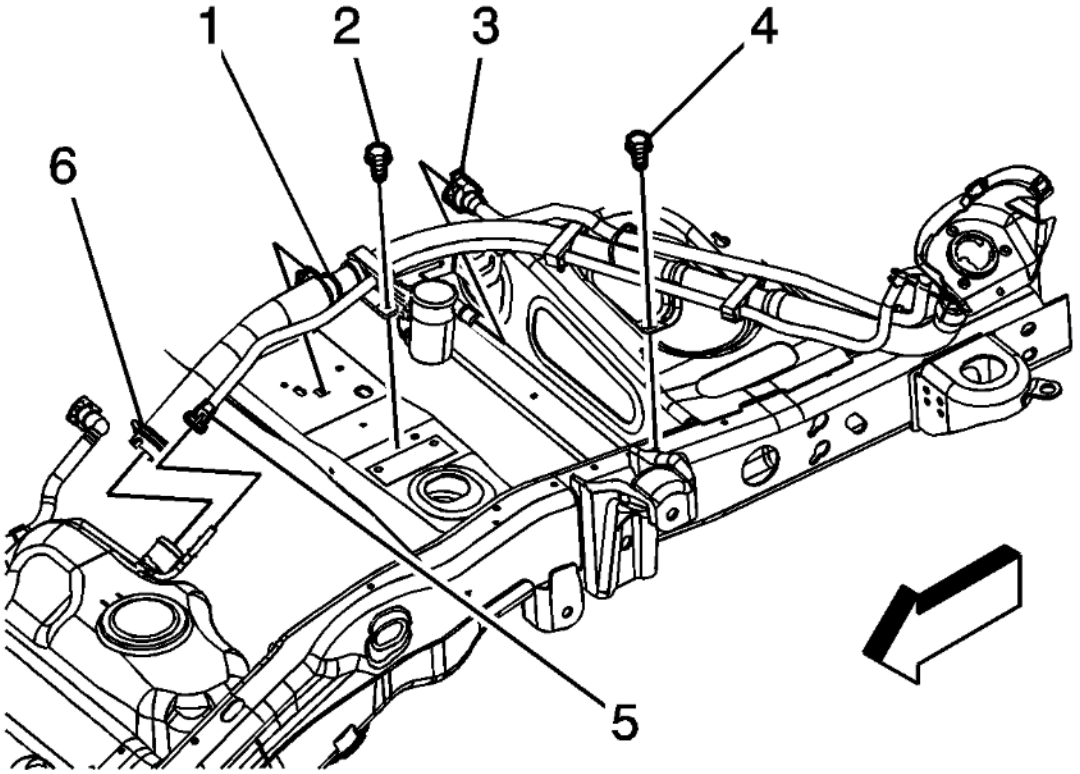


Fig. 50: Fuel Tank Vent Line Quick Connect Fitting, Hose Clamp, Bracket Bolts & Fill Hose
Courtesy of GENERAL MOTORS COMPANY

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1. Install the fuel fill hose (1) to the fuel tank. Ensure that the notch in the hose is aligned with the notch on the fuel tank.

CAUTION: Refer to Fastener Caution .

2. Tighten the fuel fill hose clamp (6). 4 N.m (35 lb in).
3. Install the fuel fill pipe bracket bolts (2, 4). Tighten to 12 N.m (106 lb in).
4. Connect the fuel fill hose vent line quick connect fitting (3) to the EVAP canister vent solenoid valve. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Connect the fuel fill pipe vent line to the fuel tank quick connect fitting (5). Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Install Automatic Level Control Air Compressor Inlet Tube **Automatic Level Control Air Compressor Inlet Tube Replacement**

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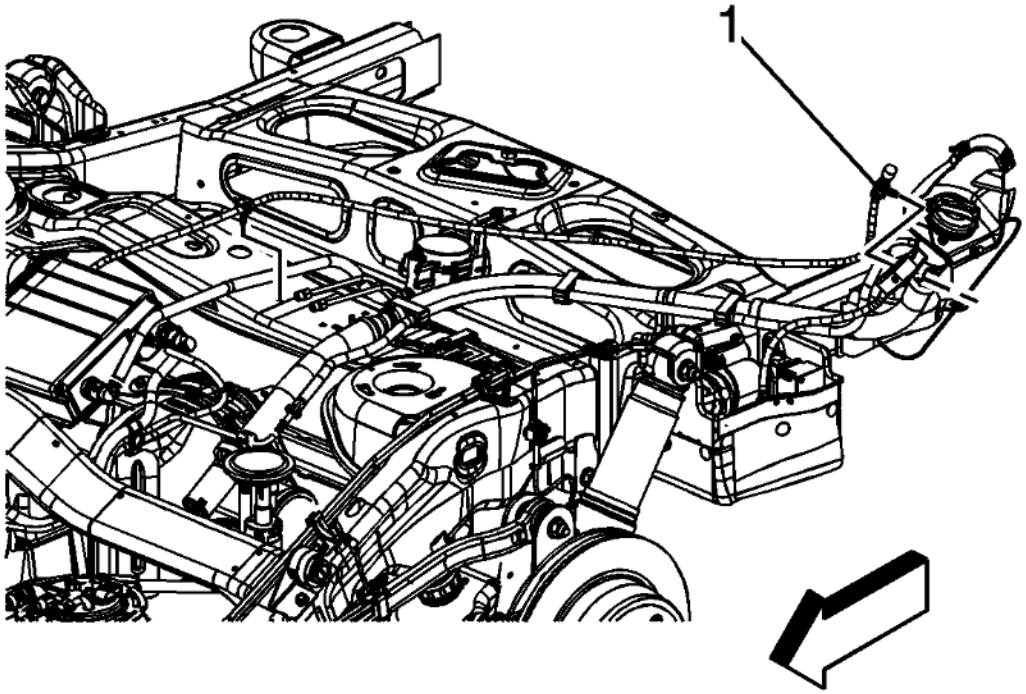


Fig. 51: View Of Rear Axle Vent Hose Clip
Courtesy of GENERAL MOTORS COMPANY

7. Install the rear axle vent hose clip (1) to the fill pipe.
8. Lower the vehicle.

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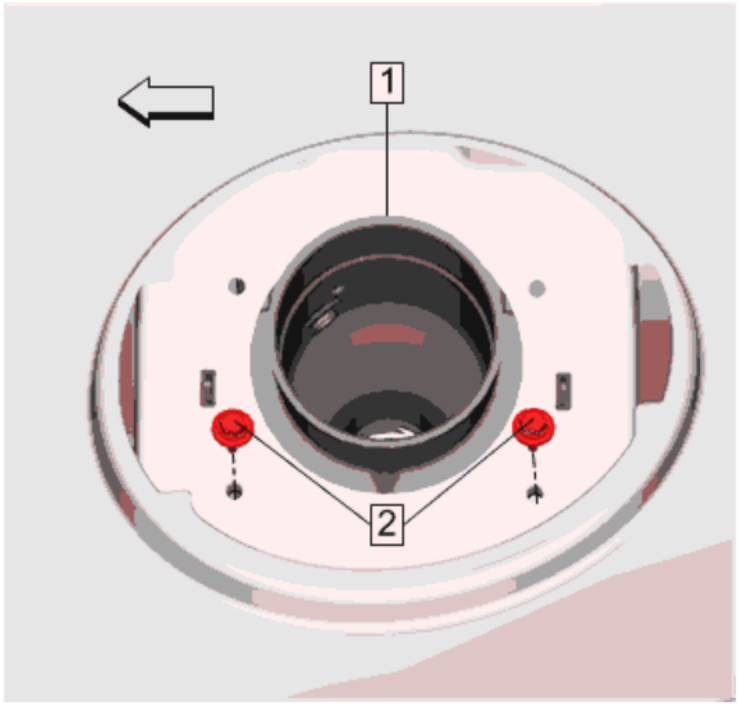


Fig. 52: Fuel Tank Filler Pipe Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Install Fuel Tank Filler Pipe Bracket Bolt (2) Tighten to 10 N.m (89 lb in).
10. Install the spare tire, if necessary.
11. Install the fuel fill cap, if necessary.
12. Install Fuel Tank Filler Pipe Housing **Fuel Tank Filler Pipe Housing Replacement**

FUEL TANK REPLACEMENT

Special Tools

J-45722 Fuel Sender Lock Ring Wrench

Removal Procedure

NOTE: **Clean the fuel and evaporative emission (EVAP) connections and surrounding areas prior to disconnecting the lines in order to avoid possible system contamination.**

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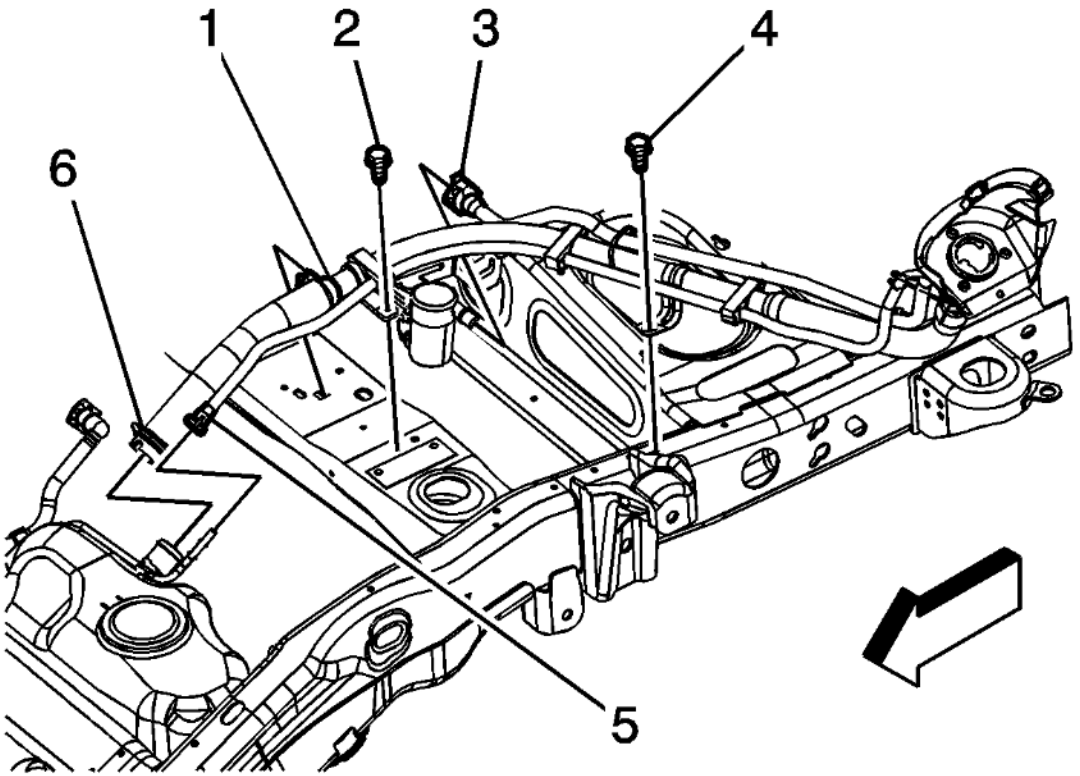


Fig. 53: Fuel Tank Vent Line Quick Connect Fitting, Hose Clamp, Bracket Bolts & Fill Hose
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Drain the fuel tank. Refer to **Fuel Tank Draining**.
3. Disconnect the fuel tank vent line quick connect fitting (5) from the fuel fill pipe vent line. Refer to **Plastic Collar Quick Connect Fitting Service**.

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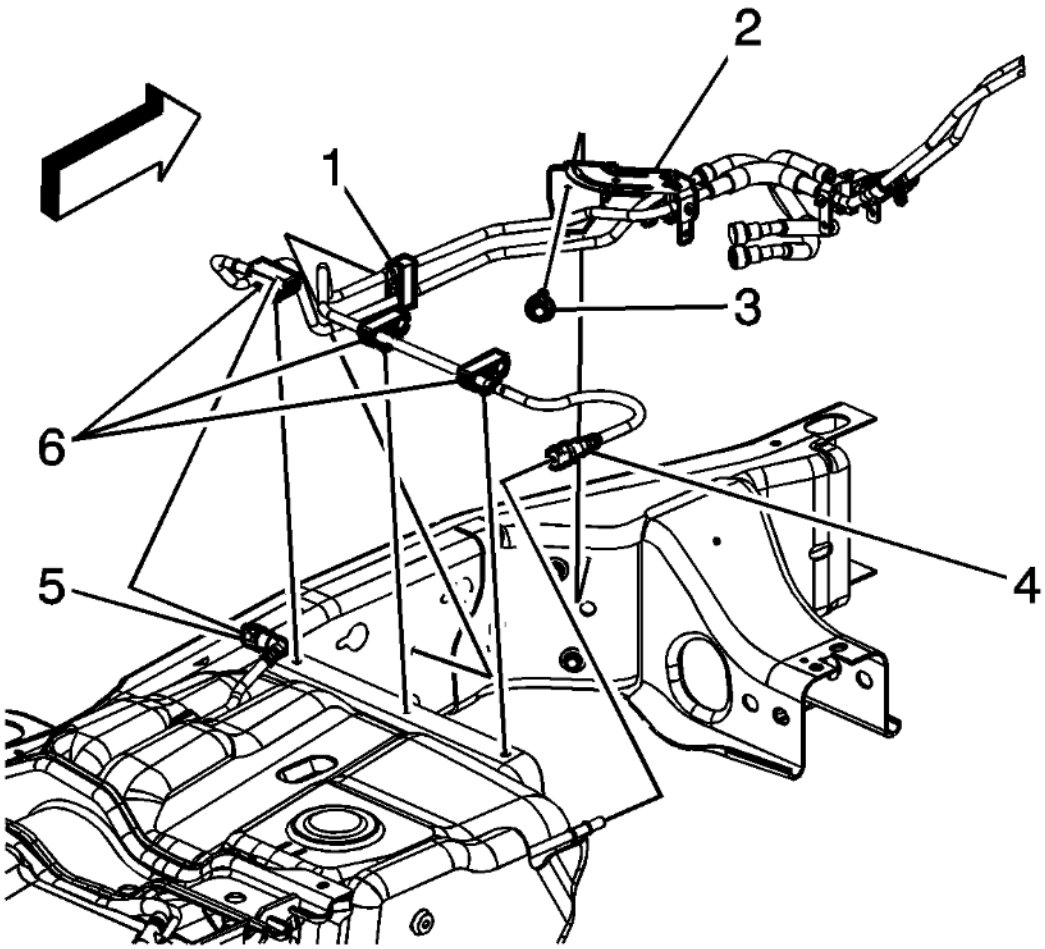


Fig. 54: View Of EVAP Lines, Fuel Feed Lines & Fittings
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the chassis EVAP line quick connect fitting (4) from the fuel tank line. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Disconnect the fuel tank fuel feed line quick connect fitting (5) from the chassis line. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Cap the fuel and EVAP lines in order to prevent possible fuel and/or EVAP system contamination.

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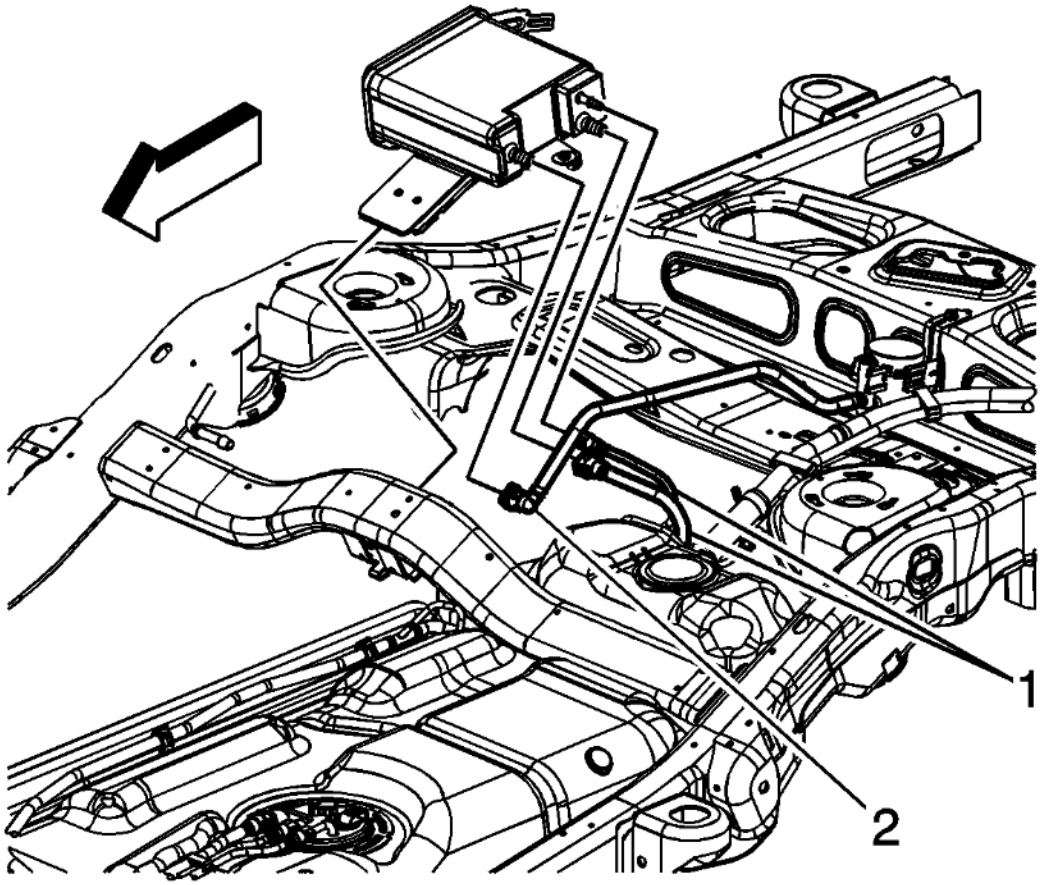


Fig. 55: View Of Fuel Tank EVAP Lines & Canister
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the fuel tank EVAP lines (1) from the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Cap the EVAP lines in order to prevent possible EVAP system contamination.
9. Using an adjustable jack, support the fuel tank.

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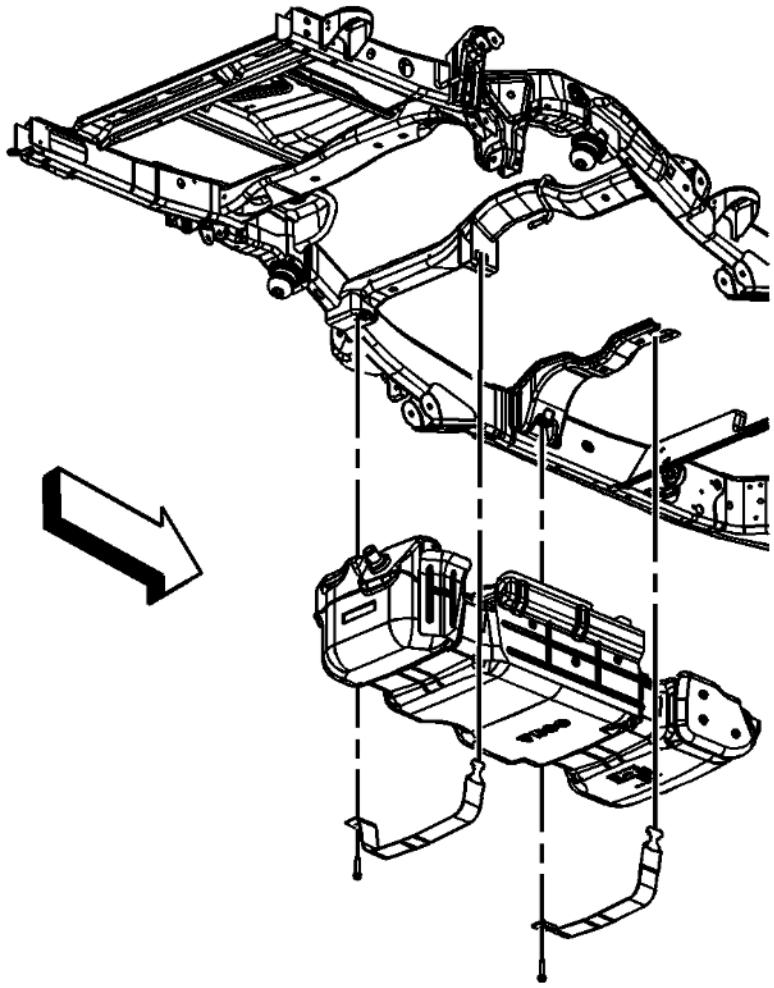


Fig. 56: View Of Fuel Tank & Straps (Single Tank)
Courtesy of GENERAL MOTORS COMPANY

10. Remove the fuel tank strap bolts.

CAUTION: **Refer to Damage to Fuel Tank Straps Caution .**

11. Remove the fuel tank straps.

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NOTE: **Carefully lower the fuel tank until the EVAP line can be repositioned.**

12. With the aid of an assistant, carefully lower the rear of the fuel tank.

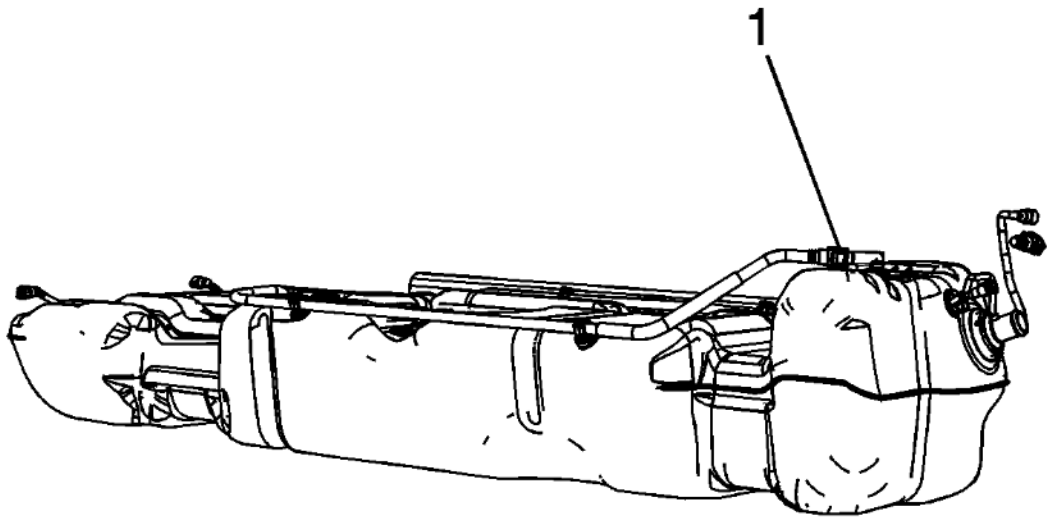


Fig. 57: Fuel Tank EVAP Line Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the fuel tank EVAP line quick connect fitting (1) at the fuel tank vent valve. Refer to **Plastic Collar Quick Connect Fitting**

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Service.

14. Slide the front of the tank away from the frame.
15. Lower the fuel tank slightly until the chassis wiring harness electrical connectors can be accessed.

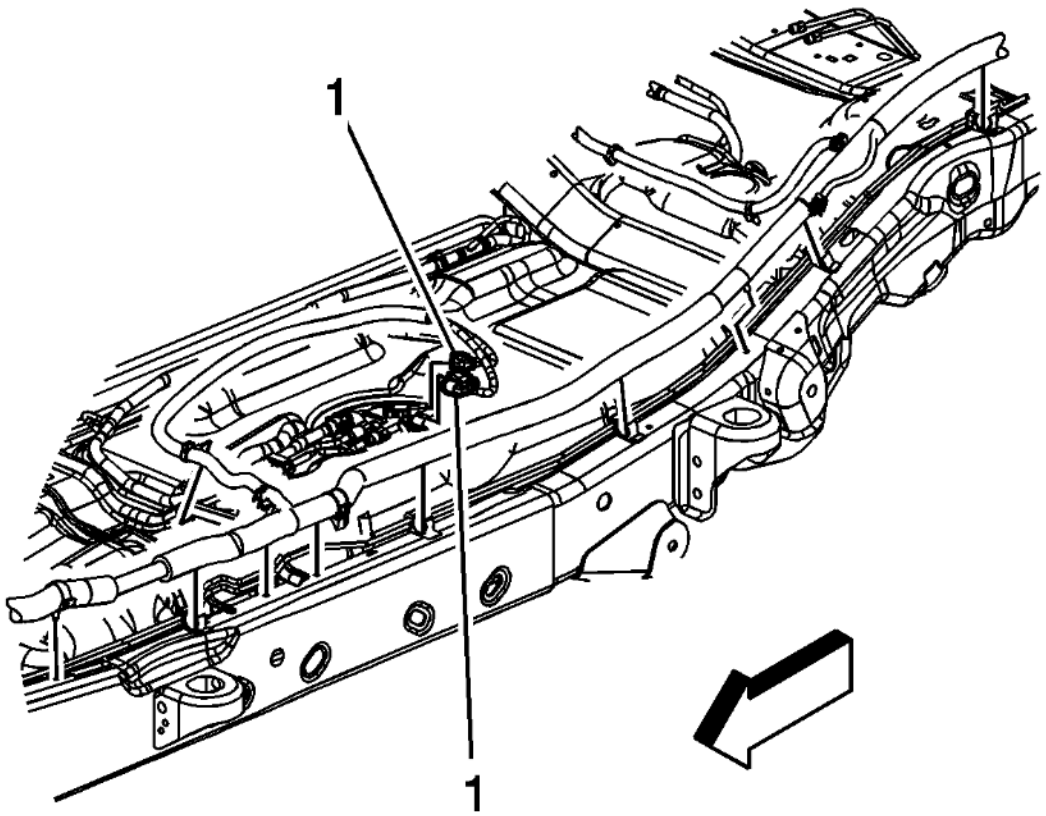


Fig. 58: View Of Chassis Wiring Harness Electrical Connectors & Module
Courtesy of GENERAL MOTORS COMPANY

16. Disengage the chassis wiring harness electrical connector, connector position assurance (CPA) retainer at the module.

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17. Disconnect the chassis wiring harness electrical connectors (1) from the module and the fuel pressure sensor.

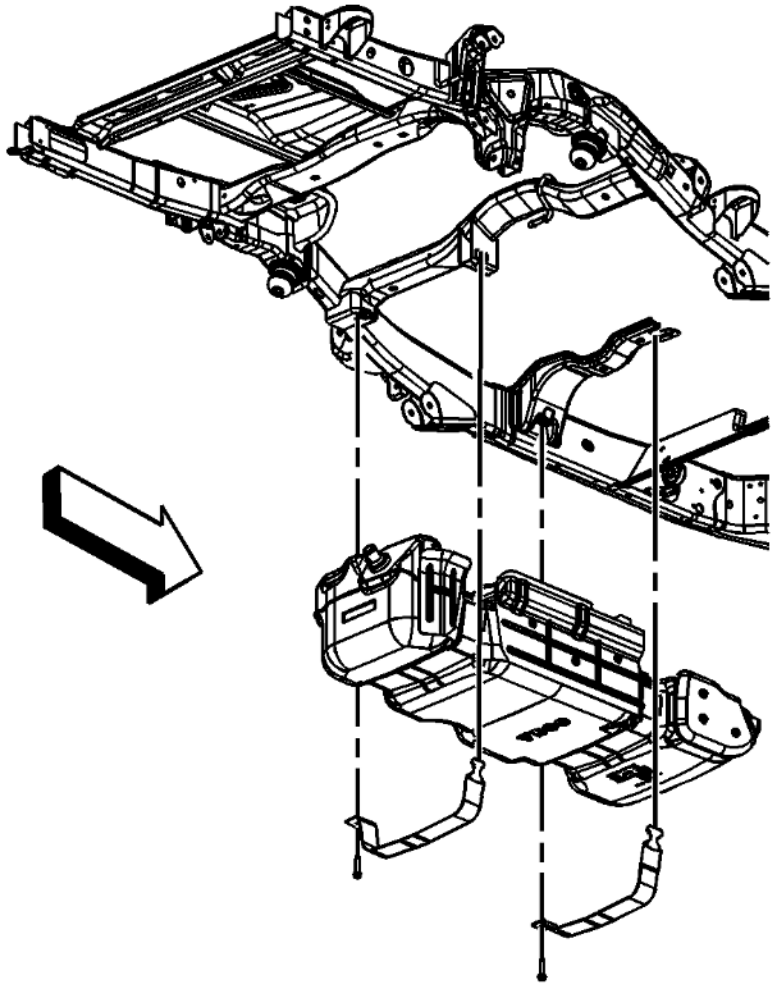


Fig. 59: View Of Fuel Tank & Straps (Single Tank)
Courtesy of GENERAL MOTORS COMPANY

18. Completely lower the fuel tank.
19. With the aid of an assistant, place the fuel tank in a suitable work area.
20. If replacing the fuel tank proceed to the next step, otherwise proceed to step 18 in the installation procedure.

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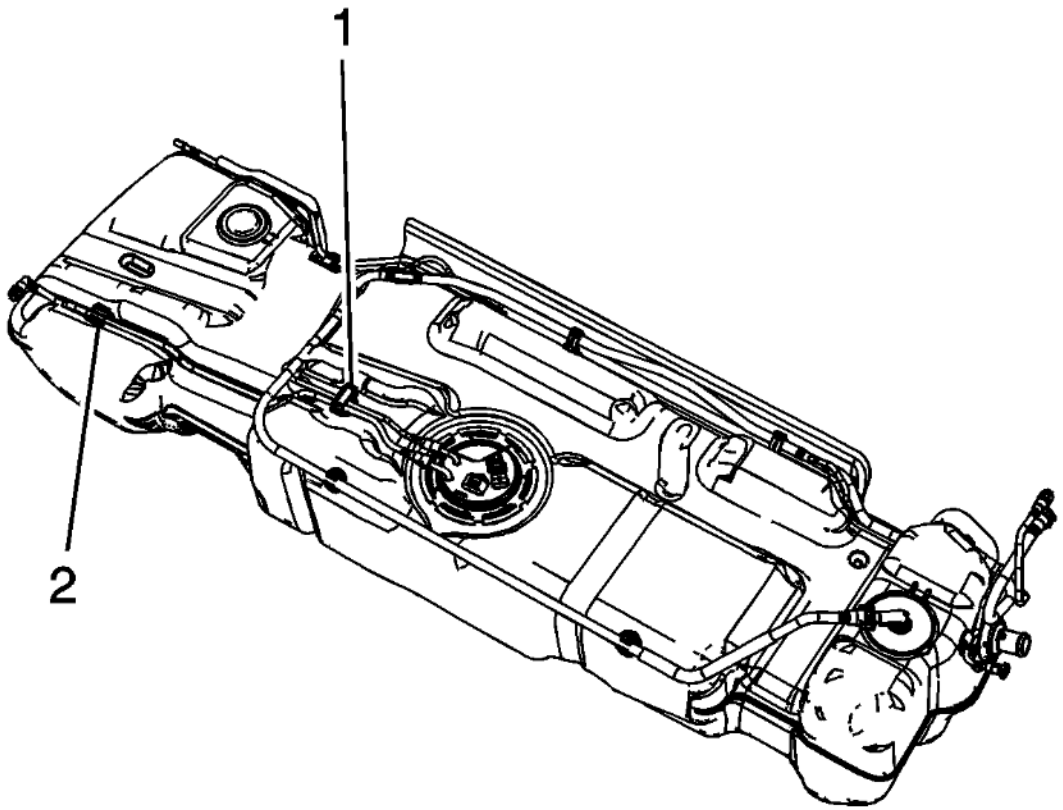


Fig. 60: View Of EVAP Line Clip & Retainer
Courtesy of GENERAL MOTORS COMPANY

21. Remove the fuel feed line from the retaining feature (2) in the fuel tank.
22. Open the fuel/EVAP line clip (1) and remove the fuel feed line from the clip.
23. Disconnect the fuel feed line quick connect fitting at the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.

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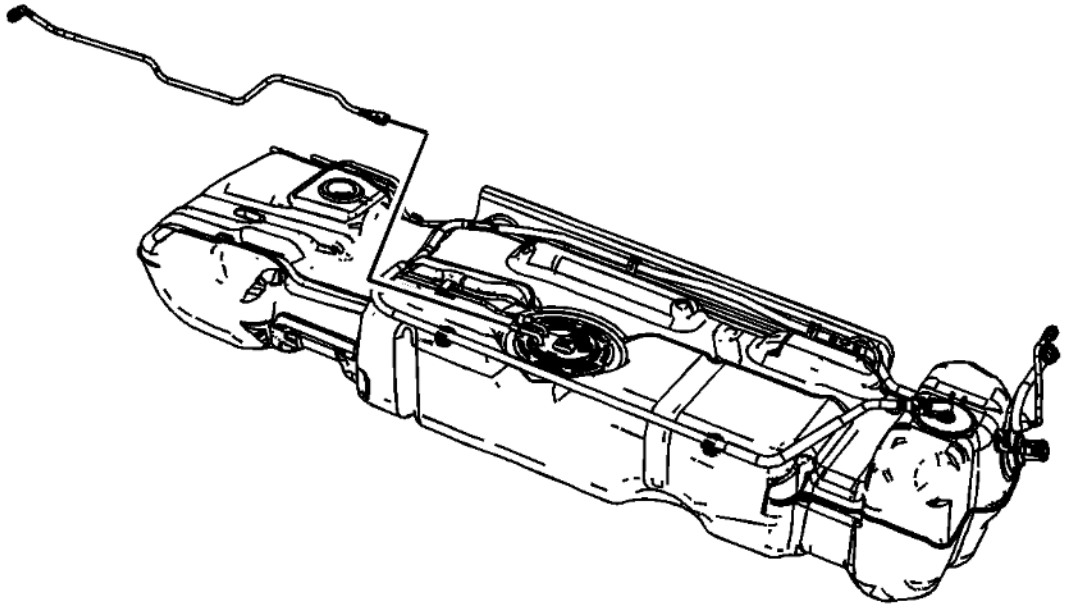


Fig. 61: View Of Fuel Feed Line
Courtesy of GENERAL MOTORS COMPANY

24. Remove the fuel feed line from the fuel tank.

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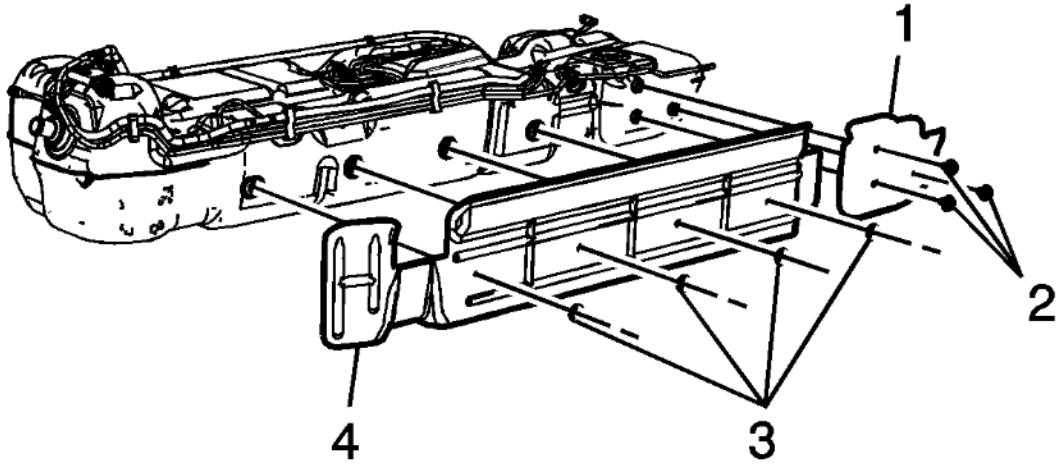


Fig. 62: View Of Fuel Tank Shields & Retainers
Courtesy of GENERAL MOTORS COMPANY

25. Remove the fuel tank shield retainers (2 and 3) and shields (1 and 4).

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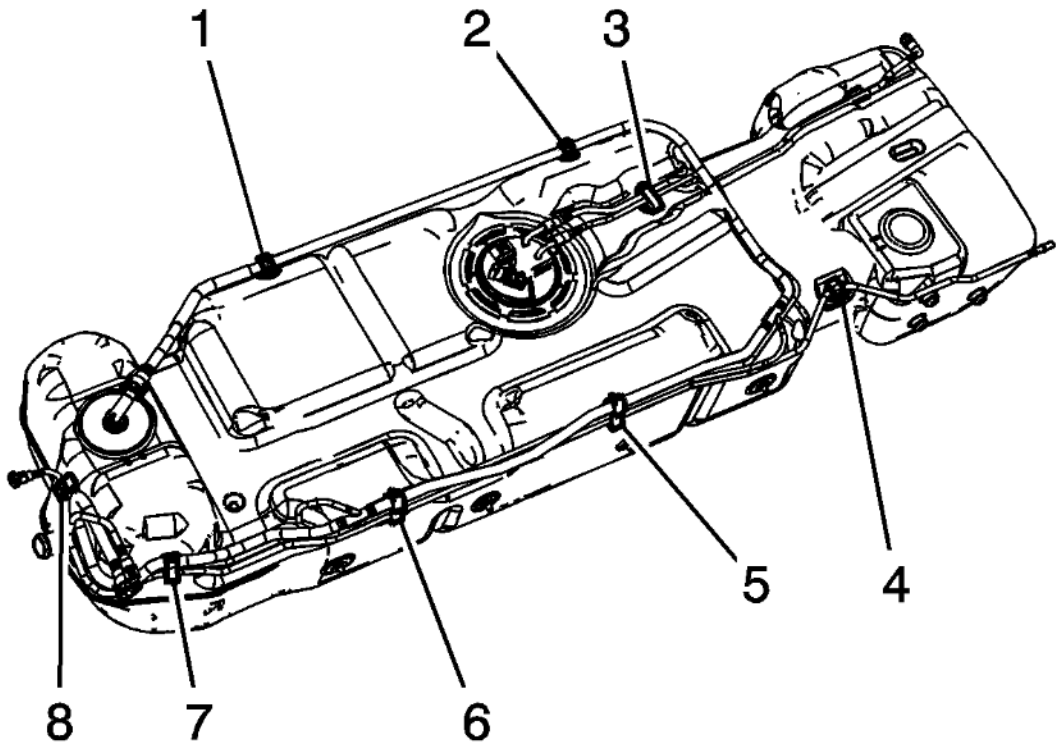


Fig. 63: View Of Fuel Tank Clips
Courtesy of GENERAL MOTORS COMPANY

26. Remove the EVAP line from the fuel tank clips (1, 2, 4, and 8).
27. Open the fuel tank clips (3, 5, 6, and 7) and remove the EVAP lines from the clips.
28. Disconnect the EVAP line quick connect fitting at the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.

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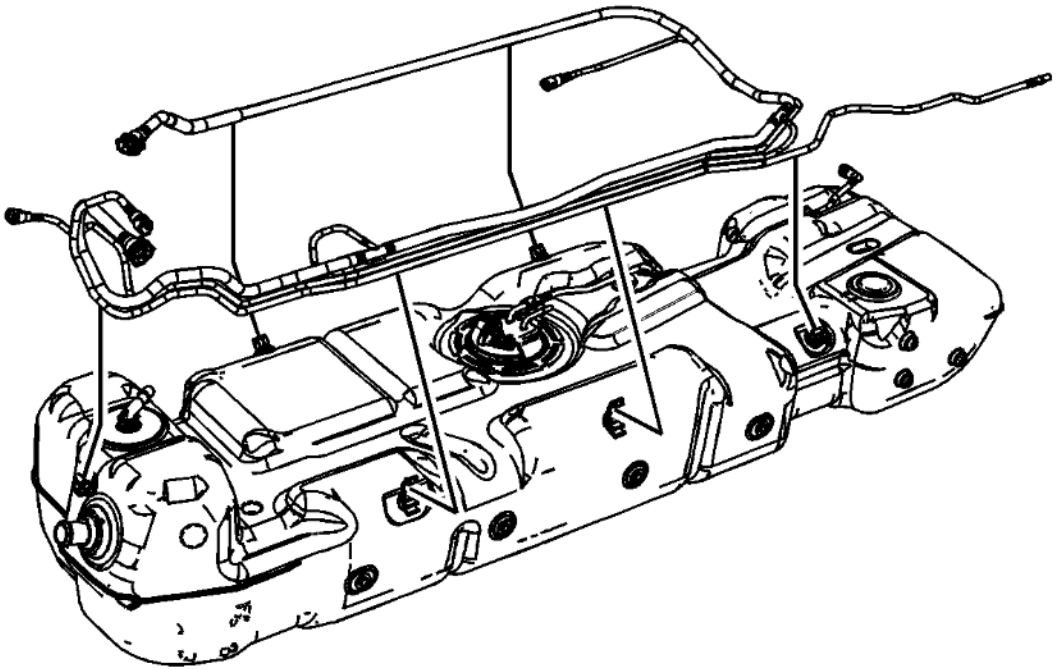


Fig. 64: View Of EVAP Lines
Courtesy of GENERAL MOTORS COMPANY

29. Remove the EVAP lines from the fuel tank.

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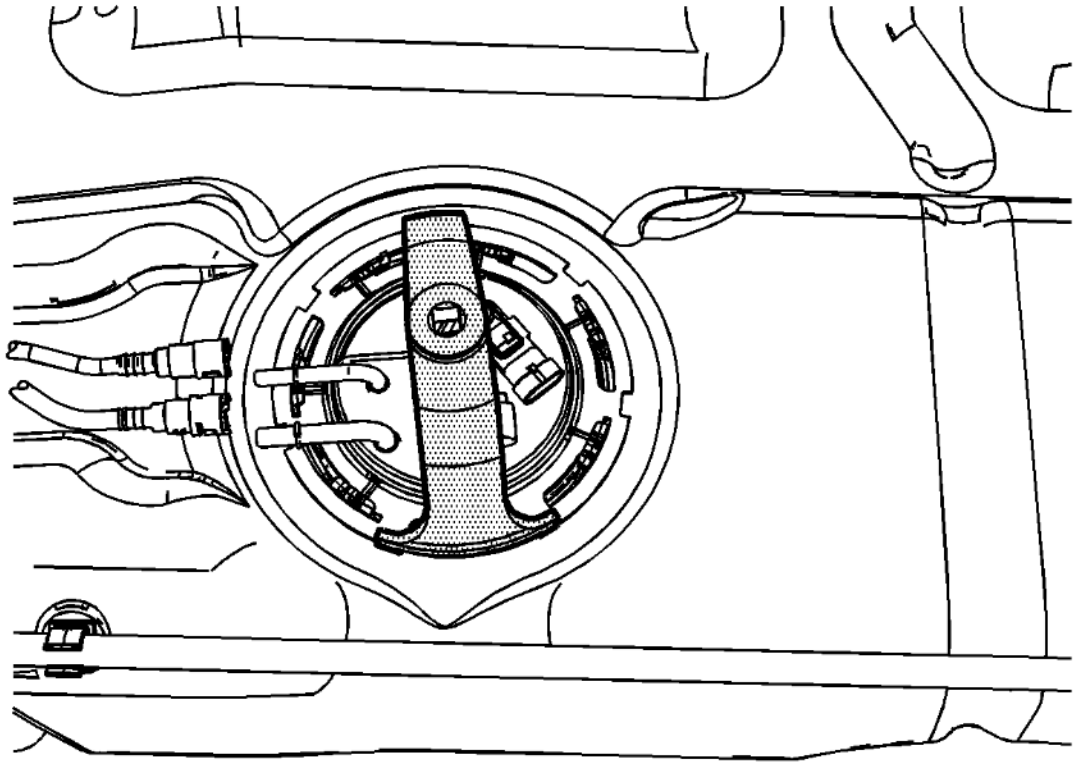


Fig. 65: View of Special Tool & Lock Ring
Courtesy of GENERAL MOTORS COMPANY

30. Using the **J-45722** wrench, remove the lock ring.

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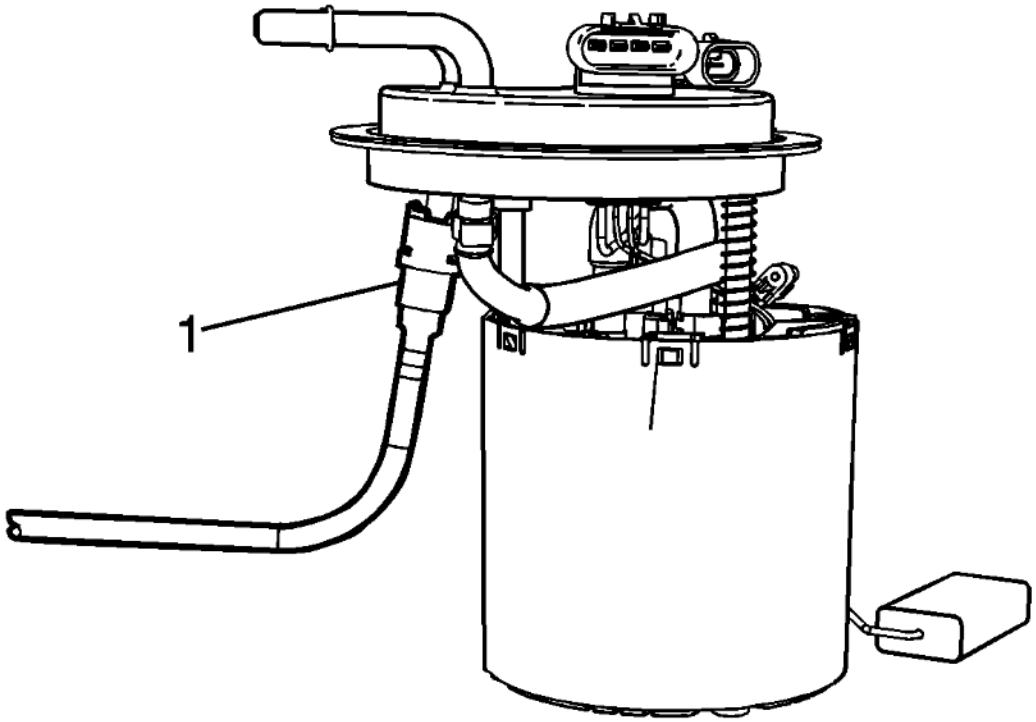


Fig. 66: View Of Fuel Tank Module & Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

31. Carefully lift the module from the fuel tank, enough to access the quick connect fitting (1) under the module cover. Disconnect the quick connect fitting. Refer to **Plastic Collar Quick Connect Fitting Service**.
32. Remove the fuel tank module.
33. Remove and discard the fuel tank module seal.

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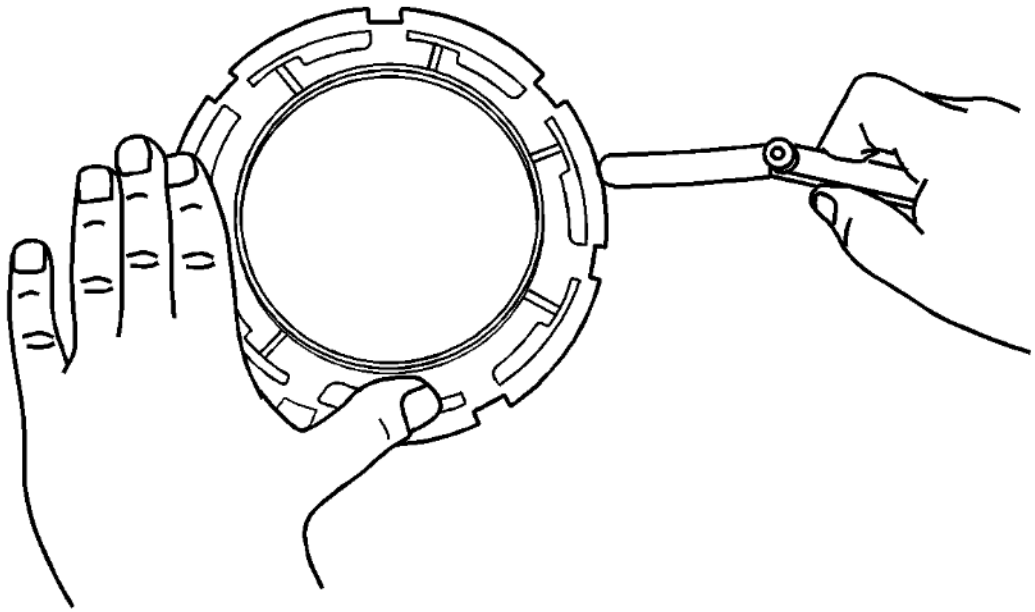


Fig. 67: Checking Lock Ring For Flatness
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.**
- **Check the lock ring for flatness.**

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34. Place the lock ring on a flat surface. Measure the clearance between the lock ring and the flat surface using a feeler gauge at 7 points.
35. If warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
36. If warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure

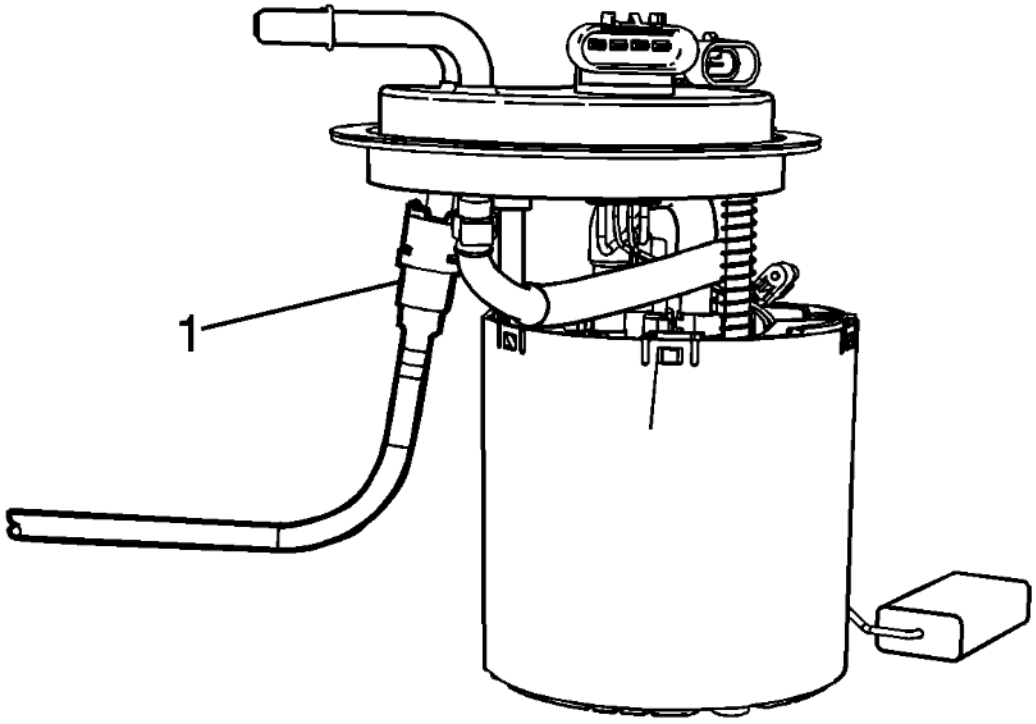


Fig. 68: View Of Fuel Tank Module & Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

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1. If the fuel tank was replaced perform the following steps, otherwise proceed to step 18.
2. Install a NEW fuel tank module seal onto the fuel tank.
3. Pull the vent line in the fuel tank up as far as possible for ease of installation.
4. Position the fuel tank module part way into the fuel tank.
5. Connect the quick connect fitting (1) to the module cover. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Install the fuel tank module into the fuel tank.
7. Place the lock ring into position.

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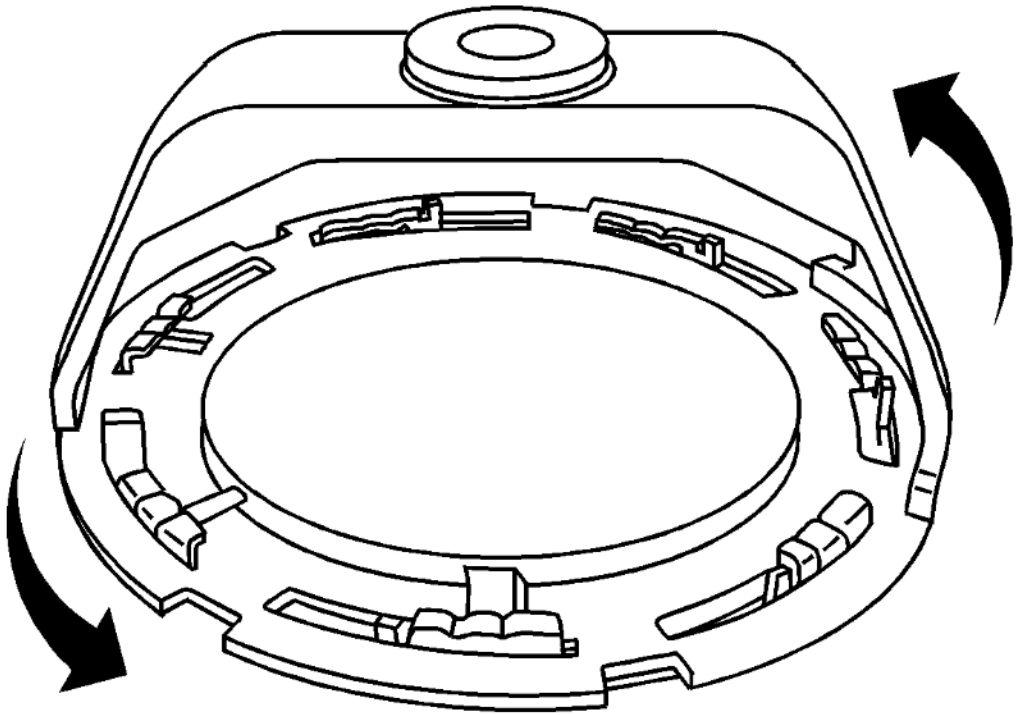


Fig. 69: Identifying Lock Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always replace the fuel module seal when installing the fuel module. Replace the lock ring if necessary. DO NOT apply any type of lubrication in the seal groove.**

Ensure the lock ring is installed with the correct side facing upward. A correctly installed lock ring will only turn in a clockwise direction.

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8. Rotate the lock ring counterclockwise using the **J-45722** wrench.

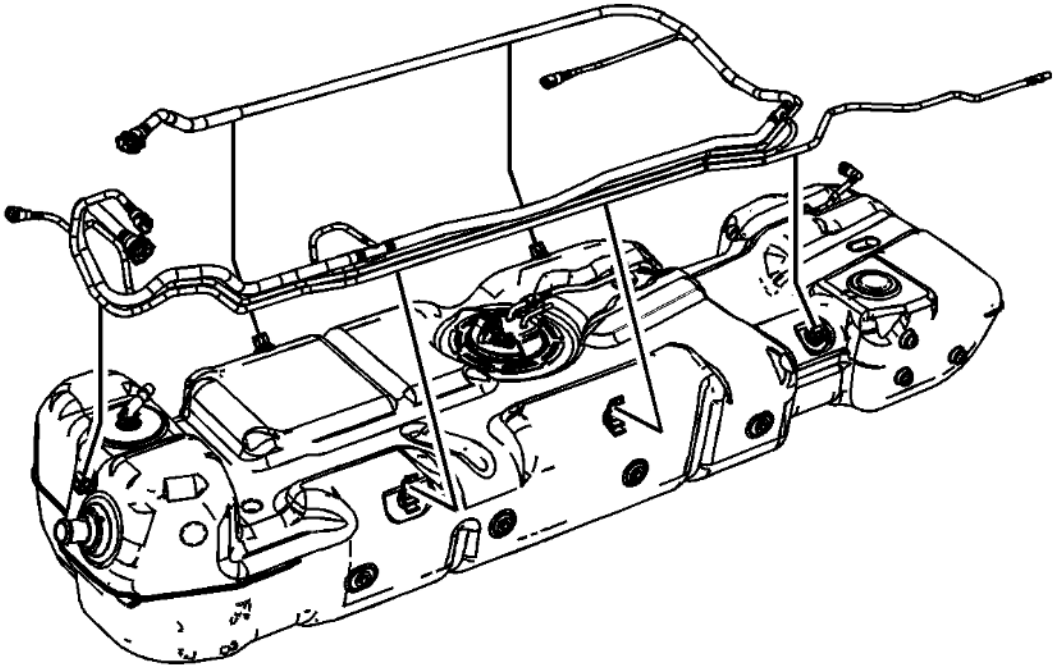


Fig. 70: View Of EVAP Lines
Courtesy of GENERAL MOTORS COMPANY

9. Install the EVAP lines to the fuel tank.

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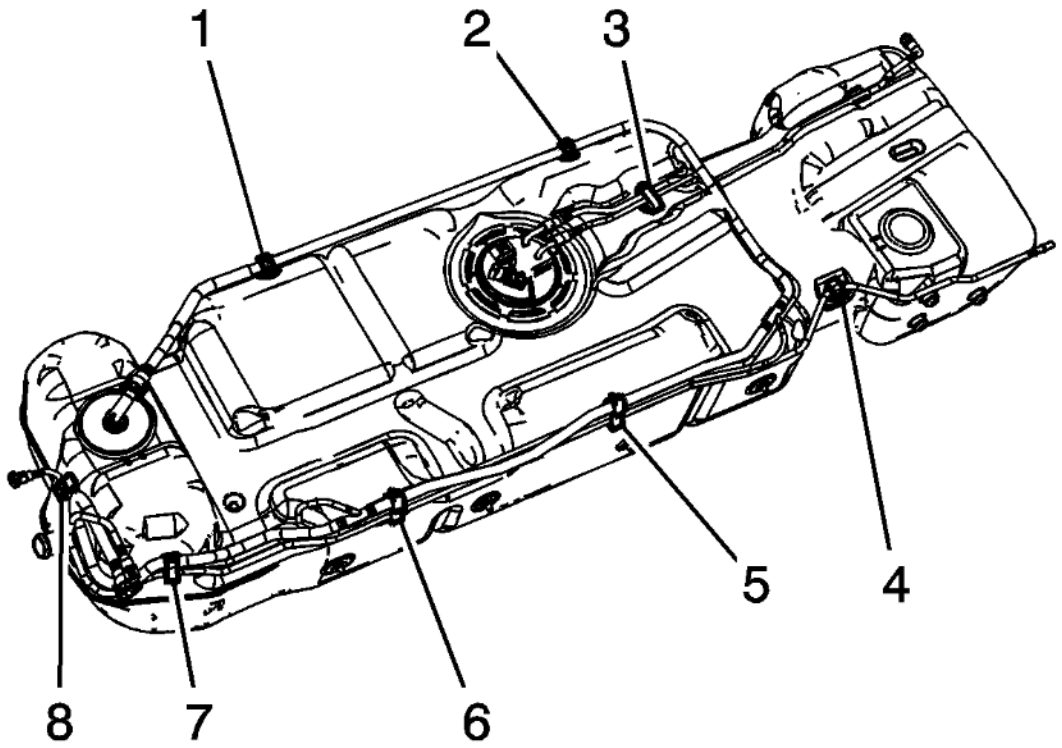


Fig. 71: View Of Fuel Tank Clips
Courtesy of GENERAL MOTORS COMPANY

10. Connect the EVAP line quick connect fitting at the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
11. Install the EVAP lines to the fuel tank clips (3, 5, 6, and 7) and close the clips.
12. Install the EVAP line to the fuel tank clips (1, 2, 4, and 8).

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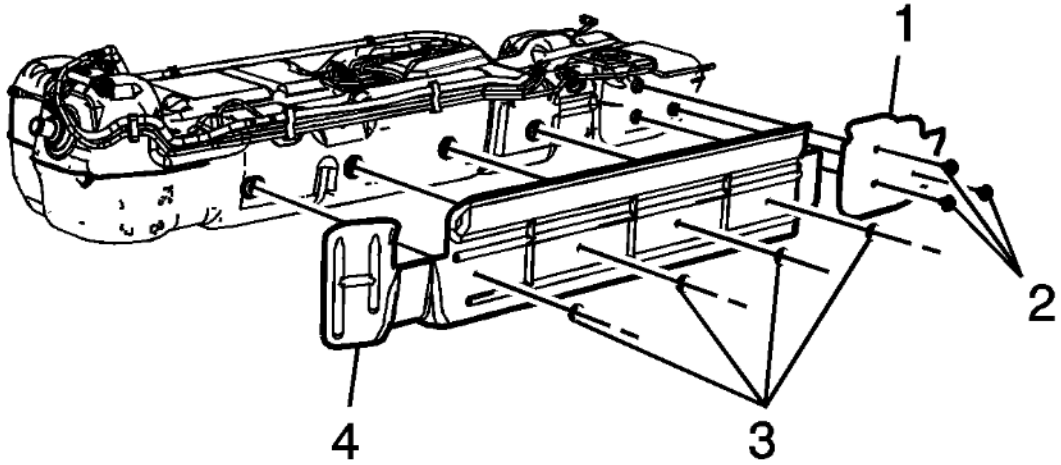


Fig. 72: View Of Fuel Tank Shields & Retainers
Courtesy of GENERAL MOTORS COMPANY

13. Install the fuel tank shields (1 and 4) and retainers (2 and 3).

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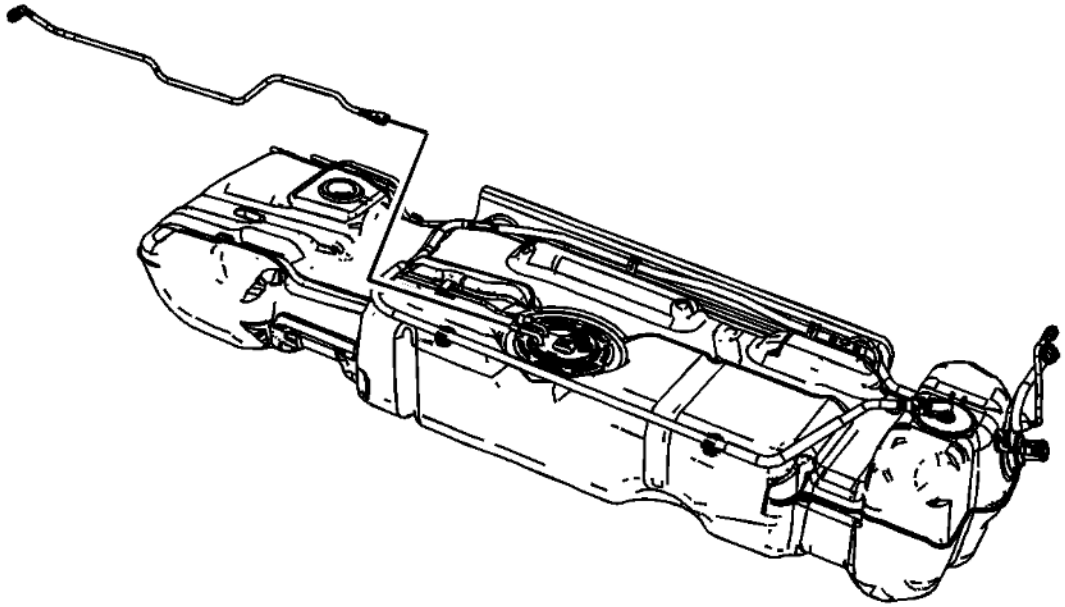


Fig. 73: View Of Fuel Feed Line
Courtesy of GENERAL MOTORS COMPANY

14. Install the fuel feed line to the fuel tank.

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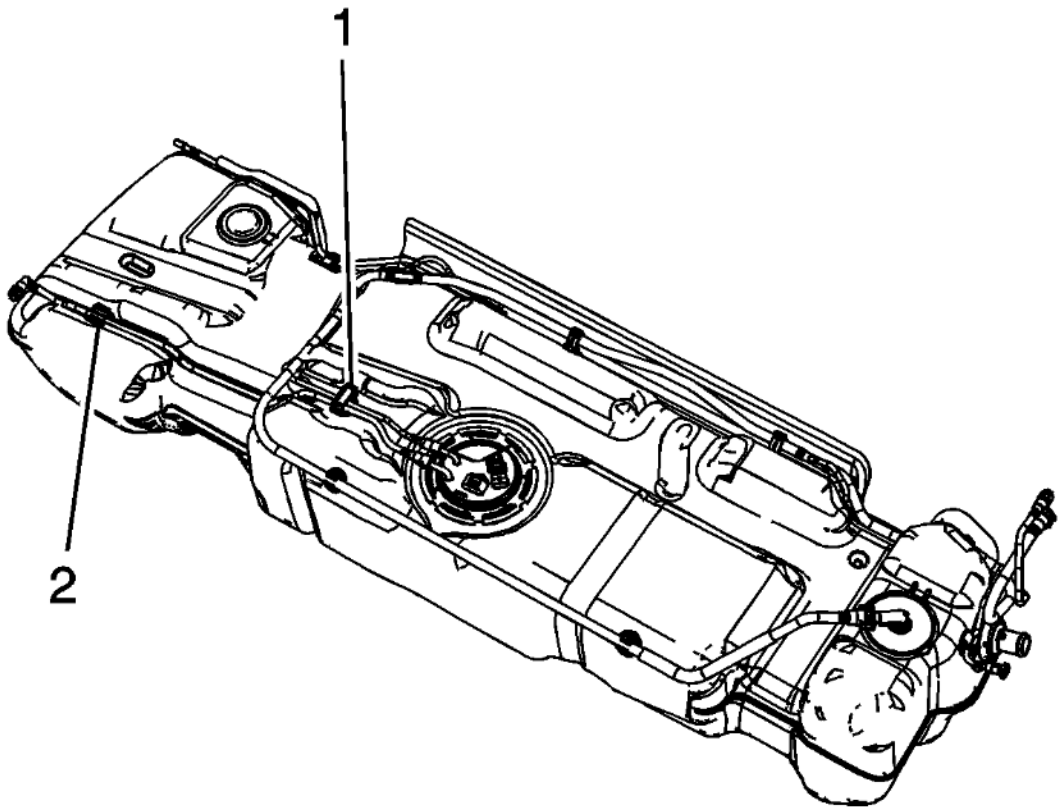


Fig. 74: View Of EVAP Line Clip & Retainer
Courtesy of GENERAL MOTORS COMPANY

15. Connect the fuel feed line quick connect fitting at the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
16. Install the fuel feed line to the clip (1) and close the clip.
17. Install the fuel feed line to the retaining feature (2) in the fuel tank.

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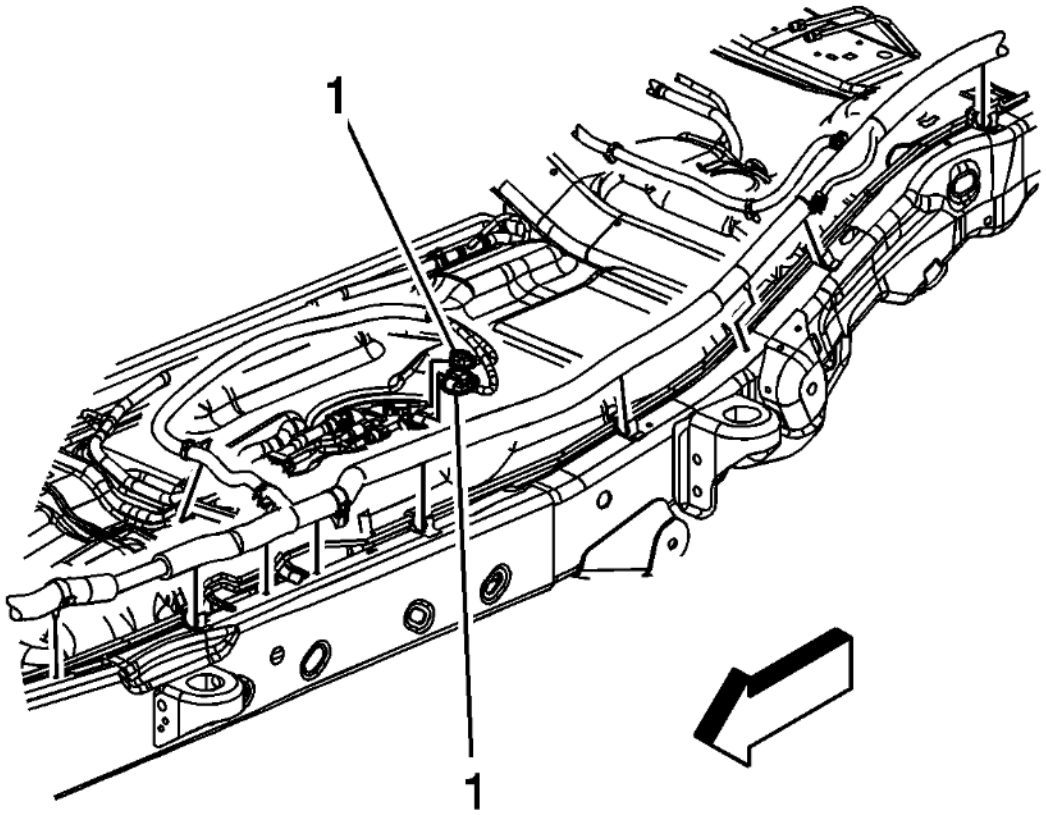


Fig. 75: View Of Chassis Wiring Harness Electrical Connectors & Module
Courtesy of GENERAL MOTORS COMPANY

18. Place the fuel tank onto a suitable jack.
19. With the aid of an assistant, partially raise the fuel tank until the electrical connections can be made.
20. Connect the chassis wiring harness electrical connectors (1) to the fuel tank module and fuel pressure sensor.
21. Engage the chassis harness electrical connector CPA retainer at the module electrical connector.

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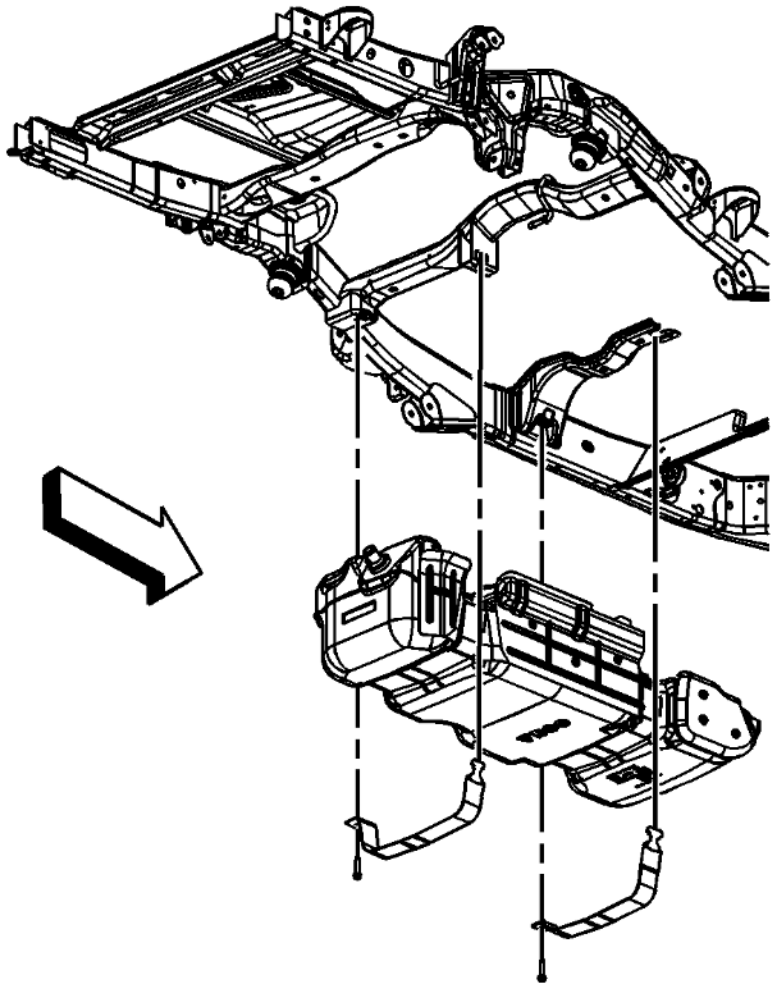


Fig. 76: View Of Fuel Tank & Straps (Single Tank)
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Carefully raise the fuel tank until the EVAP line can be positioned.**

22. Completely raise the fuel tank.

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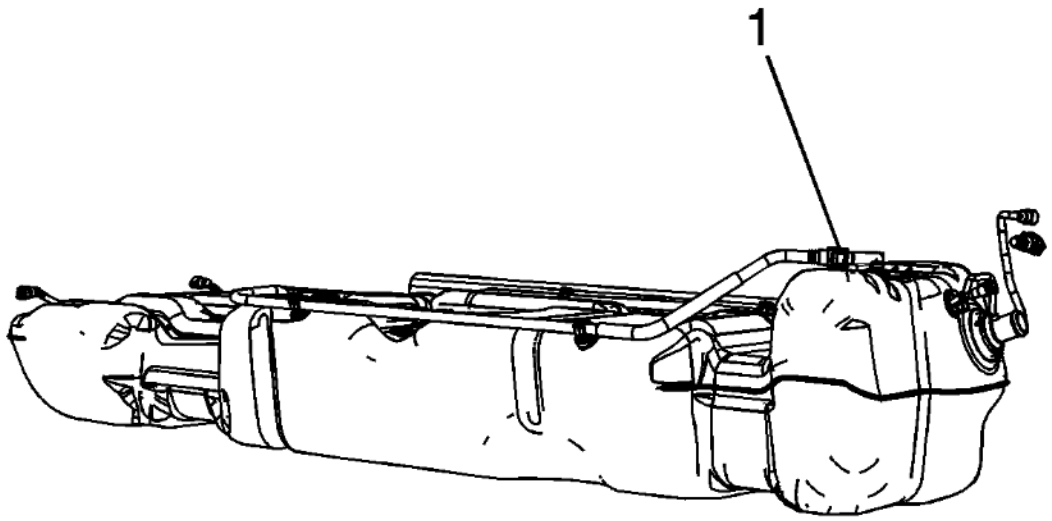


Fig. 77: Fuel Tank EVAP Line Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

23. Connect the fuel tank EVAP line quick connect fitting (1) at the fuel tank vent valve. Refer to **Plastic Collar Quick Connect Fitting Service**.
24. Install the fuel tank straps.

CAUTION: Refer to Fastener Caution .

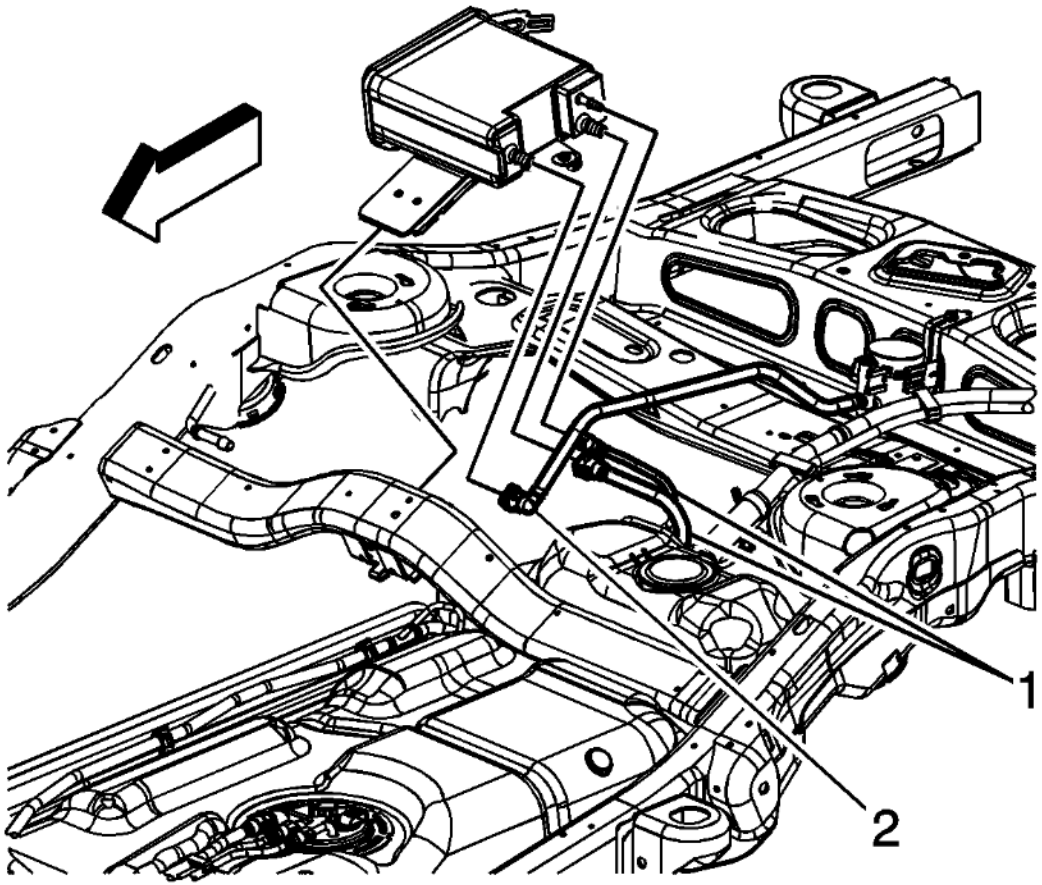
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25. Install the fuel tank strap bolts.

    Tighten

    Tighten the bolts to 40 N.m (30 lb ft).

26. Remove the adjustable jack from the fuel tank.



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Fig. 78: View Of Fuel Tank EVAP Lines & Canister
Courtesy of GENERAL MOTORS COMPANY

27. Remove the caps from the EVAP lines.
28. Connect the fuel tank EVAP lines (1) to the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

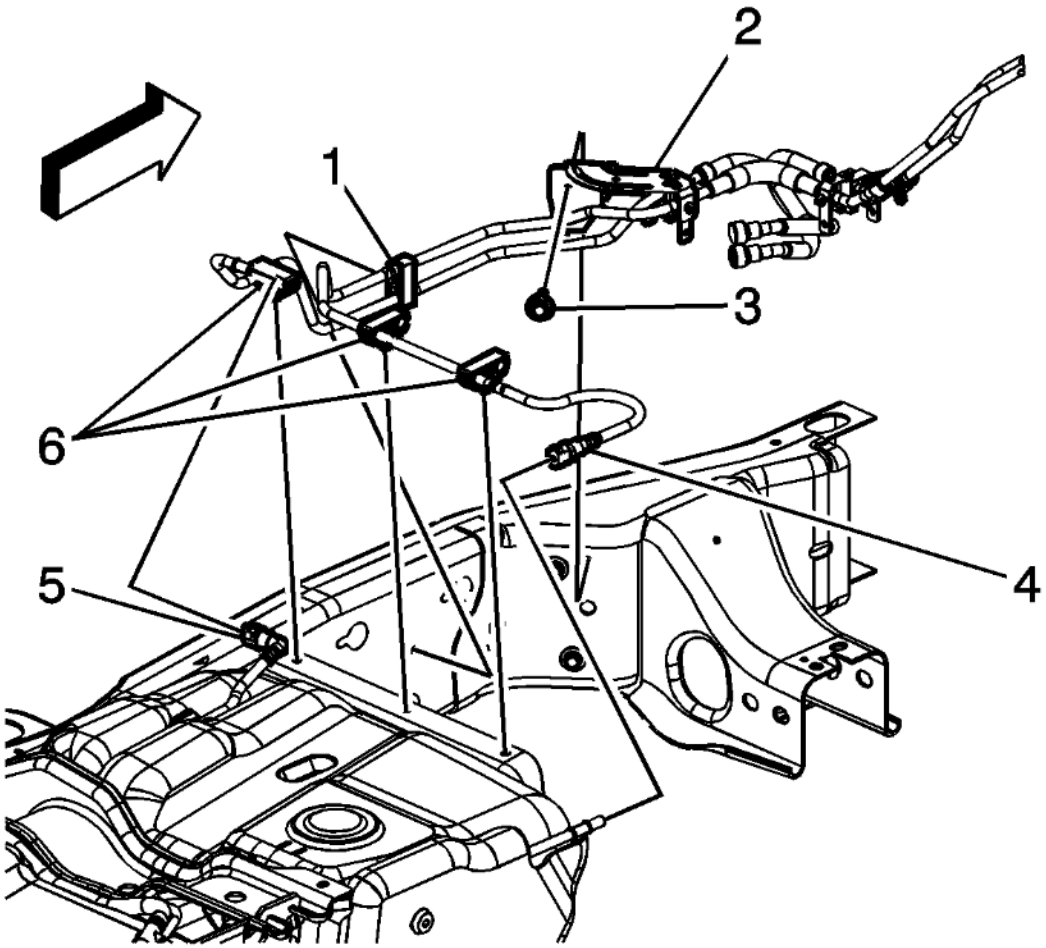


Fig. 79: View Of EVAP Lines, Fuel Feed Lines & Fittings
Courtesy of GENERAL MOTORS COMPANY

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29. Remove the caps from the fuel and EVAP lines.
30. Connect the chassis EVAP line quick connect fitting (4) to the fuel tank line. Refer to **Plastic Collar Quick Connect Fitting Service**.
31. Connect the fuel tank fuel feed line quick connect fitting (5) to the chassis line. Refer to **Plastic Collar Quick Connect Fitting Service**.

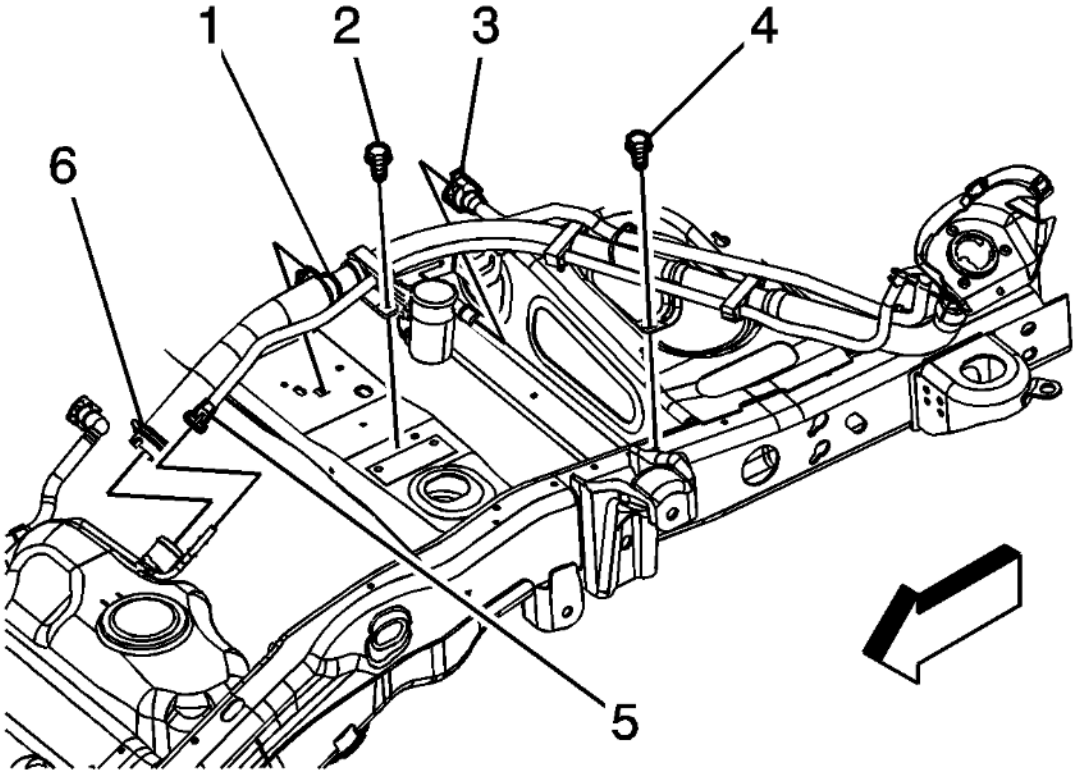


Fig. 80: Fuel Tank Vent Line Quick Connect Fitting, Hose Clamp, Bracket Bolts & Fill Hose
Courtesy of GENERAL MOTORS COMPANY

32. Connect the fuel tank vent line quick connect fitting (5) to the fuel fill pipe line. Refer to **Plastic Collar Quick Connect Fitting Service**.

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33. Install the fuel fill hose to the fuel tank. Ensure that the notch in the hose is aligned with the notch on the fuel tank.
34. Tighten the fuel fill hose clamp (6).

    Tighten

    Tighten the clamp to 4 N.m (35 lb in).

35. Lower the vehicle.
36. Refill the fuel tank.
37. Install the fuel fill cap.
38. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)** **Battery Negative Cable Disconnection and Connection (Single Battery)** .
39. Use the following procedure in order to inspect for leaks:
    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.
    4. Inspect for fuel leaks.

FUEL TANK PRESSURE SENSOR REPLACEMENT (SWB)

Removal Procedure

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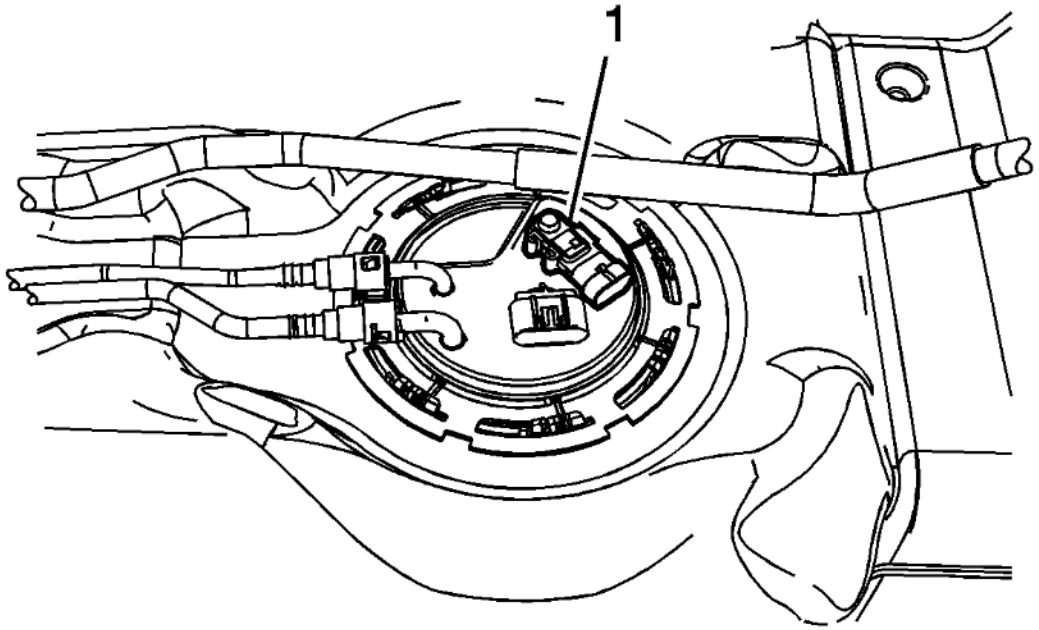


Fig. 81: View Of Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
2. Using a slight rocking motion while pulling straight up, remove the fuel tank pressure sensor (1).

Installation Procedure

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1. Transfer the fuel tank pressure sensor cover.

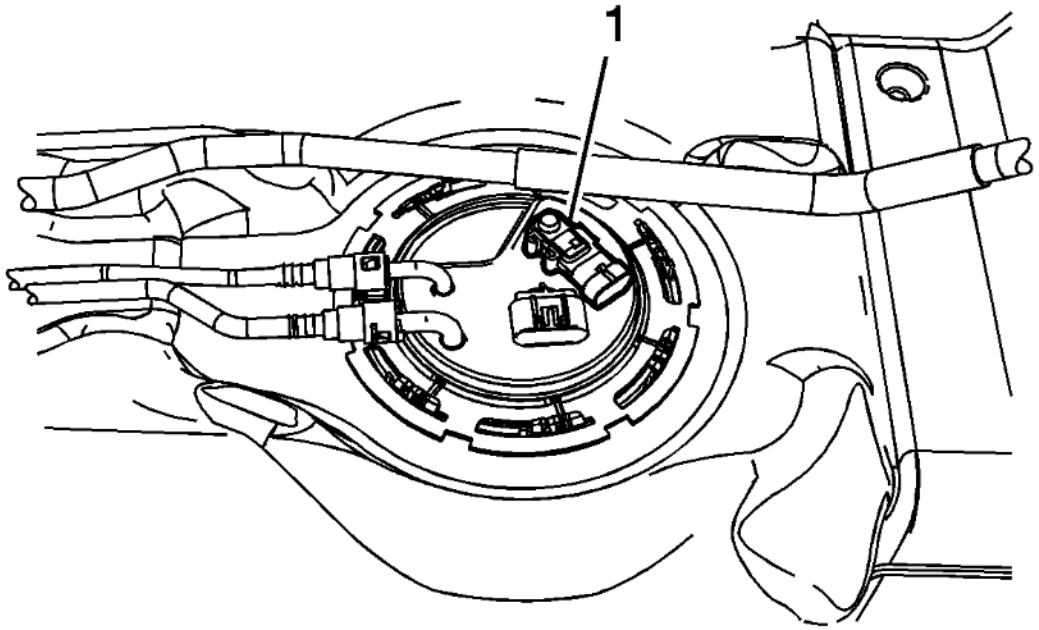


Fig. 82: View Of Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Install the fuel tank pressure sensor (1).
3. Install the fuel tank. Refer to **Fuel Tank Replacement**.

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FUEL TANK PRESSURE SENSOR REPLACEMENT (LWB)

Removal Procedure

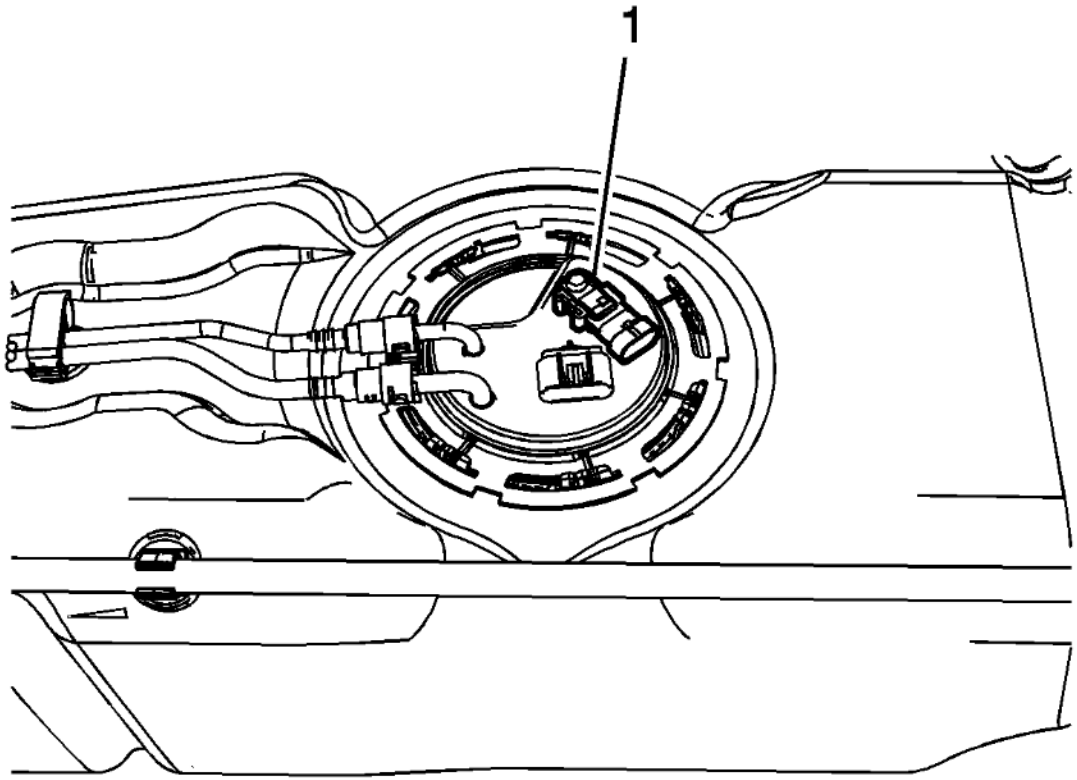


Fig. 83: View Of Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.

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2. Using a slight rocking motion while pulling straight up, remove the fuel tank pressure sensor (1).

Installation Procedure

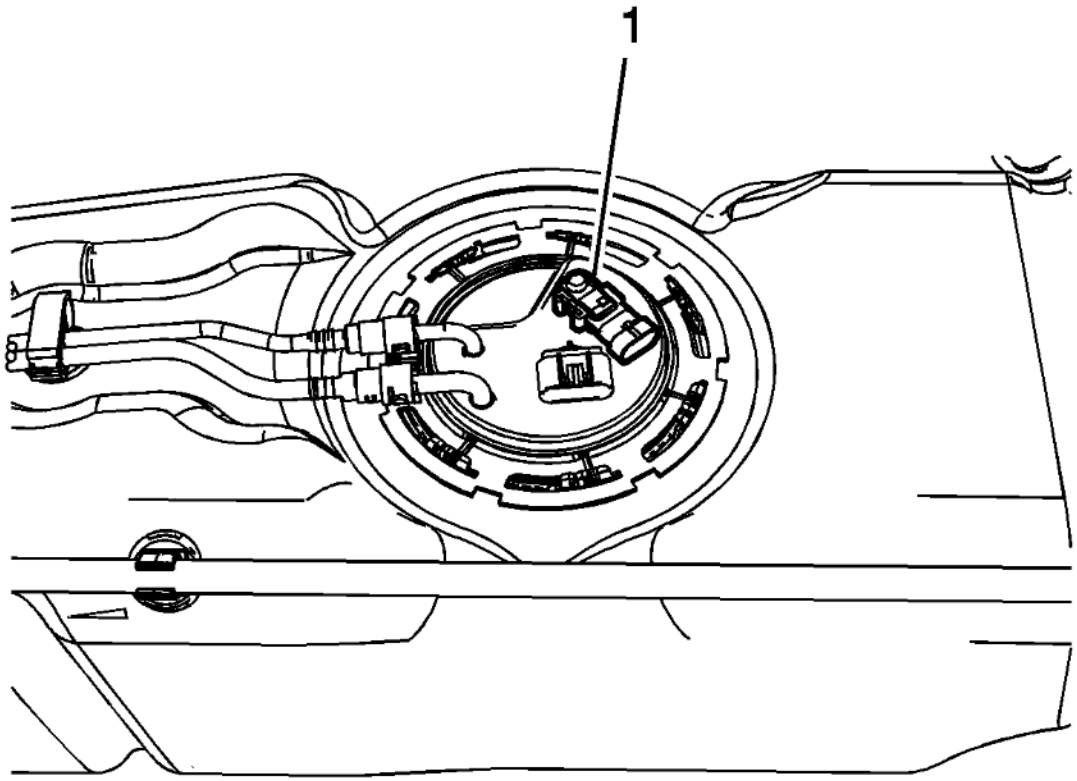


Fig. 84: View Of Fuel Tank Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel tank pressure sensor (1).

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2. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL TANK FUEL PUMP MODULE REPLACEMENT (SWB)

Special Tools

J-45722 Fuel Sender Lock Ring Wrench Fuel Sender Lock Ring Wrench

Removal Procedure

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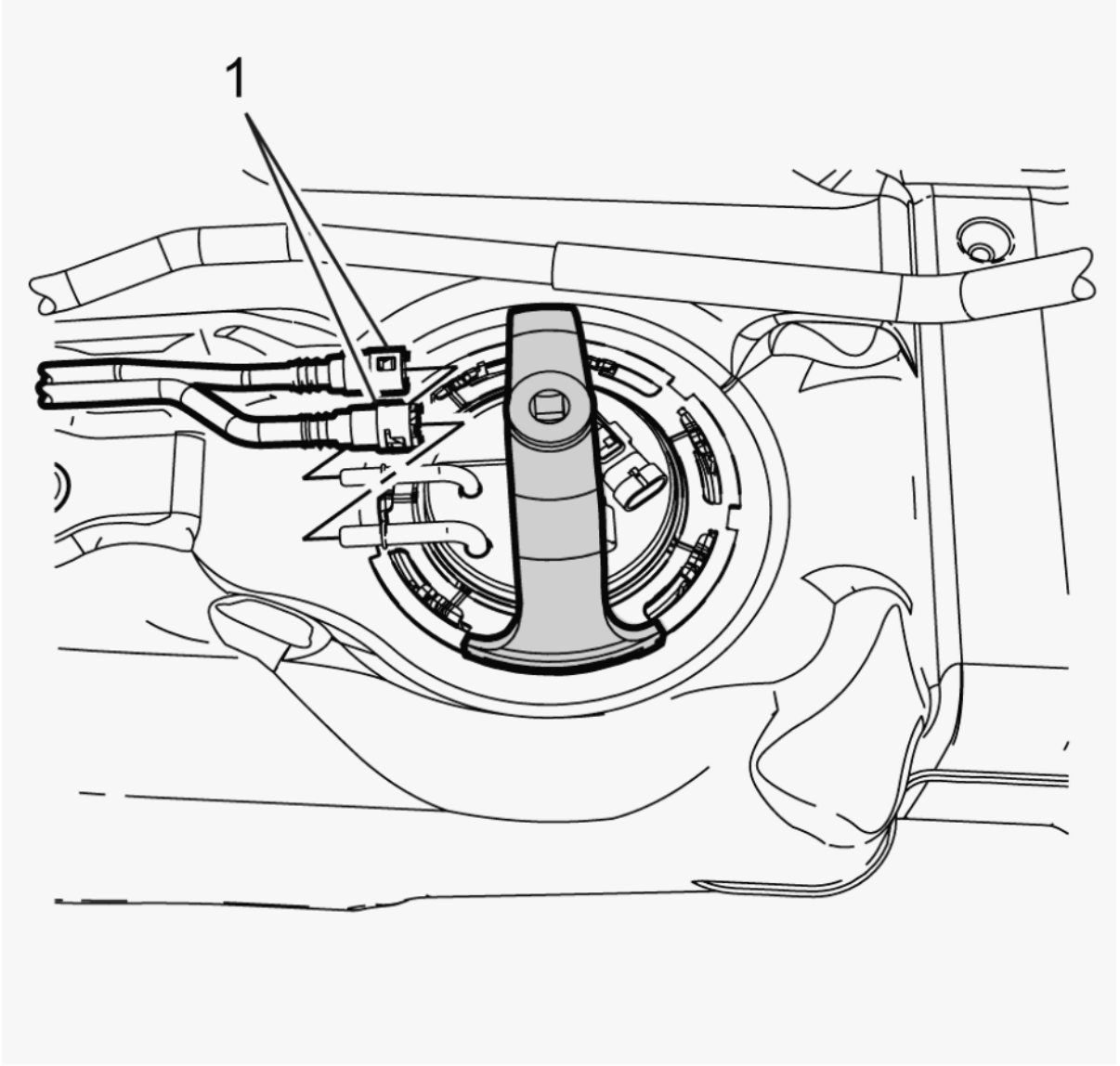


Fig. 85: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
2. Disconnect fuel and evaporative emission (EVAP) lines (1) from the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.

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3. Disconnect the EVAP vent valve line quick connect fitting at the vent valve and reposition the line out of the way. Refer to **Plastic Collar Quick Connect Fitting Service**.

CAUTION: **Avoid damaging the lock ring. Use only J-45722 to prevent damage to the lock ring.**

CAUTION: **Do Not handle the fuel sender assembly by the fuel pipes. The amount of leverage generated by handling the fuel pipes could damage the joints.**

NOTE: **Do NOT use impact tools. Significant force will be required to release the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in order to prevent fuel tank rotation.**

4. Using the **J-45722** wrench and a long breaker bar, rotate the ring clockwise unlocking the fuel tank module lock ring.
5. Remove the lock ring.

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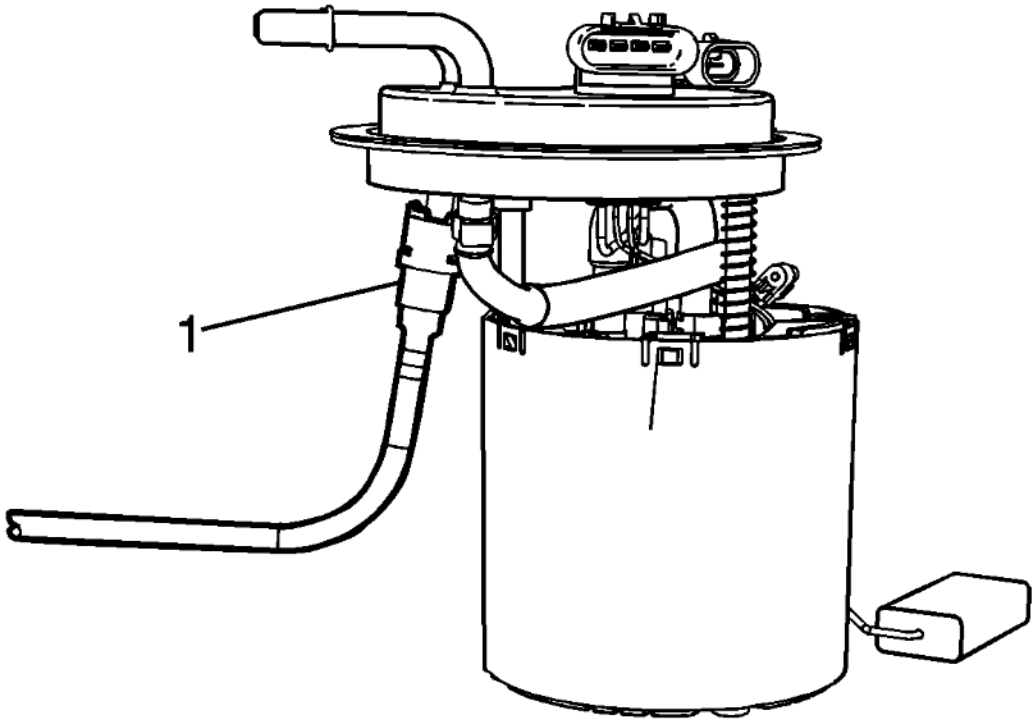


Fig. 86: View Of Fuel Tank Module & Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

6. Carefully lift the module from the fuel tank enough to access the quick connect fitting (1) under the module cover. Disconnect the quick connect fitting. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Remove the fuel tank module.
8. Remove and discard the fuel tank module seal.

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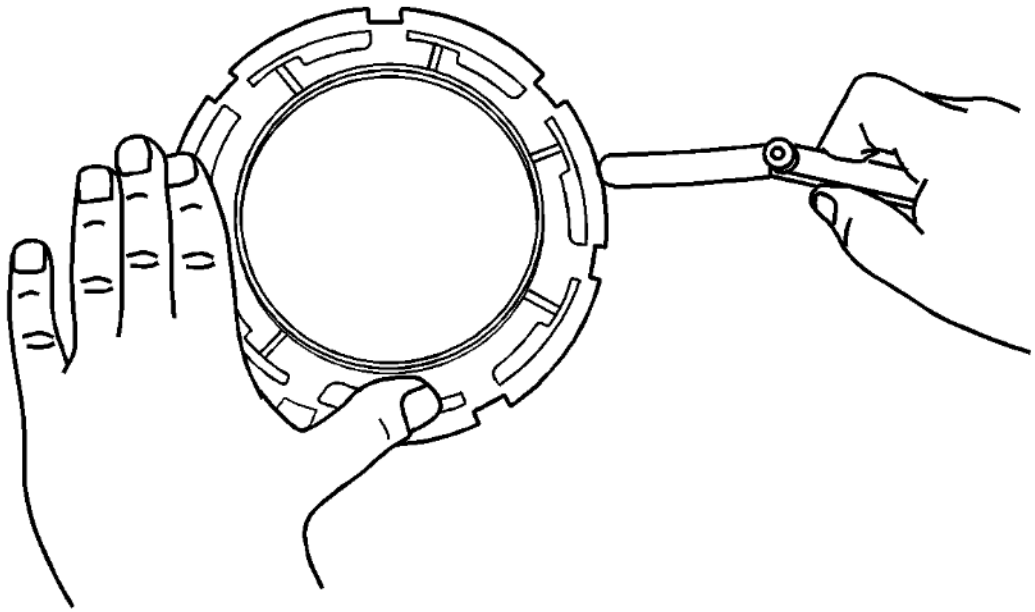


Fig. 87: Checking Lock Ring For Flatness
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.**
- **Check the lock ring for flatness.**

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9. Place the lock ring on a flat surface. Measure the clearance between the lock ring and the flat surface using a feeler gauge at 7 points.
10. If warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
11. If warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure

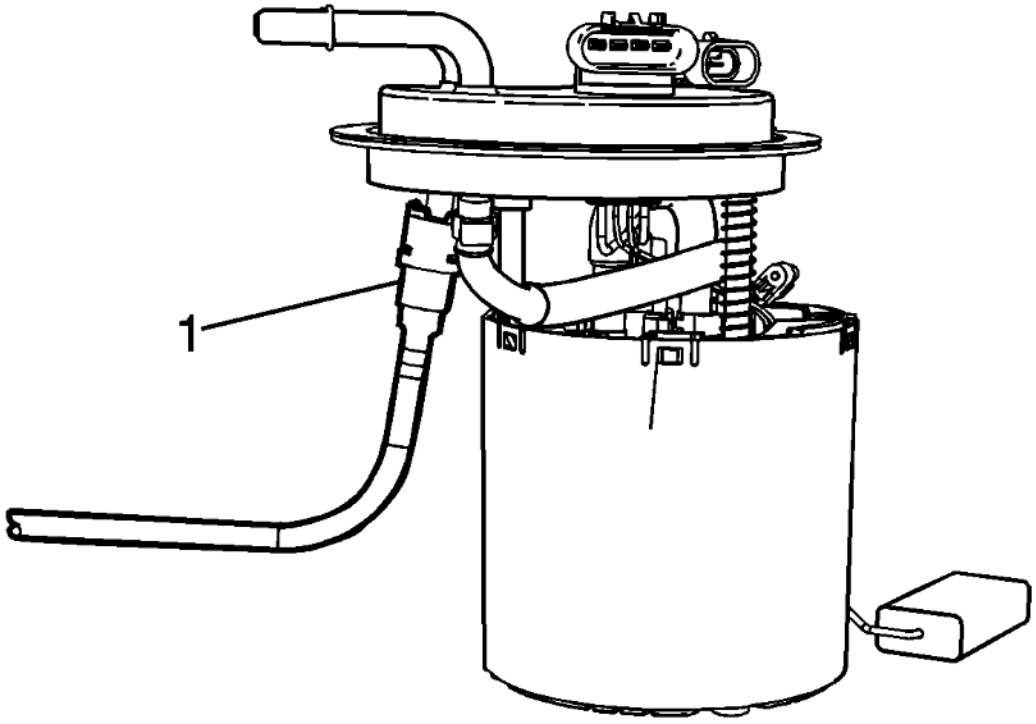
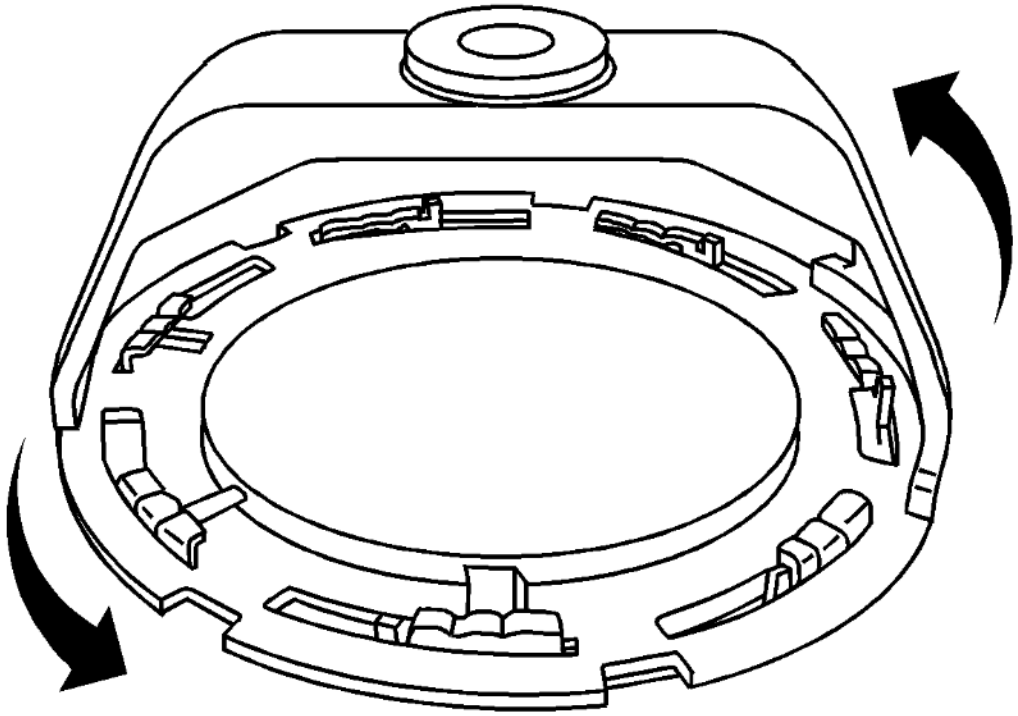


Fig. 88: View Of Fuel Tank Module & Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

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1. Install the NEW fuel tank module seal onto the fuel tank.
2. Pull the vent line in the fuel tank up as far as possible for ease of installation.
3. Position the fuel tank module part way into the fuel tank.
4. Connect the quick connect fitting (1) to the module cover. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Install the fuel tank module into the fuel tank.
6. Place the lock ring into position.



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Fig. 89: Identifying Lock Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always replace the fuel module seal when installing the fuel module. Replace the lock ring if necessary. DO NOT apply any type of lubrication in the seal groove.**

Ensure the lock ring is installed with the correct side facing upward. A correctly installed lock ring will only turn in a clockwise direction.

7. Rotate the lock ring counterclockwise using the **J-45722** wrench until fully seated.
8. Position the EVAP vent valve line and connect the EVAP vent valve line quick connect fitting to the vent valve. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Connect the fuel and EVAP lines to the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
10. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL TANK FUEL PUMP MODULE REPLACEMENT (LWB)

Special Tools

J-45722 Fuel Sender Lock Ring Wrench

Removal Procedure

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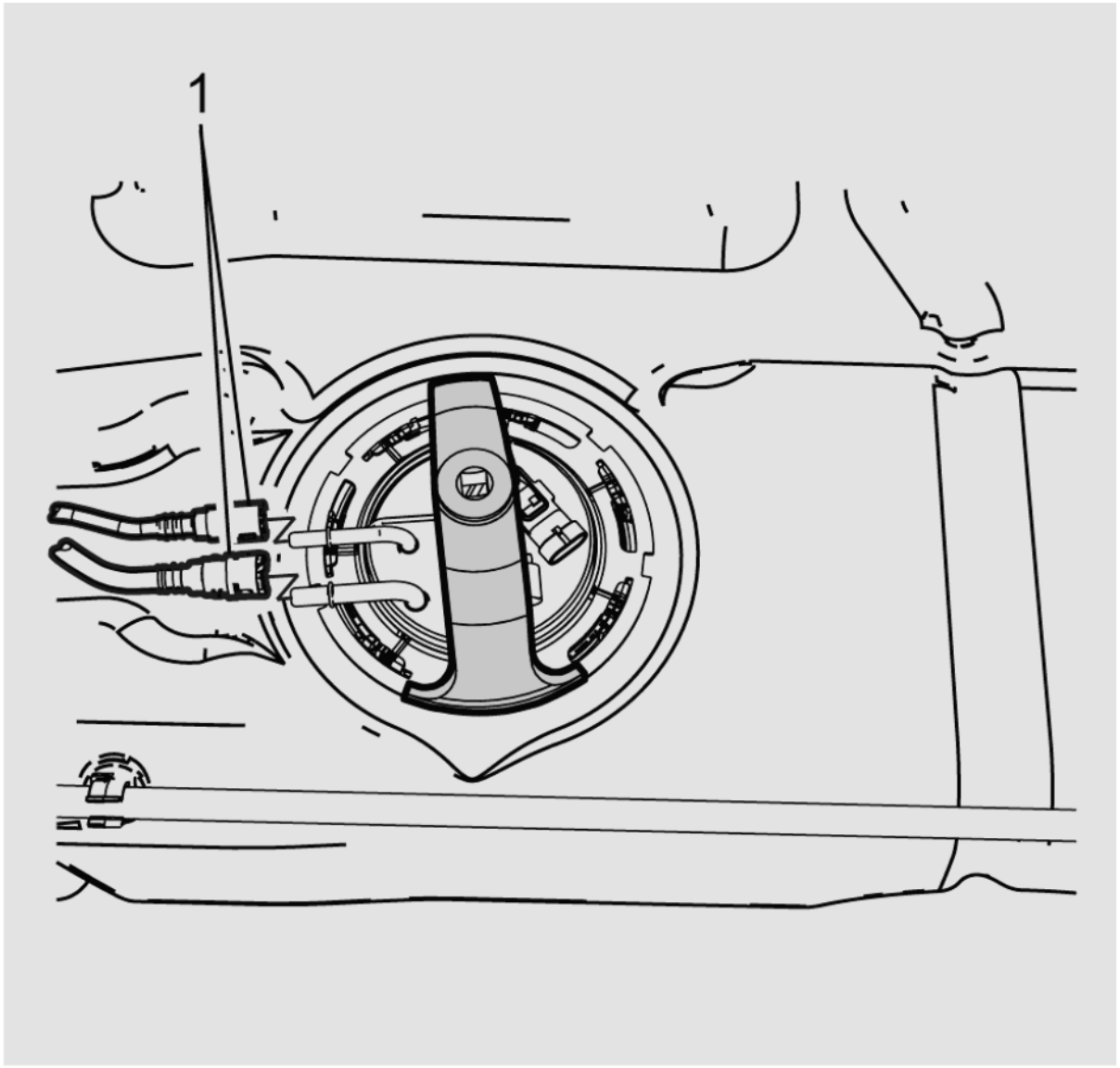


Fig. 90: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
2. Disconnect fuel and evaporative emission (EVAP) lines (1) from the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.

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CAUTION: **Avoid damaging the lock ring. Use only J-45722 to prevent damage to the lock ring.**

CAUTION: **Do Not handle the fuel sender assembly by the fuel pipes. The amount of leverage generated by handling the fuel pipes could damage the joints.**

NOTE: **Do NOT use impact tools. Significant force will be required to release the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in order to prevent fuel tank rotation.**

3. Using the **J-45722** wrench and a long breaker bar, rotate the ring clockwise unlocking the fuel tank module lock ring.
4. Remove the lock ring.

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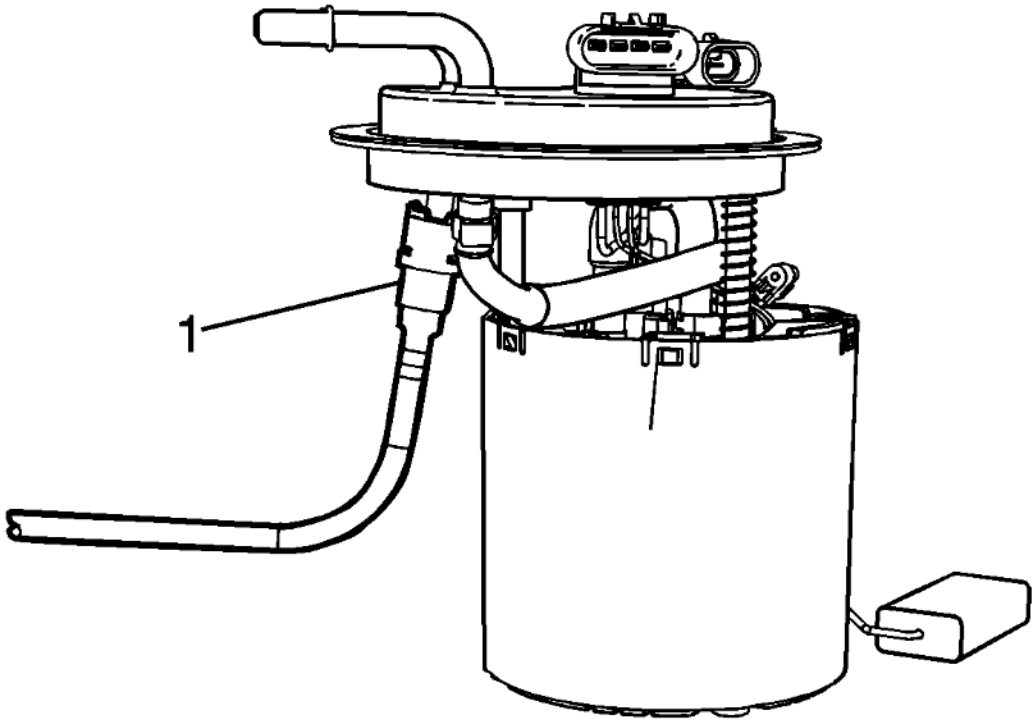


Fig. 91: View Of Fuel Tank Module & Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Carefully lift the module from the fuel tank, enough to access the quick connect fitting (1) under the module cover. Disconnect the quick connect fitting. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Remove the fuel tank module.
7. Remove and discard the fuel tank module seal.

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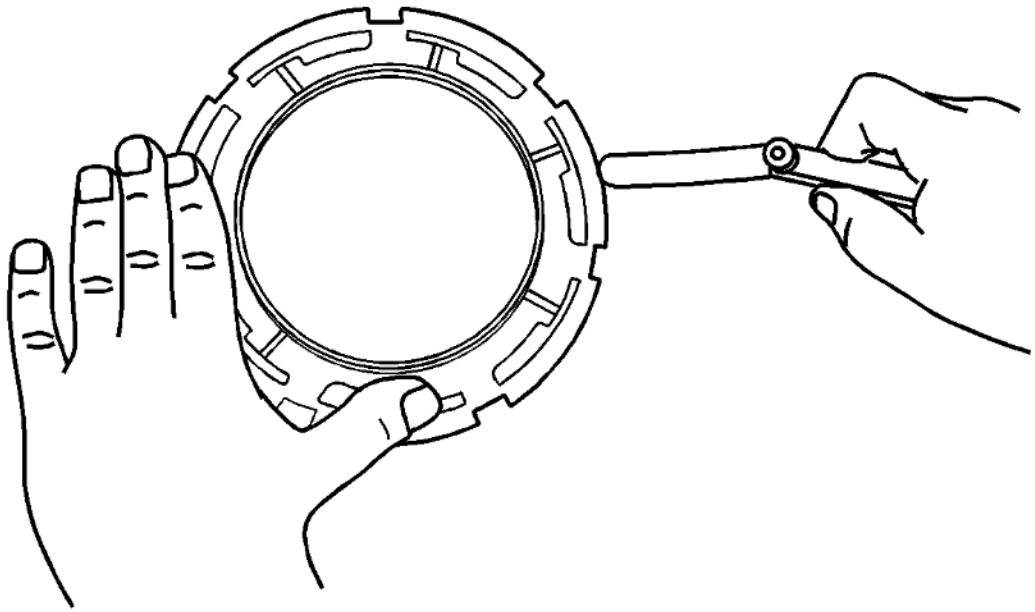


Fig. 92: Checking Lock Ring For Flatness
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.**
- **Check the lock ring for flatness.**

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8. Place the lock ring on a flat surface. Measure the clearance between the lock ring and the flat surface using a feeler gauge at 7 points.
9. If warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
10. If warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure

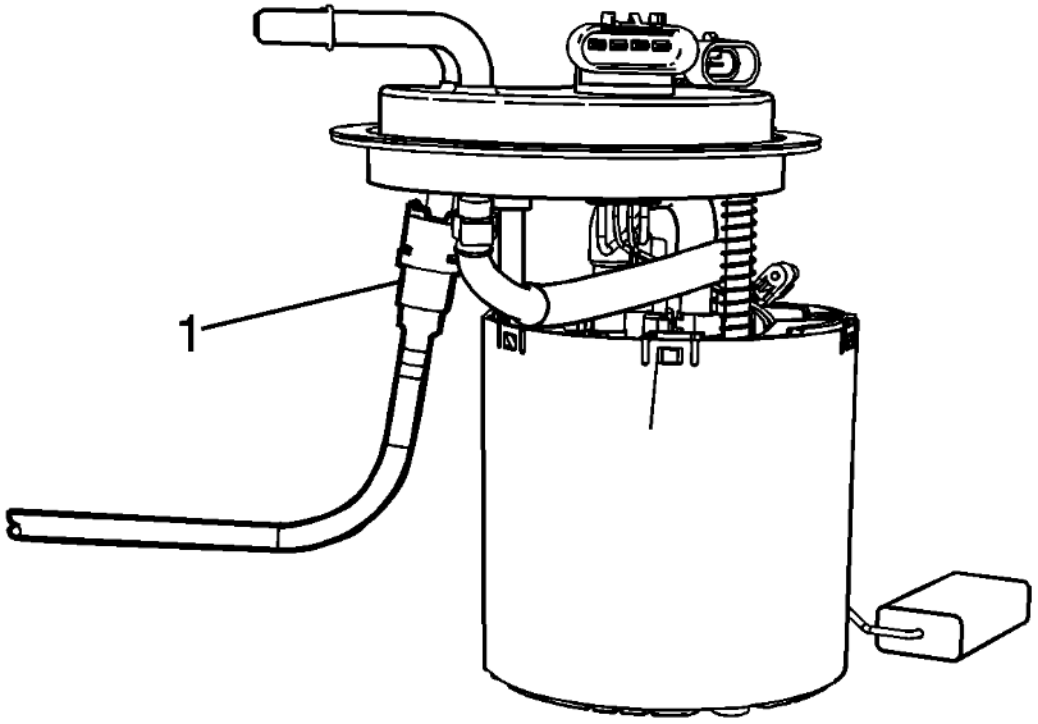
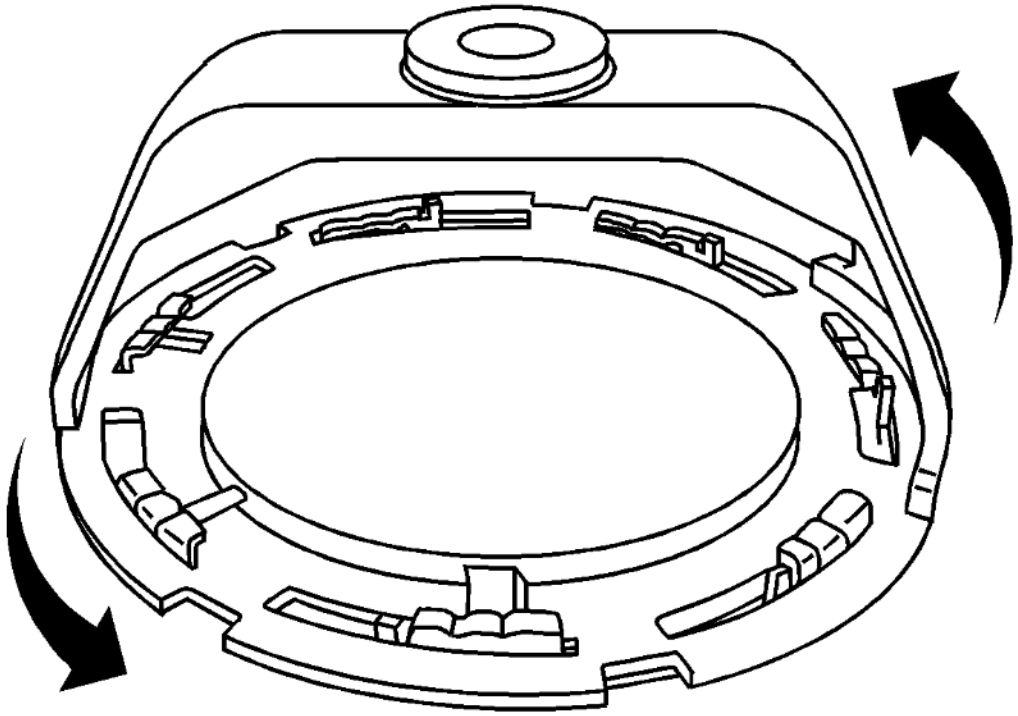


Fig. 93: View Of Fuel Tank Module & Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

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1. Install a NEW fuel tank module seal onto the fuel tank.
2. Pull the vent line in the fuel tank up as far as possible for ease of installation.
3. Position the fuel tank module part way into the fuel tank.
4. Connect the quick connect fitting (1) to the module cover. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Install the fuel tank module into the fuel tank.
6. Place the lock ring into position.



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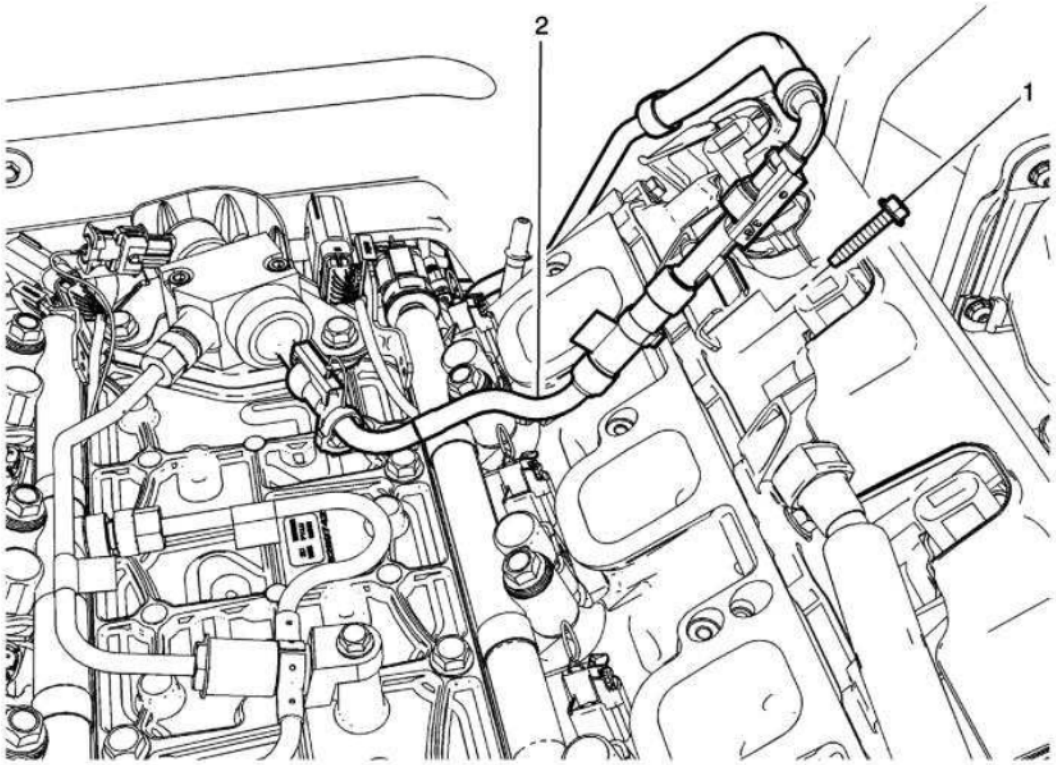
Fig. 94: Identifying Lock Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always replace the fuel module seal when installing the fuel module. Replace the lock ring if necessary. DO NOT apply any type of lubrication in the seal groove.**

Ensure the lock ring is installed with the correct side facing upward. A correctly installed lock ring will only turn in a clockwise direction.

7. Rotate the lock ring counterclockwise using the **J-45722** wrench until fully seated.
8. Connect the fuel and EVAP lines to the fuel tank module. Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL FEED PIPE REPLACEMENT (AT ENGINE)



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Fig. 95: 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. Remove the fuel pump insulator. Refer to **Fuel Pump Insulator Replacement**.	
1	Fuel Feed Pipe Bracket Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Fuel Feed Pipe **Procedure** Disconnect the fuel feed pipe quick connects. Refer to **Metal Collar Quick Connect Fitting Service**.

FUEL FEED PIPE REPLACEMENT (AT TANK)

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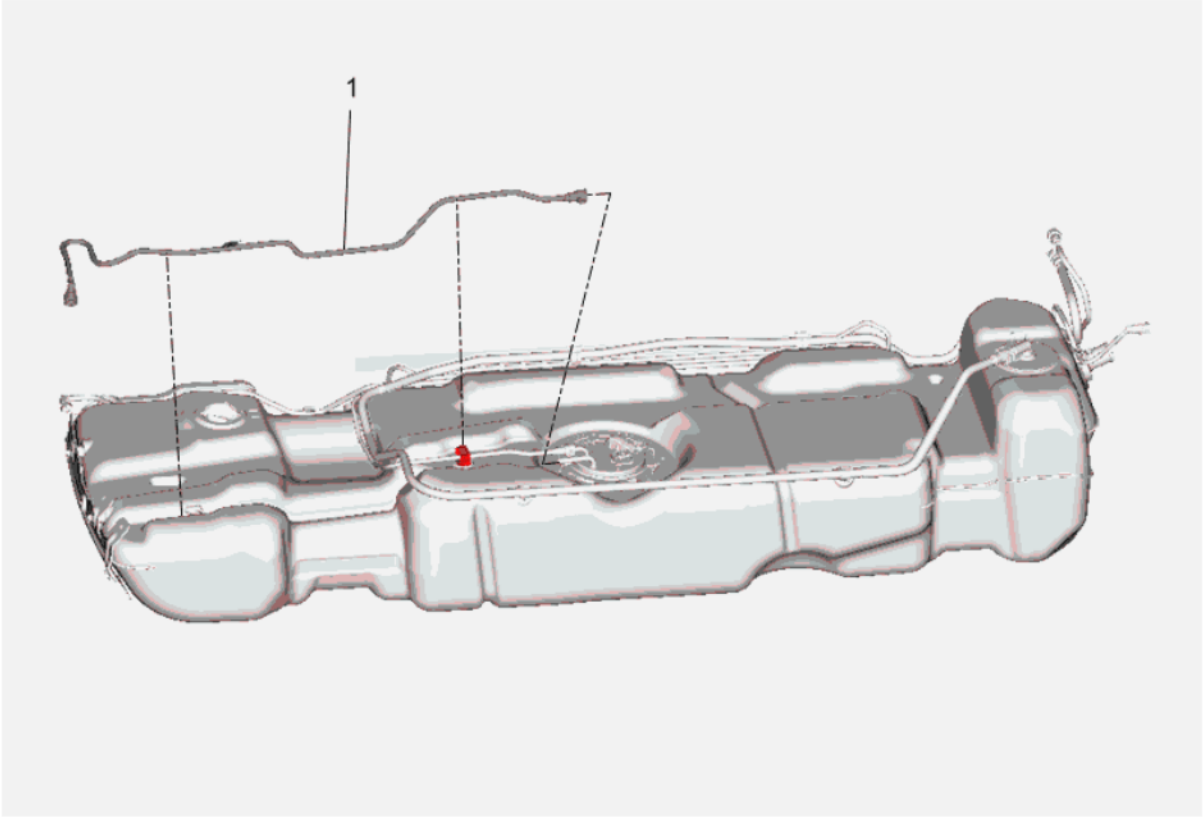


Fig. 96: Fuel Feed Pipe (At Tank)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

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Callout	Component Name
WARNING: **Refer to Gasoline/Gasoline Vapors Warning .** **WARNING:** **Refer to Safety Glasses Warning .** **Preliminary Procedure Fuel Tank Replacement**	
1	Fuel Feed Pipe **Procedure** Disconnect the fuel feed pipe from the fuel tank fuel pump module and remove from retainers. **Plastic Collar Quick Connect Fitting Service**

FUEL PUMP REPLACEMENT

Special Tools

EN-51092 Fuel Pump Installation Gauge

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

Removal Procedure

1. Relieve the fuel pressure. Refer to **Fuel Pressure Relief**.

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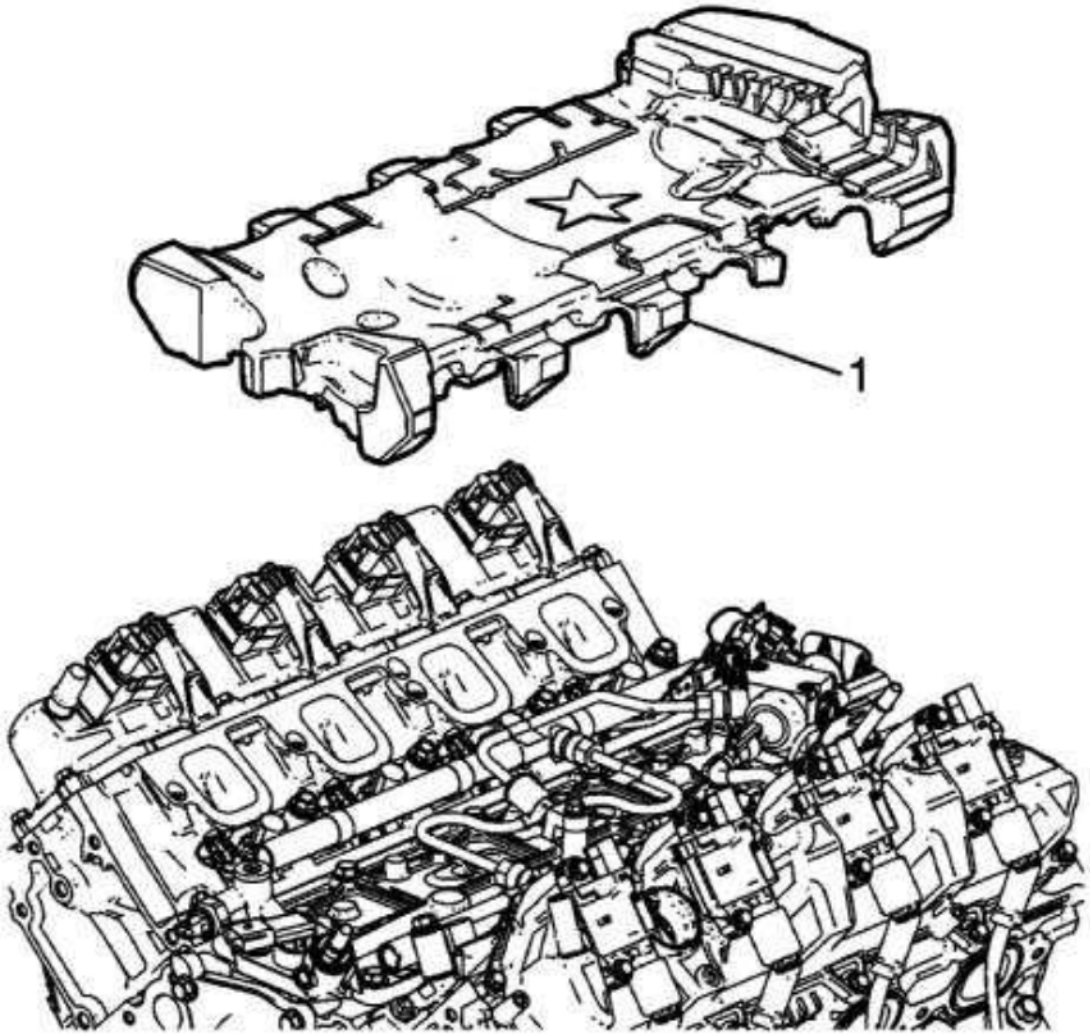


Fig. 97: Fuel Pump Insulator
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel pump insulator (1). Refer to **Fuel Pump Insulator Replacement**.

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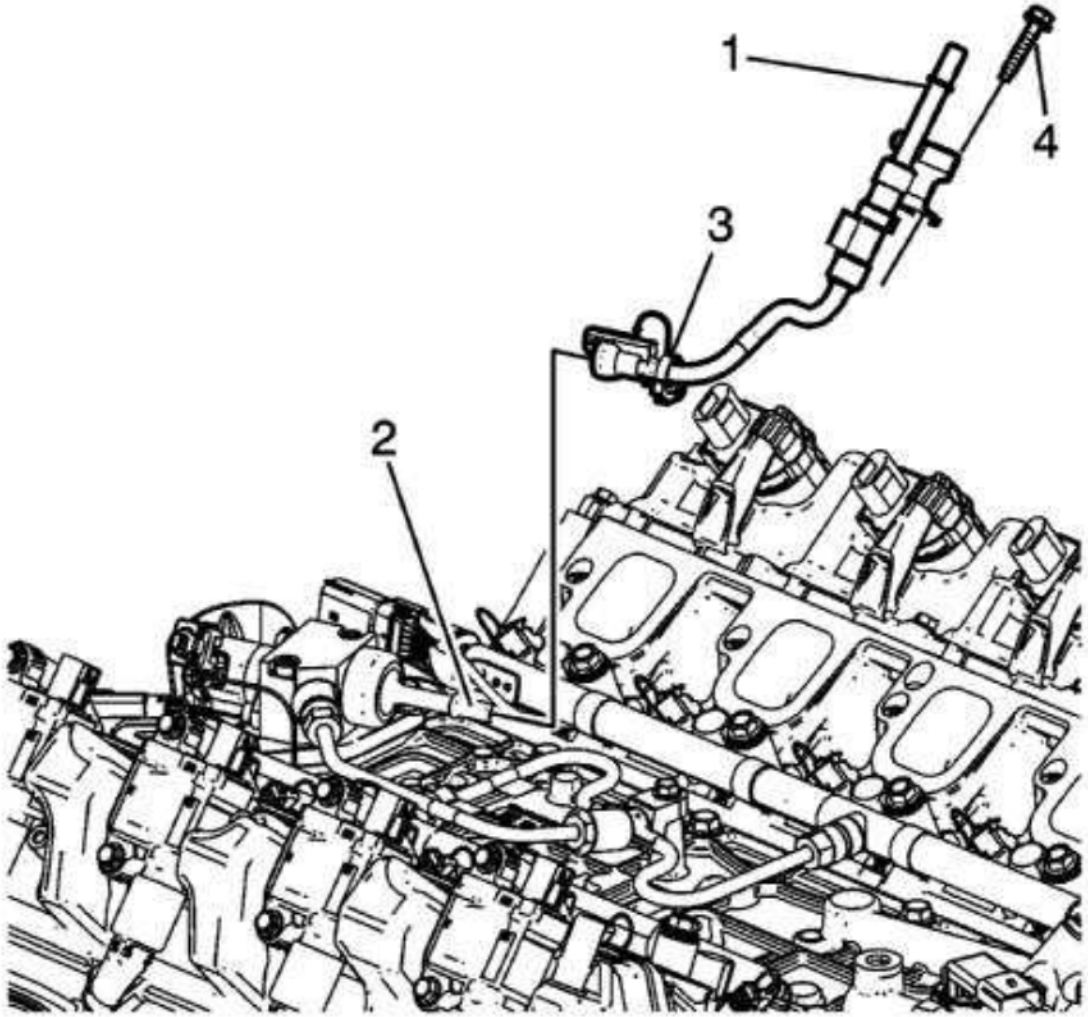


Fig. 98: Low Pressure Fuel Feed Pipe To LH Rocker Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fuel feed pipe fastener (4) then remove the low pressure fuel feed pipe (1) from the fuel pump (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

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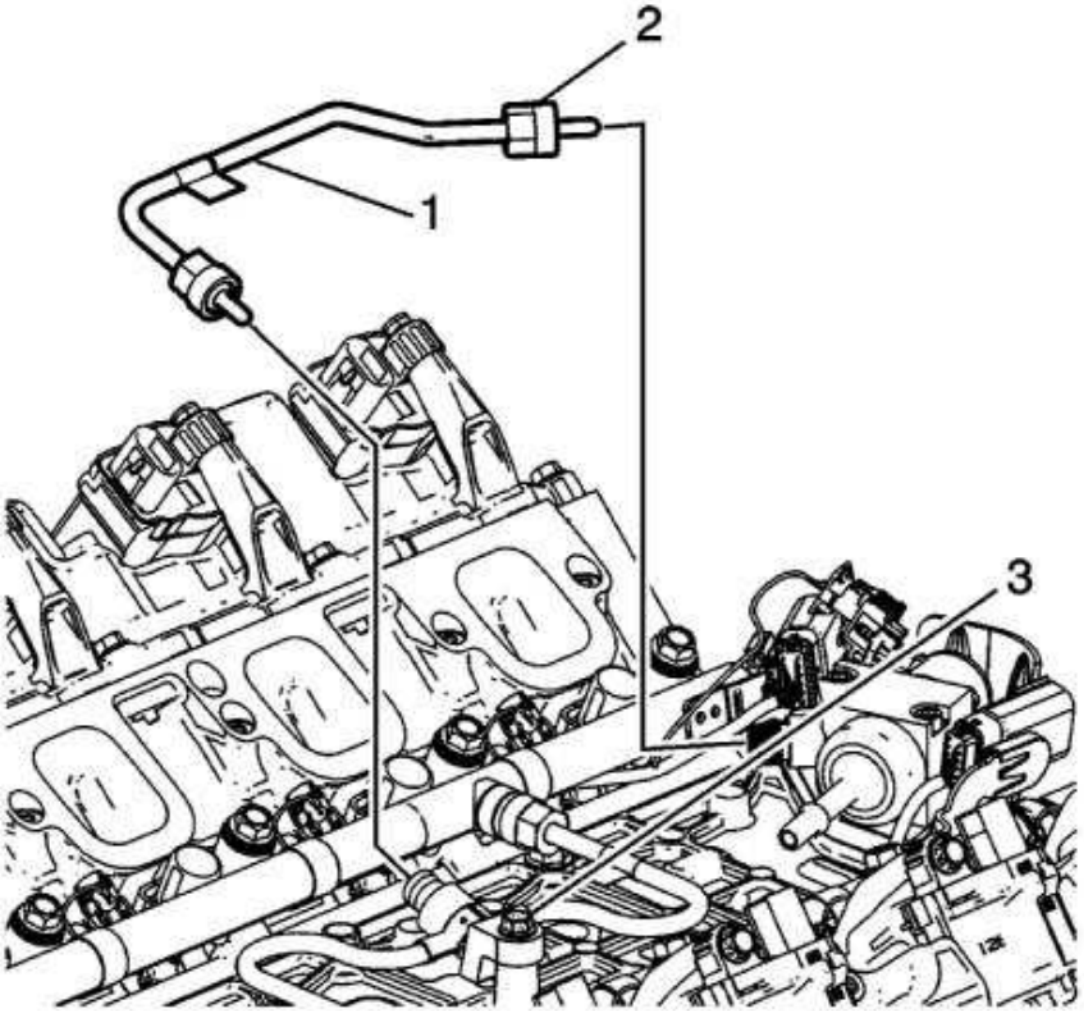


Fig. 99: Crossover Pipe And Fuel Feed Pipe Fittings
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the high pressure fuel feed pipe (1) that connects the fuel pump to the crossover pipe (3).
5. Disconnect and reposition the fuel pump and injector harness as needed.

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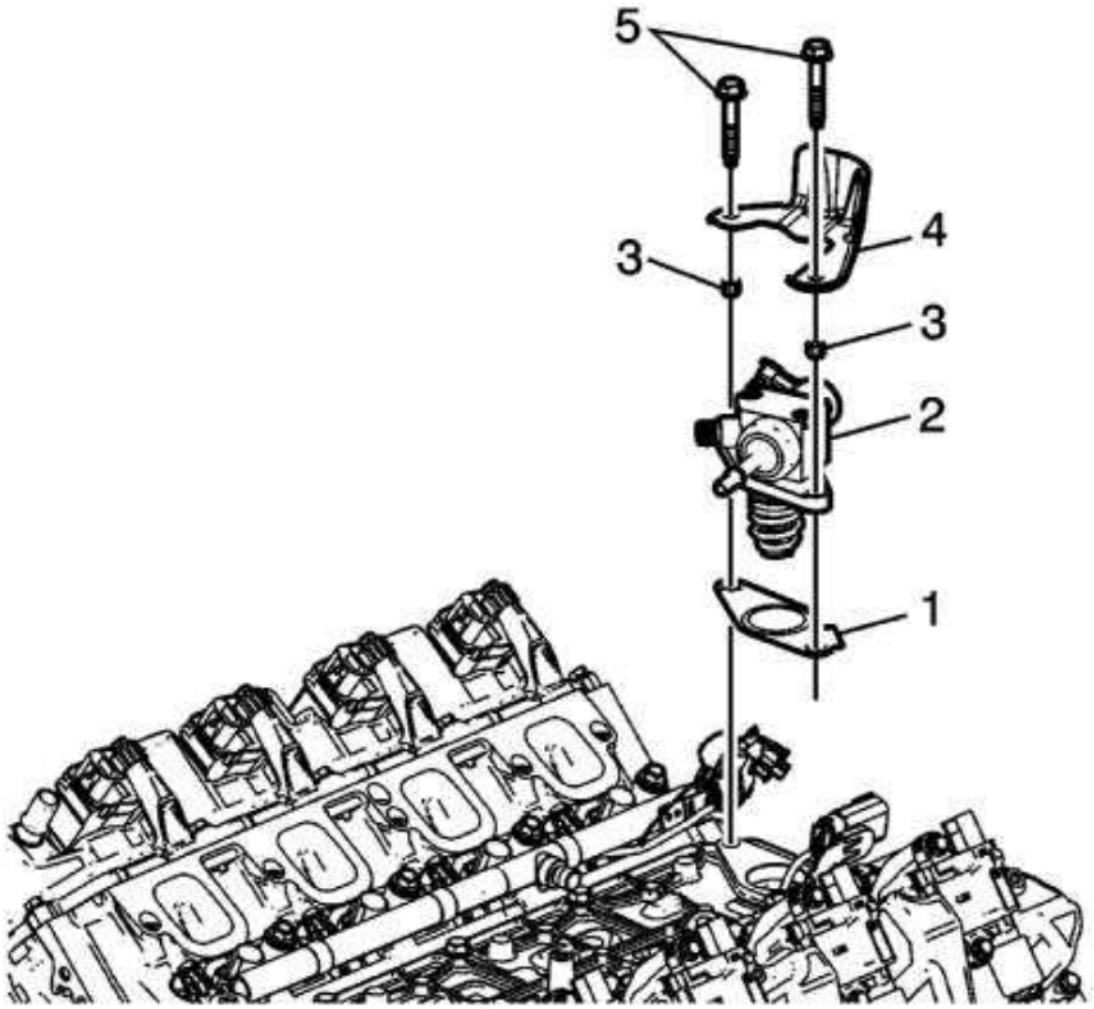


Fig. 100: NEW High Pressure Fuel Pump Gasket
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Alternately loosen the fuel pump bolts one turn at a time until the pump is fully disengaged from fuel pump lifter follower. Trying to remove the pump bolts without even side-to-side loosening may result in pump plunger damage

6. Remove the fuel pump fasteners (5) then remove the fuel pump cover (4) and the plastic fastener retainers (3).

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7. Remove the fuel pump (2) and fuel pump gasket (1) from the engine.
8. DISCARD the fuel pump gasket.

Installation Procedure

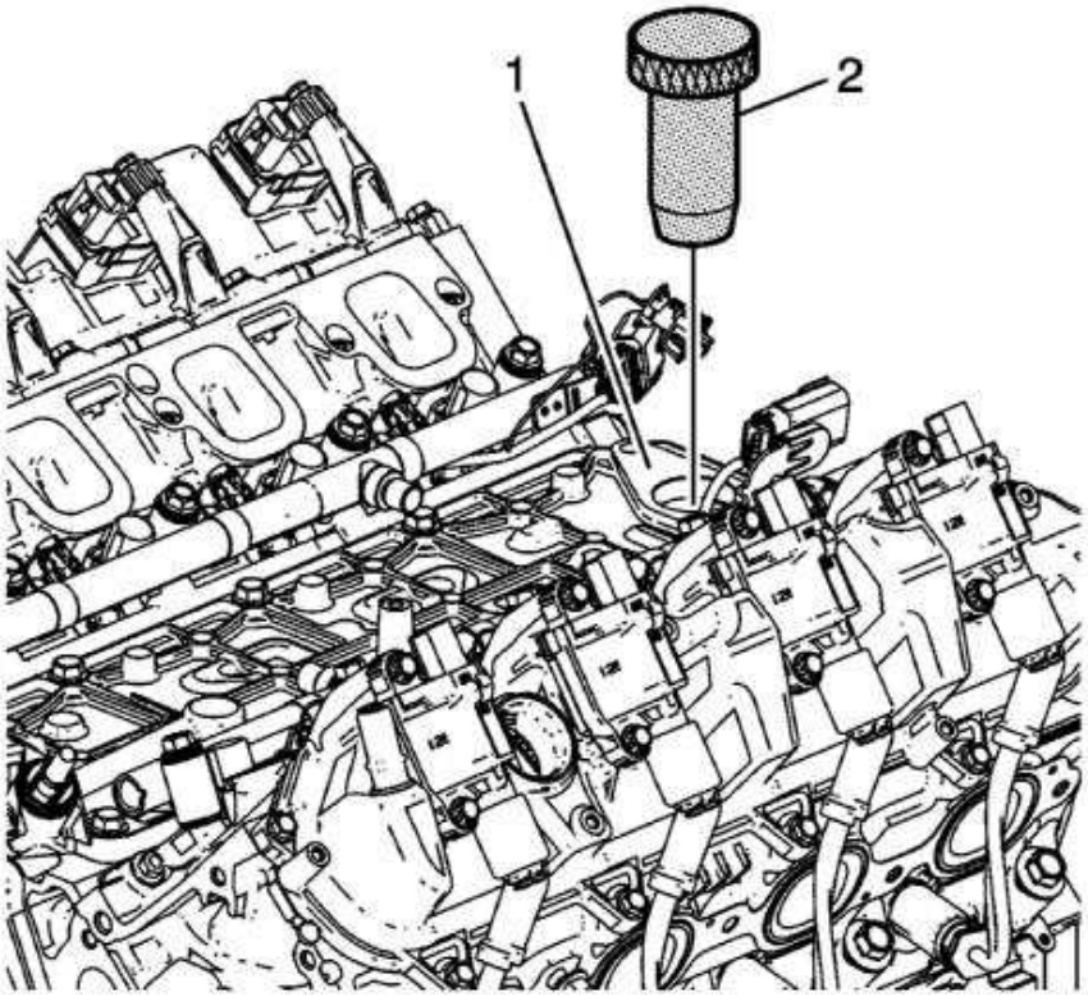


Fig. 101: Lifter Oil Manifold Assembly
Courtesy of GENERAL MOTORS COMPANY

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NOTE: **The camshaft must be in the base circle position before the high pressure fuel pump is installed.**

1. Use the **EN-51092** alignment gauge (2) to ensure that the camshaft lobe is in the base circle position. At base circle position, the tool will be flush with the top surface of the lifter oil manifold assembly (1).

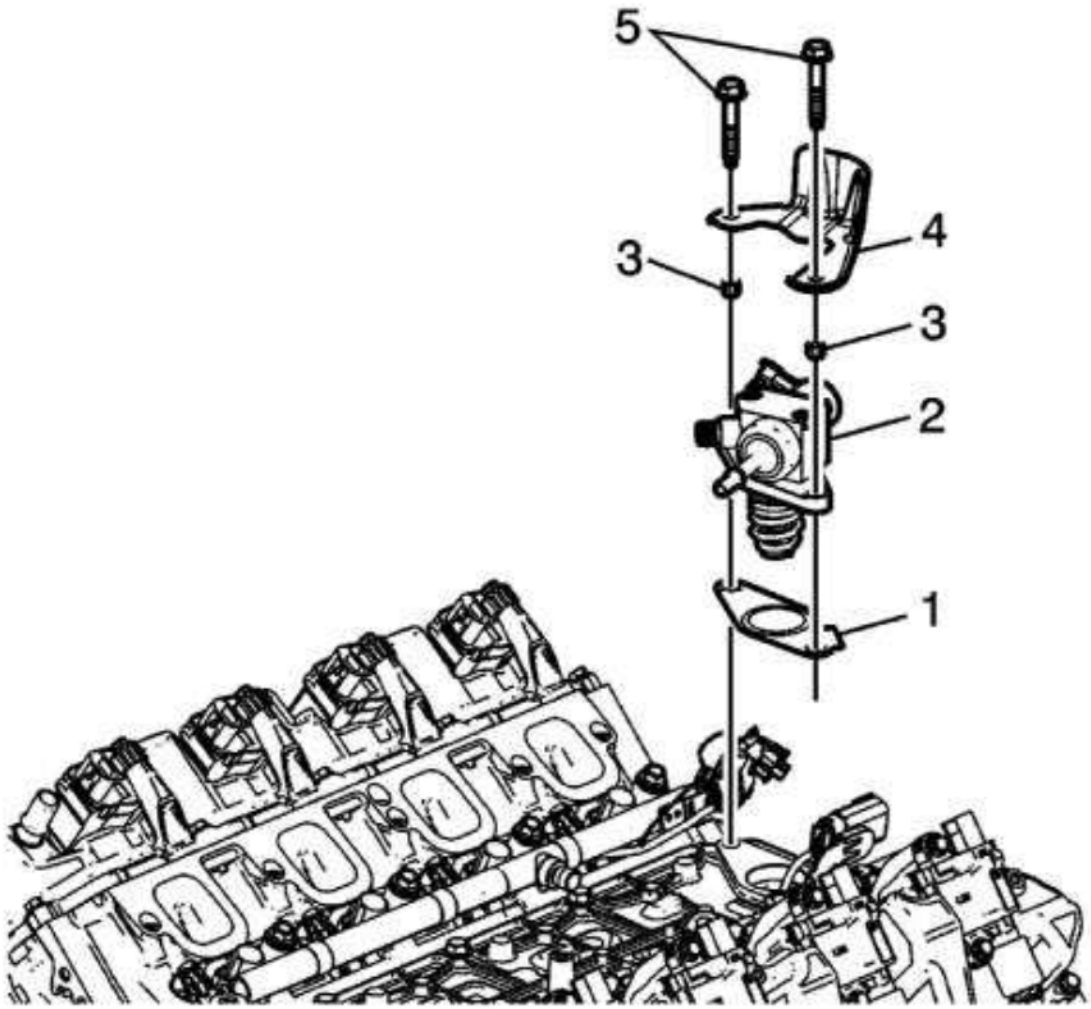


Fig. 102: NEW High Pressure Fuel Pump Gasket
Courtesy of GENERAL MOTORS COMPANY

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NOTE: **Ensure that the high pressure fuel pump roller lifter is oriented properly, the camshaft is at base circle and the number 1 piston is at top dead center (TDC) on the exhaust stroke.**

NOTE: **Ensure the plastic fastener retainers (3) are installed in the high pressure fuel pump mounting holes before installing.**

2. Install a NEW high pressure fuel pump gasket (1).
3. Install the high pressure fuel pump (2) and high pressure fuel pump cover (4).

CAUTION: **Refer to Fastener Caution .**

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.**

4. Start and hand-tighten the high pressure fuel pump fasteners (5) evenly and tighten the high pressure fuel pump fasteners to 25 N.m (18 lb ft).

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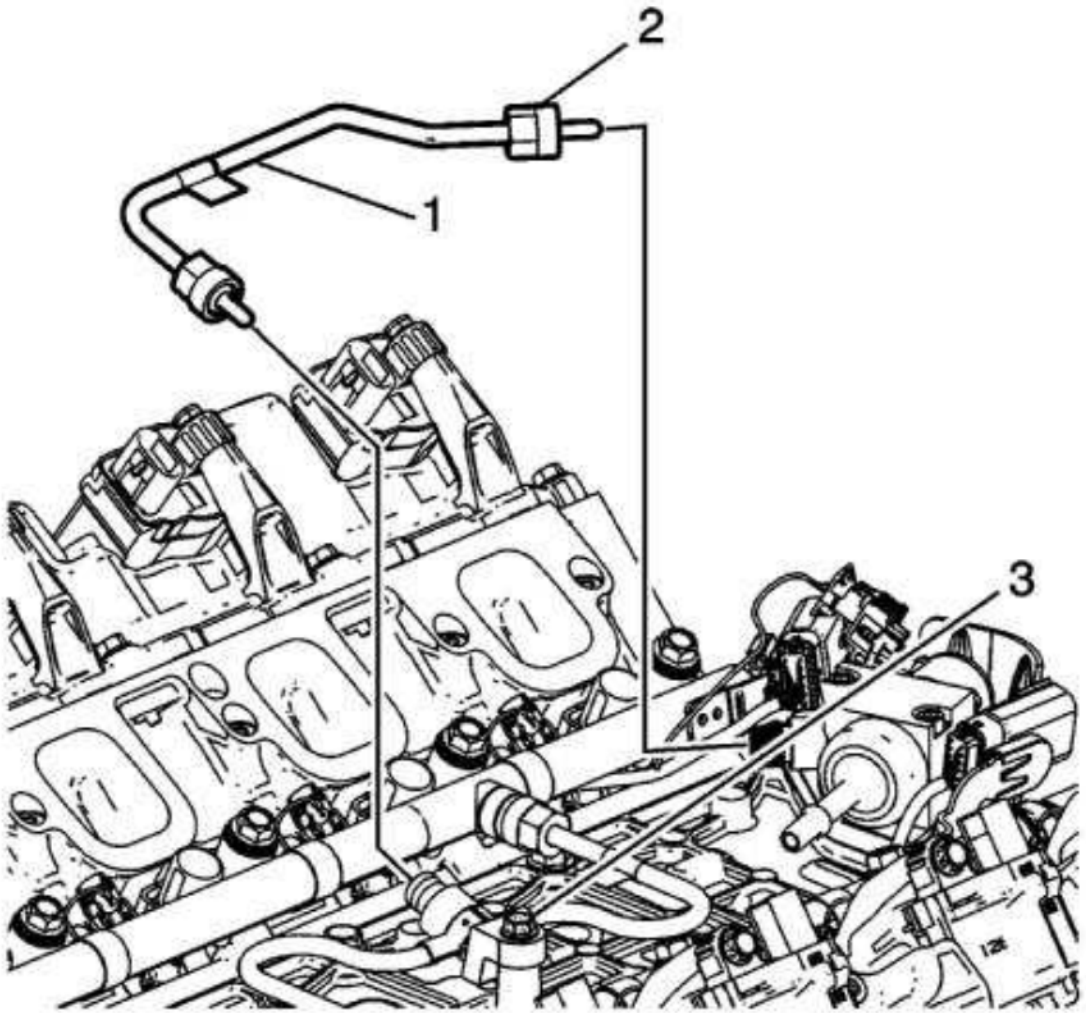


Fig. 103: Crossover Pipe And Fuel Feed Pipe Fittings
Courtesy of GENERAL MOTORS COMPANY

5. Install the NEW high pressure fuel feed pipe (1) that connects the fuel pump to the crossover pipe (3). Finger-tighten both fuel pipe fitting nuts (2).
6. Tighten the high pressure fuel feed pipe fittings to 28 N.m (21 lb ft) in the following order: at the fuel pump (1) then at the crossover (2).

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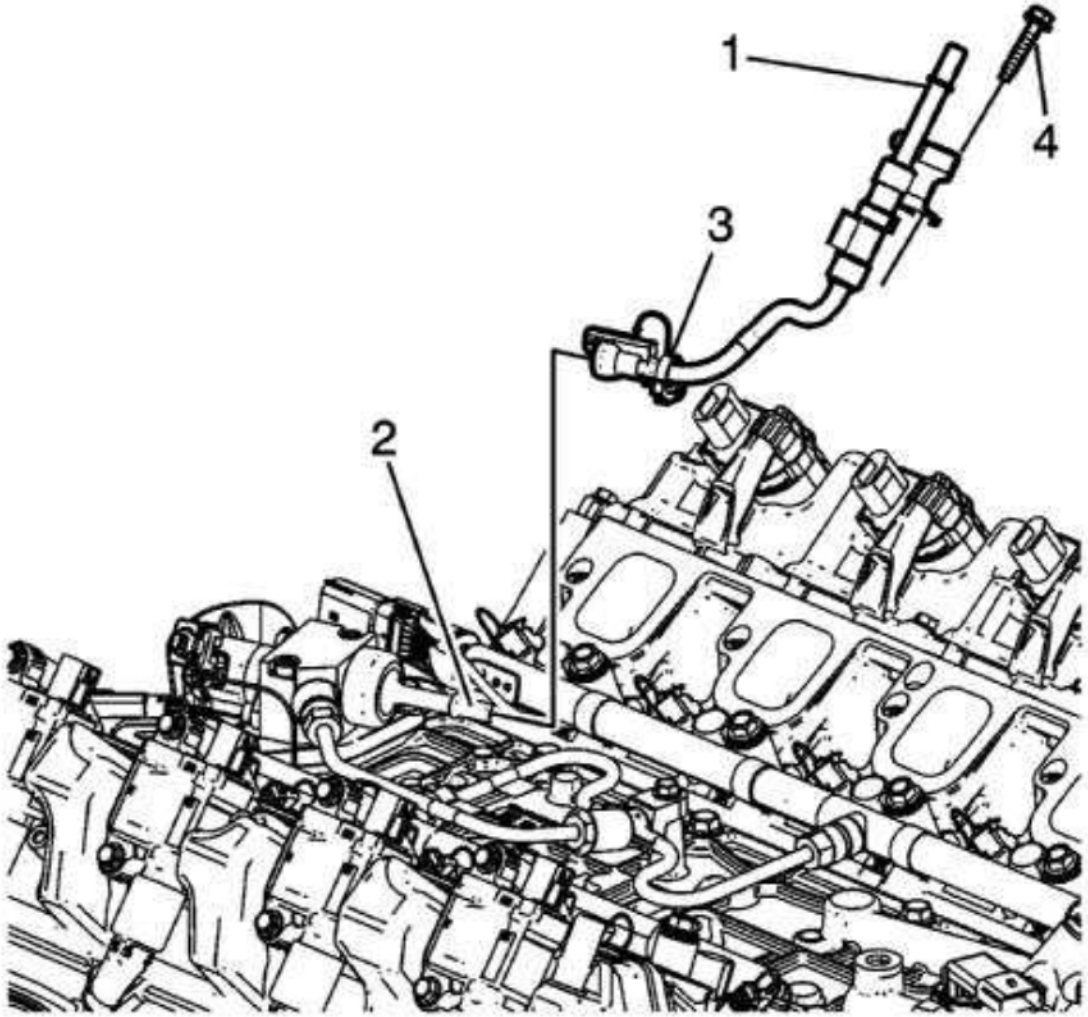


Fig. 104: Low Pressure Fuel Feed Pipe To LH Rocker Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install low pressure fuel feed pipe (1) to the fuel pump (2). Press fuel pipe until an audible click is heard. Install redundant clip (3). Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Install the low pressure fuel feed pipe to LH rocker cover. Tighten fuel feed fasteners (4) to 10 N.m (89 lb in).

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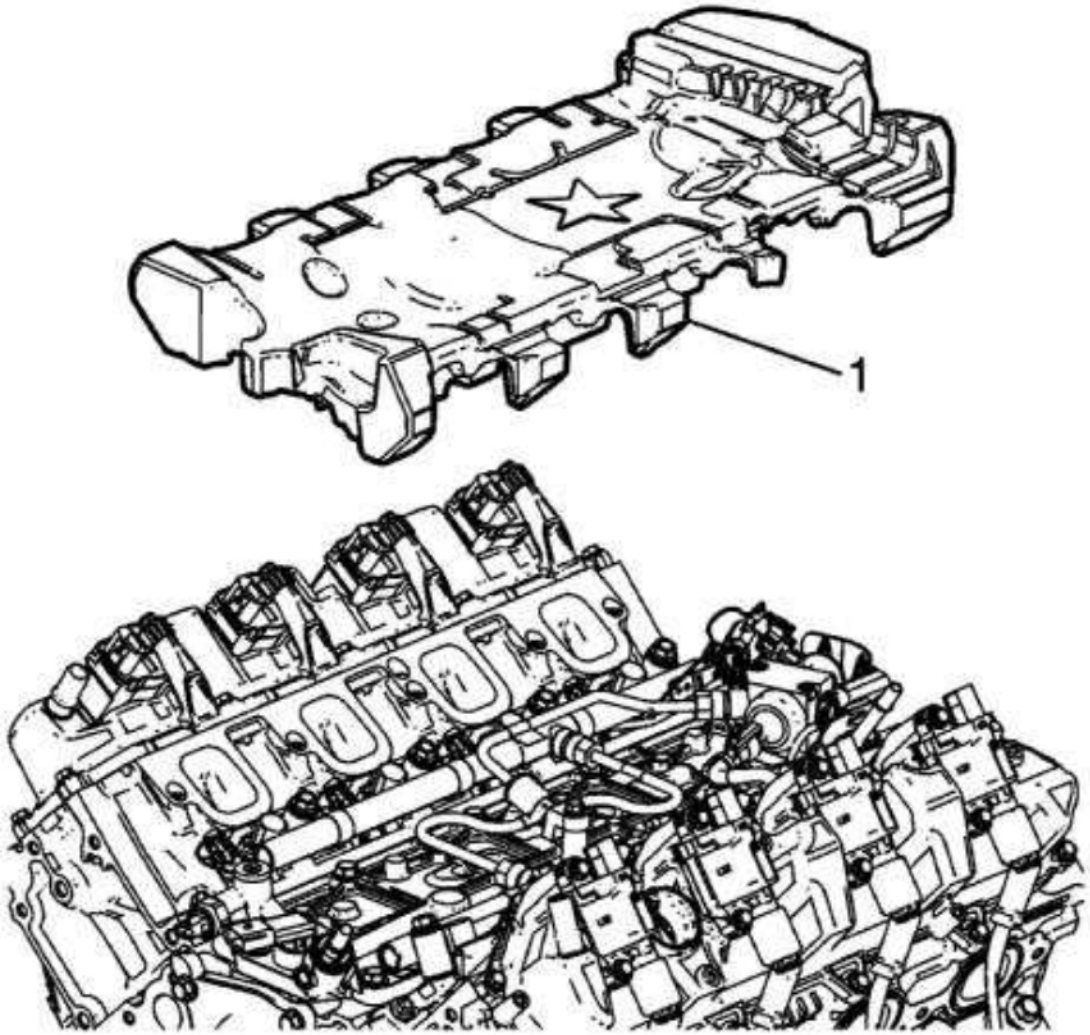


Fig. 105: Fuel Pump Insulator
Courtesy of GENERAL MOTORS COMPANY

9. Install the fuel pump insulator (1). Refer to **Fuel Pump Insulator Replacement**.

FUEL PUMP COVER REPLACEMENT

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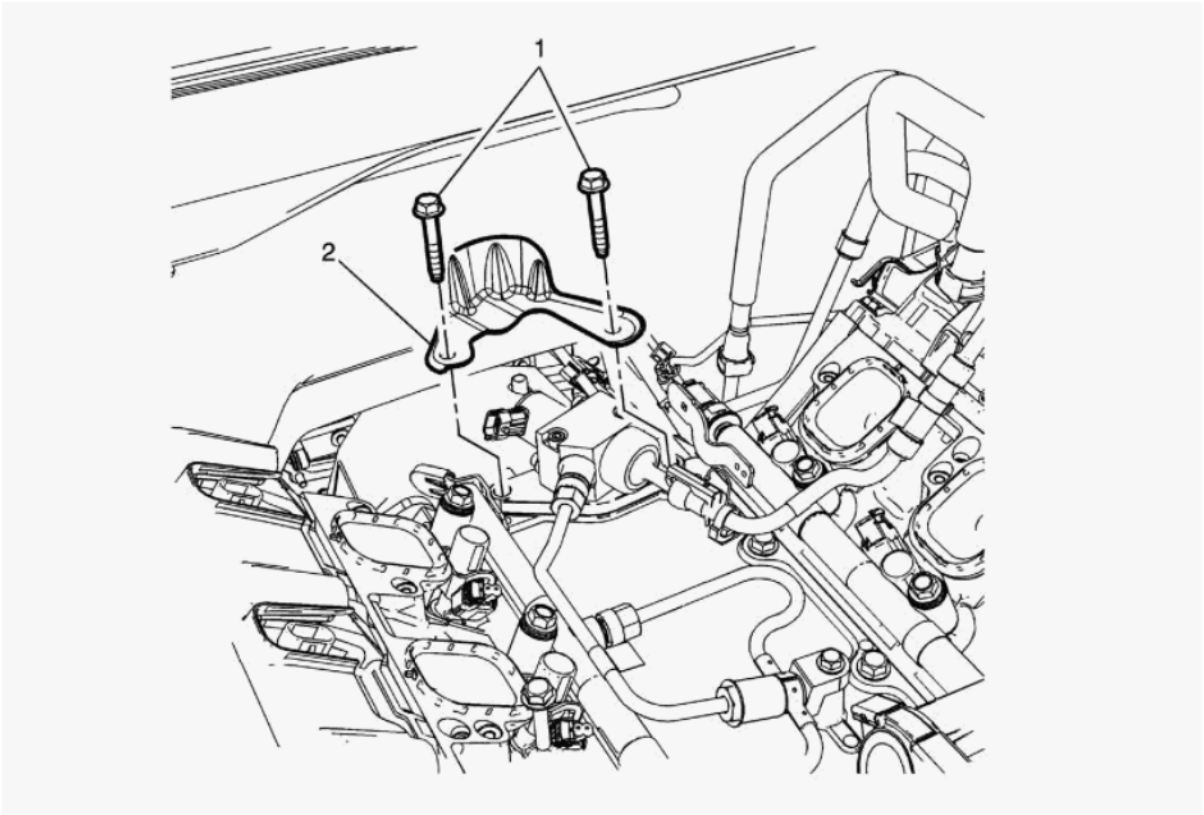


Fig. 106: Fuel Pump Cover
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the fuel pump insulator. Refer to **Fuel Pump Insulator Replacement**.	
1	Fuel Pump Fasteners (Qty: 2) **CAUTION:** **Alternately loosen the fuel pump bolts one turn at a**

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Callout	Component Name
	time until the pump is fully disengaged from fuel pump lifter follower. Trying to remove the pump bolts without even side-to-side loosening may result in pump plunger damage **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
2	Fuel Pump Cover **Procedure** Slide the fuel pump cover rearward to remove it from the fuel pump.

FUEL PUMP INSULATOR REPLACEMENT

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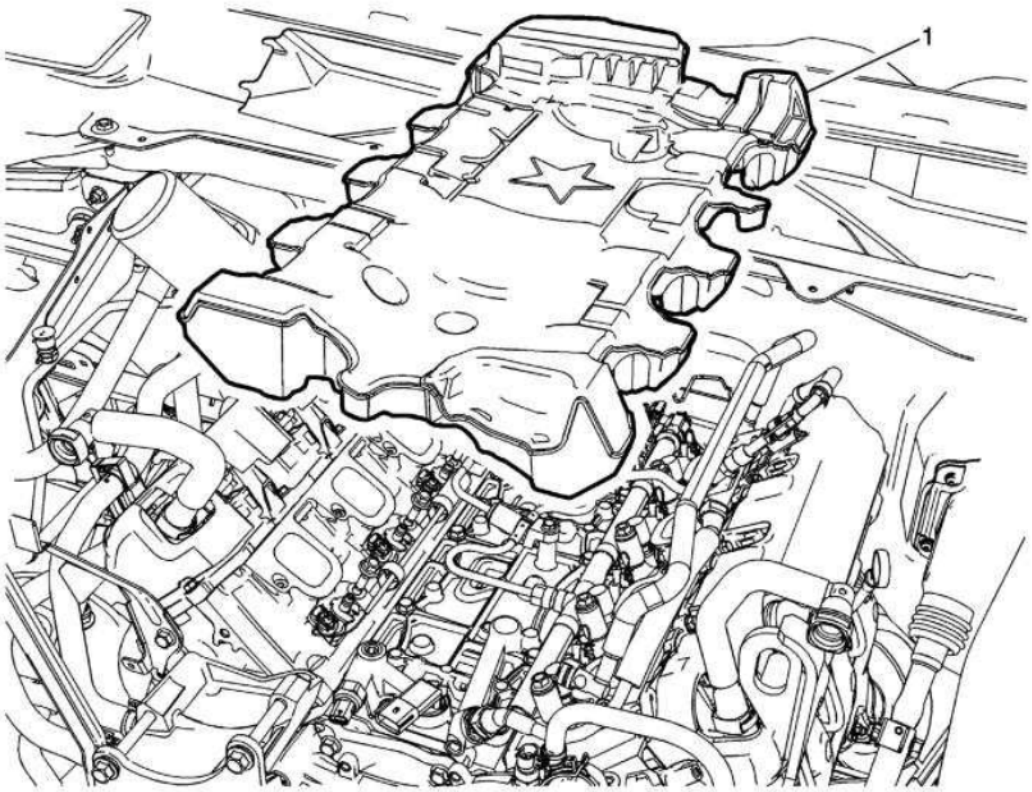


Fig. 107: Fuel Pump Insulator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the intake manifold. Refer to **Intake Manifold Replacement** .	
1	Fuel Pump Insulator **WARNING:** **The noise cancelling foam component MUST be**

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Callout	Component Name
	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.

FUEL LEVEL SENSOR REPLACEMENT

Removal Procedure

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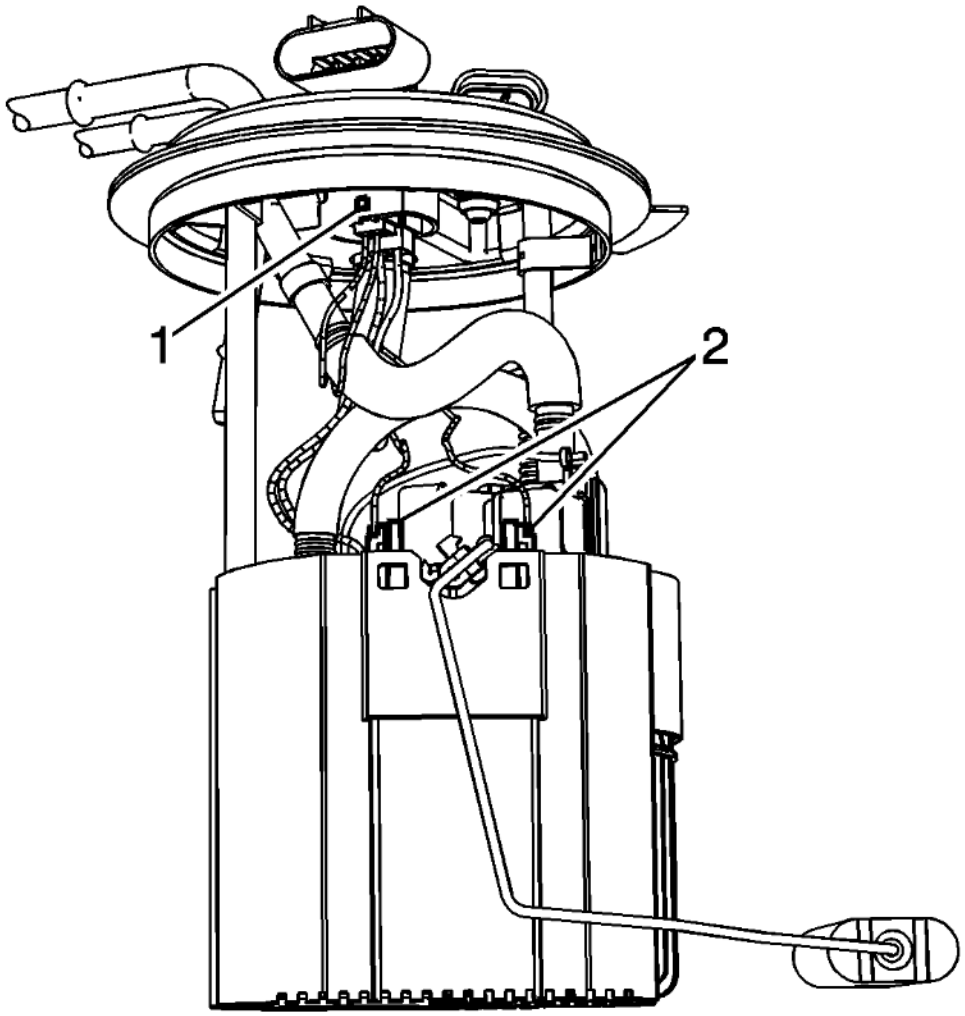


Fig. 108: Locating Fuel Level Sensor Tangs & Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel tank module. Refer to **Fuel Tank Fuel Pump Module Replacement (SWB)Fuel Tank Fuel Pump Module Replacement (LWB)**.
2. Using a small pick like tool, push in the retainer (1) in order to disengage the electrical connector.
3. Remove the fuel level sensor electrical connector from the module cover.

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4. Pull the level sensor locking tangs (2) out towards the outside of the module bucket.

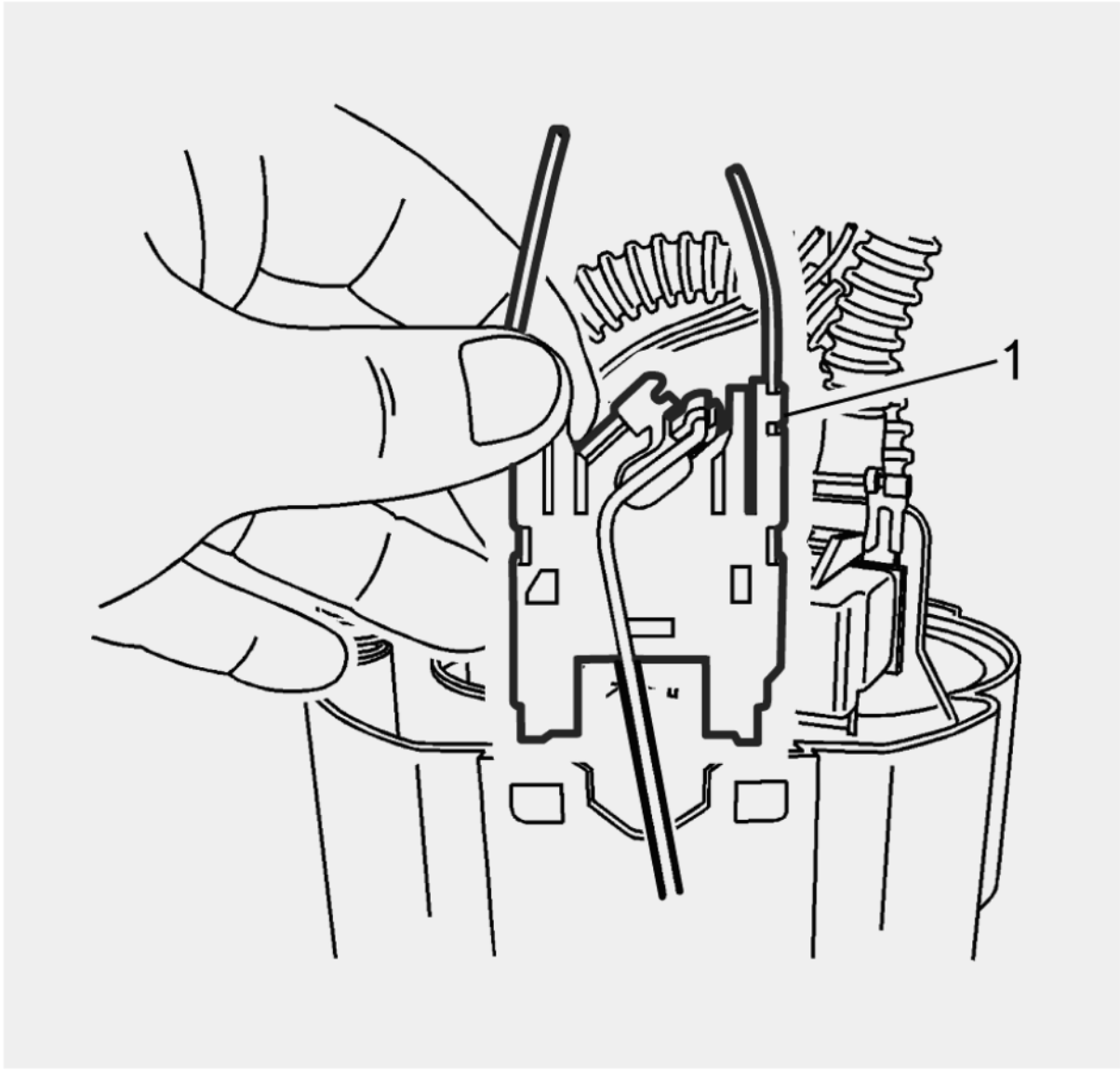


Fig. 109: Fuel Level Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Slide the fuel level sensor (1) up.

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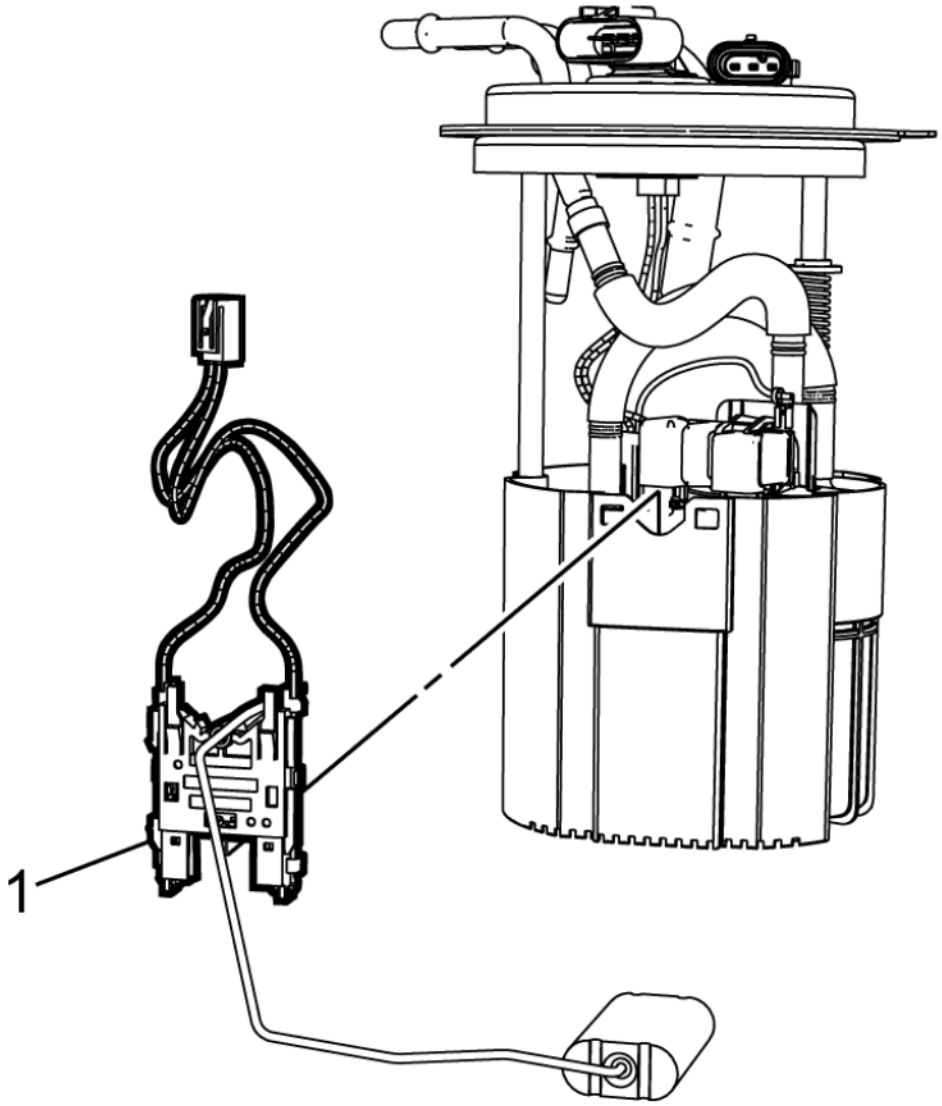


Fig. 110: Fuel Level Sensor
Courtesy of GENERAL MOTORS COMPANY

6. Remove the fuel level sensor (1) from the module.

Installation Procedure

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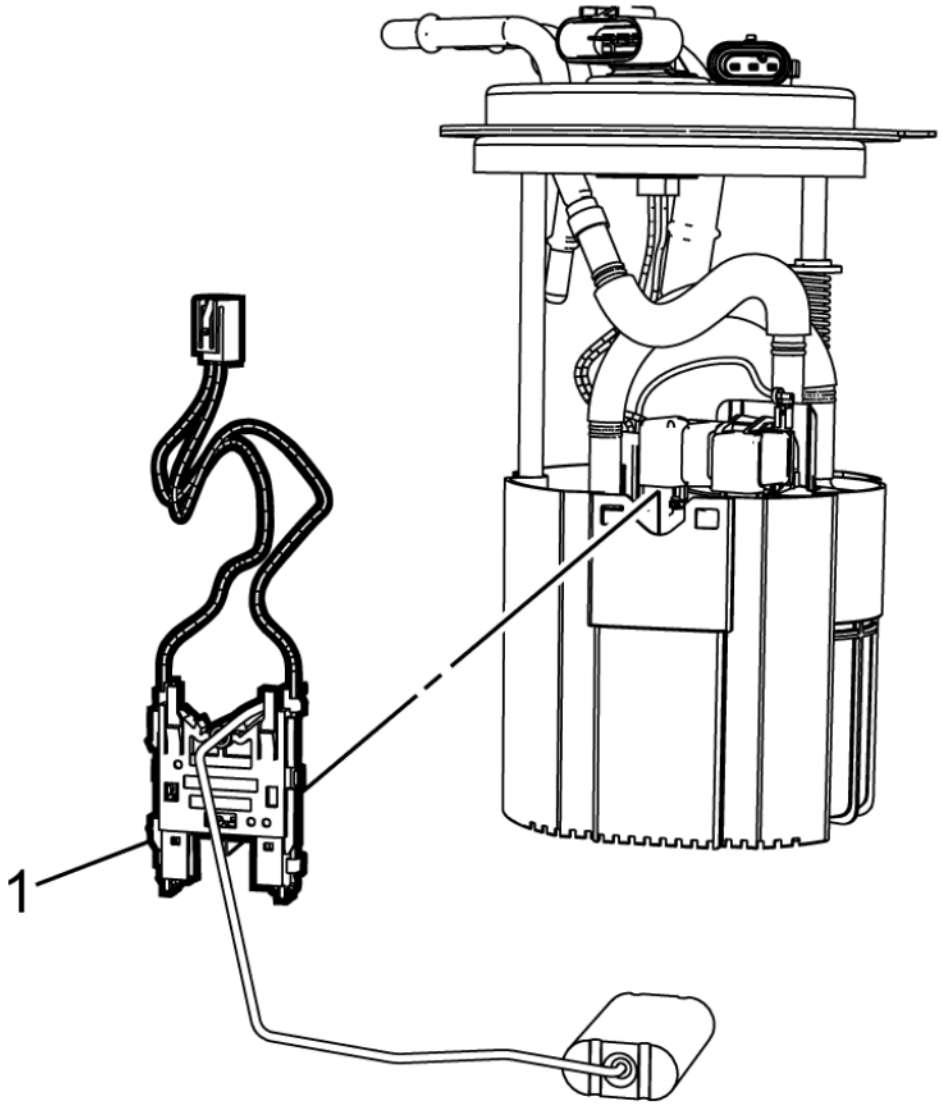


Fig. 111: Fuel Level Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel level sensor (1) to the module.

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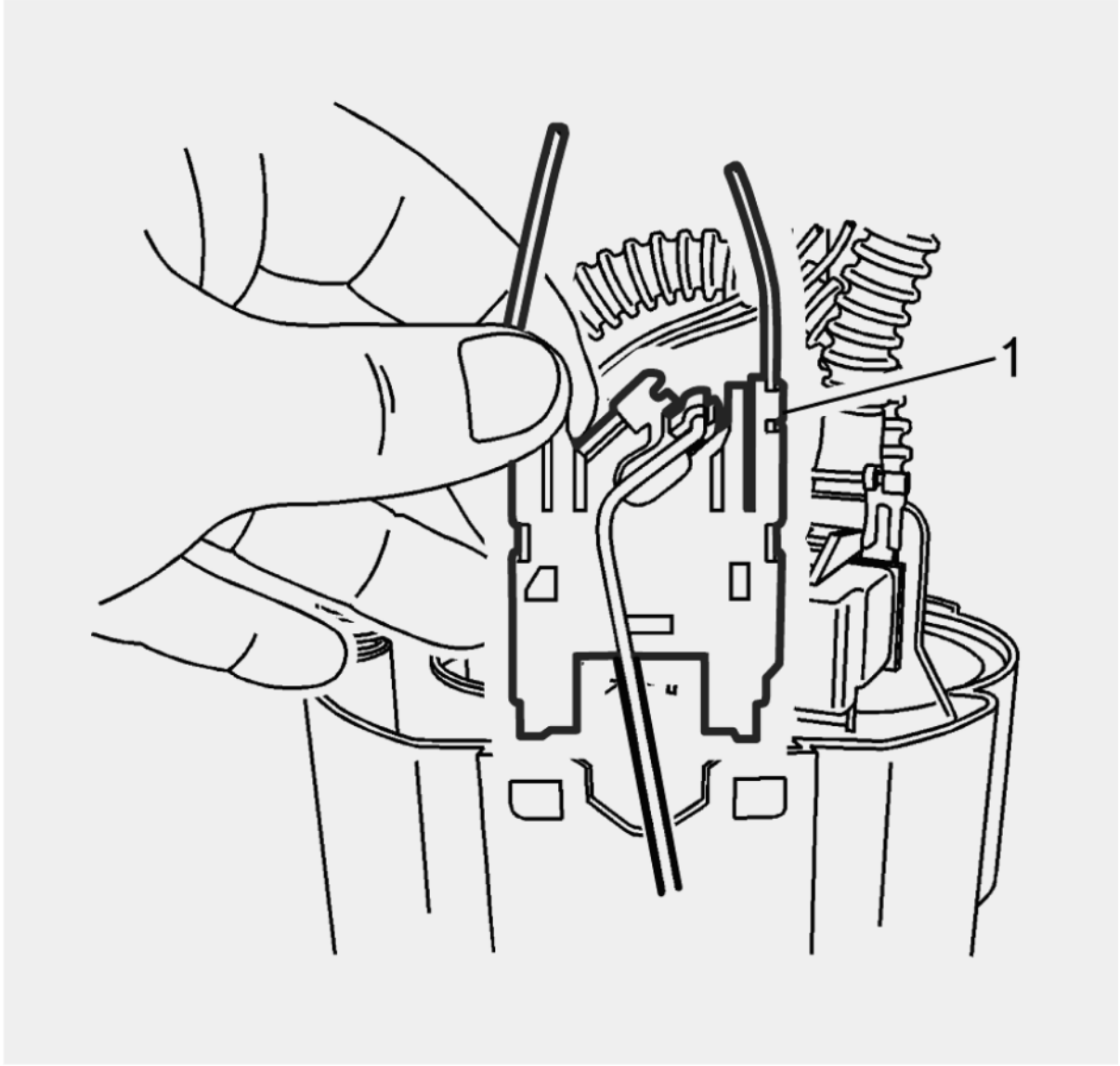


Fig. 112: Fuel Level Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Position and slide the fuel level sensor (1) down.

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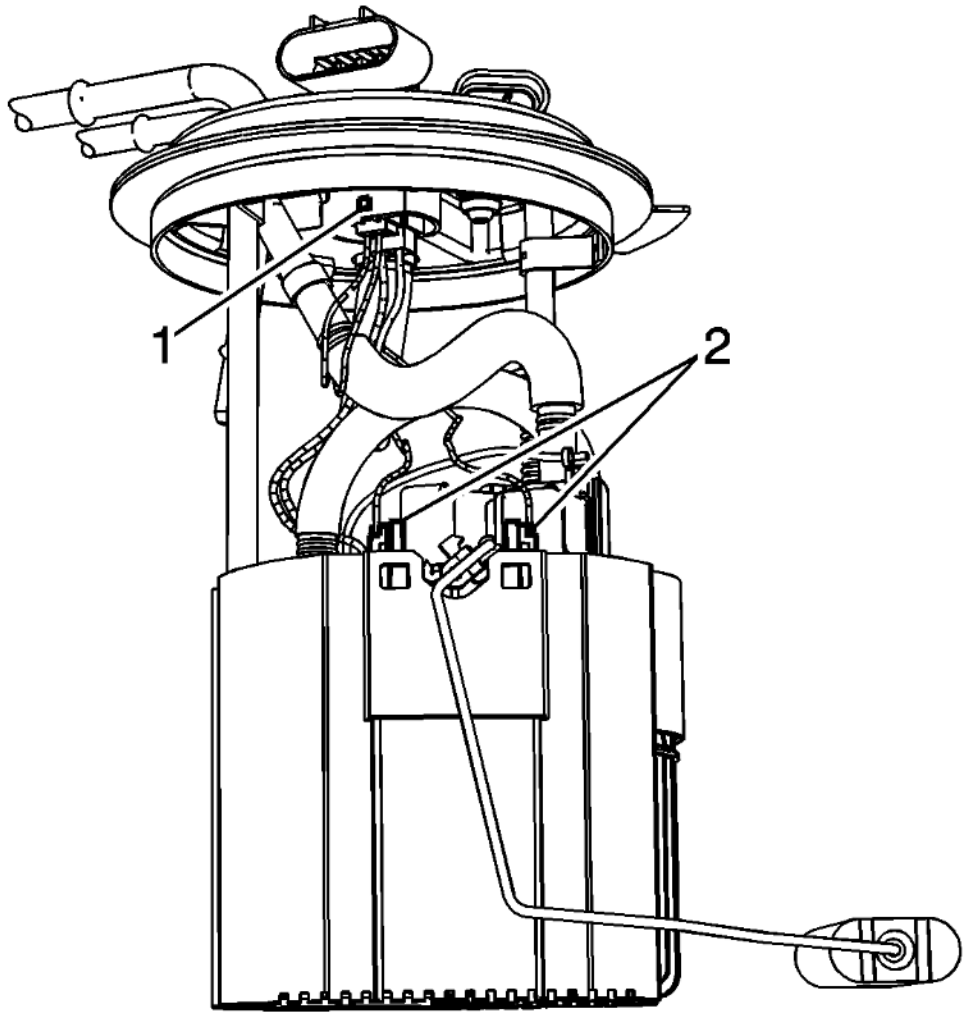


Fig. 113: Locating Fuel Level Sensor Tangs & Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Ensure that the level sensor tangs (2) are engaged at the bucket.
4. Install the fuel level sensor electrical connector to the module cover.
5. Ensure that the retainer (1) engaged the module cover.
6. Install the fuel tank module. Refer to **Fuel Tank Fuel Pump Module Replacement (SWB)Fuel Tank Fuel Pump Module Replacement**

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(LWB).

FUEL FEED AND EVAPORATIVE EMISSION HOSE REPLACEMENT

Removal Procedure

NOTE: **Clean all fuel and evaporative emission (EVAP) line connections and surrounding areas prior to disconnecting the lines in order to avoid possible fuel and/or EVAP system contamination.**

1. Lower the transmission enough to access the upper line fasteners and retainers. **Transmission Replacement** , for the 6L80 or **Transmission Replacement** for the 8L90.

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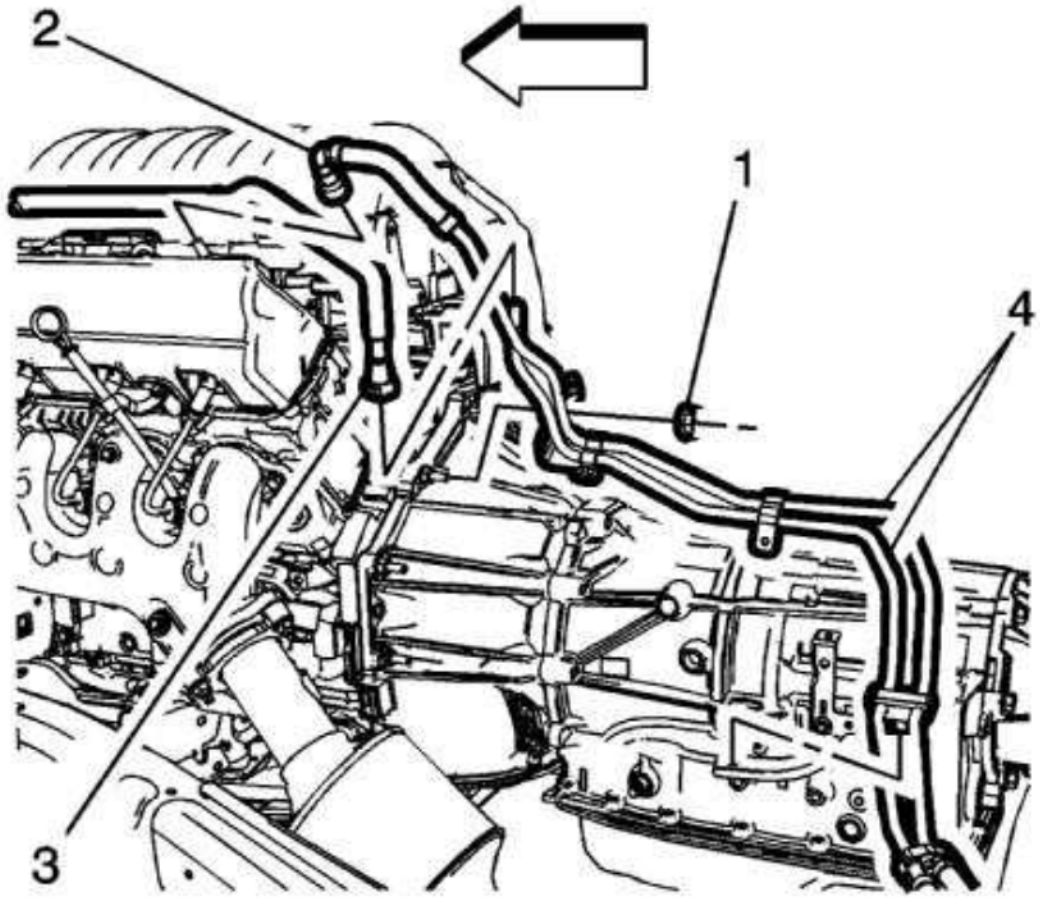


Fig. 114: Fuel Feed And EVAP Hose Nut
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel feed and EVAP hose nut (1).
3. Disconnect the fuel hose (2) from the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.
4. Disconnect the EVAP hose (3) from the EVAP canister purge tube. Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Remove the fuel feed and EVAP hose (4) from the retainers.

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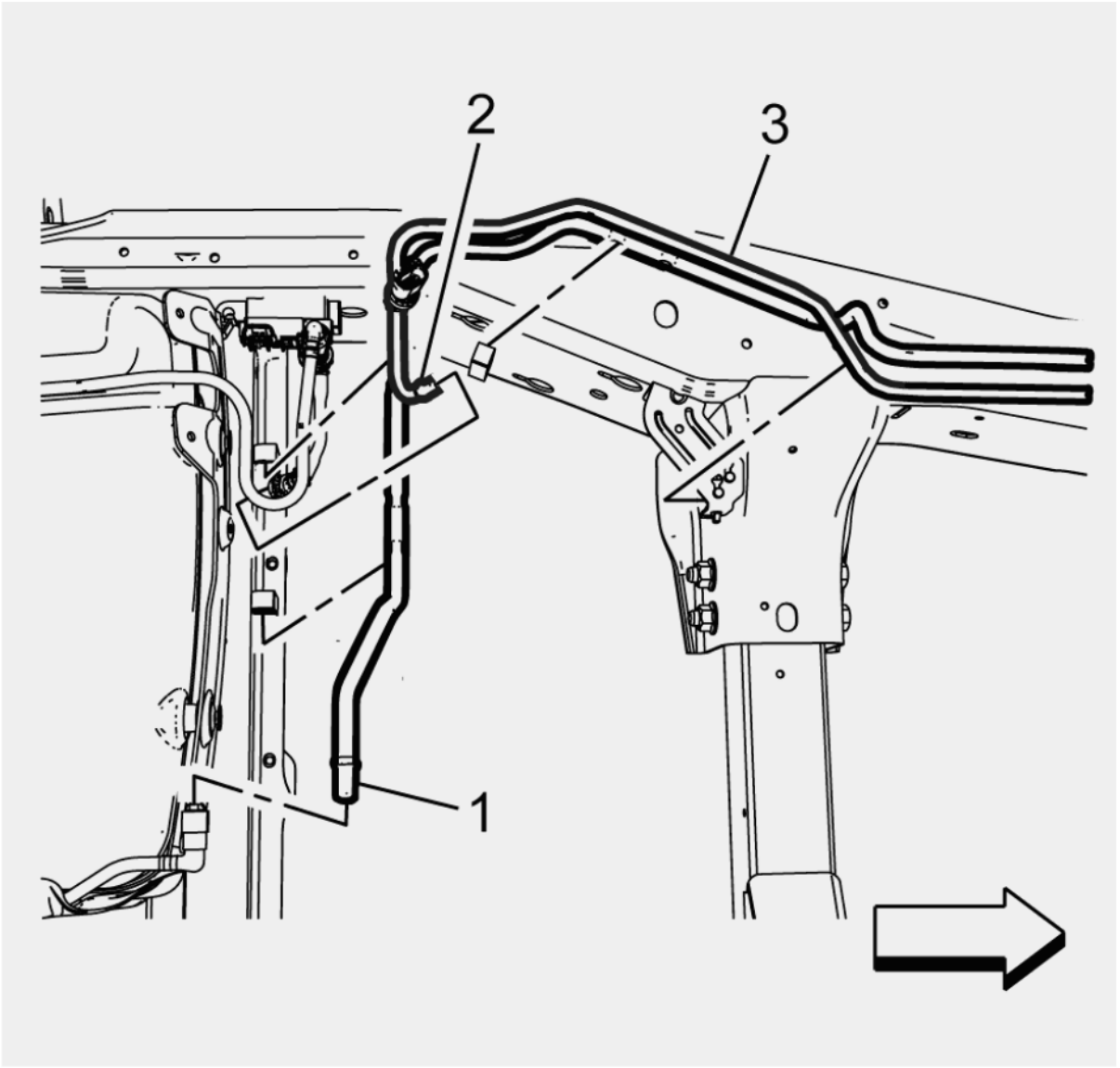


Fig. 115: EVAP hose
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the EVAP hose (1) from the EVAP pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Disconnect the fuel hose (2) from the fuel pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Disconnect the fuel pressure sensor electrical connector.

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9. Remove the fuel feed and EVAP hose (3) from the retainers and remove from vehicle.

Installation Procedure

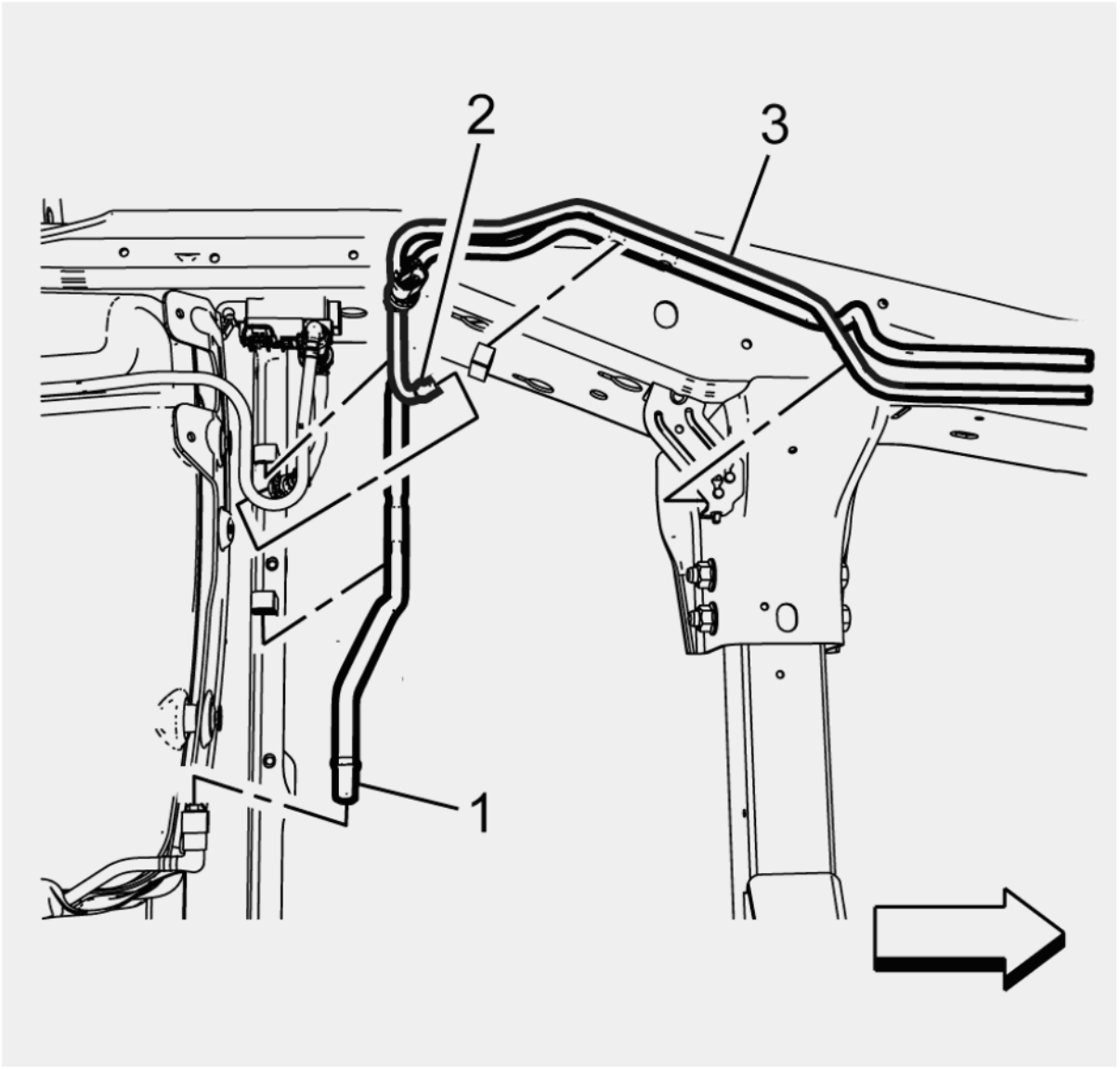


Fig. 116: EVAP hose
Courtesy of GENERAL MOTORS COMPANY

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1. Install the fuel feed and EVAP hose (3) to the vehicle and retainers.
2. Connect the fuel pressure sensor electrical connector.
3. Connect the fuel hose (2) to the fuel pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Connect the EVAP hose (1) to the EVAP pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.

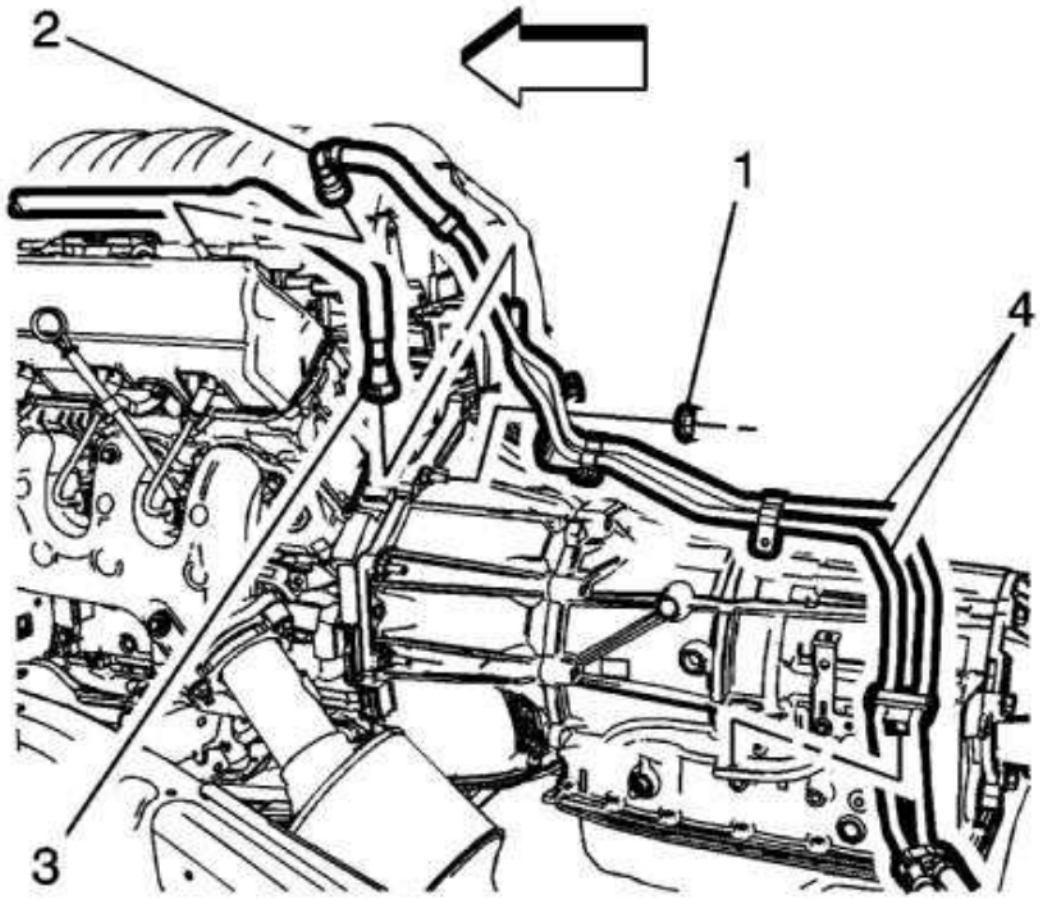


Fig. 117: Fuel Feed And EVAP Hose Nut
Courtesy of GENERAL MOTORS COMPANY

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5. Install the fuel feed and EVAP hose (4) to the retainers.
6. Connect the EVAP hose (3) to the EVAP canister purge tube. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Connect the fuel hose (2) to the fuel rail. Refer to **Metal Collar Quick Connect Fitting Service**.

CAUTION: Refer to Fastener Caution .

8. Install the fuel feed and EVAP hose nut (1) and torque to 25 N.m (18 lb ft).
9. Raise the transmission back to it original position. **Transmission Replacement** , for the 6L80 or **Transmission Replacement** for the 8L90.

FLEXIBLE FUEL SENSOR REPLACEMENT

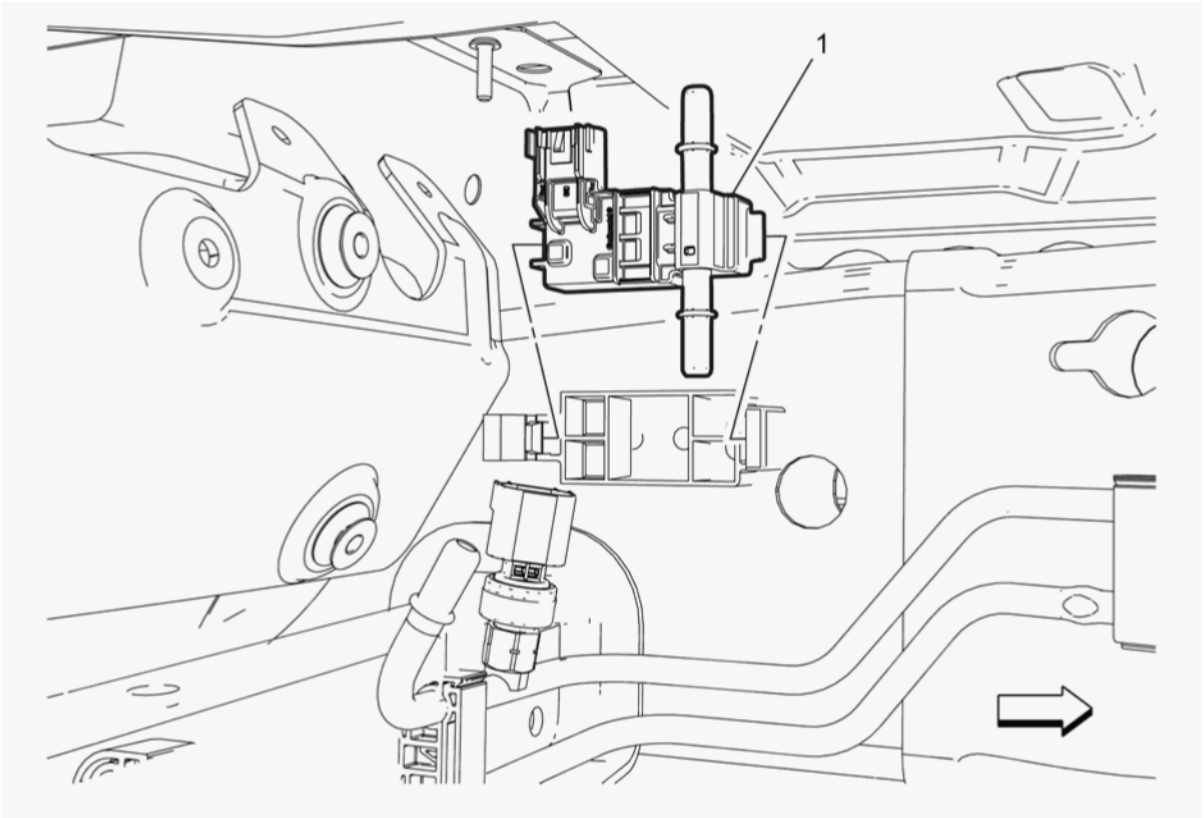


Fig. 118: Flexible Fuel Sensor
Courtesy of GENERAL MOTORS COMPANY

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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**	
1	Flexible Fuel Sensor **Procedure** 1. Disconnect the electrical connector. 2. Disconnect the fuel lines. Refer to **Plastic Collar Quick Connect Fitting Service**. 3. Depress the release tab to remove sensor from bracket.

FUEL PRESSURE SENSOR REPLACEMENT (FUEL PIPE)

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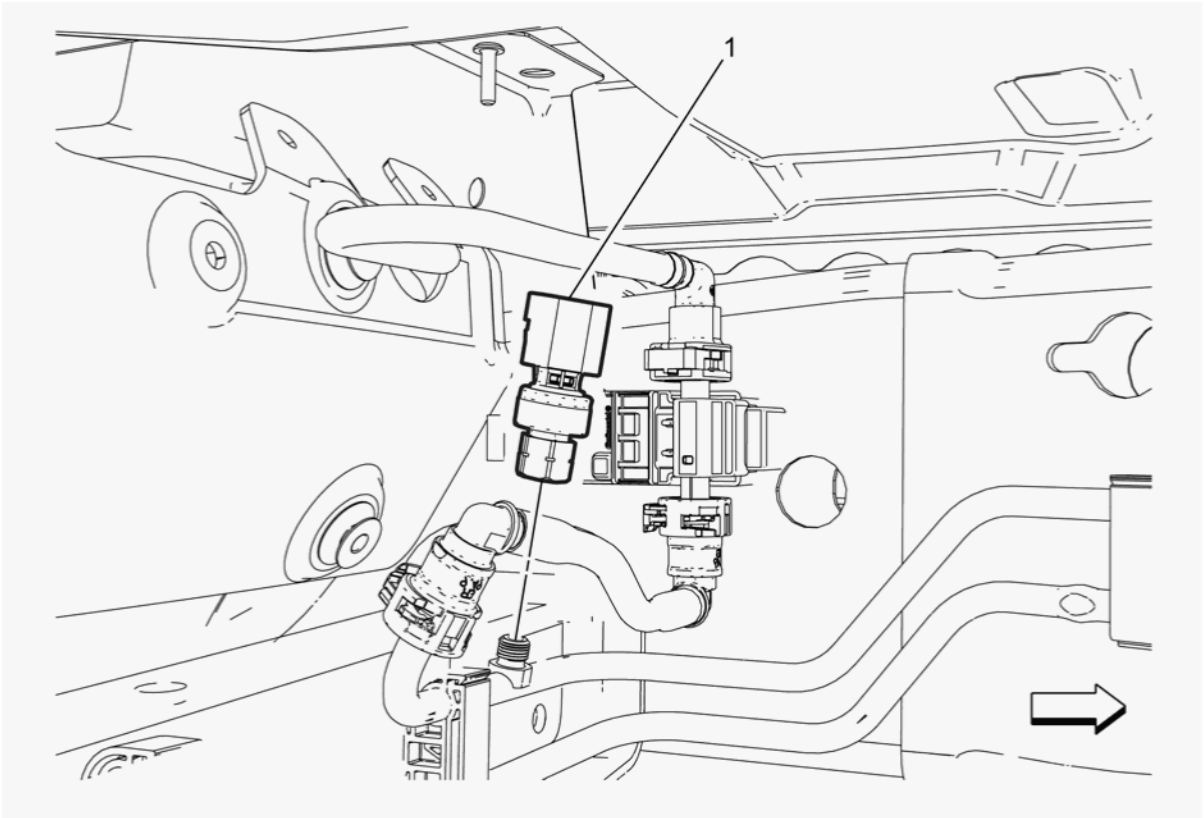


Fig. 119: Fuel Pressure Sensor (Fuel Pipe)
Courtesy of GENERAL MOTORS COMPANY

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** .	
1	Fuel Pressure Sensor **CAUTION:** **Refer to** **Component**

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Callout	Component Name
	Fastener Tightening Caution . **Procedure** 1. Disconnect the electrical connector. 2. Remove and discard the fuel pressure sensor O-ring seal. **Tighten** 15 N.m (11 lb ft)

FUEL SYSTEM CLEANING

NOTE: **Only use oil free compressed air to blow out the fuel pipes.**

1. Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection (Dual Battery) Battery Negative Cable Disconnection and Connection (Single Battery) .
2. Remove the fuel tank module. Refer to Fuel Tank Fuel Pump Module Replacement (SWB)Fuel Tank Fuel Pump Module Replacement (LWB).
3. Inspect the fuel tank module strainer, if equipped. If the strainer is contaminated replace the fuel tank module.
4. Inspect the fuel tank module inlet for dirt and debris. Replace the fuel tank module if you find dirt or debris in the fuel pump inlet.

NOTE: **When flushing the fuel tank, handle the fuel and water mixture as a hazardous material. Handle the fuel and water mixture in accordance with all applicable local, state, and federal laws and regulations.**

5. Flush the fuel tank with hot water.
6. Pour the water out of the fuel module opening. Rock the tank to be sure that removal of the water from the tank is complete.
7. Remove the fuel rail. Refer to Fuel Injection Fuel Rail Assembly Replacement - Bank 1, and Fuel Injection Fuel Rail Assembly Replacement - Bank 2.
8. Drain the fuel from the fuel rail. It will be necessary to remove the fuel injectors from the fuel rail to properly clear all debris from the fuel rail and fuel injectors. Refer to Fuel Injector Replacement.

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9. Use light shop air to remove any debris from the fuel rail and injectors.
10. Use light shop air in the opposite direction of the fuel flow in order to remove any debris from the fuel lines. Catch any fuel from the fuel lines with an approved gasoline container.
11. Install the fuel injectors to the fuel rail. Refer to **Fuel Injector Replacement**.
12. Install the fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1**, and **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**.
13. Install the fuel tank module. Refer to **Fuel Tank Fuel Pump Module Replacement (SWB)Fuel Tank Fuel Pump Module Replacement (LWB)**.
14. Refill the fuel tank.
15. Install the fuel fill cap.
16. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery) Battery Negative Cable Disconnection and Connection (Single Battery)** .

NOTE: **If the fuel pump or sender assembly was not replaced, purge the fuel sender assembly.**

17. Purge the fuel tank module.
    1. Disconnect the fuel feed line quick connect fitting from the fuel tank to the chassis line. Refer to **Plastic Collar Quick Connect Fitting Service**.
    2. Connect a length of hose to the fuel feed pipe.
    3. Insert the other end of the hose into an empty 3.8 liter (1 gallon) approved gasoline container.
    4. Add 23 liters (6 gallons) of clean fuel into the fuel tank.
    5. Turn on the fuel pump using the scan tool until 2 liters (1/2 gallon) of fuel flows into the fuel container.
18. Inspect for leaks.
    1. Turn the ignition switch ON for 2 seconds.
    2. Turn the ignition switch OFF for 10 seconds.
    3. Turn the ignition switch ON.
    4. Inspect for fuel leaks.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 1

Removal Procedure

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Special Tools

- EN-49245-3 Fuel injection seal Installer Sizer
- EN-49245-4 Fuel injection seal Installer Sizer
- EN-49248 Injector Rail Assembly Remover
- EN-51105 Injector Seal Installer Adapters

Equivalent regional tools:**Special Tools**

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 pump insulator. **Fuel Pump Insulator Replacement**
2. Remove the fuel injector intermediate pipe position 1. **Fuel Feed Intermediate Pipe Replacement - Position 1**
3. Clean the cylinder head pocket around the injectors of any dirt or buildup.
4. Disconnect the electrical wiring harness connectors from the fuel rail.
5. If replacing the fuel injection fuel rail assembly, remove the fuel injection fuel rail pressure sensor. **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**

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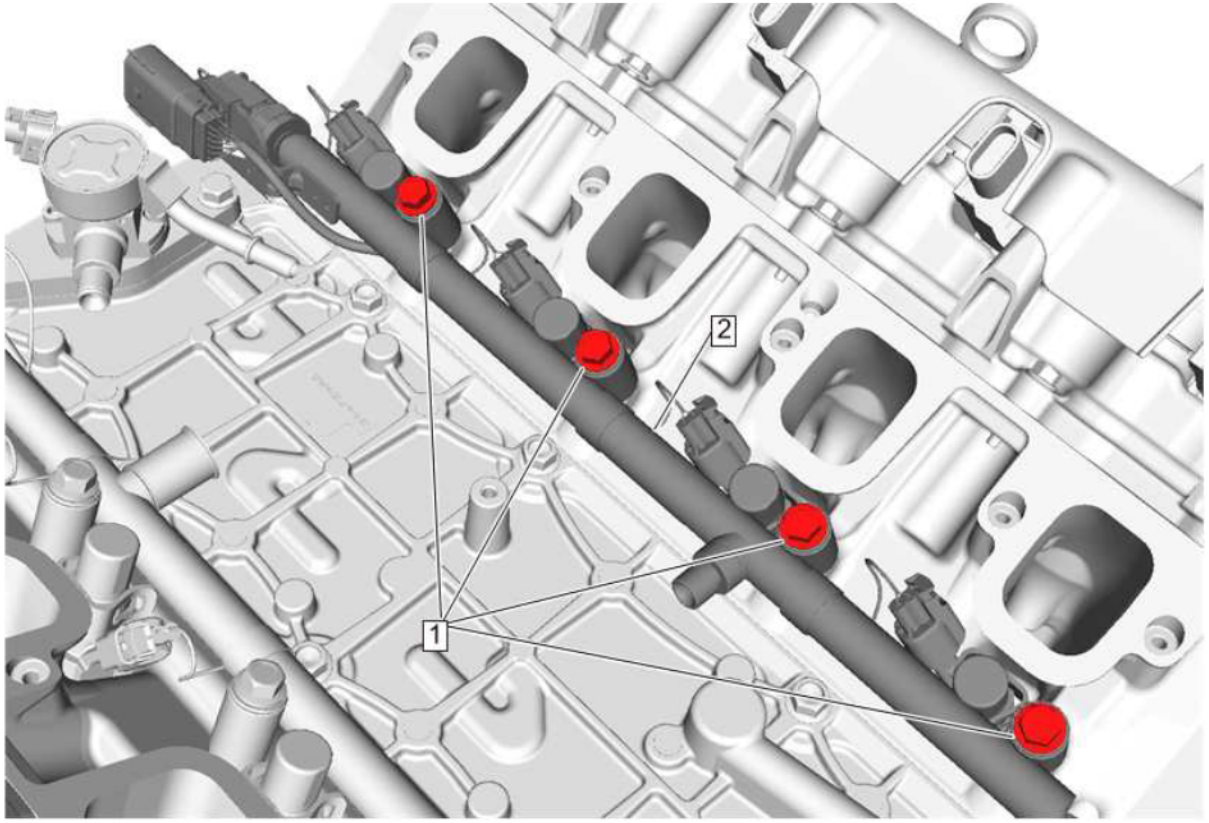


Fig. 120: Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The fuel rail fasteners are retained in the fuel rail by keepers and may be difficult to remove.**

6. Remove the fuel rail fasteners (1) securing the injector rail (2).

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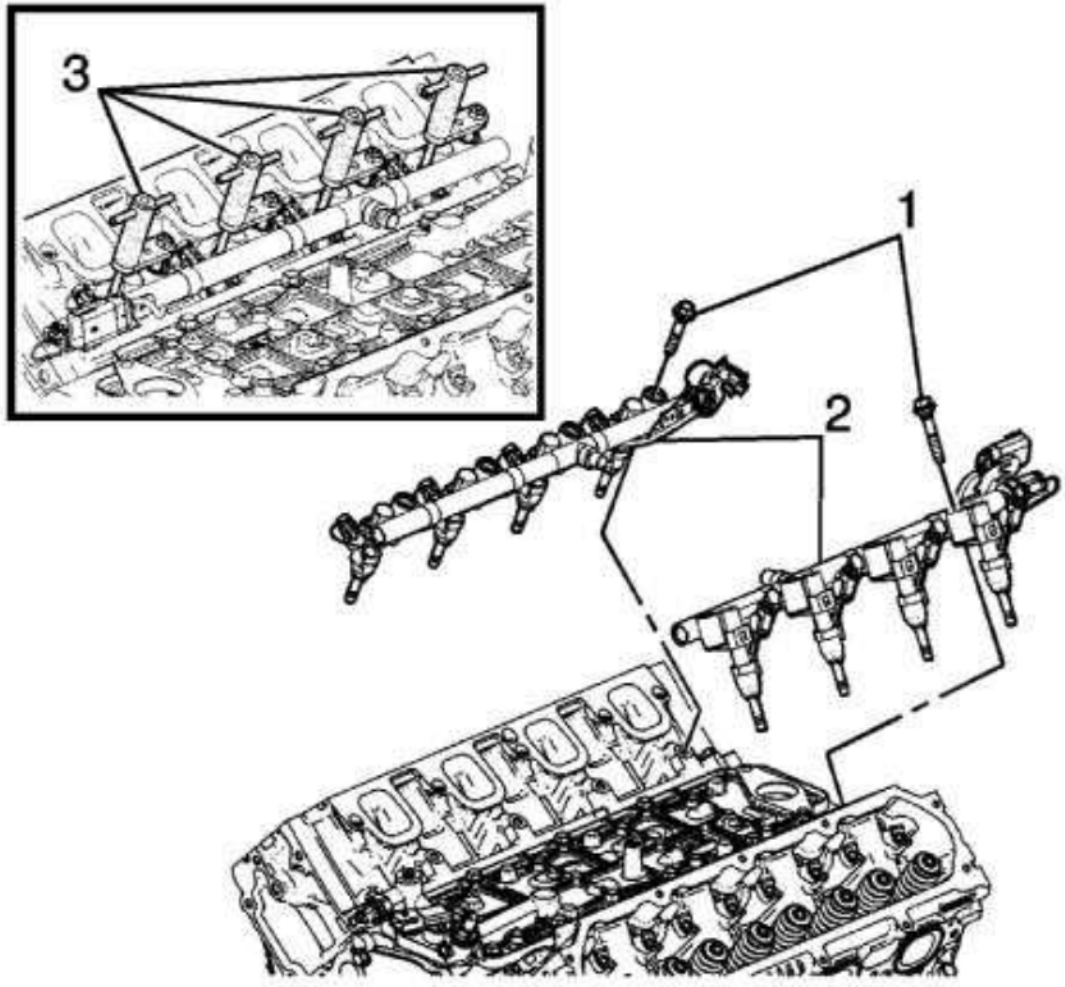


Fig. 121: Two Sets Of Remover
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **In some cases, the fuel injectors may be difficult to remove because of heavy carbon build-up or other factors. Excessive force with the removal tool can damage the fuel rail, injectors or both. If injectors are difficult to remove, apply solvent to the base of the injector bores, and allow adequate soaking time, to loosen the fuel injectors.**

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- **Pull the fuel rail and injectors as an assembly.**
- **To prevent material from entering the combustions chambers make sure the area around each injector is clean and free of debris before the injectors are removed from the injector bores.**

7. Install two sets of EN-49248 remover (3).
    1. Install one remover in each of the fuel rail fastener bores.
    2. Remove by turning each section of the EN-49248 remover an even amount to pull the fuel rail and injectors out evenly.

CAUTION:

- **Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.**
- **Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.**

    3. Simultaneously lift both ends of the fuel rail (2) and remove the fuel rail assembly from the cylinder head.
8. Remove and DISCARD the fuel injector seals.

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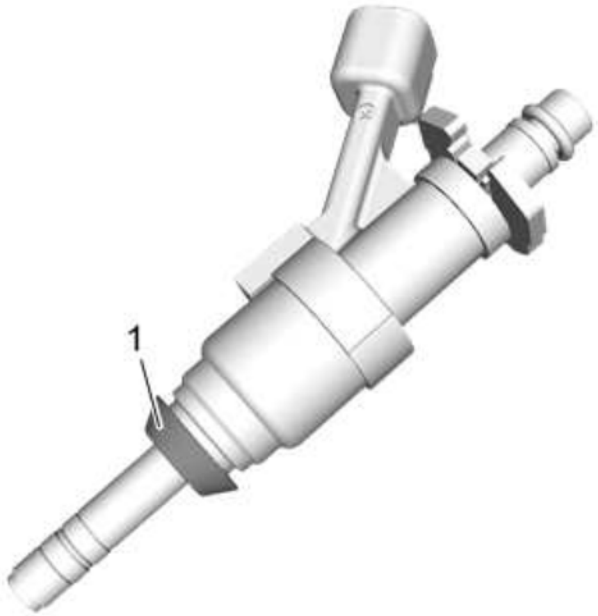


Fig. 122: Fuel Injector Dust Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Some vehicles were not originally equipped with fuel injector dust seals. A NEW seal must be installed when the injectors are removed.**

9. Remove and DISCARD the fuel injector dust seal (1).

NOTE: **Whenever the fuel injectors are removed from the cylinder head or fuel rail, they will need to be rebuilt. Fuel Rail and Injectors Cleaning and Inspection**

10. If replacing the fuel injection fuel rail, remove the fuel injectors. **Fuel Injector Replacement**

Installation Procedure

NOTE: **The injector seals should be clean and free of debris prior to installation.**

1. Inspect the fuel injection fuel rail insulators and replace if necessary.

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2. If replacing the fuel injection fuel rail, install the fuel injectors. **Fuel Injector Replacement**

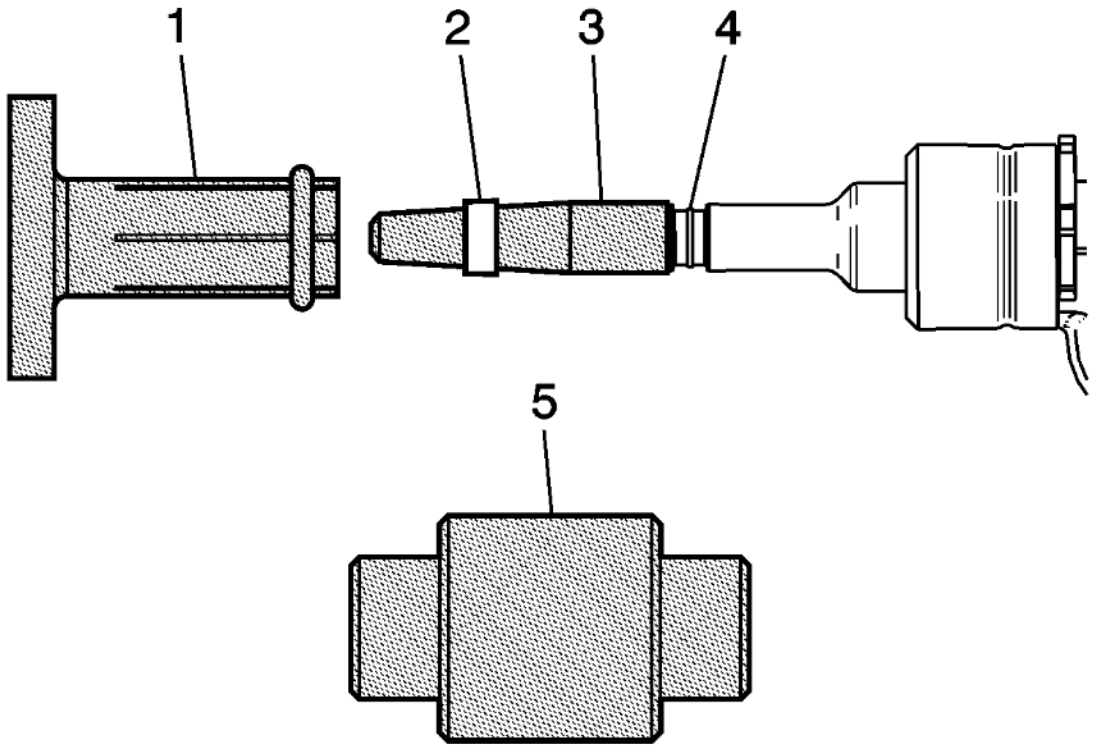


Fig. 123: Identifying Fuel Injector Tip & Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT use any type of lubricant when installing the NEW seals (2) on the fuel injector.**

3. Install EN-51105-1 long protector (3) onto the fuel injector tip, covering the first recessed area closest to the tip. Place a new seal (2) on the

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EN-51105-1 long protector.

1. Using EN-49245-3 pusher (1), install the seal onto the second recessed area (4) of the fuel injector.

NOTE: **The EN-49245-4 is two sided, and either direction will size the seal correctly.**

2. Compress the seal with your fingers, then resize the seal using the EN-49245-4 sizer (5).

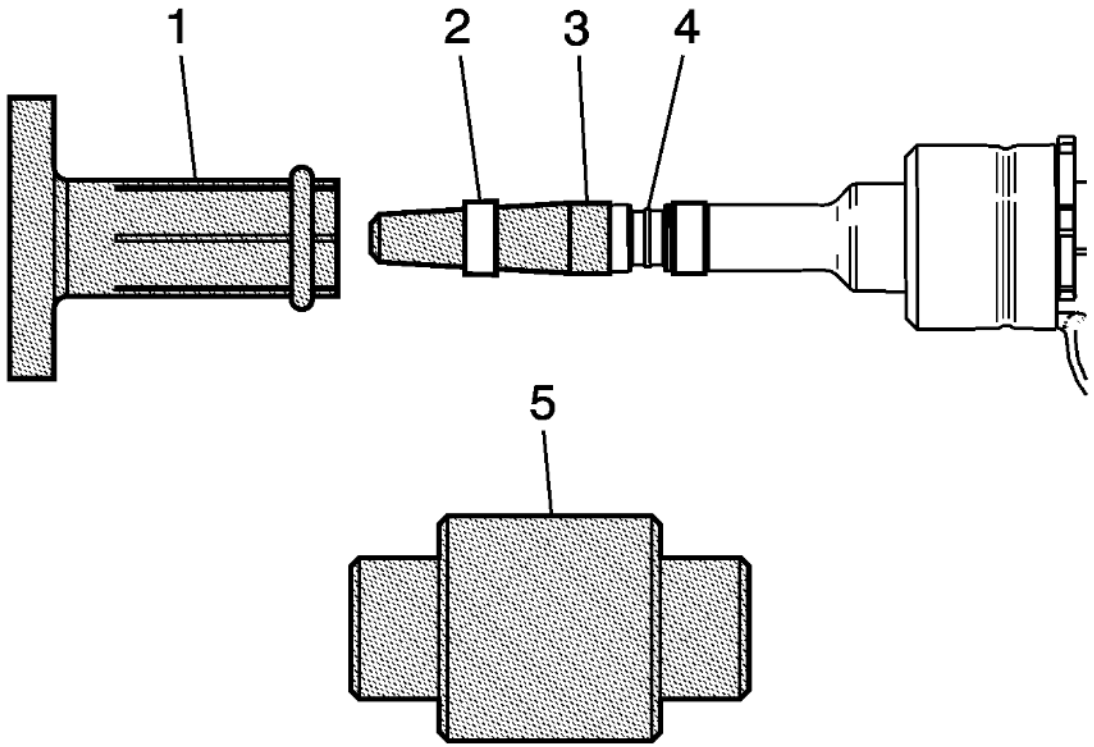


Fig. 124: Identifying Fuel Injector Tip & Seals

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Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT use any type of lubricant when installing NEW seals (2) on the injector.

4. Install EN-51105-2 short protector (3) onto the fuel injector tip. Place a NEW seal (2) on EN-51105-2 short protector.
   1. Using EN-49245-3 pusher (1), install the seal onto the first recessed area (4) of the fuel injector.

      NOTE: The EN-49245-4 is two sided, and either direction will size the seal correctly.

   2. Compress the seal with your fingers, then resize the seal using the EN-49245-4 sizer (5).

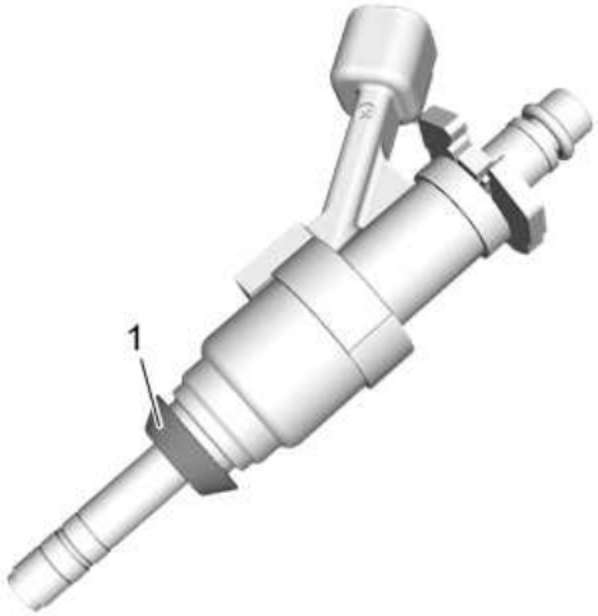


Fig. 125: Fuel Injector Dust Seal
Courtesy of GENERAL MOTORS COMPANY

5. Install the NEW fuel injector dust seal (1).

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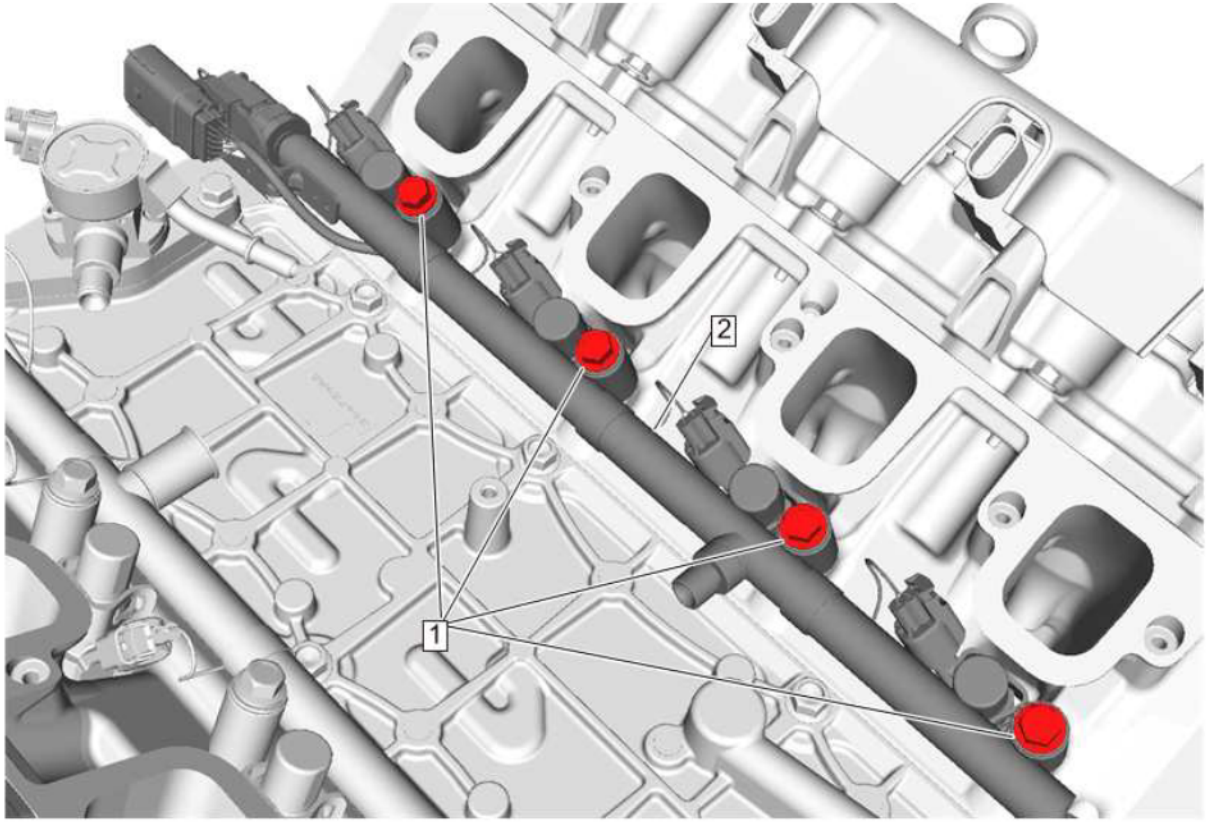


Fig. 126: Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The fuel rail fasteners are retained into the rails using keepers. Care should be taken to ensure that the threadlock is installed after the fasteners are installed in their bore.**

6. Install the fuel rail fasteners (1) into the fuel rail (2).
    1. Apply a 0.5 mm (0.02 in) band of GM approved threadlock to the threads of the fuel rail fasteners (1).

    NOTE: **Start the fuel rail fasteners by hand then draw the injector rail down evenly prior to tightening.**

    2. Install the fuel injection fuel rail assembly (2) to the cylinder head.

    CAUTION: **Refer to Fastener Caution .**

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3. Tighten to the fuel rail fasteners to 25 N.m (18 lb ft).

7. If removed, install the fuel injection fuel rail pressure sensor. **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**
8. Connect the electrical wiring harness connectors to the fuel rail.
9. Install the NEW fuel injector intermediate pipe position 1. **Fuel Feed Intermediate Pipe Replacement - Position 1**
10. Install the fuel pump insulator. **Fuel Pump Insulator Replacement**

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2

Special Tools

- EN-49245-3 Fuel injection seal Installer Sizer
- EN-49245-4 Fuel injection seal Installer Sizer
- EN-49248 Injector Rail Assembly Remover
- EN-51105 Injector Seal Installer Adapters

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

Removal Procedure

1. Relieve the fuel pressure. Refer to **Fuel Pressure Relief**.

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.**

2. Remove the fuel pump insulator. Refer to **Fuel Pump Insulator Replacement**.
3. Remove the fuel injector intermediate pipe position 1. Refer to **Fuel Feed Intermediate Pipe Replacement - Position 1**.
4. Clean the cylinder head pocket around the injectors of any dirt or buildup.
5. Disconnect the electrical wiring harness connectors from the fuel rail.

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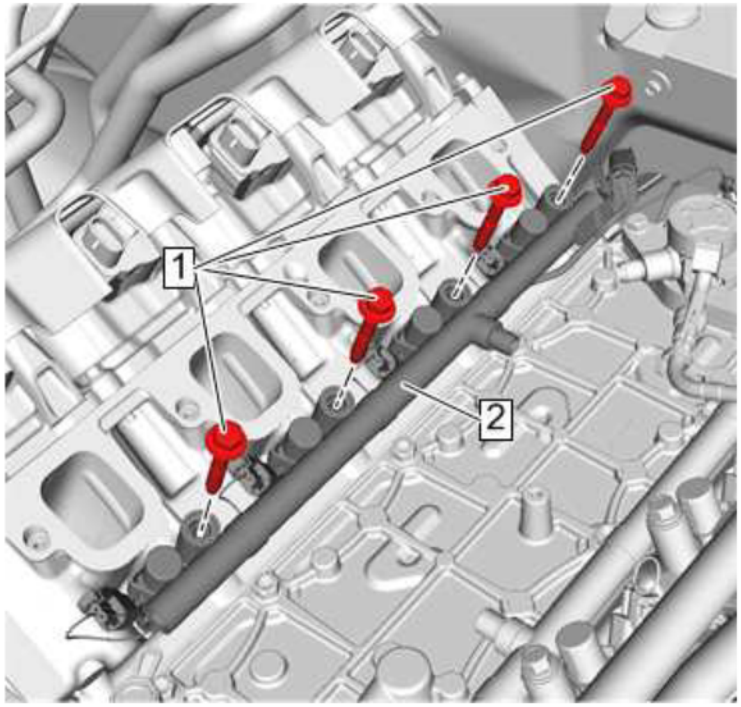


Fig. 127: Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The fuel rail fasteners are retained in the fuel rail by keepers and may be difficult to remove.**

6. Remove the fuel rail fasteners (1) securing the injector rail (2).

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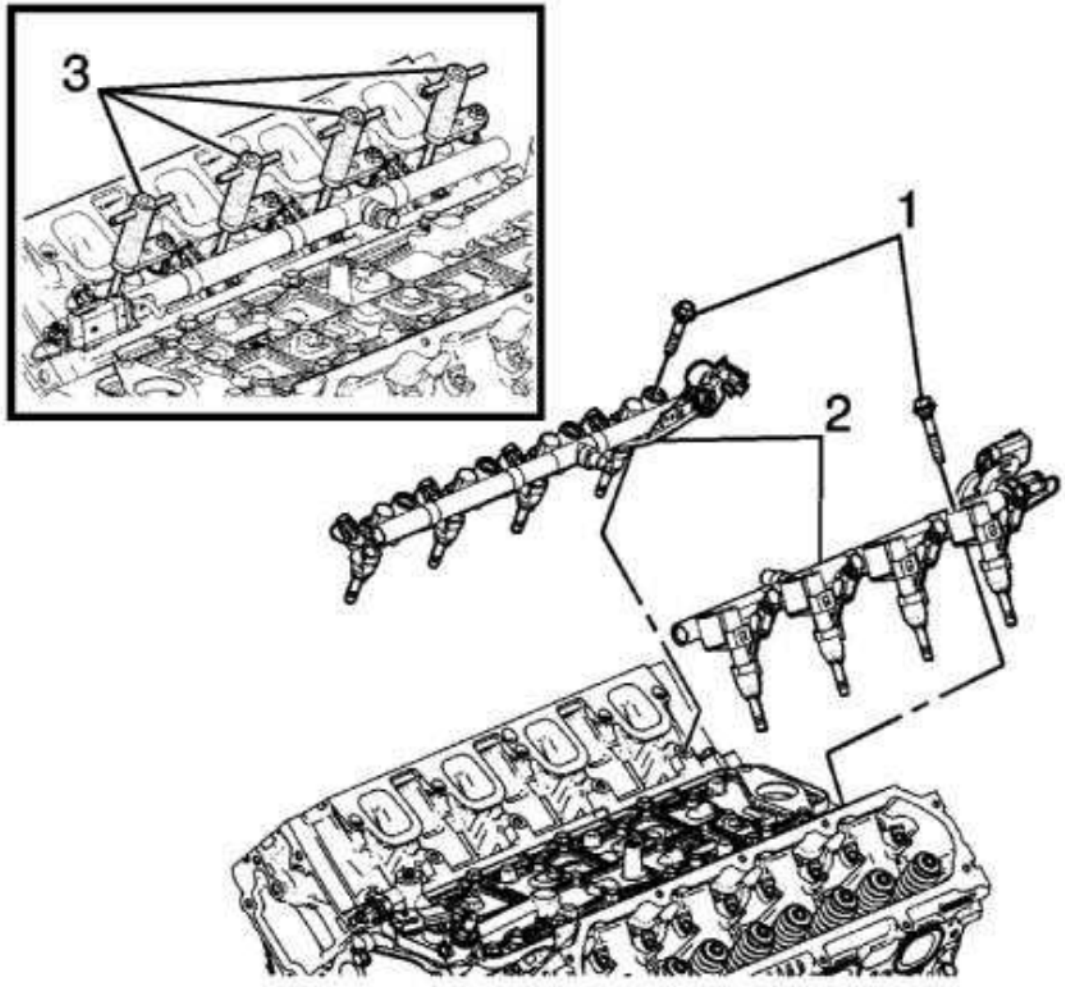


Fig. 128: Two Sets Of Remover
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **In some cases, the fuel injectors may be difficult to remove because of heavy carbon build-up or other factors. Excessive force with the removal tool can damage the fuel rail, injectors or both. If injectors are difficult to remove, apply solvent to the base of the injector bores, and allow adequate soaking time, to loosen the fuel injectors.**

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- **Pull the fuel rail and injectors as an assembly.**
- **To prevent material from entering the combustions chambers make sure the area around each injector is clean and free of debris before the injectors are removed from the injector bores.**

7. Install two sets of EN-49248 remover (3).
    1. Install one remover in each of the fuel rail fastener bores.
    2. Remove by turning each section of the EN-49248 remover an even amount to pull the fuel rail and injectors out evenly.

CAUTION:

- **Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.**
- **Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.**

    3. Simultaneously lift both ends of the fuel rail (2) and remove the fuel rail assembly from the cylinder head.
8. Remove and DISCARD the fuel injector seals.

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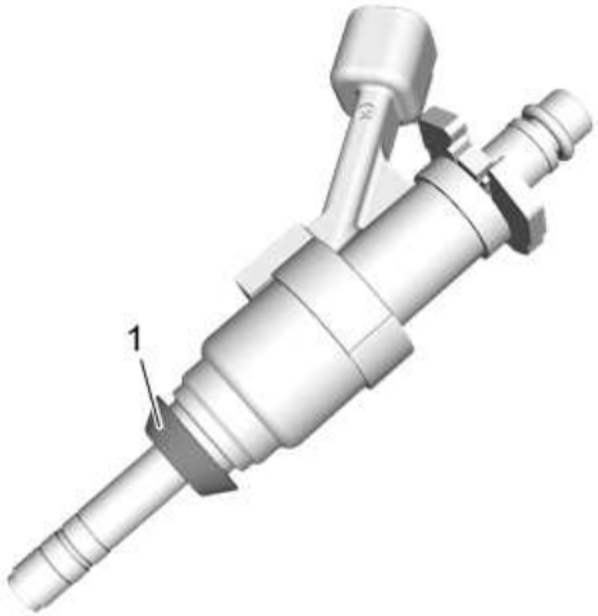


Fig. 129: Fuel Injector Dust Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Some vehicles were not originally equipped with fuel injector dust seals. A NEW seal must be installed when the injectors are removed.**

9. Remove and DISCARD the fuel injector dust seal (1).

NOTE: **Whenever the fuel injectors are removed from the cylinder head or fuel rail, they will need to be rebuilt. Refer to Fuel Rail and Injectors Cleaning and Inspection .**

10. If replacing the fuel injection fuel rail, remove the fuel injectors. Refer to **Fuel Injector Replacement**.

Installation Procedure

NOTE: **The injector seals should be clean and free of debris prior to installation.**

1. Inspect the fuel injection fuel rail insulators and replace if necessary.

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2. If replacing the fuel injection fuel rail, install the fuel injectors. Refer to **Fuel Injector Replacement**.

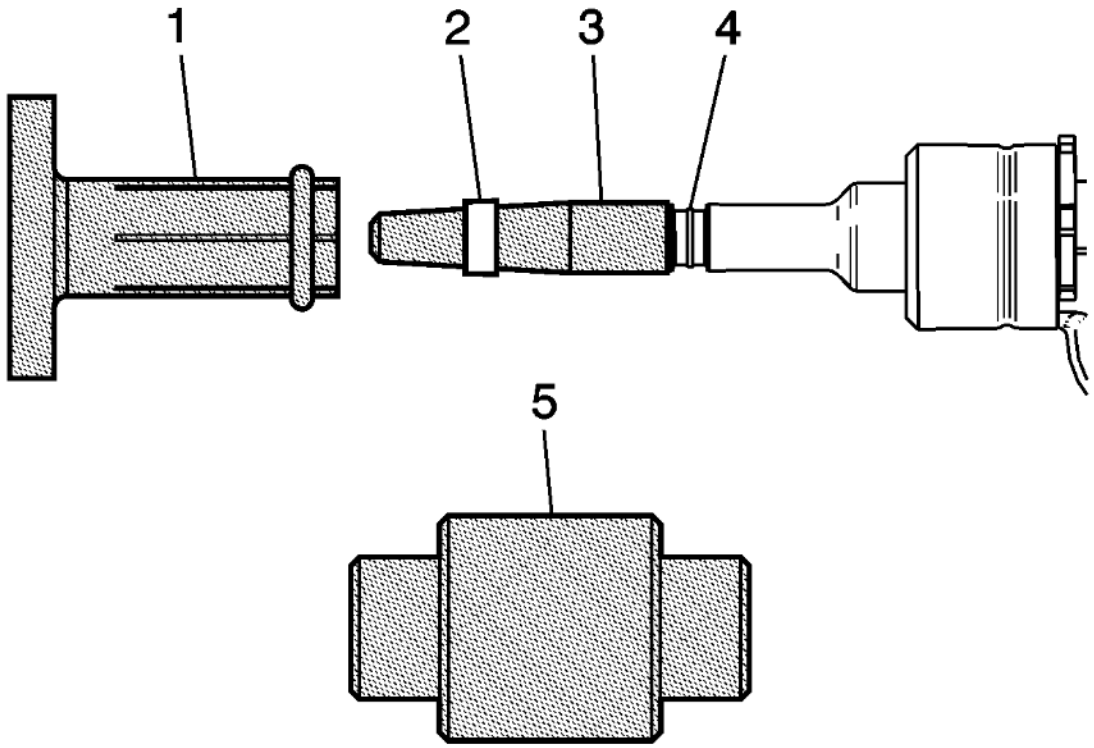


Fig. 130: Identifying Fuel Injector Tip & Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT use any type of lubricant when installing the NEW seals (2) on the fuel injector.**

3. Install EN-51105-1 long protector (3) onto the fuel injector tip, covering the first recessed area closest to the tip. Place a new seal (2) on the

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EN-51105-1 long protector.

1. Using EN-49245-3 pusher (1), install the seal onto the second recessed area (4) of the fuel injector.

NOTE: **The EN-49245-4 is two sided, and either direction will size the seal correctly.**

2. Compress the seal with your fingers, then resize the seal using the EN-49245-4 sizer (5).

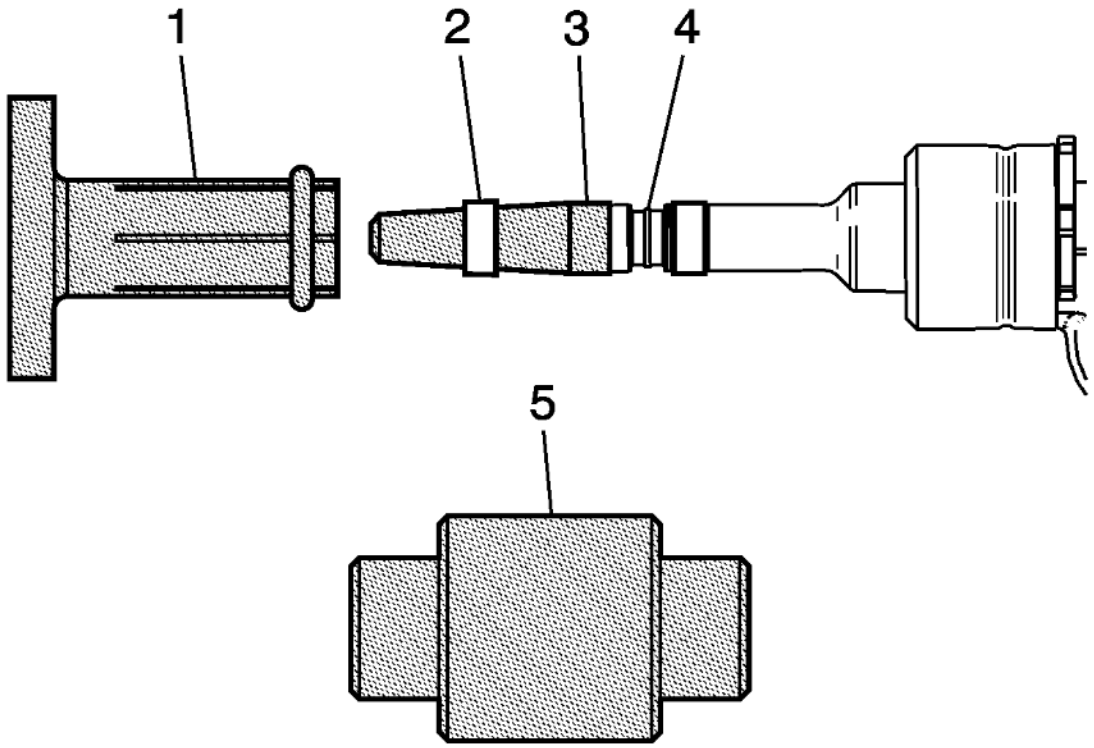


Fig. 131: Identifying Fuel Injector Tip & Seals

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Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT use any type of lubricant when installing NEW seals (2) on the injector.

4. Install EN-51105-2 short protector (3) onto the fuel injector tip. Place a NEW seal (2) on EN-51105-2 short protector.
   1. Using EN-49245-3 pusher (1), install the seal onto the first recessed area (4) of the fuel injector.

      NOTE: The EN-49245-4 is two sided, and either direction will size the seal correctly.

   2. Compress the seal with your fingers, then resize the seal using the EN-49245-4 sizer (5).

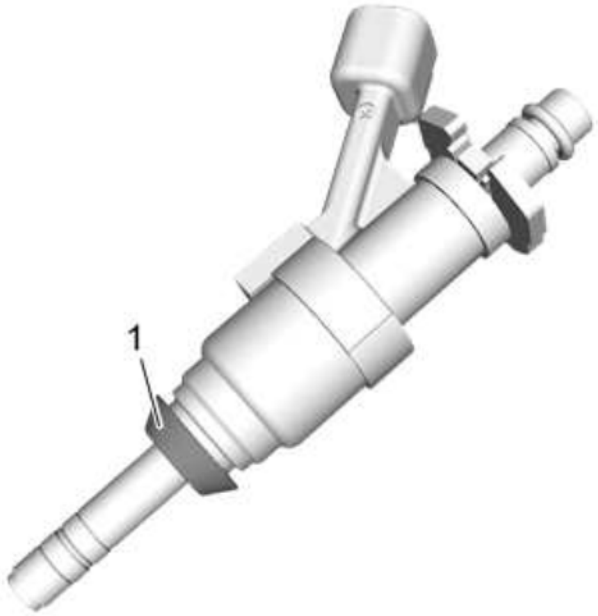


Fig. 132: Fuel Injector Dust Seal
Courtesy of GENERAL MOTORS COMPANY

5. Install the NEW fuel injector dust seal (1).

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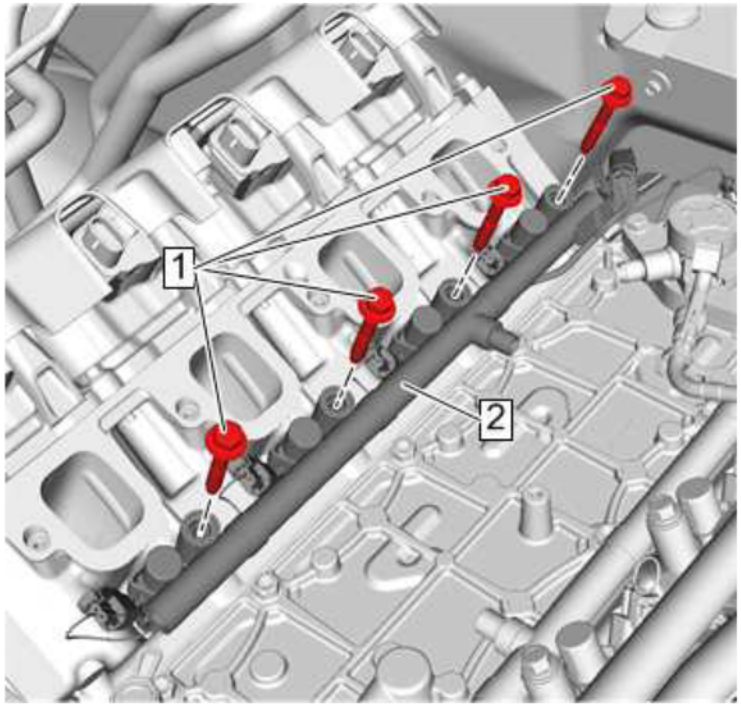


Fig. 133: Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The fuel rail fasteners are retained into the rails using keepers. Care should be taken to ensure that the threadlock is installed after the fasteners are installed in their bore.**

6. Install the fuel rail fasteners (1) into the fuel rail (2).
    1. Apply a 0.5 mm (0.02 in) band of GM approved threadlock to the threads of the fuel rail fasteners (1).
    2. Install the fuel injection fuel rail assembly (2) to the cylinder head.

        NOTE: **Start the fuel rail fasteners by hand then draw the injector rail down evenly prior to tightening.**

        CAUTION: **Refer to Fastener Caution .**

    3. Tighten to the fuel rail fasteners to 25 N.m (18 lb ft).
7. Connect the electrical wiring harness connectors to the fuel rail.

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8. Install the NEW fuel injector intermediate pipe position 1. Refer to **Fuel Feed Intermediate Pipe Replacement - Position 1**.
9. Install the fuel pump insulator. Refer to **Fuel Pump Insulator Replacement**.

FUEL INJECTION FUEL RAIL FUEL PRESSURE SENSOR REPLACEMENT

Removal Procedure

1. Relieve the fuel system pressure **Fuel Pressure Relief**.
2. Remove Fuel Pump Insulator **Fuel Pump Insulator Replacement**

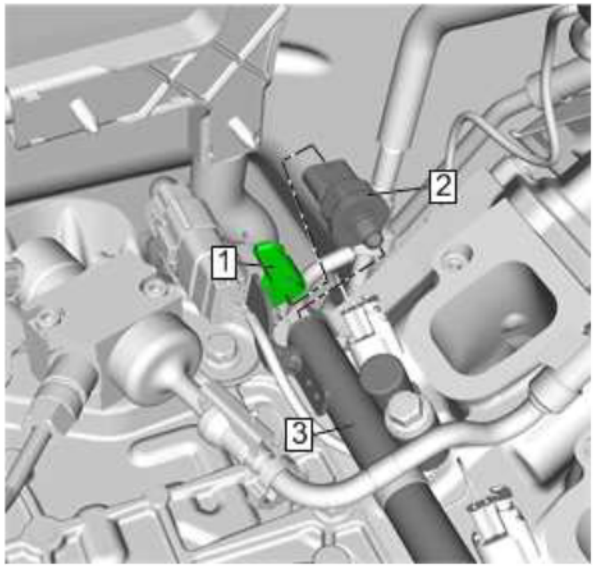


Fig. 134: Fuel Rail Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .**

NOTE: **Applying force to the plastic housing of the sensor may damage the sensor. To tighten or loosen, apply force only to the attached hexagon.**

3. Disconnect Electrical Connector (1) @Fuel Injection Fuel Rail Fuel Pressure Sensor (2)

NOTE: **Some fuel may leak from the fuel injection fuel rail fuel pressure sensor orifice after the sensor is**

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removed. Dry the area around this orifice after the removal of the sensor using a lint free cloth and inspect the fuel injection fuel rail fuel pressure sensor sealing surface. The surface should be free of fuel, debris, and burrs.

4. Remove Fuel Injection Fuel Rail Fuel Pressure Sensor (2) @Fuel Injection Fuel Rail (3) and DISCARD

Installation Procedure

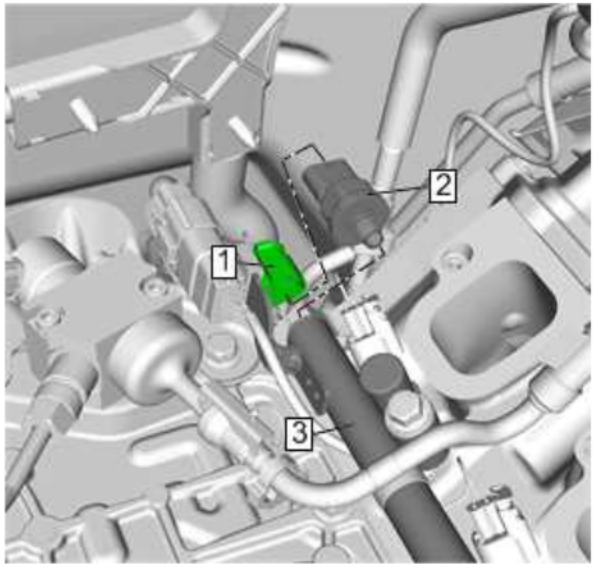


Fig. 135: Fuel Rail Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Applying force to the plastic housing of the sensor may damage the sensor. To tighten or loosen, apply force only to the attached hexagon.**

NOTE: **Ensure the fuel rail threads are clean and free of any excess fuel, or the fuel injection fuel rail fuel pressure sensor will NOT seal properly.**

1. Lubricate the threads and sealing surface of the NEW fuel injection fuel rail fuel pressure sensor with one drop of clean engine oil.
2. Install the NEW fuel injection fuel rail fuel pressure sensor (2) and hand tighten.
3. Remove Fuel Injection Fuel Rail Fuel Pressure Sensor (2) @Fuel Injection Fuel Rail (3) and re-lubricate with one drop of clean engine oil.

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CAUTION: **Refer to Component Fastener Tightening Caution .**

4. Install Fuel Injection Fuel Rail Fuel Pressure Sensor (2) @Fuel Injection Fuel Rail (3) and tighten 33 N.m (24 lb ft)
5. Connect Electrical Connector (1) @Fuel Injection Fuel Rail Fuel Pressure Sensor (2).

NOTE: **If a fuel leak occurs at the fuel rail, the fuel rail will need to be replaced.**

6. Pressurize the fuel system and inspect for leaks.
7. Install Fuel Pump Insulator **Fuel Pump Insulator Replacement**

FUEL FEED INTERMEDIATE PIPE REPLACEMENT - POSITION 1

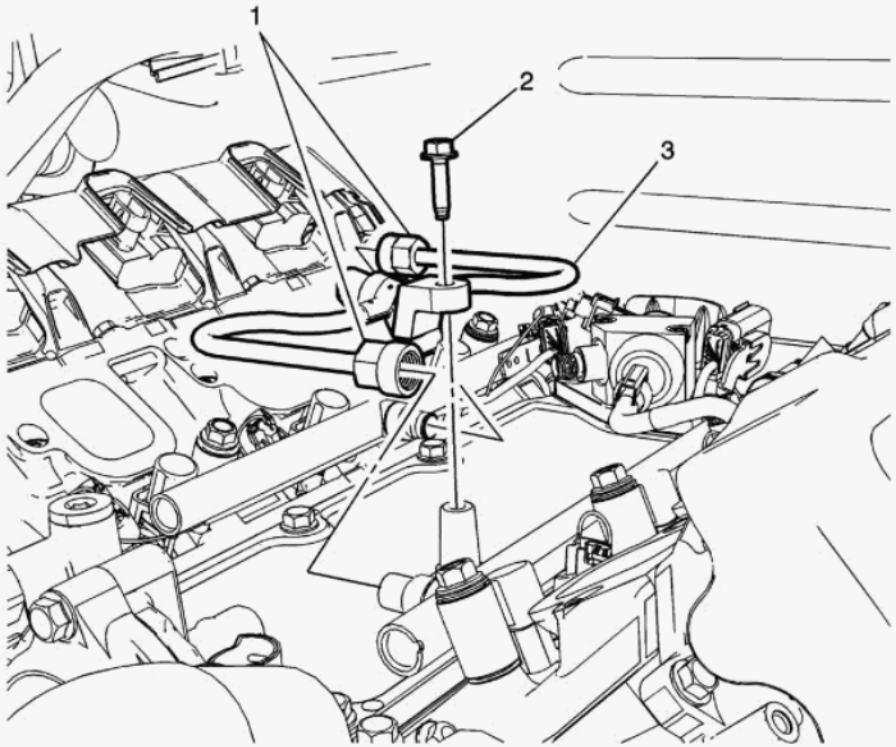


Fig. 136: Fuel Feed Intermediate Pipe - Position 1
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Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**. 2. Remove the fuel pump insulator. Refer to **Fuel Pump Insulator Replacement**. 3. Remove the fuel feed intermediate pipe position 2. Refer to **Fuel Feed Intermediate Pipe Replacement - Position 2**.	
1	Fuel Feed Intermediate Pipe Fitting (Qty:2) **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten** 28 N.m (21 lb ft)
2	Fuel Feed Intermediate Pipe Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
3	Fuel Feed Intermediate Pipe Position 1 **Procedure** 1. DISCARD the old fuel feed pipe and install a NEW fuel feed pipe. 2. Ensure that the high pressure fuel pipe, and fuel rail fittings are clean and dry prior to assembly.

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Callout	Component Name
	3. Pressure up the fuel system and check for leaks.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT - POSITION 2

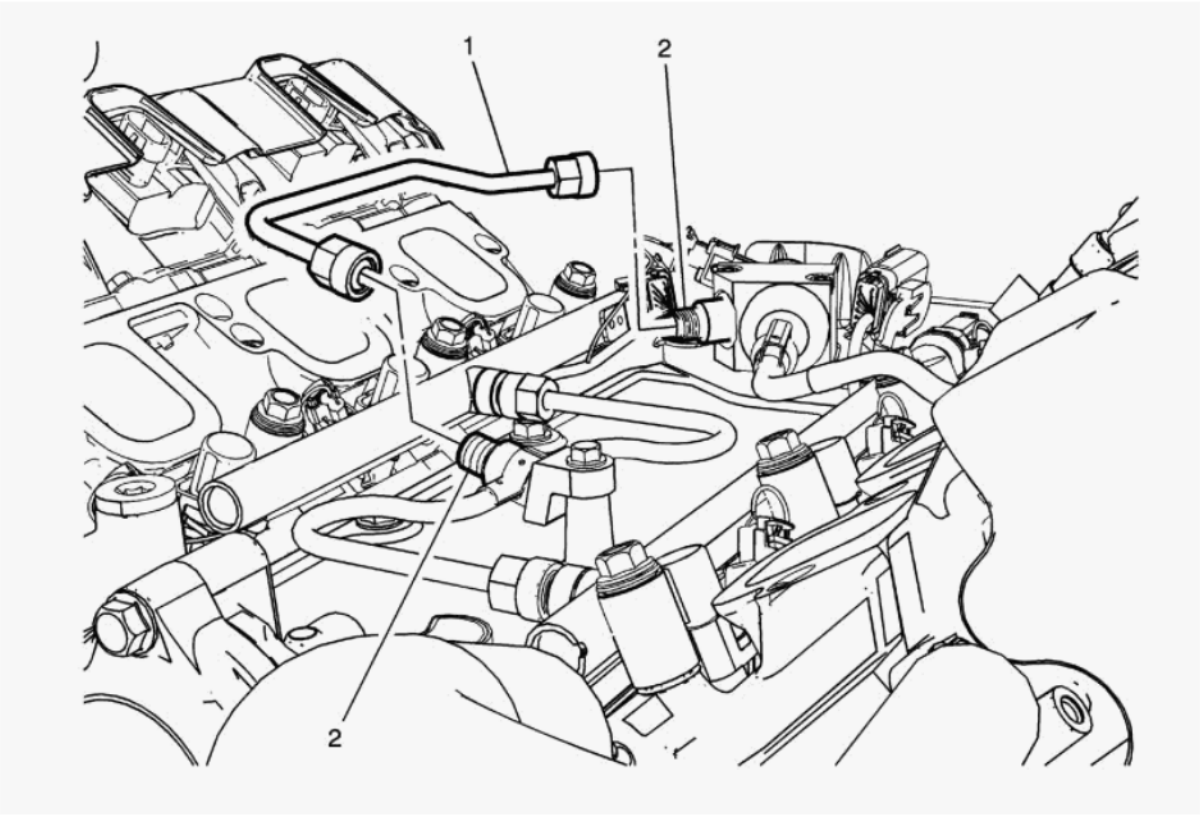


Fig. 137: Fuel Feed Intermediate Pipe - Position 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**. 2. Remove the fuel pump insulator. Refer to **Fuel Pump Insulator Replacement**.	

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Callout	Component Name
1	Fuel Feed Intermediate Pipe Fitting (Qty:2) **CAUTION:** **Refer to** **Component Fastener Tightening Caution .** **Tighten** 28 N.m (21 lb ft)
2	Fuel Feed Intermediate Pipe Position 2 **Procedure** 1. DISCARD the old fuel feed pipe and install a NEW fuel feed pipe. 2. Ensure that the high pressure fuel pipe, and fuel pump fittings are clean and dry prior to assembly. 3. Pressure up the fuel system and check for leaks.

FUEL INJECTOR REPLACEMENT

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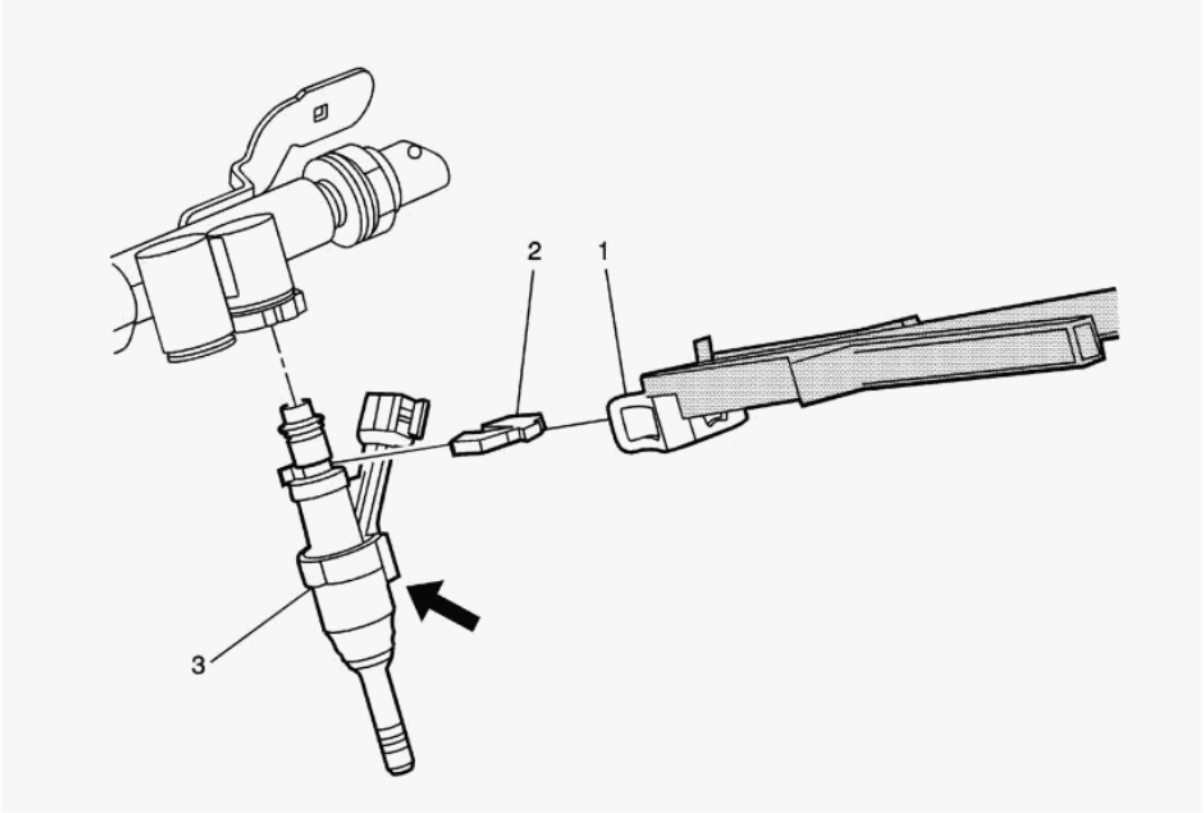


Fig. 138: Fuel Injector
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the fuel rail. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1**, and/or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**. **Special Tools** **EN-51097** Injector Retaining Clip Installer For equivalent regional tools. Refer to **Special Tools** .	
1	Fuel Injector Retainer **Procedure** Remove and discard the fuel injector retainer clips by installing EN-51097 injector retaining clip installer and spreading both sides of the clip evenly.

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Callout	Component Name
2	Fuel Injector Collars **NOTE:** **Always use NEW fuel injector collars supplied with injector when installing the new injector. If reinstalling the injector, it is not necessary to remove the collars unless the collars are being replaced.**
3	Fuel Injector **Procedure** Replace the injector seals as needed. Refer to **Fuel Rail and Injectors Cleaning and Inspection** . **NOTE:** **Inspect the injectors to be sure that they are clean and free of debris prior**

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Callout	Component Name
	to installation. Do NOT lubricate the injector seals. Rebuild the fuel injectors whenever the injector has been removed from the fuel injector rail.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

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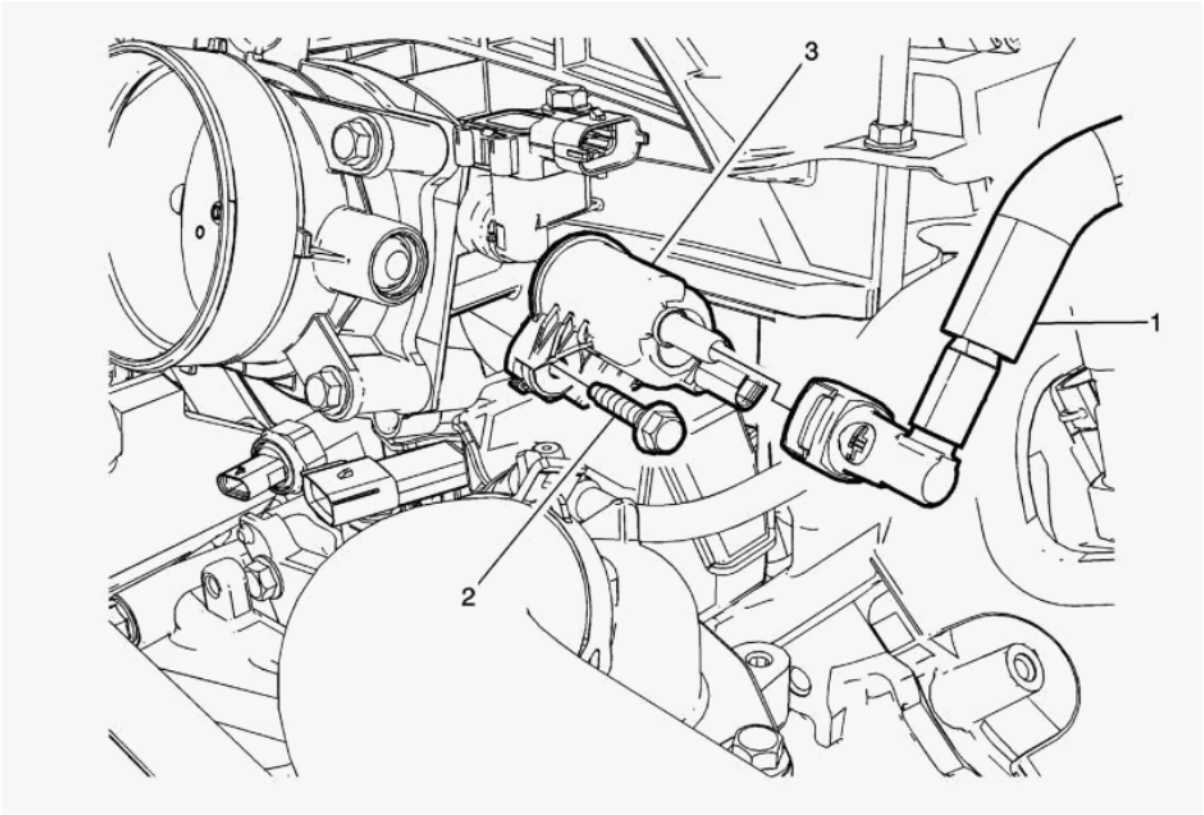


Fig. 139: Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure **Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement (Chevrolet and GMC)Air Cleaner Outlet Duct Replacement (Cadillac).**	
1	Evaporative Emission Canister Purge Solenoid Valve Hose

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Callout	Component Name
Preliminary Procedure **Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement (Chevrolet and GMC)Air Cleaner Outlet Duct Replacement (Cadillac).**	
2	Evaporative Emission Canister Purge Solenoid Valve Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
3	Evaporative Emission Canister Purge Solenoid Valve **Procedure** Disconnect the electrical wiring harness connector from the evaporative emission canister purge solenoid valve.

EVAPORATIVE EMISSION CANISTER PURGE TUBE REPLACEMENT

Removal Procedure

NOTE: **Clean all fuel and evaporative emission (EVAP) line connections and surrounding areas prior to disconnecting the lines in order to avoid possible fuel and/or EVAP system contamination.**

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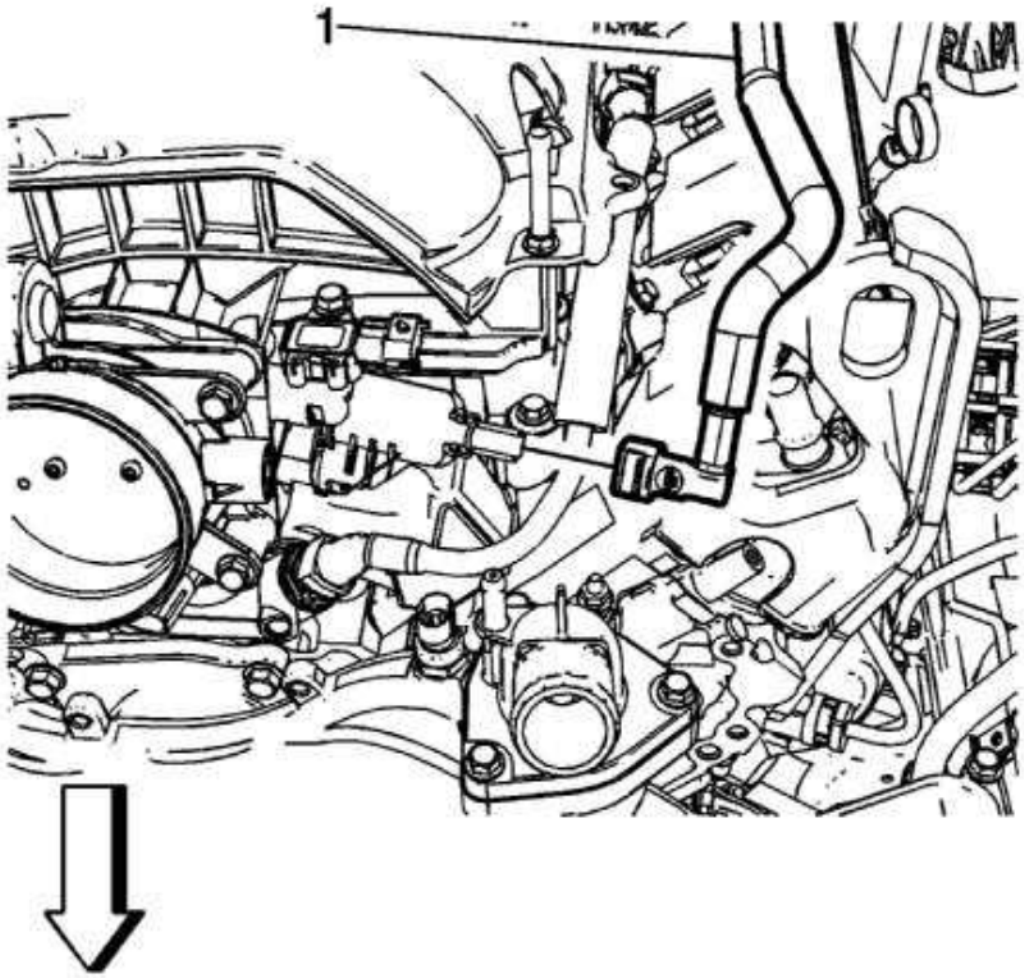


Fig. 140: EVAP Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the EVAP canister purge tube (1) from the EVAP canister solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**.

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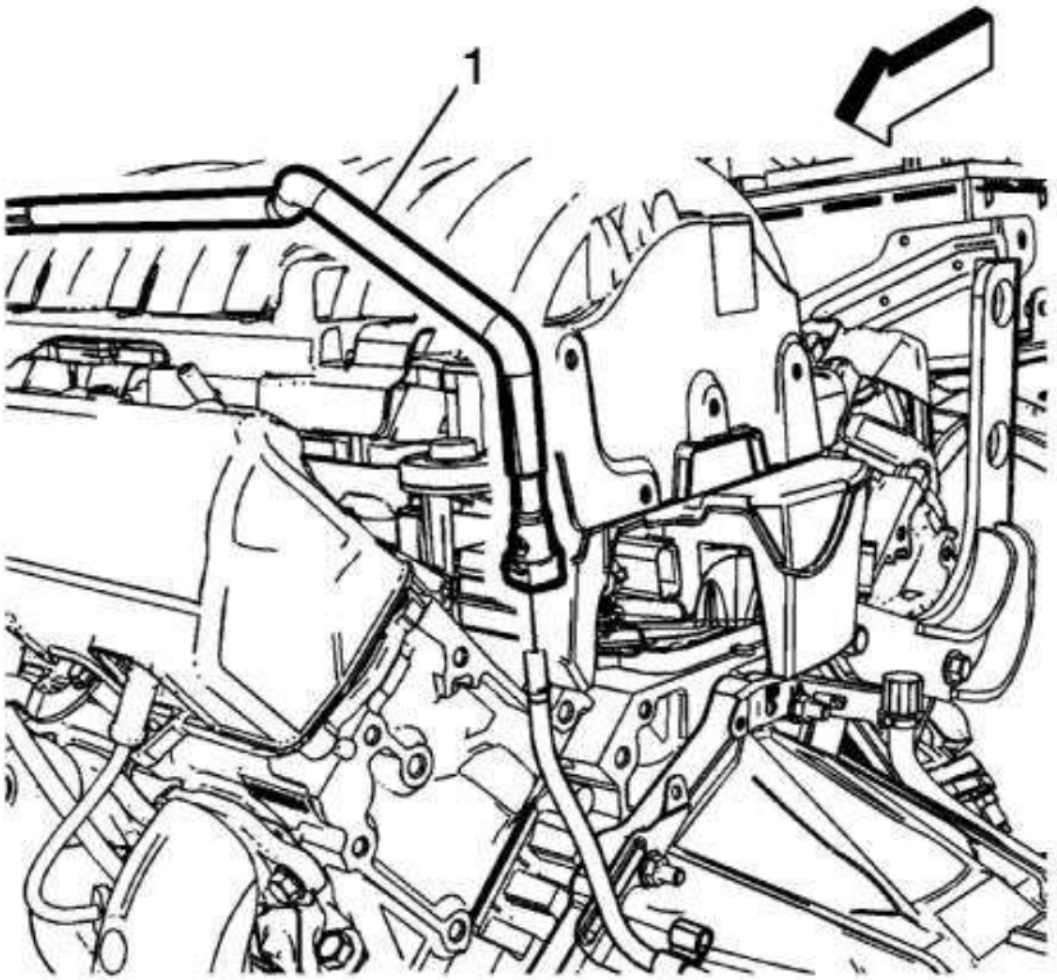


Fig. 141: EVAP Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the EVAP canister purge tube (1) from the EVAP pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Remove the EVAP canister purge tube (1) from the vehicle.

Installation Procedure

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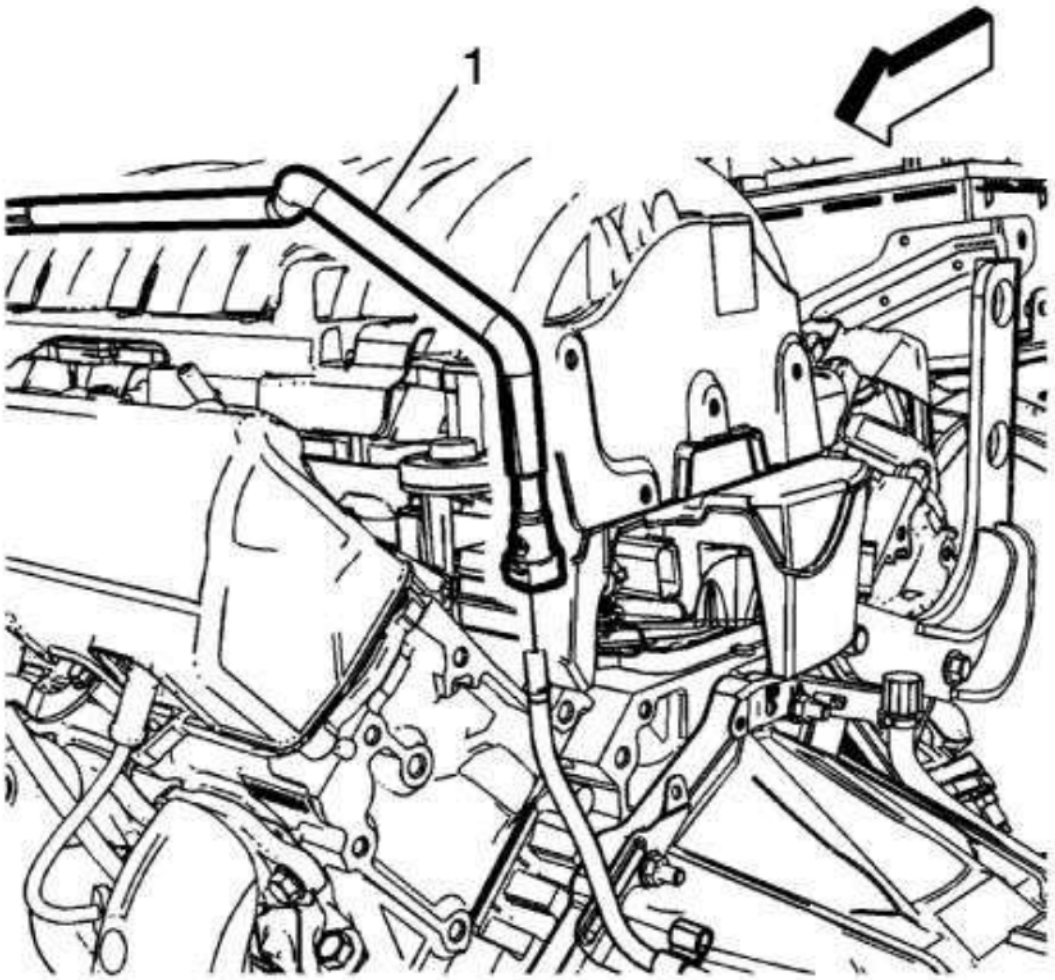


Fig. 142: EVAP Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

1. Install the EVAP canister purge tube (1) to the vehicle.
2. Connect the EVAP canister purge tube (1) to the EVAP pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.

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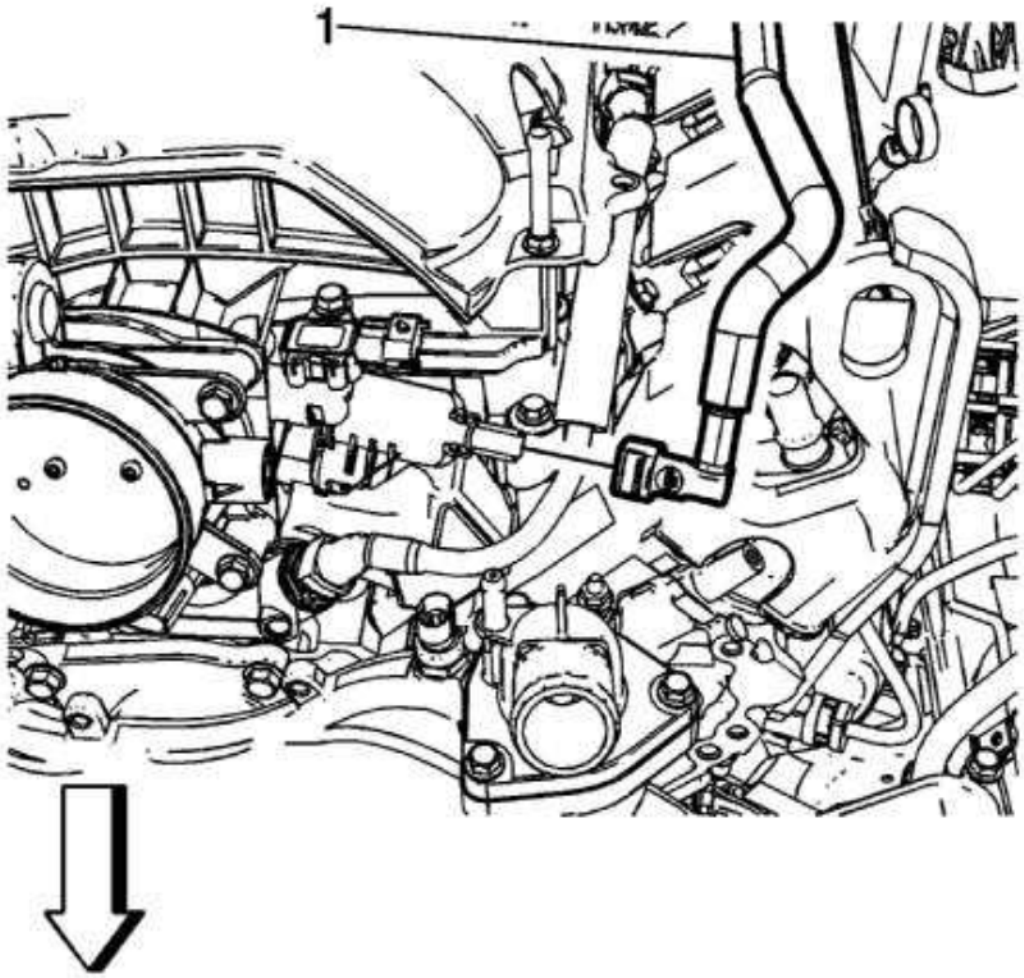


Fig. 143: EVAP Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

3. Connect the EVAP canister purge tube (1) to the EVAP canister solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**.

EVAPORATIVE EMISSION CANISTER SOLENOID REPLACEMENT

Removal Procedure

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NOTE: **Clean the evaporative emission (EVAP) connections and surrounding areas prior to disconnecting the fittings in order to avoid possible system contamination.**

1. Remove the spare tire and wheel assembly.

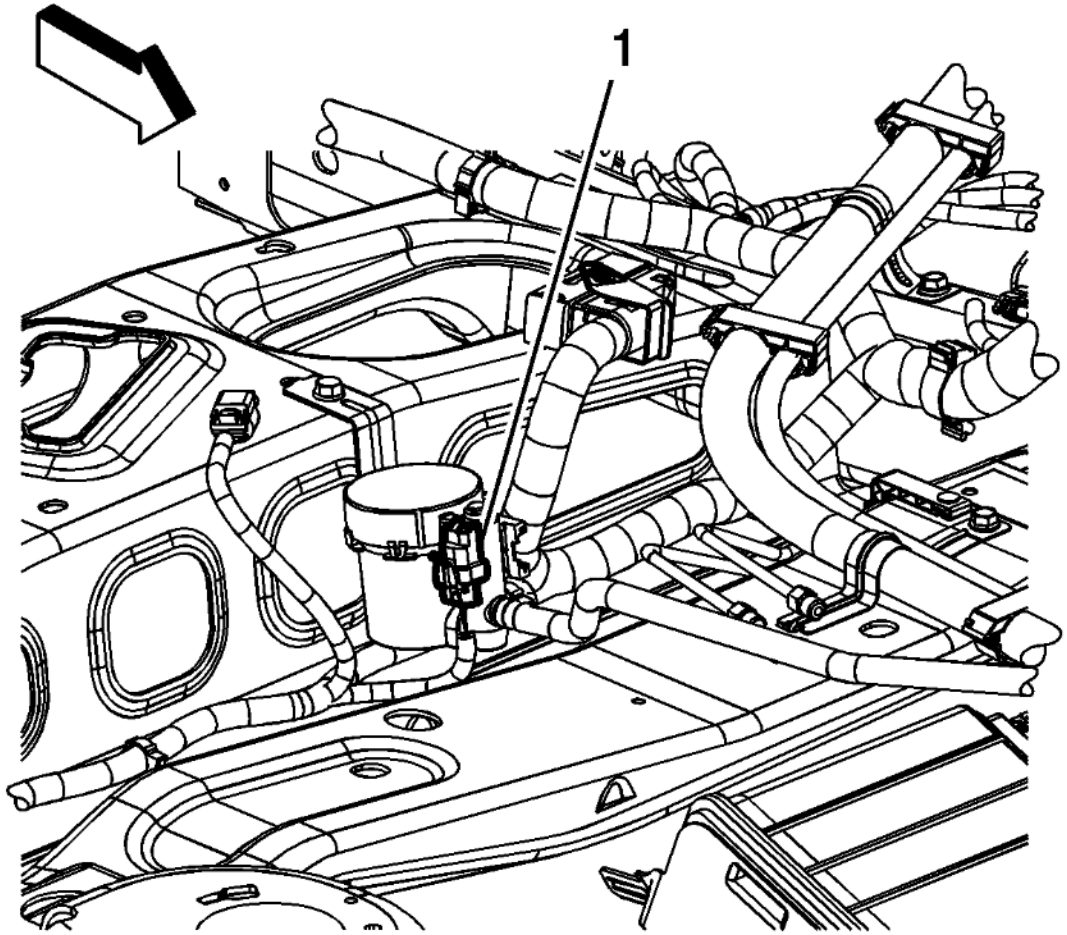


Fig. 144: View Of EVAP Canister Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

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2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Disconnect the chassis wiring harness electrical connector from the EVAP canister vent solenoid.

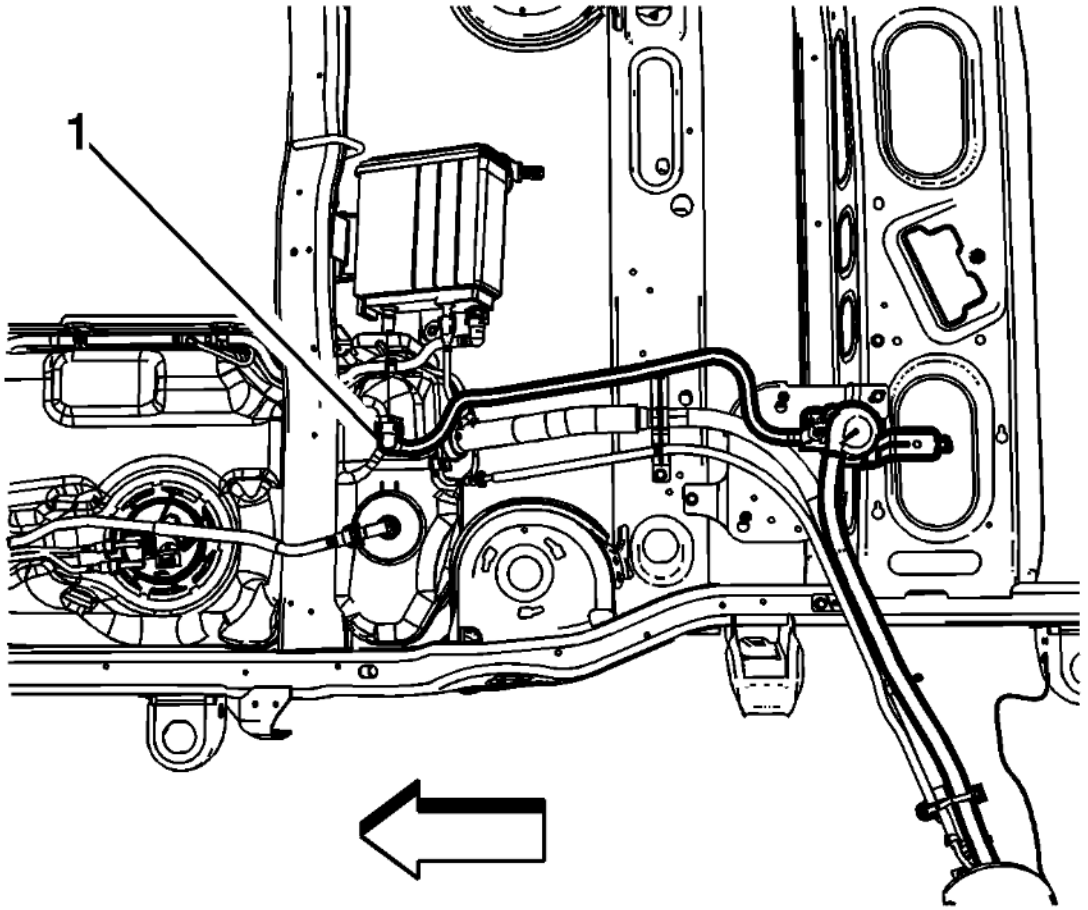


Fig. 145: EVAP Canister Vent Solenoid Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the EVAP canister vent solenoid quick connect fitting (1) from the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

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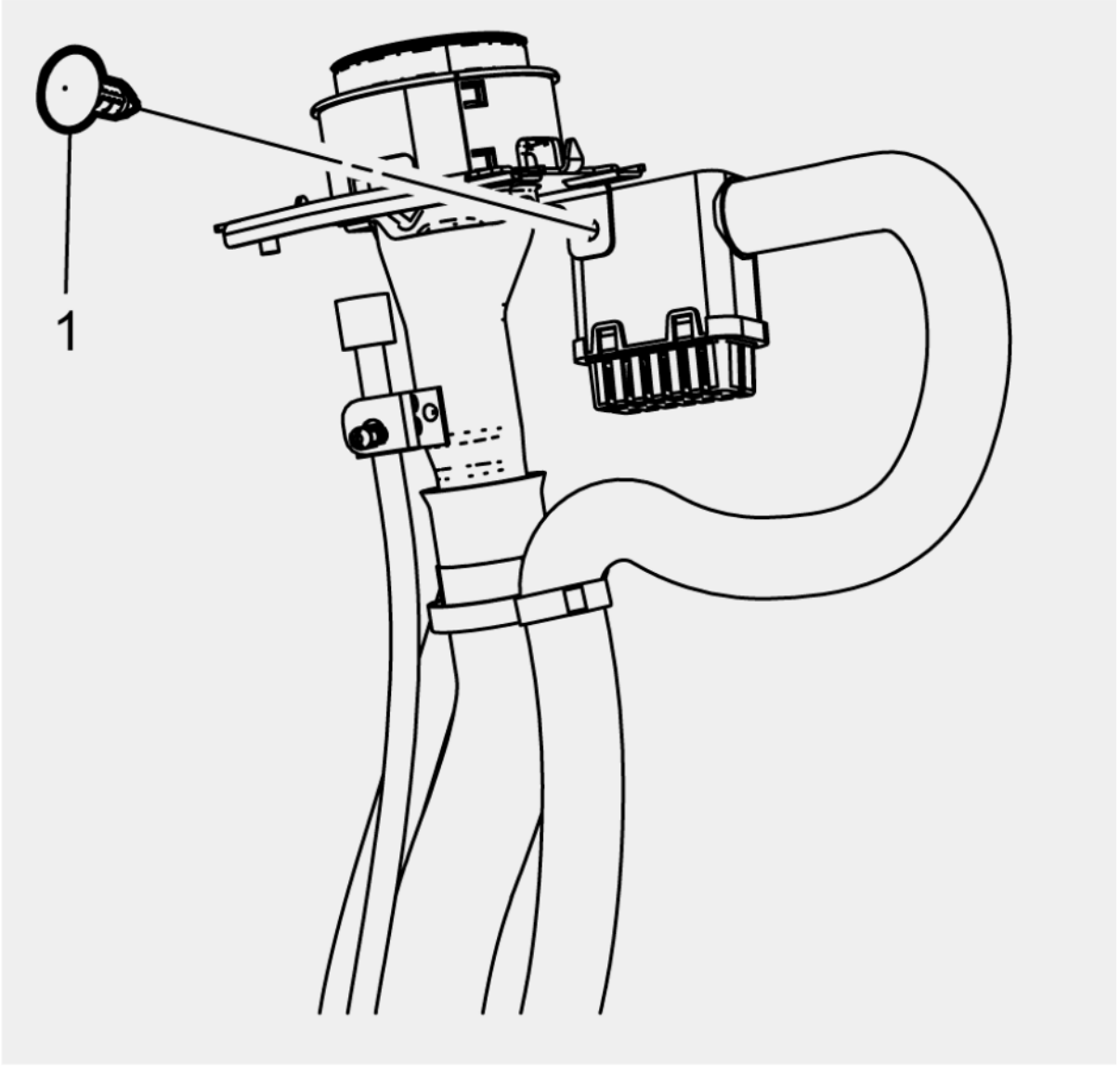


Fig. 146: Push Pin
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the solenoid vent filter from the filler pipe by removing the push pin (1).

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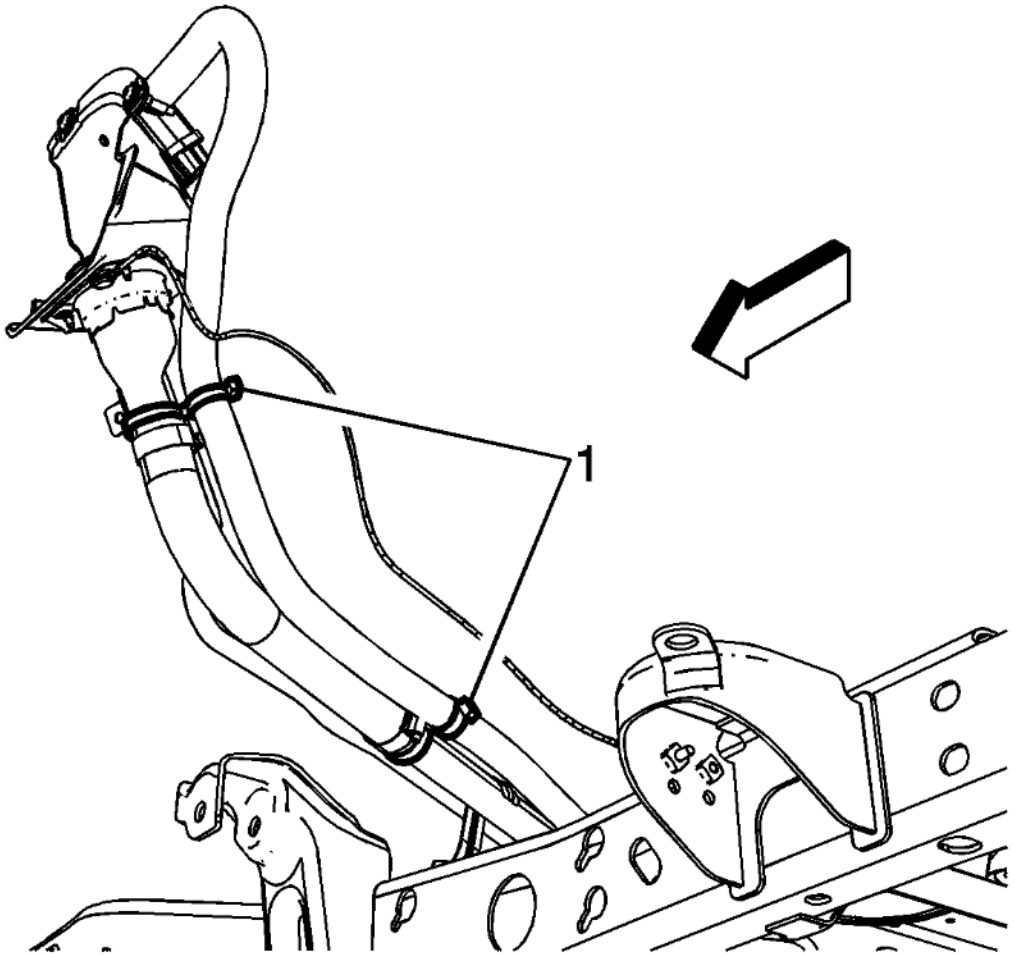


Fig. 147: 2 Tie Straps
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 2 tie straps (1) that hold the solenoid vent line to the fuel fill pipe hose.

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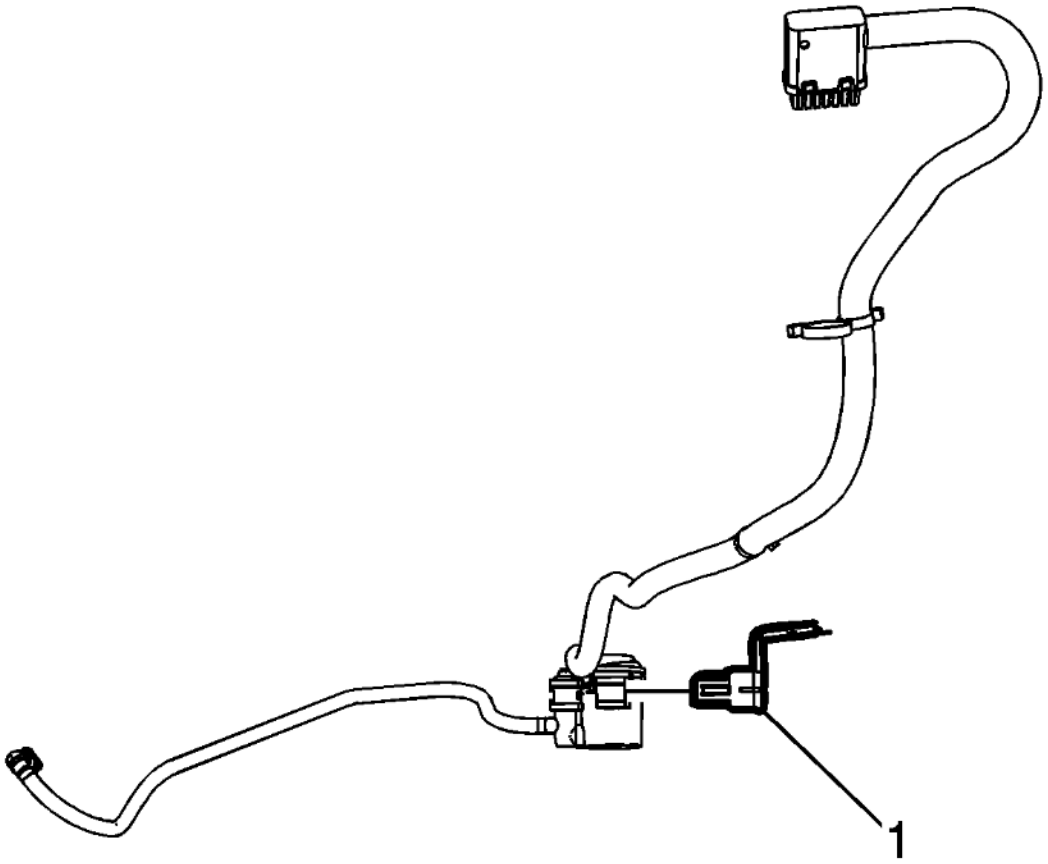


Fig. 148: EVAP Canister Vent Solenoid Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Disengage the retainer (1) securing the EVAP canister vent solenoid to the bracket.
8. Remove the EVAP canister vent solenoid assembly.

Installation Procedure

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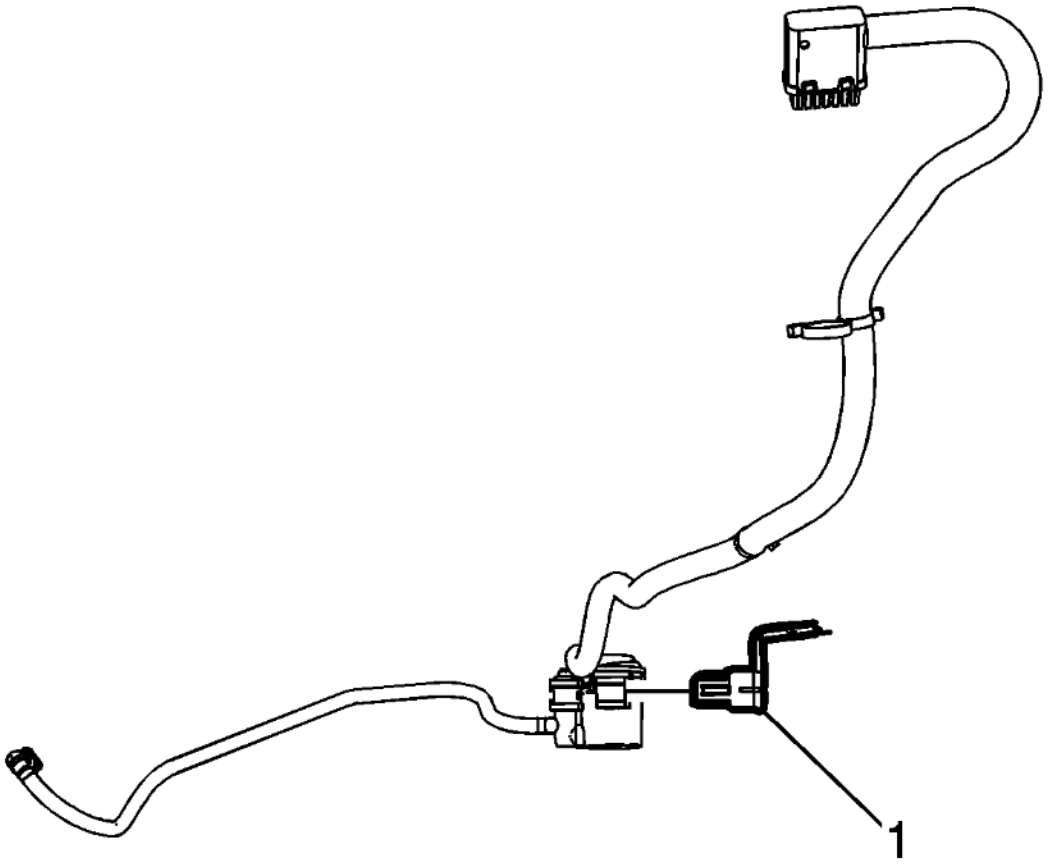


Fig. 149: EVAP Canister Vent Solenoid Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Install the EVAP canister vent solenoid.
2. Slide the EVAP canister vent solenoid onto the bracket until the retainer (1) engages the clip.

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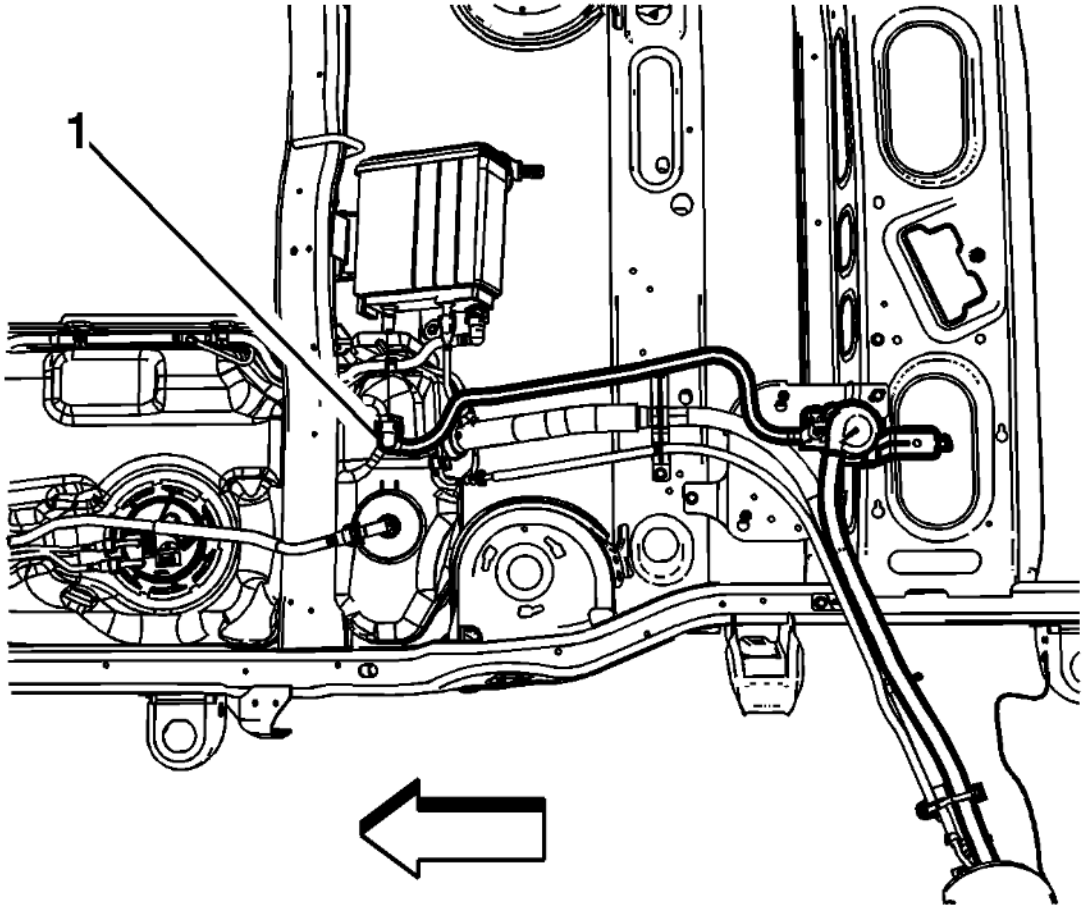


Fig. 150: EVAP Canister Vent Solenoid Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Connect the EVAP canister vent solenoid quick connect fitting (1) to the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

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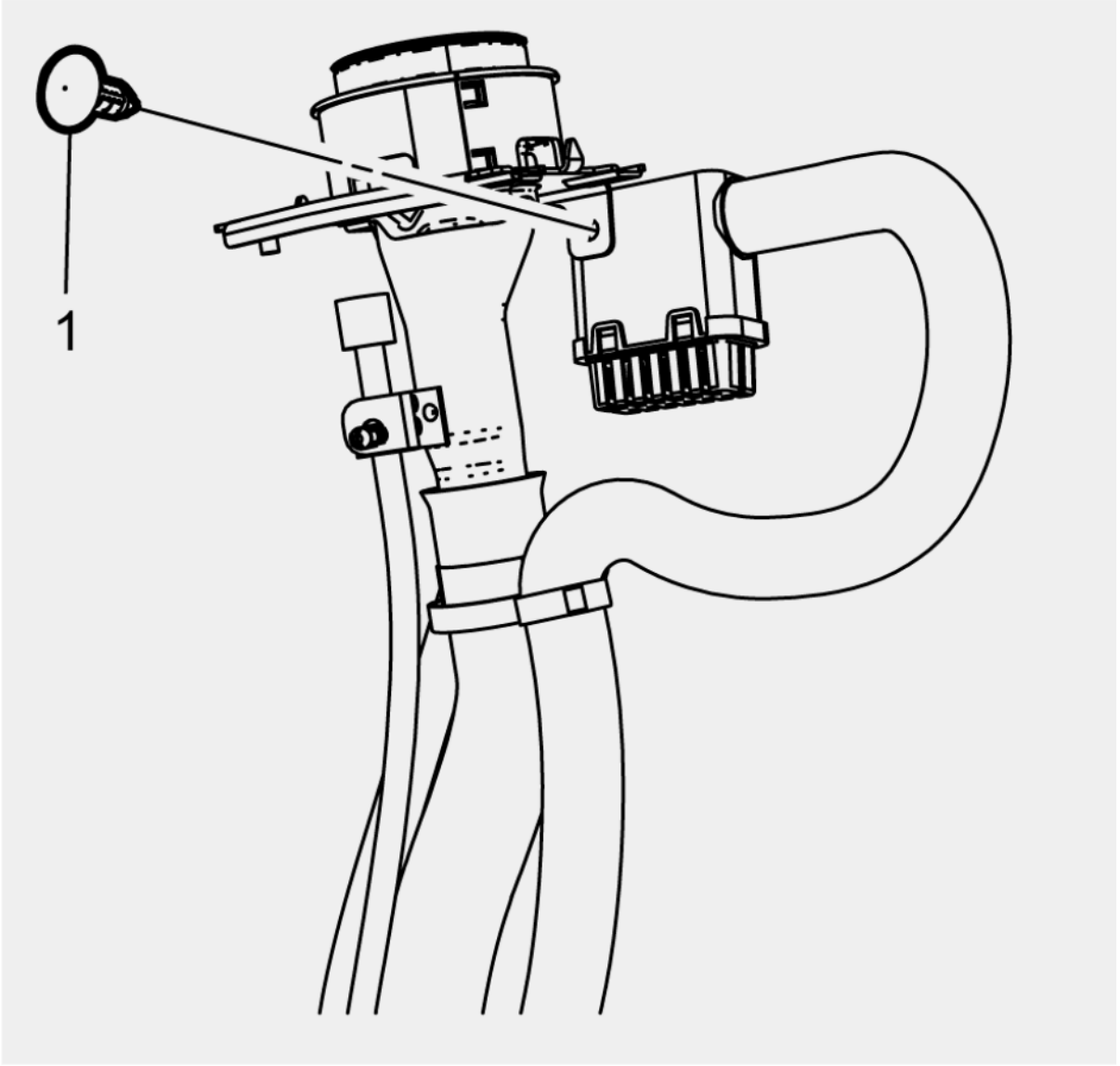


Fig. 151: Push Pin
Courtesy of GENERAL MOTORS COMPANY

4. Connect the solenoid vent filter to the filler pipe with a new push pin (1).

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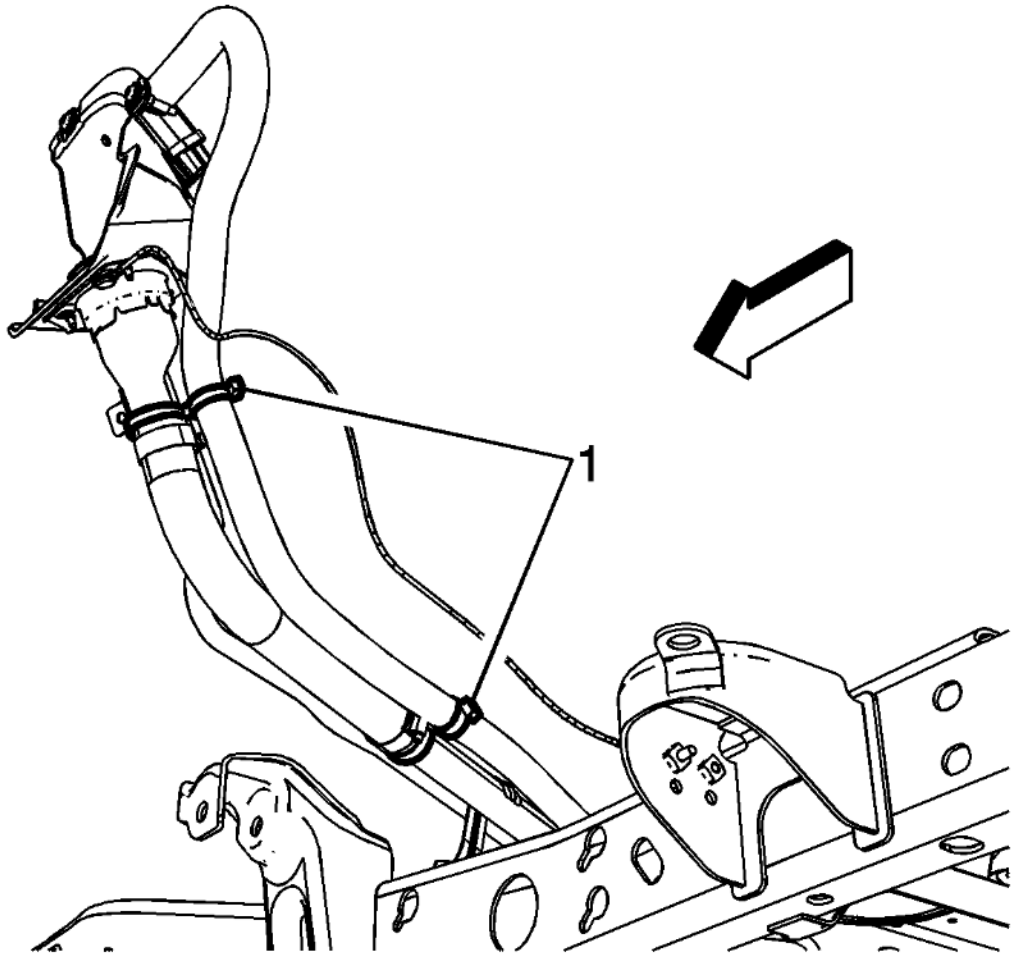


Fig. 152: 2 Tie Straps
Courtesy of GENERAL MOTORS COMPANY

5. Install 2 tie straps (1) to hold the solenoid vent line to the fuel fill pipe hose.

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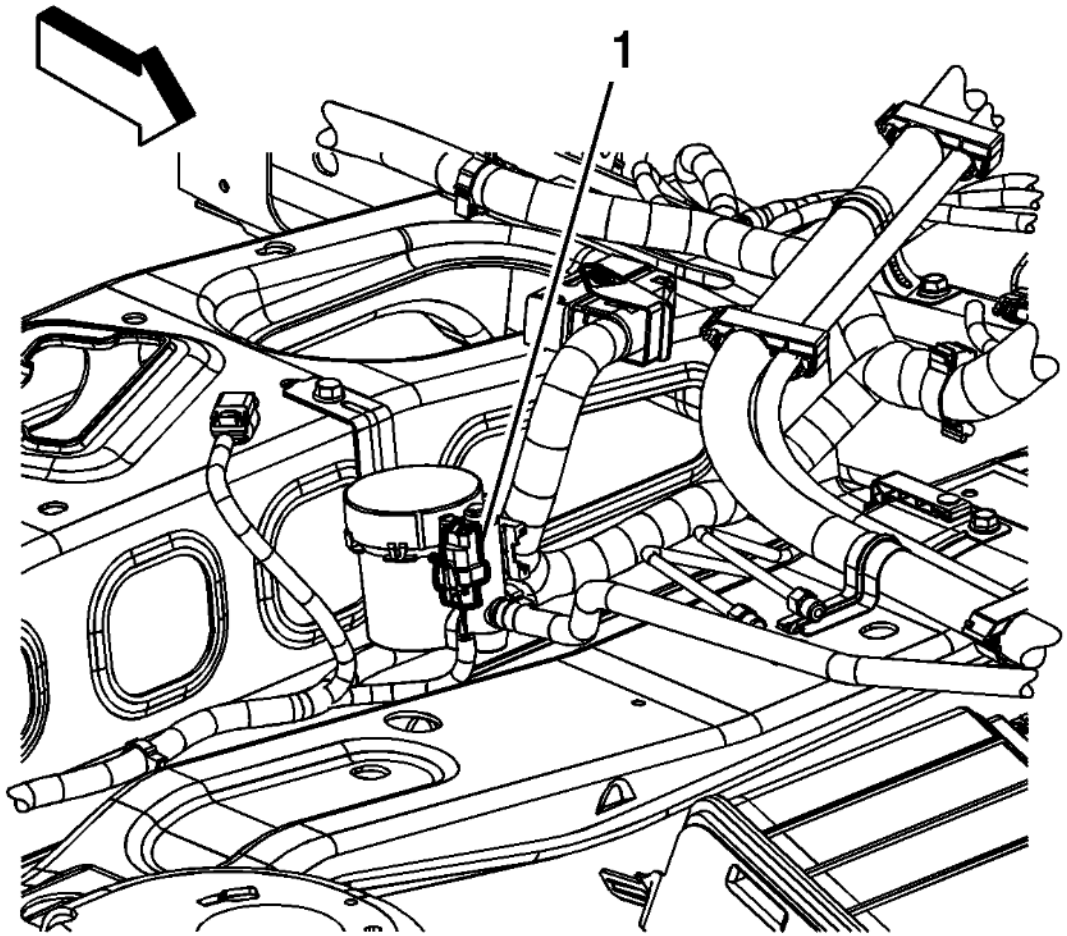


Fig. 153: View Of EVAP Canister Vent Solenoid Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Connect the chassis wiring harness electrical connector (1) to the EVAP canister vent solenoid.
7. Lower the vehicle.
8. Install the spare tire and wheel assembly.

EVAPORATIVE EMISSION CANISTER REPLACEMENT

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Removal Procedure

NOTE: **Clean all evaporative emission (EVAP) line connections and surrounding areas prior to disconnecting, in order to avoid possible EVAP system contamination.**

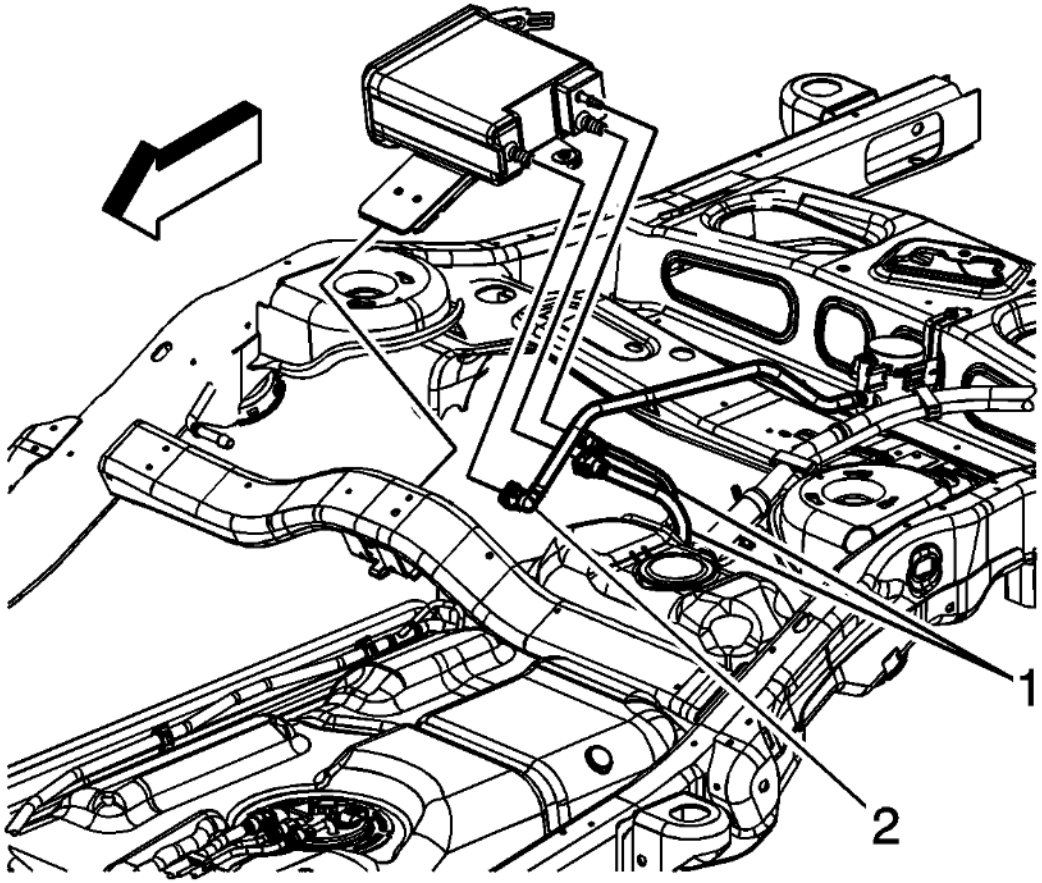


Fig. 154: View Of Fuel Tank EVAP Lines & Canister
Courtesy of GENERAL MOTORS COMPANY

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1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the EVAP canister bracket bolts and lower the EVAP canister.
3. Disconnect the fuel tank EVAP line quick connect fittings (1) from the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

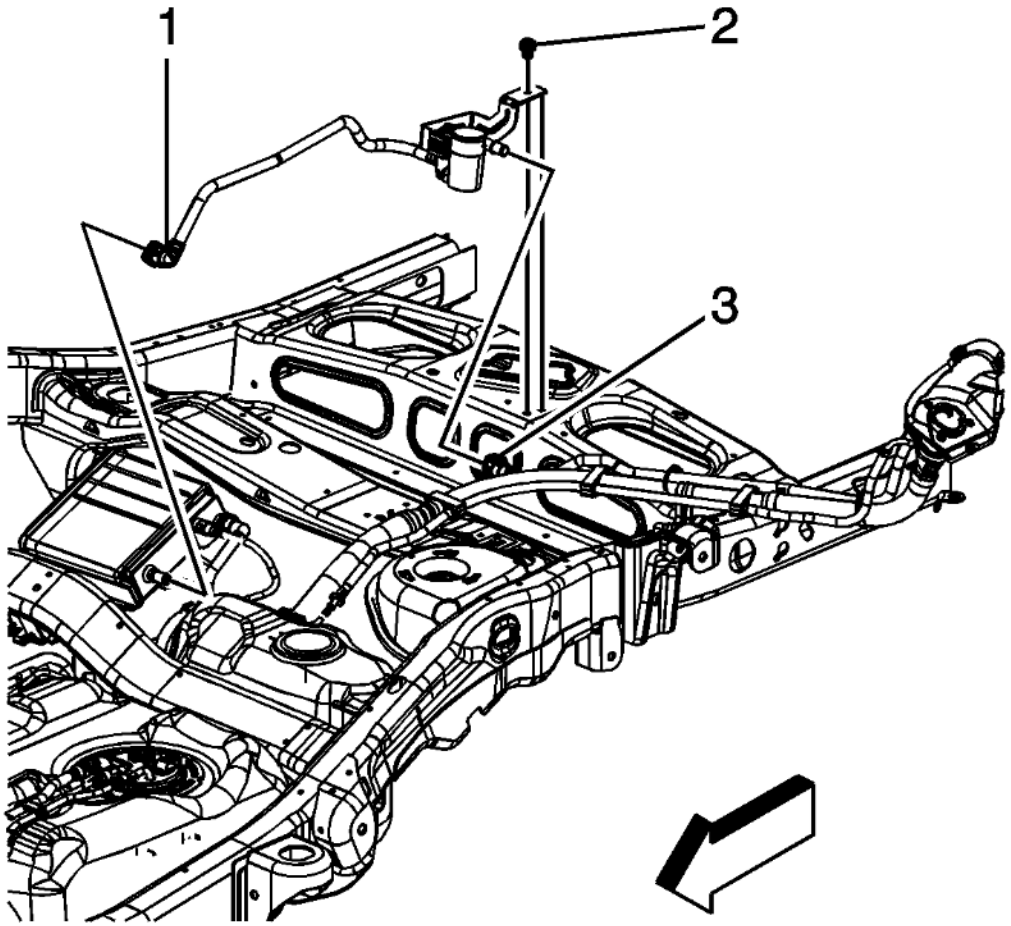


Fig. 155: View Of Quick Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the EVAP canister vent solenoid quick connecting fitting (1) from the EVAP canister. Refer to **Plastic Collar Quick Connect**

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Fitting Service.

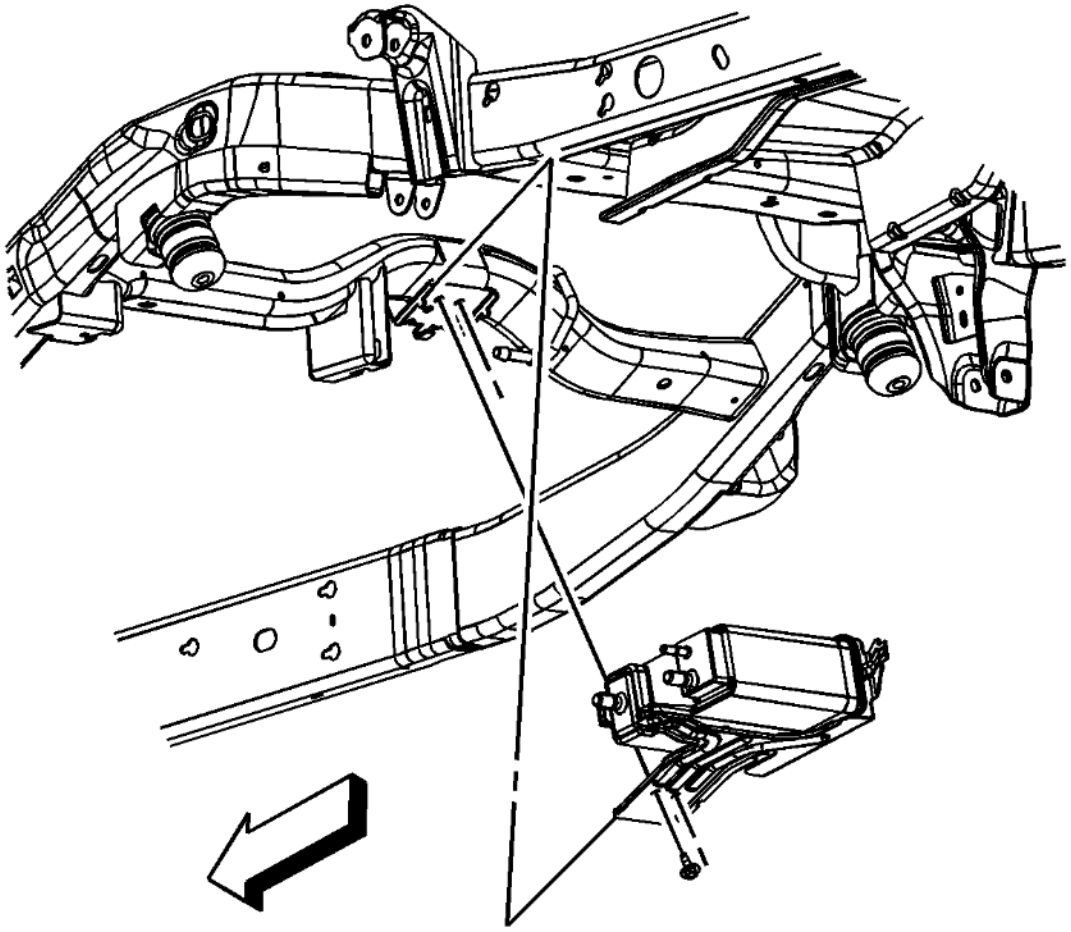


Fig. 156: View Of EVAP Canister, Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the EVAP canister.
6. If necessary, remove the EVAP canister to bracket bolt.
7. If necessary, remove the EVAP canister from the bracket.

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Installation Procedure

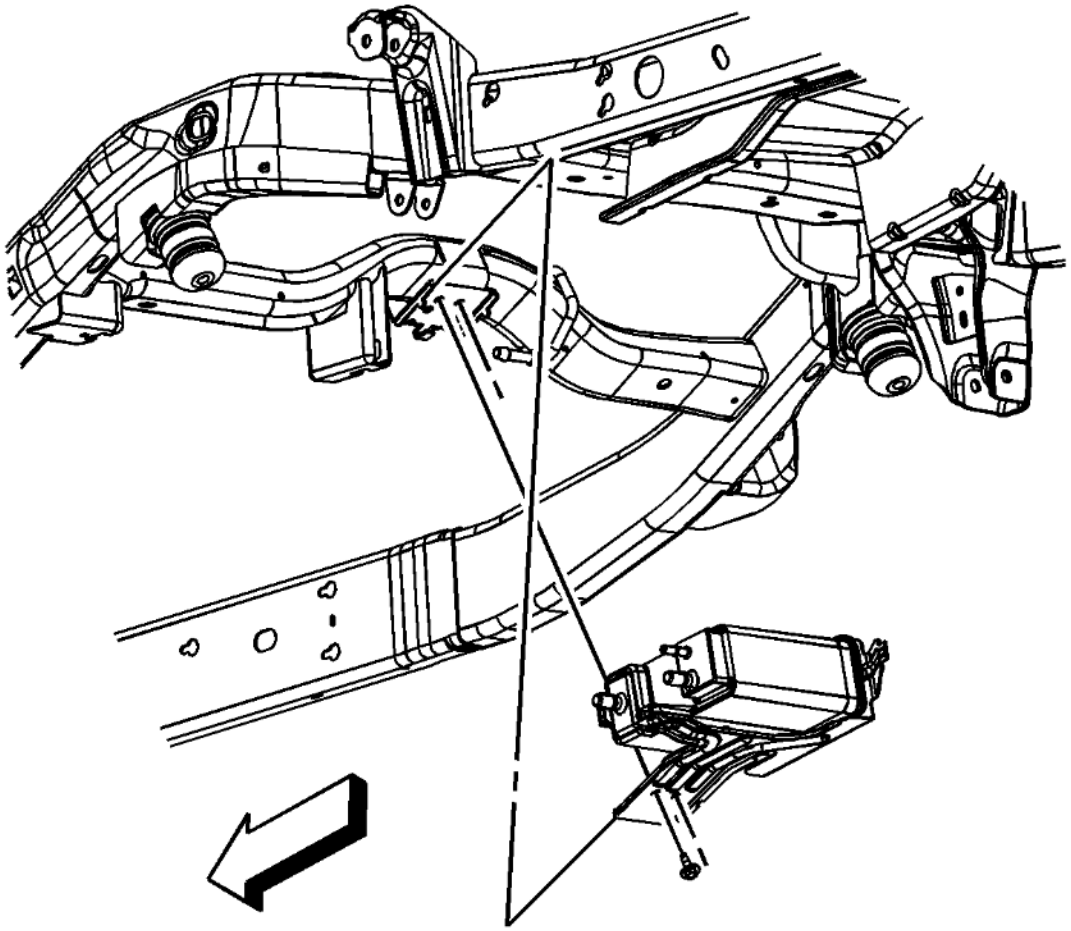


Fig. 157: View Of EVAP Canister, Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. If necessary, install the EVAP canister to the bracket.

CAUTION: **Refer to Fastener Caution .**

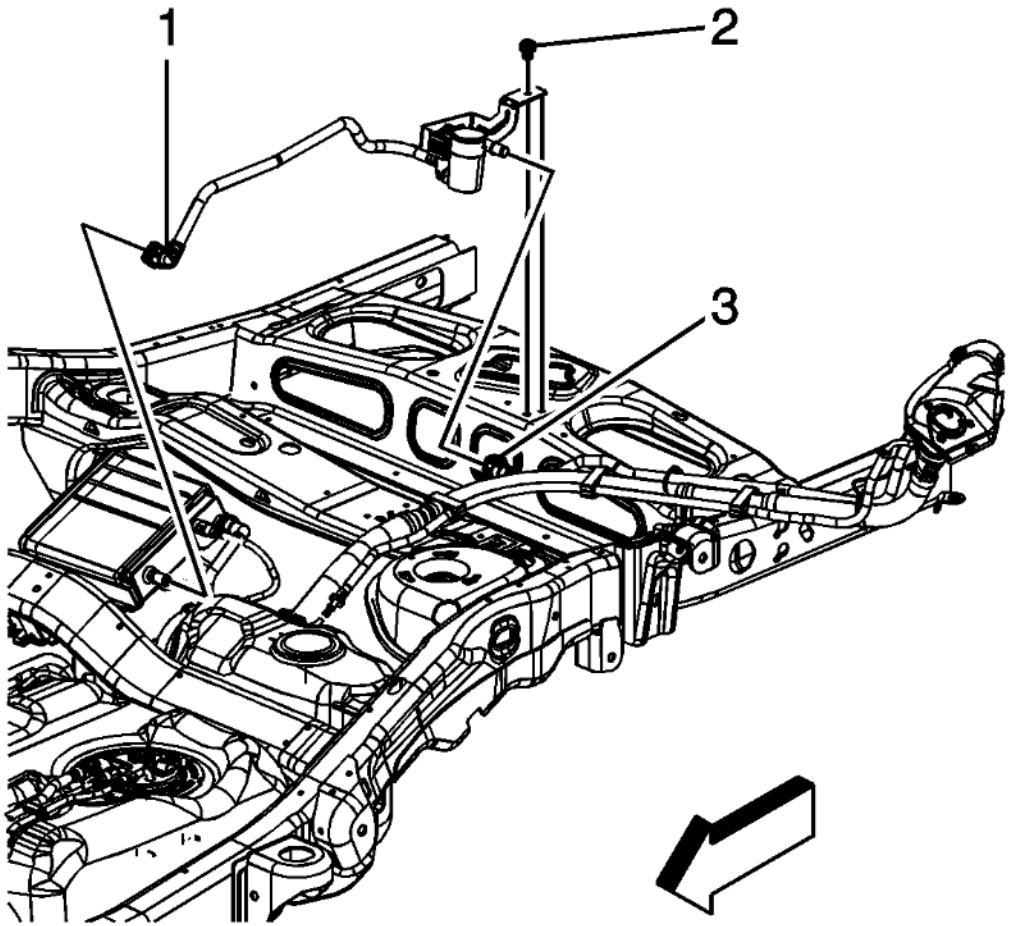
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2. If necessary, install the EVAP canister to bracket bolt.

Tighten

Tighten the bolt to 25 N.m (18 lb ft).

3. Position the EVAP canister.



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Fig. 158: View Of Quick Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

4. Connect the EVAP canister vent solenoid quick connecting fitting (1) to the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

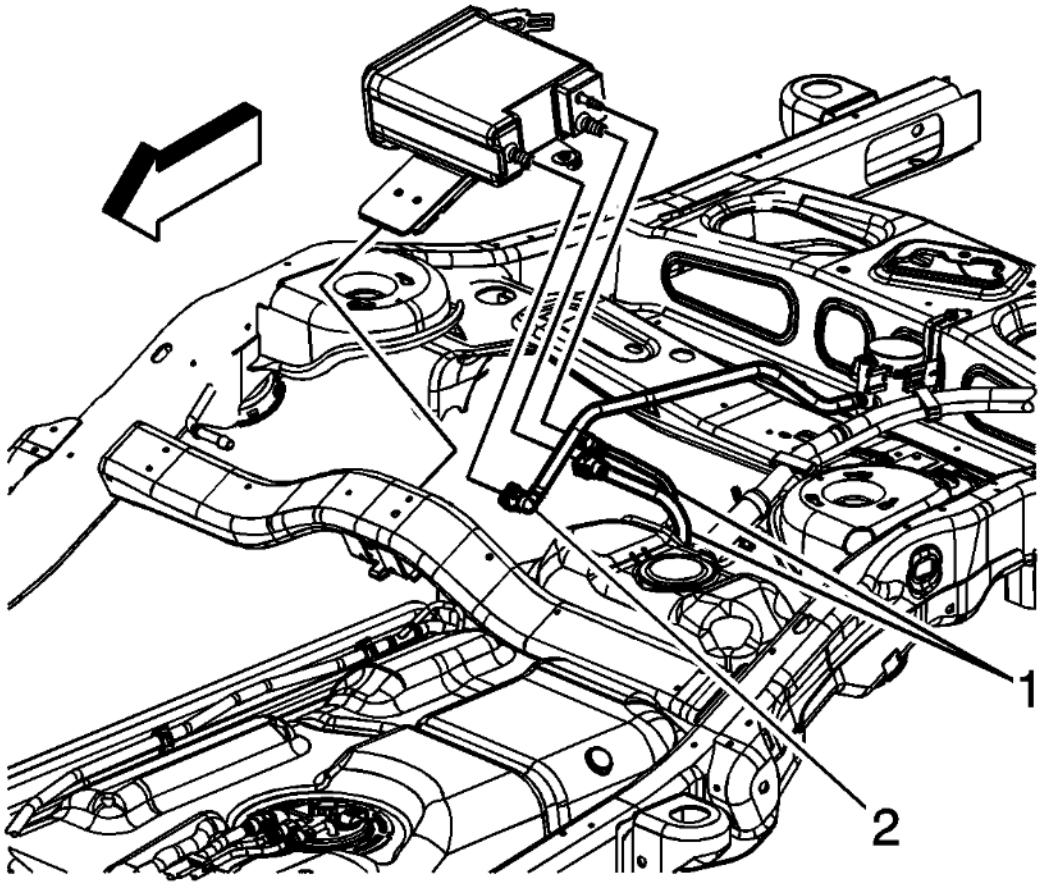


Fig. 159: View Of Fuel Tank EVAP Lines & Canister
Courtesy of GENERAL MOTORS COMPANY

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5. Connect the fuel tank EVAP line quick connect fittings (1) to the EVAP canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Install the EVAP canister bracket bolts.

   Tighten

   Tighten the bolts to 25 N.m (18 lb ft).

7. Lower the vehicle.

IGNITION COIL REPLACEMENT

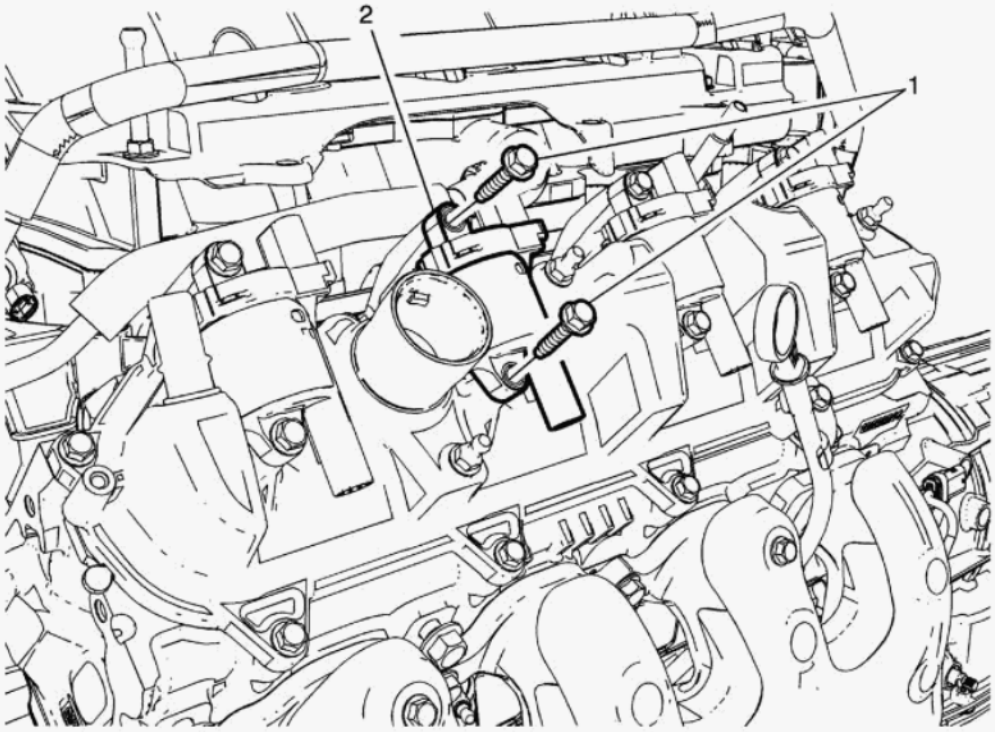


Fig. 160: Ignition Coil
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

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Callout	Component Name
Preliminary Procedure 1. Remove the valve rocker arm cover insulator. Refer to **Valve Rocker Arm Cover Insulator Replacement - Left Side** , and/or **Valve Rocker Arm Cover Insulator Replacement - Right Side** . 2. Remove the spark plug wires. Refer to **Spark Plug Wire Replacement**.	
1	Ignition Coil Fasteners (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Ignition Coil **Procedure** 1. Relocate wiring harnesses and hoses as necessary. 2. Disconnect the electrical wiring harness connector from the ignition coil.

SPARK PLUG WIRE INSPECTION

IMPORTANT: Spark plug wire integrity is vital for proper engine operation. A thorough inspection will be necessary to accurately identify conditions that may affect engine operation. Inspect for the following conditions:

1. Correct routing of the spark plug wires. Incorrect routing may cause cross-firing.
2. Inspect for any signs of cracks or splits in the wires.
3. Inspect each boot for the following conditions:
   - Tearing
   - Piercing

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- Arcing
- Carbon tracking
- Corroded terminals

4. If corrosion, carbon tracking or arcing are indicated on a spark plug wire boot or on a terminal, replace the wire and the component connected to the wire.

SPARK PLUG WIRE REPLACEMENT

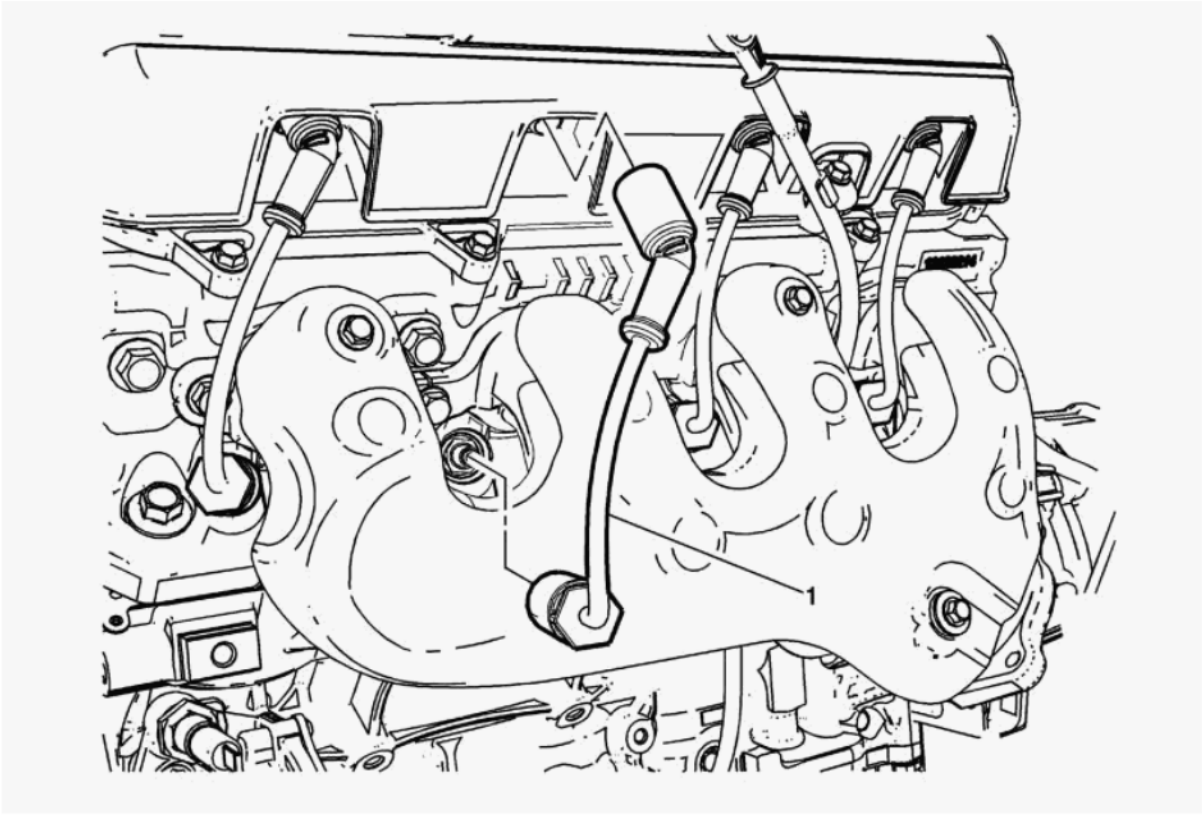


Fig. 161: Spark Plug Wire
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove the valve rocker arm cover insulator. Refer to **Valve Rocker Arm Cover Insulator Replacement - Left Side** , and/or **Valve**	

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Callout	Component Name
Rocker Arm Cover Insulator Replacement - Right Side .	
1	Spark Plug Wire **Procedure** **NOTE:** **Pull only on the spark plug wire boot to remove the wire.** 1. Twist the spark plug wire boot 1/2 turn and remove the spark plug wire. 2. Inspect the spark plug wire for damage and replace if necessary. 3. Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot up to a depth of 15 mm from the end of the boot. Refer to Adhesives, Fluids, Lubricants, and Sealers .

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

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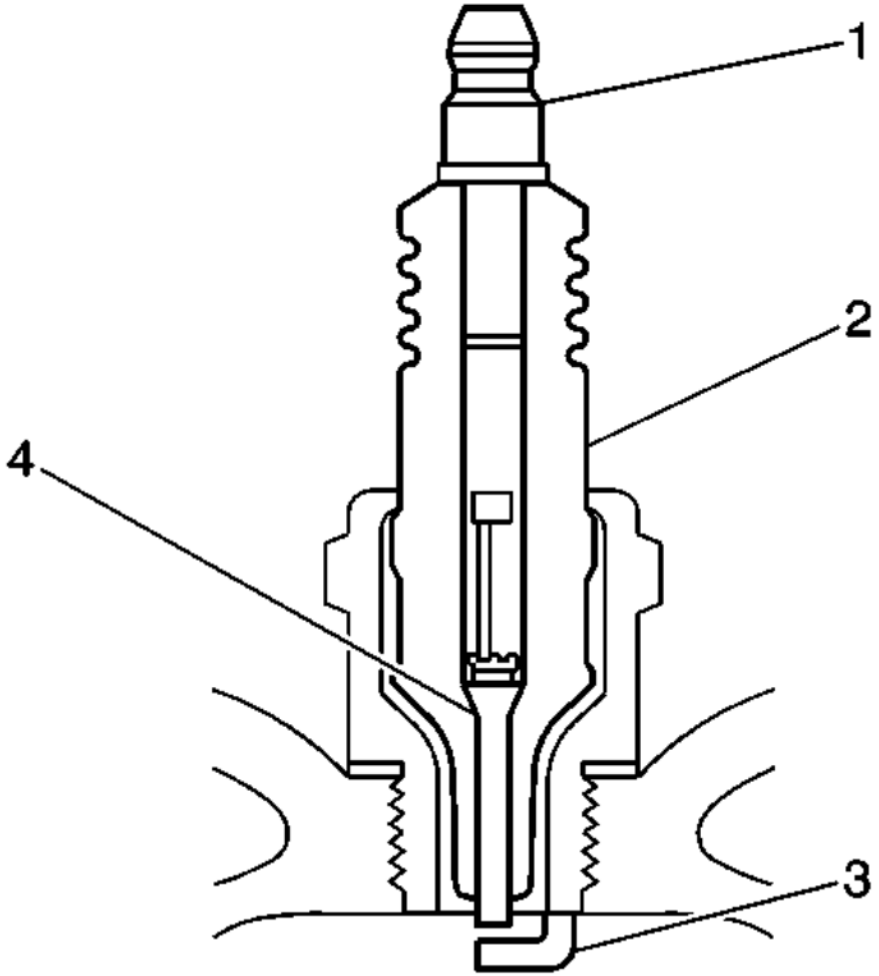


Fig. 162: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

- 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.

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- 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.

NOTE: **To avoid damage to the iridium tip on the center electrode, DO NOT attempt to adjust spark plug gap. If the spark plug gap does not meet specifications, replace the spark plug.**

  - 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.

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- 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.

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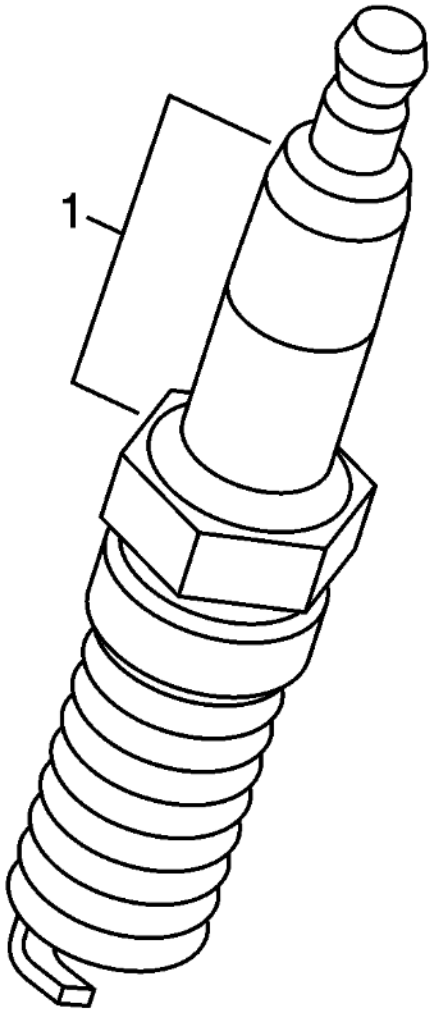


Fig. 163: Carbon On Spark Plug Tower
Courtesy of GENERAL MOTORS COMPANY

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.

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SPARK PLUG REPLACEMENT

Removal Procedure

1. Remove the spark plug wires from the spark plugs.

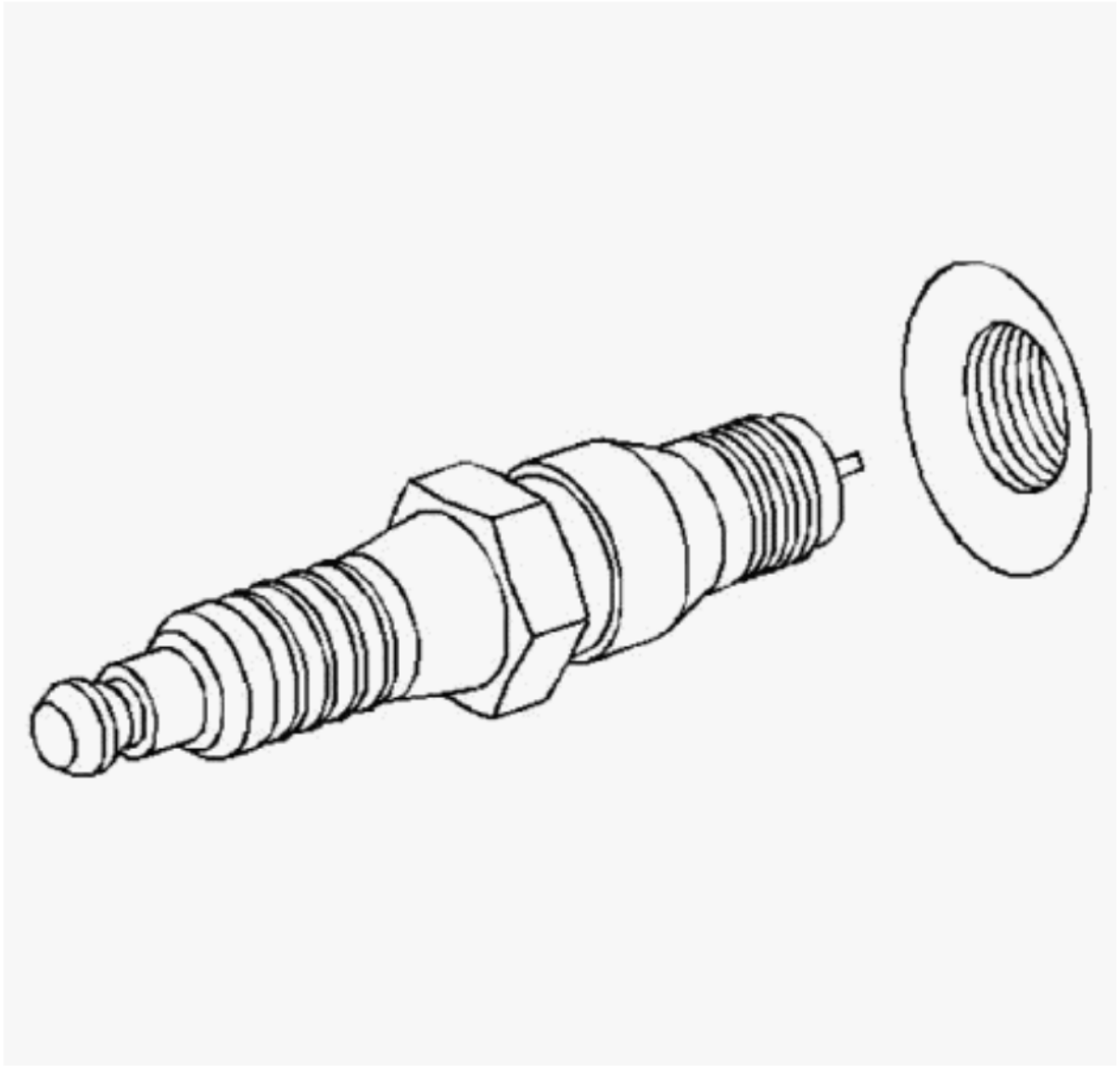


Fig. 164: Locating Spark Plug Gap

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Courtesy of GENERAL MOTORS COMPANY

2. Loosen each spark plug 1 or 2 turns.
3. Use a brush, or use compressed air in order to remove any dirt from the spark plugs.
4. Remove the spark plugs one at a time and place each plug in a tray marked with the corresponding cylinder numbers.

Installation Procedure

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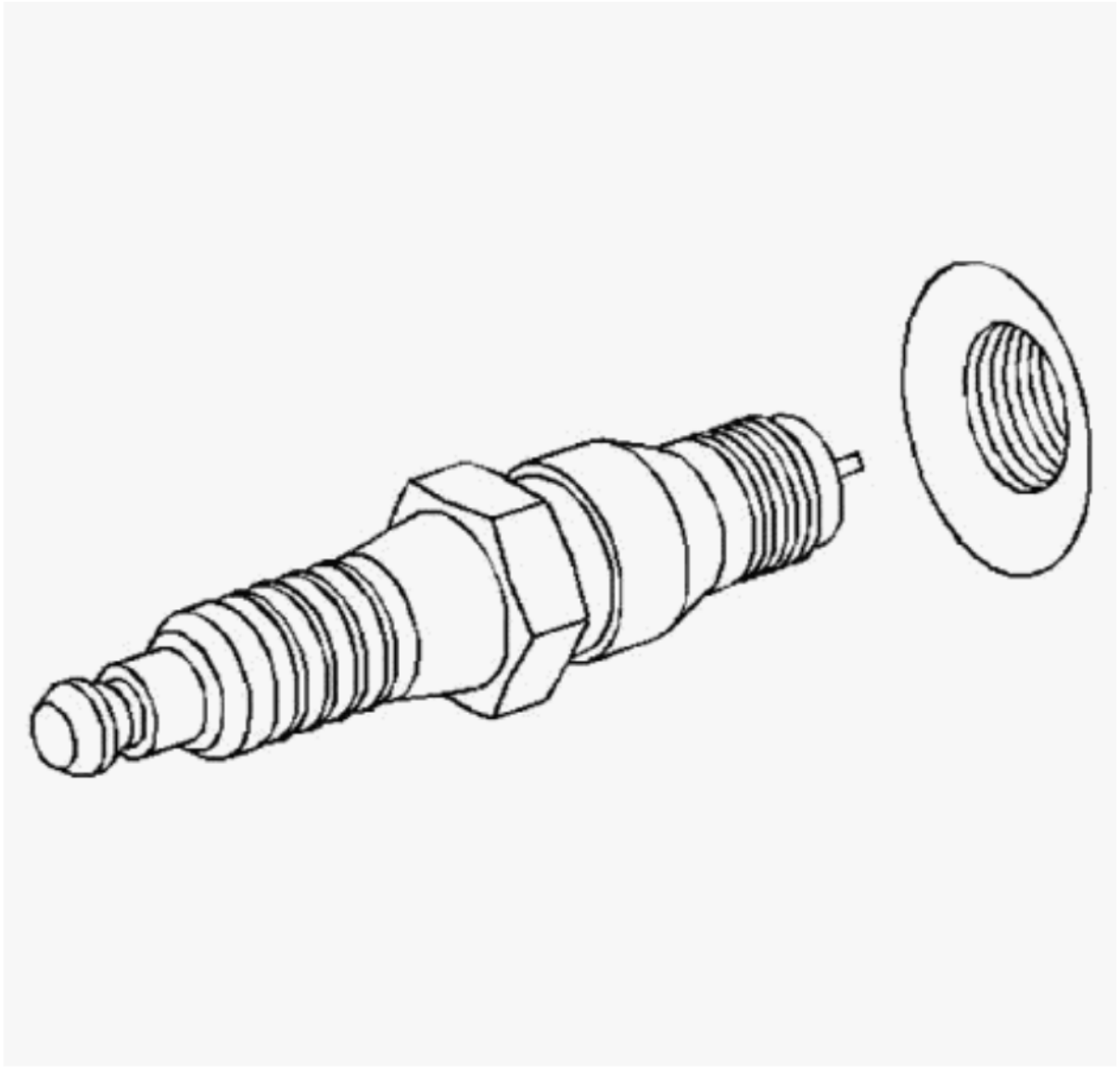


Fig. 165: Locating Spark Plug Gap
Courtesy of GENERAL MOTORS COMPANY

1. Hand start the spark plugs in the corresponding cylinders.

CAUTION: **Refer to Component Fastener Tightening Caution .**

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2. Tighten the spark plugs to 20 N.m (15 lb ft).
3. Install the spark plug wires onto the spark plugs.

CRANKSHAFT POSITION SENSOR REPLACEMENT

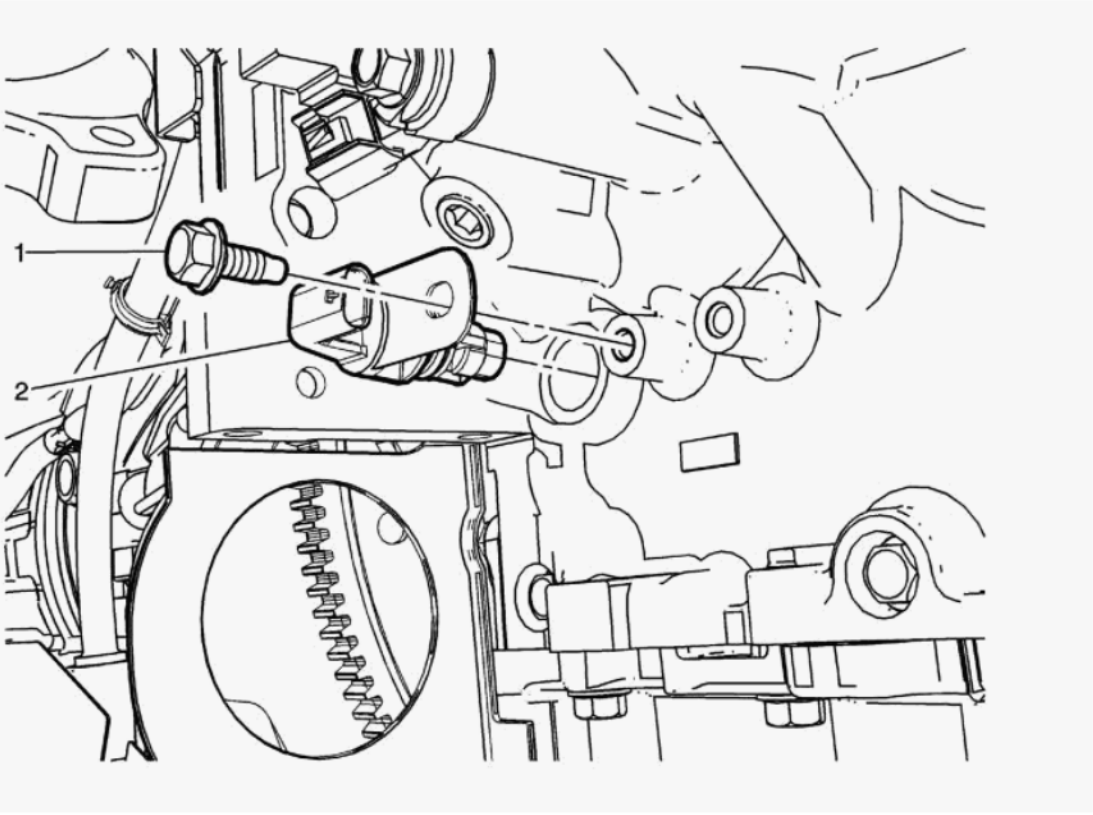


Fig. 166: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the starter. Refer to **Starter Replacement (L83, L86)** **Starter Replacement (L96)** .	
1	Crankshaft Position Sensor Fastener **CAUTION:**

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Callout	Component Name
	Refer to Fastener Caution . **Tighten** 25 N.m (18 lb ft)
2	Crankshaft Position Sensor **Procedure** Disconnect the crankshaft position sensor electrical wiring harness connector.

CAMSHAFT POSITION SENSOR REPLACEMENT

Removal Procedure

WARNING: Refer to Eye Protection Warning .

1. Disconnect the battery ground cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)** **Battery Negative Cable Disconnection and Connection (Single Battery)** .
2. Remove Drive Belt Tensioner - Accessory **Drive Belt Tensioner Replacement - Accessory** .

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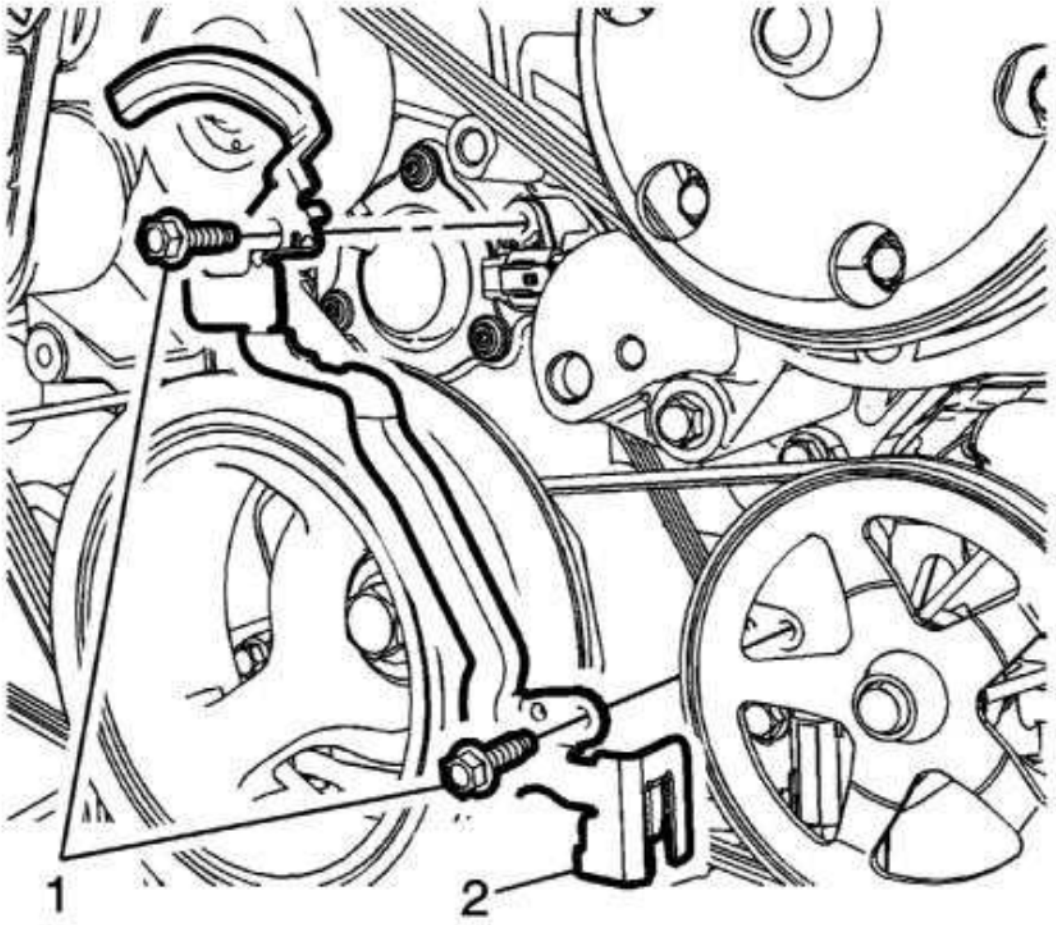


Fig. 167: Camshaft Position Sensor Bracket Fasteners And Engine Block
Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft position sensor bracket fasteners (1) from the engine block.
4. Carefully reposition the bracket aside and remove the camshaft position sensor from the engine front cover with the harness attached.

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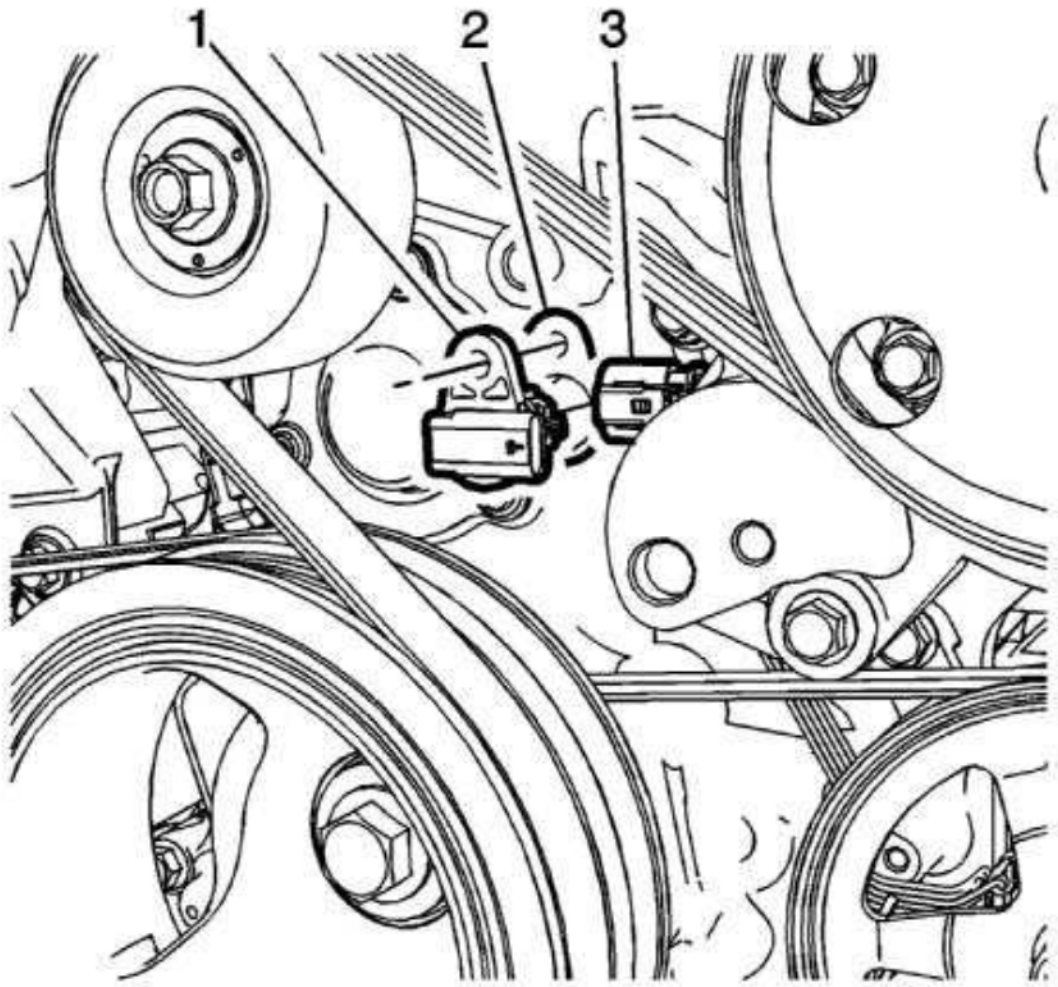


Fig. 168: Camshaft Position Sensor And Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the camshaft position sensor electrical connector (3) from the camshaft position sensor (1).

Installation Procedure

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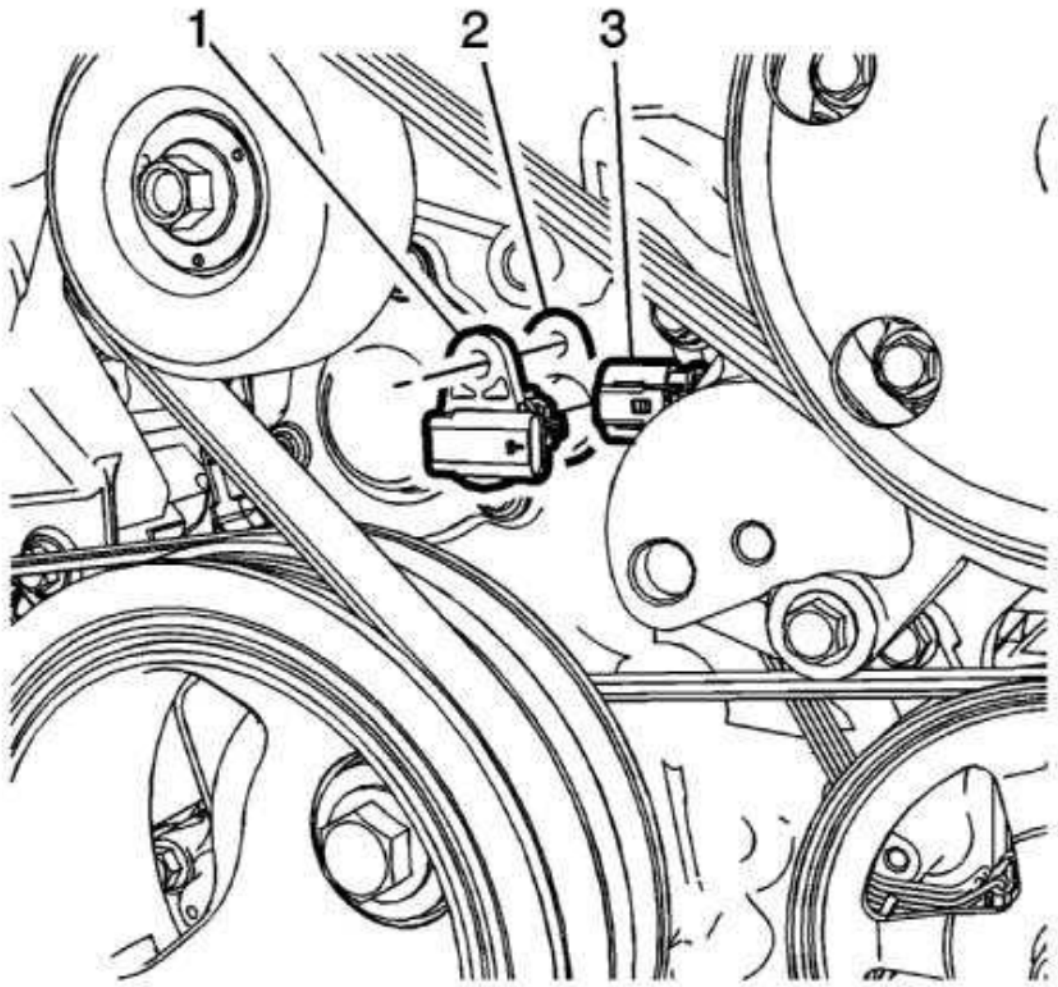


Fig. 169: Camshaft Position Sensor And Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If a new sensor is not being installed, a new camshaft sensor seal MUST be installed to prevent leaks.**

1. Connect the camshaft position sensor electrical connector (3) to the camshaft position sensor (1).
2. Install the camshaft position sensor (1) into the engine front cover (2).

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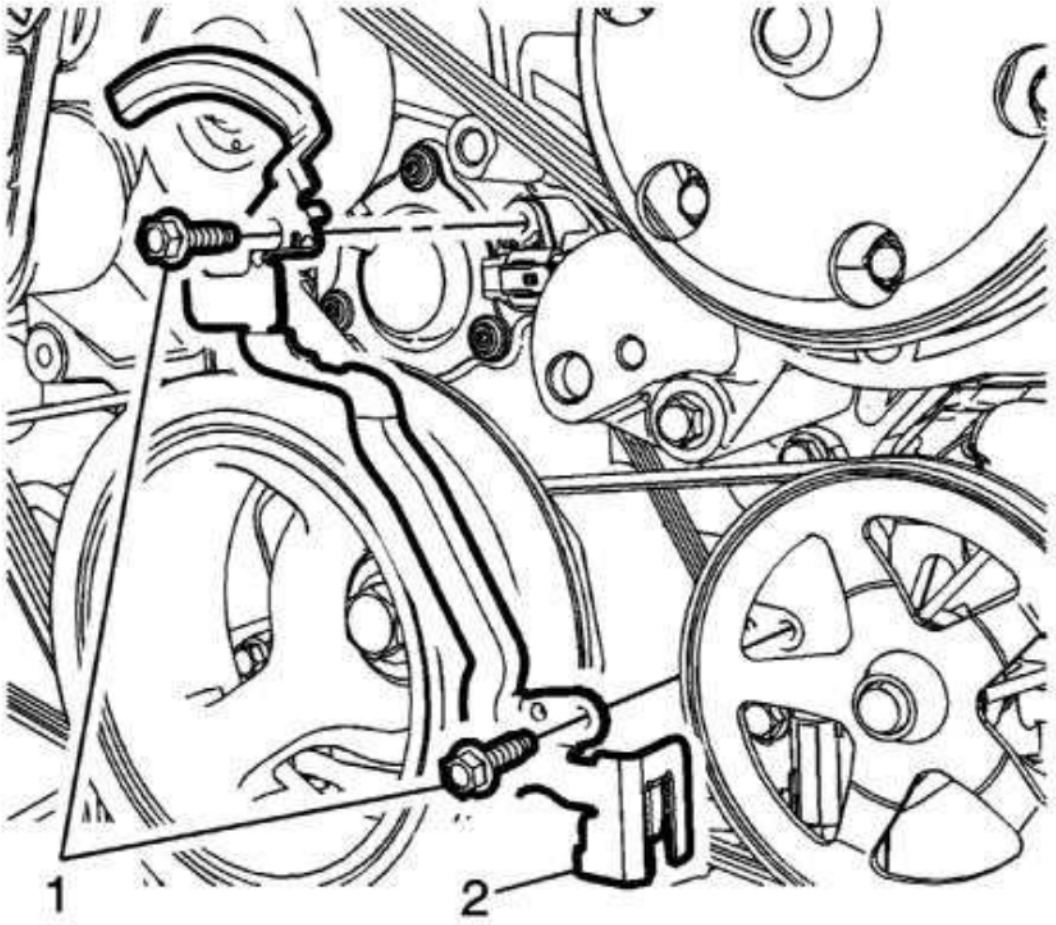


Fig. 170: Camshaft Position Sensor Bracket Fasteners And Engine Block
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Position the camshaft position sensor bracket (2) in place then install the camshaft position sensor bracket fasteners (1) and tighten to 25 N.m (18 lb ft).
4. Install **Drive Belt Tensioner Replacement - Accessory** .

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5. Connect the battery ground cable to the battery. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)** **Battery Negative Cable Disconnection and Connection (Single Battery)** .
6. If re-programming is required, refer to **Control Module References** .

CAMSHAFT POSITION ACTUATOR MAGNET REPLACEMENT

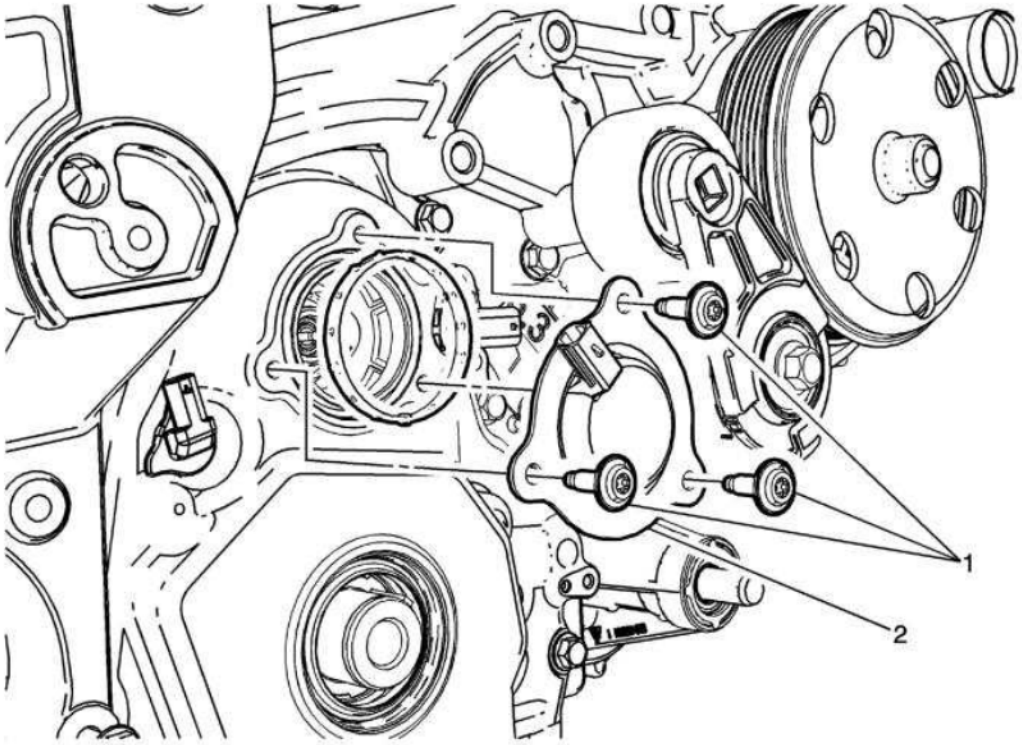


Fig. 171: Camshaft Position Actuator (Magnet)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Position Actuator Fasteners (Qty: 3) **CAUTION:**

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Callout	Component Name
	Refer to Fastener Caution . **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Actuator **Procedure** 1. Unplug the camshaft position actuator electrical connector. 2. Remove the camshaft position actuator seal from the engine front cover.

CAMSHAFT POSITION ACTUATOR MAGNET CLEANING AND INSPECTION

1. Remove the camshaft position sensor. Refer to **Camshaft Position Sensor Replacement**.
2. Clean the camshaft position sensor using a clean shop towel with an appropriate cleaner.
3. Inspect the camshaft position sensor and replace if evidence of damage or wear exists.

KNOCK SENSOR 1 REPLACEMENT

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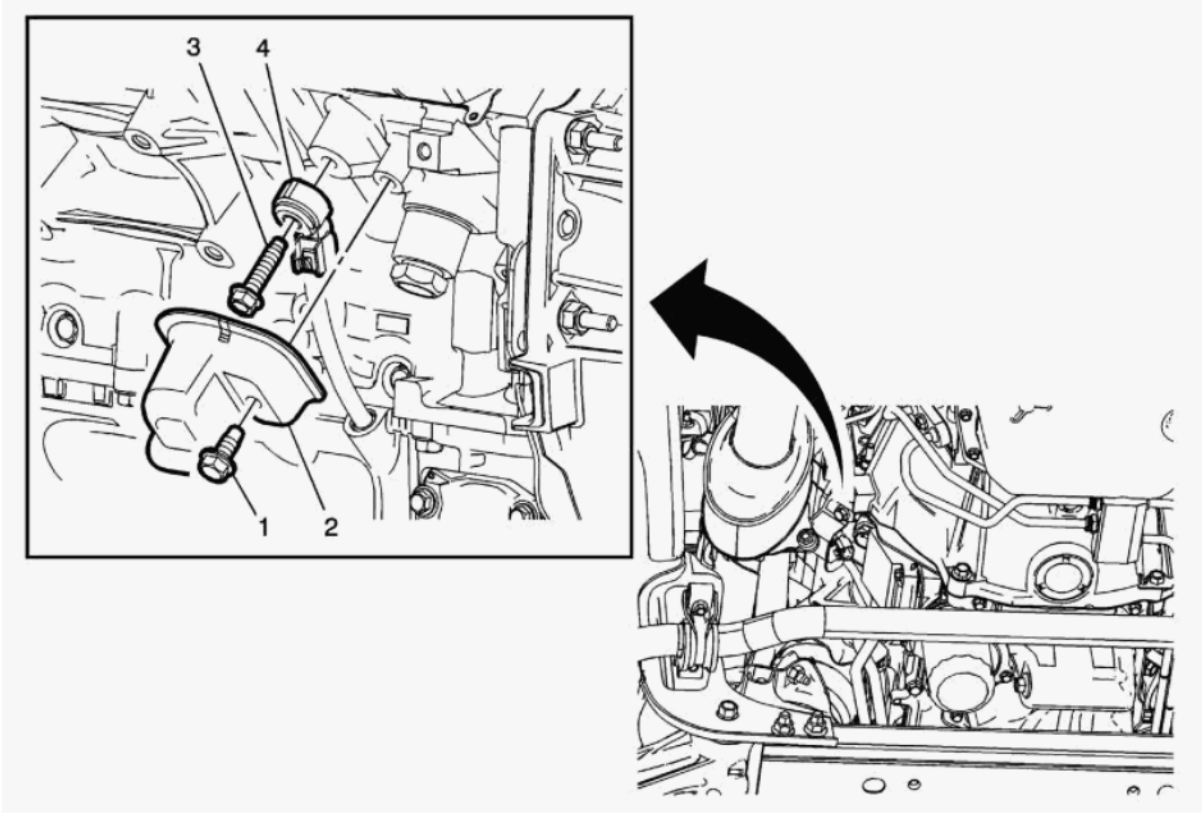


Fig. 172: Knock Sensor 1
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. **Lifting and Jacking the Vehicle** 2. If equipped **Front Axle Propeller Shaft Replacement (NPO)** **Front Axle Propeller Shaft Replacement (NQH)** **Front Axle Propeller Shaft Replacement (Heavy Duty)**	
1	Knock Sensor Shield Fastener **CAUTION:**

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Callout	Component Name
	Refer to Fastener Caution . **Tighten** 25 N.m (18 lb ft)
2	Knock Sensor Shield
3	Knock Sensor Fastener **Tighten** 25 N.m (18 lb ft)
4	Knock Sensor **Procedure** Disconnect the electrical wiring harness connector from the knock sensor.

KNOCK SENSOR 2 REPLACEMENT

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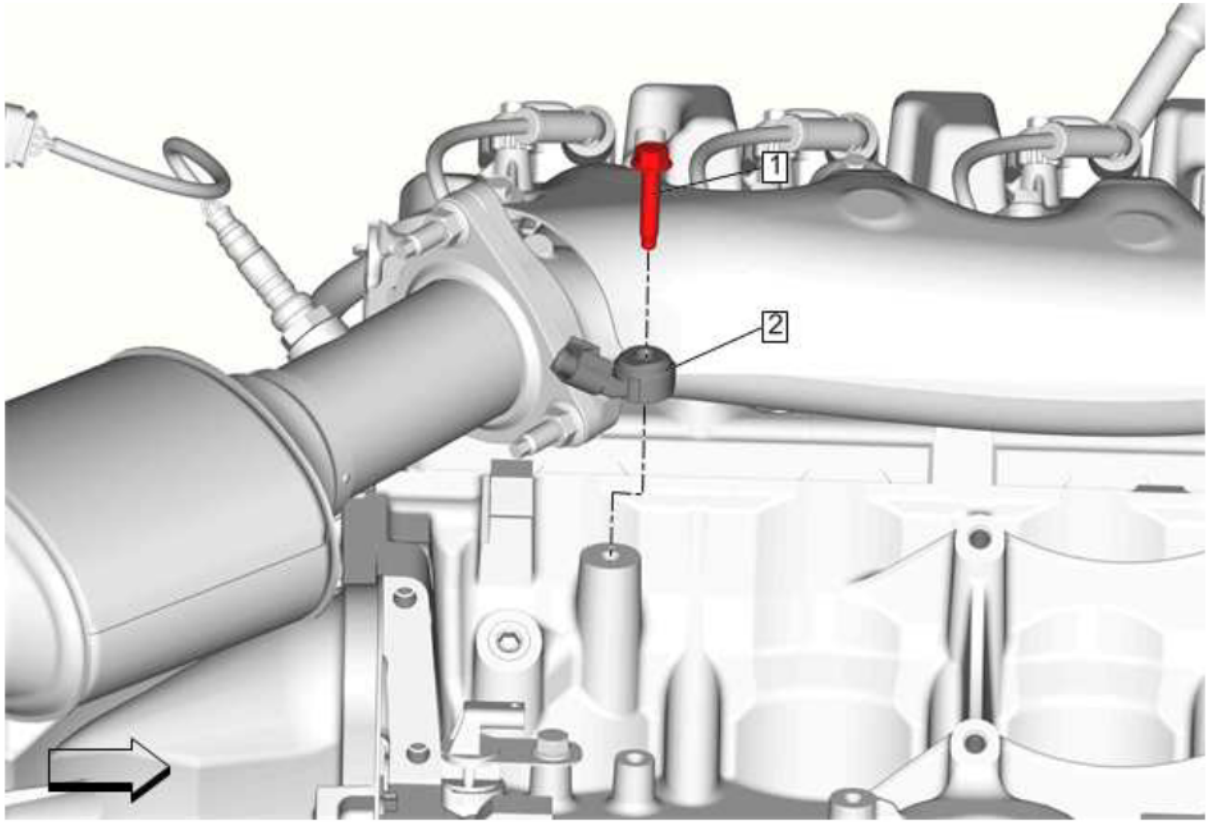


Fig. 173: Knock Sensor 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Starter Replacement (L83, L86) Starter Replacement (L96)	
1	Knock Sensor Fastener **CAUTION:** **Refer to** **Fastener Caution .**

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Callout	Component Name
	Tighten 25 N.m (18 lb ft)
2	Knock Sensor **Procedure** Disconnect the electrical wiring harness connector from the knock sensor.

VACUUM PUMP REPLACEMENT

Removal Procedure

WARNING: **To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.**

WARNING: **Refer to Eye Protection Warning .**

1. Disconnect the battery ground cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)** **Battery Negative Cable Disconnection and Connection (Single Battery)** .
2. Remove the vacuum pump belt. Refer to **Vacuum Pump Belt Replacement** .

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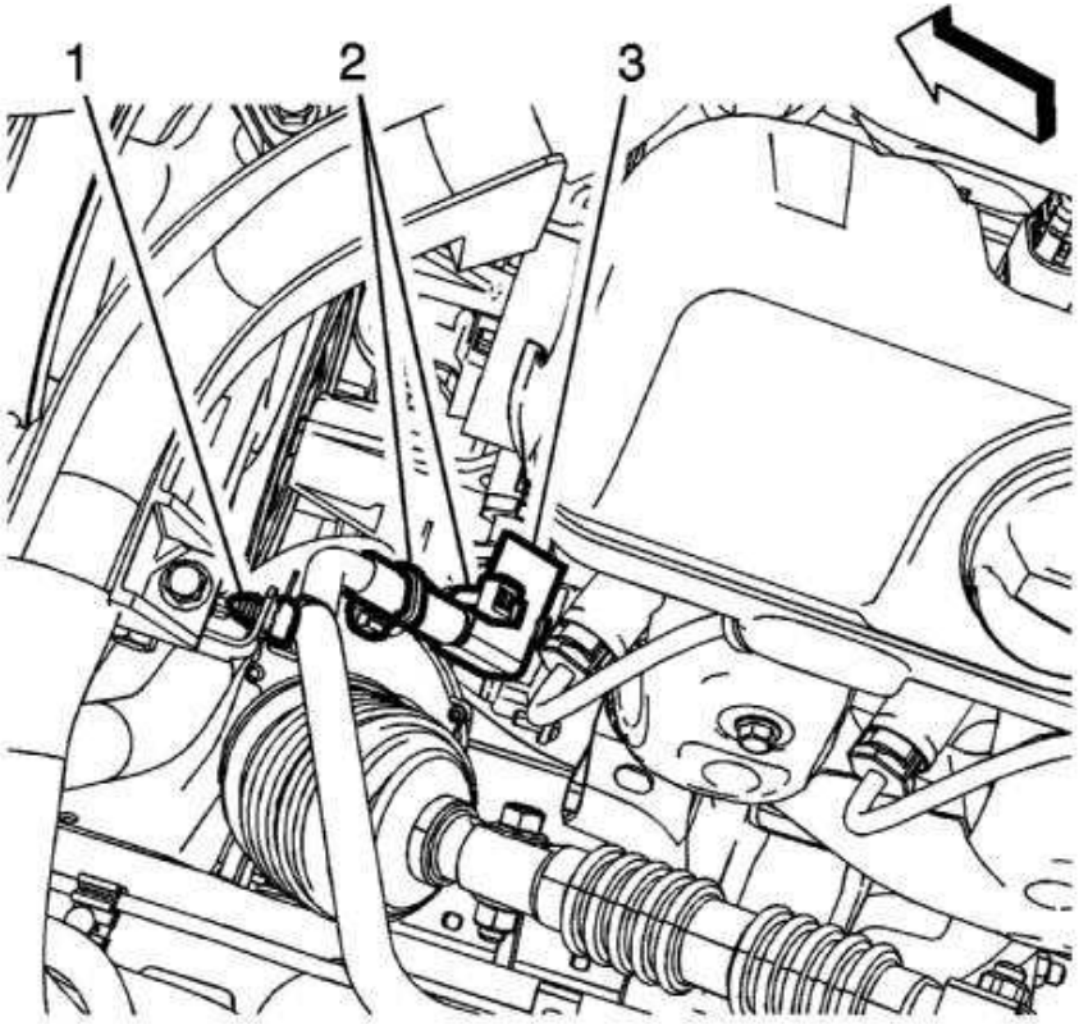


Fig. 174: Tie Straps And Vacuum Boost Pipe Sleeve
Courtesy of GENERAL MOTORS COMPANY

3. Cut the tie straps (2) off the vacuum boost pipe sleeve and remove the vacuum boost pipe sleeve (3) from the vacuum boost pipe.
4. Remove the vacuum boost pipe retainer (1) from its bracket.

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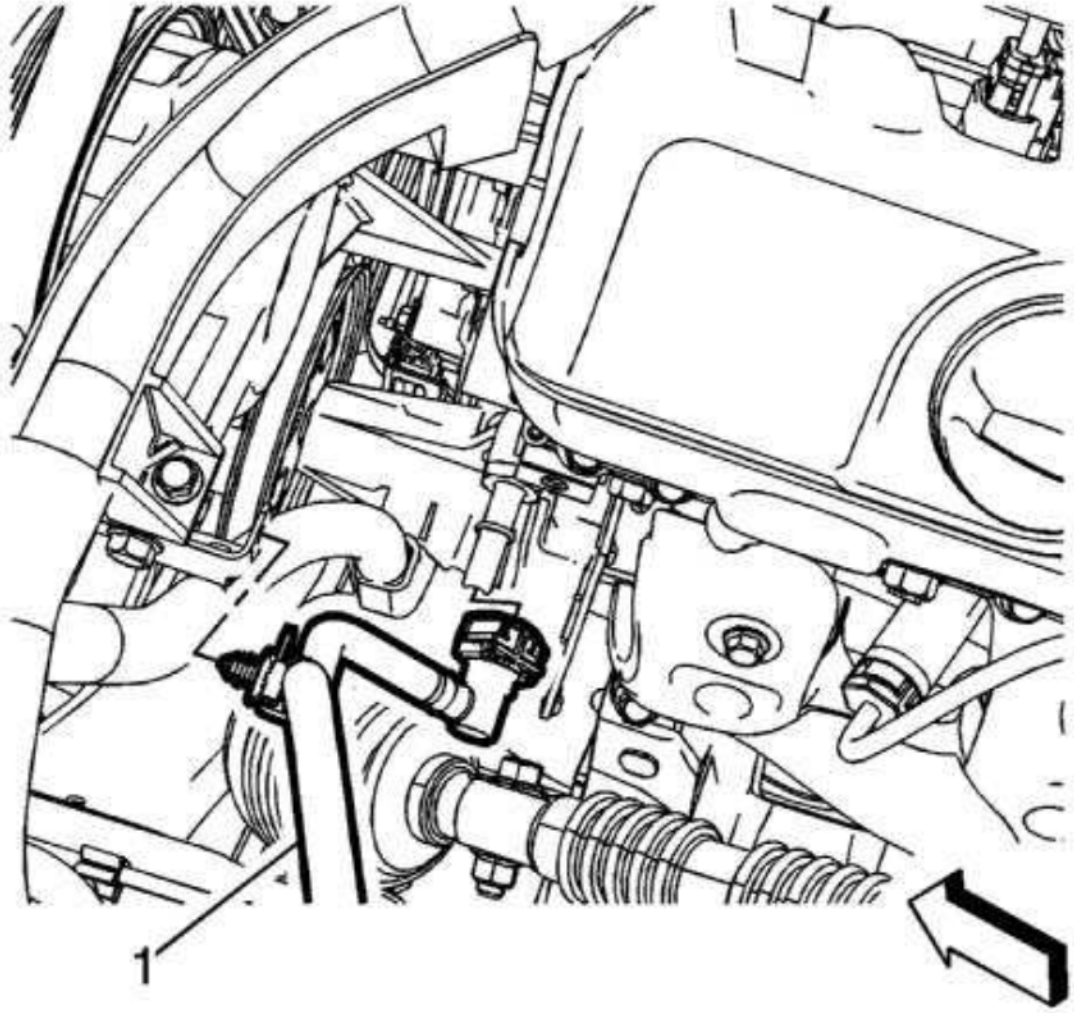


Fig. 175: Vacuum Boost Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Remove the vacuum boost pipe (1) from the vacuum pump and reposition it away from the pump. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Remove the steering gear skid shield. Refer to **Steering Gear Skid Shield Replacement** .

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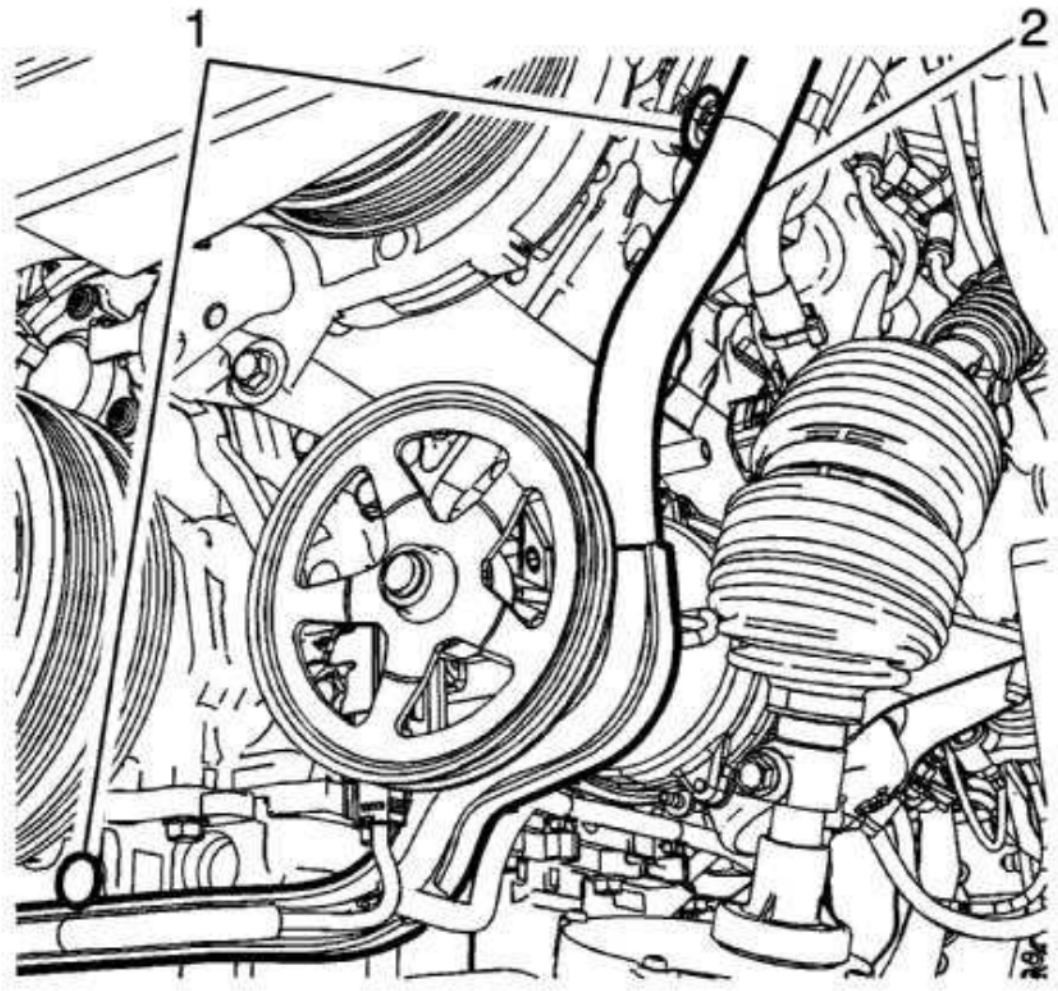


Fig. 176: Engine Electrical Wiring Harness Retainers And Reposition Harness
Courtesy of GENERAL MOTORS COMPANY

7. Remove the engine electrical wiring harness retainers (1) and reposition the harness (2) away from the vacuum pump.
8. Remove Intermediate Steering Shaft **Intermediate Steering Shaft Replacement**

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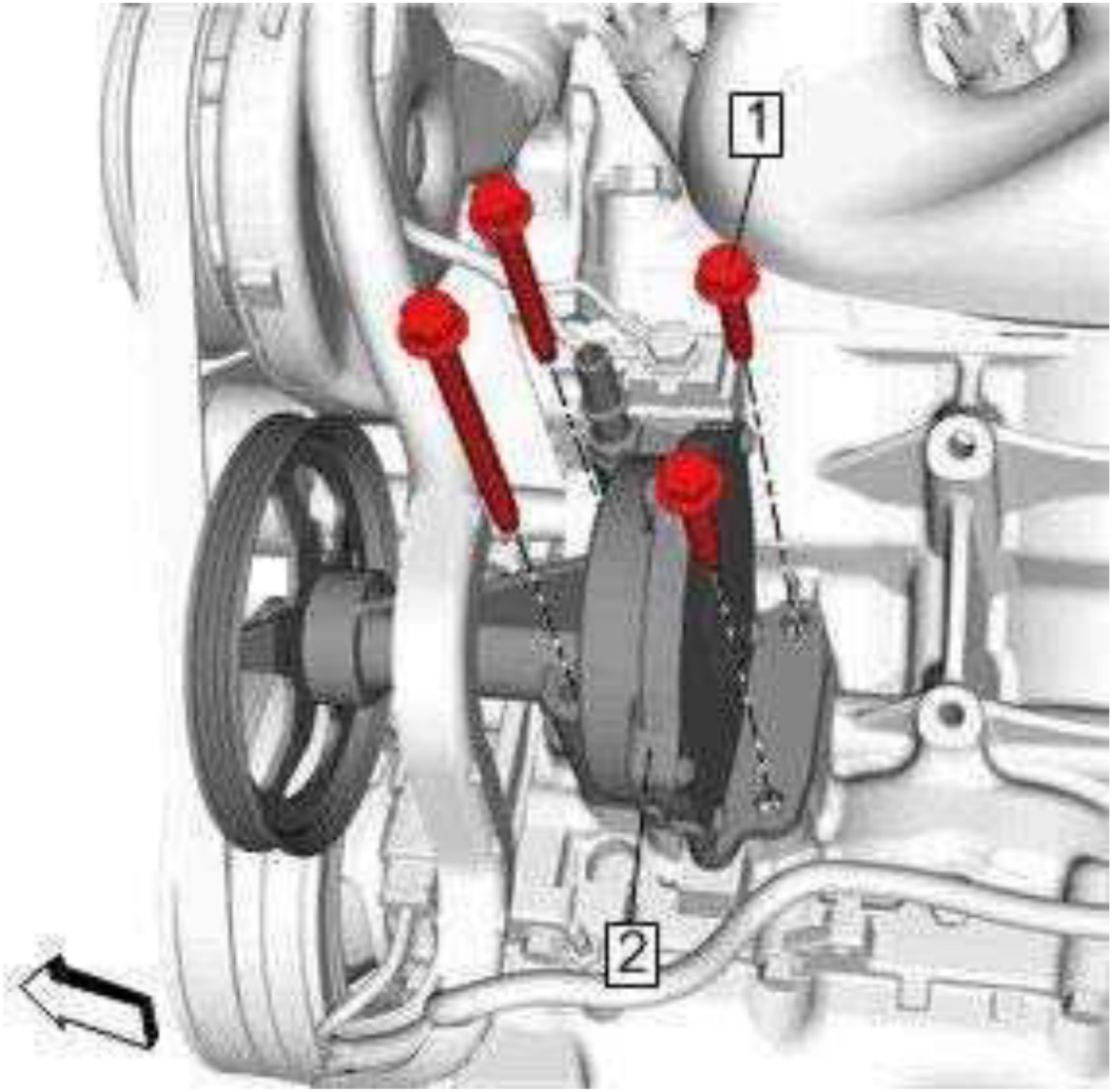


Fig. 177: Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

9. Remove Vacuum Pump Fastener (1) @Vacuum Pump (2)

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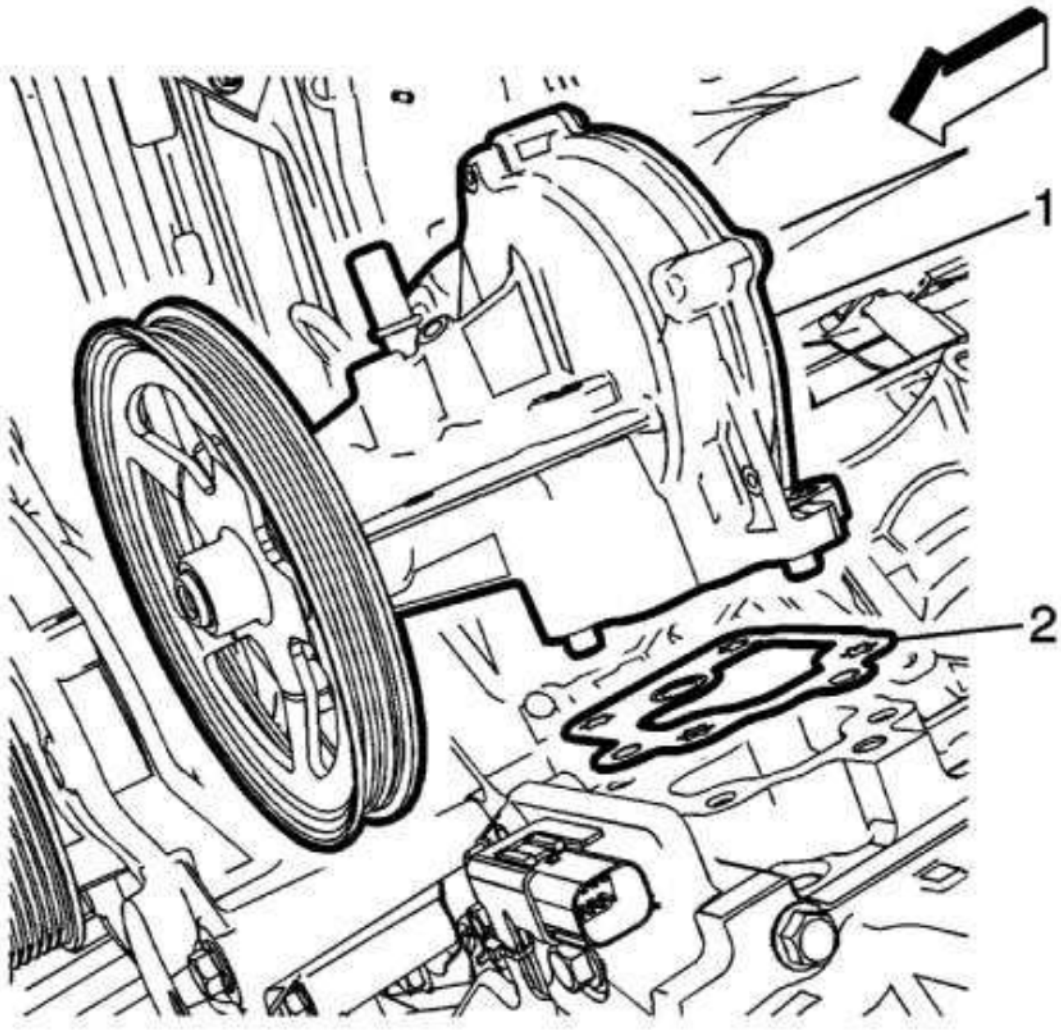


Fig. 178: Vacuum Pump And Vacuum Pump Gasket
Courtesy of GENERAL MOTORS COMPANY

10. Remove the vacuum pump (1) and the vacuum pump gasket (2) from the engine block.

Installation Procedure

NOTE: **A new vacuum pump gasket should be installed when the vacuum pump is installed to prevent leaks.**

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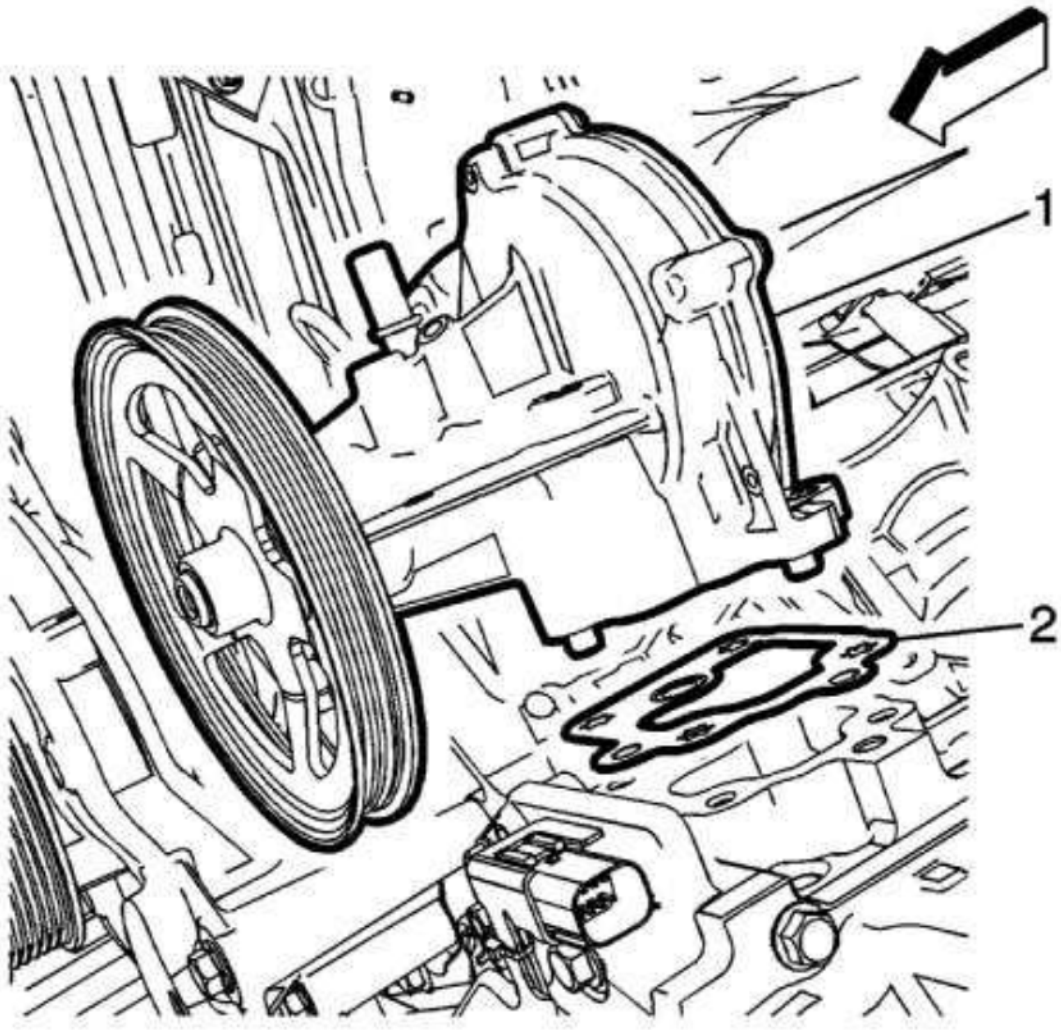


Fig. 179: Vacuum Pump And Vacuum Pump Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install the vacuum pump gasket (2) and vacuum pump (1) onto the engine block.

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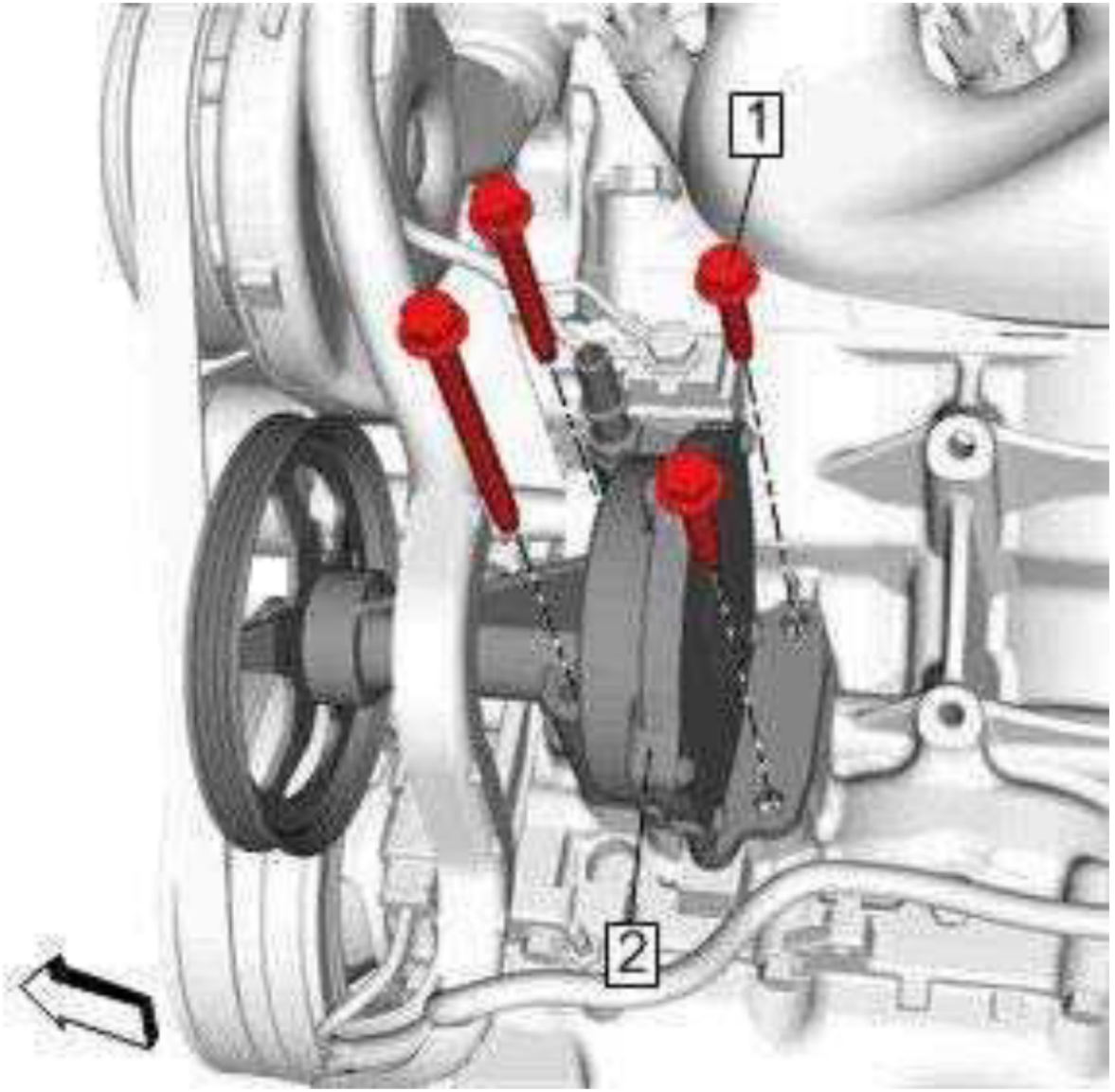


Fig. 180: Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

2. Install Vacuum Pump Fastener (1) @Vacuum Pump (2) and tighten 25 N.m (18 lb ft)
3. Install Intermediate Steering Shaft **Intermediate Steering Shaft Replacement**

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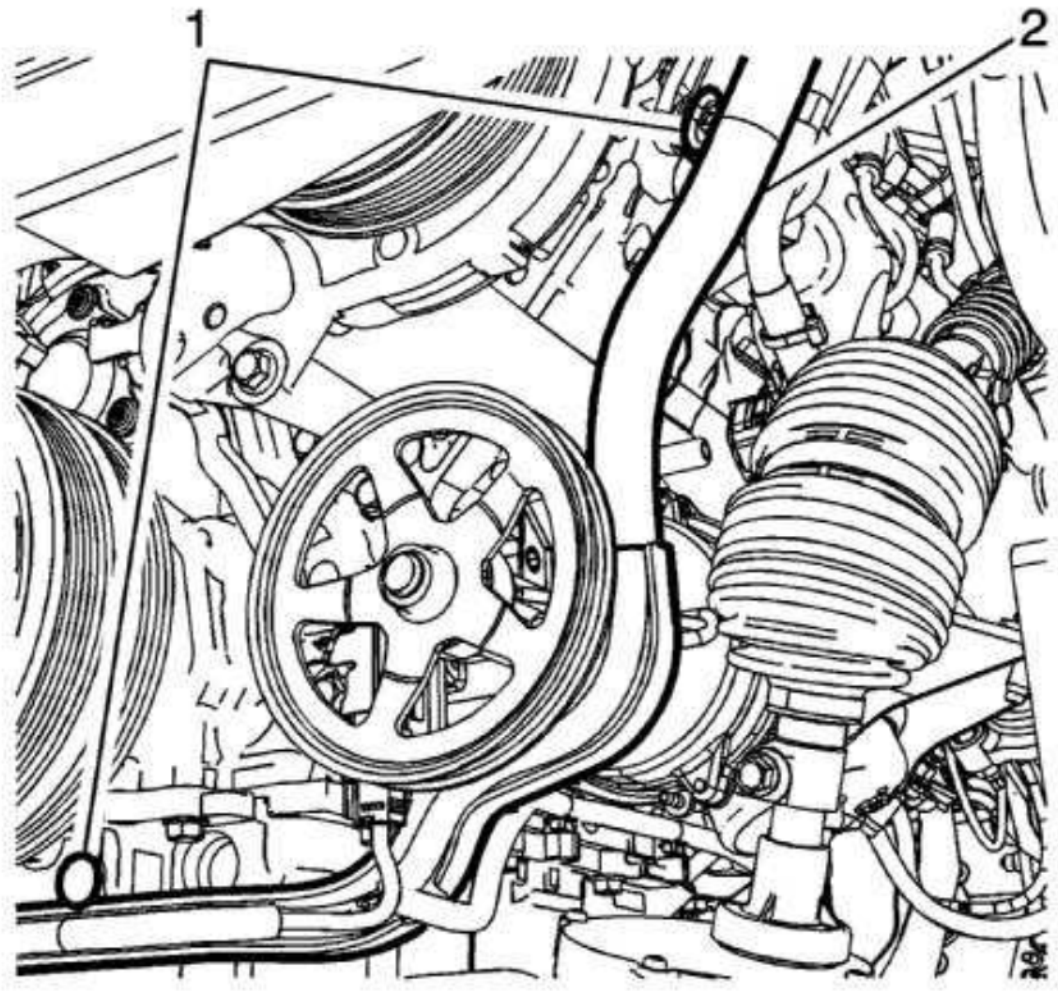


Fig. 181: Engine Electrical Wiring Harness Retainers And Reposition Harness
Courtesy of GENERAL MOTORS COMPANY

4. Reposition the engine wiring harness (2) and install the wiring harness retainers (1).
5. Install the steering gear skid shield. Refer to **Steering Gear Skid Shield Replacement** .

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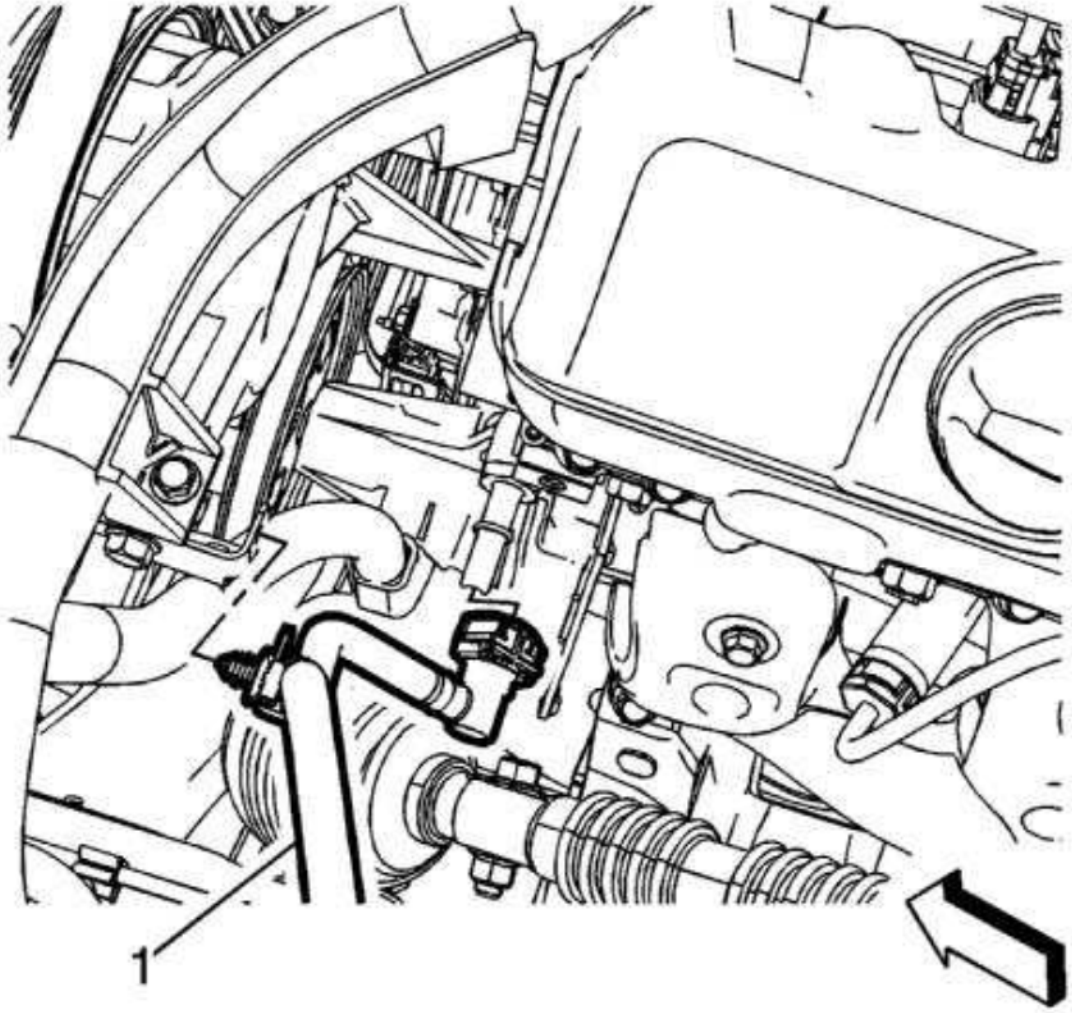


Fig. 182: Vacuum Boost Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Reposition and install the vacuum boost pipe (1) onto the vacuum pump. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Install the vacuum boost pipe (1) into its retainer.

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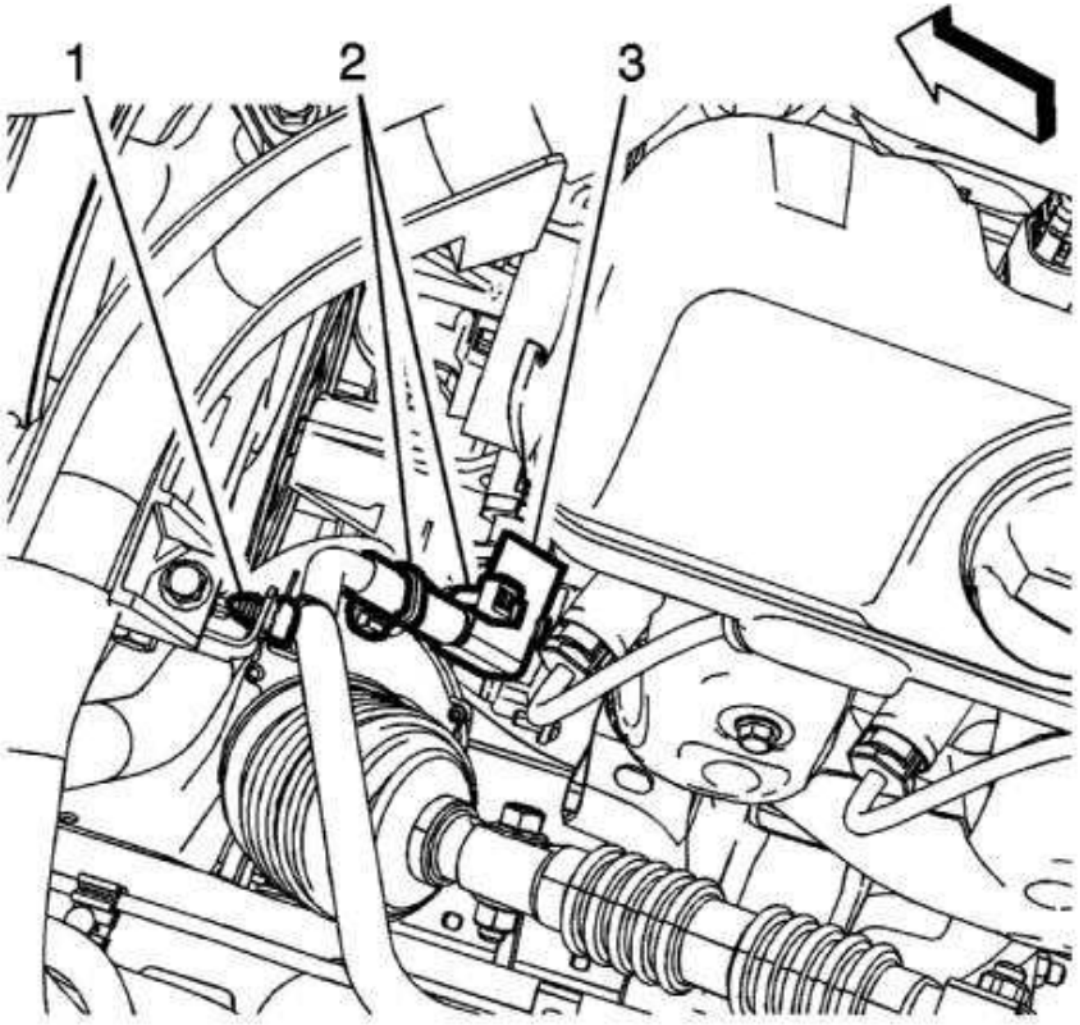


Fig. 183: Tie Straps And Vacuum Boost Pipe Sleeve
Courtesy of GENERAL MOTORS COMPANY

8. Position the vacuum boost pipe sleeve (3) in place and install zip ties (2) to secure it to the vacuum boost pipe.
9. Install the vacuum pump belt. Refer to **Vacuum Pump Belt Replacement** .
10. Connect the battery ground cable to the battery. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)** **Battery Negative Cable Disconnection and Connection (Single Battery)** .

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AIR CLEANER ELEMENT REPLACEMENT

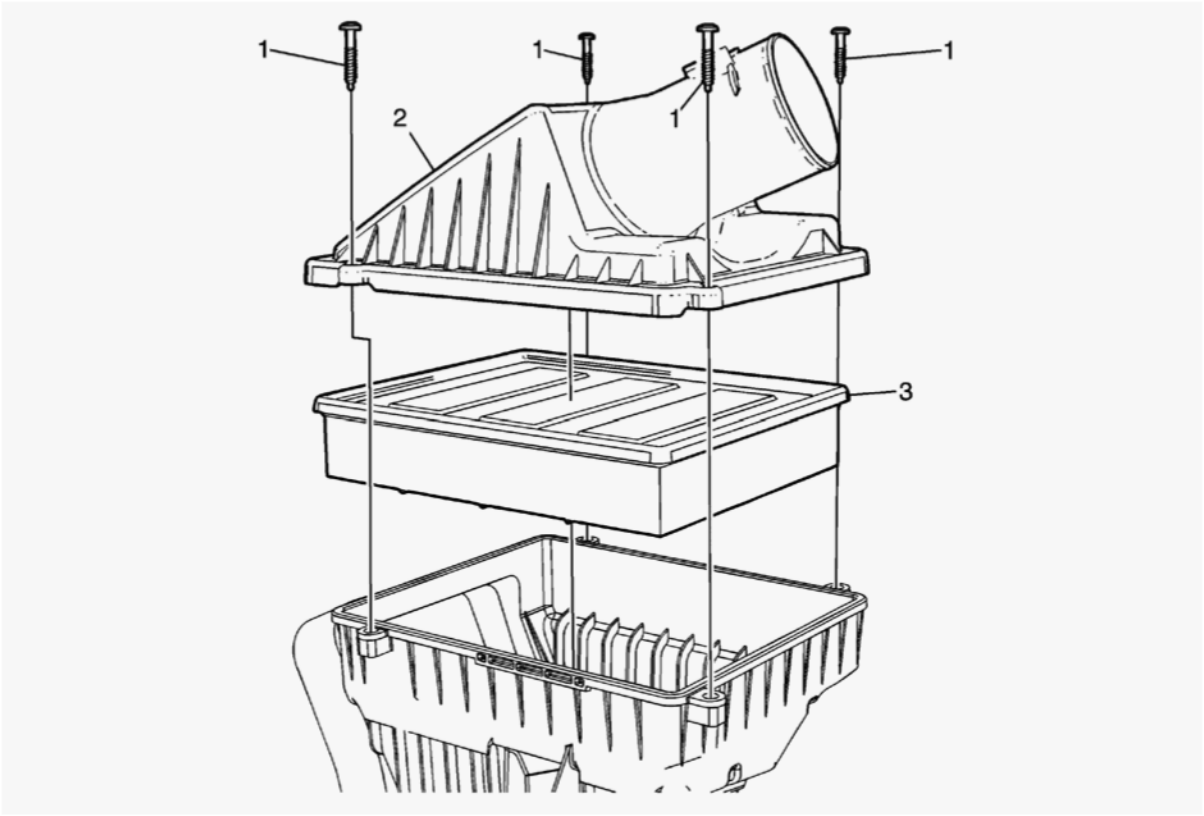


Fig. 184: View Of Air Cleaner Element
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Disconnect the air cleaner outlet duct from the air cleaner housing. Refer to **Air Cleaner Outlet Duct Replacement (Chevrolet and GMC)Air Cleaner Outlet Duct Replacement (Cadillac)**. 2. Disconnect and unclip the MAF harness from the air cleaner housing.	
1	Air Cleaner Housing Cover Screw (Qty: 4)

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Callout	Component Name
	CAUTION: **Refer to** **Fastener** Tighten **Caution** . 3 N.m (27 lb in)
2	Air Cleaner Housing
3	Air Cleaner Element

AIR CLEANER ASSEMBLY REPLACEMENT

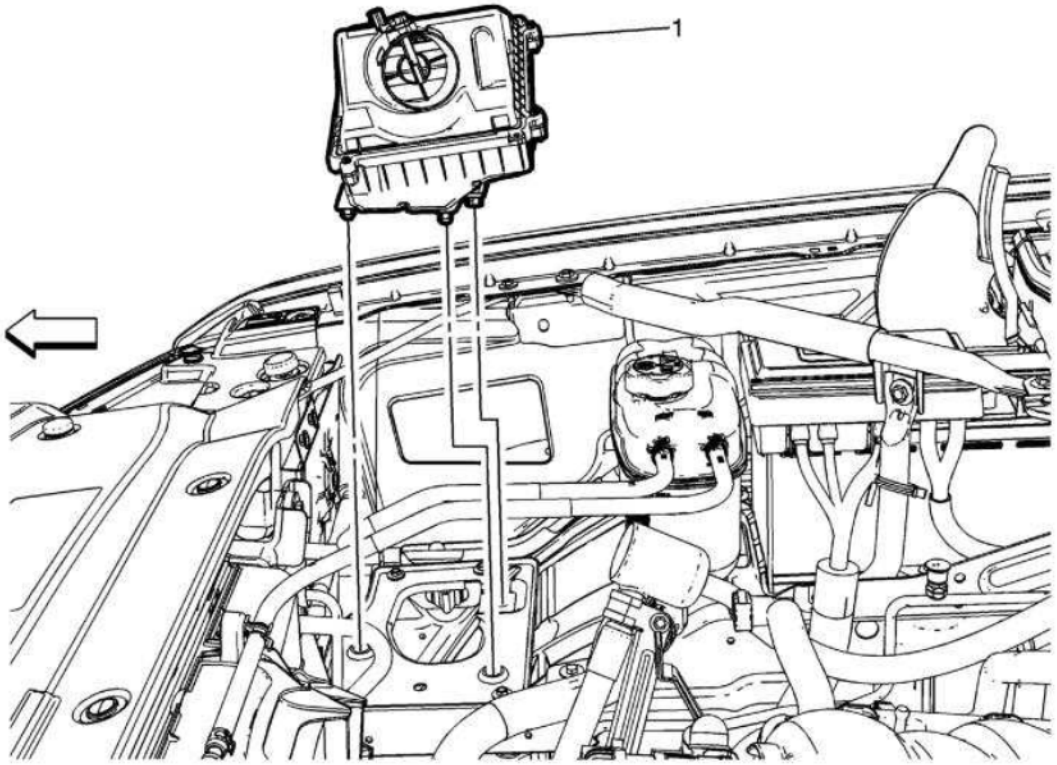
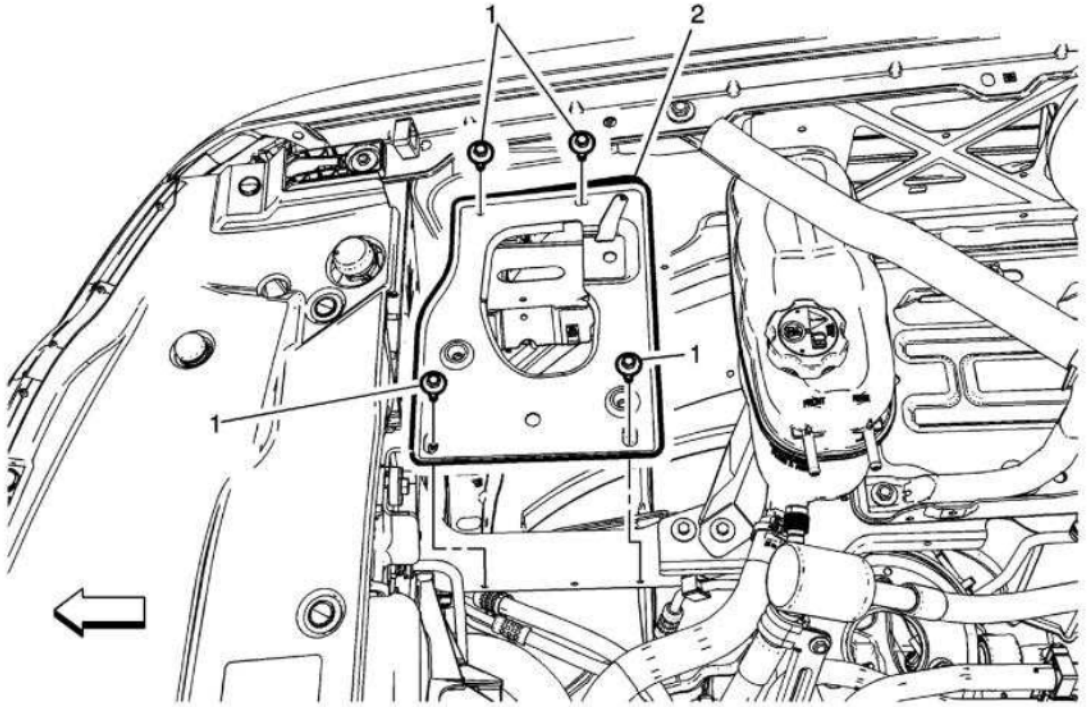


Fig. 185: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
Preliminary Procedures 1. If replacing, remove the mass airflow sensor, otherwise disconnect the mass airflow sensor electrical connector. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**. 2. Disconnect the air cleaner outlet duct from the air cleaner assembly. Refer to **Air Cleaner Outlet Duct Replacement (Chevrolet and GMC)Air Cleaner Outlet Duct Replacement (Cadillac)**.	
1	Air Cleaner Assembly **Procedure** Unclip the MAF harness retainer from the air cleaner housing. Pull upward in a jerking manner in order to disengage the air cleaner housing from the insulators.

AIR CLEANER BRACKET REPLACEMENT



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Fig. 186: Air Cleaner Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**.	
1	Air Cleaner Bracket Bolts (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Air Cleaner Bracket

AIR CLEANER OUTLET DUCT REPLACEMENT (CHEVROLET AND GMC)

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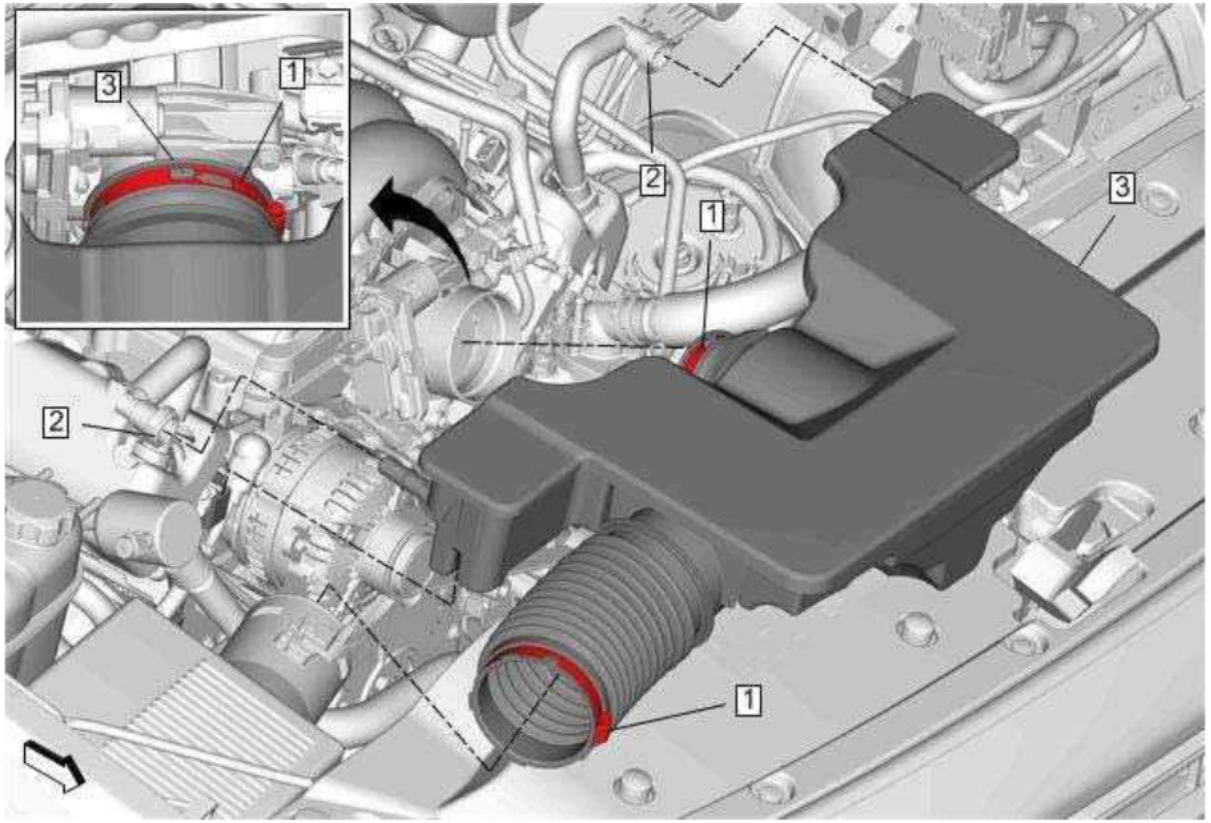


Fig. 187: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Air Cleaner Outlet Duct Clamps (Qty: 2) **NOTE:** **Ensure the outlet duct is fully seated to the mating surfaces before**

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Callout	Component Name
	clamping. Verify that the cuff is not rolled under.
2	PCV Tube Quick Connect Fitting
3	Air Cleaner Outlet Duct

AIR CLEANER OUTLET DUCT REPLACEMENT (CADILLAC)

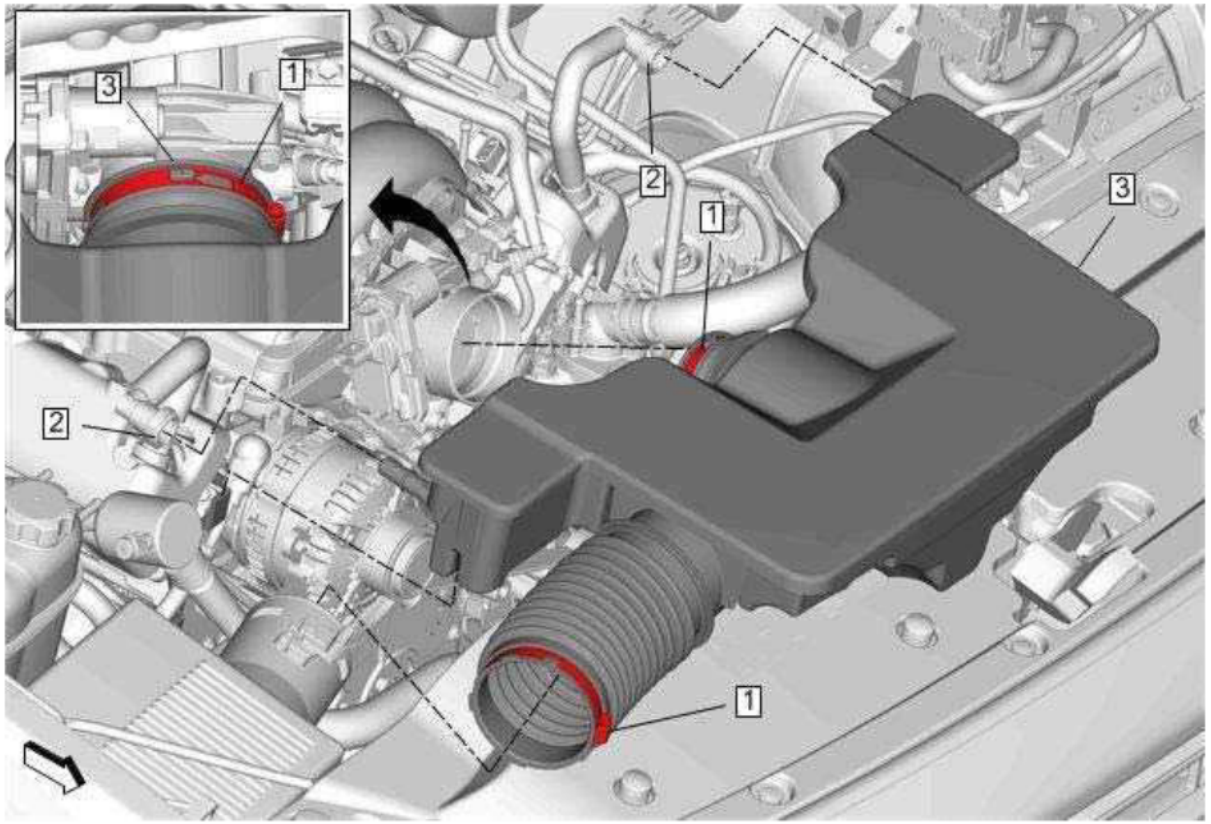


Fig. 188: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
Preliminary Procedure **Intake Manifold Cover Replacement**	
1	Air Cleaner Outlet Duct Clamp (Qty: 2) **NOTE:** **Ensure the outlet duct is fully seated to the mating surfaces before clamping. Verify that the cuff is not rolled under.**
2	PCV Tube Quick Connect Fitting
3	Air Cleaner Outlet Duct

FUEL PUMP POWER CONTROL MODULE REPLACEMENT

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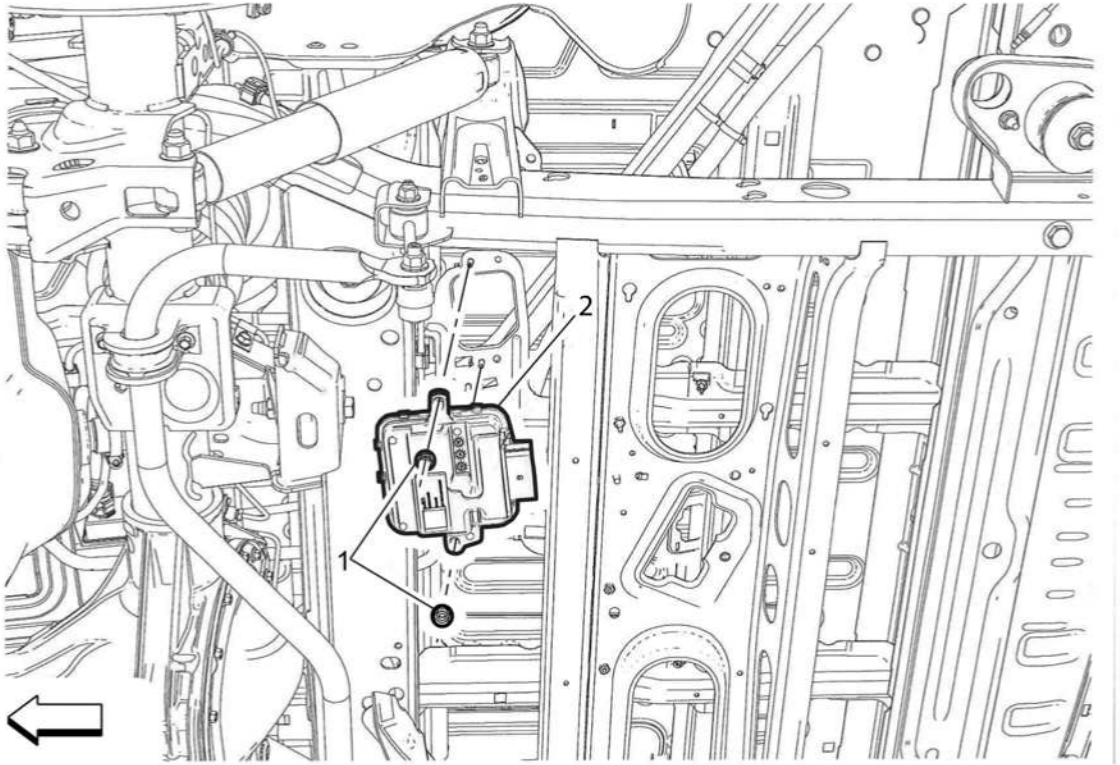


Fig. 189: Fuel Pump Power Control Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Fuel Pump Power Control Module Fastener (Qty: 2) **CAUTION:** **Refer to** **Fastener** **Caution** .

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Callout	Component Name
	Tighten 9 N.m (80 lb in)
2	Fuel Pump Power Control Module **Procedure** 1. Disconnect the electrical connector. 2. If replacing, reprogram the module. Refer to **Control Module References** .

FUEL FEED HOSE REPLACEMENT

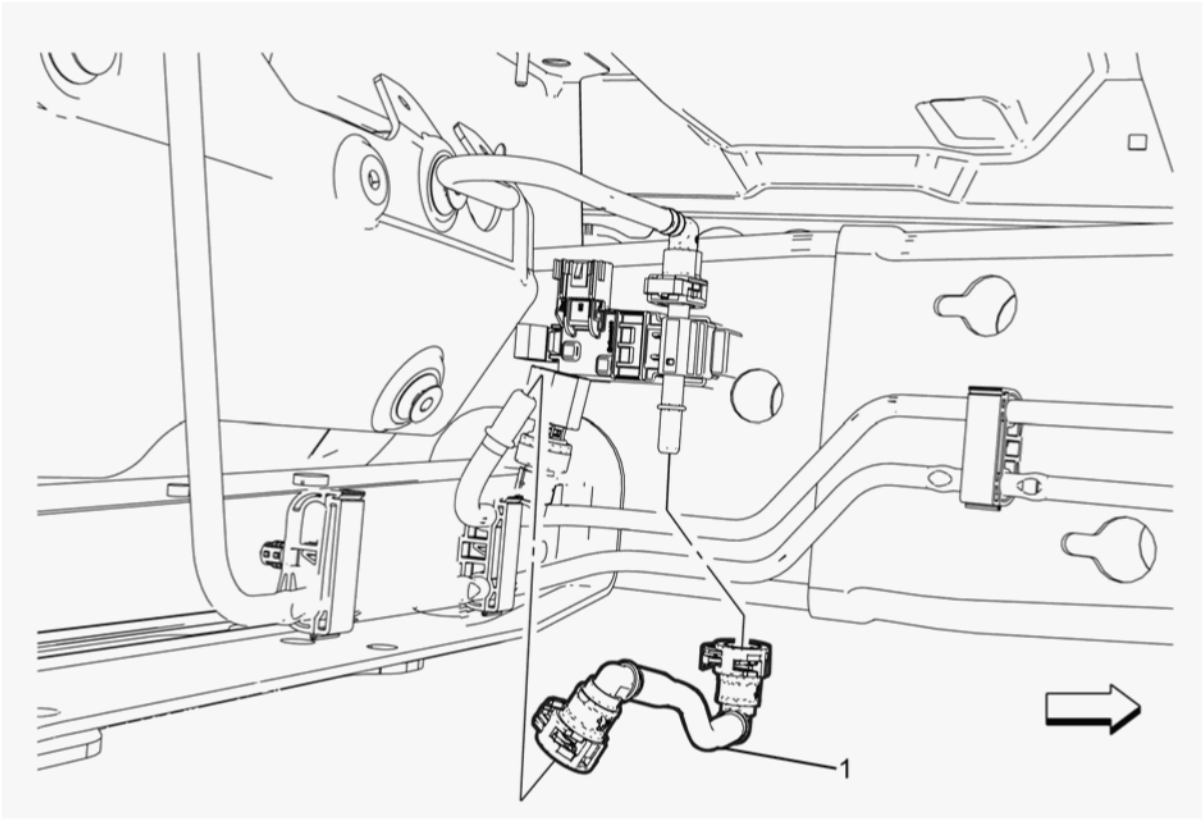


Fig. 190: Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**	
1	Fuel Feed Hose **Procedure** Disconnect the fuel feed hose quick connects. Refer to **Plastic Collar Quick Connect Fitting Service**.

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ENGINE PERFORMANCE

Engine Controls and Fuel - 5.3L (L83) or 6.2L (L86) - Schematic and Routing Diagrams - Engine Controls Schematics - Escalade, Suburban, Tahoe, Yukon

SCHEMATIC WIRING DIAGRAMS

ENGINE CONTROLS WIRING SCHEMATICS

Module Power, Ground, Serial Data and MIL

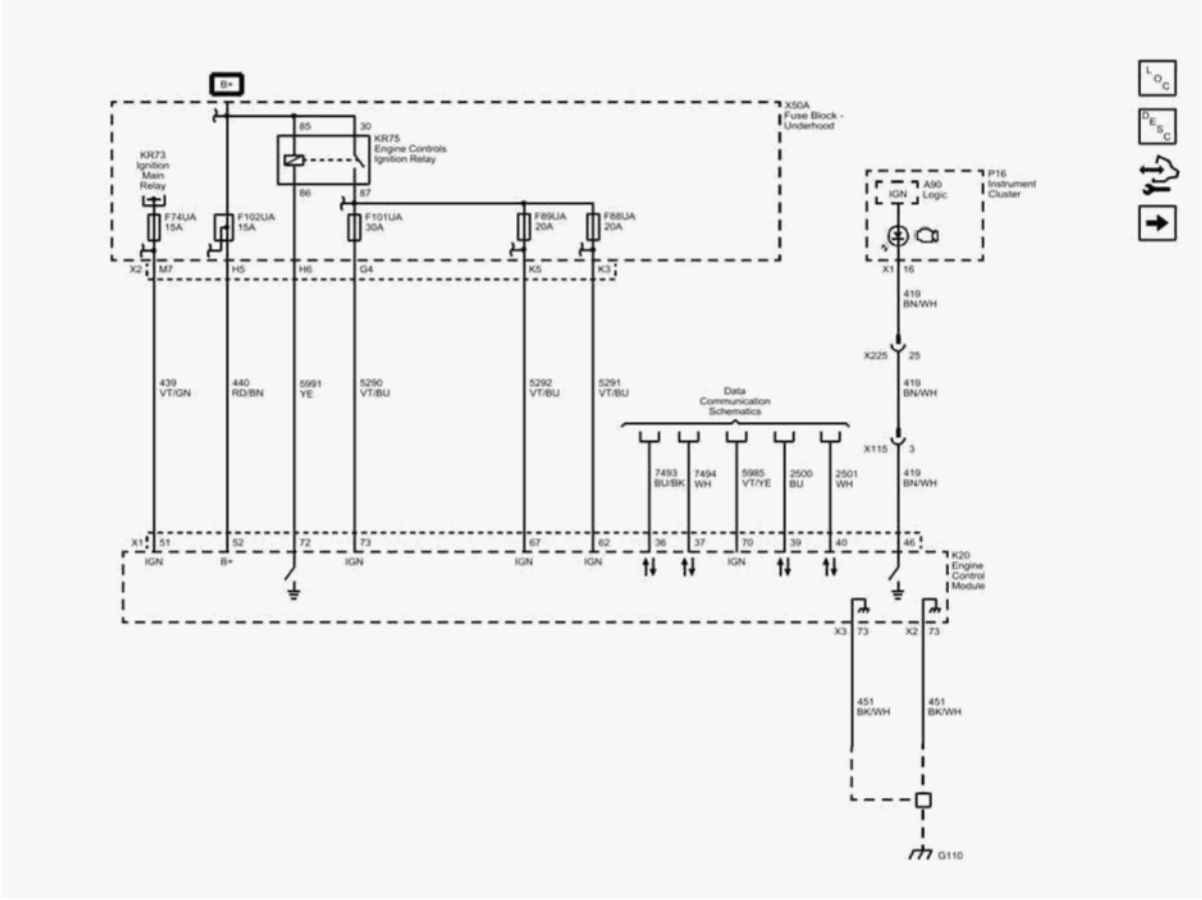


Fig. 1: Module Power, Ground, Serial Data and MIL

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Courtesy of GENERAL MOTORS COMPANY

5V and Low Reference Busses

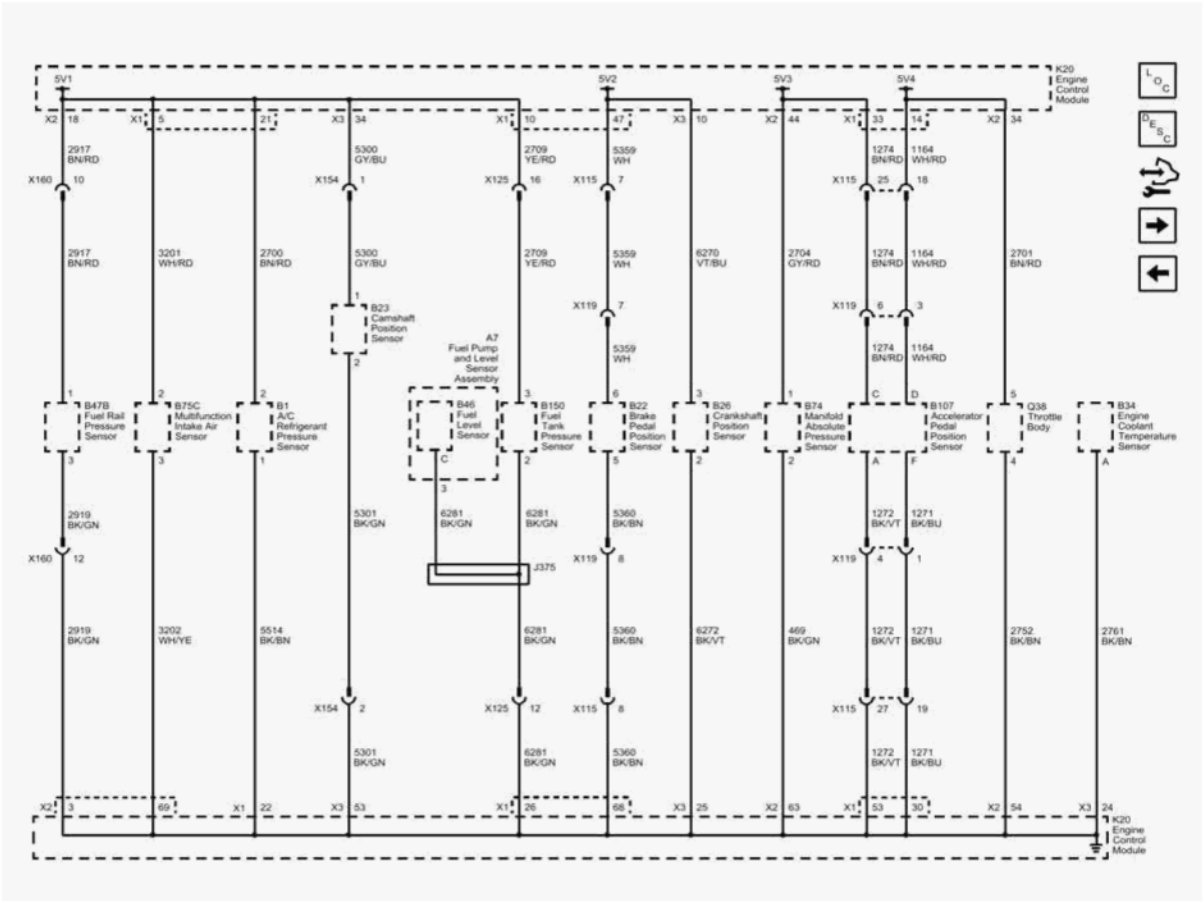


Fig. 2: 5V and Low Reference Busses
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Pressure, Temperature and Throttle Controls

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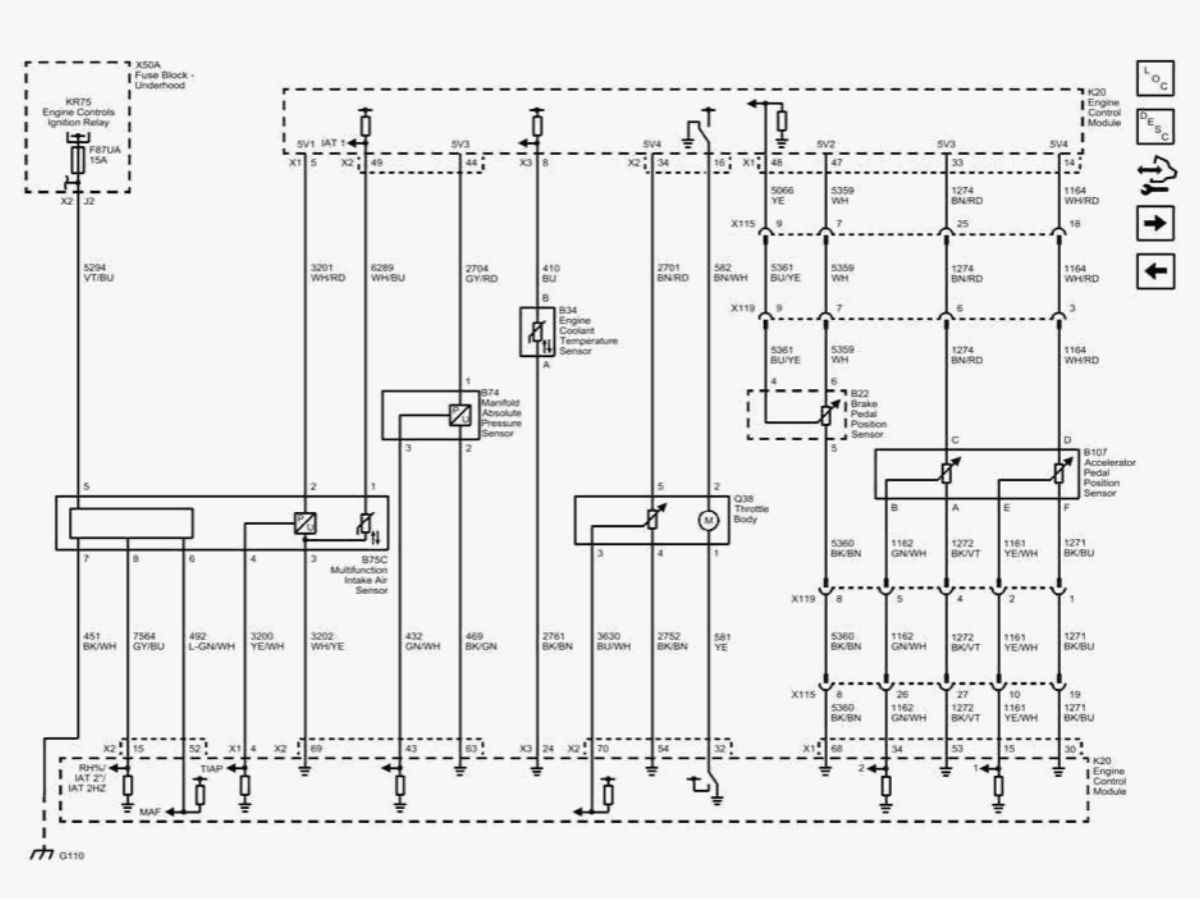


Fig. 3: Engine Data Sensors - Pressure, Temperature and Throttle Controls
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Oxygen Sensors

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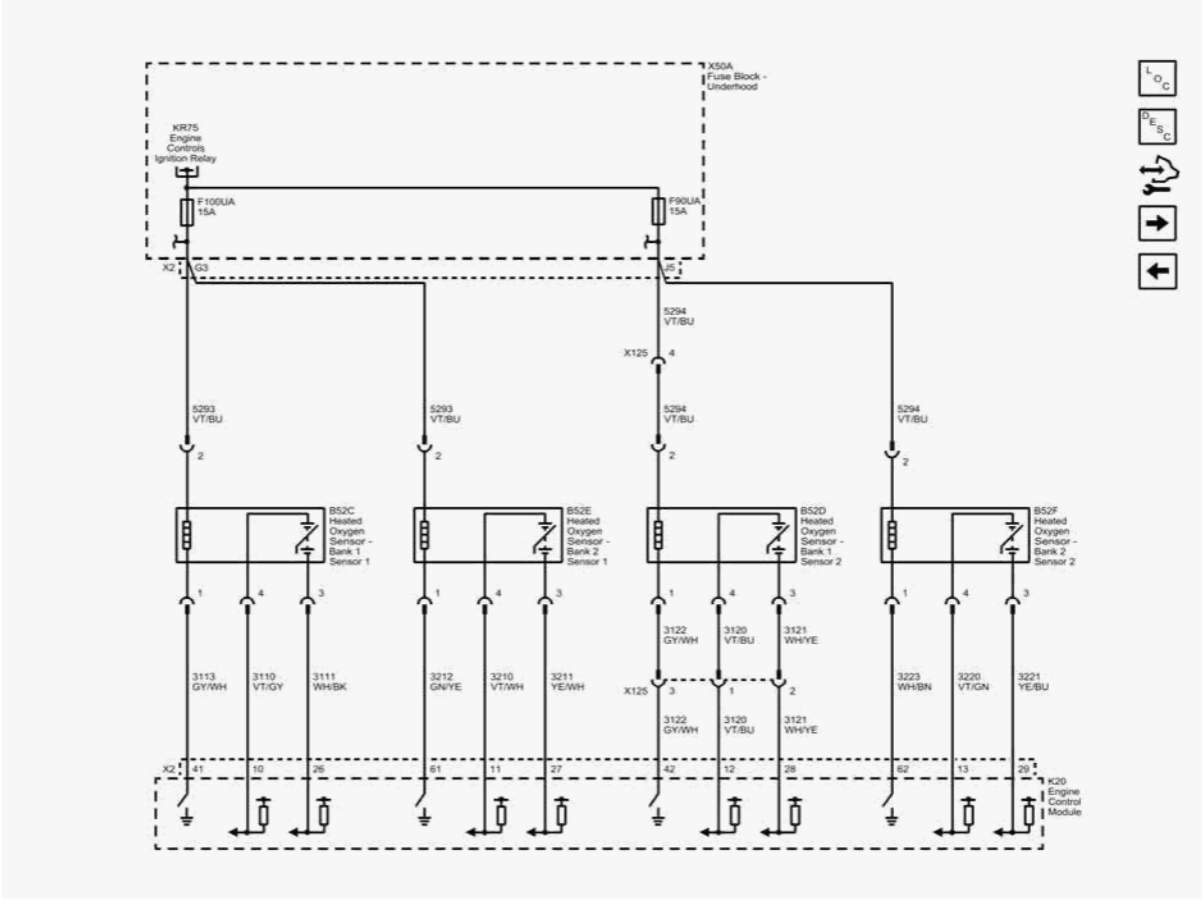


Fig. 4: Engine Data Sensors - Oxygen Sensors
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Ignition Coils Bank 1

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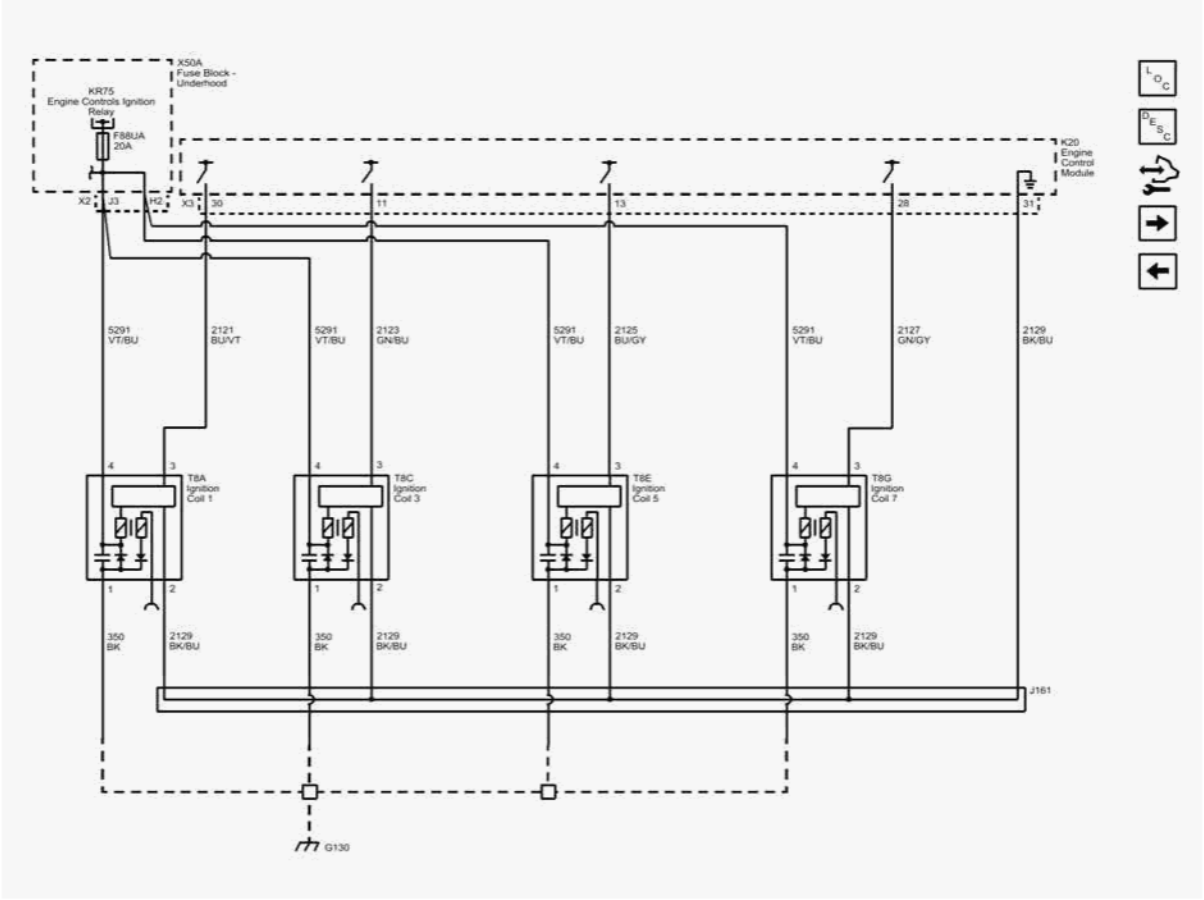


Fig. 5: Ignition Controls - Ignition Coils Bank 1

Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Ignition Coils Bank 2

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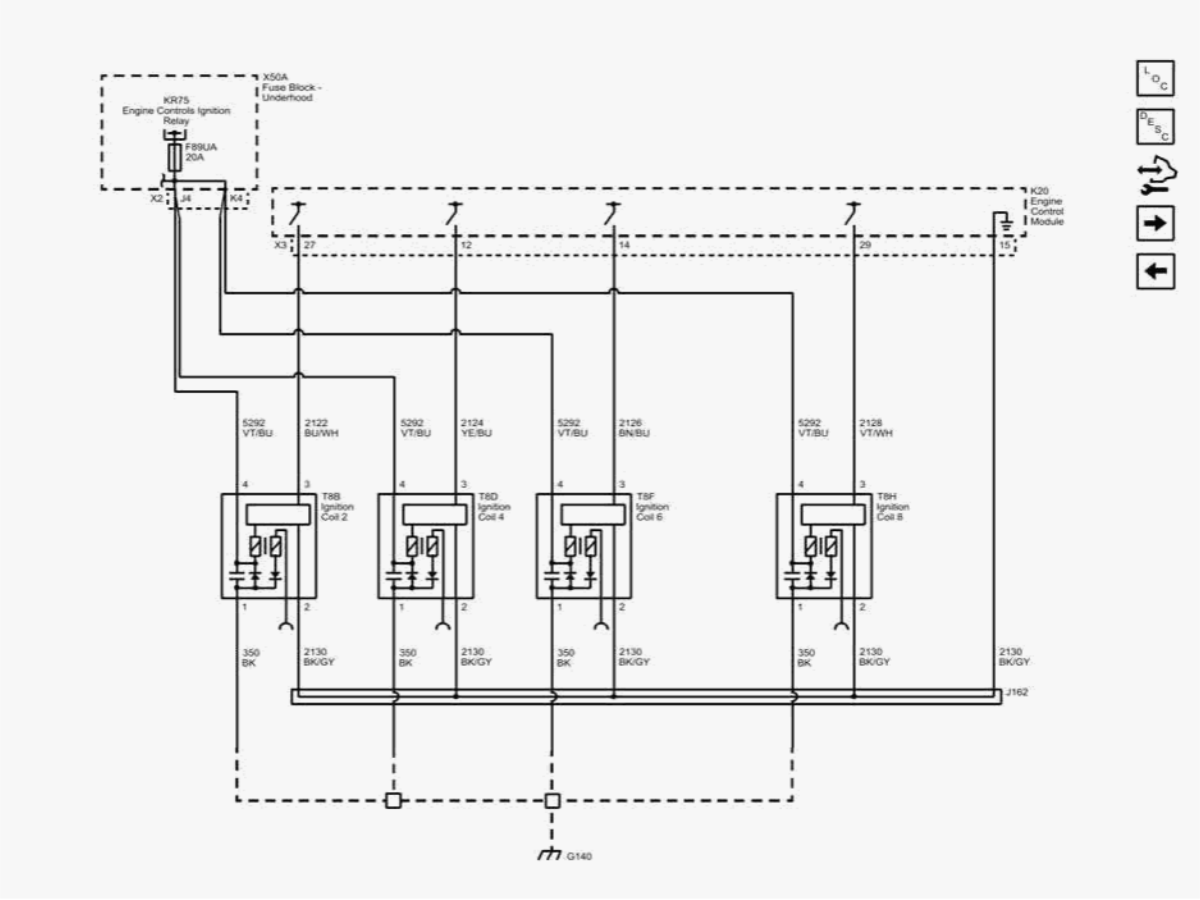


Fig. 6: Ignition Controls - Ignition Coils Bank 2
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Crankshaft Position, Camshaft Position and Knock Sensors, and Camshaft Position Actuator Solenoid

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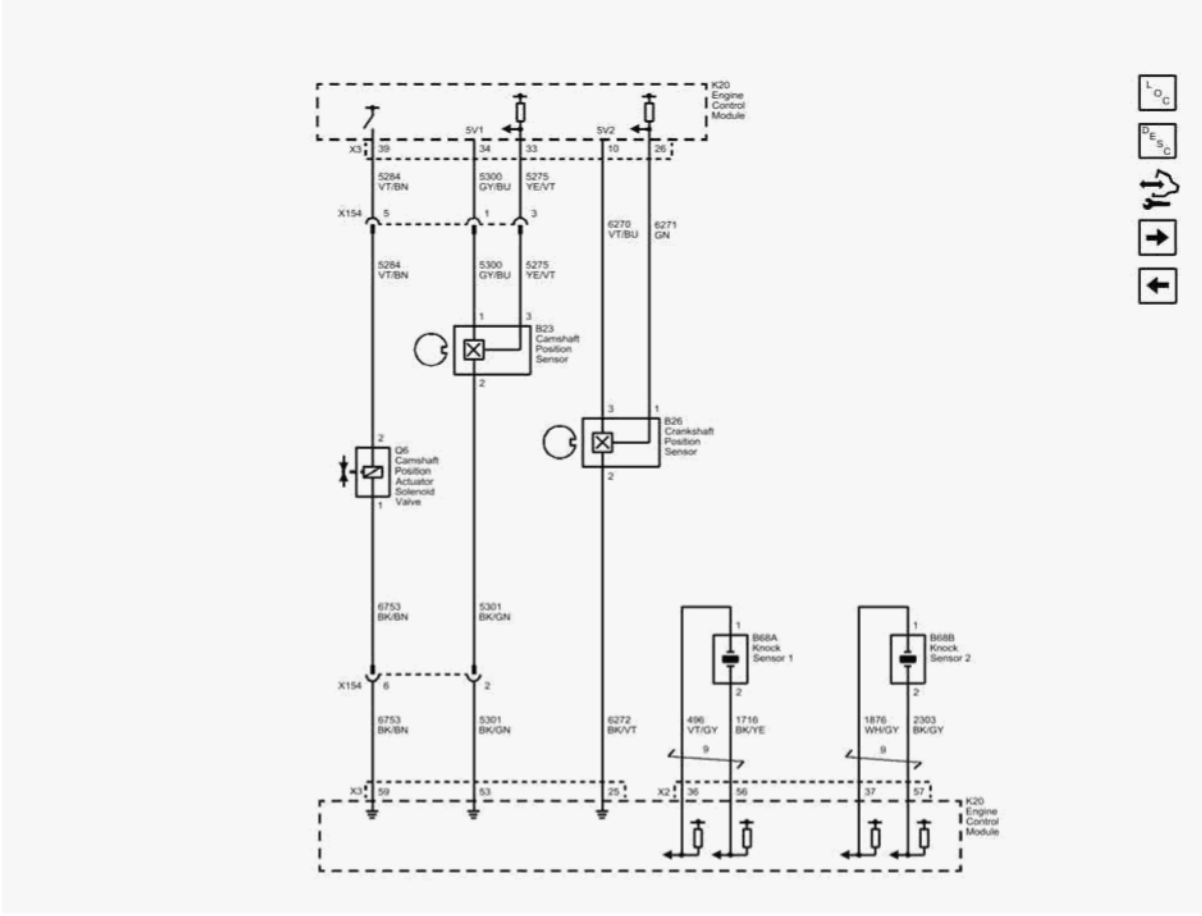


Fig. 7: Ignition Controls - Crankshaft Position, Camshaft Position and Knock Sensors, and Camshaft Position Actuator Solenoid
Courtesy of GENERAL MOTORS COMPANY

Valve Lifter Oil Manifold Assembly

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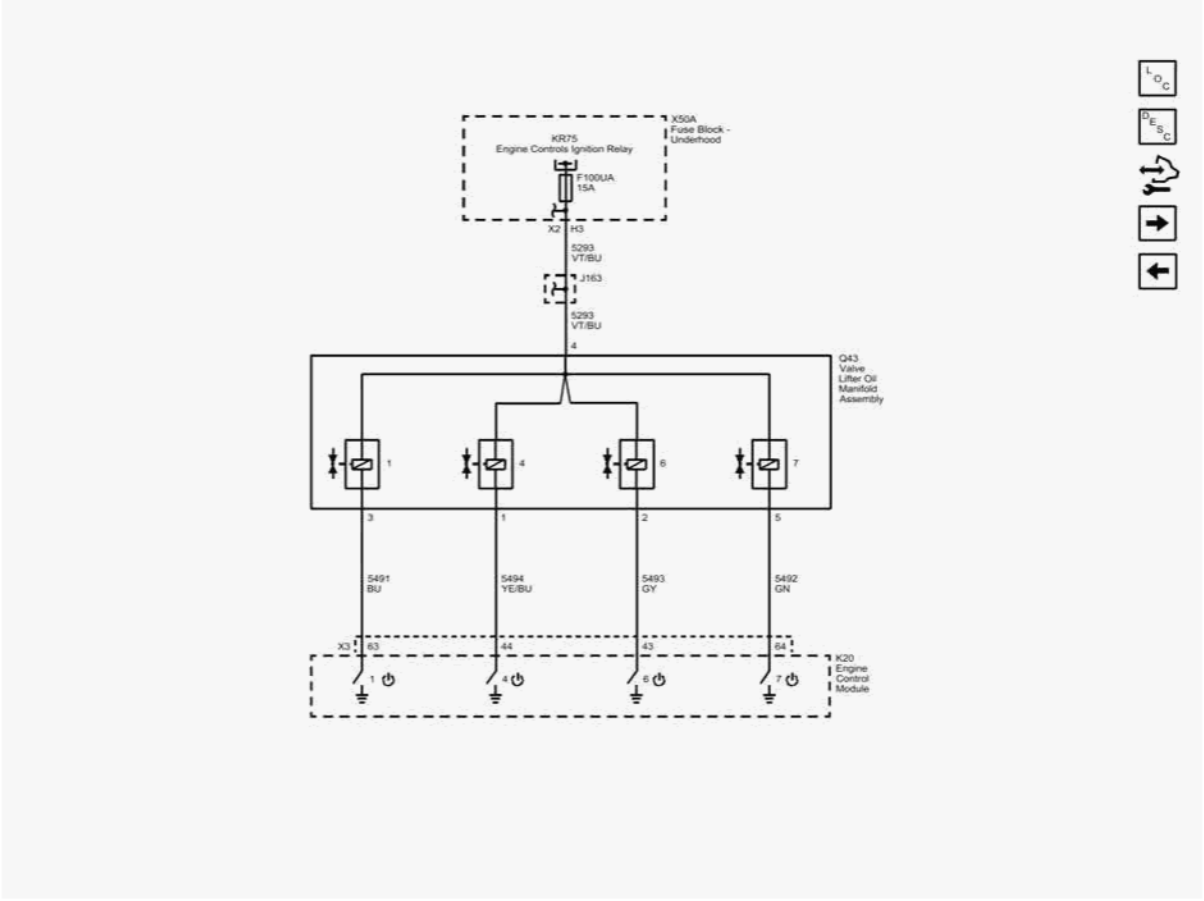


Fig. 8: Valve Lifter Oil Manifold Assembly
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Injectors and Fuel Pressure

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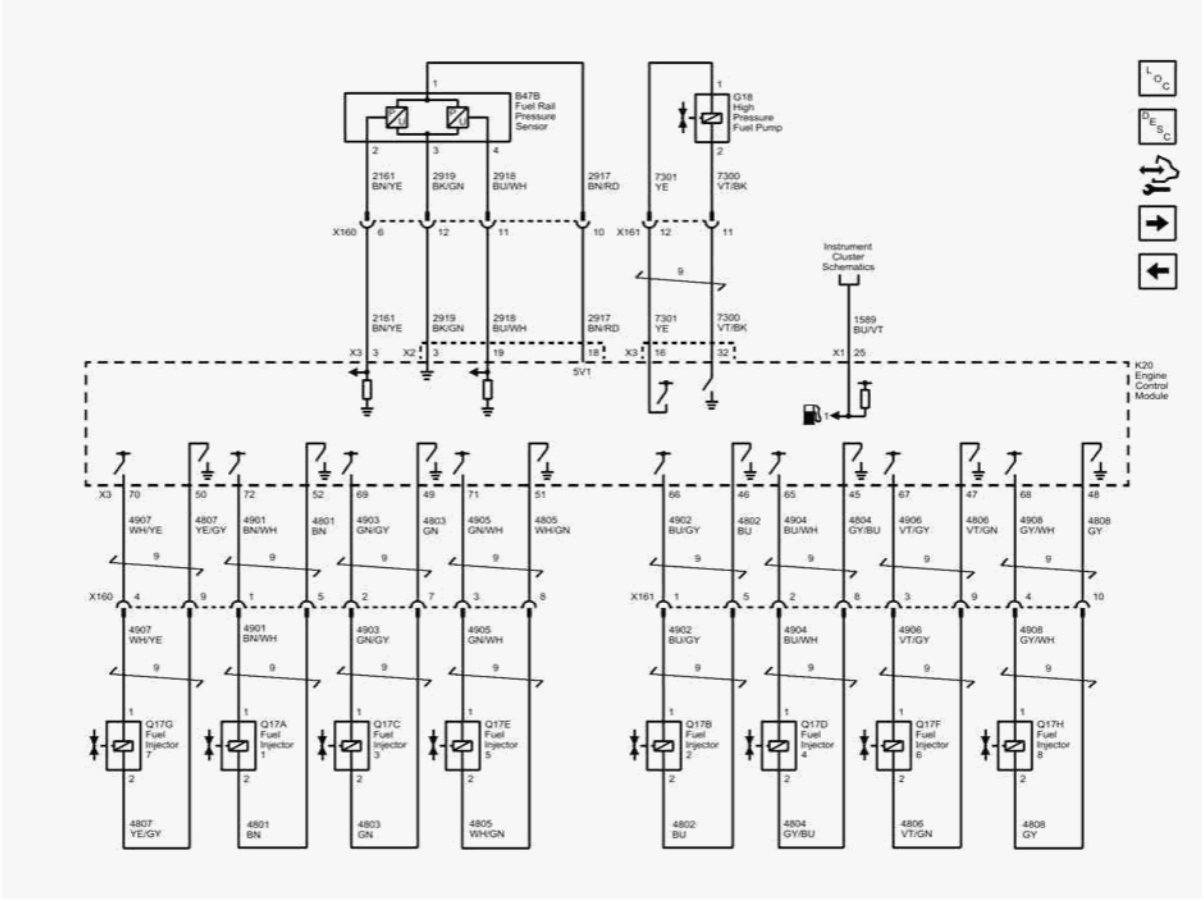


Fig. 9: Fuel Controls - Fuel Injectors and Fuel Pressure
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Pump Control

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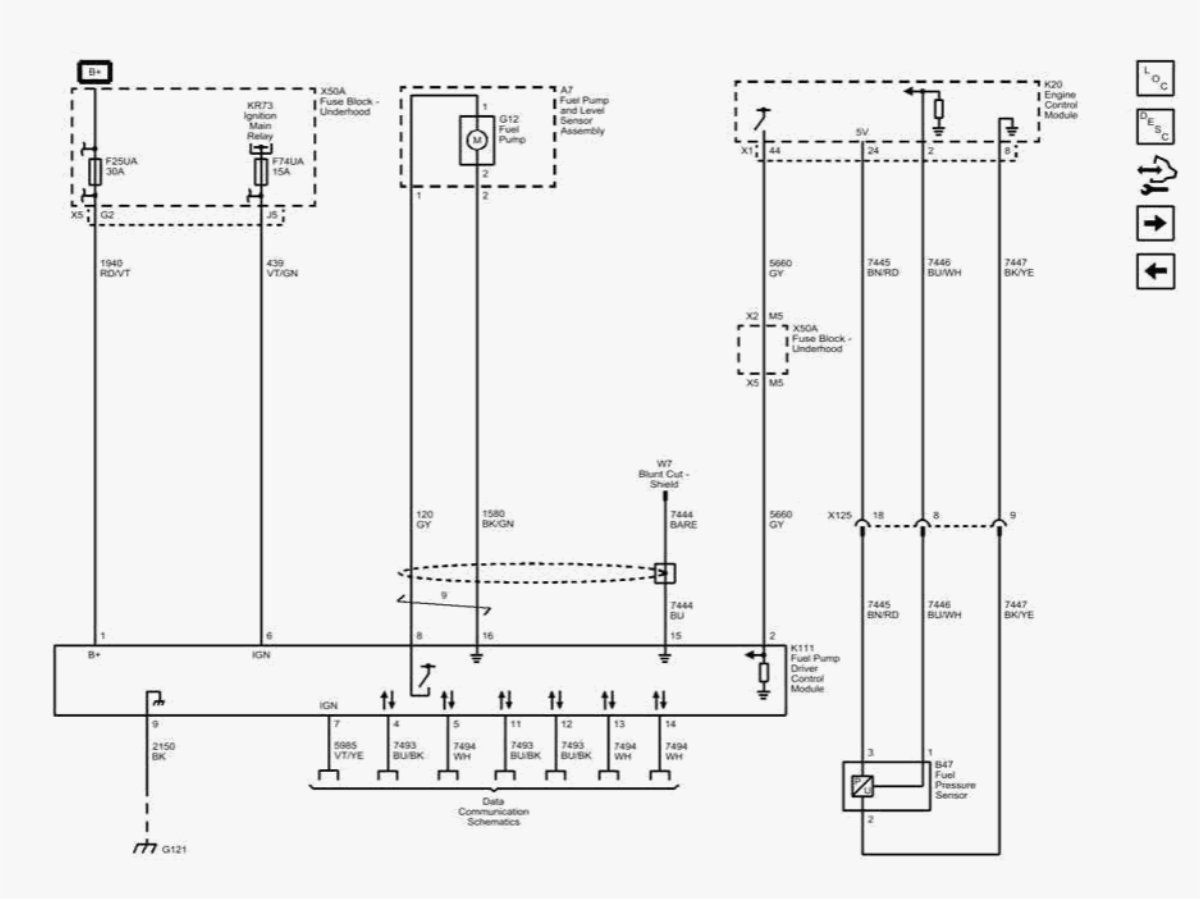


Fig. 10: Fuel Controls - Fuel Pump Control

Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Evaporative Emissions Controls

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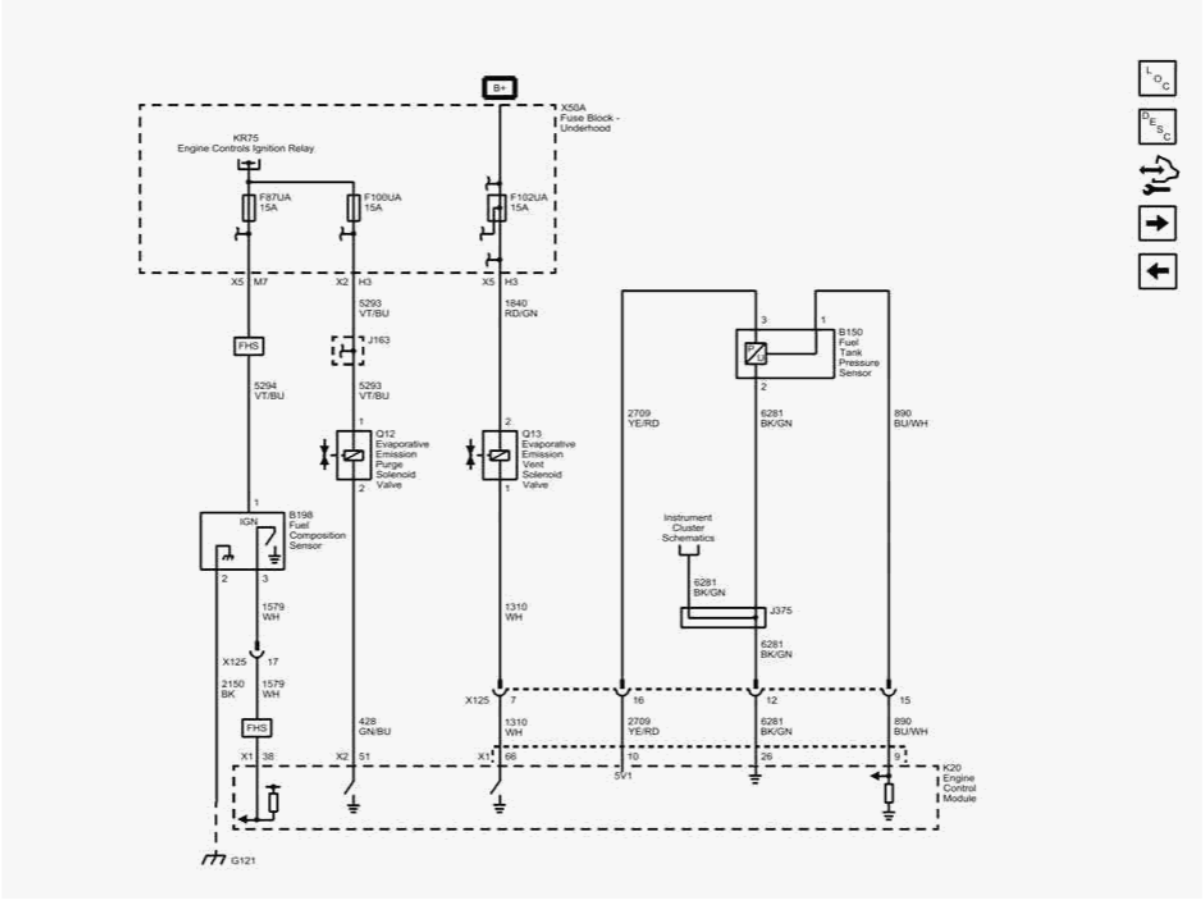


Fig. 11: Fuel Controls - Evaporative Emissions Controls
Courtesy of GENERAL MOTORS COMPANY

Controlled/Monitored Subsystem References

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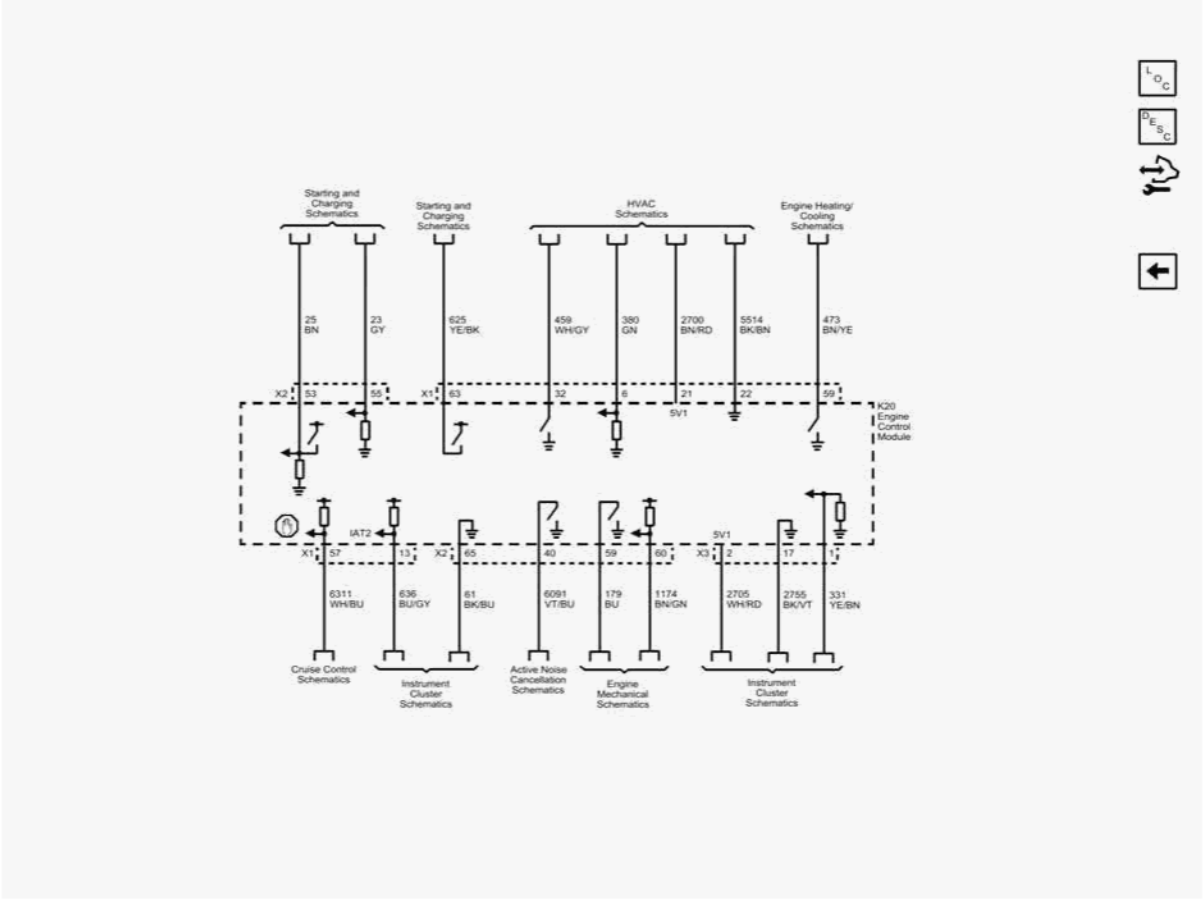


Fig. 12: Controlled/Monitored Subsystem References

Courtesy of GENERAL MOTORS COMPANY

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