2013 ENGINE PERFORMANCE

Engine Controls and Fuel - 1.8L LUW and LWE - Description and Operation - Cruze

DESCRIPTION AND OPERATION

ENGINE CONTROL MODULE DESCRIPTION

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

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

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

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

ECM Function

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

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

EEPROM

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

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

Data Link Connector (DLC)

The data link connector (DLC) provides serial data communication for ECM diagnosis. This connector allows the technician to use a scan tool in order to monitor various serial data parameters, and display DTC

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

Malfunction Indicator Lamp (MIL)

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

ECM Service Precautions

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

Emissions Diagnosis For State I/M Programs

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

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

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

Aftermarket (Add-On) Electrical And Vacuum Equipment

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

CAUTION: Connect any add-on electrically operated equipment to the vehicle's electrical system at the 12 V battery (power and ground) in order to prevent damage to the vehicle.

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

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

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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).

FUEL SYSTEM DESCRIPTION

Fuel System Overview

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

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

Electronic Returnless Fuel System

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

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Fuel Pump Flow Control Module

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

Fuel Pressure Sensor

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

Flex Fuel Sensor (If Equipped)

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

The flex 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 battery positive voltage and the ground circuit connects to an engine ground. The signal circuit carries the ethanol percentage via a frequency signal.

The flex fuel sensor uses a microprocessor inside the sensor to measure the ethanol percentage and changes the output signal accordingly. The ECM provides an internal pull-up to 5 V on the signal circuit, and the flex fuel sensor pulls the 5 V to ground in pulses. The normal range of operating frequency is between 50 and 150 Hz, with 50 Hz representing 0 percent ethanol, and 150 Hz representing 100 percent ethanol.

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. 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 flex 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

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contains only about 81 percent ethanol. The flex fuel sensor measures the actual percentage of ethanol in the fuel.

Fuel Tank

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

Fuel Filler Cap

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

Fuel Tank Fuel Pump Module

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

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

Fuel Level Sensor

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

Fuel Pump

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

Fuel Strainer

The fuel strainer is attached to the lower end of the fuel tank fuel pump module. The fuel strainer is made of woven plastic. The functions of the fuel strainer are to filter contaminants and to wick away fuel. Normally, the

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fuel strainer does not require maintenance. Fuel stoppage at this point indicates that the fuel tank contains an abnormal amount of sediment or contamination.

Jet Pump

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

Pressure Relief Regulator Valve

The pressure relief regulator valve replaces the typical fuel pressure regulator used on a mechanical returnless fuel system. The pressure relief regulator valve is closed during normal vehicle operation. The pressure relief regulator valve is used to vent pressure during hot soaks and also functions as a fuel pressure regulator in the event of the fuel pump flow control module defaulting to 100% pulse width modulation (PWM) of the fuel pump. Due to variation in the fuel system pressures, the opening pressure for the pressure relief regulator valve is set higher than the pressure that is used on a mechanical returnless fuel system pressure regulator.

Nylon Fuel Pipes

WARNING: Refer to Fuel and Evaporative Emission Pipe Warning .

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

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

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

Quick-Connect Fittings

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

Fuel Pulse Dampener

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

Fuel Rail Assembly

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

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

Fuel Injectors

The fuel injector assembly is a solenoid device controlled by the ECM that meters pressurized fuel to a single engine cylinder. The ECM energizes the high-impedance, 12 ohms, injector solenoid to open a ball valve, normally closed. This allows fuel to flow into the top of the injector, past the ball valve, and through a director plate at the injector outlet. The director plate has machined holes that control the flow of fuel, generating a spray of finely atomized fuel at the injector tip. Fuel from the injector tip is directed at the intake valve, causing the fuel to become further atomized and vaporized before entering the combustion chamber. This fine atomization improves fuel economy and emissions.

Fuel Metering Modes of Operation

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

Starting Mode

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

Clear Flood Mode

If the engine is flooded with fuel during starting and will not start, the clear flood mode can be manually enabled. To enable Clear Flood Mode, press the accelerator to wide open throttle (WOT). The ECM will completely turn OFF the fuel injectors and will maintain this mode as long as the ECM detects a WOT condition with engine speed below a predetermined value.

Run Mode

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

- The HO2S has varying voltage output, showing that the HO2S is hot enough to operate properly.

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- The ECT sensor is above a specified temperature.
- A specific amount of time has elapsed after starting the engine.

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

Acceleration Mode

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

Deceleration Mode

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

Battery Voltage Correction Mode

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

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

Fuel Cutoff Mode

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

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

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Fuel Trim

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

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

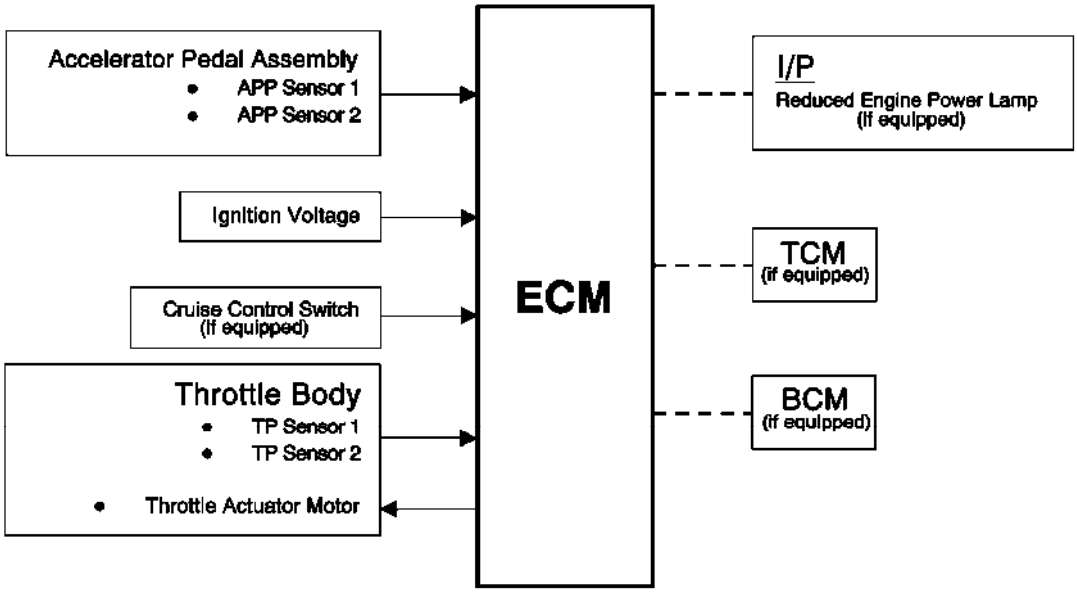


Fig. 1: Throttle Actuator Control (TAC) System Diagram
Courtesy of GENERAL MOTORS COMPANY

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

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Modes Of Operation

Normal Mode

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

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

Reduced Engine Power Mode

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

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

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

Camshaft Actuator System Overview

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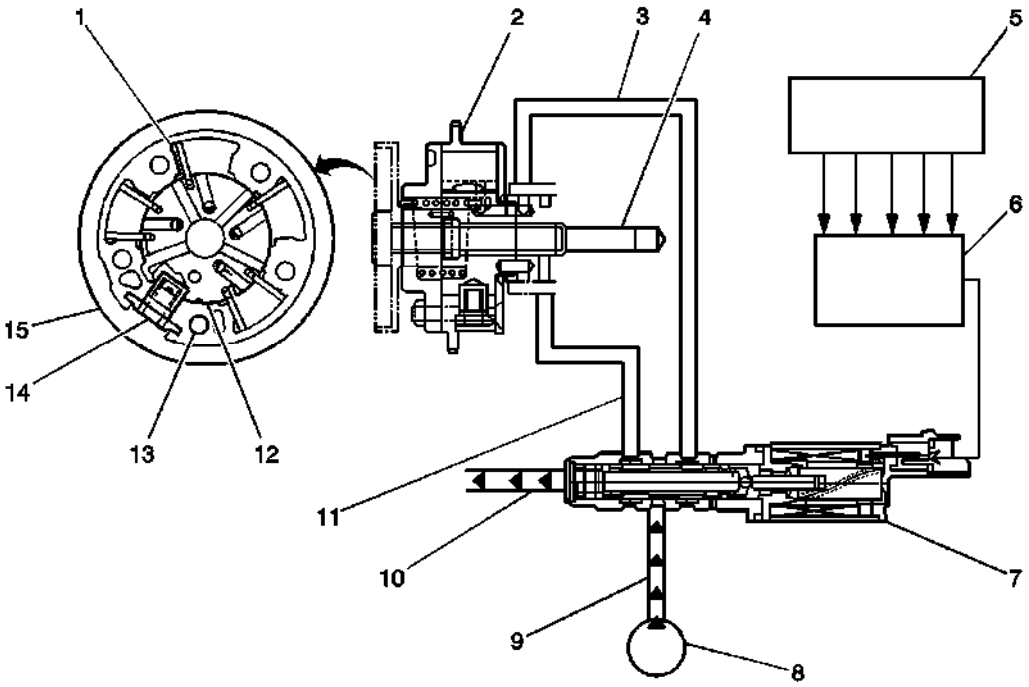


Fig. 2: Camshaft Actuator Component Views
Courtesy of GENERAL MOTORS COMPANY

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

The camshaft actuator system enables the engine control module (ECM) to change camshaft timing of all 4 camshafts while the engine is operating. The camshaft position (CMP) actuator assembly (15) varies the camshaft position in response to directional changes in oil pressure. The CMP actuator solenoid valve controls the oil pressure that is applied to advance or retard a camshaft. Modifying camshaft timing under changing

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engine demand provides better balance between the following performance concerns:

- Engine power output
- Fuel economy
- Tailpipe emissions

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

- Engine coolant temperature
- Calculated engine oil temperature (EOT)
- Mass air flow (MAF)
- Throttle position (TP)
- Vehicle speed
- Volumetric efficiency

Operation

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

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

CMP Actuator System Operation

Driving Condition	Change in Camshaft Position	Objective	Result
Idle	No Change	Minimize Valve Overlap	Stabilized Idle Speed
Light Engine Load	Retarded Valve Timing	Decrease Valve Overlap	Stabled Engine Output

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Medium Engine Load	Advanced Valve Timing	Increase Valve Overlap	Better Fuel Economy with Lower Emissions
Low to Medium RPM with Heavy Load	Advanced Valve Timing	Advance Intake Valve Closing	Improved Low to Mid-range Torque
High RPM with Heavy Load	Retarded Valve Timing	Retard Intake Valve Closing	Improved Engine Output

EVAPORATIVE EMISSION CONTROL SYSTEM DESCRIPTION

Typical Evaporative Emission (EVAP) System Hose Routing Diagram

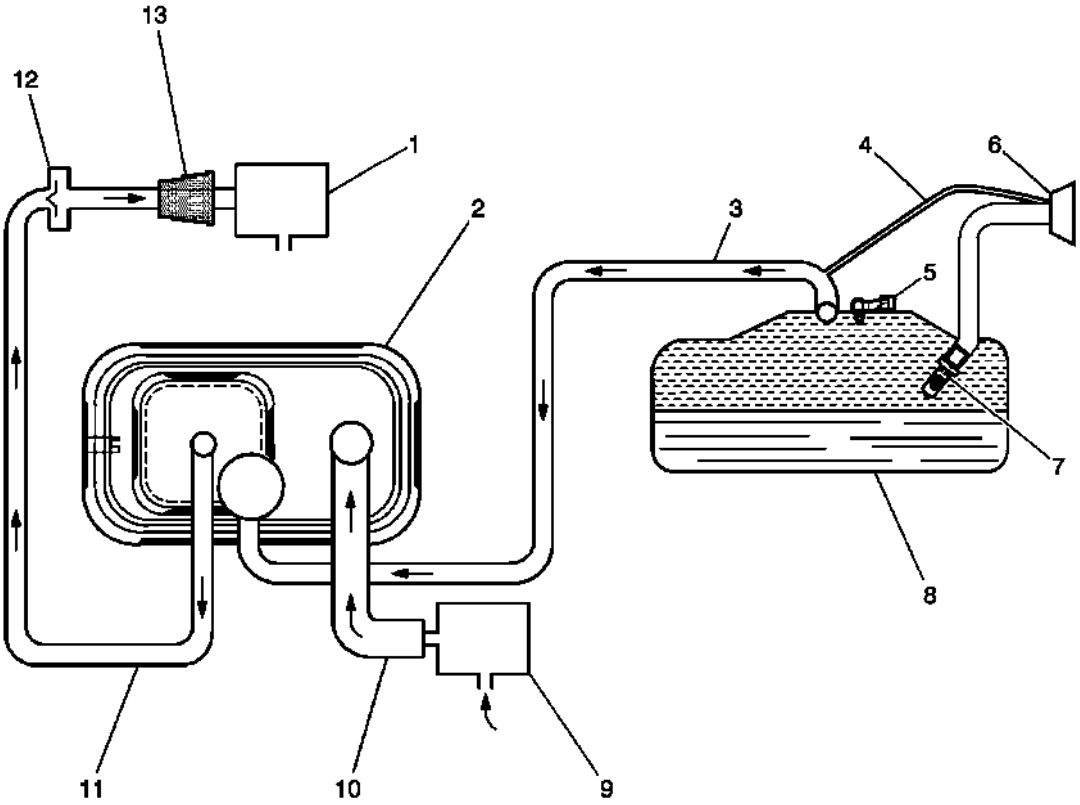


Fig. 3: View Of Evaporative Emission (EVAP) System Hose Routing Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Evaporative Emissions (EVAP) Purge Solenoid Valve
2	EVAP Canister
3	EVAP Vapor Tube

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4	Vapor Recirculation Tube
5	Fuel Tank Pressure Sensor
6	Fuel Filler Cap (Some Vehicles May Have A Capless Design)
7	Fuel Fill Pipe Inlet Check Valve
8	Fuel Tank
9	EVAP Canister Vent Solenoid Valve
10	Vent hose
11	EVAP Purge Tube
12	Purge Tube Check Valve, Turbo-Charged Applications Only
13	EVAP Canister Purge Tube Connector

EVAP System Operation

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

Purge Solenoid Valve Leak Test

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

Large Leak Test

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

Canister Vent Restriction Test

If the EVAP vent system is restricted, fuel vapors will not be properly purged from the EVAP canister. The ECM tests this by commanding the EVAP purge solenoid valve ON while commanding the EVAP vent

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solenoid valve OFF, and then monitoring the FTP sensor for an increase in vacuum. If the vacuum increases more than the expected amount, in a set amount of time, a fault will be logged by the ECM.

Small Leak Test

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

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

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

EVAP System Components

The EVAP system consists of the following components:

EVAP Purge Solenoid Valve

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

Purge Tube Check Valve

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

EVAP Canister

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

Vapor Recirculation Tube

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

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Fuel Tank Pressure Sensor

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

Fuel Fill Pipe Check Valve

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

EVAP Vent Solenoid Valve

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

Fuel Fill Cap

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

Capless Fuel Fill

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

ELECTRONIC IGNITION SYSTEM DESCRIPTION

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) collects information from the crankshaft position sensor and the intake/exhaust camshaft position sensors to determine the sequence, dwell, and timing of the spark for each cylinder. The ECM transmits a frequency signal to the ignition coil module on the individual ignition control circuits to fire the spark plugs.

Crankshaft Position Sensor

The crankshaft position sensor is an externally magnetically biased digital output integrated circuit sensing device. The sensor provides a pulse for each magnetic pole of the encoder wheel on the crankshaft. The sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the sensor output depends on the velocity of the crankshaft. The ECM uses sensor signal pulse to determine crankshaft speed and position to calculate the best timing for ignition and fuel injection. The ECM also uses the crankshaft position sensor information 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.

The crankshaft position sensor is connected to the engine control module by the circuits listed below:

- A 5 V reference circuit
- A low reference circuit
- A signal circuit

Crankshaft Encoder Wheel

The crankshaft encoder wheel is part of the crankshaft. The encoder wheel consists of 58 tooth and a reference gap. Each tooth on the encoder wheel is spaced 6° apart with a 12° space for the reference gap. The pulse from the reference gap is known as the sync pulse. The sync pulse is used to synchronize the ignition coil module firing sequence with the crankshaft position while the other tooth provides cylinder location during a revolution.

Camshaft Position Sensors

The intake and exhaust camshaft position sensors are each triggered by a notched reluctor wheel built onto the camshaft sprockets. The four signal pulses occur every camshaft revolution. Each notch is a different size which is used to identify the compression stroke of each cylinder and to enable sequential fuel injection. The camshaft position sensors are connected to the ECM by the circuits listed below:

- A 5 V reference circuit
- A low reference circuit
- A signal circuit

Ignition Coil Module

The ignition coil module integrates the 4 coils and the ignition control module within a single sealed component.

The ignition coil module has the following circuits:

- An ignition voltage circuit
- A ground
- A low reference circuit
- 4 ignition coil control circuits

The ECM controls the individual coils by transmitting timing pulses on the ignition coil control circuit to each ignition coil to enable a spark event.

The spark plugs are connected to each coil by a short boot. The boot contains a spring that conducts the spark energy from the coil to the spark plug. The spark plug electrode is coated with platinum for long wear and higher efficiency.

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Engine Control Module (ECM)

The ECM controls all ignition system functions and constantly adjusts the spark timing. The ECM monitors information from various sensor inputs that include the following:

- The crankshaft position sensor
- The accelerator pedal position (APP)
- The manifold absolute pressure (MAP) sensor
- The intake air temperature (IAT) sensor
- The vehicle speed sensor (VSS)
- The engine knock sensor
- The engine coolant temperature (ECT) sensor
- The mass airflow (MAF) sensor
- The camshaft position sensors

KNOCK SENSOR SYSTEM DESCRIPTION

Circuit/System Description

The knock sensor system enables the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The ECM uses the knock sensor system to test for abnormal engine noise that may indicate detonation, also known as spark knock.

Sensor Description

This knock sensor system uses one or two flat response two-wire sensors. The sensor uses piezo-electric crystal technology that produces an alternating current 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 2 isolated signal circuits.

If the ECM has determined that knock is present, it will retard the ignition timing to attempt to reduce the knock. The ECM is capable of controlling spark retard on an individual cylinder basis. The ECM will always try to work back to a zero compensation level, or no spark retard. Knock sensor diagnostics are calibrated to detect faults with the knock sensor circuitry inside the ECM, the knock sensor wiring, or the knock sensor voltage output. Some diagnostics are also calibrated to detect constant noise from an outside influence such as a loose/damaged component or excessive mechanical engine noise.

CRANKCASE VENTILATION SYSTEM DESCRIPTION

Results of Incorrect Operation

A plugged positive crankcase ventilation (PCV) orifice or hose may cause the following conditions:

- Rough idle
- Stalling or slow idle speed

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- Oil leaks
- Oil in the throttle body
- Sludge in the engine

Functional Check

With these systems, any blow-by in excess of the system capacity, from a badly worn engine, sustained heavy load, etc., is exhausted into the air cleaner and is drawn into the engine.

Proper operation of the crankcase ventilation system depends upon a sealed engine. If oil slugging or dilution is noted and the crankcase ventilation system is functioning properly, check the engine for a possible cause. Correct any problems.

If an engine is idling rough, inspect for a clogged PCV orifice, a dirty vent filter, air cleaner element, or plugged hose. Replace as required. Use the following procedure:

- Remove the PCV hose from the cylinder head cover.
- Operate the engine at idle.
- Place your thumb over the end of the hose in order to check for a vacuum. If there is no vacuum at the hose, inspect for the following items:
  - Plugged hoses
  - The manifold port
- Turn OFF the engine.
- Inspect the PCV orifice in the cylinder head cover for debris or blockage.

AIR INTAKE SYSTEM DESCRIPTION

Circuit/System Description

The primary function of the air intake system is to provide filtered air to the engine. The system uses a filter element mounted in a housing. The filter housing is remotely mounted and uses intake ducts to route the incoming air into the throttle body. The secondary function of the air intake system is to muffle air induction noise. This is achieved by the use of resonators attached to the air intake ducts. The resonators are tuned to the specific powertrain. The intake air temperature (IAT) sensor is used to measure the temperature of the air entering the engine.

Intake Manifold Tuning Solenoid Valve

The intake manifold tuning solenoid valve system uses variable air induction tuning in order to achieve maximum performance and efficiency over the entire operating range of the engine. The characteristic torque curve of a normally aspirated engine depends mainly on how the engines average pressure changes over the engine speed range. The average pressure is proportional to the volume of the air mass present in the cylinder when the inlet valve is closed. The design of the inlet system determines how large an air mass can be drawn into a cylinder at a given engine speed. An intake manifold tuning solenoid valve is used to change the intake manifold plenum configuration. When the intake manifold tuning solenoid valve is open, the intake manifold is configured to one large plenum. When the intake manifold tuning solenoid valve is closed, the intake manifold

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is configured to two smaller plenums. The two intake manifold plenum sizes result in different torque curves which improves performance at low and high engine speeds.

During low speed, high load conditions the intake manifold tuning solenoid valve is closed creating a longer runner path inside the plenum which increases torque. During higher engine speeds and loads, the intake manifold tuning solenoid valve opens creating a shorter runner path inside the plenum which increases horsepower. Ignition voltage is supplied to the intake manifold tuning solenoid valve solenoid through a fuse when the ignition key is turned ON. The intake manifold tuning solenoid valve solenoid is normally closed which will not allow vacuum to pass through it. When the engine speed and load are increased above a calibrated threshold, the ECM provides a ground to the intake manifold tuning solenoid valve, energizing the intake manifold tuning solenoid valve and allowing a vacuum from the intake manifold tuning valve vacuum tank to be applied to the intake manifold tuning actuator valve. The intake manifold tuning actuator valve then opens the intake manifold tuning valve in the intake manifold for desired performance. The variable intake manifold system consists of the following components:

- The intake manifold tuning solenoid valve
- The intake manifold tuning valve vacuum reservoir
- The intake manifold tuning vacuum actuator
- The intake manifold tuning valve
- An intake manifold

Ignition voltage is supplied directly to the intake manifold tuning solenoid valve. The engine control module (ECM) controls the intake manifold tuning solenoid valve by grounding the control circuit via an internal driver switch. The primary function of the driver is to supply ground for the intake manifold tuning solenoid valve. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the voltage on the control circuit.

SECONDARY AIR INJECTION SYSTEM DESCRIPTION

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

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

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

The ECM monitors the secondary air injection system pressure by tracking voltage signal from the pressure

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sensor, which is integral to the solenoid (shutoff and check) valve assembly.

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

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

During phase 2, DTCs P2430 and P2440 run and only the secondary air injection pump is activated. The valve is closed. Pressure sensor performance and valve deactivation are tested. Expected system pressure is 14-25 kPa (2.0-3.6 psi) above BARO.

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

The secondary air injection system includes the following components:

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

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

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

System Fault Detection

The ECM monitors the secondary air injection system for faults during cold start operation. When the system's pressure or relay circuits operations vary too far from the expected values, a DTC will set. Diagnostics detect the following conditions:

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- A partially or fully blocked or leaking secondary air injection system
- A malfunctioning secondary air injection pump
- A malfunctioning secondary air injection solenoid (shutoff and check) valve assembly
- A malfunctioning secondary air injection pressure sensor
- A restricted exhaust system
- A malfunctioning secondary air injection pump and secondary air injection valve relay

The following DTCs set when a secondary air injection system fault is detected:

- DTC P0411 - A secondary air injection system insufficient airflow fault condition has been detected.
- DTC P0412 - A secondary air injection valve relay coil circuit fault condition has been detected.
- DTC P0418 - A secondary air injection pump relay coil circuit fault condition has been detected.
- DTC P2430 - A secondary air injection pressure sensor signal stuck in range fault condition has been detected.
- DTC P2431 - A skewed air injection pressure sensor signal has been detected.
- DTC P2432 - A secondary air injection pressure sensor signal voltage below the minimum range of the sensor fault condition has been detected.
- DTC P2433 - A secondary air injection pressure sensor signal voltage is above the maximum range of the sensor fault condition has been detected.
- DTC P2440 - The solenoid (shutoff and check) valve is stuck open or a system leak between the pump and the valve has been detected.
- DTC P2444 - A secondary air injection pump stuck ON fault condition has been detected.

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2013 ENGINE PERFORMANCE

Engine Controls and Fuel - 1.8L LUW and LWE - Diagnostic Information and Procedures - Cruze

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0010, P0013, OR P2088-P2091

Diagnostic Instructions

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

DTC Descriptors

DTC P0010

Intake Camshaft Position Actuator Solenoid Valve Control Circuit

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit

DTC P2088

Intake Camshaft Position Actuator Solenoid Control Circuit Low Voltage

DTC P2089

Intake Camshaft Position Actuator Solenoid Control Circuit High Voltage

DTC P2090

Exhaust Camshaft Position Actuator Solenoid Control Circuit Low Voltage

DTC P2091

Exhaust Camshaft Position Actuator Solenoid Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Camshaft Position	P0010,			P0010,	

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Actuator Solenoid Valve High Control	P0013, P2088, P2090	P0010, P0013	P0010, P0013	P0013, P2089, P2091	P0011, P0014
Camshaft Position Actuator Solenoid Valve Low Reference	-	P0010, P0013	P0010, P0013	-	-

Circuit/System Description

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

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

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The ignition switch is in the crank or run position.
- The ECM has commanded the Camshaft Position Actuator Solenoid Valve ON.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTCs P0010, P0013, P2088, P2089, P2090 and P2091 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0010, P0013, P2088, P2089, P2090 and P2091 are type B DTCs.

Diagnostic Aids

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

Reference Information

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Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

1. Ignition ON.
2. Verify DTC P0335, P0336, P0340, and P0341 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 do not display Malfunction:
   - Camshaft Position Actuator Solenoid Valve Control Circuit Open test status
   - Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage test status
   - Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage test status
   - **If Malfunction is displayed**

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Refer to Circuit/System Testing below.

- **If Malfunction is not displayed**

4. Engine idling at normal operating temperature.
5. Verify the scan tool parameters listed below do not display Malfunction when commanding the appropriate scan tool Camshaft Position Actuator from 0-10° and back to 0° with a scan tool:
   - Camshaft Position Actuator Solenoid Valve Control Circuit Open test status
   - Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage test status
   - Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage test status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing below.

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

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

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

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

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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.
    2. Disconnect the harness connector at the K20 Engine Control Module.
    3. Ignition ON.
    4. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit
        - If less than 1 V, replace the K20 Engine Control Module
    - **If the test lamp does not illuminate**
5. Remove the test lamp.
6. Connect the DMM black lead to the control circuit terminal 2. Connect the DMM red lead to B+. Set the DMM on the diode setting. Command the CMP actuator solenoid ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
    - **If the circuit voltage does not correspond to the specified values**
    1. Ignition OFF.
    2. Disconnect the harness connector at the K20 Engine Control Module.
    3. Test for less than 2 ohms in the control circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance or short to ground in the circuit
        - If less than 2 ohms, replace the K20 Engine Control Module
    - **If the circuit voltage corresponds to the specified values**
7. Test or replace the appropriate Q6 Camshaft Position Actuator Solenoid Valve.

Component Testing

1. Ignition OFF.
2. Disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
3. Test for 7-12 ohms between the control terminal 2 and the low reference circuit terminal 1.
    - **If not between 7-12 ohms**

      Replace the Q6 Camshaft Position Actuator Solenoid Valve.

    - **If between 7-12 ohms**
4. Test for infinite resistance between each terminal and theQ6 Camshaft Position Actuator Solenoid Valve housing.
    - **If not infinite resistance**

      Replace the Q6 Camshaft Position Actuator Solenoid Valve.

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

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Repair Instructions

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

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

DTC P0011 OR P0014

Diagnostic Instructions

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

DTC Descriptors

DTC P0011

Intake Camshaft Position System Performance

DTC P0014

Exhaust Camshaft Position System Performance

Diagnostic Fault Information

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

Circuit/System Description

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshafts while the engine is operating. The camshaft position actuator solenoid valves are operated hydraulically in order to change the angle of the camshaft relative to crankshaft position. The camshaft position actuator solenoid valves are controlled by the engine control module (ECM). The ECM sends a pulse width modulated signal to the camshaft position actuator solenoid valves. The camshaft position actuator solenoid valves control the amount of engine oil flow that applies the pressure to advance or retard the camshafts.

Conditions for Running the DTC

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- DTC P0010, P0013, P0016, P0017, P0335, P0340, P0341, P0365, or P0366 is not set.
- The engine is running.
- The ignition voltage is between 11-32 V.
- The camshaft position actuator is enabled.
- The rate of change in the camshaft position is less than 3° for 4 s.
- DTCs P0011 and P0014 runs continuously once the above conditions are met for greater than 0.1 s.

Conditions for Setting the DTC

The ECM detects a difference between the camshaft position angle and the desired camshaft position angle is greater than 6 to 10° based on engine coolant temperature and engine speed.

Action Taken When the DTC Sets

DTCs P0011 and P0014 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0011 and P0014 are Type B DTCs.

Diagnostic Aids

- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this DTC. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life Remaining parameter. Advise the customer an oil change may be required.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing belt can cause this DTC to set.
- A resistance greater than 8 ohms on the camshaft position actuator solenoid valve control circuit may set this DTC. If you suspect high resistance, ground the control circuit while the engine is idling. The scan tool Intake or Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status should display Malfunction. If the parameter displays OK, test the control circuit for high resistance.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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Camshaft Actuator System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

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

1. Ignition ON.
2. Verify the correct engine 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 DTC P0010, P0013, P0016, P0017, P0335, P0336, P0340, P0341, P0365, P0366, P2088, P2089, P2090 or P2091 is not set.

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

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

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

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

     Refer to Circuit/System Testing below.

   - **If less than 2°**
6. Verify that DTC P0011 or P0014 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing below.

   - **If none of the DTCs set**
7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
8. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

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

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3. Ignition ON.

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

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

     Replace the Q6 Camshaft Position Actuator Solenoid Valve.

   - **If a condition is not found**

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

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9. Ignition OFF, swap the Q6 Camshaft Position Actuator Solenoid Valve with the Q6 Camshaft Position Actuator Solenoid Valve that is operating correctly.
10. Engine idling.
11. Verify the scan tool Camshaft Position Variance parameter is less than 2° in each of the commanded states when commanding the Camshaft Position Actuator from 0-20° and back to 0° with a scan tool.
    - **If 2° or greater**

      Replace the mechanical camshaft position actuator.

    - **If less than 2°**
12. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

Component Testing

1. Vehicle OFF
2. Disconnect the harness connector at the Q6 Camshaft Position Actuator Solenoid Valve.
3. Test for 7-12 ohms between the control terminal 2 and the low reference circuit terminal 1.
    - **If not between 7-12 ohms**

      Replace the Q6 Camshaft Position Actuator Solenoid Valve.

    - **If between 7-12 ohms**
4. 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**
5. All OK

Repair Instructions

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

- **Camshaft Position Actuator Solenoid Valve Replacement**
- **Control Module References** for ECM replacement, programming and setup.

DTC P0016 OR P0017

Diagnostic Instructions

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

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

DTC Descriptors

DTC P0016

Crankshaft Position - Intake Camshaft Position Not Plausible

DTC P0017

Crankshaft Position - Exhaust Camshaft Position Not Plausible

Circuit/System Description

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

Conditions for Running the DTC

- Crankshaft and camshaft position sensor signals are synchronized.
- The engine is cranking or running.
- The camshaft position actuator solenoid valves are in the parked position.
- DTCs P0335, P0336, P0340, P0341, P0365, P0366, P0641, or P0651 is not set.
- Time since last execution of the diagnostic is less than 1 s.

Conditions for Setting the DTC

The ECM detects a camshaft to crankshaft misalignment. The DTC sets if the crankshaft position sensor detects 3 sensor pulses that are greater than 12 degrees before or after the normal position during 1 camshaft revolution.

Action Taken When the DTC Sets

DTCs P0016 and P0017 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0016 and P0017 are Type B DTCs.

Diagnostic Aids

The following conditions can also set the DTCs:

- A short to ground in a camshaft position actuator solenoid valve control circuit.
- Crankshaft end play out of specification.
- A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC).

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Reference Information

Description and Operation

Camshaft Actuator System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0335, P0336, P0340, P0341, P0365, P0366, P0641 or P0651 is not set.
   - **If any of the DTCs are set**

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

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

     Inspect for the following and repair as necessary:

     - A Q6 Camshaft Position Actuator Solenoid Valve that is stuck in the full advance or retard position.
     - The correct installation of the Q6 Camshaft Position Actuator Solenoid Valves.
     - The correct installation of the B23 Camshaft Position Sensors.
     - The correct installation of the B26 Crankshaft Position Sensor.
     - A timing belt tensioner condition.
     - An incorrectly installed timing belt.
     - Excessive play in the timing belt.
     - A timing belt with damaged teeth.
     - A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC) on the crankshaft.
   - **If the DTC is not set**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

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

     A mechanical condition listed above still exists.

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

Repair Instructions

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

- **Camshaft Position Actuator Solenoid Valve Replacement**
- **Camshaft Position Sensor Replacement**
- **Crankshaft Position Sensor Replacement**
- **Timing Belt Replacement**

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0030

HO2S Heater Control Circuit Sensor 1

DTC P0031

HO2S Heater Control Circuit Low Voltage Sensor 1

DTC P0032

HO2S Heater Control Circuit High Voltage Sensor 1

DTC P0036

HO2S Heater Control Circuit Sensor 2

DTC P0037

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HO2S Heater Control Circuit Low Voltage Sensor 2

DTC P0038

HO2S Heater Control Circuit High Voltage Sensor 2

DTC P0053

HO2S Heater Resistance Sensor 1

DTC P0054

HO2S Heater Resistance Sensor 2

DTC P0135

HO2S Heater Performance Sensor 1

DTC P0141

HO2S Heater Performance Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Heater Voltage Supply	P0030, P0036, P0037, P0132, P0134, P0135, P0138, P0141, *	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0690	P0135, P0141
HO2S Heater Control	P0030, P0031, P0036, P0037, P0053, P0054, P0135, P0141	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141	P0030, P0032, P0036, P0038, P0132, P0134, P0135, P0138, P0140, P0141, P0690	P0135, P0141
* Opens Fuse				

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. Each HO2S must reach operating temperature to provide an accurate voltage signal. A heating element inside each of the HO2S minimizes the time required for the sensor 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 ECM. The ECM uses pulse-width

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modulation (PWM) to control the HO2S heater operation to maintain a specific HO2S operating temperature range.

Conditions for Running the DTC

P0030, P0031, P0032, P0036, P0037 and P0038

- The engine speed is greater than 400 RPM.
- The Ignition voltage is between 11-32 V.
- The DTCs run continuously when the above conditions are met for greater than 5 s.

P0053 and P0054

- DTCs P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119 or P2610 are not set.
- The ignition is OFF for greater than 8 h.
- The engine is running.
- The engine coolant temperature (ECT) and the intake air temperature (IAT) are within 8°C (14°F).
- The ECT is between -30 to +45°C (-22 to +113°F).
- The Ignition voltage is less than 32 V.
- The DTCs run once per valid cold start-up when the above conditions are met.

P0135 and P0141

- DTCs P0116, P0117, P0118, P0119 or P0128 are not set.
- The system voltage is between 10-32 V.
- The HO2S heaters are at operating temperature.
- The scan tool HO2S Heater device control is not active.
- The commanded HO2S heater duty cycle is greater than 0%.
- The DTCs run twice per drive cycle when the above conditions are met for greater than 30 s.

Conditions for Setting the DTC

P0030, P0031, P0032, P0036, P0037 and P0038

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

P0053 and P0054

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

P0135 and P0141

The ECM detects the HO2S heater current is less than 0.30 A or greater than 2.5 A for greater than 8 s.

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Action Taken When the DTC Sets

DTC P0030, P0031, P0032, P0036, P0037, P0038, P0053, P0054, P0135, and P0141 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0030, P0031, P0032, P0036, P0037, P0038, P0053, P0054, P0135, and P0141 are Type B DTCs.

Diagnostic Aids

- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool circuit status parameters for the component. The circuit status parameters will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.
- An open fuse in the heated oxygen sensor heater circuit may be caused by the heater element in one of the sensors. The condition may not be present until the sensor operates for a period of time. If no fault is present in the heater circuit, monitor the amperage of each heater with a scan tool to determine if one of the heater elements is the cause of the open fuse. Inspect the sensor pigtail or the harness for contacting the exhaust system.

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. Engine running.

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

     Refer to Circuit/System Testing below.

   - **If Malfunction is not displayed**
3. Observe the scan tool HO2S 1 Heater or HO2S 2 Heater parameter. The amperage should be between 0.3-2.4 A.
   - **If not between 0.3-2.4 A**

     Refer to Circuit/System Testing below.

   - **If between 0.3-2.4 A**
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 the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.

   - **If the DTC does not set**
6. 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 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 ohms in the ignition circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, 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 fuse and replace as necessary.

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- **If the test lamp illuminates**

3. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal 1 and the control circuit terminal 2.
   - **If the test lamp illuminates**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **If the test lamp does not illuminate**
4. Remove the test lamp.
5. Engine running, verify the scan tool HO2S 1 or 2 Heater Control Circuit Open Test Status parameter displays Malfunction.
   - **If Malfunction 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 Malfunction is displayed**

NOTE:

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

6. Ignition OFF, install a 3A fused jumper wire between the control circuit terminal 2 and ground. Engine running.
7. Verify the scan tool HO2S 1 or 2 Heater Control Circuit Low Voltage Test Status parameter is Malfunction.
   - **If Malfunction is not displayed**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the control circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If Malfunction is displayed**
8. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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

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- **Heated Oxygen Sensor Replacement - Sensor 1**
- **Heated Oxygen Sensor Replacement - Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing a HO2S.
- **Control Module References** for ECM replacement, programming and setup

DTC P0068 OR P1101

Diagnostic Instructions

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

DTC Descriptor

DTC P0068

Throttle Body Air Flow Performance

DTC P1101

Intake Air Flow System Performance

Circuit/System Description

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

Conditions for Running the DTC

DTC P0068

- DTC P0102, P0103, P0107, P0108, or P0651 is not set
- The engine speed is at least 800 RPM.
- The Ignition signal is at least 6.0 V.
- The throttle actuator control system is not in reduced power mode, without LUW
- The DTC runs continuously when the above conditions are met.

DTC P1101

- DTC P0102, P0103, P0107, P0108, P0117, P0118, P0128, P0335, or P0336 is not set
- The engine speed is between 400-7 000 RPM; 400-6 000 RPM with LUW
- The engine coolant temperature (ECT) is between -7 to +125°C (+19 to +257°F).
- The intake air temperature (IAT) is between -20 to +125°C (-4 to +257°F).

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

Conditions for Setting the DTC

The ECM detects that the airflow rate is more than the calculated airflow for greater than 0.2 s.

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.

Diagnostic Aids

Use a solution of dish soap and water in a spray bottle to pinpoint any suspected air leaks in the induction system. This includes vacuum lines, positive crankcase ventilation system, intake manifold, throttle body.

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

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Circuit/System Verification

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

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

   - **If none of the DTCs are set**
2. Ignition ON, verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
   - **If 90 % or greater**

     Refer to **Throttle Body Inspection and Cleaning** .

   - **If less than 90 %**
3. 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, or P2135** for further diagnosis.

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

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

   - **If the MAP Sensor parameter is within range**
6. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26-52 kPa (3.8-7.5 PSI) and changes with accelerator pedal input.
   - **If not between 26-52 kPa (3.8-7.5 PSI) or does not change**

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

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

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- **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**

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 below.

   - **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 following conditions exist:
   - Any damaged components
   - Improperly installed components
   - Collapsed, restricted, or damaged components
   - Loose clamps, cracks, or other damage
   - An air flow restriction
   - Restricted air filter
   - Splits, kinks, leaks, or improper connections at the vacuum hoses
   - Vacuum leaks at the intake manifold, MAP sensor, and throttle body
   - Water intrusion
   - Any snow or ice buildup, in cold climates
   - Contamination of the MAF sensor element
   - Missing, restricted, or leaking exhaust components-Refer to **Symptoms - Engine Exhaust** for further diagnosis.
   - **If a condition is found**

     Repair or replace component as appropriate.

   - **If no condition is found**
2. Test the engine for a mechanical condition. Refer to **Symptoms - Engine Mechanical** for diagnosis.
   - **If a condition is found**

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Repair or replace component as appropriate.

- **If no condition is found**

3. All OK

Repair Instructions

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

Control Module References for ECM replacement, programming, and setup

DTC P0096 OR P0111

Diagnostic Instructions

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

DTC 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
Sensor	P0112, P0114, P2199**	P0113, P0114, P2199**	P0113*, P0114, P2199**	P0111, P0114
Low Reference	-	P0097, P0113, P11C2, P2227, P2229	*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. ** Where used.				

IAT Sensor 2

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

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5 V Reference	P0097, P0651, P11C2, P2199**, P2227, P2228	P0096, P0097, P11C2, P2199**, P2227, P2228	P0097, P0651, P11C2, P2199**, P2227, P2228	-
Sensor	P0097, P11C3, P2199**	P0097, P11C2, P2199**	P0097*, P11C2, P2199**	-
Low Reference	-	P0097, P0113, P11C2, P2227, P2229	*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. ** Where used.				

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

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			
5 V Reference	-40°C (-40°F) 10 Hz	-40°C (-40°F) 10 Hz	-
Signal	-40°C (-40°F)	-40°C (-40°F)	-40°C (-40°F)* 10 Hz*
Ground	-	-40°C (-40°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 multifunction intake air sensor:

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

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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 °C (°F).

The IAT sensor 2 produces a frequency signal based on the inlet air temperature very close to the humidity sensor within the sensor bore. The signal varies with inlet air temperature and is displayed by the scan tool as ° C (°F) and Hertz (Hz). The signal circuit is shared by the IAT sensor 2 and the humidity sensor.

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

Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for the mass air flow (MAF) sensor.

IAT Sensor 1 - Temperature, Resistance, Voltage Table

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

IAT Sensor 2 - Temperature, Frequency Table

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

Conditions for Running the DTCs

P0096 and P0111

- DTCs P0097, P0098, P0112, P0113, P0117, P0118, P0119, or P1682 are not set.
- The vehicle has been OFF at least 8 hours.
- Ignition 1 voltage is at least 11 V for longer than 0.9 s.
- These DTCs run once per ignition cycle when the enabling conditions are met.

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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 25°C (45°F).

  AND

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

P0111

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than 25°C (45°F).

  AND

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

Action Taken When the DTCs Set

DTCs P0096 and P0111 are Type B DTCs.

Conditions for Clearing the DTCs

DTCs P0096 and P0111 are Type B DTCs.

Diagnostic Aids

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

Reference Information

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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

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

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

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

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

NOTE: To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 3 and 4 of this verification procedure only if the ignition has been OFF for 8 hours or more.

3. Ignition ON.
4. Verify the following scan tool parameters are within 25°C (45°F) of each other.
   - Start-Up IAT Sensor 1
   - IAT Sensor 2

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- IAT Sensor 3; where equipped
- **If not within 25°C (45°F)**

  Refer to Circuit/System Testing below.

- **If within 25°C (45°F)**

5. Engine idling, verify the following scan tool parameters are between: -38 and +149°C (-36 and +300°F).
   - IAT Sensor 1
   - IAT Sensor 2
   - IAT Sensor 3; where equipped
   - **If not between: -38 and +149°C (-36 and +300°F)**

     Refer to Circuit/System Testing below.

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

     Refer to Circuit/System Testing below.

   - **If the DTCs do not set**
8. All OK

Circuit/System Testing

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

1. Check the integrity of the entire air induction system and verify that none of the following conditions exist:
   - A loose or disconnected charge air cooler hose or pipe; where equipped
   - A blocked or obstructed charge air cooler, including: after-market grill covers; where equipped
   - Any snow or ice build-up at the charge air cooler in cold climates; where equipped
   - Any mud or dirt build-up at the charge air cooler; where equipped
   - A restricted or collapsed air intake duct
   - An intake manifold leak
   - A MAP sensor seal that is leaking, missing, or damaged
   - A misaligned or damaged air intake duct
   - Any water intrusion in the induction system
   - An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing

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- **If a condition exists**

  Repair or replace component as appropriate.

- **If no condition exists**

2. Ignition OFF, and all vehicle systems OFF, it may take up to 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
3. Test for less than 2 ohms between the low reference circuit terminal 7 and ground.
   - **If 2 ohms or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the low reference circuit end to end.
      - If 2 ohms or greater, repair the open or high resistance in the circuit.
      - If less than 2 ohms replace the K20 Engine Control Module.
   - **If less than 2 ohms**
4. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 2 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the signal circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

     NOTE: If the 5 V reference circuit is shorted to a voltage the engine control module or the sensor may be damaged.

   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 4.8-5.2 V**
5. Ignition ON, test for 4.8-5.2 V between the 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

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3. Test for less than 2 ohms in the signal circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

6. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than -39°C (-38°F).
    - **If warmer than -39°C (-38°F).**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 8 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 ohms in the signal circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.
    - **If colder than -39°C (-38°F).**
7. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 8 and the low reference circuit terminal 7.
8. Verify the scan tool IAT Sensor 1 parameter is warmer than 148°C (298°F).
    - **If colder than 148°C (298°F).**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 ohms in the signal circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.
    - **If warmer than 148°C (298°F).**
9. Ignition ON, test for 4.8-5.2 V between the signal terminal 1 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 signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

10. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
    - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
    1. Replace the K20 Engine Control Module.
    2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
    3. Verify the DTC does not set.
        - **If the DTC sets**

          Refer to step 14.

        - **If no DTCs set**
    4. All OK.
    - **EL-38522-A, Variable Signal Generator; or equivalent is available**
11. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
    - Red lead to the signal circuit terminal 1 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
12. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
    - Signal switch to 5 V
    - Duty Cycle switch to 50 % (Normal)
    - Frequency switch to 30 Hz
13. Ignition ON, 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**

14. Circuits and ECM test OK. Test or replace the appropriate temperature 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 (Bosch Sensor)** table for Bosch Sensors. The resistance values should be in range of the table values.
   - **If not within the specified range.**

     Replace the B75C Multifunction Intake Air sensor.

   - **If within the specified range.**
3. All OK

Multifunction Intake Air Sensor

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

- **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement.
- **Control Module References** for ECM replacement, programming, and setup

DTC P0097, P0098, OR P0099

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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.
- **Diagnostic Procedure Instructions** provides 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
5 V Reference	P0097, P0651, P11C2, P2199**, P2227, P2228	P0096, P0097, P11C2, P2199**, P2227, P2228	P0097, P0651, P11C2, P2199**, P2227, P2228	-
Sensor	P0097, P11C3, P2199**	P0097, P11C2, P2199**	P0097*, P11C2, P2199**	-
Low Reference	-	P0097, P0113, P11C2, P2227, P2229	*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. ** Where used.				

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			
5 V Reference	-40°C (-40°F) 10 Hz	-40°C (-40°F) 10 Hz	-
			-40°C (-40°F)*

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Signal	-40°C (-40°F)	-40°C (-40°F)	10 Hz*
Ground	-	-40°C (-40°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 multifunction intake air sensor:

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

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 °C (°F).

The IAT sensor 2 produces a frequency signal based on the inlet air temperature very close to the humidity sensor within the sensor bore. The signal varies with inlet air temperature and is displayed by the scan tool as ° C (°F) and Hertz (Hz). The signal circuit is shared by the IAT sensor 2 and the humidity sensor.

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

Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for the mass air flow (MAF) sensor.

IAT Sensor 2 - Temperature, Frequency Table

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

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Conditions for Running the DTCs

P0097, P0098, and P0099

- The ignition is ON, or the engine is running.
- The Ignition 1 voltage is at least 11 V for longer than 0.9 s.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P0097

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

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

P0098

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

P0099

The ECM monitors the IAT sensor 2 signal every 0.1 s, to determine if the signal has changed more than 100°C (212°F). The DTC fails when the condition exists for longer than 4 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/DTCs

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

Diagnostic Aids

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

Reference Information

Schematic Reference

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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** .

Circuit/System Verification

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

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

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

NOTE: To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 3 and 4 of this verification procedure only if the ignition has been OFF for 8 hours or more.

3. Ignition ON.
4. Verify the following scan tool parameters are within 25°C (45°F) of each other.
   - Start-Up IAT Sensor 1
   - IAT Sensor 2

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- Start-Up ECT
- **If not within 25°C (45°F)**

  Refer to Circuit/System Testing below.

- **If within 25°C (45°F)**

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

     Refer to Circuit/System Testing below.

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

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification before proceeding with 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 B75C Multifunction Intake Air sensor.
2. Test for less than 2 ohms between the low reference circuit terminal 7 and ground.
   - **If 2 ohms or greater**
     1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
     2. Test for less than 2 ohms in the low reference circuit end to end.
        - If 2 ohms or greater, repair the open or high resistance in the circuit.
        - If less than 2 ohms replace the K20 Engine Control Module.
   - **If less than 2 ohms**
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 2 and ground.
   - **If less than 4.8 V**
     1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

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2. Test for infinite resistance between the signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

NOTE: If the 5 V reference circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

4. Ignition ON, test for 4.8-5.2 V between the intake air temperature signal 2 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 ohms in the signal circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

5. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
    - **EL-38522-A, Variable Signal Generator; or equivalent is not available**

1. Replace the K20 Engine Control Module.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle

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within the conditions that you observed from the freeze frame/failure records data.

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

     Refer to step 9.

   - **If the DTC does not set**
4. All OK.
   - **EL-38522-A, Variable Signal Generator; or equivalent is available**

6. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
   - Red lead to the signal circuit terminal 1 at the harness connector
   - Black leads to ground
   - Battery voltage supply lead to B+
7. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
   - Signal switch to 5 V
   - Duty Cycle switch to 50 % (Normal)
   - Frequency switch to 30 Hz
8. Ignition ON, verify the scan tool IAT Sensor 2 parameter is between 28-32 Hz.
   - **If not between 28-32 Hz**

     Replace the K20 Engine Control Module.

   - **If between 28-32 Hz**
9. 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 (Bosch Sensor)** table for Bosch Sensors. The resistance values should be in range of the table values.
   - **If not within the specified range.**

     Replace the B75C Multifunction Intake Air sensor.

   - **If within the specified range.**
3. All OK

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Multifunction Intake Air Sensor

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

- **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement.
- **Control Module References** for ECM replacement, programming, and setup

DTC P0101

Diagnostic Instructions

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

DTC Descriptor

DTC P0101

Mass Air Flow (MAF) Sensor Performance

Diagnostic Fault Information

MAF Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0102	P0102, P01101	P0690	P0101
Sensor	P0102, P1101	P0102, P1101	P0102*	P0101, P1101
Ground	-	P0102	-	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

MAF Sensor

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

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

The MAF sensor is an air flow meter that measures the amount of air flowing 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 signal circuit. The sensor produces 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). Vehicle ignition voltage and ground circuits are also supplied to the MAF sensor.

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.

Vehicle ignition voltage and ground circuits are supplied to the MAF sensor.

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:

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

Conditions for Running the DTCs

- DTC P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0128, P0335, or P0336 is not set.
- The engine speed is between 400-6, 000 RPM.
- The engine coolant temperature (ECT) is between -7 and +125°C (+19 and +257°F).
- The intake air temperature (IAT) is between -20 and +100°C (-4 and +212°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0101 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0101 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

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Connector End View Reference

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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

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

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

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

   - **If none of the DTCs are set**
2. Ignition ON, verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
   - **If 90 % or greater**

     Refer to **Throttle Body Inspection and Cleaning** .

   - **If less than 90 %**
3. 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, or P2135** for further diagnosis.

   - **If Agree**
4. Determine the current vehicle testing altitude.
5. 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**

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

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

6. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26-52 kPa (3.8-7.5 PSI) and changes with accelerator pedal input.
   - **If not between 26-52 kPa (3.8-7.5 PSI) or does not change**

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

   - **If between 26-52 kPa (3.8-7.5 PSI) and changes**
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.
   - **If the MAF Sensor parameter does not change smoothly and gradually**

     Refer to Circuit/System Testing for further diagnosis.

   - **If 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 does set**

     Refer to Circuit/System Testing for further diagnosis.

   - **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. Check the integrity of the entire air induction system by verifying that none of the following conditions exist:
   - Any damaged components
   - Improperly installed components
   - Collapsed, restricted, or damaged components
   - Loose clamps, cracks, or other damage

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- 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
- Improper operation of the positive crankcase ventilation system

- **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 ohms between the ground circuit terminal 4 and ground.
   - **If 2 ohms or greater**
   1. Ignition OFF.
   2. Test for less than 2 ohms in the ground circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, repair the open/high resistance in the ground connection.
   - **If less than 2 ohms**
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 circuit.
   2. Test for less than 2 ohms in the ignition circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp and remove the fuse for the ignition 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. Test for greater than 2 ohms between the ignition circuit terminal 5 and ground.
      - If less than 2 ohms, repair the short to ground on the circuit.
      - If greater than 2 ohms, test all the components connected to the circuit and repair or replace as necessary.
   - **If a test lamp illuminates**
6. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal 3 and ground.

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- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
   - If less than infinite resistance, repair the short to ground on the circuit.
   - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
   - If 2 ohms or greater, repair the open/high resistance in the circuit.
   - If less than 2 ohms, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

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. Replace the K20 Engine Control Module.
   2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
   3. Verify the DTC does not set.
      - **If the DTC sets**

        Refer to step 11.

      - **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 follows:
   - Red lead to the signal circuit terminal 3 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 following specifications.
   - Signal switch to 5 V
   - Frequency switch to 5 kHz
   - Duty Cycle switch to 50 % (Normal)
10. Engine idling, verify the scan tool MAF Sensor parameter is between 4, 950-5, 050 Hz.
    - **If not between 4, 950-5, 050 Hz.**

      Replace the K20 Engine Control Module.

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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.

- **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement.
- **Control Module References** for ECM replacement, programming and setup

DTC P0102 OR P0103

Diagnostic Instructions

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

DTC Descriptors

DTC P0102

Mass Air Flow (MAF) Sensor Circuit Low Frequency

DTC P0103

Mass Air Flow (MAF) Sensor Circuit High Frequency

Diagnostic Fault Information

MAF Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0102	P0102, P01101	P0690	P0101
Sensor	P0102, P1101	P0102, P1101	P0102*	P0101, P1101
Ground	-	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:** 1, 500-10, 000 Hz			
Ignition Voltage	0 Hz	0 Hz	-

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Signal	0 Hz	0 Hz	0 Hz
Ground	-	0 Hz	-

Circuit Description

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

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

The MAF sensor is an air flow meter that measures the amount of air flowing 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 signal circuit. The sensor produces 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). Vehicle ignition voltage and ground circuits are also supplied to the MAF sensor.

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

Conditions for Running the DTC

- The engine is running for at least 1 s.
- The engine speed is at least 300 RPM.
- The ignition signal is at least 8 V.
- The above conditions are met for at least 1 s.
- The DTC runs continuously when the above conditions are met.

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Conditions for Setting the DTC

P0102

The ECM detects that the MAF Sensor signal parameter is less than 100 Hz (about 0.15 g/s) for at least 500 cylinder firing events.

P0103

The ECM detects that the MAF Sensor signal parameter is at least 14, 500 Hz (about 270.2 g/s) for at least 500 cylinder firing events.

Action Taken When the DTCs Set

DTCs P0102 and P0103 are Type B DTCs.

Conditions for Clearing the MIL/DTCs

DTCs P0102 and P0103 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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EL-38522-A Variable Signal Generator

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

Circuit/System Verification

1. Engine idling, verify the scan tool MAF Sensor parameter is between 2.5-5.5 g/s.
   - **If not between 2.5-5.5 g/s**

     Refer to Circuit/System Testing below.

   - **If between 2.5-5.5 g/s**
2. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
   1. Engine idling
   2. Perform the scan tool snapshot function.
   3. Increase the engine speed slowly to 3, 000 RPM and then back to idle.
   4. Exit from the scan tool snapshot and review the data.
   5. Observe the MAF Sensor parameter frame by frame with a scan tool.
   - **The MAF Sensor parameter does not change smoothly and gradually**

     Refer to Circuit/System Testing below.

   - **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 does set**

     Refer to Circuit/System Testing for further diagnosis.

   - **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, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 2 ohms between the ground circuit terminal 4 and ground.
   - **If 2 ohms or greater**
   1. Ignition OFF. Disconnect the sensor chassis ground.

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2. Test for less than 2 ohms in the ground circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, repair the open/high resistance in the chassis ground connection.
- **If less than 2 ohms**

3. Ignition ON.
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 circuit.
    2. Test for less than 2 ohms in the ignition circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF, remove the test lamp and remove the fuse for the ignition 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. Test for greater than 2 ohms between the ignition circuit terminal 5 and ground.
        - If less than 2 ohms, repair the short to ground on the circuit.
        - If greater than 2 ohms, test all the components connected to the circuit and repair or replace as necessary.
    - **If a test lamp illuminates**
5. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal 3 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 ohms in the signal circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 4.8-5.2 V**
6. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
    - **EL-38522-A, Variable Signal Generator; or equivalent is not available**

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1. Replace the K20 Engine Control Module.
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
3. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to step 10.

   - **If no DTCs set**
4. 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 follows:
   - Red lead to the signal circuit terminal 3 at the harness connector
   - Black leads to ground
   - Battery voltage supply lead to B+
8. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
   - Signal switch to 5 V
   - Frequency switch to 5 kHz
   - Duty Cycle switch to 50 % (Normal)
9. Engine idling, verify the scan tool MAF Sensor parameter is between 4, 950-5, 050 Hz.
   - **If not between 4, 950-5, 050 Hz.**

     Replace the K20 Engine Control Module.

   - **If between 4, 950-5, 050 Hz.**
10. Replace the B75C Multifunction Intake Air sensor.

Repair Instructions

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

- **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement.
- **Control Module References** for ECM replacement, programming, and setup

DTC P0106

Diagnostic Instructions

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

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DTC Descriptor

DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P0697	P0106, P0107	P0107	P0106, P0108, P0697	P0106
Signal	P0106, P0107	P0106, P0107	P0106, P0107	P0106, P0108*	P0106, P1101
Low Reference	-	P0106, P0108	P0106, P0108	-	P0106
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.					

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** 12-103 kPa (1.7-14.9 PSI) (varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	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 **Parameter Normal Range:** 12-225 kPa (1.7-32.6 PSI) (varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)*
Low Reference	-	255 kPa (36.9 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, barometric pressure (BARO) and

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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 P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0125, P0128, P222C, P222D, P0335, P0336, P0401, P042E or P2610 are not set
- The engine speed is between 400-6500 RPM.
- The engine coolant temperature (ECT) Sensor is between -7 to +125°C (19.4-257°F).
- The intake air temperature (IAT) sensor is between -20 to +100°C (-4 to +212°F).
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0106 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0106 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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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** .

Circuit/System Verification

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

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

   - **If none of the DTCs are set**
2. If you were sent here from DTC P0068, P0101, P0121, or P1101; refer to Circuit/System Testing below.
3. Ignition ON, verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90%.
   - **If 90% or greater**

     Refer to **Throttle Body Inspection and Cleaning** for this publication.

   - **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, 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.

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

  Refer to Circuit/System Testing below.

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

7. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26-52 kPa (3.8-7.5 PSI) and changes with accelerator pedal input.
   - **If not between 26-52 kPa (3.8-7.5 PSI) or does not change**

     Refer to Circuit/System Testing below.

   - **If between 26-52 kPa (3.8-7.5 PSI) and changes**
8. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
   1. Engine idling
   2. Perform the scan tool snapshot function.
   3. Increase the engine speed slowly to 3000 RPM and then back to idle.
   4. Exit from the scan tool snapshot and review the data.
   5. Observe the MAF Sensor parameter frame by frame with a scan tool.
   - **If the MAF Sensor parameter does not change smoothly and gradually**

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

   - **If the MAF Sensor parameter changes smoothly and gradually**
9. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
10. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing below.

    - **If the DTC does not set**
11. 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 **Symptoms - Engine Exhaust**
- Engine mechanical condition; for example: low compression or incorrect timing chain or belt 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 ohms between the low reference circuit terminal 2 and ground.
   - **If 2 ohms or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the low reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If less than 2 ohms**
4. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the 5 V reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.

   NOTE: If the signal circuit is shorted to a voltage the ECM or the MAP Sensor may be damaged.

   -
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.

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- If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**

5. Ignition ON, verify the scan tool MAP Sensor parameter is less than 0.5 V.
   - **If 0.5 V or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Ignition ON, test for less than 1 V between the signal circuit terminal 3 and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If less than 0.5 V**
6. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1.
7. Ignition ON, verify the scan tool MAP Sensor voltage parameter is greater than 4.5 V.
   - **If 4.5 V or less**
   1. Ignition OFF, disconnect the K20 Engine Control Module.
   2. Remove the jumper wire, test for infinite resistance between the signal circuit terminal 3 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the signal circuit end to end.
      - If 2 ohms or greater, repair the open or high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 4.5 V**
8. Test or replace the B74 Manifold Absolute Pressure Sensor.

Component Testing

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

Skewed Sensor Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply 17 kPa (5.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A** . Verify the scan tool MAP Sensor pressure parameter decreases between 13-21 kPa (1.8-3.0 PSI).
   - **If the parameter does not decrease between 13-21 kPa (1.8-3.0 PSI).**

     Replace the B74 Manifold Absolute Pressure Sensor.

   - **If the parameter does decrease between 13-21 kPa (1.8-3.0 PSI).**

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3. Apply 34 kPa (10.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A** . Verify the scan tool MAP Sensor pressure parameter decreases between 30-38 kPa (4.4-5.5 PSI).
   - **If the parameter does not decrease between 30-38 kPa (4.4-5.5 PSI).**

     Replace the B74 Manifold Absolute Pressure Sensor.

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

Erratic Signal Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply between 0-15 kPa (0-4.4 in Hg) of vacuum to the sensor with the **GE-23738-A** . Verify the voltage changes, without any spikes or dropouts and is between 0.2-4.9 V.
   - **If not between 0.2-4.9 V or has spikes or dropouts**

     Replace the B74 Manifold Absolute Pressure Sensor.

   - **If between 0.2-4.9 V and there are no spikes or dropouts**
7. All OK.

Repair Instructions

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

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

DTC P0107 OR P0108

Diagnostic Instructions

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

DTC Descriptors

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DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0106, P0107, P0697	P0106, P0107	P0107	P0106, P0108, P0697	P0106
Signal	P0106, P0107	P0106, P0107	P0106, P0107	P0106, P0108*	P0106, P1101
Low Reference	-	P0106, P0108	P0106, P0108	-	P0106
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.					

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** 12-103 kPa (1.7-14.9 PSI)			
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 **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 Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the

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

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

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

Conditions for Running the DTC

P0107

This DTC runs continuously.

P0108

This DTC runs continuously.

Conditions for Setting the DTC

P0107

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

Engine Controls Schematics

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Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

GE-23738-A Vacuum Pump

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

Circuit/System Verification

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

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

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

     Refer to Circuit/System Testing for further diagnosis.

   - **If the MAP Sensor parameter is within range**
4. Verify the engine is equipped with a turbocharger.
   - **If not equipped with a turbocharger**

     Refer to Step 6.

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- **If equipped with a turbocharger**

5. Engine idling, verify the scan tool MAP Sensor voltage parameter is between 0.3-4.8 V and changes with accelerator pedal input.
   - **If not between 0.3-4.8 V or does not change**

     Refer to Circuit/System Testing below.

   - **If between 0.3-4.8 V and changes**

     Refer to Step 7.

6. Engine idling, verify the scan tool MAP Sensor voltage parameter is between 0.2-4.5 V and changes with accelerator pedal input.
   - **If not between 0.2-4.5 V or does not change**

     Refer to Circuit/System Testing below.

   - **If between 0.2-4.5 V and changes**
7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
8. Verify a DTC does not set.
   - **If any DTC sets**

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B74 Manifold Absolute Pressure Sensor.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down. Test for less than 2 ohms between the low reference circuit terminal 2 and ground.
   - **If 2 ohms or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the low reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If less than 2 ohms**
3. Ignition ON, 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.

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2. Test for infinite resistance between the 5 V reference circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 ohms in the 5 V reference circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, replace the K20 Engine Control Module.

NOTE: If the signal circuit is shorted to a voltage the ECM or the MAP Sensor may be damaged.

-
- **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

4. Ignition ON, verify the scan tool MAP Sensor parameter is less than 0.5 V.
    - **If 0.5 V or greater**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit terminal 3 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.

    - **If less than 0.5 V**

5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1.
6. Ignition ON, verify the scan tool MAP Sensor voltage parameter is greater than 4.5 V.
    - **If 4.5 V or less**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Remove the jumper wire, test for infinite resistance between the signal circuit terminal 3 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 ohms in the signal circuit end to end.
        - If 2 ohms or greater, repair the open or high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.

    - **If greater than 4.5 V**

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

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Component Testing

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

Skewed Sensor Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply 17 kPa (5.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A** . Verify the scan tool MAP Sensor pressure parameter decreases between 13-21 kPa (1.8-3.0 PSI).
   - **If the parameter does not decrease between 13-21 kPa (1.8-3.0 PSI).**

     Replace the B74 Manifold Absolute Pressure Sensor.

   - **If the parameter does decrease between 13-21 kPa (1.8-3.0 PSI).**
3. Apply 34 kPa (10.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A** . Verify the scan tool MAP Sensor pressure parameter decreases between 30-38 kPa (4.4-5.5 PSI).
   - **If the parameter does not decrease between 30-38 kPa (4.4-5.5 PSI).**

     Replace the B74 Manifold Absolute Pressure Sensor.

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

Erratic Signal Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply between 0-15 kPa (0-4.4 in Hg) of vacuum to the sensor with the **GE-23738-A** . Verify the voltage changes, without any spikes or dropouts and is between 0.2-4.9 V.
   - **If not between 0.2-4.9 V or has spikes or dropouts**

     Replace the B74 Manifold Absolute Pressure Sensor.

   - **If between 0.2-4.9 V and there are no spikes or dropouts**
7. All OK.

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Repair Instructions

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

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

DTC P0112, P0113, OR P0114

Diagnostic Instructions

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

DTC Descriptors

DTC P0112

Intake Air Temperature (IAT) Sensor 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
Sensor	P0112, P0114, P2199**	P0113, P0114, P2199**	P0113*, P0114, P2199**	P0111, P0114
Low Reference	-	P0097, P0113, P11C2, P2227, P2229	*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. ** Where used.				

Typical Scan Tool Data

IAT Sensor 1

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

Circuit/System Description

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

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

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 °C (°F).

The IAT sensor 2 produces a frequency signal based on the inlet air temperature very close to the humidity sensor within the sensor bore. The signal varies with inlet air temperature and is displayed by the scan tool as ° C (°F) and Hertz (Hz). The signal circuit is shared by the IAT sensor 2 and the humidity sensor.

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

Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for the mass air flow (MAF) sensor.

IAT Sensor 1 - Temperature, Resistance, Voltage Table

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage

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Cold	High	High
Warm	Low	Low

Conditions for Running the DTCs

P0112, P0113, and P0114

- The ignition is ON, or the engine is running.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0112

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

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

P0113

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

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

P0114

The ECM monitors the IAT sensor signal every 0.1 s, to determine if the signal has changed more than 80°C (176°F). The DTC fails when the condition exists for longer than 4 s.

Action Taken When the DTCs Set

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

Conditions for Clearing the DTCs

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

Diagnostic Aids

- With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor 1 will gradually increase the scan tool IAT Sensor 1 parameter. This is due to the heat that is generated by the MAF sensor heating elements.
- Depending on the ambient temperature, an IAT sensor 1 signal circuit or low reference circuit that is shorted to the MAF sensor signal circuit can cause a DTC P0113 and/or P0114 to set. This condition causes a rapid fluctuation in the IAT Sensor 1 parameter.

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

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

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

NOTE: To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 3 and 4 of this verification procedure only if the ignition has been OFF for 8 hours or more.

3. Ignition ON.
4. Verify the following scan tool parameters are within 55°C (99°F) of each other.
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - Start-Up ECT

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- **If not within 55°C (99°F)**

  Refer to Circuit/System Testing below.

- **If within 55°C (99°F)**

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

     Refer to Circuit/System Testing below.

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

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification before proceeding with 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 B75C Multifunction Intake Air sensor.
2. Test for less than 2 ohms between the low reference circuit terminal 7 and ground.
   - **If 2 ohms or greater**
     1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
     2. Test for less than 2 ohms in the low reference circuit end to end.
        - If 2 ohms or greater, repair the open or high resistance in the circuit.
        - If less than 2 ohms replace the K20 Engine Control Module.
   - **If less than 2 ohms**
3. Ignition ON, test for 4.8-5.2 V between the 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.

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

- **If greater than 5.2 V**

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

4. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than -39°C (-38°F).
   - **If warmer than -39°C (-38°F).**

   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 8 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the signal circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.

   - **If colder than -39°C (-38°F).**

5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 8 and the low reference circuit terminal 7.
6. Verify the scan tool IAT Sensor 1 parameter is warmer than 148°C (298°F).
   - **If colder than 148°C (298°F).**

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

   - **If warmer than 148°C (298°F).**

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7. 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 (Bosch Sensor)** table for Bosch Sensors. The resistance values should be in range of the table values.
   - **If not within the specified range.**

     Replace the B75C Multifunction Intake Air sensor.

   - **If within the specified range.**
3. All OK

Repair Instructions

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

- **Mass Airflow Sensor Replacement** for B75C Multifunction Intake Air sensor replacement.
- **Control Module References** for ECM replacement, programming, and setup.

DTC P0116 (LUW)

Diagnostic Instructions

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

DTC Descriptors

DTC P0116

Engine Coolant Temperature (ECT) Sensor Performance

Diagnostic Fault Information

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

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ECT Sensor Signal	P0117	P0118	P0118	P0116, P0119, P0128
Low Reference	-	P0118	-	P0116, P0119, P0128

Typical Scan Tool Data

ECT Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The ignition is ON, or the engine is running **Parameter Normal Range:** Varies with ambient air temperature, within a range of -40 to +140°C (-40 to +284°F)			
ECT Sensor Signal	140°C (284°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT 1 sensor signal circuit and a ground for the low reference circuit.

The purpose of the P0116 diagnostic is to analyze the performance of the ECT sensor by comparing the response and the range of the sensor signal to two distinct models under various operating conditions.

- The first model verifies that the sensor is not stuck in range.
- The second model verifies that the sensor is within an acceptable operating range of the calculated ECT. Both models use various parts of the information derived from the following inputs:
  - Ambient air temperature
  - ECT
  - Engine OFF time
  - Intake air temperature (IAT)
  - Engine OFF time

Conditions for Running the DTC

- The ignition is ON, or the engine is running.
- DTCs P0111, P0112, P0113, P0117, P0118, P0722, P0723 or P2610 are not set.
- The ignition has been off for greater than 8 h before the engine is started.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

P0116 Engine Running, Sensor Signal Stuck Test

- The ECM detects that the ECT sensor signal has abruptly changed a minimum of 20°C (68°F) warmer than intake air temperature (IAT) at engine start.

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- The measured ECT is greater than measured IAT at engine start, is not within range of the calibrated model.

P0116 Engine Running, Sensor Within Range Test

- The ECT at engine start is not within range of the calibrated model.
- The ECT is greater than measured IAT at engine start, is not within range of the calibrated model.

Action Taken When the DTC Sets

- DTC P0116 is a Type B DTC.
- The cooling fans will be commanded ON.
- The A/C compressor will be commanded OFF.

Conditions for Clearing the DTC

DTC P0116 is a Type B DTC.

Diagnostic Aids

- Inspect the ECT sensor terminals for corrosion and for engine coolant leaking through the sensor. 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 intake air temperature (IAT) sensor that is biased colder at various ambient temperatures due to greater resistance than is normal will increase the range between these 2 sensors. Measure and record the resistance of the IAT sensor at various ambient temperatures, then compare those measurements to the Temperature vs. Resistance table. Refer to **Temperature Versus Resistance (ECT)** .
- Test the ECT sensor at various temperature levels in order to evaluate the possibility of a biased sensor. A sensor that is biased warmer can result in a driveability condition. Refer to **Temperature Versus Resistance (ECT)** .
- 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.
- If the condition is intermittent, allow the vehicle to sit for greater than 8 h with the ignition OFF, may help isolate the condition. Compare the scan tool and ECT Sensor temperature sensor values at ignition on. The Radiator Coolant Temperature Sensor and the ECT Sensor values should display within 3°C (5° F).

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cooling System Description and Operation (1.4L LUV) , **Cooling System Description and Operation (1.8L LUW and LWE)**

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. Verify that DTC P0112, P0113, P0117, or P0118 are not set.
    - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition off, inspect the cooling system surge tank for the proper coolant level. Refer to **Loss of Coolant** , and **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE-47716 Fill)** .
3. If the ignition has been OFF for 8 h or greater, observe the scan tool parameters list below. The temperatures should be within 20°C (68°F).
    - ECT Sensor
    - IAT Sensor
4. Engine running, observe the ECT Sensor parameter. The reading should be between -40 to +140°C (-40 to +284°F) depending on the current ambient temperature and the vehicle operating conditions.
5. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B34A Engine Coolant Temperature Sensor 1.
2. Ignition OFF, test for less than 5 ohms between the low reference circuit terminal 2 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the

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circuit tests normal, replace the K20 Engine Control Module.

3. Ignition ON, verify the scan tool ECT Sensor 1 is at -40°C (-40°F).
   - If warmer than the specified range, test the signal circuit terminal 1 for a short to ground. If the circuit tests normal, replace the K20 Engine Control Module.

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.

4. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the scan tool ECT Sensor 1 is at 140°C (284°F).
   - If colder than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the K20 Engine Control Module.
5. If all circuits test normal, test or replace the B34A Engine Coolant Temperature Sensor 1.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the B34A Engine Coolant Temperature Sensor 1.

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

2. Test the B34A Engine Coolant Temperature Sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance (ECT)** table and verify that the resistance is within 5% of the specification.
   - If not within the specified range, replace the B34A Engine Coolant Temperature Sensor 1.

Repair Instructions

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

- **Engine Coolant Temperature Sensor Replacement - Thermostat Side**
- **Control Module References** for ECM replacement, programming, and setup

DTC P0117, P0118, OR P0119

Diagnostic Instructions

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

DTC Descriptors

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DTC P0117

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DTC P0119

Engine Coolant Temperature (ECT) Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117	P0118, P0119	P0118*, P0119	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 at various operating conditions **Parameter Normal Range:** Varies with coolant temperature			
Signal	140°C (284°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT sensor signal circuit and a ground for the low reference circuit. This diagnostic checks for an open, short to ground or an intermittent circuit condition between the ECM and ECT sensor.

Conditions for Running the DTC

P0117

- The ignition is ON.

  OR

- The engine is running for greater than 10 s.

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OR

- The engine run time is less than 10 s when the intake air temperature (IAT) is colder than 50°C (122°F).
- This DTC runs continuously within the enabling conditions.

P0118

- The ignition is ON.

OR

- The engine is running for greater than 10 s.

OR

- The engine run time is less than 10 s when the IAT is warmer than 0°C (32°F).
- This DTC runs continuously within the enabling conditions.

P0119

- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

P0117

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

P0118

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

P0119

The ECM detects that the ECT is intermittent or has abruptly changed for greater than 4 seconds.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

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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 the scan tool ECT Sensor parameter is between -39 to + 120°C (-38 to +248°F) and changes with engine run time.
    - **If not between -39 to + 120°C (-38 to +248°F) or does not change**

      Refer to Circuit/System Testing below.

    - **If between -39 to + 120°C (-38 to +248°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 below.

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

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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 ohms between the low reference circuit terminal 2 and ground.
    - **If 5 ohms or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 ohms in the low reference circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.
    - **If less than 5 ohms**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39°C (-38°F).
    - **If warmer than -39°C (-38°F)**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If colder than -39°C (-38°F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149°C (300°F).
    - **If colder than 149°C (300°F)**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 ohms in the signal circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.
    - **If warmer than 149°C (300°F)**
7. Test or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance** table. The resistance values should be in range of

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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.

- **Engine Coolant Temperature Sensor Replacement - Thermostat Side**
- **Engine Control Module Replacement** engine control module replacement, programming, and setup

DTC P0121-P0123, P0222, P0223, OR P2135

Diagnostic Instructions

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

DTC Descriptors

DTC P0121

Throttle Position Sensor 1 Performance

DTC P0122

Throttle Position Sensor 1 Circuit Low Voltage

DTC P0123

Throttle Position Sensor 1 Circuit High Voltage

DTC P0222

Throttle Position Sensor 2 Circuit Low Voltage

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DTC P0223

Throttle Position Sensor 2 Circuit High Voltage

DTC P2135

Throttle Position Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P06A3, P2135	P2135	P0122, P0222	P06A3, P2135	P0068, P0121
Throttle Position Sensor 1 Signal	P0122	P2135	P0122	P0123	P0068, P0121
Throttle Position Sensor 2 Signal	P0222	P2135	P0223	P0223	P0068, P0121
Low Reference	-	P2135	P0123, P0223	-	P0068, P0121

Typical Scan Tool Data

Throttle Position Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Normal Range:** 4.75-0.35 V			
5 V Reference	0 V	0 V	5 V
Throttle Position Sensor 1 Signal	0 V	0 V	5 V
Low Reference	-	4-5 V	-

Throttle Position Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** 0.35-4.65 V			
5 V Reference	0 V	0 V	5 V
Throttle Position Sensor 2 Signal	0 V	5 V	5 V
Low Reference	-	4-5 V	-

Circuit/System Description

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

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

Conditions for Running the DTC

P0122, P0123, P0222, and P0223

- DTC P06A3 is not set.
- The run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- The ignition is ON or the engine is operating.
- DTC P0122, P0123, P0222, P0223 run continuously when the above conditions are met.

P0121

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0315, P0335, P0336, or is not set.
- The engine speed is between 400 and 6, 000 RPM.
- The engine coolant temperature (ECT) is between -7 to +125°C (19-257°F).
- The intake air temperature (IAT) is between -20 to +100°C (-4 to +212°F).
- DTC P0121 runs continuously when the above conditions are met.

P2135

- DTC 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 ignition is ON or the engine is operating.
- DTC P2135 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0121

The ECM detects the throttle position sensor is stuck within range for greater than 1 s.

P0122

The ECM detects the throttle position sensor 1 voltage is less than 0.325 V for greater than 1 s.

P0123

The ECM detects the throttle position sensor 1 voltage is greater than 4.75 V for greater than 1 s.

P0222

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The ECM detects that the throttle position sensor 2 voltage is less than 0.25 V for greater than 1 s.

P0223

The ECM detects the throttle position sensor 2 voltage is greater than 4.59 V for greater than 1 s.

P2135

The ECM detects the difference between the throttle position sensor 1 and throttle position sensor 2 exceeds a predetermined value for greater than 1 s.

Action Taken When the DTC Sets

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

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

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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. If you were sent here from DTC P0068, P0101, P0106, or P1101 refer to Circuit/System Testing below.
3. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
   - **If any of the DTCs are set**

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

   - **If none of the DTCs are set**
4. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
   - **90 % or greater**

     Refer to **Throttle Body Inspection and Cleaning** .

   - **If less than 90 %**
5. Verify the scan tool Throttle Position Sensor 1 and Throttle Position Sensor 2 voltage parameters are between 1.0-4.0 V and change with accelerator pedal input.
   - **If not between 1.0-4.0 V or does not change**

     Refer to Circuit/System Testing below

   - **If between 1.0-4.0 V and changes**
6. Verify the scan tool Throttle Position Sensor 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
   - **If Disagree**

     Refer to Circuit/System Testing below

   - **If Agree**
7. Determine the current vehicle testing altitude.

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8. Verify the scan tool MAP Sensor pressure parameter is within range specified in the **Altitude Versus Barometric Pressure** table.
   - **The MAP Sensor pressure is not in range**

     Refer to **DTC P0106**.

   - **The MAP Sensor pressure is within range**
9. Engine idling.
10. Verify the scan tool MAP Sensor pressure parameter is between 26-52 kPa (3.8-7.5 psi) and changes with accelerator pedal input.
    - **If not between 26-52 kPa (3.8-7.5 psi) or does not change**

      Refer to **DTC P0106**.

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

      Refer to **DTC P0101**.

    - **The MAF Sensor parameter changes smoothly and gradually**
12. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
13. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing below

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

Circuit/System Testing

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

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at Q38 Throttle Body. It

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may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 5 ohms between the low reference circuit terminal C or 6 and ground.
    - **If 5 ohms or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 ohms in the low reference circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.
    - **If less than 5 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal E or 2 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 ohms in the 5 V reference circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 4.8-5.2 V**
5. Ignition ON.
6. Test for less than 1 V between the throttle position sensor 1 signal circuit terminal D or 1 and ground.
    - **If 1.0 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 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 1.0 V or less**
7. Install a 3 A fused jumper wire between throttle position sensor 1 signal circuit terminal D or 1 and the 5 V reference circuit terminal E or 2.
8. Verify the scan tool Throttle Position Sensor 1 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 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 ohms in the signal circuit end to end.
   - If 2 ohms or greater, repair the open/high resistance in the circuit.
   - If less than 2 ohms, replace the K20 Engine Control Module.

- **If 4.8 or greater**

9. Test for 4.8-5.2 V between the throttle position sensor 2 signal circuit terminal F or 4 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the signal circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 4.8-5.2 V**
10. Test or replace the Q38 Throttle Body.

Repair Instructions

- **Throttle Body Assembly Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

Repair Verification

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

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Test or replace the Q38 Throttle Body assembly.

- **If Agree**

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

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

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

DTC P0128

Diagnostic Instructions

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

DTC Descriptor

DTC P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

Diagnostic Fault Information

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

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The ignition is ON, or the engine is running **Parameter Normal Range:** Varies with engine coolant temperature, within a range of -39 to +120°C (-38 to +248°F)			
Signal	140°C (284°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)

Circuit/System Description

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

The purpose of this diagnostic is to analyze the performance of the thermostat by comparing the measured ECT to a modeled ECT using information from the following inputs:

- ECT
- Engine load
- Intake air temperature (IAT)
- Mass air flow (MAF)
- Vehicle speed (VS)

The ECM uses the start-up ECT and ambient air temperature to begin the diagnostic calculation. This diagnostic monitors the amount of energy going into and out of the engine cooling system during the warm up process to determine if the ECT does increase normally and then maintains that temperature within a calibrated range of the modeled ECT.

Conditions for Running the DTC

- DTC P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0221, P0222, P0223, P0335, P0336, or P0501 is not set.
- The decrease in ECT after engine start is within a calibrated range.
- The engine not run time is greater than 30 m.
- The start-up ECT is between -10 and +75°C (14-167°F).
- The start-up IAT is warmer than -10°C (14°F).
- The DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

The ECM determines that the modeled ECT has met the calibrated target temperature of 92°C (198°F) and the measured ECT is less than 79°C (174°F) for greater than 2 s.

Action Taken When the DTC Sets

- DTC P0128 is a Type B DTC.
- The Engine Coolant Temperature Gauge is inoperative.
- The cooling fans will be commanded ON.
- The AC compressor will be commanded OFF.

Conditions for Clearing the MIL/DTC

DTC P0128 is a Type B DTC.

Diagnostic Aids

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- DTC P0128 occurring with insufficient vehicle interior heating is an indication of improper thermostat operation.
- Corrosion on the ECT sensor terminals or the ECT harness connector results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.
- A slight to moderate resistance in the ECT sensor signal circuit or low reference circuit will affect this diagnostic. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.
- DTC P0128 and DTC 2181 both currently failed could indicate a stuck open thermostat.

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. Verify the cooling system is filled to the correct coolant level. Refer to **Cooling System Leak Testing** , and **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE-47716 Fill)** .
    - **If the coolant level is not correct**

      Repair as necessary

    - **If the coolant level is correct**
2. Verify the DTC P00B7, P0116, P0117, P0118, P0597, P0598, or P0599 is not set.

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- **If a DTC is set**

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

- **If a DTC is not set**

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 79°C (174°F) when commanding the Engine Coolant Thermostat Heater to 0%.
   - **If less than 79°C (174°F)**

     Replace the E41 Engine Coolant Thermostat Heater.

   - **If greater than 79°C (174°F)**
5. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Step 1.

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

Component Testing

1. Ignition OFF, disconnect the B34 Engine Coolant Temperature Sensor harness connector at the sensor.
2. Test for refer to **Temperature Versus Resistance (ECT)** Temperature Versus Resistance between the signal circuit terminal 1 and the low reference terminal 2.
   - **If the temperature versus resistance are not within the specified ranges**

     Replace the B34 Engine Coolant Temperature Sensor.

   - **If the temperature versus resistance are within the specified ranges**
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

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

- **Engine Coolant Temperature Sensor Replacement - Thermostat Side**
- **Engine Coolant Thermostat Replacement**
- **Control Module References** for ECM replacement, programming, and setup.

DTC P0131, P0132, P0134, P0137, P0138, OR P0140

Diagnostic Instructions

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

DTC Descriptors

DTC P0131

HO2S Circuit Low Voltage Sensor 1

DTC P0132

HO2S Circuit High Voltage Sensor 1

DTC P0134

HO2S Circuit Insufficient Activity Sensor 1

DTC P0137

HO2S Circuit Low Voltage Sensor 2

DTC P0138

HO2S Circuit High Voltage Sensor 2

DTC P0140

HO2S Circuit Insufficient Activity Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P1133*, P015A*, P015B*

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HO2S Low Signal	P0131, P0137	P0132, P0134, P0138, P0140	P0132, P0134, P0138, P0140	P0133, P1133*, P015A*, P015B*
*If equipped				

Typical Scan Tool Data

HO2S 1 or 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine operating in Closed Loop **Parameter Normal Range:** 200-800 mV			
HO2S 1 or 2 High Signal	0 mV	1700-2 100 mV	1700-2 100 mV
HO2S 1 or 2 Low Signal	-	1700-2 100 mV	1700-2 100 mV

Circuit/System Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an open loop mode, ignoring the HO2S signal voltage while calculating the air to fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1 000 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

DTC P0131 or P0137

- DTCs P0068, P0106, P0108, P0122, P0123, P0201, P0202, P0203, P0204, P0222, P0223, P0442, P0443, P0449, P0452, P0455, P0496, P0606, P16F3 and P2101 are not set.
- The Ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The fuel composition is less than 87% ethanol.
- The fuel system is in Closed Loop.
- The engine is not decelerating.
- DTC P0131 runs continuously when the above conditions are met for greater than 3 s.
- DTC P0137 runs continuously when the above conditions are met for greater than 5 s.

DTC P0132 or P0138

- DTCs P0106, P0108, P0201, P0202, P0203, P0204, P0442, P0443, P0449, P0452, P0453, P0455 and

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P0496 are not set.
- The Ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The fuel composition is less than 87% ethanol.
- The fuel system is in Closed Loop.
- The engine runtime is greater than 60 s.
- The engine is not decelerating.
- DTC P0132 and P0138 run continuously when the above conditions are met for greater than 3 s.

DTC P0134 or P0140

- DTCs P0068, P0101, P0102, P0103, P0122, P0123, P0222, P0223, P0606 and P16F3 are not set.
- The Ignition voltage is between 10-32 V.
- The heated oxygen sensor heater warm up is completed.
- The engine runtime is greater than 50 s.
- The fuel composition is less than 87% ethanol.
- DTC P0134 and P0140 run continuously when the above conditions are met.

Conditions for Setting the DTC

P0131 or P0137

The engine control module detects that the heated oxygen sensor voltage is less than 20 mV for greater than 38 s.

P0132 or P0138

The engine control module detects that the heated oxygen sensor voltage is greater than 1 050 mV for greater than 10 s.

P0134 or P0140

The engine control module detects that the heated oxygen sensor voltage is greater than 1 700 mV for greater than 10 s.

Action Taken When the DTC Sets

DTCs P0131, P0132, P0134, P0137, P0138 and P0140 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0131, P0132, P0134, P0137, P0138 and P0140 are Type B DTCs.

Reference Information

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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 HO2S heater DTC is set.**

     Refer to **DTC P0030-P0032, P0036-P0038, P0053, P0054, P0135, or P0141**.

   - **If no HO2S heater DTC is set.**
3. Allow the engine to reach operating temperature, engine running.
4. Verify the scan tool HO2S Sensor 1 or 2 voltage parameters are between 50-1 050 mV.
   - **If not between 50-1 050 mV.**

     Refer to Circuit/System Testing below.

   - **If between 50-1 050 mV.**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets.**

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Refer to Circuit/System Testing below.

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

7. All OK.

Circuit/System Testing

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at the appropriate B52 Heated Oxygen Sensor. It may take up to 2 min 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.
      - If infinite resistance
   3. Test for less than 2 ohms in the high signal circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 3.0 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the high signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 1.7-3.0 V**
3. Verify the scan tool 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**
4. Connect a 3 A fused jumper wire between the high signal circuit terminal 4 and the low signal circuit terminal A.

NOTE: The low signal circuit is tied to a pull-up circuit within the engine control module. A voltage of 0.0-1.10 V on the low signal circuit is normal.

5. Verify the scan tool heated oxygen sensor 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.

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2. Test for less than 2 ohms in the low signal circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms.
3. Test for less than 1 V between the low signal circuit terminal 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 following conditions exist:
    - Lean or rich fuel injectors. Refer to **Fuel Injector Diagnosis** .
    - Water intrusion in the HO2S harness connector
    - Low or high fuel system pressure. Refer to **Fuel System Description** .
    - Fuel that is contaminated. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
    - Fuel saturation of the evaporative emission (EVAP) canister
    - Exhaust leaks near the HO2S
    - Engine vacuum leaks
    - **If any of the conditions exist**

      Repair as necessary.

    - **If none of the conditions exist**
7. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

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

- **Heated Oxygen Sensor Replacement - Sensor 1**
- **Heated Oxygen Sensor Replacement - Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing a HO2S.
- **Control Module References** for ECM replacement, programming, and setup

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

Diagnostic Instructions

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

DTC Descriptors

DTC P0133

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HO2S Slow Response Sensor 1

DTC P013A

HO2S Slow Response Rich to Lean Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Sensor 2

DTC P013F

HO2S Delayed Response Lean to Rich Sensor 2

DTC P015A

HO2S Delayed Response Rich to Lean Sensor 1

DTC P015B

HO2S Delayed Response Lean to Rich Sensor 1

DTC P2270

HO2S Signal Stuck Lean Sensor 2

DTC P2271

HO2S Signal Stuck Rich Sensor 2

Circuit/System Description

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

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

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sooner.

Conditions for Running the DTC

DTC P0133

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0131, P0132, P0134, P0201, P0202, P0203, P0204, P0222, P0223, P0300, P0442, P0443, P0449, P0452, P0455, P0496, P16F3, P2101 or P2135 is not set.
- The ignition voltage is between 10-32 V.
- The device controls are not active.
- The engine speed is between 1 200-3 500 RPM.
- The engine coolant temperature (ECT) is hotter than 60°C (140°F).
- The intake air temperature (IAT) is hotter than -40°C (-40°F).
- The barometric pressure (BARO) is greater than 70 kPa (10 PSI).
- The engine has been operating for greater than 150 s.
- The mass air flow (MAF) is between 12-30 g/s.
- The HO2S heater is commanded ON for greater than 40 s.
- The fuel system is in Closed Loop.
- The vehicle is not decelerating.
- The learned heater resistance is valid.
- The fuel composition is less than 87% ethanol.
- The DTCs run continuously when the above conditions are met for greater than 1 s.

P013A

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0171, P0172, P0201, P0202, P0203, P0204, P0222, P0223, P0300, P16F3, P2101 or P2135 is not set.
- The ignition voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- DTC P013B, P013E, P013F, P2270 or P2271 have failed this key cycle.
- DTC P013E and P2270 have passed.
- The DTC runs once per trip, during deceleration fuel cut-off (DFCO) mode, when the above conditions are met.

P013B

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0171, P0172, P0201, P0202, P0203, P0204, P0222, P0223, P0300, P16F3, P2101 or P2135 is not set.

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- The ignition voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- DTC P013A, P013E, P013F, P2270 or P2271 have failed this key cycle.
- DTC P013A, P013E, P013F, P2270 and P2271 have passed.
- The DTC runs once per trip, during the fuel enrich mode, when the above conditions are met.

P013E

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0171, P0172, P0201, P0202, P0203, P0204, P0222, P0223, P0300, P16F3, P2101 or P2135 is not set.
- The ignition voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- DTC P013A, P013B, P013F, P2270 and P2271 have failed this key cycle.
- DTC P2270 have passed.
- The DTC runs once per trip, during deceleration fuel cut-off (DFCO) mode, when the above conditions are met.

P013F

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0171, P0172, P0201, P0202, P0203, P0204, P0222, P0223, P0300, P16F3, P2101 or P2135 is not set.
- The ignition voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- DTC P013A, P013B, P013E, P2270 and P2271 have failed this key cycle.
- DTC P013A, P013E, P2270 and P2271 have passed.
- The DTC runs once per trip, during the fuel enrich mode, when the above conditions are met.

P015A and P015B

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0131, P0132, P0134, P0171, P0172, P0201, P0202, P0204, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P16F3, P2101 or P2135 is not set.
- The ignition voltage is between 10-32 V.
- The device controls are not active.
- The fuel level is greater than 10%.
- The HO2S heater is commanded ON for greater than 40 s.

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- The learned heater resistance is valid.
- The engine coolant temperature (ECT) is hotter than 60°C (140°F).
- The intake air temperature (IAT) is hotter than -40°C (-40°F).
- The engine has been operating for greater than 150 s.
- The engine speed is between 1 550-3 500 RPM to initially enable the test.
- The vehicle speed is between 70-125 km/h (44-78 mph) to initially enable the test.
- The engine speed is between 1 350-3 650 RPM to keep the test enabled.
- The vehicle speed is between 65-130 km/h (41-81 mph) to keep the test enabled.
- The mass air flow (MAF) is between 2-20 g/s.
- The fuel system is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The predicted catalytic converter temperature is between 550-900°C (1 022-1 652°F).
- DTC P015A runs once per trip, during the deceleration fuel cut-off (DFCO) mode, when the above conditions are met.
- DTC P015B runs once per trip, during the fuel enrich mode, when the above conditions are met.

P2270

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0171, P0172, P0201, P0202, P0203, P0204, P0222, P0223, P0300, P16F3, P2101 or P2135 is not set.
- The ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine speed is between 1 400-3 500 RPM to initially enable the test.
- The vehicle speed is between 45-125 km/h (28-78 mph) to initially enable the test.
- The engine speed is between 1 350-3 650 RPM to keep the test enabled.
- The vehicle speed is between 40-130 km/h (25-81 mph) to keep the test enabled.
- The mass air flow (MAF) is between 2-20 g/s.
- The fuel system is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The HO2S heater is commanded ON for greater than 40 s.
- The predicted catalytic converter temperature is between 550-900°C (1 022-1 652°F).
- DTC P013A, P013B, P013E, P013F, P2270 or P2271 have failed this key cycle.
- The DTC runs once per trip, during the fuel enrich mode, when the above conditions are met for 1.5 s.

P2271

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0171, P0172, P0201, P0202, P0203, P0204, P0222, P0223, P0300, P16F3, P2101 or P2135 is not set.

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- The ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine speed is between 1 400-3 500 RPM.
- The vehicle speed is between 45-125 km/h (28-78 mph).
- The mass air flow (MAF) is between 2-20 g/s.
- The fuel system is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The HO2S heater is commanded ON for greater than 40 s.
- The predicted catalytic converter temperature is between 550-900°C (1 022-1 652°F).
- DTC P013A, P013B, P013E, P013F or P2270 have failed this key cycle.
- DTC P013A, P013E and P2270 have passed.
- The DTC runs once per trip, during deceleration fuel cut-off (DFCO) mode, when the above conditions are met.

Conditions for Setting the DTC

P0133

- The ECM detects that the HO2S 1 average response time is more than a calculated value.
- DTC P0133 sets within 60 s when the above condition is met.

P013A

The ECM detects that the accumulated mass air flow monitored during rich to lean transitions between 150-450 mV is greater than 10 g.

P013B

The ECM detects that the accumulated mass air flow monitored during rich to lean transitions between 335-650 mV is greater than 140 g.

P013E

The ECM detects that the Post O2 sensor voltage is greater than 450 mV and the accumulated mass air flow monitored during the delayed Response Test is greater than 20 g.

P013F

The ECM detects that the Post O2 sensor voltage is less than 350 mV and the accumulated mass air flow monitored during the delayed Response Test is greater than 260 g.

P2270

- The ECM detects that the heated oxygen sensor (HO2S) 2 sensor cannot achieve voltage less than 775

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mV.

and

- The ECM detects that the accumulated mass air flow monitored during the Stuck Lean Voltage Test is greater than 60 g.

P2271

- The ECM detects that the heated oxygen sensor (HO2S) 2 sensor cannot achieve voltage greater than 100 mV.

and

- The ECM detects that the accumulated mass air flow monitored during the stuck rich voltage test is greater than 30 g.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Heated Oxygen Sensor 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 no HO2S heater DTCs are set.
   - **If a HO2S heater DTC is set**

     Refer to **DTC P0030-P0032, P0036-P0038, P0053, P0054, P0135, or P0141**.

   - **If no HO2S heater DTC is set**
3. Allow the engine to reach operating temperature, engine running.
4. Verify the scan tool HO2S Sensor 1 or 2 voltage parameters are between 50-1 050 mV.
   - **If not between 50-1 050 mV**

     Refer to **DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, or P2271**.

   - **If between 50-1 050 mV**
5. Verify none of the following conditions exist:
   - Lean or rich fuel injectors
   - Water intrusion in the HO2S harness connector
   - Low or high fuel system pressure-Refer to **Fuel System Diagnosis** .
   - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks
   - Engine vacuum leaks
   - Engine oil consumptions-Refer to **Oil Consumption Diagnosis** .
   - Engine coolant consumption-Refer to **Symptoms - Engine Cooling** .
   - **If any of the above conditions exist**

     Repair as necessary.

   - **If none of the above conditions exist**
6. Operate the vehicle within the conditions for running the DTC. Or 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**

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Replace the B52 Heated Oxygen Sensor.

- **If the DTC does not set**

8. All OK.

Repair Instructions

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

- **Heated Oxygen Sensor Replacement - Sensor 1**
- **Heated Oxygen Sensor Replacement - Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an HO2S.
- **Control Module References** for ECM replacement, programming and setup

DTC P0171 OR P0172

Diagnostic Instructions

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

DTC Descriptors

DTC P0171

Fuel Trim System Lean

DTC P0172

Fuel Trim System Rich

Circuit/System Description

The engine control module (ECM) controls 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

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- DTCs P0030, P0053, P0101, P0102, P0103, P0106, P0107, P0108, P0131-P0135, P0201-P0204, P0300-P0304, P0411, P0442, P0455, P0458, P0496, P0506, P0507, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2440, or P2444 are not set.
- The engine is in Closed Loop status.
- The catalyst monitor diagnostic intrusive test, post 02 diagnostic intrusive test, and EVAP diagnostic test are not active.
- The engine coolant temperature (ECT) is between -20°C and +150°C (-4°F and +302°F).
- The intake air temperature (IAT) is between -20°C and +150°C (-4°F and +302°F).
- The manifold absolute pressure (MAP) is between 10-255 kPa (1.5-37 psi).
- The engine speed is between 400-7, 000 RPM.
- The mass air flow (MAF) is between 1-512 g/s.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 psi).
- The fuel level is greater than 10 % and no fuel sensor fault is present.
- This diagnostic runs continuously when the above conditions have been met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTCs P0171 and P0172 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0171 and P0172 are Type B DTCs.

Diagnostic Aids

- Allow the engine to reach operating temperature. With the engine running, observe the HO2S parameter with a scan tool. The HO2S value should vary from approximately 40 mV to approximately 900 mV, and respond to fueling changes.
- The normal Short Term Fuel Trim and Long Term Fuel Trim parameters should be between +10 and -10 % with 0 % the optimum, with the engine running at operating temperature.
- It is very unlikely that an HO2S will cause this DTC to set without the occurrence of the circuit related HO2S DTCs. Do not replace an HO2S to address this DTC without first performing all the steps in Circuit/System Verification.
- Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks.
- A MAF sensor condition can cause this DTC without setting a MAF DTC. If there is a MAF sensor condition, the MAF sensor parameters will appear to be within range.

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- 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

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no other DTCs are set.
   - **If any other DTCs are set**

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

   - **If no other DTCs are set**
3. Verify DTC P0171 or P0172 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing below

   - **If no DTC is set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
5. Verify DTC P0171 or P0172 is not set.
   - **If any of the DTCs set**

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Refer to Circuit/System Testing below

- **If none of the DTCs set**

6. All OK.

Circuit/System Testing

1. Ignition ON.
2. Verify the manifold absolute pressure sensor is within the range specified for your altitude. Refer to **Altitude Versus Barometric Pressure**
   - **If not within the specified range**

     Refer to **DTC P0106**

   - **If within the specified range**
3. Engine running, allow the engine to reach operating temperature.
4. Verify the Long Term Fuel Trim parameter is between -25 % and +25 % (LWE) or -30 % and +30 % (LUW).
   - **If not within the specified range, verify that none of the conditions listed below exist:**

P0171

- Mass air flow (MAF) sensor signal skewed. If the Short Term Fuel Trim parameter changes greater than 20 % when the MAF sensor is disconnected, refer to **DTC P0101**.
- Fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
- Missing, restricted, or leaking exhaust components. Refer to **Symptoms - Engine Exhaust** .
- Malfunctioning fuel injectors. Refer to **Fuel Injector Diagnosis** .
- Split, kinked, or improperly connected vacuum hoses
- Insufficient fuel in the tank
- Low fuel pressure. Refer to **Fuel System Diagnosis** .
- Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
- Leaks in the air induction system and the air intake ducts
- Missing air filter element
- Cracked EVAP canister
- Evaporative pipes obstructed or leaking
- Leaks in the crankcase ventilation system. Refer to **Crankcase Ventilation System Inspection/Diagnosis** .

P0172

- Mass air flow (MAF) sensor signal skewed. If the Short Term Fuel Trim parameters for both banks changes greater than 20 % when the MAF sensor is disconnected, refer to **DTC P0101**.
- Fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .

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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**

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

Repair Instructions

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

DTC P018B-P018D

Diagnostic Instructions

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

DTC Descriptors

DTC P018B

Fuel Pressure Sensor Performance

DTC P018C

Fuel Pressure Sensor Circuit Low Voltage

DTC P018D

Fuel Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

	Short to	Open/High	Short to	

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Circuit	Ground	Resistance	Voltage	Signal Performance
5 V Reference	P018C, P0641, P06A6	P018C	P018D	P06A6
Signal	P018C	P018C	P018D	P018B
Low Reference	-	P018D	-	P06A6

Circuit/System Description

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

The fuel pump control module does not detect a change in the fuel pressure of at least 30 kPa (4.4 psi) when the fuel pump is operating. The fuel pressure sensor performance diagnostic provides a means to detect fuel pressure sensor output that is stuck within the normal operating range of the sensor.

Action Taken When the DTC Sets

DTC P018B, P018C and P018D are Type A DTCs.

Conditions for Clearing the DTC

DTC P018B, P018C and P018D are Type A DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the scan tool Fuel Pressure Sensor Voltage parameter is between 0.2-4.8 V.
   - **If not between 0.2-4.8 V**

     Refer to Circuit/System Testing below.

   - **If between 0.2-4.8 V**
3. All OK.

Circuit/System Testing

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

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B47 Fuel Pressure Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 2 and ground.
   - **If 10 ohms or greater**
     1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module.
     2. Test for less than 2 ohms in the low reference circuit end to end.

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- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K27 Fuel Pump Control Module.

- **If less than 10 ohms**

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

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- If less than 2 ohms, replace the K27 Fuel Pump Control Module.
- **If greater than 4.8 V**

8. Test or replace the B47 Fuel Pressure Sensor.

Repair Instructions

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

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

DTC P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, OR P0271

Diagnostic Instructions

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

DTC Descriptors

DTC P0201

Cylinder 1 Injector Control Circuit

DTC P0202

Cylinder 2 Injector Control Circuit

DTC P0203

Cylinder 3 Injector Control Circuit

DTC P0204

Cylinder 4 Injector Control Circuit

DTC P0261

Cylinder 1 Injector Control Circuit Low Voltage

DTC P0262

Cylinder 1 Injector Control Circuit High Voltage

DTC P0264

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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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0201*, P0202*, P0203*, P0204*, P0261*, P0264*, P0267*, P0270*	P0201**, P0202**, P0203**, P0204**, P0261**, P0264**, P0267**, P0270**	-	-
Injector 1 Control	P0201, P0261	P0201, P0300	P0262, P0300	-
Injector 2 Control	P0202, P0264	P0202, P0300	P0265, P0300	-
Injector 3 Control	P0203, P0267	P0203, P0300	P0268, P0300	-
Injector 4 Control	P0204, P0270	P0204, P0300	P0271, P0300	-
* Open fuse, cranks no start. ** Cranks no start if the condition is between the fuse and the splice.				

Circuit/System Description

The engine control module (ECM) enables the appropriate fuel injector pulse for each cylinder. Ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector by grounding the control circuit via a solid state device called a driver. The ECM monitors the status of each driver. If the ECM detects an incorrect

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voltage for the commanded state of the driver, a fuel injector control circuit DTC sets.

Conditions for Running the DTC

- The engine is running for greater than 1 s.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The control module detects an incorrect voltage on the fuel injector control circuit for more than 5 s.

Action Taken When the DTC Sets

DTCs P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, and P0271 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, and P0271 are Type B DTCs.

Diagnostic Aids

Performing the Fuel Injector Diagnosis may help isolate an intermittent condition. Refer to **Fuel Injector Diagnosis** .

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

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Scan Tool Reference

Control Module References for scan tool information

Special Tool

CH 34730-2C Noid Light, if available

Circuit/System Verification

1. Engine cranking or running.
2. Verify the scan tool parameters listed below do not display Malfunction.
   - Cylinder 1-4 Injector Control Circuit Low Voltage Test Status
   - Cylinder 1-4 Injector Control Circuit Open Test Status
   - Cylinder 1-4 Injector Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing below.

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

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate Q17 Fuel Injector, ignition ON.
2. Verify a test lamp illuminates between the ignition 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 ohms in the ignition circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, 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.

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- If infinite resistance

3. Replace the fuse, ignition ON.
4. Verify the fuse is good after connecting each of the components one at a time.
    - If the fuse opens, replace the component that opens the fuse when connected.
    - If the fuse is good, all OK.

- **If the test lamp illuminates**

3. Ignition OFF, connect the test lamp to the affected fuel injector connector.
4. Engine cranking.
5. Verify the test lamp turns ON and OFF.
    - **If the test lamp is always OFF**

    1. Ignition OFF, remove the test lamp, disconnect the X2 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
    3. Ignition OFF.
    4. Test for less than 2 ohms in the control circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.

    - **If the test lamp is always ON**

    1. Ignition OFF, remove the test lamp, disconnect the X2 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 turns ON and OFF**
6. Test or replace the appropriate Q17 Fuel Injector.

Component Testing

Fuel Injector Diagnosis

Repair Instructions

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

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

DTC P0231, P0232, OR P023F

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

DTC Descriptors

DTC P0231

Fuel Pump Control Circuit Low Voltage

DTC P0232

Fuel Pump Control Circuit High Voltage

DTC P023F

Fuel Pump Control Circuit

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

P0231, P023F

The ignition voltage is between 9-18 V.

P0232

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

Conditions for Setting the DTC

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The fuel pump control module detects a fault on the fuel pump voltage circuit that is less than 11 V or greater than 18 V.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

Diagnostic Aids

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

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

Reference Information

Schematic Reference

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

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Control Module References for scan tool information

Circuit/System Testing

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

Repair Instructions

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

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

DTC P025A

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

DTC Descriptor

DTC P025A

Fuel Pump Control Module Enable Circuit

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P025A is a Type A DTC.

Conditions for Clearing the DTC

DTC P025A is a Type A DTC.

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 Testing

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

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K27 fuel pump control module, ignition ON.
2. Connect a test lamp between the control circuit terminal 20 and ground.
3. Verify the test lamp turns ON and OFF when commanding the fuel pump ON and OFF using the scan tool ECM fuel pump enable control function.
    - **If the test lamp is always OFF**
    1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 ohms in the control circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 engine control module.

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- **If the test lamp is always ON**

1. Ignition OFF, disconnect the harness connector at the K20 engine control module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 engine control module.

- **If the test lamp turns ON and OFF**

4. Test or replace the K27 fuel pump control module.

Repair Instructions

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

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

DTC P0300-P0304 OR P0313

Diagnostic Instructions

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

DTC Descriptors

DTC P0300

Engine Misfire Detected

DTC P0301

Cylinder 1 Misfire Detected

DTC P0302

Cylinder 2 Misfire Detected

DTC P0303

Cylinder 3 Misfire Detected

DTC P0304

Cylinder 4 Misfire Detected

Circuit/System Description

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The engine control module (ECM) uses information from the crankshaft position sensor in order to determine when an engine misfire is occurring and uses information from the camshaft position sensor - intake and camshaft position sensor - exhaust sensors in order 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. If the ECM detects a misfire rate sufficient to cause emission levels to exceed mandated standards, DTC P0300 sets. Under certain driving conditions, a misfire rate can be high enough to cause the 3-way catalyst to overheat, possibly damaging the converter. The malfunction indicator lamp (MIL) will flash ON and OFF when converter overheating, damaging conditions are present and DTC P0300 is set. DTCs P0301- P0304 correspond to cylinders 1-4. If the ECM is able to determine that a specific cylinder that is misfiring, the DTC for that cylinder will set.

Conditions for Running the DTC

- DTCs P0010, P0011, P0013, P0014, P0016, P0017, P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0222, P0223, P0315, P0335, P0336, P0502, P0651, and P2135 are not set.
- The engine speed is between 600-6 528 RPM.
- The ignition voltage is between 11-18 V.
- The engine coolant temperature (ECT) sensor is between -7 to +125°C (+19 to +257°F).
- The A/C compressor clutch is not changing states.
- The fuel tank level is greater than 15%.
- The ECM is not in fuel cut-off or deceleration fuel cut-off mode.
- The ECM is not receiving a rough road signal.
- The throttle angle is steady within 5%.
- The throttle angle is greater than 3% when the vehicle speed is greater than 5 km/h (3 MPH).
- The transmission is not changing gears.
- The antilock brake system (ABS) and the traction control system, if equipped, is not active.
- DTCs P0300, P0301, P0302, P0303, and P0304 run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM is detecting a crankshaft rotation speed variation indicating a misfire sufficient to cause emission or catalyst damaging levels to exceed mandated standards.

Action Taken When the DTC Sets

DTCs P0300, P0301, P0302, P0303 and P0304 are Type A (MIL flashing) or Type B DTCs.

Conditions for Clearing the DTC

DTCs P0300, P0301, P0302, P0303 and P0304 are Type A (MIL flashing) or Type B DTCs.

Diagnostic Aids

- A misfire may only occur when the engine is under a load or when the engine is cold.
- A misfire DTC may be caused by an excessive vibration from sources other than the engine. Inspect for

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the following possible sources:

- A tire or wheel that is out of round or out of balance
- Variable thickness brake rotors
- Certain rough road conditions
- A damaged accessory drive component or belt
- A damaged reluctor wheel

- 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.
- The MIL indicator flashes when there is an engine misfire.

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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- **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
- **EN 36012-A** Ignition System Diagnostic Harness

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

Circuit/System Verification

NOTE: Before starting vehicle, review freeze frame data to determine if misfire sets during cold start or warmed up operation. If the vehicle has a cold start problem and the vehicle is started, the vehicle will require to be not started for many hours before next attempt to operate the vehicle within the fail conditions.

1. Engine idling at the normal operating temperature.
2. Verify there is no abnormal engine noise.
   - **If there is an engine noise**

     Refer to **Symptoms - Engine Mechanical** .

   - **If there is no abnormal engine noise**
3. Verify no DTCs other than P0300-P0304 are set.
   - **If any DTCs other than P0300-P0304 are set**

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

   - **If only DTCs P0300-P0304 are set**

     Refer to Circuit/System Testing below.

   - **If no DTCs are set**
4. Verify the scan tool Cylinder 1-4 Current Misfire Counter Misfire parameters are not incrementing.
   - **If Misfire Current Counters are incrementing**

     Refer to Circuit/System Testing below.

   - **If Misfire Current Counters are not incrementing**
5. Engine idling.
6. Verify the engine speed changes when performing the Cylinder Power Balance Test with a scan tool.
   - **If engine speed does not change**

     Refer to Circuit/System Testing below.

   - **If the engine speed changes**
7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
8. Verify the DTCs are not set.
   - **If any of the DTCs set**

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Refer to Circuit/System Testing below.

- **If none of the DTCs set**

9. All OK.

Circuit/System Testing

1. Perform the **Crankshaft Position System Variation Learn** procedure. Verify the scan tool displays Learned Successful.
   - **If the scan tool did not display Learned Successful**

     Inspect for the following conditions and repair as necessary:

     - Worn crankshaft main bearings
     - A damaged or misaligned reluctor wheel
     - Excessive crankshaft runout
     - Interference in the signal circuit of the crankshaft position sensor
     - The ignition switch is in the ON position until there is insufficient system voltage.
     - An ECM power disconnect with the ignition ON that may have erased the crankshaft position system variation values and set DTC P0315
     - Debris between the crankshaft position sensor and the reluctor wheel
   - If the engine control module is still unable to complete the learn procedure, replace the K20 Engine Control Module..
   - **If the scan tool displays Learned Successful**
2. Verify that the following conditions do not exist:
   - Vacuum hose splits, kinks, and incorrect connections
   - Engine vacuum leaks
   - Crankcase ventilation system for vacuum leaks
   - Fuel pressure that is too low or too high-Refer to **Fuel System Diagnosis** .
   - Contaminated fuel-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
   - Exhaust system restrictions
     - **If a condition is found**

       Repair or replace as necessary.

     - **If no condition is found**
3. Ignition OFF, remove the K35 Ignition Coil Module and connect the **(EL 26792)** HEI Spark Tester to the coil of the misfiring cylinder.
4. Verify that the following conditions do not exist with the boot of the K35 Ignition Coil Module:
   - Holes
   - Tears
   - Carbon tracking

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- Oil contamination
- Water intrusion
- **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.

5. Verify the **(EL 26792)** HEI Spark Tester sparks while cranking or starting the engine.
   - **If there is no spark**

     Refer to **Electronic Ignition System Diagnosis** for diagnosis of the ignition coil.

   - **If there is spark**
6. Ignition OFF, remove the spark plug from the misfiring cylinder.
7. Exchange the suspected spark plug with another cylinder that is operating correctly.
8. Engine idling.
9. Verify the scan tool Cylinder 1-4 Current Misfire Counter parameter does not increment on the spark plug coil it was removed from.
   - **If the misfire does follow the spark plug exchange**

     Replace the spark plug.

   - **If the misfire does not follow the spark plug exchange**
10. Test or inspect for the following:
    - A lean or rich Q17 fuel injector-Refer to **Fuel System Diagnosis** .
    - An engine mechanical condition-Refer to **Symptoms - Engine Mechanical** .

Repair Instructions

- **Ignition Coil Replacement**
- **Spark Plug Replacement**

Repair Verification

1. If the customer concern was a flashing MIL, operate the vehicle within the conditions for running DTC P0420. Refer to **DTC P0420** .
2. Clear the DTCs with a scan tool.
3. Turn OFF the ignition for 60 s.
4. Start the engine.
5. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within

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the conditions that you observed from the freeze frame/failure records.

6. If the DTC fails this ignition, a misfire still exists.

DTC P0315 (LUW)

Diagnostic Instructions

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

DTC Descriptor

DTC P0315

Crankshaft Position System Variation Not Learned

Circuit/System Description

The crankshaft position sensor system variation learn feature is used to calculate reference period errors caused by slight build tolerance variations in the crankshaft position sensor, crankshaft, and crankshaft position sensor position. 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 wide range of engine speeds and load conditions. The ECM stores the crankshaft position system variation values after a learn procedure has been performed. If the actual crankshaft position variation is not stored within the crankshaft position sensor compensating value look up table, then DTC P0300 may set. If the crankshaft position sensor system variation values are not stored in the ECM memory, or a proper ECM power down does not occur after completing the crankshaft position sensor Learn Procedure, then DTC P0315 sets.

Conditions for Running the DTC

- The engine is running.
- The DTC runs continuously.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0315 is a Type A DTC.

Conditions for Clearing the DTC

DTC P0315 is a Type A DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End 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 Testing

NOTE: The crankshaft position sensor system variation learn procedure may have to be repeated up to 5 times before the procedure is learned.

1. Perform the crankshaft position variation learn procedure.
2. If the crankshaft position variation learn procedure cannot be performed successfully, inspect for the following conditions:
   - Any worn crankshaft main bearings
   - A damaged or misaligned reluctor wheel
   - Excessive crankshaft runout
   - A damaged crankshaft. Refer to **Crankshaft and Bearing Cleaning and Inspection** .
   - Interference in the signal circuit of the B26 Crankshaft Position Sensor
   - The ignition switch is left in the ON position, until the battery is discharged
   - An ECM power disconnect, with the ignition ON, that may have erased the crankshaft position sensor system variation values and set DTC P0315

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- Any debris between the crankshaft position sensor and the reluctor wheel
  - If there is a condition, repair as necessary.

3. If the ECM is still unable to complete the learn procedure, replace the K20 Engine Control Module.

Repair Instructions

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

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

DTC P0324, P0326, OR P06B6

Diagnostic Instructions

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

DTC Descriptors

DTC P0324

Knock Sensor (KS) System Performance

DTC P0326

Knock Sensor (KS) Performance

DTC P06B6

Control Module Knock Sensor Processor 1 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0327	P0325	P0328	P0326
Low Reference	P0327	P0325, P06B6	P0328	P0326

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

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signals. The ECM receives the two knock sensor signals through 2 isolated circuits. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges. The ECM monitors for a normal knock sensor signal. The ECM monitors the two internal knock sensor processors by verifying a 20 KHz signal generated on the signal circuits is detected on the sensors' low reference circuits.

Conditions for Running the DTCs

P0324 or P0326-Condition 1; Excessive Knock Diagnostic

- Engine speed is between 400 and 8, 500 RPM.
- Engine is running for greater than 2 s.
- The number of engine revolutions above the minimum engine speed is least 200 revolutions.
- The engine coolant temperature (ECT) is warmer than -40°C (-40°F).
- The intake air temperature (IAT) sensor 1 is warmer than -40°C (-40°F).
- The DTCs run continuously when the above conditions are met.

P0324 or P0326-Condition 2; Abnormal Noise Diagnostic and Condition 3; Flat Signal Diagnostic

- Engine speed is at least 8, 500 RPM.
- The number of engine revolutions above the minimum engine speed is least 200 revolutions.
- The ECT is warmer than -40°C (-40°F).
- The IAT sensor 1 is warmer than -40°C (-40°F).
- The DTCs run continuously when the above conditions are met.

P06B6

- Engine speed is between 500 and 5, 500 RPM.
- The number of engine revolutions within the engine speed window is least 100 revolutions.
- Engine is running greater than 2 s.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0324

The ECM detects that the knock sensor signal's performance is out of the normal expected range due to an excessive engine knock, or abnormal noise, or a flat signal; in at least a single cylinder.

P0326

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

  OR

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- The ECM detects that the knock sensor signal indicates an excessive engine knock is present.

P06B6

The ECM has detected an internal knock sensor processor fault.

Action Taken When the DTCs Set

- DTCs P0324, P0326, and P06B6, 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, and P06B6 are Type B DTCs.

Reference Information

Schematic Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Engine running, observe the DTC information with a scan tool.
3. Verify DTC P0325, P0327, P0328 and P06B6 is not set.

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- **IF DTC P0325, P0327, or P0328 is set with P06B6**

  Refer to **DTC P0325, P0327, or P0328** for further diagnosis.

- **If only DTC P06B6 is set**

  Verify that no external knock sensor circuit issues exist, then; replace the K20 Engine Control Module.

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

4. Vehicle OFF, inspect for the following:
   - The affected B68 Knock Sensor for physical damage. A sensor that is dropped or damaged may cause a DTC to set
   - The sensor for proper installation. A sensor that is loose or not at the correct torque may cause a DTC to set. Refer to **Fastener Tightening Specifications** .
   - The sensor mounting surface for burrs, casting flash, and foreign material
   - The sensor must be clear of hoses, brackets, and engine electrical wiring
   - Loose brackets
   - Loose or broken accessory drive belts, brackets, components
   - An engine mechanical condition-Refer to **Symptoms - Engine Mechanical**
   - **If a condition is found**

     Repair or replace component as appropriate.

   - **If no condition is found**
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 any of the DTCs set**

     Test or replace the B68 Knock Sensor.

   - **If none of the DTCs set**
6. All OK

Repair Instructions

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

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

DTC P0325, P0327, OR P0328

Diagnostic Instructions

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

DTC Descriptors

DTC P0325

Knock Sensor Circuit

DTC P0327

Knock Sensor Circuit Low Voltage

DTC P0328

Knock Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0327	P0325	P0328	P0324, P0326, P06B6
Low Reference	P0327	P0325	P0328	P0324, P0326, P06B6

Circuit/System Description

The knock sensor system enables the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The knock sensor produces an 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 knock sensor signal. The ECM receives the knock sensor signal through a signal circuit and a low reference circuit. The ECM learns a minimum knock sensor noise level at idle and uses calibrated values for the rest of the RPM range. The ECM should monitor a normal knock sensor signal within the noise channel.

Conditions for Running the DTC

P0325

- Engine speed is between 600-8 500 RPM.
- The ECT is greater than -40°C (-40°F).
- The IAT is greater than -40°C (-40°F).
- The engine runtime is greater than 5 s.
- The DTC runs continuously when the above conditions are met.

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P0327 or P0328

- Engine speed is between 0-8 500 RPM.
- DTCs P0327 and P0328 run continuously when the above condition is met.

Conditions for Setting the DTC

P0325

The ECM detects the knock sensor signal circuit is open for greater than 5 s.

P0327

The ECM detects that the sensor input signal is less than 0.57 V or the sensor return signal is less than 0.40 V for greater than 5 s.

P0328

The ECM detects that the sensor input signal is greater than 2.76 V or the sensor return signal is greater than 1.95 V for greater than 5 s.

Action Taken When the DTC Sets

- DTCs P0325, P0327, and P0328 are Type B DTCs.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

Conditions for Clearing the DTC

DTCs P0325, P0327, and P0328 are Type B DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Electronic Ignition System Description

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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. Engine running
2. Verify DTC P0325, P0327, P0328 or P06B6 is not set.
    - **If DTC P0325, P0327 or P0328 is set with P06B6**

      Refer to Circuit/System Testing below.

    - **If only DTC P06B6 is set**

      Replace the K20 Engine Control Module.

    - **If none of the DTCs are set**
3. Verify the affected B68 Knock Sensor is properly tightened. Refer to **Fastener Tightening Specifications** .
4. Verify the scan tool parameters below display NO while moving the related harnesses and connectors for the affected B68 Knock Sensor.
    - Cylinder 1 Knock Detected
    - Cylinder 2 Knock Detected
    - Cylinder 3 Knock Detected
    - Cylinder 4 Knock Detected
        - **If NO is not displayed**

          Refer to Circuit/System Testing below.

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- **If NO is displayed**

5. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure Records data.
   - **If any of the DTCs set**

     Refer to Circuit/System Testing below.

   - **If none of the DTCs set**
6. All OK

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B68 Knock Sensor, ignition ON.
2. Test for 1-4 V between each of the following circuits and ground:
   - Signal terminal 1
   - Low reference terminal 2
   - **If less than 1 V**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the affected circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the affected circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 4 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 affected 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 1-4 V**
3. Replace the B68 Knock Sensor.

Repair Instructions

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

- **Knock Sensor Replacement**
- **Control Module References** for ECM replacement, programming, and setup.

DTC P0335 OR P0336

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

DTC Descriptors

DTC P0335

Crankshaft Position Sensor Circuit

DTC P0336

Crankshaft Position Sensor Performance

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

P0335 Condition 1

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

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OR

- DTCs P0101, P0102 and P0103 are not set.

AND

- The airflow into the engine is greater than 2 g/s.

Condition 2

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

Condition 3

- The engine is running or the starter is engaged.
- DTCs P0365, P0366, P0641, or P0651 are not set.

P0336 Condition 1

- The airflow into the engine is greater than 2 g/s.
- Engine speed is greater than 450 RPM.
- DTCs P0335 or P0651 are not set.

Condition 2

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

Condition 3

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

OR

- DTCs P0101, P0102, and P0103 are not set.
- The airflow into the engine is greater than 2 g/s.

Condition 4

- The engine is running or the starter is engaged.
- DTCs P0365, P0366, P0641, or P0651 are not set.

The DTCs run continuously once the above conditions are met.

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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 0.1 s.

Condition 3

The ECM does not detect a crankshaft position sensor pulse for 2 out of 10 engine revolutions.

P0336 Condition 1

The ECM detects that 10 or more crankshaft resynchronization have occurred within 10 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 greater than 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

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Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0651 is not set.
   - **If the DTC is set**

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

   - **If the DTC is not set**
3. Engine Running.
4. Verify the scan tool Crankshaft Position Active Counter parameter increments.
   - **If the counter does not increment**

     Refer to Circuit/System Testing below.

   - **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 below.

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- **If 0 counts and the engine does not stumble or stall**

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

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B26 Crankshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
   - **If 5 ohms or greater**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the low reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If 2 ohms or less, replace the K20 Engine Control Module.
   - **If less than 5 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 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 on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the 5 V reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the X2 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.

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- **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 signal circuit and ground.
   - If less than infinite resistance, repair the short to ground on the circuit.
   - If infinite resistance.
3. Test for less than 2 ohms in the signal circuit end to end.
   - If 2 ohms or greater, repair the open/high resistance in the circuit.
   - If less than 2 ohms, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.

- **If 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.

   - **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.

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- **If the DTC is not set**

9. Test or replace the B26 Crankshaft Position Sensor.

Repair Instructions

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

- **Crankshaft Position Sensor Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0340, P0341, P0365, OR P0366

Diagnostic Instructions

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

DTC Descriptors

DTC P0340

Intake Camshaft Position Sensor Circuit

DTC P0341

Intake Camshaft Position Sensor Performance

DTC P0365

Exhaust Camshaft Position Sensor Circuit

DTC P0366

Exhaust Camshaft Position Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0340, P0365, P0532, P0641	P0340	P0641	-
Signal	P0340	P0340	P0340	P0341, P0366
Low Reference	-	P0340	-	-

Circuit/System Description

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The camshaft position sensors each have 3 circuits consisting of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency with 4 varying width output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM uses the exhaust camshaft position sensor to determine injector and ignition system synchronization. The intake and exhaust camshaft position sensors are also used to determine camshaft to crankshaft relationship. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft to control camshaft phasing and limp-home operation.

Conditions for Running the DTC

P0340 or P0365 Condition 1

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

  OR

- DTCs P0101, P0102, and P0103 are not set.
- The airflow into the engine is greater than 2 g/s.

Condition 2

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

Condition 3

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

Condition 4

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

P0341 or P0366 Condition 1

- The crankshaft is synchronized.
- The starter is engaged.

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- DTC P0335, P0336, P0641, or P0651 are not set.

Condition 2

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

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0340 or P0365 Condition 1

The ECM does not detect a camshaft position sensor pulse for greater than 5.5 s or greater than 4.0 s since the time the starter has been engaged.

Condition 2

The ECM detects less than 4 camshaft position sensor pulses for greater than 3.0 s.

Condition 3

The ECM does not detect a camshaft position sensor pulse during the first 2 engine revolutions.

Condition 4

The ECM does not detect a camshaft position sensor pulse during 200 engine revolutions.

P0341 or P0366 Condition 1

The ECM detects less than 4 or greater than 6 camshaft position sensor pulses during the first 2 engine revolutions.

Condition 2

The ECM detects less than 398 or greater than 402 camshaft position sensor pulses during 200 engine revolutions.

Action Taken When the DTC Sets

- DTCs P0340, P0341, P0365, and P0366 are Type B DTCs.
- The camshaft position actuator is commanded to the Home or Parked position.
- The ignition system defaults to a failed camshaft position sensor limp home mode.

Conditions for Clearing the MIL/DTC

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DTCs P0340, P0341, P0365, and P0366 are Type B DTCs.

Diagnostic Aids

- With a DTC set, the engine may crank for an extended period of time at start-up
- The exhaust camshaft position sensor is used for injector and ignition system synchronization. A stalling condition will occur if the camshaft position sensor signal is intermittent and a DTC may not set. Inspect the intake and exhaust camshaft position sensor circuits for poor connections.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

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

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

3. Engine Running.
4. Verify the scan tool parameters listed below increment:
   - Exhaust Camshaft Position Active Counter
   - Intake Camshaft Position Active Counter
   - **If any counter does not increment**

     Refer to Circuit/System Testing below.

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

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B23 Camshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the low reference circuit terminal 2 and ground.
   - **If 5 ohms or greater**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the low reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If 2 ohms or less, replace the K20 Engine Control Module.
   - **If less than 5 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the 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 on the circuit.
      - If infinite resistance.
   3. Test for less than 2 ohms in the 5 V reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.

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- If less than 2 ohms, 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. 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 X2 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
   - If less than infinite resistance, repair the short to ground on the circuit.
   - If infinite resistance.
3. Test for less than 2 ohms in the signal circuit end to end.
   - If 2 ohms or greater, repair the open/high resistance in the circuit.
   - If less than 2 ohms, replace the K20 Engine Control Module.

   - **If 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 signal circuit and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.

   - **If between 4.8-5.2 V**

6. Verify DTC P0341 or P0366 is not set.
   - **If any of the DTCs are set**

     Inspect for the conditions listed below:

     - Excessive play or looseness of the B23 Camshaft Position Sensor or the reluctor wheel
     - Improper installation of the B23 Camshaft Position Sensor
     - Foreign material passing between the B23 Camshaft Position Sensor and the reluctor wheel
     - Damaged reluctor wheel
     - Excessive air gap between the B23 Camshaft Position Sensor and the reluctor wheel
     - Engine oil for debris
     - Timing chain, tensioner, and sprockets for wear or damage

   - If any of the conditions above are found, repair as necessary.
   - If all components test normal, test or replace the B23 Camshaft Position Sensor.
   - **If none of the DTCs are set**

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7. Replace the B23 Camshaft Position Sensor.

Repair Instructions

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

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

DTC P0351-P0354

Diagnostic Instructions

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

DTC Descriptors

DTC P0351

Ignition Coil 1 Control Circuit

DTC P0352

Ignition Coil 2 Control Circuit

DTC P0353

Ignition Coil 3 Control Circuit

DTC P0354

Ignition Coil 4 Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	1	2	-	-
Ignition Coil 1 Control	P0300, P0351	P0300, P0351	P0300, P0351	P0300, P0351
Ignition Coil 2 Control	P0300, P0352	P0300, P0352	P0300, P0352	P0300, P0352
Ignition Coil 3 Control	P0300, P0353	P0300, P0353	P0300, P0353	P0300, P0353
Ignition Coil 4 Control	P0300, P0354	P0300, P0354	P0300, P0354	P0300, P0354
Low Reference	-	-	-	-

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Ground	-	3	-	-

1. The engine cranks but does not run and opens the fuse that supplies voltage to the ignition coils.
2. The engine cranks but does not run
3. The engine may still run

Circuit/System Description

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

Conditions for Running the DTC

- The engine is running.
- Ignition voltage is greater than 5 V.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The engine control module detects that the voltage command state of the driver and the actual state of the control circuit do not match.

Action Taken When the DTC Sets

DTCs P0351, P0352, P0353, and P0354 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0351, P0352, P0353, and P0354 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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Electronic Ignition System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine Running.
2. Verify the scan tool parameters listed below do not display Malfunction:
   - Ignition Coil 1-4 Control Circuit High Voltage Test Status
   - Ignition Coil 1-4 Control Circuit Low Voltage Test Status
   - Ignition Coil 1-4 Control Circuit Open Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing below.

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

     Refer to Circuit/System Testing below.

   - **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 K35 Ignition Coil Module.
2. Remove the fuel injector fuse.

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3. Connect a DMM between the appropriate K35 Ignition Coil Module control circuit listed below and ground. Set the DMM to the DC Hz scale and utilize the Min-Max function:
    - Ignition Coil 1 terminal D
    - Ignition Coil 2 terminal E
    - Ignition Coil 3 terminal F
    - Ignition Coil 4 terminal G
4. Engine Cranking, test for greater than 1.5 Hz.
    - **If less than 1.5 Hz**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 ohms in the control circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms
    4. Ignition ON.
    5. 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 greater than 1.5 Hz**
5. Replace the K35 Ignition Coil Module.

Repair Instructions

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

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

DTC P0411

Diagnostic Instructions

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

DTC Descriptor

DTC P0411

Secondary Air Injection System Incorrect Air Flow Detected

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Circuit/System Description

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

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

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

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

During phase 1, the secondary air injection pump and the secondary air injection shutoff and check valve are activated. Normal secondary air function occurs. Expected system pressure is 5-13 kPa (0.7-1.9 psi) above BARO.

During phase 2, only the secondary air injection pump is activated. The shutoff and check valve is closed. Pressure sensor performance and shutoff and check valve deactivation are tested. Expected system pressure is 14-25 kPa (2.0-3.6 psi) above BARO.

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

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0351, P0352, P0353, P0354, P0412, P0418, P0420, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2430, P2431, P2432, or P2433 is not set.
- Greater than 60 min has elapsed since the last cold start.
- The ignition voltage is between 10-32 V.
- The engine speed is less than 5, 000 RPM.
- The intake air temperature (IAT) is greater than -10°C (14°F).
- The engine coolant temperature (ECT) is between -10 and +80°C (12.2-176°F).
- The barometric pressure (BARO) is greater than 60 kPa (8.7 psi).
- The manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- The mass air flow (MAF) is less than 50 g/s.

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- The secondary air injection pump is commanded ON.
- DTC P0411 runs once per ignition cycle when the above conditions are met for greater than 7 s.

Conditions for Setting the DTC

- The actual system pressure at the shutoff/check valve is at least 4.5 kPa (0.7 psi) greater or 7.5 kPa (1.1 psi) less than the predicted system pressure for greater than 7 s.

  OR

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

Action Taken When the DTC Sets

DTC P0411 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0411 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection System Description

Electrical Information Reference

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

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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 36169-HD Fused Jumper

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

Circuit/System Verification

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

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

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

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

     Refer to **DTC P2227-P2230** .

   - **If within the specified range**
4. Verify the scan tool Secondary Air Injection Pressure Sensor and the BARO pressure parameters are within 3 kPa (0.4 psi).
   - **If not within the specified range**

     Replace the Q29 Secondary Air Injection Solenoid Valve

   - **If within the specified range**

NOTE: Engine coolant temperature must be greater than 5°C (41°F) to enable scan tool device control. It may be necessary to use one of the methods listed below to verify valve operation:

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- **Use a stethoscope to listen for valve operation.**
- **Disconnect the secondary air injection pipe from the secondary air injection solenoid valve and visually inspect the valve inlet port for valve stem movement.**
- **Disconnect the Q29 Secondary Air Injection Solenoid Valve and verify airflow through the valve when commanding the Secondary Air Injection System Active with a scan tool.**

5. Verify the Q29 Secondary Air Injection Solenoid Valve opens and closes when commanding the Secondary Air Injection Solenoid Valve Open and Closed with a scan tool.
   - **If the valve does not open and close**

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

   - **If the valve opens and closes**

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

6. Verify the G21 Secondary Air Injection Pump turns ON and OFF when commanding the Secondary Air Injection Pump Relay between ON and OFF with a scan tool.
   - **If the pump does not turn ON and OFF**

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

   - **If the pump turns ON and OFF**
7. Engine running
8. Verify the scan tool Secondary Air Injection Pressure Sensor parameter increases between 14-25 kPa (2.0-3.6 psi) when the Secondary Air Injection Pump Relay is commanded ON with a scan tool.
   - **If not within the specified range**

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

   - **If within the specified range**
9. Verify the scan tool Secondary Air Injection Pressure Sensor parameter increases between 5-13 kPa (0.7-1.9 psi) when the Secondary Air Injection System is commanded ON with a scan tool.
   - **If not within the specified range**

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

   - **If within the specified range**

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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 below

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

Circuit/System Testing

Secondary Air Injection Shutoff and Check Valve Malfunction

1. Ignition OFF, disconnect the KR26 Secondary Air Injection Solenoid Valve Relay. Ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Test for less than 2 ohms in the B+ circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Disconnect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
    4. Test for infinite resistance between the control circuit terminal 5 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    5. Test or replace the Q29 Secondary Air Injection Solenoid Valve.
    - **If the test lamp illuminates**
3. Disconnect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
4. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down. Test for less than 10 ohms between the Q29 Secondary Air Injection Solenoid Valve ground circuit terminal 4 and ground.
    - **If 10 ohms or greater**
    1. Ignition OFF.
    2. Test for less than 2 ohms in the ground circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, repair the open/high resistance in the ground connection.

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- **If less than 10 ohms**

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

Secondary Air Injection Pump Malfunction

1. Ignition OFF, disconnect the KR25 Secondary Air Injection Pump Relay.
2. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF
   2. Test for less than 2 ohms in the B+ circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
   4. Test for infinite resistance between the control circuit terminal A and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   5. Test or replace the G21 Secondary Air Injection Pump.
   - **If the test lamp illuminates**
3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
4. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down. Test for less than 10 ohms between the G21 Secondary Air Injection Pump ground circuit terminal B and ground.
   - **If 10 ohms or greater**
   1. Ignition OFF.
   2. Test for less than 2 ohms in the ground circuit end to end.

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

- **If less than 10 ohms**

5. Connect the harness connector at the G21 Secondary Air Injection Pump.
6. Connect a 40 A **EL 36169-HD** between the B+ circuit terminal 30 and the control circuit terminal 87.

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

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

Secondary Air Injection System Pressure Not In Range

1. Verify the following conditions do not exist with the secondary air injection shutoff and check valve:
   - Hoses/pipes restricted or blocked
   - Hoses/pipes leaking or disconnected
   - Damaged secondary air injection shutoff and check valve
   - Restricted or blocked cylinder head secondary air injection inlet ports and passages
   - **If a condition is located**

     Repair or replace the affected component as necessary.

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

     Replace the G21 Secondary Air Injection Pump.

   - **If airflow**

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5. Disconnect the appropriate Q29 Secondary Air Injection Solenoid Valve from the engine.
6. Connect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
7. Connect the secondary air injection pipe between the Q29 Secondary Air Injection Solenoid Valve and the G21 Secondary Air Injection Pump.
8. Ignition ON, command the Secondary Air Injection System Active with a scan tool. Verify there is airflow through the valve.
    - **If no airflow**

      Replace the Q29 Secondary Air Injection Solenoid Valve

    - **If airflow**
9. Replace the G21 Secondary Air Injection Pump.

Component Testing

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 70-110 ohms between terminals 85-86.
    - **If less than 70 ohms or greater than 110 ohms**

      Replace the relay.

    - **If between 70-110 ohms**
3. Test for infinite resistance between the terminals listed below:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - **If less than infinite resistance**

      Replace the relay.

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

      Replace the relay.

    - **If less than 2 ohms**
6. All OK.

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Repair Instructions

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

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Secondary Air Injection Pump Replacement**
- **Secondary Air Injection Check Valve Replacement** for secondary air injection solenoid valve replacement
- **Secondary Air Injection Pump Pipe Replacement**

DTC P0412 OR P0418

Diagnostic Instructions

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

DTC Descriptor

DTC P0412

Secondary Air Injection Valve Control Circuit

DTC P0418

Secondary Air Injection Pump Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Secondary Air Injection Pump Relay Coil Voltage Supply	-	P0418	P0690	-
Secondary Air Injection Pump Relay Coil Control	P0418	P0418	P0690, P2413	-
Solenoid Relay Coil Voltage Supply	P0412	P0412	P0690	-
Solenoid Relay Coil Control	P0412	P0412	P0412, P0690	-

Circuit/System Description

The secondary air injection system aids in the reduction of hydrocarbon emissions during a cold start. The electric air pump forces fresh air into the exhaust stream in order to accelerate the catalyst operation. Ignition

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voltage is supplied directly to the secondary air injection pump relay and secondary air solenoid valve relay. The engine control module (ECM) controls the relays by grounding the control circuit with a solid state device called a driver. The ECM monitors the control circuits for open, short to ground, or short to voltage conditions.

Conditions for Running the DTC

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

Conditions for Setting the DTC

DTC P0412 or P0418

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

Action Taken When the DTC Sets

DTC P0412 and P0418 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0412 and P0418 are Type B DTCs.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Secondary Air Injection Solenoid Valve Control Circuit and Secondary Air Injection Pump Relay Control Circuit status parameters. The circuit status parameter changes 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

Secondary Air Injection 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

P0412

1. Ignition ON
2. Verify a click is heard or felt from the KR25 Secondary Air Injection Pump Relay and the KR26 Secondary Air Injection Solenoid Valve Relay when commanding the Secondary Air Injection System between Inactive and Active with a scan tool.
    - **If a click is not heard or felt at one or more of the relays**

      Refer to Circuit/System Testing below

    - **If a click is heard or felt at each of the relays**
3. Verify the circuit status parameters listed below do not display Malfunction when commanding the Secondary Air Injection System between Inactive and Active with a scan tool:
    - Secondary Air Injection Pump Relay Control Circuit Low Voltage Test Status
    - Secondary Air Injection Pump Relay Control Circuit Open Test Status
    - Secondary Air Injection Pump Relay Control Circuit High Voltage Test Status
    - Secondary Air Injection Solenoid Valve Control Circuit Low Voltage Test Status
    - Secondary Air Injection Solenoid Valve Control Circuit Open Test Status
    - Secondary Air Injection Solenoid Valve Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing below

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

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Refer to Circuit/System Testing below

- **If a DTC does not set**

6. All OK

Circuit/System Testing

P0412

1. Ignition OFF, disconnect the KR26 Secondary Air Injection Solenoid Valve Relay. Ignition ON.
2. Verify a test lamp illuminates between the relay coil ignition circuit terminal 85 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 ohms in the ignition circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for infinite resistance between the ignition circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test or replace the KR26 Secondary Air Injection Solenoid Valve Relay
      - **If the test lamp illuminates**
3. Connect a DMM, set on the diode setting, between the control circuit terminal 86 and ground.
4. Verify the DMM reading is greater than 2.5 V or displays O.L. when commanding the Secondary Air Injection Solenoid Valve Closed with a scan tool.
   - **If 2.5 V or less**
   1. Ignition OFF, disconnect the 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 on the circuit.
      - If less than 1 V
   3. Ignition OFF.
   4. 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, test or replace the K20 Engine Control Module
   - **If greater than 2.5 V or displays O.L.**
5. Verify the DMM reading is less than 1 V when commanding the Secondary Air Injection Solenoid Valve Open with a scan tool.
   - **If 1 V or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the control circuit end to end.

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- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K20 Engine Control Module.
- **If less than 1 V**

6. Test or replace the KR26 Secondary Air Injection Solenoid Valve Relay.

P0418

1. Ignition OFF, disconnect the KR25 Secondary Air Injection Pump Relay. Ignition ON.
2. Verify a test lamp illuminates between the relay coil ignition circuit terminal 85 and ground.
   - **If the test lamp does not illuminate**
   1. Ignition OFF.
   2. Test for less than 2 ohms in the ignition circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - **If the test lamp illuminates**
3. Connect a DMM, set on the diode setting, between the control circuit terminal 86 and ground.
4. Verify the DMM reading is greater than 2.5 V or displays O.L. when commanding the Secondary Air Injection Pump Relay OFF with a scan tool.
   - **If 2.5 V or less**
   1. Ignition OFF, disconnect the 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 on the circuit.
      - If less than 1 V
   3. Ignition OFF.
   4. 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, test or replace the K20 Engine Control Module
   - **If greater than 2.5 V or displays O.L.**
5. Verify the DMM reading is less than 1 V when commanding the Secondary Air Injection Pump Relay ON with a scan tool.
   - **If 1 V or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the control circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
      - **If less than 1 V**
6. Test or replace the KR25 Secondary Air Injection Pump Relay.

Component Testing

Relay Test

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1. Ignition OFF, disconnect the appropriate relay.
2. Test for 70-110 ohms between terminals 85-86.
   - **If less than 70 ohms or greater than 110 ohms**

     Replace the relay.

   - **If between 70-110 ohms**
3. Test for infinite resistance between the terminals listed below:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87
   - **If less than infinite resistance**

     Replace the relay.

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

     Replace the relay.

   - **If less than 2 ohms**
6. All OK.

Repair Instructions

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

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

DTC P0420

Diagnostic Instructions

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

DTC Descriptor

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DTC P0420

Catalyst System Low Efficiency

Circuit/System Description

A 3-way catalytic converter 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 catalytic converter also stores oxygen. The ECM monitors this process by using a heated oxygen sensor (HO2S) that is in the exhaust stream after the 3-way catalytic converter. The HO2S 2 produces an output signal that the ECM uses to calculate the oxygen storage capacity of the catalyst. This indicates the ability of the catalyst to convert the exhaust emissions efficiently. The ECM monitors the efficiency of the catalyst by allowing the catalyst to heat, then wait for a stabilization period while the engine is idling. The ECM then adds and removes fuel while monitoring the HO2S 2. When the catalyst is functioning properly, the HO2S 2 response to the extra fuel is slow compared to the response of the HO2S 1, which is located before the 3-way catalytic converter. When the HO2S 2 response is near that of the HO2S 1, the oxygen storage capability and efficiency of the catalyst may be degraded below an acceptable threshold.

Conditions for Running the DTC

- DTC P0016, P0017, P0030, P0036, P0053, P0054, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P015A, P015B, P0171, P0172, P0222, P0223, P0300, P0301, P0302, P0303, P0304, P0335, P0336, P0340, P0341, P0365, P0366, P0443, P0506, P0507, P0606, P0697, P06A3, P16F3, P2101, P2122, P2123, P2127, P2128, P2135, P2138, P2270 or P2271 is not set.
- Before the ECM performs the idle test, the vehicle must be driven under the conditions listed below:
  - The engine speed is greater than 1, 100 RPM.
  - The engine run time is greater than a calibrated value
  - Both conditions exist for at least 5 s
- The vehicle speed is less than 2 km/h (1.24 mph).
- Divers foot is off accelerator pedal
- The throttle is in the rest position.
- The run/crank voltage is greater than 11 V.
- The intake air temperature (IAT) is between -20 to +250°C (-4 to +482°F).
- The engine coolant temperature (ECT) is between 40-140°C (104-284°F).
- The engine has been idling less than 50 s.
- The short term fuel trim is between 0.8-1.3 %.
- The barometric pressure (BARO) is greater than 70 kPa.
- The intake mass air flow (MAF) is between 1.5-7.0 g/s.
- The engine is operating in closed loop.
- The calculated catalyst temperature is between 550-950°C (1, 022-1, 742°F).

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- The Evaporative Emission (EVAP), Fueltrim, Post O2, or other intrusive tests are not active
- The transmission is not in P/N (automatic transmission only).
- This diagnostic attempts one test during each valid idle period once the above conditions have been met. This diagnostic attempts up to 8 tests during each drive cycle.

Conditions for Setting the DTC

The ECM determines that the efficiency of the catalyst has degraded below a calibrated threshold.

Action Taken When the DTC Sets

DTC P0420 is a Type A DTC.

Conditions for Clearing the DTC

DTC P0420 is a Type A DTC.

Diagnostic Aids

Inspect for the conditions listed below, which may cause a catalytic converter to degrade:

- An engine misfire
- High engine oil or high coolant consumption
- Retarded spark timing
- A weak or poor spark
- A lean fuel mixture
- A rich fuel mixture
- A damaged oxygen sensor or wiring harness

Reference Information

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 there are no other DTCs set.
   - **If a DTC is set**

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

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

     Refer to step 3.

   - **If Yes is displayed**
5. When the conditions are safe, stop and idle the vehicle in gear (If equipped with automatic transmission) or neutral (If equipped with manual transmission).
6. Verify the Catalyst Monitor Test Result parameter displays Pass when performing the steps listed below:
   1. Apply the service brake.
   2. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.

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

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

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

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

        Refer to Circuit /System Testing below

      - **If the Catalyst Monitor Test Result parameter indicates Pass**
7. All OK.

Circuit/System Testing

1. Verify the conditions listed below do not exist with the catalytic converter(s):
   - Dents

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- Severe discoloration caused by excessive temperatures
- Road damage
- Internal rattles caused by damaged catalyst substrate
- Restrictions
  - **If a condition is found**

    Replace the catalytic converter(s).

  - **If no condition is found**

2. Verify the conditions listed below do not exist with the exhaust system:
   - Leaks
   - Physical damage
   - Loose or missing hardware
     - **If a condition is found**

       Repair or replace the component as necessary.

     - **If no condition is found**
3. Verify the conditions listed below do not exist with the B52B heated oxygen sensor 2:
   - Incorrect torque
   - Damage
   - **If a condition is found**

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

   - **If no condition is found**
4. Test or replace the catalytic converter and the exhaust front pipe.

Repair Instructions

NOTE: A new converter with less than 160 km (100 mi) on it may set DTC P0420 due to outgassing of the internal matting. Operating the vehicle at highway speeds for approximately 1 h may correct the condition.

- **Catalytic Converter Replacement (1.4L LUV)** , **Catalytic Converter Replacement (1.8L LUW and LWE)**
- **Exhaust Front Pipe Replacement**
- **Heated Oxygen Sensor Replacement - Sensor 2**

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. 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. When the conditions are safe, stop and idle the vehicle in gear (If equipped with automatic transmission) or neutral (If equipped with manual transmission).
8. Verify the Catalyst Monitor Test Result parameter displays Pass when performing the steps listed below:
   1. Apply the service brake.
   2. Monitor the scan tool Catalyst Monitor Test State parameter. When the parameter indicates Active, the Catalyst Monitor Test is running.

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

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

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

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

        Refer to Circuit /System Testing below

      - **If the Catalyst Monitor Test Result parameter indicates Pass**
9. All OK.

DTC P0442

Diagnostic Instructions

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

DTC Descriptor

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DTC P0442

Evaporative Emission (EVAP) System Small Leak Detected

Circuit/System Description

The engine off natural vacuum (EONV) test is the small leak detection diagnostic for the evaporative emission (EVAP) system. This diagnostic tests the EVAP system for a small leak when the key is turned OFF and the correct conditions are met. Heat from the exhaust system is transferred into the fuel tank while the vehicle is operating. When the vehicle is turned OFF and the EVAP system is sealed a change in the fuel tank vapor temperature occurs which results in a corresponding pressure change in the fuel tank vapor space. This change is monitored by the ECM using the fuel tank pressure (FTP) sensor input. With a leak in the system, the amount of pressure change will be less than that of a sealed system.

Conditions for Running the DTC

- DTCs P010C, P010D, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0125, P0128, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0461, P0462, P0463, P0464, P0496, P0502, P0503, P0722, P0723, P2227, P2228, P2229, P2230, P2610. are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant sensor (ECT) is greater than 63°C (145°F)
- No fuel filling during the EONV test period.
- The fuel level is between 10-90%.
- The start-up engine coolant temperature (ECT) and the start-up intake air temperature (IAT) are within 8° C (46°F).
- The engine run time before shut-off was greater than 10 min.
- The drive distance before engine shut-off was more than 5 km (3 mi).
- The ambient air temperature at the end of the drive cycle is between 0-34°C (32-93°F).
- DTC P0442 runs once per drive cycle during the hot soak period after the ignition is turned OFF and may require up to 40 min to complete. The controller will not make more than 2 test attempts per day. The time since the last completed EONV test must be at least 17 h if passed or 10 h if failed.

Conditions for Setting the DTC

- The ECM detects a leak in the EVAP system that is greater than a calibrated amount.
- The ECM must complete several EONV tests before the diagnostic can turn the MIL on or off.

Action Taken When the DTC Sets

DTC P0442 is a Type A DTC.

Conditions for Clearing the DTC

DTC P0442 is a Type A DTC.

Diagnostic Aids

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- The EVAP system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. When injecting smoke at the service port tool temporarily leave the EVAP vent solenoid valve open until smoke is observed then close the system and continue testing.
- To help locate intermittent leaks using the **GE 41413-A** , move all EVAP components while observing smoke with the **GE 41413-SPT** .
- Individual components can be isolated and tested using adapters in the **GE 41413-300** .
- When servicing the EVAP system, test pressure must not exceed 13 in 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 FTP parameter for vacuum decay.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48096** EVAP Service Port Access Tool
- **GE 41413-A** Evaporative Emissions System Tester (EEST)

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- **GE 41413-300** EVAP Cap and Plug Kit
- **GE 41413-SPT** High Intensity White Light

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

Circuit/System Testing

NOTE:

- **Refer to the GE 41413-A operation manual for detailed instructions in Evaporative Emission Control System Diagnosis**
- **Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize or produce smoke from a leak.**
- **Ensure that the underbody temperature of the vehicle and the tester are similar.**

1. Disconnect the purge tube at the quick connector on the EVAP canister side of the Q12 Evaporative Emission Canister Purge Solenoid Valve and install the **CH 48096** .
2. Connect the **GE 41413-A** to the **CH 48096** .
3. Command the EVAP Purge/Seal function to System Seal with a scan tool to seal the EVAP system.
4. Use the flow meter on the **GE 41413-A** , calibrated to 0.51 mm (0.020 in) to determine 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**
    - **No leak in the EVAP system**
5. All OK.

Repair Instructions

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

DTC P0443

Diagnostic Instructions

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

DTC Descriptor

DTC P0443

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit

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Diagnostic Fault Information

Circuit	Short to Ground	Open / High Resistance	Short to Voltage
Ignition - Purge Supply	P0031, P0033, P0034, P0037, P0132, P0134, P0135, P0138, P0140, P0245, P0443, P0597, P0507, P0598	P0443	P0690
EVAP Purge Solenoid Valve Control	P0443	P0443	P0443, P0690

Circuit/System Description

An ignition voltage is supplied directly to the evaporative emission (EVAP) purge solenoid valve. The engine control module (ECM) grounds the EVAP purge solenoid valve control circuit through an internal switch called a driver. The ECM monitors the status of the driver. The EVAP purge solenoid valve is pulse width modulated (PWM). A scan tool will display the amount of ON time as a percentage. If the ECM detects an incorrect voltage for the commanded state of the driver this DTC sets.

Conditions for Running the DTC

- The system voltage is greater than 11 V.
- DTC P0443 runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 0.25 s.

Action Taken When the DTC Sets

DTC P0443 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0443 is a Type B 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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below do not display malfunction when commanding the EVAP purge solenoid valve from 0 to 50 % and back to 0 % with a scan tool.
    - EVAP Purge Solenoid Valve Control Circuit Low Voltage Test Status
    - EVAP Purge Solenoid Valve Control Circuit Open Test Status
    - EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing below

    - **If Malfunction is not display**
3. 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 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 ohms in the ignition circuit end to end.

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- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms verify the fuse is not open and there is voltage at the fuse.

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

1. Ignition OFF, remove the test lamp.
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, test the Q12 Evaporative Emission Purge Solenoid Valve and replace as necessary.

- **If the test lamp illuminates**

3. Verify that a test lamp does not illuminate between the ignition circuit terminal 2 and the control circuit terminal 1.
   - **If the test lamp illuminates**

   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.

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

4. Remove the test lamp.
5. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the EVAP purge solenoid valve ON with a scan tool.
   - **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**

6. Install a 3 A fused jumper wire between the control circuit terminal 1 and the ignition circuit terminal 2.
7. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the EVAP Purge Solenoid Valve ON with a scan tool.
   - **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 ohms in the control circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms replace the K20 Engine Control Module.

   - **If the parameter is Malfunction**

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

Component Testing

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Static Test

1. Ignition OFF, disconnect the harness connector at the Q12 Evaporative Emission Purge Solenoid Valve.
2. Test for 10.0-30.0 ohms between the control circuit terminal 1 and the ignition circuit terminal 2 of the Q12 Evaporative Emission Purge Solenoid Valve.
    - **If not between 10.0-30.0 ohms**

      Replace the Q12 Evaporative Emission Purge Solenoid Valve

    - **If between 10.0-30.0 ohms**
3. All OK.

Repair Instructions

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

- **Evaporative Emission Canister Purge Solenoid Valve Replacement**
- **Control Module References** for ECM replacement, setup, and programming

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DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0446

Diagnostic Instructions

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

DTC Descriptor

DTC P0446

Evaporative Emission (EVAP) Vent System Performance

Typical Scan Tool Data

Fuel Tank Pressure Sensor Signal Voltage	Fuel Tank Pressure
1.5 V	Atmospheric Pressure / BARO
Less than 1.5 V	Positive Pressure
More than 1.5 V	Negative Pressure / Vacuum

Circuit/System Description

This DTC tests the evaporative emission (EVAP) system for a restricted or blocked EVAP vent path that would cause excess amounts of vacuum to be developed in the EVAP system. The engine control module (ECM) uses the fuel tank pressure (FTP) sensor to monitor EVAP system vacuum. With the purge valve and vent valve open, if the EVAP system vacuum goes above a calibrated threshold, P0446 will set.

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

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

Conditions for Running the DTC

- DTCs P00C8, P00C9, P010C, P010D, P0068, P16F3, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0122, P0123, P0125, P0128, P160E, P160D, P0191, P0192, P0193, P0222,

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P0223, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0606, P0722, P0723, P1104, P2100, P2101, P2102, P2103, P2135, P2227, P2228, P2229, or P2230 is not set

- The ignition voltage is between 11-32 V.
- The barometric pressure (BARO) is more than 70 kPa.
- The fuel level is between 10-90 %.
- The startup engine coolant temperature (ECT) is less than 35°C (95°F).
- The startup intake air temperature (IAT) is between 4-30°C (39-86°F).
- DTC P0446 runs once per cold start, for up to 17 min, when the above conditions are met.

Conditions for Setting the DTC

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

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

  OR

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

Action Taken When the DTC Sets

DTC P0446 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0446 is a Type B DTC.

Diagnostic Aids

- An intermittent condition could be caused by a damaged EVAP vent housing, a temporary blockage at the EVAP vent solenoid valve inlet, or a pinched vent hose. A blockage in the vent system may also cause a poor fuel fill condition.
- An EVAP canister filter that is restricted can cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

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Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

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

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

Circuit/System Verification

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

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

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

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

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- **If between the 1.3-1.7 V**

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

     Refer to Circuit/System Testing below.

   - **If 2.5 V or less**
7. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

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

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

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

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

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

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

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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 H2O**

8. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
   - **If the DTC sets**

     Refer to step 1 above.

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

Repair Instructions

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

- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Evaporative Emission Canister Replacement**
- **Fuel Tank Pressure Sensor Replacement**

DTC P0449

Diagnostic Instructions

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

DTC Descriptors

DTC P0449

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open / High Resistance	Short to Voltage
Battery - Vent Supply	P0449	P0449	-
EVAP Vent Solenoid Valve Control	P0449	P0449	P0449

Circuit/System Description

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Battery voltage is supplied to the evaporative emissions (EVAP) vent solenoid valve. 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 for the control circuit. A scan tool will display the commanded state of the EVAP vent solenoid valve as OFF - Venting or ON - Not Venting.

Conditions for Running the DTC

DTC P0449 runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 0.25 s.

Action Taken When the DTC Sets

DTC P0449 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0449 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, engine OFF,
2. Command the EVAP Vent Solenoid Valve ON - Not Venting and OFF - Venting with a scan tool.
3. You should hear the solenoid click when commanded ON and OFF.
   - **No clicking heard**

     Refer to Circuit/System Testing below

   - **Clicking is heard**
4. Engine idling, command the EVAP Vent Solenoid Valve ON - Not Venting and OFF - Venting with a scan tool while observing the following control circuit status parameters:
   - EVAP Vent Solenoid Valve Control Circuit Low Voltage Test Status
   - EVAP Vent Solenoid Valve Control Circuit Open Test Status
   - EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status
   - **If the Parameters display Malfunction**

     Refer to Circuit/System Testing below

   - **If the Parameters display OK or Not Run**
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 below.

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q13 Evaporative Emissions Vent Solenoid Valve, ignition ON.
2. Verify that a test lamp illuminates between the B+ 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 ohms in the B+ circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.

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- If less than 2 ohms verify the fuse is not open and there is voltage at the fuse.

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

1. Ignition OFF, remove the test lamp.
2. Test for infinite resistance between the B+ circuit and ground.
    - If less than infinite resistance, repair the short to ground in the circuit.
    - If infinite resistance, test the Q13 Evaporative Emissions Vent Solenoid Valve 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 2 and the control circuit terminal 1.
    - **If the test lamp illuminates**
    1. Ignition OFF, disconnect the harness connector at the Q13 Evaporative Emissions Vent Solenoid Valve.
    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 ON with a scan tool.
    - **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 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 the Parameter is OK**
6. Install a 3 A fused jumper wire between the control circuit terminal 1 and the B+ circuit terminal 2.
7. Verify the scan tool EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the EVAP Vent Solenoid Valve ON with a scan tool.
    - **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 ohms in the control circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms replace the K20 Engine Control Module.
    - **If the Parameter is Malfunction**
8. Test or replace the Q13 Evaporative Emission Vent Solenoid Valve.

Component Testing

Static Test

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1. Ignition OFF, disconnect the harness connector at the Q13 Evaporative Emission Vent Solenoid Valve.
2. Test for 10-30 ohms between the control terminal 1 and the B+ voltage terminal 2.
   - **If not between 10.0-30.0 ohms**

     Replace the Q13 Evaporative Emission Vent Solenoid Valve.

   - **If between 10.0-30.0 ohms**
3. All OK.

Repair Instructions

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

- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Control Module References** for ECM replacement, setup, and programming.

DTC P0451-P0454

Diagnostic Instructions

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

DTC Descriptors

DTC P0451

Fuel Tank Pressure Sensor Performance

DTC P0452

Fuel Tank Pressure Sensor Circuit Low Voltage

DTC P0453

Fuel Tank Pressure Sensor Circuit High Voltage

DTC P0454

Fuel Tank Pressure Sensor Circuit Intermittent

Diagnostic Fault Information

	Short to			**Short to**	

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Circuit	Ground	High Resistance	Open	Voltage	Signal Performance
5 V Reference	P0236, P0237, P0452, P0532, P0641	P0451	P0452	P0236, P0238, P0453, P0641, P1101, P2227	-
Signal	P0452	P0451	P0452	P0453	P0451, P0454
Low Reference	-	P0446, P0451	P0453, P0463	-	P0451

Typical Scan Tool Data

FTP Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF **Parameter Normal Range:** 1.3-1.7 V			
FTP Sensor 5 V Reference	0 V	0 V	4.2-5 V
FTP Sensor Signal	0 V	0 V	5 V
FTP Sensor Low Reference	-	4.5 V	-

Circuit/System Description

The Fuel Tank Pressure (FTP) sensor measures pressure or vacuum in the evaporative emission (EVAP) system. The engine control module (ECM) supplies a 5 V reference and a low reference circuit to the FTP sensor. The FTP sensor signal voltage varies depending on EVAP system pressure or vacuum. The controller also uses this FTP signal to determine atmospheric pressure for use in the engine-off small leak test, DTC P0442. Before using this signal as an atmospheric reference it must first be re-zeroed.

Conditions for Running the DTC

P0451

- DTC P0451 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- The number of times this test runs can range from 0-2 per engine-off period. The length of the test can be up to 10 min.

P0452 and P0453

DTC P0452 and P0453 run continuously when the ignition is ON.

P0454

- DTC P0454 runs only when the engine-off natural vacuum small leak test, P0442, executes and the EVAP Vent Solenoid Valve is closed.
- This test can run once per engine-off period. The length of the test can be up to 10 min.

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- A refueling event is not detected. A refueling event is confirmed if the fuel level has a persistent change of 10 % for 30 s.

Conditions for Setting the DTC

P0451

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

P0452

The FTP sensor voltage is less than 0.15 V for more than 10 s.

P0453

The FTP sensor voltage is more than 4.9 V for more than 10 s.

P0454

If, during the engine-off natural vacuum small leak test, P0442, the ECM detects an abrupt FTP signal change, other than a refueling event, this DTC will set. An abrupt change is defined as a change of 0.45 in H2O in the span of 1 s but less than 1 in H2O in 12.5 ms.

Action Taken When the DTC Sets

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

Diagnostic Aids

P0451 and P0454

- A restriction in the EVAP canister or vent lines could prevent fuel vapor pressure from bleeding off fast enough. If the vent system cannot bleed off pressure fast enough, the re-zero procedure may not complete successfully, which could cause this code to set.
- Ensure that the reference port on the FTP sensor is unobstructed.
- An FTP sensor that is skewed or does not have a linear transition from low to high may cause this code to set. Scan tool output controls, snapshot, and plot functions can help detect erratic sensor response. To test the sensor signal under vacuum conditions, use the Quick Snapshot and the Purge/Seal functions to capture data while commanding purge to 20 %, then plot the data to look for erratic sensor operation. A

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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.

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

Special Tools

GE 41413-A Evaporative Emission System Tester (EEST)

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

Circuit/System Verification

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

      Refer to Circuit/System Testing below

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- **If between 1.3-1.7 V**

4. 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 ohms of resistance between the low reference circuit terminal 2 and ground.
   - **If 5 ohms or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the low reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If less than 5 ohms**
3. Ignition ON.
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 ohms in the 5 V reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 4.8-5.2 V**
5. Verify the scan tool FTP 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.

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7. Verify the scan tool FTP sensor parameter is greater than 4.7 V.
    - **If 4.7 V or less**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 ohms in the signal circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, replace the K20 Engine Control Module.
    - **If greater than 4.7 V**
8. Test or replace the B150 Fuel Tank Pressure Sensor.

Repair Instructions

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

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

DTC P0455

Diagnostic Instructions

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

DTC Descriptor

DTC P0455

Evaporative Emission (EVAP) System Large Leak Detected

Circuit/System Description

The 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 within a set amount of time.

Conditions for Running the DTC

- DTCs P00C8, P00C9, P010C, P010D, P16A0, P16A1, P16A2, P160E, P160D, P16F3, P0068, P0101,

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P0102, P0103, P0111, P0112, P0113, P0114 P0116, P0117, P0118, P0122, P0123, P0125, P0128, P0191, P0192, P0193, P0222, P0223, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0601, P0604, P0606, P0722, P0723, P1104, P1682, P2100, P2101, P2102, P2103, P2135, P2176, P2227, P2228, P2229, P2230 are not set.

- The ignition voltage is between 11-32 V.
- The barometric pressure (BARO) is greater than 70 kPa.
- The fuel level is between 10-90%.
- The EVAP purge flow is greater than 4.50%
- The cold startup engine coolant temperature (ECT) and the startup intake air temperature (IAT) are within 8°C (46°F).
- The startup engine coolant temperature (ECT) is less than 35°C (95°F).
- The startup intake air temperature (IAT) is between 4-30°C (39-86°F).
- DTC P0455 runs once per cold start, for up to 17 min, when the above conditions are met.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0455 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0455 is a Type B DTC.

Diagnostic Aids

- Inspect for a loose, missing, damaged, or incorrect fuel fill cap.
- Inspect for a damaged fuel filler neck seal surface.
- A blockage or restriction in the EVAP purge solenoid valve, purge pipe, EVAP canister, or vapor pipe, can cause this DTC to set.
- The EVAP system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. For example, when injecting smoke at the service port remove the fuel fill cap, or temporarily leave the vent open, until smoke is observed, then close the system and continue testing. If using a fuel cap adapter at the filler neck, use the **J 41413-VLV** at the service port to allow the system to fill faster.
- To help locate intermittent leaks using the **GE 41413-A** , move all EVAP components while observing

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smoke with the **GE 41413-SPT** .

- Individual components can be isolated and tested using adapters in the **J 41413-300** .
- When servicing the EVAP system, test pressure must not exceed 13 in 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 FTP Sensor parameter for vacuum decay.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48096** EVAP Service Access Port Tool
- **GE 41415-30** Fuel Tank Cap Adapter
- **GE 41413-A** Evaporative Emissions System Tester (EEST)
- **J 41413-300** EVAP Cap and Plug Kit
- **GE 41413-SPT** High Intensity White Light

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- **J 41413-311** EVAP Plug (Brass Nozzle)
- **J 41413-VLV** EVAP Service Port Vent Fitting

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

Circuit/System Testing

IMPORTANT:

- **Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize or produce smoke from a leak.**
- **Refer to the GE 41413-A operation manual for detailed instructions in Evaporative Emission Control System Diagnosis .**

1. Disconnect the purge tube at the quick connector on the EVAP canister side of the purge solenoid valve and install the **CH 48096** .
2. Connect the **GE 41413-A** to the vehicle EVAP service port adapter.
3. Command the EVAP Purge/Seal function to System Seal with a scan tool to seal the EVAP system.
4. Verify that there is no leak in the EVAP system using the flow meter on the **GE 41413-A** , calibrated to 0.51 mm (0.020 in)..
   - **If a leak is detected**
   1. Apply smoke to the EVAP system at the service access port adapter with the **GE 41413-A** .
   2. Locate the leak using the **GE 41413-SPT**
   - When the leak is located, repair or replace the affected component as necessary.
   - **If no leak detected**

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

5. Connect the **GE 41413-A** nitrogen/smoke hose to the **J 41413-311** .
6. Disconnect the hose at the fuel cap end of the **GE 41415-30** and connect to the **J 41413-311** .
7. Install the **GE 41415-30** , filler neck end only, to the vehicle.
8. Engine idling, command the Purge/Seal function to System Seal with a scan tool to seal the system.
9. Command the EVAP Purge Solenoid Valve to 30% with a scan tool.
10. Verify the vacuum/pressure gauge on the **GE 41413-A** and the scan tool Fuel Tank Pressure Sensor parameter both show vacuum.
    - **If the vacuum/pressure gauge shows vacuum, but the FTP parameter does not show vacuum**

      Replace the B150 Fuel Tank Pressure Sensor.

    - **If neither the FTP parameter nor the vacuum/pressure gauge shows vacuum**

      Repair the restriction in the purge path.

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11. Verify that the Fuel Tank Pressure Sensor parameter increases to greater than 3.2 V, and the pressure values are similar between the scan tool Fuel Tank Pressure Sensor and the vacuum/pressure gauge on the **GE 41413-A** .
    - **If not within the specified range**

      Replace the B150 Fuel Tank Pressure Sensor.

    - **If within the specified range**
12. All OK

Repair Instructions

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

- **Fuel Tank Pressure Sensor Replacement**
- **Control Module References** for ECM replacement, programming and setup

DTC P0496

Diagnostic Instructions

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

DTC Descriptor

DTC P0496

Evaporative Emission (EVAP) System Flow During Non-Purge

Circuit/System Description

This DTC tests for undesired intake manifold vacuum flow to the evaporative emission (EVAP) system. The engine control module (ECM) seals the EVAP system by commanding the EVAP purge solenoid valve OFF and the vent solenoid valve ON. The ECM monitors the fuel tank pressure (FTP) sensor to determine if a vacuum is being drawn on the EVAP system. If vacuum in the EVAP system is more than a predetermined value within a predetermined time, this DTC sets.

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

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

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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, P0125, P0128, P0191, P0192, P0193, P0222, P0223, P0601, P0604, P0606, P0697, P06A3, P06DB, P06DE, P0A1D, P1104, P127A, P127C, P127D, P15F2, P160D, P160E, P1682, P16A0, P16A1, P16A2, P16F3, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0722, P0723, 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 35°C (95°F).
- The startup intake air temperature (IAT) is between 4-34°C (39-93°F).
- DTC P0496 runs once per cold start, for up to 17 min, when the above conditions are met.

Conditions for Setting the DTC

- The ECM detects more than 10 in H2O vacuum for 5 s during a non-purge condition.
- This test will run with the purge valve closed and the vent valve closed.

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 or system tubing.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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Evaporative Emission Control System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

     Refer to Circuit/System Testing below

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

Circuit/System Testing

1. Ignition ON, engine OFF.
2. Command the EVAP Purge/Seal function to System Seal with a scan tool to seal the EVAP system.
3. Start the engine.
4. Observe the Fuel Tank Pressure Sensor with a scan tool. The Fuel Tank Pressure Sensor parameter should be less than 1.7 V after 90 s.
   - **If not within specifications**

     Replace the Q12 Evaporative Emission Purge Solenoid Valve

   - **Within Specifications**
5. All OK

Repair Instructions

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

Evaporative Emission Canister Purge Solenoid Valve Replacement

DTC P0506 OR P0507

Diagnostic Instructions

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

DTC Descriptors

DTC P0506

Idle Speed Low

DTC P0507

Idle Speed High

Circuit/System Description

The throttle actuator control (TAC) motor is 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, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0171, P0172, P0201, P0202, P0203, P0204, P0222, P0223, P0300, P0351, P0352, P0353, P0354, P0461, P0462, P0463, P0496, P0502, P0503, P0606, P0697, P06A3, P0806, P0807, P0808, P16F3, P2101, P2122, P2123, P2127, P2128, P2135, P2138 or P2771 are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine runtime is greater than 60 s.
- The engine is idling for greater than 10 s.
- The torque converter clutch (TCC) is not changing states.
- The transmission is not changing gears.
- The intake air temperature (IAT) is greater than -20°C (-4°F).
- The engine coolant temperature (ECT) is between 60-120°C (140-248°F).
- The ignition voltage is between 11-32 V.

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- The vehicle speed is less than 3.2 km/h (2 mph).
- The commanded engine speed is steady within 25 RPM.
- The DTCs run continuously when the above conditions are met for greater than 10 s.

Conditions for Setting the DTC

P0506

The ECM detects that the actual idle speed is approximately 91 RPM lower than the desired idle speed.

P0507

The ECM detects that the actual idle speed is approximately 182 RPM higher than desired idle speed.

Action Taken When the DTC Sets

DTC P0506 and P0507 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0506 and P0507 are Type B DTCs.

Diagnostic Aids

- A stalling condition can cause DTC P0506 to set.
- 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**

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify there are no other DTCs set.
   - **If any other DTCs are set**

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

   - **If no other DTCs are set**
3. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
   - **90 % or greater**

     Refer to **Throttle Body Inspection and 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 below.

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

     Refer to Circuit/System Testing below.

   - **If 200 RPM less than the Desired Idle Speed**

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

      Refer to Circuit/System Testing below.

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

Circuit/System Testing

P0506

1. Verify the conditions listed below do not exist.
    - Restricted exhaust
    - Mechanical conditions that limits engine speed
    - Parasitic load on the engine-For example, a transmission condition, a belt driven accessory condition.
    - **If a condition is found**

      Repair as necessary.

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

P0507

1. Verify the conditions listed below do not exist.
    - Vacuum leaks
    - A throttle valve that does not close correctly
    - Verify the correct operation of the crankcase ventilation system. Inspect for the conditions listed below:
        - Improper routing of the positive crankcase ventilation (PCV) system
        - Vacuum leaks in the PCV system-Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
    - **If a condition is found**

      Repair as necessary.

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

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Repair Verification

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

- **Throttle Body Inspection and Cleaning**
- **Throttle Body Assembly Replacement**

DTC P0601-P0604, P0606, OR P062F (FUEL PUMP CONTROL MODULE)

Diagnostic Instructions

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

DTC Descriptors

DTC P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0606

Control Module Processor Performance

DTC P062F

Control Module Long Term Memory Performance

Circuit/System Description

The internal fault detection is handled inside the fuel pump control module. No external circuits are involved.

Conditions for Running the DTC

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The fuel pump control module runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

Conditions for Setting the DTC

The fuel pump control module has detected an internal malfunction.

Action Taken When the DTC Sets

DTC P0601, P0602, P0603, P0604, P0606 and P062F are type A DTCs.

Conditions for Clearing the DTC

DTC P0601, P0602, P0603, P0604, P0606 and P062F are type A DTCs.

Reference Information

Description and Operation

Engine Controls Schematics

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

NOTE: This DTC may be stored as a history DTC without affecting the operation of the module. If stored only as a history DTC and not retrieved as a current DTC, do not replace the module.

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

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- If the DTC does not set.

3. All OK.
   - **If DTC P0602 is not set**

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

Repair Instructions

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

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

DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, OR P262B (ECM)

Diagnostic Instructions

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

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DTC P0606

Control Module Processor Performance

DTC P062F

Control Module Long Term Memory Performance

DTC P0630

VIN Not Programmed or Mismatched - Engine Control Module (ECM)

DTC P16F3

Control Module Redundant Memory Performance

DTC P262B

Control Module Power Off Timer Performance

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed.

Conditions for Running the DTCs

P0601, P0602, P0630

These DTCs run continuously when the ignition is in ON.

P0603, P062F

These DTCs run once per ignition cycle.

P0604

DTC P0604 runs continuously when the ignition is ON for greater than 30 s.

P0606

DTC P0606 runs continuously when Ignition 1 Signal voltage is greater than 11 V.

P16F3

- The engine speed is greater than 500 RPM.
- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P2227, P2228, P2229, or P2230 are not set.

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- DTC P16F3 runs continuously when the above conditions are met.

P262B

DTC P262B runs on 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, P062F, P0630, and P16F3 are Type A DTCs.
- DTC P262B is a Type B DTC.

Conditions for Clearing the MIL/DTC

- DTCs P0601, P0602, P0603, P0604, P0606, P062F, P0630, and P16F3 are Type A DTCs.
- DTC P262B is a Type B DTC.

Diagnostic Aids

Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set. Verify the following:

- The battery cables are clean and tight, and the battery is fully charged. Refer to **Battery Inspection/Test** .
- The ECM ground circuits do not have an open or high resistance.
- The ECM power circuits do not have an open, short to ground, or high resistance.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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Electrical Information Reference

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- **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, clear the DTC information with a scan tool. Observe the DTC information with a scan tool.
2. Verify that DTC P0641, P0651, P0697, or P06A3 does not set.
   - **If a DTC is set**

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

   - **If DTC P0641, P0651, P0697, or P06A3 does not set**
3. Observe the DTC information with a scan tool. Verify DTC P0602 or P0630 is not set.
   - **If DTC P0602 or P0630 is set**
   1. Program the K20 Engine Control Module. Refer to **Control Module References** .
   2. Verify DTC P0602 or P0630 is not set.
      - If DTC P0602 or P0630 sets, replace the K20 Engine Control Module.
      - If DTC P0602 or P0630 does not set
   3. All OK.
   - **If DTC P0602 or P0630 is not set**
4. Verify DTC P0601, P0603, P0604, P0606, P062F, P16F3, or P262B is not set.
   - **If DTC P0601, P0603, P0604, P0606, P062F, P16F3, or P262B is set**

     Replace the K20 Engine Control Module.

   - **If DTC P0601, P0603, P0604, P0606, P062F, P16F3, or P262B is not set**
5. All OK.

Repair Instructions

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

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

DTC P0627-P0629

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

DTC Descriptors

DTC P0627

Fuel Pump Enable Circuit

DTC P0628

Fuel Pump Enable Circuit Low Voltage

DTC P0629

Fuel Pump Enable Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0628	P0627, P0629	P0629	-

Circuit/System Description

The engine control module (ECM) provides ignition voltage to the fuel pump flow control module whenever the engine is cranking or running. The control module enables the fuel pump flow control module as long as the engine is cranking or running, and ignition system reference pulses are received. While this enable voltage is being received, the fuel pump flow control module supplies a varying voltage to the in-tank fuel pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

P0627 and P0629

- The ignition voltage is 11 V or greater.
- The ECM has commanded the fuel pump OFF.
- The DTCs run continuously when the above conditions are met for greater than 1 s.

P0628

- The ignition voltage is 11 V or greater.
- The ECM has commanded the fuel pump ON.
- The DTC runs continuously when the above conditions are met for greater than 1 s.

Conditions for Setting the DTC

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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.

Action Taken When the DTC Sets

DTCs P0627, P0628, and P0629 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0627, P0628, and P0629 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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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 that DTC P0627, P0628, or P0629 is not set.
    - **If a DTC is set**

      Refer to Circuit/System Testing below.

    - **If a DTC is not set**
3. Verify the parameters listed below do not display Malfunction when commanding the Fuel Pump Enable

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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 below

- **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 below.

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module.
2. Ignition ON for 10 s.
3. Verify that a test lamp does not illuminate between the control circuit terminal 20 and ground.
   - **If the test lamp illuminates**
   1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool Fuel Pump Enable Circuit Low Voltage Test Status parameter is OK when commanding the Fuel Pump Enable On with a scan tool.
   - **If OK is not displayed**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **If OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal 20 and ground.

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7. Verify the scan tool Fuel Pump Enable Circuit Low Voltage Test Status parameter is Malfunction when commanding the Fuel Pump Enable On with a scan tool.
   - **If Malfunction is not displayed**
   1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the control circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If Malfunction is displayed**
8. Replace the K27 Fuel Pump Control Module.

Repair Instructions

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

Control Module References for Engine Control Module or Fuel Pump Flow Control Module replacement, programming, and setup

DTC P0641 OR P06A6 (FUEL PUMP CONTROL MODULE)

Diagnostic Instructions

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

DTC Descriptors

DTC P0641

5 V Reference Circuit

DTC P06A6

5 V Reference 1 Performance

Diagnostic Fault Information

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

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Circuit/System Description

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

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The fuel pump control module detects that the fuel pressure 5 V reference is above or below a predetermined voltage threshold.

Action Taken When the DTC Sets

DTCs P0641 and P06A6 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0641 and P06A6 are Type A DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

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

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1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K27 Fuel Pump Control Module.

- **If less than 1 V**

6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.
7. Verify the scan tool Fuel Pressure Sensor Voltage parameter is greater than 4.8 V.

- **If 4.8 V or less**

1. Ignition OFF, disconnect the harness connector at the K27 Fuel Pump Control Module.
2. Test for infinite resistance between the signal circuit terminal 1 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, replace the K27 Fuel Pump Control Module.

- **If greater than 4.8 V**

8. Test or replace the B47 Fuel Pressure Sensor.

Repair Instructions

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

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

DTC P0641, P0651, P0697, OR P06A3 (ECM)

Diagnostic Instructions

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

DTC Descriptors

DTC P0641

5V Reference 1 Circuit

DTC P0651

5V Reference 2 Circuit

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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 ground or voltage on any of the 5V reference circuits for greater than 0.5 s.

Action Taken When the DTC Sets

DTCs P0641, P0651, P0697, and P06A3 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0641, P0651, P0697, and P06A3 are Type A DTCs.

Diagnostic Aids

P0641

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

- Air conditioning (A/C) refrigerant pressure sensor
- Exhaust and intake camshaft position sensors
- Fuel tank pressure sensor
- Multifunction intake air sensor

P0651

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

- Brake pedal position sensor (automatic transmission)
- Clutch pedal position sensor (manual transmission)

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- Crankshaft position sensor
- Secondary air injection pressure sensor, if equipped
- Vehicle speed sensor (manual transmission)

P0697

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

- Accelerator pedal position sensor 2
- Manifold absolute pressure sensor

P06A3

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

- Accelerator pedal position sensor 1
- Throttle position sensor 1 and 2

Disconnecting one component at a time from the affected 5V reference circuit while observing the scan tool 5V Reference Circuit Status parameter may help locate the fault. The scan tool parameter will change from Malfunction to OK when the source of the fault is disconnected. If all 5V reference components have been disconnected and a fault is still indicated, the fault may exist in the wiring harness.

Reference Information

Schematic Reference

Engine Controls Schematics

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

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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 all scan tool 5V Reference Circuit Status parameters do not display Malfunction.
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing below.

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

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

NOTE: Additional DTCs will set when disconnecting the components.

1. Ignition OFF, disconnect the harness connector at all appropriate sensors for the applicable DTC. Refer to Diagnostic Aids.
2. Ignition ON.
3. Test for 4.8-5.2 V between one of the 5V reference circuits and ground.
   - **If less than 4.8 V**
     1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
     2. Test for infinite resistance between the 5V reference circuit for each applicable component and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
     1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
     2. Test for less than 1 V between the 5V reference circuit for each applicable component and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.

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- 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**

     Replace the component.

   - **If OK is displayed after all components have been connected**
5. All OK.

Repair Instructions

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

- **Accelerator Pedal Position Sensor Replacement**
- **Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement**
- **Brake Pedal Position Sensor Replacement**
- **Camshaft Position Sensor Replacement**
- **Clutch Pedal Position Sensor Replacement**
- **Crankshaft Position Sensor Replacement**
- **Fuel Tank Pressure Sensor Replacement**
- **Manifold Absolute Pressure Sensor Replacement**
- **Mass Airflow Sensor Replacement**
- **Secondary Air Injection Check Valve Replacement**
- **Throttle Body Assembly Replacement**
- **Vehicle Speed Sensor Replacement**
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P0650, P263A, OR P263B

Diagnostic Instructions

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

DTC Descriptor

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DTC P0650

Malfunction Indicator Lamp (MIL) Control Circuit Open

DTC P263A

Malfunction Indicator Lamp (MIL) Control Circuit Low Voltage

DTC P263B

Malfunction Indicator Lamp (MIL) Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0650	P0650	-	-
MIL Control	P0650, P263A*	P0650, P263A	P0650, 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 engine control system requires service. Ignition voltage is supplied directly to the MIL. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit when the emission system fault occurs. Under normal operating conditions, the MIL should be ON only when the ignition is ON and the engine is OFF.

Conditions for Running the DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 11-32 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P0650

The ECM detects low voltage during the MIL control circuit driver OFF state.

DTC P263A

The ECM detects low voltage during the MIL control circuit driver OFF state.

DTC P263B

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The ECM detects high voltage on the MIL control circuit during the driver ON state.

Action Taken When the DTC Sets

DTC P0650, P263A, and P263B are Type B DTCs.

Conditions for Clearing the DTC

DTC P0650, P263A, and P263B are Type B DTCs.

Diagnostic Aids

- If the condition is intermittent, move the related harnesses and connectors while monitoring the scan tool MIL control circuit status parameters. Perform this test with the ignition ON and the engine OFF, and with the engine running. The MIL control circuit status parameters change from OK or Not Run to Fault if there is a condition with a circuit or a connection.
- If the ECM detects low voltage on the MIL control circuit during the MIL control circuit driver OFF state, DTCs P0650 and DTC P263A may set simultaneously.

Reference Information

Schematic Reference

- **Engine Controls Schematics**
- **Instrument Cluster Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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1. Ignition ON.
2. Command the malfunction indicator lamp ON and OFF with a scan tool.
3. Verify that the malfunction indicator lamp turns ON and OFF as commanded.
    - **If the malfunction indicator lamp does not turn ON and OFF as commanded**

      Refer to Circuit/System Testing below

    - **If the malfunction indicator lamp turns ON and OFF as commanded**
4. Ignition ON.
5. Command the malfunction indicator lamp ON and OFF with a scan tool and verify that the control circuit status parameters listed below display OK or Not Run.
    - 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 below

    - **If OK or Not Run is displayed**
6. Engine running.
7. Command the malfunction indicator lamp ON and OFF with a scan tool and verify that the control circuit status parameters listed below display OK or Not Run.
    - 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 below

    - **If OK or Not Run is 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.
    - **If the DTC sets**

      Refer to Circuit/System Testing below

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

Circuit/System Testing

1. Ignition OFF.

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2. Disconnect the X1 harness connector at the K20 Engine Control Module.
3. Ignition ON.
4. Verify the malfunction indicator lamp does not illuminate.
    - **If the malfunction indicator lamp illuminates**
    1. Test for infinite resistance between the malfunction indicator lamp control circuit terminal X1 1 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**
5. Connect a 3 A fused jumper wire between the malfunction indicator lamp control circuit terminal X1 1 and ground.
6. Verify the malfunction indicator lamp illuminates.
    - **If the malfunction indicator lamp does not illuminate**
    1. Test the malfunction indicator lamp control circuit terminal X1 1 for a short to voltage or an open/high resistance.
        - If the malfunction indicator lamp control circuit terminal X1 1 is shorted to voltage or has an open/high resistance, repair as necessary.
        - If the malfunction indicator lamp control circuit terminal X1 1 tests normal
    2. Test the instrument cluster ignition voltage circuit for a short to ground or open/high resistance.
        - If the instrument cluster ignition voltage circuit is shorted to ground or has an open/high resistance, repair as necessary.
        - If the instrument cluster ignition voltage circuit tests normal, replace the P16 instrument panel cluster/bulb.
    - **If the malfunction indicator lamp illuminates**
7. Replace the K20 Engine Control Module.

Repair Instructions

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

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

DTC P0660, P0661, OR P0662

Diagnostic Instructions

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

DTC Descriptors

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DTC P0660

Intake Manifold Tuning Control Valve Control Circuit

DTC P0661

Intake Manifold Tuning Control Valve Control Circuit Low Voltage

DTC P0662

Intake Manifold Tuning Control Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Ignition 1 Voltage	P0661	-	P0660, P0661	-	-
Intake Manifold Tuning Valve Solenoid Control	P0661	-	P0660, P0661	P0662	-

Circuit/System Description

The intake manifold tuning valve controls the length of the intake runners in the intake manifold. The intake manifold contains both long and short runners. The tuning valve controls only the short runners. When the valve is closed, the short runners are blocked, which forces the air through the long runners. This results in tuning effects in the manifold that increases the torque produced by the engine at lower engine speeds. When the valve is open, both the long runners and short runners are open, but the majority of the air travels through the short runners, since the air will naturally follow the shortest path into the cylinder. This allows the air to flow through the short runners, which results in increased torque at higher engine speeds.

Ignition voltage is supplied directly to the intake manifold tuning valve actuator. The engine control module (ECM) controls the valve actuator motor 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 signal.

The tuning valve actuator contains a position sensor, which outputs a pulse width modulated (PWM) signal, to detect the actual position of the tuning valve in relation to its commanded position. Variations in the duty cycle of the PWM signal enables the ECM to detect a physically broken, restricted or stuck tuning valve.

Conditions for Running the DTC

- Engine speed is at least 400 rpm.
- The battery voltage is at least 11 V.
- DTCs P0660, P0661 and P0662 run continuously when the above conditions are met.

Conditions for Setting the DTC

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P0660

The ECM detects an open circuit on the intake manifold tuning valve control circuit for greater than 0.5 s.

P0661

The ECM detects a short to ground or an open circuit on the intake manifold tuning valve control circuit for greater than 0.5 s.

P0662

The ECM detects a short to voltage on the intake manifold tuning valve control circuit for greater than 0.5 s.

Action Taken When the DTC Sets

DTCs P0660, P0661 and P0662 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0660, P0661 and P0662 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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1. Engine running.
2. Verify a click is heard or felt from the Q22 Intake Manifold Tuning Solenoid Valve when commanding the Intake Manifold Tuning Control Valve Open and Closed with a scan tool.
   - **If a click is not heard or felt**

     Refer to Circuit/System Testing below

   - **If a click is heard or felt**
3. Verify the circuit status parameters listed below do not display Malfunction when commanding the Intake Manifold Tuning Control Valve Open and Closed with a scan tool:
   - Intake Manifold Tuning Control Valve Control Circuit High Voltage Test Status
   - Intake Manifold Tuning Control Valve Control Circuit Open Test Status
   - Intake Manifold Tuning Control Valve Control Circuit Low Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing below

   - **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.
   - **If a DTC sets**

     Refer to Circuit/System Testing below

   - **If a DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q22 Intake Manifold Tuning Solenoid Valve. Ignition ON.
2. 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 good**
   1. Ignition OFF, remove the test lamp.
   2. Test for less than 2 ohms in the ignition circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp.

NOTE: An internal short in any component supplied by the fuse may cause the fuse to open and set a DTC when the component is activated.

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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 control circuit terminal 2 and the ignition circuit terminal 1.
    - **If the test lamp illuminates**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool Intake Manifold Tuning Control Valve Control Circuit High Voltage Test Status parameter is OK when commanding the Intake Manifold Tuning Control Valve Open 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 3 and the ignition circuit terminal 1.
7. Verify the scan tool Intake Manifold Tuning Control Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the Intake Manifold Tuning Control Valve Open with a scan tool.
    - **If Malfunction is not displayed**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 ohms in the control circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.
    - **If Malfunction is displayed**
8. Replace the Intake Manifold.

Repair Instructions

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

- **Intake Manifold Replacement**
- **Control Module References** for replacement, programming, and setup.

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DTC P0685-P0687, P0689, P0690, OR P1682

Diagnostic Instructions

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

DTC Descriptors

DTC P0685

Engine Controls Ignition Relay Control Circuit

DTC P0686

Engine Controls Ignition Relay Control Circuit Low Voltage

DTC P0687

Engine Controls Ignition Relay Control Circuit High Voltage

DTC P0689

Engine Controls Ignition Relay Feedback Circuit Low Voltage

DTC P0690

Engine Controls Ignition Relay Feedback Circuit High Voltage

DTC P1682

Ignition 1 Switch Circuit 2

Diagnostic Fault Information

Powertrain 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

Ignition Main Relay

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

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1. No Crank condition.
2. Engine continues to operate with ignition OFF.

Typical Scan Tool Data

Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status-Component Commanded OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage Test 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			
Battery Voltage	Malfunction	Malfunction	-
Engine Controls Ignition Relay Control Circuit	Malfunction	Malfunction	Not Run

Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status-Component Commanded ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded ON **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/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			
Battery Voltage	Not Run	Not Run	-
Engine Controls Ignition Relay Control Circuit	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 powertrain relay, and the other is supplied by the ignition main relay. The ECM monitors and compares the ignition voltage supplied by the 2 relays.

Conditions for Running the DTC

P0685, P0686, P0687

The DTC runs when Ignition 1 signal voltage is greater than 11 V.

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P0689

- DTC P0685 is not set.
- The powertrain relay is commanded ON.
- Ignition 1 signal voltage is greater than 11 V.
- The DTC runs continuously when the above conditions are met.

P0690

- P0685 is not set.
- The powertrain relay is commanded OFF.
- The DTC runs continuously when the above conditions are met.

P1682

- The powertrain 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 when the powertrain relay is commanded ON.

P0690

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

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P1682

The ECM detects that the voltage level difference is greater than 3 V between the 2 ignition voltage circuits for less than 1 s.

Action Taken When the DTC Sets

- DTCs P0685, P0686, P0687, P0689, and P0690 are Type B DTCs.
- DTC P1682 is a Type A DTC.

Conditions for Clearing the DTC

- DTCs P0685, P0686, P0687, P0689, and P0690 are Type B DTCs.
- DTC P1682 is a Type A DTC.

Diagnostic Aids

The powertrain relay may also be labeled the engine controls ignition 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

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Center Identification Views**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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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. Verify DTC P0685, P0686, P0687, P0689, P0690, or P1682 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing below

   - **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 any of the DTCs are set**

     Refer to Circuit/System Testing below

   - **If none of the DTCs are 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 Powertrain Relay.
2. Verify a test lamp illuminates between ground and the relay circuit terminals listed below:
   - Terminal 1
   - Terminal 3
   - **If the test lamp does not illuminate**

     Replace the front compartment fuse block. Refer to **Front Compartment Fuse Block Replacement** .

   - **If the test lamp illuminates**

NOTE:

- **High resistance in the circuit/underhood fuse block for either the powertrain relay or the ignition main relay can cause DTC P1682 to set.**

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- **A short to voltage on any of the circuits supplied by the powertrain 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 5 and ground.
   - **If the test lamp illuminates**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Ignition ON.
   3. Test for less than 1 V between ground and connector terminals 28.
      - 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 relay switch B+ circuit terminal 3 and the relay switch ignition voltage circuit terminal 5.
6. Ignition ON.
7. Observe the scan tool Engine Controls Ignition Relay Feedback Signal parameter. The K20 Engine Control Module should communicate, and the parameter should display B+.
   - **If the parameter does not display B+ or the K20 Engine Control Module does not communicate**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module
   2. Test for less than 2 ohms in the relay switch ignition voltage circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms
   3. Test for 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 the parameter displays B+**
8. Ignition OFF, connect a DMM, set to the diode setting, between control circuit terminal 2 and ground.
9. Verify the DMM displays OL.
   - **If the DMM does not display OL**
   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 the DMM displays OL**
10. Ignition ON.
11. Verify the DMM displays less than 1 V.
   - **If the DMM does not display less than 1 V**
   1. Ignition OFF, disconnect the X1 connector at the K20 Engine Control Module.

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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 ohms in the control circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - if less than 2 ohms, replace the K20 Engine Control Module.

- **If the DMM displays less than 1 V**

12. Test or replace the KR75 Powertrain Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR75 Powertrain Relay.
2. Test for 70-110 ohms between terminals 1 and 2:
    - **If less than 70 ohms or greater than 110 ohms**

      Replace the relay.

    - **If between 70-110 ohms**
3. Test for infinite resistance between the terminals listed below:
    - 3 and 2
    - 3 and 5
    - 3 and 1
    - 1 and 5
    - **If less than infinite resistance**

      Replace the relay.

    - **If infinite resistance**
4. Install a 20 A fused jumper wire between relay terminal 1 and 12 V. Install a jumper wire between relay terminal 2 and ground.
5. Test for less than 2 ohms between terminals 3 and 5.
    - **If 2 ohms or greater**

      Replace the relay.

    - **If less than 2 ohms**
6. All OK.

Repair Instructions

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

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

DTC P069E

Diagnostic Instructions

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

DTC Descriptor

DTC P069E

Fuel Pump Control Module Requested MIL Illumination

Circuit/System Description

The fuel pump control module monitors the fuel pump control system for any conditions which may adversely affect vehicle emissions. If an adverse condition is detected, the fuel pump control module sets a fuel pump control system DTC. The fuel pump control module then sends a serial data message to the engine control module (ECM) requesting malfunction indicator lamp (MIL) illumination. When the ECM receives the message from the fuel pump control module, DTC P069E will set in the ECM.

Conditions for Running the DTC

The ignition is ON, or the engine is running for greater than 3 s.

Conditions for Setting the DTC

The fuel pump control module requests the ECM to illuminate the MIL.

Action Taken When the DTC Sets

- DTC P069E is a Type A DTC.
- DTC P069E will continue to be current or active as long as the fuel pump control module is requesting MIL illumination.

Conditions for Clearing the DTC

DTC P069E is a Type A DTC.

Diagnostic Aids

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Communication codes, U-codes, as well as powertrain codes, P-codes, set in the fuel pump control module will cause the fuel pump control module to request DTC P069E to be set in the ECM.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

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

1. Verify there are no engine control or communication DTCs set.
   - **If a DTC is set**

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

   - **If a DTC is not set**
2. Verify there are no fuel pump control module DTCs set.
   - **If a DTC is set**

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

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

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

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

Repair Instructions

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

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DTC P0700

Diagnostic Instructions

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

DTC Descriptor

DTC P0700

Transmission Control Module Requested MIL Illumination

Circuit/System Description

Diagnostic trouble code (DTC) P0700 is an informational DTC that indicates that an emission related transmission DTC has set in the transmission control module (TCM). The engine control module (ECM) turns ON the malfunction indicator lamp (MIL) when the TCM sends a message over the serial data circuit requesting MIL illumination. The DTC information for the ECM will only display DTC P0700, and the ECM Freeze Frame/Failure Records data will display the engine operating conditions that were present when the transmission DTC was set. The TCM Freeze Frame/Failure records data is available from the DTC that was set in the TCM.

Conditions for Running the DTC

- The ignition is ON or the engine is operating.
- DTC P0700 runs continuously.

Conditions for Setting the DTC

The ECM receives a serial data message from the TCM requesting the ECM to turn ON the MIL.

Action Taken When the DTC Sets

DTC P0700 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P0700 is a Type A DTC.

Diagnostic Aids

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the TCM can cause the TCM to request DTC P0700 to be set in the ECM.

Reference Information

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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:

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

1. Verify there are no engine control or communication DTCs set.
   - **If a DTC is set**

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

   - **If a DTC is not set**
2. Verify there are no transmission control module DTCs set.
   - **If a DTC is set**

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

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

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

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

Repair Instructions

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

DTC P11C2-P11C4

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

DTC Descriptors

DTC P11C2

Intake Air Humidity Sensor Circuit Low Voltage

DTC P11C3

Intake Air Humidity Sensor Circuit High Voltage

DTC P11C4

Intake Air Humidity Sensor Circuit Erratic

Diagnostic Fault Information

Intake Air Humidity Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0097, P0651, P11C2, P2199**, P2227, P2228	P0096, P0097, P11C2, P2199**, P2227, P2228	P0097, P0651, P11C2, P2199**, P2227, P2228	-
Signal	P0097, P11C3, P2199**	P0097, P11C2, P2199**	P0097*, P11C2, P2199**	-
Low Reference	-	P0097, P0113, P11C2, P2227, P2229	*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+. ** Where used.				

Typical Scan Tool Data

Intake Air Humidity

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient humidity and temperature; and engine bay conditions			
5 V Reference	0 %	0 %	-
Signal	100 %	0 %	0 %*
Low Reference	-	0 %	*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

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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 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 engine control module (ECM) applies 5 V to the signal circuit. The humidity sensor and the IAT sensor 2 share the same circuit.

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

Conditions for Running the DTCs

P11C2, P11C3, and P11C4

- The ignition is ON.
- The Ignition 1 voltage is at least 11 V for longer than 0.9 s.
- These DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P11C2

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

P11C3

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

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P11C4

The ECM monitors the humidity sensor signal every 0.1 s, to determine if the signal has changed more than 80 %. The DTC fails when the condition exists for longer than 4 s.

Action Taken When the DTC Sets

- DTCs P11C2, P11C3, P11C4 are Type B DTCs.
- DTCs P11C2, P11C3, P11C4 are Type C DTCs; with RPO LUW.

Conditions for Clearing the MIL/DTC

- DTCs P11C2, P11C3, P11C4 are Type B DTCs.
- DTCs P11C2, P11C3, P11C4 are Type C DTCs; with RPO LUW.

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

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

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

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

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

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

NOTE: To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 3 and 4 of this verification procedure only if the ignition has been OFF for 8 hours or more.

3. Ignition ON.
4. Verify the following scan tool parameters are within 25°C (45°F) of each other.
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - Start-Up ECT
   - **If not within 25°C (45°F)**

     Refer to Circuit/System Testing below.

   - **If within 25°C (45°F)**
5. 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 below.

   - **If between 5 and 90 %**
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 does set**

     Refer to Circuit/System Testing below.

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- **If the DTC does not set**

8. All OK

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification before proceeding with 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 B75C Multifunction Intake Air sensor.
2. Test for less than 2 ohms between the low reference circuit terminal 7 and ground.
   - **If 2 ohms or greater**
     1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
     2. Test for less than 2 ohms in the low reference circuit end to end.
        - If 2 ohms or greater, repair the open or high resistance in the circuit.
        - If less than 2 ohms replace the K20 Engine Control Module.
   - **If less than 2 ohms**
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 2 and ground.
   - **If less than 4.8 V**
     1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
     2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
     3. Test for less than 2 ohms in the signal circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

     NOTE: If the 5 V reference circuit is shorted to a voltage the engine control module or the sensor may be damaged.

     1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
     2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 4.8-5.2 V**
4. Ignition ON, test for 4.8-5.2 V between the humidity 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.

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

- **If greater than 5.2 V**

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

5. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
   - **If EL-38522-A, Variable Signal Generator; or equivalent is not available**

   1. Replace the K20 Engine Control Module.
   2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   3. Verify the DTC does not set.
      - **If the DTC sets**

        Refer to step 9.

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

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

6. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
   - Red lead to the signal circuit terminal 1 at the harness connector
   - Black leads to ground
   - Battery voltage supply lead to B+
7. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
   - Signal switch to 5 V
   - Frequency switch to 250 Hz
   - Duty Cycle switch to 50 % (Normal)
8. Ignition ON, verify the scan tool Intake Air Humidity parameter is between 45-55 %.
   - **If not between 45-55 %**

     Replace the K20 Engine Control Module.

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- **If between 45-55 %**

9. 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 (Bosch Sensor)** table for Bosch Sensors. The resistance values should be in range of the table values.
   - **If not within the specified range.**

     Replace the B75C Multifunction Intake Air sensor.

   - **If within the specified range.**
3. All OK

Repair Instructions

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

- **Mass Airflow Sensor Replacement** for B75C Multifunction Intake Air sensor replacement.
- **Control Module References** for ECM replacement, programming, and setup

DTC P1255 OR P064A

Diagnostic Instructions

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

DTC Descriptors

DTC P064A

Fuel Pump Control Module Performance

DTC P1255

Fuel Pump Control Module Driver High Temperature

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Circuit/System Description

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

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

The fuel pump control module detects an over-temperature fault.

Action Taken When the DTC Sets

DTCs P064A and P1255 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P064A and P1255 are Type A DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

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

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

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

     Replace the K27 fuel pump control module.

   - **If DTC P1255 or P064A is not set.**
6. All OK.

Repair Instructions

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

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

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DTC P1400

Diagnostic Instructions

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

DTC Descriptor

DTC P1400

Cold Start Emission Reduction Control System

Circuit/System Description

The 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 idle speed is elevated and spark timing is retarded to allow the catalyst to warm quickly. This diagnostic monitors the following to build an exhaust energy model:

- Engine speed
- Spark advance
- Throttle position
- Engine airflow
- Engine coolant temperature
- Engine run time
- Park/neutral position
- Vehicle speed

The actual model is then compared to the expected exhaust energy model.

Conditions for Running the DTC

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0222, P0223, P0300, P0301, P0302, P0303, P0304, P0335, P0336, P0351, P0352, P0353, P0354, P0502, P0503, P0506, P0507, P0697, P06A3, P0722, P0723, P0806, P0807, P0808, P182E, P1915, P2122, P2123, P2127, P2128, P2135, and P2138 are not set.
- The catalyst temperature is less than 300°C (572°F).
- The engine coolant temperature (ECT) sensor is greater than -10°C (14°F).
- The vehicle speed is less than 2 km/h (1 MPH).
- The ECM will exit the diagnostic if the calculated three way catalyst temperature is greater than 700°C (1292°F) and the engine run time is greater than 30 s.

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- The ECM will exit the diagnostic if the ECT is greater than 40°C (104°F) or the engine run time is greater than 80 s.
- 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

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. Allow the engine to cool until the catalyst temperature is less than 300°C (572°F) and the engine coolant is between -10°C (14°F) and 40°C (104°F).
2. Engine idling for at least 2 min, observe the scan tool DTC information. DTC P1400 should not set.
3. Operate the vehicle within the conditions for running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.

Circuit/System Testing

1. Verify none of the conditions listed below exists with the air intake system:

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- Damage, restriction, or modification
- Dirty or deteriorating air filter element
- Crankcase ventilation system for correct operation. Refer to **Crankcase Ventilation System Inspection/Diagnosis**
- Water intrusion
- Vacuum leak and other unmetered air downstream of the mass air flow (MAF) sensor
- Intake manifold leak
    - If there is a condition, repair as necessary.

2. Verify none of the conditions listed below exists with the exhaust system:
    - Water intrusion
    - Exhaust leak
    - Damaged, restricted, or modified exhaust system. Refer to **Symptoms - Engine Exhaust**
        - If there is a condition, repair as necessary.
3. Inspect for an engine mechanical condition that could alter the air flow into the combustion chamber. Refer to **Symptoms - Engine Mechanical**

Repair Instructions

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

DTC P150C

Diagnostic Instructions

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

DTC Descriptor

DTC P150C

Transmission Control Module Engine Speed Request Signal Message Counter Incorrect

Circuit/System Description

This diagnostic applies to communication integrity between the engine control module (ECM) and the transmission control module (TCM). The ECM determines that the engine speed signal counter is incorrect for the current vehicle operation.

Conditions for Running the DTC

- DTCs P0506, P0507, or U0101 are not set.
- The engine is running 0.5 s.

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- 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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Correct any other engine controls and communication DTCs before diagnosing transmission control module DTCs.

1. DTC P150C is an informational DTC. If there are no engine controls or communication DTCs, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for diagnosis of transmission control module DTCs. Do not replace the ECM for this DTC.
2. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Repair Instructions

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

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

DTC P1516, P2101, P2119, OR P2176

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

DTC Descriptors

DTC P1516

Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance

DTC P2101

Throttle Actuator Position Performance

DTC P2119

Throttle Closed Position Performance

DTC P2176

Minimum Throttle Position Not Learned

Diagnostic Fault Information

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

Circuit/System Description

The Engine Control Module (ECM) controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the throttle position (TP) sensors 1 and 2 to determine the actual throttle valve position.

Conditions for Running the DTC

P1516

- 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

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- DTC P1682 is not set.
- The run/crank or powertrain relay voltage is greater than 5.5 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

- The ignition is ON.
- DTC P0121, P0122, P0123, P0222, P0223, P0697, P06A3, or P2135 is not set.
- The run/crank or powertrain relay voltage is greater than 5.5 V and reduced power is not active.
- DTC P2119 runs continuously when the above conditions are met.

P2176

- The ignition is ON.
- The run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- The ECM enable the minimum throttle learn procedure.
- DTC P2176 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P1516

The ECM detects an unstable throttle position for greater than 1 s.

P2101

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

P2119

The ECM detects the throttle blade did not return to the default position when the TAC motor is de-energized for greater than 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.

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Action Taken When the DTC Sets

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

Conditions for Clearing the MIL/DTC

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

Diagnostic Aids

- Depending on the Start Up ECT, the Desired Throttle Position percentage maybe greater or less than the Throttle Position with the TAC motor at rest. When the ignition is initially turned ON, or when the engine is cranking or running the Desired and Actual Throttle positions should closely match.
- Inspect for a condition in which the throttle valve may have been held open. For example, ice may have formed in the throttle bore causing the throttle valve not to close.
- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- A low battery condition may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

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

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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.

   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 Inspection and 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 below.

   - **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 below.

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

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

9. Verify the scan tool TAC Motor parameter displays Enabled while performing the Throttle Sweep Test with a scan tool.
   - **If Enabled is not displayed**

     Test or replace the Q38 Throttle Body Assembly.

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

      Refer to Circuit/System Testing below.

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

Circuit/System Testing

1. Ignition OFF.

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

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

NOTE:

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

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- A throttle blade that is not in the rest position
- A throttle blade that is binding open or closed
- A throttle blade that is free to move open or closed without spring pressure
- **If a condition is found**

  Test or replace the Q38 Throttle Body assembly.

- **If a condition is not found**

3. Ignition OFF.

NOTE:

- **Disconnecting the throttle body harness connector may cause additional DTCs to set.**
- **The Test Lamp must be connected to circuit before turning ignition on or incorrect diagnosis may occur.**

4. Disconnect the harness connector at the Q38 Throttle Body assembly.
5. Cycle the Ignition ON and OFF and then ON again.
6. Verify that a test lamp illuminates between each motor control circuit listed below and ground.
   - TAC Motor Control Closed circuit terminal A or 3
   - TAC Motor Control Open circuit terminal B or 5
   - **If the test lamp does not illuminate**

   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the appropriate control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms on the control circuit from end to end.
      - If greater than 2 ohms, repair the open or high resistance on the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.

   - **If the test lamp illuminates**
7. Disconnect the harness connector at the K20 Engine Control Module.
8. Test for less than 1 V between each motor control circuit listed below and ground.
   - TAC Motor Control Closed circuit terminal A or 3
   - TAC Motor Control Open circuit terminal B or 5
   - **If greater than 1 V**

     Repair the short to voltage on the circuit.

   - **If less than 1 V**
9. Test or replace the Q38 Throttle Body assembly.

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Repair Instructions

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

Repair Verification

1. Ignition OFF.
2. Install any components that have been removed or replaced during diagnosis.
3. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
4. Ignition ON.
5. Clear the DTCs with a scan tool.
6. Turn the ignition OFF for 60 s.
7. Ignition ON.
8. Verify the scan tool TAC Motor parameter displays Enabled while performing the Throttle Sweep Test with a scan tool.
   - **If Enabled is not displayed**

     Test or replace the Q38 Throttle Body assembly.

   - **If Enabled is displayed**
9. 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**
10. All OK.

DTC P2070 OR P2071

Diagnostic Instructions

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

DTC Descriptors

DTC P2070

Intake Manifold Tuning Control Valve Stuck Open

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DTC P2071

Intake Manifold Tuning Control Valve Stuck Closed

Circuit/System Description

The intake manifold tuning valve controls the length of the intake runners in the intake manifold. The intake manifold contains both long and short runners. The tuning valve controls only the short runners. When the valve is closed, the short runners are blocked, which forces the air through the long runners. This results in tuning effects in the manifold that increases the torque produced by the engine at lower engine speeds. When the valve is open, both the long runners and short runners are open, but the majority of the air travels through the short runners, since the air will naturally follow the shortest path into the cylinder. This allows the air to flow through the short runners, which results in increased torque at higher engine speeds.

Ignition voltage is supplied directly to the intake manifold tuning valve actuator. The engine control module (ECM) controls the valve actuator motor 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 signal.

The tuning valve actuator contains a position sensor, which outputs a pulse width modulated (PWM) signal, to detect the actual position of the tuning valve in relation to its commanded position. Variations in the duty cycle of the PWM signal enables the ECM to detect a physically broken, restricted or stuck tuning valve.

Conditions for Running the DTC

- DTCs P0660, P2077 or P2078 are not set.
- The DTCs run continuously when the above condition is met for greater than 4 s.

Conditions for Setting the DTC

P2070

The ECM detects the time after the close command without the intake manifold tuning valve reaching the closed position is greater than 5 s.

P2071

The ECM detects the time after the open command without the intake manifold tuning valve reaching the open position is greater than 5 s.

Action Taken When the DTC Sets

DTC P2070 and P2071 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2070 and P2071 is a Type B DTC.

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Diagnostic Aids

- Ignition ON, command the Intake Manifold Tuning Solenoid Valve Open and Closed with a scan tool and observe if anything interferes with the motion.
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool circuit test status parameters for the component. A circuit test 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

Air Intake 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 P0660, P0661, P0662, P2077, or P2078 is not set.
    - **If any of the DTCs are set**

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

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

3. Verify the Q22 Intake Manifold Tuning Solenoid Valve Opens and Closes when commanding the Intake Manifold Tuning Control Valve Open and Closed with a scan tool.
   - **If the valve does not Open and Close**

     Refer to Circuit/System Testing below

   - **If the valve Opens and Closes**
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 below

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

Circuit/System Testing

1. Verify the following conditions do not exist with the Q22 Intake Manifold Tuning Solenoid Valve assembly:
   - Disconnected or damaged linkage
   - Linkage binding
   - Interference with hoses, wiring, or any other components
   - **If a condition is located**

     Repair or replace the affected component as necessary.

   - **If all components test normal**
2. Disconnect the linkage from the Q22 Intake Manifold Tuning Solenoid Valve.
3. Verify the Q22 Intake Manifold Tuning Solenoid Valve Opens and Closes when commanding the Intake Manifold Tuning Control Valve Open and Closed with a scan tool.
   - **If the solenoid valve does not Open and Close**

     Replace the intake manifold

   - **If the solenoid valve Opens and Closes**
4. Verify the following conditions do not exist with the intake manifold:
   - Carbon build-up that limits or restricts the movement of the intake manifold tuning valve vanes.
   - Casting flash that limits or restricts the movement of the intake manifold tuning valve vanes.
   - Foreign material that limits or restricts the movement of the intake manifold tuning valve vanes.

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- **If a condition is located**

  Repair or replace the intake manifold as necessary.

- **If all components test normal**

5. Replace the intake manifold.

Repair Instructions

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

- **Intake Manifold Replacement**
- **Control Module References** for ECM replacement, programming, and setup.

DTC P2076

Diagnostic Instructions

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

DTC Descriptor

DTC P2076

Intake Manifold Tuning Control Valve Position Sensor Performance

Diagnostic Fault Information

DTC P2076

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	*	P0443, P0660, P2078	-	P2076
Intake Manifold Tuning Valve Control Circuit	P0660, P2071	P0660, P2070	-	P2076
Intake Manifold Tuning Valve Signal Circuit	P2077	P2078	P2076, P2077, P2078	P2076
Intake Manifold Tuning Valve Ground	-	P2078	-	P2076
*Opens the fuse that supplies voltage to the Intake Manifold Tuning Valve Solenoid.				

Circuit/System Description

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The intake manifold tuning valve controls the length of the intake runners in the intake manifold. The intake manifold contains both long and short runners. The tuning valve controls only the short runners. When the valve is closed, the short runners are blocked, which forces the air through the long runners. This results in tuning effects in the manifold that increases the torque produced by the engine at lower engine speeds. When the valve is open, both the long runners and short runners are open, but the majority of the air travels through the short runners, since the air will naturally follow the shortest path into the cylinder. This allows the air to flow through the short runners, which results in increased torque at higher engine speeds.

Ignition voltage is supplied directly to the intake manifold tuning valve actuator. The engine control module (ECM) controls the valve actuator motor 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 signal.

The tuning valve actuator contains a position sensor, which outputs a pulse width modulated (PWM) signal, to detect the actual position of the tuning valve in relation to its commanded position. Variations in the duty cycle of the PWM signal enables the ECM to detect a physically broken, restricted or stuck tuning valve.

Conditions for Running the DTC

- The powertrain relay voltage is greater than 11 V.
- The engine run time is greater than 1 s.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

- The ECM detects the intake manifold tuning valve actuator learn sequence has been initiated for greater than 5 s and the valve position is between 5-35%

  OR

- The ECM detects an intake manifold tuning valve actuator learn sequence has been initiated for greater than 0.2 s and the valve position is between 5-35% for greater than 10 times in one ignition cycle.

Action Taken When the DTC Sets

DTC P2076 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2076 is a Type B DTC.

Diagnostic Aids

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

Reference Information

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Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Air Intake 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 P0660, P0661, P0662, P2070, P2071, P2077, or P2078 is not set.
   - **If any of the DTCs are set**

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

   - **If none of the DTCs are set.**
3. Verify the Q22 Intake Manifold Tuning Solenoid Valve Opens and Closes when commanding the Intake Manifold Tuning Control Valve Open and Closed with a scan tool.
   - **If the valve does not Open and Close**

     Refer to Circuit/System Testing below

   - **If the valve Opens and Closes**
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.

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

      Refer to Circuit/System Testing below

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

Circuit/System Testing

1. Verify the following conditions do not exist with the Q22 Intake Manifold Tuning Solenoid Valve assembly:
    - Disconnected or damaged linkage
    - Linkage binding
    - Interference with hoses, wiring, or any other components
    - **If a condition is located**

      Repair or replace the affected component as necessary.

    - **If all components test normal**
2. Disconnect the linkage from the Q22 Intake Manifold Tuning Solenoid Valve.
3. Verify the Q22 Intake Manifold Tuning Solenoid Valve Opens and Closes when commanding the Intake Manifold Tuning Control Valve Open and Closed with a scan tool.
    - **If the solenoid valve does not Open and Close**

      Replace the intake manifold

    - **If the solenoid valve Opens and Closes**
4. Verify the following conditions do not exist with the intake manifold:
    - Carbon build-up that limits or restricts the movement of the intake manifold tuning valve vanes.
    - Casting flash that limits or restricts the movement of the intake manifold tuning valve vanes.
    - Foreign material that limits or restricts the movement of the intake manifold tuning valve vanes.
    - **If a condition is located**

      Repair or replace the intake manifold as necessary.

    - **If all components test normal**
5. Replace the intake manifold.

Repair Instructions

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

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Intake Manifold Replacement

DTC P2077 OR P2078

Diagnostic Instructions

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

DTC Descriptors

DTC P2077

Intake Manifold Tuning Control Valve Position Sensor Circuit Low Voltage

DTC P2078

Intake Manifold Tuning Control Valve Position Sensor Circuit High Voltage

Diagnostic Fault Information

DTC P2077 or P2078

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	*	P0443, P0660, P2078	-	P2076
Intake Manifold Tuning Valve Control Circuit	P0660, P2071	P0660, P2070	-	P2076
Intake Manifold Tuning Valve Signal Circuit	P2077	P2078	P2076, P2077, P2078	P2076
Intake Manifold Tuning Valve Ground	-	P2078	-	P2076
*Opens the fuse that supplies voltage to the Intake Manifold Tuning Valve Solenoid.				

Circuit/System Description

The intake manifold tuning valve controls the length of the intake runners in the intake manifold. The intake manifold contains both long and short runners. The tuning valve controls only the short runners. When the valve is closed, the short runners are blocked, which forces the air through the long runners. This results in tuning effects in the manifold that increases the torque produced by the engine at lower engine speeds. When the valve is open, both the long runners and short runners are open, but the majority of the air travels through the short runners, since the air will naturally follow the shortest path into the cylinder. This allows the air to flow through the short runners, which results in increased torque at higher engine speeds.

Ignition voltage is supplied directly to the intake manifold tuning valve actuator. The engine control module

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(ECM) controls the valve actuator motor 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 signal.

The tuning valve actuator contains a position sensor, which outputs a pulse width modulated (PWM) signal, to detect the actual position of the tuning valve in relation to its commanded position. Variations in the duty cycle of the PWM signal enables the ECM to detect a physically broken, restricted or stuck tuning valve.

Conditions for Running the DTC

- The ignition is ON or the engine is operating.
- The DTCs run continuously once the above condition is met for greater than 4 s.

Conditions for Setting the DTC

P2077

The ECM detects a continuous open or short to low in the intake manifold tuning valve position sensor circuit.

P2078

The ECM detects a continuous short to high in the intake manifold tuning valve position sensor circuit.

Action Taken When the DTC Sets

DTC P2077 and P2078 are Type B DTCs.

Conditions for Clearing the DTC

DTC P2077 and P2078 are Type B DTCs.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool circuit test status parameters for the component. A circuit test 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

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Air Intake 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 P2077, or P2078 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing below

   - **If none of the DTCs are set.**
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify a DTC does not set.
   - **If a DTC sets**

     Refer to Circuit/System Testing below

   - **If a DTC does not set**
5. All OK

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the Q22 Intake Manifold Tuning Solenoid Valve. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 ohms between the ground circuit terminal 2 and ground.
   - **If 5 ohms or greater**
     1. Ignition OFF.

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

3. Ignition ON, 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 good**

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

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

1. Ignition OFF, remove the test lamp.
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

NOTE: The vehicle may not be equipped with each circuit and component as listed below.

3. Test for greater than 10 ohms between each of the ignition circuits listed below and ground:
    - Ignition circuit terminal 1 - B52A Heated Oxygen Sensor 1
    - Ignition circuit terminal 1 - B52B Heated Oxygen Sensor 2
    - Ignition circuit terminal 2 - E41 Engine Coolant Thermostat Heater
    - Ignition circuit terminal 2 - Q12 Evaporative Emission Purge Solenoid
    - If 10 ohms or less, disconnect the appropriate component and retest to verify if the short is in the circuit or the component.
    - If greater than 10 ohms, replace the intake manifold
- **If the test lamp illuminates**

4. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal 4 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 signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
    - If 2 ohms or greater, repair the open/high resistance in the circuit.
    - If less than 2 ohms, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

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1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**

5. Replace the Intake Manifold.

Repair Instructions

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

- **Intake Manifold Replacement**
- **Control Module References** for ECM replacement, programming, and setup.

DTC P2096

Diagnostic Instructions

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

DTC Descriptor

DTC P2096

Post Catalyst Fuel Trim System Low Limit

Circuit Description

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

Conditions for Running the DTC

- DTC P0016, P0017, P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P015A, P015B, P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0340, P0341, P0365, P0366, P0411, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P219A, P2227, P2228, P2229, P2230, P2270, P2271, P2440, or P2444 is not set.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 PSI).

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- The manifold absolute pressure (MAP) is between 0-200 kPa (0-29 PSI).
- The intake air temperature (IAT) is between -20°C and +200°C (-4 and +392°F).
- The start up engine coolant temperature is warmer than -20°C (-4°F).
- The fuel control intrusive diagnostics are not active.
- The engine is operating under cruise conditions.
- DTC P2096 runs continuously when the conditions above have been met.

Conditions for Setting the DTC

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

Action Taken when the DTC Sets

- DTCs P2096 is a Type B DTC.
- The ECM records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the ECM stores this information in the Failure records. If the diagnostic reports a failure on the second ignition cycle, the ECM records the operating conditions at the time of the failure. The ECM writes the operating conditions to the Freeze Frame and updates the Failure records. The ECM illuminates the malfunction indicator lamp (MIL) when one of the following occurs:
  - The ECM detects the same fuel trim failure during 2 consecutive trips.
  - The ECM detects any fuel trim failure during any subsequent trip if the conditions at the time of failure meet the following criteria:
    - The engine load is within 20 percent of the previous test that failed.
    - The engine speed is within 375 RPM of the previous test that failed.
    - The engine coolant temperature is in the same range of the previous test that failed.

Conditions for Clearing the MIL/DTC

- DTCs P2096 is a Type B DTC.
- The ECM turns OFF the malfunction indicator lamp (MIL) at the beginning of the fourth ignition cycle, after 3 ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.

Diagnostic Aids

- It is very unlikely that an HO2S will cause this DTC to set without the occurrence of circuit related HO2S DTCs. Do not replace an HO2S to address this DTC without first performing all the steps in Circuit/System Verification and Circuit/System Testing.
- 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.

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- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
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 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing below

   - **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 is not set.

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- **If a DTC is set**

  Refer to Circuit/System Testing below

- **If no DTC is set**

6. All OK.

Circuit/System Testing

Verify none of the conditions listed below exist:

- Air intake duct collapsed or restricted.
- Air filter dirty or restricted.
- Objects blocking the throttle body.
- Excessive fuel in the crankcase. Change engine oil as necessary.
- Rich fuel injectors. Refer to **Fuel Injector Diagnosis**.
- Excessive fuel system pressure. Refer to **Fuel System Diagnosis**.
- Fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Fuel saturation of the evaporative emissions (EVAP) canister
- Stuck open or leaking EVAP purge valve
- Restricted exhaust. Refer to **Symptoms - Engine Exhaust** .
- Improper operation of the crankcase ventilation system. Refer to **Crankcase Ventilation System Inspection/Diagnosis** .

- If a condition is found

  Repair as necessary.

Repair Instructions

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

DTC P2097

Diagnostic Instructions

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

DTC Descriptor

DTC P2097

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Post Catalyst Fuel Trim System High Limit

Circuit Description

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

Conditions for Running the DTC

- DTC P0016, P0017, P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P015A, P015B, P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0340, P0341, P0365, P0366, P0411, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P1248, P1249, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P219A, P2227, P2228, P2229, P2230, P2270, P2271, P2440, or P2444 is not set.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 PSI).
- The manifold absolute pressure (MAP) is between 0-200 kPa (0-29 PSI).
- The intake air temperature (IAT) is between -20°C and +200°C (-4 and +392°F).
- The start up engine coolant temperature is warmer than -20°C (-4°F).
- The fuel control intrusive diagnostics are not active.
- The engine is operating under cruise conditions.
- DTC P2097 runs continuously when the conditions above have been met.

Conditions for Setting the DTC

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

Action Taken when the DTC Sets

- DTCs P2097 is a Type B DTC.
- The ECM records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the ECM stores this information in the Failure records. If the diagnostic reports a failure on the second ignition cycle, the ECM records the operating conditions at the time of the failure. The ECM writes the operating conditions to the Freeze Frame and updates the Failure records. The ECM illuminates the malfunction indicator lamp (MIL) when one of the following occurs:
  - The ECM detects the same fuel trim failure during 2 consecutive trips.
  - The ECM detects any fuel trim failure during any subsequent trip if the conditions at the time of failure meet the following criteria:
    - The engine load is within 20 percent of the previous test that failed.
    - The engine speed is within 375 RPM of the previous test that failed.
    - The engine coolant temperature is in the same range of the previous test that failed.

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Conditions for Clearing the MIL/DTC

- DTCs P2097 is a Type B DTC.
- The ECM turns OFF the malfunction indicator lamp (MIL) at the beginning of the fourth ignition cycle, after 3 ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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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 P2097 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing below

   - **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 P2097 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing below

   - **If no DTC is set**
6. All OK.

Circuit/System Testing

Verify none of the conditions listed below exist:

- Exhaust system leaks. Refer to **Symptoms - Engine Exhaust** .
- Vacuum hoses for splits, kinks, and proper connections
- Insufficient fuel in the tank
- Air induction system and air intake ducts for leaks
- Missing air filter element
- Cracked evaporative canister
- Evaporative pipes plugged, obstructed, or leaking
- Crankcase ventilation system leaking. Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
- Engine vacuum leaks
- Low fuel system pressure. Refer to **Fuel System Diagnosis**.
- Contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Lean fuel injectors. Refer to **Fuel Injector Diagnosis**.

- If a condition is found

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Repair as necessary.

Repair Instructions

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

DTC P2122, P2123, P2127, P2128, OR P2138

Diagnostic Instructions

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

DTC Descriptors

DTC P2122

Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

DTC P2123

Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

DTC P2127

Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

DTC P2128

Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

DTC P2138

Accelerator Pedal Position (APP) Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
APP Sensor 1 5V Reference	P2122	P2122	P2123	-
APP Sensor 1 Signal	P2122	P2122	P2123	P2138
APP Sensor 1 Low Reference	-	P2123	-	-
APP Sensor 2 5V	P2127	P2127	P2128	-

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Reference				
APP Sensor 2 Signal	P2127	P2127	P2128	P2138
APP Sensor 2 Low Reference	-	P2128	-	-

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:** 0.13-4.88 V			
APP Sensor 1 5V Reference	0 V	0 V	5 V
APP Sensor 1 Signal	0 V	0 V	5 V
APP Sensor 1 Low Reference	-	4.96 V	-

APP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle **Parameter Normal Range:** 0.12-2.64 V			
APP Sensor 2 5V Reference	0 V	0 V	5 V
APP Sensor 2 Signal	0 V	0 V	5 V
APP Sensor 2 Low Reference	-	4.92 V	-

Circuit/System Description

The throttle actuator control (TAC) system uses two accelerator pedal position (APP) sensors to monitor the accelerator pedal position. The APP sensors 1 and 2 are located within the pedal assembly. Each sensor has a 5 V reference circuit, a low reference circuit, and a signal circuit.

Two processors are also used to monitor the TAC motor system data. Both processors are located within the ECM. Each signal circuit provides both processors with a signal voltage proportional to pedal movement. The processors share and monitor data to verify that the indicated APP sensor calculation is correct.

Conditions for Running the DTC

P2122 and P2123

- DTC P0697, or P06A3 is not set.
- The ignition is ON.
- The DTCs run continuously when the above conditions are met.

P2127 and P2128

- DTC P0697, or P06A3 is not set.
- The ignition is ON.

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

P2138

- DTCs P0641, P0651, P0697, or P06A3 is not set.
- The ignition is ON.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2122

The ECM detects that APP sensor 1 voltage is less than 0.61 V for greater than 0.5 s.

P2123

The ECM detects that APP sensor 1 voltage is greater than 4.59 V for greater than 0.5 s.

P2127

The ECM detects that APP sensor 2 voltage is less than 0.10 V for greater than 0.5 s.

P2128

The ECM detects that APP sensor 2 voltage is greater than 2.5 V for greater than 0.5 s.

P2138

The ECM detects that the difference between APP sensor 1 and APP sensor 2 exceeds a predetermined value for greater than 2 s.

Action Taken When the DTC Sets

- DTCs P2122, P2123, P2127, P2128 and P2138 are Type A DTCs.
- The ECM commands the TAC motor system to operate in reduced engine power mode.

Conditions for Clearing the DTC

DTCs P2122, P2123, P2127, P2128, and P2138 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

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

Circuit/System Verification

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

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

    - **If none of the DTCs are set**
3. Verify the scan tool APP Sensor 1 parameter. The reading should be between 0.32-4.87 V, and change with the accelerator pedal input.
4. Verify the scan tool APP Sensor 2 parameter. The reading should be between 0.16-2.30 V, and change with the accelerator pedal input.
    - **If the reading does not change**

      Refer to Circuit/System Testing below.

    - **If the reading does change**
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**

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Refer to Circuit/System Testing below.

- **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 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 ohms between each low reference circuit terminal listed below and ground.
   - Low reference circuit terminal 4
   - Low reference circuit terminal 5
   - **If 5 ohms or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the low reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If less than 5 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between each 5 V reference circuit terminal listed below and ground.
   - 5 V reference circuit terminal 1
   - 5 V reference circuit terminal 2
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the 5 V reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 4.8-5.2 V**
5. Verify the scan tool APP sensor 1 and 2 voltage parameter is less than 0.1 V.
   - **If 0.1 V or greater**
   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 terminal listed below and ground.
    - APP sensor 1 signal circuit terminal 3
    - APP sensor 2 signal circuit terminal 6
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
- **If less than 0.1 V**

6. Install a 3 A fused jumper wire between each signal circuit terminal listed below and the 5 V reference circuit terminal 1.
    - APP sensor 1 signal circuit terminal 3
    - APP sensor 2 signal circuit terminal 6
7. Verify the scan tool APP sensor 1 and 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 ohms in the signal circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.
    - **If greater than 4.8 V**
8. Test or replace the B107 Accelerator Pedal Position Sensor.

Repair Instructions

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

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

DTC P2199

Diagnostic Instructions

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

DTC Descriptor

DTC P2199

Intake Air Temperature (IAT) Sensor 1-2 Correlation

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Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Sensor	P0112, P0114, P2199	P0113, P0114, P2199	P0113, P0114, P2199*	P0111, P0114
Low Reference	-	P0097, P0113, P11C2, 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
5 V Reference	P0097, P0651, P11C2, P2199, P2227, P2228	P0096, P0097, P11C2, P2199, P2227, P2228	P0097, P0651, P11C2, P2199, P2227, P2228	-
Sensor	P0097, P11C3, P2199	P0097, P11C2, P2199	P0097, P11C2, P2199*	-
Low Reference	-	P0097, P0113, P11C2, 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 or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Sensor	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	-	-40°C (-40°F)	-40°C (-40°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

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			
5 V Reference	-40°C (-40°F) 10 Hz	-40°C (-40°F) 10 Hz	-
Signal	-40°C (-40°F)	-40°C (-40°F)	-40°C (-40°F)* 10 Hz*

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Ground	-	-40°C (-40°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 multifunction intake air sensor:

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

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 °C (°F).

The IAT sensor 2 produces a frequency signal based on the inlet air temperature very close to the humidity sensor within the sensor bore. The signal varies with inlet air temperature and is displayed by the scan tool as ° C (°F) and Hertz (Hz). The signal circuit is shared by the IAT sensor 2 and the humidity sensor.

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

Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for the mass air flow (MAF) 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

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IAT Sensor 2 - Temperature, Frequency Table

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

Conditions for Running the DTC

- The ignition is ON.
- Ignition 1 voltage is at least 11 V for at least 0.9 s.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

The ECM detects that the absolute difference between the IAT sensor 1 and the IAT sensor 2 temperatures is greater than 55°C (99°F) for longer than 5 s.

Action Taken When the DTC Sets

DTC P2199 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2199 is a Type B DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

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

Special Tools

EL-38522-A Variable Signal Generator

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

Circuit/System Verification

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

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

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

NOTE: To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 3 and 4 of this verification procedure only if the ignition has been OFF for 8 hours or more.

3. Ignition ON.
4. Verify the following scan tool parameters are within 25°C (45°F) of each other.
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - Start-Up ECT
   - **If not within 25°C (45°F)**

     Refer to Circuit/System Testing below.

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

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

  Refer to Circuit/System Testing below.

- **If between: -38 and +149°C (-36 and +300°F)**

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 does set**

     Refer to Circuit/System Testing below.

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

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification before proceeding with 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 B75C Mass Air Flow/Multifunction Intake Air sensor.
2. Test for less than 2 ohms between the low reference circuit terminal 7 and ground.
   - **If 2 ohms or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the low reference circuit end to end.
      - If 2 ohms or greater, repair the open or high resistance in the circuit.
      - If less than 2 ohms replace the K20 Engine Control Module.
   - **If less than 2 ohms**
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 2 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the signal circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

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NOTE: If the 5 V reference circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

4. Ignition ON, test for 4.8-5.2 V between the signal 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 ohms in the signal circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

5. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than -39°C (-38°F).
   - **If warmer than -39°C (-38°F).**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 8 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the signal circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If colder than -39°C (-38°F).**
6. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 8 and the low reference circuit terminal 7.

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7. Verify the scan tool IAT Sensor 1 parameter is warmer than 148°C (298°F).
   - **If colder than 148°C (298°F).**
   1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V
   3. Ignition OFF.
   4. Test for less than 2 ohms in the signal circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If warmer than 148°C (298°F).**
8. Ignition ON, test for 4.8-5.2 V between the IAT 2 signal 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 ohms in the signal circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

     NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Ignition ON, test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 4.8-5.2 V**
9. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
   - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
   1. Replace the K20 Engine Control Module.
   2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
   3. Verify the DTC does not set.
      - **If the DTC sets**

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Refer to step 13.

- **If the DTC does not set**

4. All OK.

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

10. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
    - Red lead to the signal circuit terminal 1 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
11. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
    - Signal switch to 5 V
    - Duty Cycle switch to 50 % (Normal)
    - Frequency switch to 30 Hz
12. Ignition ON, verify the scan tool IAT Sensor 2 parameter is between 28-32 Hz.
    - **If not between 28-32 Hz**

      Replace the K20 Engine Control Module.

    - **If between 28-32 Hz**
13. 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 (Bosch Sensor)** table for Bosch Sensors. The resistance values should be in range of the table values.
    - **If not within the specified range.**

      Replace the B75C Multifunction Intake Air sensor.

    - **If within the specified range.**
3. All OK

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be

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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.

- **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement.
- **Control Module References** for ECM replacement, programming, and setup

DTC P219A

Diagnostic Instructions

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

DTC Descriptor

DTC P219A

Fuel Trim Cylinder Balance

Circuit/System Description

The Air Fuel Imbalance diagnostic detects a rich or lean cylinder to cylinder air/fuel ratio imbalance. The diagnostic monitors the pre-catalyst heated oxygen sensor (HO2S) signal's frequency and amplitude characteristics by calculating an accumulated voltage over a predetermined sample period. An imbalance is indicated when multiple samples of the accumulated voltage are consistently higher than the desired value.

Conditions for Running the DTC

- DTCs P0016, P0017, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0122, P0123, P0128, P0201-P0204, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301-P0304, P0340, P0341, P0365, P0366, P0411, P0442, P0455, P0496, P1248, P1249, P124A, P124B, P2101, P2135, P2147, P2148, P2150. P2151, P2153, P2154, P2156, P2157, P2440, P2444 are not set.
- The EVAP device control and intrusive diagnostics are not active.
- The engine overspeed protection is not active.
- The engine is in closed loop status.

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- The system voltage is greater than 11 V.
- The engine coolant temperature (ECT) is warmer than -20°C (-4°F).
- The engine speed is between 1, 200-3, 200 RPM.
- The mass air flow is between 10-100 g/s.
- The AIR pump is not ON.
- Engine run time is greater than 30 s.
- Fuel level is greater than 10% and no fuel level sensor fault is present.
- The DTC runs continuously when the above conditions have been met.

Conditions for Setting the DTC

Multiple samples of the pre-catalyst HO2S accumulated voltage are consistently greater than the desired value.

Action Taken When the DTC Sets

DTC P219A is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P219A is a Type A DTC.

Diagnostic Aids

- The air fuel imbalance diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.
- Monitoring the misfire current counters, or misfire graph, may help to isolate the cylinder that is causing the condition.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**

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- **Troubleshooting with a Test Lamp**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no other DTCs are set.
   - **If any other DTCs are set**

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

   - **If no other DTCs are set**
3. Verify DTC P219A is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing below

   - **If no DTC is set**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
5. Verify DTC P219A is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing below

   - **If no DTC is set**
6. All OK.

Circuit/System Testing

1. Engine idling, verify the manifold absolute pressure (MAP) sensor parameter is between 20-48 kPa.
   - **If not within the specified range** .

     Refer to **DTC P0106** , or **DTC P0107 or P0108**

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- **If within the specified range, verify that none of the conditions listed below exist:**
- 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** .
- Improperly operating fuel injectors. Refer to **Fuel Injector Diagnosis**.
- Contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Excessive fuel in the crankcase due to leaking injectors. Change engine oil as necessary.
- Improper ignition system operation. 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 diagnostic procedure.

DTC P2227-P2230

Diagnostic Instructions

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

DTC Descriptors

DTC P2227

Barometric Pressure (BARO) Sensor Performance

DTC P2228

Barometric Pressure (BARO) Sensor Circuit Low Voltage

DTC P2229

Barometric Pressure (BARO) Sensor Circuit High Voltage

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DTC P2230

Barometric Pressure (BARO) Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641, P2227, P2228	P2228	P0641, P2229	P2227
Signal	P2227, P2228	P2227, P2228	P2227, P2229	P2227
Low Reference	-	P2227, P2229	-	P2227

Typical Scan Tool Data

BARO

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF **Parameter Normal Range:** 56-105 kPa (8.1-15.2 psi), varies with altitude			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
Signal	0 kPa (0 psi)	0 kPa (0 psi)	127 kPa (18.4 psi)
Low Reference	-	127 kPa (18.4 psi)	-

Circuit/System Description

The barometric pressure (BARO) sensor is integral to the multifunction intake air sensor and responds to changes in altitude and atmospheric conditions. This gives the ECM an indication of barometric pressure. The ECM uses this information to calculate fuel delivery. The BARO sensor provides a voltage signal to the ECM relative to the atmospheric pressure changes. The ECM monitors the BARO sensor signal for a voltage outside of the normal range.

Conditions for Running the DTC

P2227

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P1516, P2101, P2135, P2228, or P2229 is not set.
- Engine is running for greater than 30 s.

OR

- DTC P0106, P0107, P0108, P2228, P2229, P2230, or P2610 is not active.
- DTC P0107, P0108, P2228, or P2229 is not pending.
- Engine is OFF for at least 7 min.

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- Ignition is ON
- DTC P2227 runs continuously when the above conditions are met.

P2228 or P2229

- Engine is running for greater than 30 s.
- The DTCs run continuously when the above condition is met.

P2230

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P1516, P2101, P2135, P2228, or P2229 is not set.
- Ignition is ON
- DTC P2230 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2227

- The engine is running.
- The ECM detects that the difference between the actual BARO and the calculated BARO is greater than a calibrated threshold.

  OR

- Ignition ON, engine OFF
- The ECM detects that the BARO pressure is less than 50 kPa (7.3 psi) or greater than 115 kPa (16.7 psi).

P2228

The ECM detects that the BARO sensor voltage is less than 2 V for greater than 5 s.

P2229

The ECM detects that the BARO sensor voltage is greater than 4.5 V for greater than 5 s.

P2230

The ECM detects that the cumulative difference between BARO sensor readings, over a specific length of time, is greater than a calibrated threshold.

Action Taken When the DTC Sets

DTCs P2227, P2228, P2229, and P2230 are Type B DTCs.

Conditions for Clearing the MIL/DTC

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DTCs P2227, P2228, P2229, and P2230 are Type B 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 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 below.

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

      Refer to Circuit/System Testing below.

    - **If the DTC does not set**

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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 ohms between the low reference circuit terminal 7 and ground.
    - **If 5 ohms or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 ohms in the low reference circuit end to end.
        - If greater than the specified value, repair the open or high resistance in the circuit.
        - If 2 ohms or less replace the K20 Engine Control Module.
    - **If less than 5 ohms**
4. Ignition ON.
5. Test for 4.8-5.2 V between the 5 V reference circuit terminal 2 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 ohms in the 5 V reference circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 4.8-5.2 V**
6. Verify the scan tool BARO Sensor parameter is less than 0.2 V.
    - **If 0.2 V or greater**

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1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 1 V between the signal circuit terminal 6 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 6 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 6 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 ohms in the signal circuit end to end.
    - If 2 ohms or greater, repair the open or high resistance in the circuit.
    - If less than 2 ohms, replace the K20 Engine Control Module.

- **If greater than 4.5 V**

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

Repair Instructions

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

- **Mass Airflow Sensor Replacement** for multifunction intake air sensor replacement
- **Control Module References** for engine control module replacement, programming, and setup

DTC P2430 OR P2431

Diagnostic Instructions

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

DTC Descriptor

DTC P2430

Secondary Air Injection System Pressure Sensor Circuit

DTC P2431

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Secondary Air Injection System Pressure Sensor Performance

Circuit/System Description

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

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

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

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

During phase 1, the secondary air injection pump and the secondary air injection shutoff and check valve are activated. Normal secondary air function occurs. Expected system pressure is 5-13 kPa (0.7-1.9 psi) above BARO.

During phase 2, only the secondary air injection pump is activated. The shutoff and check valve is closed. Pressure sensor performance and shutoff and check valve deactivation are tested. Expected system pressure is 14-25 kPa (2.0-3.6 psi) above BARO.

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

Conditions for Running the DTC

P2430

- DTC P0412, P0418, P0606, P2431, P2432, or P2433 is not set.
- Greater than 30 min has elapsed since the last cold start.
- The ignition voltage is between 10-32 V.
- The engine speed is less than 5, 000 RPM.
- The intake air temperature (IAT) is greater than -11°C (12.2°F).
- The engine coolant temperature (ECT) is between -11 and +56°C (12.2-133°F).
- The barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- The manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- The mass air flow (MAF) is less than 50 g/s.

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- The secondary air injection pump is commanded ON.
- DTC P2430 runs once per ignition cycle when the above conditions are met for greater than 5 s.

P2431

- DTC P0101, P0102, P0103, P0300, P0301, P0302, P0303, P0304, P2430, P2432, or P2433 is not set.
- Greater than 30 min has elapsed since the last cold start.
- The ignition voltage is between 10-32 V.
- The engine speed is less than 5, 000 RPM.
- The intake air temperature (IAT) is greater than -11°C (12.2°F).
- The engine coolant temperature (ECT) is between -11 and +56°C (12.2-133°F).
- The barometric pressure (BARO) is greater than 74 kPa (10.7 psi).
- The manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- The mass air flow (MAF) is less than 50 g/s.
- DTC P2431 runs continuously when the above conditions are met for greater than 15 s.

Conditions for Setting the DTC

P2430

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

P2431

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

  OR

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

Action Taken When the DTC Sets

DTCs P2430 and P2431 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2430 and P2431 are Type B DTCs.

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 36169-HD Fused Jumper

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

Circuit/System Verification

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

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

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

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

3. Verify the scan tool BARO pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.
   - **If not within the specified range**

     Refer to **DTC P2227-P2230**.

   - **If within the specified range**
4. Verify the scan tool Secondary Air Injection Pressure Sensor and the BARO pressure parameters are within 3 kPa (0.4 psi).
   - **If not within the specified range**

     Replace the Q29 Secondary Air Injection Solenoid Valve

   - **If within the specified range**

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

5. Verify the G21 Secondary Air Injection Pump turns ON and OFF when commanding the Secondary Air Injection Pump Relay between ON and OFF with a scan tool.
   - **If the pump does not turn ON and OFF**

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

   - **If the pump turns ON and OFF**
6. Engine running
7. Verify the scan tool Secondary Air Injection Pressure Sensor parameter increases between 14-25 kPa (2.0-3.6 psi) when the Secondary Air Injection Pump Relay is commanded ON with a scan tool.
   - **If not within the specified range**

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

   - **If within the specified range**
8. Verify the scan tool Secondary Air Injection Pressure Sensor parameter increases between 5-13 kPa (0.7-1.9 psi) when the Secondary Air Injection System is commanded Active with a scan tool.
   - **If not within the specified range**

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

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- **If within the specified range**

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

      Refer to Circuit/System Testing below

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

Circuit/System Testing

Secondary Air Injection Pump Malfunction

1. Ignition OFF, disconnect the KR25 Secondary Air Injection Pump Relay. Ignition ON.
2. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF
    2. Test for less than 2 ohms in the B+ circuit end to end.
        - If 2 ohms or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
    4. Test for infinite resistance between the control circuit terminal A and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    5. Test or replace the G21 Secondary Air Injection Pump.
    - **If the test lamp illuminates**
3. Disconnect the harness connector at the G21 Secondary Air Injection Pump.
4. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down. Test for less than 10 ohms between the G21 Secondary Air Injection Pump ground circuit terminal B and ground.
    - **If 10 ohms or greater**
    1. Ignition OFF.
    2. Test for less than 2 ohms in the ground circuit end to end.

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

- **If less than 10 ohms**

5. Connect the harness connector at the G21 Secondary Air Injection Pump.
6. Connect a 50 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.

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

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

Secondary Air Injection System Pressure Not In Range

1. Verify the following conditions do not exist with the secondary air injection shutoff and check valve:
   - Hoses/pipes restricted or blocked
   - Hoses/pipes leaking or disconnected
   - Damaged secondary air injection shutoff and check valve
   - Restricted or blocked cylinder head secondary air injection inlet ports and passages
   - **If a condition is located**

     Repair or replace the affected component as necessary.

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

     Replace the G21 Secondary Air Injection Pump.

   - **If airflow**

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5. Disconnect the appropriate Q29 Secondary Air Injection Solenoid Valve from the engine.
6. Connect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
7. Connect the secondary air injection pipe between the Q29 Secondary Air Injection Solenoid Valve and the G21 Secondary Air Injection Pump.
8. Ignition ON, command the Secondary Air Injection System Active with a scan tool. Verify there is airflow through the valve.
    - **If no airflow**

      Replace the Q29 Secondary Air Injection Solenoid Valve

    - **If airflow**
9. Replace the G21 Secondary Air Injection Pump.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR25 Secondary Air Injection Pump Relay.
2. Test for 70-110 ohms between terminals 85-86.
    - **If less than 70 ohms or greater than 110 ohms**

      Replace the KR25 Secondary Air Injection Pump Relay.

    - **If between 70-110 ohms**
3. Test for infinite resistance between the terminals listed below:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - **If less than infinite resistance**

      Replace the KR25 Secondary Air Injection Pump Relay.

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

      Replace the KR25 Secondary Air Injection Pump Relay.

    - **If less than 2 ohms**
6. All OK.

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Repair Instructions

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

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Secondary Air Injection Pump Replacement**
- **Secondary Air Injection Check Valve Replacement** for secondary air injection solenoid valve replacement
- **Secondary Air Injection Pump Pipe Replacement**

DTC P2432 OR P2433

Diagnostic Instructions

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

DTC Descriptors

DTC P2432

Secondary Air Injection System Pressure Sensor Circuit Low Voltage

DTC P2433

Secondary Air Injection System Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

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

Typical Scan Tool Data

Secondary Air Injection Pressure Sensor

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

Circuit/System Description

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

Conditions for Running the DTC

- DTC P0606 is not set.
- The ignition is ON, or the engine is running.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P2432

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

P2433

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

Action Taken When the DTC Sets

DTCs P2432 and P2433 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2432 and P2433 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

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Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON
2. Verify that DTC P0651 is not set.
   - **If the DTC is set**

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

   - **If the DTC is not set.**
3. Verify the scan tool BARO pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure** table.
   - **If not within the specified range**

     Refer to **DTC P2227-P2230**.

   - **If within the specified range**
4. Verify the scan tool Secondary Air Injection Pressure Sensor and the BARO pressure parameters are within 3 kPa (0.4 psi).
   - **If not within the specified range**

     Refer to Circuit/System Testing below

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- **If within the specified range**

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 below

   - **If the DTC does not set**
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 Q29 Secondary Air Injection Solenoid Valve.
2. Test for less than 5 ohms of resistance between the low reference circuit terminal 3 and ground.
   - **If 5 ohms or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the low reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If less than 5 ohms**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the 5 V reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **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 Secondary Air Injection Pressure Sensor parameter is less than 0.5 V.
   - **If 0.5 V or greater**

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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 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 0.5 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 Secondary Air Injection Pressure Sensor 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 1 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 ohms in the signal circuit end to end.
   - If 2 ohms or greater, repair the open/high resistance in the circuit.
   - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If greater than 4.8 V**
8. Test or replace the Q29 Secondary Air Injection Solenoid Valve.

Repair Instructions

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

- **Secondary Air Injection Check Valve Replacement** for secondary air injection solenoid valve replacement
- **Control Module References** for ECM replacement, programming, and setup

DTC P2440

Diagnostic Instructions

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

DTC Descriptor

DTC P2440

Secondary Air Injection System Cut-Off Valve Stuck Open

Circuit/System Description

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

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

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

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

During phase 1, the secondary air injection pump and the secondary air injection shutoff and check valve are activated. Normal secondary air function occurs. Expected system pressure is 5-13 kPa (0.7-1.9 psi) above BARO.

During phase 2, only the secondary air injection pump is activated. The shutoff and check valve is closed. Pressure sensor performance and shutoff and check valve deactivation are tested. Expected system pressure is 14-25 kPa (2.0-3.6 psi) above BARO.

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

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0351, P0352, P0353, P0354, P0412, P0418, P0420, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2430, P2431, P2432, or P2433 is not set.
- Greater than 30 min has elapsed since the last cold start.
- The ignition voltage is between 10-32 V.
- The engine speed is less than 5, 000 RPM.
- The intake air temperature (IAT) is greater than -11°C (12.2°F).
- The engine coolant temperature (ECT) is between -11 and +56°C (12.2-133°F).
- The barometric pressure (BARO) is greater than 60 kPa (8.7 psi).
- The manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- The mass air flow (MAF) is less than 50 g/s.
- The secondary air injection pump is commanded ON.
- Secondary air injection diagnostic test Phase 1 has run and passed.

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- DTC P2440 runs once per ignition cycle when the above conditions are met for greater than 3 s.

Conditions for Setting the DTC

The ECM detects that the secondary air system pressure is less than a calibrated threshold for greater than 1.5 s.

Action Taken When the DTC Sets

DTC P2440 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2440 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

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2. Verify that DTC P0411, P0412, P0418, P2430, P2431, P2432, or P2433 is not set.
   - **If any of the DTCs are set**

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

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

     Refer to **DTC P2227-P2230**.

   - **If within the specified range**
4. Verify the scan tool Secondary Air Injection Pressure Sensor parameter and the BARO pressure parameter are within 3 kPa (0.4 psi).
   - **If not within the specified range**

     Replace the Q29 Secondary Air Injection Solenoid Valve

   - **If within the specified range**
5. Engine running
6. Verify the scan tool Secondary Air Injection Pressure Sensor parameter increases between 14-25 kPa (2.0-3.6 psi) when the Secondary Air Injection Pump Relay is commanded ON with a scan tool.
   - **If not within the specified range**

     Refer to Circuit/System Testing below

   - **If within the specified range**
7. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - **If the DTC sets**

     Refer to Circuit/System Testing below

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

Circuit/System Testing

1. Ignition OFF, disconnect the KR26 Secondary Air Injection Solenoid Valve Relay. Ignition ON.
2. Verify a test lamp does not illuminate between the control circuit terminal 87 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**

3. Ignition OFF, connect the KR26 Secondary Air Injection Solenoid Valve Relay.
4. Disconnect the harness connector at the Q29 Secondary Air Injection Solenoid Valve. Ignition ON.
5. Verify a test lamp does not illuminate between the control circuit terminal 5 and ground.
   - **If the test lamp illuminates**

     Test or replace the KR26 Secondary Air Injection Solenoid Valve Relay.

   - **If the test lamp does not illuminate**
6. Verify the conditions listed below do not exist:
   - Hoses/pipes restricted or blocked upstream of valve
   - Hoses/pipes leaking or disconnected
   - Damaged or restricted secondary air injection pump
   - Damaged secondary air injection check valve
   - **If a condition exists**

     Repair or replace the affected component as necessary.

   - **If none of the conditions exist**
7. Ignition OFF, remove the Q29 Secondary Air Injection Solenoid Valve.
8. Connect the harness connector at the Q29 Secondary Air Injection Solenoid Valve.
9. Connect the secondary air injection pipe to the Q29 Secondary Air Injection Solenoid Valve.
10. Ignition ON, command the Secondary Air Injection Pump Relay ON with a scan tool. Verify there is NO airflow through the valve.
    - **If airflow**

      Replace the Q29 Secondary Air Injection Solenoid Valve.

    - **If no airflow**
11. Replace the G21 Secondary Air Injection Pump.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR26 Secondary Air Injection Solenoid Valve Relay.
2. Test for 70-110 ohms between terminals 85-86.
   - **If less than 70 ohms or greater than 110 ohms**

     Replace the KR26 Secondary Air Injection Solenoid Valve Relay.

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- **If between 70-110 ohms**

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 KR26 Secondary Air Injection Solenoid Valve Relay.

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

     Replace the KR26 Secondary Air Injection Solenoid Valve Relay.

   - **If less than 2 ohms**
6. All OK

Repair Instructions

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

- **Relay Replacement (Within an Electrical Center)** , **Relay Replacement (Attached to Wire Harness)**
- **Secondary Air Injection Pump Replacement**
- **Secondary Air Injection Check Valve Replacement** for secondary air injection solenoid valve replacement
- **Secondary Air Injection Pump Pipe Replacement**

DTC P2444

Diagnostic Instructions

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

DTC Descriptor

DTC P2444

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Secondary Air Injection System Pump Stuck On

Circuit/System Description

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

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

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

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

During phase 1, the secondary air injection pump and the secondary air injection shutoff and check valve are activated. Normal secondary air function occurs. Expected system pressure is 5-13 kPa (0.7-1.9 psi) above BARO.

During phase 2, only the secondary air injection pump is activated. The shutoff and check valve is closed. Pressure sensor performance and shutoff and check valve deactivation are tested. Expected system pressure is 14-25 kPa (2.0-3.6 psi) above BARO.

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

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0128, P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301, P0302, P0303, P0304, P0351, P0352, P0353, P0354, P0412, P0418, P0420, P124A, P124B, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P2227, P2228, P2229, P2230, P2430, P2431, P2432, or P2433 is not set.
- Greater than 30 min has elapsed since the last cold start.
- The ignition voltage is between 10-32 V.
- The engine speed is less than 5, 000 RPM.
- The intake air temperature (IAT) is greater than -11°C (12.2°F).
- The engine coolant temperature (ECT) is between -11 and +56°C (12.2-133°F).
- The barometric pressure (BARO) is greater than 60 kPa (8.7 psi).

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- The manifold absolute pressure (MAP) sensor is greater than 20 kPa (2.9 psi).
- The mass air flow (MAF) is less than 50 g/s.
- Secondary air injection pump is commanded ON.
- Secondary air injection diagnostic test Phase 1 and Phase 2 have run and passed.
- DTC P2444 runs once per ignition cycle when the above conditions are met for greater than 3 s.

Conditions for Setting the DTC

The ECM detects that average difference between the predicted system pressure and the actual system pressure is greater than or less than calibrated thresholds for greater than 2 s.

Action Taken When the DTC Sets

DTC P2444 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P2444 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Secondary Air Injection System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON
2. Verify that DTC P0412, P0418, P2432 or P2433 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.**

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

3. Verify the G21 Secondary Air Injection Pump turns ON and OFF when commanding the Secondary Air Injection Pump Relay ON and OFF with a scan tool.
   - **If the pump does not turn ON and OFF**

     Refer to Circuit/System Testing below

   - **If the pump turns ON and OFF**
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 below

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

Circuit/System Testing

1. Ignition OFF, disconnect the KR25 Secondary Air Injection Pump Relay.
2. Ignition ON, verify a test lamp does not illuminate between the control circuit terminal 87 and ground.
   - **If the test lamp illuminates**

     Repair the short to voltage on the circuit.

   - **If the test lamp does not illuminate**
3. Test or replace the KR25 Secondary Air Injection Pump Relay.

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Component Testing

Relay Test

1. Ignition OFF, disconnect the KR25 Secondary Air Injection Pump Relay.
2. Test for 70-110 ohms between terminals 85-86.
   - **If less than 70 ohms or greater than 110 ohms**

     Replace the KR25 Secondary Air Injection Pump Relay.

   - **If between 70-110 ohms**
3. Test for infinite resistance between the terminals listed below:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87
   - **If less than infinite resistance**

     Replace the KR25 Secondary Air Injection Pump Relay.

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

     Replace the KR25 Secondary Air Injection Pump Relay.

   - **If less than 2 ohms**
6. All OK

Repair Instructions

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

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

DTC P2534 (FUEL PUMP CONTROL MODULE)

Diagnostic Instructions

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

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DTC Descriptor

DTC P2534

Ignition On/Start Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P2534	P2534	-	-

Circuit/System Description

The fuel pump control module monitors the ignition voltage circuit in order to determine if the voltage is within the normal operating range.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

The fuel pump control module detects that the ignition voltage is less than 6.0 V.

Action Taken When the DTC Sets

DTC P2534 is a Type A DTC.

Conditions for Clearing the DTC

DTC P2534 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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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

1. Ignition ON.
2. Verify DTC P0562 is not set.
   - **If the DTC is set**

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

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

Repair Instructions

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

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

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DTC P2544

Diagnostic Instructions

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

DTC Descriptors

DTC P2544

Transmission Torque Request Signal Message Counter Incorrect

Circuit/System Description

To improve shift feel, the transmission control module (TCM) is constantly sending the engine control module (ECM) serial data messages with information regarding it's request for modifying engine speed or torque. The serial data messages are sent through two circuits which are part of a communication network called the controller area network (CAN). The ECM sets DTC P2544 when it detects a discrepancy in the structure of the message causing the integrity of the message to be questioned.

Conditions for Running the DTC

- The engine run time is greater than 0.5 s.
- No other CAN errors are present.

Conditions for Setting the DTC

The ECM detects that the engine speed and torque modification messages from the TCM are either corrupted or intermittently missing for greater than 4 s.

Action Taken When the DTC Sets

- DTC P2544 is a Type B DTC.
- The TCM commands maximum line pressure during shifts, which results in harsh shifts.
- The TCM freezes adaptive functions.

Conditions for Clearing the DTC

DTC P2544 is a Type B DTC.

Diagnostic Aids

An intermittent fault in the CAN circuits will cause the ECM to set DTC P2544.

Reference Information

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

NOTE:

- **DTC 2544 is an informational DTC.**
- **Diagnose all other engine control module DTCs prior to DTC 2544.**

1. Verify that no other DTCs are set except for DTC 2544.
   - **If any other DTCs are set**

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

   - **If only DTC P2544 is set**
2. Replace the K17 Electronic Brake Control Module.
3. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
   - **If DTC sets**

     Replace the K20 Engine Control Module.

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

Repair Instructions

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

Control Module References for ECM or control solenoid valve assembly replacement, programming, and setup.

DTC P2635 (FUEL PUMP CONTROL MODULE)

Diagnostic Instructions

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

DTC Descriptor

DTC P2635

Fuel Pump Flow Performance

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Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

- DTC P018B, P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The system voltage is greater than 11 V.
- The engine has been running for more than 30 seconds.
- Low fuel level warning not present.

Conditions for Setting the DTC

This DTC sets when the fuel pump control module detects a predetermined fuel pressure performance degradation between the desired fuel pressure and the current fuel pressure.

Action Taken When the DTC Sets

DTC P2635 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2635 is a Type B DTC.

Diagnostic Aids

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

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

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Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

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

1. Ignition ON.
2. Verify DTCs P018B, P018C, P018D, P0231, P0232 or P023F are not set.
   - **If any of the DTCs are set**

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

   - **If none of the DTCs are set**
3. Verify the proper fuel system pressure. Perform the fuel system pressure test, refer to **Fuel System Diagnosis**.

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

  Replace the G12 Fuel Pump.

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

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

Repair Instructions

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

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

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SYMPTOMS - ENGINE CONTROLS

Diagnostic Instructions

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

Symptoms Description

Symptoms cover conditions that are not covered by DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause specific symptoms are listed separately under additional symptoms testing. Perform the symptoms testing before using the additional symptoms testing.

Symptoms Definition

Backfire

Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Cuts Out, Misses

A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1 500 RPM or 48 km/h (30 MPH). The exhaust has a steady spitting sound at idle or at low speed.

Detonation/Spark Knock

A mild to severe ping which usually gets worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Engine Control Module (ECM) Commanded Reduced Engine Power

The ECM illuminates the Reduced Engine Power lamp and will limit engine power under potential engine/vehicle damaging or emissions related conditions. A DTC may not be set.

Dieseling, Run-On

Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

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

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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.

Poor Fuel Fill Quality

Difficulty when refueling the vehicle.

Rough, Unstable, or Incorrect Idle and Stalling

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 that the malfunction indicator lamp (MIL) is operating correctly. Use the scan tool to command the lamp ON and OFF.
- Verify that there are no DTCs that are stored.
- Verify that the scan tool data is within a normal operating range. Refer to **Control Module References** for scan tool information.
- Verify the customer concern.
- Verify there are no Bulletins for the current symptom.
- Verify that the vehicle tires are correctly inflated and meet original equipment specifications.
- 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

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Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

- Moisture and water intrusion in connectors, terminals, and components
- Incomplete connector mating
- Poor terminal contact
- High circuit or component resistance-High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness that is too short or tight
- Wire insulation that is chaffed or cut
- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surfaces
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of aftermarket, add on accessories

Visual/Physical Check

- Verify that the control module grounds are clean, tight, and correctly located.
- Verify that the vacuum hoses are not split or kinked, and are properly connected, as shown on the Vehicle Emission Control Information label.
- Verify that the air filter is clean and free from restrictions.
- Verify that there is no water intrusion in connectors terminals and components.
- Inspect the air intake ducts for the following conditions:
  - Collapsed
  - Damaged areas
  - Looseness
  - Incorrect installation
  - Leaking
- Inspect for air leaks at the throttle body mounting area, the mass air flow (MAF) sensor and intake manifold sealing surfaces.
- Inspect the wiring harness for the following conditions:
  - Poor connections
  - Pinches

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  - Cuts
- Inspect for loose, damaged, unseated, or missing sensors/components.
- Inspect the terminals for corrosion and correct contact.

Symptoms Testing

Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Engine Control Module (ECM) Commanded Reduced Engine Power, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles

1. Test for the following conditions:
   - An incorrectly operating fuel system. Test for the following:
     - Correct fuel pressure-Refer to **Fuel System Diagnosis**.
     - Fuel injectors that are leaking or improper operation-Refer to **Fuel Injector Diagnosis**.
     - Contaminated or a poor fuel quality condition-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
   - An incorrectly operating ignition system. Test or inspect for the following:
     - Spark plugs with an incorrect heat range or an abnormal condition-Refer to **Spark Plug Replacement** .
     - Coolant or oil fouled spark plugs-Refer to **Spark Plug Inspection** , and **Ignition System Specifications** .
     - Secondary ignition system susceptible to moisture-Engine running, wet down the secondary ignition system with water from a spray bottle to help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied.
     - Weak spark using the **EL 26792** HEI Spark Tester -For equivalent regional tools, refer to **Special Tools** . Refer to **Electronic Ignition System Diagnosis**.
   - An incorrectly operating A/C compressor
   - Items that can cause an engine to run lean or rich-Refer to **DTC P0171 or P0172** .
   - Incorrectly installed mass air flow (MAF)/intake air temperature (IAT) sensor.
   - Incorrect crankshaft position sensor resistance-The crankshaft position sensor resistance may be out of range after a hot soak. The resistance should be between 700-1 200 ohms.
   - Split or kinked vacuum hoses-Verify that the routing and connections are as shown on the vehicle emission control information label.
   - Excessive knock sensor system spark retard activity-Refer to **Knock Sensor Replacement** , and **DTC P0324, P0326, or P06B6** , and **DTC P0325, P0327, or P0328** .
   - Electromagnetic interference on the reference circuit can cause a misfire condition. You can usually detect electromagnetic interference with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that electromagnetic interference is present. Inspect the high voltage components near the ignition control circuit if a condition exists.
   - A leaking or restricted positive crankcase ventilation system

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- A stuck open evaporative emission (EVAP) canister purge solenoid valve
- An incorrectly operating engine cooling system-Test or inspect for the following:
  - A thermostat with an incorrect heat range-Refer to **Thermostat Diagnosis (1.8L LUW and LWE)** .
  - Improper engine coolant level-Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE-47716 Fill)** .
- Incorrectly operating or damaged exhaust system components-Test for the following:
  - Physical damage or possible internal failure
  - Restricted three way catalytic converters

  For more information, refer to **Symptoms - Engine Exhaust** .
- An engine mechanical failure-Test for the following:
  - Excessive oil in the combustion chamber or leaking valve seals
  - Incorrect cylinder compression
  - Sticking or leaking valves
  - Worn camshaft lobes
  - Incorrect valve timing
  - Broken valve springs
  - Excessive carbon buildup in the combustion chambers-Clean the chambers with top engine cleaner, if necessary. Follow the instructions on the can.
  - Incorrect engine parts

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

2. 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.

Engine Control Module (ECM) Commanded Reduced Engine Power

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

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Verify or inspect for the following:

- Vehicle being operated at sustained high engine speeds, or, towing heavy loads up an incline for an extended period of time, which may cause the engine oil or coolant to overheat. A repair may not be necessary. Inspect the airflow passageways in front of the engine for obstructions and clear away any debris or foreign material that is found. If no obstructions are found, review approved driving habits with the customer. The customer may need to operate the vehicle at a higher engine speed to improve cooling system performance, or, at a slower engine speed to reduce engine load.
- A cooling fan condition which may cause the engine control module to reduce engine power-Refer to **Cooling Fan Description and Operation** , and **Cooling System Description and Operation (1.8L LUW and LWE)** to verify correct operation of the cooling fan.
- Temporarily reduced engine power. Under extremely cold ambient temperatures some SIDI equipped vehicles may experience engine control module commanded reduced engine power for a few minutes during engine warm-up. This would be a normal condition, noticeable only at wide open throttle, and the reduced engine power lamp would not be illuminated.
- If the vehicle is equipped with the OnStar® feature, reduced engine power may be due to OnStar® remote command. Verify the vehicle is not in the OnStar® initiated Stolen Vehicle Slowdown mode. Refer to **OnStar Stolen Vehicle Slowdown Active** , and **Remote Vehicle Speed Limiting Description and Operation** for additional information.
- High fuel pressure system pressure out of range-Refer to **Fuel System Diagnosis**, and **Fuel System Description** to verify high fuel pressure system operation.
- Maximum recommended engine oil life exceeded-Refer to the Owners Manual for scheduled maintenance recommendations.
- Intake air temperature out of range too high-Engine running, observe the scan tool IAT Sensor parameter. The readings should be between -40°C and +149°C (-40°F and +300°F). Refer to **DTC P0112, P0113, or P0114** for additional information.
- Fuel temperature out of range too high
- An incorrect learned brake pedal position (BPP) sensor-Verify the following actions have not occurred:
  - An engine control module (ECM) has been replaced.
  - A BPP sensor 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 a saturated EVAP canister. Refer to **Evaporative Emission Control System Description** .
- Inspect for a condition with the internal components of the fuel tank assembly. Refer to **Fuel System Description** .

Hard Start

- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore

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and clean, if necessary. Refer to **Throttle Body Inspection and Cleaning** .

- Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within approximately 3°C (5°F). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to **Temperature Versus Resistance (ECT)** for resistance specifications. Replace the ECT sensor if the resistance is not within specification. If the sensor is within the specification, test the ECT circuits for a high resistance.
- Test the fuel pump relay operation. The fuel pump should turn ON for 2 s when the ignition is turned ON. Refer to **Fuel Pump Electrical Circuit Diagnosis**.

Hesitation, Sag, Stumble

- Test the fuel pressure. Refer to **Fuel System Diagnosis**.
- Test the manifold absolute pressure (MAP) sensor. Refer to **DTC P0106** .
- Test the generator. Refer to **Symptoms - Engine Electrical** . Repair the charging system if the generator output voltage is less than 9 V or more than 16 V.

NOTE: The following actions may need to be repeated in order to verify an intermittent intake or exhaust camshaft actuator condition.

- Engine warm and idling, verify the correct operation of the camshaft actuator system. Command the intake and exhaust camshaft actuators from 0 degrees to 25 degrees and back to zero while observing the scan tool Intake Camshaft Position Variance and Exhaust Camshaft Position Variance parameters. Each parameter should be less than 2 degrees in each of the commanded states.
  - If any of the parameters is greater than 2 degrees, inspect the suspect camshaft actuator and camshaft actuator solenoid valve and valve bore for contamination, obstruction, and damage. Refer to **Camshaft Actuator System Description** , and **Camshaft Position Actuator Solenoid Valve Replacement** .

Poor Fuel Economy

- Inspect for heavy loads being carried or towed.
- Inspect for acceleration rate too much or too often.
- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and bore and clean, if necessary. Refer to **Throttle Body Inspection and Cleaning** .
- Inspect the brake system for brake drag.

Poor Fuel Fill Quality

- Inspect for restricted vent lines.
- Inspect for high fuel temperature.
- Inspect for a condition with the internal components of the fuel tank assembly

For more information, refer to the following:

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- **Evaporative Emission Control System Diagnosis**
- **Engine Controls Schematics**
- **Fuel System Description**
- **Evaporative Emission Control System Description**

Rough, Unstable, or Incorrect Idle and Stalling

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

Surges/Chuggles

- Verify that each injector harness is connected to the correct injector.
- Inspect for slow responding heated oxygen sensors (HO2S). The heated oxygen sensors should respond quickly to a change in throttle position. If the heated oxygen sensors do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The engine control module reduces the amount of fuel delivered to the engine, causing a drivability condition. Refer to **DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, or P2271** for additional information.

MALFUNCTION INDICATOR LAMP (MIL) DIAGNOSIS

Diagnostic Instructions

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

Circuit/System Description

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

Diagnostic Aids

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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 Fault if there is a condition with a circuit or a connection.

Reference Information

Schematic Reference

- **Engine Controls Schematics**
- **Instrument Cluster Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

1. Ignition ON.
2. Command the malfunction indicator lamp ON and OFF with a scan tool.
3. Verify that the malfunction indicator lamp turns ON and OFF as commanded.
    - **If the malfunction indicator lamp does not turn ON and OFF as commanded**

      Refer to Circuit/System Testing below

    - **If the malfunction indicator lamp turns ON and OFF as commanded**
4. Ignition ON.
5. Command the malfunction indicator lamp ON and OFF with a scan tool and verify that the control circuit status parameters listed below display OK or Not Run
    - The MIL Control Circuit Low Voltage Test Status
    - The MIL Control Circuit Open Test Status

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- The MIL Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

  Refer to Circuit/System Testing below

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

6. Engine running.
7. Command the malfunction indicator lamp ON and OFF with a scan tool and verify that the control circuit status parameters listed below display OK or Not Run.
   - 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 below

   - **If OK or Not Run is displayed**
8. All OK.

Circuit/System Testing

1. Ignition OFF.
2. Disconnect the X1 harness connector at the K20 Engine Control Module.
3. Ignition ON.
4. Verify the malfunction indicator lamp does not illuminate.
   - **If the malfunction indicator lamp illuminates**
   1. Test for infinite resistance between the malfunction indicator lamp control circuit terminal X1 1 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**
5. Connect a 3 A fused jumper wire between the malfunction indicator lamp control circuit terminal X1 1 and ground.
6. Verify the malfunction indicator lamp illuminates.
   - **If the malfunction indicator lamp does not illuminate**
   1. Test the malfunction indicator lamp control circuit terminal X1 1 for a short to voltage or an open/high resistance.
      - If the malfunction indicator lamp control circuit terminal X1 1 is shorted to voltage or has an open/high resistance, repair as necessary.
      - If the malfunction indicator lamp control circuit terminal X1 1 tests normal
   2. Test the instrument cluster ignition voltage circuit for a short to ground or open/high resistance.

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    - If the instrument cluster ignition voltage circuit is shorted to ground or has an open/high resistance, repair as necessary.
    - If the instrument cluster ignition voltage circuit tests normal, replace the P16 instrument panel cluster/bulb.
  - **If the malfunction indicator lamp illuminates**
7. Replace the K20 Engine Control Module.

Repair Instructions

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

- **Instrument Cluster Replacement**
- **Control Module References** for 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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine cranks but does not run is an organized approach to identify a condition which causes the engine to crank but not start. This diagnostic directs the technician to the appropriate system diagnosis.

This diagnostic assumes the system voltage levels are adequate for starter motor operation. Fuel level and fuel quality must be determined for correct diagnosis.

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. Refer to **Fuel Injector Diagnosis**.
- 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 ECM receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Check all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values from a known vehicle in good condition.
- Check the crankshaft position sensor engine reference signal with a scan tool. Observe the engine speed

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parameter while cranking the engine. The scan tool should indicate a steady 200-300 RPM while cranking. If erratic values, such as sudden spikes in the engine speed, are displayed, the engine reference signal is not stable enough for the engine to start and run properly.

- Inspect the engine for good secure electrical grounds.
- If the engine almost starts and then stalls, check for an open in the ground circuits of the crankshaft position sensor and the camshaft position sensor - Intake or camshaft position sensor - Exhaust.
- Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 min in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.
- A vehicle that starts and runs after being brought to the repair shop for a no start condition, may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to check for an engine starting or will not stay running concern.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48027** Digital Pressure Gauge
- **EN 36012-A** Ignition System Diagnostic Harness
- **EL 26792** HEI Spark Tester
- **J 34730-2C** Injector Test Lamp

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

Circuit/System Testing

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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 s.
2. Verify that DTC P0117, P0118, P0122, P0123, P018C, P018D, P0222, P0223, P0231, P0232, P023F, P025A, P0335, P0336, P0513, P0562, P0563, P0601, P0602, P0603, P0604, P0606, P0628, P0629, P062F, P0633, P0685, P0689, P0690, P1516, P1631, P1682, P16F3, P2101, P2119, or P2610 are not set.
   - **If any of the DTCs are set**

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

   - **If none of the DTCs are set**
3. Ignition ON
4. Verify the security indicator on the instrument cluster illuminates momentarily.
   - **If the security indicator stays ON or is flashing**

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

   - **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**

NOTE: It may be necessary to secure the EN 36012-A to the spark plug boots with electrical tape.

6. Install the **EN 36012-A** Ignition System Diagnostic Harness to the spark plug boots.
7. Connect the **EL 26792** Spark Tester between the boot of a spark plug wire and ground.
8. Connect the remaining wires to the appropriate cylinders.

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

9. Verify the spark tester sparks while cranking the engine.
   - **If the spark tester does not spark**

     Refer to **Electronic Ignition System Diagnosis** for diagnosis of the ignition coil.

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- **If the spark tester sparks**

10. Ignition OFF, all accessories OFF, install the **CH 48027** Digital Pressure Gauge.
11. Ignition ON.

NOTE: Do not start the engine for this test.

12. Command the Fuel Pump Enable ON several times with a scan tool.
13. Verify that the fuel pressure is between 345-650 kPa (50-94 PSI) with the fuel pump running.
    - **If not within the specified range**

      Refer to **Fuel System Diagnosis**.

    - **If within the specified range**
14. Verify that the fuel pressure 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**
15. Ignition OFF, disconnect the harness connector at a Q17 Fuel Injector.
16. Connect the **J 34730-2C** Injector Test Lamp between the control circuit and the ignition voltage circuit.
17. Verify the injector test lamp flashes while cranking the engine.
    - **If the injector test lamp does not flash**

      Refer to **Fuel Injector Diagnosis**.

    - **If the injector test lamp flashes**
18. Verify the following conditions do not exist:
    - Air intake duct to the throttle body collapsed
    - Air filter or air intake system restricted
    - Gas or coolant fouled spark plugs. Refer to **Spark Plug Inspection** .
    - A skewed manifold absolute pressure (MAP) sensor.
    - A skewed engine coolant temperature (ECT) sensor.
    - Exhaust system restricted. Refer to **Restricted Exhaust** .
    - Contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
    - An engine mechanical condition, for example, worn timing belt or low compression. Refer to **Symptoms - Engine Mechanical** .
    - **If a condition exists**

      Repair as necessary.

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- **If no condition exists**

19. All OK.

Repair Verification

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

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

Circuit/System Description

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

The fuel tank stores the fuel supply. An electric turbine style fuel pump attaches to the fuel tank fuel pump module inside the fuel tank. The fuel pump supplies high pressure fuel through the fuel feed pipe to the fuel injection system. The fuel pump also supplies fuel to a venturi pump located on the bottom of the fuel tank fuel pump module. The function of the venturi pump is to fill the fuel tank fuel pump module reservoir. The fuel tank fuel pump module contains a reverse flow check valve. The check valve maintains fuel pressure in the fuel feed pipe and the fuel rail in order to prevent long cranking times.

Reference Information

Description and Operation

Fuel System Description

Electrical Information Reference

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

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

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48027** Digital Pressure Gauge
- **EN 37287** Fuel Line Shut-off Adapter

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

Circuit/System Verification

NOTE:

- **Repair all fuel system related DTCs before performing this diagnostic.**
- **Inspect the fuel system for damage or external leaks before proceeding.**
- **Verify that adequate fuel is in the fuel tank before proceeding.**
- **The Fuel Pump Enable may need to be commanded On a few times in order to obtain the highest possible fuel pressure.**
- **Before proceeding with this test review the User Manual CH 48027-5 for Safety Information and Instructions.**

1. Ignition OFF, all accessories OFF, install a **CH 48027** Gauge.

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

2. Ignition ON, engine OFF, command the Fuel Pump Enable On several times with a scan tool.
3. Verify the fuel pressure is between 345-650 kPa (50-94 psi) with the fuel pump running.
   - **If less than 345 kPa (50 psi)**

     Refer to Circuit/System Testing below - Fuel Pressure Low.

   - **If greater than 650 kPa (94 psi)**

     Replace the G12 Fuel Pump.

   - **If between 345-650 kPa (50-94 psi)**
4. Verify that the fuel pressure decreases to less than 600 kPa (87 psi) after the fuel pump is turned off.

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- **If greater than 600 kPa (87 psi)**

  Replace the G12 Fuel Pump.

- **If less than 600 kPa (87 psi)**

5. Verify that the fuel pressure does not decrease more than 34 kPa (5 psi) in 1 minute.
   - **If greater than 34 kPa (5 psi)**

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

   - **If less than 34 kPa (5 psi)**
6. Relieve the fuel pressure to 69 kPa (10 psi).
7. Verify that the fuel pressure does not decrease more than 14 kPa (2 psi) in 5 min.
   - **If greater than 14 kPa (2 psi)**

     Replace the G12 Fuel Pump.

   - **If less than 14 kPa (2 psi)**
8. Engine idling at normal operating temperature.
9. Verify the Fuel Pump Control Module Fuel Pressure Sensor parameter is between 300-400 kPa (43-58 psi).
   - **If less than 300 kPa (43 psi)**

     Refer to Circuit/System Testing below - Fuel Pressure Low.

   - **If greater than 400 kPa (58 psi)**

     Replace the G12 Fuel Pump.

   - **If between 300-400 kPa (43-58 psi)**
10. Operate the vehicle within the conditions of the customer's concern while monitoring the fuel pressure with the **CH 48027** Gauge.
11. 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 below - Fuel Pressure Drops Off.

    - **If the fuel pressure does not drop off**
12. If the fuel system components test normal, refer to **Symptoms - Engine Controls**, and **Fuel Injector Diagnosis**.

Circuit/System Testing

Fuel Pressure Low

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1. Verify none of the conditions listed below exist:
   - Restricted fuel feed pipe
   - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
   - **If a condition exists**

     Repair as necessary.

   - **If none of the conditions exist**

     Replace the G12 Fuel Pump.

Fuel Pressure Leaks Down

1. Ignition OFF, relieve the fuel pressure. Refer to **Fuel Pressure Relief** .
2. Install the **EN 37287** Adapter between the chassis fuel feed hose and the engine compartment fuel feed pipe.
3. Open the valve on the **EN 37287** Adapter.
4. Ignition ON, command the Fuel Pump Enable On with a scan tool and bleed the air from the **CH 48027** Gauge.
5. Command the Fuel Pump Enable On and then Off with a scan tool.
6. Close the valve on the **EN 37287** Adapter.
7. Verify that the fuel pressure does not decrease more than 34 kPa (5 psi) in 1 min.
   - **If greater than 34 kPa (5 psi)**

     Locate and replace the leaking Q17 Fuel Injector.

   - **If less than 34 kPa (5 psi)**

     Replace the G12 Fuel Pump.

Fuel Pressure Drops Off

1. Verify none of the conditions listed below exist:
   - Restricted fuel feed pipe
   - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
   - **If a condition exists**

     Repair as necessary.

   - **If none of the conditions exist**

     Replace the G12 Fuel Pump.

Repair Instructions

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

- **Fuel Feed Pipe Replacement**
- **Fuel Injector Replacement**
- **Fuel Tank Fuel Pump Module Replacement**

FUEL PUMP ELECTRICAL CIRCUIT DIAGNOSIS

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Pump High Signal	P0231	P023F	P0232	P023F, P2635
Fuel Pump Low Signal	-	P023F	-	P023F, P2635

Circuit/System Description

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

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

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

Circuit/System Testing

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

Repair Instructions

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

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

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

Circuit/System Description

The engine control module (ECM) enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The ECM controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. 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.

When performing the fuel injector balance test with the fuel injector tester or the scan tool, the scan tool is first used to enable the fuel pump. The fuel injector tester or the scan tool is then used to pulse each injector for a precise amount of time, allowing a measured amount of fuel to be injected. This causes a drop in the system fuel pressure that can be recorded and used to compare each injector.

Diagnostic Aids

- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.
- Perform the fuel injector coil test within the conditions of the concern from the customer. A fuel injector condition may only be apparent at a certain temperature, or under certain conditions.
- Monitoring the Current Misfire Counters, or misfire graph, may help to 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

Electrical Information Reference

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

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Special Tools

- **CH 48027** Digital Pressure Gauge
- **EL 39021** Fuel Injector Coil and Balance Tester

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

Fuel Injector Coil Test

Verify the resistance of each Q17 Fuel Injector with one of the following methods:

- If the engine coolant temperature (ECT) sensor is between 10-32°C (50-90°F), the resistance of each fuel injector should be 11-14 ohms. If the injectors measure OK, perform the Fuel Injector Balance Test.
  - If not within the specified range, replace the Q17 Fuel Injector.
- If the ECT sensor is not between 10-32°C (50-90°F), measure and record the resistance of each fuel injector. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 3 ohms. If the injectors measure OK, perform the Fuel Injector Balance Test.
  - If not within the specified range, add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance value by the number of fuel injectors to obtain an average resistance value. Subtract the lowest individual fuel injector resistance value from the average resistance value. Compute the difference between the highest individual fuel injector resistance value and the average resistance value. Replace the Q17 Fuel Injector that displays the greatest difference above or below the average.

Fuel Injector Balance Test with Special Tool

NOTE:

- **DO NOT perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.**
- **Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.**
- **Before proceeding with this test review the User Manual CH 48027-5 for Safety Information and Instructions.**

1. Verify the correct fuel system pressure. Refer to **Fuel System Diagnosis**.
2. Set the amperage supply selector switch on the fuel injector tester to the Balance Test 0.5-2.5 A position.
3. Connect the **EL 39021** fuel injector coil and balance tester to a Q17 Fuel Injector.
4. Command the Fuel Pump Relay On and then Off three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each injector.
5. Command the Fuel Pump Relay On one more time and energize the fuel injector by depressing the Push to Start Test button on the **EL 39021** fuel injector coil and balance tester at the previously selected pressure.

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6. After the injector stops pulsing, select Min from the Display Mode on the **CH 48027** gauge and record the Min pressure.

NOTE: New test results will not be recorded if the Min/Max results are not cleared after each injector is tested.

7. Clear the Min/Max results on the **CH 48027** gauge.
8. Select Normal from the Display Mode on the **CH 48027** gauge.
9. Repeat steps 3 and 5 through 8 for each fuel injector.
10. Subtract the minimum pressure from the starting pressure for one fuel injector. The result is the pressure drop value.
11. Obtain a pressure drop value for each fuel injector.
12. Add all of the individual pressure drop values except for the injector suspected of being faulty. This is the total pressure drop.
13. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop. The difference between any individual pressure drop and the average pressure drop should not be more than 20 kPa (3 psi).
    - If the difference between any individual pressure drop and the average pressure drop is more than 20 kPa (3 psi), replace the Q17 Fuel Injector.

Fuel Injector Balance Test with Scan Tool

1. Verify the correct fuel system pressure. Refer to **Fuel System Diagnosis**.
2. Command the Fuel Pump Relay On and then Off three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each injector.
3. With a scan tool, select the Fuel Injector Balance Test function within the Special Functions menu.
4. Select an injector to be tested.
5. Press Enter to prime the fuel system.
6. Energize the fuel injector by depressing the Pulse Injector button on the scan tool at the previously selected pressure.
7. After the injector stops pulsing, select Min from the Display Mode on the **CH 48027** gauge and record the Min pressure.

NOTE: New test results will not be recorded if the Min/Max results are not cleared after each injector is tested.

8. Clear the Min/Max results on the **CH 48027** gauge.
9. Select Normal from the Display Mode on the **CH 48027** gauge.
10. Press Enter on the scan tool to bring you back to the Select Injector screen.
11. Repeat steps 4 through 10 for each fuel injector.

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12. Subtract the minimum pressure from the starting pressure for one fuel injector. The result is the pressure drop value.
13. Obtain a pressure drop value for each fuel injector.
14. Add all of the individual pressure drop values except for the injector suspected of being faulty. This is the total pressure drop.
15. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop. The difference between any individual pressure drop and the average pressure drop should not be more than 20 kPa (3 psi).
    - If the difference between any individual pressure drop and the average pressure drop is more than 20 kPa (3 psi), replace the Q17 Fuel Injector.

Repair Instructions

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

Fuel Injector Replacement

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS

Diagnostic Instructions

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

Test Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10 percent can cause driveability conditions and fuel system deterioration. Fuel with more than 10 percent ethanol could result in driveability conditions such as hesitation, lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

Reference Information

Special Tool

CH 44175-A Fuel Composition Tester, if available

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

System Verification

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The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear.

- If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample, perform the Particulate Contaminants in Fuel Testing Procedure.
- If alcohol contamination is suspected, perform the Alcohol in Fuel Testing procedure.

Alcohol in Fuel Testing with Special Tool, If Available

1. Test the fuel composition using the **CH 44175-A** Fuel Composition Tester and the Instruction Manual.
2. If water appears in the fuel sample, clean the fuel system.
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
4. If the fuel sample contains more than 15 percent ethanol, add fresh, regular gasoline to the vehicle's fuel tank.
5. Test the fuel composition.
6. If testing shows the ethanol percentage is still more than 15 percent, replace the fuel in the vehicle.

Alcohol in Fuel Testing without Special Tool

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.034 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.38 oz) and install a stopper.
3. Shake the cylinder vigorously for 10-15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10-15 seconds.
6. Put the cylinder on a level surface for approximately 5 min in order to allow adequate liquid separation. If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10 ml (0.34 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5 percent alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.

Particulate Contaminants in Fuel Testing Procedure

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel.
2. Place the container on a level surface for approximately 5 min in order to allow settling of the particulate contamination. Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles.
3. Observe the fuel sample. If any physical contaminants or water are present, clean the fuel system.

Repair Instructions

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

- **Fuel System Cleaning**

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- **Fuel Tank Draining**

EVAPORATIVE EMISSION CONTROL SYSTEM DIAGNOSIS

Special Tools

EN 41413-VLV EVAP Service Port Vent Fitting

Operating Instructions for the Evaporative Emission System Tester (EEST)

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 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.

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 evaporative emission

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(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 ORVR pipe and orifice.**

7. Press and release the remote switch to activate the nitrogen flow and fill the system.
8. Compare the stable floating indicator position to the red flag.
   - Below the red flag, the result is acceptable, Pass. Test complete
   - Above the red flag, the result is unacceptable, Fail. Go to the Smoke Procedure
9. Press and release the remote switch to deactivate the tester.

Smoke Procedure - Locate the Leak

NOTE: **It is not recommended to use the tester in an outside repair bay area because wind and sunlight may affect temperature and your ability to see the smoke.**

1. Turn OFF any fans that may cause air movement around or near the vehicle.

NOTE: **Completely unwind the nitrogen/smoke hose from the bracket to optimize the tester's performance.**

2. Connect the nitrogen/smoke hose to the vehicle as directed in the service procedures. Some vehicles require that the nitrogen/smoke hose be connected at the front of the EVAP system at the EVAP service port. An adapter may be necessary. Other vehicles require the connection be made at the rear of the system using an adapter at the fuel fill cap. Consult the service procedures for DTCs that relate to

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evaporative emission (EVAP) system leaks for vehicle specific instructions regarding connection location and adapters.

3. Open the nitrogen tank valve and turn the nitrogen/smoke valve on the control panel to smoke.

NOTE: The remote switch operates on a push ON, push OFF fashion.

4. Press and release the remote switch to activate the tester and inject smoke into the EVAP system.
5. Verify smoke has filled the EVAP system by opening the system opposite the end where smoke is injected. When injecting smoke at the service port, remove the fuel fill cap until smoke is observed. Then close the system and continue testing. If using a special tool fuel fill cap adapter at the filler neck, vent the system at the service port, with special tool EN 41413-VLV EVAP Service Port Vent Fitting, until smoke is observed then remove the vent fitting tool and close the system to continue with the test.

NOTE: Inject smoke in less than 2 min cycles for optimum tester performance.

6. Press and release the remote switch to deactivate the tester.

NOTE: For optimum visual smoke performance, deactivate the smoke flow and allow the system pressure to drop. Allowing the smoke to exit small holes at a low flow rate greatly enhances visibility.

7. Introduce smoke into the system for an additional 60 s. Continue introducing smoke at 15 s intervals, as necessary.
8. Using a high-intensity white light, inspect the entire EVAP system path, and look for the source of the leak indicated by the exiting smoke. Introduce smoke at 15 s intervals, as needed, until leak source is identified.

Temperature Variation Instructions

The Concern

Ideal circumstances for conducting the EVAP flow meter test require equal temperatures between the nitrogen gas and the vehicle EVAP system. Significant differences in temperature between them can result in a flow or pressure change during testing, causing misleading results. Typically, the EEST is stored indoors, approximately 21°C (70°F). Vehicles brought in for diagnosis may have an EVAP system at significantly different temperatures.

For Example

NOTE: With no temperature difference between the nitrogen gas and EVAP system, the resulting vehicle EVAP system pressure will remain stable at 3.2 kPa, 13 in. H2O (0.5 PSI) once pressurized, providing no leaks are present.

When the EVAP flow meter tests are performed with significant differences in temperature between the nitrogen gas and the vehicle EVAP system, the following results can occur:

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- An increase in flow during the flow meter test can be caused by a vehicle's warm EVAP system cooling down.
- A decrease in flow during the flow meter test can be caused by a vehicle's cool EVAP system warming up.

The Solution

When working on a vehicle with significant temperature differences between the vehicle EVAP system and the nitrogen gas, allow the vehicle EVAP system temperature to stabilize as close as possible to the temperature of the nitrogen gas before conducting the Flow Meter Test.

INTAKE MANIFOLD RUNNER CONTROL SYSTEM DIAGNOSIS

Diagnostic Instructions

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

Circuit/System Description

An intake manifold tuning solenoid valve is used to change the intake manifold plenum configuration. When the intake manifold tuning solenoid valve is open, the intake manifold is configured to one large plenum. When the intake manifold tuning solenoid valve is closed, the intake manifold is configured to 2 smaller plenums. The intake manifold tuning solenoid valve improves engine performance at low and high engine speeds.

Ignition voltage is supplied directly to the intake manifold tuning solenoid valve. The engine control module (ECM) controls the solenoid 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.

The intake manifold tuning solenoid valve also contains a position sensor which is used to detect the actual position of the intake manifold tuning solenoid valve in relation to its commanded position. The ECM supplies the intake manifold tuning solenoid valve position sensor with a 5 V signal circuit and the position sensor uses a common ground circuit. The position sensor enables the ECM to detect a physically broken or stuck intake manifold tuning solenoid valve.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool circuit test status parameters for the component. A circuit test 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

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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, observe the scan tool DTC information. Verify that DTCs P0660, P2070, P2071, P2076, P2077, or P2078 are not set.
    - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Command the Intake Manifold Tuning Valve ON with a scan tool. The intake manifold tuning valve actuator should move to the closed position.

Circuit/System Testing

1. Inspect the linkage between the Q22 Intake Manifold Tuning Solenoid Valve and the valve at the intake manifold for the conditions listed below:
    - Linkage for being connected
    - Linkage binding
    - Interference with hoses, wiring, or any other components
    - If a condition is found, repair as necessary.
2. Remove the linkage from the Q22 Intake Manifold Tuning Solenoid Valve.
3. Ignition ON, disconnect the harness connector at the Q22 Intake Manifold Tuning Solenoid Valve and then reconnect. The Q22 Intake Manifold Tuning Solenoid Valve should move. Repeat procedure several times.
    - If the solenoid did not move, replace the intake manifold.
4. Inspect the inside of the intake manifold for the following conditions:
    - Carbon build-up that limits the movement of the Q22 Intake Manifold Tuning Solenoid Valve.

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- Casting flash that limits the movement of the Q22 Intake Manifold Tuning Solenoid Valve.
- Foreign material that limits the movement of the Q22 Intake Manifold Tuning Solenoid Valve.
  - If a condition is found, repair as necessary.

5. If all components test normal, clean or replace the intake manifold.

Repair Instructions

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

Intake Manifold Replacement

ELECTRONIC IGNITION SYSTEM DIAGNOSIS

Diagnostic Instructions

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

Circuit/System Description

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

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

Scan Tool Reference

Control Module References

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 K35 Ignition Coil Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 ohms between the ground circuit terminal B and ground.
   - **If 5 ohms or greater**
   1. Ignition OFF.
   2. Test for less than 2 ohms in the ground circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, repair the open/high resistance in the ground connection.
   - **If less than 5 ohms**
3. Test for less than 5 ohms between the low reference circuit terminal C and ground.
   - **If 5 ohms or greater**
   1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 ohms in the low reference circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, replace the K20 Engine Control Module.
   - **If less than 5 ohms**
4. Ignition ON.
5. Verify a test lamp illuminates between the ignition circuit terminal A and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp.
   2. Test for less than 2 ohms in the ignition circuit end to end.
      - If 2 ohms or greater, repair the open/high resistance in the circuit.
      - If less than 2 ohms, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**

NOTE: The ignition circuit may supply voltage to other components. Make

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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**

6. Replace the K35 Ignition Coil Module.

Repair Instructions

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

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

INSPECTION/MAINTENANCE SYSTEM CHECK

Diagnostic Instructions

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

Circuit/System Description

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and the inspection/maintenance (I/M) emission inspection in order to renew license plates. This is accomplished by viewing the I/M System Status display on a scan tool. Using a scan tool, the technician can observe the I/M System Status in order to verify that the vehicle meets the criteria that complies with the local area requirements. While testing in the I/M System Status mode, some DTCs may occur that are called I/M Test DTCs. An I/M Test DTC is defined as a fault code that is currently commanding the MIL ON, and is stored in non-volatile memory. The intended use of this data is to prevent vehicles from passing I/M inspection without proper repair to the vehicle. These fault codes are not erasable from any scan tool command or erasable by disconnecting power to the controller. The I/M Test DTCs will be supported by all emissions related ECUs such as ECMs, TCMs, FPCMs, etc. An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing which occurs 5 s after ignition OFF.

Conditions for Updating the I/M System Status

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Each system monitor requires at least one, and sometimes several, diagnostic tests. The result of each test is reported by a diagnostic trouble code (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 inspection/maintenance system status display will indicate YES in the Completed column.

For example, when the HO2S Heater Monitor indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has two heated oxygen sensors, either both heater circuit tests have passed or one of the heater circuit tests has illuminated the MIL. The inspection/maintenance 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 may set the inspection/maintenance 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 engine control module (ECM) power or ground has been interrupted.
- The ECM has been reprogrammed.
- The ECM DTCs have been cleared.

Conditions for Clearing I/M Test DTCs

1. Only the OBD II System can erase the I/M Test DTC. The OBD II system must determine that the malfunction that caused the I/M Test DTC to be stored is no longer present and is not commanding the MIL. Each of the following represents ways to clear an I/M Test DTC:
    - If the MIL goes out due to 3 passing drive cycles, scan tool code clear is not used, the I/M Test DTC is erased at power down of the last drive cycle.
    - If a scan tool code clear is used to turn OFF the MIL, the I/M Test DTC is not erased, the DTC must PASS and not FAIL. The I/M Test DTC is erased at power down of the drive cycle.
    - If the controller is reflashed/reprogrammed, all I/M Test DTCs are erased.
2. For the OBD II System to run a single drive cycle for clearing an I/M Test DTC, all of the following conditions must occur:
    - Cumulative time of engine run time is greater than 600 s.
    - Cumulative vehicle operation above 40 km/h (25 mph) for over 300 s.
    - Continuous vehicle idle for greater than 30 s.
    - Turn ignition OFF for 5 s and allow the code to clear.

Monitored Emission Control Systems

The OBD II system monitors all emission control systems that are on-board. Not all vehicles need every possible emission control system. For example, a vehicle may not be equipped with secondary air injection (AIR) or exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following; if equipped:

- The air conditioning system

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- The catalyst 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 (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 (LUW)**, **Inspection/Maintenance (I/M) System DTC Table (LWE)**. 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 inspection/maintenance system status indicator.

Diagnostic Aids

The I/M System Status display provides an indication of when the control module has completed the required tests. This does not necessarily mean that the test has passed, only that a decision was made. If the diagnostic fails, a DTC will indicate the failure. If a failure indication is present for a DTC associated with one of the I/M regulated systems, it may prevent other required tests from running. For example, a DTC for the control circuit of the EVAP purge solenoid may not be listed in the Inspection/Maintenance System DTC Table because it is a continuous test. If this DTC is set, the Active Tests for the EVAP system may not run.

The I/M System Status information may be useful for a technician to determine if diagnostics have run when verifying repairs.

Circuit/System Verification

Review the I/M System Status indicators. All I/M System Status indicators should report YES, and no I/M Test DTCs should be present.

Circuit/System Testing

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

1. Observe the Engine DTC information with a scan tool. Verify no DTCs are present.
    - If a DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.
    - If a control module re-program or other repair is required, perform the **Inspection/Maintenance Complete System Set Procedure**.

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3. Observe the I/M System Status indicators.
    - If any I/M System Status indicators report NO, perform the **Inspection/Maintenance Complete System Set Procedure**.
4. Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.
    - If an I/M Test DTC is set and all of the I/M System Status indicators are Yes, there is no need to perform the Complete System Set Procedure. Diagnose the DTC using the **Diagnostic Trouble Code (DTC) List - Vehicle** and refer to Conditions for Clearing the I/M Test DTCs.
    - If an I/M Test DTC is set and the I/M System Status indicators are NO, diagnosis the DTC and perform the **Inspection/Maintenance Complete System Set Procedure**.

INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE

Diagnostic Instructions

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

Circuit/System Description

The purpose of the inspection/maintenance complete system set procedure is to satisfy the enable criteria necessary to execute all of the inspection/maintenance readiness diagnostics and complete the trips for those particular diagnostics. When all inspection/maintenance monitored diagnostic tests are completed, the inspection/maintenance system status indicators are set to yes. Perform the inspection/maintenance complete system set procedure if any inspection/maintenance system status indicators are set to NO.

Condition for Meeting a Cold Start

- The ignition voltage between 10-18 V.
- The barometric pressure (BARO) is more than 75 kPa (10.15 PSI).
- The engine coolant temperature (ECT) at start-up is greater than -5°C (23°F).
- The intake air temperature (IAT) at start-up is less than 40°C (104°F).
- The difference between the start-up IAT and ECT are within 3°C (5°F)
- The engine is OFF for greater than 6 h or the following conditions must be met:
    - The start-up IAT minus start-up ECT 1 are within 12°C (22°F).
    - The start-up ECT minus start-up IAT are within 50°C (90°F).
- Fuel level is between 25-75%.

Circuit/System Verification

Review the inspection/maintenance system status indicators. All inspection/maintenance system status indicators should report yes.

Inspection/Maintenance System Set Procedure

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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.
    - If the Evaporative Emission (EVAP) inspection/maintenance system status indicator displays NO, perform the EVAP Service Bay test if applicable.
2. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc., and open the hood.
3. Set the vehicle parking brake and ensure the vehicle is in park for automatic transmission or neutral for manual transmission.
4. Turn the ignition ON for 1 min.
5. Start and idle the engine for 5 m.
6. Run the engine for 6 min within the following conditions:
    - Calculated air flow is between 9-30 g/s.
    - Engine speed is steady between 1 300-3 000 RPM.
7. Apply and hold brake pedal, and shift to Drive for automatic, or apply clutch pedal for manual and operate the vehicle within the following conditions for 2 minutes:
    - Manifold Absolute Pressure (MAP) signal is greater than 12 g/s.
    - Engine speed is greater than 1 000 RPM.

NOTE: Do NOT touch the accelerator pedal until told to do so. A change in throttle position sensor angle or an increase in engine speed may invalidate this portion of the test.

8. Release the accelerator pedal and shift the vehicle to Park for automatic, or Neutral and release clutch pedal for manual, and allow the engine to idle for 2 min.
9. Close the hood, release the parking brake and drive vehicle at 90 km/h (55 MPH) for 2 min.
10. Release the accelerator pedal for at least 10 s. This will allow the vehicle to enter the deceleration fuel cut off.
11. Safely stop the vehicle, with the engine in drive for automatic or neutral with the clutch pedal depressed and parking brake applied for manual. Allow the vehicle to idle for 2 min.

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.

12. Shift the vehicle to park for automatic and neutral for manual. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 45 min.
13. Observe the Inspection/Maintenance System Status with a scan tool. All of the inspection/maintenance System Status indicators should display YES.

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- If the EVAP inspection/maintenance system status indicator displays NO, turn OFF the ignition, ensure that the vehicle meets the conditions for a cold start, and repeat steps 6 through 11 three more times, or until the EVAP inspection/maintenance system status indicator transitions to yes. If the indicator continues to display NO, refer to the **Inspection/Maintenance (I/M) System DTC Table (LUW)**, **Inspection/Maintenance (I/M) System DTC Table (LWE)** to identify the DTCs that did not run.
- If any of the inspection/maintenance system status indicators display NO, refer to the **Inspection/Maintenance (I/M) System DTC Table (LUW)**, **Inspection/Maintenance (I/M) System DTC Table (LWE)** for the indicator which did not display yes. The inspection/maintenance system DTC table identifies the DTCs associated with each inspection/maintenance system status Indicator.

INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE (LUW)

Inspection/Maintenance (I/M) System DTC Table (LUW)

System	DTCs Required to Set System Status to YES
If an inspection/maintenance system status indicator did NOT update to YES during the **Inspection/Maintenance System Check**, review each indicator and reference this table to determine each DTC associated with the inspection/maintenance 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 inspection/maintenance system status indicators to transition to YES.	
Catalyst Monitor	**DTC P0420** .
Evaporative Emission (EVAP)	• **DTC P0442** . • **DTC P0446**. • **DTC P0455**.
Fuel System	**DTC P219A**
Oxygen Sensor	• **DTC P0131, P0132, P0134, P0137, P0138, or P0140** • **DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, or P2271** .
Oxygen Sensor Heater	**DTC P0030-P0032, P0036-P0038, P0053, P0054, P0135, or P0141**
Camshaft System	**DTC P0011 or P0014**

INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE (LWE)

Inspection/Maintenance (I/M) System DTC Table (LWE)

System	DTCs Required to Set System Status to YES
If an inspection/maintenance system status indicator did NOT update to YES during the **Inspection/Maintenance System Check**, review each indicator and reference this table to determine each DTC associated with the inspection/maintenance system status indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included within the conditions are	

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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 inspection/maintenance system status indicators to transition to YES.	
AIR	• **DTC P0411** • **DTC P2430 or P2431**. • **DTC P2440**. • **DTC P2444**.
Catalyst Monitor	**DTC P0420** .
Evaporative Emission (EVAP)	• **DTC P0442** . • **DTC P0446**. • **DTC P0455**.
Fuel System	**DTC P219A**
Oxygen Sensor	• **DTC P0131, P0132, P0134, P0137, P0138, or P0140** • **DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, or P2271** .
Oxygen Sensor Heater	**DTC P0030-P0032, P0036-P0038, P0053, P0054, P0135, or P0141**
Camshaft System	**DTC P0011 or P0014**

FUEL PRESSURE MEASUREMENT

Special Tools

EN-34730-91 Pressure Tester

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

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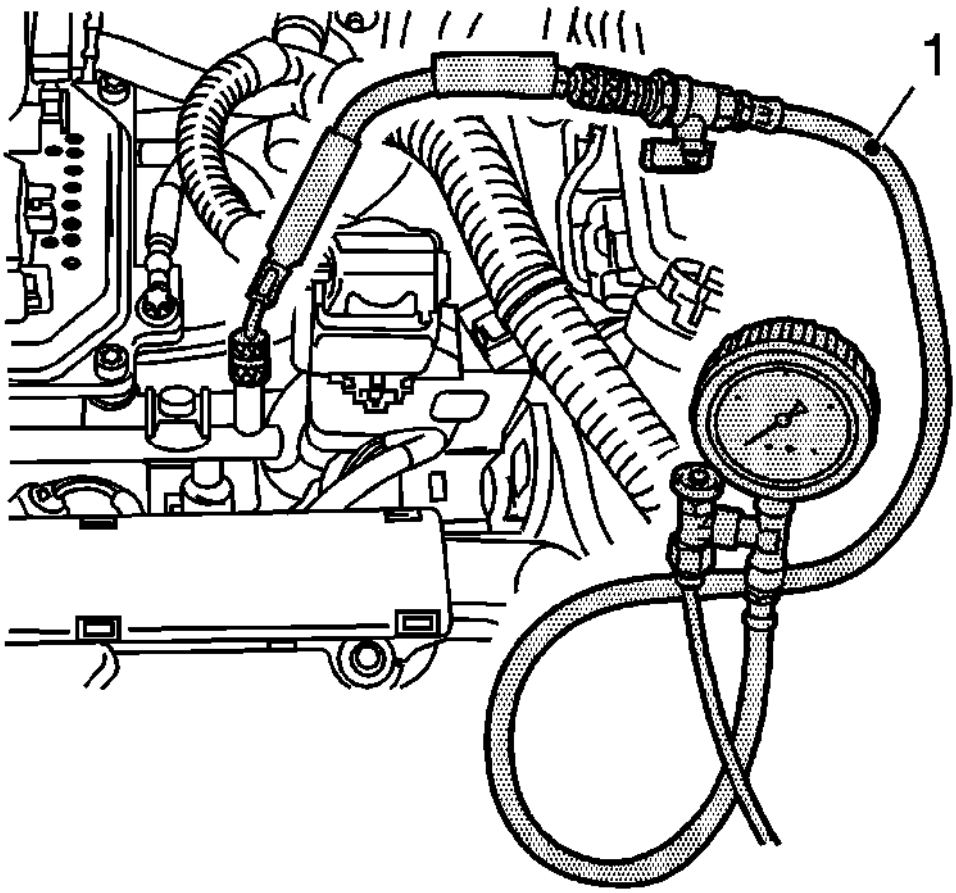


Fig. 1: View Of Fuel Pressure Tester
Courtesy of GENERAL MOTORS COMPANY

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: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

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1. Remove the protective cap from the test connection.
2. Attach the **EN-34730-91** tester (1) to the test connection.
3. Start the engine.
   - Bleed the pressure tester at idling speed.
   - Collect the exiting fuel in a suitable container.
   - Read the fuel pressure from the pressure gauge.

   Nominal value 380 kPa (3.8 bar)

   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**

4. Detach the pressure gauge **EN-34730-91** tester from the test connection.

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2013 ENGINE PERFORMANCE

Engine Controls and Fuel - 1.8L LUW and LWE - Repair Instructions - Cruze

REPAIR INSTRUCTIONS

ENGINE CONTROL MODULE REPLACEMENT

Service of the engine control module (ECM) should consist of either replacement of the ECM or of programming of the electrically erasable programmable read only memory (EEPROM). If the diagnostic procedures call for the ECM to be replaced, the replacement ECM should be checked to ensure that the correct part is being used. If the correct part is being used, remove the faulty ECM and install the new service ECM.

CAUTION:

- **Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module (battery cable, powertrain control module (PCM)/engine control module (ECM)/transaxle control module (TCM) pigtail, control module fuse, jumper cables, etc.) in order to prevent internal control module damage.**
- **Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control module, using battery booster cables, or when charging the vehicle battery.**
- **In order to prevent any possible electrostatic discharge damage to the control module, do no touch the connector pins or the soldered components on the circuit board.**
- **Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module.**
- **The replacement control module must be programmed.**

NOTE: **It is necessary to record the engine oil life percentage remaining. Use the scan tool to reset the engine oil life remaining back to the original percentage recorded.**

NOTE: **It is necessary to record the remaining automatic transmission fluid life. If the replacement module is not programed with the remaining automatic transmission fluid life, the automatic transmission fluid life will default to 100 percent. If the replacement module is not programmed with the remaining automatic transmission fluid life, the automatic transmission fluid will need to be changed at 83000 km (50.000 mi) from the last automatic transmission fluid change.**

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Removal Procedure

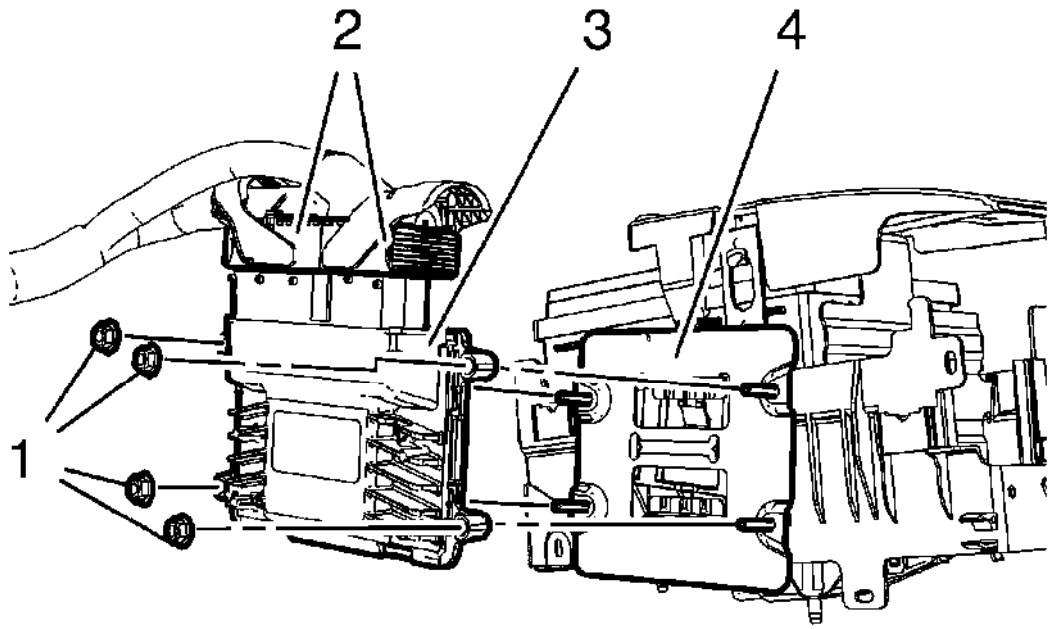


Fig. 1: Engine Control Module Components
Courtesy of GENERAL MOTORS COMPANY

1. Prepare the ECM for replacement. Refer to **Control Module References** .
2. Using a scan tool, retrieve the percentage of remaining engine oil. Record the remaining engine oil life.
3. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
4. Disconnect the 2 wiring harness plug (2) from the engine control module (3).
5. Unclip the engine control module bracket (4) from the battery tray.
6. Remove the 4 nuts (1).
7. Remove the engine control module (3) from the engine control module bracket (4).

Installation Procedure

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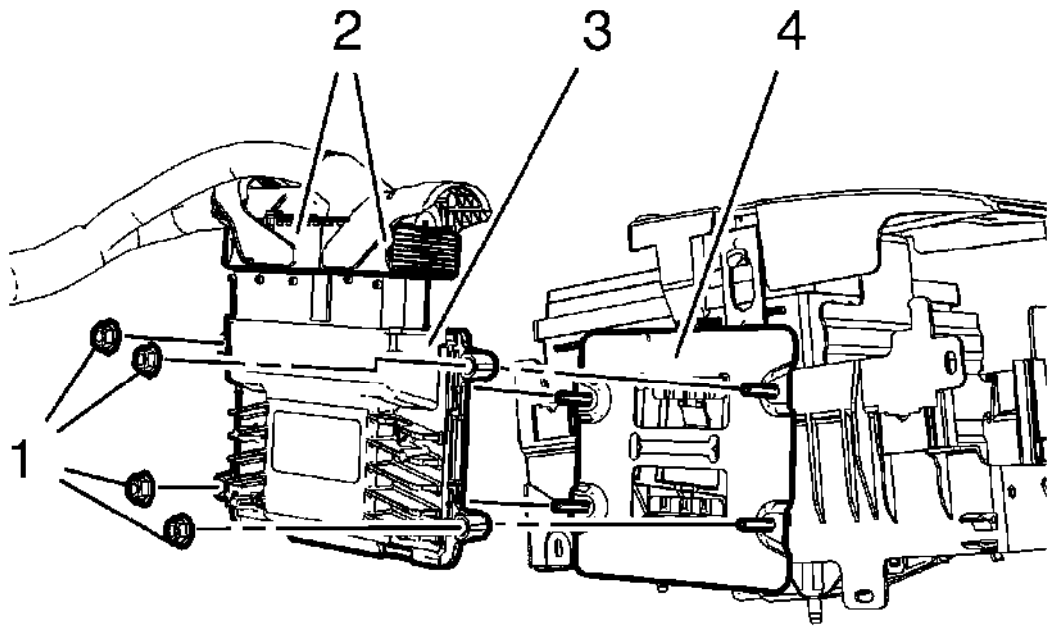


Fig. 2: Engine Control Module Components
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine control module (3) to the engine control module bracket (4).

CAUTION: Refer to Fastener Caution .

2. Install the 4 nuts (1) and tighten to 9 N.m (80 lb in).
3. Clip the engine control module bracket (4) to the battery tray.
4. Connect the 2 wiring harness plug (2) to the engine control module (3).
5. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
6. Program the ECM. Refer to **Control Module References** .

CRANKSHAFT POSITION SYSTEM VARIATION LEARN

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NOTE: **The crankshaft position sensor system variation learn procedure is required when the following service procedures have been performed, regardless of whether DTC P0315 is set:**

- **Engine replacement**
- **Engine control module (ECM) replacement**
- **Crankshaft damper replacement**
- **Crankshaft replacement**
- **Crankshaft Position Sensor Replacement**
- **Any engine repairs which disturb the crankshaft to crankshaft position sensor relationship**

NOTE: **The scan tool monitors certain component signals to determine if all the conditions are met to continue with the crankshaft position sensor system variation learn procedure. The scan tool only displays the condition that inhibits the procedure. The scan tool monitors the following components:**

- **Crankshaft Position Sensor activity - If there is a crankshaft position sensor condition, refer to the applicable DTC that set.**
- **Camshaft position signal activity - If there is a camshaft position sensor signal condition, refer to the applicable DTC that 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. Install a scan tool.
2. Monitor the ECM for DTCs with a scan tool. If other DTCs are set, except DTC P0315, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
3. With a scan tool, select the Crankshaft Position System Variation Learn procedure and perform the following:
    1. Observe the fuel cut-off for the applicable engine.
    2. Block the drive wheels.
    3. Set the parking brake.
    4. Place the vehicles transmission in Park or Neutral.
    5. Turn the air conditioning (A/C) OFF.
    6. Cycle the ignition from OFF to ON.
    7. Apply and hold the brake pedal for the duration of the procedure.
    8. Start and idle the engine.
    9. Accelerate to wide open throttle (WOT). The engine should not accelerate beyond the calibrated fuel cut-off RPM value noted in step 3.1. Release the throttle immediately if the value is exceeded.

NOTE: **While the learn procedure is in progress, release the throttle**

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immediately when the engine starts to decelerate. The engine control is returned to the operator and the engine responds to throttle position after the learn procedure is complete.

10. Release the throttle when fuel cut-off occurs.

NOTE: While the learn procedure is in progress, release the throttle immediately when the engine starts to decelerate. The engine control is returned to the operator and the engine responds to throttle position after the learn procedure is complete.

11. Accelerate to wide open throttle (WOT). The engine should not accelerate beyond the calibrated fuel cut-off RPM value noted in step 3.1. Release the throttle immediately if the value is exceeded.

4. The scan tool displays Learn Status: Learned this Ignition. If the scan tool indicates that DTC P0315 ran and passed, the crankshaft position sensor variation learn procedure is complete. If the scan tool indicates DTC P0315 failed or did not run, refer to **DTC P0315** . If any other DTCs set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for the applicable DTC that set.
5. Turn OFF the ignition for 30 s after the learn procedure is completed successfully.

THROTTLE/IDLE LEARN

Description

The engine control module (ECM) learns the airflow through the throttle body to ensure the correct idle. The learned airflow values are stored within the ECM. These values are learned to adjust for production variation and will continuously learn during the life of the vehicle to compensate for reduced airflow due to throttle body coking. Anytime the throttle body airflow rate changes, for example due to cleaning or replacing, the values must be relearned.

An engine that had a heavily coked throttle body that has been cleaned or replaced may take several drive cycles to learn out the coking. To accelerate the process, the scan tool has the ability to reset all learned values back to zero. A new ECM will also have values set to zero.

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

Conditions for Running the Throttle Learn Procedure

Scan tool Idle Learn or Idle Learn Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- Ignition ON, engine OFF.
- The vehicle speed sensor (VSS) is 0 km/h (0 mph).

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Service Bay/On Road Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P1516, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, or P2176 are not set.
- The engine speed is between 450-4, 000 RPM.
- The manifold absolute pressure (MAP) is greater than 5 kPa.
- The mass air flow (MAF) is greater than 2 g/s.
- The ignition voltage is greater than 10 volts.

Throttle Learn

Scan Tool Idle Learn or Idle Learn Reset Procedure - Performed after the throttle body is cleaned or replaced

1. Ignition ON, engine OFF, perform the Idle Learn or Idle Learn Reset in Configuration/Reset or Module Setup.
2. Engine idling, observe the scan tool Throttle Body Idle Airflow Compensation parameter. The Throttle Body Idle Airflow Compensation value should equal 0 % and the engine should be idling at a normal idle speed.
3. Clear the DTCs and return to the diagnostic that referred you here.

Service Bay/On Road Idle Learn Procedure - Performed after the ECM is programmed or replaced

NOTE: Do NOT perform this procedure if DTCs are set. Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

1. Engine idling for 3 minutes.
2. Observe the scan tool Desired Idle Speed and the actual Engine Speed parameters.
3. The ECM will start to learn the new idle cells and the Desired Idle Speed should start to decrease.
4. Ignition OFF for 60 seconds.
5. Start and idle the engine for 3 minutes.
6. After the 3 minute run time the engine should be idling normal.

NOTE: During the drive cycle the check engine light may come on with idle speed DTCs. If idle speed codes are set, clear codes so the ECM can continue to learn.

   - If the engine idle speed has not been learned the vehicle will need to be driven at speeds above 70 km/h (44 mph) with several decelerations and extended idles.

7. After the drive cycle, the engine should be idling normally.
   - If the engine idle speed has not been learned, turn OFF the ignition for 60 seconds and repeat step

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6.

8. Once the engine speed has returned to normal, clear DTCs and return to the diagnostic that referred you here.

INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

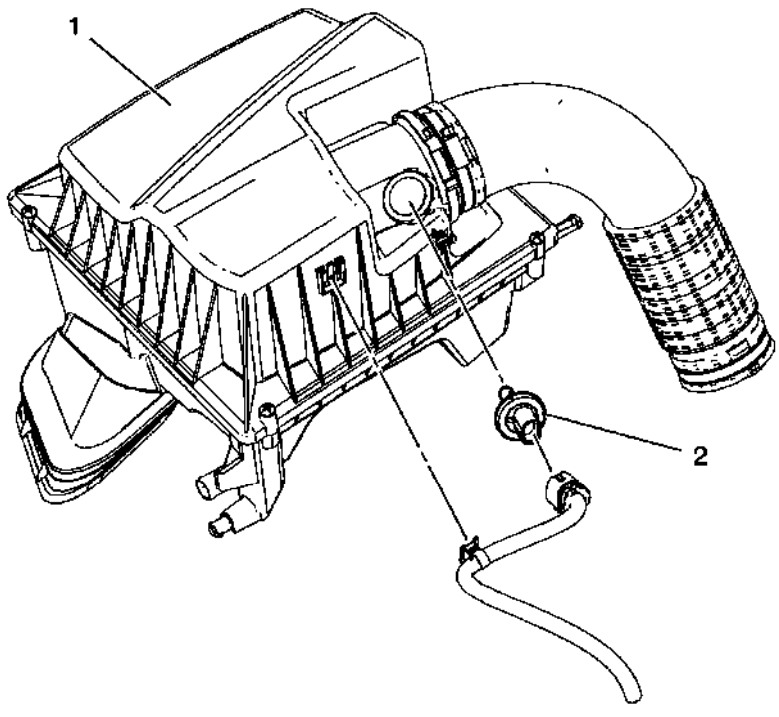


Fig. 3: Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Intake Air Temperature Sensor Replacement

Callout	Component Name
1	Intake Air Temperature Sensor Assembly **CAUTION:** **Any time service is being performed which requires removal of the air cleaner assembly, always cover the throttle body opening. This will prevent any foreign material from entering the engine.**
2	Intake Air Temperature Sensor Cable Clip

MASS AIRFLOW SENSOR REPLACEMENT

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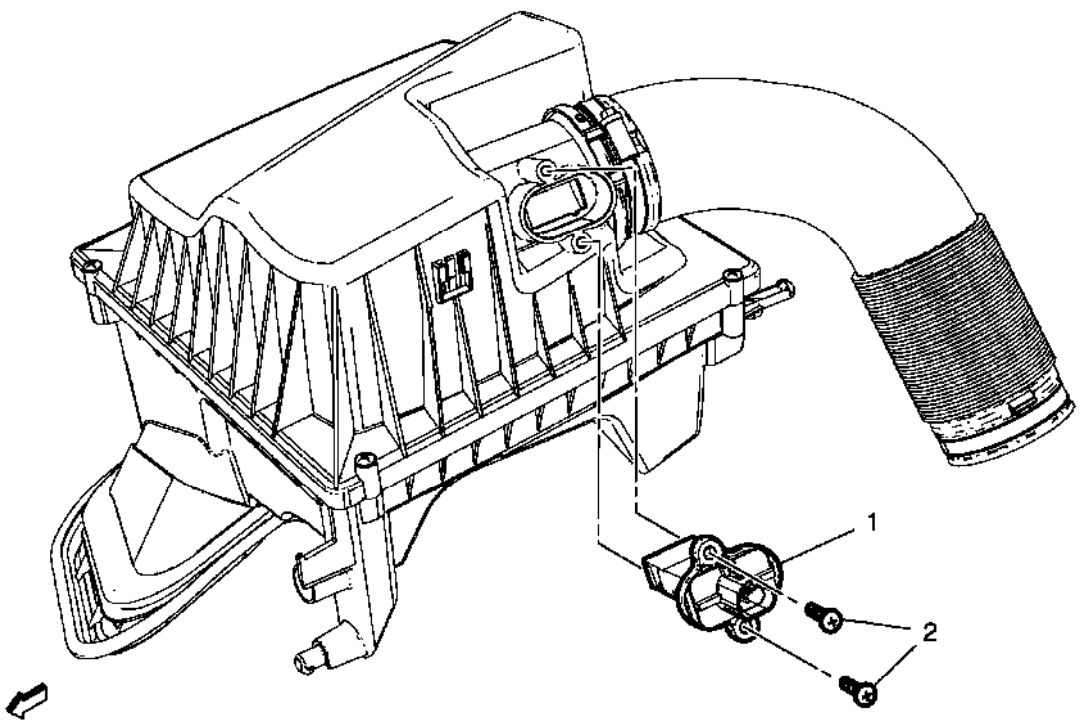


Fig. 4: Mass Airflow Sensor
Courtesy of GENERAL MOTORS COMPANY

Mass Airflow Sensor Replacement

Callout	Component Name
1	Mass Airflow Sensor Bolts (Qty 2) **CAUTION:** **Refer to Fastener Caution .**
2	Mass Airflow Sensor **Procedure** 1. Disconnect the electrical connector. 2. After replacement of mass air flow sensor, use a scan tool to run the learn functions. Refer to **K20 Engine Control Module: Programming and Setup** .

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

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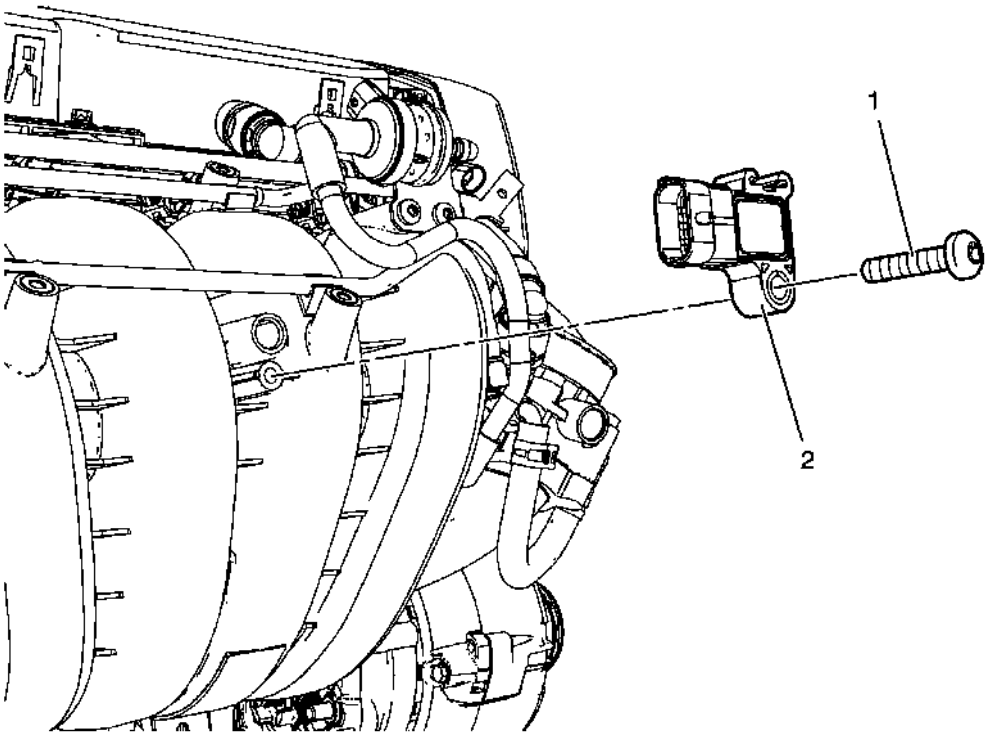


Fig. 5: Manifold Absolute Pressure Sensor (1.8L LUW)
Courtesy of GENERAL MOTORS COMPANY

Manifold Absolute Pressure Sensor Replacement

Callout	Component Name
1	Manifold Absolute Pressure Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 1.6 (53 lb in)
2	Manifold Absolute Pressure Sensor **Procedure** Disconnect the electrical connector.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT - RADIATOR SIDE

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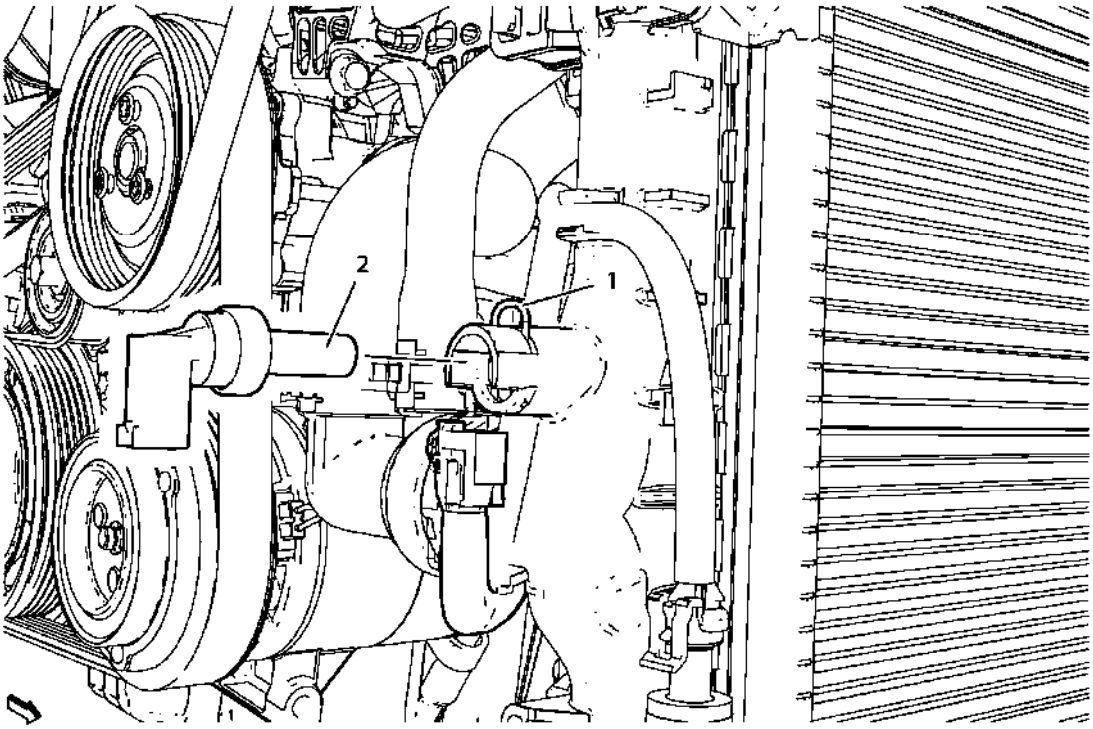


Fig. 6: Engine Coolant Temperature Sensor (Radiator) Side
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Temperature Sensor Replacement - Radiator Side

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE-47716 Fill)** . 2. Disconnect the electrical connection.	
1	Retaining Clamp
2	Engine Coolant Temperature Sensor

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT - THERMOSTAT SIDE

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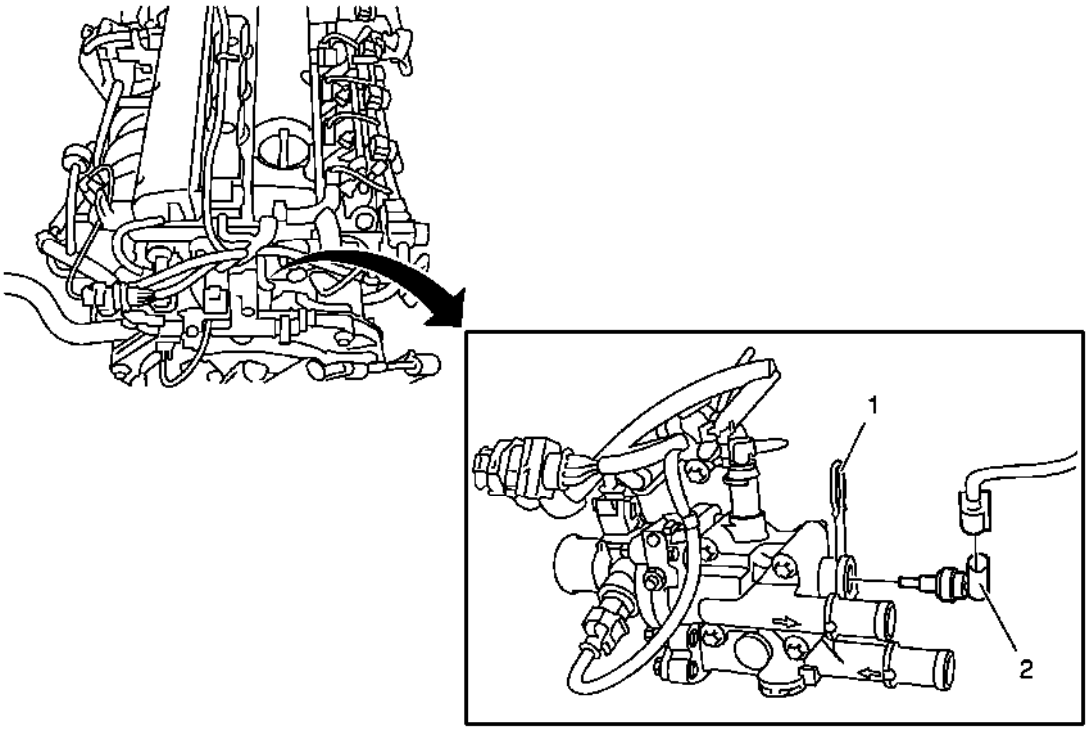


Fig. 7: Engine Coolant Temperature Sensor - Thermostat Side
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Temperature Sensor Replacement - Thermostat Side

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (Static Fill)** , **Cooling System Draining and Filling (GE-47716 Fill)** . 2. Disconnect the electrical connection.	
1	Engine Coolant Temperature Sensor Fastener
2	Engine Coolant Temperature Sensor

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 1

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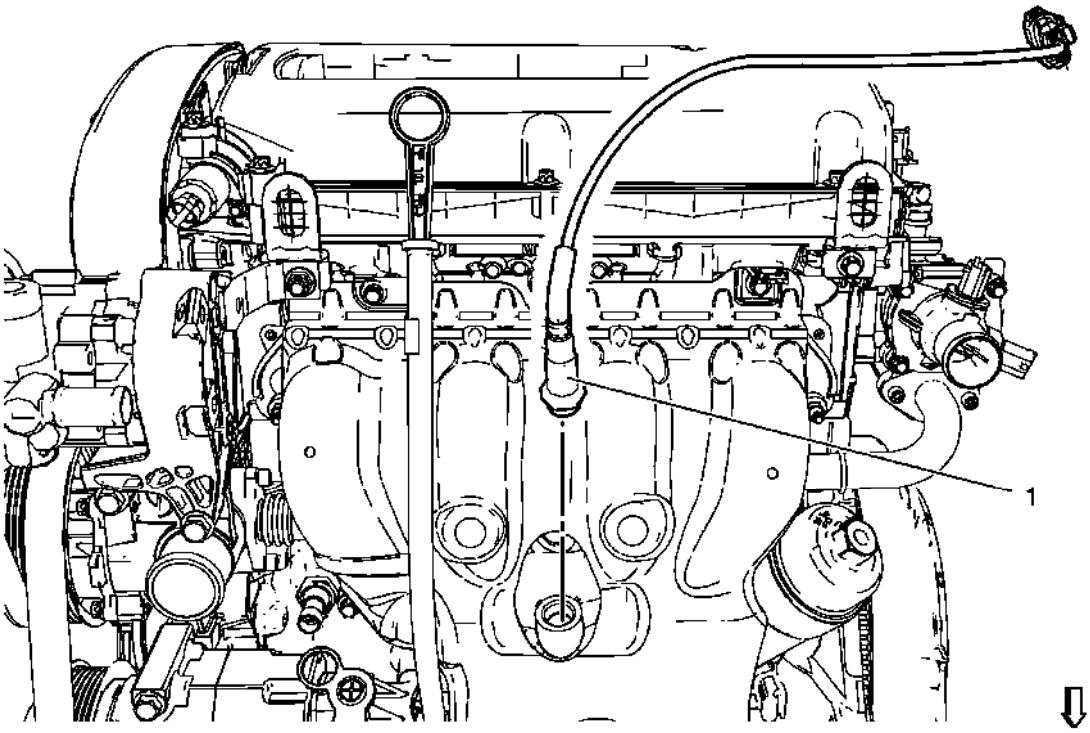


Fig. 8: Heated Oxygen Sensor - Sensor 1 (1.6L LDE, LXV And 1.8L 2H0)
Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Sensor 1

Callout	Component Name
WARNING: **In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.** **Preliminary Procedures** Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .	
1	Heated Oxygen Sensor **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Disconnect the heated oxygen sensor wiring harness connector. 2. Remove the heated oxygen sensor. 3. When re-using the heated oxygen sensor, coat the thread with assembly paste.

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	Tighten 42 N.m (31 lb ft) **Special Tools** **EN-6179** Heated Oxygen Sensor Remover / Installer For equivalent regional tools, refer to **Special Tools** .

HEATED OXYGEN SENSOR REPLACEMENT - SENSOR 2

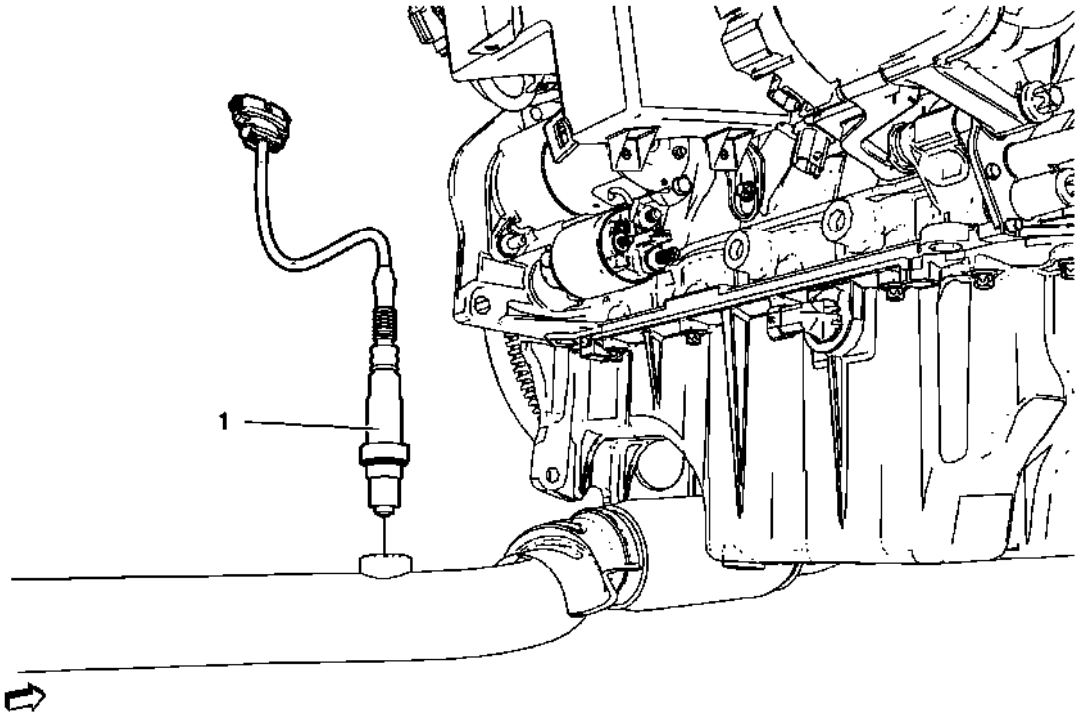


Fig. 9: Heated Oxygen Sensor - Sensor 2
Courtesy of GENERAL MOTORS COMPANY

Heated Oxygen Sensor Replacement - Sensor 2

Callout	Component Name
1	Heated Oxygen Sensor 2 **WARNING:** **In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.** **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Disconnect the heated oxygen sensor 2 wiring harness plug.

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	2. Remove the heated oxygen sensor 2. 3. When re-using the heated oxygen sensor, coat the thread with assembly paste. **Tighten** 42 N.m (31 lb ft) **Special Tools** **EN-6179** Heated Oxygen Sensor Remover / Installer For equivalent regional tools, refer to **Special Tools** .

ENGINE OIL PRESSURE INDICATOR SWITCH REPLACEMENT

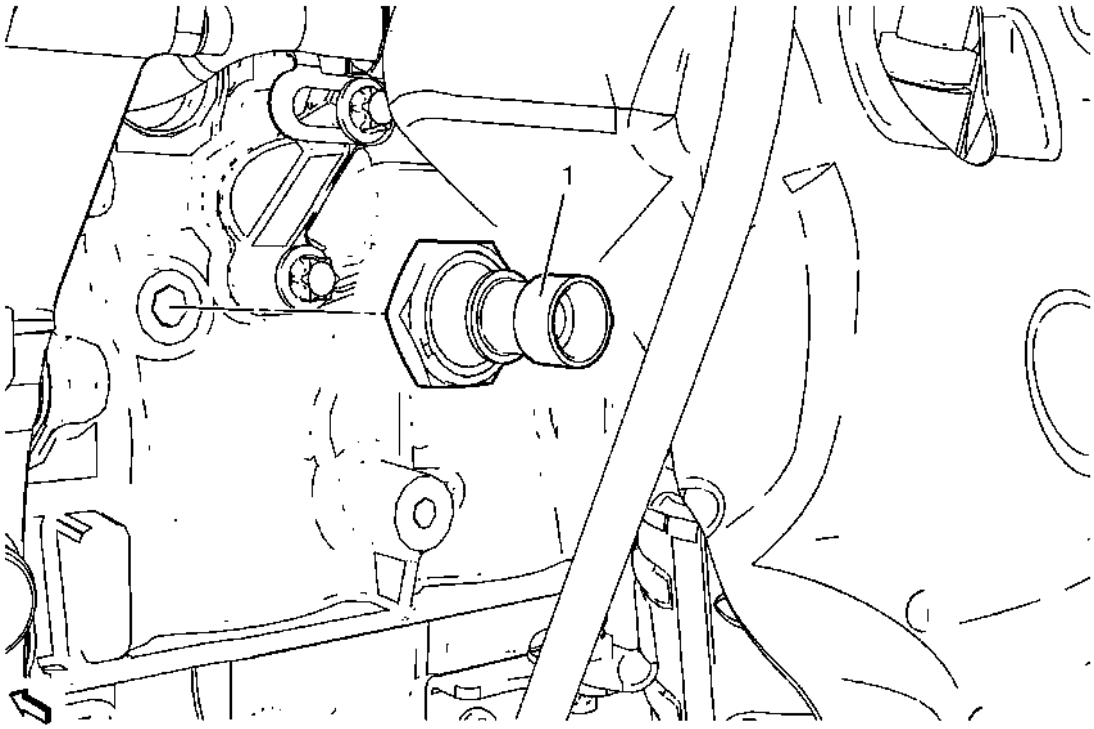


Fig. 10: Engine Oil Pressure Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Pressure Indicator Switch Replacement

Callout	Component Name
Preliminary Procedure Remove the air conditioning compressor. Refer to **Air Conditioning Compressor Replacement (1.8L LUW and LWE)** , **Air Conditioning Compressor Replacement (1.4L LUV)** .	
	Oil Pressure Switch **CAUTION:**

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1	**Refer to Fastener Caution .** **Procedure** Disconnect the oil pressure switch wiring harness plug and remove the switch. **Tighten** 30 (22 lb ft)

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

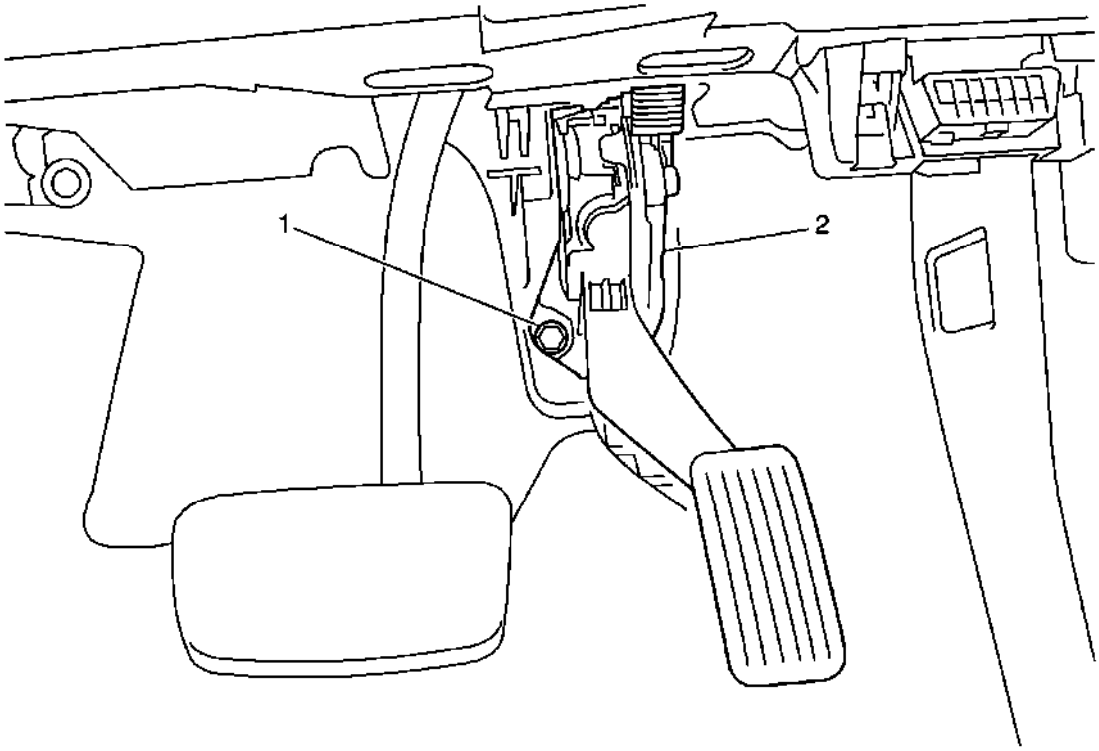


Fig. 11: Accelerator Pedal Position Sensor & Fastener
Courtesy of GENERAL MOTORS COMPANY

Accelerator Pedal Position Sensor Replacement

Callout	Component Name
1	Accelerator Pedal Position Sensor Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
	Accelerator Pedal Position Sensor

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2	**Procedure** Disconnect electrical connector.

THROTTLE BODY ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

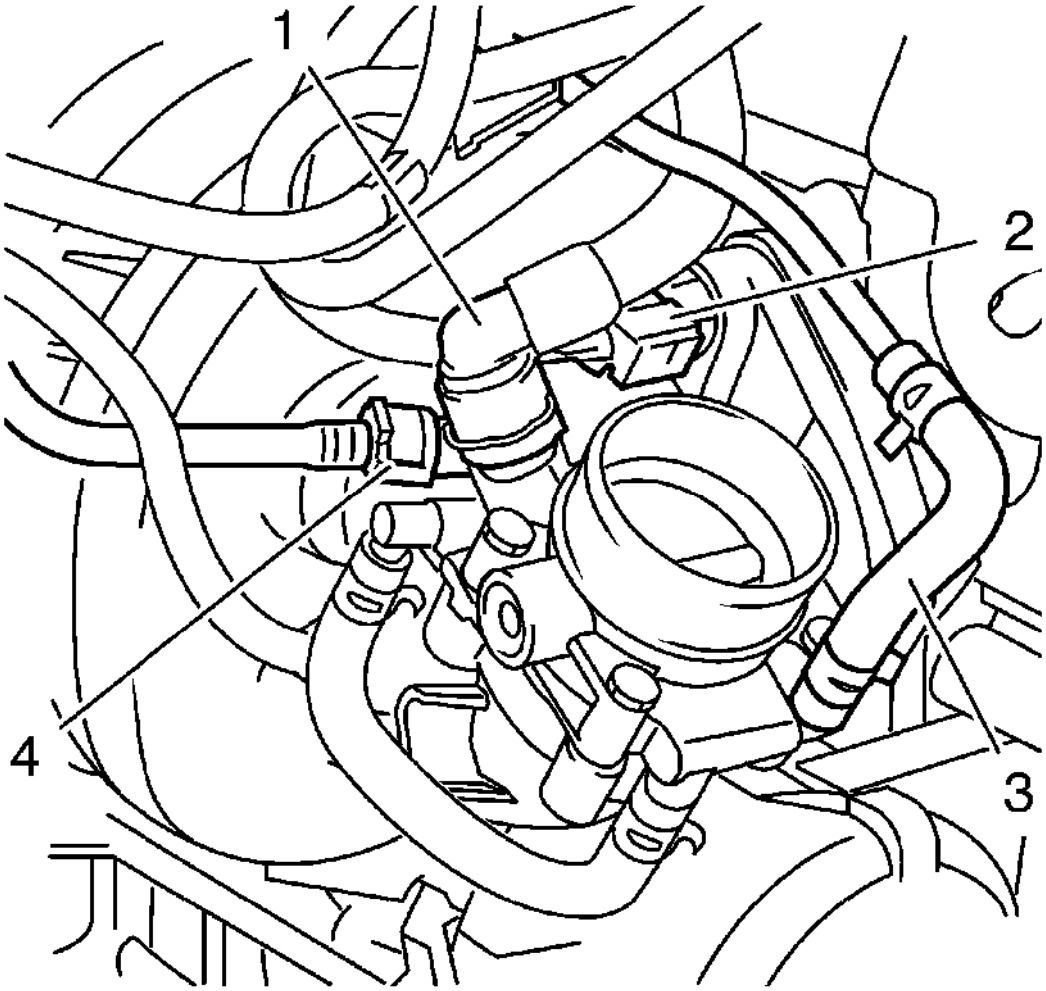


Fig. 12: Throttle Body Heater Outlet Pipe, Throttle Body Heater Inlet Pipe And Positive Crankcase Ventilation Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the wiring harness plug (2).
3. Disconnect the positive crankcase ventilation pipe (1).
4. Place collecting basin underneath.

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5. Disconnect the throttle body heater outlet pipe (4).
6. Disconnect the throttle body heater inlet pipe (3).

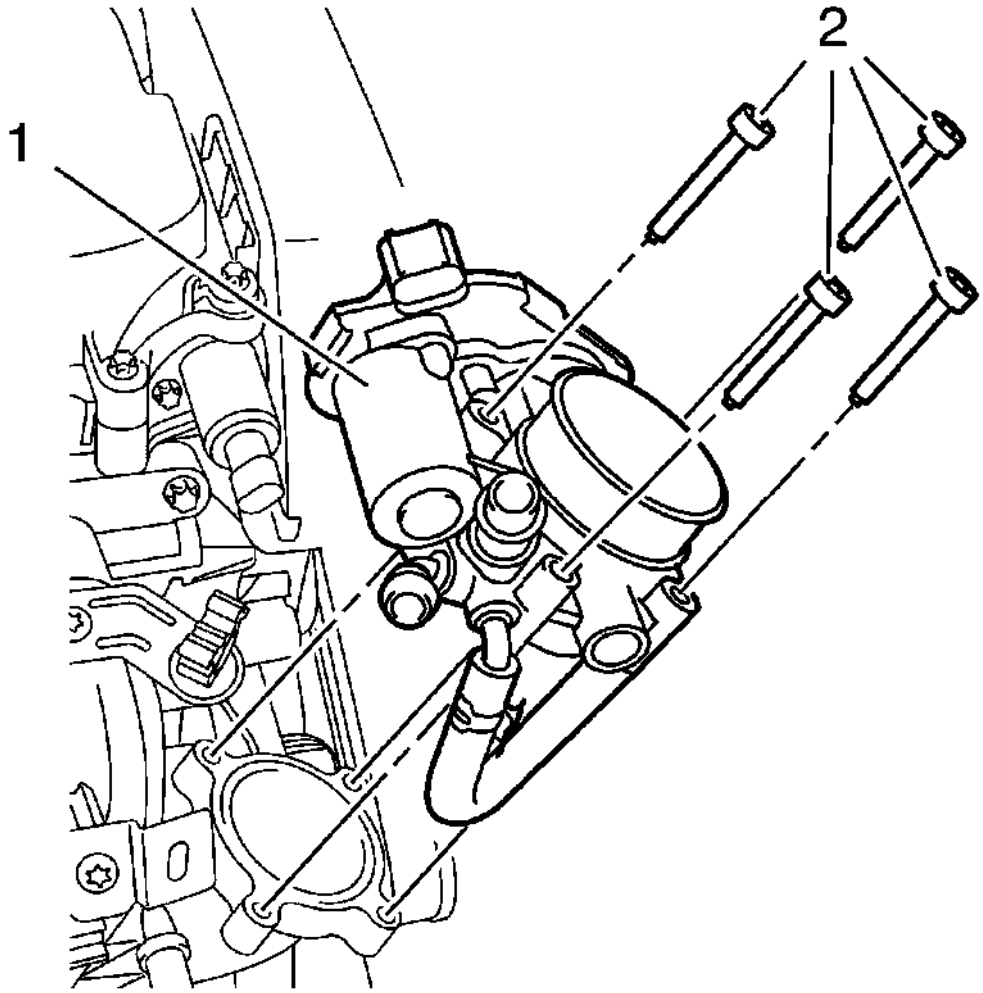


Fig. 13: Throttle Body
Courtesy of GENERAL MOTORS COMPANY

7. Remove the 4 throttle body bolts (2).
8. Remove the throttle body (1).
9. Remove and DISCARD the throttle body gasket.

Installation Procedure

1. Install a NEW throttle body gasket.

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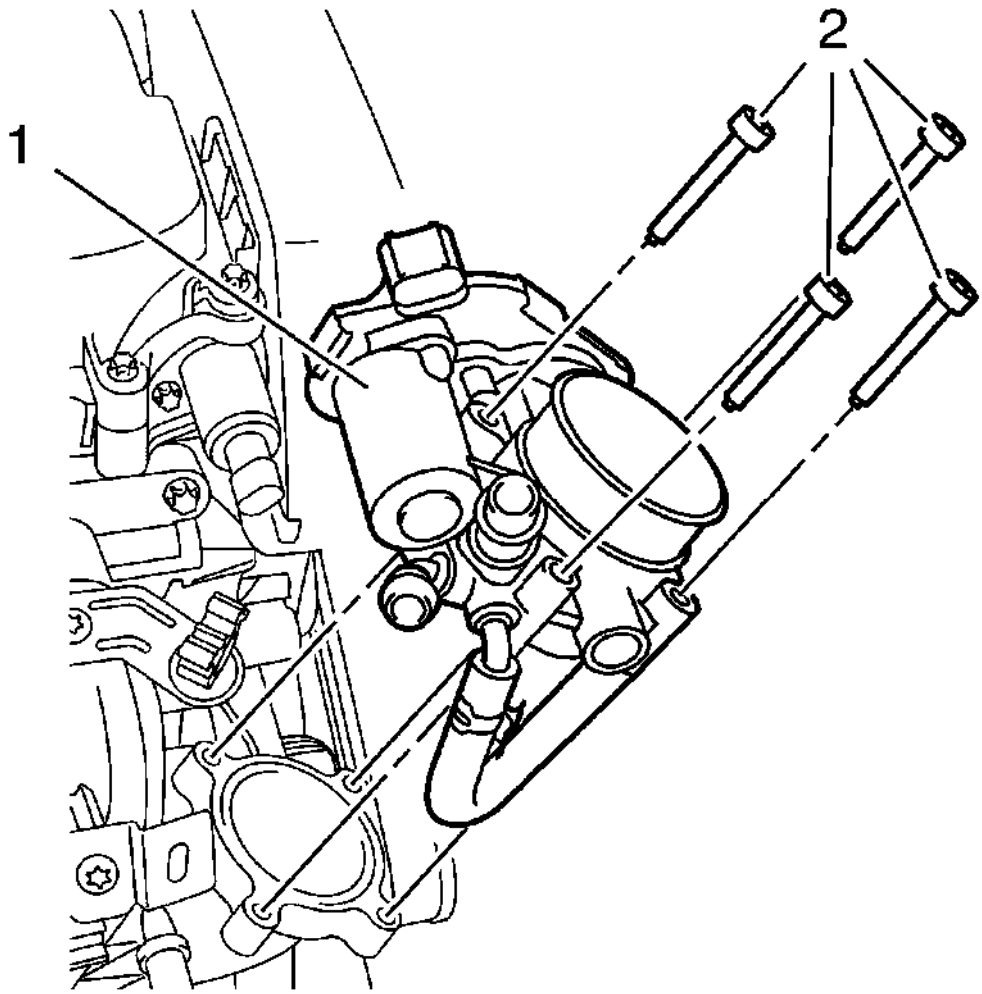


Fig. 14: Throttle Body
Courtesy of GENERAL MOTORS COMPANY

2. Install the throttle body (1).

CAUTION: Refer to Fastener Caution .

3. Install the 4 throttle body bolts (2) and tighten to 8 N.m (71 lb in).

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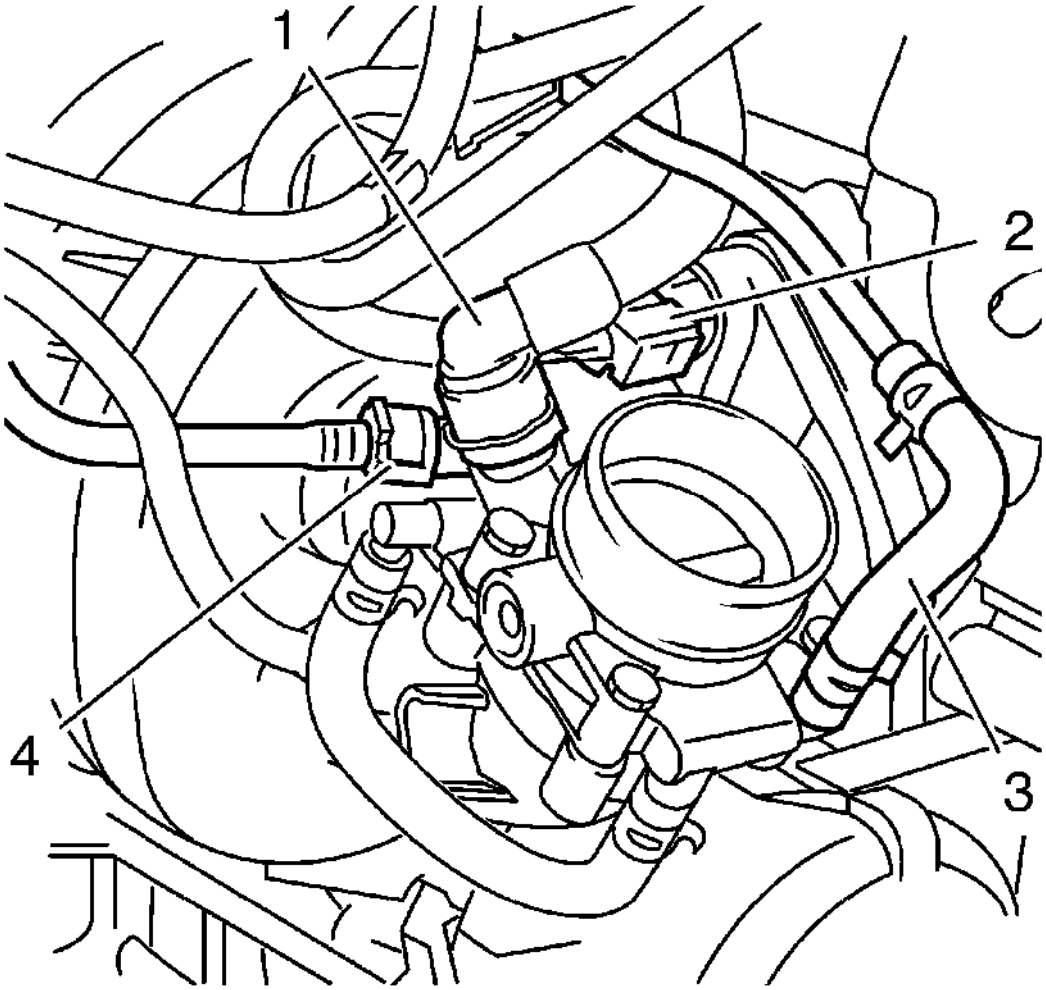


Fig. 15: Throttle Body Heater Outlet Pipe, Throttle Body Heater Inlet Pipe And Positive Crankcase Ventilation Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Connect the throttle body heater inlet pipe (3).
5. Connect the throttle body heater outlet pipe (4).
6. Connect the positive crankcase ventilation pipe (1).
7. Connect the wiring harness plug (2).
8. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
9. Perform the throttle/idle learn procedure. Refer to **Throttle/Idle Learn**.

SECONDARY AIR INJECTION PUMP INLET HOSE REPLACEMENT

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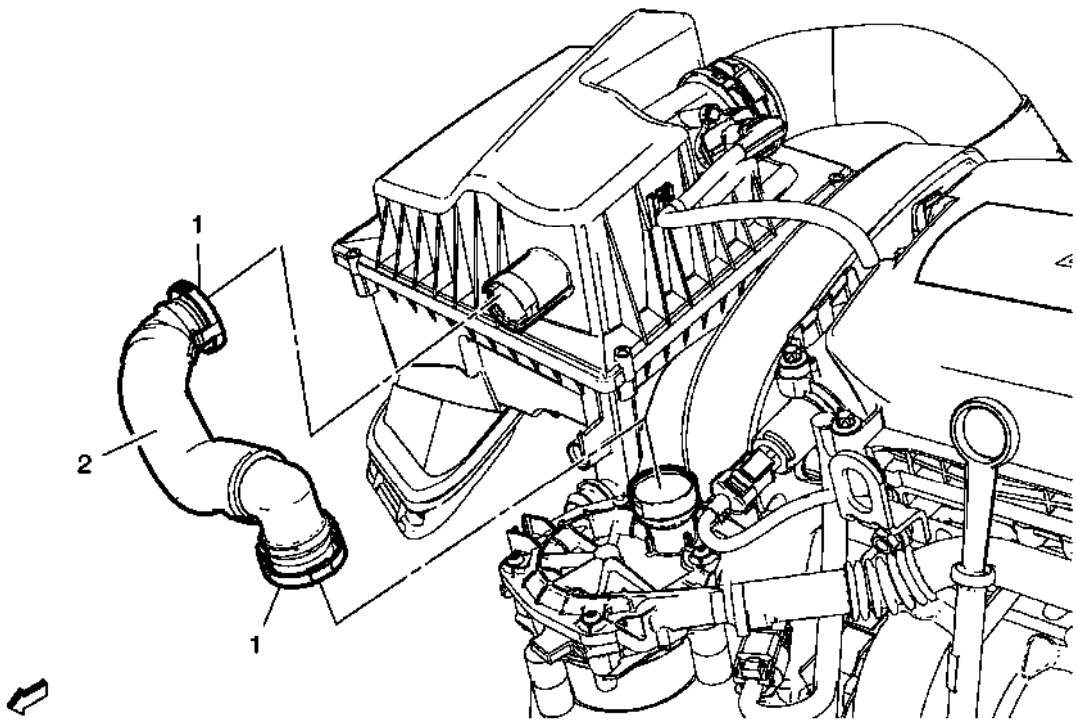


Fig. 16: Secondary Air Injection Pump Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Pump Inlet Hose Replacement

Callout	Component Name
1	Hose Retainer (Qty: 2) Refer to **Plastic Collar Quick Connect Fitting Service**.
2	Secondary Air Injection Pump Inlet Hose **Procedure** Disconnect the hose from the secondary air injection pump and the air cleaner assembly.

SECONDARY AIR INJECTION CHECK VALVE REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

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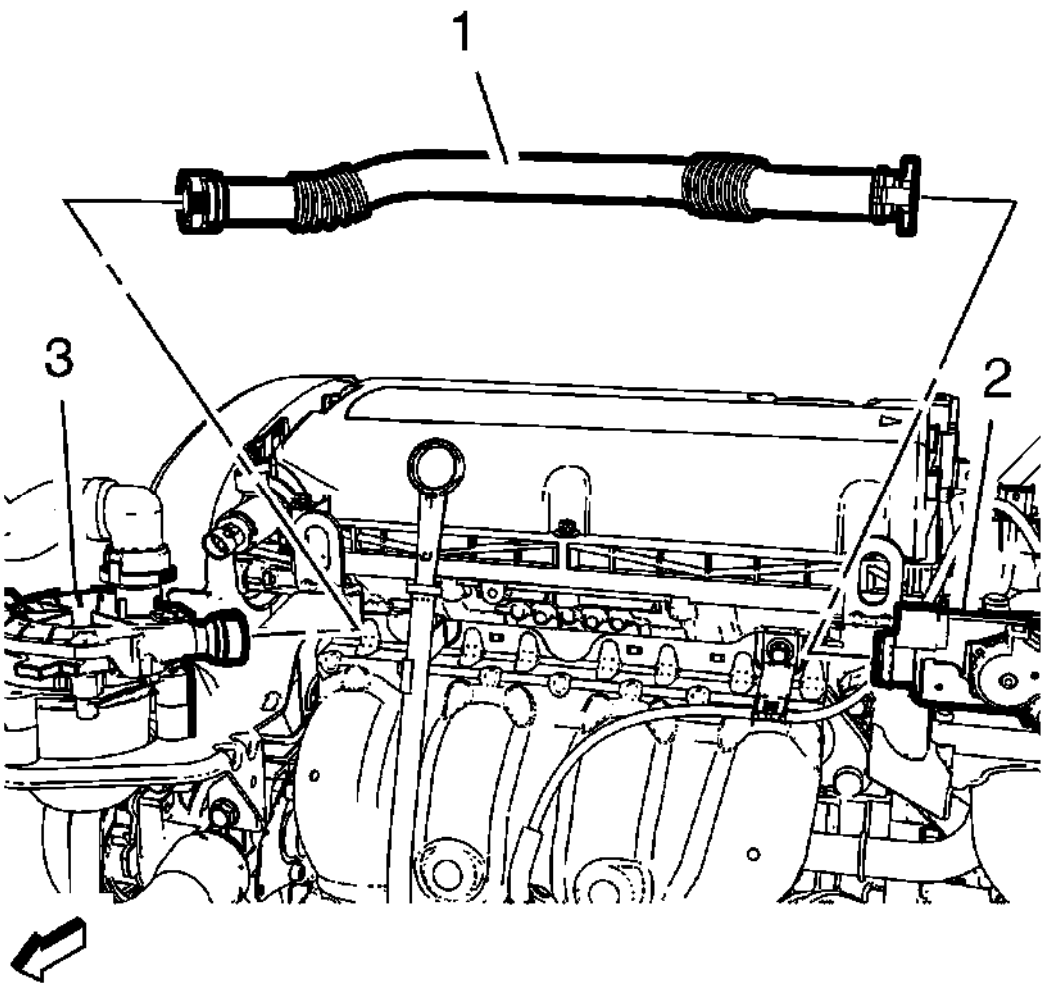


Fig. 17: Secondary Air Injection Pump Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the secondary air injection pump pipe (1) from the secondary air injection check valve (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

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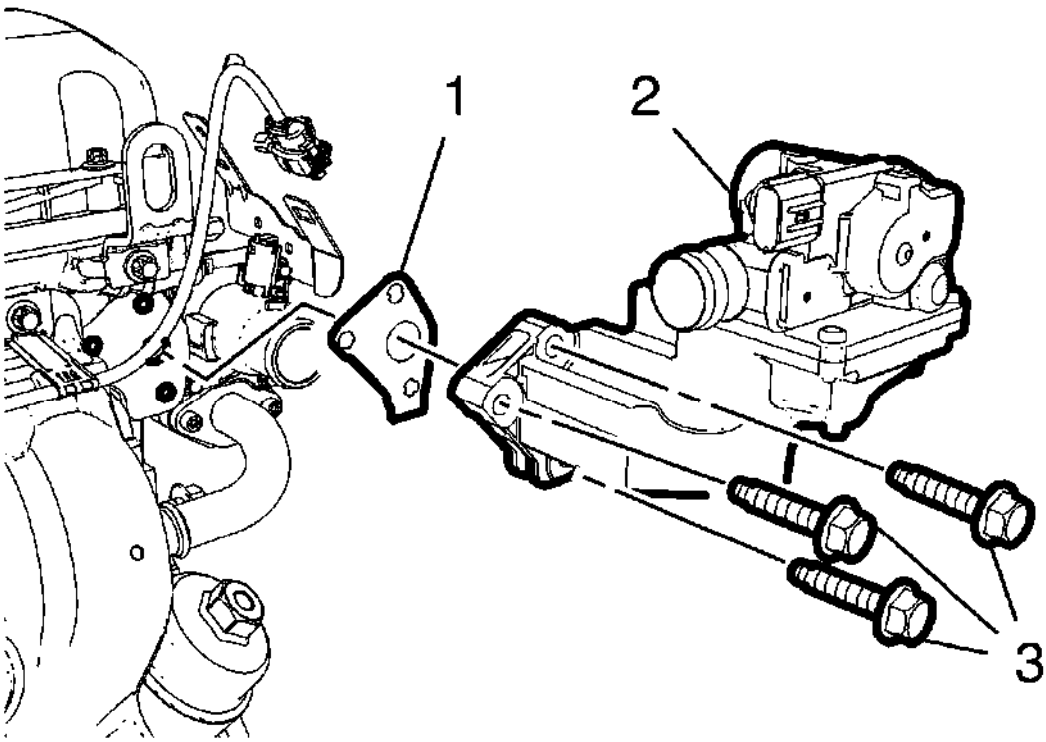


Fig. 18: Secondary Air Injection Check Valve Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 3 secondary air injection check valve bolts (3).
4. Remove and DISCARD the secondary air injection check valve gasket (1).
5. Remove the secondary air injection check valve (2).

Installation Procedure

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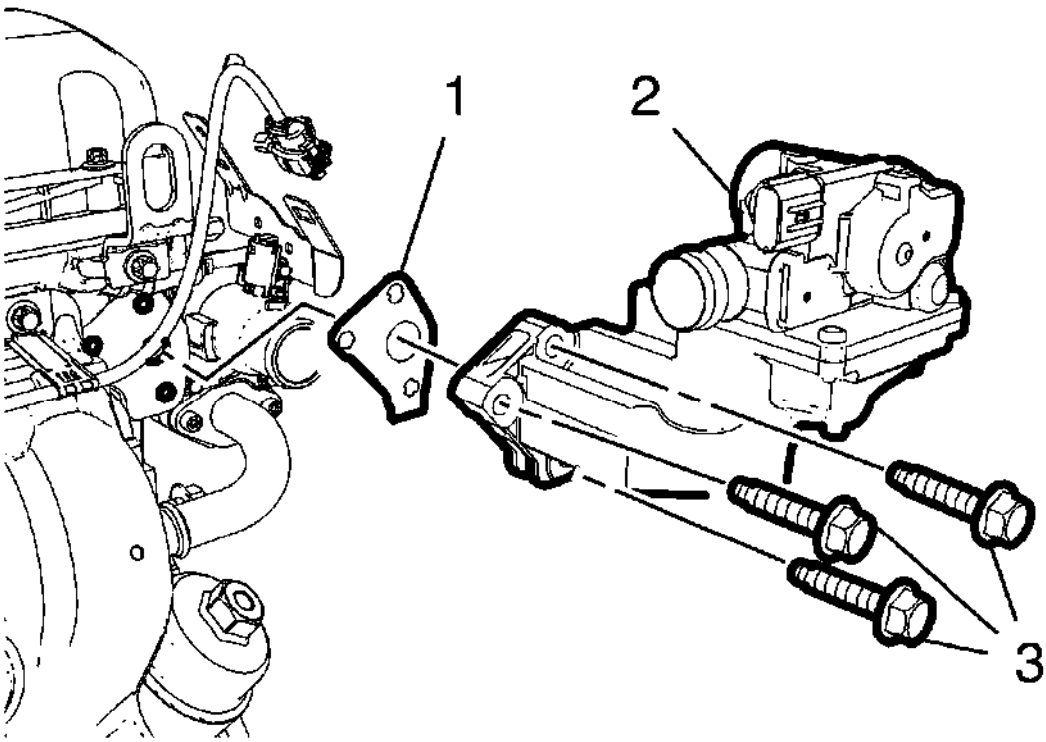


Fig. 19: Secondary Air Injection Check Valve Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW secondary air injection check valve gasket (1).
2. Install the secondary air injection check valve (2).

CAUTION: Refer to Fastener Caution .

3. Install the 3 secondary air injection check valve bolts (3) and tighten to 22 N.m (16 lb ft).

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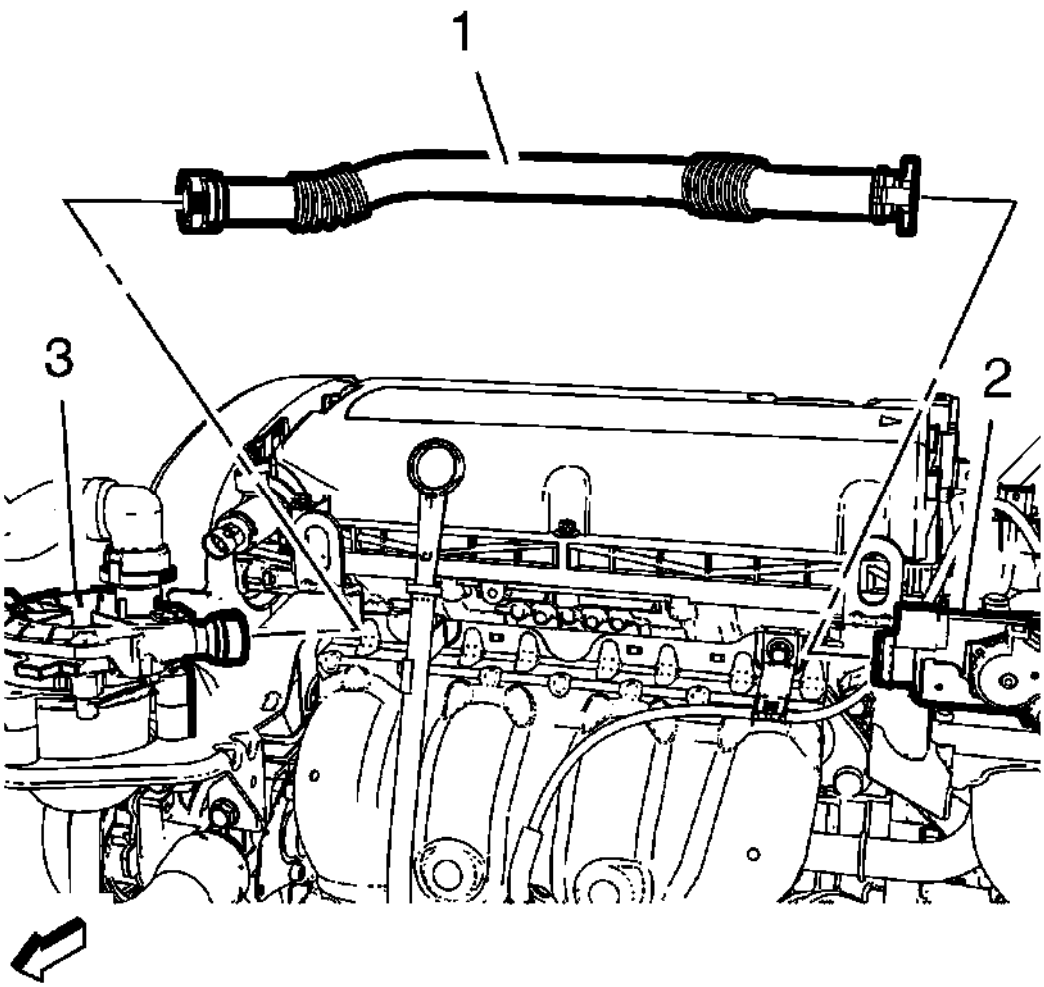


Fig. 20: Secondary Air Injection Pump Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Connect the secondary air injection pump pipe (1) to the secondary air injection check valve (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
5. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

SECONDARY AIR INJECTION PUMP PIPE REPLACEMENT

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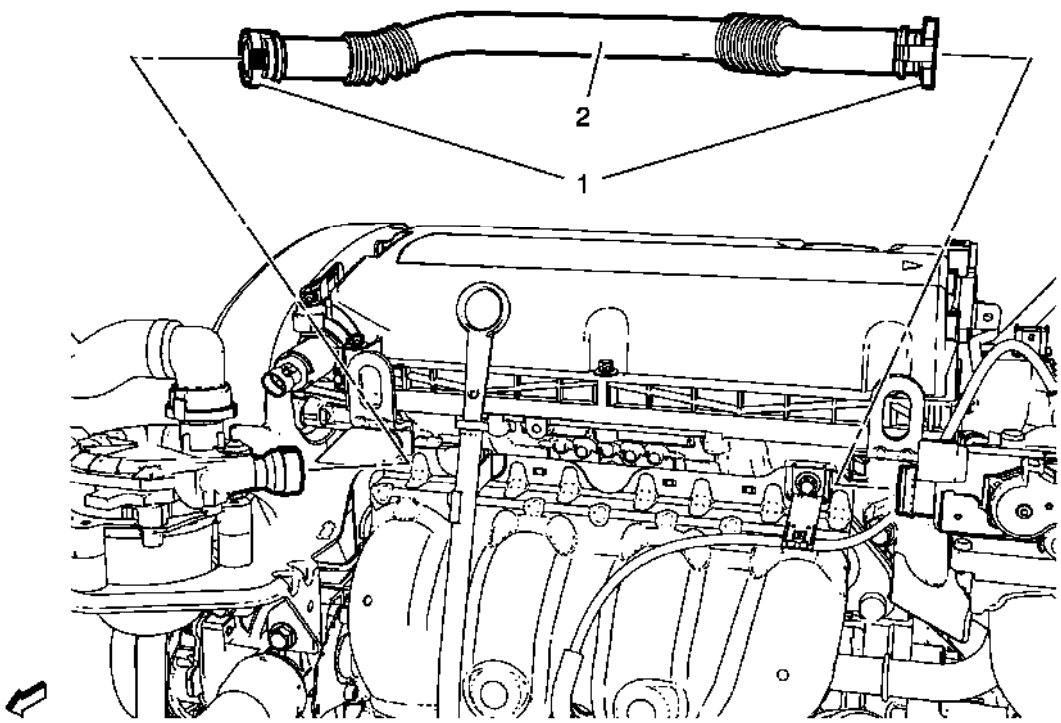


Fig. 21: Secondary Air Injection Pump Pipe
Courtesy of GENERAL MOTORS COMPANY

Secondary Air Injection Pump Pipe Replacement

Callout	Component Name
1	Pipe Retainer (Qty: 2) Refer to **Plastic Collar Quick Connect Fitting Service**.
2	Secondary Air Injection Pump Pipe. **Procedure** Disconnect the pipe from the secondary air injection pump and the secondary air injection check valve.

SECONDARY AIR INJECTION PUMP REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

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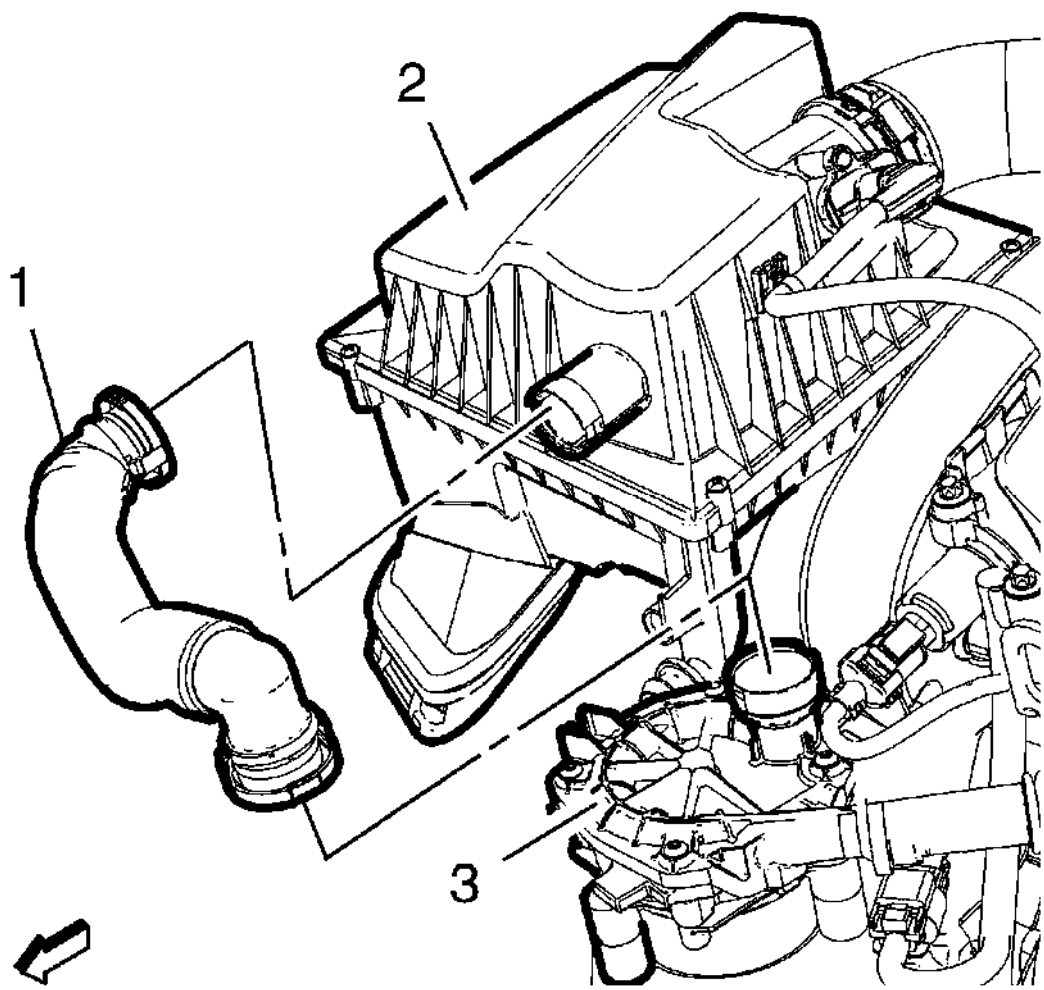


Fig. 22: Secondary Air Injection Pump Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the secondary air injection pump inlet hose (1) from the secondary air injection pump (3) and the air cleaner assembly (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

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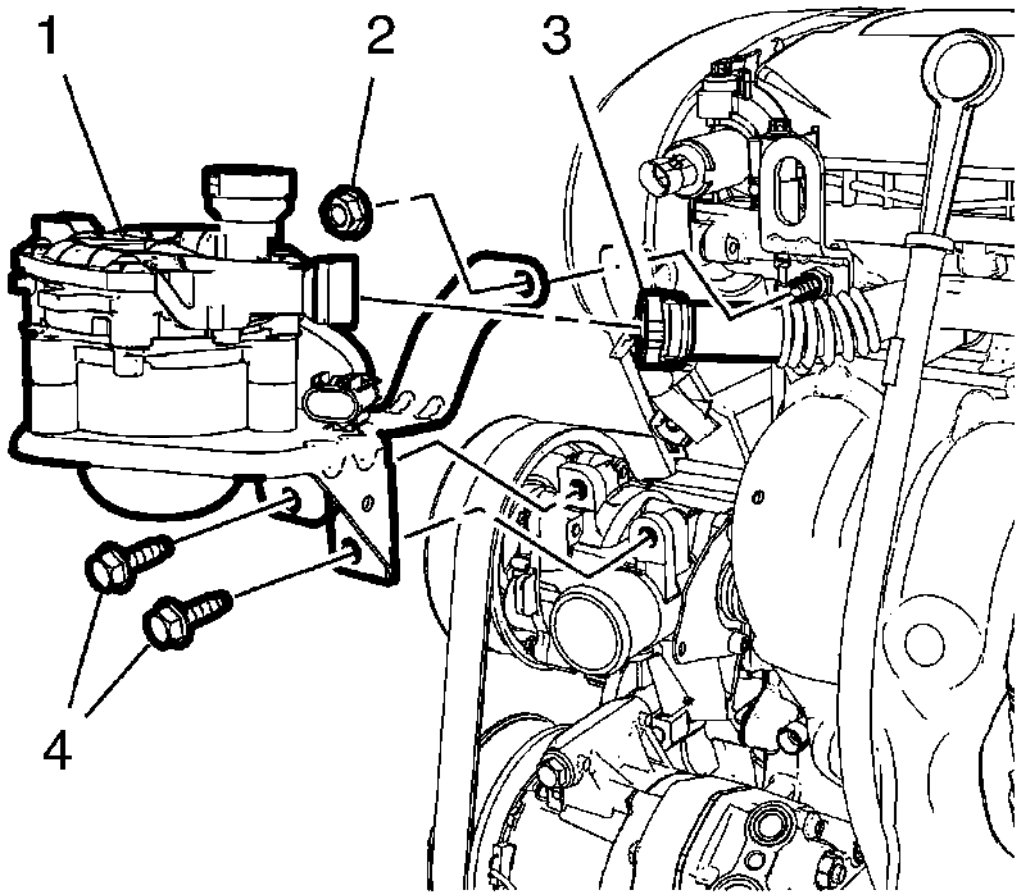


Fig. 23: Secondary Air Injection Pump Pipe
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the secondary air injection pump pipe (3). Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Remove the secondary air injection pump nut (2) and the 2 secondary air injection pump bolts (4).
5. Remove the secondary air injection pump (1).

Installation Procedure

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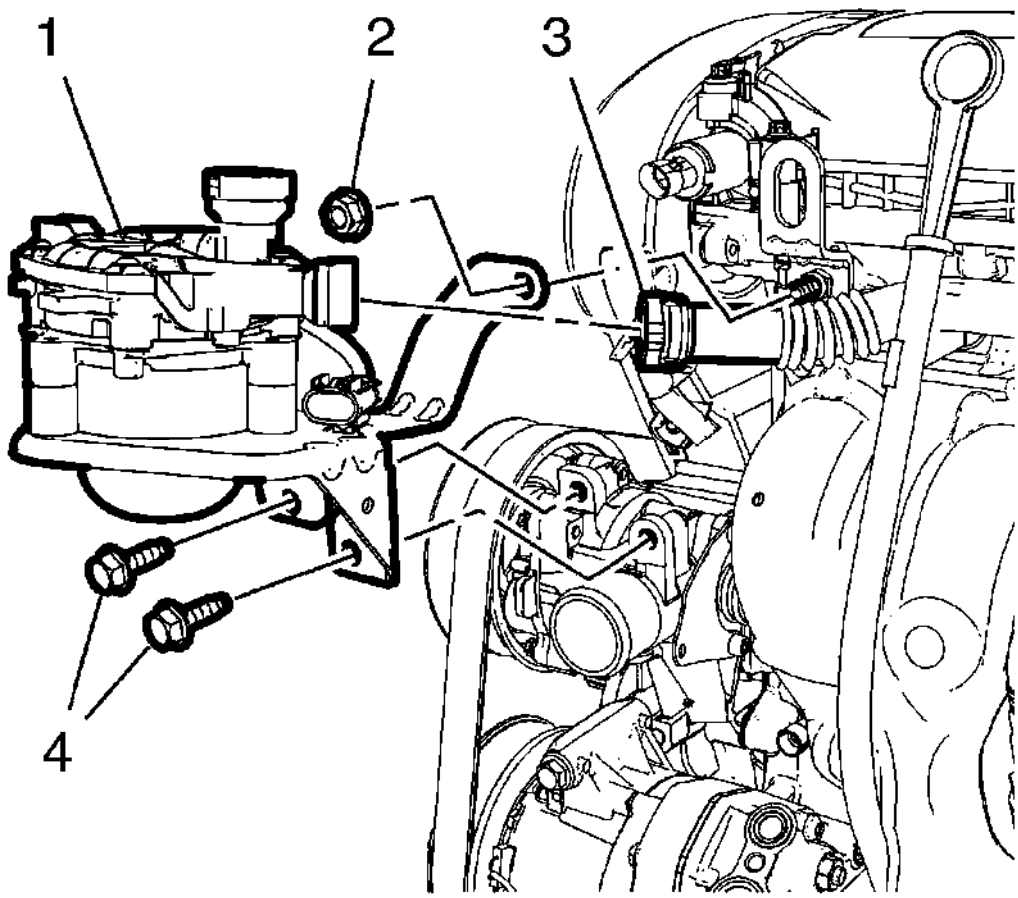


Fig. 24: Secondary Air Injection Pump Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install the secondary air injection pump (1).
2. Loosely install the secondary air injection pump nut (2) and the 2 secondary air injection pump bolts (4).

CAUTION: Refer to Fastener Caution .

3. Tighten the secondary air injection pump nut (2) and the 2 secondary air injection pump bolts (4) to 22 N.m (16 lb ft).
4. Connect the secondary air injection pump pipe (3). Refer to **Plastic Collar Quick Connect Fitting Service**.

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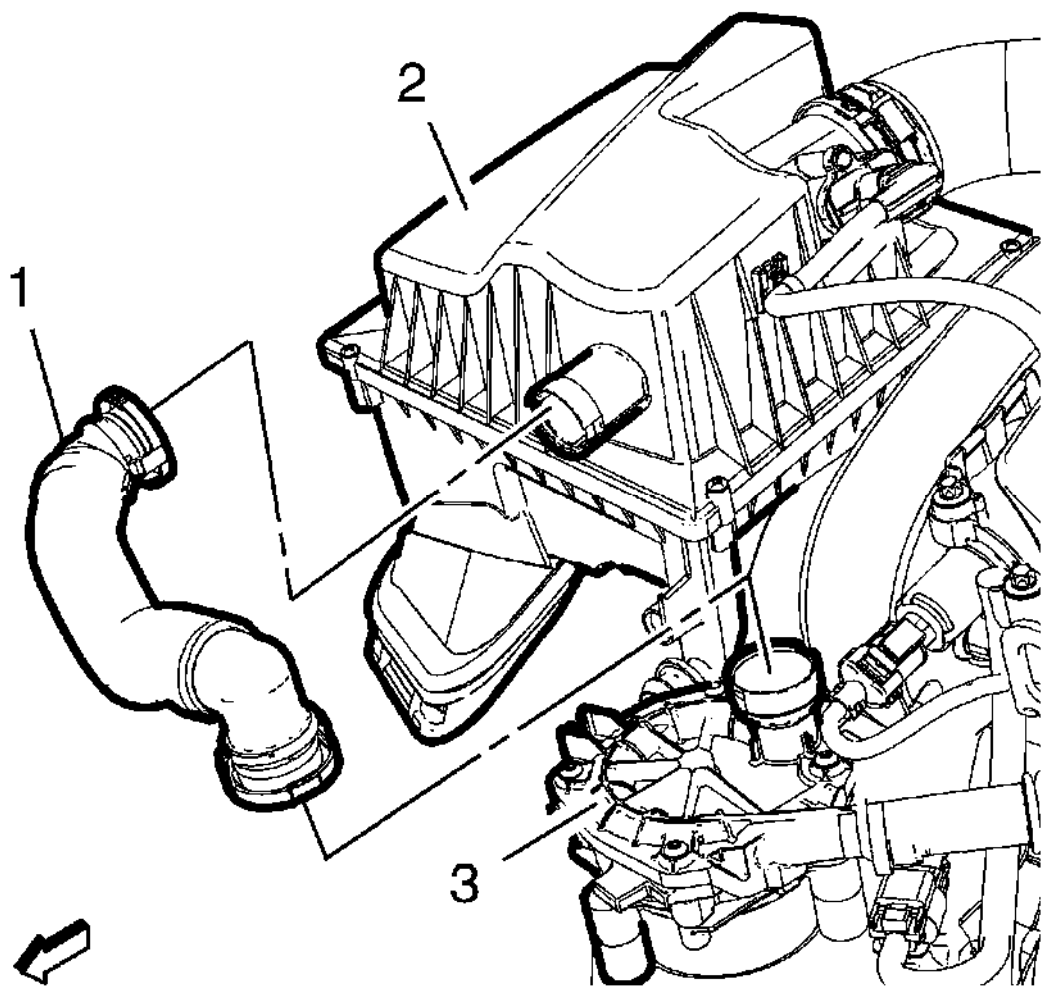


Fig. 25: Secondary Air Injection Pump Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

5. Connect the secondary air injection pump inlet hose (1) to the secondary air injection pump (3) and the air cleaner assembly (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

THROTTLE BODY INSPECTION AND CLEANING

NOTE: Over extended time and mileage, deposits may accumulate on the back of the throttle valve plate. The source of the deposit is exhaust gas. Typically these deposits pose no problem. Occasionally the deposit may accumulate to a point where perceived pedal effort or throttle valve movement is effected. This procedure should not be performed on vehicles with mileage under 80, 450 km (50, 000 mi).

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

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

CAUTION: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

2. Inspect the throttle body bore and the throttle valve plate for deposits. You will need to open the throttle valve in order to inspect all surfaces.

CAUTION: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

3. Clean the throttle body bore and the throttle valve plate using a clean shop towel with an appropriate cleaner.
4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
5. Perform the throttle/idle learn procedure. Refer to **Throttle/Idle Learn**.

FUEL PRESSURE RELIEF

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

1. Disconnect the battery. Refer to **Battery Negative Cable Disconnection and Connection** .

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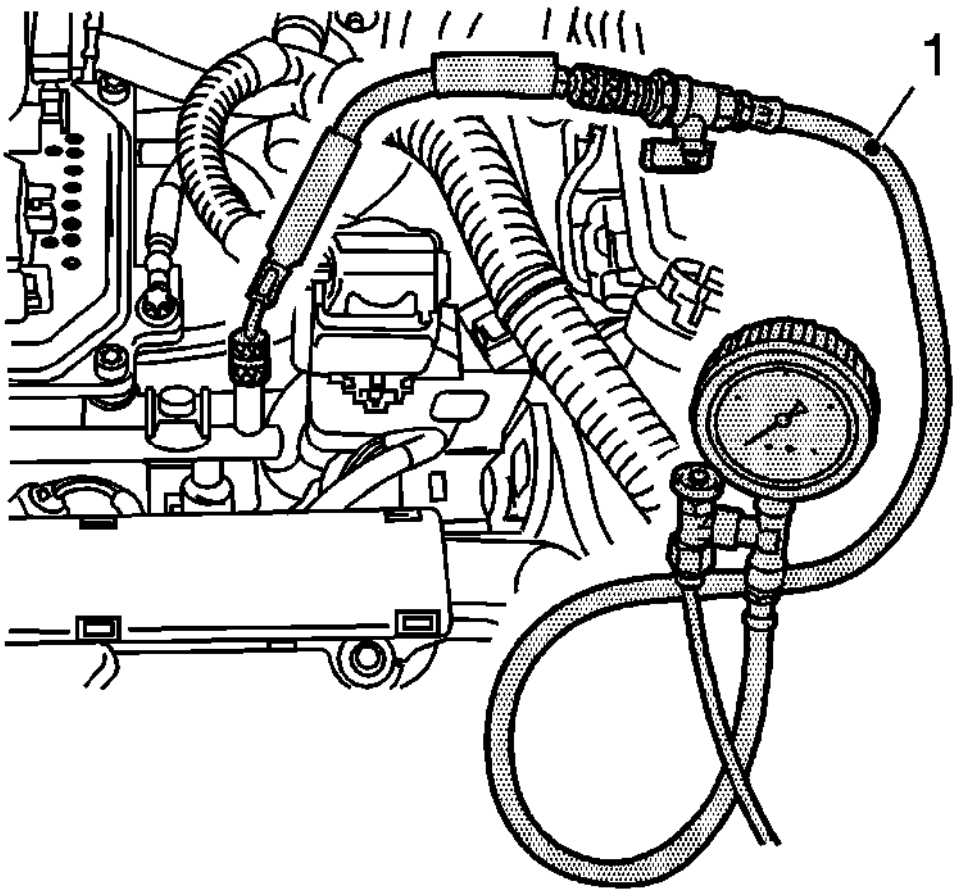


Fig. 26: View Of Fuel Pressure Tester
Courtesy of GENERAL MOTORS COMPANY

2. Remove the protective cap from the test connection.
3. Relieve the fuel pressure, using the **EN-34730-91** Pressure Tester (1).

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Plastic Quick Connect Fitting Type Identification

Plastic Quick Connect Fitting Type A

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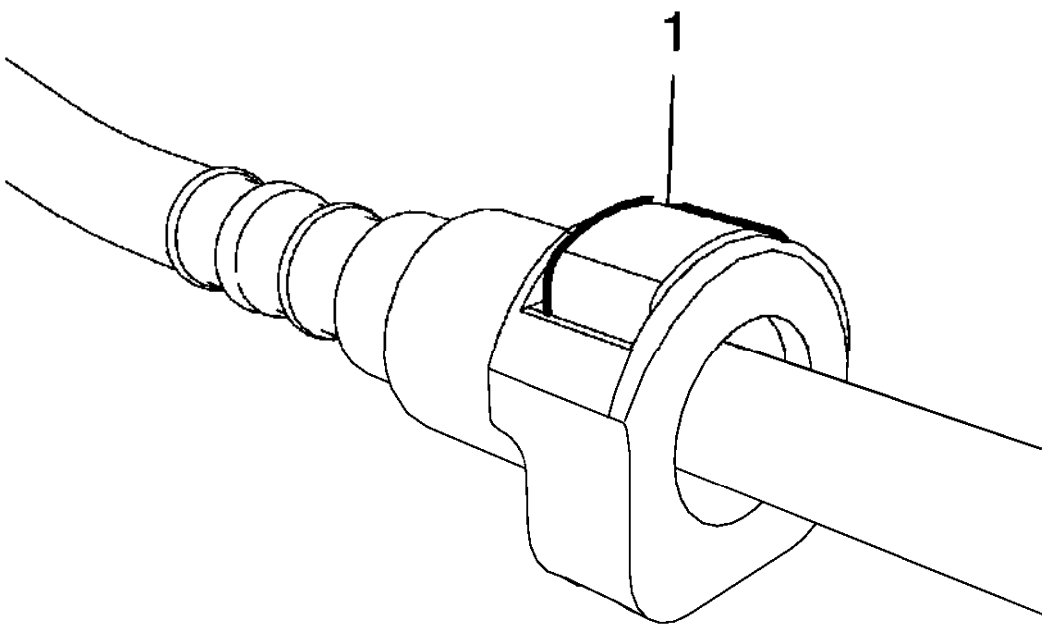


Fig. 27: Quick Connect Fitting Type A
Courtesy of GENERAL MOTORS COMPANY

Quick connect fitting type A - TI loc with one latch (1).

Plastic Quick Connect Fitting Type B

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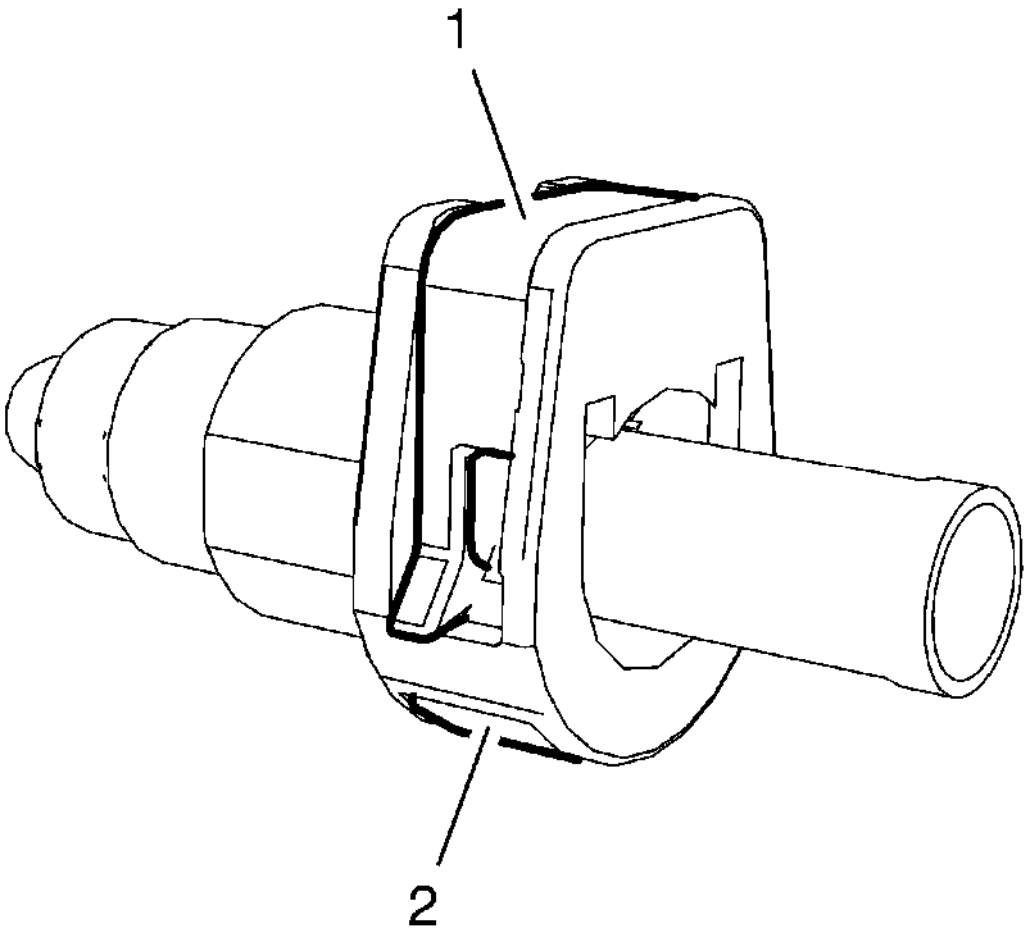


Fig. 28: Quick Connect Fitting Type B
Courtesy of GENERAL MOTORS COMPANY

- Quick connect fitting type B - TI loc upper latch (1).
- Quick connect fitting type B - TI loc lower latch (2).

Plastic Quick Connect Fitting Type C

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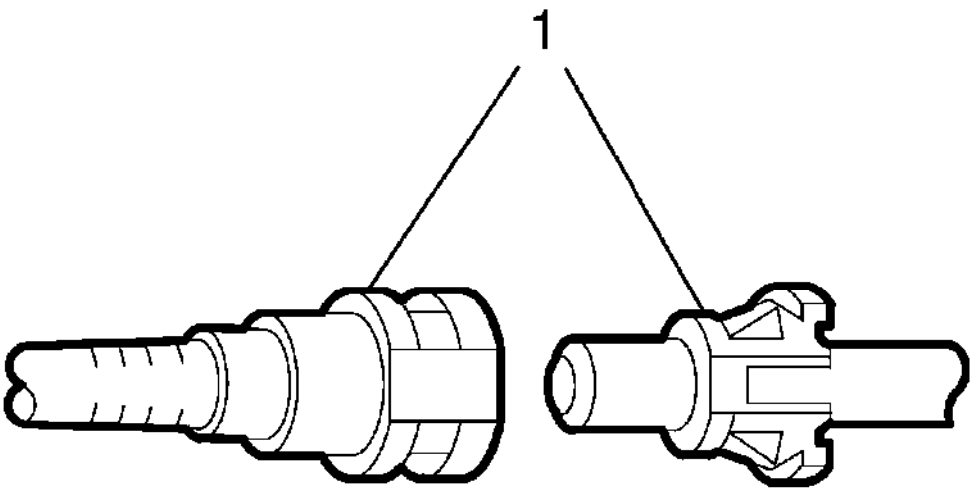


Fig. 29: Quick Connect Fitting Type C
Courtesy of GENERAL MOTORS COMPANY

Quick connect fitting type C (1).

Plastic Quick Connect Fitting Type D

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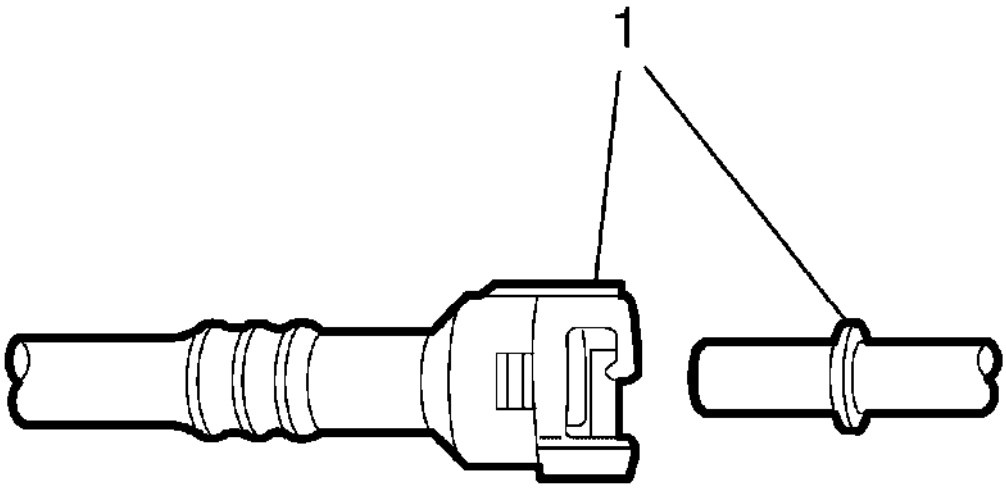


Fig. 30: Quick Connect Fitting Type D
Courtesy of GENERAL MOTORS COMPANY

Quick connect fitting type D (1).

Plastic Quick Connect Fitting Type E

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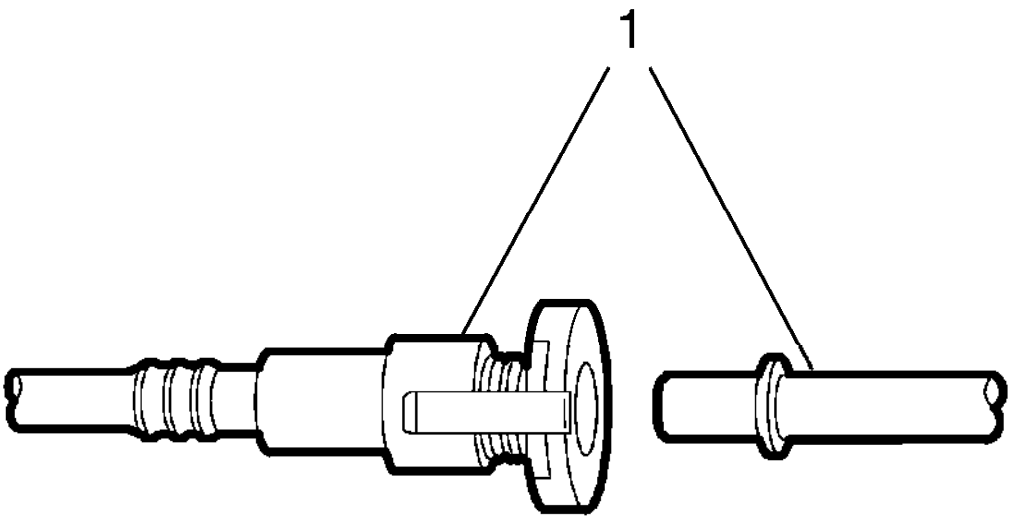


Fig. 31: Quick Connect Fitting Type E
Courtesy of GENERAL MOTORS COMPANY

Quick connect fitting type E (1).

Plastic Quick Connect Fitting Type F

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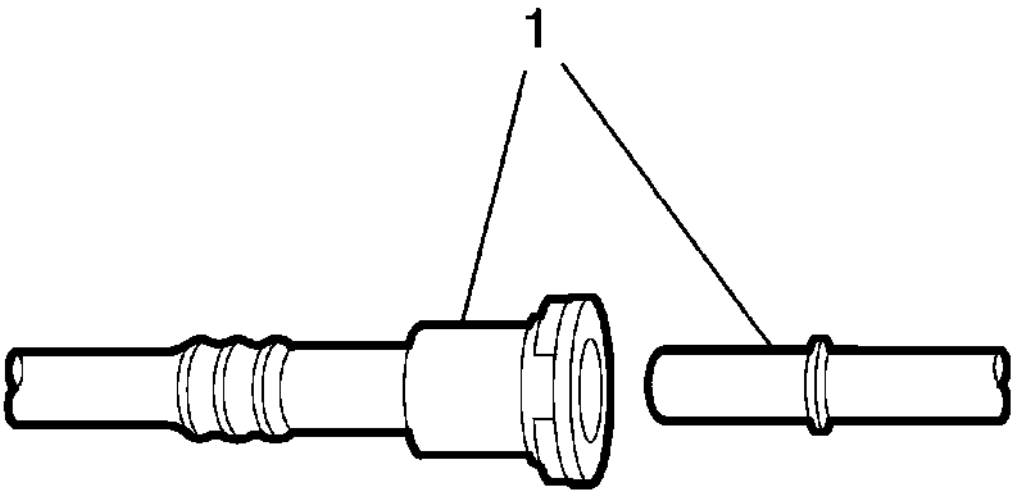


Fig. 32: Quick Connect Fitting Type F
Courtesy of GENERAL MOTORS COMPANY

Quick connect fitting type F (1).

Plastic Quick Connect Fitting Type G

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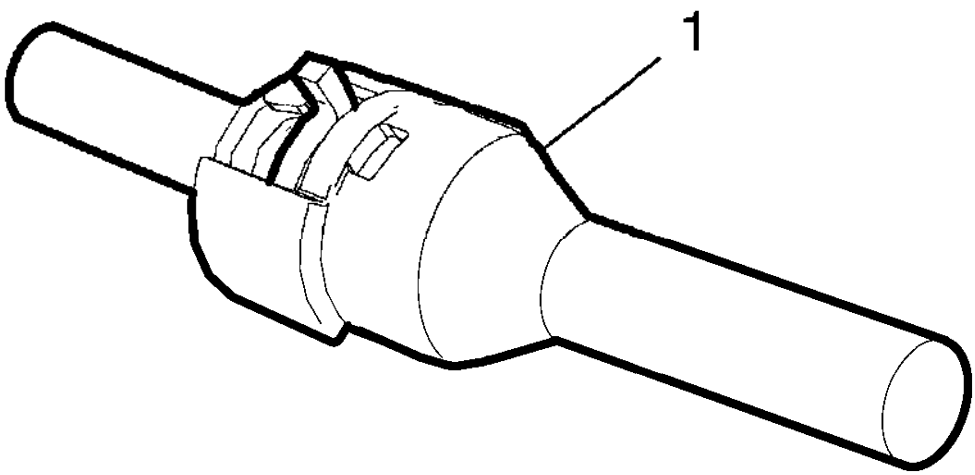


Fig. 33: Quick Connect Fitting Type G
Courtesy of GENERAL MOTORS COMPANY

Quick connect fitting type G (1).

Plastic Quick Connect Fitting Type H

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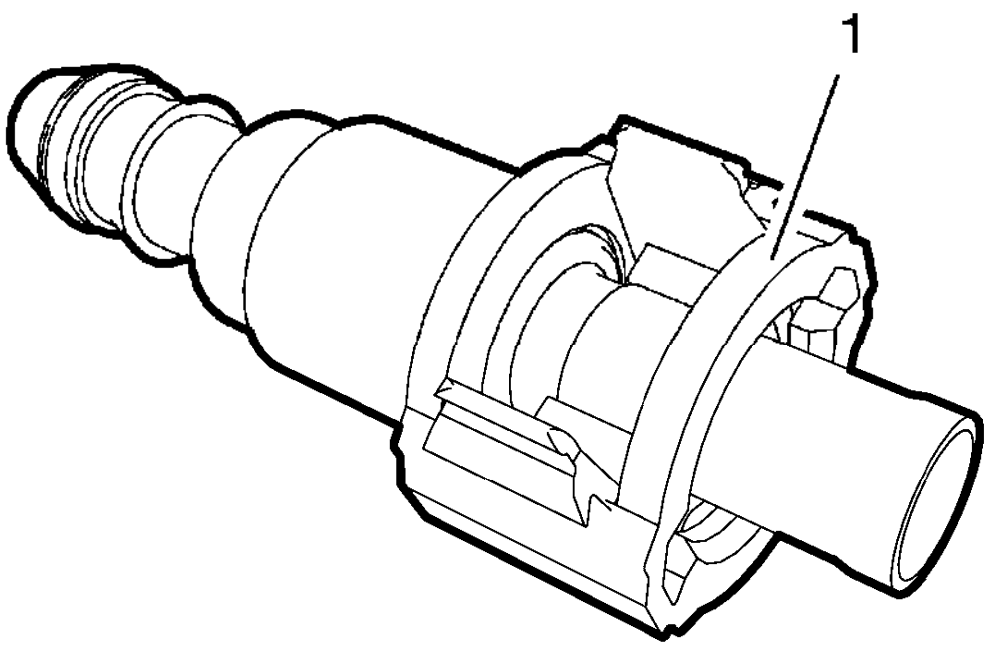


Fig. 34: Quick Connect Fitting Type H
Courtesy of GENERAL MOTORS COMPANY

Quick connect fitting type H (1).

General Instructions for Handling the Connectors

Before Disconnection

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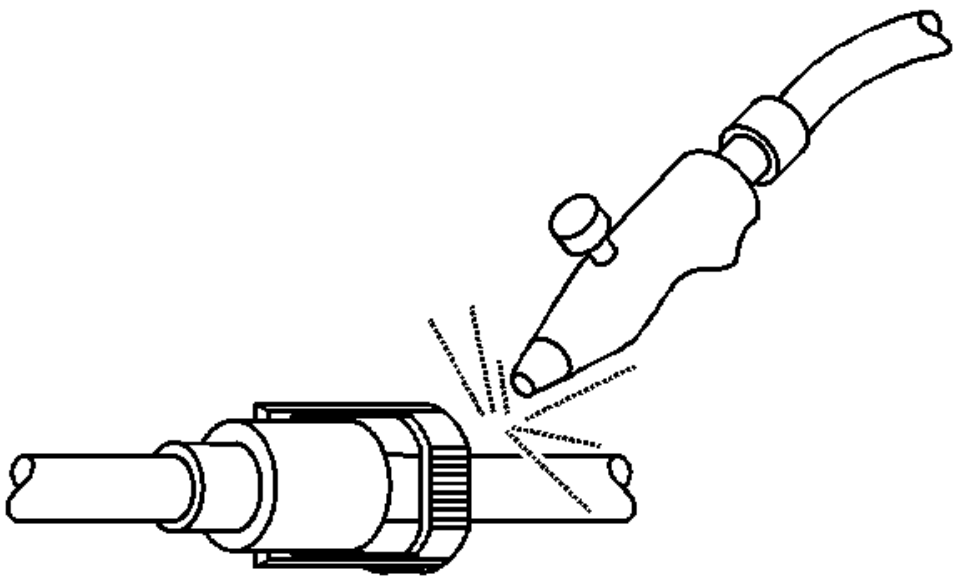


Fig. 35: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

NOTE: The following instructions apply to all of these types of fittings.

Using compressed air, to blow any dirt out of the quick connect fitting.

After Disconnection

- Wipe off the male pipe end using a clean shop towel.
- Inspect both ends of the fitting for dirt and burrs.
- Clean components as required.
- Replace damaged components.

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Type A - Disconnect/Connect

Disconnect

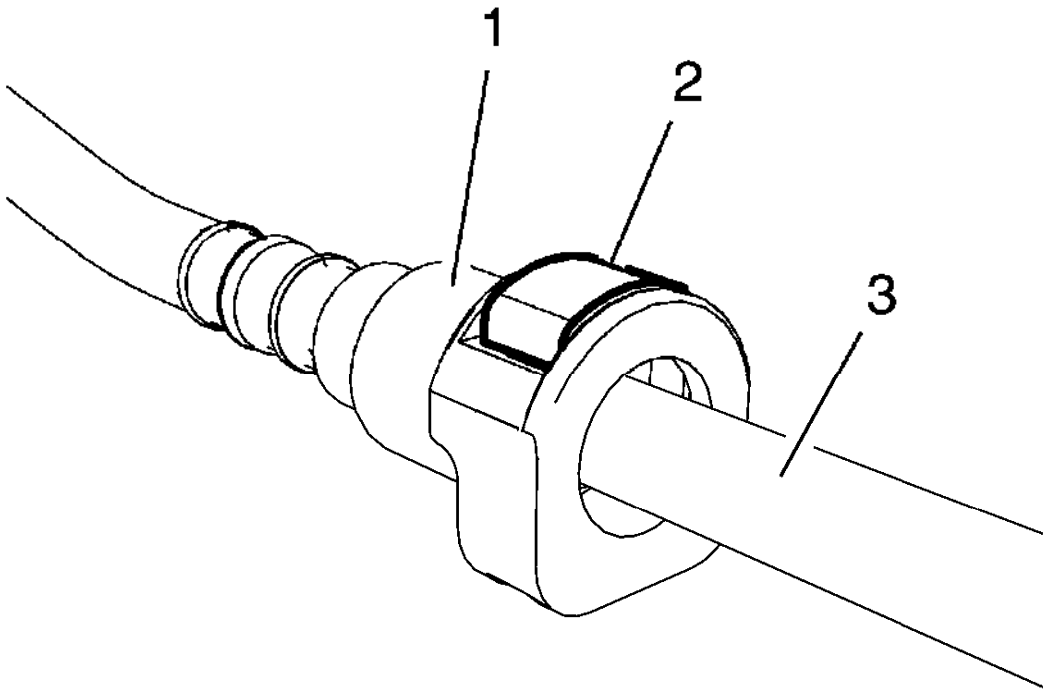


Fig. 36: Pushing Latch Down
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mechanical violence is not necessary for a successful disconnection/connection.

1. Push the tube (3) into the connector (1) and push down the latch (2).

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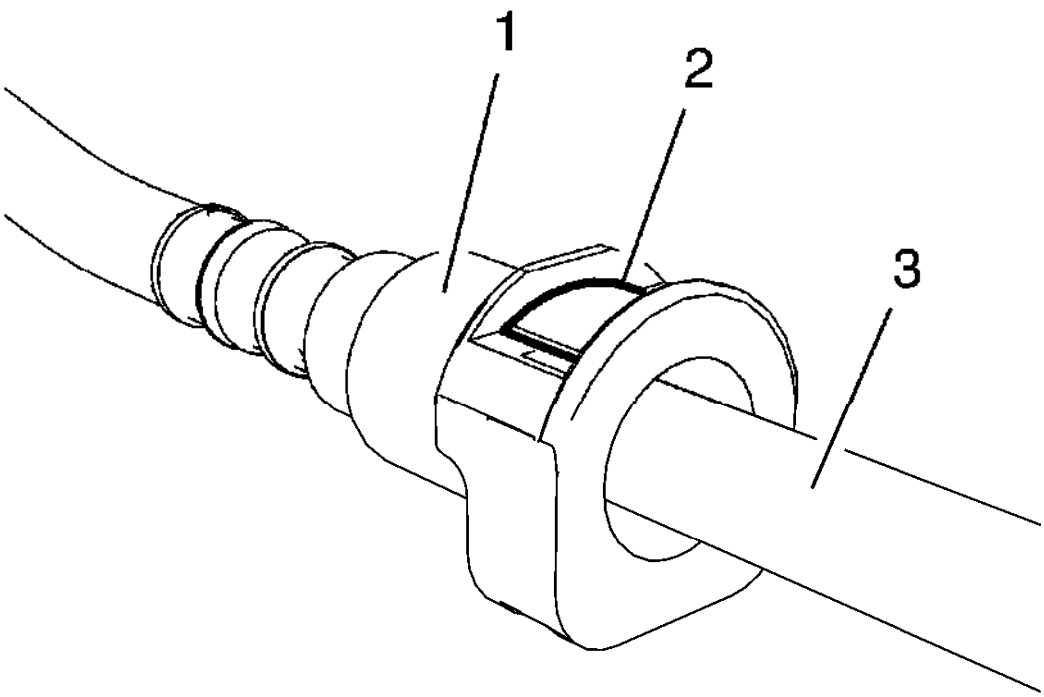


Fig. 37: Pushing Latch Into Connector
Courtesy of GENERAL MOTORS COMPANY

2. Push the latch (2) into the connector (1).

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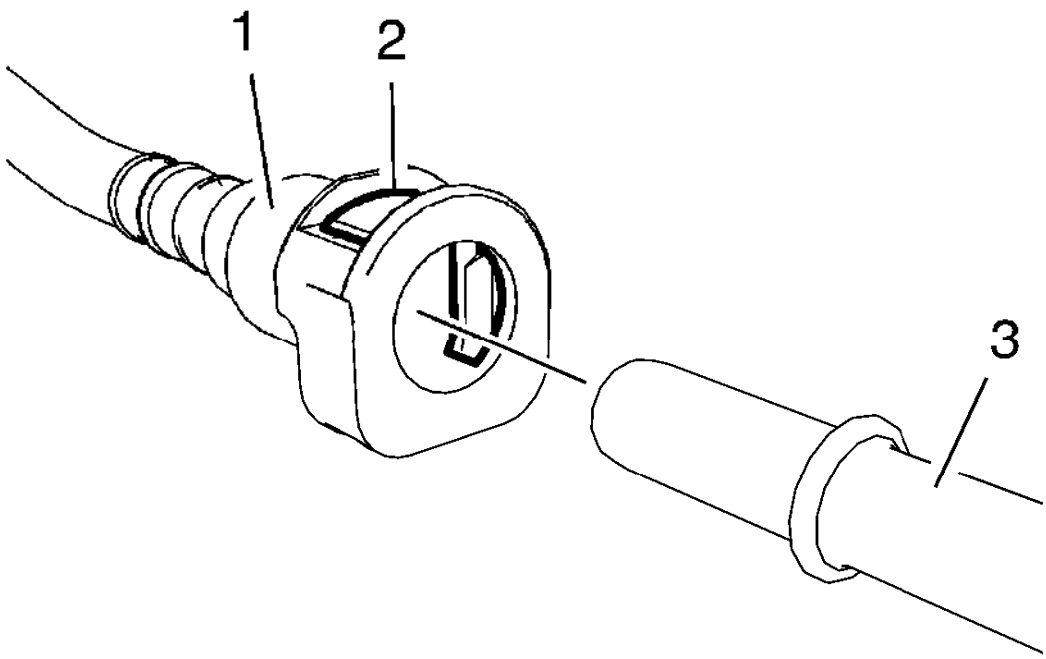


Fig. 38: Pulling Pipe Out Of Connector
Courtesy of GENERAL MOTORS COMPANY

3. Pull the pipe (3) out of the connector (1).
4. Release the latch (2).

Connect

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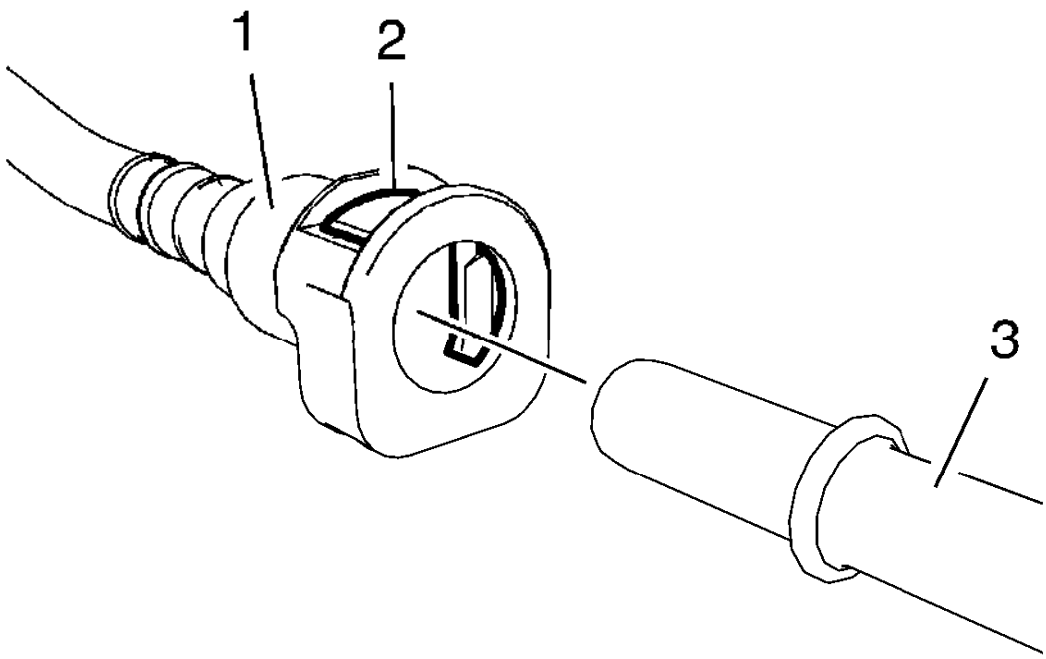


Fig. 39: Pulling Pipe Out Of Connector
Courtesy of GENERAL MOTORS COMPANY

1. Push the pipe (3) into the connector (1).

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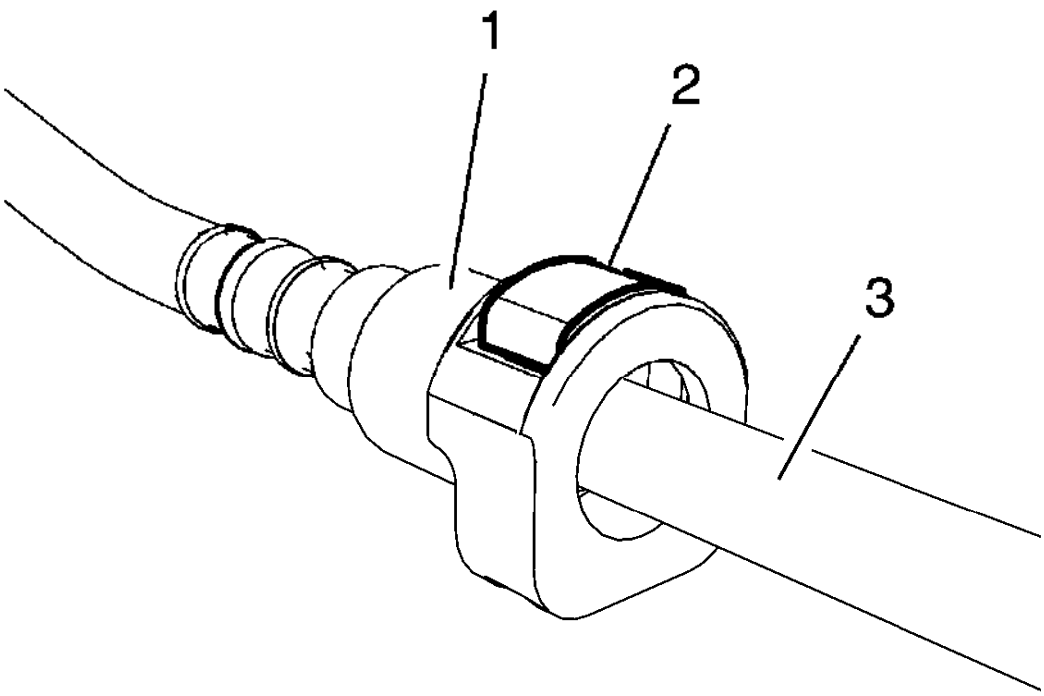


Fig. 40: Pushing Latch Down
Courtesy of GENERAL MOTORS COMPANY

2. When the connector is locked correctly, the latch (2) must align to the connector (1).
3. Do not rely only on the audible click to confirm a secure connection has been made.

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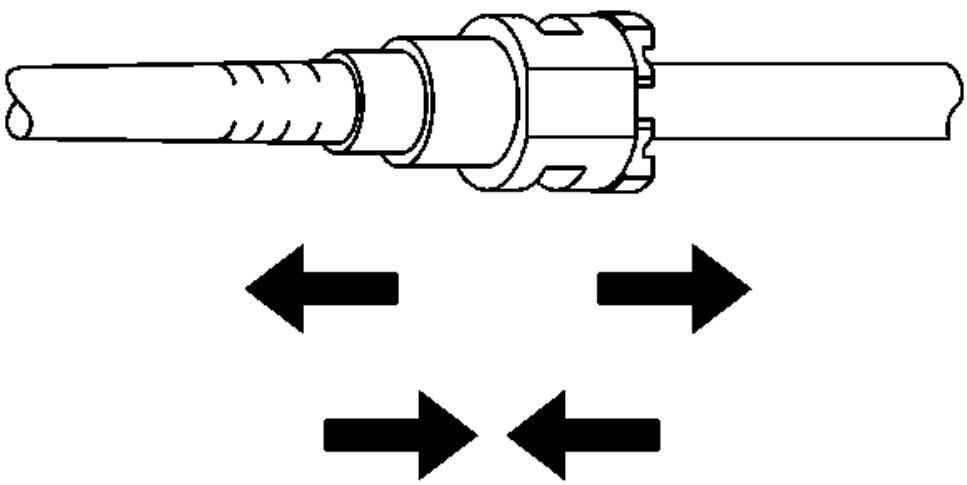


Fig. 41: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

4. Pull on both sides of the quick connect fitting in order to make sure the connection is secure.

Type B - Disconnect/Connect

Disconnect

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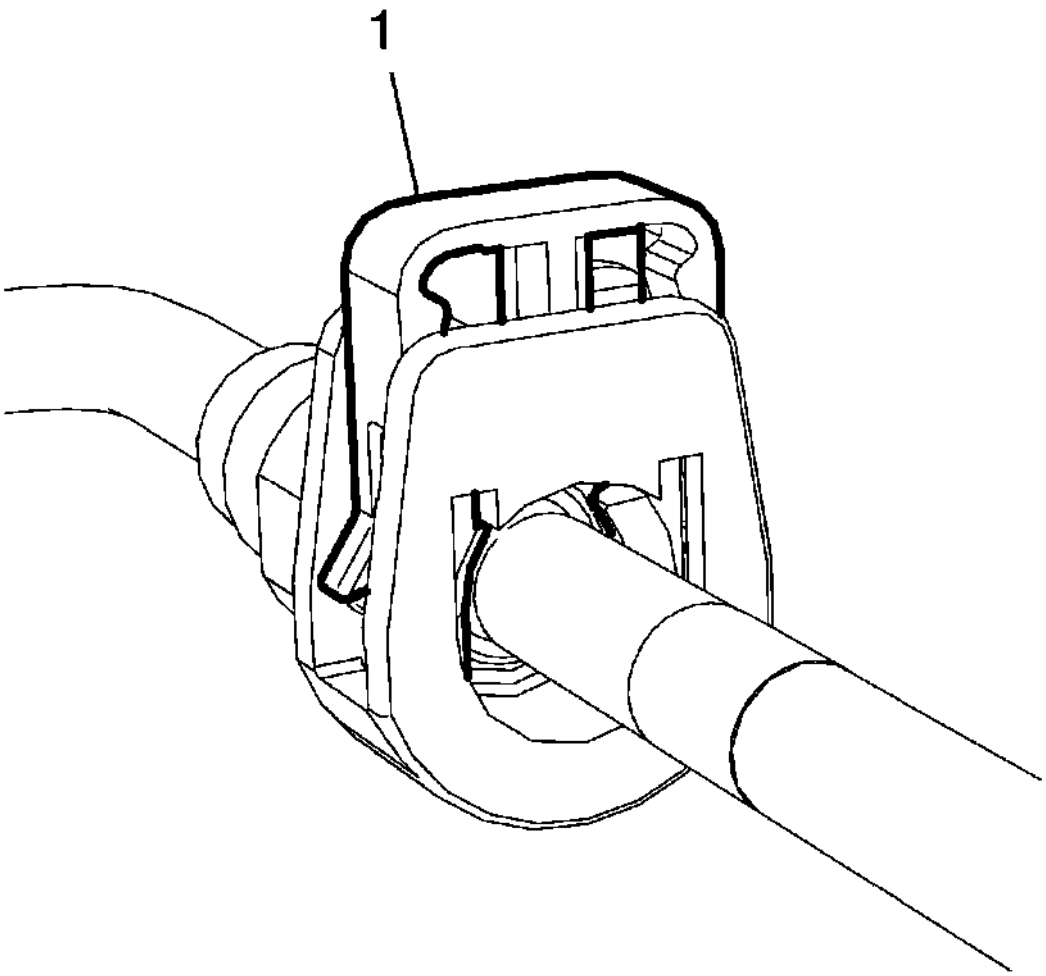


Fig. 42: Pulling Latch Out Of Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mechanical violence is not necessary for a successful disconnection/connection.

1. Unlock the connector by pulling the latch (1) out of the connector. Use a suitable tool if necessary.

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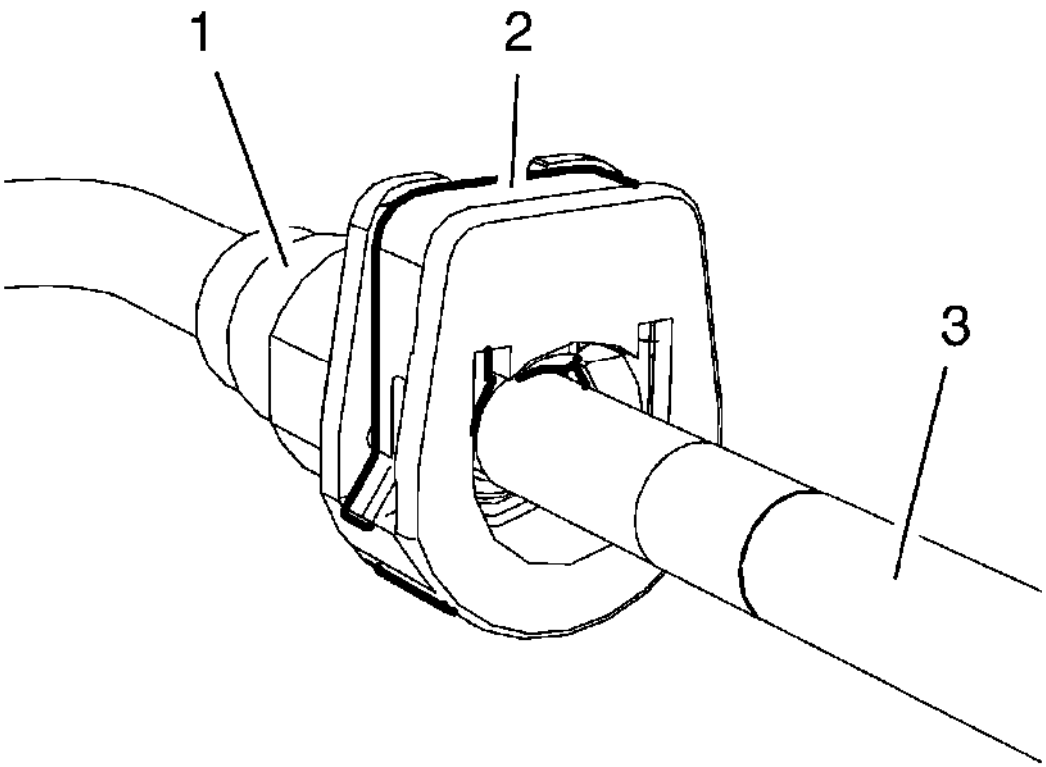


Fig. 43: Pushing Pipe Into Connector
Courtesy of GENERAL MOTORS COMPANY

2. Push the pipe (3) into the connector (1).

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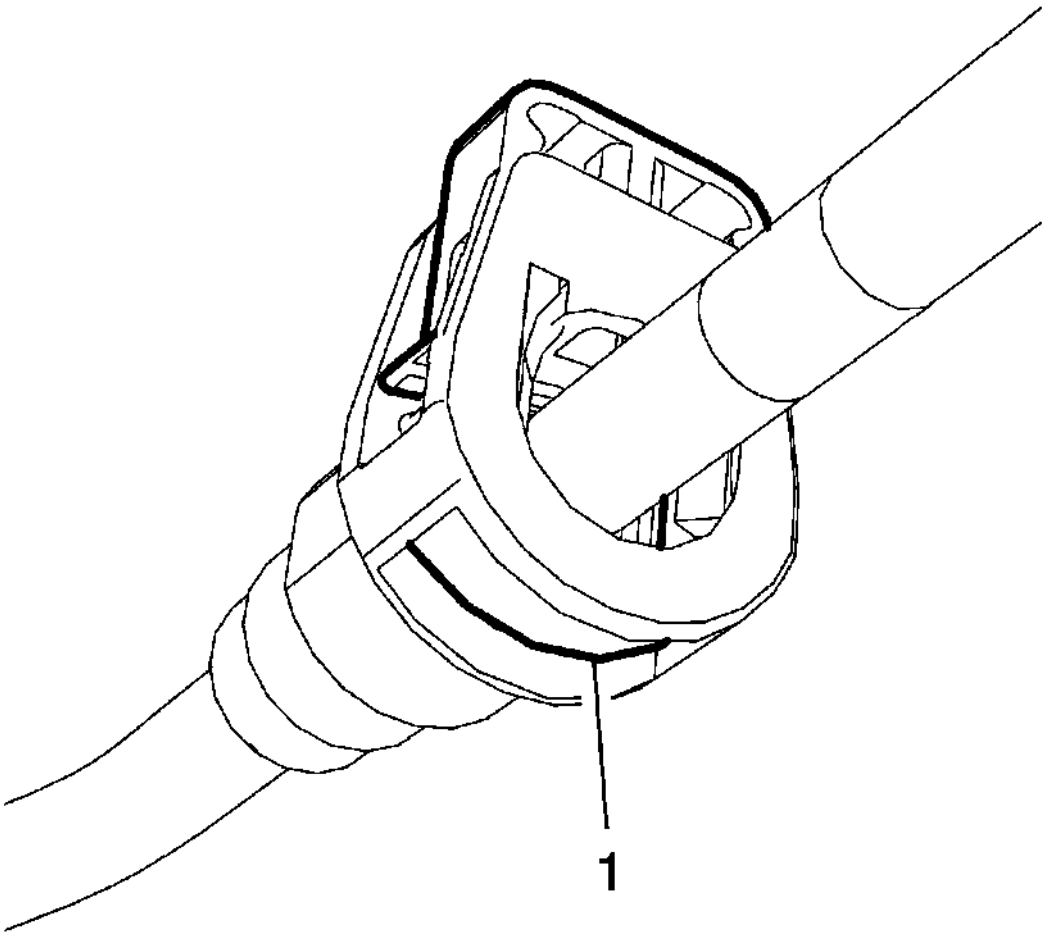


Fig. 44: Pushing Latch Into Connector
Courtesy of GENERAL MOTORS COMPANY

3. Push the latch (1) into the connector.

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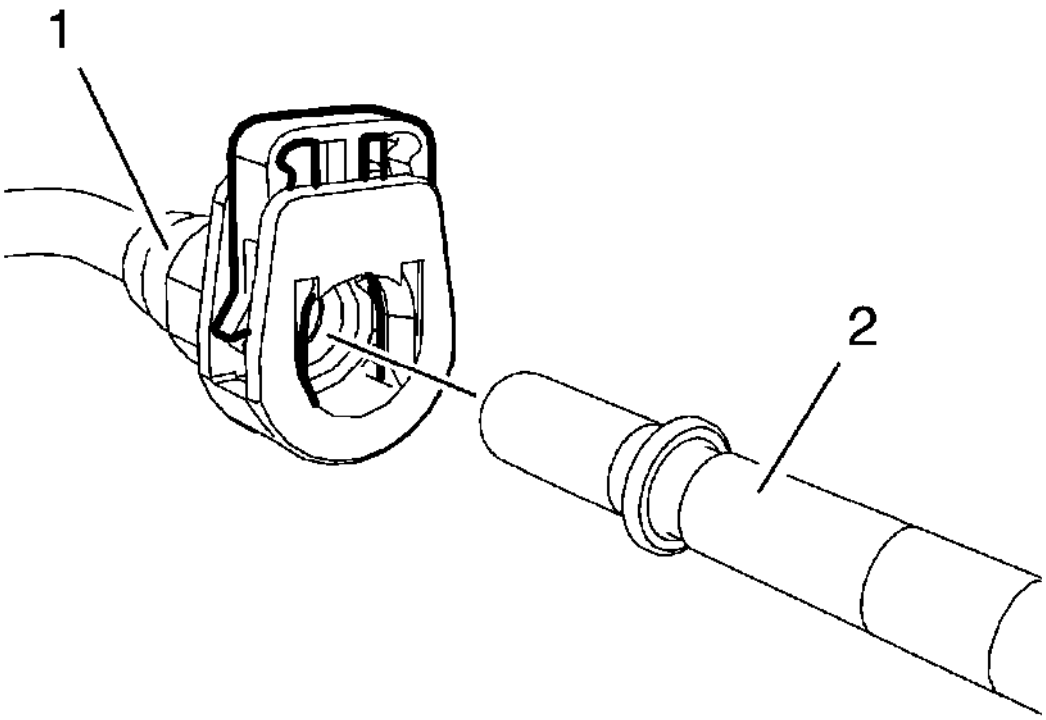


Fig. 45: Pulling Pipe Out Of Connector
Courtesy of GENERAL MOTORS COMPANY

4. Pull the pipe (2) out of the connector (1).
5. Release the latch.

Connect

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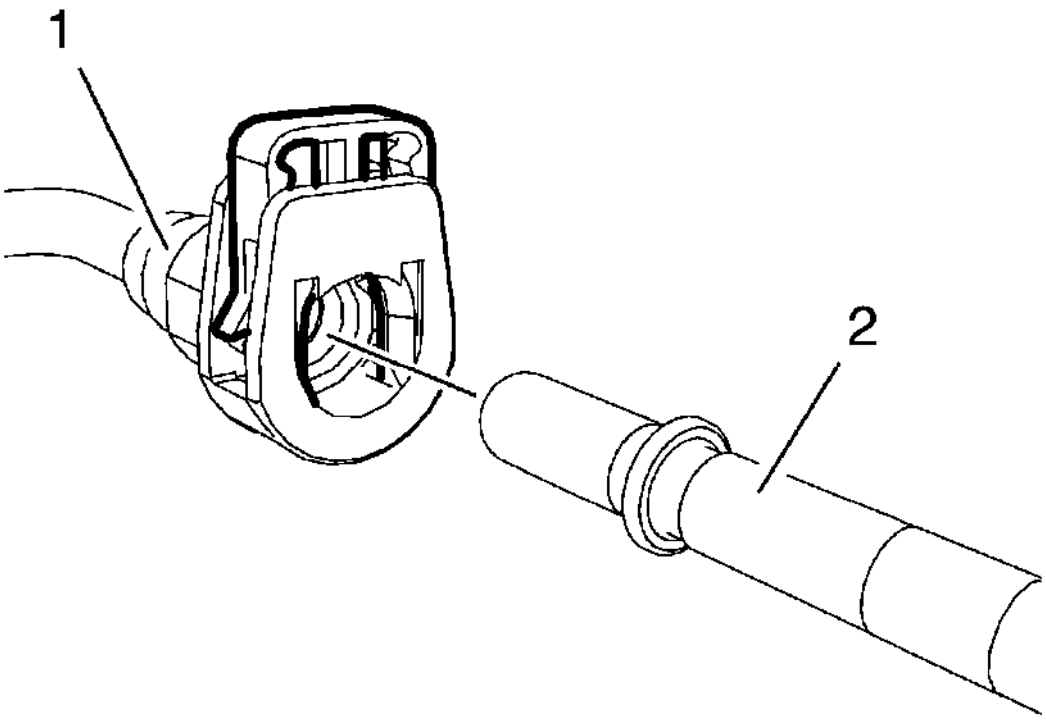


Fig. 46: Pulling Pipe Out Of Connector
Courtesy of GENERAL MOTORS COMPANY

1. Push the pipe (2) into the connector (1).

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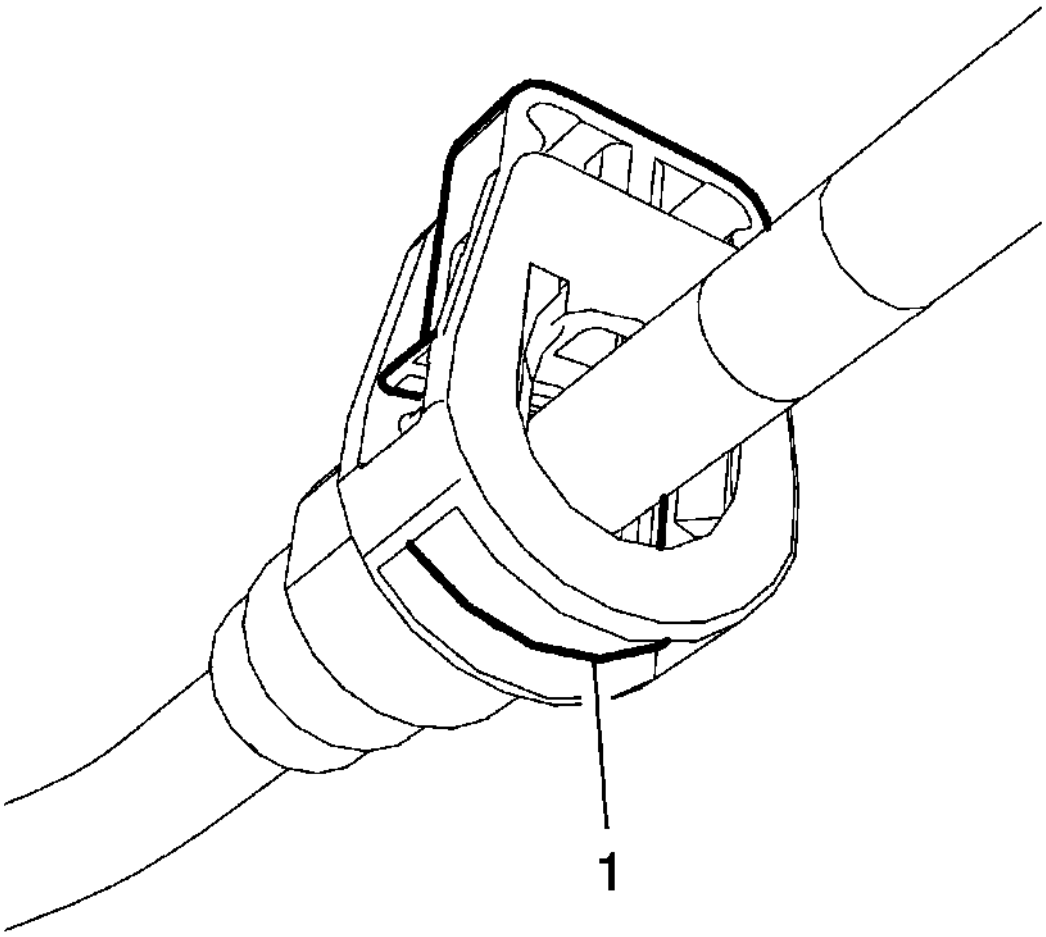


Fig. 47: Pushing Latch Into Connector
Courtesy of GENERAL MOTORS COMPANY

2. When the connector is locked correctly, the latch (1) must align to the connector.

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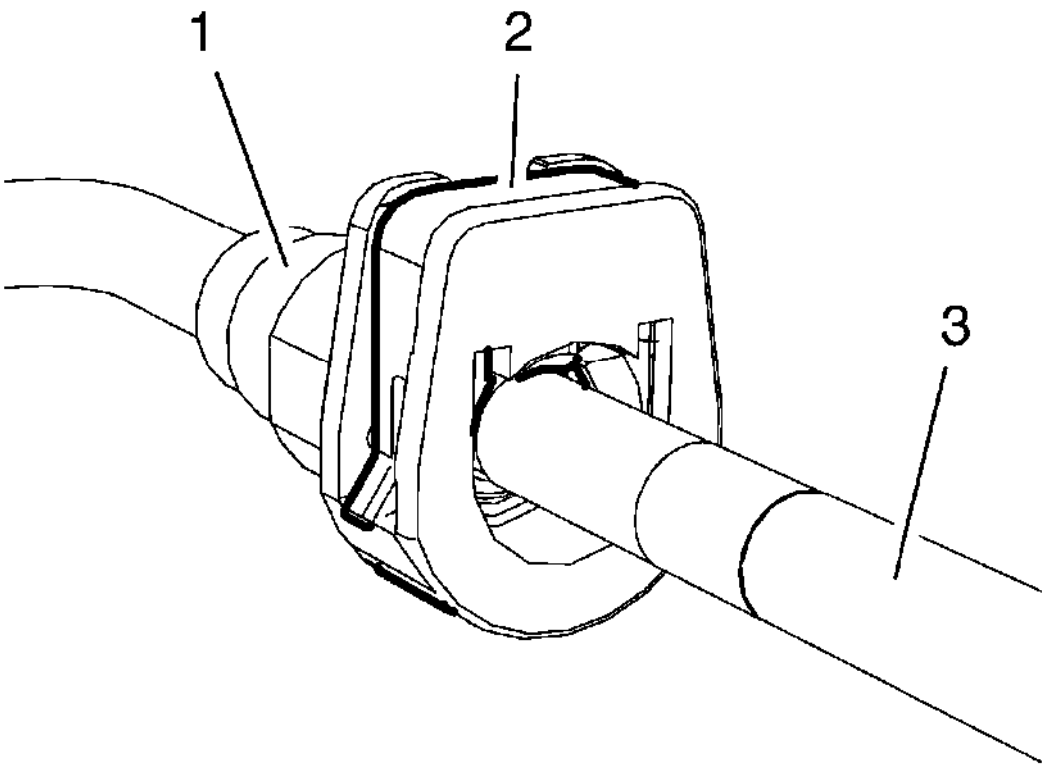


Fig. 48: Pushing Pipe Into Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: The latch (2) can only pushed into the connector (1) when the pipe (3) is connected correctly.

3. Push the latch (2) into the connector (1) to secure the connection.
4. Do not rely only on the audible click to confirm a secure connection has been made.

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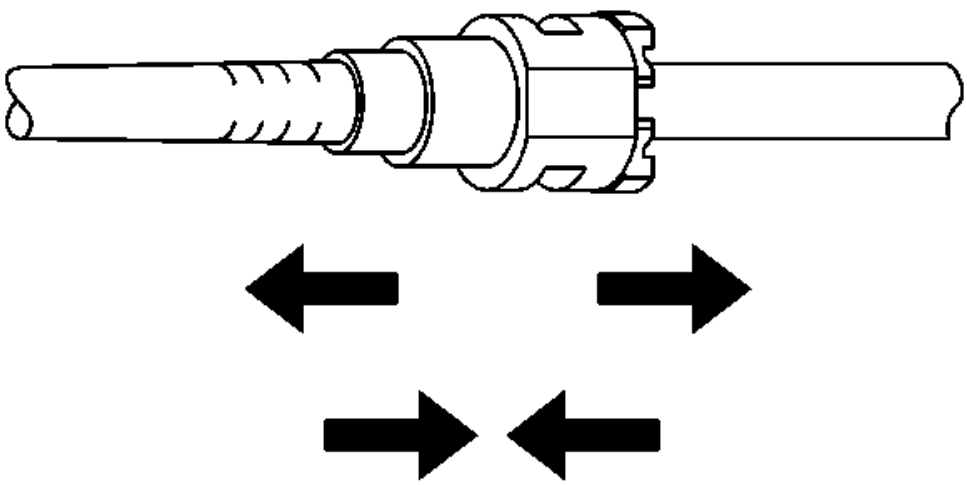


Fig. 49: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Pull on both sides of the quick connect fitting in order to make sure the connection is secure.

Type C - Disconnect/Connect

Disconnect

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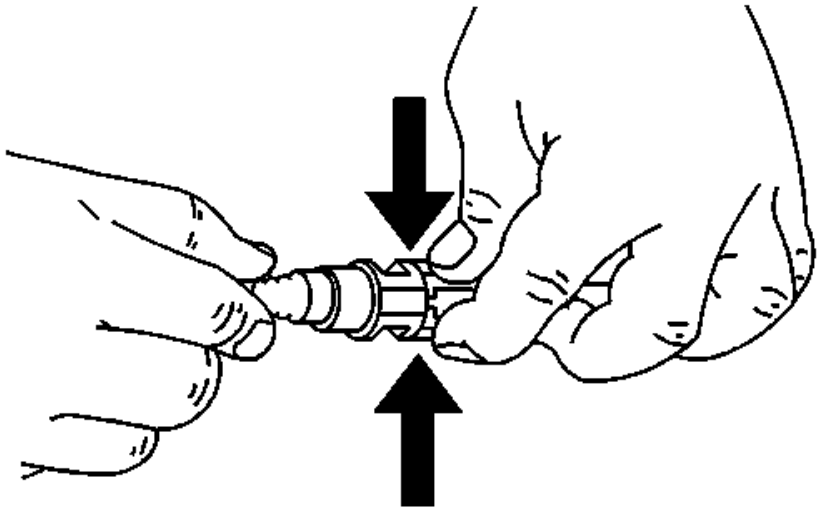


Fig. 50: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mechanical violence is not necessary for a successful disconnection/connection.

1. Squeeze the plastic quick connect fitting release tabs with the **EN-796-A** release tool.

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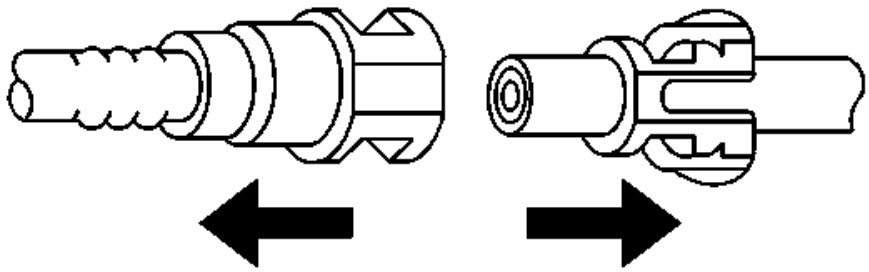


Fig. 51: View Of Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Pull the connection apart.

Connect

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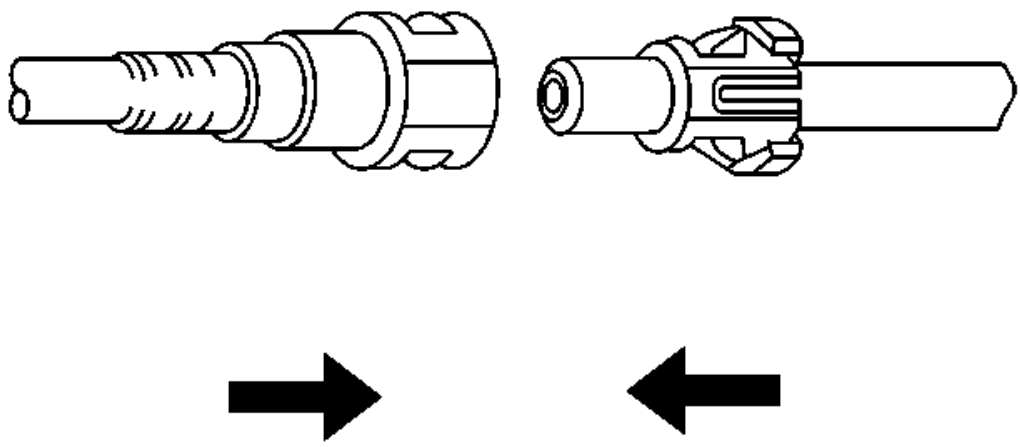


Fig. 52: Connecting Fittings (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

1. Push both sides of the quick connect fitting together in order to cause the retaining feature to snap into place.
2. Do not rely only on the audible click to confirm a secure connection has been made.

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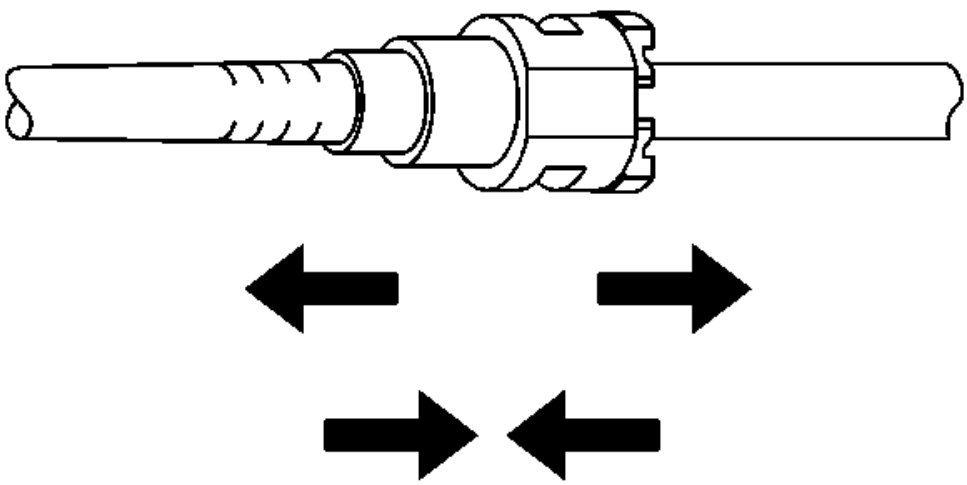


Fig. 53: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the quick connect fitting in order to make sure the connection is secure.

Type D - Disconnect/Connect

Disconnect

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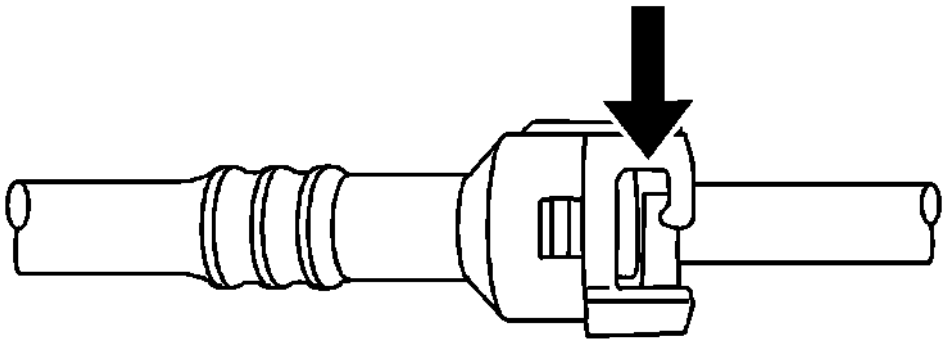


Fig. 54: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mechanical violence is not necessary for a successful disconnection/connection.

1. Release the fitting by pushing the tab toward the other side of the slot in the fitting.

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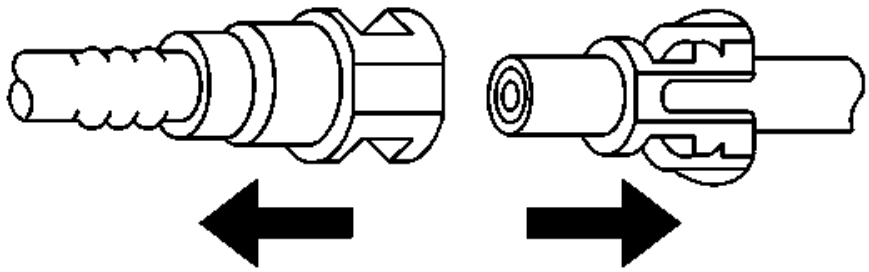


Fig. 55: View Of Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Pull the connection apart.

Connect

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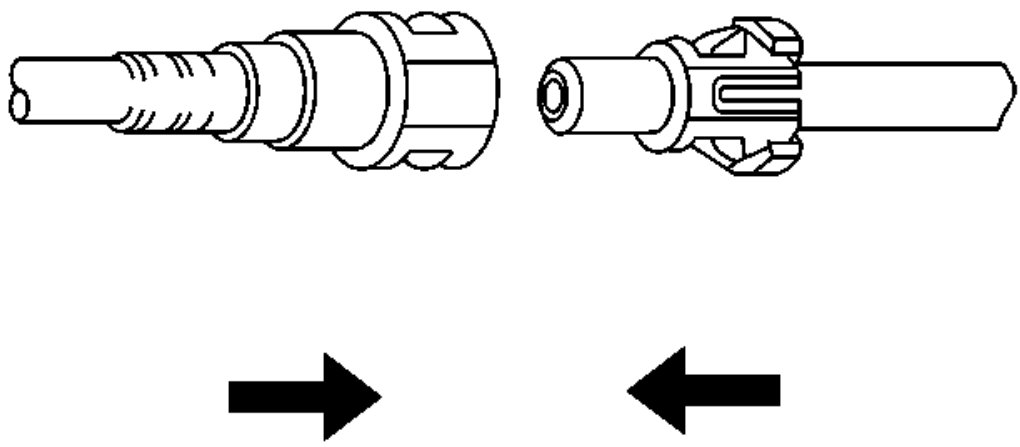


Fig. 56: Connecting Fittings (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

1. Push both sides of the quick connect fitting together in order to cause the retaining feature to snap into place.
2. Do not rely only on the audible click to confirm a secure connection has been made.

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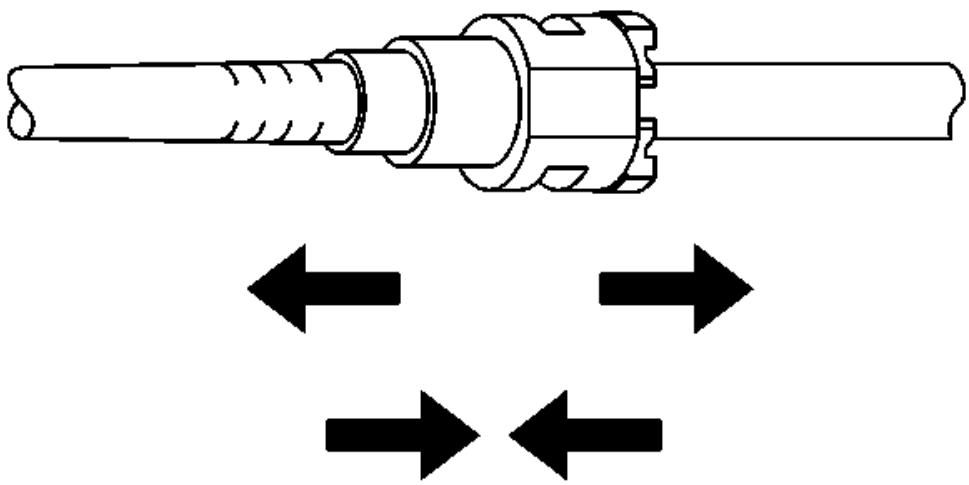


Fig. 57: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the quick connect fitting in order to make sure the connection is secure.

Type E - Disconnect/Connect

Disconnect

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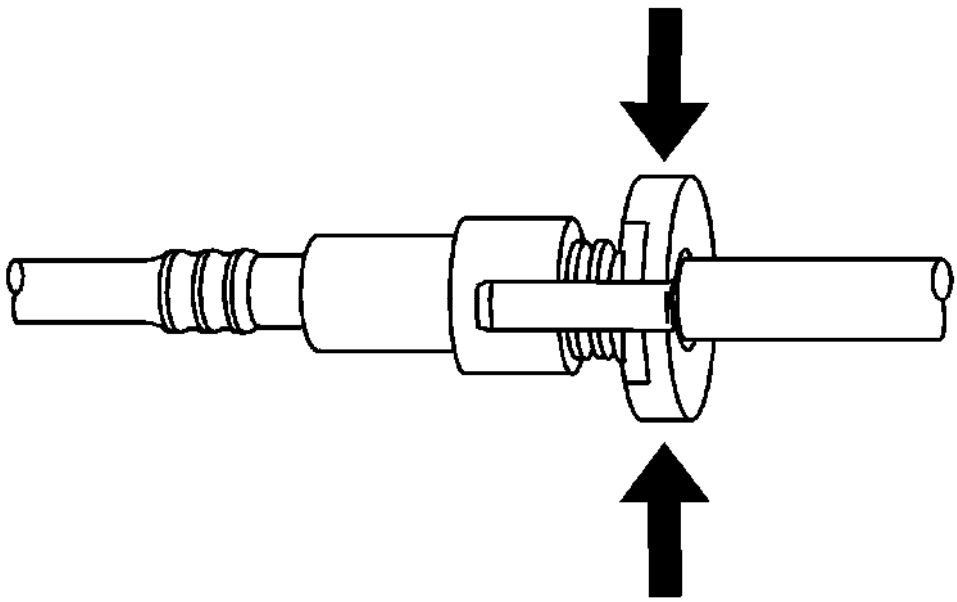


Fig. 58: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mechanical violence is not necessary for a successful disconnection/connection.

1. Squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick connect fitting.

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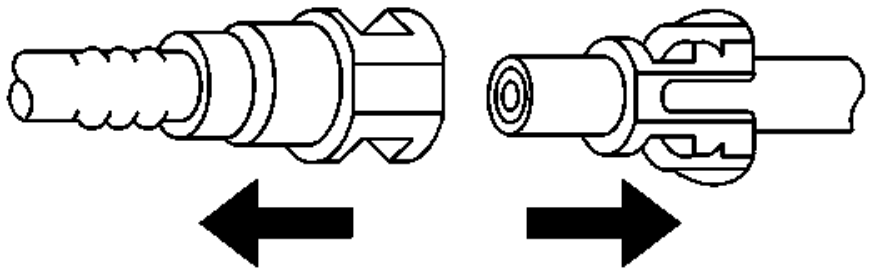


Fig. 59: View Of Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Pull the connection apart.

Connect

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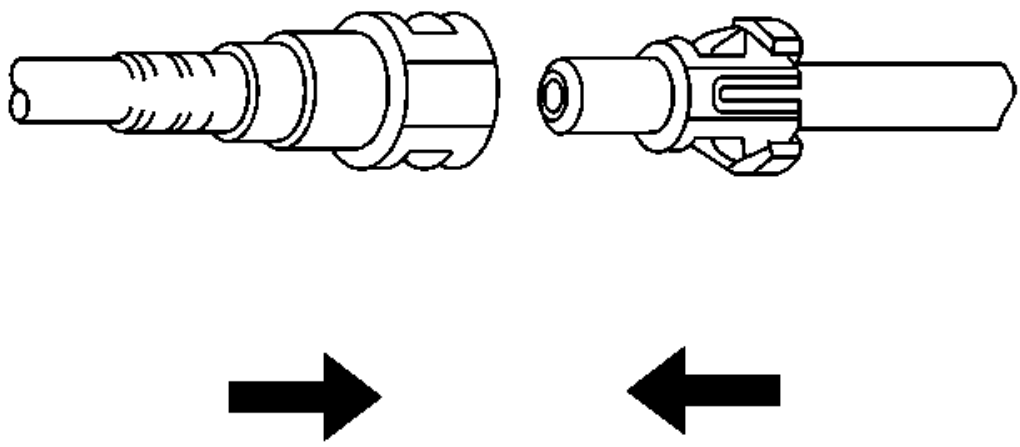


Fig. 60: Connecting Fittings (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

1. Push both sides of the quick connect fitting together in order to cause the retaining feature to snap into place.
2. Do not rely only on the audible click to confirm a secure connection has been made.

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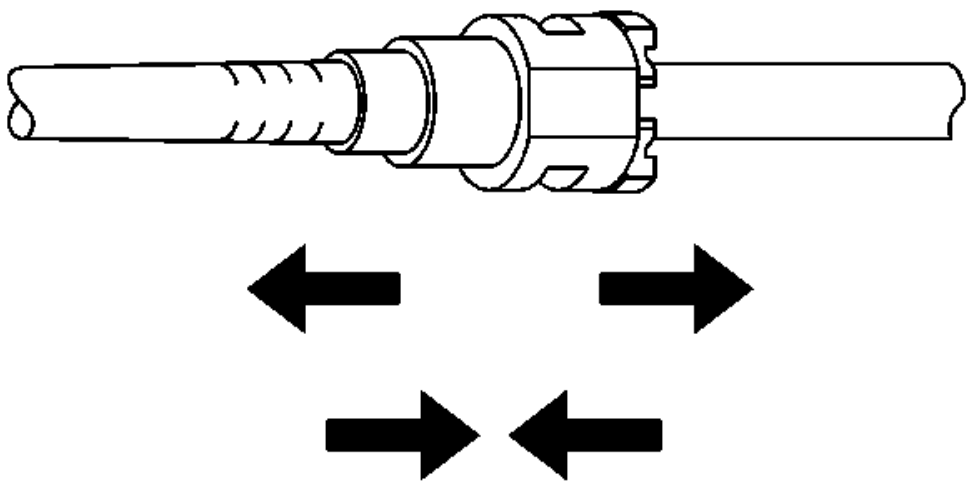


Fig. 61: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the quick connect fitting in order to make sure the connection is secure.

Type F - Disconnect/Connect

Disconnect

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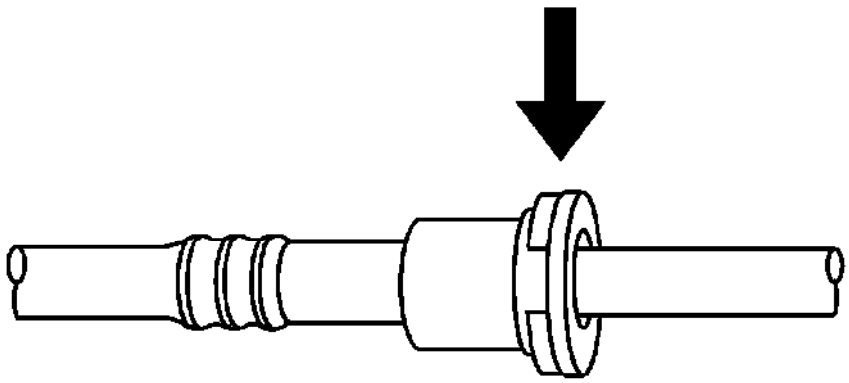


Fig. 62: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mechanical violence is not necessary for a successful disconnection/connection.

1. 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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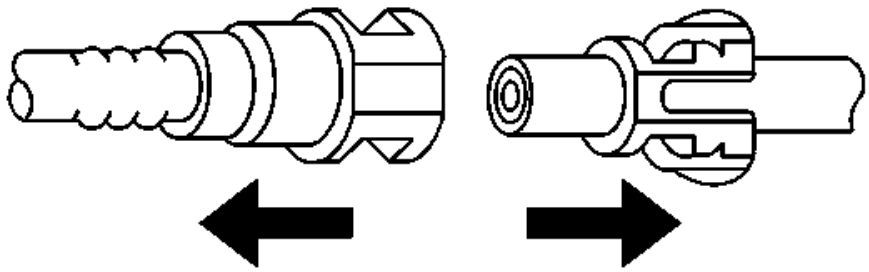


Fig. 63: View Of Pulling Connection Apart (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Pull the connection apart.

Connect

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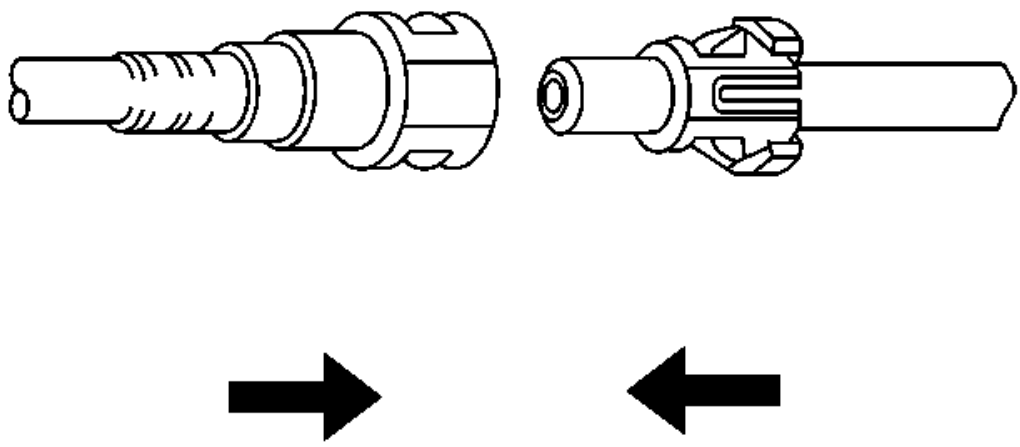


Fig. 64: Connecting Fittings (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

1. Push both sides of the quick connect fitting together in order to cause the retaining feature to snap into place.
2. Do not rely only on the audible click to confirm a secure connection has been made.

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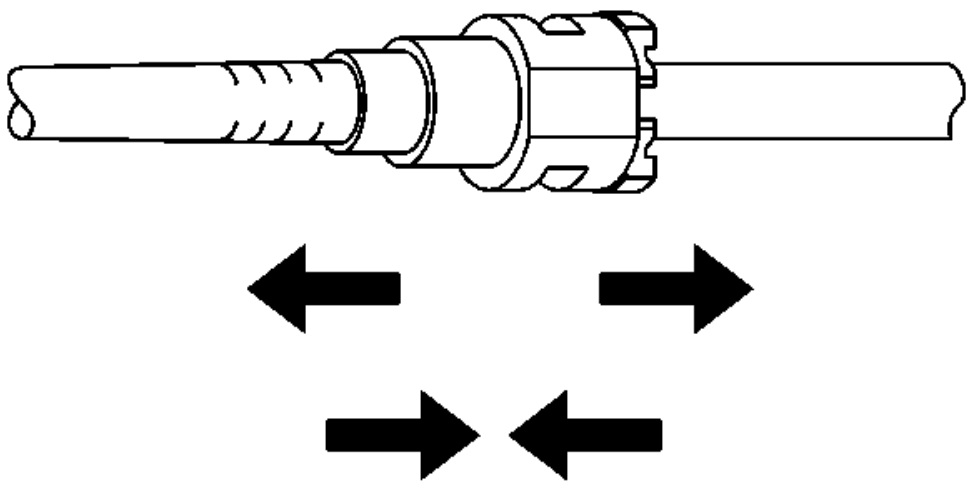


Fig. 65: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the quick connect fitting in order to make sure the connection is secure.

Type G - Disconnect/Connect

Disconnect

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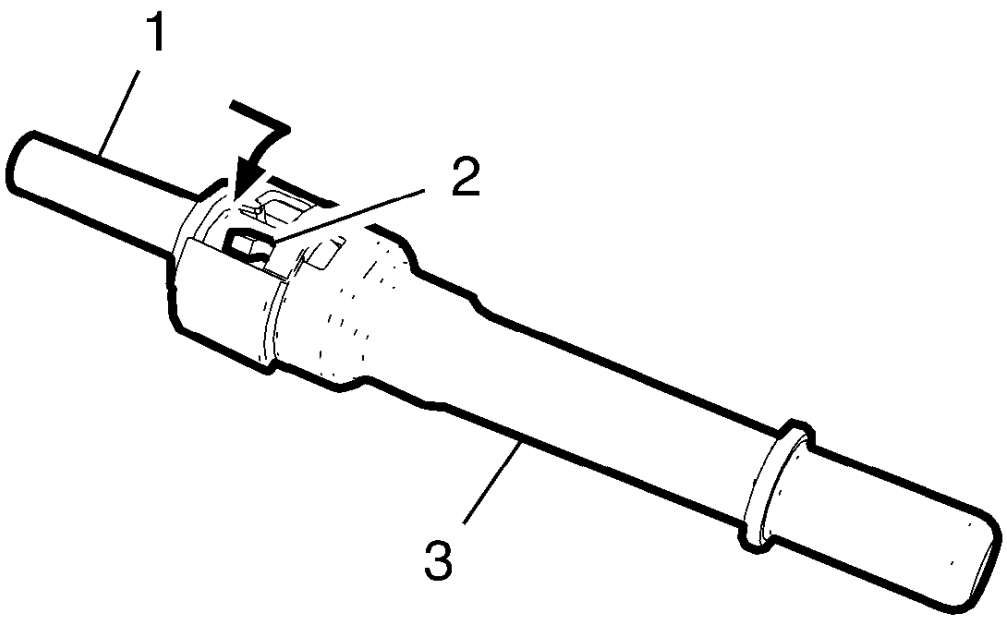


Fig. 66: View Of Connector Latch
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mechanical violence is not necessary for a successful disconnection/connection.

1. Push the tube (3) into the connector (1) and push down the latch (2) as the arrow shows.
2. Hold the latch (2) in this position.

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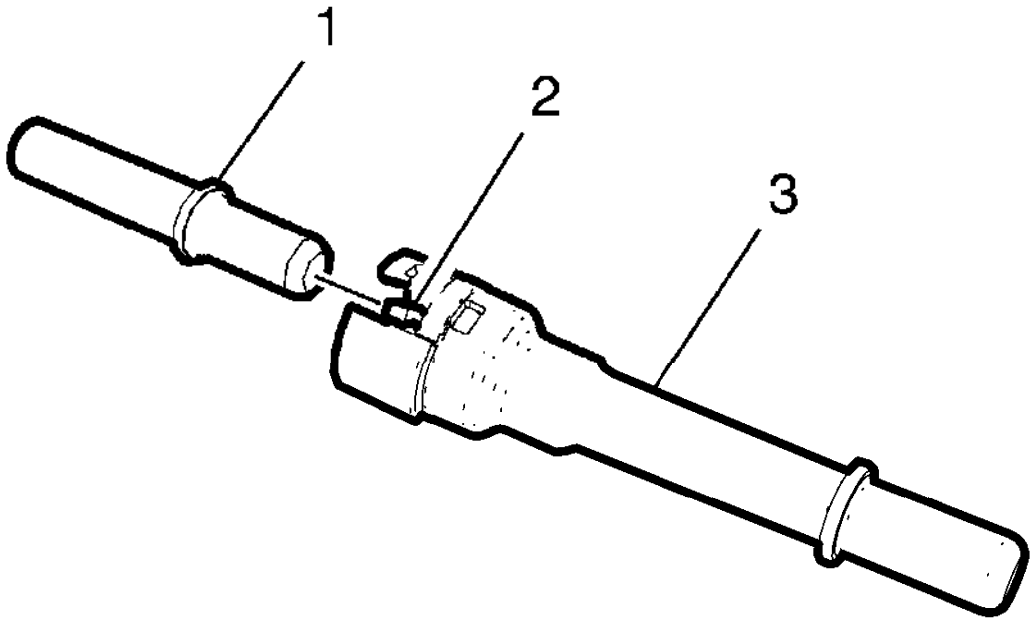


Fig. 67: Pulling Pipe Out Of Connector
Courtesy of GENERAL MOTORS COMPANY

3. Pull the pipe (3) out of the connector (1).
4. Release the latch (2).

Connect

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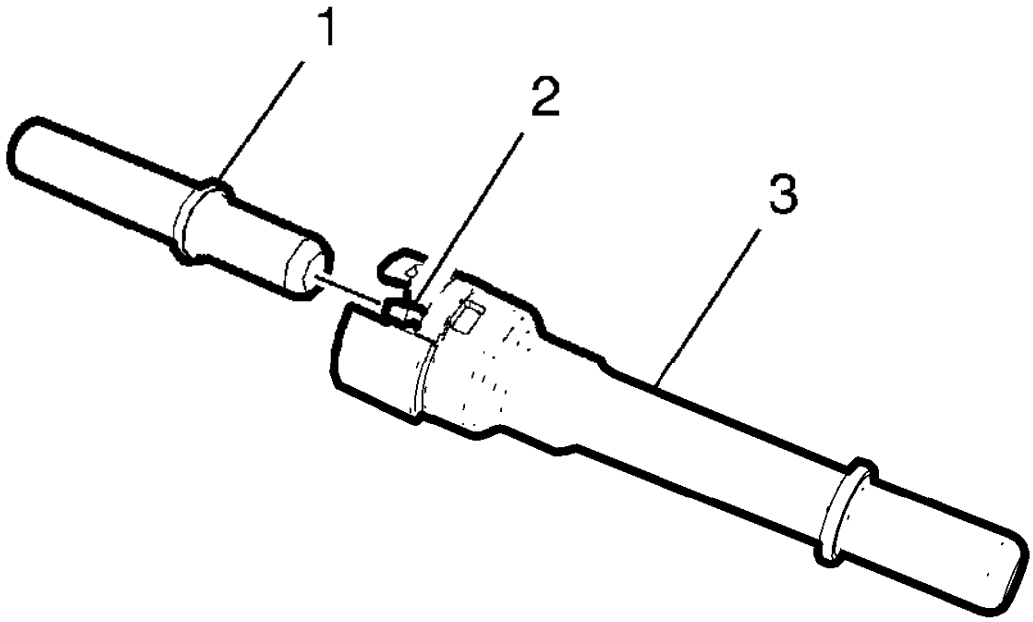


Fig. 68: Pulling Pipe Out Of Connector
Courtesy of GENERAL MOTORS COMPANY

1. Push the pipe (3) into the connector (1).

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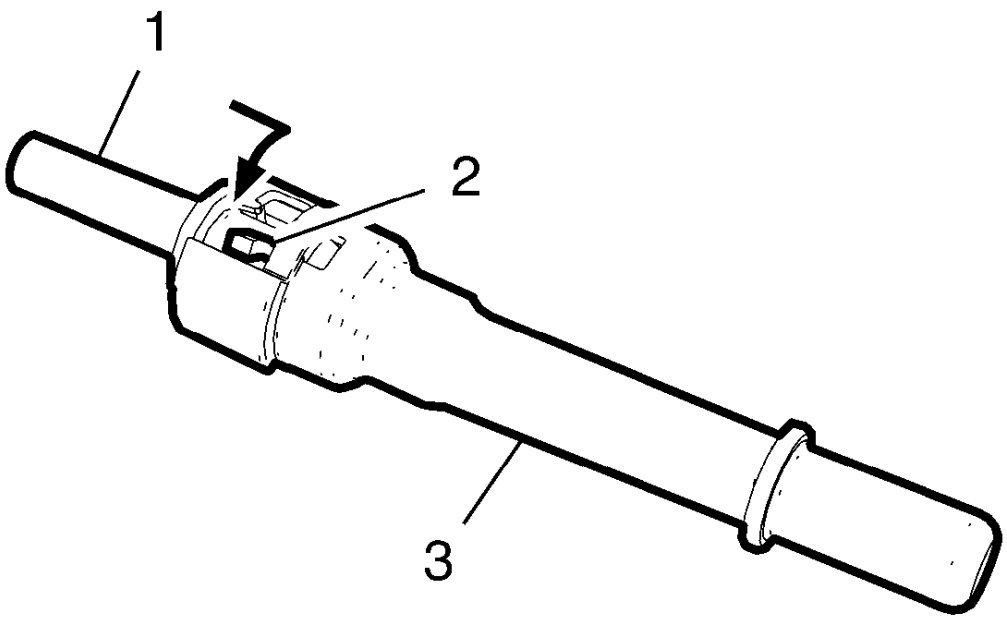


Fig. 69: View Of Connector Latch
Courtesy of GENERAL MOTORS COMPANY

2. When the connector is locked correctly, the latch (2) must go back in opposite arrow direction.
3. Do not rely only on the audible click to confirm a secure connection has been made.

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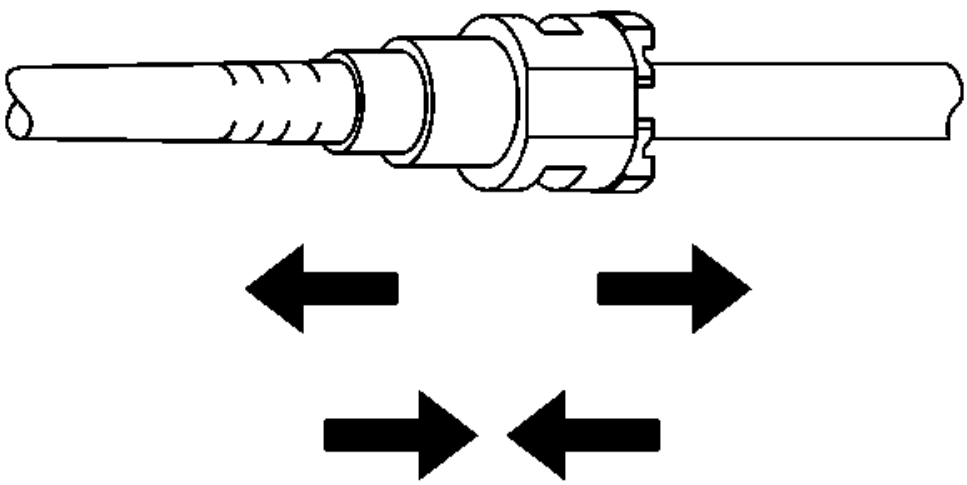


Fig. 70: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

4. Pull on both sides of the quick connect fitting in order to make sure the connection is secure.

Type H - Disconnect/Connect

Disconnect

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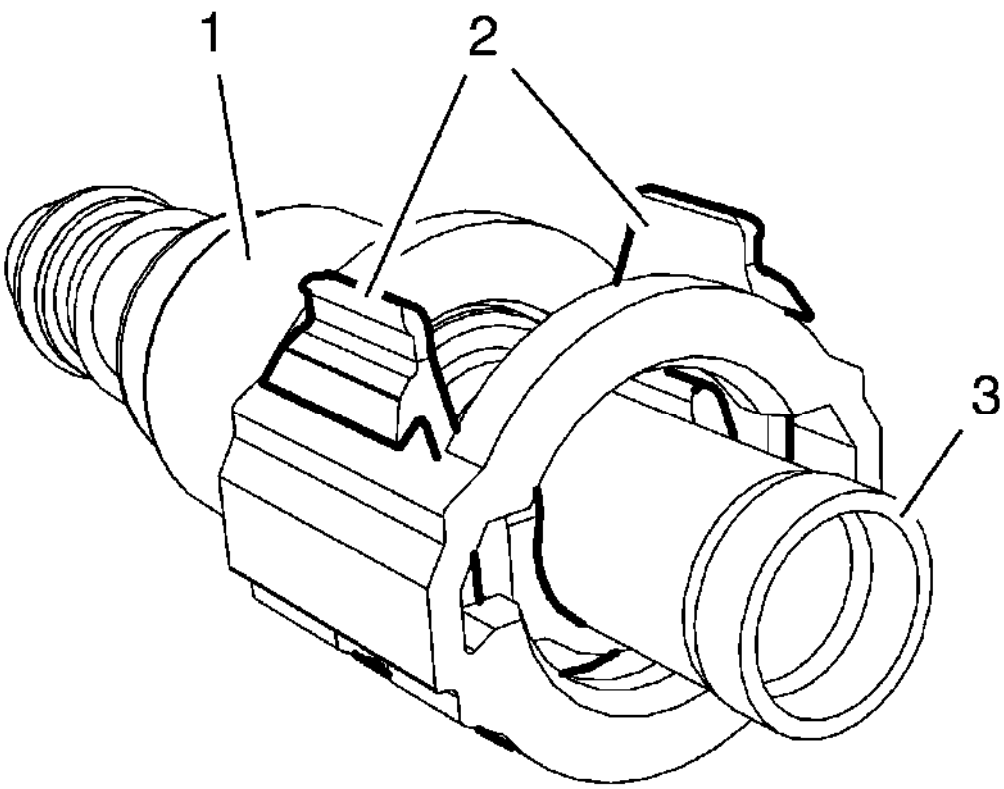


Fig. 71: Connector And Latches
Courtesy of GENERAL MOTORS COMPANY

NOTE: Mechanical violence is not necessary for a successful disconnection/connection.

1. Push the tube (3) into the connector (1) and press the latches (2) together.
2. Hold the latch (2) in this position.

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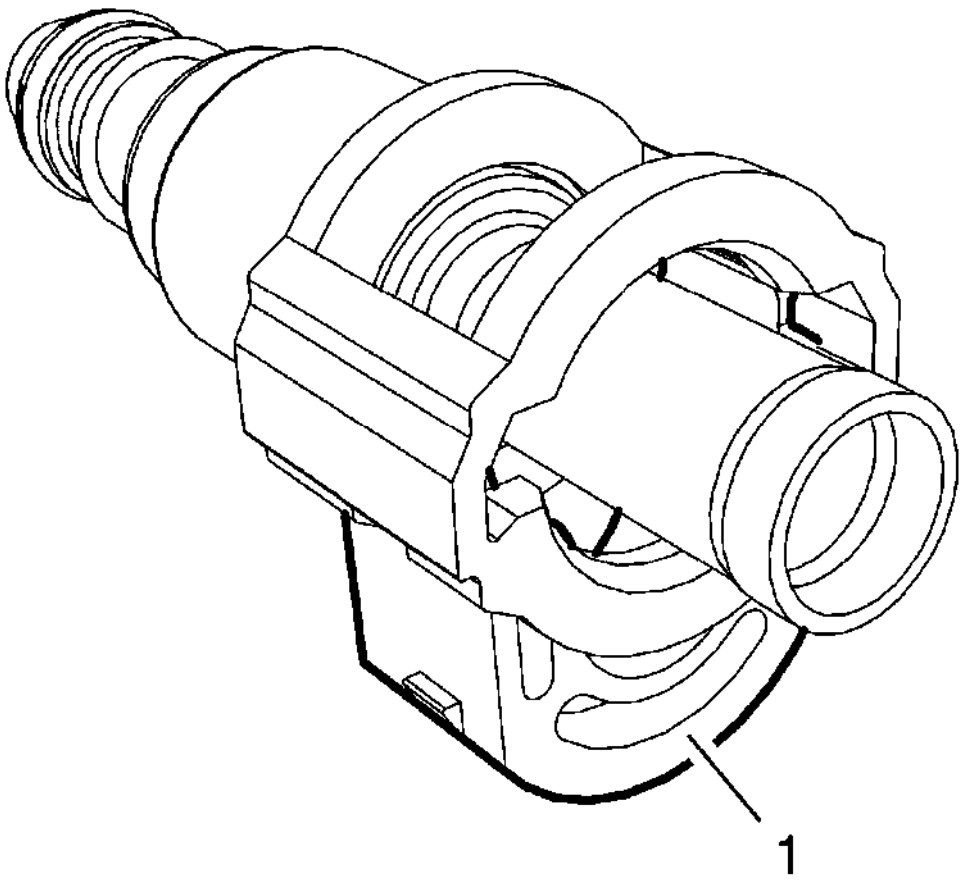


Fig. 72: Connector Latch
Courtesy of GENERAL MOTORS COMPANY

3. Push the latch (1) completely down into the connector.

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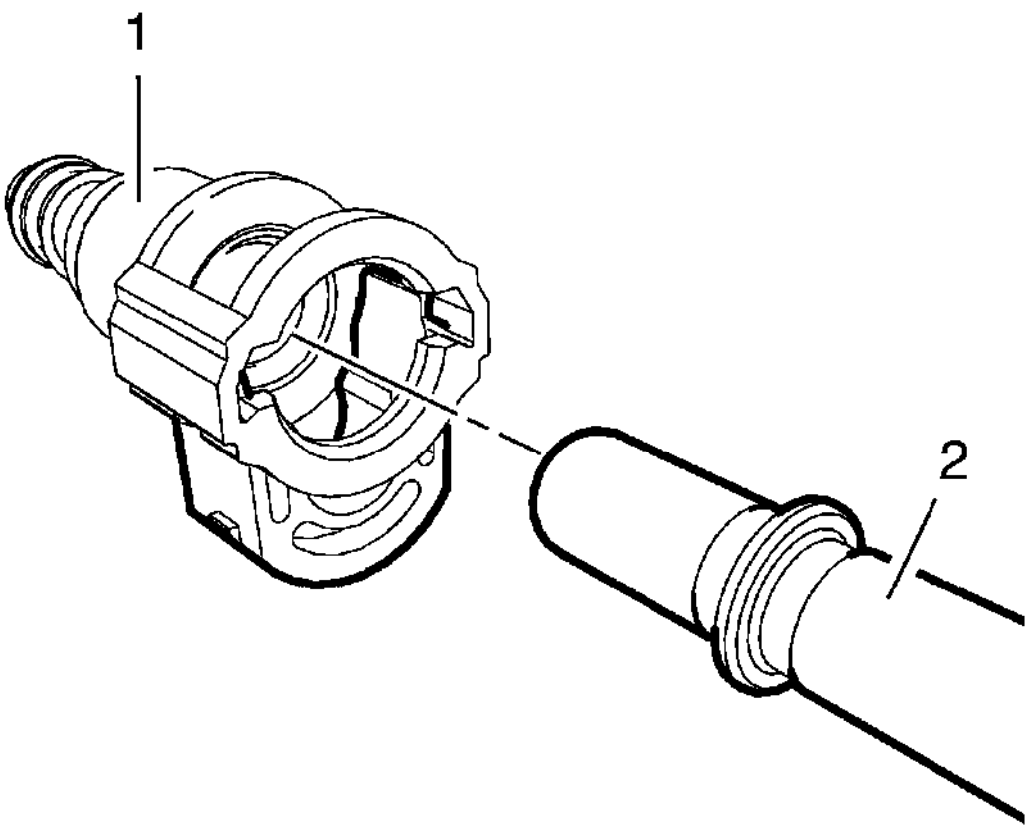


Fig. 73: Pipe And Connector
Courtesy of GENERAL MOTORS COMPANY

4. Pull the pipe (2) out of the connector (1).

Connect

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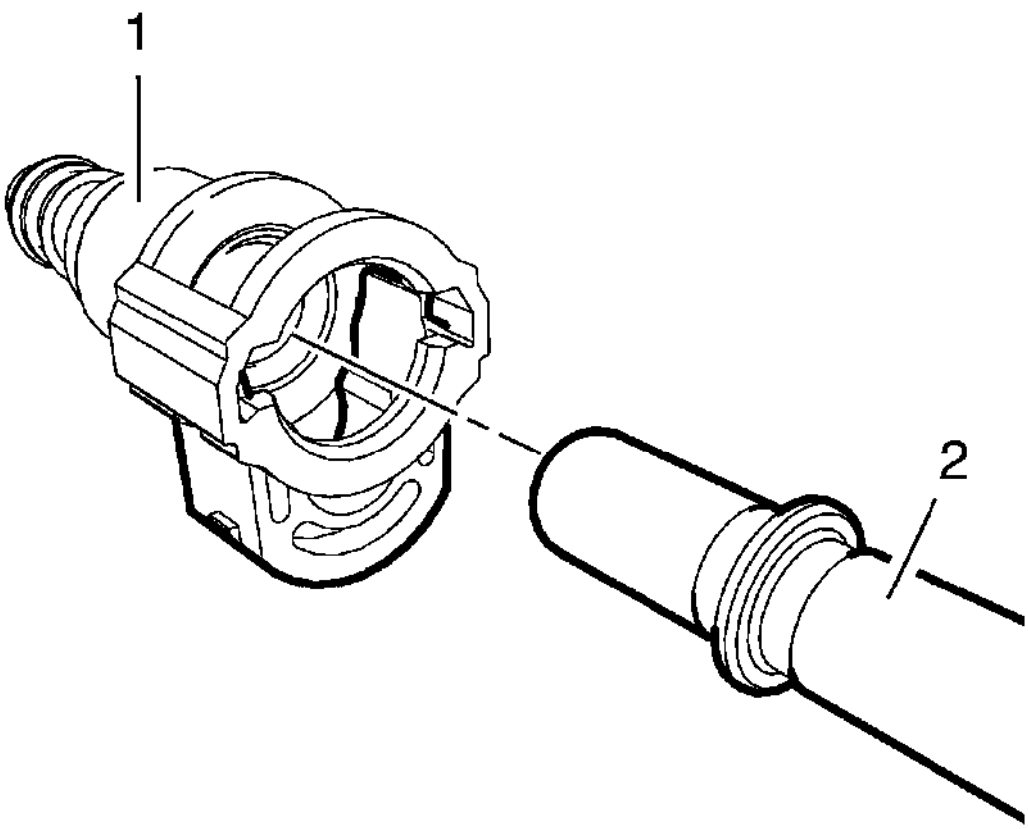


Fig. 74: Pipe And Connector
Courtesy of GENERAL MOTORS COMPANY

1. Push the pipe (2) into the connector (1).

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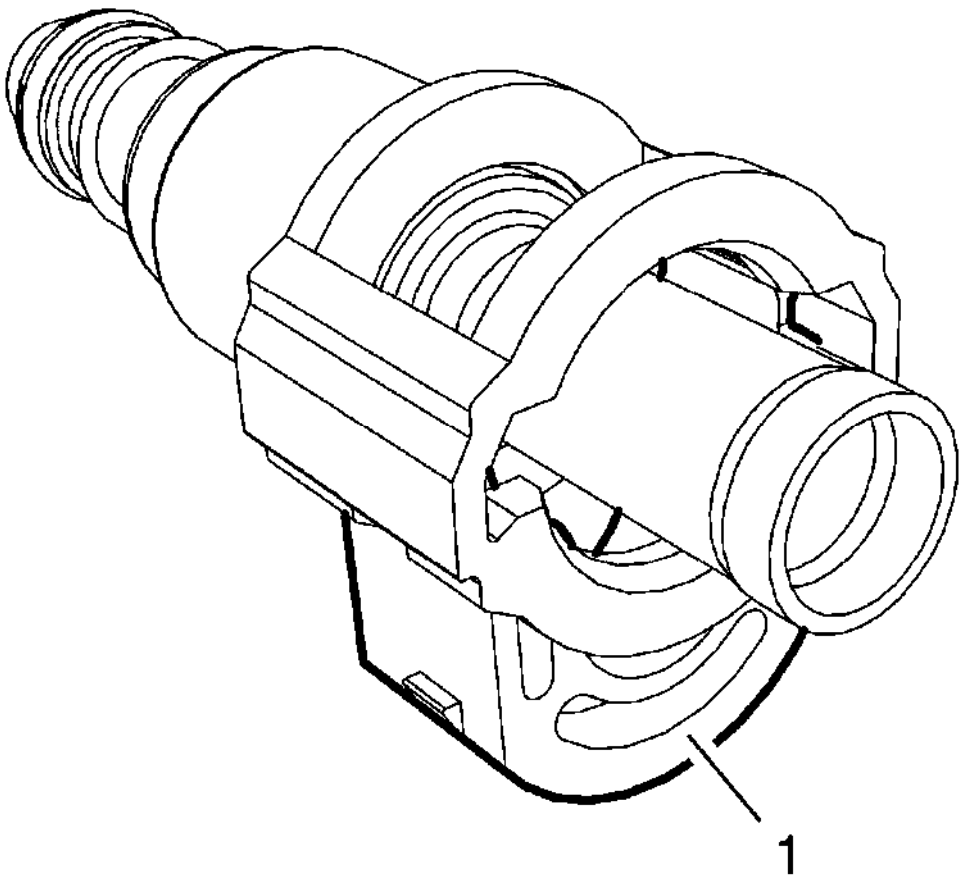


Fig. 75: Connector Latch
Courtesy of GENERAL MOTORS COMPANY

NOTE: The latch (1) can only pushed into the connector when the pipe is connected correctly.

2. When the connector is connected completely, push the latch (1) back into the connector.

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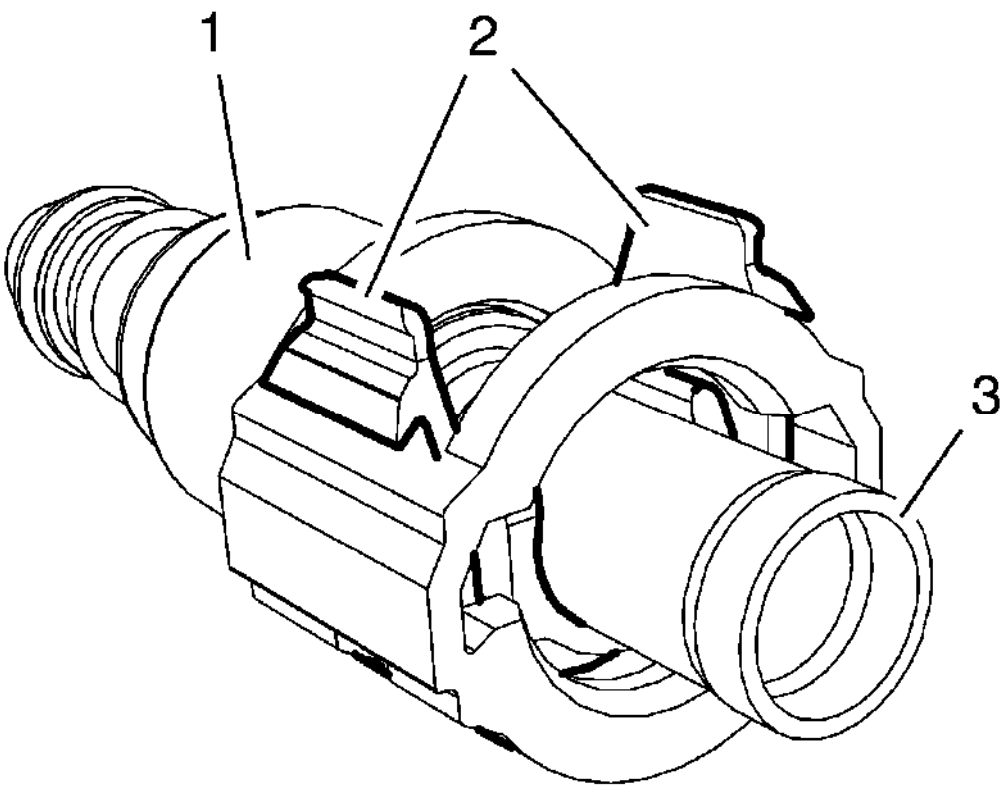


Fig. 76: Connector And Latches
Courtesy of GENERAL MOTORS COMPANY

3. The latch (2) must completely lock at the outside at the connector (1).
4. Do not rely only on the audible click to confirm a secure connection has been made.

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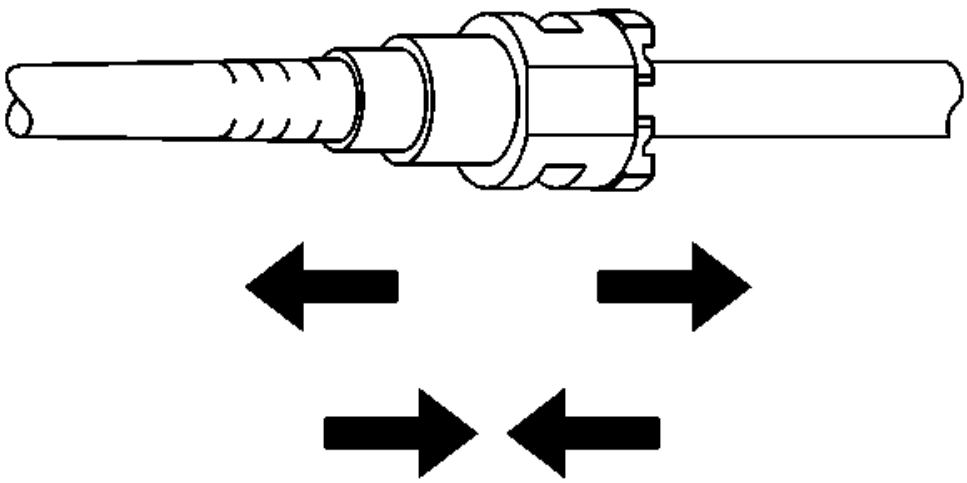


Fig. 77: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Pull on both sides of the quick connect fitting in order to make sure the connection is secure.

FUEL TANK DRAINING

Special Tools

CH-45004 Fuel Tank Drain Hose

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

WARNING: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

WARNING: Place a dry chemical (Class B) fire extinguisher nearby before performing

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any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

WARNING: Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.

1. Open the hood.
2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove the fuel fill cap.
4. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the fuel tank filler pipe from the fuel tank. Refer to **Fuel Tank Filler Pipe Replacement**.
6. Insert the **CH-45004** drain hose into the fuel tank until the hose reaches the bottom of the fuel tank.
7. Use an hand or air operated pump device in order to drain as much fuel as possible.

FUEL TANK REPLACEMENT

Removal Procedure

1. Open the hood.
2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the right rear tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
5. Remove the rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .
6. Drain the fuel tank. Refer to **Fuel Tank Draining**.
7. Raise the vehicle.

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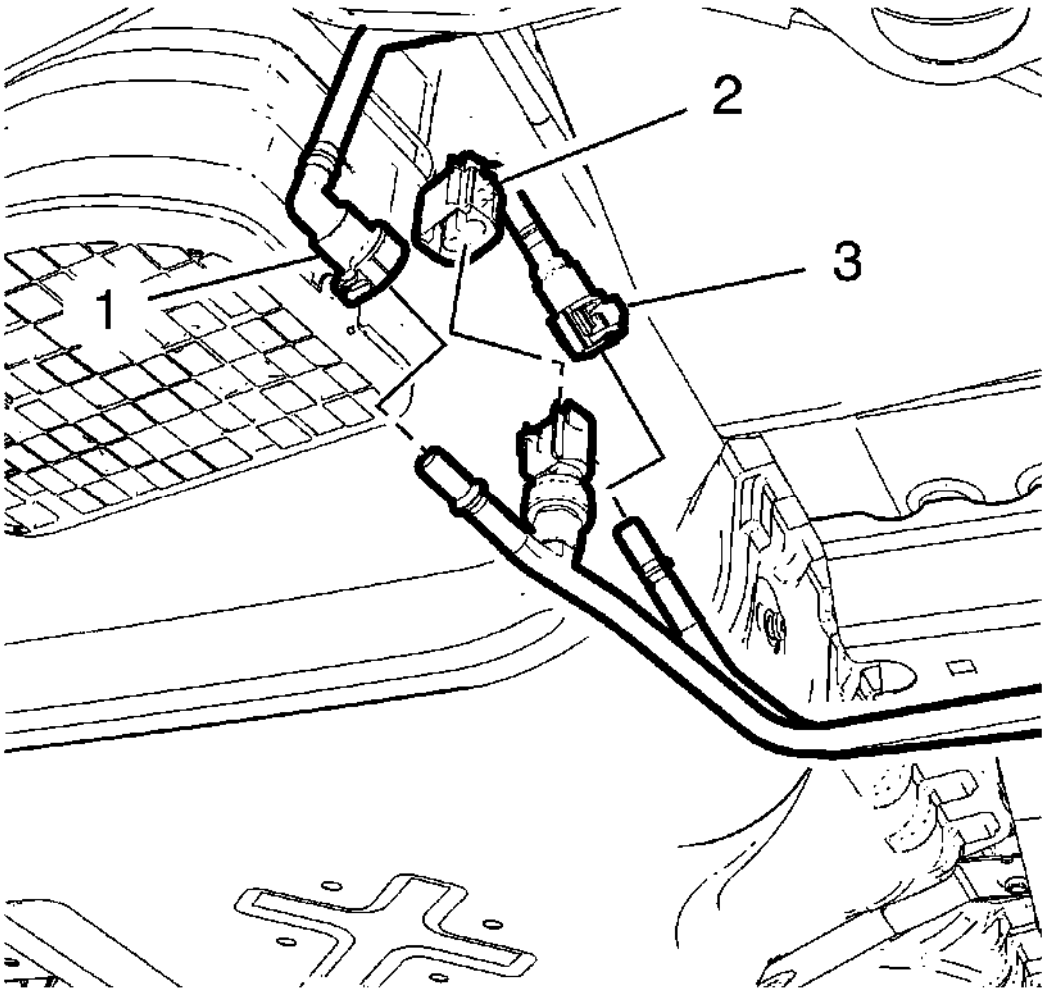


Fig. 78: Fuel Pressure Sensor Wiring Harness Plug, Fuel Tank Vent Pipe, Fuel Feed Pipe Connector And Fuel Tank Vent Pipe Connector
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the fuel pressure sensor wiring harness plug (2).
9. Disconnect the fuel feed pipe connector (1) from the fuel feed pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
10. Disconnect the fuel tank vent pipe connector (3) from the fuel tank vent pipe (3). Refer to **Plastic Collar Quick Connect Fitting Service**.
11. Install suitable caps on the fuel pipes.

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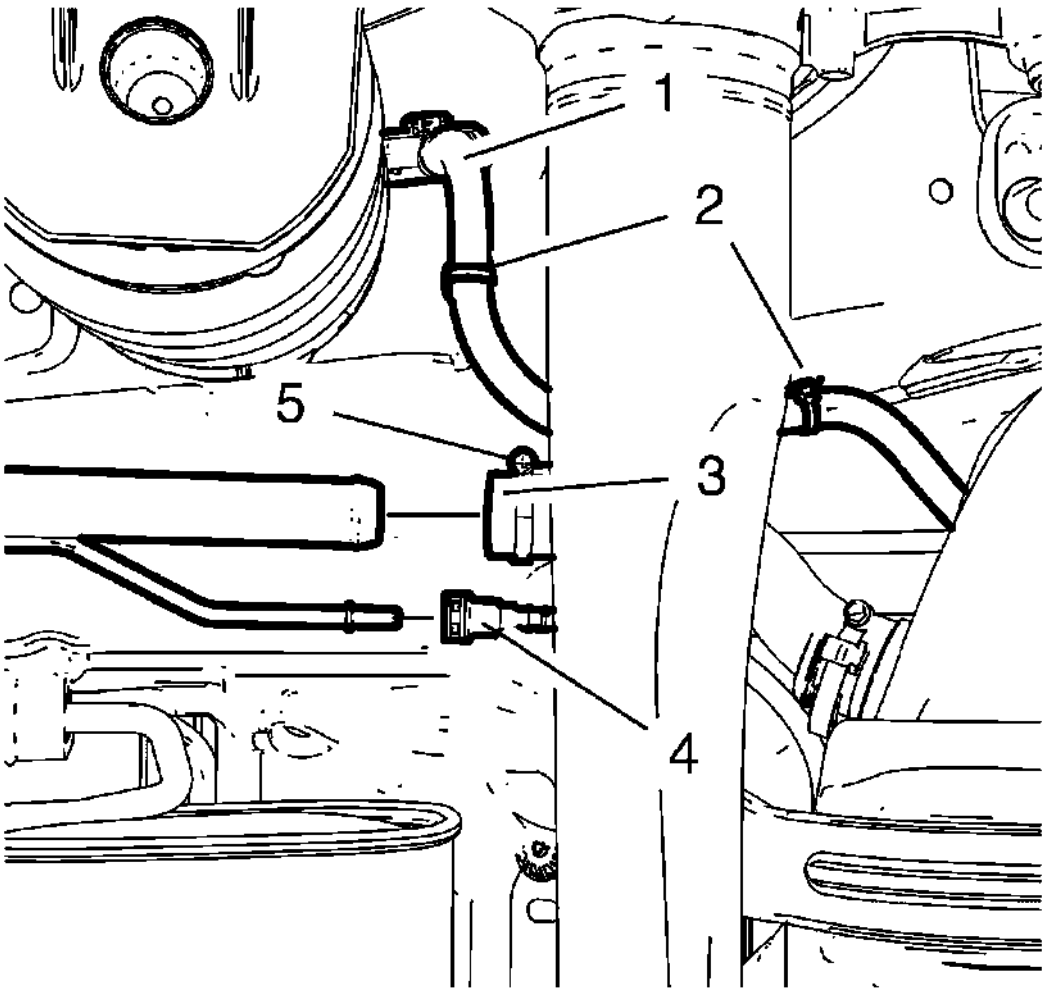


Fig. 79: Fuel Tank Wiring Harness Inline Connector
Courtesy of GENERAL MOTORS COMPANY

WARNING: Do not breathe the air through the EVAP component tubes or hoses. The fuel vapors inside the EVAP components may cause personal injury.

12. Loosen the fuel tank filler hose clamp (5).
13. Remove the fuel tank filler hose (3) from the fuel tank filler pipe.
14. Disconnect the fuel tank filler vent pipe connector (4) from the fuel tank filler vent pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
15. Plug the fuel tank filler vent pipe with a suitable cap.
16. Disconnect the fuel tank wiring harness inline connector (1) and unclip the wiring harness from 2 retainer clips (2).

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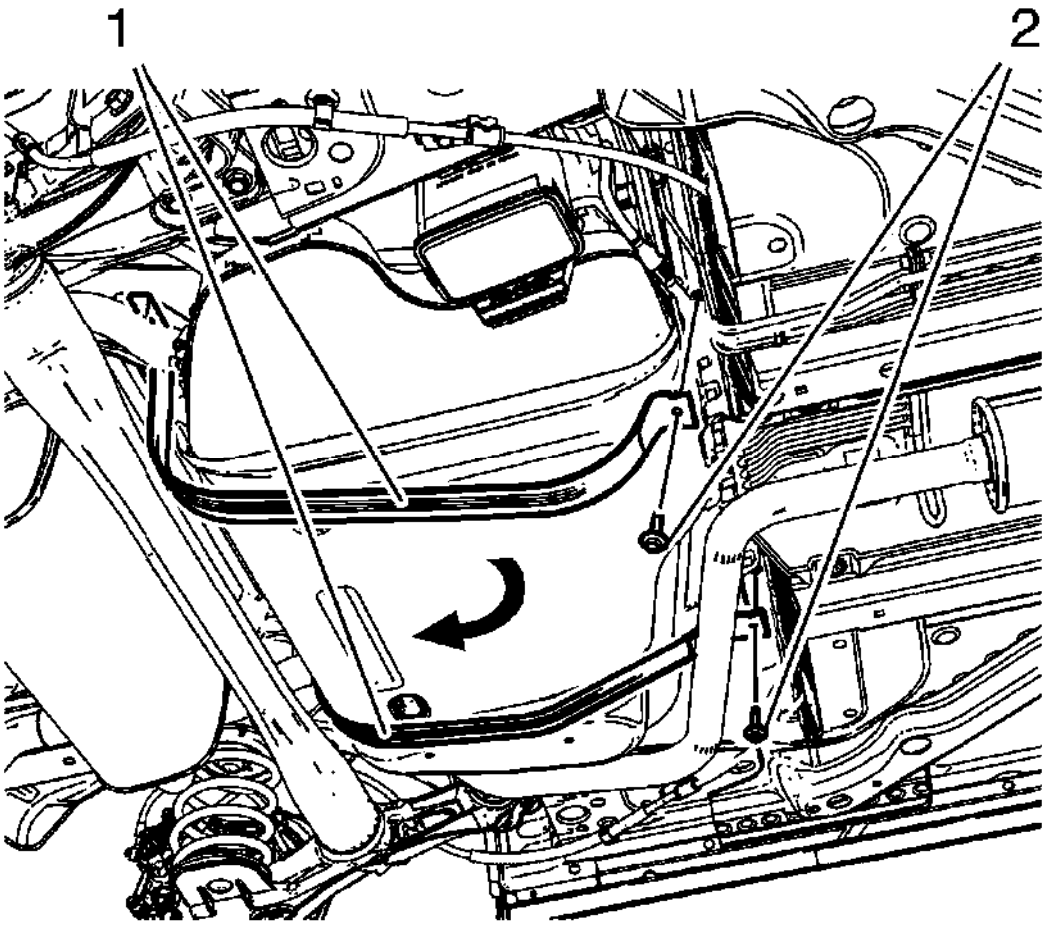


Fig. 80: Fuel Tank Straps
Courtesy of GENERAL MOTORS COMPANY

WARNING: To help avoid personal injury, always use jack stands when you are working on or under any vehicle that is supported only by a jack.

CAUTION: When you are jacking or lifting a vehicle at the frame side rails or other prescribed lift points, be certain that the lift pads do not contact the catalytic converter, the brake pipes or the fuel lines. If such contact occurs, vehicle damage or unsatisfactory vehicle performance may result.

17. Place a suitable adjustable jack under the fuel tank.
18. Remove the 2 fuel tank strap bolts (2).
19. Remove the 2 fuel tank straps (1).

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NOTE: A second technician is required.

NOTE: Retract the jack.

20. Remove the fuel tank.

Disassemble Procedure

1. Remove the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.

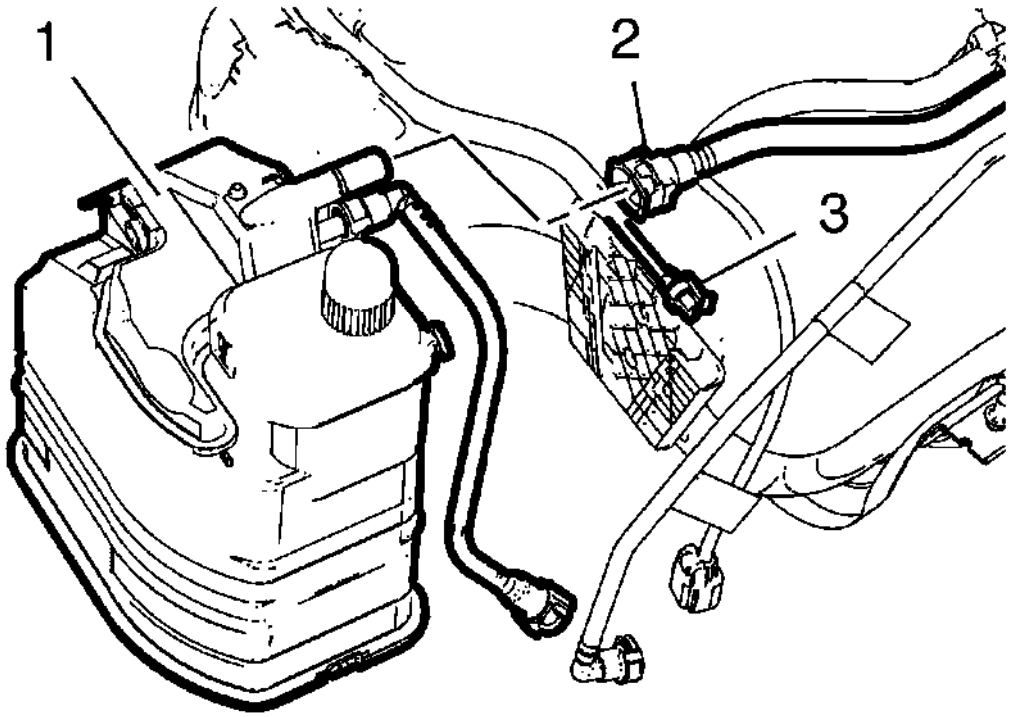


Fig. 81: Evaporative Emission Canister
Courtesy of GENERAL MOTORS COMPANY

WARNING: Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.

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2. Disconnect the fuel tank vent pipe (2).
3. Disconnect the evaporative emission canister wiring harness plug (3).
4. Remove the evaporative emission canister (1) from the evaporative emission canister bracket by releasing tab and lifting it upwards.
5. Remove the fuel tank baffles. Refer to **Fuel Tank Baffle Replacement**.

Assemble Procedure

1. Install the fuel tank baffles. Refer to **Fuel Tank Baffle Replacement**.

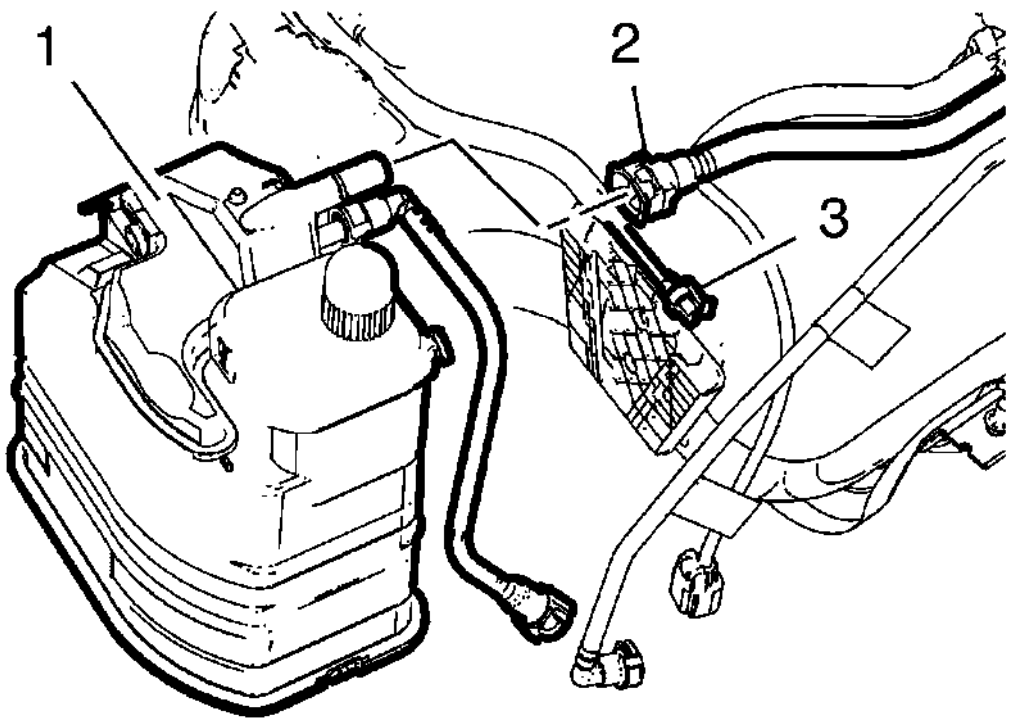


Fig. 82: Evaporative Emission Canister
Courtesy of GENERAL MOTORS COMPANY

2. Install the evaporative emission canister (1) to the evaporative emission canister bracket.
3. Connect the evaporative emission canister wiring harness plug (3).
4. Connect the fuel tank vent pipe (2).

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5. Install the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.

Installation Procedure

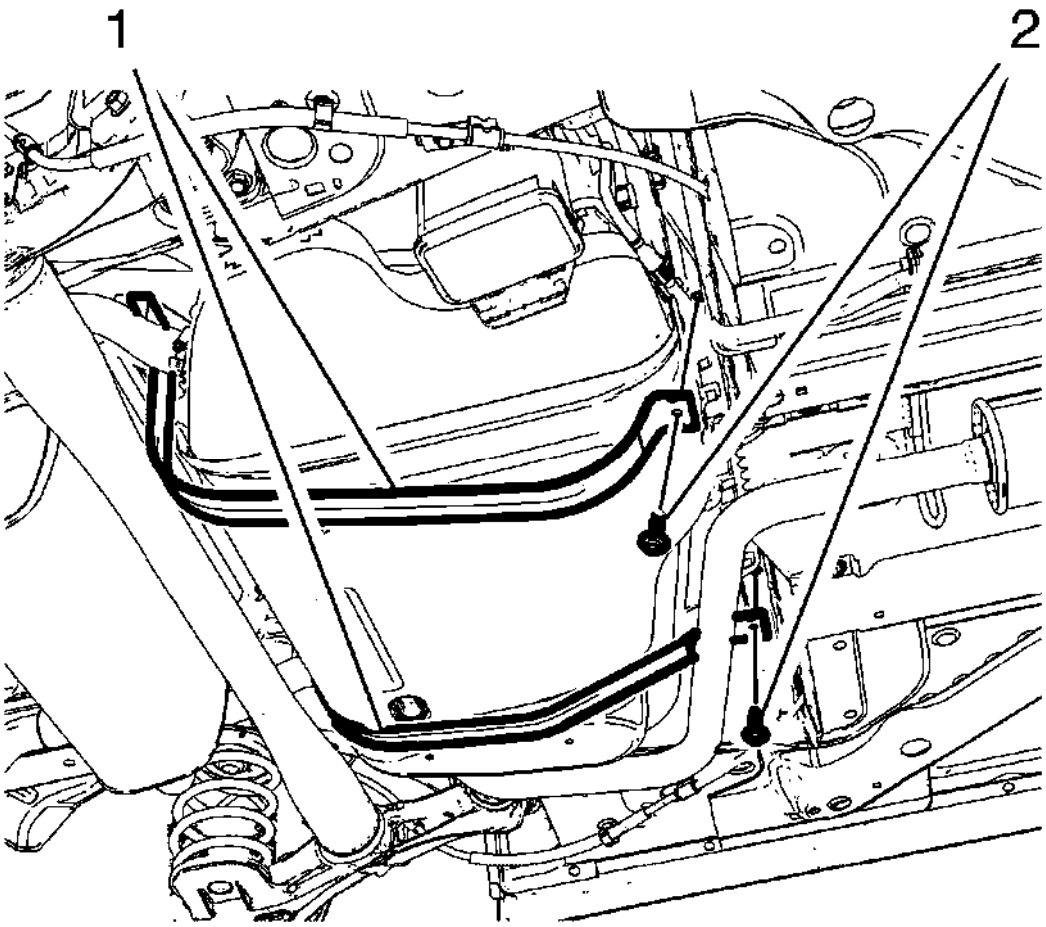


Fig. 83: Fuel Tank Straps
Courtesy of GENERAL MOTORS COMPANY

NOTE: A second technician is required.

NOTE: Extend the jack.

1. Install the fuel tank.
2. Install the 2 fuel tank straps (1).

CAUTION: Refer to Fastener Caution .

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3. Install the 2 fuel tank strap bolts (2) and tighten to 22 N.m (16 lb ft).

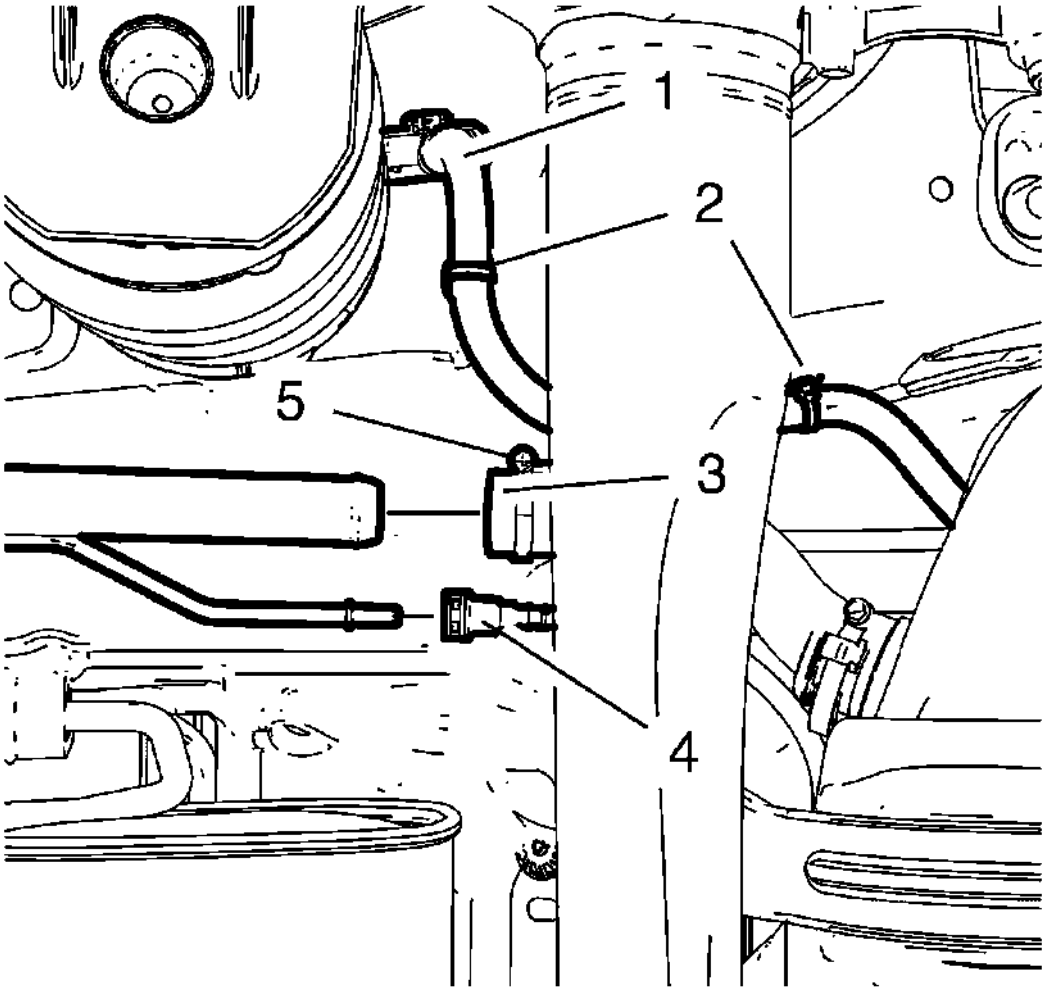


Fig. 84: Fuel Tank Wiring Harness Inline Connector
Courtesy of GENERAL MOTORS COMPANY

4. Install the fuel tank filler hose (3) to the fuel tank filler pipe.
5. Tighten the fuel tank filler hose clamp (5).
6. Remove the cap from the fuel tank filler vent pipe.
7. Connect the fuel tank filler vent pipe connector (4) to the fuel tank filler vent pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
8. Connect the fuel tank wiring harness inline connector (1) and clip in the wiring harness to 2 retainer clips (2).

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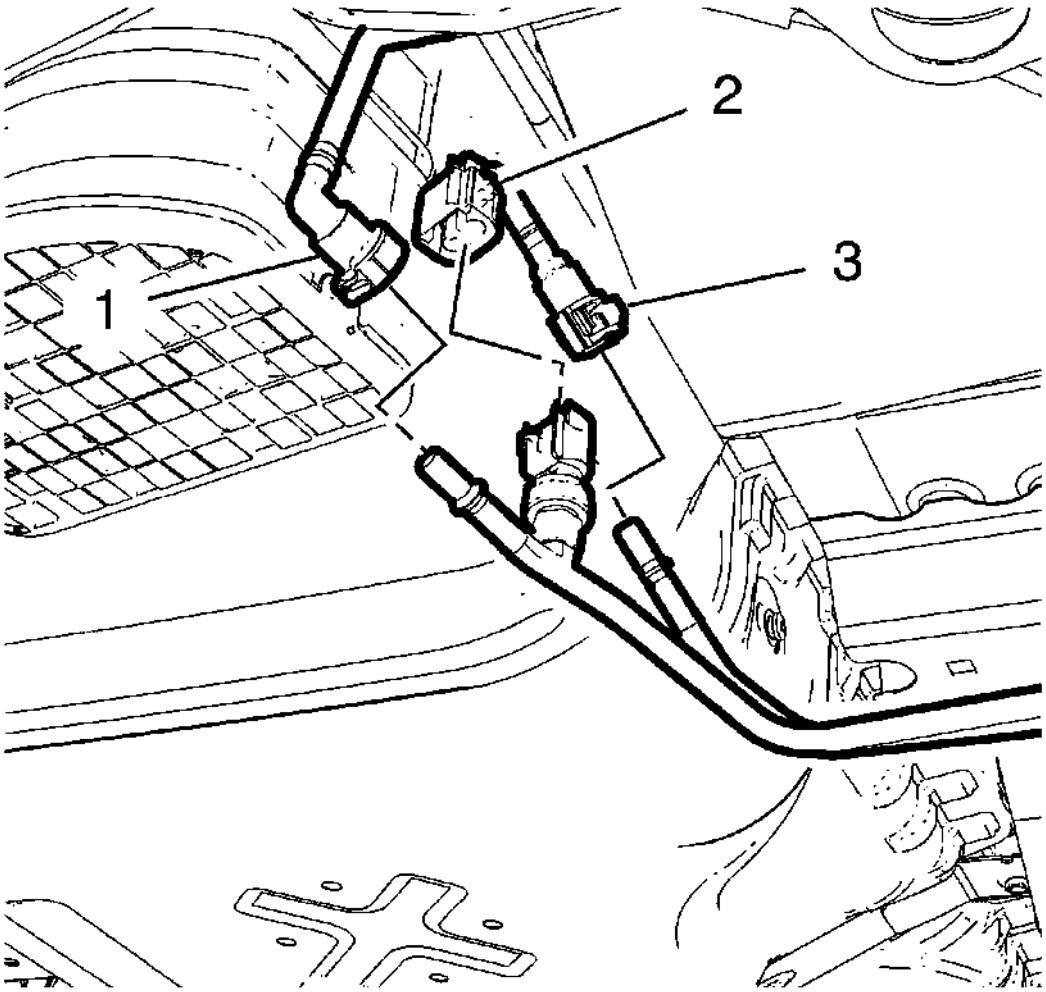


Fig. 85: Fuel Pressure Sensor Wiring Harness Plug, Fuel Tank Vent Pipe, Fuel Feed Pipe Connector And Fuel Tank Vent Pipe Connector
Courtesy of GENERAL MOTORS COMPANY

9. Remove the caps from the fuel pipes.
10. Connect the fuel tank vent pipe connector (3) to the fuel tank vent pipe (3). Refer to **Plastic Collar Quick Connect Fitting Service**.
11. Connect the fuel feed pipe connector (1) to the fuel feed pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.
12. Connect the fuel pressure sensor wiring harness plug (2).
13. Lower the vehicle.
14. Install the rear wheelhouse panel liner. Refer to **Rear Wheelhouse Liner Replacement** .
15. Install the right rear tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
16. Lower the vehicle.
17. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

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18. Close the hood.

FUEL TANK BAFFLE REPLACEMENT

Removal Procedure

WARNING: Refer to Fuel Vapors in Evaporative Emission Components Warning .

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Goggles and Fuel Warning .

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
2. Place the fuel tank onto a workbench.
3. Remove the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.

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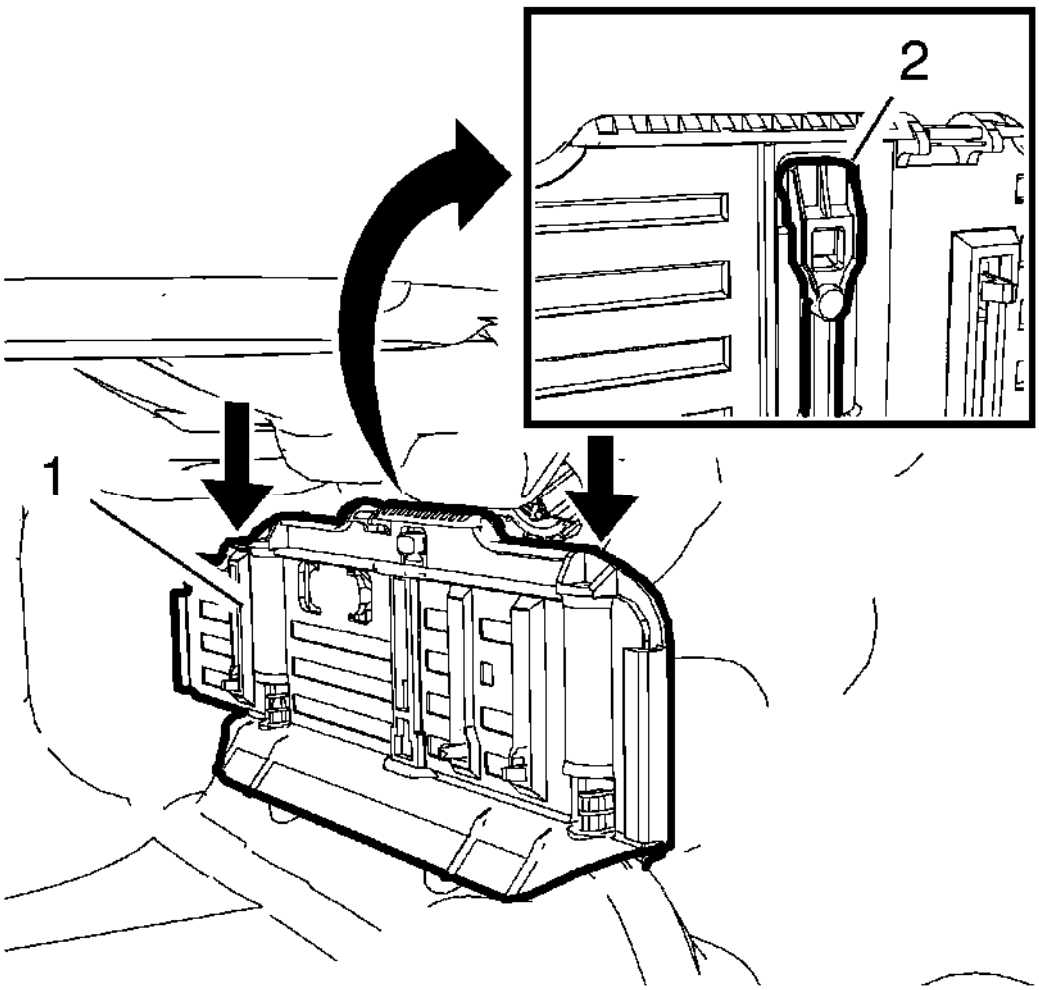


Fig. 86: Fuel Tank Baffle And Lug
Courtesy of GENERAL MOTORS COMPANY

4. Press the fuel tank baffle (1) completely down as shown in the picture.
5. Push the lug (2) toward the baffle and hold it.
6. Release tension from the fuel tank baffle (1) until the lug (2) engages safely.

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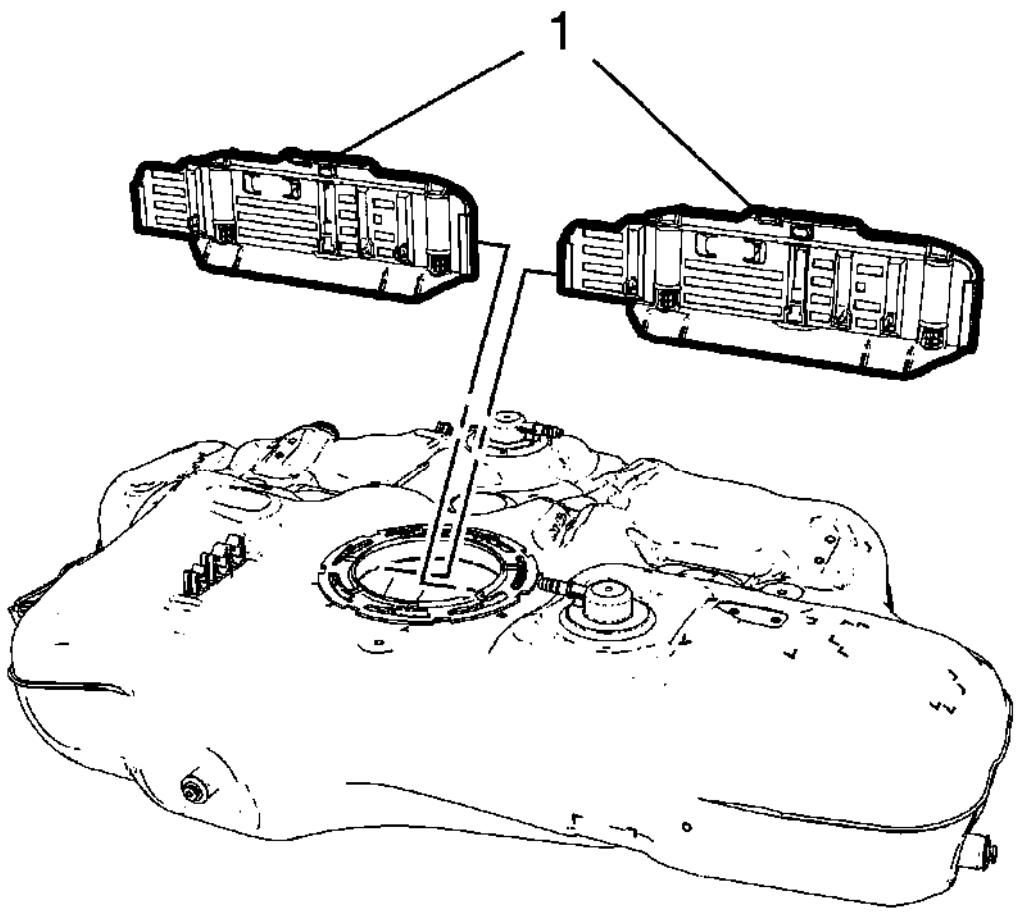


Fig. 87: Fuel Tank Baffles
Courtesy of GENERAL MOTORS COMPANY

7. Remove the baffles (1) one by one.
8. Repeat steps 5 to 8 to remove the other baffle.

Installation Procedure

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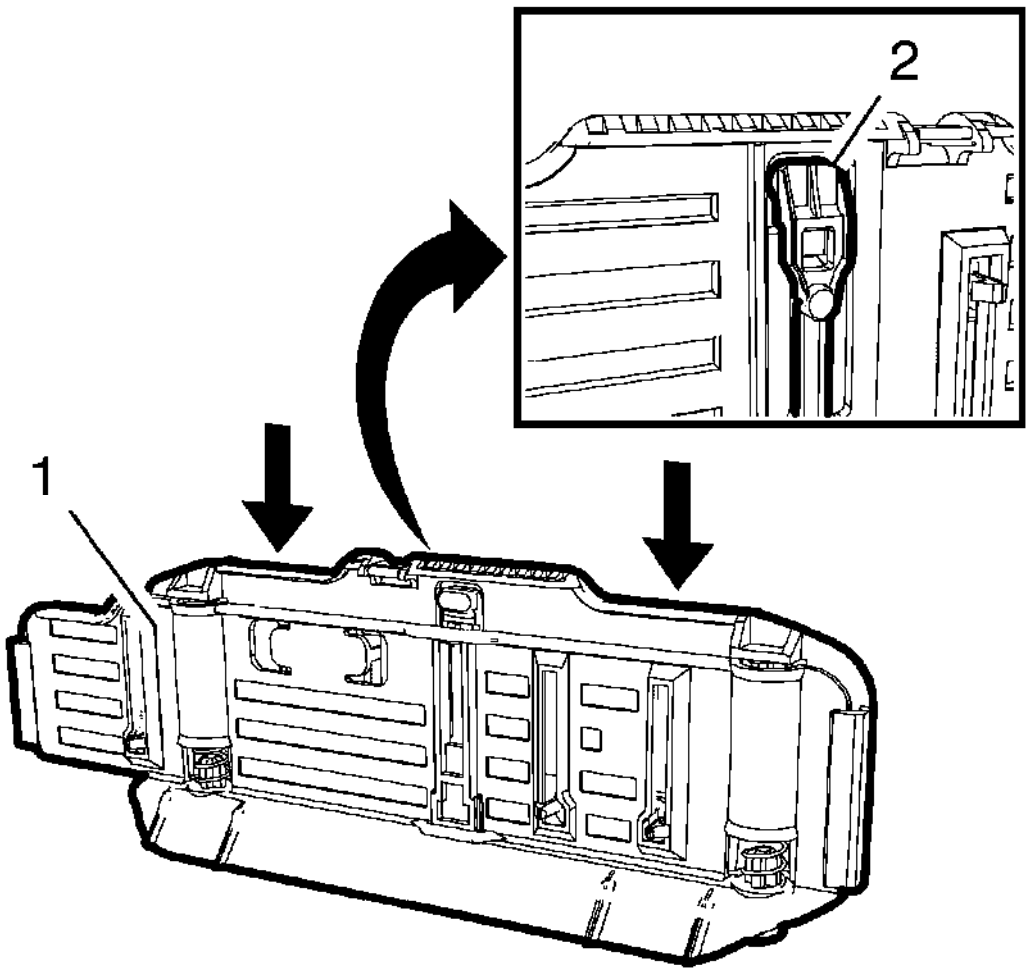


Fig. 88: Fuel Tank Baffle And Lugs
Courtesy of GENERAL MOTORS COMPANY

NOTE: Perform the steps 1-3 only when the fuel tank baffles are not transferred from the OLD to the NEW tank.

1. Tension the fuel tank baffle (1) completely by pressing it down.
2. Push the lug (2) toward the baffle and hold it.
3. Release tension from the fuel tank baffle (1) until the lug (2) engages safely.

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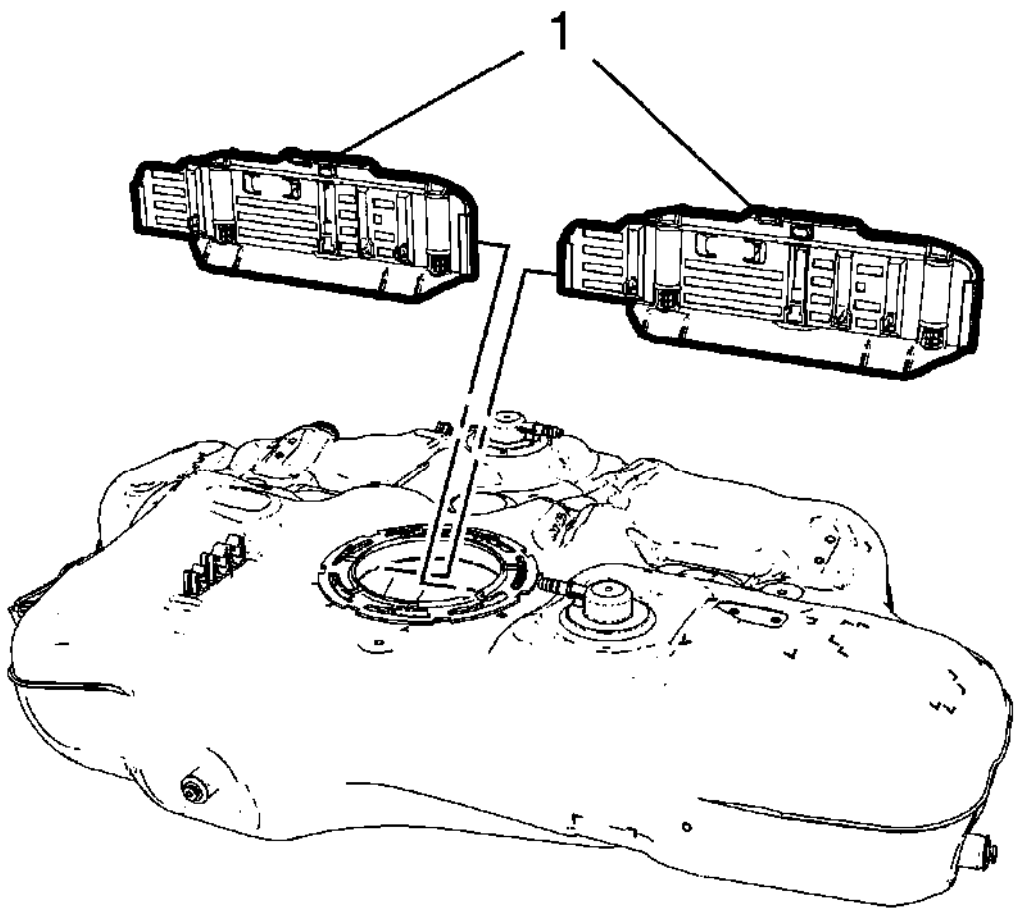


Fig. 89: Fuel Tank Baffles
Courtesy of GENERAL MOTORS COMPANY

4. Install the baffles (1) one by one.

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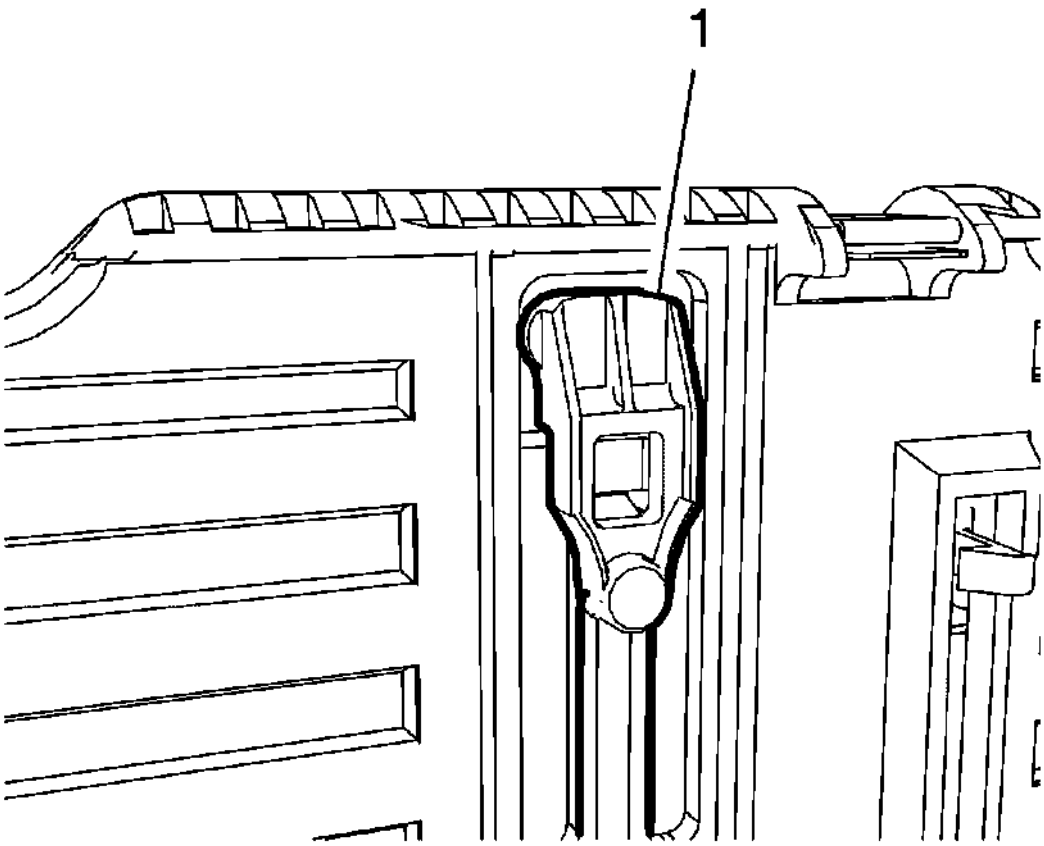


Fig. 90: Fuel Tank Baffle Lug
Courtesy of GENERAL MOTORS COMPANY

5. Press the fuel tank baffle together until the lug (1) becomes unlocked.
6. Release tension slowly from the fuel tank baffle and let the baffle engage safely in the installation site.

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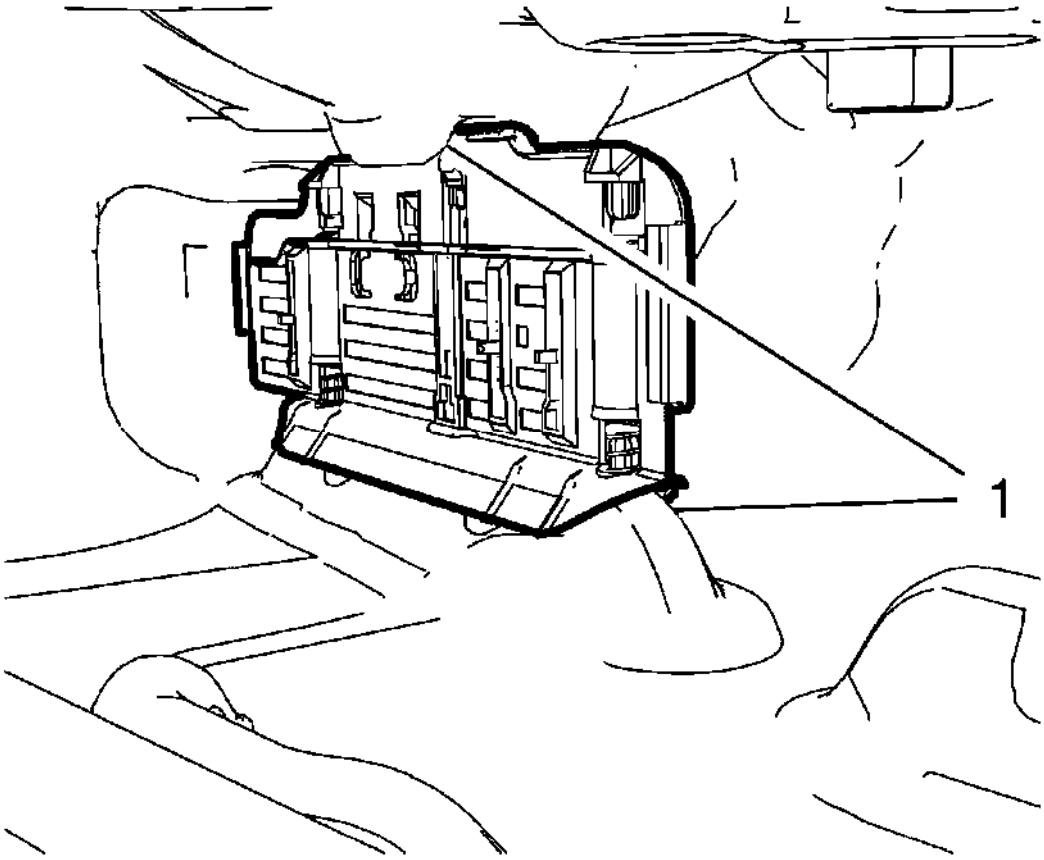


Fig. 91: Fuel Tank Installation Sites
Courtesy of GENERAL MOTORS COMPANY

7. Check the proper seat of the fuel tank baffle at the fuel tank installation sites (1). Use a mirror if necessary.
8. Repeat steps 1-7 to install the other baffle.
9. Install the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.
10. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL TANK VENT PIPE REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning

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WARNING: Refer to Safety Goggles and Fuel Warning

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

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

1. Open the hood.
2. Disconnect the battery negative cable **Battery Negative Cable Disconnection and Connection** .

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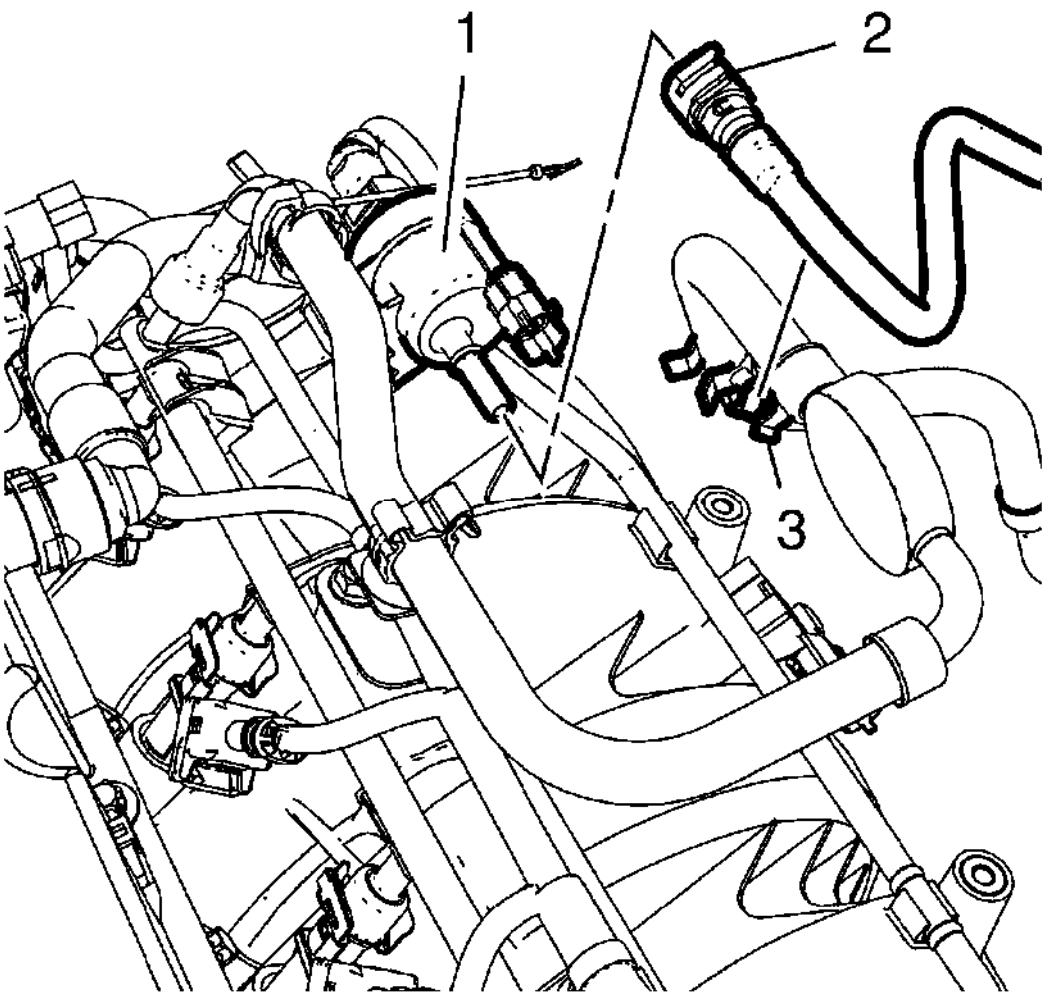


Fig. 92: Fuel Tank Vent Pipe And Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fuel tank vent pipe (2) from the evaporative emission canister purge solenoid valve (1) and from the clip (3).

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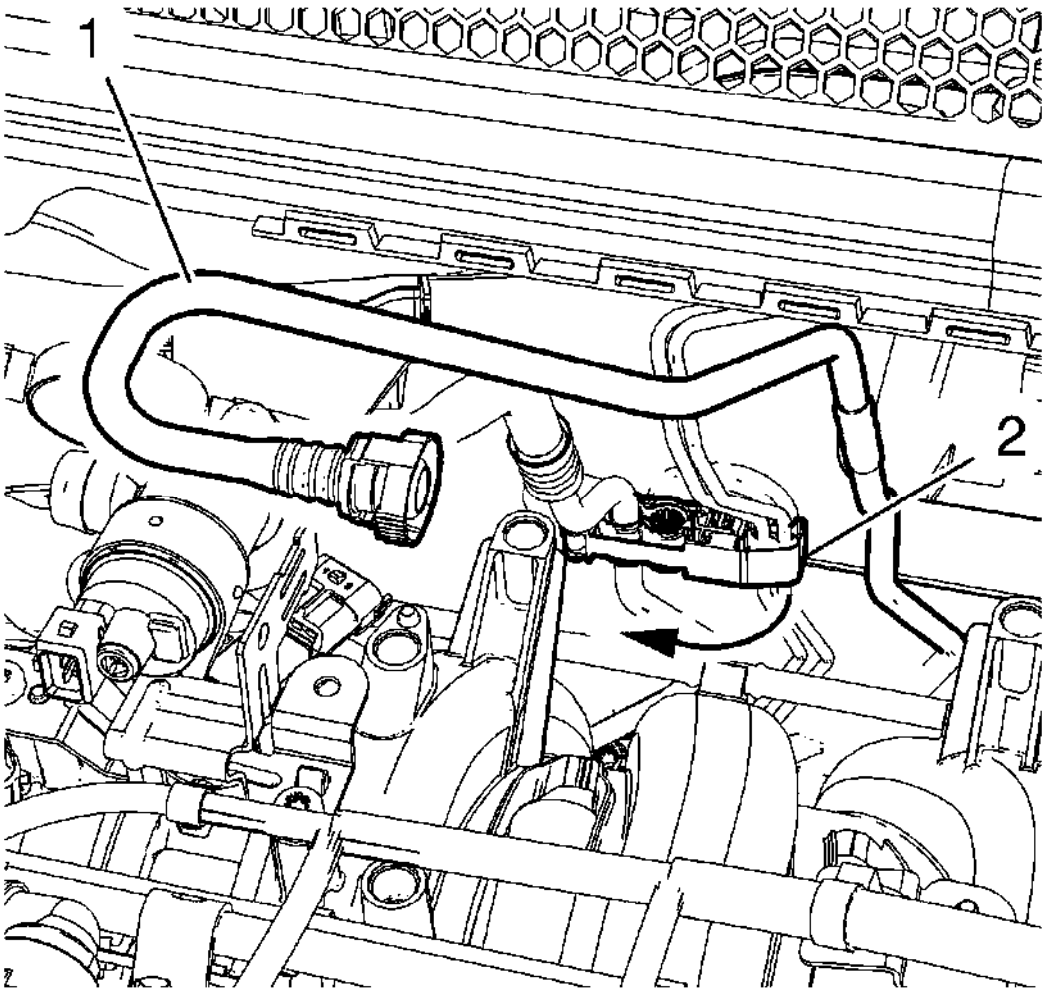


Fig. 93: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Open the upper bulk head clip (2).
5. Remove the fuel tank vent pipe (1) from the upper bulkhead clip.
6. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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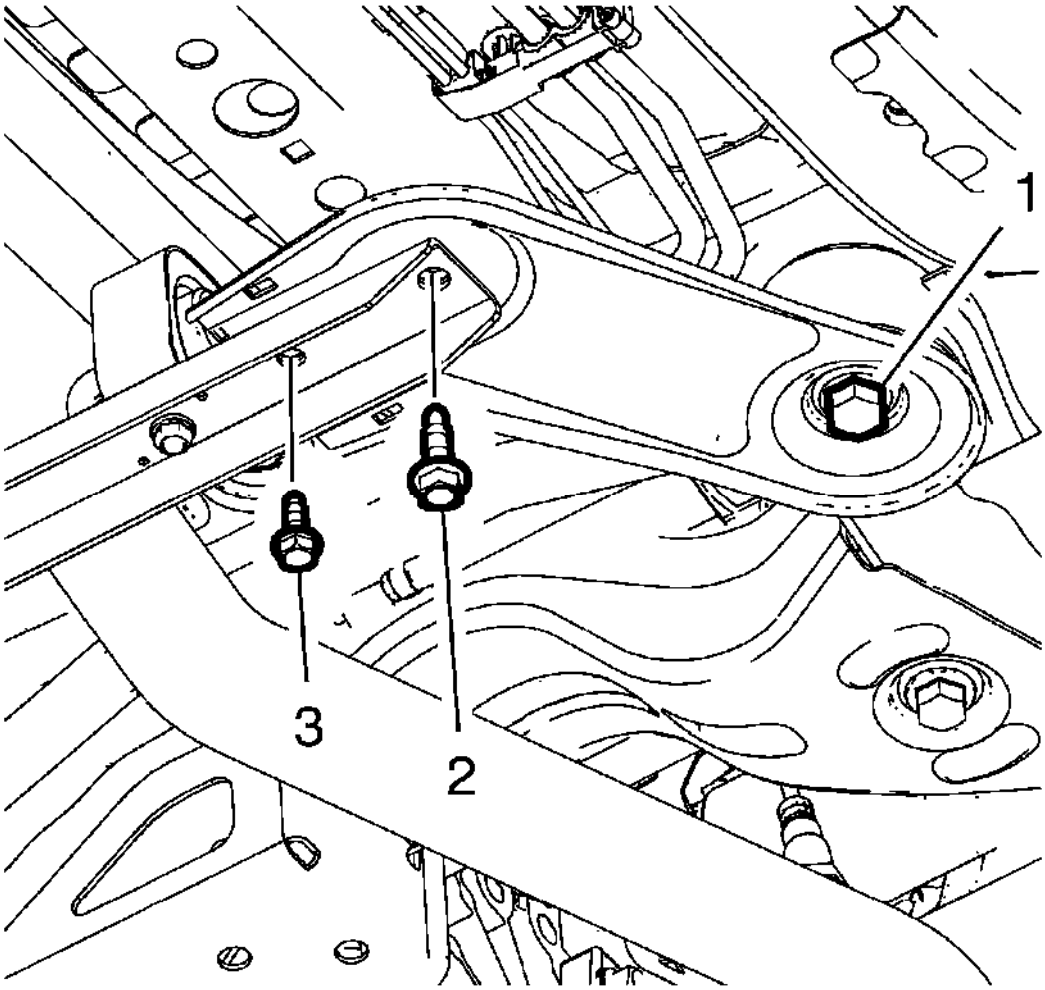


Fig. 94: Front Exhaust Hanger Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove and DISCARD the exhaust front hanger bracket bolt (3).
8. Remove and DISCARD the frame reinforcement bolt (2).
9. Loosen the drive train and front suspension frame bolt (1).

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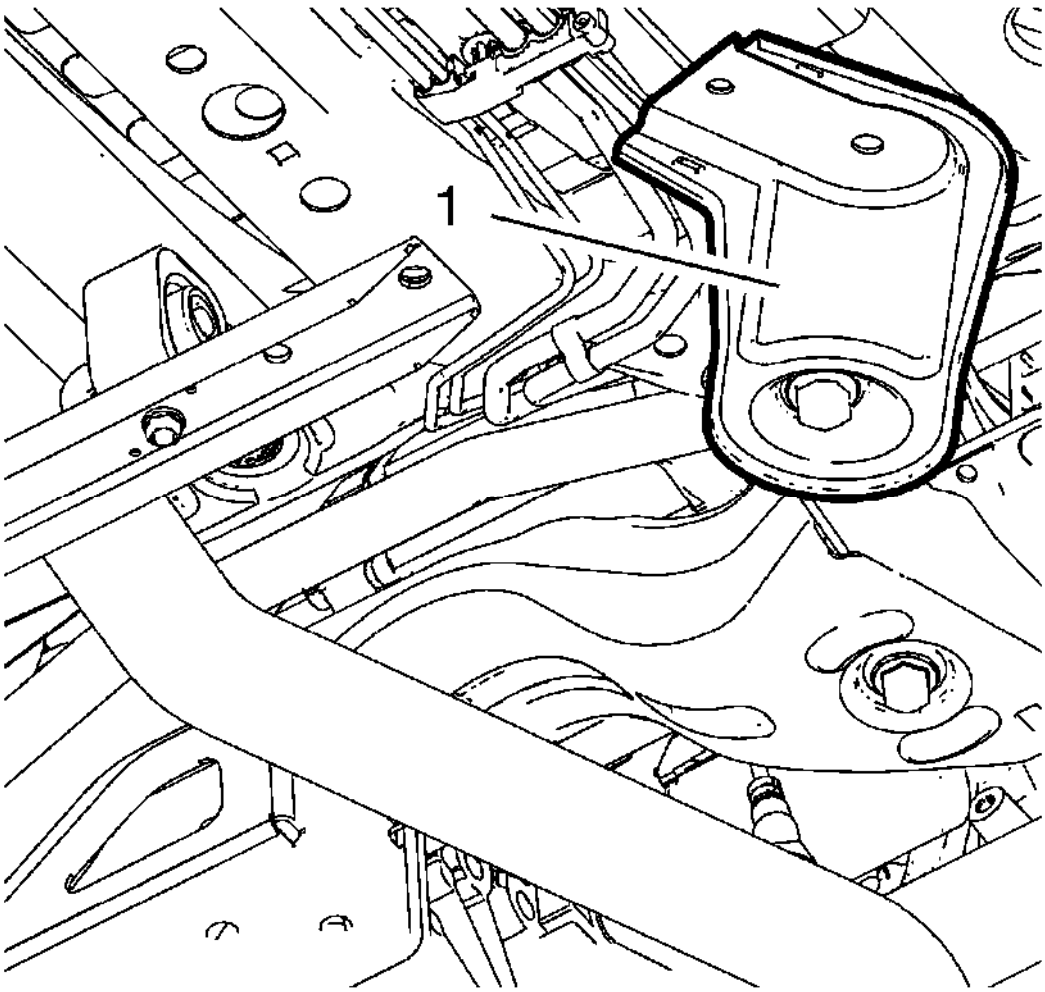


Fig. 95: Right Frame Reinforcement
Courtesy of GENERAL MOTORS COMPANY

10. Rotate the right frame reinforcement (1) to a position shown to get access to the fuel pipes.

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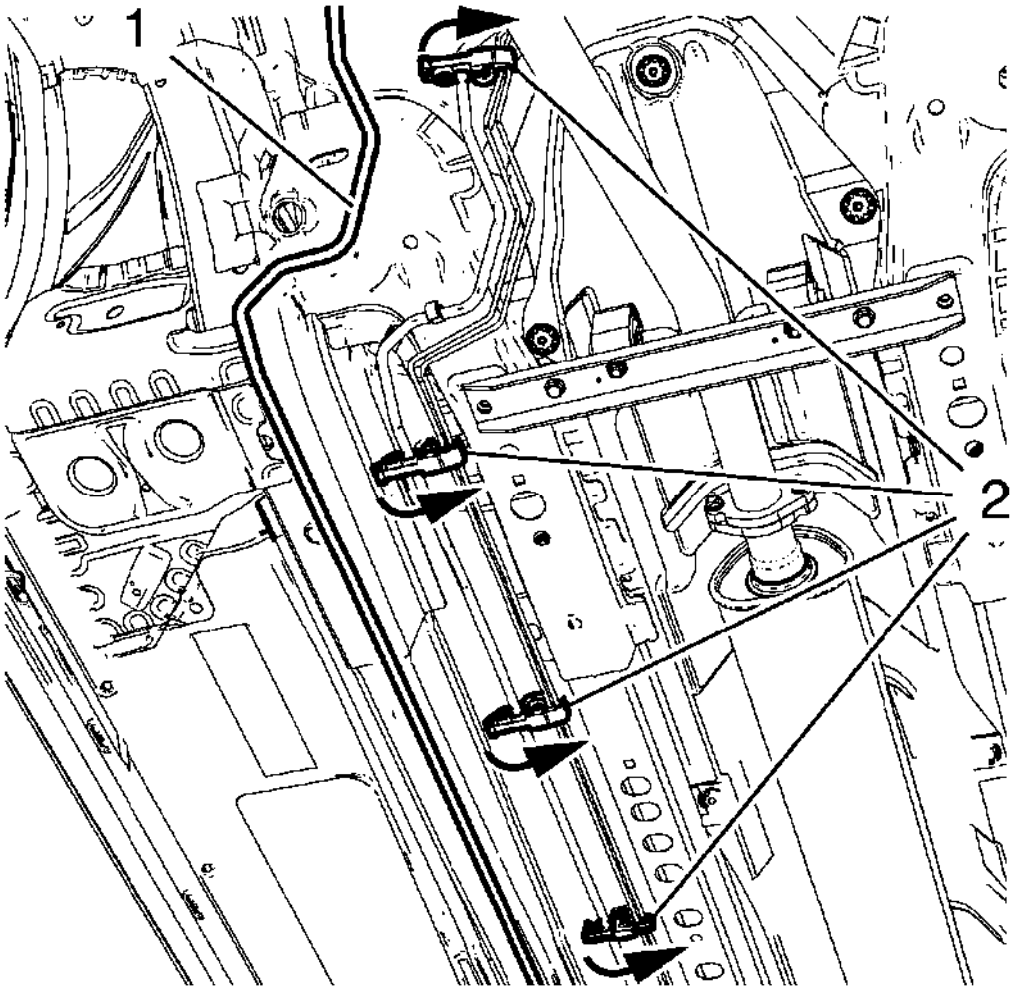


Fig. 96: Fuel Feed Pipe And Clips
Courtesy of GENERAL MOTORS COMPANY

11. Open the 4 fuel pipe clips (2).
12. Remove the lower bulk head clip.

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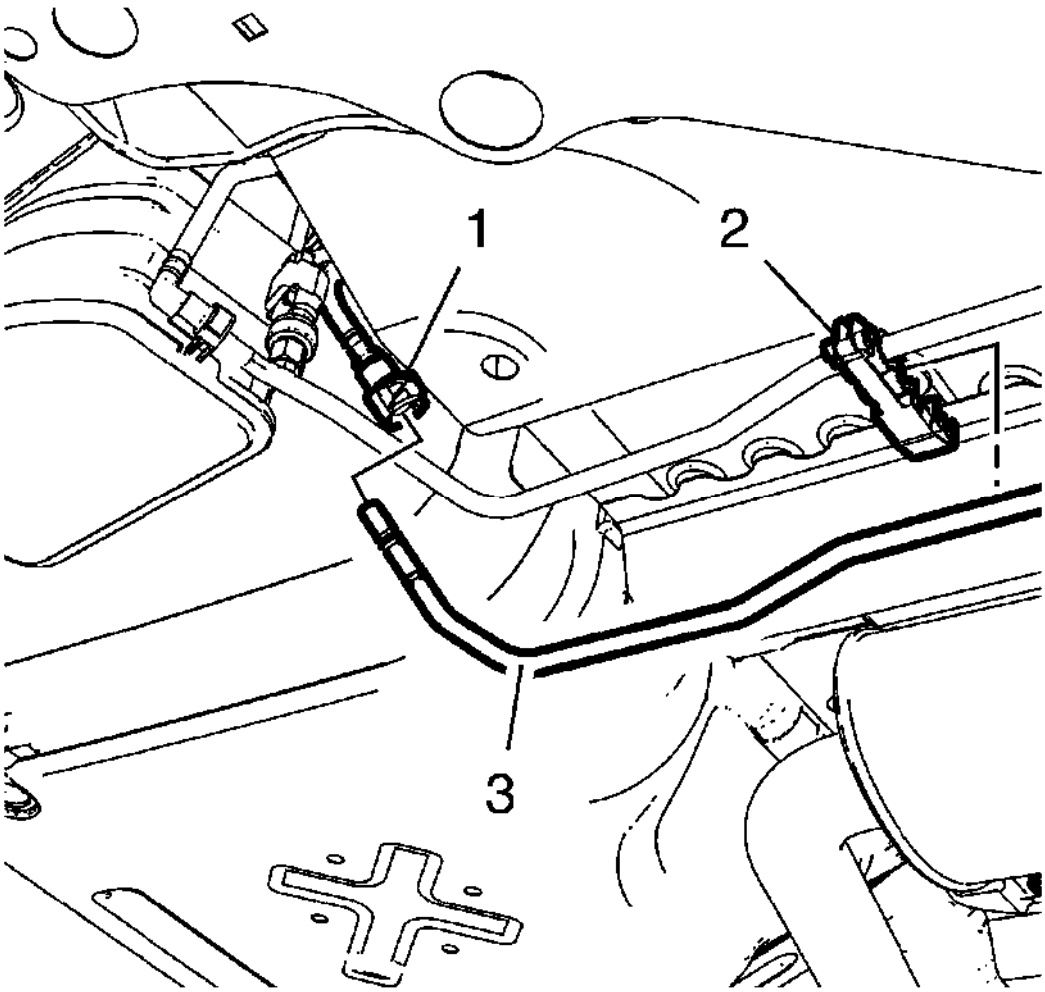


Fig. 97: Evaporative Emission Canister Fuel Vent Pipe Connector
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the evaporative emission canister fuel vent pipe connector (1) from the fuel tank vent pipe (3). Refer to **Plastic Collar Quick Connect Fitting Service**.
14. Close the fuel tank vent pipe and emission canister fuel vent pipe with suitable caps.
15. Open the fuel pipe clip (2) and remove the fuel tank vent pipe (3).

Installation Procedure

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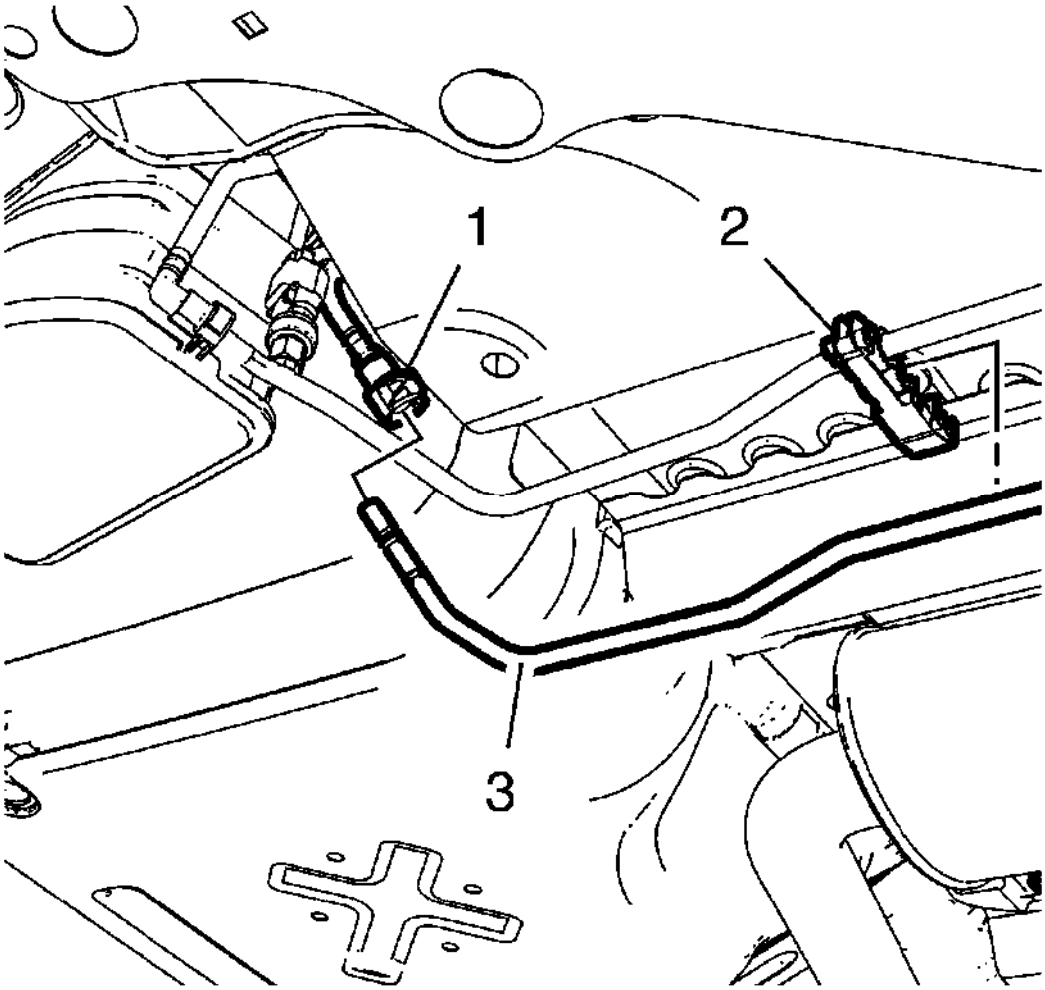


Fig. 98: Evaporative Emission Canister Fuel Vent Pipe Connector
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel tank vent pipe (3) and close the fuel pipe clip (2).
2. Remove the caps from emission canister fuel vent pipe and fuel tank vent pipe.
3. Connect the emission canister fuel vent pipe to fuel tank vent pipe. Refer to **Plastic Collar Quick Connect Fitting Service**.

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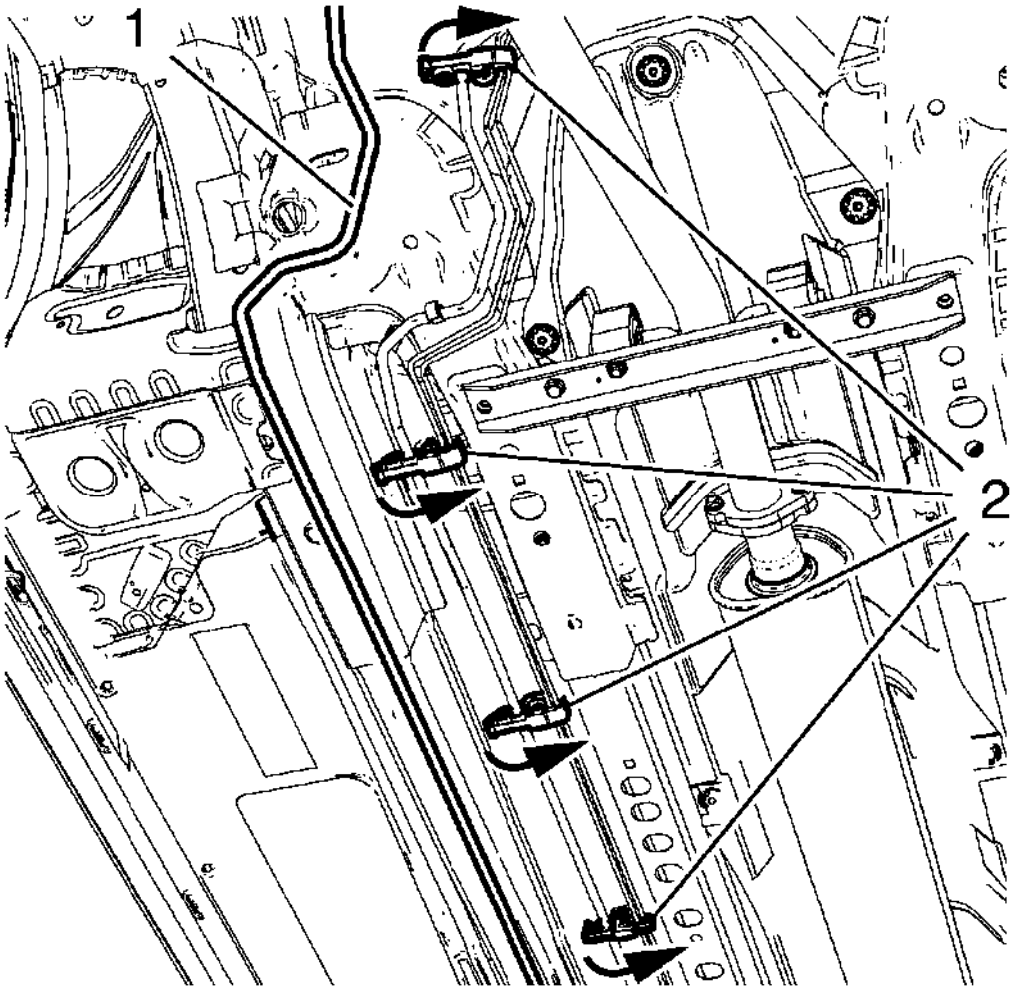


Fig. 99: Fuel Feed Pipe And Clips
Courtesy of GENERAL MOTORS COMPANY

4. Install the lower bulk head clip.
5. Close the 4 fuel pipe clips (2).

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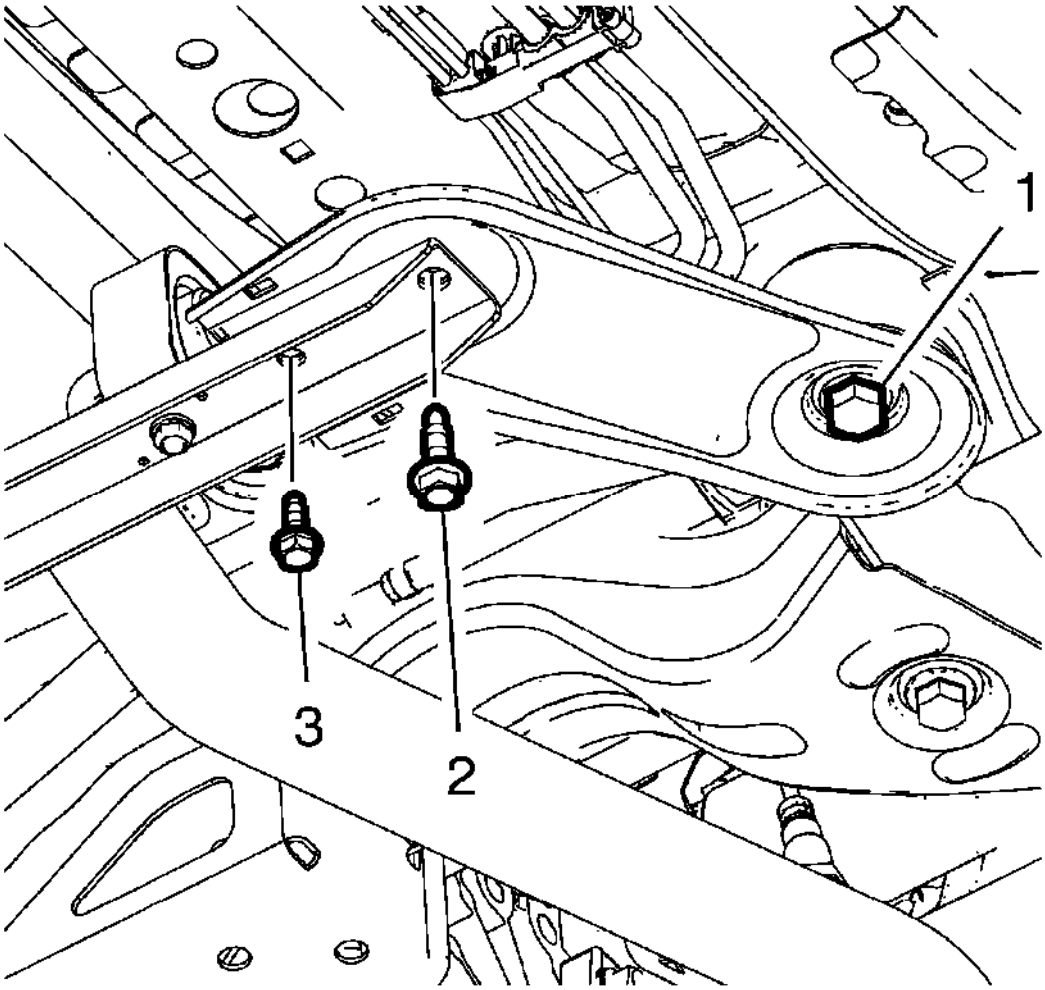


Fig. 100: Front Exhaust Hanger Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Rotate the right frame reinforcement to its original position.
7. Install the exhaust front hanger bracket bolt (3).
8. Install the frame reinforcement bolt (2).

CAUTION: Refer to Fastener Caution .

CAUTION: Refer to Torque-to-Yield Fastener Caution .

9. Tighten the NEW exhaust front hanger bracket bolt (3) to 22 (16 lb ft).
10. Tighten the NEW frame reinforcement bolt (2) to 60 (44 lb ft).

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11. Tighten the drivetrain and front suspension frame bolt (1) to 160 (118 lb ft).
12. Lower the vehicle.

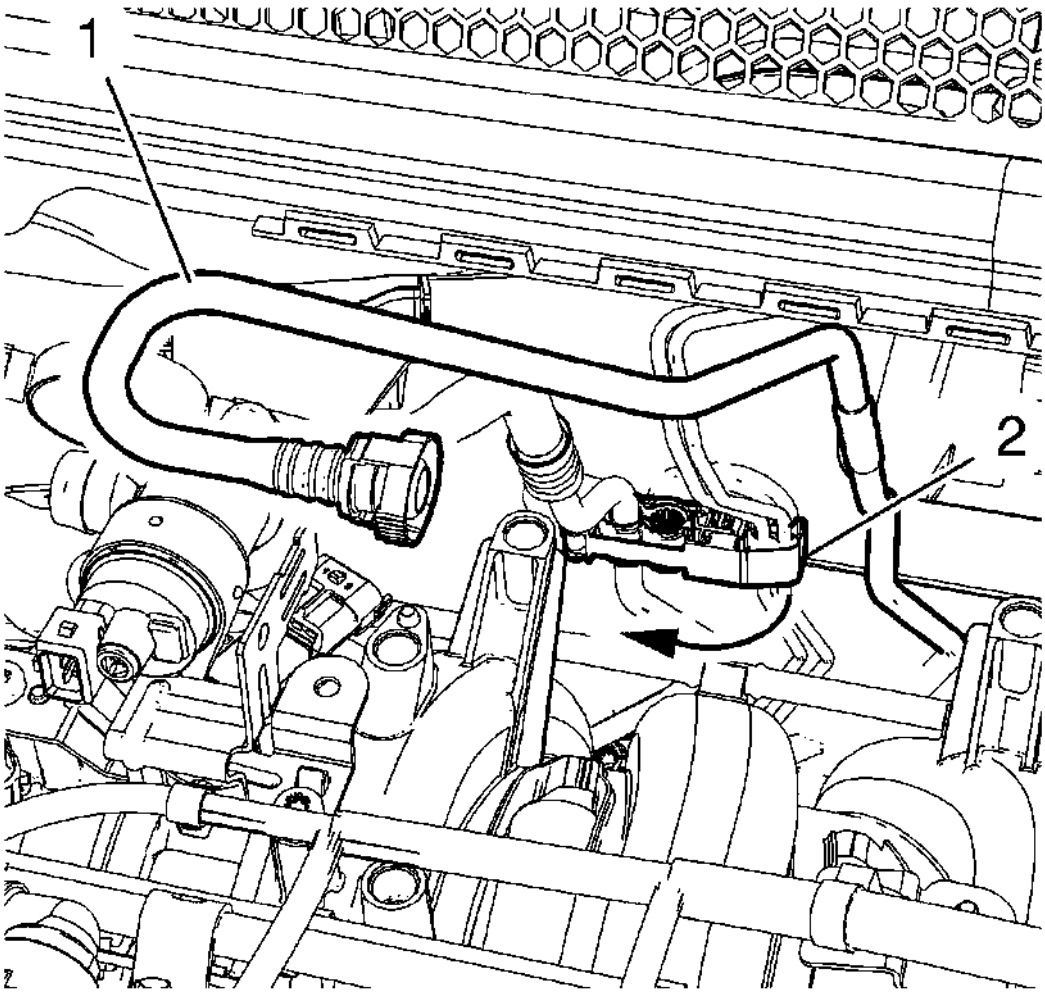


Fig. 101: Fuel Tank Vent Pipe
Courtesy of GENERAL MOTORS COMPANY

13. Install the fuel tank vent pipe (1) to the upper bulkhead clip.
14. Close the upper bulk head clip (2).

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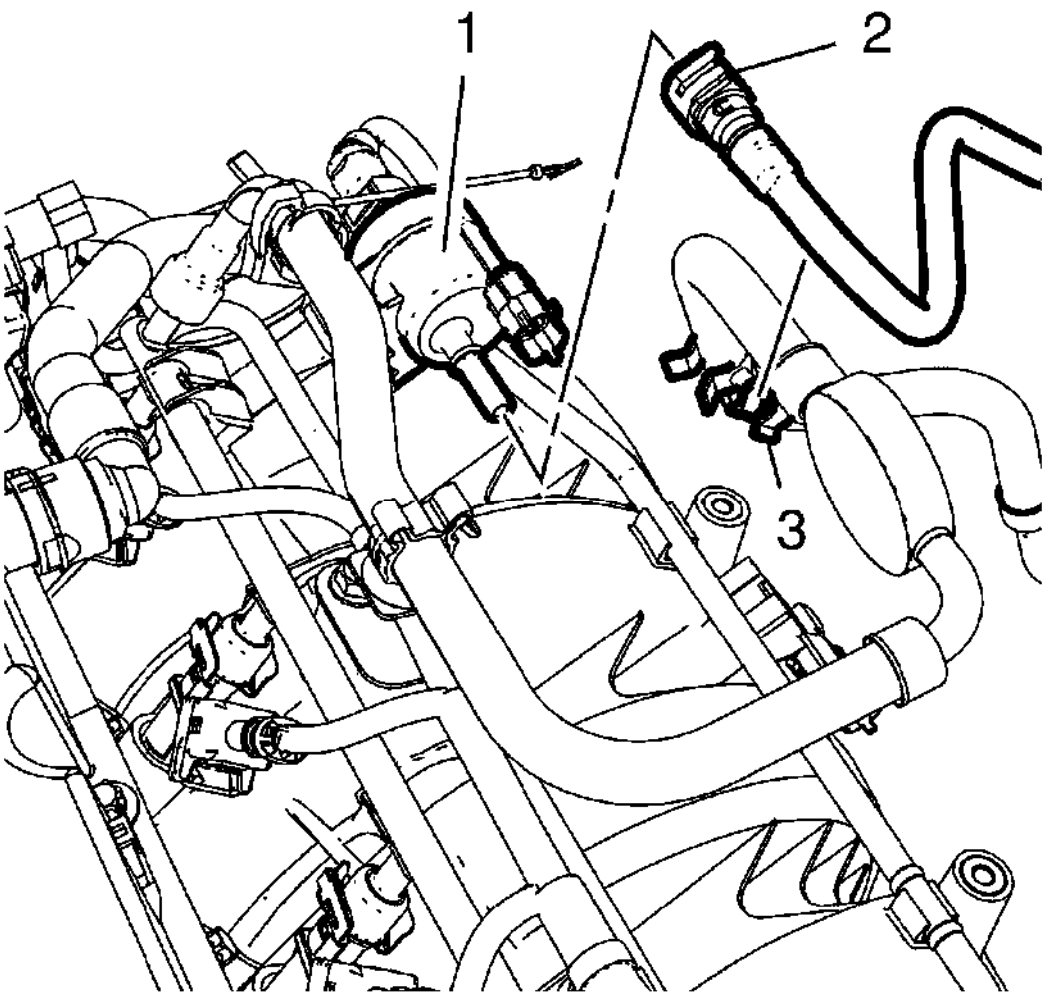


Fig. 102: Fuel Tank Vent Pipe And Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

15. Install the fuel tank vent pipe (2) to the evaporative emission canister purge solenoid valve (1) and to the clip (3).
16. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

FUEL TANK FILLER PIPE REPLACEMENT

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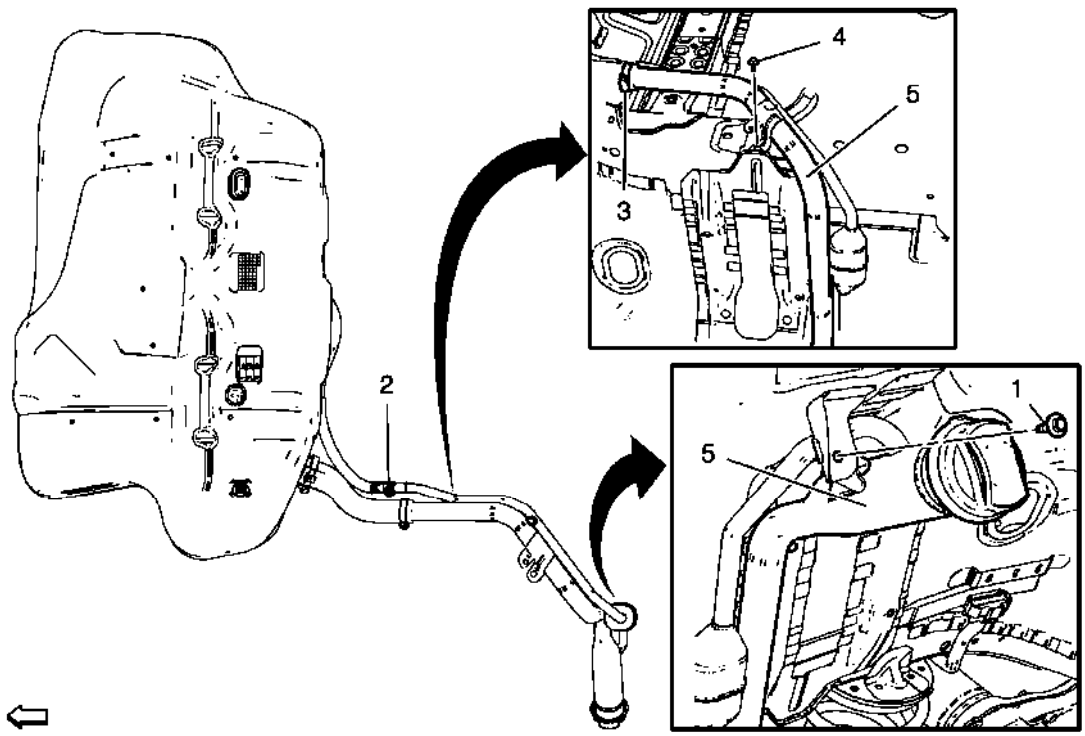


Fig. 103: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

Fuel Tank Filler Pipe Replacement

Callout	Component Name
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.** **Preliminary Procedures** 1. Disconnect battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** . 2. Remove the fuel tank filler pipe housing. Refer to **Fuel Tank Filler Pipe Housing Replacement** . 3. Drain the fuel tank. Refer to **Fuel Tank Draining**.	
1	Fuel Tank Filler Pipe Bracket Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)

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2	Lower Recirculation Tube Quick Release Fitting
3	Fuel Tank Filler Pipe Clamp
4	Fuel Tank Filler Pipe Ground Bolt **Tighten** 9 N.m (80 lb in)
5	Fuel Tank Filler Pipe

FUEL FEED PIPE REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning

WARNING: Refer to Safety Goggles and Fuel Warning

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

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

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**

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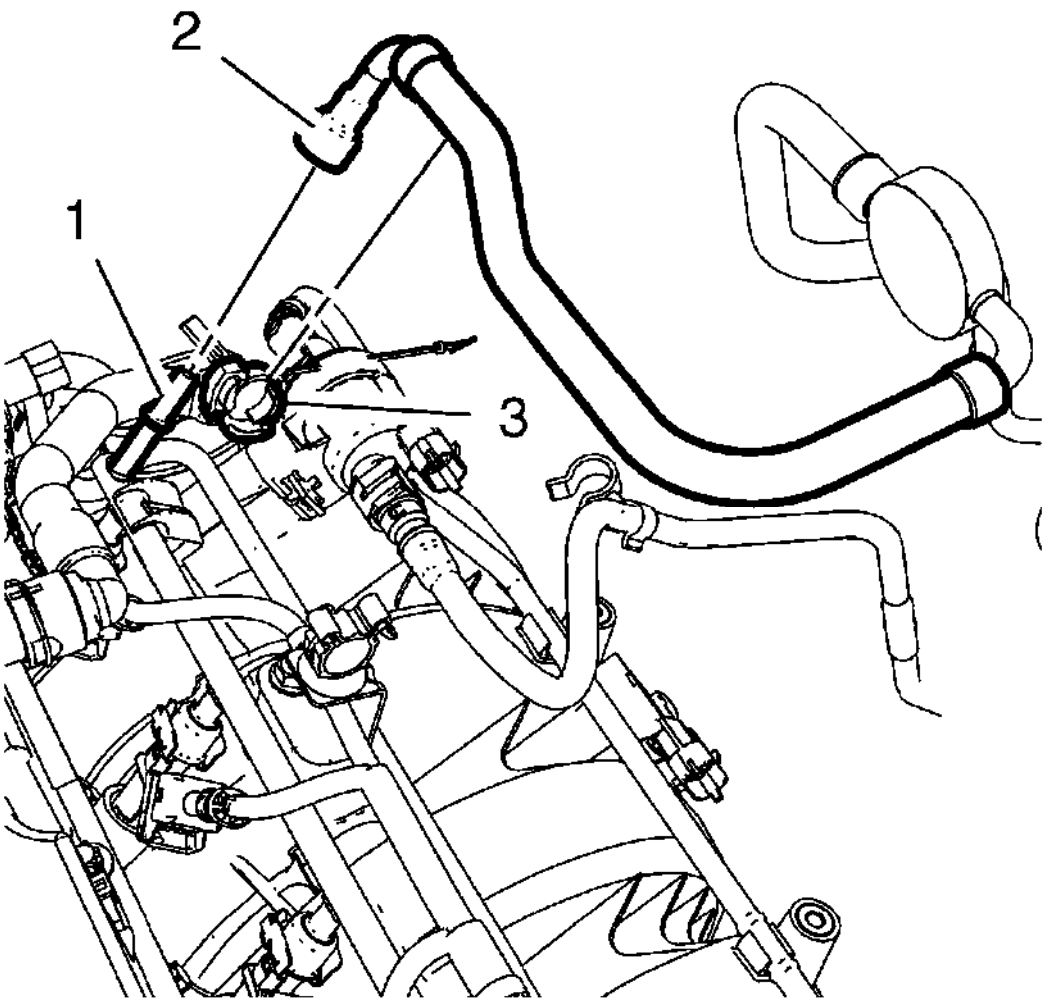


Fig. 104: Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Unclip the fuel feed pipe (2) from the fuel feed pipe clip (3).
3. Release the fuel feed pipe (2) from the multiport fuel injection fuel rail (1) and remove the fuel feed pipe.
4. Close the fuel feed pipe and the fuel rail with a suitable cap.

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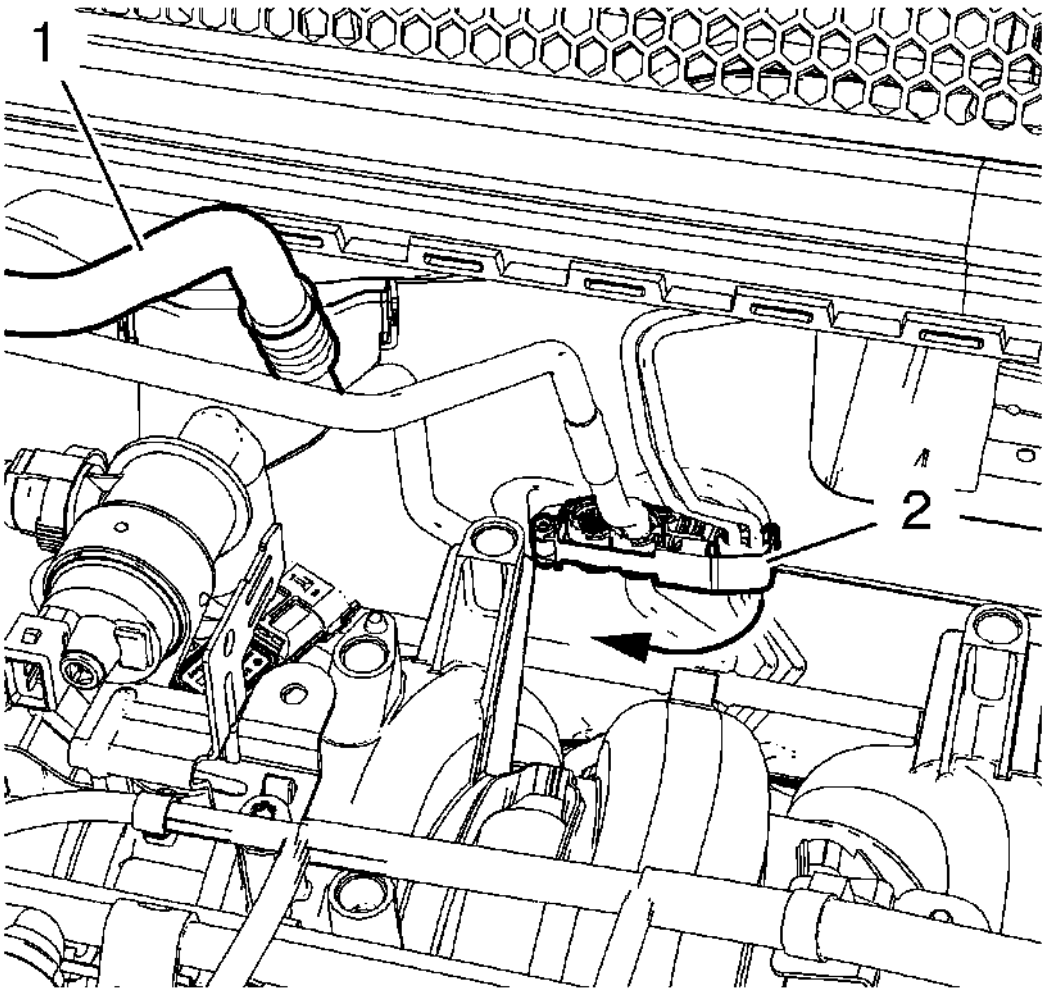


Fig. 105: Fuel Feed Pipe And Fuel Pipe Clip
Courtesy of GENERAL MOTORS COMPANY

5. Open the upper bulk head clip (2).
6. Remove the fuel feed pipe (1) from the upper bulkhead clip.
7. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

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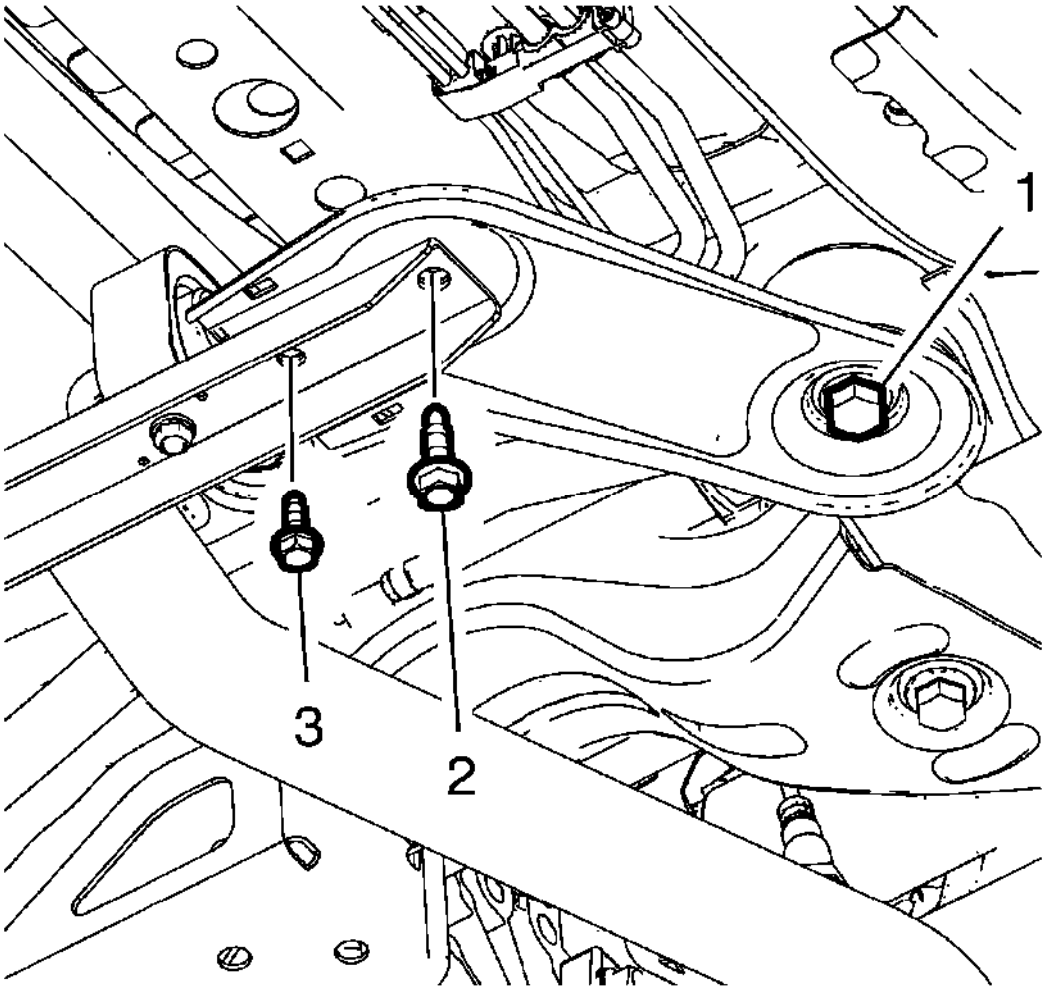


Fig. 106: Front Exhaust Hanger Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove and DISCARD the exhaust front hanger bracket bolt (3).
9. Remove and DISCARD the frame reinforcement bolt (2).
10. Loosen the drive train and front suspension frame bolt (1).

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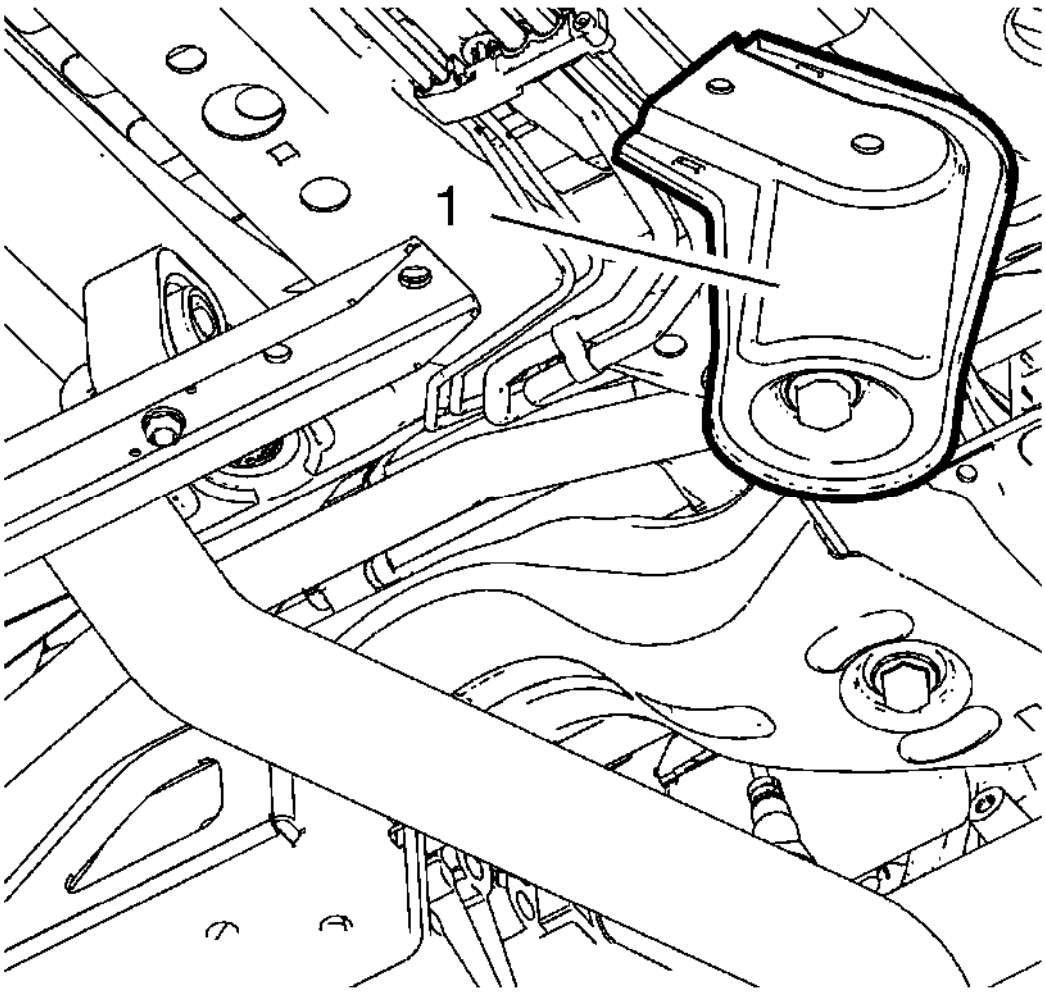


Fig. 107: Right Frame Reinforcement
Courtesy of GENERAL MOTORS COMPANY

11. Rotate the right frame reinforcement (1) to a position shown to get access to the fuel pipes.

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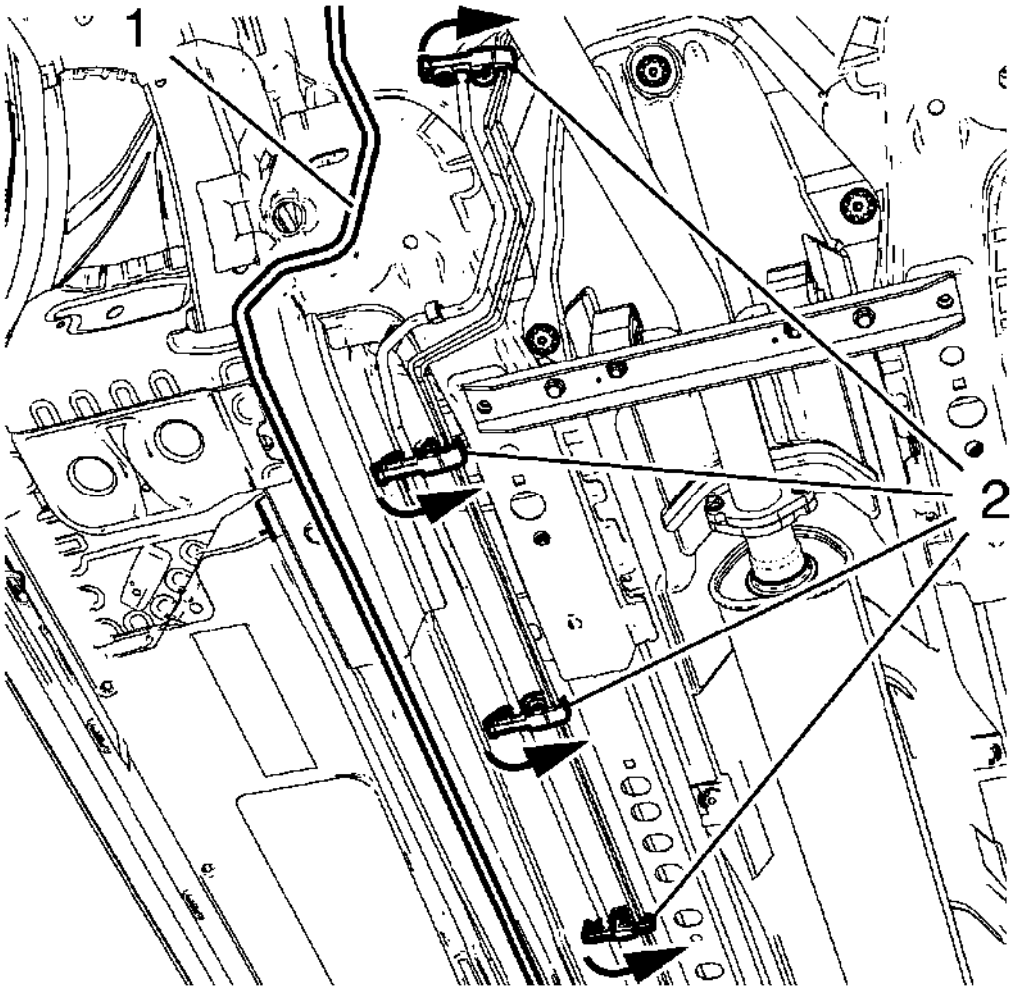


Fig. 108: Fuel Feed Pipe And Clips
Courtesy of GENERAL MOTORS COMPANY

12. Open the 4 fuel pipe clips (2).
13. Remove the lower bulk head clip.

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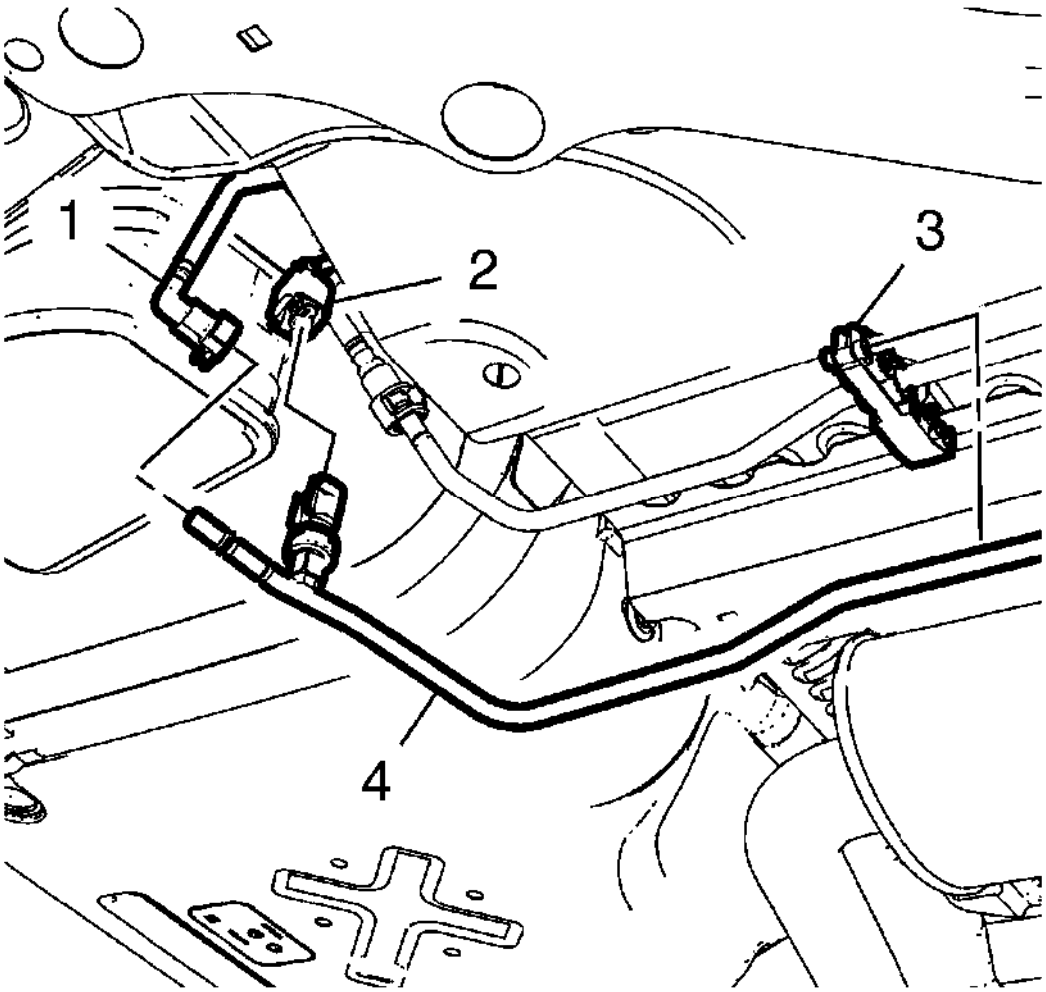


Fig. 109: Fuel Tank Feed Pipe Connector
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect the fuel tank feed pipe connector (1) from fuel feed pipe (4). Refer to **Plastic Collar Quick Connect Fitting Service**
15. Close the fuel feed pipe and fuel tank feed pipe with suitable caps.
16. Disconnect the wiring harness plug (2).
17. Open the fuel pipe clip (3) and remove the fuel feed pipe (4).
18. Close the fuel pipes with suitable caps.

Installation Procedure

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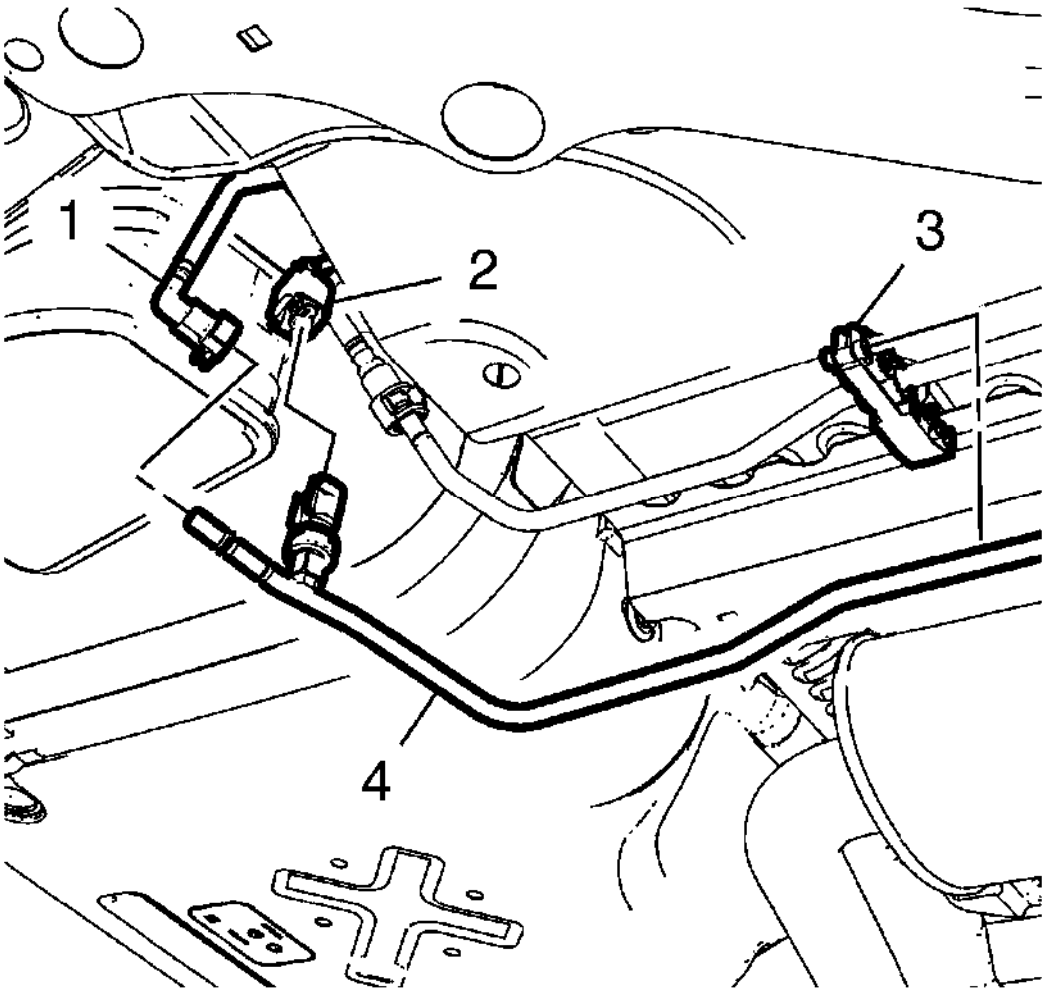


Fig. 110: Fuel Tank Feed Pipe Connector
Courtesy of GENERAL MOTORS COMPANY

1. Remove the caps from the fuel feed tank pipe and from the fuel feed pipe.
2. Install the fuel feed pipe (4) and close the fuel pipe clip (3).
3. Connect the fuel tank feed pipe connector (1) to fuel feed pipe (4). Refer to **Plastic Collar Quick Connect Fitting Service**
4. Connect the wiring harness plug (2).

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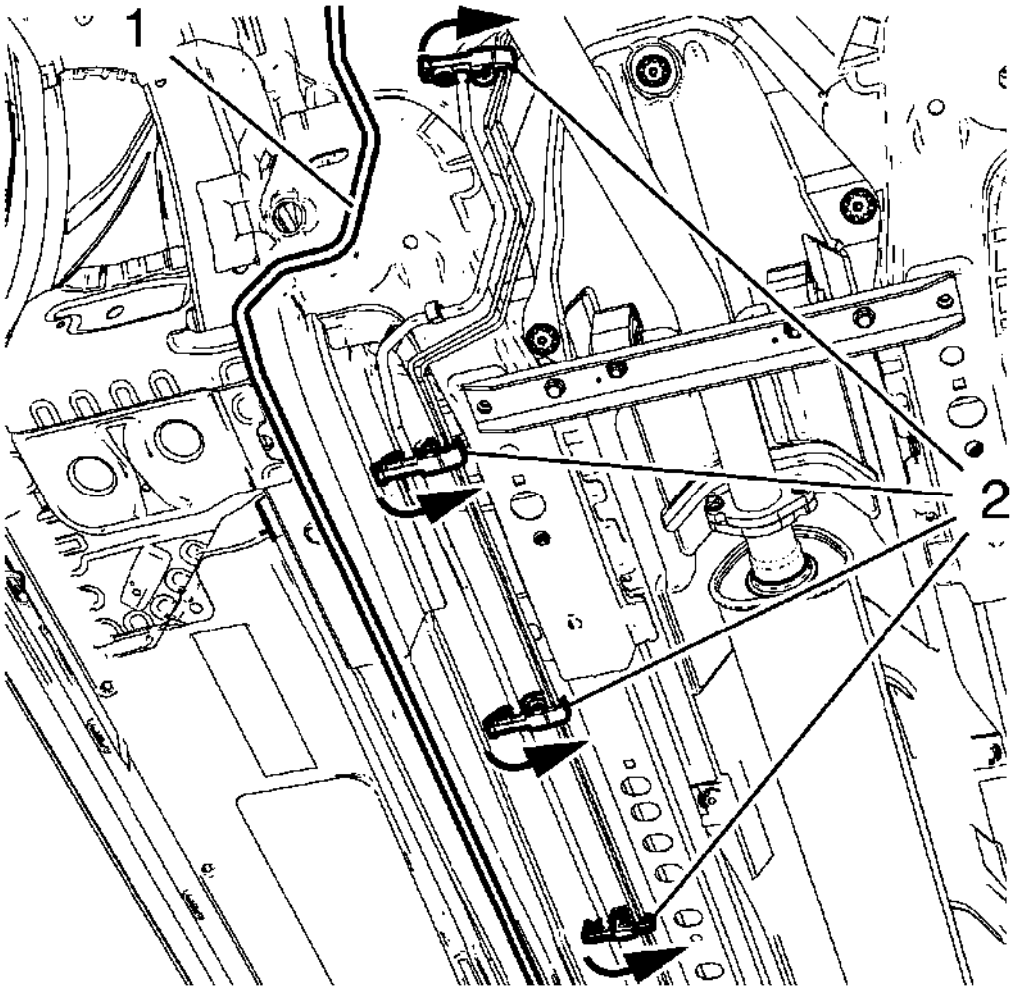


Fig. 111: Fuel Feed Pipe And Clips
Courtesy of GENERAL MOTORS COMPANY

5. Install the lower bulk head clip.
6. Close the 4 fuel pipe clips (2).

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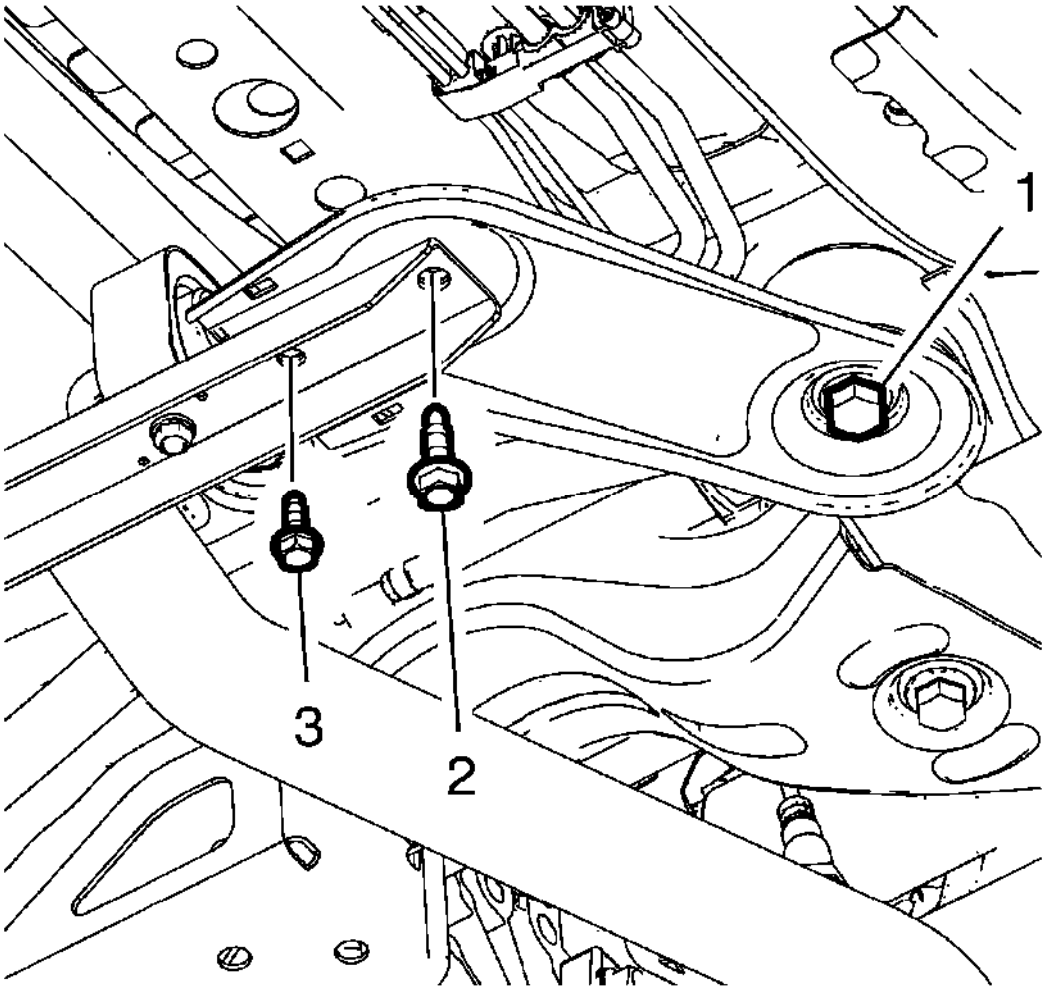


Fig. 112: Front Exhaust Hanger Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Rotate the right frame reinforcement to its original position.
8. Install the exhaust front hanger bracket bolt (3).
9. Install the frame reinforcement bolt (2).

CAUTION: Refer to Fastener Caution

CAUTION: Refer to Torque-to-Yield Fastener Caution

10. Tighten the NEW exhaust front hanger bracket bolt (3) to 22 N.m (16 lb ft).
11. Tighten the NEW frame reinforcement bolt (2) to 60 N.m (44 lb ft).

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12. Tighten the drivetrain and front suspension frame bolt (1) to 160 N.m (118 lb ft).
13. Lower the vehicle.

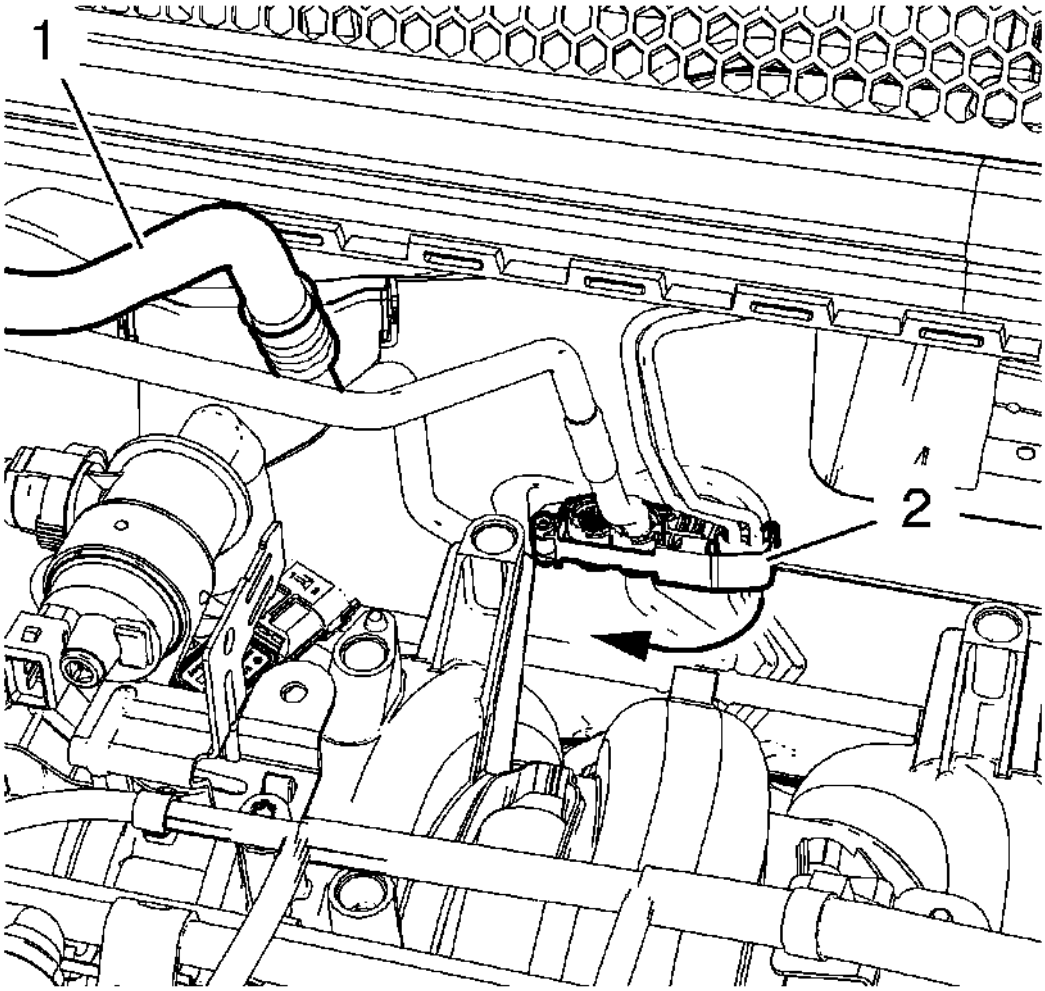


Fig. 113: Fuel Feed Pipe And Fuel Pipe Clip
Courtesy of GENERAL MOTORS COMPANY

14. Install the fuel feed pipe (1) to the upper bulkhead clip.
15. Close the upper bulk head clip (2).

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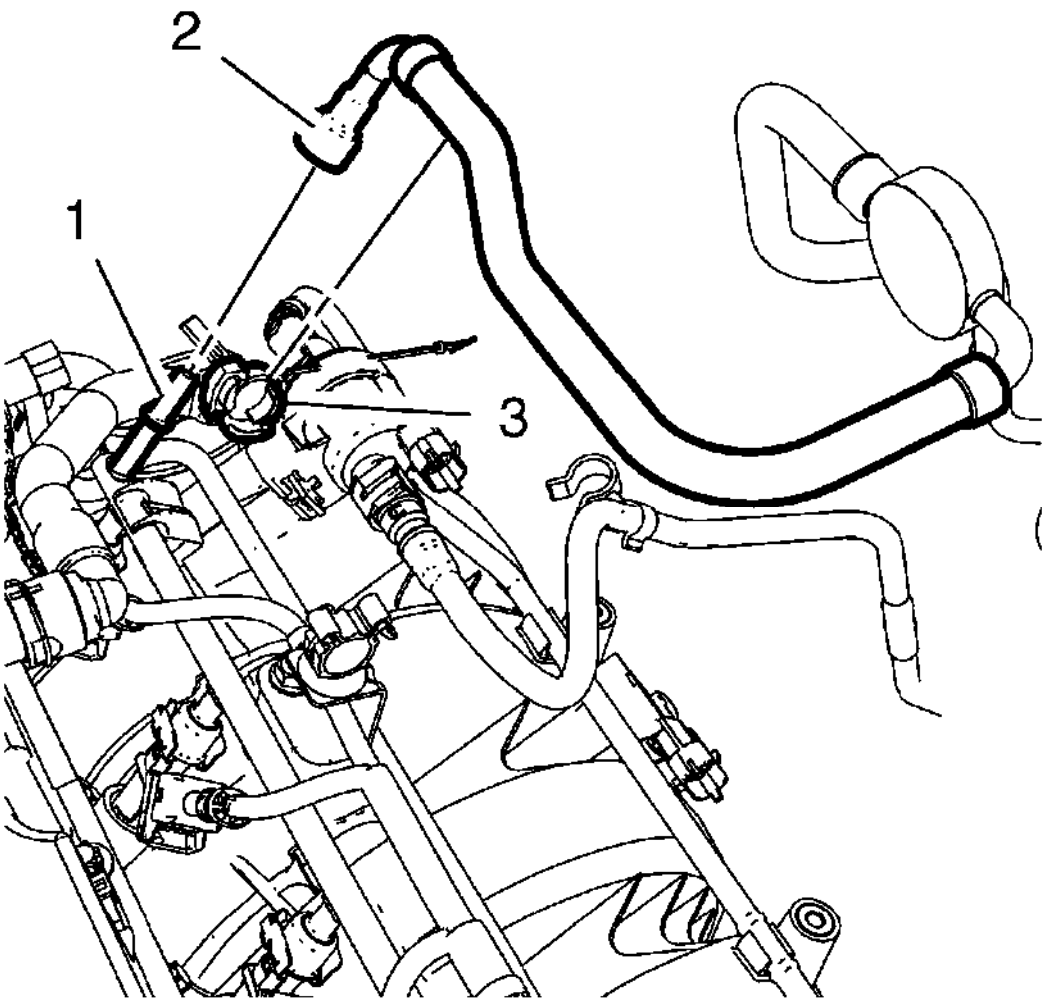


Fig. 114: Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

16. Remove the caps from the fuel feed pipe (2) and from the multiport fuel injection fuel rail (1).
17. Install the fuel feed pipe (2) to the multiport fuel injection fuel rail (1).
18. Clip in the fuel feed pipe (2) to the fuel feed pipe clip (3).
19. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**

FUEL TANK FUEL PUMP MODULE REPLACEMENT

Special Tools

CH-45722 Fuel Sender Lock Ring Wrench

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

Removal Procedure

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1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.

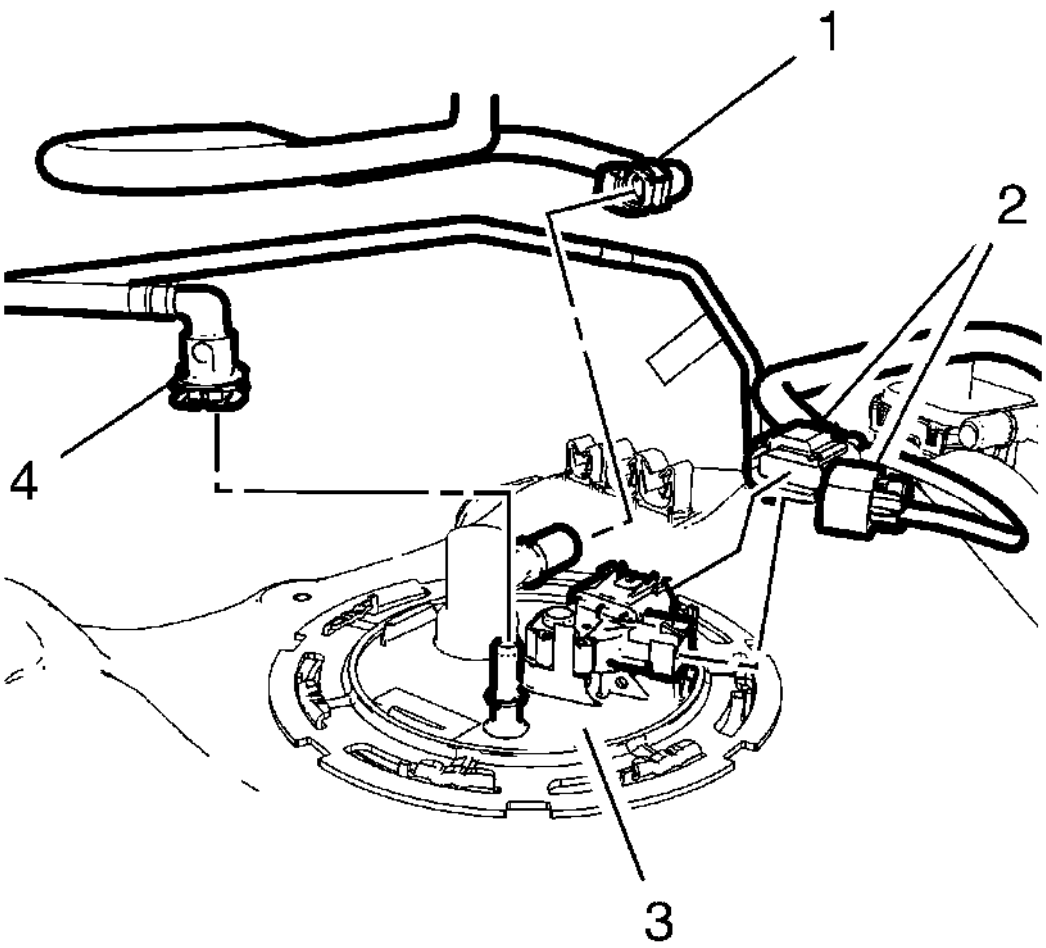


Fig. 115: Fuel Tank Fuel Pump Module, Fuel Tank Vent Pipe And Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the fuel tank vent pipe (1) and the fuel feed pipe (4) from the fuel tank fuel pump module (3).
3. Disconnect the fuel tank fuel pump module wiring harness (2) from the fuel tank fuel pump module (3).
4. Close the fuel feed pipe and the fuel tank vent feed pipe with suitable caps.

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.**

5. Using the **CH-45722** wrench and a long breaker-bar, rotate the fuel pump module lock ring in a counterclockwise direction in order to unlock the lock ring.

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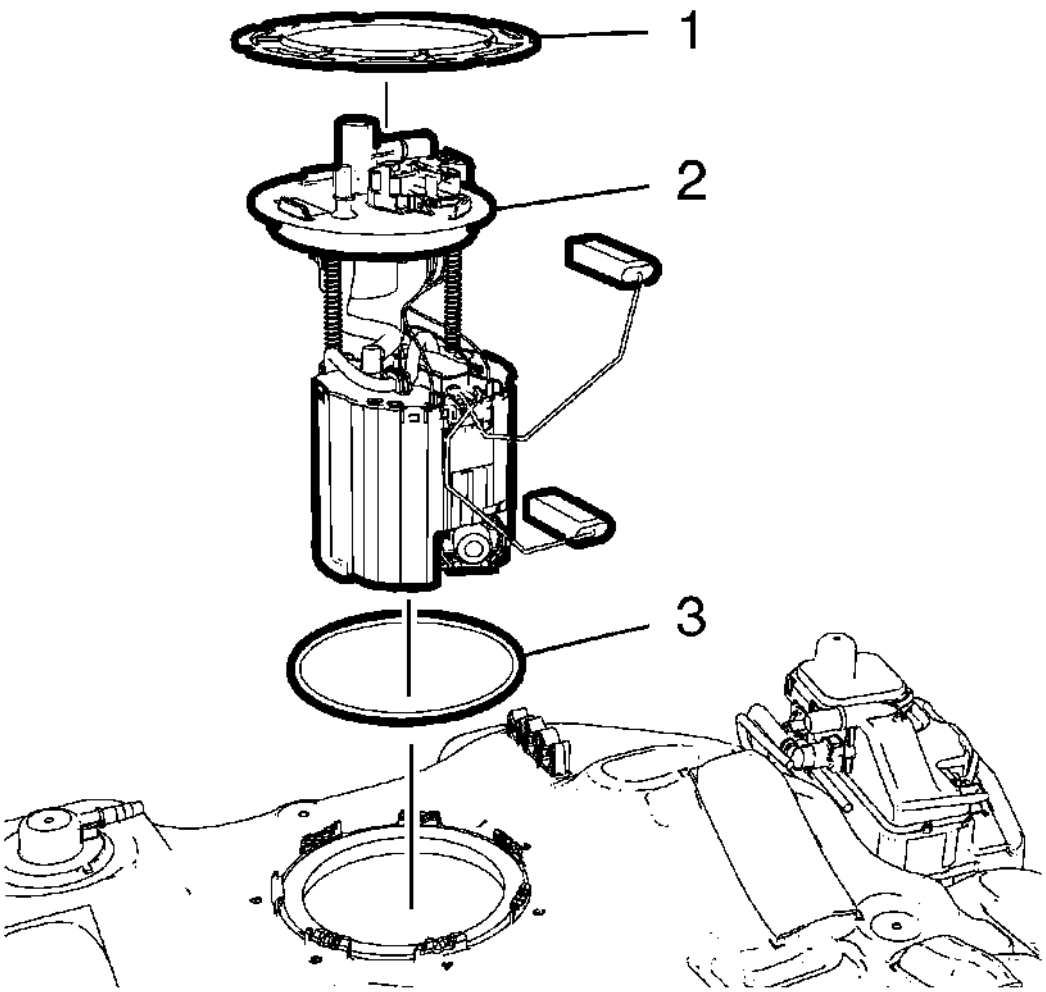


Fig. 116: Fuel Tank Fuel Pump Module
Courtesy of GENERAL MOTORS COMPANY

6. Remove fuel tank fuel pump module lock ring (1).

NOTE: Lift the fuel tank fuel pump module up slightly.

7. Remove the fuel tank fuel pump module (2).
8. Remove and DISCARD the fuel pump module seal (3).
9. Remove the fuel level sensor from the fuel tank fuel pump module. Refer to **Fuel Level Sensor Replacement**.

Installation Procedure

1. Install the fuel level sensor to the fuel tank fuel pump module. Refer to **Fuel Level Sensor Replacement**.

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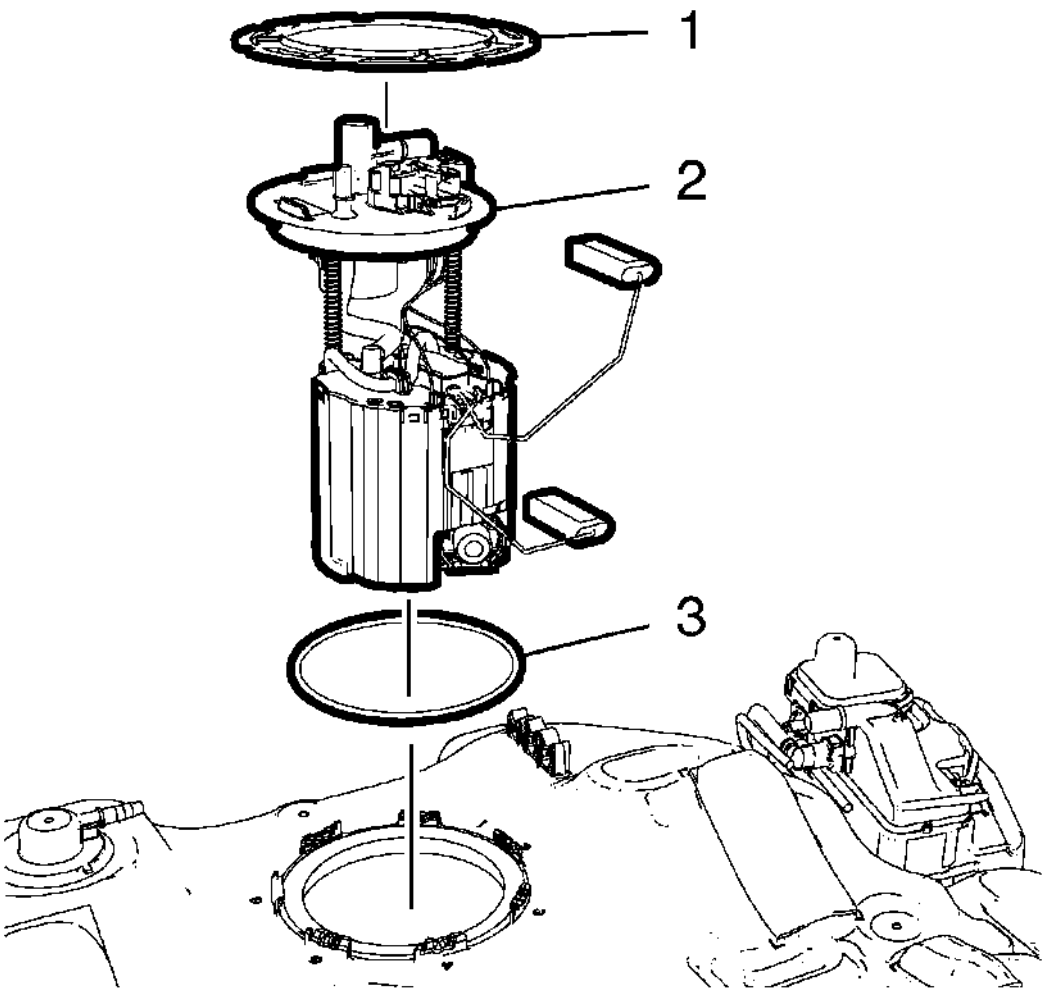


Fig. 117: Fuel Tank Fuel Pump Module
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW fuel tank module seal (3).
3. Install the fuel tank fuel pump module (2).
4. Install the fuel pump module lock ring (1).

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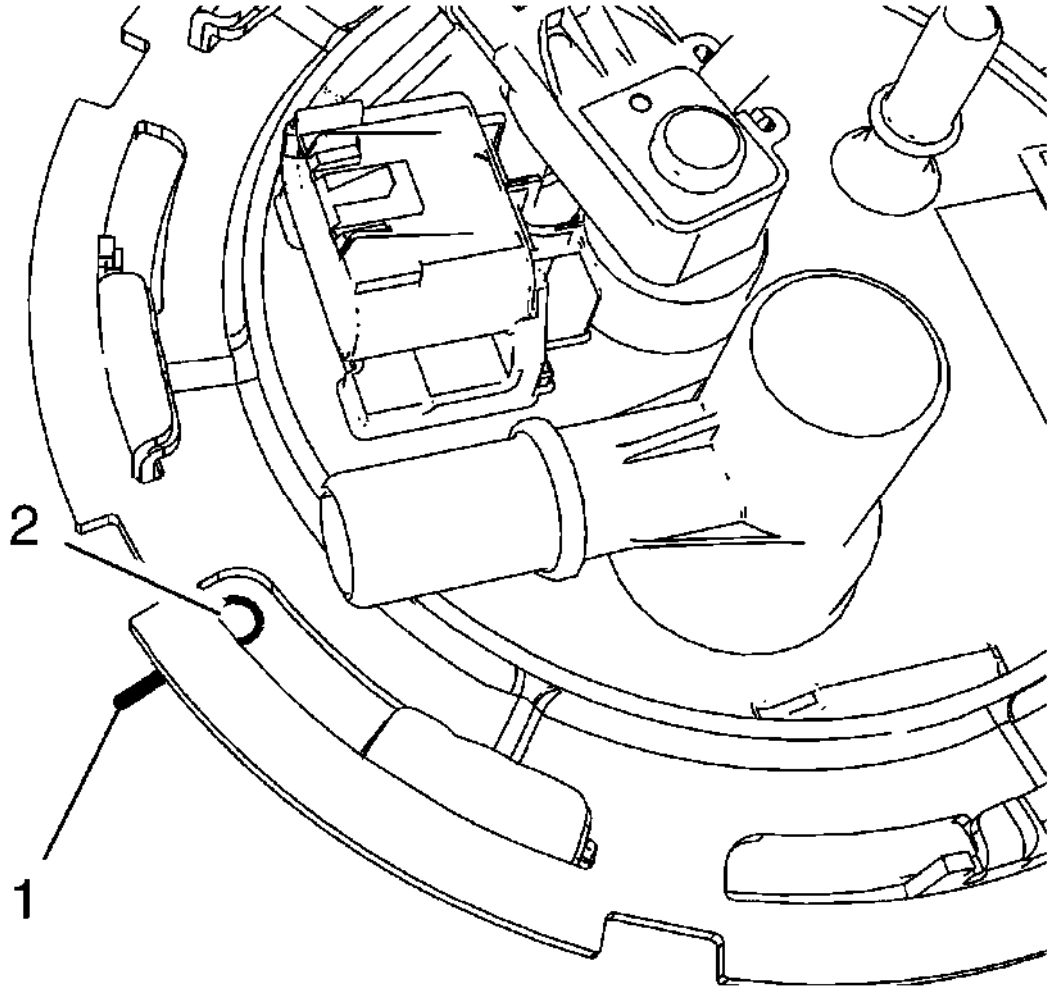


Fig. 118: Fuel Tank Fuel Pump Module Alignment Mark
Courtesy of GENERAL MOTORS COMPANY

5. Make sure that the fuel tank fuel pump module (2) align with the fuel tank line (1).

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.**

6. Using the **CH-45722** wrench and a long breaker-bar, rotate the lock ring in a clockwise direction in order to lock the lock ring.

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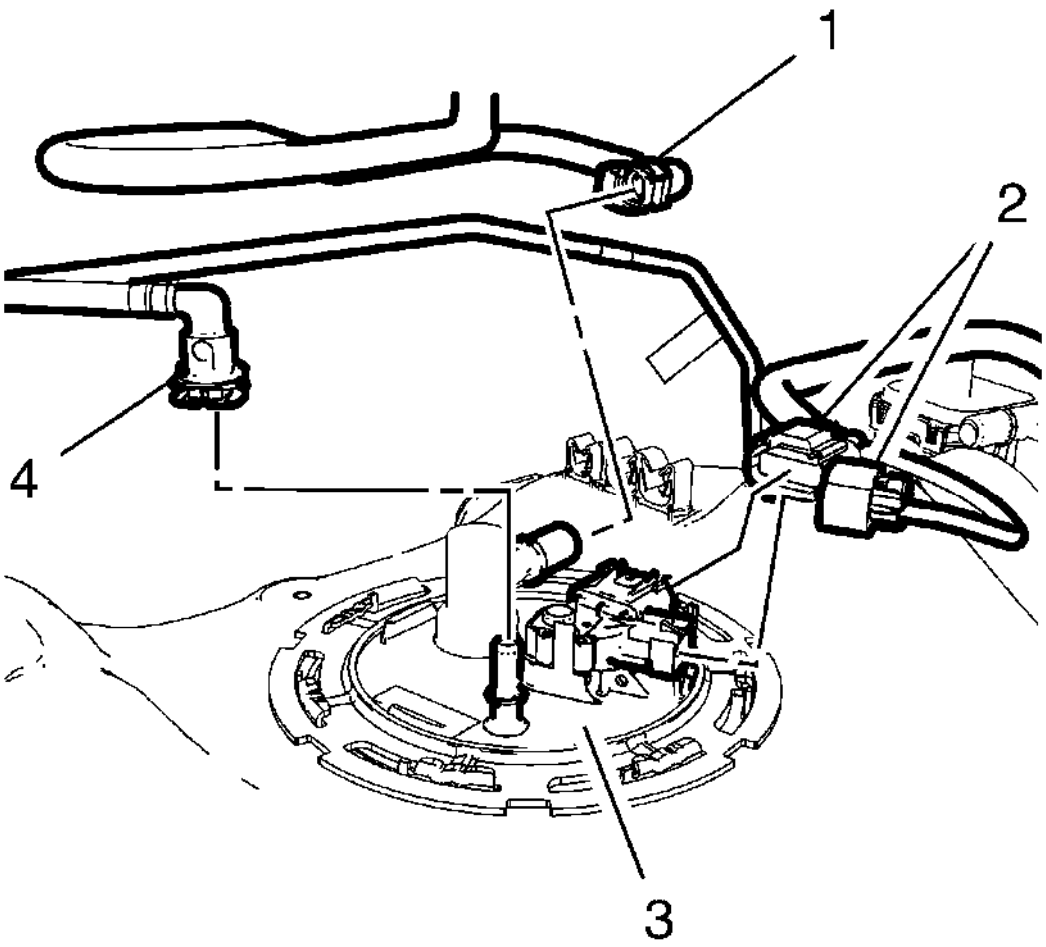


Fig. 119: Fuel Tank Fuel Pump Module, Fuel Tank Vent Pipe And Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Connect the fuel tank fuel pump module wiring harness (2) to the fuel tank fuel pump module (3).
8. Remove the caps from the fuel feed pipe and the fuel tank vent feed pipe.
9. Connect the fuel tank vent pipe (1) and the fuel feed pipe (4) to the fuel tank fuel pump module (3).
10. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL TANK PRESSURE SENSOR REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the fuel tank. Refer to **Fuel Tank Replacement**.

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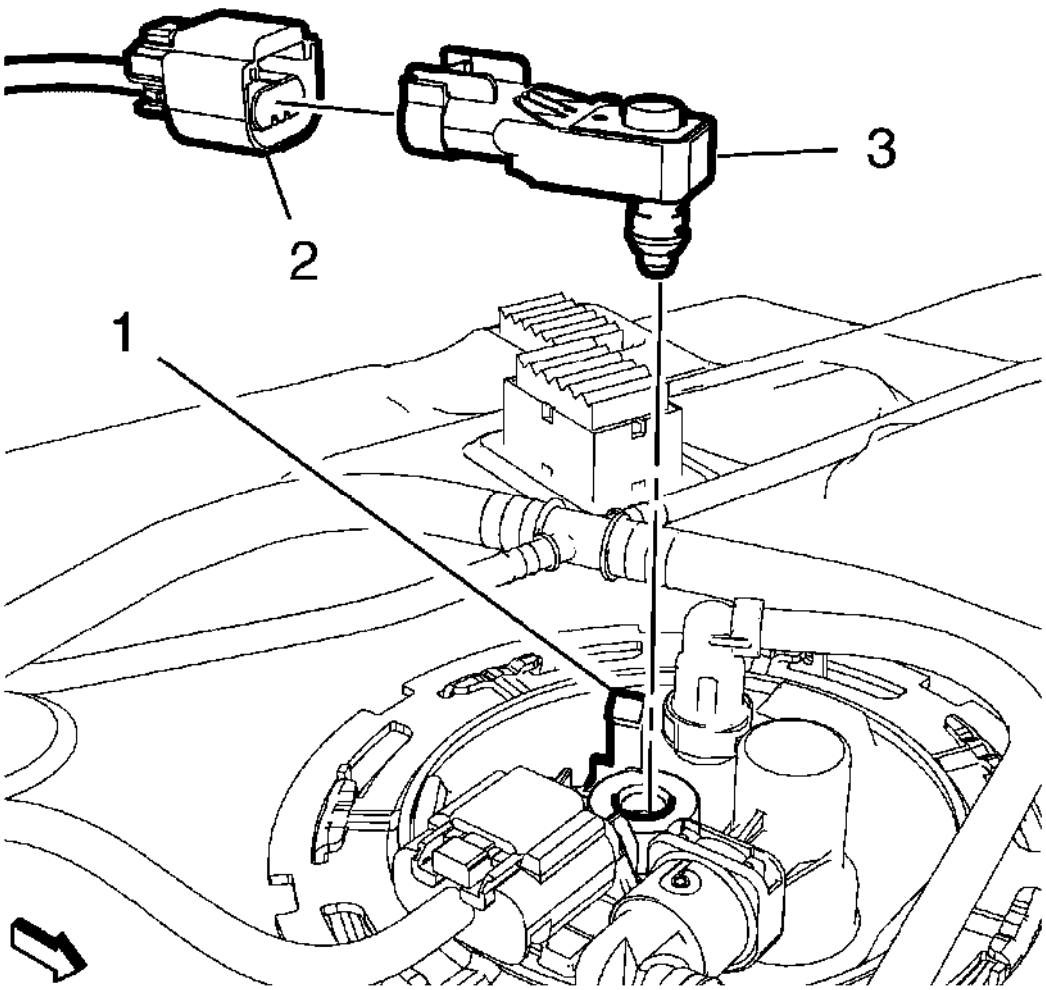


Fig. 120: Fuel Tank Pressure Sensor, Wiring Harness Plug And Pump Module Clip
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the fuel tank pressure sensor wiring harness plug (2).
4. Unclip the fuel tank pressure sensor (3) from the fuel tank pump module clip (1).

Installation Procedure

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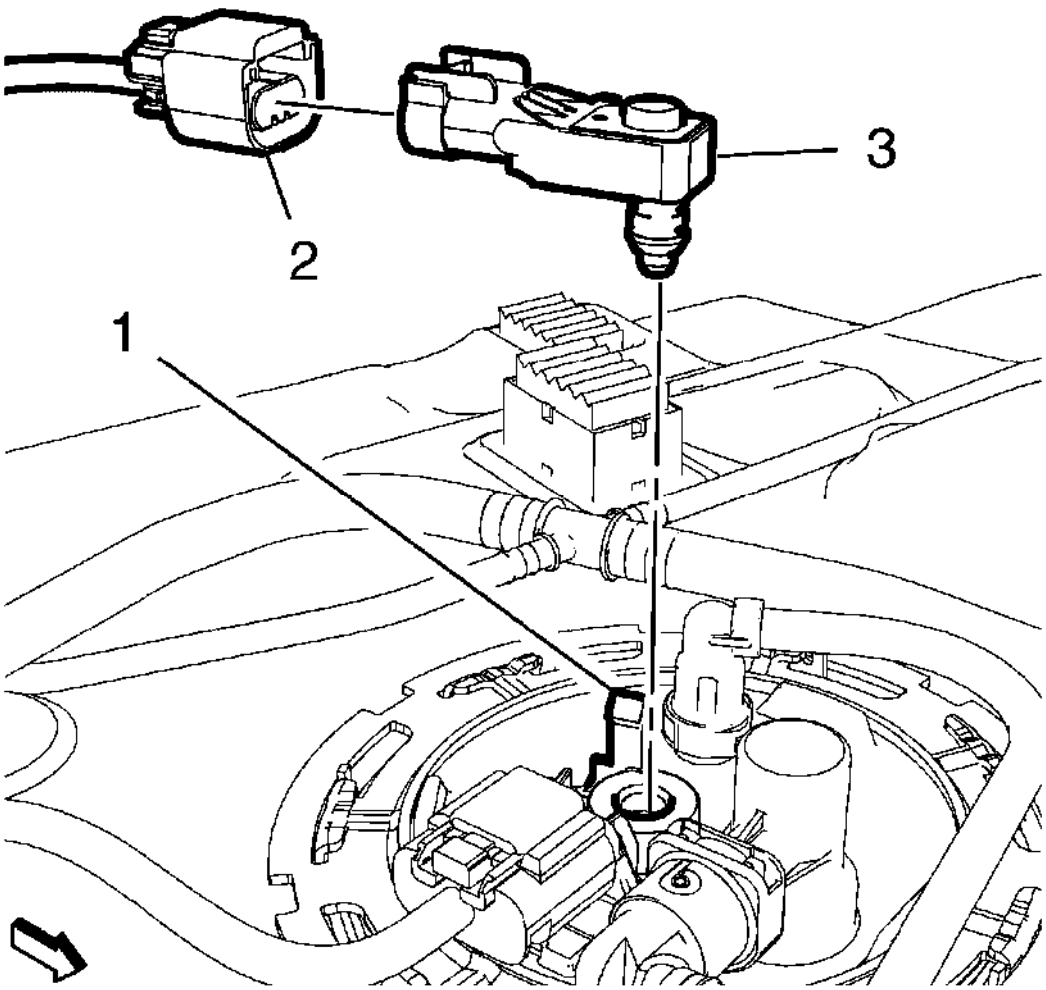


Fig. 121: Fuel Tank Pressure Sensor, Wiring Harness Plug And Pump Module Clip
Courtesy of GENERAL MOTORS COMPANY

1. Clip the fuel tank pressure sensor (3) to the fuel tank pump module clip (1).
2. Connect the fuel tank pressure sensor wiring harness plug (2).
3. Install the fuel tank. Refer to **Fuel Tank Replacement**.
4. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT

Removal Procedure

1. Open the rear lid.
2. Remove the rear compartment side trim - right side. Refer to **Rear Compartment Side Trim Replacement - Right Side** .

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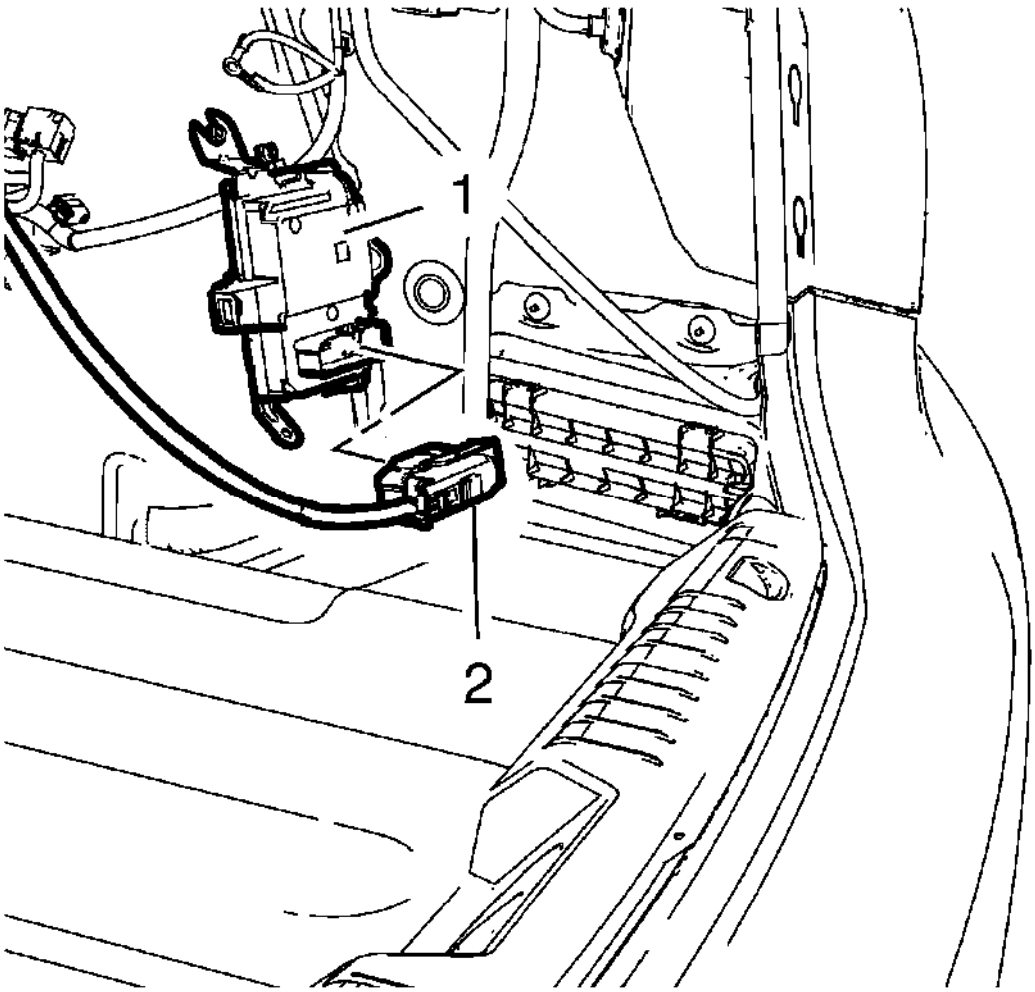


Fig. 122: Fuel Pump Flow Control Module
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fuel pump flow control module wiring harness plug (2) from the fuel pump flow control module (1).

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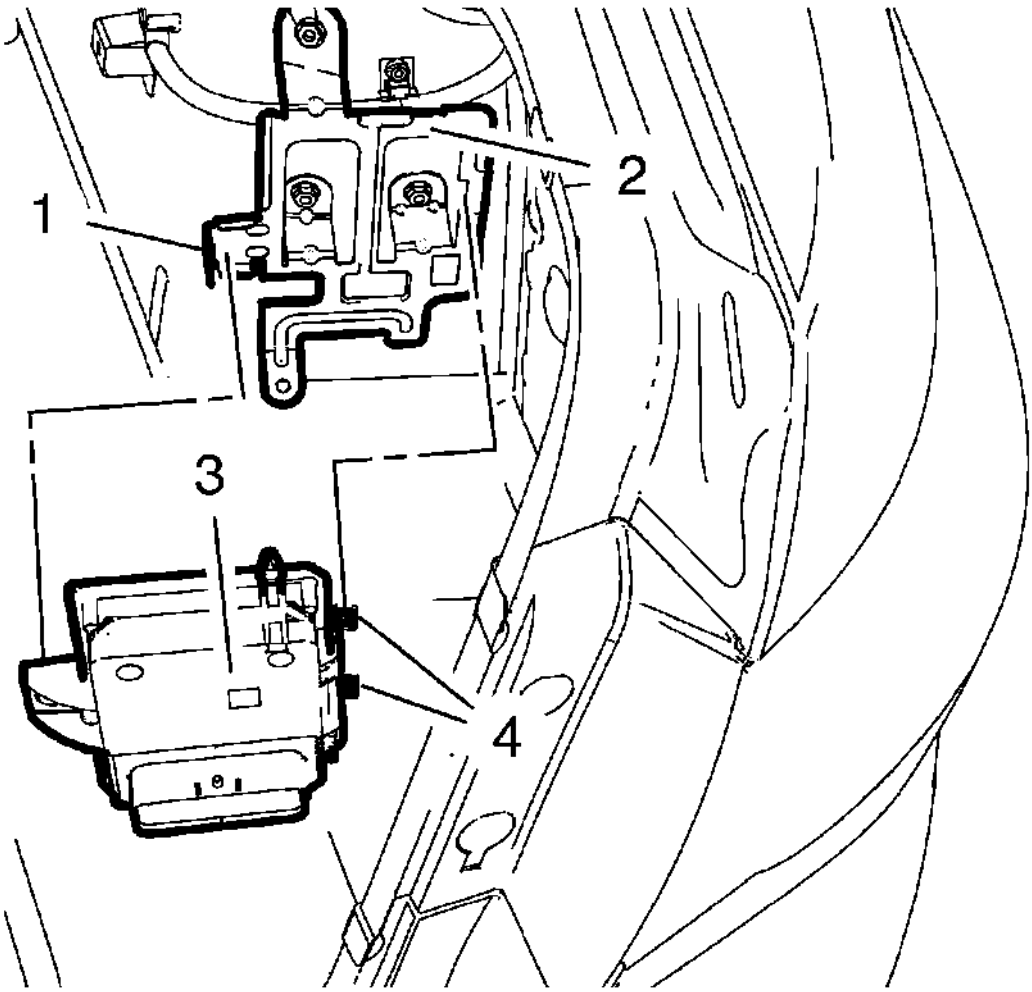


Fig. 123: Fuel Pump Flow Control Module
Courtesy of GENERAL MOTORS COMPANY

4. Unclip the fuel pump flow control module bracket clip (1) from the fuel pump flow control module (3).
5. Unclip the 2 fuel pump flow control module clips (4) from the fuel pump flow control module bracket (2).

Installation Procedure

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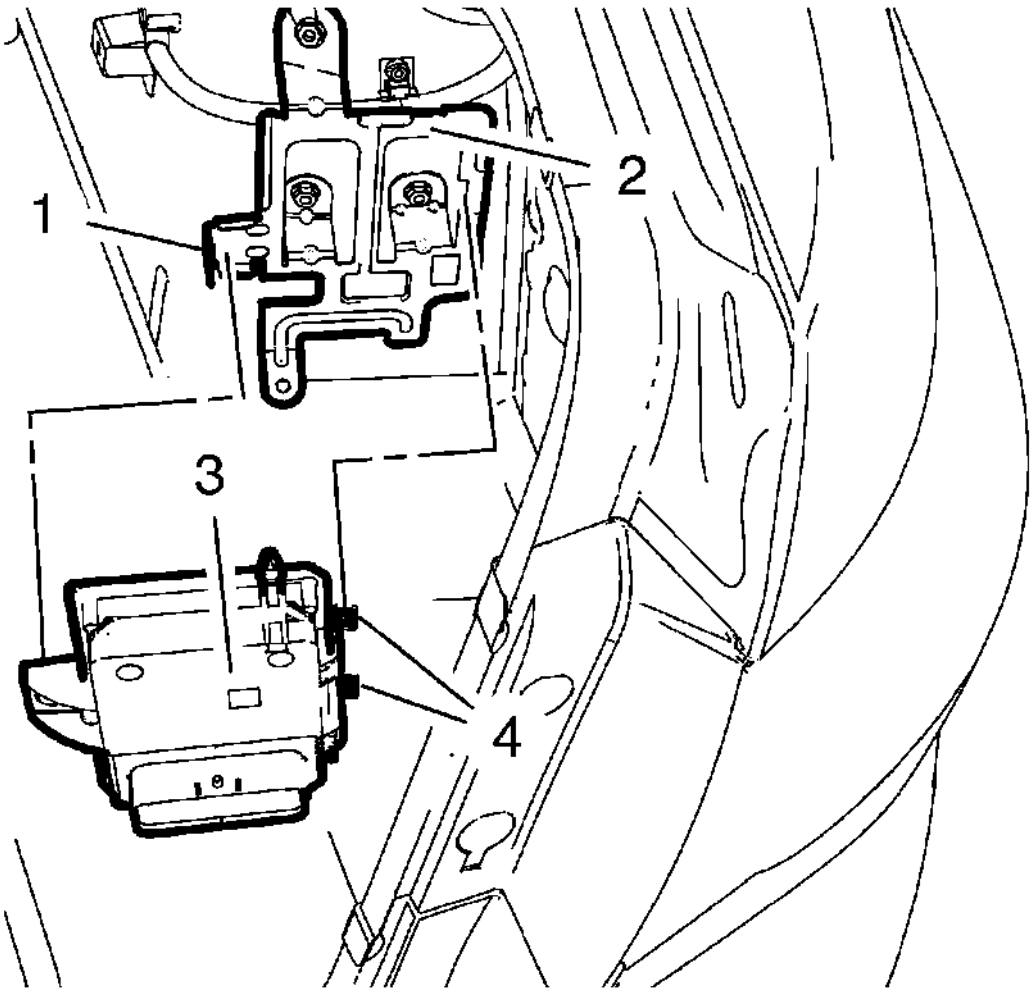


Fig. 124: Fuel Pump Flow Control Module
Courtesy of GENERAL MOTORS COMPANY

1. Clip the 2 fuel pump flow control module clips (4) to the fuel pump flow control module bracket (2).
2. Clip the fuel pump flow control module (3) to the fuel pump flow control module bracket clip (1).

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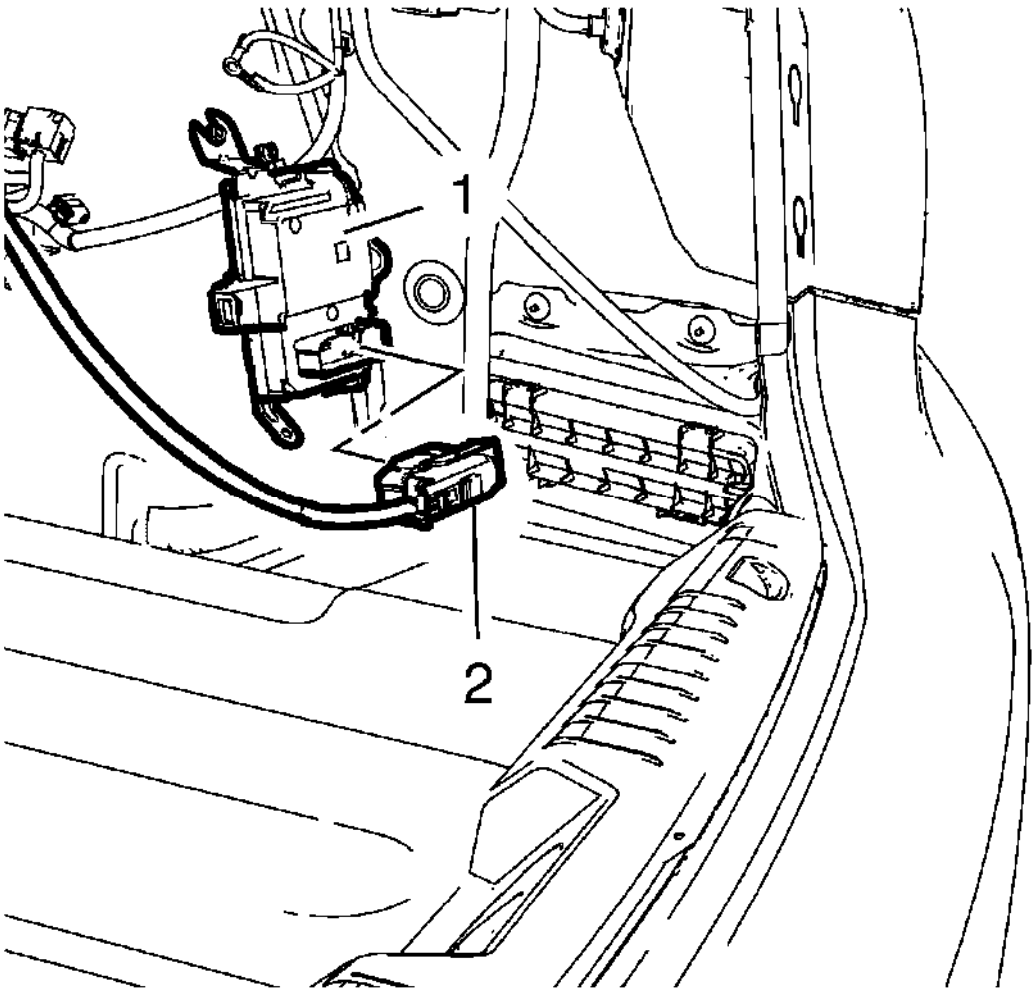


Fig. 125: Fuel Pump Flow Control Module
Courtesy of GENERAL MOTORS COMPANY

3. Plug the fuel pump flow control module wiring harness plug (2) to the fuel pump flow control module (1).
4. Install the rear compartment side trim - right side. Refer to **Rear Compartment Side Trim Replacement - Right Side** .
5. Close the rear lid.
6. Program the control module. Refer to **Fuel Pump Control Module Programming and Setup**

FUEL LEVEL SENSOR REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

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WARNING: Refer to Safety Goggles and Fuel Warning .

CAUTION: Use care while handling the fuel sender to prevent damage and incorrect fuel level readings.

1. Remove the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.

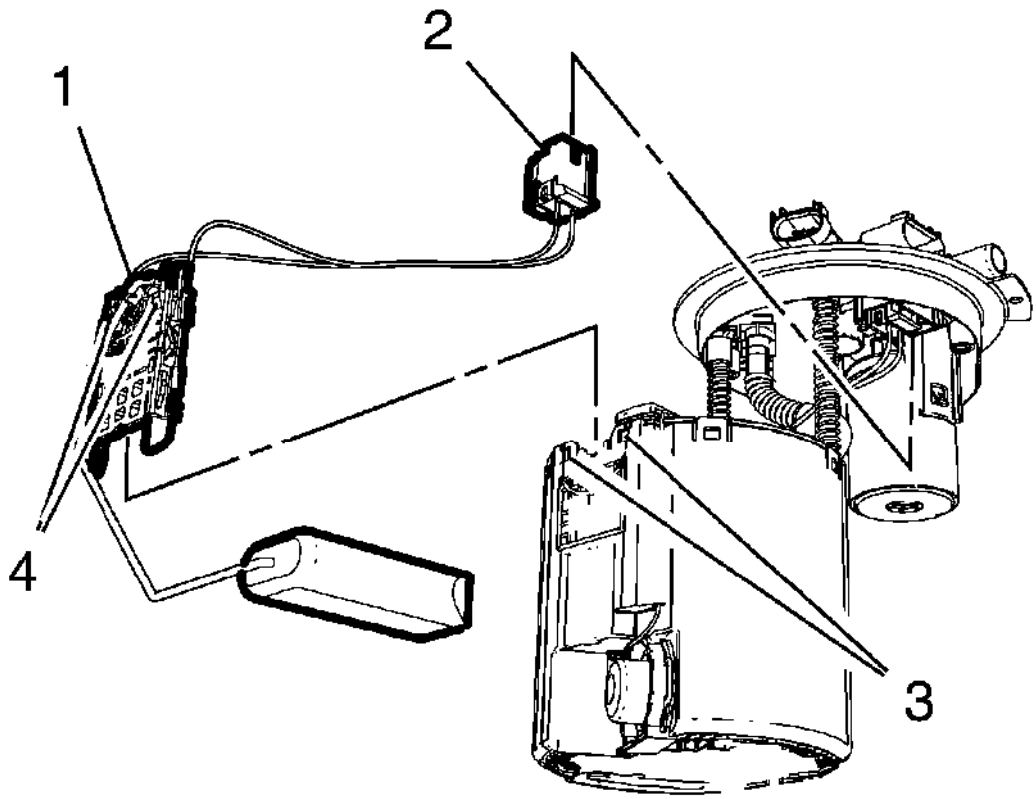


Fig. 126: Fuel Level Sensor And Components
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the fuel level sensor wiring harness plug (2) from the fuel tank fuel pump module.
3. Unclip the 2 fuel level sensor retainer pins (4) from the fuel level sensor retainer pin holes (3).
4. Remove the fuel level sensor (1) from the fuel tank fuel pump module.

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Installation Procedure

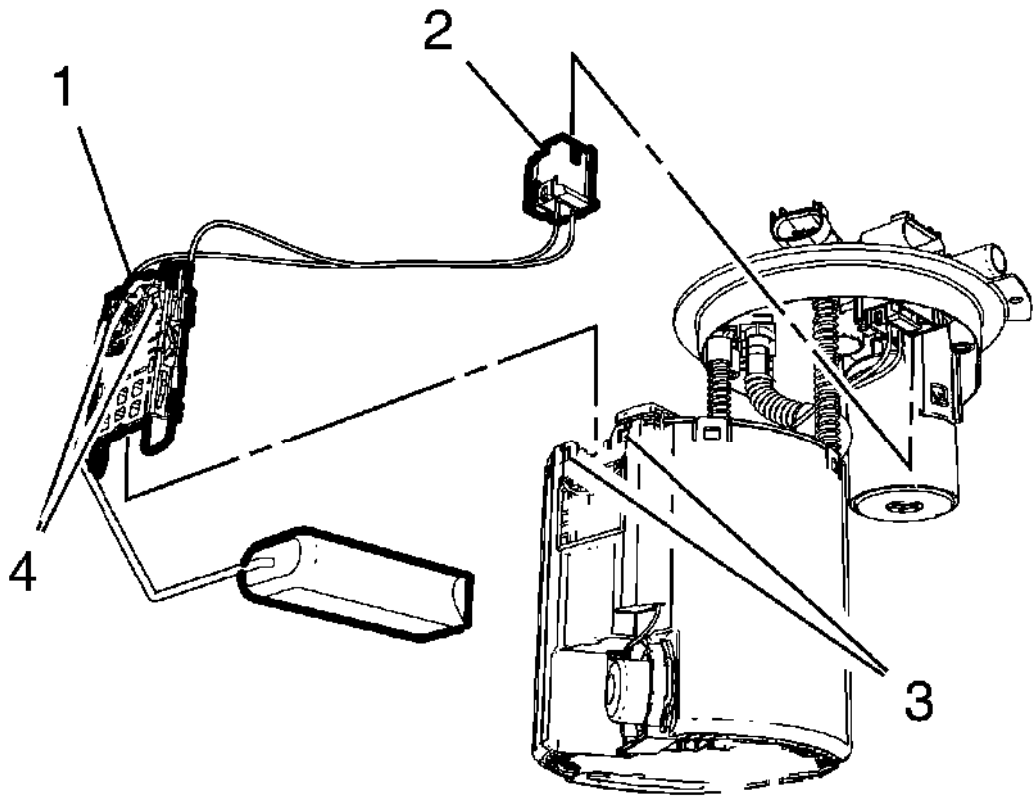


Fig. 127: Fuel Level Sensor And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel level sensor (1) to the fuel tank fuel pump module.
2. The fuel level sensor retainer pins (4) must engage audibly in the fuel level sensor retainer pin holes (3).
3. Connect the fuel level sensor wiring harness plug (2) to the fuel tank fuel pump module.
4. Install the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.

FUEL PRESSURE SENSOR REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

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WARNING: Refer to Safety Goggles and Fuel Warning .

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief**.
2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

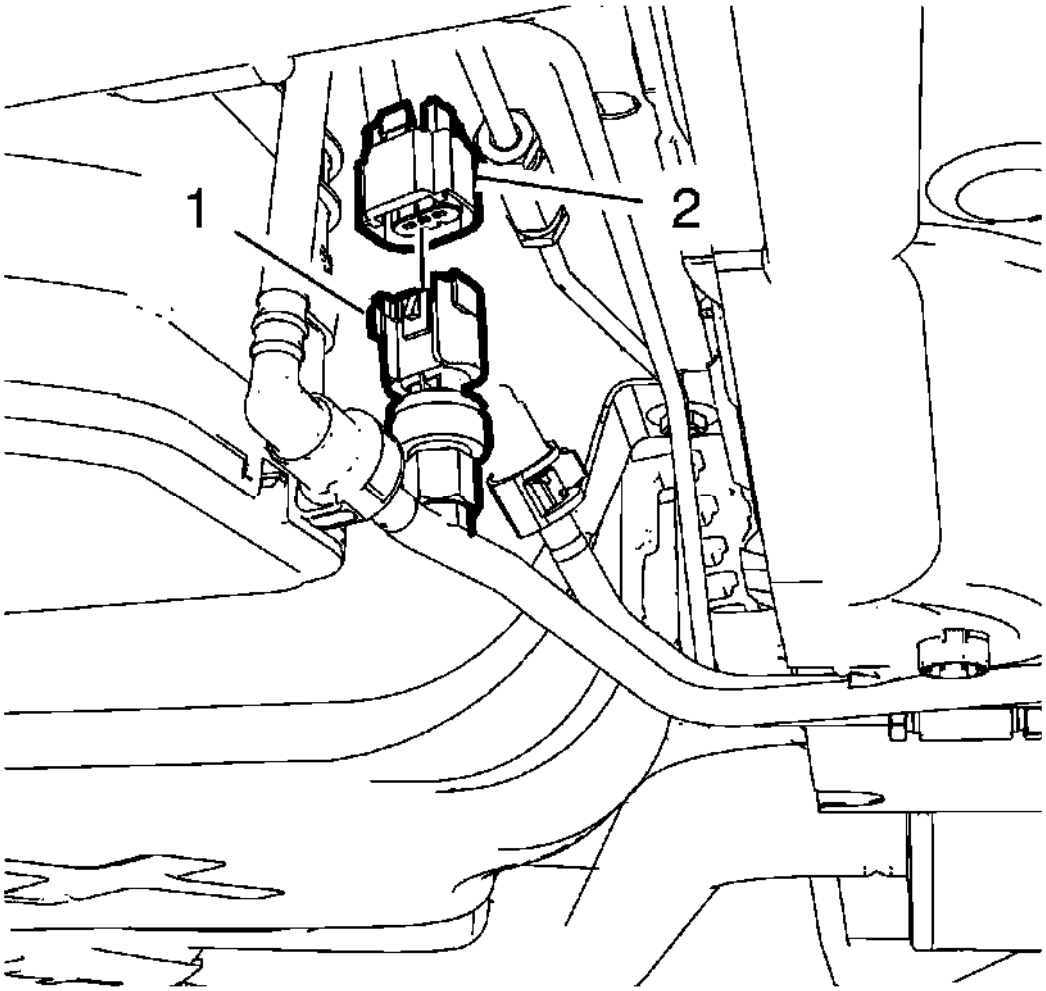


Fig. 128: Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel pressure sensor wiring harness plug (2) from the fuel pressure sensor (1).

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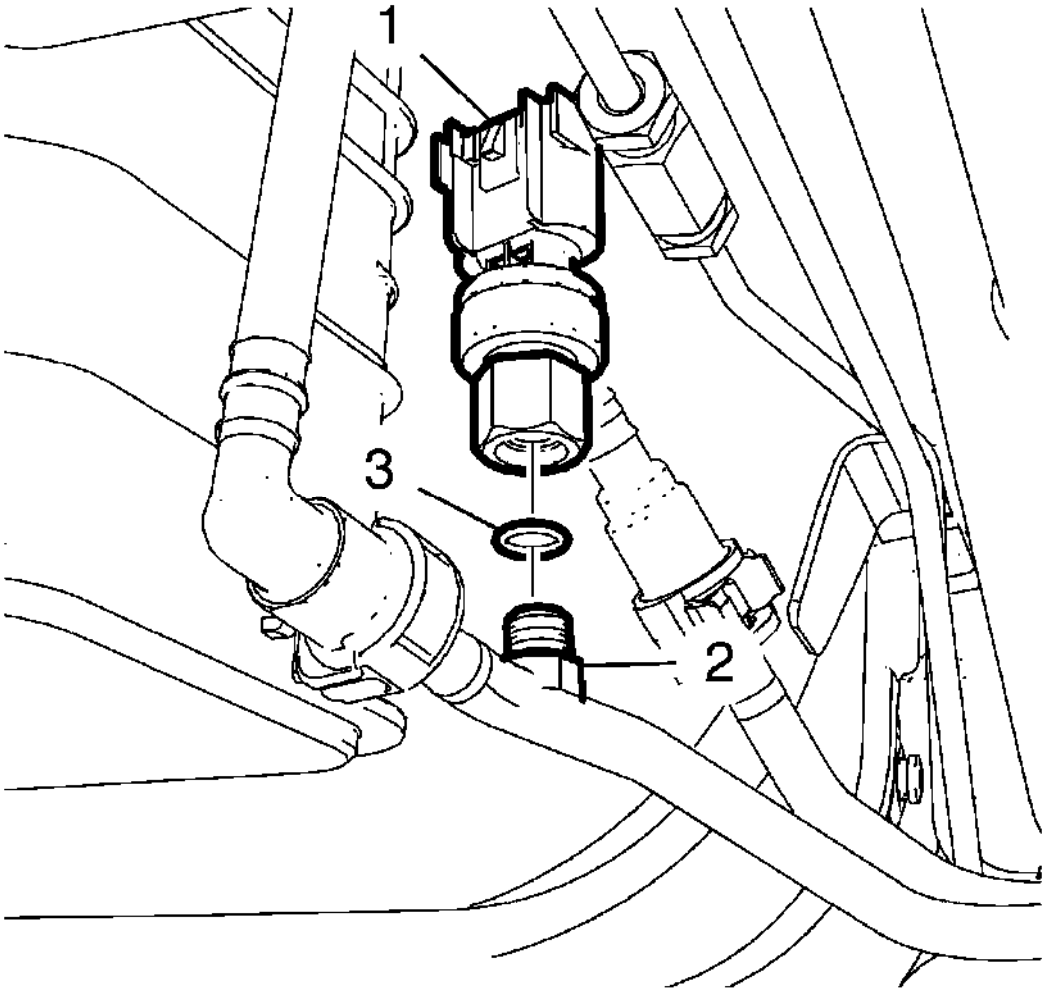


Fig. 129: Fuel Pressure Sensor And Fuel Pressure Relief Valve
Courtesy of GENERAL MOTORS COMPANY

5. Place a appropriate container/drain pan to catch excess fuel.
6. Remove the fuel pressure sensor (1) from the fuel pressure line (2).
7. Remove the fuel pressure sensor seal ring (3).

Installation Procedure

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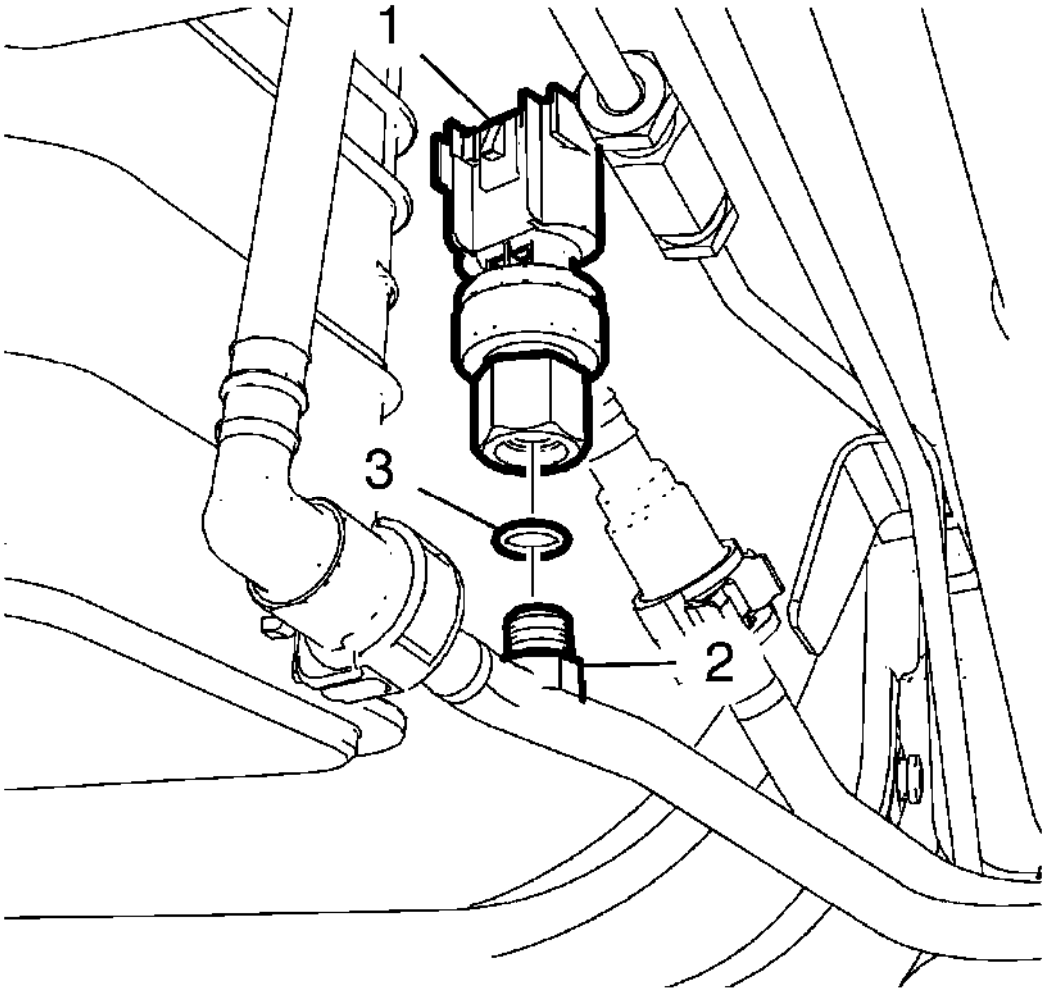


Fig. 130: Fuel Pressure Sensor And Fuel Pressure Relief Valve
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW fuel pressure sensor seal ring (3).

CAUTION: Refer to Fastener Caution .

2. Install the fuel pressure sensor (1) to the fuel pressure line (2) and tighten to 19 N.m (14 lb ft).

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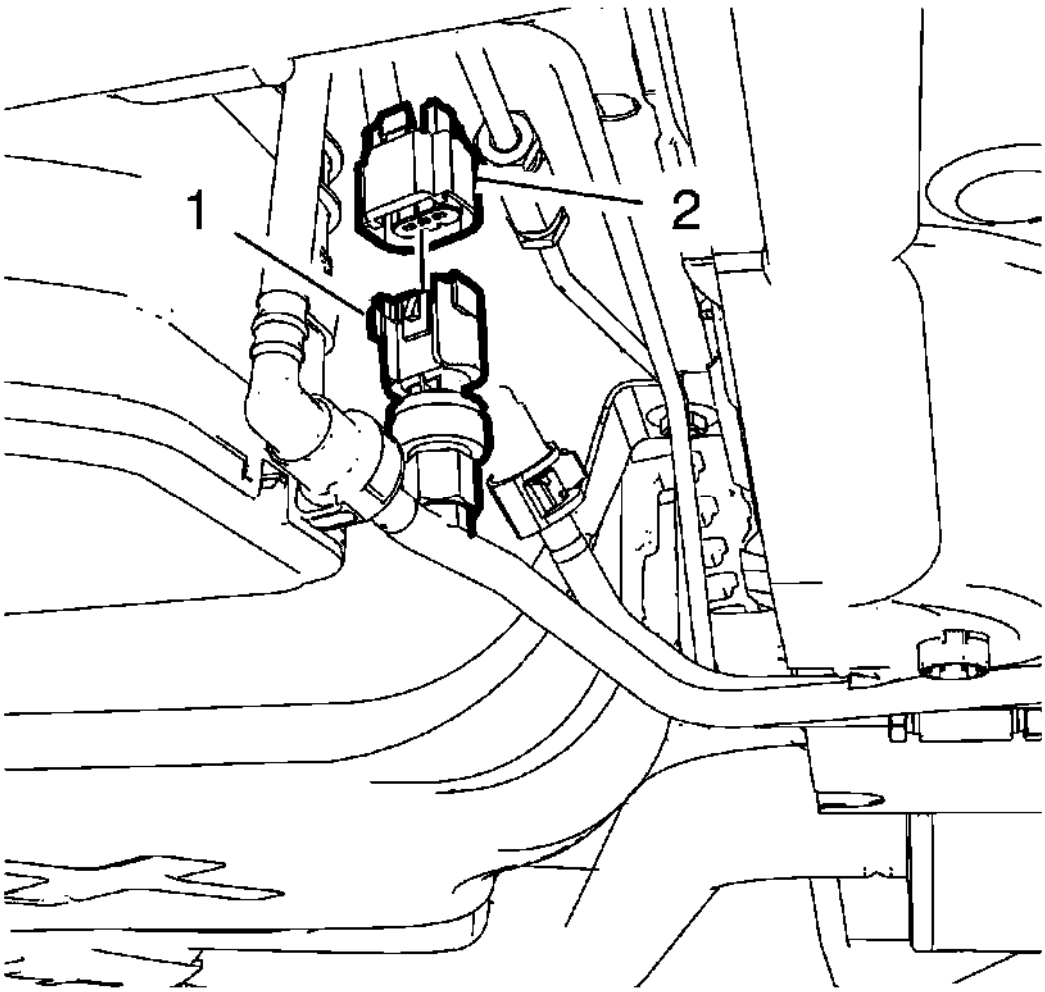


Fig. 131: Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Plug the fuel pressure sensor wiring harness plug (2) to the fuel pressure sensor (1).
4. Lower the vehicle.
5. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .

FUEL SYSTEM CLEANING

NOTE: If the fuel filter is plugged, the fuel tank should be inspected internally and cleaned if necessary.

1. Drain the fuel tank. Refer to **Fuel Tank Draining**.
2. Remove the fuel pump module assembly. Refer to **Fuel Tank Fuel Pump Module Replacement**.
3. Inspect the fuel pump module strainer. Replace the pump module assembly if the fuel strainer is contaminated.

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NOTE: When flushing the fuel tank, handle the fuel and water mixture as a hazardous material. Handle the fuel and water in accordance with all applicable local, state, and federal laws and regulations.

4. Flush the fuel tank with hot water.
5. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to be sure that the removal of the water from the fuel tank is complete.
6. Allow the tank to dry completely before reassembly.
7. Disconnect the fuel feed pipe at the engine fuel rail. Refer to **Fuel Feed Pipe Replacement**.

NOTE: Only use oil-free compressed air to blow out the fuel pipes.

8. Clean the fuel pipes by applying air pressure in the opposite direction of the fuel flow.
9. Connect the fuel feed pipe to the engine fuel rail. Refer to **Fuel Feed Pipe Replacement**.
10. Install the fuel pump module assembly. Refer to **Fuel Tank Fuel Pump Module Replacement**.

FUEL INJECTOR REPLACEMENT

Special Tools

- **CH-48027** Fuel Pressure Gauge
- **CH-41769** Fuel Line Disconnect Tool Set

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

Removal Procedure

1. Open the hood.
2. Disconnect the negative cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Remove the positive crankcase ventilation tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement** .
4. Disconnect the wiring harness from the:
    1. Evaporative emission purge valve
    2. Fuel injectors
    3. Manifold absolute pressure sensor
5. Place a drain pan underneath the vehicle.

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.

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6. Release the fuel pressure using the test connection with **CH-48027** gauge.

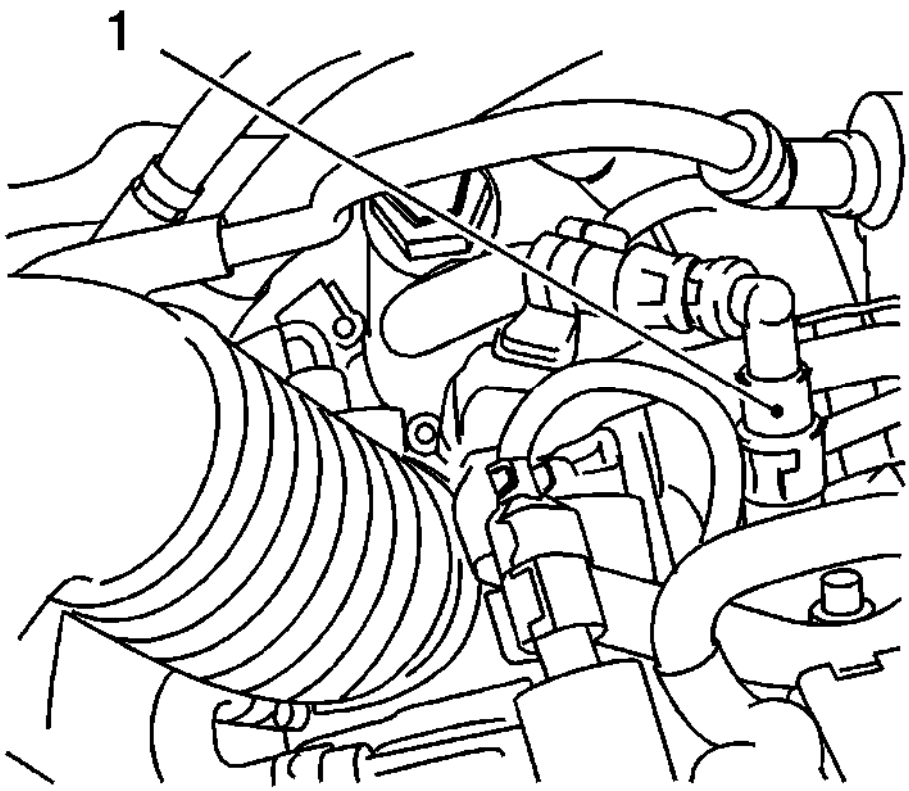


Fig. 132: View Of Fuel Return Line
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the quick-release fitting of the fuel feed pipe (1) with **CH-41769** tool set.
8. Install a suitable cap to the fuel feed pipe.

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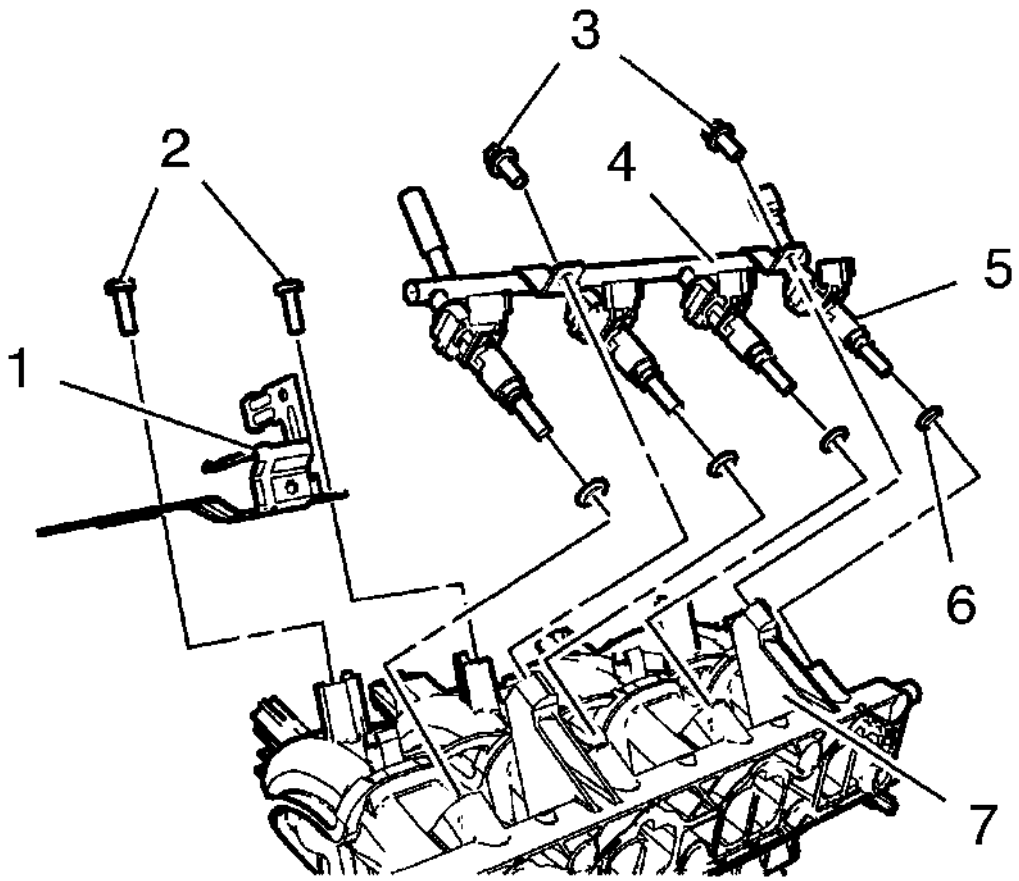


Fig. 133: Multiport Fuel Injection Fuel Rail And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the 2 evaporative emission canister purge solenoid valve bracket bolts (2).
10. Remove the evaporative emission canister purge solenoid valve bracket (1) from the intake manifold (7).
11. Remove the 2 multiport fuel injection fuel rail bolts (3).
12. Remove the multiport fuel injection fuel rail (4) with the fuel injectors (5) from the intake manifold (7).
13. Remove the 4 fuel injector seals (6).

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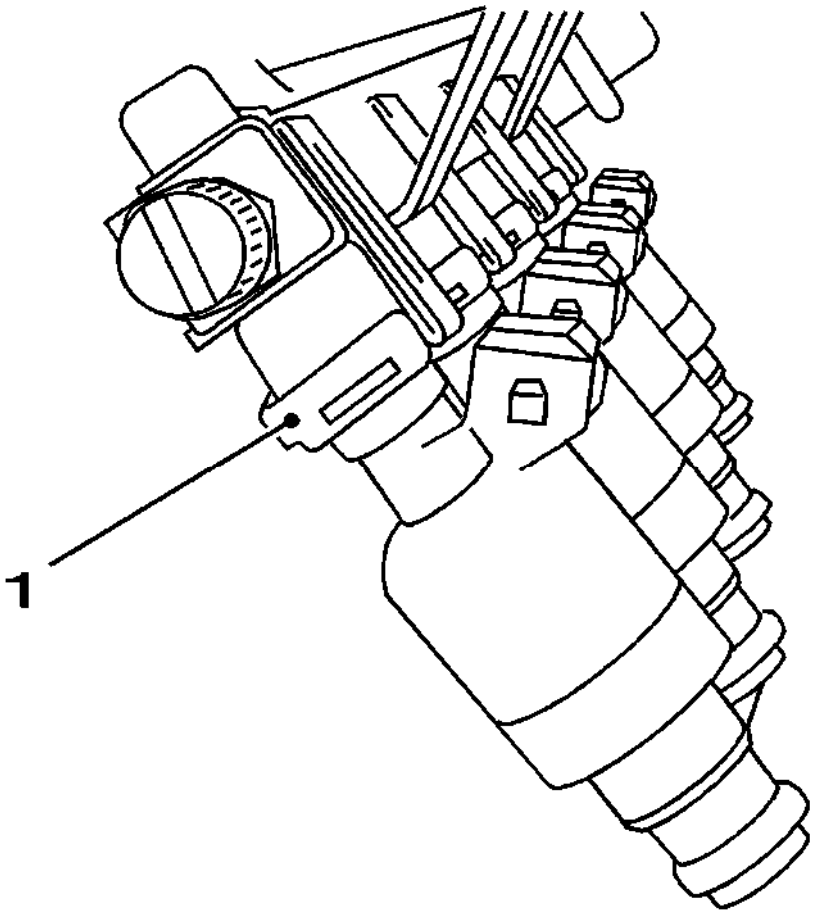


Fig. 134: View Of Injectors Retaining Clamps
Courtesy of GENERAL MOTORS COMPANY

14. Remove the fuel injector retainer (1).
15. Remove the fuel injectors.

Installation Procedure

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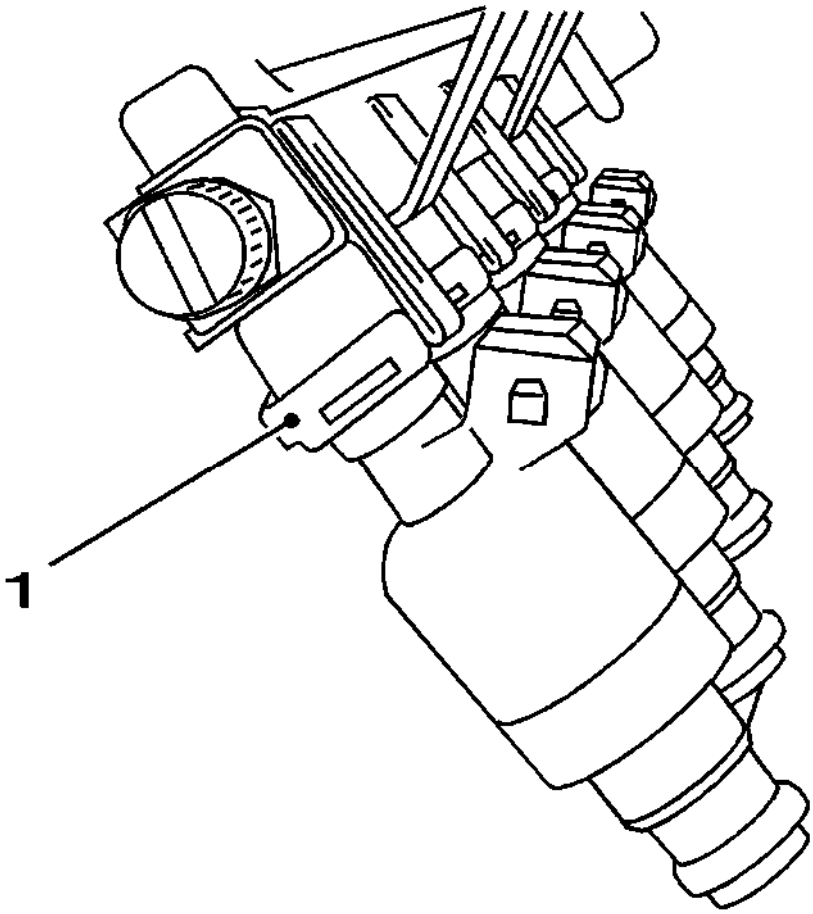


Fig. 135: View Of Injectors Retaining Clamps
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel injectors.

NOTE: Install NEW fuel injector seals, coat the multiport fuel injector seals with silicone grease.

2. Install the fuel injector retainer (1).

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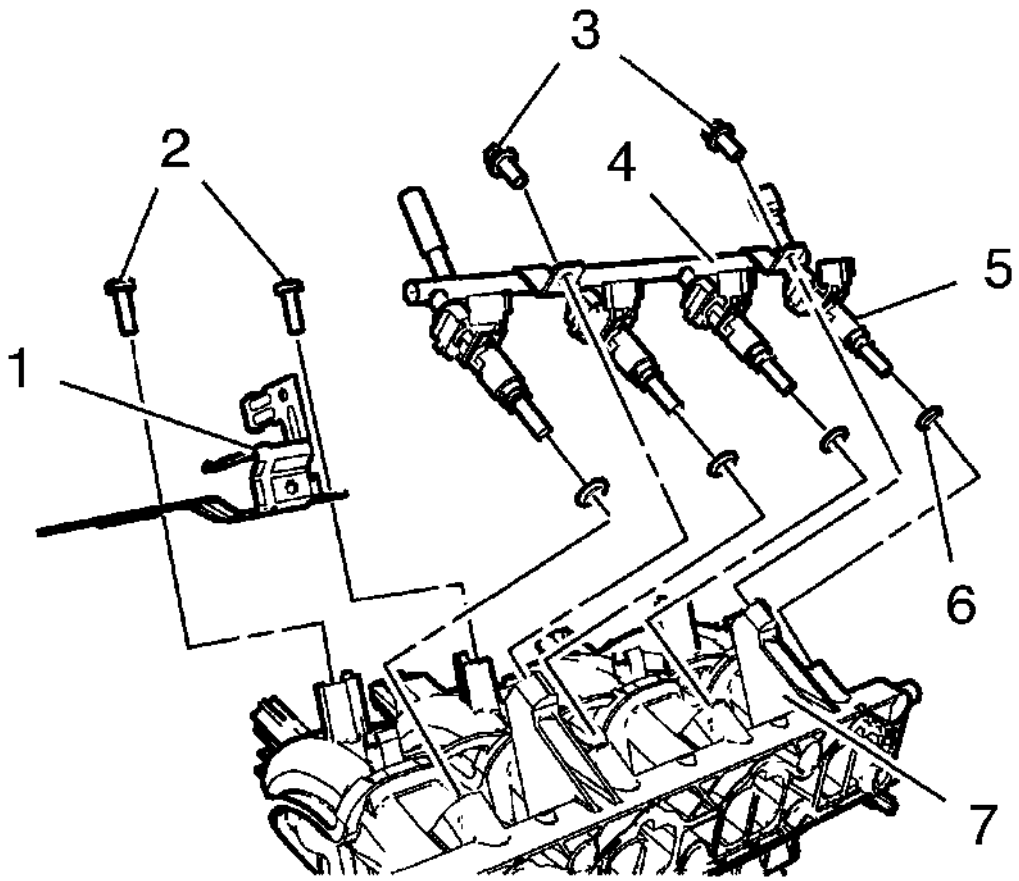


Fig. 136: Multiport Fuel Injection Fuel Rail And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Coat the fuel injector seals with silicone grease.

3. Install the 4 NEW fuel injector seals (6).
4. Install the multiport fuel injection fuel rail (4) and the fuel injectors (5) to the intake manifold (7).

CAUTION: Refer to Fastener Caution .

5. Install the 2 multiport fuel injection fuel rail bolts (3) and tighten to 8 N.m (71 lb in).
6. Install the evaporative emission canister purge solenoid valve bracket (1) to the intake manifold (7).
7. Install the 2 evaporative emission canister purge solenoid valve bracket bolts (2) and tighten to 8 N.m (71 lb in).

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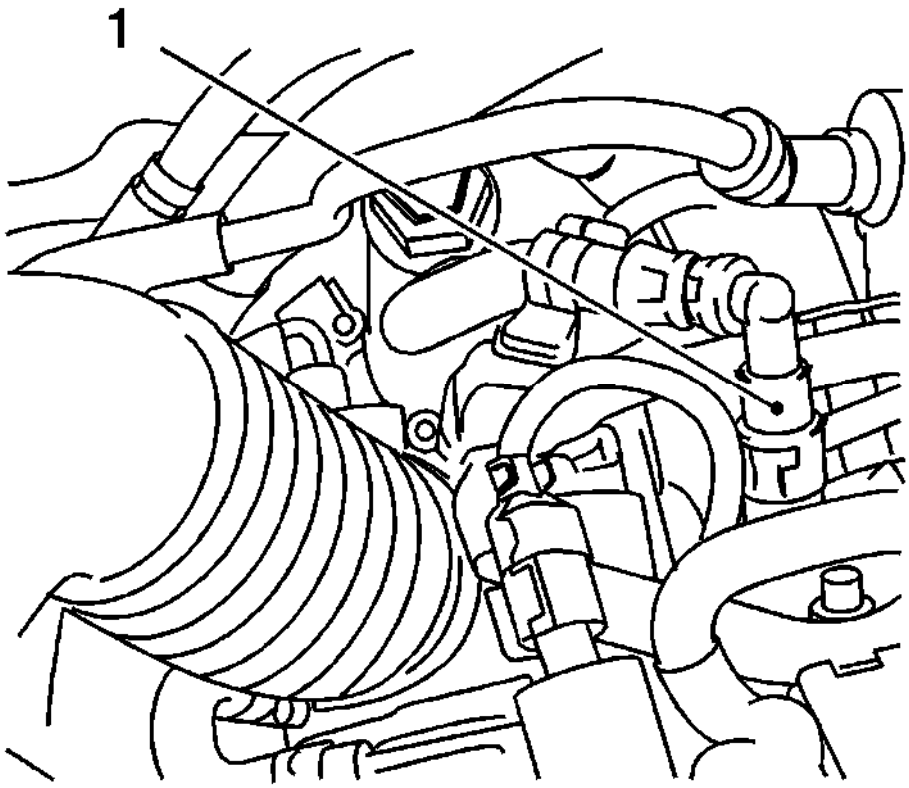


Fig. 137: View Of Fuel Return Line
Courtesy of GENERAL MOTORS COMPANY

8. Remove the cap from the fuel feed pipe (1).
9. Connect the quick-release fitting of fuel feed pipe (1).
10. Connect the wiring harness to the:
    1. Evaporative emission purge valve
    2. Fuel injectors
    3. Manifold absolute pressure sensor
11. Install the positive crankcase ventilation tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement** .
12. Connect the negative cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
13. Close the hood.

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

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Removal Procedure

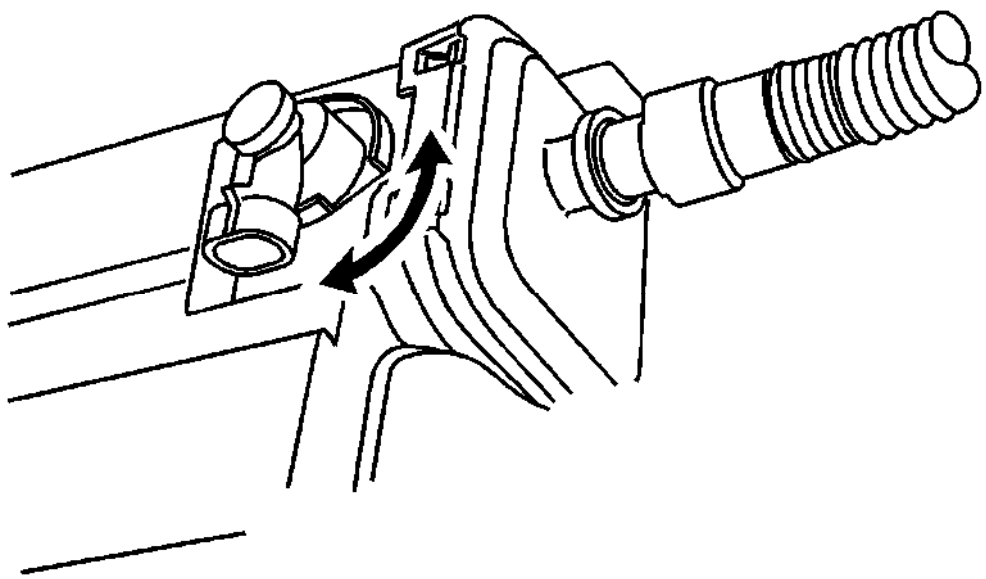


Fig. 138: Rotating EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS COMPANY

1. Remove the evaporative emission (EVAP) canister. Refer to **Evaporative Emission Canister Replacement**.
2. Rotate the EVAP canister vent valve counterclockwise to release from the locked position.

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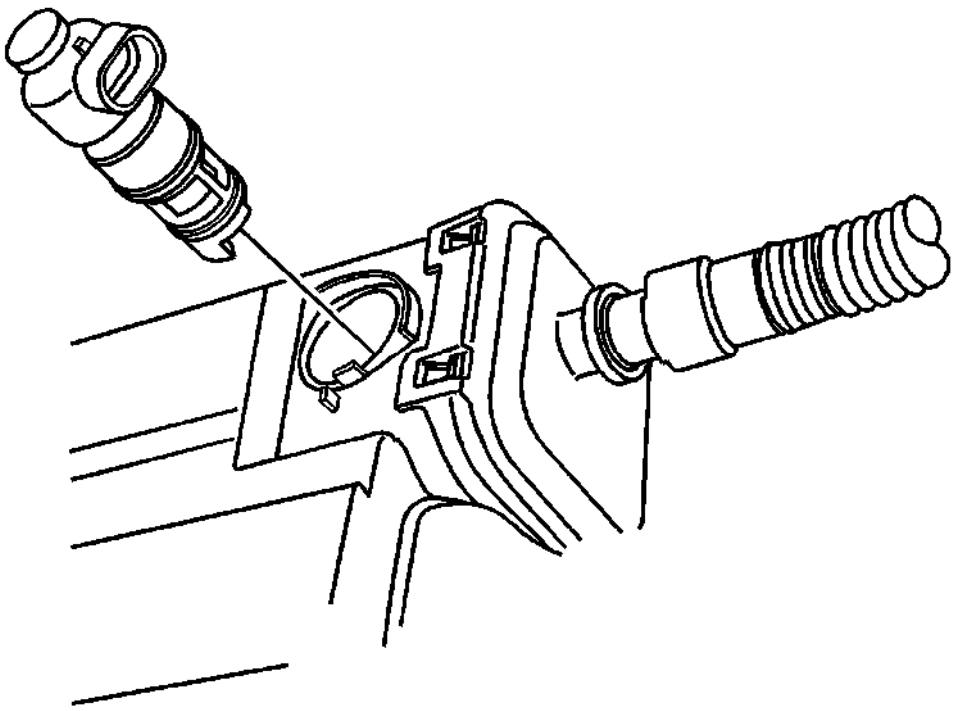


Fig. 139: View Of EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS COMPANY

3. Remove the vent valve from the EVAP canister.

Installation Procedure

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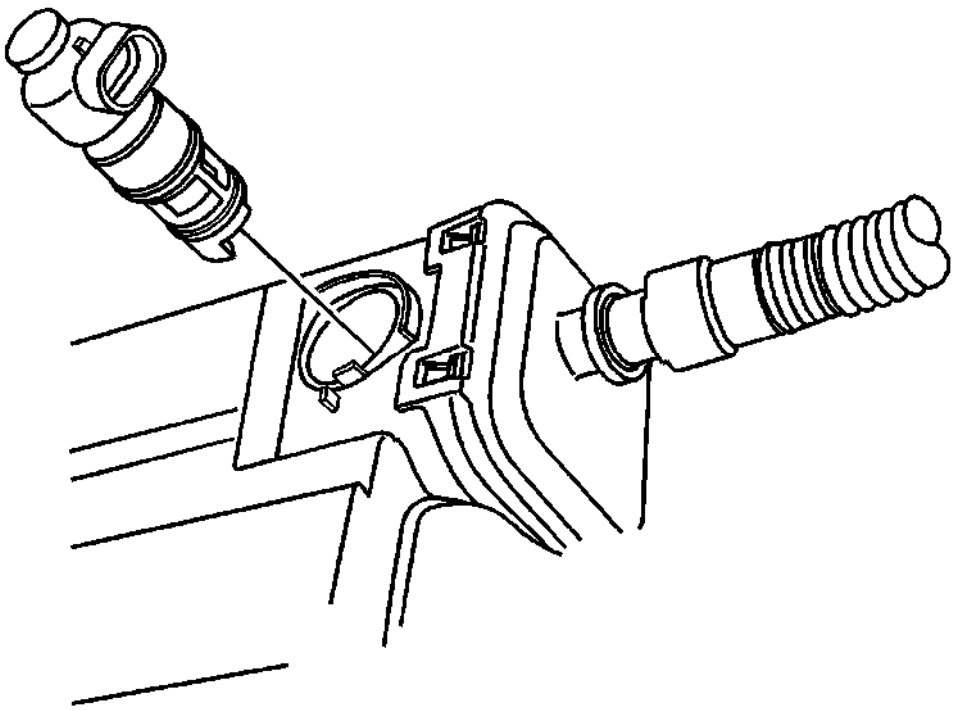


Fig. 140: View Of EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS COMPANY

1. Insert the EVAP canister vent solenoid valve into the EVAP canister, with the valve aligned to the released position.

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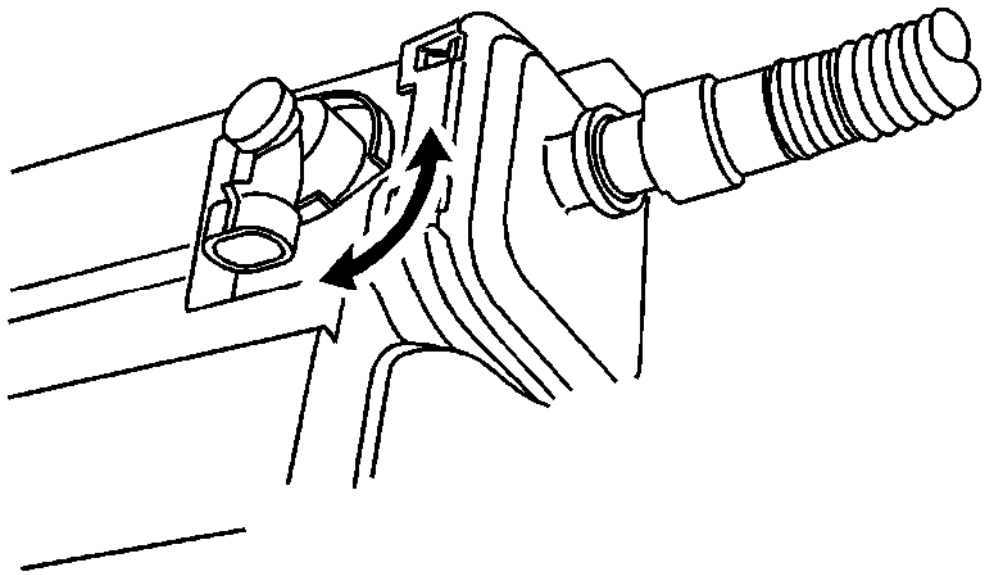


Fig. 141: Rotating EVAP Canister Vent Valve
Courtesy of GENERAL MOTORS COMPANY

2. Rotate vent valve clockwise to secure into the locked position.
3. Install the EVAP canister. Refer to **Evaporative Emission Canister Replacement**.

EVAPORATIVE EMISSION CANISTER REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Safety Goggles and Fuel Warning .

1. Open the hood.

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2. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

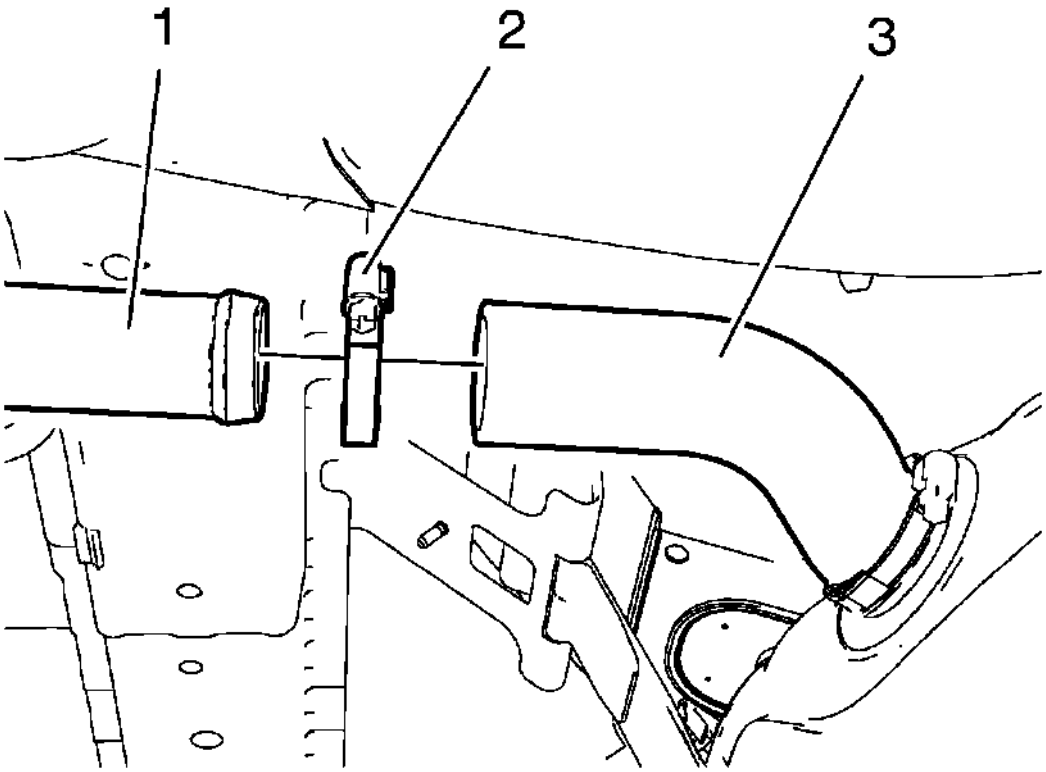


Fig. 142: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

WARNING: Do not breathe the air through the EVAP component tubes or hoses. The fuel vapors inside the EVAP components may cause personal injury.

NOTE: Do not remove the fuel tank filler hose when the fuel tank is over half filled with fuel.

4. Remove the clamp (2).

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If the fuel level is over half filled. Refer to **Fuel Tank Draining**.

5. Remove the fuel tank filler hose (3) from the fuel tank filler pipe (1).

WARNING: To help avoid personal injury, always use jack stands when you are working on or under any vehicle that is supported only by a jack.

CAUTION: When you are jacking or lifting a vehicle at the frame side rails or other prescribed lift points, be certain that the lift pads do not contact the catalytic converter, the brake pipes or the fuel lines. If such contact occurs, vehicle damage or unsatisfactory vehicle performance may result.

6. Place a suitable adjustable jack under the fuel tank.

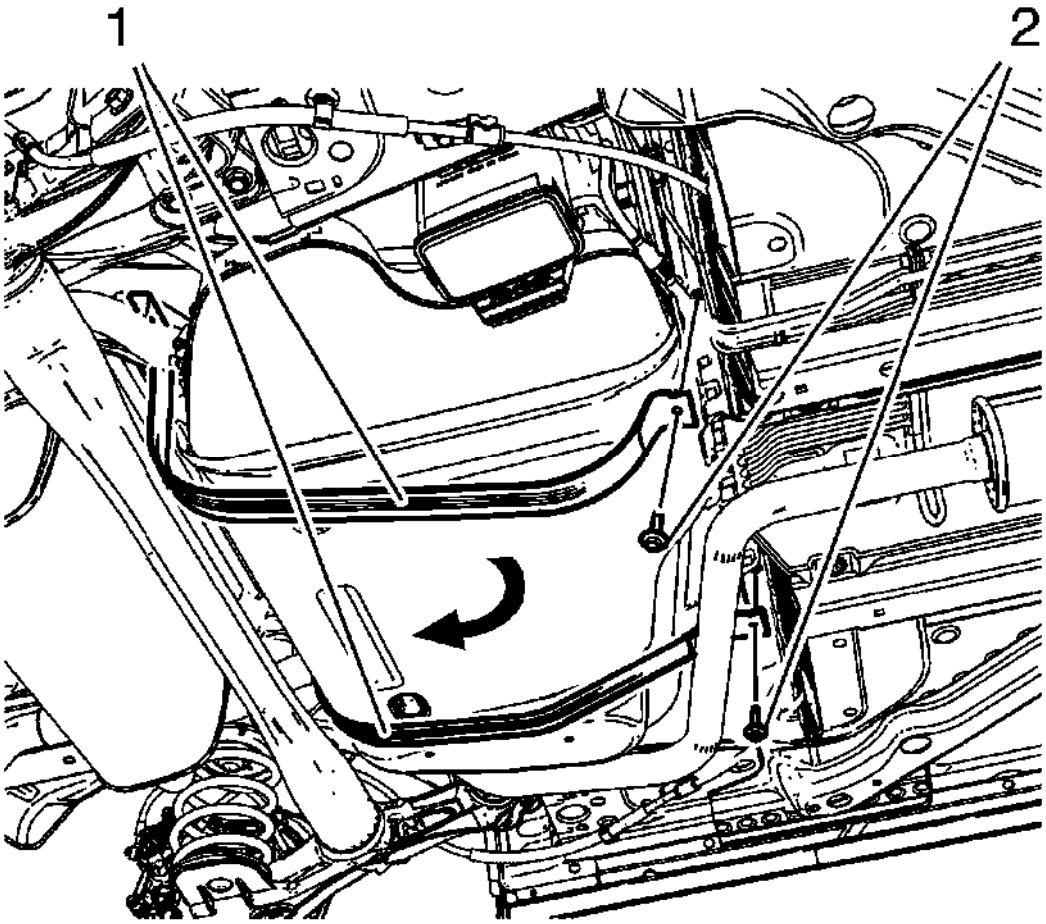


Fig. 143: Fuel Tank Straps

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Courtesy of GENERAL MOTORS COMPANY

7. Remove the 2 fuel tank strap bolts (2).
8. Remove the 2 fuel tank straps (1).

NOTE: Closely watch parts like pipes or hoses that are still installed to the fuel tank. If lowering the fuel tank slightly does not provide enough access to remove the fuel tank, refer to Fuel Tank Replacement.

9. Lower the fuel tank to a height where the evaporative emission canister is easily accessible.

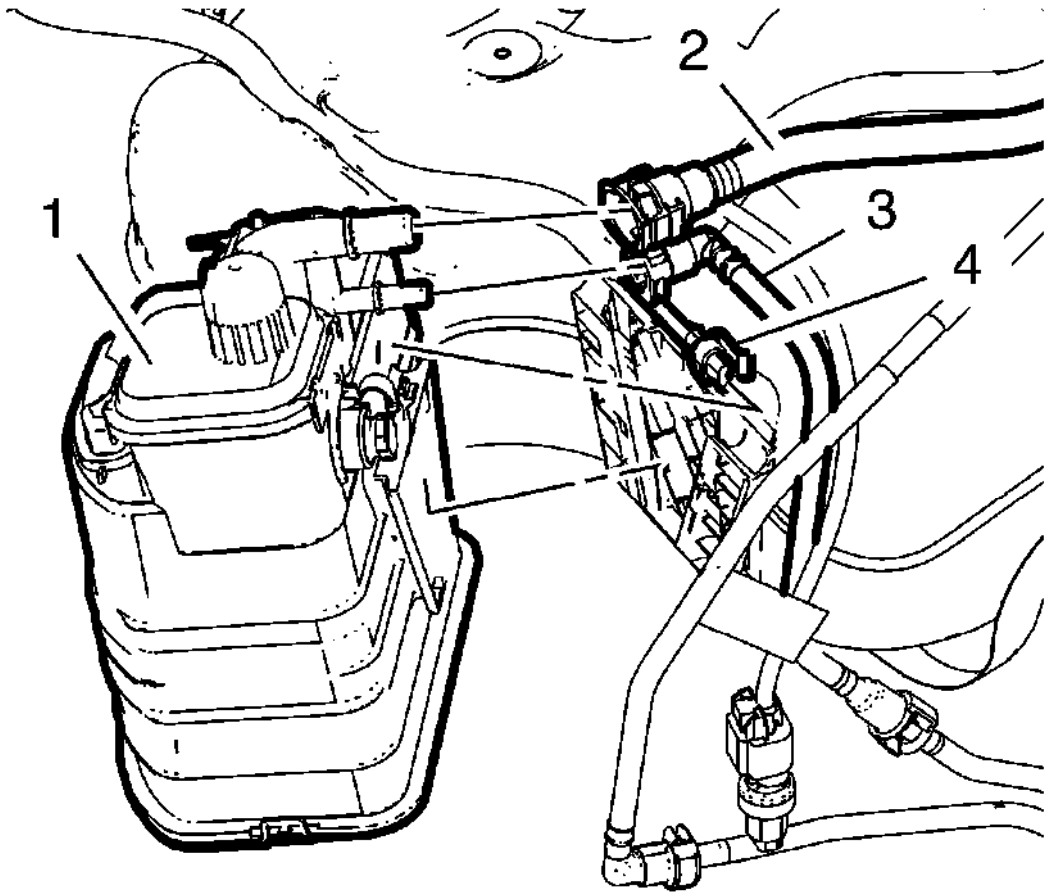


Fig. 144: Evaporative Emission Canister
Courtesy of GENERAL MOTORS COMPANY

WARNING: Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.

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10. Disconnect the evaporative emission vent pipe (2).
11. Disconnect the evaporative emission canister wiring harness plug (4).
12. Disconnect the evaporative emission canister purge pipe (3).
13. Remove the evaporative emission canister (1) from the evaporative emission canister bracket.

Installation Procedure

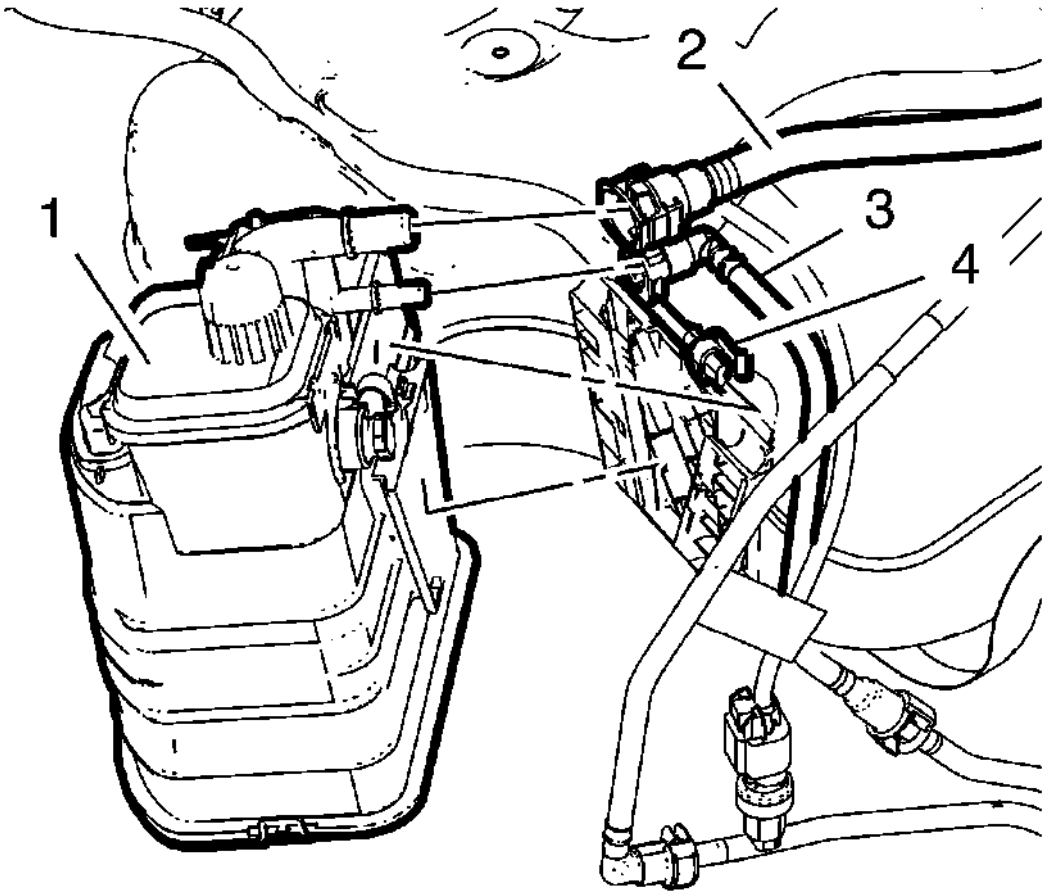


Fig. 145: Evaporative Emission Canister
Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission canister (1) to the evaporative emission canister bracket.
2. Connect the evaporative emission canister purge pipe (3).
3. Connect the evaporative emission canister wiring harness plug (4).
4. Connect the evaporative emission vent pipe (2).
5. Raise the fuel tank to its original position.

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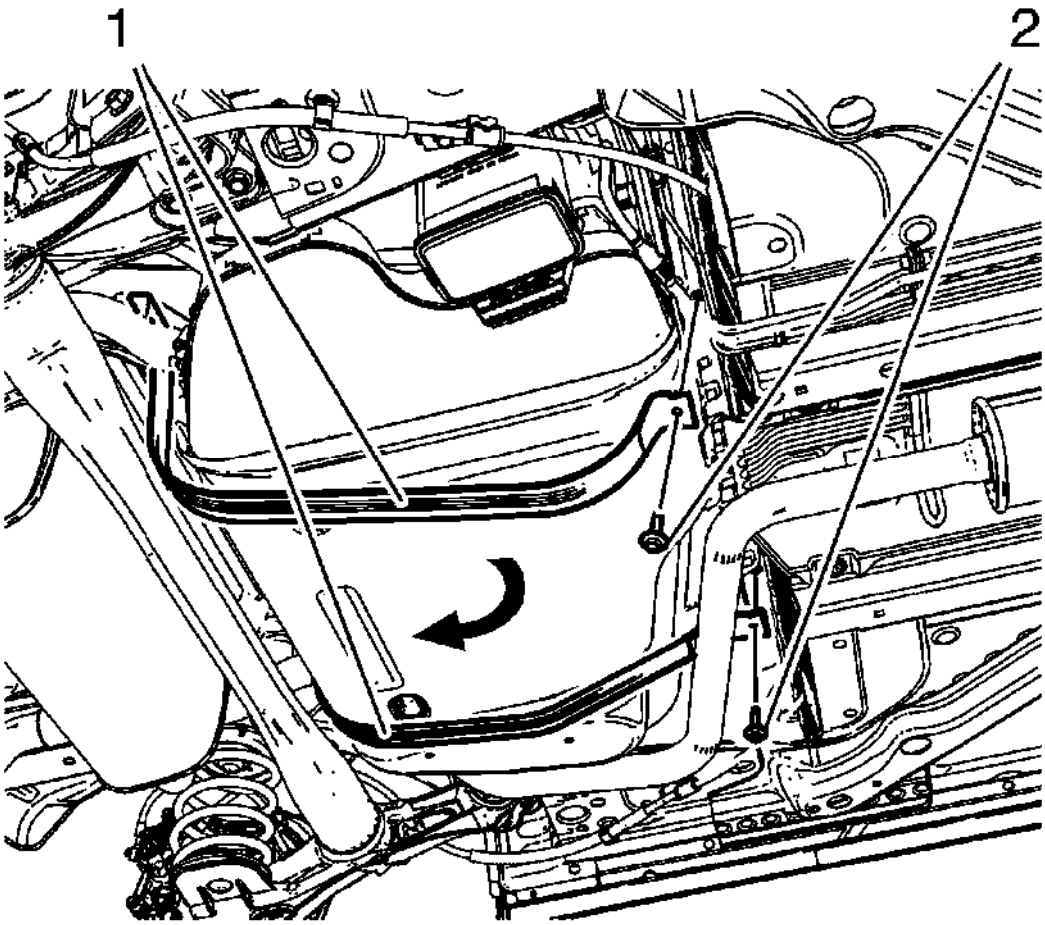


Fig. 146: Fuel Tank Straps
Courtesy of GENERAL MOTORS COMPANY

6. Install the 2 fuel tank straps (1).

CAUTION: Refer to Fastener Caution .

7. Install the 2 fuel tank strap bolts (2) and tighten to 22 N.m (16 lb ft).
8. Remove the suitable adjustable jack.

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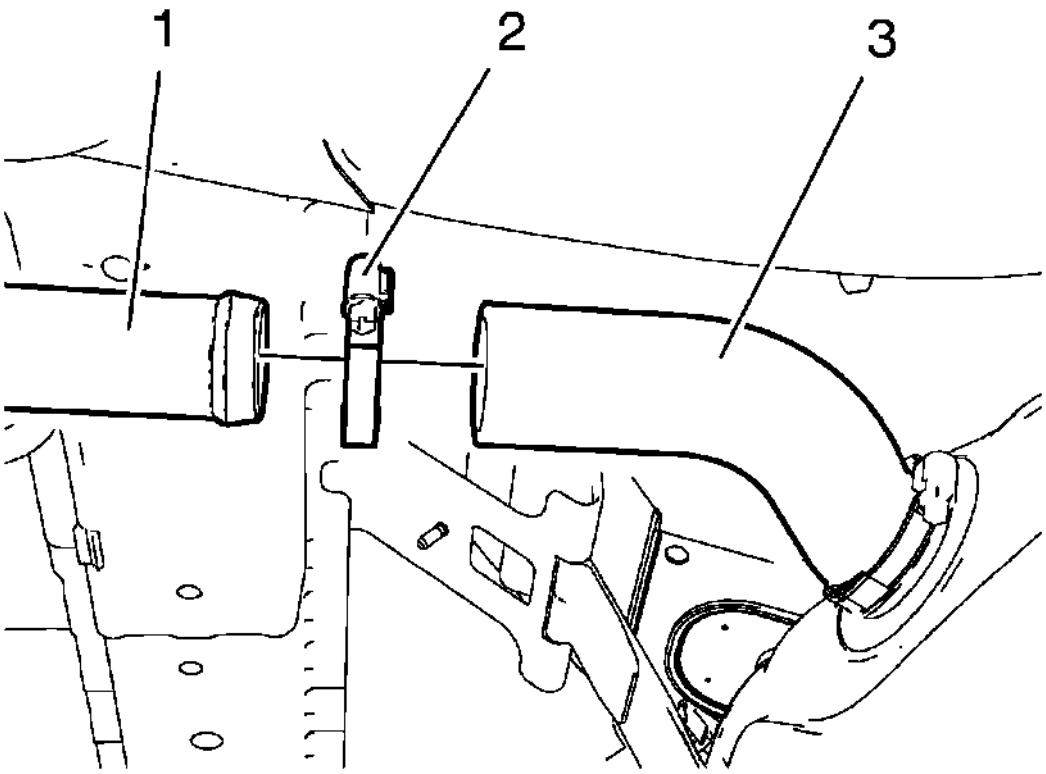


Fig. 147: Fuel Tank Filler Pipe
Courtesy of GENERAL MOTORS COMPANY

9. Install the fuel tank filler hose (3) to the fuel tank filler pipe (1).
10. Install the clamp (2).
11. Lower the vehicle.
12. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .
13. Close the hood.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

Removal Procedure

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

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WARNING: Refer to Safety Goggles and Fuel Warning .

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

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

1. Open the hood.
2. Disconnect the battery negative cable **Battery Negative Cable Disconnection and Connection** .

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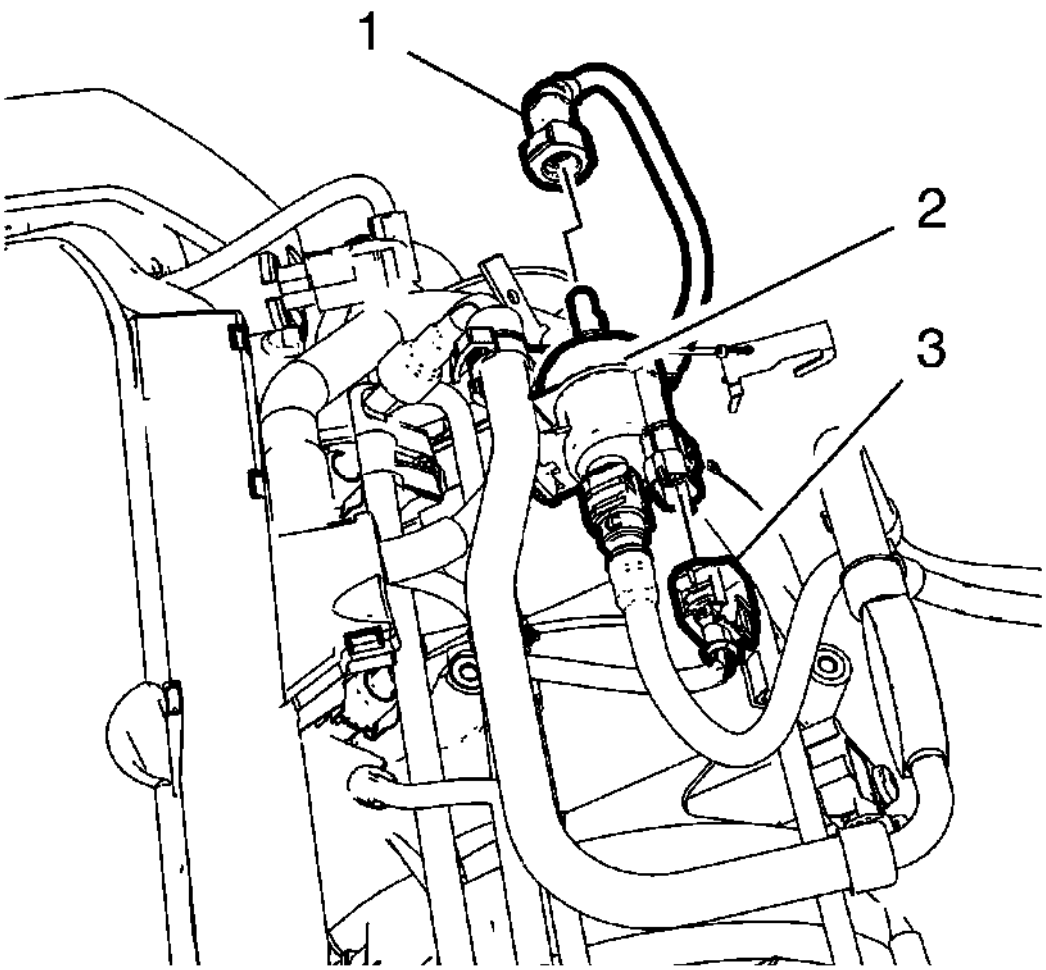


Fig. 148: Evaporative Emission Pipe And Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

3. Remove the evaporative emission pipe (1) from the evaporative emission canister purge solenoid valve (2).
4. Install a suitable cap on the evaporative emission pipe.
5. Disconnect the wiring harness plug (3) from the evaporative emission canister purge solenoid valve (2).

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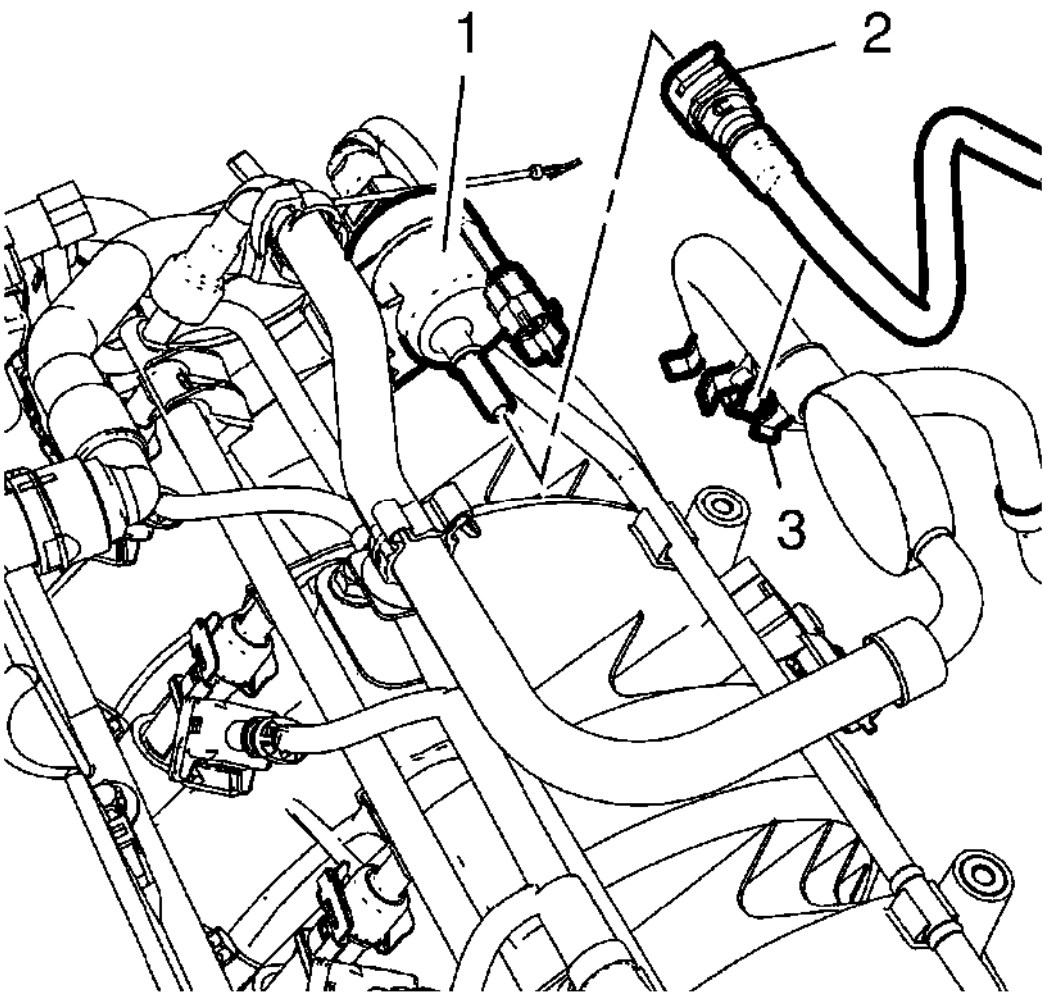


Fig. 149: Fuel Tank Vent Pipe And Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

6. Remove the fuel tank vent pipe (2) from the evaporative emission canister purge solenoid valve (1) and from the clip (3).
7. Install a suitable cap on the fuel tank vent pipe.

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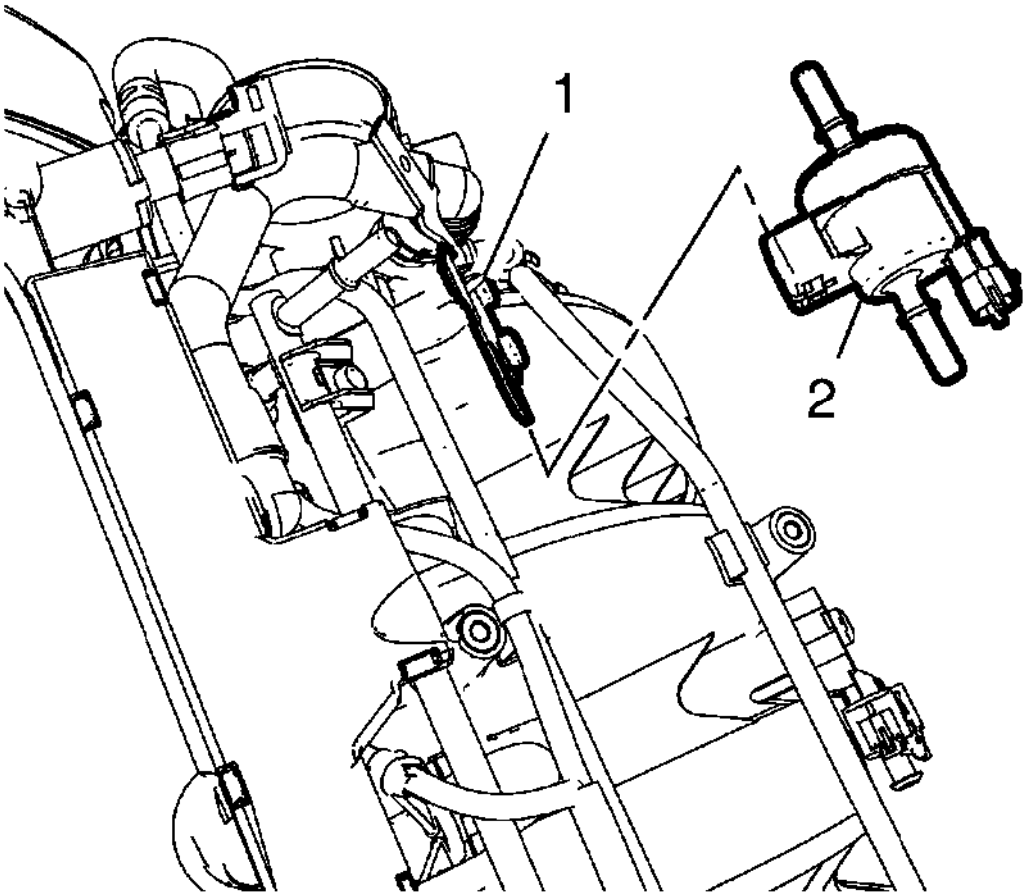


Fig. 150: Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

8. Remove the evaporative emission canister purge solenoid valve (2) from the bracket (1).

Installation Procedure

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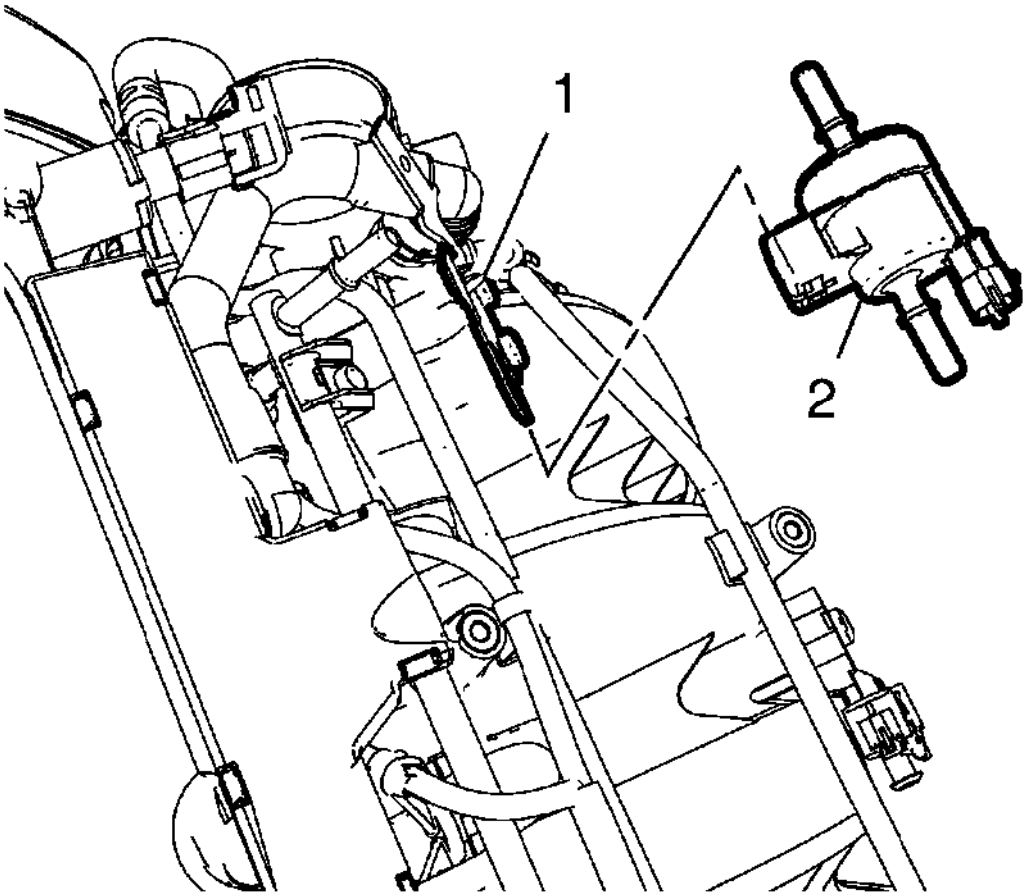


Fig. 151: Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission canister purge solenoid valve (2) to the bracket (1).
2. Remove the cap from the fuel tank vent pipe.

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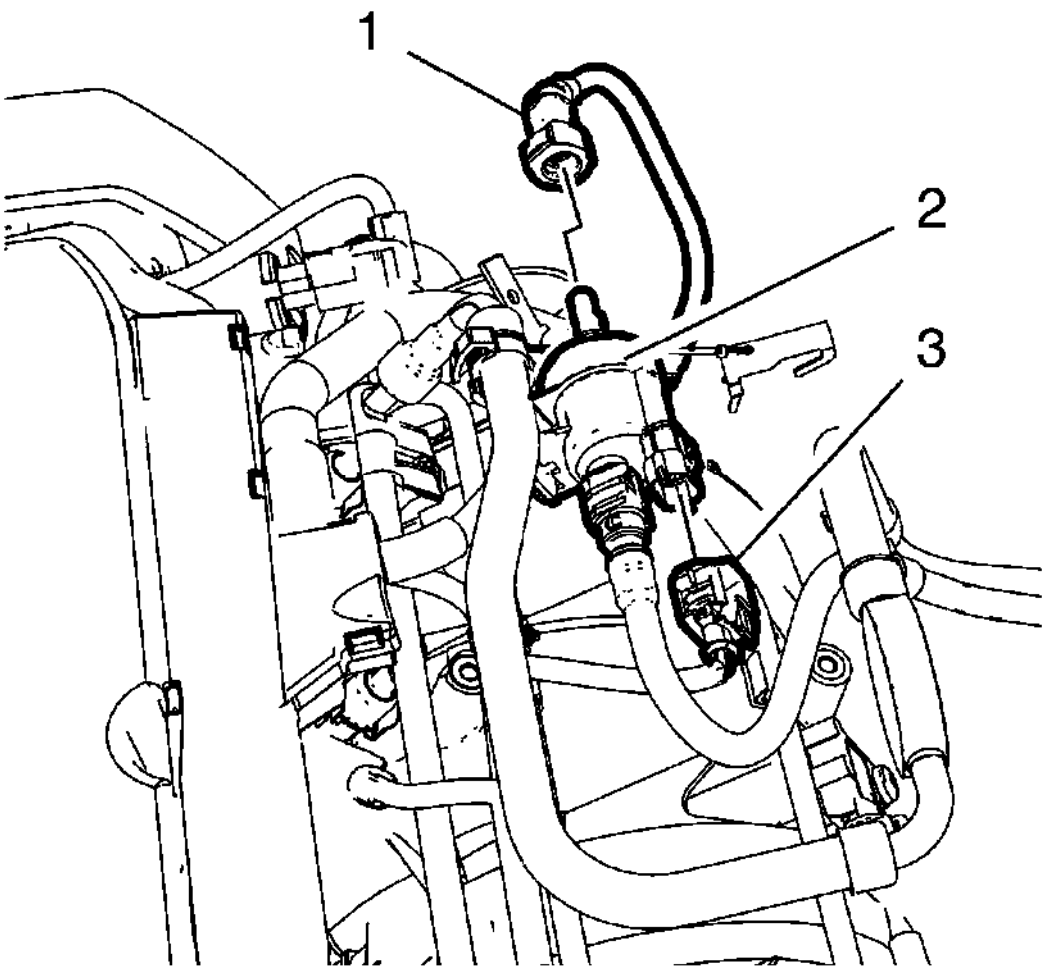


Fig. 152: Evaporative Emission Pipe And Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

3. Connect the wiring harness plug (3) to the evaporative emission canister purge solenoid valve (2).
4. Install the evaporative emission pipe (1) to the evaporative emission canister purge solenoid valve (2).
5. Remove the cap from the evaporative emission pipe.

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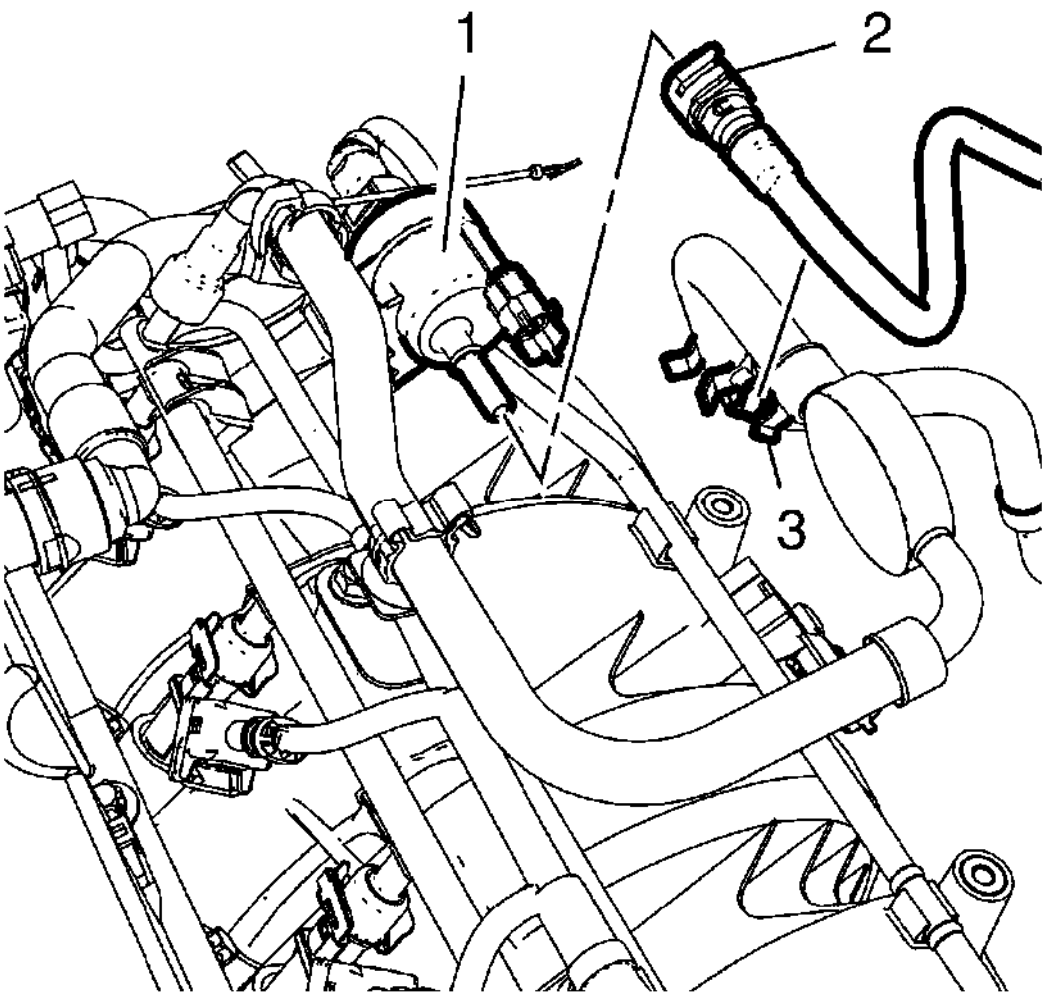


Fig. 153: Fuel Tank Vent Pipe And Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

6. Install the fuel tank vent pipe (2) to the evaporative emission canister purge solenoid valve (1) and to the clip (3).
7. Connect the battery negative cable **Battery Negative Cable Disconnection and Connection** .
8. Close the hood.

IGNITION COIL REPLACEMENT

Special Tools

EN-6009 Remover and Installer Ignition Coil

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

Removal Procedure

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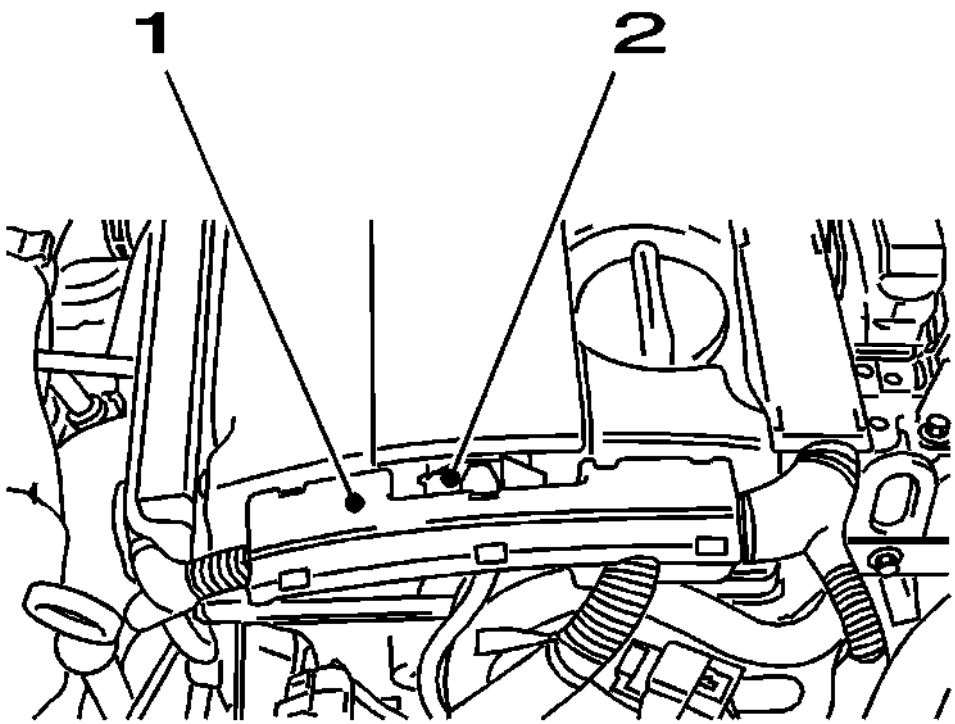


Fig. 154: View Of Engine Wiring Trough And DIS-ignition Module Wiring Harness Plug
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine wiring harness guide (1) from the cylinder head.
2. Disconnect the ignition coil plug (2).

NOTE: Note the arrow on the cover.

3. Remove the cover of the ignition coil in the direction of the arrow.
4. Remove the 2 ignition coil bolts.

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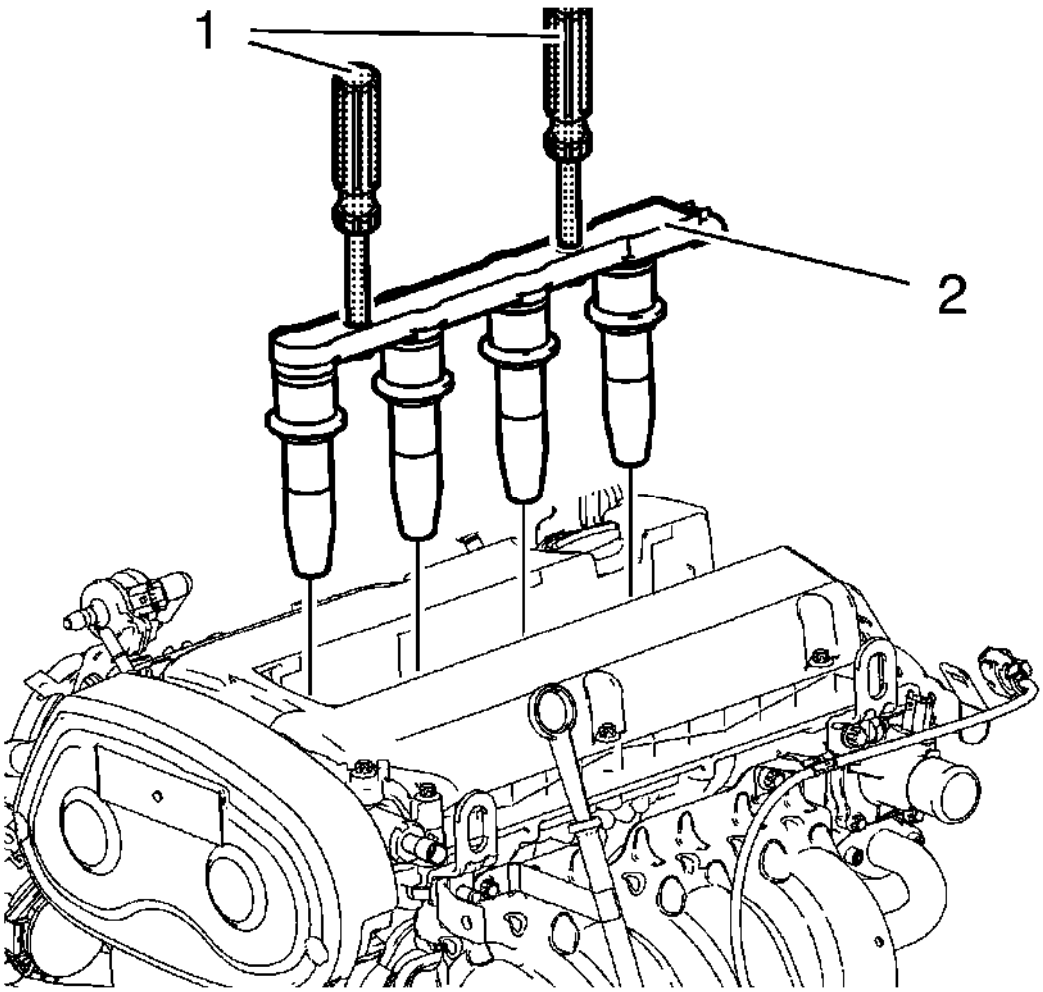


Fig. 155: Ignition Coil Module And Special Tool
Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-6009** remover/installer (1).
6. Remove the ignition coil (2).
7. Remove the **EN-6009** remover/installer (1).

Installation Procedure

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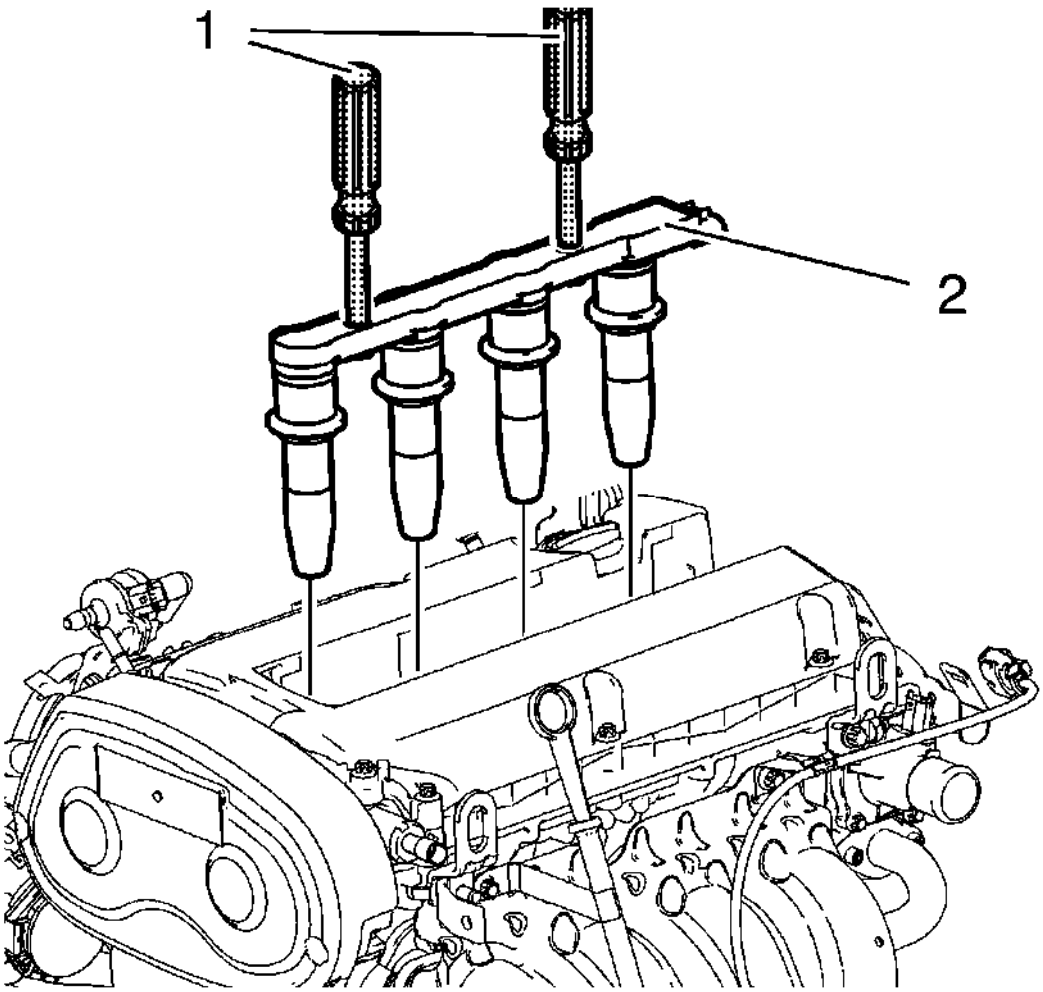


Fig. 156: Ignition Coil Module And Special Tool
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-6009** remover/installer (1).
2. Remove the ignition coil (2).
3. Remove the **EN-6009** remover/installer (1).
4. Install the 2 ignition coil bolts an tighten to 8 N.m (71 lb in).

NOTE: Note the arrow on the cover.

5. Install the ignition coil cover in the direction of the arrow.

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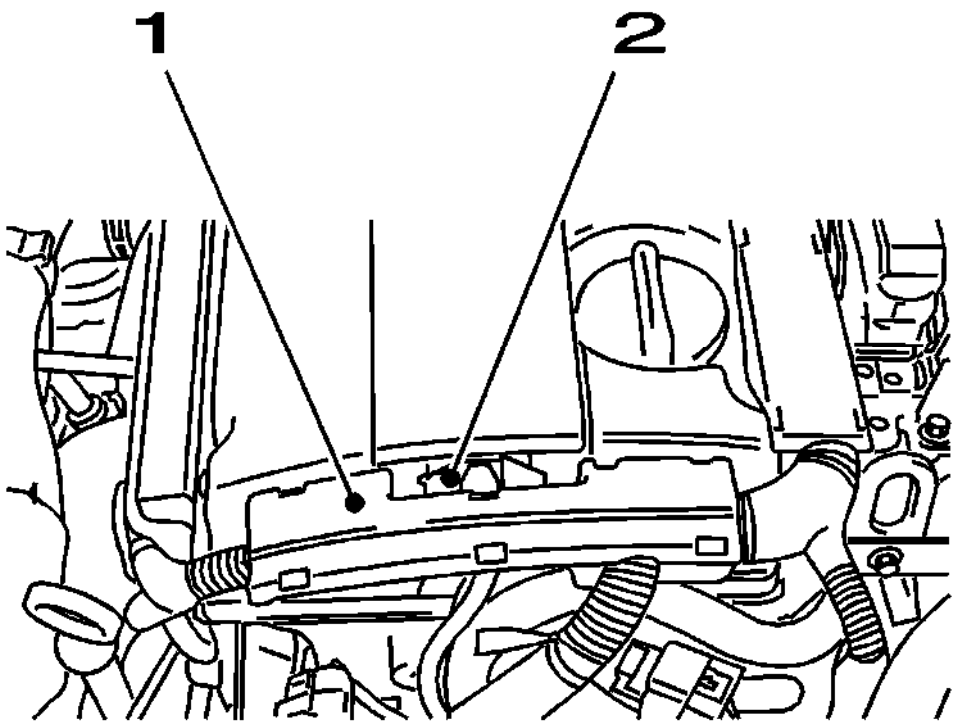


Fig. 157: View Of Engine Wiring Trough And DIS-ignition Module Wiring Harness Plug
Courtesy of GENERAL MOTORS COMPANY

6. Connect the ignition coil plug (2).
7. Install the engine wiring harness guide (1) at the cylinder head.

SPARK PLUG INSPECTION

Spark Plug Usage

1. Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to the electronic parts catalog for the correct spark plug.
2. Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
   - Spark plug fouling-Colder plug
   - Pre-ignition causing spark plug and/or engine damage-Hotter plug

Spark Plug Inspection

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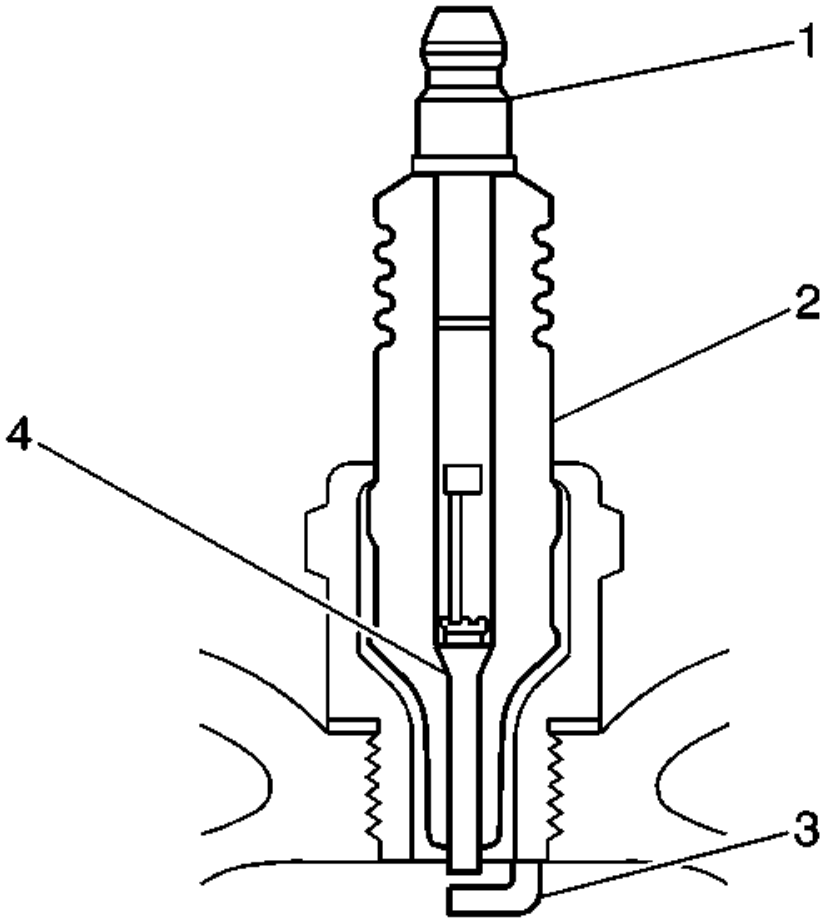


Fig. 158: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

1. 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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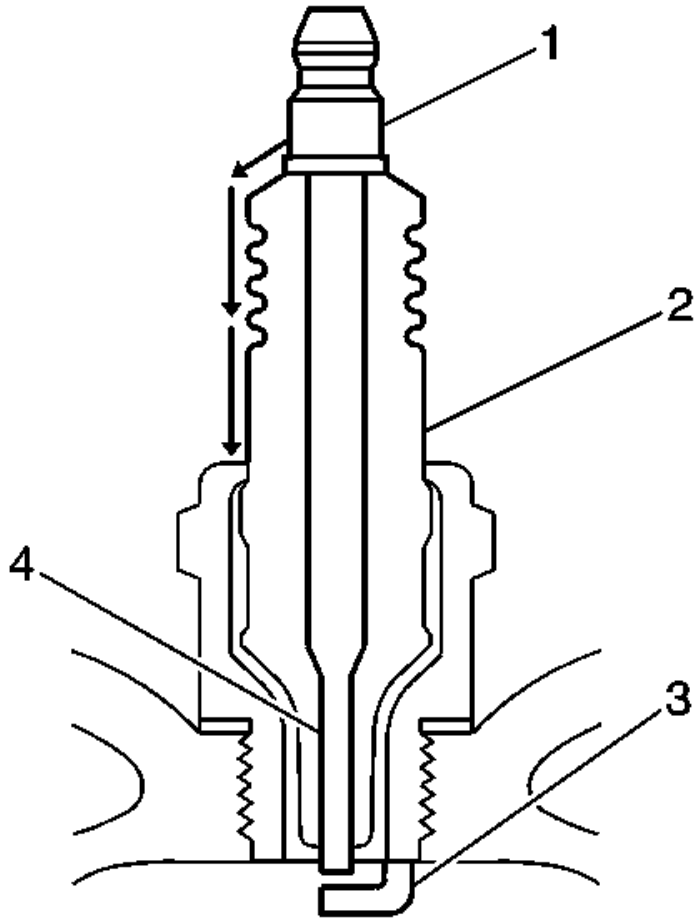


Fig. 159: Identifying Points For Inspecting Spark Plug For Flashover Or Carbon Tracking Soot
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the insulator (2) for flashover or carbon tracking, soot. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
    - Inspect the spark plug boot for damage.
    - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant, or water. A spark plug boot that is saturated causes arcing to ground.

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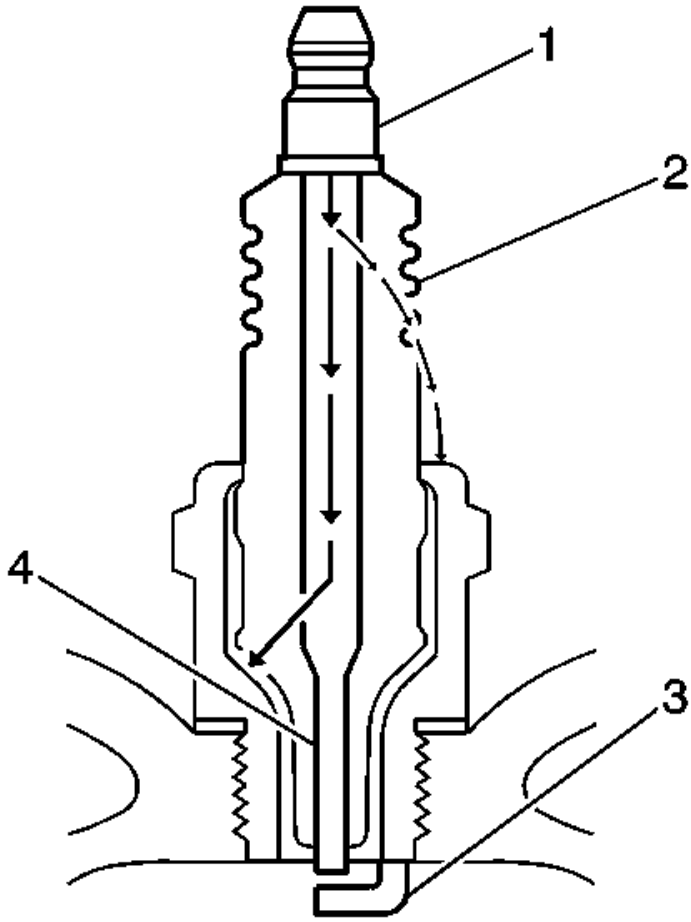


Fig. 160: Inspecting Spark Plug Insulator
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).

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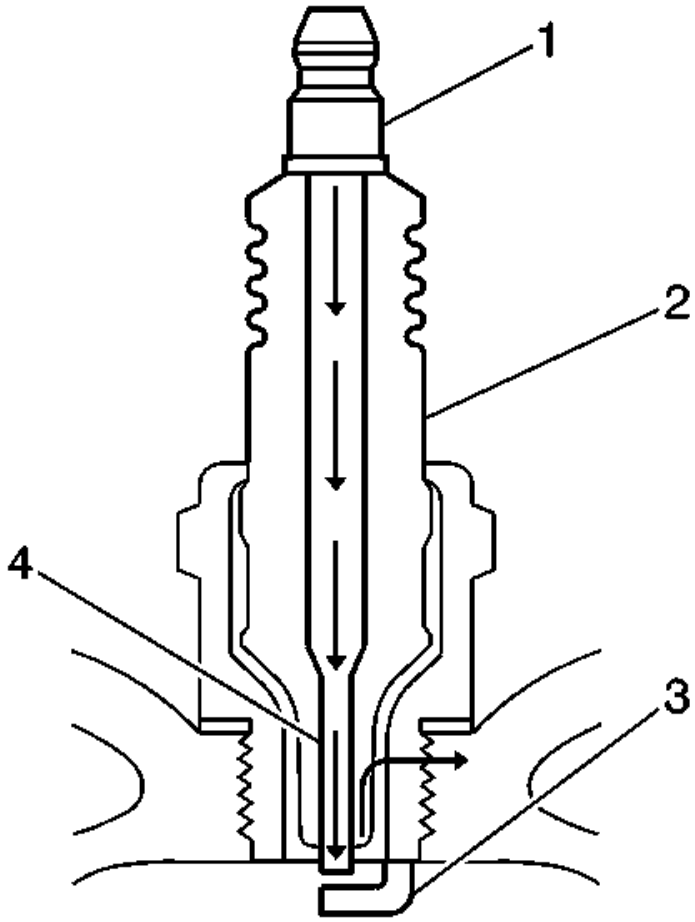


Fig. 161: Cutaway/Description View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

4. Inspect for evidence of improper arcing.
   - Measure the gap between the center electrode (4) and the side electrode (3) terminals. Refer to **Ignition System Specifications** . An excessively wide electrode gap can prevent correct spark plug operation.
   - Inspect for the correct spark plug torque. Refer to **Ignition System Specifications** . Insufficient torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.
   - Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
   - Inspect for a broken or worn side electrode (3).
   - Inspect for a broken, worn, or loose center electrode (4) by shaking the spark plug.
5. A rattling sound indicates internal damage.
6. 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.

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- 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

1. Normal operation-Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
2. Carbon Fouled-Dry, fluffy black carbon, or soot caused by the following conditions:
   - Rich fuel mixtures
   - Leaking fuel injectors
   - Excessive fuel pressure
   - Restricted air filter element
   - Incorrect combustion
   - Reduced ignition system voltage output
   - Weak coils
   - Worn ignition wires
   - Incorrect spark plug gap
   - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
   - Deposit Fouling-Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

SPARK PLUG REPLACEMENT

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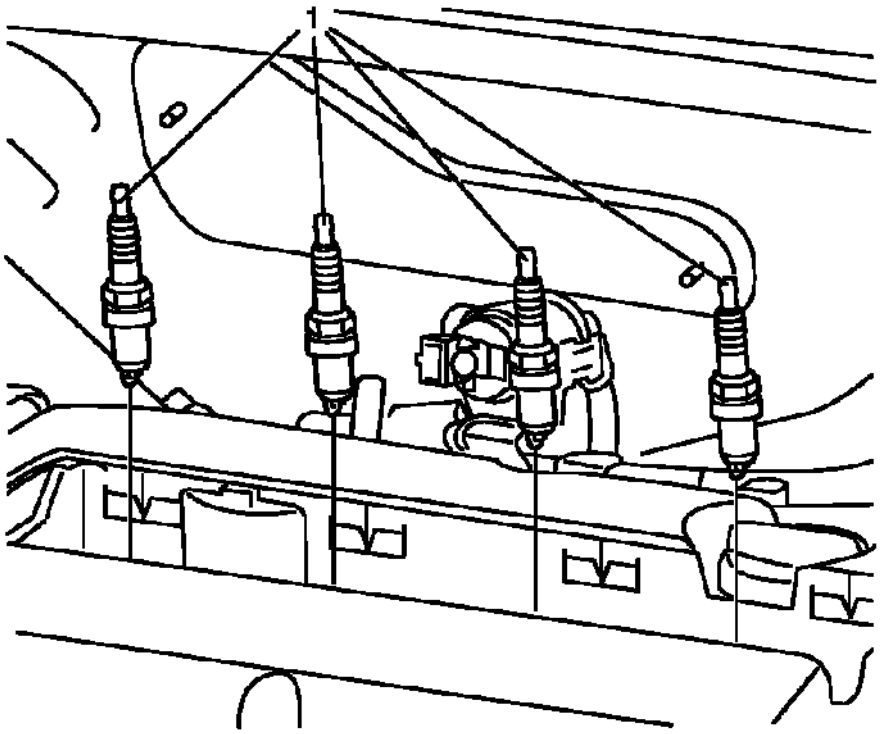


Fig. 162: Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

Spark Plug Replacement

Callout	Component Name
Preliminary Procedure Remove the ignition coil. Refer to **Ignition Coil Replacement**.	
1	Spark Plug Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)

CRANKSHAFT POSITION SENSOR REPLACEMENT

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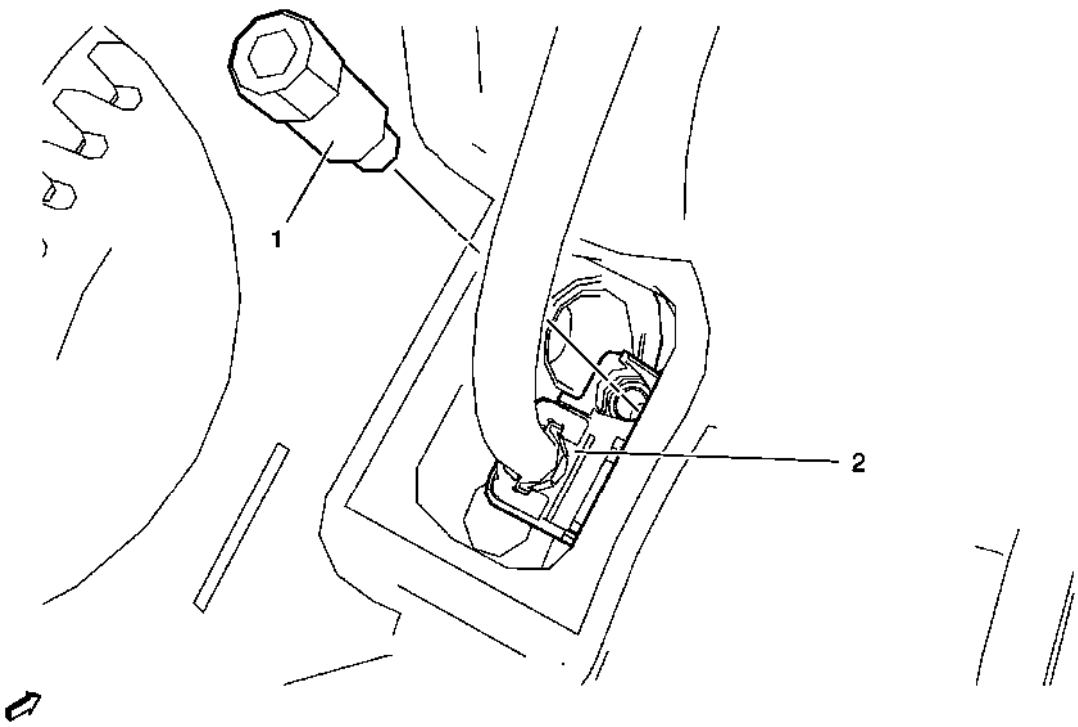


Fig. 163: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Position Sensor Replacement

Callout	Component Name
Preliminary Procedure Remove the starter motor. Refer to **Starter Replacement (1.4L LUV)** , **Starter Replacement (1.8L LUW and LWE)** .	
1	Crankshaft Position Sensor Fastener **CAUTION:** **Refer to Fastener Caution .** **Procedure** Remove the crankshaft position sensor bolt **Tighten** 4.5 N.m (40 lb in)
2	Crankshaft Position Sensor **Procedure** Disconnect all electrical connectors as needed.

CAMSHAFT POSITION SENSOR REPLACEMENT

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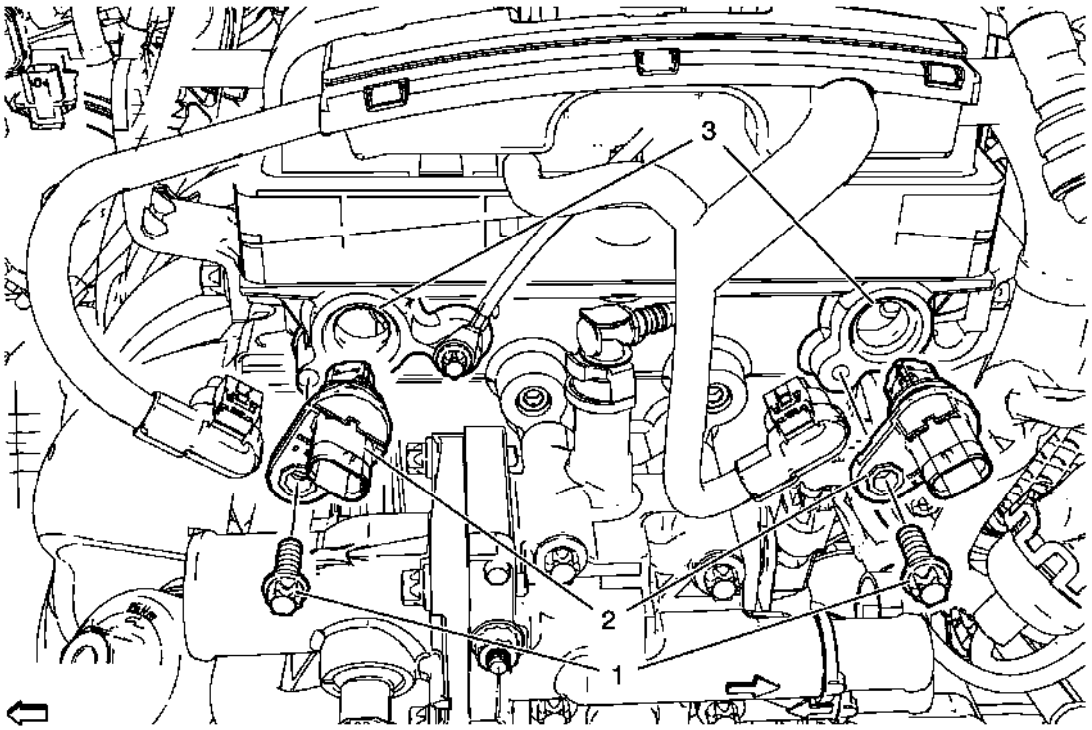


Fig. 164: Camshaft Position Sensor (1.8L)
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Replacement

Callout	Component Name
1	Camshaft Position Sensor Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 6 N.m (53 lb in)
2	Camshaft Position Sensor **Procedure** Disconnect electrical connectors as needed.
3	Camshaft Position Sensor Seal Ring

KNOCK SENSOR REPLACEMENT

Removal Procedure

1. Open the hood.
2. Disconnect the negative cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection** .

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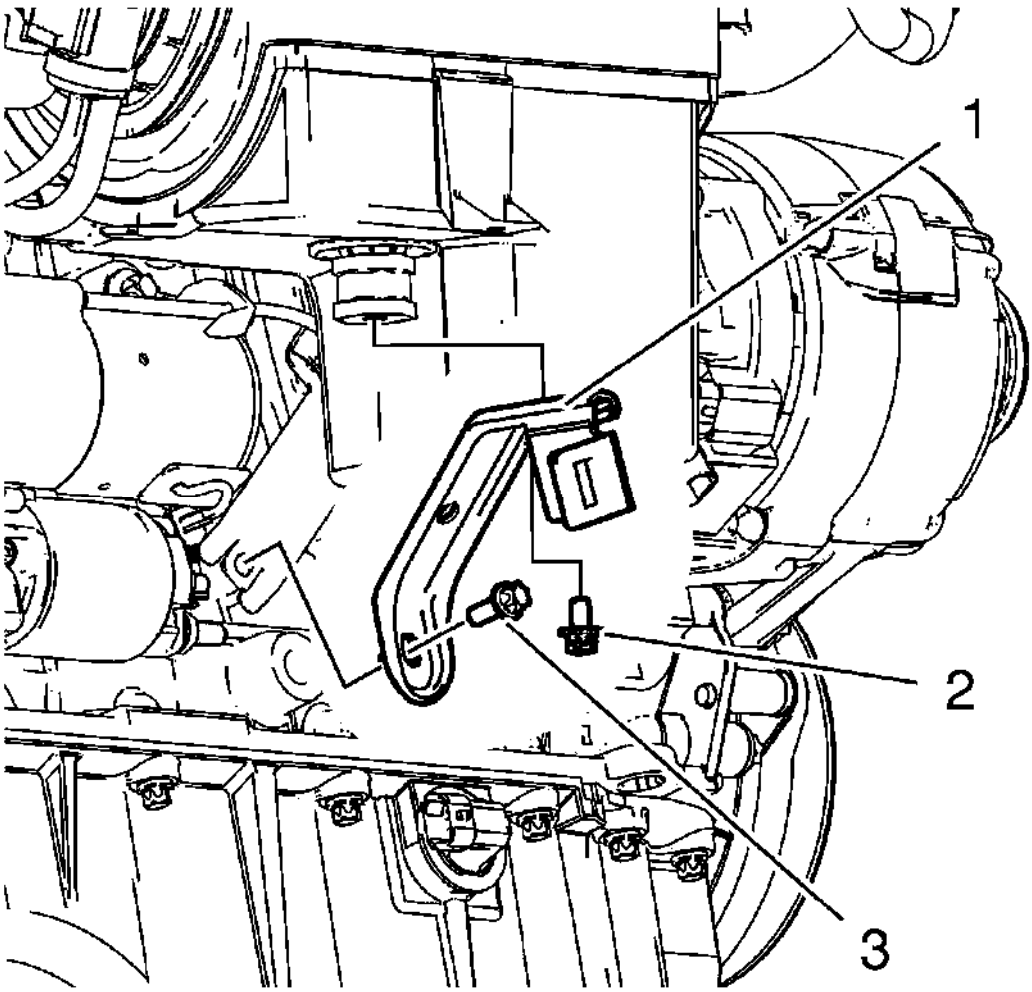


Fig. 165: Intake Manifold Bracket
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 2 intake manifold bracket bolts (2, 3).
4. Unclip the wiring harness.
5. Remove the intake manifold bracket (1).

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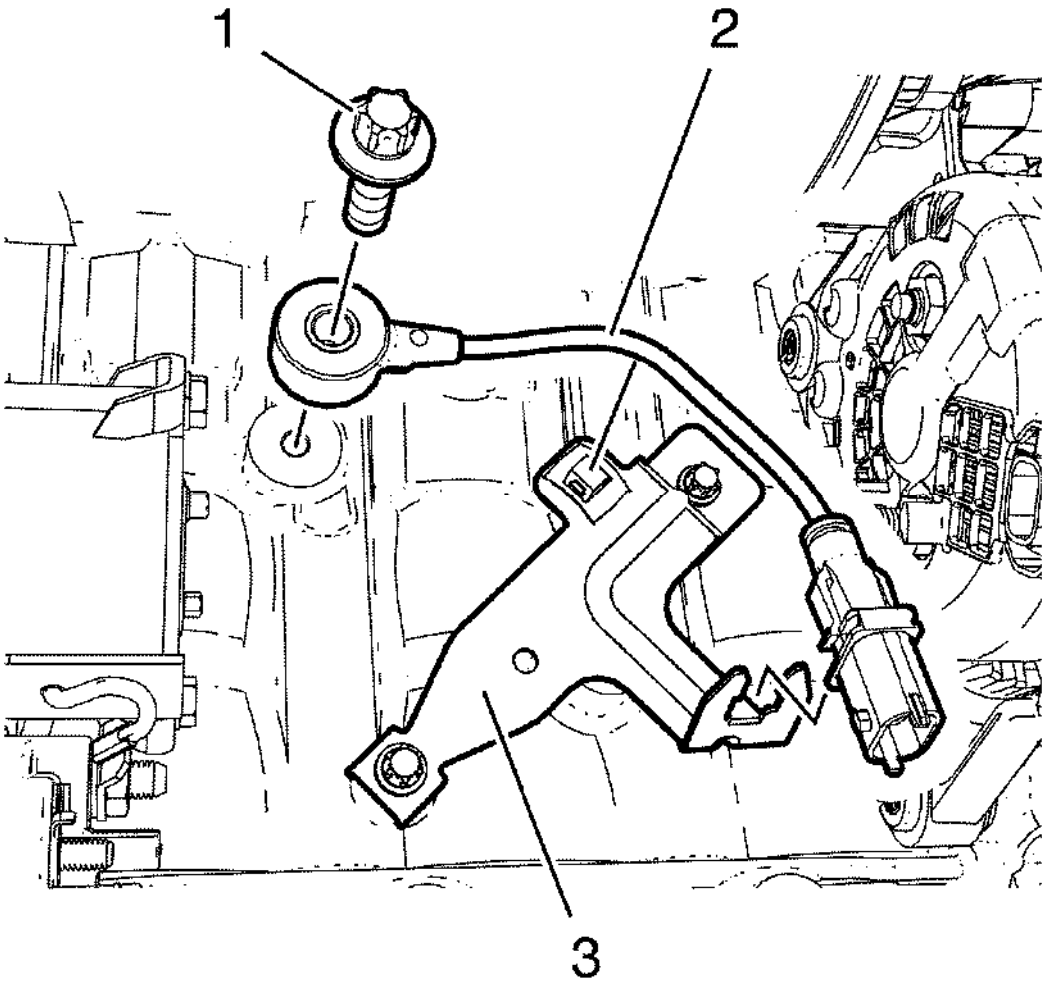


Fig. 166: Knock Sensor And Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Remove the sensor bolt (1).
7. Disconnect the wiring harness plug.
8. Remove the knock sensor (2) from the bracket (3).

Installation Procedure

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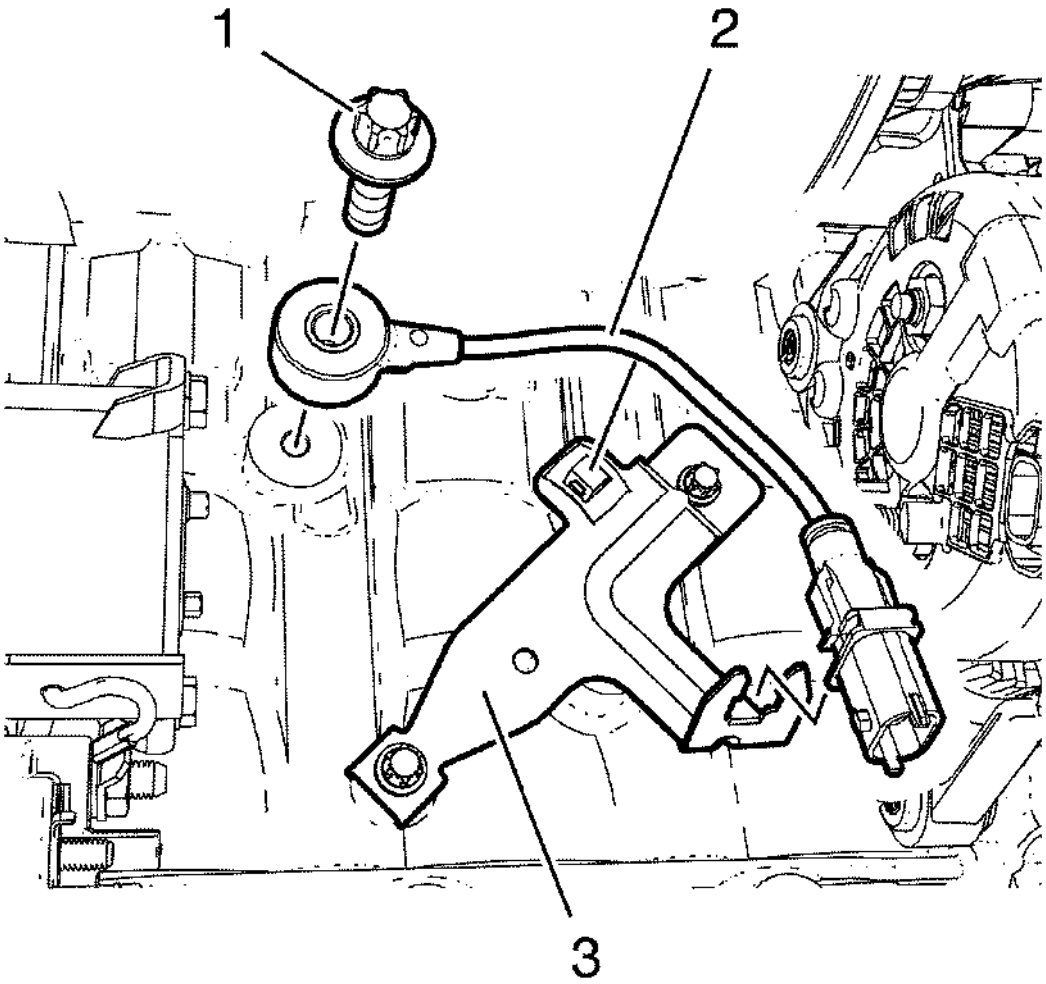


Fig. 167: Knock Sensor And Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Install the knock sensor (2) to the bracket (3).

CAUTION: Refer to Fastener Caution

2. Install the sensor bolt (1) and tighten to 20 N.m (15 lb ft).
3. Connect the wiring harness plug.

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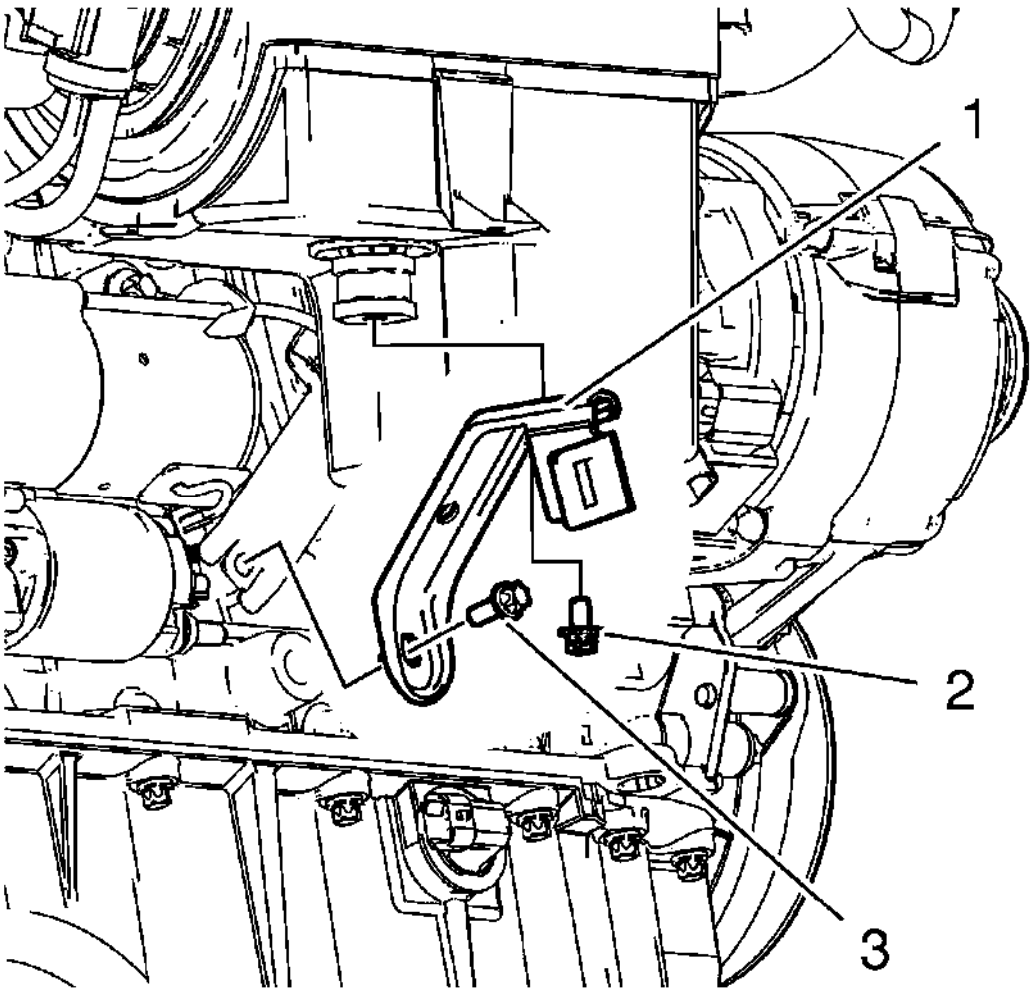


Fig. 168: Intake Manifold Bracket
Courtesy of GENERAL MOTORS COMPANY

4. Install the intake manifold bracket (1).
5. Clip in the wiring harness.
6. Install the 2 intake manifold bracket bolts (2, 3) and tighten to 8 N.m (71 lb in).
7. Connect the negative cable to the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
8. Close the hood.

AIR CLEANER INLET DUCT REPLACEMENT

Removal Procedure

1. Remove the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .

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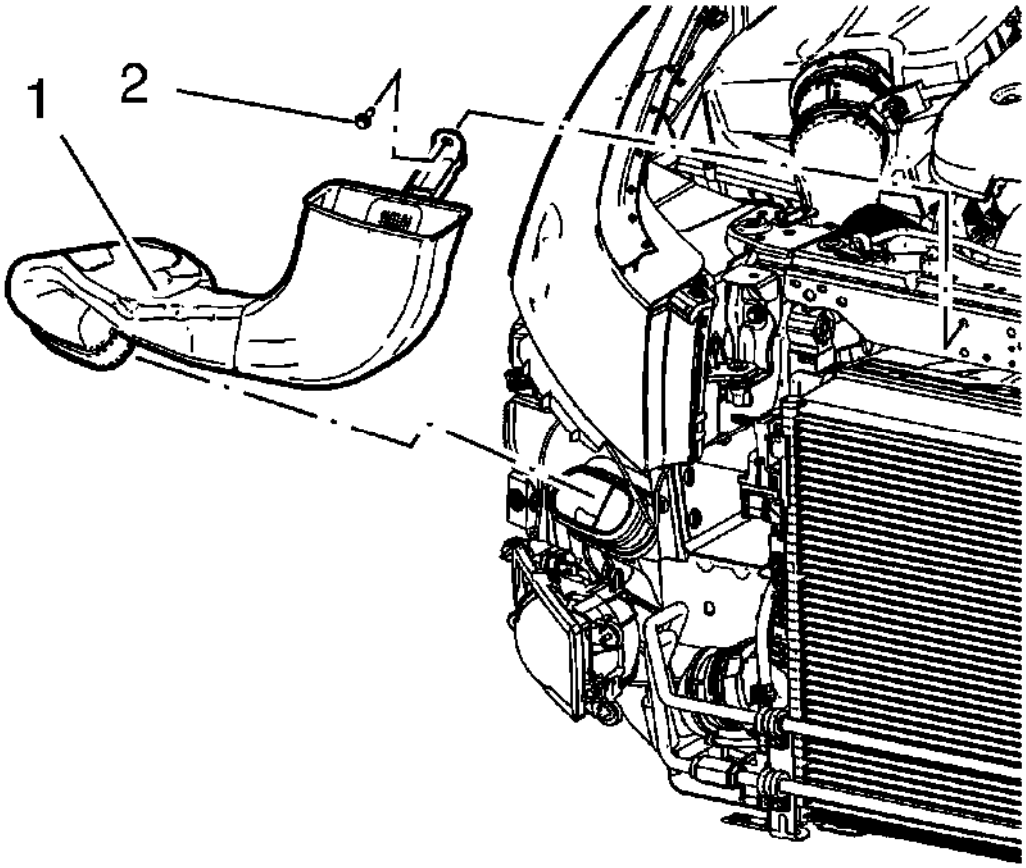


Fig. 169: Intake Air Duct And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the intake air duct bolt (2).
3. Remove the intake air duct (1).

Installation Procedure

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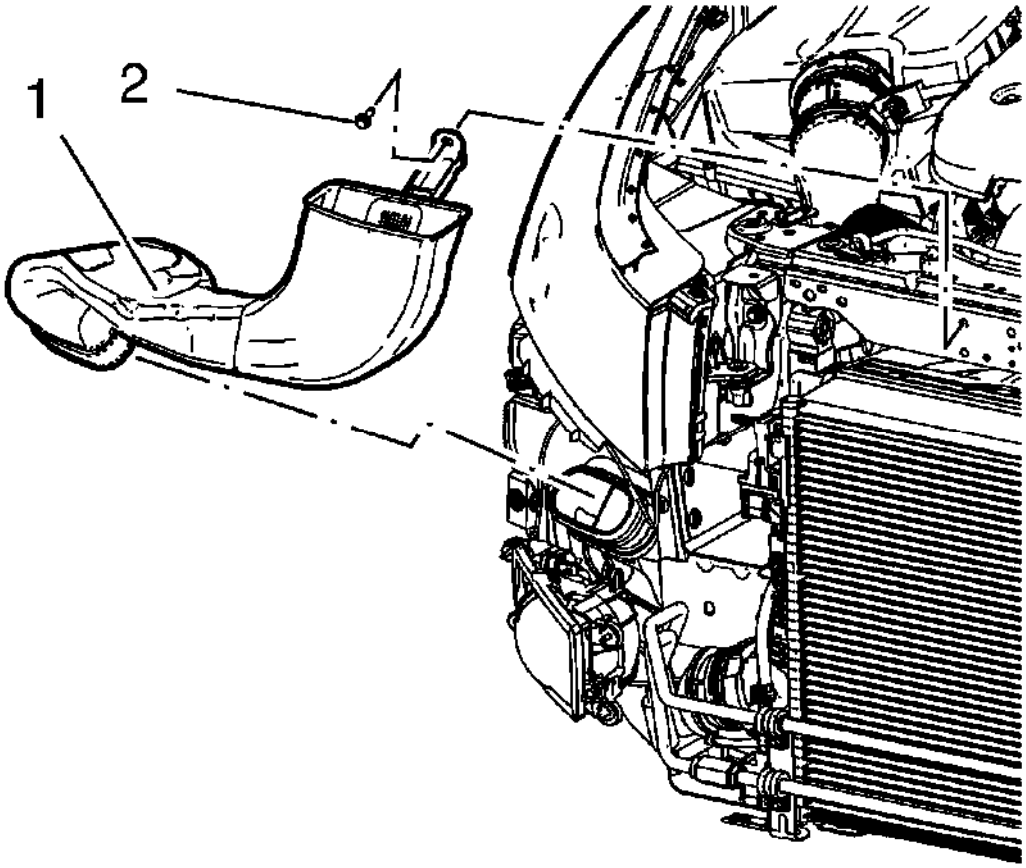


Fig. 170: Intake Air Duct And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the intake air duct (1).

CAUTION: Refer to Fastener Caution .

2. Install the intake air duct bolt (2) and tighten the to 5 N.m (44 lb in).
3. Install the front bumper fascia. Refer to **Front Bumper Fascia Replacement** .

AIR CLEANER OUTLET DUCT REPLACEMENT

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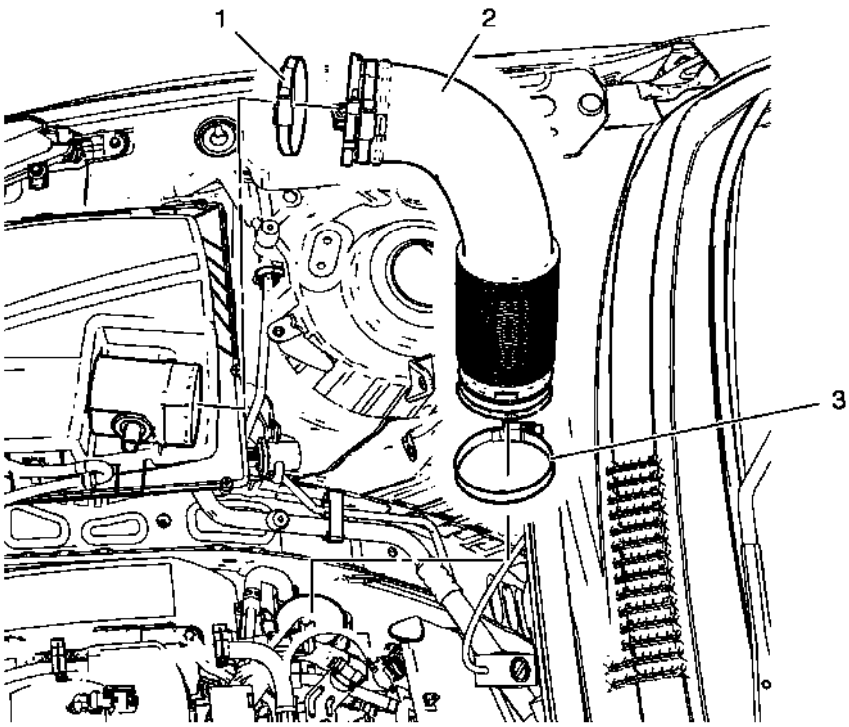


Fig. 171: Air Cleaner Outlet Duct (1.8L LUW)
Courtesy of GENERAL MOTORS COMPANY

Air Cleaner Outlet Duct Replacement

Callout	Component Name
1	Air Cleaner Outlet Duct to Air Cleaner Housing Cover Clamp **CAUTION:** **Any time service is being performed which requires removal of the air cleaner assembly, always cover the throttle body opening. This will prevent any foreign material from entering the engine.** **CAUTION:** **Refer to Fastener Caution .** **Tighten** 3.5 N.m (31 lb in)
2	Air Cleaner Outlet Duct
3	Air Cleaner Outlet Duct to Intake Manifold Clamp **Tighten** 3.5 N.m (31 lb in)

AIR CLEANER ELEMENT REPLACEMENT

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Removal Procedure

1. Open the hood.

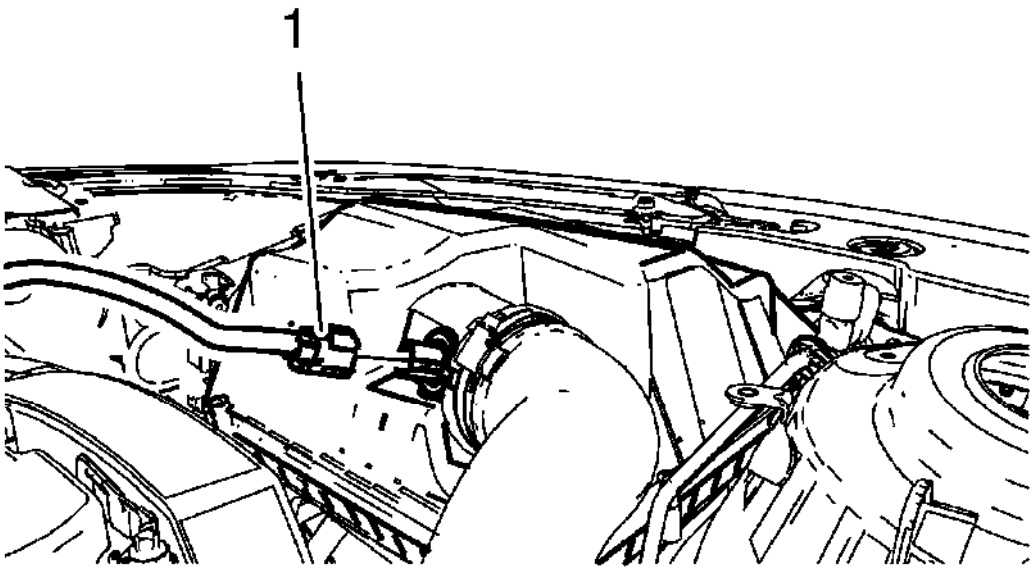


Fig. 172: Intake Air Sensor Wiring Harness Plug
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the intake air sensor wiring harness plug (1).
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

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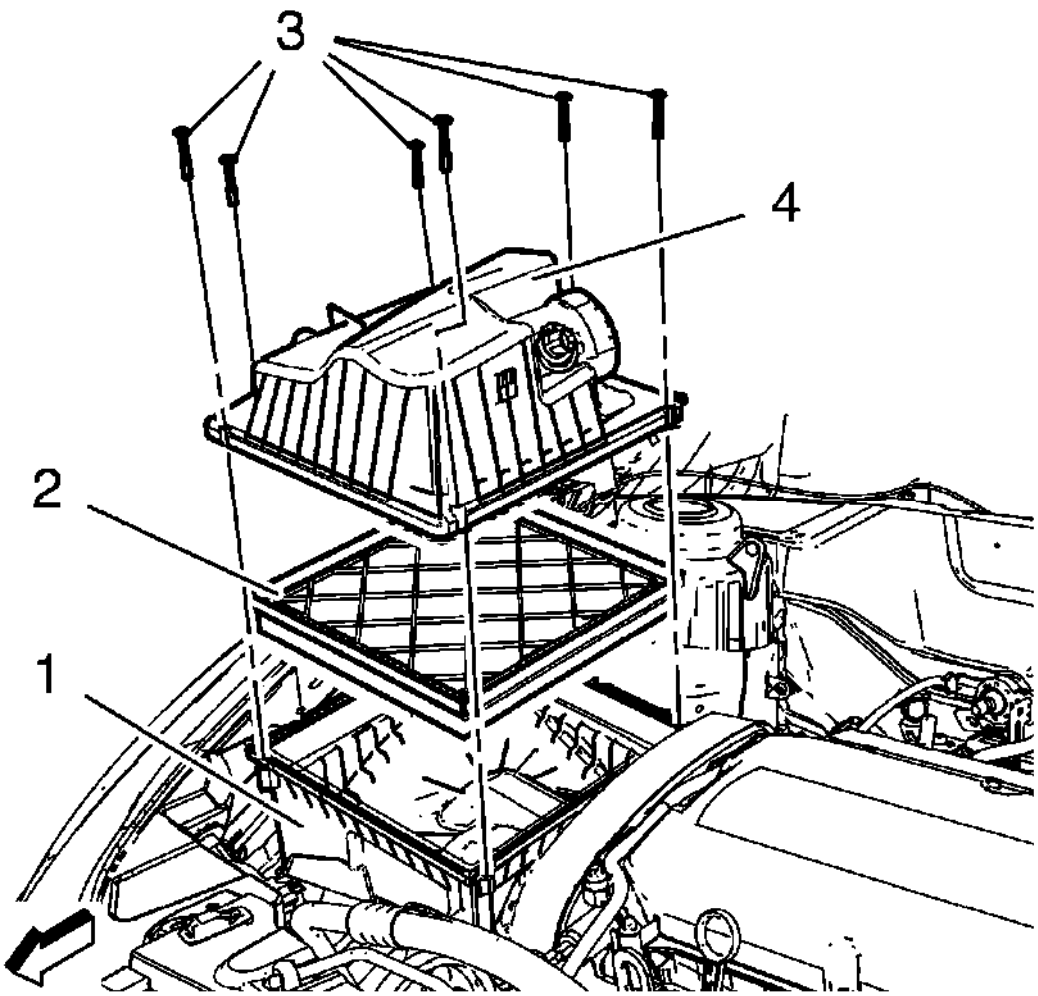


Fig. 173: Air Cleaner Element, Air Cleaner Housing, Air Cleaner Housing Cover And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the 6 air cleaner housing cover bolts (3)
5. Remove the air cleaner housing cover (4).
6. Remove the air cleaner element (2) from the air cleaner housing (1).

Installation Procedure

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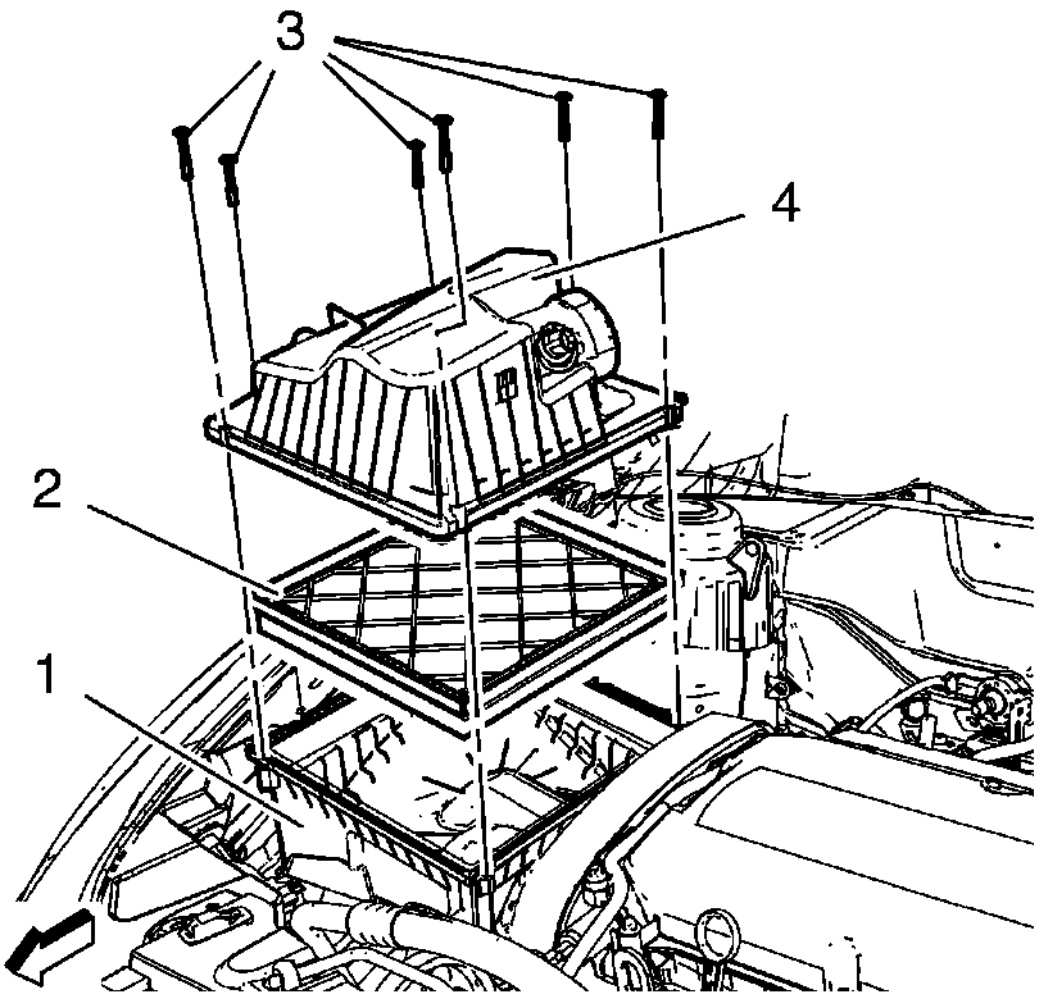


Fig. 174: Air Cleaner Element, Air Cleaner Housing, Air Cleaner Housing Cover And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the air cleaner element (2) into the air cleaner housing (1).
2. Install the air cleaner housing cover (4).

CAUTION: Refer to Fastener Caution .

3. Install the 6 air cleaner housing cover bolts (3) and tighten to 5 N.m (44 lb in).
4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

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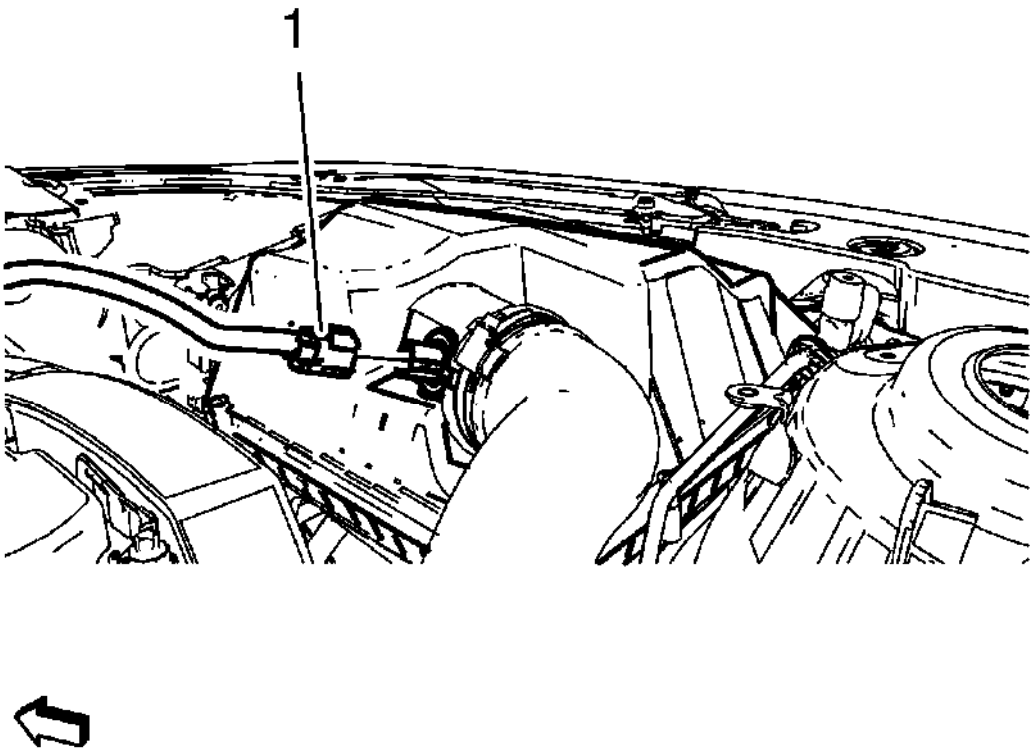


Fig. 175: Intake Air Sensor Wiring Harness Plug
Courtesy of GENERAL MOTORS COMPANY

5. Connect the intake air sensor wiring harness plug (1).
6. Close the hood.

AIR CLEANER ASSEMBLY REPLACEMENT (1.8L LUW)

Removal Procedure

1. Open the hood.

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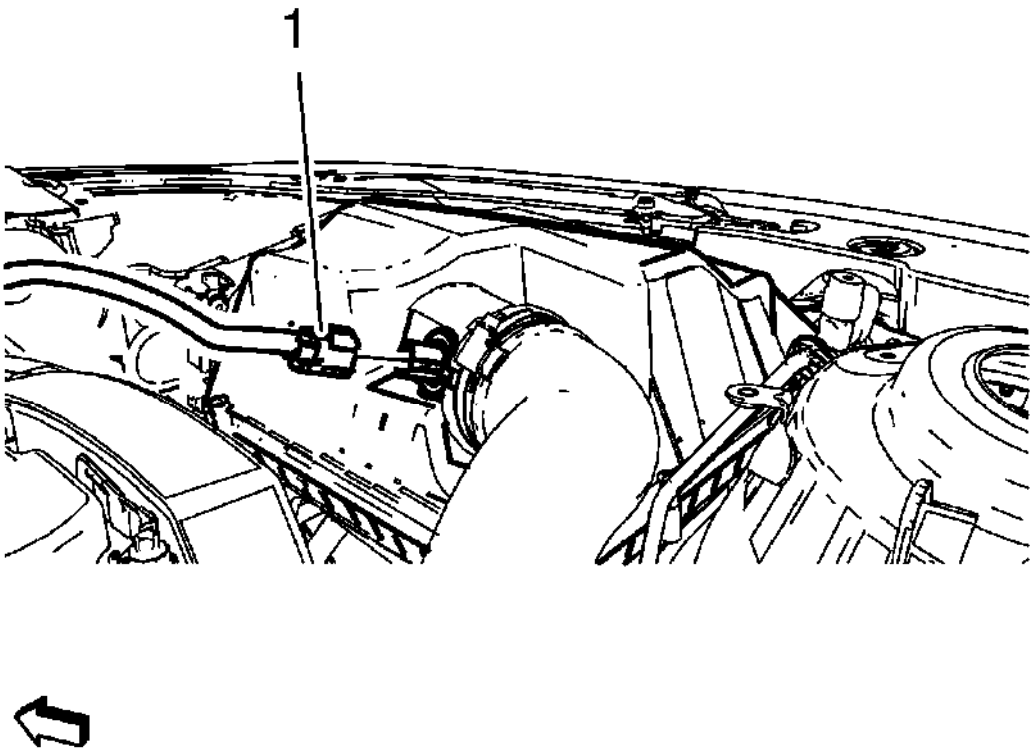


Fig. 176: Intake Air Sensor Wiring Harness Plug
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the intake air temperature sensor wiring harness plug (1).
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

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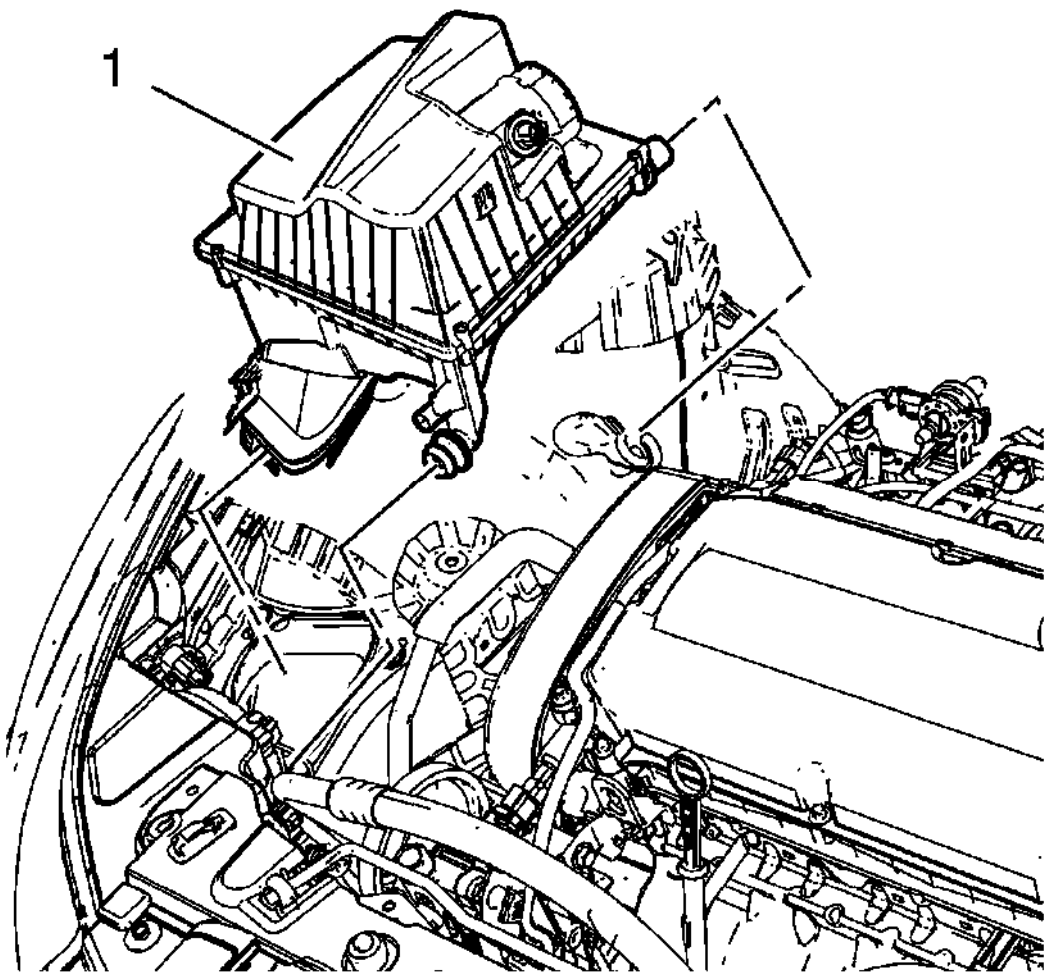


Fig. 177: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Remove the air cleaner assembly (1).
    - Unclip the air cleaner inlet duct
    - Unclip the drain hose, if equipped

Installation Procedure

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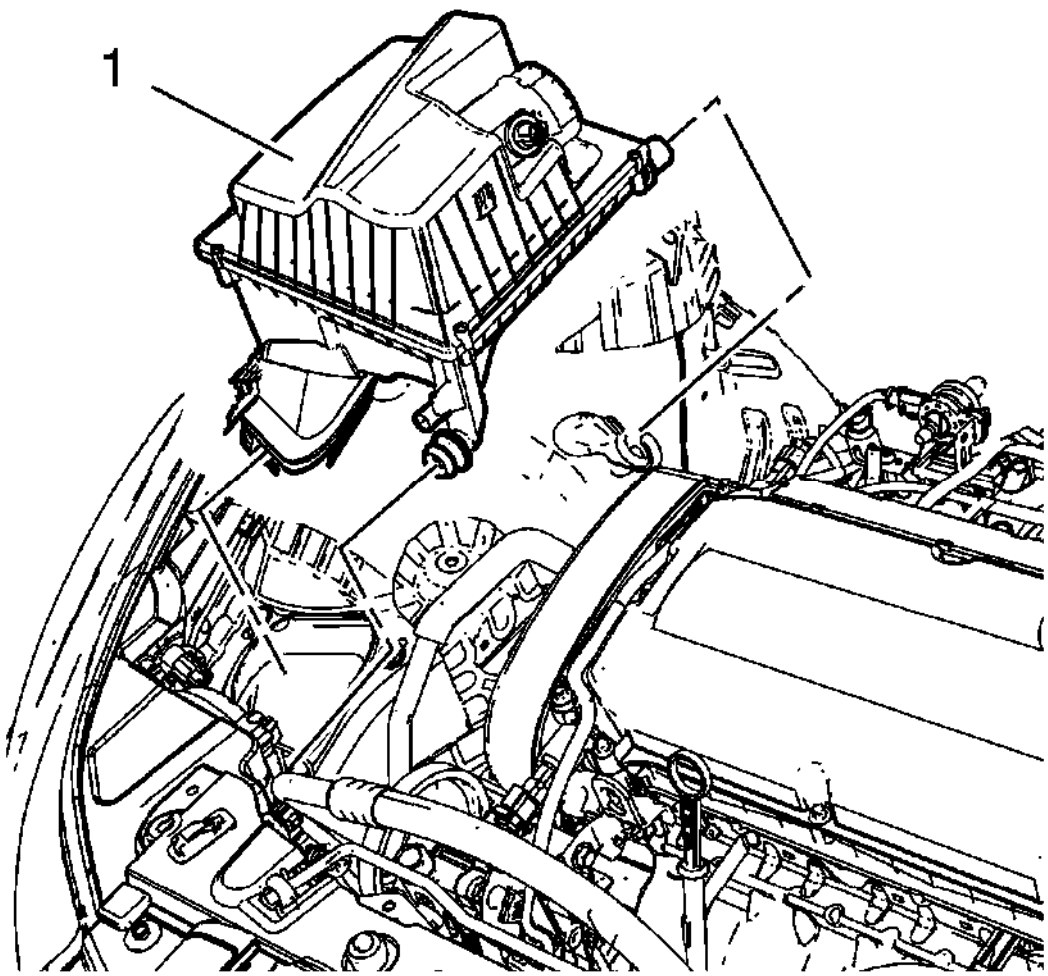


Fig. 178: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the air cleaner assembly (1).
    - Clip in the drain hose, if equipped
    - Clip in the air cleaner inlet duct
2. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

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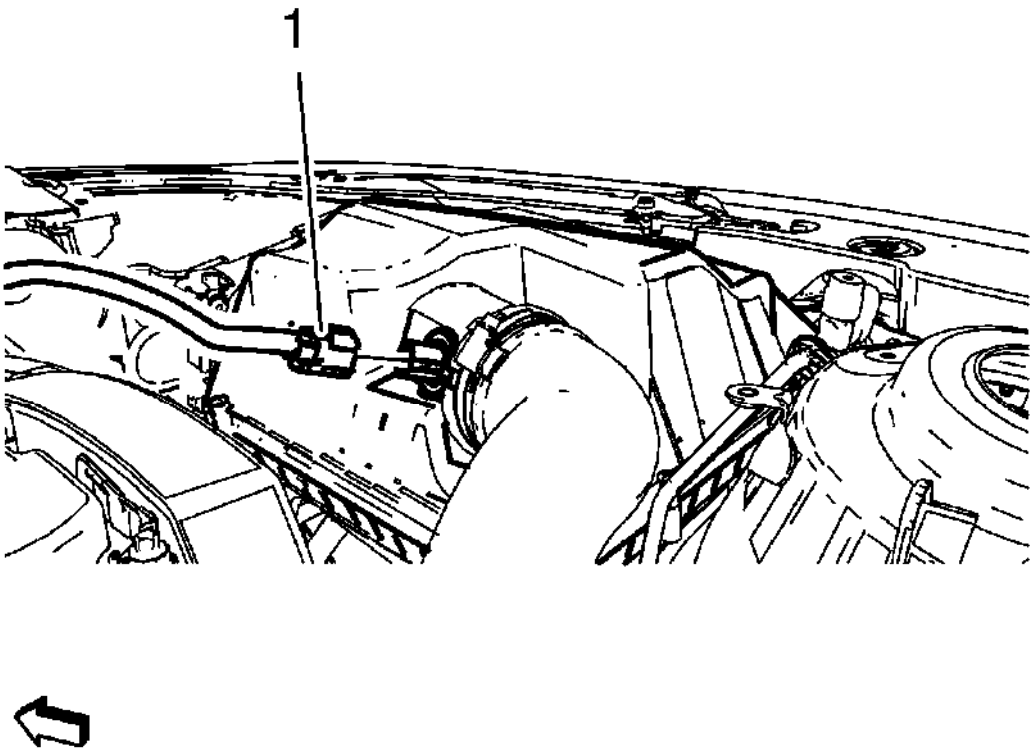


Fig. 179: Intake Air Sensor Wiring Harness Plug
Courtesy of GENERAL MOTORS COMPANY

3. Connect the intake air temperature sensor wiring harness plug (1).
4. Close the hood.

AIR CLEANER ASSEMBLY REPLACEMENT (1.8L LWE)

Removal Procedure

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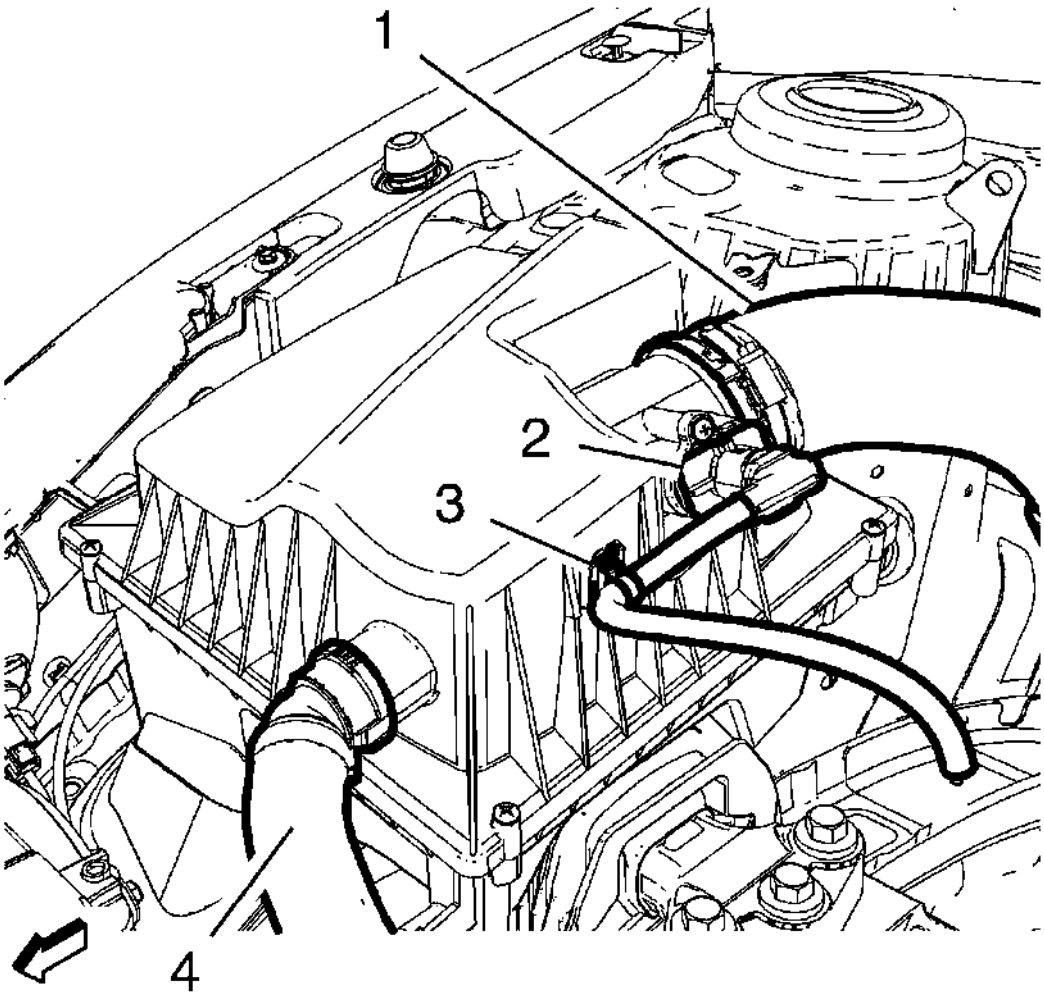


Fig. 180: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the mass airflow sensor / intake air temperature sensor wiring harness plug (2).
2. Unclip the engine control module (ECM) wiring harness (3) from the air cleaner housing.
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
4. Remove the secondary air injection pump inlet hose (4) from the air cleaner upper housing. Refer to **Secondary Air Injection Pump Inlet Hose Replacement**.

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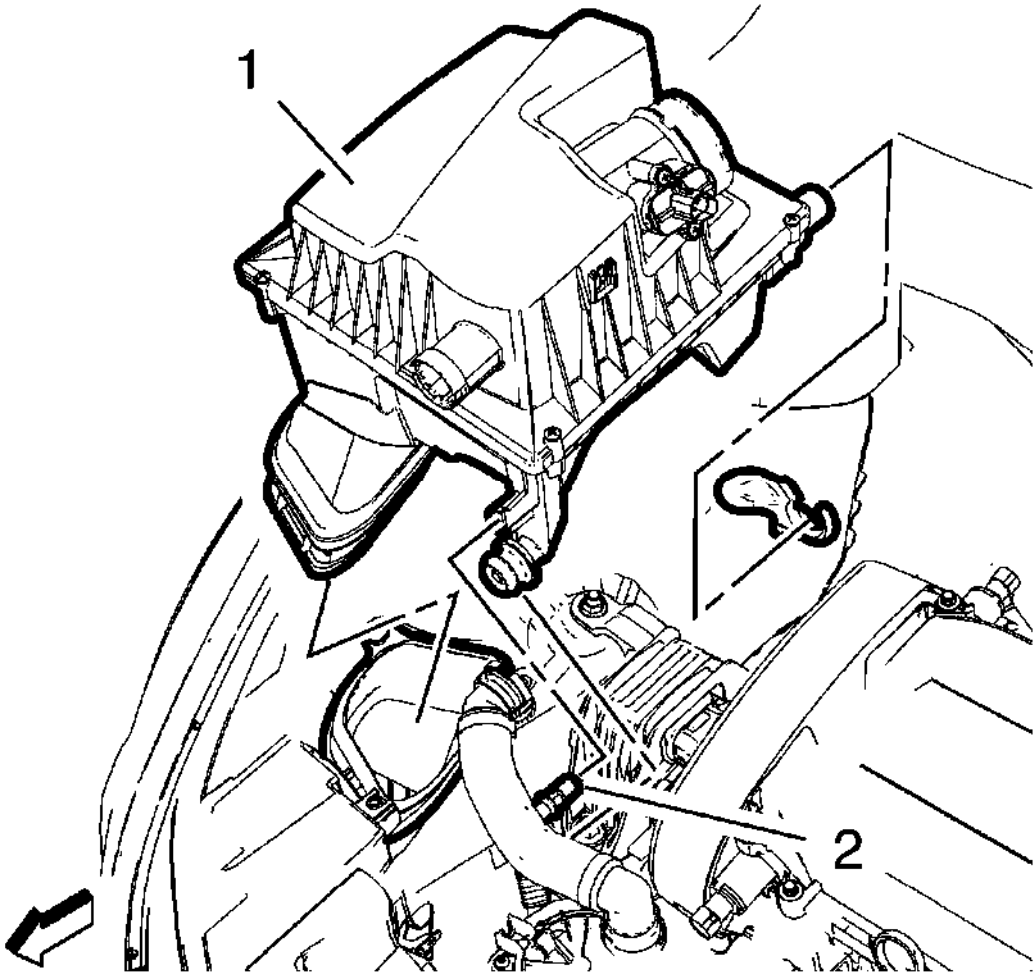


Fig. 181: Water Drain Hose
Courtesy of GENERAL MOTORS COMPANY

5. Unclip the water drain hose (2) from the air cleaner lower housing (1).
6. Remove the air cleaner assembly (1).

Installation Procedure

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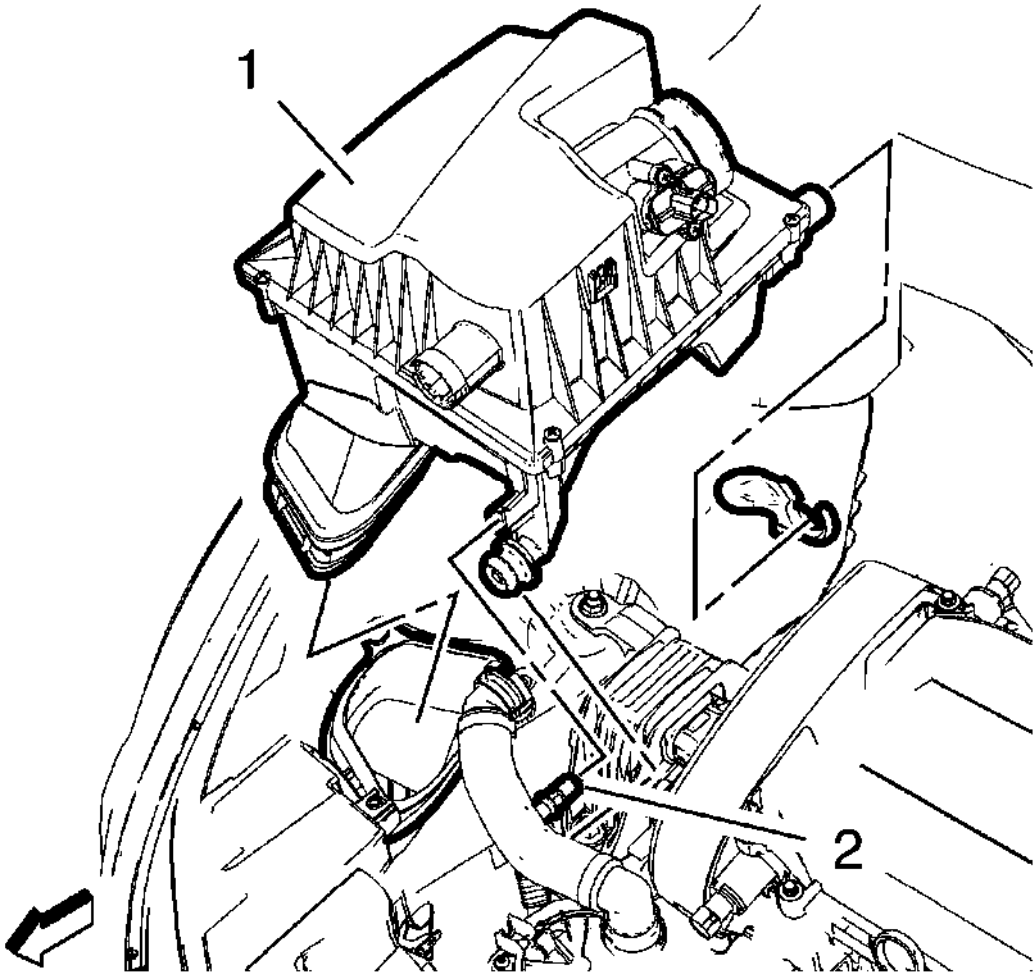


Fig. 182: Water Drain Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install the air cleaner assembly (1).
2. Clip in the water drain hose (2) to the air cleaner lower housing (1).

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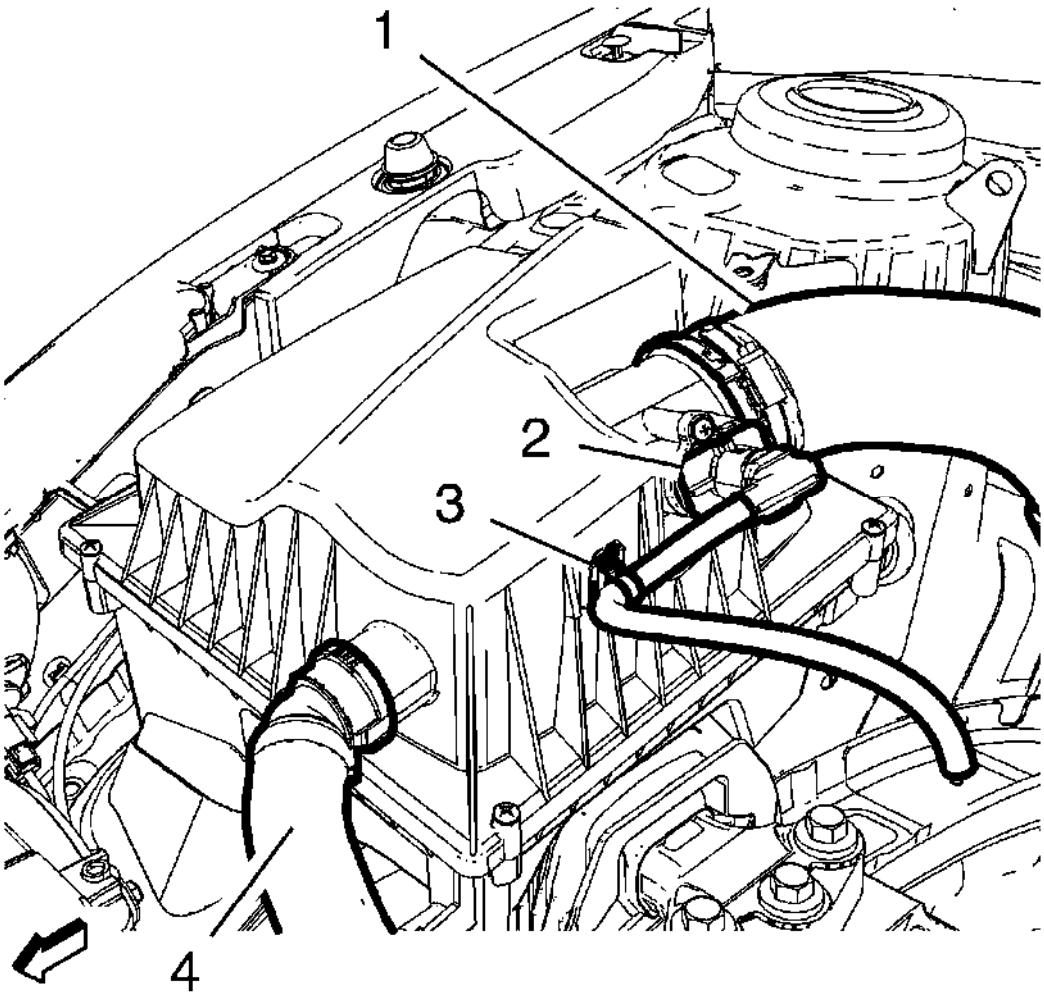


Fig. 183: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

3. Install the air cleaner outlet duct (1). Refer to **Air Cleaner Outlet Duct Replacement**.
4. Install the secondary air injection pump inlet hose (4) to the air cleaner upper housing. Refer to **Secondary Air Injection Pump Inlet Hose Replacement**.
5. Connect the mass airflow sensor / intake air temperature sensor wiring harness plug (2).
6. Clip in the ECM wiring harness (3) the air cleaner housing.

AIR CLEANER UPPER HOUSING REPLACEMENT (1.8L LUW)

Removal Procedure

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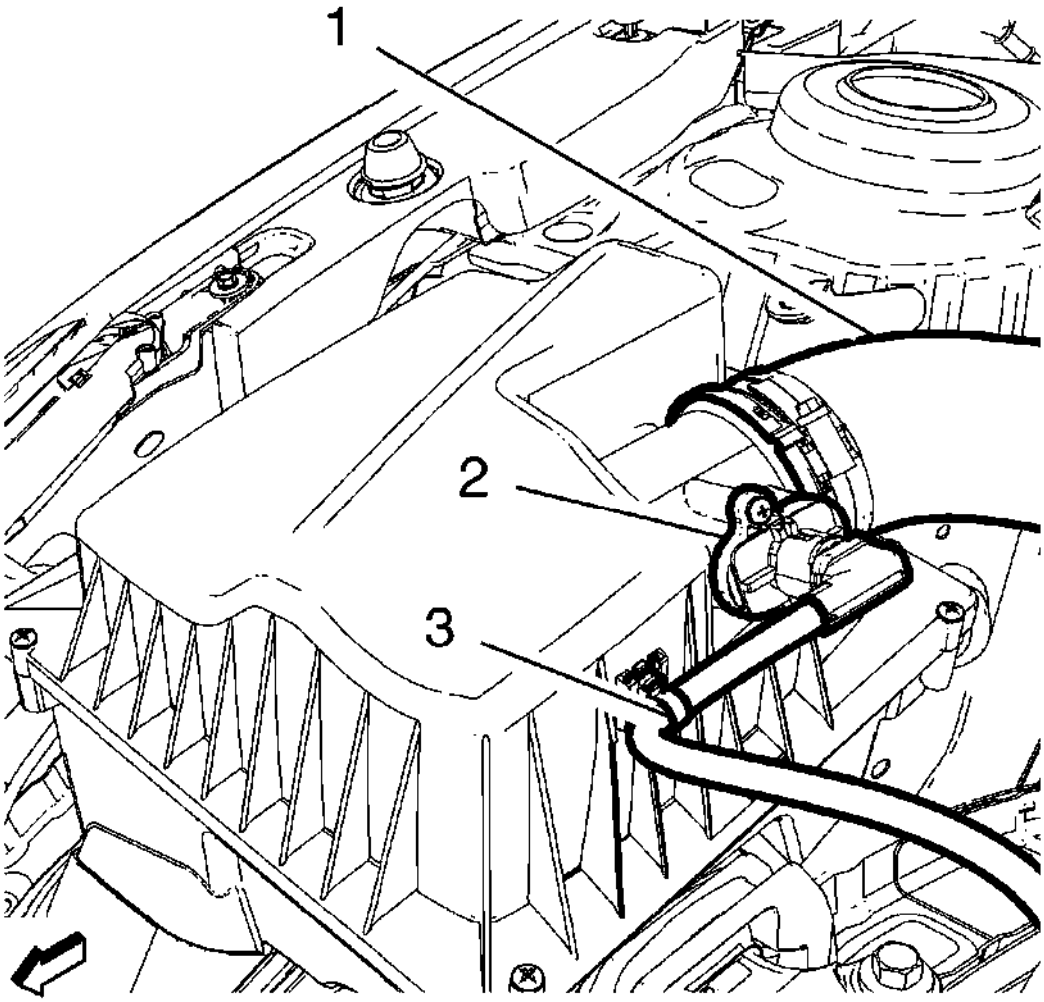


Fig. 184: ECM Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the mass airflow sensor / intake air temperature sensor wiring harness plug (2).
2. Unclip the ECM wiring harness (3) from the air cleaner housing.
3. Remove the air cleaner outlet duct (1). Refer to **Air Cleaner Outlet Duct Replacement**.

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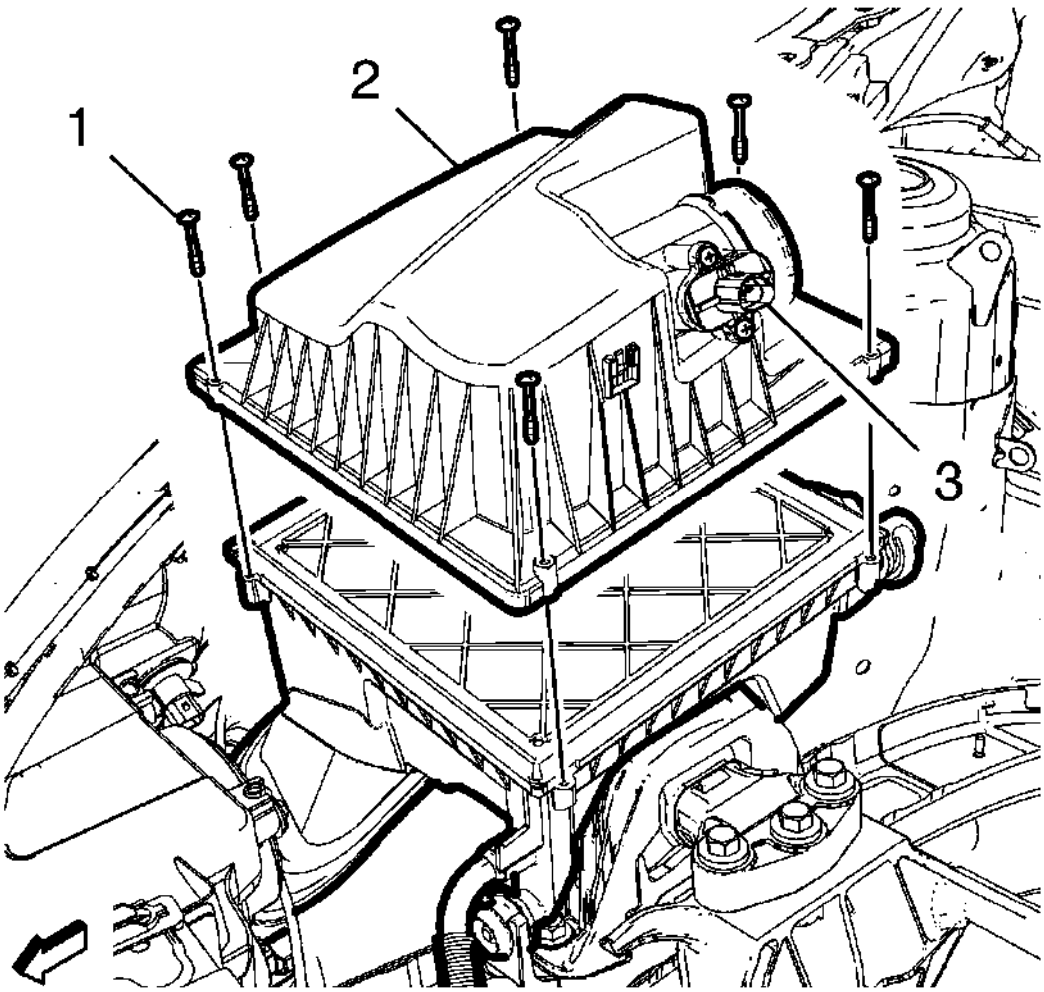


Fig. 185: Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Remove the mass airflow sensor / intake air temperature sensor (3) from the air cleaner upper housing (2).
   - For the mass airflow sensor, refer to **Mass Airflow Sensor Replacement**.
   - For the intake air temperature sensor, refer to **Intake Air Temperature Sensor Replacement**.
5. Remove the 6 air cleaner housing cover bolts (1).
6. Remove the air cleaner upper housing (2).

Installation Procedure

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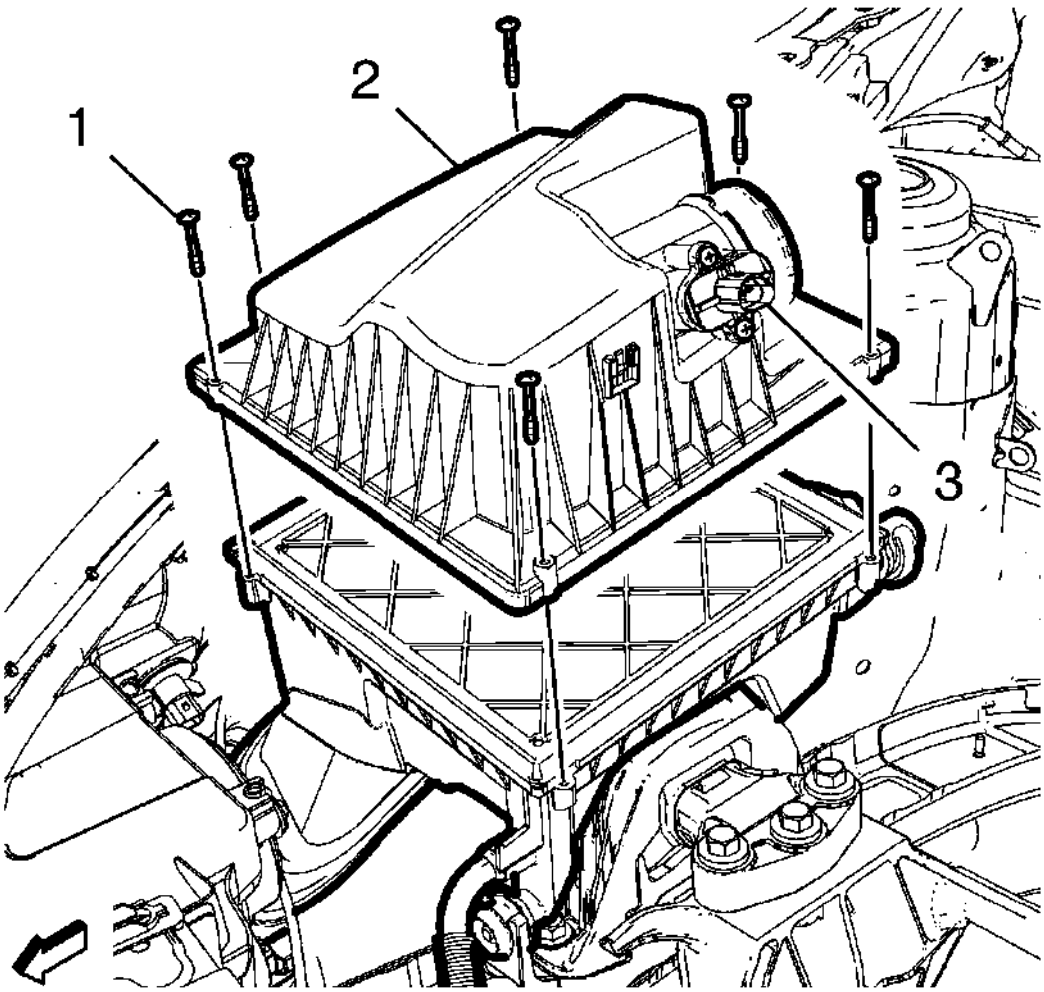


Fig. 186: Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install the air cleaner upper housing (2).

CAUTION: Refer to Fastener Caution .

2. Install the 6 air cleaner housing cover bolts (1) and tighten to 5 N.m (44 lb in).
3. Install the mass airflow sensor / intake air temperature sensor (3) to the air cleaner upper housing (2).
   - For the mass airflow sensor, refer to **Mass Airflow Sensor Replacement**.
   - For the intake air temperature sensor, refer to **Intake Air Temperature Sensor Replacement**.

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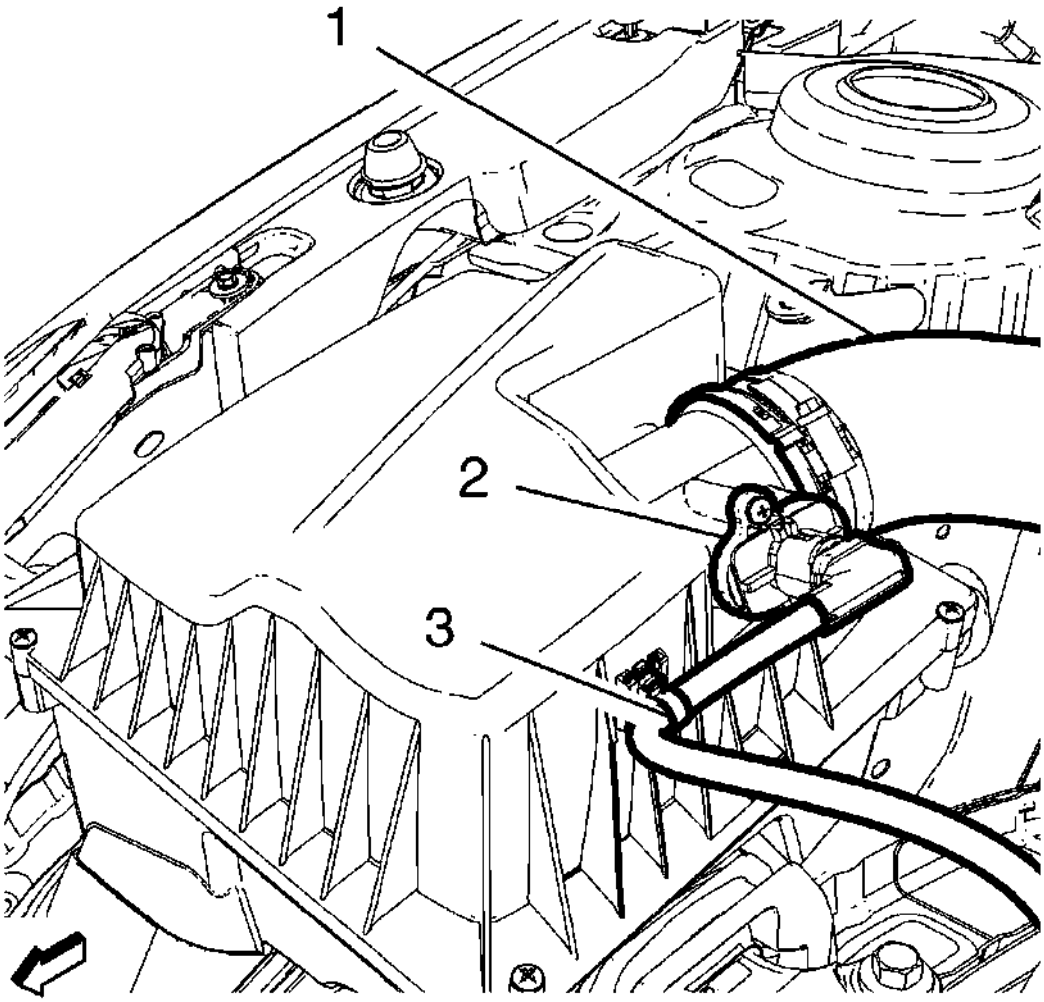


Fig. 187: ECM Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

4. Install the air cleaner outlet duct (1). Refer to **Air Cleaner Outlet Duct Replacement**.
5. Connect the mass airflow sensor / intake air temperature sensor wiring harness plug (2).
6. Clip in the ECM wiring harness (3) the air cleaner housing.

AIR CLEANER UPPER HOUSING REPLACEMENT (1.8L LWE)

Removal Procedure

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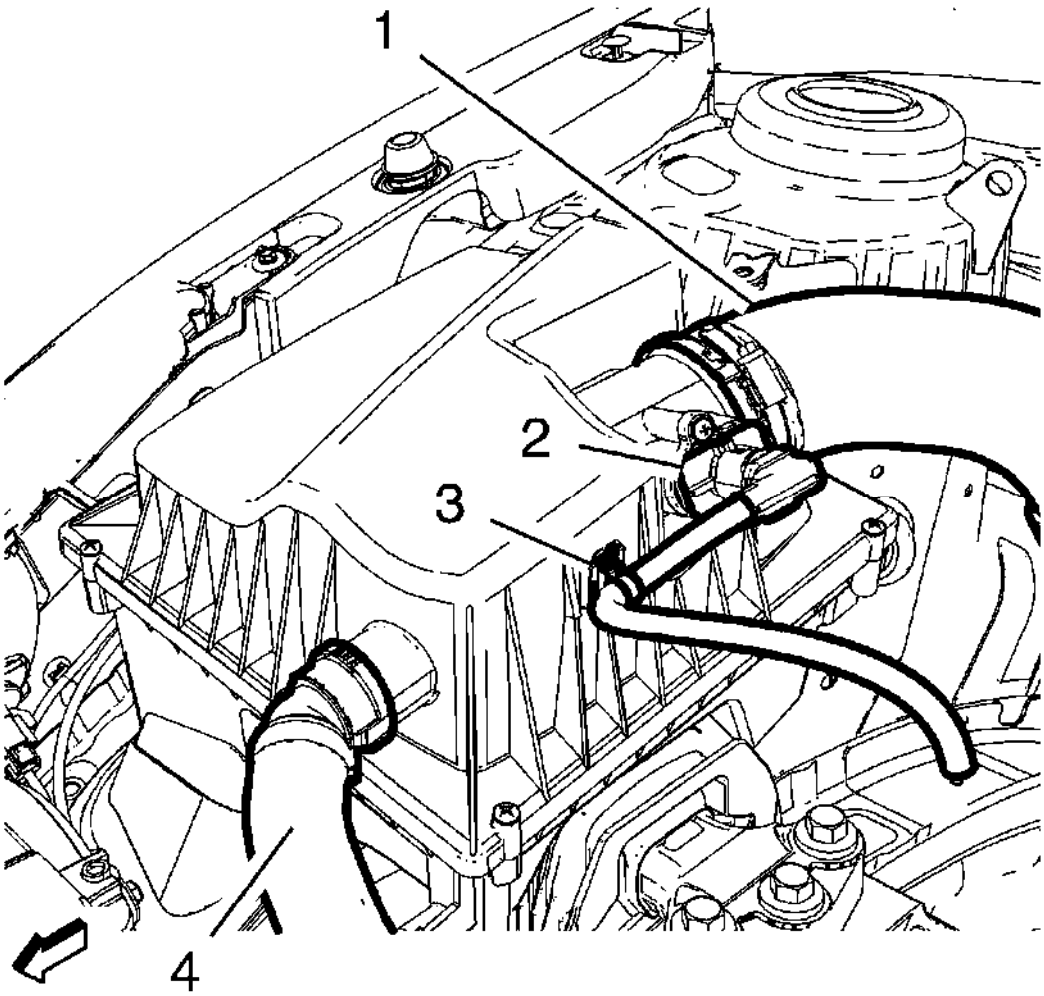


Fig. 188: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the mass airflow sensor / intake air temperature sensor wiring harness plug (2).
2. Unclip the engine control module (ECM) wiring harness (3) from the air cleaner housing.
3. Remove the air cleaner outlet duct (1). Refer to **Air Cleaner Outlet Duct Replacement**.
4. Remove the secondary air injection pump inlet hose (4) from the air cleaner upper housing.

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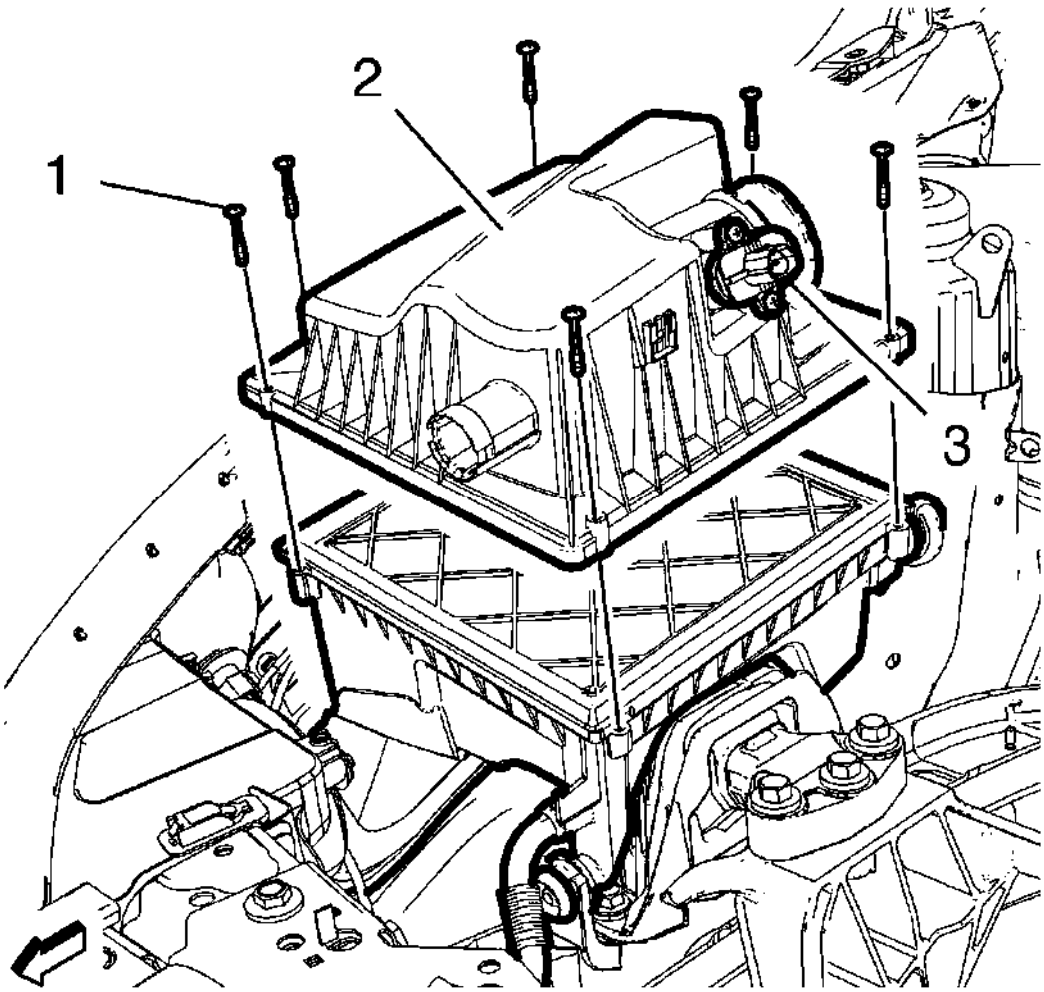


Fig. 189: Mass Airflow Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Remove the mass airflow sensor (3) from the air cleaner upper housing (2). Refer to **Mass Airflow Sensor Replacement**.
6. Remove the 6 air cleaner housing cover bolts (1).
7. Remove the air cleaner upper housing (2).

Installation Procedure

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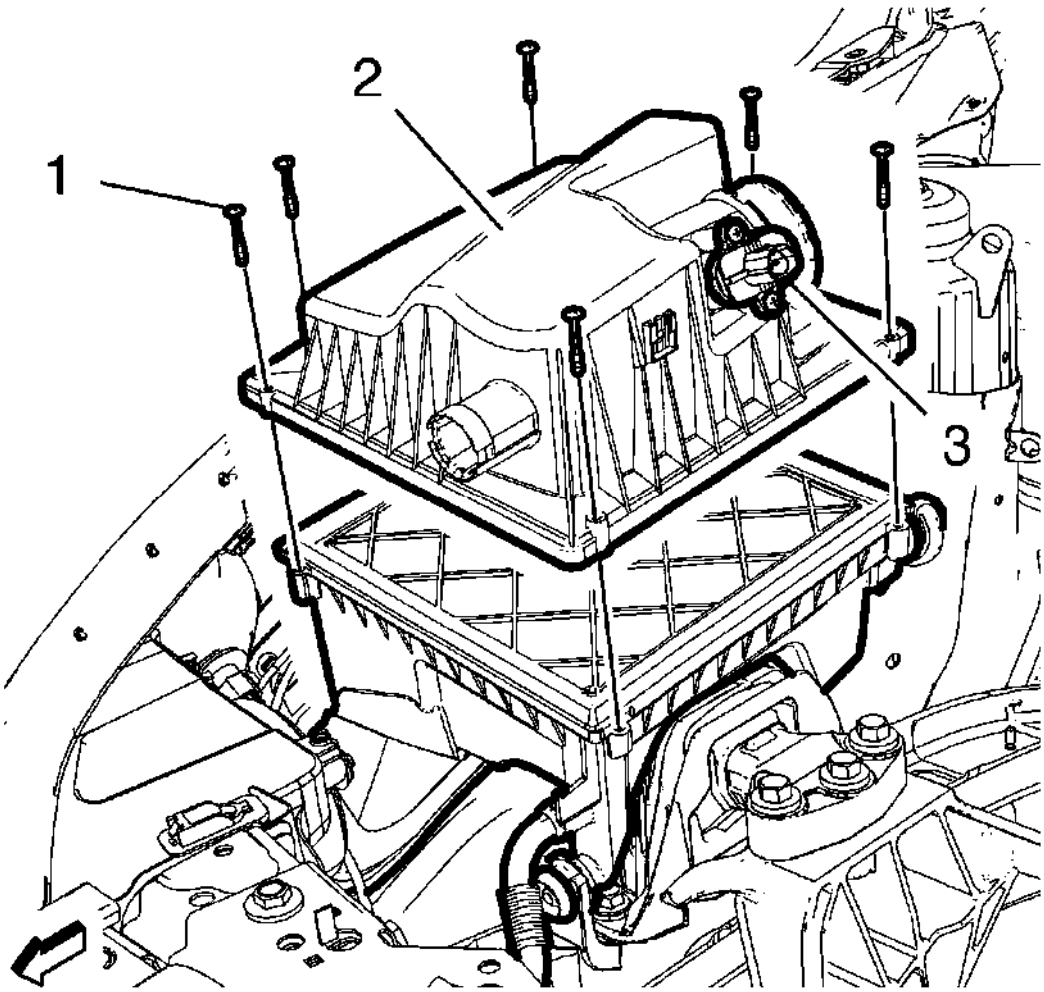


Fig. 190: Mass Airflow Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install the air cleaner upper housing (2).

CAUTION: Refer to Fastener Caution .

2. Install the 6 air cleaner housing cover bolts (1) and tighten to 5 N.m (44 lb in).
3. Install the mass airflow sensor (3) to the air cleaner upper housing (2). Refer to **Mass Airflow Sensor Replacement**.

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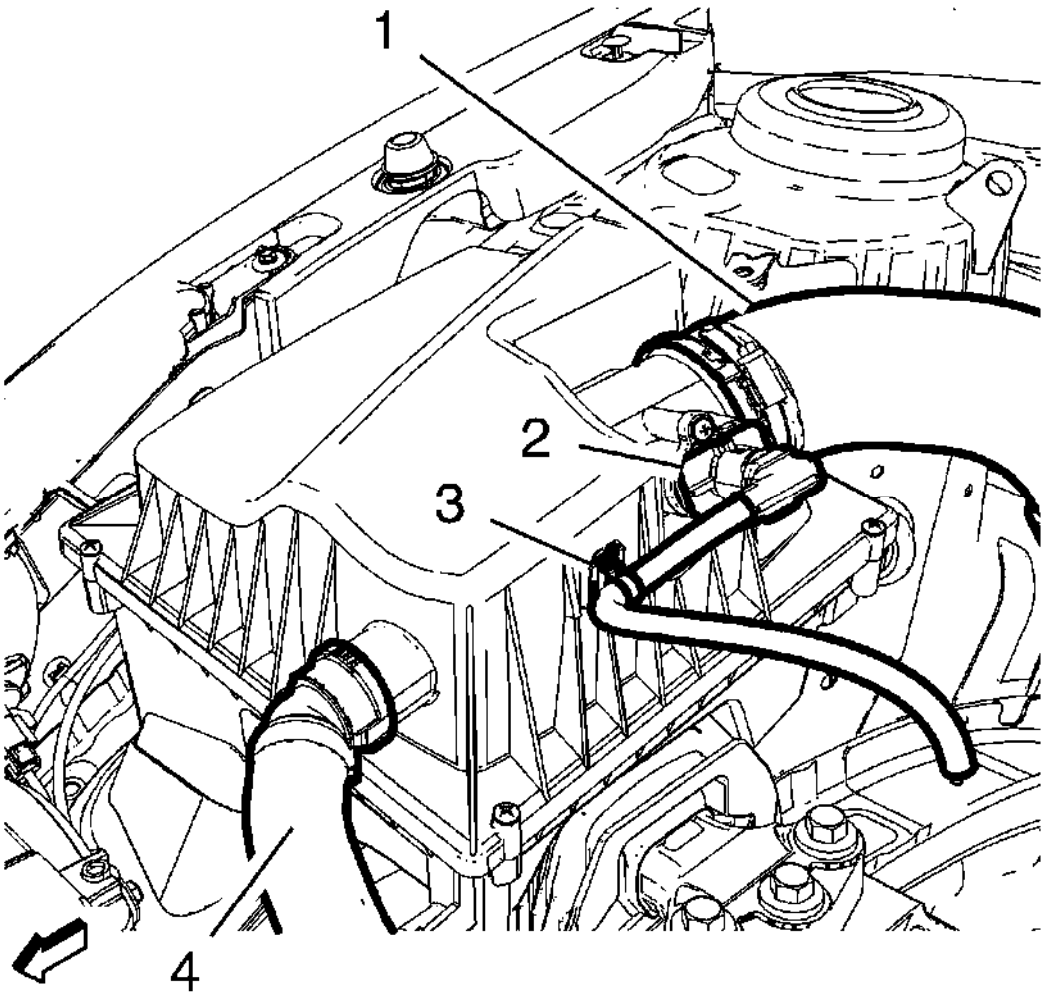


Fig. 191: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

4. Install the air cleaner outlet duct (1). Refer to **Air Cleaner Outlet Duct Replacement**.
5. Install the secondary air injection pump inlet hose (4) to the air cleaner upper housing.
6. Connect the mass airflow sensor / intake air temperature sensor wiring harness plug (2).
7. Clip in the ECM wiring harness (3) the air cleaner housing.

AIR CLEANER LOWER HOUSING REPLACEMENT

Removal Procedure

1. Remove the air cleaner upper housing. Refer to **Air Cleaner Upper Housing Replacement (1.8L LUW)**, **Air Cleaner Upper Housing Replacement (1.8L LWE)**.
2. Remove the air cleaner element. Refer to **Air Cleaner Element Replacement**.

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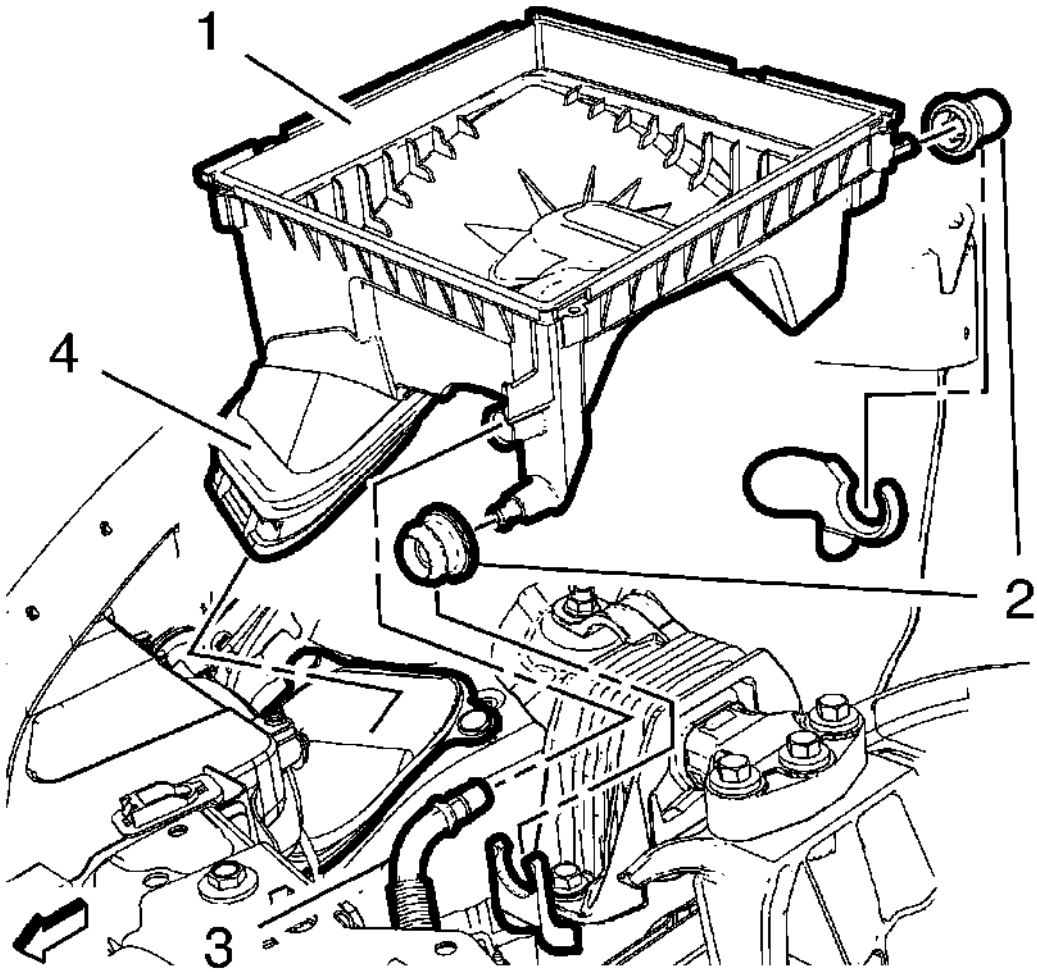


Fig. 192: Air Cleaner Insulator And Air Cleaner Lower Housing
Courtesy of GENERAL MOTORS COMPANY

3. Unclip the water drain hose (3) from the air cleaner lower housing (1) if equipped.
4. Remove the air cleaner lower housing (1) from the air cleaner brackets.
5. Remove the air cleaner bracket insulators (2) from the air cleaner lower housing (1).
6. Remove the air cleaner insulator (4) from the air cleaner lower housing (1).

Installation Procedure

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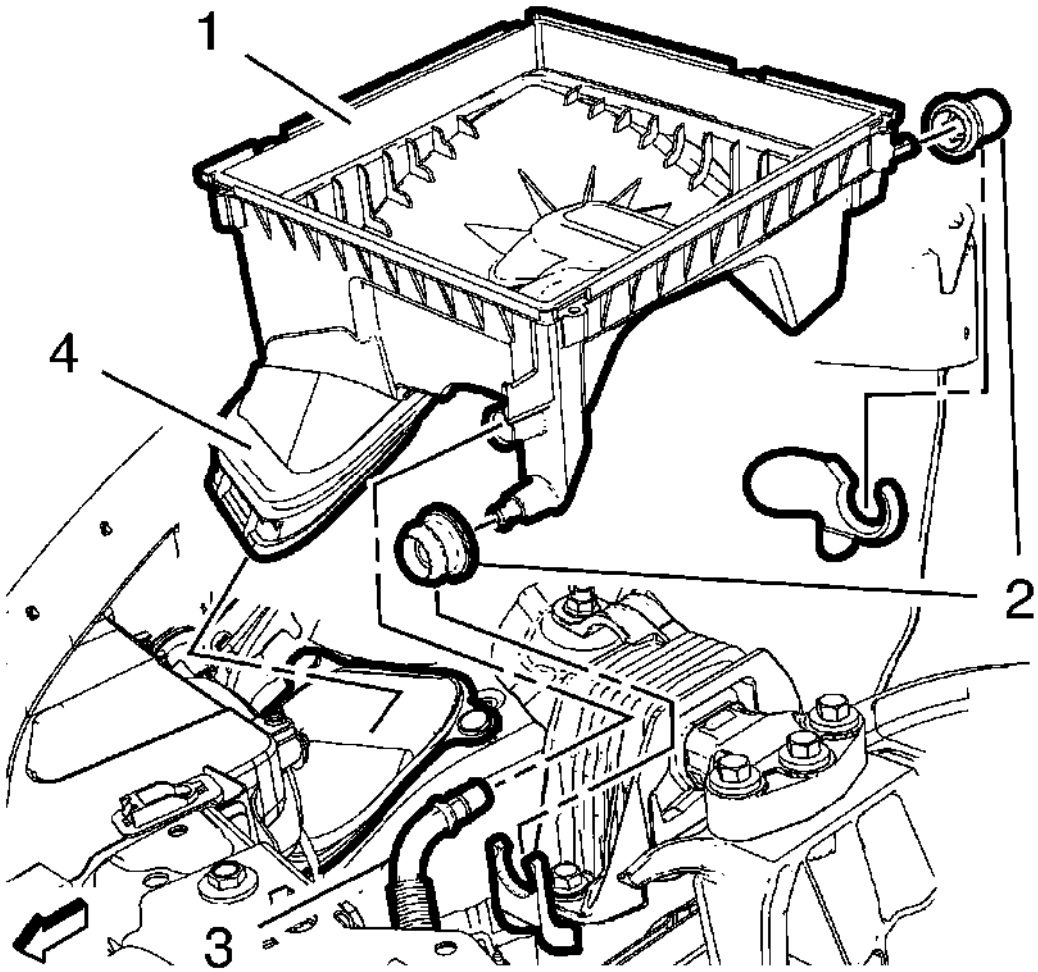


Fig. 193: Air Cleaner Insulator And Air Cleaner Lower Housing
Courtesy of GENERAL MOTORS COMPANY

1. Install the air cleaner insulator (4) to the air cleaner lower housing (1).
2. Install the air cleaner bracket insulators (2) to the air cleaner lower housing (1).
3. Install the air cleaner lower housing (1) to the air cleaner brackets.
4. Install the water drain hose (3) to the air cleaner lower housing (1) if equipped.
5. Install the air cleaner element. Refer to **Air Cleaner Element Replacement**.
6. Install the air cleaner upper housing. Refer to **Air Cleaner Upper Housing Replacement (1.8L LUW)**, **Air Cleaner Upper Housing Replacement (1.8L LWE)**.

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2013 ENGINE PERFORMANCE

Engine Controls and Fuel - 1.8L LUW and LWE - Schematic and Routing Diagrams - Engine Controls Schematics - Cruze

WIRING SCHEMATIC DIAGRAMS

ENGINE CONTROLS WIRING SCHEMATICS

Power, Ground, Serial Data, and MIL Wiring Schematics

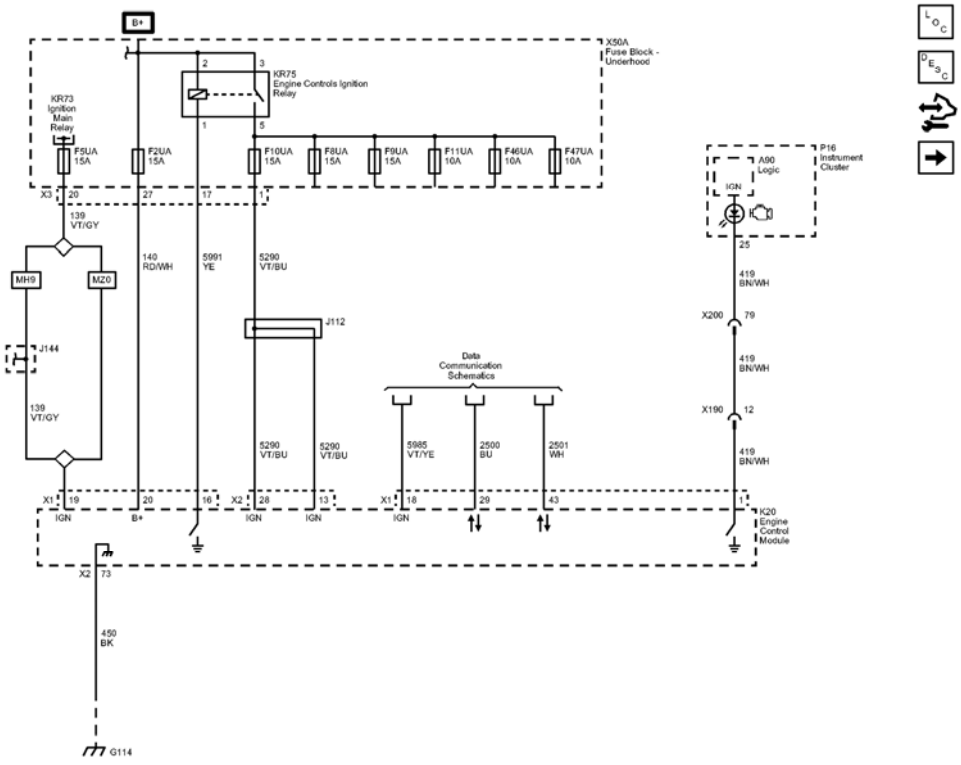


Fig. 1: Power, Ground, Serial Data, and MIL Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
139	Run/Crank Ignition 1 Voltage
139_VT/GY	139 VT/GY
CAV_19	19
CONN_X1	X1
CAV_20	20
CONN_X3	X3
139_VT/GY	139 VT/GY

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MH9	TRANSMISSION-AUTO 6 SPD, HMD, X24F
MZ0	TRANSMISSION-MAN 6 SPD, OPEL, 76.5 MM, 3.82 1ST, 0.74 6TH, (M32 WR)
140	Battery Positive Voltage
140_RD/WH	140 RD/WH
CAV_20	20
CAV_27	27
5991	Powertrain Relay Coil Control
5991_YE	5991 YE
CAV_16	16
CAV_17	17
5290	Powertrain Main Relay Fused Supply (1)
5290_VT/BU	5290 VT/BU
CAV_28	28
CONN_X2	X2
CAV_1	1
5290_VT/BU	5290 VT/BU
CAV_13	13
5290_VT/BU	5290 VT/BU
5985	Accessory Wakeup Serial Data
5985_VT/YE	5985 VT/YE
CAV_18	18
CONN X1	X1
2500	High Speed GMLAN Serial Data (+) (1)
2500_BU	2500 BU
CAV_29	29
2501	High Speed GMLAN Serial Data (-) (1)
2501_WH	2501 WH
CAV_43	43
419	Check Engine Indicator Control
419_BN/WH	419 BN/WH
CAV_1	1
CAV_25	25
419_BN/WH	419 BN/WH
419_BN/WH	419 BN/WH
CAV_79	79
CAV_12	12

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450	Ground
450_BK	450 BK
CAV_73	73
CONN_X2	X2
CAV_1	1
CAV_2	2
CAV_3	3
CAV_5	5
G114	G114
F5UA	F5UA 15A
F2UA	F2UA 15A
F10UA	F10UA 15A
F8UA	F8UA 15A
F9UA	F9UA 15A
F11UA	F11UA 10A
F46UA	F46UA 10A
F47UA	F47UA 10A
J112	J112
X200	X200
X190	X190
KR73	
X50A	
K20	
A90	Logic
P16	
Data_Communication_Schematics_REF	Data Communication Schematics
KR75	

5V and Low Reference Bus (1 of 2) Wiring Schematics

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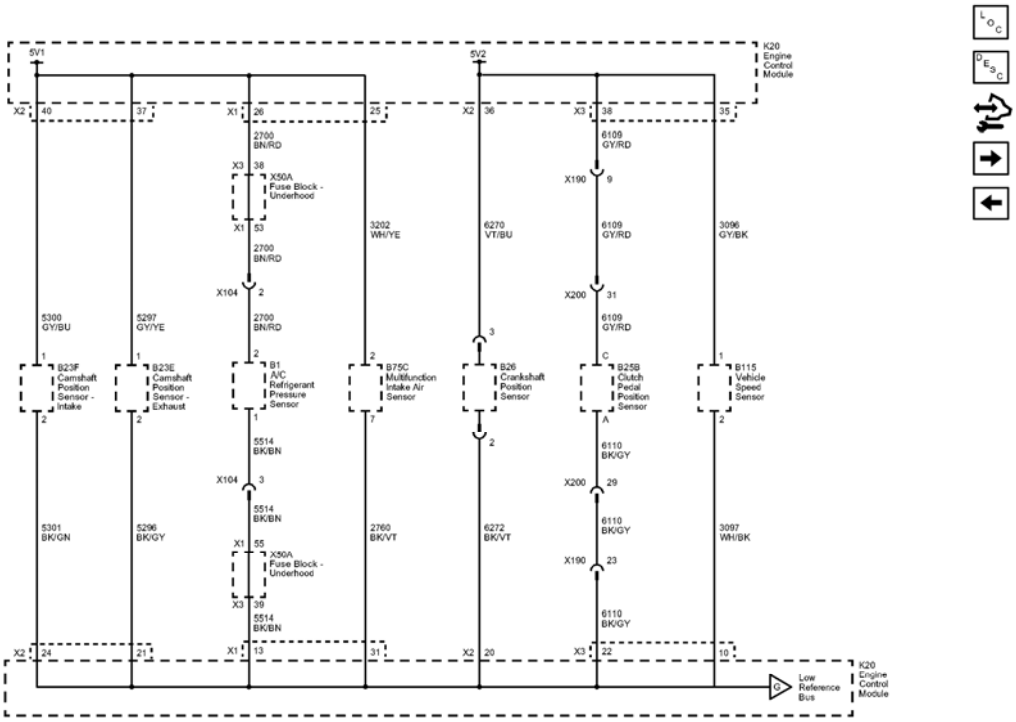


Fig. 2: 5V and Low Reference Bus (1 of 2) Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
5300	Camshaft Position Intake Sensor Supply Voltage (1)
5300_GY/BU	5300 GY/BU
CAV_1	1
CAV_40	40
CONN_X2	X2
5297	Camshaft Position Exhaust Sensor Supply Voltage (1)
5297_GY/YE	5297 GY/YE
CAV_1	1
CAV_37	37
2700	A/C Pressure Sensor 5 Volt Reference
2700_BN/RD	2700 BN/RD
CAV_38	38
CONN_X3	X3
CAV_26	26
CONN_X1	X1
3202	Throttle Inlet Absolute Pressure Sensor 5V Return
3202_WH/YE	3202 WH/YE

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CAV_2	2
CAV_25	25
2700_BN/RD	2700 BN/RD
CAV_2	2
CAV_53	53
CONN_X1	X1
6270	Crankshaft 60X Sensor Voltage
6270_VT/BU	6270 VT/BU
CAV_36	36
CONN_X2	X2
6109	Clutch Apply Sensor Voltage Reference
6109_GY/RD	6109 GY/RD
CAV_C	C
CAV_38	38
CONN_X3	X3
3096	Output Speed (Digital) 5V Sensor Reference
3096_GY/BK	3096 GY/BK
CAV_1	1
CAV_35	35
5301	Camshaft Position Intake Sensor Low Reference (1)
5301_BK/GN	5301 BK/GN
CAV_24	24
CONN_X2	X2
CAV_2	2
5296	Camshaft Position Exhaust Sensor Low Reference (1)
5296_BK/GY	5296 BK/GY
CAV_21	21
CAV_2	2
5514	A/C Refrigerant Pressure Sensor Low Reference
5514_BK/BN	5514 BK/BN
CAV_55	55
CONN_X1	X1
CAV_1	1
5514_BK/BN	5514 BK/BN
CAV_13	13
CONN_X1	X1
CAV_39	39
CONN_X3	X3
2760	Intake Air Temperature Sensor Low Reference
2760_BK/VT	2760 BK/VT
CAV_31	31

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	7
6272	Crankshaft 60X Sensor Low Reference
6272_BK/VT	6272 BK/VT
CAV_20	20
CONN_X2	X2
6110	Clutch Apply Sensor Low Reference
6110_BK/GY	6110 BK/GY
CAV_22	22
CONN_X3	X3
CAV_A	A
3097	Output Speed (Digital) 5V Sensor Return
3097_WH/BK	3097 WH/BK
CAV_10	10
CAV_2	2
5514_BK/BN	5514 BK/BN
6110_BK/GY	6110 BK/GY
6110_BK/GY	6110 BK/GY
CAV_3	3
CAV_2	2
CAV_29	29
CAV_23	23
CAV_3	3
CAV_31	31
CAV_9	9
6109_GY/RD	6109 GY/RD
6109_GY/RD	6109 GY/RD
CAV_2	2
2700_BN/RD	2700 BN/RD
X104	X104
X200	X200
X190	X190
X200	X200
X190	X190
X104	X104
B23F	
B23E	
B26	
B75C	
B1	
X50A	
X50A	

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	(MF3 or MZ0)
B115	(MF3 or MZ0)
K20	
K20	

5V and Low Reference Bus (2 of 2) Wiring Schematics

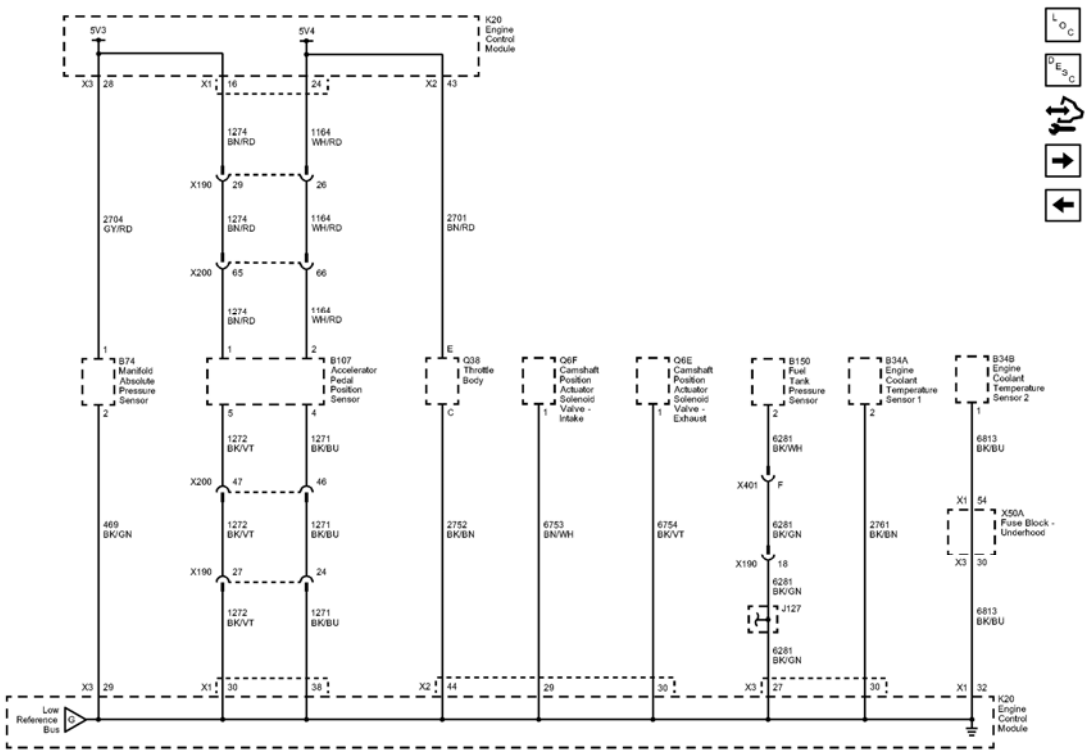


Fig. 3: 5V and Low Reference Bus (2 of 2) Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2704	Manifold Absolute Pressure Sensor 5 Volt Reference
2704 GY/RD	2704 GY/RD
CAV_1	1
CAV 28	28
CONN_X3	X3
1274	Accelerator Pedal Position 5 Volt Reference (2)
1274_BN/RD	1274 BN/RD
CAV_1	1
CAV_16	16
CONN_X1	X1

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1164	Accelerator Pedal Position 5 Volt Reference (1)
1164_WH/RD	1164 WH/RD
CAV_2	2
CAV_24	24
2701	Throttle Position Sensor 5 Volt Reference
2701_BN/RD	2701 BN/RD
CAV_E	E
CAV_43	43
CONN_X2	X2
469	Manifold Absolute Pressure Sensor Low Reference
469_BK/GN	469 BK/GN
CAV_29	29
CONN_X3	X3
CAV_2	2
1272	Accelerator Pedal Position Low Reference (2)
1272_BK/VT	1272 BK/VT
CAV_30	30
CONN_X1	X1
CAV_5	5
1271	Accelerator Pedal Position Low Reference (1)
1271_BK/BU	1271 BK/BU
CAV_38	38
CAV_4	4
2752	Throttle Position Sensor Low Reference
2752_BK/BN	2752 BK/BN
CAV_44	44
CONN_X2	X2
CAV_C	C
6753	Cam Phaser W Return Low Reference
6753_BN/WH	6753 BN/WH
CAV_29	29
CAV_1	1
6754	Cam Phaser X Return Low Reference
6754_BK/VT	6754 BK/VT
CAV_30	30
CAV_1	1
6281	Fuel Level Sensor Low Reference
6281_BK/WH	6281 BK/WH
CAV_2	2
6281_BK/GN	6281 BK/GN
CAV_27	27
CONN_X3	

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	X3
2761	Coolant Temperature Sensor Low Reference
2761_BK/BN	2761 BK/BN
CAV_30	30
CAV_2	2
6813	Coolant Temperature Sensor #2 Low Reference
6813_BK/BU	6813 BK/BU
CAV_54	54
CONN_X1	X1
CAV_1	1
6813_BK/BU	6813 BK/BU
CAV_32	32
CONN_X1	X1
CAV_30	30
CONN_X3	X3
1274_BN/RD	1274 BN/RD
1274_BN/RD	1274 BN/RD
1164_WH/RD	1164 WH/RD
1164_WH/RD	1164 WH/RD
1272_BK/VT	1272 BK/VT
1271_BK/BU	1271 BK/BU
1272_BK/VT	1272 BK/VT
1271_BK/BU	1271 BK/BU
6281_BK/GN	6281 BK/GN
6281_BK/GN	6281 BK/GN
CAV_F	F
CAV_18	18
X190	X190
CAV_27	27
CAV_24	24
X200	X200
CAV_47	47
CAV_46	46
X200	X200
CAV_65	65
CAV_66	66
X190	X190
CAV_29	29
CAV_26	26
X401	X401
X190	X190

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	X190
X200	X200
X200	X200
X190	X190
K20	
Q38	
B74	
B107	
B34A	
B34B	
Q6F	
Q6E	
X50A	
K20	
B150	

Engine Data Sensors - Pressure and Temperature Wiring Schematics

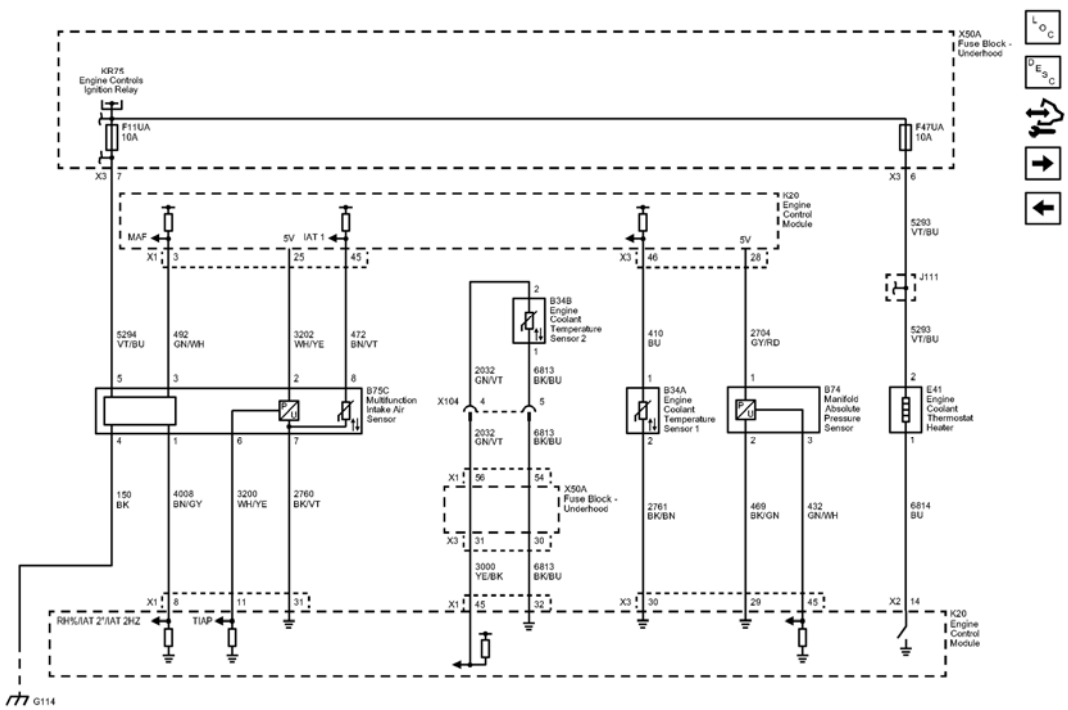


Fig. 4: Engine Data Sensors - Pressure and Temperature Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

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Callout	Component Name
5294	Powertrain Main Relay Fused Supply (5)
5294_VT/BU	5294 VT/BU
CAV_5	5
CAV_7	7
CONN_X3	X3
492	Mass Air Flow Sensor Signal
492_GN/WH	492 GN/WH
CAV_3	3
CAV_3	3
CONN_X1	X1
3202	Throttle Inlet Absolute Pressure Sensor 5V Return
3202 WH/YE	3202 WH/YE
CAV_2	2
CAV_25	25
472	Intake Air Temperature Sensor Signal
472_BN/VT	472 BN/VT
CAV_8	8
CAV_45	45
2032	Coolant Temperature Sensor Signal
2032_GN/VT	2032 GN/VT
CAV_56	56
CONN_X1	X1
CAV_2	2
6813	Coolant Temperature Sensor #2 Low Reference
6813_BK/BU	6813 BK/BU
CAV_54	54
CAV 1	1
410	Engine Coolant Temperature Sensor Signal
410 BU	410 BU
CAV_1	1
CAV_46	46
CONN_X3	X3
2704	Manifold Absolute Pressure Sensor 5 Volt Reference
2704_GY/RD	2704 GY/RD
CAV_1	1
CAV_28	28
5293	Powertrain Main Relay Fused Supply (4)
5293_VT/BU	5293 VT/BU
CAV_2	2
CAV_6	6
CONN_X3	

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	X3
6814	Thermostat Engine Cool Control
6814_BU	6814 BU
CAV_14	14
CONN_X2	X2
CAV_1	1
432	Manifold Absolute Pressure Sensor Signal
432_GN/WH	432 GN/WH
CAV_45	45
CAV_3	3
469	Manifold Absolute Pressure Sensor Low Reference
469_BK/GN	469 BK/GN
CAV_29	29
CAV_2	2
2761	Coolant Temperature Sensor Low Reference
2761_BK/BN	2761 BK/BN
CAV_30	30
CONN_X3	X3
CAV_2	2
6813_BK/BU	6813 BK/BU
CAV_32	32
CAV_30	30
3000	Coolant Temperature Sensor #2 Signal
3000_YE/BK	3000 YE/BK
CAV_45	45
CONN_X1	X1
CAV_31	31
CONN_X3	X3
2760	Intake Air Temperature Sensor Low Reference
2760_BK/VT	2760 BK/VT
CAV_31	31
CAV_7	7
3200	Throttle Inlet Absolute Pressure Sensor Signal
3200_WH/YE	3200 WH/YE
CAV_11	11
CAV_6	6
4008	Humidity Sensor Signal
4008_BN/GY	4008 BN/GY
CAV_8	8
CONN_X1	X1
CAV_1	1
150	

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	Ground
150_BK	150 BK
CAV_4	4
2032_GN/VT	2032 GN/VT
6813_BK/BU	6813 BK/BU
5293_VT/BU	5293 VT/BU
X104	X104
CAV_5	5
CAV_4	4
G114	G114
F11UA	F11UA 10A
F47UA	F47UA 10A
X104	X104
B74	
K20	
B34A	
B75C	
X50A	
X50A	
B34B	
E41	
K20	
KR75	

Engine Data Sensors - Throttle Controls Wiring Schematics

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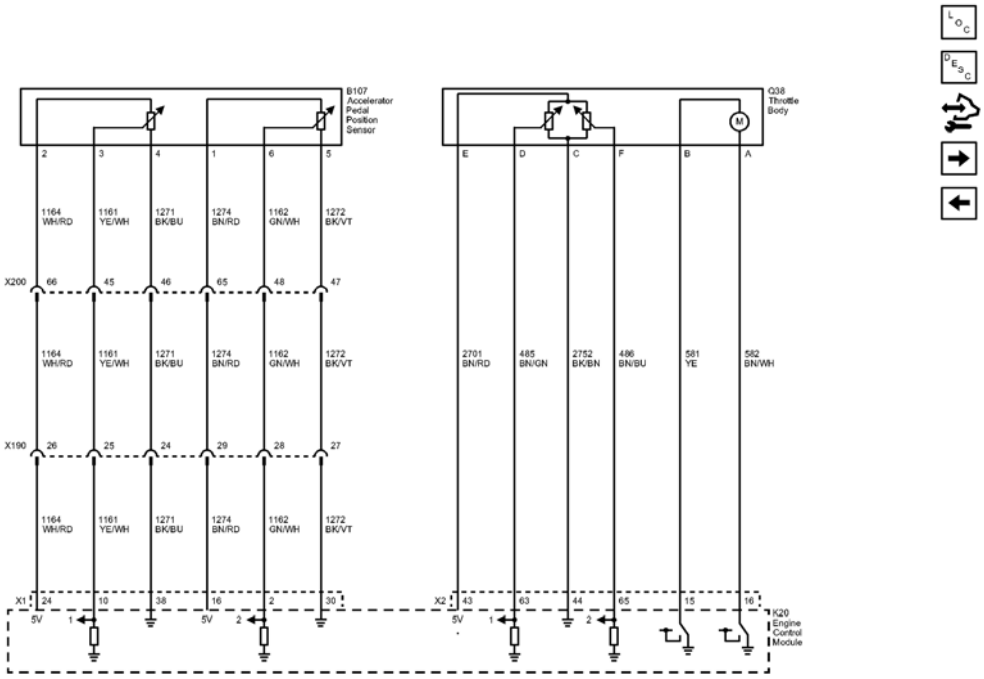


Fig. 5: Engine Data Sensors - Throttle Controls Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1164	Accelerator Pedal Position 5 Volt Reference (1)
1164 WH/RD	1164 WH/RD
CAV_24	24
CONN_X1	X1
CAV_2	2
1161	Accelerator Pedal Position Signal (1)
1161_YE/WH	1161 YE/WH
CAV_10	10
CAV_3	3
1271	Accelerator Pedal Position Low Reference (1)
1271_BK/BU	1271 BK/BU
CAV_38	38
CAV_4	4
1274	Accelerator Pedal Position 5 Volt Reference (2)
1274_BN/RD	1274 BN/RD
CAV_16	16
CAV_1	1

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1162	Accelerator Pedal Position Signal (2)
1162_GN/WH	1162 GN/WH
CAV_2	2
CAV_6	6
1272	Accelerator Pedal Position Low Reference (2)
1272_BK/VT	1272 BK/VT
CAV_30	30
CAV_5	5
2701	Throttle Position Sensor 5 Volt Reference
2701_BN/RD	2701 BN/RD
CAV_43	43
CONN_X2	X2
CAV_E	E
485	Throttle Position Sensor Signal (1)
485_BN/GN	485 BN/GN
CAV_63	63
CAV_D	D
2752	Throttle Position Sensor Low Reference
2752_BK/BN	2752 BK/BN
CAV_44	44
CAV_C	C
486	Throttle Position Sensor Signal (2)
486_BN/BU	486 BN/BU
CAV_65	65
CAV_F	F
581	Throttle Actuator Control Open
581_YE	581 YE
CAV_15	15
CAV_B	B
582	Throttle Actuator Control Close
582_BN/WH	582 BN/WH
CAV_16	16
CAV_A	A
1164_WH/RD	1164 WH/RD
1161_YE/WH	1161 YE/WH
1271_BK/BU	1271 BK/BU
1274_BN/RD	1274 BN/RD
1162_GN/WH	1162 GN/WH
1272_BK/VT	1272 BK/VT
1164_WH/RD	1164 WH/RD
1161_YE/WH	1161 YE/WH
1271_BK/BU	

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	1271 BK/BU
1274_BN/RD	1274 BN/RD
1162_GN/WH	1162 GN/WH
1272_BK/VT	1272 BK/VT
X200	X200
CAV_66	66
CAV_45	45
CAV_46	46
CAV_65	65
CAV_48	48
CAV_47	47
X190	X190
CAV 26	26
CAV_25	25
CAV_24	24
CAV_29	29
CAV_28	28
CAV_27	27
X200	X200
X190	X190
B107	
Q38	
K20	

Oxygen Sensors and Ignition System Wiring Schematics

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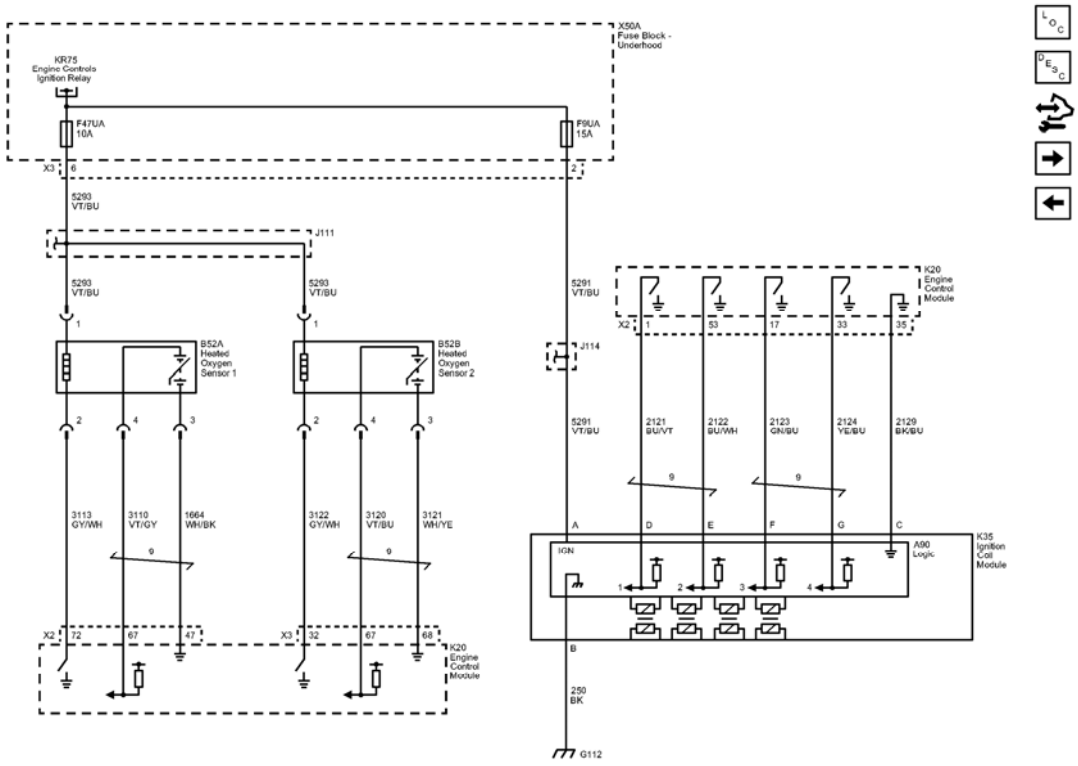


Fig. 6: Oxygen Sensors and Ignition System Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
5293	Powertrain Main Relay Fused Supply (4)
5293 VT/BU	5293 VT/BU
CAV_6	6
CONN_X3	X3
5293_VT/BU	5293 VT/BU
CAV_1	1
5293_VT/BU	5293 VT/BU
CAV_1	1
3113	Heated Oxygen Sensor Heater Low Control Bank 1 Sensor (1)
3113_GY/WH	3113 GY/WH
CAV 72	72
CONN_X2	X2
3110	Heated Oxygen Sensor High Signal Bank 1 Sensor (1)
3110_VT/GY	3110 VT/GY
CAV_67	67

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1664	Heated Oxygen Sensor Low Signal Bank 1 Sensor (1)
1664_WH/BK	1664 WH/BK
CAV_47	47
CAV_2	2
CAV_4	4
CAV_3	3
3122	Heated Oxygen Sensor Heater Low Control Bank 1 Sensor (2)
3122_GY/WH	3122 GY/WH
CAV_32	32
CONN_X3	X3
3120	Heated Oxygen Sensor High Signal Bank 1 Sensor (2)
3120 VT/BU	3120 VT/BU
CAV_67	67
3121	Heated Oxygen Sensor Low Signal Bank 1 Sensor (2)
3121_WH/YE	3121 WH/YE
CAV_47	47
CAV_2	2
CAV_4	4
CAV_3	3
5291	Powertrain Main Relay Fused Supply (2)
5291_VT/BU	5291 VT/BU
CAV_A	A
CAV_2	2
5291_VT/BU	5291 VT/BU
2121	Ignition Control (1)
2121_BU/VT	2121 BU/VT
CAV D	D
CAV_1	1
CONN_X2	X2
2122	Ignition Control (2)
2122_BU/WH	2122 BU/WH
CAV_E	E
CAV_53	53
2123	Ignition Control (3)
2123_GN/BU	2123 GN/BU
CAV_F	F
CAV_17	17
2124	Ignition Control (4)
2124_YE/BU	2124 YE/BU

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CAV_G	G
CAV_33	33
2129	Ignition Control Low Reference Bank 1
2129_BK/BU	2129 BK/BU
CAV_C	C
CAV_35	35
250	Ground
250_BK	250 BK
CAV_B	B
G112	G112
F47UA	F47UA 10A
F9UA	F9UA 15A
TWIST 9	9
TWIST_9	9
TWIST_9	9
TWIST_9	9
B52A	
B52B	
K20	
K20	
X50A	
A90	Logic
K35	
KR75	

Camshaft, Crankshaft, and Knock Sensors, Camshaft Actuators Wiring Schematics

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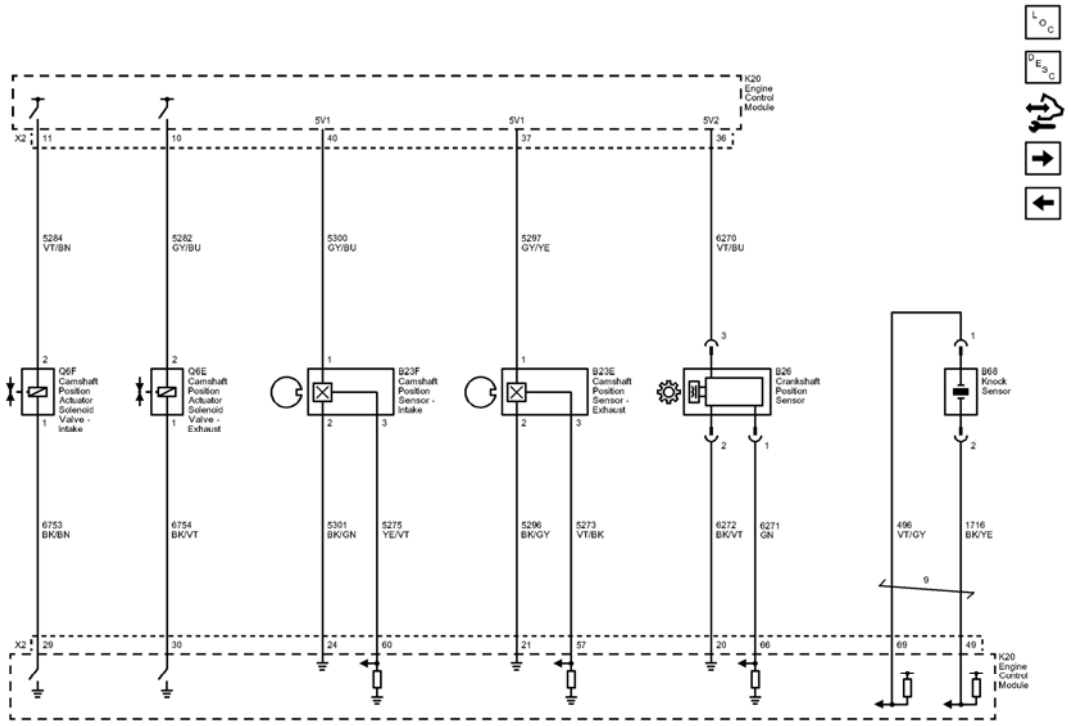


Fig. 7: Camshaft, Crankshaft, and Knock Sensors, Camshaft Actuators Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
5284	Camshaft Phaser Intake Solenoid (1)
5284 VT/BN	5284 VT/BN
CAV_2	2
CAV_11	11
CONN_X2	X2
5282	Camshaft Phaser Exhaust Solenoid (1)
5282_GY/BU	5282 GY/BU
CAV_2	2
CAV_10	10
5300	Camshaft Position Intake Sensor Supply Voltage (1)
5300_GY/BU	5300 GY/BU
CAV_1	1
CAV_40	40
5297	Camshaft Position Exhaust Sensor Supply Voltage (1)
5297_GY/YE	5297 GY/YE
CAV_1	1
CAV_37	37

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6270	Crankshaft 60X Sensor Voltage
6270_VT/BU	6270 VT/BU
CAV_36	36
6753	Cam Phaser W Return Low Reference
6753_BK/BN	6753 BK/BN
CAV_29	29
CONN_X2	X2
CAV_1	1
6754	Cam Phaser X Return Low Reference
6754_BK/VT	6754 BK/VT
CAV_30	30
CAV_1	1
5301	Camshaft Position Intake Sensor Low Reference (1)
5301_BK/GN	5301 BK/GN
CAV_24	24
CAV_2	2
5275	Camshaft Position Intake Sensor (1)
5275_YE/VT	5275 YE/VT
CAV_60	60
CAV_3	3
5296	Camshaft Position Exhaust Sensor Low Reference (1)
5296_BK/GY	5296 BK/GY
CAV_21	21
CAV_2	2
5273	Camshaft Position Exhaust Sensor (1)
5273_VT/BK	5273 VT/BK
CAV_57	57
CAV 3	3
6272	Crankshaft 60X Sensor Low Reference
6272 BK/VT	6272 BK/VT
CAV_20	20
6271	Crankshaft 60X Sensor Signal
6271_GN	6271 GN
CAV_66	66
496	Knock Sensor Signal (1)
496_VT/GY	496 VT/GY
CAV_69	69
1716	Knock Sensor Low Reference (1)
1716_BK/YE	1716 BK/YE
CAV_49	49
CAV_2	2

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	1
CAV_1	1
CAV_2	2
CAV_3	3
TWIST_9	9
K20	
B23F	
B23E	
B26	
Q6F	
Q6E	
B68	
K20	

Fuel Controls - Fuel Injectors and Evaporative Controls Wiring Schematics

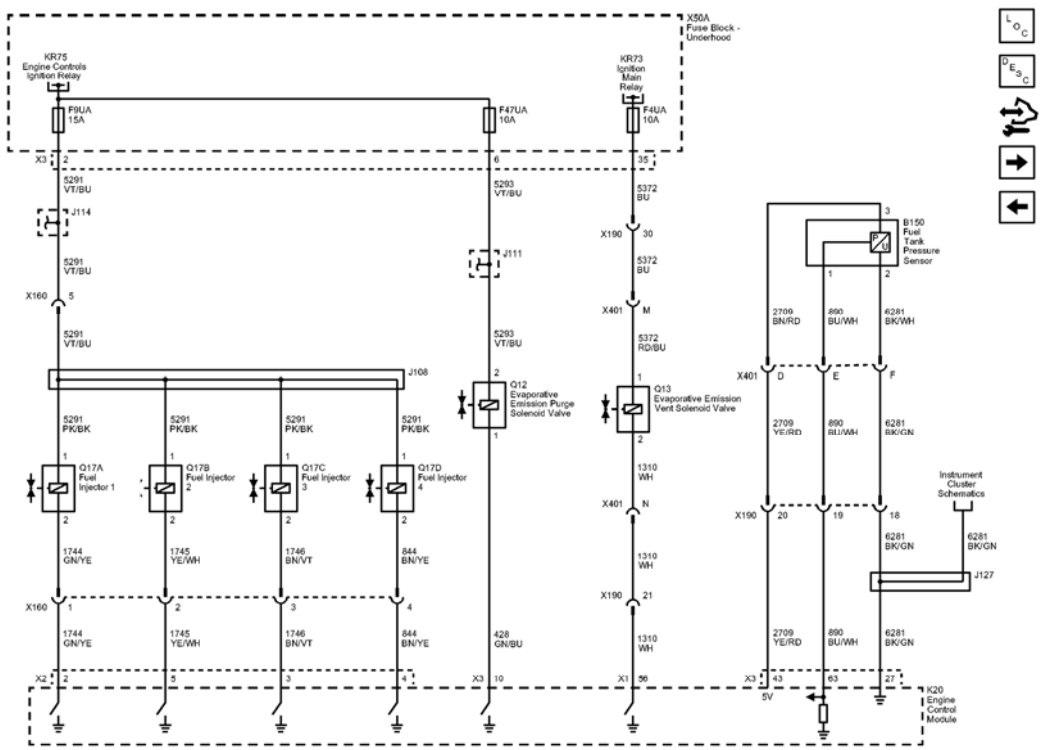


Fig. 8: Fuel Controls - Fuel Injectors and Evaporative Controls Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
5291	Powertrain Main Relay Fused

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	Supply (2)
5291_VT/BU	5291 VT/BU
CAV_2	2
CONN_X3	X3
5291_PK/BK	5291 PK/BK
CAV_1	1
5291_PK/BK	5291 PK/BK
CAV_1	1
5291_PK/BK	5291 PK/BK
CAV_1	1
5291_PK/BK	5291 PK/BK
CAV_1	1
5293	Powertrain Main Relay Fused Supply (4)
5293_VT/BU	5293 VT/BU
CAV_2	2
CAV_6	6
5372	Canister Valve Solenoid
5372 BU	5372 BU
CAV_35	35
5372 RD/BU	5372 RD/BU
CAV_1	1
1310	EVAP Canister Vent Solenoid Control
1310_WH	1310 WH
CAV_56	56
CONN_X1	X1
CAV_2	2
428	EVAP Canister Purge Solenoid Control
428_GN/BU	428 GN/BU
CAV_10	10
CONN_X3	X3
CAV_1	1
844	Fuel Injector Control (4)
844_BN/YE	844 BN/YE
CAV 4	4
CAV_2	2
1746	Fuel Injector Control (3)
1746_BN/VT	1746 BN/VT
CAV_3	3
CAV_2	2

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1745	Fuel Injector Control (2)
1745_YE/WH	1745 YE/WH
CAV_5	5
CAV_2	2
1744	Fuel Injector Control (1)
1744_GN/YE	1744 GN/YE
CAV_2	2
CONN_X2	X2
CAV_2	2
2709	Fuel Tank Pressure Sensor 5 Volt Reference
2709_BN/RD	2709 BN/RD
CAV_3	3
2709_YE/RD	2709 YE/RD
CAV_43	43
CONN_X3	X3
890	Fuel Tank Pressure Sensor Signal
890_BU/WH	890 BU/WH
CAV_63	63
CAV_1	1
6281	Fuel Level Sensor Low Reference
6281_BK/WH	6281 BK/WH
CAV_2	2
6281_BK/GN	6281 BK/GN
CAV_27	27
6281_BK/GN	6281 BK/GN
890_BU/WH	890 BU/WH
890_BU/WH	890 BU/WH
2709_YE/RD	2709 YE/RD
6281_BK/GN	6281 BK/GN
6281_BK/GN	6281 BK/GN
CAV_21	21
CAV_N	N
1310_WH	1310 WH
1310 WH	1310 WH
844_BN/YE	844 BN/YE
1746_BN/VT	1746 BN/VT
1745_YE/WH	1745 YE/WH
1744_GN/YE	1744 GN/YE
5291_VT/BU	5291 VT/BU

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5291_VT/BU	5291 VT/BU
CAV_5	5
5372_BU	5372 BU
5293_VT/BU	5293 VT/BU
CAV_30	30
CAV_M	M
X401	X401
CAV_D	D
CAV_E	E
CAV_F	F
X190	X190
CAV_20	20
CAV_19	19
CAV_18	18
X160	X160
CAV_1	1
CAV_2	2
CAV_3	3
CAV_4	4
F9UA	F9UA 15A
F47UA	F47UA 10A
F4UA	F4UA 10A
X190	X190
X401	X401
X160	X160
X190	X190
X401	X401
J108	J108
J127	J127
X401	X401
X190	X190
X160	X160
Q17A	
Q17B	
Q17C	
Q17D	
Q12	
KR73	
B150	
Instrument_Cluster_Schematics_REF	Instrument Cluster Schematics
K20	

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KR75	
Q13	

Fuel Controls - Fuel Pump Controls Wiring Schematics

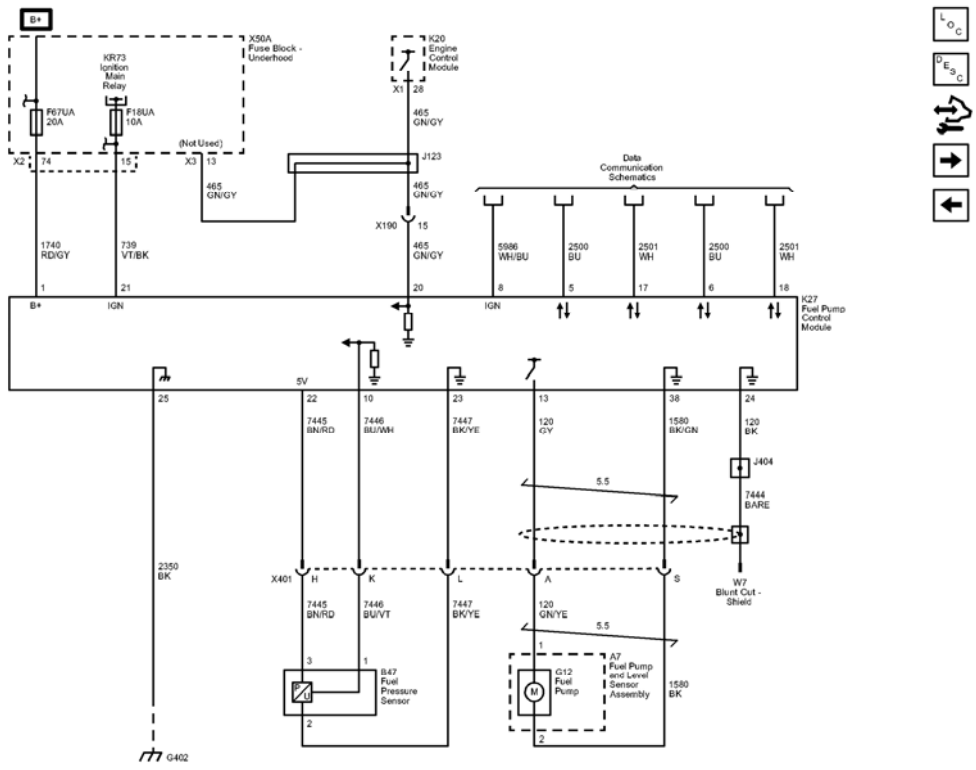


Fig. 9: Fuel Controls - Fuel Pump Controls Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1740	Battery Positive Voltage
1740_RD/GY	1740 RD/GY
CAV 1	1
CAV_74	74
CONN X2	X2
739	Run/Crank Ignition 1 Voltage
739_VT/BK	739 VT/BK
CAV_21	21
CAV_15	15
465	Fuel Pump Primary Relay Control

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465_GN/GY	465 GN/GY
CAV_13	13
CONN_X3	X3
465_GN/GY	465 GN/GY
CAV_20	20
CAV_28	28
CONN_X1	X1
5986	Serial Data Communication Enable
5986_WH/BU	5986 WH/BU
CAV_8	8
2500	High Speed GMLAN Serial Data (+) (1)
2500 BU	2500 BU
CAV_5	5
2501	High Speed GMLAN Serial Data (-) (1)
2501_WH	2501 WH
CAV_17	17
2500 BU	2500 BU
CAV_6	6
2501 WH	2501 WH
CAV_18	18
2350	Ground
2350_BK	2350 BK
CAV_25	25
7445	Fuel Line Pressure Sensor 5V Reference
7445_BN/RD	7445 BN/RD
CAV_3	3
CAV_22	22
7446	Fuel Line Pressure Sensor Signal
7446_BU/WH	7446 BU/WH
CAV_10	10
7446 BU/VT	7446 BU/VT
CAV_1	1
7447	Fuel Line Pressure Sensor Low Reference
7447_BK/YE	7447 BK/YE
CAV_2	2
CAV_23	23

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120	Fuel Pump Supply Voltage
120_GY	120 GY
CAV_13	13
120_GN/YE	120 GN/YE
CAV_1	1
1580	Fuel Pump Low Reference
1580_BK/GN	1580 BK/GN
CAV_38	38
1580_BK	1580 BK
CAV_2	2
120_BK	120 BK
CAV_24	24
7444	Fuel System Control Module Shield
7444_BARE	7444 BARE
7447_BK/YE	7447 BK/YE
7445_BN/RD	7445 BN/RD
465_GN/GY	465 GN/GY
CAV 15	15
465_GN/GY	465 GN/GY
X401	X401
CAV_H	H
CAV_K	K
CAV_L	L
CAV_A	A
CAV_S	S
G402	G402
F67UA	F67UA 20A
F18UA	F18UA 10A
J404	J404
X190	X190
TWIST_5.5	5.5
TWIST_5.5	5.5
J123	J123
X401	X401
KR73	
K20	
B47	
W7	
K27	
Data_Communication_Schematics_REF	Data Communication

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	Schematics
G12	
A7	
X50A	

Intake Tuning Valve, Secondary Air Injection (NU6) Wiring Schematics

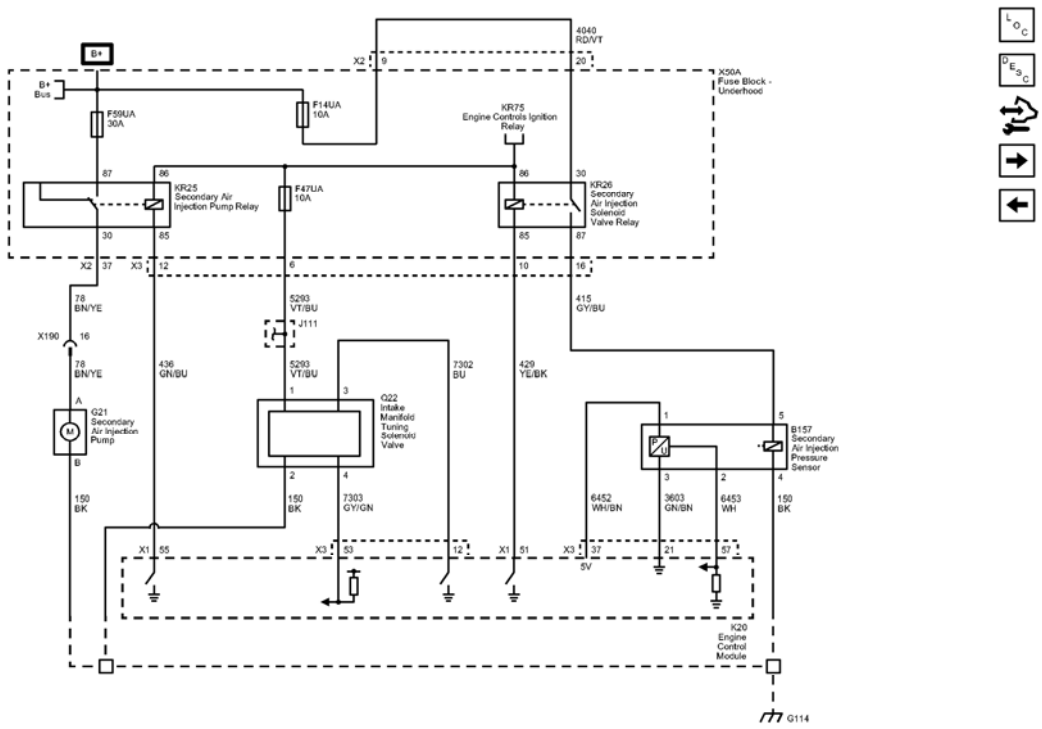


Fig. 10: Intake Tuning Valve, Secondary Air Injection (NU6) Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
4040	Battery Positive Voltage
4040 RD/VT	4040 RD/VT
CAV_9	9
CONN X2	X2
CAV_20	20
CAV_87	87
CAV_86	86
CAV_30	30
CAV_85	85
CAV_86	86

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CAV_30	30
CAV_85	85
CAV_87	87
78	Air Injection Reaction Pump Supply Voltage
CAV_A	A
CAV_37	37
CONN_X2	X2
78_BN/YE	78 BN/YE
78_BN/YE	78 BN/YE
CAV_16	16
5293	Powertrain Main Relay Fused Supply (4)
5293_VT/BU	5293 VT/BU
CAV 1	1
CAV_6	6
5293_VT/BU	5293 VT/BU
436	Air Injection Reaction Pump Relay Coil Control
436_GN/BU	436 GN/BU
CAV_55	55
CONN_X1	X1
CAV_12	12
CONN_X3	X3
7302	Intake Manifold Tuning Valve (IMTV) Control - Signal
7302_BU	7302 BU
CAV_12	12
CAV_3	3
429	Air Injection Reaction Solenoid Control
429_YE/BK	429 YE/BK
CAV_51	51
CONN_X1	X1
CAV_10	10
415	Air Injection Reaction Solenoid Supply Voltage
415_GY/BU	415 GY/BU
CAV_5	5
CAV_16	16
150	Ground
150_BK	150 BK
CAV_B	B
150_BK	150 BK
CAV_2	2
7303	Intake Manifold Tuning Valve (IMTV) Position -

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	Signal
7303_GY/GN	7303 GY/GN
CAV_53	53
CONN_X3	X3
CAV_4	4
6452	Air Injection Reaction Pump Sensor Supply Voltage
6452_WH/BN	6452 WH/BN
CAV_37	37
CONN_X3	X3
CAV_1	1
3603	Intake Manifold Control (3)
3603_GN/BN	3603 GN/BN
CAV 21	21
CAV_3	3
6453	Air Injection Reaction Pump Sensor Signal
6453_WH	6453 WH
CAV_57	57
CAV_2	2
150_BK	150 BK
CAV_4	4
G114	G114
F14UA	F14UA 10A
F59UA	F59UA 30A
F47UA	F47UA 10A
X190	X190
KR25	
K20	
X50A	
G21	
B157	
Q22	(LUW/LWE)
KR26	
KR75	

Controlled/Monitored Subsystem References Wiring Schematics

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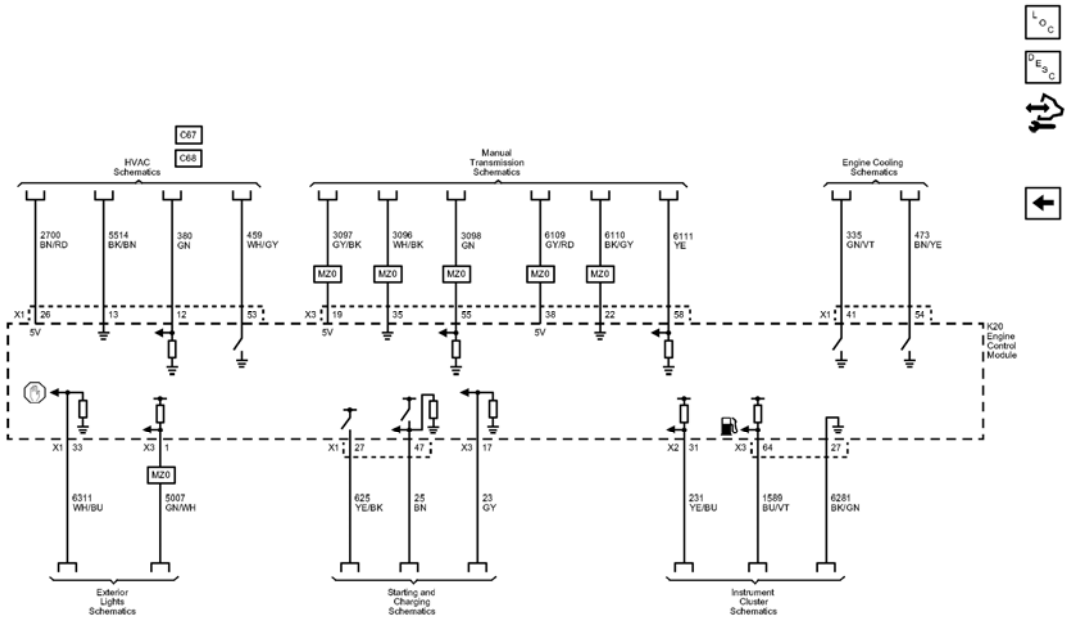


Fig. 11: Controlled/Monitored Subsystem References Wiring Schematics
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
2700	A/C Pressure Sensor 5 Volt Reference
2700_BN/RD	2700 BN/RD
CAV_26	26
CONN_X1	X1
5514	A/C Refrigerant Pressure Sensor Low Reference
5514_BK/BN	5514 BK/BN
CAV_13	13
380	A/C Refrigerant Pressure Sensor Signal
380_GN	380 GN
CAV_12	12
459	A/C Compressor Clutch Relay Control
459_WH/GY	459 WH/GY
CAV_53	53

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3097	Output Speed (Digital) 5V Sensor Return
3097_GY/BK	3097 GY/BK
CAV_19	19
CONN_X3	X3
3096	Output Speed (Digital) 5V Sensor Reference
3096_WH/BK	3096 WH/BK
CAV_35	35
3098	Output Speed (Digital) Signal
3098_GN	3098 GN
CAV_55	55
6109	Clutch Apply Sensor Voltage Reference
6109_GY/RD	6109 GY/RD
CAV_38	38
6110	Clutch Apply Sensor Low Reference
6110_BK/GY	6110 BK/GY
CAV_22	22
6111	Clutch Apply Sensor Signal
6111_YE	6111 YE
CAV_58	58
335	Low Speed Cooling Fan Relay Control
335_GN/VT	335 GN/VT
CAV_41	41
CONN_X1	X1
473	High Speed Cooling Fan Relay Control
473_BN/YE	473 BN/YE
CAV_54	54
6311	Cruise/ETC/TCC Brake Signal
6311_WH/BU	6311 WH/BU
CAV_33	33
CONN_X1	X1
5007	Reverse Switch Signal
5007_GN/WH	5007 GN/WH
CAV_1	1
CONN_X3	X3
625	Starter Enable Relay Control
625_YE/BK	625 YE/BK

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CAV_27	27
CONN_X1	X1
25	Charge Indicator Control
25_BN	25 BN
CAV_47	47
23	Generator Field Duty Cycle Signal
23_GY	23 GY
CAV_17	17
CONN_X3	X3
231	Oil Pressure Switch Signal
231_YE/BU	231 YE/BU
CAV_31	31
CONN_X2	X2
1589	Primary Fuel Level Sensor Signal
1589_BU/VT	1589 BU/VT
CAV_64	64
CONN_X3	X3
6281	Fuel Level Sensor Low Reference
6281 BK/GN	6281 BK/GN
CAV_27	27
MZ0	TRANSMISSION-MAN 6 SPD, OPEL, 76.5 MM, 3.82 1ST, 0.74 6TH, (M32 WR)
MZ0	TRANSMISSION-MAN 6 SPD, OPEL, 76.5 MM, 3.82 1ST, 0.74 6TH, (M32 WR)
MZ0	TRANSMISSION-MAN 6 SPD, OPEL, 76.5 MM, 3.82 1ST, 0.74 6TH, (M32 WR)
MZ0	TRANSMISSION-MAN 6 SPD, OPEL, 76.5 MM, 3.82 1ST, 0.74 6TH, (M32 WR)
MZ0	TRANSMISSION-MAN 6 SPD, OPEL, 76.5 MM, 3.82 1ST, 0.74 6TH, (M32 WR)
MZ0	TRANSMISSION-MAN 6 SPD, OPEL, 76.5 MM, 3.82 1ST, 0.74 6TH, (M32 WR)
C67	HVAC SYSTEM-AIR CONDITIONER FRT, ELECTRONIC CONTROLS

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C68	HVAC SYSTEM-AIR CONDITIONER FRT, AUTO, ELECTRONIC CONTROLS
K20	
Engine_Cooling_Schematics_REF	Engine Cooling Schematics
HVAC_Schematics_REF	HVAC Schematics
Instrument_Cluster_Schematics_REF	Instrument Cluster Schematics
Starting_and_Charging_Schematics_REF	Starting and Charging Schematics
Exterior_Lights_Schematics_REF	Exterior Lights Schematics
Manual_Transmission_Schematics_REF	Manual Transmission Schematics

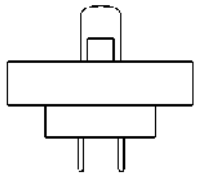
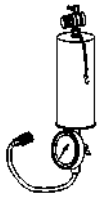
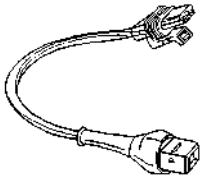
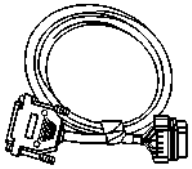
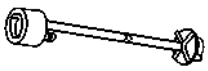
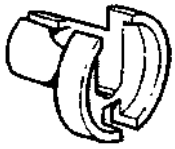
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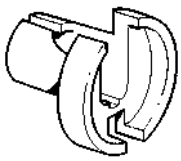
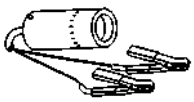
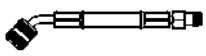
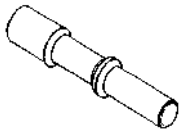
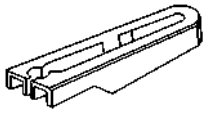
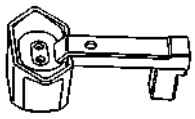
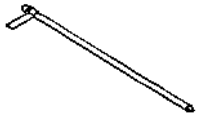
Engine Controls and Fuel - 1.8L LUW and LWE - Special Tools and Equipment - Special Tools - Cruze

SPECIAL TOOLS AND EQUIPMENT

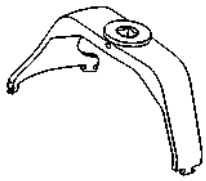
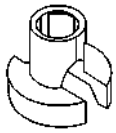
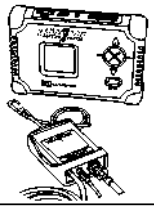
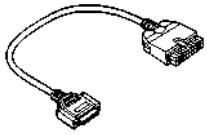
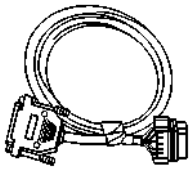
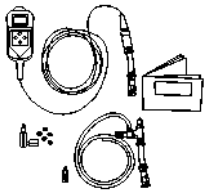
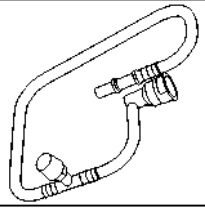
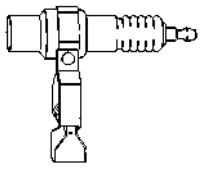
SPECIAL TOOLS

Illustration	Tool Number/Description
	CH-34730-2C J-34730-2C Injector Test Lamp
	CH-35800-A J-35800-A Fuel Injector Cleaner
	CH-39021-380 J-39021-380 Fuel Injector Harness Adapter
	CH-39021-450 J-39021-450 Fuel Injector Harness Adapter
	CH-41415-30 J-41415-30 Fuel Tank Cap Adapter South America - Use Local Equivalent
	CH-41769-1 Fuel Line Quick Connect Separator 3/8

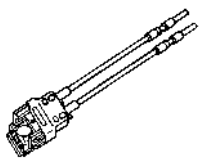
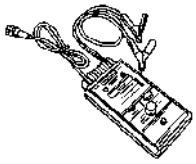
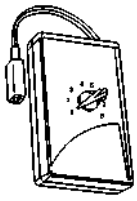
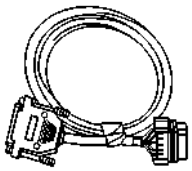
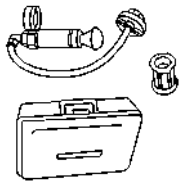
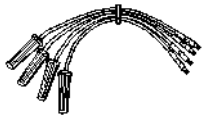
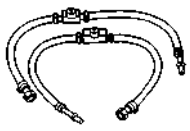
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	CH-41769-2 Fuel Line Quick Connect Separator 5/16
	CH-42220 J-42220 Universal 12 Volt Leak Detection Lamp
	CH-42242 J-42242 Fuel Pressure Gauge Adapter
	CH-42960-2 J-42960-2 Fuel Flapper Door Holder
	CH-42982 J-42982 Fuel Pressure Gauge Adapter
	CH-43178 J-43178 Fuel Line Disconnect Tool
	CH-44175 J-44175 Fuel Composition Testers South America - Use Local Equivalent
	CH-45004 J-45004 Fuel Tank Drain Hose South America- Use Local Equivalent

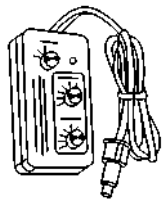
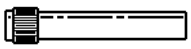
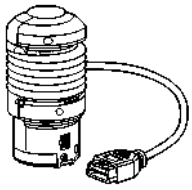
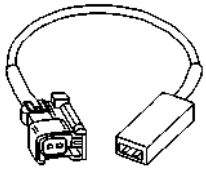
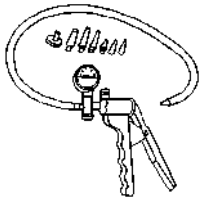
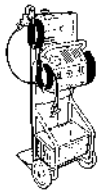
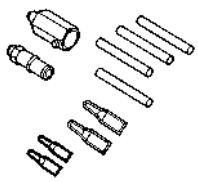
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	CH-45722 J-45722 Fuel Sender Lock Ring Wrench
	CH-47831 Fuel Line Disconnect Tool
	CH-47976 Active Fuel Injector Tester (AFIT)
	CH-47976-60 AFIT Harness Adapter
	CH-47976-75 Fuel Injector Harness Adapter
	CH-48027 Digital Pressure gauge South America - Use Local Equivalent
	CH-48096 EVAP Service Access Port Tool
	EL-26792 J-26792 HEI Spark Tester South America - Use Local Equivalent

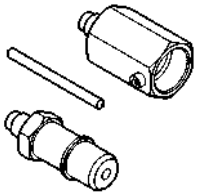
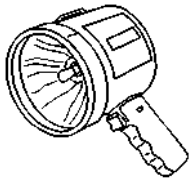
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	EL 36169-HD J 36169-HD Heavy Duty Fused Jumper
	EL-39021 J-39021 Fuel Injector Coil and Balancer Tester
	EL-39021-210 J-39021-210 Injector Tester Adapter Box
	EL-39021-460 J-39021-460 Fuel Injector Test Adapter
	EN-24460-A J-24460-A Cooling System Pressure Tester
	EN-36012-A J-36012-A Ignition System Diagnosis Harness
	EN-37287 J-37287 Fuel Line Shut-Off Adapters (Flex Fuel)
	EN-38522 J-38522 Variable Signal Generator

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	EN-41413-VLV J-41413-VLV EVAP Service Port Vent Fitting South America - Use Local Equivalent
	EN-42598-B J-42598-B Vehicle Data Recorder
	EN-44602 J-44602 Injector Test Adapter
	EN-47969 Fuel Supply Diagnostic Hose
	GE-23738-A J-23738-A Vacuum Pump
	GE-41413-A J-41413-A Evaporative Emissions System Tester (EEST) South America - Use Local Equivalent
	GE-41413-300 J-41413-300 EVAP Cap and Plug Kit South America - Use Local Equivalent

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	GE-41413-320 J-41413-320 EVAP Cap and Plug Kit South America - Use Local Equivalent
	GE-41413-SPT J-41413-SPT High Intensity White Light South America - Use Local Equivalent

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2013 ENGINE PERFORMANCE

Engine Controls and Fuel - 1.8L LUW and LWE - Specifications - Cruze

SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE (ECT)

Temperature Versus Resistance (ECT)

°C	°F	OHMS
Temperature vs Resistance Values (Approximate)		
140	284	50
126	258	75
116	240	100
108	226	120
99	210	160
92	197	200
84	183	250
78	172	300
69	156	400
63	145	500
58	136	600
51	123	750
47	116	900
39	102	1200
33	91	1500
29	84	1800
24	75	2250
19	66	2800
15	59	3500
9	48	4500
5	41	5500
1	33	7000
-6	+22	9500
-9	+16	12000
-14	+7	16000
-19	-2	21500
-24	-11	28500
-24	-11	31000
-27	-16	33000
-27	-16	35000
-28	-18	39000

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-30	-22	49000
-33	-27	60000
-37	-34	70000
-40	-40	93000

TEMPERATURE VERSUS RESISTANCE - INTAKE AIR TEMPERATURE SENSOR (BOSCH SENSOR)

Temperature Versus Resistance - Intake Air Temperature Sensor (Bosch Sensor)

Temperature C°/F°	Resistance Minimum Ohms	Resistance Maximum Ohms
Bosch Intake Air Temperature (IAT) Sensor		
-40/-40	36, 595	42, 717
-20/-4	12, 947	14, 744
-10/14	8, 082	9, 105
0/32	5, 191	5, 789
20/68	2, 309	2, 530
25/77	1, 913	2, 088
40/104	1, 122	1, 210
60/140	587	625
80/176	328	345
100/212	193	201
120/248	119	125
140/284	76	81

ALTITUDE VERSUS BAROMETRIC PRESSURE

Altitude Versus Barometric Pressure

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)	Barometric Pressure Measured in Pounds Per Square Inch (PSI)
Determine your altitude by contacting a local weather station or by using another reference source.			
4, 267	14, 000	56-64	8.1-9.3
3, 962	13, 000	58-66	8.4-9.6
3, 658	12, 000	61-69	8.8-10.0
3, 353	11, 000	64-72	9.3-10.4
3, 048	10, 000	66-74	9.6-10.7
2, 743	9, 000	69-77	10.0-11.2
2, 438	8, 000	71-79	10.3-11.5
2, 134	7, 000	74-82	10.7-11.9
1, 829	6, 000	77-85	11.2-12.3
1, 524	5, 000	80-88	11.6-12.8

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1, 219	4, 000	83-91	12.0-13.2
914	3, 000	87-95	12.6-13.8
610	2, 000	90-98	13.1-14.2
305	1, 000	94-102	13.6-14.8
0	0 Sea Level	96-104	13.9-15.1
-305	-1, 000	101-105	14.6-15.2

IGNITION SYSTEM SPECIFICATIONS

Ignition System Specifications

Application	Specification
Ignition Type	Ignition Coil Module
Firing Order	1-3-4-2
Spark Plug Torque	Refer to **Fastener Tightening Specifications**
Spark Plug Gap - All (Except LFH, LUW, and LWE)	0.8-0.9 mm (0.031-0.035 in)
Spark Plug Gap - LFH, LUW, and LWE	0.6-0.7 mm (0.024-0.028 in)
Spark Plug Type	Refer to Electronic Parts Catalogue

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Accelerator Pedal Position Sensor Fastener	10 N.m	89 lb in
Air Cleaner Housing Cover Bolt	5 N.m	44 lb in
Air Cleaner Inlet Duct Bolt	5 N.m	44 lb in
Air Cleaner Outlet Front Duct Clamp	3.5 N.m	31 lb in
Air Cleaner Outlet Rear Duct Clamp	3.5 N.m	31 lb in
Camshaft Position Sensor Bolt	6 N.m	53 lb in
Crankshaft Position Sensor Fastener	4.5 N.m	40 lb in
Engine Control Module Nut	9 N.m	80 lb in
Engine Coolant Fan Bolt	4 N.m	35 lb in
Engine Coolant Temperature Sensor Fastener	35 N.m	26 lb ft
Engine Oil Pressure Indicator Switch	20 N.m	15 lb ft
Evaporative Emission Canister Purge Solenoid Valve Bracket Bolt	8 N.m	71 lb in
Fuel Injection Fuel Rail Bolt	8 N.m	71 lb in
Fuel Pressure Sensor	20 N.m	14 lb ft
Fuel Tank Filler Hose Clamp	19 N.m	27 lb in
Fuel Tank Filler Pipe Bracket Bolt	9 N.m	80 lb in
Fuel Tank Filler Pipe Ground Bolt	9 N.m	80 lb in
Fuel Tank Strap Bolts	22 N.m	16 lb ft

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Heated Oxygen Sensor 1	42 N.m	31 lb ft
Heated Oxygen Sensor 2	42 N.m	31 lb ft
Ignition Coil Bolts	8 N.m	71 lb in
Intake Air Duct Bolt	5 N.m	44 lb in
Knock Sensor Bolt	20 N.m	15 lb ft
Manifold Absolute Pressure Sensor Bolt	6 N.m	53 lb in
Secondary Air Injection Check Valve Bolt	22 N.m	16 lb ft
Secondary Air Injection Pump Bolt	22 N.m	16 lb ft
Spark Plug	25 N.m	18 lb ft
Throttle Body Bolt	8 N.m	71 lb in

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2013 ENGINE PERFORMANCE

Engine Controls and Fuel - 1.8L LUW and LWE - Cruze

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC P0010, P0013, or P2088-P2091	DTC P0010 Intake Camshaft Position Actuator Solenoid Valve Control Circuit DTC P0013 Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit DTC P2088 Intake Camshaft Position Actuator Solenoid Control Circuit Low Voltage DTC P2089 Intake Camshaft Position Actuator Solenoid Control Circuit High Voltage DTC P2090 Exhaust Camshaft Position Actuator Solenoid Control Circuit Low Voltage DTC P2091 Exhaust Camshaft Position Actuator Solenoid Control Circuit High Voltage
DTC P0011 or P0014	DTC P0011 Intake Camshaft Position System Performance DTC P0014 Exhaust Camshaft Position System Performance
DTC P0016 or P0017	DTC P0016 Crankshaft Position - Intake Camshaft Position Not Plausible DTC P0017 Crankshaft Position - Exhaust Camshaft Position Not Plausible
DTC P0030-P0032, P0036-P0038, P0053, P0054, P0135, or P0141	DTC P0030 HO2S Heater Control Circuit Sensor 1 DTC P0031 HO2S Heater Control Circuit Low Voltage Sensor 1 DTC P0032 HO2S Heater Control Circuit High Voltage Sensor 1 DTC P0036 HO2S Heater Control Circuit Sensor 2 DTC P0037 HO2S Heater Control Circuit Low Voltage Sensor 2 DTC P0038 HO2S Heater Control Circuit High Voltage Sensor 2 DTC P0053 HO2S Heater Resistance Sensor 1 DTC P0054 HO2S Heater Resistance Sensor 2 DTC P0135 HO2S Heater Performance Sensor 1 DTC P0141 HO2S Heater Performance Sensor 2
DTC P0068 or P1101	DTC P0068 Throttle Body Air Flow Performance DTC P1101 Intake Air Flow System Performance
DTC P0096 or P0111	DTC P0096 Intake Air Temperature (IAT) Sensor 2 Performance

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	DTC P0111 Intake Air Temperature (IAT) Sensor 1 Performance
DTC P0097, P0098, or P0099	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
DTC P0101	DTC P0101 Mass Air Flow (MAF) Sensor Performance
DTC P0102 or P0103	DTC P0102 Mass Air Flow (MAF) Sensor Circuit Low Frequency DTC P0103 Mass Air Flow (MAF) Sensor Circuit High Frequency
DTC P0106	DTC P0106 Manifold Absolute Pressure (MAP) Sensor Performance
DTC P0107 or P0108	DTC P0107 Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage DTC P0108 Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage
DTC P0112, P0113, or P0114	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
DTC P0116 (LUW)	DTC P0116 Engine Coolant Temperature (ECT) Sensor Performance
DTC P0117, P0118, or P0119	DTC P0117 Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage DTC P0118 Engine Coolant Temperature (ECT) Sensor Circuit High Voltage DTC P0119 Engine Coolant Temperature (ECT) Sensor Circuit Intermittent
DTC P0121-P0123, P0222, P0223, or P2135	DTC P0121 Throttle Position Sensor 1 Performance DTC P0122 Throttle Position Sensor 1 Circuit Low Voltage DTC P0123 Throttle Position Sensor 1 Circuit High Voltage DTC P0222 Throttle Position Sensor 2 Circuit Low Voltage DTC P0223 Throttle Position Sensor 2 Circuit High Voltage DTC P2135 Throttle Position Sensors 1-2 Not Plausible
DTC P0128	DTC P0128 Engine Coolant Temperature (ECT)

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	Below Thermostat Regulating Temperature
DTC P0131, P0132, P0134, P0137, P0138, or P0140	DTC P0131 HO2S Circuit Low Voltage Sensor 1 DTC P0132 HO2S Circuit High Voltage Sensor 1 DTC P0134 HO2S Circuit Insufficient Activity Sensor 1 DTC P0137 HO2S Circuit Low Voltage Sensor 2 DTC P0138 HO2S Circuit High Voltage Sensor 2 DTC P0140 HO2S Circuit Insufficient Activity Sensor 2
DTC P0133, P013A, P013B, P013E, P013F, P015A, P015B, P2270, or P2271	DTC P0133 HO2S Slow Response Sensor 1 DTC P013A HO2S Slow Response Rich to Lean Sensor 2 DTC P013B HO2S Slow Response Lean to Rich Sensor 2 DTC P013E HO2S Delayed Response Rich to Lean Sensor 2 DTC P013F HO2S Delayed Response Lean to Rich Sensor 2 DTC P015A HO2S Delayed Response Rich to Lean Sensor 1 DTC P015B HO2S Delayed Response Lean to Rich Sensor 1 DTC P2270 HO2S Signal Stuck Lean Sensor 2 DTC P2271 HO2S Signal Stuck Rich Sensor 2
DTC P0171 or P0172	DTC P0171 Fuel Trim System Lean DTC P0172 Fuel Trim System Rich
DTC P018B-P018D	DTC P018B Fuel Pressure Sensor Performance DTC P018C Fuel Pressure Sensor Circuit Low Voltage DTC P018D Fuel Pressure Sensor Circuit High Voltage
DTC P0201, P0202, P0203, P0204, P0261, P0262, P0264, P0265, P0267, P0268, P0270, or P0271	DTC P0201 Cylinder 1 Injector Control Circuit DTC P0202 Cylinder 2 Injector Control Circuit DTC P0203 Cylinder 3 Injector Control Circuit DTC P0204 Cylinder 4 Injector Control Circuit DTC P0261 Cylinder 1 Injector Control Circuit Low Voltage DTC P0262 Cylinder 1 Injector Control Circuit High Voltage DTC P0264 Cylinder 2 Injector Control Circuit Low Voltage DTC P0265 Cylinder 2 Injector Control Circuit High Voltage DTC P0267 Cylinder 3 Injector Control Circuit Low Voltage DTC P0268 Cylinder 3 Injector Control Circuit High Voltage

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	DTC P0270 Cylinder 4 Injector Control Circuit Low Voltage DTC P0271 Cylinder 4 Injector Control Circuit High Voltage
DTC P0231, P0232, or P023F	DTC P0231 Fuel Pump Control Circuit Low Voltage DTC P0232 Fuel Pump Control Circuit High Voltage DTC P023F Fuel Pump Control Circuit
DTC P025A	DTC P025A Fuel Pump Control Module Enable Circuit
DTC P0300-P0304 or P0313	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 P0315 (LUW)	DTC P0315 Crankshaft Position System Variation Not Learned
DTC P0324, P0326, or P06B6	DTC P0324 Knock Sensor (KS) System Performance DTC P0326 Knock Sensor (KS) Performance DTC P06B6 Control Module Knock Sensor Processor 1 Performance
DTC P0325, P0327, or P0328	DTC P0325 Knock Sensor Circuit DTC P0327 Knock Sensor Circuit Low Voltage DTC P0328 Knock Sensor Circuit High Voltage
DTC P0335 or P0336	DTC P0335 Crankshaft Position Sensor Circuit DTC P0336 Crankshaft Position Sensor Performance
DTC P0340, P0341, P0365, or P0366	DTC P0340 Intake Camshaft Position Sensor Circuit DTC P0341 Intake Camshaft Position Sensor Performance DTC P0365 Exhaust Camshaft Position Sensor Circuit DTC P0366 Exhaust Camshaft Position Sensor Performance
DTC P0351-P0354	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 P0411	DTC P0411 Secondary Air Injection System Incorrect Air Flow Detected
DTC P0412 or P0418	DTC P0412 Secondary Air Injection Valve Control Circuit DTC P0418 Secondary Air Injection Pump Control

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	Circuit
DTC P0420	DTC P0420 Catalyst System Low Efficiency
DTC P0442	DTC P0442 Evaporative Emission (EVAP) System Small Leak Detected
DTC P0443	DTC P0443 Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit
DTC P0446	DTC P0446 Evaporative Emission (EVAP) Vent System Performance
DTC P0449	DTC P0449 Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit
DTC P0451-P0454	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
DTC P0455	DTC P0455 Evaporative Emission (EVAP) System Large Leak Detected
DTC P0496	DTC P0496 Evaporative Emission (EVAP) System Flow During Non-Purge
DTC P0506 or P0507	DTC P0506 Idle Speed Low DTC P0507 Idle Speed High
DTC P0601-P0604, P0606, or P062F (Fuel Pump Control Module)	DTC P0601 Control Module Read Only Memory Performance DTC P0602 Control Module Not Programmed DTC P0603 Control Module Long Term Memory Reset DTC P0604 Control Module Random Access Memory Performance DTC P0606 Control Module Processor Performance DTC P062F Control Module Long Term Memory Performance
DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)	DTC P0601 Control Module Read Only Memory Performance DTC P0602 Control Module Not Programmed DTC P0603 Control Module Long Term Memory Reset DTC P0604 Control Module Random Access Memory Performance DTC P0606 Control Module Processor Performance DTC P062F Control Module Long Term Memory Performance DTC P0630 VIN Not Programmed or Mismatched - Engine Control Module (ECM)

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	DTC P16F3 Control Module Redundant Memory Performance DTC P262B Control Module Power Off Timer Performance
DTC P0627-P0629	DTC P0627 Fuel Pump Enable Circuit DTC P0628 Fuel Pump Enable Circuit Low Voltage DTC P0629 Fuel Pump Enable Circuit High Voltage
DTC P0641 or P06A6 (Fuel Pump Control Module)	DTC P0641 5 V Reference Circuit DTC P06A6 5 V Reference 1 Performance
DTC P0641, P0651, P0697, or P06A3 (ECM)	DTC P0641 5V Reference 1 Circuit DTC P0651 5V Reference 2 Circuit DTC P0697 5V Reference 3 Circuit DTC P06A3 5V Reference 4 Circuit
DTC P0650, P263A, or P263B	DTC P0650 Malfunction Indicator Lamp (MIL) Control Circuit Open DTC P263A Malfunction Indicator Lamp (MIL) Control Circuit Low Voltage DTC P263B Malfunction Indicator Lamp (MIL) Control Circuit High Voltage
DTC P0660, P0661, or P0662	DTC P0660 Intake Manifold Tuning Control Valve Control Circuit DTC P0661 Intake Manifold Tuning Control Valve Control Circuit Low Voltage DTC P0662 Intake Manifold Tuning Control Valve Control Circuit High Voltage
DTC P0685-P0687, P0689, P0690, or P1682	DTC P0685 Engine Controls Ignition Relay Control Circuit DTC P0686 Engine Controls Ignition Relay Control Circuit Low Voltage DTC P0687 Engine Controls Ignition Relay Control Circuit High Voltage DTC P0689 Engine Controls Ignition Relay Feedback Circuit Low Voltage DTC P0690 Engine Controls Ignition Relay Feedback Circuit High Voltage DTC P1682 Ignition 1 Switch Circuit 2
DTC P069E	DTC P069E Fuel Pump Control Module Requested MIL Illumination
DTC P0700	DTC P0700 Transmission Control Module Requested MIL Illumination
DTC P11C2-P11C4	DTC P11C2 Intake Air Humidity Sensor Circuit Low Voltage DTC P11C3 Intake Air Humidity Sensor Circuit High Voltage DTC P11C4 Intake Air Humidity Sensor Circuit

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	Erratic
DTC P1255 or P064A	DTC P064A Fuel Pump Control Module Performance DTC P1255 Fuel Pump Control Module Driver High Temperature
DTC P1400	DTC P1400 Cold Start Emission Reduction Control System
DTC P150C	DTC P150C Transmission Control Module Engine Speed Request Signal Message Counter Incorrect
DTC P1516, P2101, P2119, or P2176	DTC P1516 Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance DTC P2101 Throttle Actuator Position Performance DTC P2119 Throttle Closed Position Performance DTC P2176 Minimum Throttle Position Not Learned
DTC P2070 or P2071	DTC P2070 Intake Manifold Tuning Control Valve Stuck Open DTC P2071 Intake Manifold Tuning Control Valve Stuck Closed
DTC P2076	DTC P2076 Intake Manifold Tuning Control Valve Position Sensor Performance
DTC P2077 or P2078	DTC P2077 Intake Manifold Tuning Control Valve Position Sensor Circuit Low Voltage DTC P2078 Intake Manifold Tuning Control Valve Position Sensor Circuit High Voltage
DTC P2096	DTC P2096 Post Catalyst Fuel Trim System Low Limit
DTC P2097	DTC P2097 Post Catalyst Fuel Trim System High Limit
DTC P2122, P2123, P2127, P2128, or P2138	DTC P2122 Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage DTC P2123 Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage DTC P2127 Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage DTC P2128 Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage DTC P2138 Accelerator Pedal Position (APP) Sensors 1-2 Not Plausible
DTC P2199	DTC P2199 Intake Air Temperature (IAT) Sensor 1-2 Correlation
DTC P219A	DTC P219A Fuel Trim Cylinder Balance
	DTC P2227 Barometric Pressure (BARO) Sensor Performance DTC P2228 Barometric Pressure (BARO) Sensor Circuit Low Voltage

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DTC P2227-P2230	DTC P2229 Barometric Pressure (BARO) Sensor Circuit High Voltage DTC P2230 Barometric Pressure (BARO) Sensor Circuit Erratic
DTC P2430 or P2431	DTC P2430 Secondary Air Injection System Pressure Sensor Circuit DTC P2431 Secondary Air Injection System Pressure Sensor Performance
DTC P2432 or P2433	DTC P2432 Secondary Air Injection System Pressure Sensor Circuit Low Voltage DTC P2433 Secondary Air Injection System Pressure Sensor Circuit High Voltage
DTC P2440	DTC P2440 Secondary Air Injection System Cut-Off Valve Stuck Open
DTC P2444	DTC P2444 Secondary Air Injection System Pump Stuck On
DTC P2534 (Fuel Pump Control Module)	DTC P2534 Ignition On/Start Switch Circuit Low Voltage
DTC P2544	DTC P2544 Transmission Torque Request Signal Message Counter Incorrect
DTC P2635 (Fuel Pump Control Module)	DTC P2635 Fuel Pump Flow Performance

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